McLaren
APPLIED TECHNOLOGIES

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McLaren Applied Technologies makes control and data systems. High performance electronics, software and components. Everything we make is designed and built to be safe, secure and reliable.

We supply the standard Engine Control Units (ECUs) to all competitors in Formula One (since 2008), NASCAR (since 2012) and IndyCar (since 2007). These are the biggest motor racing series in the world with hundreds of millions of people watching most weekends throughout the year between February and November. We also supply the complete electric powertrain to the Formula E racing series and systems and products to teams and engine makers competing at Le Mans, rally car, GT and other endurance racing categories.

Beyond motor racing, we supply safety critical control systems to the automotive and aerospace industries and real-time video and data systems for railways. We also provide alternators and specialised sensors for several aerospace applications.

The company is based in Woking, United Kingdom and in Huntersville, NC, USA.

Control

We make the TAG-320 and TAG-310 control units for Formula One and LMP1 endurance racing and the TAG-400 units for NASCAR, IndyCar, GT racing and various automotive pre-development projects. We also have a range of automotive control platforms. All support model-based application code, a feature pioneered and exploited in Formula One since the start of the 2000 racing series. It enables rapid, reliable and re-usable software development.

Data logging

Our High-Speed Loggers (HSLs) are used by racing and other customers. These loggers support truly simultaneous logging of many parameters and complex onboard processing, via the same model-based application approach that we use in our ECUs. We also provide a range of CAN-linked companion units to expand the systems even further. In addition to these parts, we also have a range of other data logging units for transport and specialist instrumentation applications.

Software

We provide software for real-time recording, displaying and analysing data (ATLAS), logging and analyzing complex data (vTAG), and efficiently storing and retrieving time-series and other data (SQL Race). We also offer our System Monitor for managing the software and configuration of embedded units and our Graphical Development Environment (GDE) for supporting model-based application code development in ECUs and data loggers.

Sensors

We offer a complete and diverse range of motorsport sensors. These include non-contact position, speed and temperature sensors, torque sensors, accelerometers, pressure sensors and modules and many others. We offer standard and bespoke parts to fit individual installations in small, medium and large quantities. All parts are built to be small, accurate, consistent and reliable.

Alternators

We make high output alternators for motorsport and aerospace applications. These are used in NASCAR, Le Mans Prototypes, GT, rally and other racing applications. Our alternators are selected when size, weight, robustness and reliability really matter.

The standard products represent only a portion of the parts that we design, make and sell. We are always happy to consider making bespoke variants or brand new electronics, software and components for existing or new market sectors.

Electronics

Electronic Control Units

Compatability Matrix

The reference table below details the compatibility of the main MAT electronic units with our main expansion units. I/O information including details of interfaces with sensors and lap triggers can be found within the individual product summaries.

Please contact our Technical Consultancy department for details about compatibility with other MAT units and third-party units.

TAG-320

Comms Support		Expansion Unit Support	
Function	**Link**	**Function**	**Link**
System Monitor	Ethernet	SIU-400	CAN
ATLAS	Ethernet	SIU-300	CAN
CBT-610	ARCNET	LIU-4	CAN
CBM-470 & WMX-470	ARCNET	PIN-3	CAN
CBX-460	CAN	PIN-8	CAN
		PIN-16	CAN
		TIU-32C	CAN
		TPR	CAN
		PCU-6D	CAN
		PCU-8D	PCU
		PCU-8	CAN
		HIU-3	CAN+HSD
		SN-32 via config CAN	CAN
		SN-32LT via config CAN	CAN
		SN-320 via config CAN/ FLEXRAY	CAN/FLEXRAY
		PB2006	CAN+DIG
		IGN-310	CAN+DIG
		INJ-310	CAN+DIG
		INJ-320	CAN+DIG
		ICU-308	CAN+TRIGGER

TAG-310B

Comms Support		Expansion Unit Support	
Function	**Link**	**Function**	**Link**
System Monitor	Ethernet	SIU-400	CAN
ATLAS	Ethernet	SIU-300	CAN
CBT-610	ARCNET	LIU-4	CAN
CBM-470 & WMX-470	CAN	PIN-3	CAN
CBX-460	CAN	PIN-8	CAN
		PIN-16	CAN
		TIU-32C	CAN
		TPR	CAN
		PCU-6D	CAN
		PCU-8D	PCU
		PCU-8	CAN

Comms Support		Expansion Unit Support	
Function	**Link**	**Function**	**Link**
		HIU-3	CAN/HSD
		SN-32	SBUS
		SN-32 via config CAN	CAN
		SN-32LT	SBUS
		SN-320 via config CAN	CAN
		PB2006	CAN+DIG
		IGN-310	CAN+DIG
		INJ-310	CAN+DIG
		INJ-320	CAN+DIG
		ICU-308	CAN+TRIGGER

TAG-400i

Comms Support		Expansion Unit Support	
Function	**Link**	**Function**	**Link**
System Monitor	Ethernet	SIU-400	CAN
ATLAS	Ethernet	SIU-300 via config CAN	CAN
CBT-610	RS232	SN-32 via config CAN	CAN
CBM-470 & WMX-470	CAN	SN-320 via config CAN	CAN
CBX-460	CAN	LIU-4	CAN
		PIN-3 via config CAN	CAN
		PIN-8 via config CAN	CAN
		PIN-16 via config CAN	CAN
		TIU-32C (two)	CAN
		TPR via config CAN	CAN
		PCU-6D	CAN
		PCU-8D	PCU
		PCU-8	CAN
		DataTAG	CAN
		INJ-310	CAN+DIG
		INJ-320	CAN+DIG

TAG-400 ECU

Comms Support		Expansion Unit Support	
Function	**Link**	**Function**	**Link**
System Monitor	Ethernet	SIU-400	CAN
ATLAS	Ethernet	SIU-300 via config CAN	CAN
CBT-610	RS232	SN-32 via config CAN	CAN
CBM-470 & WMX-470	CAN	SN-320 via config CAN	CAN
CBX-460	CAN	LIU-4	CAN
		PIN-3 via config CAN	CAN
		PIN-8 via config CAN	CAN
		PIN-16 via config CAN	CAN

Comms Support		Expansion Unit Support	
Function	**Link**	**Function**	**Link**
		TIU-32C (two)	CAN
		TPR via config CAN	CAN
		PCU-6D	CAN
		PCU-8D	PCU
		PCU-8	CAN
		DataTAG	CAN

Powertrain Control Unit
TAG-320

TAG-320 is the main processing unit for powertrain control of a racing car. It may be used with an external driver unit to provide direct control of ignition and direct or manifold injection, along with all other powertrain control functions. The TAG-320 provides a powerful processing platform with minimum latencies for customer applications based on 32-bit microprocessors. Application code is autocoded from Matlab/Simulink control modules. Advanced data logging, high-speed telemetry control and rich communications are all provided.

The TAG-320 is built with full FIA security measures including advanced memory protection and supports applications already running on the TAG-310B.

Application

- Control and monitoring of a racing car powertrain
- Up to 8-cylinder engines
- Throttle-by-wire
- Clutch-by-wire
- Semi-automatic gearbox
- Powerful onboard data logging and telemetry control
- Ethernet connection to application and data analysis tools (System Monitor and ATLAS)

Key Features

- Application processing power 4000MIPS
- Extremely low latency, high frequency input sampling
- Digital filtering on all analogue inputs
- Data logging memory 8GB Flash

Electrical

- Supply voltage 7.5 to 16V DC
- Supply voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- Supply current quiescent (ignition off) 4mA
- Supply current operating (no load on outputs) 3A typical at 13.8V
- Supply current operating (max load on supplies) 5A typical at 13.8V
- 32-bit Real Time Operating System
- Internal tri-axis accelerometer

Mechanical

- Aluminium case (hard black anodised)
- Weight 1.35kg

Connection definition

Integral, sealed, motorsport connectors:

- Connector A 66-way
- Connector B 114-way
- Connector C 114-way

Environmental

- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Internal temperature not to exceed 70°C as measured by internal diagnostic sensors
- Adequate forced-air cooling must be applied to ensure the internal operating temperature remains within specified limits
- Storage temperature -25°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended

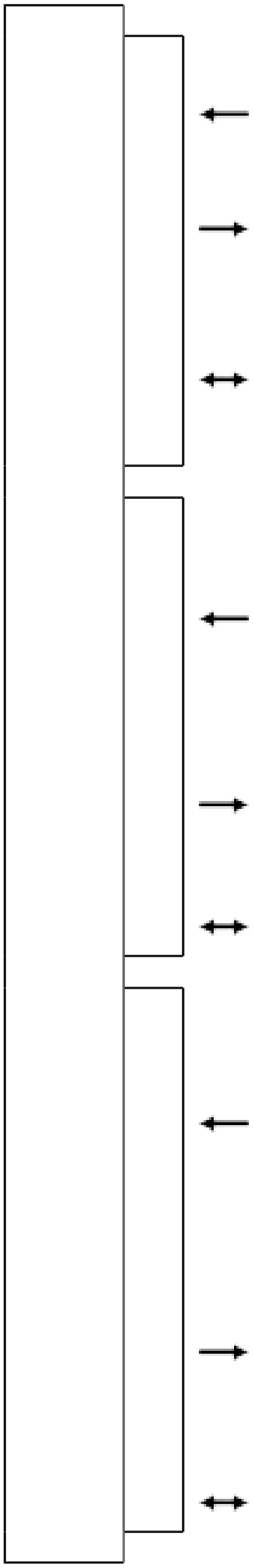
Electro Magnetic Compatibility

Complies with the essential protection requirements of 89/336/EEC

Service

Recommended service interval 12 months (internal battery is replaced)

Connection Definition



Connector A

- Four analogue/digital in (12-bit, 10ksps)
- One pits pedal input (12-bit, 1ksps)
- One IP address input (12-bit, 1ksps)

- Eight high-side outputs (7A)
- One high-side output (3A)
- Two high-side outputs (1A)
- Two oscilloscope outputs

- One Ethernet link (10/100/1000Mbps)
- One dual FlexRay link (20Mbps)
- One ARCNET link (10Mbps)
- Four CAN links (1Mbps)
- One RS232 link (up to 1Mbps)

Connector B

- 42 analogue inputs (12-bit, 10ksps)
- Two analogue inputs (12-bit, 100ksps)
- Four analogue/digital in (12-bit, 10ksps)
- Six analogue/Pt1000 (12-bit, 10ksps)
- Six DHE speed inputs
- One lap trigger input

- Two low-side outputs (3A)
- Two high-side outputs (1A)
- Six servo drive outputs
- Six gen-purpose open-drain outputs
- Two gen-purpose TTL outputs (shared with analogue inputs)
- One time sync output

- Five CAN links (1Mbps)

Connector C

- 24 analogue (12-bit, 10ksps), one of which may be used as a second lap trigger input
- Two analogue (12-bit, 100ksps)
- 10 analogue/Pt1000 (12-bit, 10ksps)
- Two DHE speed inputs
- Two thermocouple input
- Three inductive speed sensor inputs
- Two wide-band lambda inputs

- Eight low-side output (3A)
- Six high-side output (1A)
- Eight open-drain ignition control outputs (four shared with DHE speed inputs)
- Eight TTL injection control outputs
- Four servo drive outputs
- Two general-purpose open-drain outputs
- Two general-purpose TTL outputs (shared with analogue inputs)
- One engine sync output

- Two CAN links (1Mbps)

Sensor Inputs

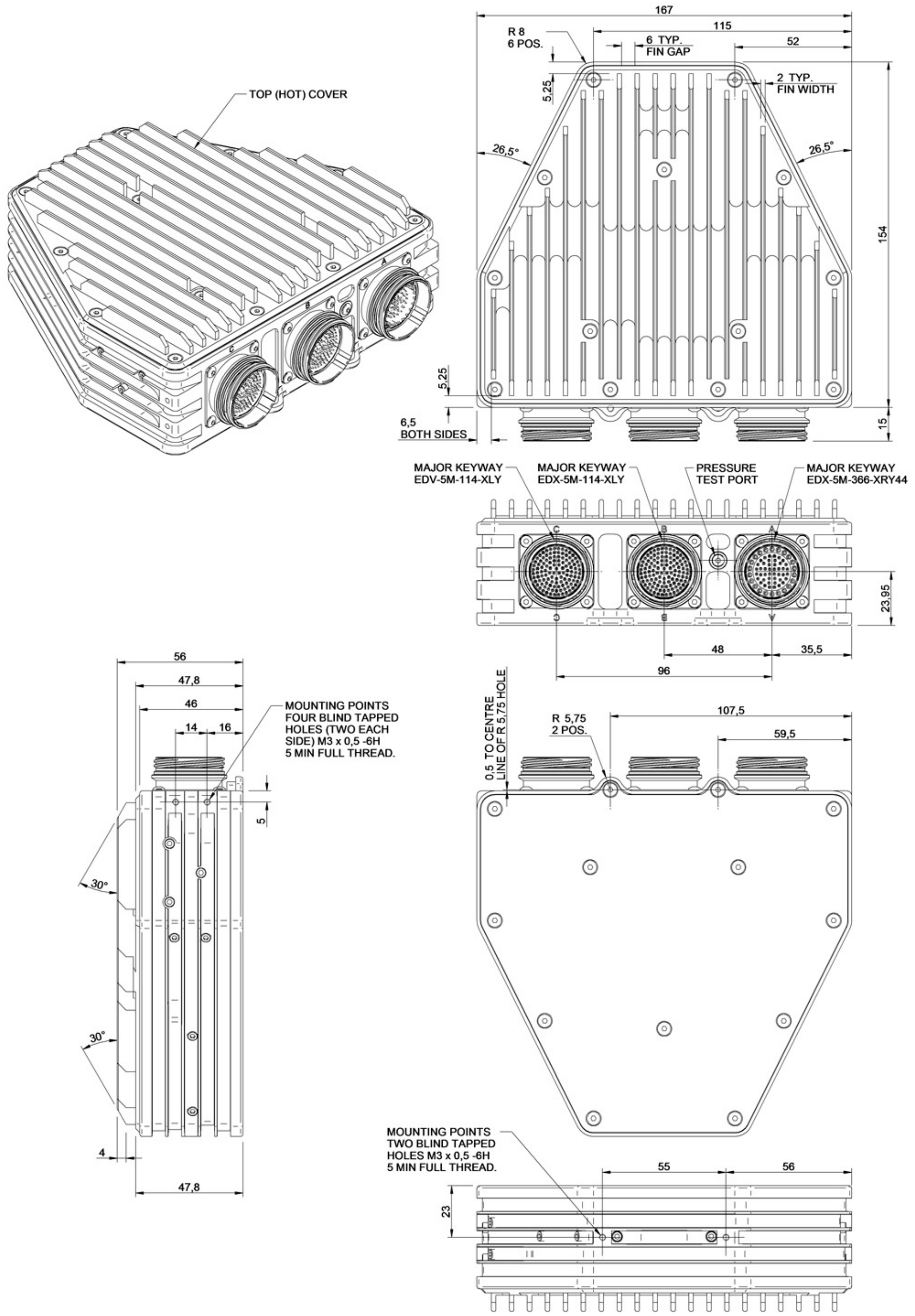
- Up to 66 general-purpose 0 to 5V analogue inputs (12-bit, 10ksps, four of which are software configurable as general-purpose TTL outputs)
- 16 general-purpose configurable 0 to 5V or Pt1000 analogue inputs (12-bit, 10ksps)
- Eight general-purpose configurable 0 to 5V analogue inputs with optional strong pull-ups for use with digital switches (12-bit, 10ksps)
- Four high-speed 0 to 5V analogue inputs (12-bit, 100ksps)
- “Pits pedal” and “Ethernet IP address” analogue inputs (12-bit, 1ksps)
- Three inductive or DHE speed inputs (factory configured)
- Eight DHE speed inputs
- Two K-type thermocouple inputs (12-bit)
- Two wide-band lambda interfaces (12-bit)
- Lap trigger interface
- Ignition switch input

Outputs

- 10 ±12mA servo valve drive stages (10ksps)
- 10 3A low-side drive stages (software configurable for freewheel or fast-turn-off operation)
- 10 1A high-side drive stages
- One 3A high-side drive stage
- Eight 7A high-side drive stages
- Eight TTL injection control outputs
- Up to four general-purpose TTL outputs (all of which are software configurable as analogue inputs)
- Eight open-drain ignition control outputs
- Eight general purpose open-drain outputs
- Two RS422 differential outputs for 1ms time synchronisation and engine synchronisation signals
- Two oscilloscope outputs
- Four 150mA 12V sensor supplies
- One 150mA 10V sensor supply for digital-output sensors
- One 150mA 5V supply for lap trigger receiver
- Eight 100mA 5V precision sensor supplies

Communications

- One Wired Gigabit Ethernet interface
- One RS232 interface (1Mbps maximum)
- One ARCNET interface (10Mbps maximum)
- One dual-channel FlexRay interface (20Mbps)
- 11 CAN interfaces (1Mbps maximum)



Description	Ordercode
TAG-320 (eight ignition control outputs and eight DHE speed inputs)	O 030 072 017 000

Powertrain Control Unit

TAG-310B

The TAG-310B is the main processing unit for complete powertrain control of a racing car. It may be used with companion driver units (e.g. IGN-310 and ING-310 or PB2006) to provide direct control of ignition and injection, along with all other powertrain control functions. The TAG-310B provides a powerful processing platform with minimum latencies for customer applications based on PowerPC processors. Application code is autocoded using our Graphical Development Environment (GDE) from Matlab/Simulink control modules. The unit comes with integral data logging and high speed communications capabilities.

The TAG-310B is configured by System Monitor and the logged data is displayed and analysed by ATLAS.

For example system configurations please refer to the Application Notes.

Application

Control and monitoring of complete powertrain.

- 10 cylinder engine
- Throttle-by-wire
- Clutch-by-wire
- Semi-automatic gearbox

Powerful onboard data logging

Ethernet connection to application and data analysis tools

Electrical

- Supply Voltage 7.5 to 16V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- Supply Current quiescent (ignition off) 5mA typical @12V
- Supply Current operating (no load on inputs) 1.2A typical @13.8V
- Supply Current operating (max load on supplies) 3.0A typical @13.8V
- TAGOS 32-bit Real Time Operating System
- Application processing power 1700 MIPS
- Data retention not battery dependant
- Data logging memory 1Gbyte Flash, 16Mbyte SRAM

Mechanical

- Available with magnesium (chromate converted and painted with stippled black epoxy) or aluminium case (hard black anodised)
- Aluminium case weight 1300g
- Magnesium case weight 1130g

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC

Service

- Recommended service interval 12 months (internal battery is replaced)

Connection Definition

- Integral, sealed, military standard connectors

Front connector A	100-way	CGK-S0T 22N-35PN
Centre connector B	100-way	CGK-S0T 22N-35PB
Rear connector C	100-way	CGK-S0T 22N-35PC

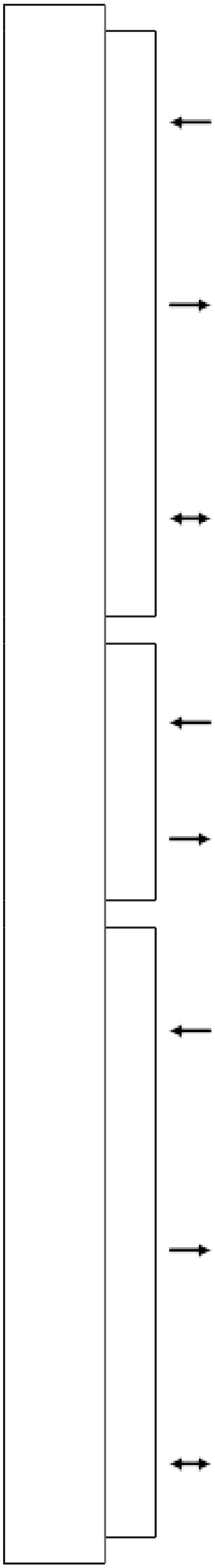
For pin numbers, please request further details from our Technical Consultancy Department.

Environmental

- Splash resistant to standard motorsport fluids

- Lids sealed with o-rings
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Internal Temperature not to exceed 70°C as measured by internal diagnostic sensors
- Storage Temperature -10°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended

Connection Definition



Front Connector

- 5 Analogue inputs (10bit)
- 8 Analogue inputs (12bit)
- 4 Programmable Analogue/Pt1000
- 1 lap trigger input
- 1 Digital switch input

- 7 Moog outputs
- 4 Low side outputs (2A)
- 2 High side outputs (1A)
- 2 High side outputs (7A)
- 1 Open drain digital
- 1 Diagnostic timing output
- 2 Scope outputs
- 1 Differential Engine Synch
- 1 Differential time synchro output

- 5 CAN bus interfaces
- 1 PCU comms
- 1 STAR bus interface
- 1 RS-232 interface
- 1 Telemetry interface
- 1 Ethernet comms
- 1 Sensor bus comms

Centre Connector

- 43 Analogue inputs (12bit)
- 4 Programmable Analogue/Pt1000
- 8 DHE speed inputs
- 1 digital input

- 4 High side output (1A)
- 1 High side output (5A)
- 4 Low side outputs (2A)
- 9 Moog outputs

Rear Connector

- 14 Analogue inputs (10bit)
- 8 Programmable Analogue/Pt1000
- 10 Analogue inputs (12bit)
- 1 Digital input
- 2 Lambda inputs
- 2 Thermocouple inputs

- 2 High side output (1A)
- 2 High side output (2A)
- 4 Low side outputs
- 2 Lambda heater high side driver
- 2 Oscilloscope outputs
- Sensor node drive stage
- 2 digital outputs
- 2 Fuel pump outputs
- 10 Low current open drain
- 10 TTL digital outputs
- 3 Moog outputs

- Sensor Node interface
- RS232 Communications
- Telemetry interface
- 3 CAN bus interfaces
- STAR bus interface

Sensor Inputs

- 47 general purpose 0 to 5V 12bit analogue inputs
- 15 0 to 5V 12-bit analogue inputs (10kHz)
- 16 general purpose configurable 0 to 5V or Pt1000 10bit analogue inputs
- 19 general purpose 0 to 5V 10 bit analogue inputs
- Three inductive speed sensor inputs
- Eight hall speed sensor inputs
- Two general purpose digital inputs
- Two wideband UEGO lambda interfaces (12bit)
- One lap trigger interface
- Two thermocouple inputs (12bit)

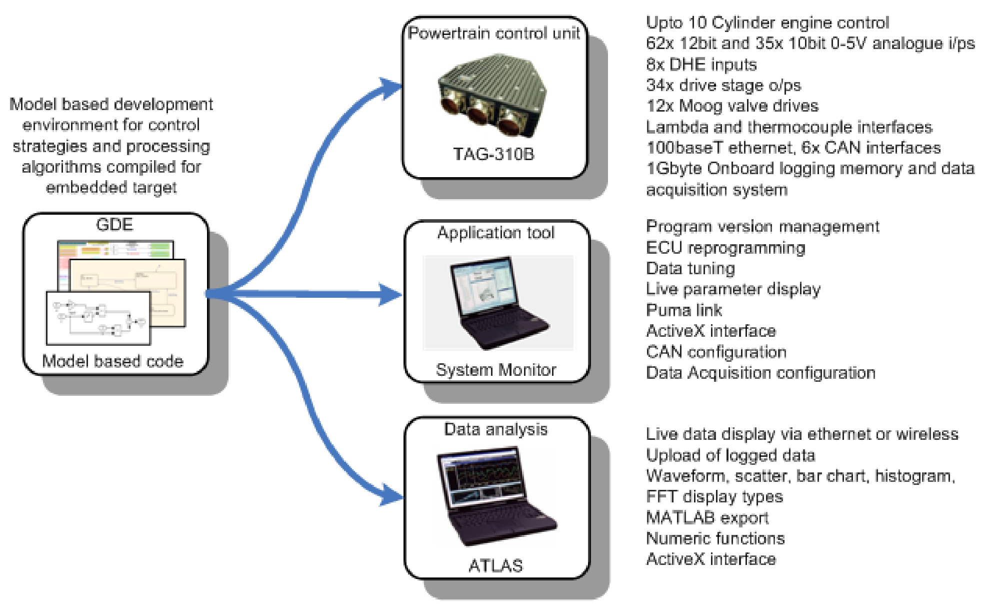
Outputs

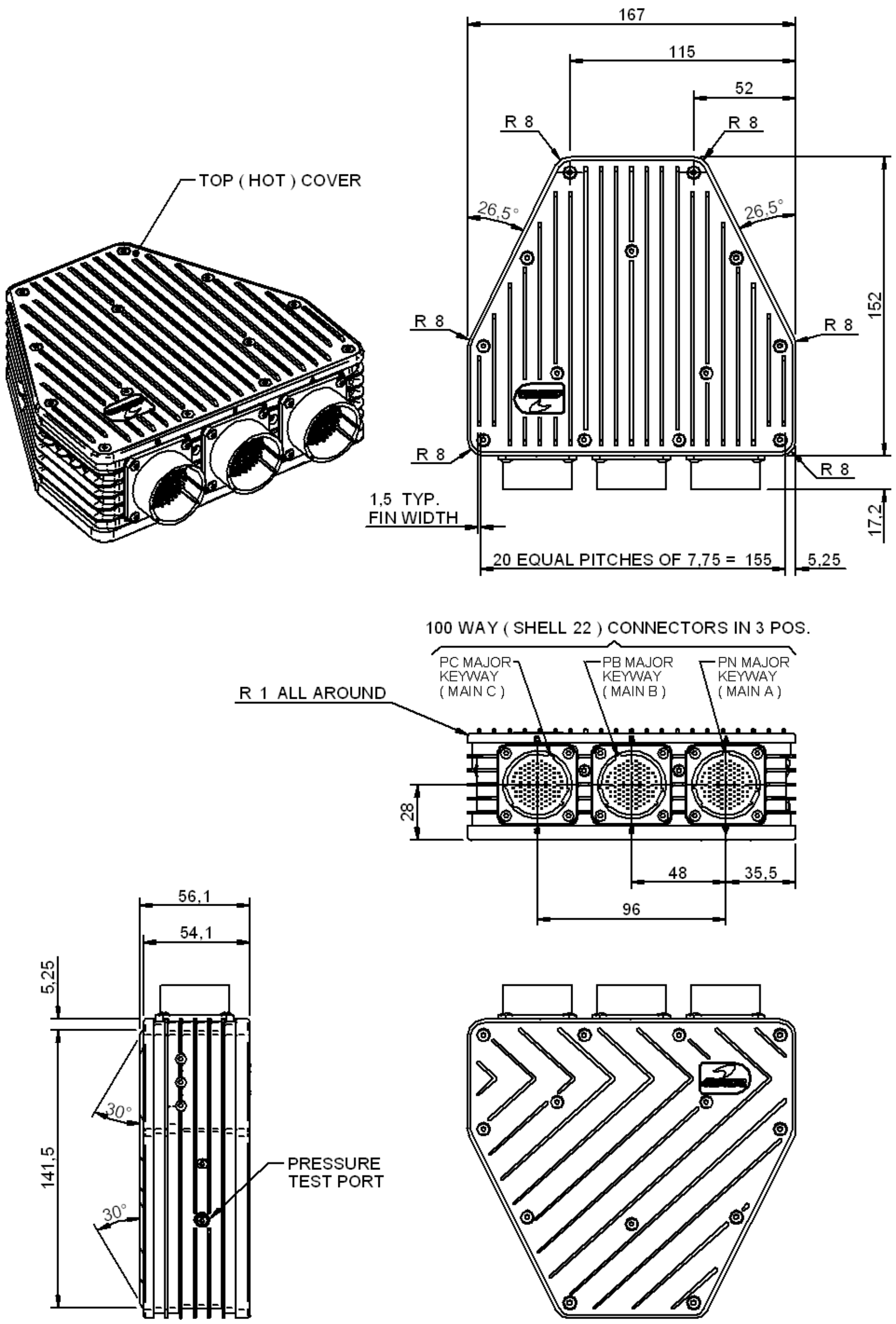
- 12 Moog drive stages
- Eight general purpose low-side drive stages
- Four fast-discharge low-side drive stages
- Two fuel pump drive stages
- One sensor node supply drive stage
- Two lambda Heater drive stages
- Nine high-side, high-power, drive stages
- Eight high-side, low-power, drive stages
- Two oscilloscope diagnostic outputs or 0 to 5V analogue outputs
- One TTL digital output
- One open drain digital Output
- 10 open drain TPU ignition control outputs
- 10 TTL digital TPU injector control outputs
- 5V and 10V output supplies for transducers

Communications

- One RS232 interface, up to 57.6kbps
- Six CAN bus interfaces, up to 1Mbps
- One PCU dashboard comms
- One wide band or Narrow band telemetry interface up to 16Mbps
- One interface to MES Sensor Nodes, 2Mbps asynchronous HDLC
- One interface to System Monitor ATLAS, 100baseTX Ethernet link
- One interface to STAR bus, 8Mbps synchronous HDLC
- One differential engine synchronous timing signal
- Two differential time synchronous timing signal

TAG-310B development system





Description	Ordercode
TAG-310B	O 030 072 013 002

Electronics

Electronic Control Unit
TAG-400N (NASCAR)

The TAG-400N is a compact, self-contained engine management system and data logger for race engines up to eight cylinders. The unit is complete with integrated ignition and injection drivers and so needs no external units to run an engine.

The TAG-400N exploits Freescale Power architecture technology to provide a powerful and flexible platform for extracting the optimum performance from an engine. Turnkey systems or customer prepared applications are both supported.

Large internal data logging memory and data analysis tool licence included.

Security protection features for mandated software applications and code verification/ checking tools available as standard.

Race-proven single-series pedigree.

Application
- Control and monitoring of engine and/or gearbox.

Electrical
- Supply Voltage 7.9 to 16.0V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- TAGOS 32-bit Real Time Operating System
- Data logging memory capacity 256Mbyte

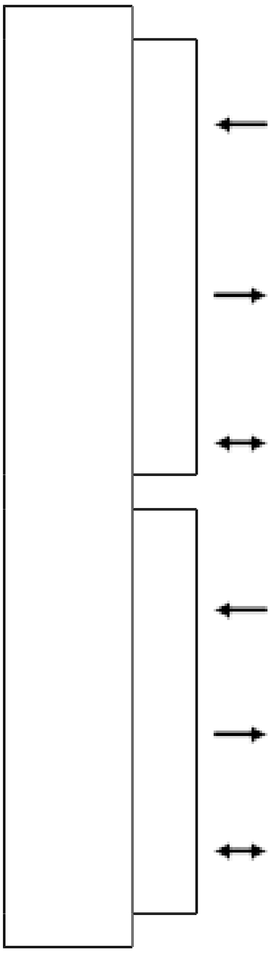
Mechanical
- Case material hard anodized aluminum
- Weight 22 ounces

Other Features
- Status LEDs included for ease of use.
- One System Monitor configuration tool software licence supplied per team purchasing TAG-400Ns.

Environmental
- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings and screws sealed with silicone rubber
- Maximum humidity 100%
- Minimum operating temperature 14°F
- Internal temperature not to exceed 160°F as measured by internal diagnostic sensors
- Storage temperature 14 to 185°F
- Vibration 100 to 1000Hz, all axes, 24hrs

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

Connector Diagrams



Engine Connector

- 2 Inductive speed
- 4 Hall Effect speed
- 2 Lambda

- 2 Lambda heater
- 8 Ignition drivers
- 8 Injection drivers
- 2 Low Side Drivers
- 3 High Sides Drivers
- 2 Tacho/Speedo
- 2 Gauge Driver

- 1 CAN

Chassis Connector

- 22 Analogue inputs
- 3 Switch inputs
- 7 Temperature
- 1 Lap trigger

- 2 Gauge Drivers
- 2 High Sides
- 2 High Sides/1 H-Bridge

- 1 Ethernet
- 1 CAN
- 1 RS232

Connection Definition

- Integral, sealed, military-standard connectors.

Sensor Inputs

- Two Inductive Speed Sensors (Crank)
- Four HE Speed Sensors (Cam + spares)
- 22 Analog (0 to 5V)
- Four Pt1000 Temperature Sensors (configurable as analogs in software)
- Three NTC Temperature Sensors (configurable as analogs in software)
- Two Wideband Lambda
- Three switches to GND
- One lap trigger

Outputs

- Eight high-voltage (30V) switched mode, current controlled injector drive stages
- Eight inductive ignition drive stages
- Two low side drivers
- Two high side drivers (can be software configured as one 16kHz H-bridge driver)
- Five high side drive stages
- Two Lambda heaters (5A)
- Two Tacho/Speedo outputs
- Four 0-5V Gauge Drivers
- External sensor supplies

Communications

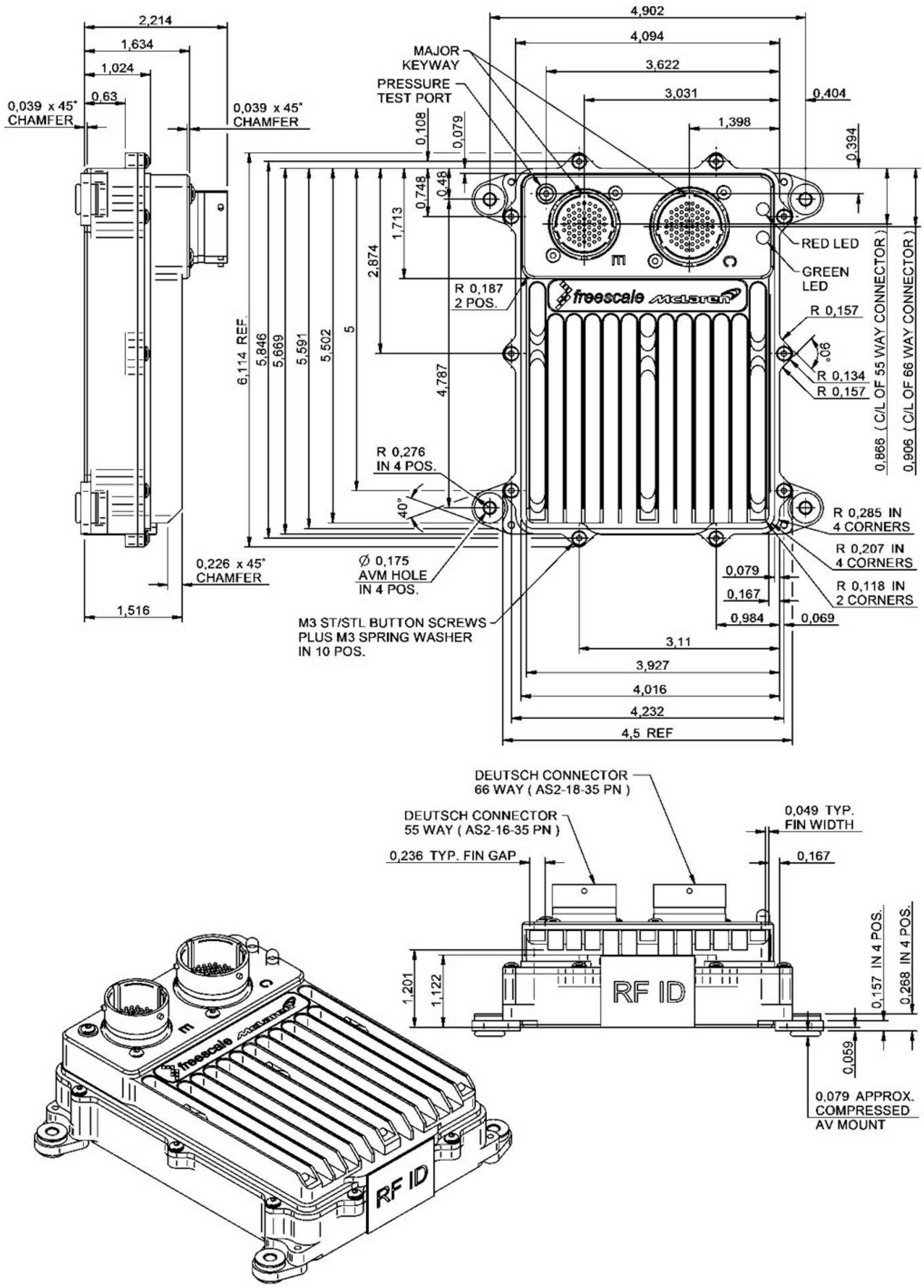
- One Ethernet
- Two CAN 2.0B bus (up to 1Mbps)
- One RS232 (up to 222kbps

Data logging

- 256Mbyte

Diagnostics

- Sensor readings are checked for out of range and open circuit
- The following internal parameters are monitored:
  - Board temperatures
  - Unit supply voltages



Description	Ordercode
TAG-400N	S 030 012 011 009

Engine Control Unit

TAG-400i (IndyCar Series)

The TAG-400i is a compact, self-contained engine management system and data logger for race engines.

The unit is an evolution of the TAG-400 which has been used successfully in open-wheel and motorcycle racing applications. The TAG-400i has extended functionality with increased processing power and I/O capability.

The TAG-400i exploits Power PC technology, but with an uprated processor that now offers more than six times the application processing power than the TAG-400, providing a powerful and flexible platform for extracting the optimum performance from an engine.

The TAG-400i can be offered as part of a turnkey system or can support customer prepared applications autocoded from Simulink models using our Graphical Development Environment (GDE).

Application

- Control and monitoring of engine and/or gearbox.

Electrical

- Supply Voltage 7.9 to 16.0V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- TAGOS 32-bit Real Time Operating System
- Data logging memory capacity 1Gbyte
- High performance application processor running at 264MHz

Mechanical

- Case material hard anodised aluminium
- Weight 939g

Other Features

- One System Monitor configuration tool software licence supplied per team purchasing TAG-400i

Connection Definition

- Integral, sealed, military standard connectors

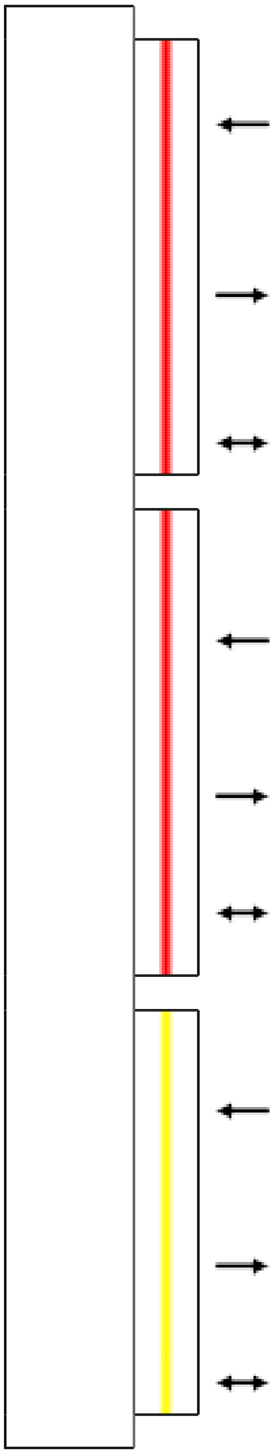
Environmental

- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings and screws sealed with silicone rubber
- Maximum humidity 95% non-condensing
- Minimum operating temperature -10°C
- Internal temperature not to exceed 70°C as measured by internal diagnostic sensors
- Storage temperature -10 to +85°C
- Vibration 100 to 1000Hz, all axes, 24hrs

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC

Connection Definition



Engine Connector

- Two Inductive crank speed
- Four DHE speed
- Two Lambda

- Two Lambda heater
- Eight Ignition drivers
- Eight Injection drivers (30V)
- Six Low side (1A)
- Two Low side (0.5A)
- Two High side (3A)
- Two High side (2A)

- One CAN

Chassis Connector

- 18 Analogue inputs
- Three Switch inputs
- Seven Temperature
- Two Thermocouple
- Four Knock
- One Lap trigger

- Two Scope
- One High Side (5A)
- Two High side (2A)

- One Ethernet
- One CAN
- One RS232

AUX Connector

- Five Analogue inputs
- Two Turbo Speed inputs
- Seven Switch inputs
- One DHE speed

- Six Inj Trigger Outputs
- Two Sync Trigger Outputs
- One Timesync output
- Four High Side (2A)
- Two H-Bridge (7.5A)

- Two CAN

Sensor Inputs

- Four Inductive Speed Sensors (two Crank Sync; two Turbo speed)
- One DHE Cam Sensor
- Four DHE Speed Sensors
- 23 Analog (0 to 5V, 1KHz)
- Seven NTC Temperature Sensors (configurable as analogues)
- Two K-type thermocouples
- Two wideband Lambda
- Four Knock Sensors (configurable as analogues)
- 10 switches
- One Lap trigger

Outputs

- Eight inductive ignition drive stages (20A)

- Eight manifold injector drive stages (30V)
- Eight trigger outputs for external injector drive unit
- One Timesync for external drive unit
- One High side driver (5A)
- Two High side drivers (3A)
- Eight High side drivers (2A)
- Six Low side drivers (1A)
- Two Low side drivers (Tacho/Speedo) (0.5A)
- Two H-Bridge Drivers (7.5A)
- Two Engine Synchronous low side drivers (1.5A)
- Two Lambda heaters
- Two Oscilloscope Diagnostic
- External sensor supplies

Communications

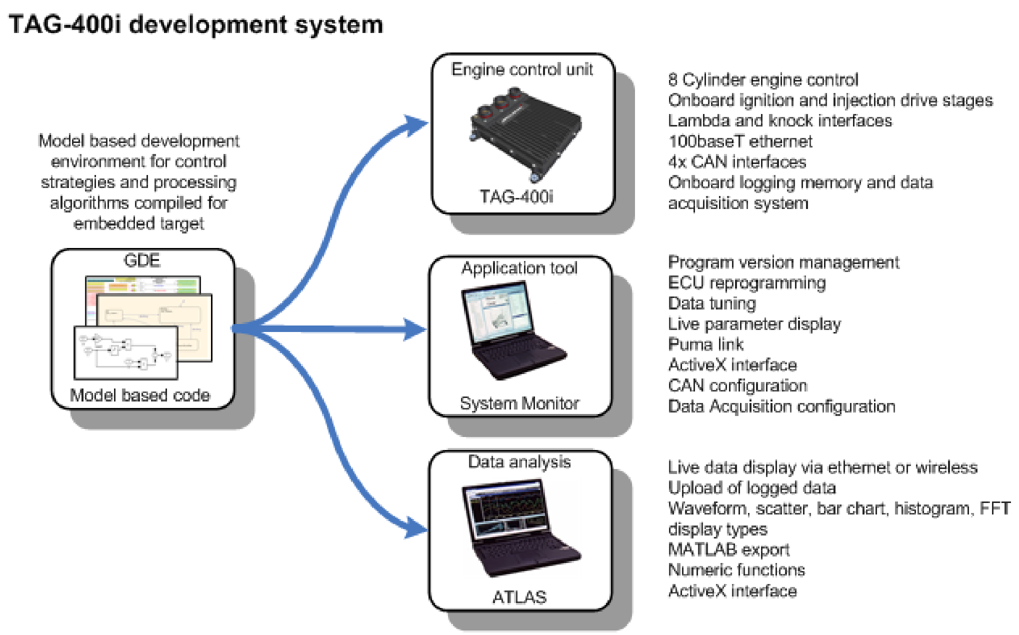
- One Ethernet
- Four CAN 2.0B bus (up to 1Mbps)
- One RS232 (up to 222kbps)

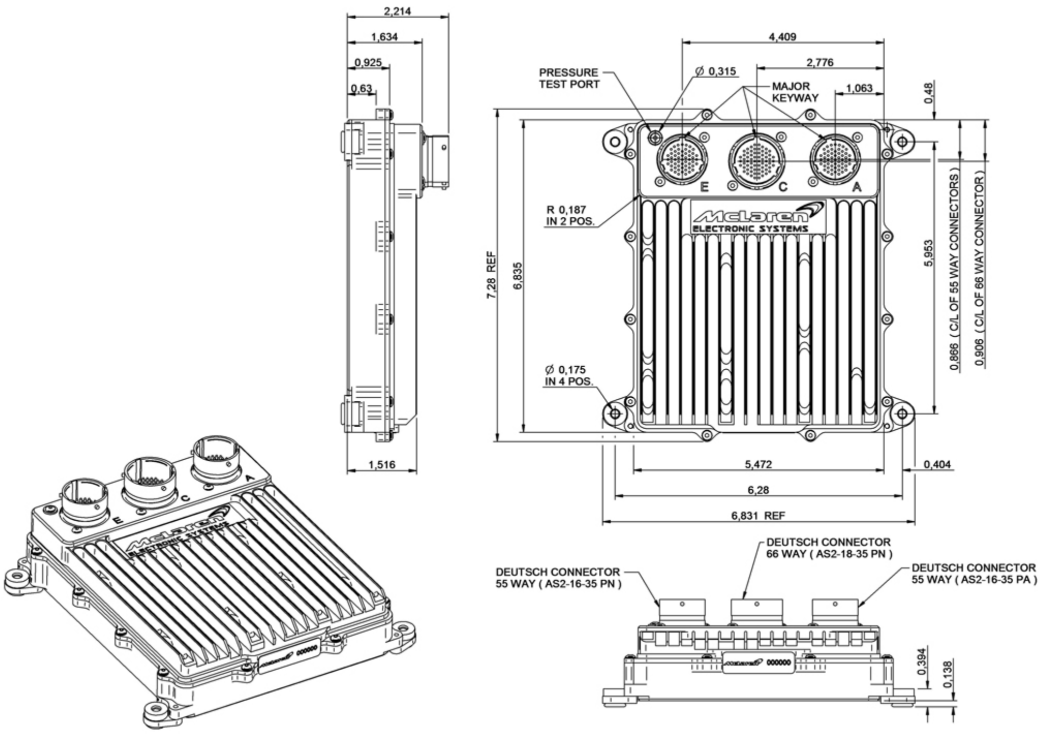
Data logging

- 1Gbyte

Diagnostics

- Sensor readings are checked for out of range and open circuit
- The following internal parameters are monitored:
  - Board temperatures
  - Unit supply voltages





Description	Ordercode
TAG-400i	O 030 012 015 000

Electronic Control Unit
TAG-400

The TAG-400 is a compact, self-contained engine management system and data logger for race engines up to eight cylinders. The unit is complete with integrated ignition and injection drivers and so needs no external units to run an engine.

The unit is suitable for controlling high-revving motorcycle engines plus normally-aspirated and turbo-charged rally, sportscar or open-wheel racing cars. Advanced traction control, Knock control and quickshift features can all be provided, where permitted by regulations.

The TAG-400 exploits Power PC technology to provide a powerful and flexible platform for extracting the optimum performance from an engine. Turnkey systems or customer prepared applications are both supported.

Application code may be autocoded using our Graphical Development Environment (GDE) from Matlab/Simulink control modules.

Application
- Control and monitoring of engine and/or gearbox.

Electrical
- Supply Voltage 7.9 to 16.0V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- TAGOS 32-bit Real Time Operating System
- Data logging memory capacity 16Mbytes (1Gbyte version also available)

Mechanical
- Case material hard anodised aluminium
- Weight 585g

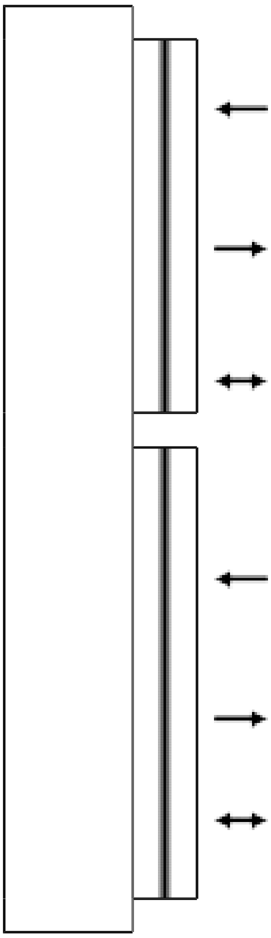
Other Features
- One System Monitor configuration tool software licence supplied per team purchasing TAG-400s

Connection Definition
- Integral, sealed, military standard connectors

Environmental
- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings and screws sealed with silicone rubber
- Maximum humidity 100%
- Minimum operating temperature -10°C
- Internal temperature not to exceed 70°C as measured by internal diagnostic sensors
- Storage temperature -10 to +85°C
- Vibration 100 to 1000Hz, all axes, 24hrs

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

Connector Diagrams



Engine Connector

- 2 Inductive speed
- 2 Lambda

- 2 Lambda heater
- 8 Ignition drivers
- 8 Injection drivers
- 6 Low Side
- 4 High Sides
- 2 Tacho/Speedo

- 1 CAN

Chassis Connector

- 18 Analogue inputs
- 3 Switch inputs
- 7 Temperature
- 2 Thermocouple
- 4 Knock
- 1 Lap trigger

- 2 Scope
- 3 High Sides

- 1 Ethernet
- 1 CAN
- 1 RS232

Sensor Inputs

- Two Inductive Speed Sensors
- Four DHE Speed Sensors
- 18 Analog (0 to 5V)
- Four Pt1000 (or NTC) Temperature Sensors (configurable as analogs)
- Three NTC Temperature Sensors (configurable as analogs)
- Two K type thermocouples
- Two Wideband Lambda
- Four Knock Sensors (configurable as analogs)
- Three switch (configurable as analogs)
- One lap trigger

Outputs

- Eight High Voltage (30V) switched mode, current controlled injector drive stages
- Eight inductive ignition drive stages
- Six Low side drivers (pairs of low-sides can be software configured as 500Hz H-bridge drivers or as 20mA Moog drive stages)
- Two High side drivers (can be software configured as one 16kHz H-bridge driver)
- Five High side drive stages
- Two Lambda heaters
- Two Tacho/Speedo outputs
- Two Oscilloscope Diagnostic
- External sensor supplies

Communications

- One Ethernet
- Two CAN 2.0B bus (up to 1Mbps)
- One RS232 (up to 222kbps)

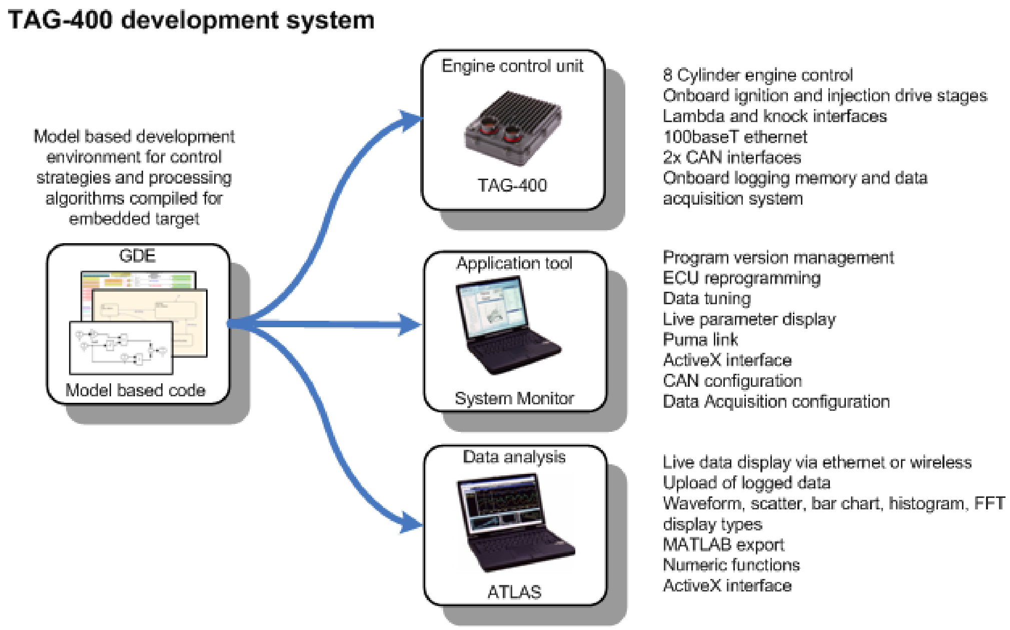
Data logging

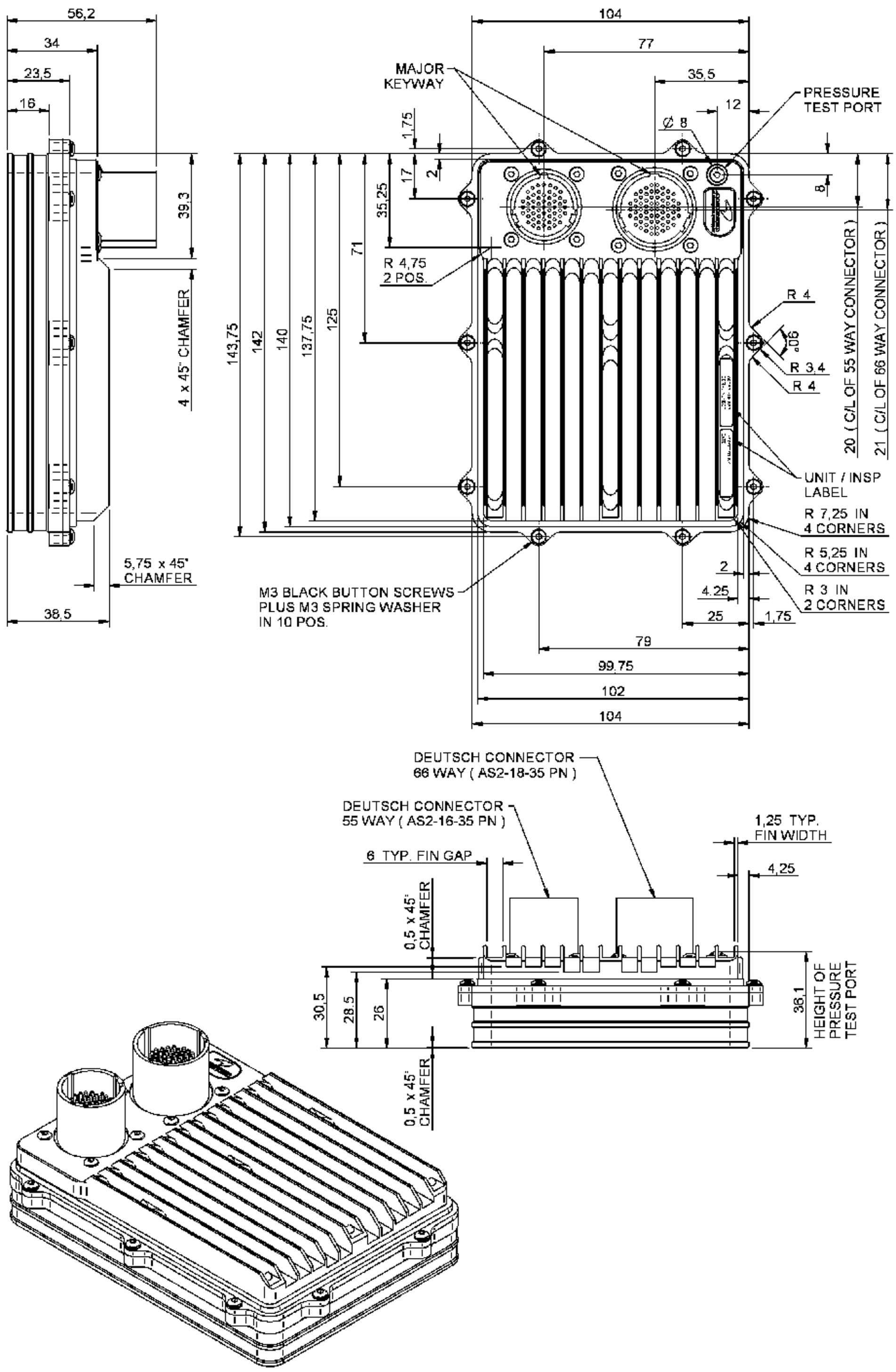
- 16Mbytes (standard) or 1Gbyte logging memory (factory fit option)

Diagnostics

- Sensor readings are checked for out of range and open circuit
- The following internal parameters are monitored:

  Board temperatures
  Unit supply voltages





Description	Ordercode
TAG-400 (16Mbyte logging memory)	O 030 012 011 000
TAG400 (1Gbyte logging memory)	O 030 012 011 006

Control Interface Unit
CIU-400

CIU-400 is compact auxiliary processing unit for control applications on board a racing car. The CIU-400 provides a powerful 128MHz processing platform with 1kHz sampling of analogue input channels and actuation of high side drive stage outputs. A PowerPC processor provides the processing resource for application code which may be autocoded from Matlab/Simulink using our GDE and reprogrammed using the System Monitor application tool.

The unit includes three CAN interfaces for communications with System Monitor, host ECU and other CAN linked system devices.

The CIU-400 may operate as a stand alone controller with a direct CAN connection to System Monitor for programming and configuration or may run as a companion unit to one of our motorsport ECUs.

Application
- Generic control applications
- Interfacing to remote sensors
- CAN linked I/O expansion

Electrical
- Supply Voltage 8 to 16V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- Supply Current operating (no load on inputs) 0.55A typical @13.8V
- Supply Current operating (max load on supplies) 0.7A typical @13.8V
- BIOS 32-bit Real Time Operating System
- 128MHz 32bit application processor.
- System memory: 2Mbyte Program Flash, 64kbyte SRAM, 64kbyte EEPROM

Mechanical
- Available with magnesium (chromate converted and painted with stippled black epoxy)
- Magnesium case weight 215g

Connection Definition
- Integral, sealed, Deutsch autosport double density connectors:

Power & comms connector	41way	N Keyway (part no: ASDD212-41PN)
Sensor connector	41way	A Keyway (part no: ASDD212-41PA

For pin numbers, please request further details from our Technical Consultancy Department.

Environmental
- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Internal Temperature not to exceed 70°C as measured by internal diagnostic sensors
- Storage Temperature -10°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

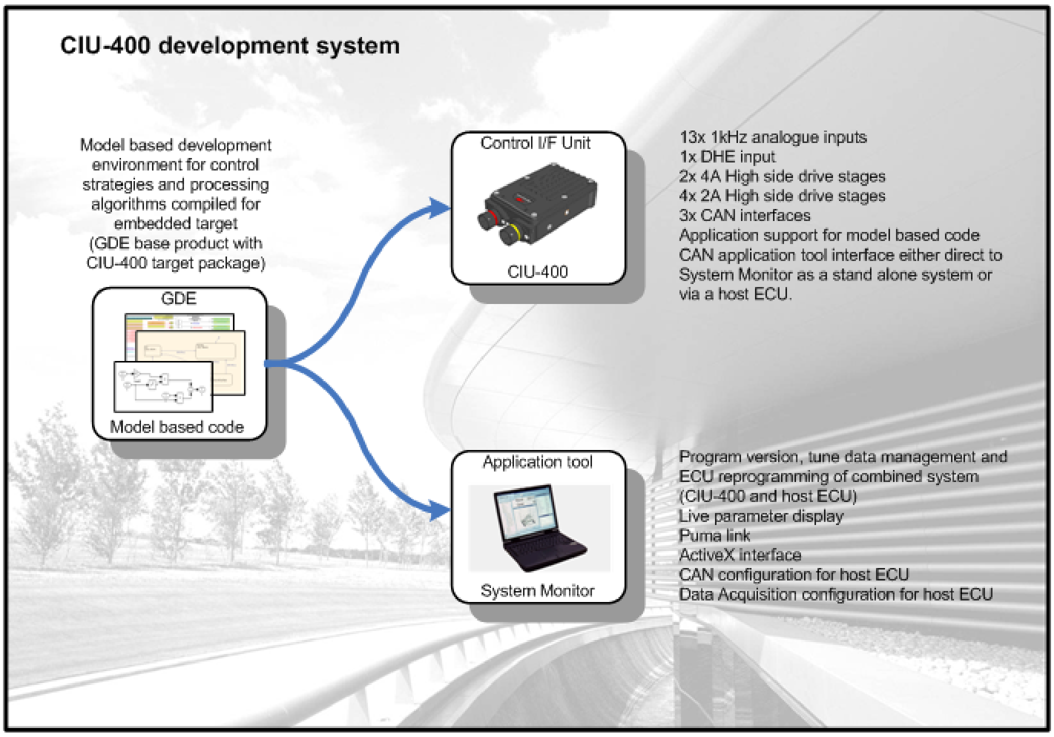
Sensor Inputs
- 12 General Purpose configurable 0 to 5V or Pt1000 12bit Analogue inputs
- One General Purpose configurable 0 to 5V 12bit Analogue input
- One Hall speed sensor inputs
- One Time Synchronisation input

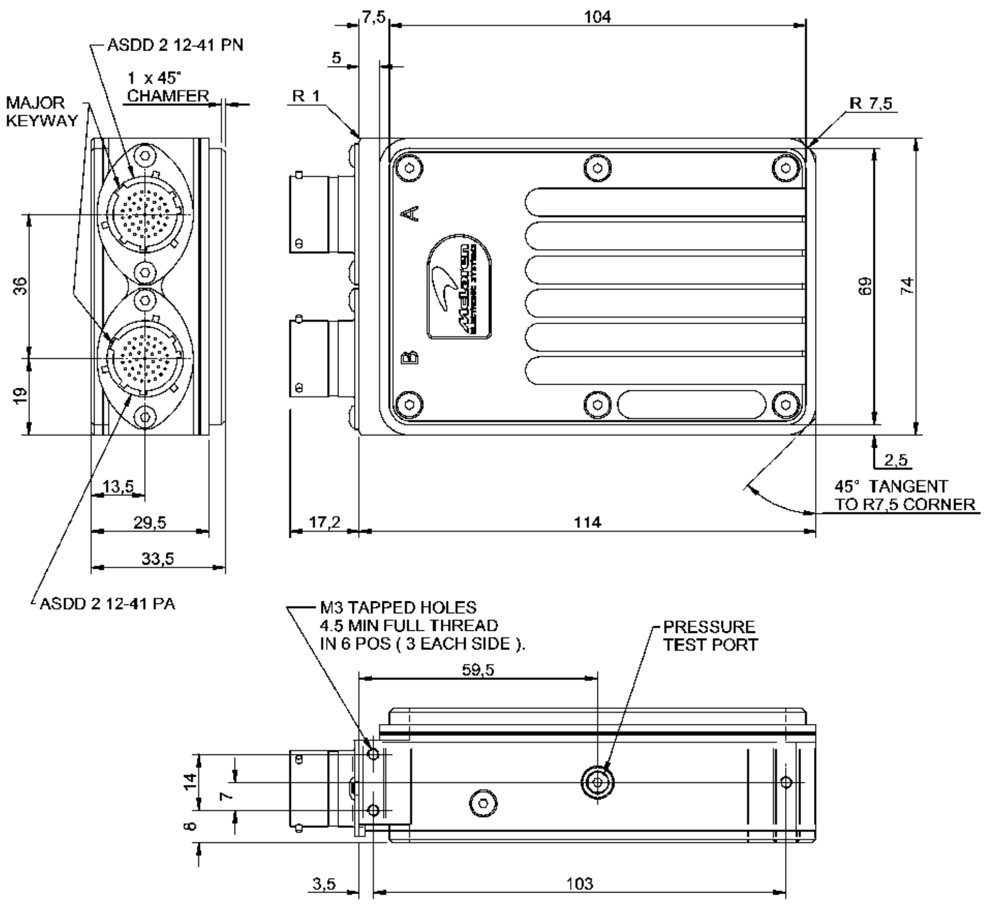
Outputs

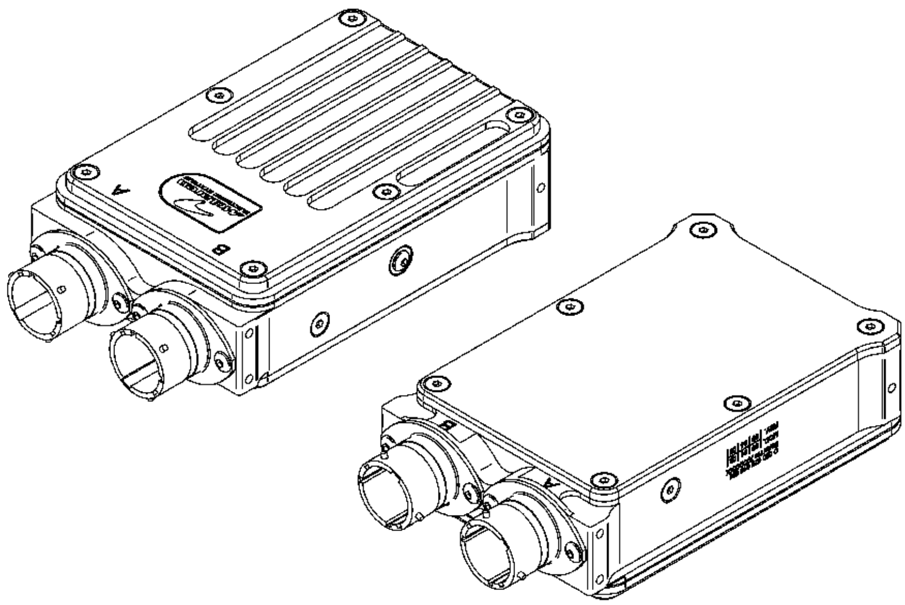
- Two High Side, 4A, drive stages
- Four High Side, 2A, drive stages
- 5V (100mA) output supply for transducers

Communications

- Three CAN bus interfaces, up to 1Mbps







Description	Ordercode
CIU-400	O 030 110 013 000

Powertrain & Chassis Control Unit
CIU-100

CIU-100 is a cost-effective auxiliary processing unit for general purpose control applications. The CIU-100 provides a powerful 128MHz processing platform with 1kHz sampling of analogue input channels and actuation of high/low side drive stage pairs. A PowerPC processor provides the processing resource for application code which may be autocoded from Matlab/Simulink using our GDE and reprogrammed using the System Monitor application tool.

The unit includes three CAN interfaces for communication with System Monitor, the host ECU and other CAN linked system devices.

The CIU-100 can be used as a stand-alone control unit with a direct CAN connection to System Monitor for programming and configuration or could make an ideal companion to one of our ECUs.

Application
- General control applications
- Solenoid/hydraulic system control
- Interfacing to remote sensors
- CAN linked I/O expansion

Electrical
- Supply Voltage 8 to 16V DC
- BIOS 32-bit Real Time Operating System
- 128MHz 32-bit application processor
- System memory: 2Mbyte Flash, 64kbyte SRAM
- 40MHz monitor processor for SIL functionality

Sensor Inputs
- 21 general purpose 0 to 5V analogue inputs
- Six NTC (configurable as analogue, 0 to 5V)
- Eight speed sensor inputs (Schmidt)
- Two general purpose digital inputs (12V)
- One "ignition switch" input, with keep-alive

Outputs
- 28 high side outputs with current sensing (3.5A) *
- 28 low side drives (paired with the above, 3.5A)
- Two low side, drive stages (1A), with diagnostics
- Two H-bridge drives (3.5A) with diagnostics
- Three independent sensor supplies (5V, 150mA)
- One constant current output (200mA)

* grouped as 4 banks of 20A each, for fault tolerance

Communications
- Three CAN bus interfaces up to 1Mbps (two with wake-up)

Diagnostics
- Dual on-board temperature sensors
- Dual hardware and software watchdogs
- Onboard power supply sensing and I/O diagnostics

Mechanical
- Cast aluminium housing, black painted pressed steel lid
- Weight 850g

Connection Definition
- One 154-way connector divided into two cavities (96, 58-way)

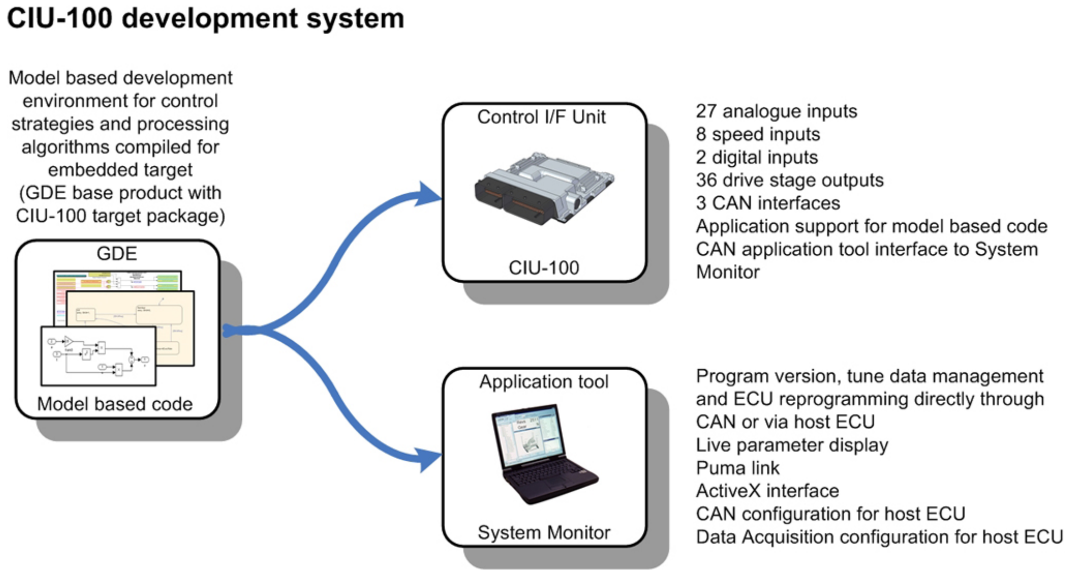
For pin numbers, please request further details from our Technical Consultancy Department.

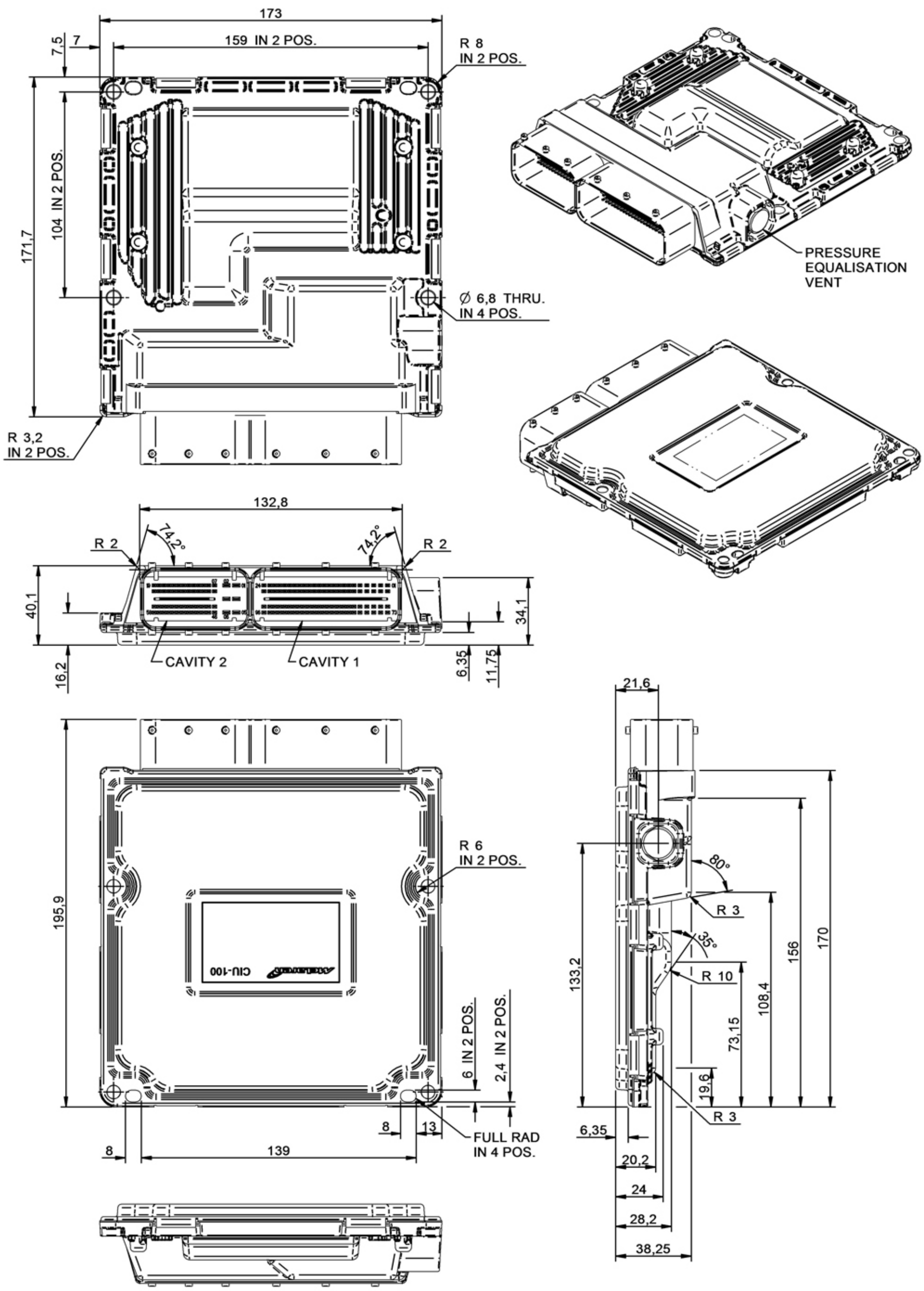
Environmental

- Permanently sealed (water resistant to IP6K)
- Maximum humidity 100%
- Operating temperature -40°C to +85°C (as seen internally)
- Storage Temperature -10°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC





Description	Ordercode
CIU-100	O 030 110 015 000

Control Interface Unit
CIU-010

The CIU-010 is a general purpose electronic control unit for use in light-weight automotive control applications such as HVAC control and general body functions such as switch gateways.

A wide selection of I/O is provided, and the unit is equipped with three CAN buses and two LIN buses to facilitate interfacing to other electronic devices on the vehicle.

The unit is provided with a kernel and accompanying API that exposes all of the underlying I/O and communications interfaces. This allows application specific software to be written. MES can provide an application software development service if required.

Units ordered in large quantities can be provided pre-loaded with software as required. Developers can re-program the units via a CAN bus.

Application
- Light-weight automotive control applications and switch gateways.

Electrical
- Supply Voltage 6 to 16V DC
- Max quiescent current in standby 125uA
- Reverse battery voltage protected on supply pins
- Kernel, API and boot-loader included
- 40MHz 16-bit application processor (with 80MHz co-processor)
- System memory: 1Mbyte Flash, 4kbyte EEPROM

Sensor Inputs
- One Ignition input
- Seven NTC temperature sensor inputs
- One HVAC pressure sensor input
- Two Solar inputs
- Five 0-5V sensor inputs
- Six Digital inputs
- Two Speed inputs

Outputs
- Low-side drive (1.5A, 400Hz PWM)
- Two Digital (250mA, 125Hz PWM)
- Two LIN bus high-side supplies (0.5A and 3A)
- Two 5V +/-0.5% sensor supply (100mA)
- Two Low-side drives (0.5A)
- Three High-side drives (0.5A, 250Hz PWM)
- Three High-side drives (3A, 3A, 0.5A)
- Two H-bridge drives (1A, 200Hz to 2kHz PWM)
- One Low-side supply (3A)

Communications
- Three CAN buses
- Two LIN buses

Mechanical
- Black ABS thermoplastic housing
- Weight 225g

Connection definition
- One 76-way connector divided into four cavities

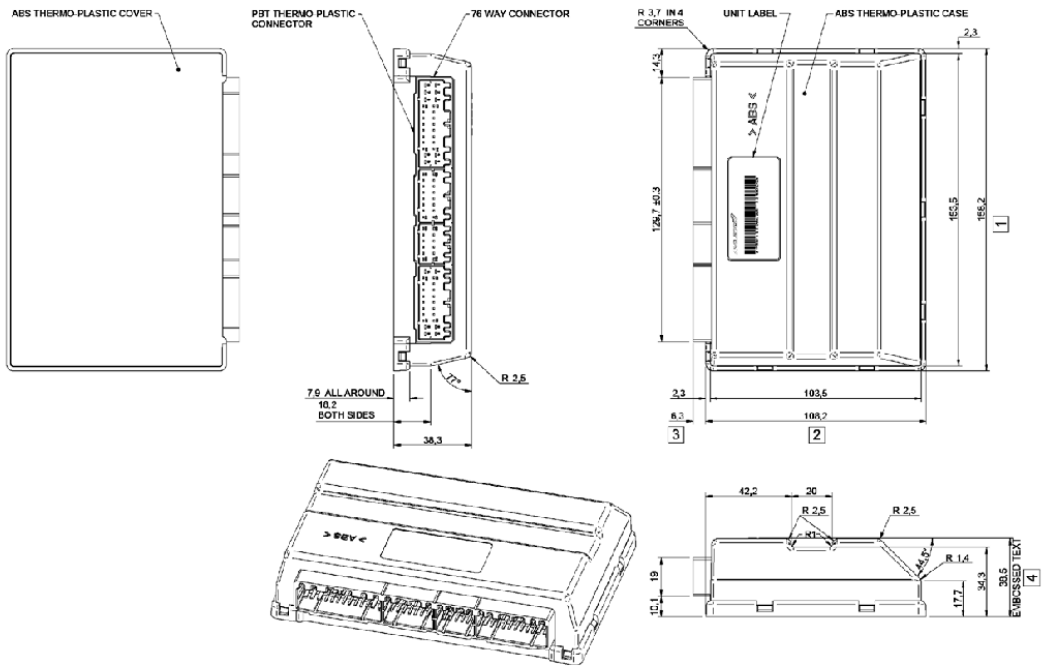
For pin numbers, please request further details from our Technical Consultancy Department.

Environmental

- IP40 rated
- PCB protected against moisture with conformal coating
- Maximum humidity 100%
- Operating temperature -30°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC



Description	Ordercode
CIU-010	O 030 071 013 002

Data Loggers

Compatability Matrix

The reference table below details the compatibility of the main MAT data loggers with our main expansion units. I/O information including details of interfaces with sensors and lap triggers can be found within the individual product summaries.

Please contact our Technical Consultancy department for details about compatibility with other MAT units and third party units.

EDR-400/EDR-400T

Comms Support		Expansion Unit Support	
Function	**Link**	**Function**	**Link**
System Monitor	Ethernet	SIU-400	CAN
ATLAS	Ethernet	SIU-300 via config CAN	CAN
CBT-610	RS232	SN-32 via config CAN	CAN
		SN-320 via config CAN	CAN
		LIU-4	CAN
		PIN-3 via config CAN	CAN
		TIU-32C (Two)	CAN
		TPR via config CAN	CAN
		PCU-6D can be supported through the customer application	PCU
		PCU-8	CAN
		DataTAG	CAN

HSL-500/HSL-300

Comms Support		Expansion Unit Support	
Function	**Link**	**Function**	**Link**
System Monitor	Ethernet	SIU-400	CAN
ATLAS	Ethernet	SIU-300	CAN
CBT-610	ARCNET	SN-32 via config CAN	CAN
CBM-470 & WMX-470	ARCNET	SN-320 via config CAN/ FLEXRAY (for HSL-500)	CAN/FLEXRAY
		SN-320 via config CAN (for HSL-300)	CAN
		LIU-4	CAN
		PIN-3	CAN
		PIN-8	CAN
		PIN-16	CAN
		TIU-32C	CAN
		TPR	CAN
		PCU-8	CAN
		PCU-8D	CAN

High-Speed Data Logger
HSL-500

The HSL-500 is a compact, self-contained data logger for applications in top-level motorsport. It includes many innovative features including advanced hardware acceleration of front-end signal processing functions including filtering and down-sampling.

The unit can acquire data from on-board interfaces at rates of up to 400 kilosamples per second, and from remote units via communications links. A high-performance on-board PowerPC microprocessor offering over 1000MIPS processing power hosts customer applications for real-time data analysis. Application code may be autocoded using our Graphical Development Environment (GDE) from Matlab/Simulink control modules. Data is logged to 2GB of on-board Flash memory and downloaded for analysis via a Gigabit Ethernet network connection.

For example system configurations please refer to our Units and Datalogging application notes.

Application
- General purpose data logging
- Real time telemetry transmission via ARCNET connection to MES telemetry system

Electrical
- Supply voltage 8V to 16V DC with reverse polarity and transient over-voltage protection
- 2GB Flash memory for logging
- Hardware acceleration of front-end signal processing functions including filtering and down-sampling
- Customer application processing power >1000MIPS

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

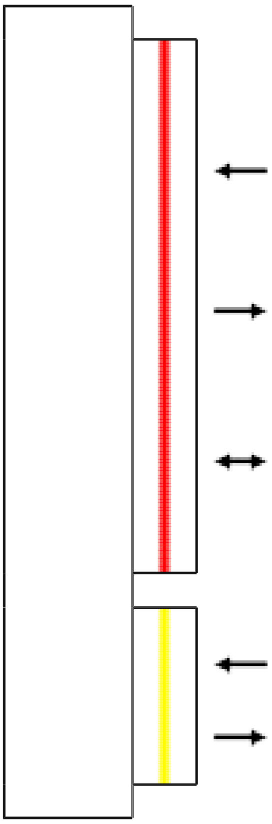
Other Features
- ATLASLite and System Monitor configuration software licences supplied with each unit

Connection Definition
- Two 64-way Deutsch AS Double Density connectors

Mechanical
- Case material aluminium alloy, hard-anodised black
- Weight 625g

Environmental
- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Maximum operating temperature 70°C
- Storage Temperature -10°C to 85°C
- Vibration isolation is recommended

Connector Details



Connector One

- One Lap Trigger
- Eight DHE speed
- One 5V sensor supply
- Ignition switch
- “Force Boot”
- “IP Address select”

- One DHE sensor supply
- One lap trigger supply

- One Ethernet
- One RS232
- One FlexRay link[1]
- One ARCNET
- Six CAN1
- One Timing synchronisation

Connector Two

- 48 Analogue inputs[2]

- Three 5V sensor supplies
- Five 12V sensor supplies

One CAN link can be replaced by a second FlexRay link as a build option

Eight analogue inputs can be hardware configured to Pt1000 inputs

Sensor Inputs

- 12 analogue inputs supporting sampling rates #400 kilosamples per second, 0-5V
- 36 analogue inputs supporting sampling rates #100 kilosamples per second, 0-5V (Eight can be hardware configured to Pt1000 inputs)
- One Lap trigger input
- Eight DHE speed inputs
- Timing synchronisation input/output
- Ignition switch input
- “Force Boot” analogue input, 1ksps, 0-5V
- “IP Address Select” analogue input, 1ksps, 0-5V

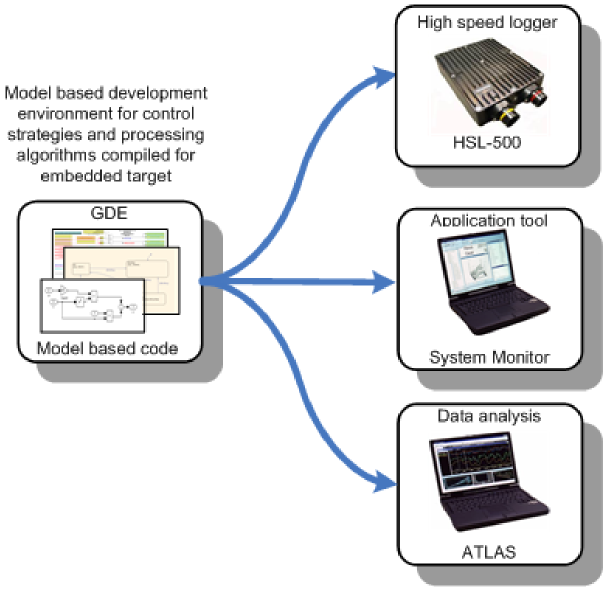
Outputs

- Three sensor supplies at 5V, 100mA (one shared between both connectors)
- Five sensor supplies at 12V, 200mA
- One DHE sensor supply at 12V, 200mA
- One lap trigger supply at 5V, 200mA

Communications

- One Gigabit Ethernet link (10/100/1000Mbps)
- One RS232 link (up to 1Mbps)
- One FlexRay links (10Mbps) (A second Flex Ray can replace one CAN as a build option)
- One ARCNET link (10Mbps)
- Six CAN links (1Mbps) (One CAN can be replaced by 2nd FlexRay as a build option)

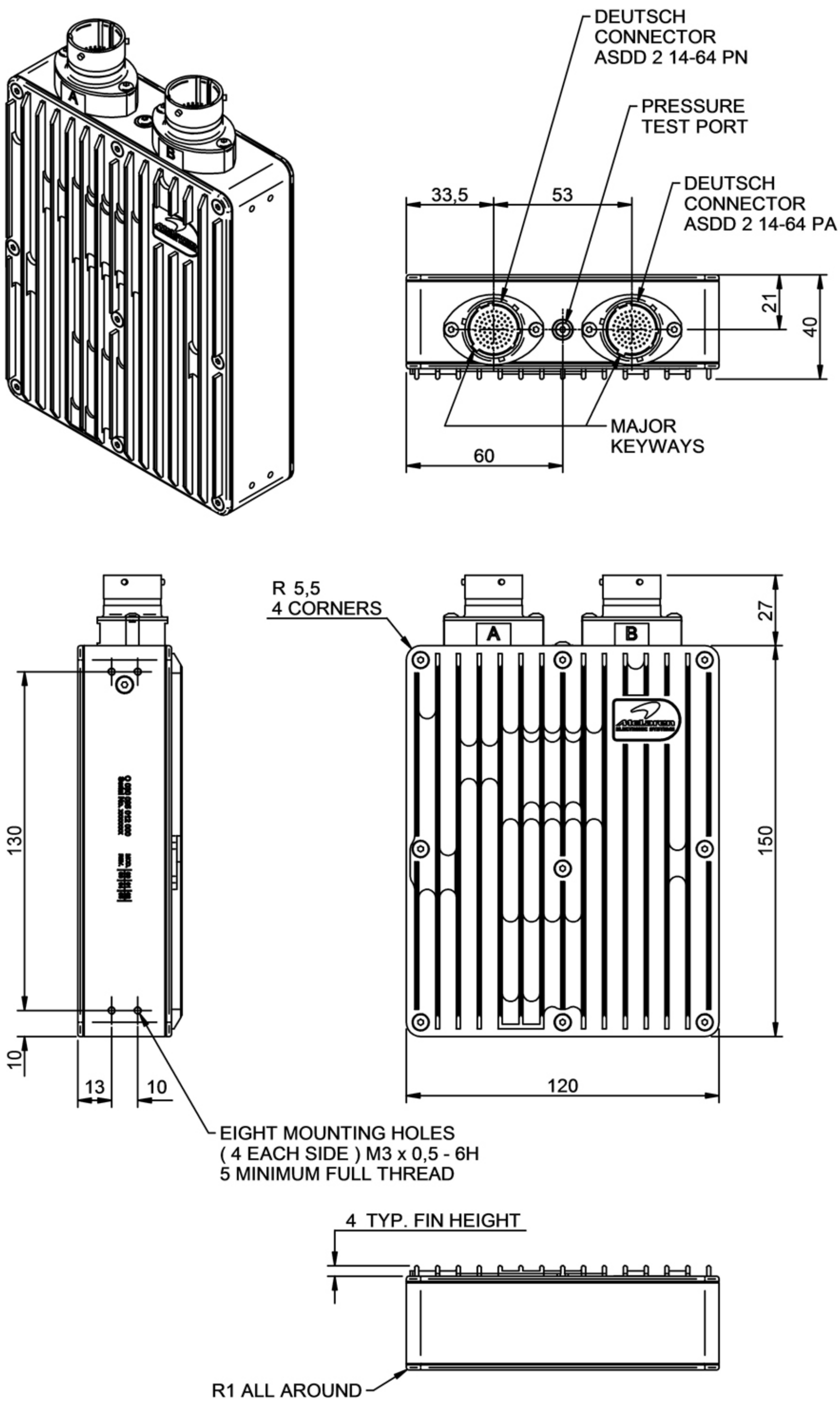
HSL-500 development system



- 12x 400kHz 12bit analogue 0-5V
- 36x 100kHz 12bit analogue 0-5V
- 8x DHE inputs
- 1x Lap trigger I/P
- 1Gbit ethernet
- 6x CAN interfaces
- 1x ARCNET link to telemetry transmitter
- 2Gbyte Onboard logging memory and data acquisition system
- Supports logging of up to 1024 parameters

- Program version management
- ECU reprogramming
- Data tuning
- Live parameter display
- ActiveX interface
- CAN configuration
- Data Acquisition configuration

- Live data display via ethernet or wireless
- Upload of logged data
- Waveform, scatter, bar chart, histogram, FFT display types
- MATLAB export
- Numeric functions
- ActiveX interface



Description	Ordercode
HSL-500 High Speed Logger (2GB memory, six CAN and one Flexray)	O 030 095 012 000

High-Speed Data Logger
HSL-300

The HSL-300 sets the standard for self-contained data logging for applications in top-level motorsport. It includes many innovative features from the HSL-500 including advanced hardware acceleration of front-end signal processing functions and support for custom application code. An upgrade is also available to full HSL-500 functionality.

The unit can acquire data from on-board interfaces at rates of up to 10 kilosamples per second, and from remote units via communications links. A high-performance on-board PowerPC microprocessor offering over 1000MIPS processing power hosts customer applications for real-time data analysis. Application code may be autocoded using our Graphical Development Environment (GDE) from Matlab/Simulink control modules. Data is logged to 2GB of on-board Flash memory and downloaded for analysis via a Gigabit Ethernet network connection.

For example system configurations please refer to our Units and Datalogging application notes.

Application
- General purpose data logging
- Real time telemetry transmission via ARCNET connection to MES telemetry system

Electrical
- Supply voltage 8V to 16V DC with reverse polarity and transient over-voltage protection
- 2GB Flash memory for logging
- Hardware acceleration of front-end signal processing functions including filtering and down-sampling
- Customer application processing power >1000MIPS

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

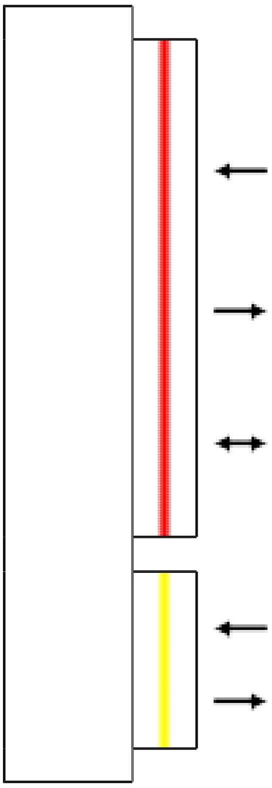
Other Features
- ATLASLite and System Monitor configuration software licences supplied with each unit

Connection Definition
- Two 64-way Deutsch AS Double Density connectors

Mechanical
- Case material aluminium alloy, hard-anodised black
- Weight 625g

Environmental
- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Maximum operating temperature 70°C
- Storage Temperature -10°C to 85°C
- Vibration isolation is recommended

Connector Details



Connector One

- One Lap Trigger
- Eight DHE speed
- One 5V sensor supply
- Ignition switch
- "Force Boot"
- "IP Address select"

- One DHE sensor supply
- One lap trigger supply

- One Ethernet
- One RS232
- One ARCNET
- Four CAN
- One Timing synchronisation

Connector Two

- 48 Analogue inputs[1]

- Three 5V sensor supplies
- Five 12V sensor supplies

Eight analogue inputs can be hardware configured to Pt1000 inputs

Sensor Inputs

- Eight analogue inputs supporting sampling rates #10 kilosamples per second, 0-5V
- 40 analogue inputs supporting sampling rates #1 kilosamples per second, 0-5V (Eight can be hardware configured to Pt1000 inputs)
- One Lap trigger input
- Eight DHE speed inputs
- Timing synchronisation input/output
- Ignition switch input
- "Force Boot" analogue input, 1ksps, 0-5V
- "IP Address Select" analogue input, 1ksps, 0-5V

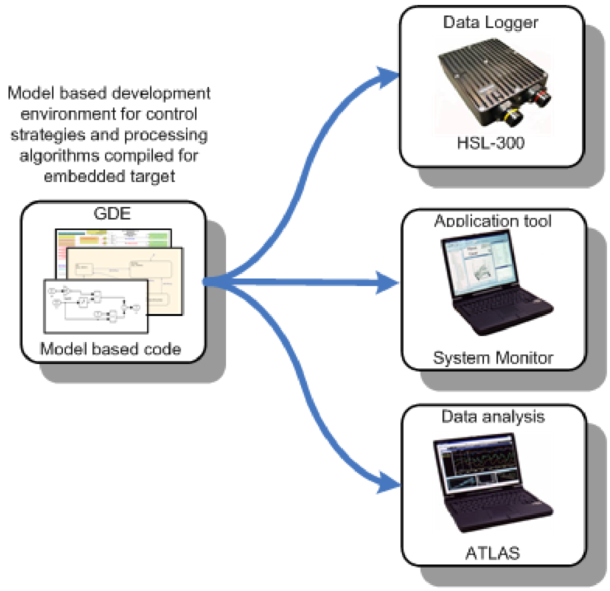
Outputs

- Three sensor supplies at 5V, 100mA (one shared between both connectors)
- Five sensor supplies at 12V, 200mA
- One DHE sensor supply at 12V, 200mA
- One lap trigger supply at 5V, 200mA

Communications

- One Gigabit Ethernet link (10/100/1000Mbps)
- One RS232 link (up to 1Mbps)
- One ARCNET link (10Mbps)
- Four CAN links (1Mbps)

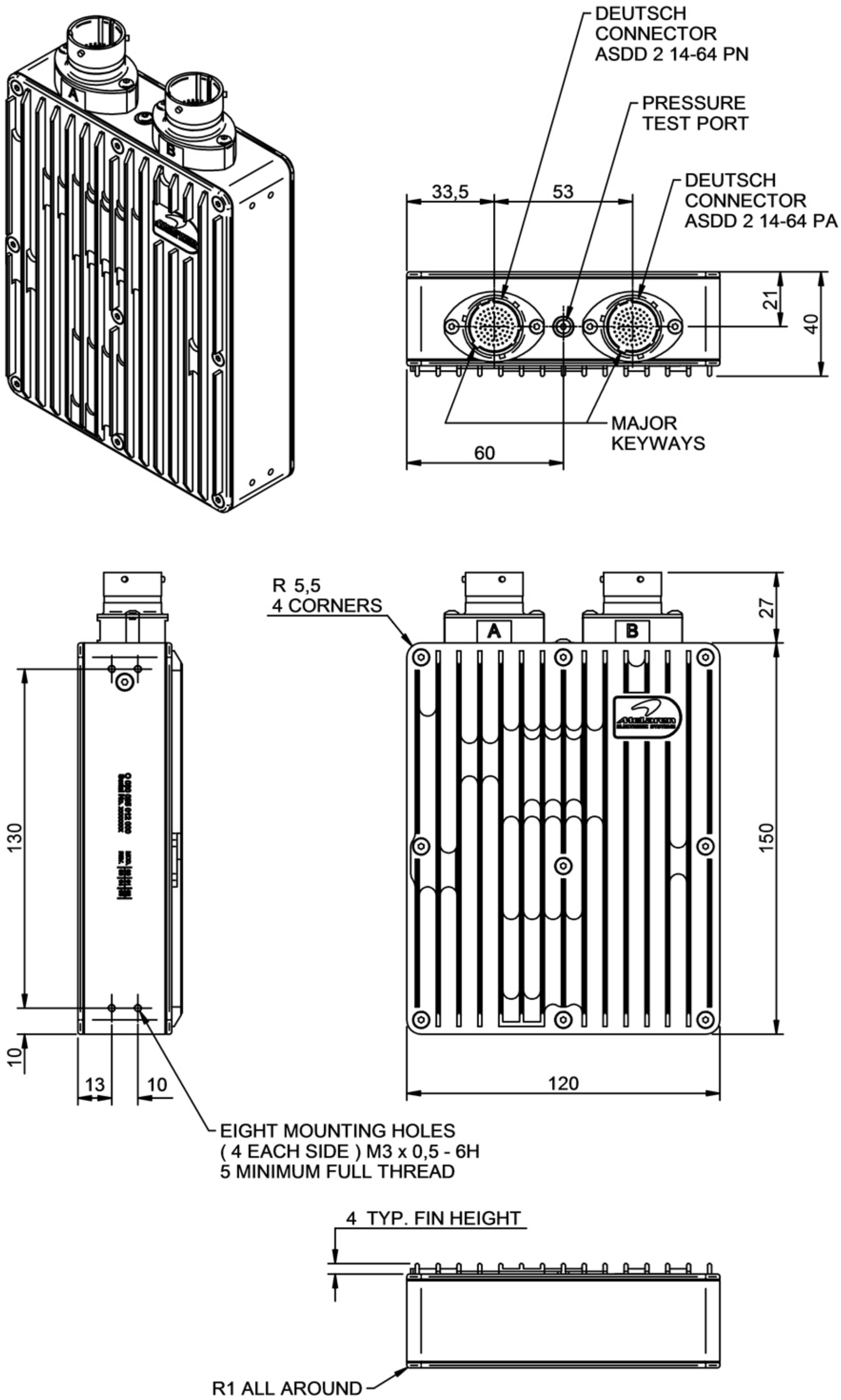
HSL-300 development system



8x 10kHz 12bit analogue 0-5V
40x 1kHz 12bit analogue 0-5V
8x DHE inputs
1x Lap trigger I/P
1Gbit ethernet
4x CAN interfaces
1x ARCNET link to telemetry transmitter
2Gbyte Onboard logging memory and data acquisition system
Supports logging of up to 512 parameters

Program version management
ECU reprogramming
Data tuning
Live parameter display
ActiveX interface
CAN configuration
Data Acquisition configuration

Live data display via ethernet or wireless
Upload of logged data
Waveform, scatter, bar chart, histogram, FFT display types
MATLAB export
Numeric functions
ActiveX interface



Description	Ordercode
HSL-300 High Speed Logger	O 030 095 012 004
Upgrade from HSL-300 to HSL-500	O 030 095 012 005

Embedded PC Logger
EPL-310

The EPL-310 Embedded PC Logger is a local data acquisition unit for automotive applications designed to provide data capture from USB devices such as onboard cameras.

The unit is based around a 1.6GHz Intel® Atom™ processor running the Microsoft Windows XP Embedded operating system. Applications for on board data processing may be developed using the McLaren Electronics GDE products run under the vTAG execution environment. vTAG provides functionality for data processing and data acquisition for subsequent upload to ATLAS.

Application

- Data logging applications requiring data capture from USB devices such as onboard cameras.

Electrical

- Supply Voltage +9.0 to +16.0V DC
- Reverse polarity input protection provided on the supply
- Supply Current 0.80A (typical) at 13.8V

Communications

- One Ethernet (100BaseTX)
- One CAN bus interface, operating at up to 1Mbps
- One RS232 (PC COM1)
- Four USB 2.0

Other features

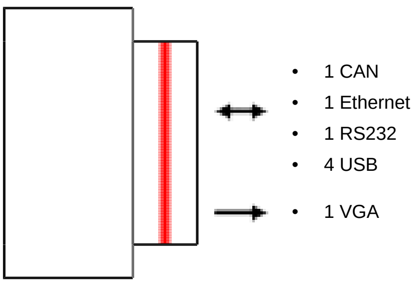
- VGA for direct connection to a display screen
- Intel® Atom™ series microprocessor operating at 1.6GHz
- 1GB DDR2 RAM
- 2GB Flash memory for Windows XPe and program storage
- 32GB Flash memory for data acquisition storage
- Capable of logging camera images up to 100Hz

Mechanical

- Case material magnesium alloy finished with black epoxy polyester, stippled
- Weight 545g

Connection Definition

- Unit connector ASDD-12-41PN (harness mating connector ASDD6-12-41SN)



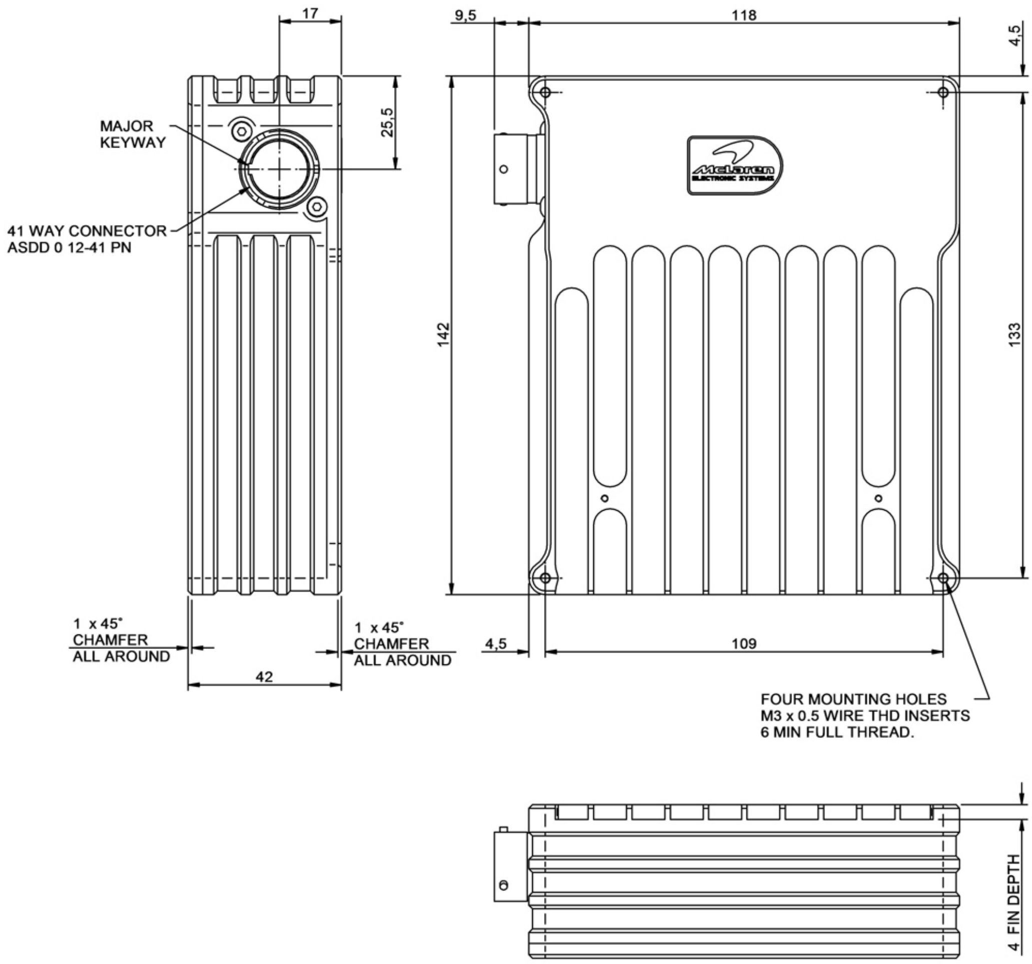
For pin numbers please contact our technical consultancy department

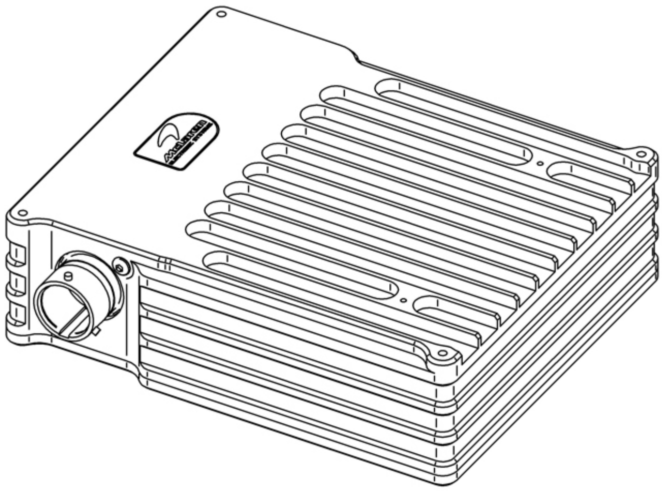
Environmental

- Splash resistant to standard motorsport fluids
- Lid is sealed to the case, all through-case fixings sealed with silicone sealant, sealed motorsport connector
- Operating temperature 0 to +70°C
- If necessary cooling should be applied to ensure temperature remains within these limits
- Storage temperature 0 to +70°C
- Vibration 100 to 1000Hz, all axes, 24hrs

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 2004/108/EC





Description	Ordercode
EPL-310	O 030 095 015 000

Embedded PC Logger

EPL-110/EPL-111

The EPL-110 and EPL-111 Embedded PC Loggers are local data acquisition units for transport applications designed to provide data capture from USB devices and video cameras.

The units are based around a 1.33GHz Intel Atom processor running the Microsoft Embedded XP operating system. Applications for on board data processing may be developed using the McLaren Electronics GDE products run under the vTAG execution environment. vTAG provides functionality for data processing and data acquisition for subsequent upload to ATLAS.

Application

- Data logging applications requiring data capture from USB devices and video cameras.

Electrical

- Supply Voltage +28 to +40VDC
- Reverse polarity input protection is provided
- Supply input current 1.3A @36V

Communications

- One Ethernet 10/100Mbps
- One 4.9GHz WiFi / 802.11
- One 5.8GHz or 2.4GHz WiFi / 802.11
- One CAN 2.0B up to 1Mbps
- One RS232
- Four USB 2.0

Inputs

- One general purpose 0–5V analogue input
- Four analogue video inputs

Other features

- Tri-axis accelerometer (+/-4g range)
- GPS module
- Video server module which converts analogue (composite) video to a MPEG-4 / Motion JPEG digital video stream for transfer / streaming over Ethernet
- VGA for direct connection to a display screen
- Intel Atom series microprocessor operating at 1.33GHz
- 1GB DDR2 RAM
- 2GB Flash memory for Windows XPE and program storage
- 2GB Flash memory for data acquisition storage

Connection Definition

- Four USB 2.0 (Type A socket)
- One CAN 2.0B (9-way D-Sub socket)
- One RS232 (9-way D-Sub plug)
- One Ethernet (RJ45)
- One VGA Monitor (15-way high-density D-Sub socket)
- Four Analogue video (BNC)
- Four WiFi Antenna (SMA)
- One GPS antenna (SMA)
- One Analogue input (LEMO 3 way F-series size 0F socket)
- One Power supply (LEMO 2 way F-series size 0F plug)

Environmental

- Dust seal rated to IP50 (IEC 60529)
- Operating temperature 0 to +50°C
- If necessary cooling should be applied to ensure temperature remains within these limits
- Storage temperature -25 to +85°C

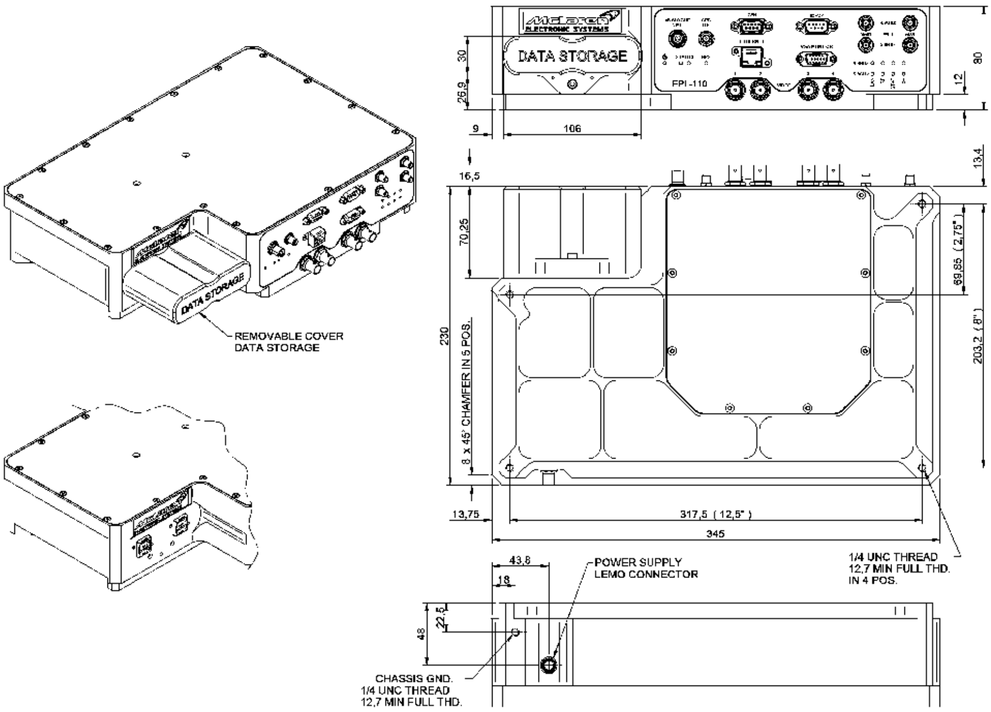
- Vibration 10 to 2000Hz, all axes, 24hrs

Electro Magnetic Compatibility

- Certification to meet the requirements of FCC part 15 pending

Mechanical

- Aluminium case, painted silver
- Weight 4kg



Description	Ordercode
EPL-110 (5.8GHz WiFi)	O 030 095 017 000
EPL-111 (2.4GHz WiFi)	O 030 095 017 001

Enhanced Data Recorder
EDR-400

The EDR-400 is a compact, self-contained data logger developed specially for on-board racing applications.

The unit provides 42 direct inputs, and additional inputs via CAN-linked sensor interface units. The unit comes with 1Gbytes integrated logging memory, GPS and integrated 115.2kbps telemetry option.

Additional functionality may be added by the customer using our Graphical Development Environment (GDE) to auto generate applications from Matlab/Simulink control modules.

For compatibility with existing units and expansion potential, please refer to the application notes.

Application
- General data logging and control.

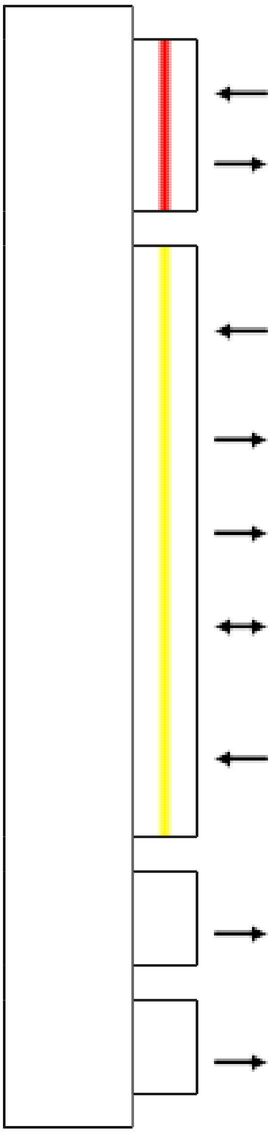
Electrical
- Supply Voltage 7.5 to 16.0V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- TAGOS 32-bit Real Time Operating System
- Internal Data logging memory capacity 1Gbytes
- Maximum logging data rate 100Kbytes/sec
- Up to 200 channels can be logged.
- Maximum sample rate 1KHz per channel
- GPS with 4Hz update rate (maximum)

Mechanical
- Case material Aluminium, anodised black
- Weight 550g (605g including telemetry option)

Connection Definition
- Integral, sealed, military standard connectors

Other Features
- One ATLASLite licence supplied with each unit
- One System Monitor configuration software licence supplied per team

Connector Details



(A) Sensor Group

- 32 Analog inputs
- 5V sensor supply (x2)
- Analog Ground (x2)

(B) Chassis Group

- 1 Lap Trigger
- 7 DHE speed
- 2 K type thermocouples
- PCU-6 supply
- 5V general purpose supply
- Digital Ground (x1)
- 4 High/Low sides
- 3 Low sides
- 1 Ethernet
- 2 CAN
- 1 RS232
- Power Grounds
- Ignition switch
- Unit supply
- H-Bridge supply

QMA Group

- GPS Antenna (active)

SMA Group

- Telemetry Antenna

Environmental

- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings and screws sealed with silicone rubber
- Maximum humidity 95% non-condensing
- Minimum operating temperature -10°C
- Internal temperature not to exceed 70°C as measured by internal diagnostic sensors
- Storage temperature -10 to +85°C
- Vibration 100 to 1000Hz, all axes, 24hrs

Electro-Magnetic Compatibility

- Complies with the essential protection requirements of EMC Directive 2004/108/EC

Telemetry Option

- Integrated 902 to 928MHz FHSS transceiver
- Peak data rate 115.2kbps (19.2 to 115.2kbps settings)
- Maximum 1W output power (programmable)
- Car antenna O 030 065 014 000
- Pit antenna O 030 065 015 000
- CBR-400 Modem Receiver (O 030 052 012 000)

Sensor Inputs

- Seven DHE Speed Sensors
- 22 Analog (0 to 5V)
- Four Pt1000 temperature sensors (programmable as analogs)
- Three NTC temperature sensors (programmable as analogs)

- Three switch inputs (programmable as analogs)
- Two K-type thermocouples
- Lap Trigger

Outputs

- Two H-Bridges or four High/Low side drivers (programmable)
- Three Low side drivers
- External sensor supplies
- PCU-6 drivers (requires two High/Low-side drives and the three Low-side drivers)

Communications

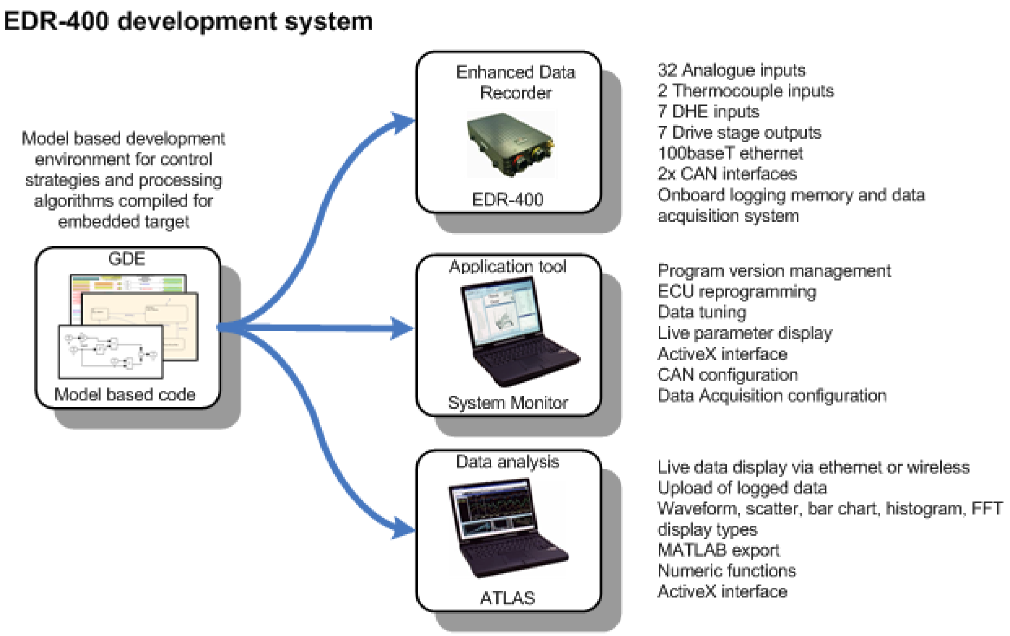
- One Ethernet (up to 100Mbps)
- Two CAN 2.0B bus (up to 1Mbps)
- One RS232 (up to 230kbps)
- One bi-directional telemetry option (19.2 to 115.2kbps settings)

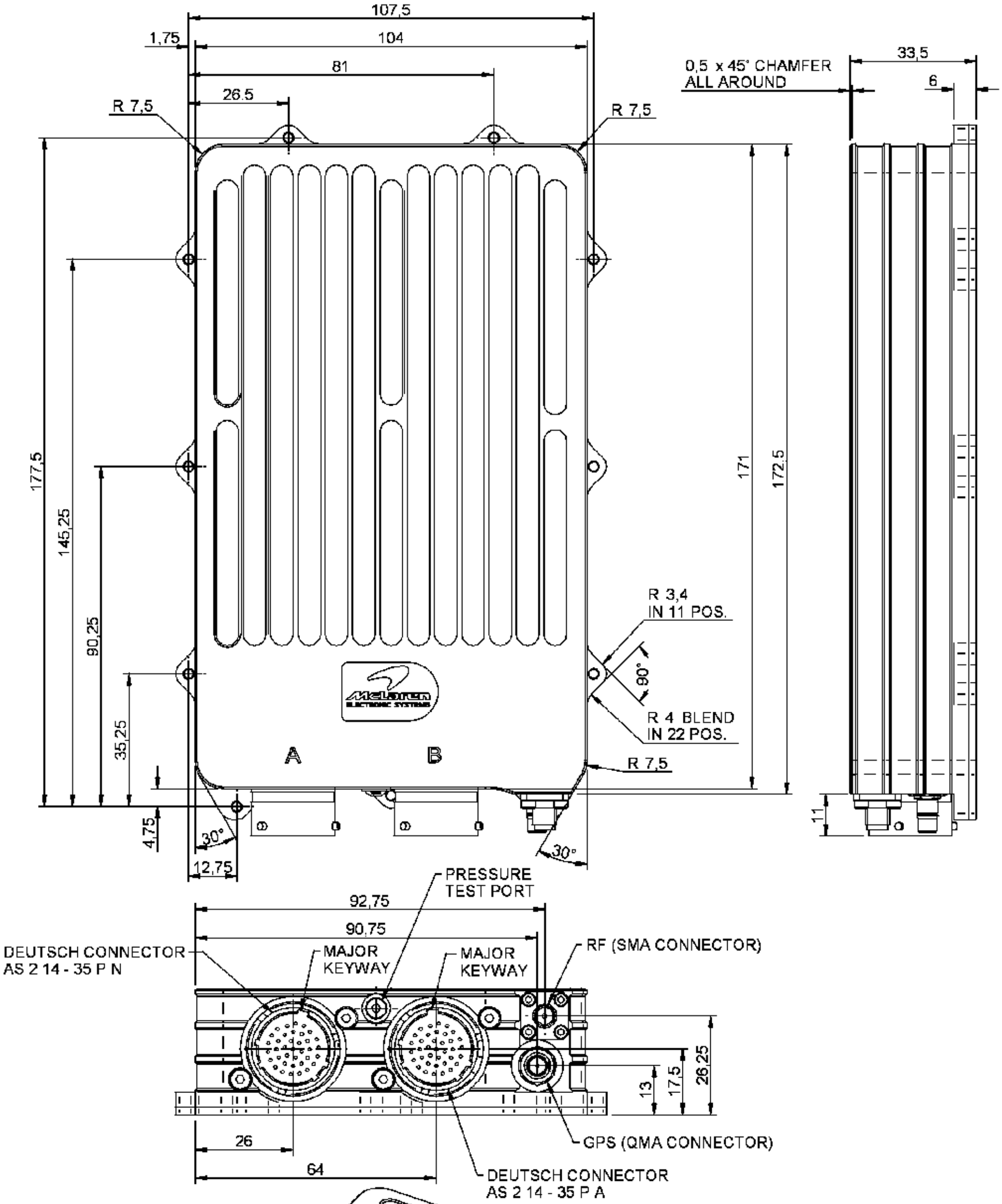
Data Logging

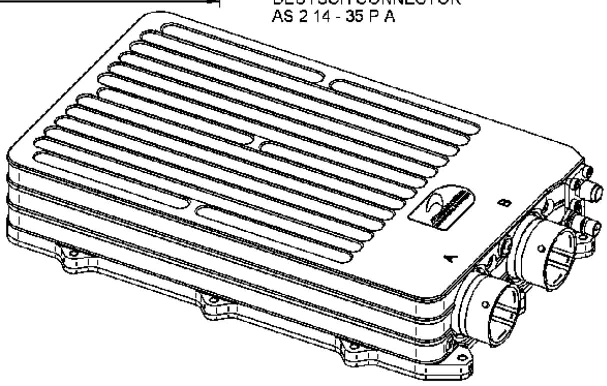
- 1 Gbyte logging memory

Diagnostics

- Sensor readings are checked for out of range and open circuit
- The following internal parameters are monitored:
  - Board temperatures
  - Unit supply voltages
  - Bridge/High side currents
  - HS/LS output status
  - GPS system status







Description	Ordercode
EDR-400	O 030 071 010 000
EDR-400T (with telemetry option)	O 030 071 010 001

Data Logger

ADL-100

The ADL-100 is a general purpose cost-effective data-logger which records data passed via CAN from the host ECU.

The part is ideally suited to logging data for accident data analysis and includes an in-built two-axis accelerometer

Application

- General purpose data logging

Electrical

- Supply voltage 7V to 14V DC, 30V maximum, with protection against transients
- Two independent external supply inputs for increased reliability
- Current 150mA at 14V typical, 192mA at 14V max

Summary of features

- Internal 2 axis ±10g accelerometer, 10Hz response time
- Two Mbyte non-volatile logging flash memory
- Four Kbyte serial EEPROM
- Five year data retention
- Real Time Clock with lithium battery backup
- Supply, battery voltage and temperature diagnostics

Communications

- One 1Mbps CAN bus communications interface

Connection Definition

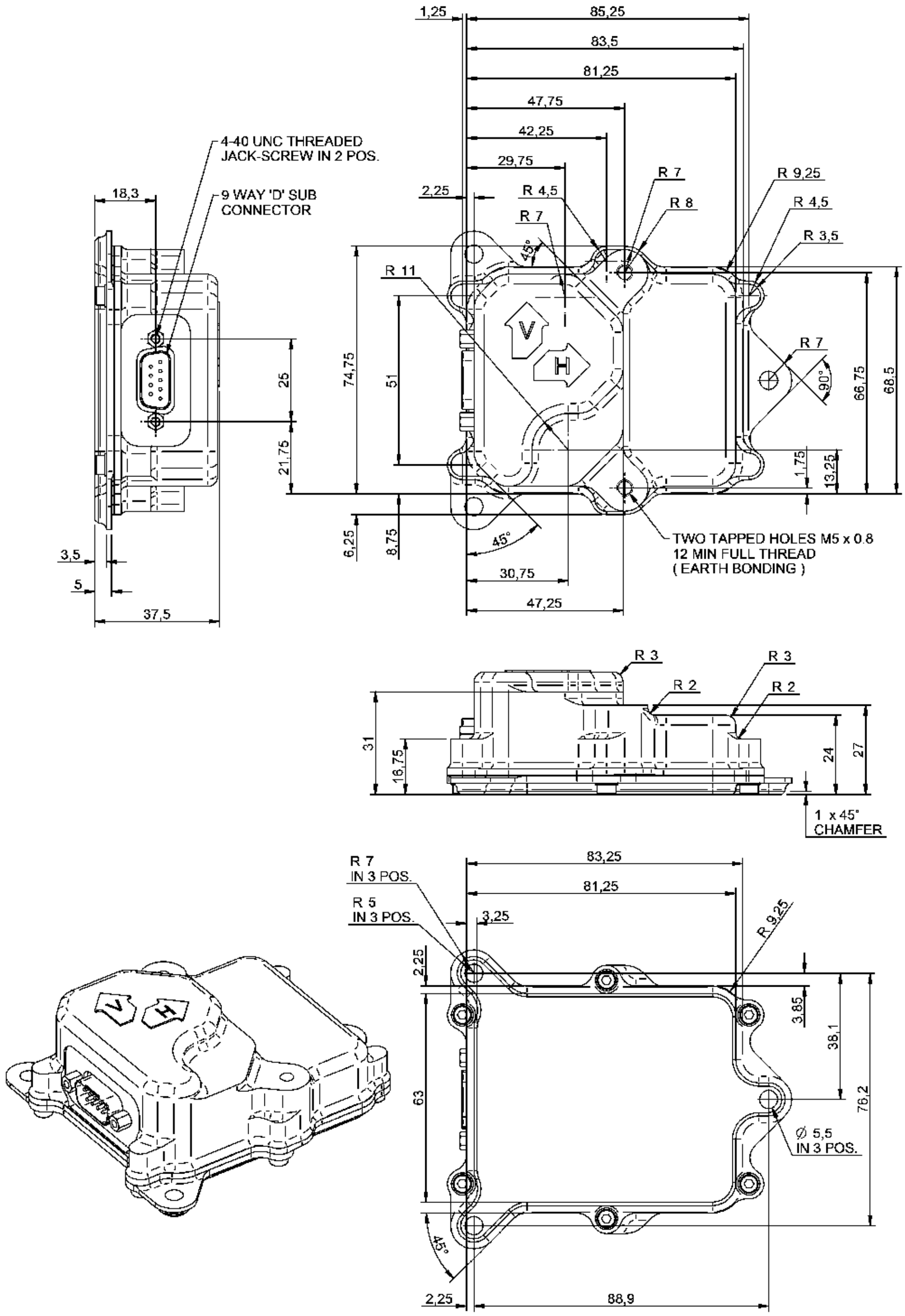
- Sealed 9-way D-sub connector

Mechanical

- Case material aluminium alloy, hard-anodised black
- Weight 250g

Environmental

- Splash resistant to standard motorsport fluids
- Maximum humidity 100%
- Minimum operating temperature -40°C
- Maximum operating temperature +85°C



Description	Ordercode
ADL-100	O 030 095 013 000

Data Logger
DataTAG

DataTAG is a MultiMedia/SecureData card data logger for storing 'raw data' sent from a host unit via CAN or RS232.

Full support is provided for a host unit such as the TAG-400 or MCU-300 to create and change directories, open/close files and write data for a Windows FAT compatible file system. Information for software interfacing to third party host units can be provided upon request.

Application

- Data logging applications which require more data logging memory than provided in the host unit.

Electrical

- Supply Voltage +8.0 to +17.0V DC
- Supply inputs >17V (excluding transients) will lead to failure of the suppressor and cause permanent damage to the unit
- Reverse polarity input protection provided on the supply
- Supply input current 150mA @ 13.8V
- LED indicators for memory card status and operating mode

Inputs

- Permanent supply

Outputs

- None

Communications

- One RS232 interface, full duplex, operating at standard baud rates up to 500kbps
- One CAN bus interface, 2.0B, operating up to 1Mbps

Other features

- Wake up management of device from RS232 or CAN
- Real Time Clock, with capacitor battery backup
- SPI mode MultiMedia/SecureData Card Slot
- 1 Gbyte SD card included
- Hall effect switch protection against inadvertent removal of memory card without file closing

Recommended Operation

- Only pre-formatted Windows FAT MMC/SD cards should be used. The recommended card type is the SanDisk Extreme III 1 Gbyte SD card, Part No. SDSDX3-1024-902 (Retail version).

Connection Definition

- Connector AS 108-35 PN on flying lead
- Connection

Pin 1	Permanent supply
Pin 2	Unit ground
Pin 3	RS232 transmit data output
Pin 4	RS232 receive data input
Pin 5	CAN interface +
Pin 6	CAN interface -

To allow operation at 500kbps, the RS232 cable length should be kept below four metres to reduce noise susceptibility and cable loadings

Mechanical

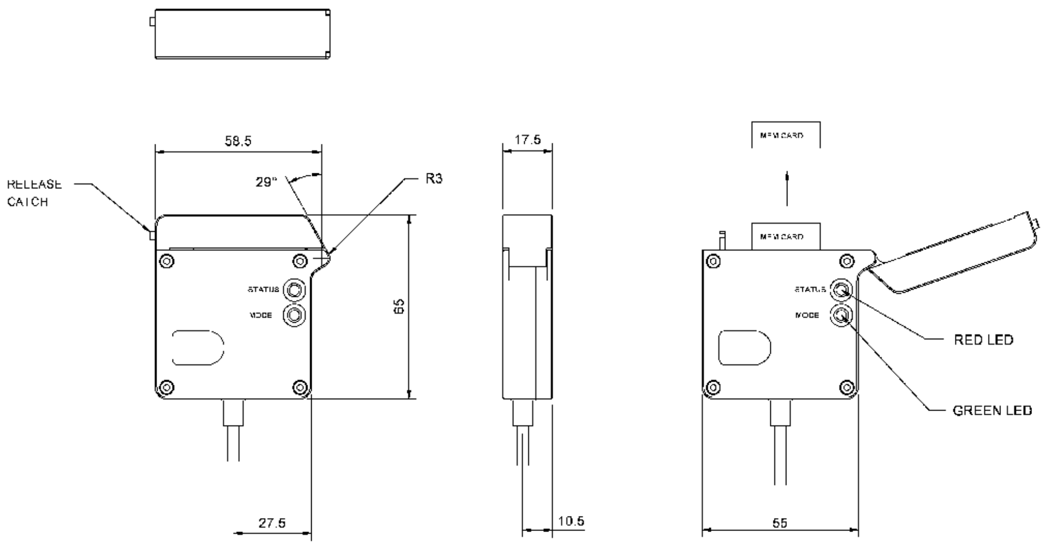
- Case material hard black anodised aluminium
- Weight approximately 110g
- Vibration isolation is recommended

Environmental

- Splash resistant to standard motorsport fluids
- Lid is sealed to the case, all through-case fixings sealed with silicone sealant, sealed motorsport connectors
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Internal temperature not to exceed 85°C as measured on the temperature diagnostic
- Storage temperature -10 to +85°C
- Vibration 100 to 1000Hz, all axes, 24hrs

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC



Description	Ordercode
DataTAG	O 030 095 010 000

Electronics

Data Logger
DataTAG-2

DataTAG-2 is a MultiMedia/SecureData card data logger for applications in which an external power supply is not always available. The unit may be powered by a simple alkaline or rechargeable AA battery.

The unit supports external inputs, RS-232 and CAN. It writes data onto removable data cards according to a Windows FAT compatible file system.

Application
- Data logging applications which require battery-powered unit, for example motorcross.

Electrical
- AA 1.5V battery
- Supply Voltage +7.0 to +16.0V DC (recharge)
- Supply inputs >18V (excluding transients) will lead to failure of the suppressor and cause permanent damage to the unit
- Reverse polarity input protection provided on the supply
- Supply input current 100mA @ 13.8V (recharging)
- LED indicators for power, recharger status and operating mode

Inputs
- Permanent supply (optional)
- 10 analogue inputs (10-bit)
  (Four inputs may be software configured as two bridge inputs for load cells and the remaining inputs as NTC temperature inputs)
- DHE speed input

Outputs
- 5V reference sensor supply
- 10V regulated sensor supply

Communications
- One RS232 interface, full duplex, operating at standard baud rates up to 115kbps
- One CAN bus interface, 2.0B, operating at up to 1Mbps

Other Features
- Logging rates up to 500Hz (logging up to five channels) or 100Hz (any channels)
- Real Time Clock
- SPI mode MultiMedia/SecureData Card Slot
- 1Gbyte SD card included
- Hall effect switch protection against inadvertent removal of memory card without file closing
- One ATLASLite licence supplied with each unit

Recommended Operation
- Only pre-formatted Windows FAT MMC/SD cards should be used. The recommended card type is the SanDisk Extreme III 1 Gbyte SD card, Part No. SDSDX3-1024-902 (Retail version).

Connection Definition
- Three motorsport Lemo connectors (8-way)
- Connector One
  - External supply
  - RS-232
  - CAN
  - 10V sensor supply
  - DHE speed input
- Connectors Two & Three
  - 5V sensor supply
  - AGND

- Five analogue inputs (each)

Mechanical

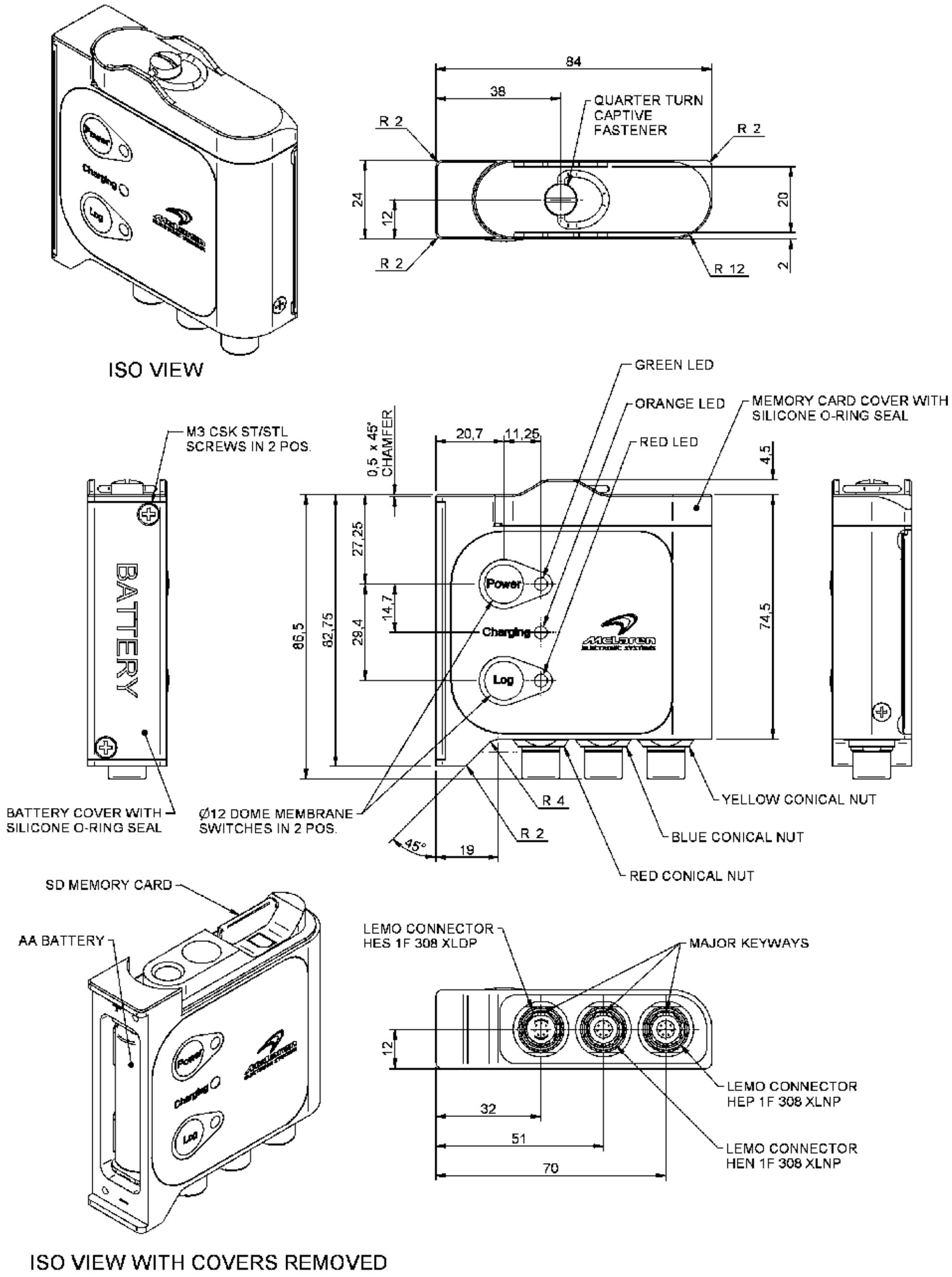
- Case material hard black anodised aluminium
- Weight approximately 230g including battery
- Size approximately 84mm x 86mm x 24mm
- Vibration isolation is recommended

Environmental

- Splash resistant to standard motorsport fluids
- Lid is sealed to the case, all through-case fixings sealed with silicone sealant, sealed motorsport connectors
- Maximum humidity 100%
- Operating temperature 0 to +50°C (battery power) or 0 to +70°C (external power)
- Storage temperature -10 to +70°C
- Vibration 100 to 1000Hz, all axes, 24hrs

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC



Description	Ordercode
DataTAG-2	O 030 095 011 000

Telemetry

Telemetry Unit
CBM-470B

The CBM-470B telemetry unit is for motorsport and automotive applications designed to support wireless data transfer and provide local data logging. The CBM is very versatile and depending on the antenna module attached can support a number of different wireless technologies, including WiMAX telemetry with our WMX-470B.

The CBM-470B's main purpose is to take telemetry data from ARCNET, Ethernet and CAN plus high quality driver audio. Driver audio is sampled at audio rates significantly minimizing the impact of engine noise.

The unit is based around an Intel Atom processor core running a highly optimised Linux based RTOS.

Application

Telemetry applications requiring data capture and storage. Can also be used for VOIP applications (e.g. voice radio).

Electrical

- V_{BAT} supply voltage 8.5V (9V WMX) to 16.0V DC

Supply current	CBM	incl. 1 WMX	incl. 2 WMX
Typical at 13.8V	0.4A	0.7A	1.0A
Max at 13.8V	1.1A	1.7A	2.3A
Max at V_{BAT} min	1.8A	2.8A	3.8A

Inputs

- Four 0V – 5V general purpose analogue inputs
- Two digital inputs (pull-up to V_{BAT} (1x) and 5V (1x))
- Two audio / electret type microphone inputs (s/w contr. internal bias voltage 2.5V / 3.75V with 10k# to microphone input (+), 1µF ac coupling to codec input, max input level 1.6Vrms, input impedance 47k#, s/w contr. boost gains of +10dB / +20dB / +30dB)
- One time synchronisation input (s/w selectable 120#)
- One external shut-down input (V_{BAT} level, default on)

Outputs (sourced from supply input)

- One 5V reference supply (100mA max)
- Two WMX supplies (s/w contr. 1A max each, V_{BAT})
- Two USB 5V supplies (s/w contr. 0.5A max each)
- Two audio / earphone outputs (individually protected bridged outputs with R_s 8.2#, 0.15Wrms (max) into 16# at max codec output level of 1.2Vrms, high-pass response with fL 20Hz typ)

Communications

- One Ethernet Port (10 baseT / 100 baseTx)
- Two CAN bus interfaces, operating at up to 1Mbps
- Two RS232
- Four USB 1.1 (12Mbps) / 2.0
- One ARCNET (10Mbps max, s/w selectable 120#)

Other Features

- 0.8GB mass storage for data logging
- 512MB DDR2 RAM
- Unit internal temperature and voltage diagnostics

Connection Definition

- Unit connectors:
  - Deutsch ASDD212-41PN
  - Deutsch ASDD210-23PN
- Harness mating connectors (recommended):

- ASDD612-41SN
- ASDD610-23SN

For pin allocations please contact our Technical Consultancy Department

Mechanical

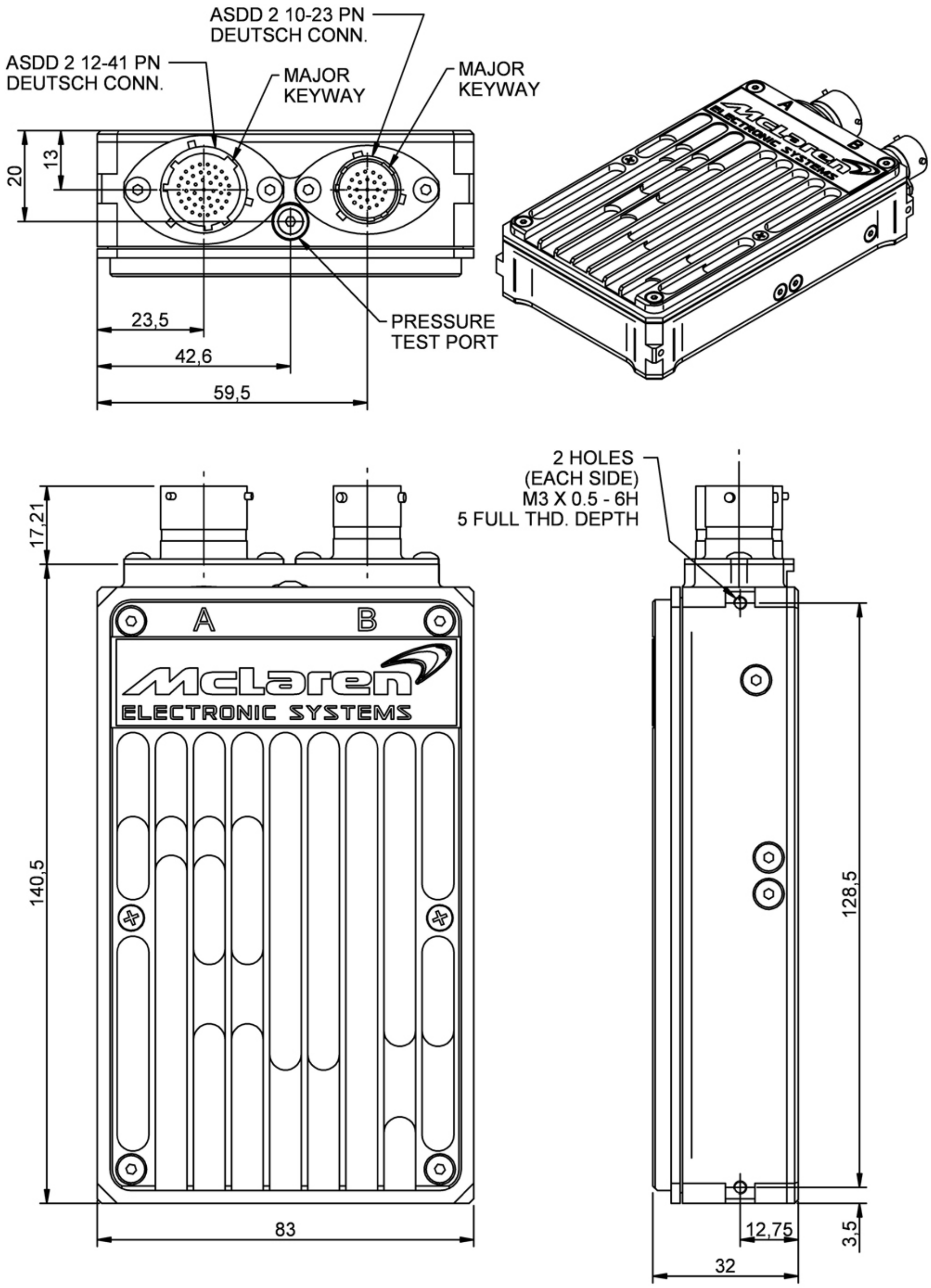
- Case Material: black painted magnesium alloy
- Weight: 320g (typical)

Environmental

- Splash resistant to standard motorsport fluids
- Lid is sealed to the case, all through-case fixings sealed with silicone sealant, sealed motorsport connector
- Operating temperature 0°C to +70°C (internal)
- If necessary cooling should be applied to ensure temperature remains within these limits (P_d max 10W)
- Storage temperature -10°C to +70°C Vibration 100 to 1000Hz, all axes, 24hrs

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 2004/108/EC



Description	Ordercode
CBM-470B	O 030 051 014 001

L-Band Receiver
CBR-610

The CBR-610 receiver is a pit-based L-Band receiver for telemetry data for use with the CBT-610 transmitter.

The CBR-610 is designed to plug into a sub-rack, which also contains the required power supplies. Up to three CBR-610 receivers can be plugged into a sub-rack at the same time, allowing simultaneous reception from up to three CBT-610s. The CBR-610 can be connected directly to an antenna to receive CBT-610 RF data. Alternatively, the CBR-610s can be used with a splitter module (ordercode O 030 052 006 000) to allow the signals from up to two antennas to be combined and split between the receivers in the sub-rack, thus avoiding the need for dedicated antennas per receiver.

Each receiver has a dedicated 100Mbps Ethernet interface for direct TCP/IP connection to a network or PC.

The unit provides a supply to an external mast-head Low Noise Amplifier (LNA).

Application

- High data rate continuous telemetry receiver, decoding 1.85MHz RF bandwidth OFDM signals from CBT-610 (using 74 carriers, 25kHz apart).
- Frequency range specified in ordercode details (L-Band), tuneable in 2 MHz steps.
- High-speed DSP performs automatic frequency control and automatic gain control for optimum signal processing, signal correlation, decoding of QPSK, 8PSK or 16PSK data, performs error correction through Turbo Product Code decoding, and also performs data de-scrambling and CRC computation.
- 48MByte memory board for data buffering for improved Ethernet network usage.

Electrical

- Supply Voltages 24V, ±12V, 5V with transient protection on all supplies
- Supply Current (typical operating current)
  40mA @ 24V (up to 200mA if an LNA is used)
  200mA @ 12V
  150mA @ -12V
  2.8A @ 5V
- Front panel LEDs to indicate Ethernet status, RF carrier detection and synchronisation and LNA power routing.

For programming information please contact our technical consultancy service

Communications

- One 100BaseT full-duplex Ethernet link
- Two RS232 serial links, up to 57.6kbps

Connection Definition

- 96-way DIN41612 connector

For pin numbers please consult our Technical Consultancy Department

Electro Magnetic Compatibility

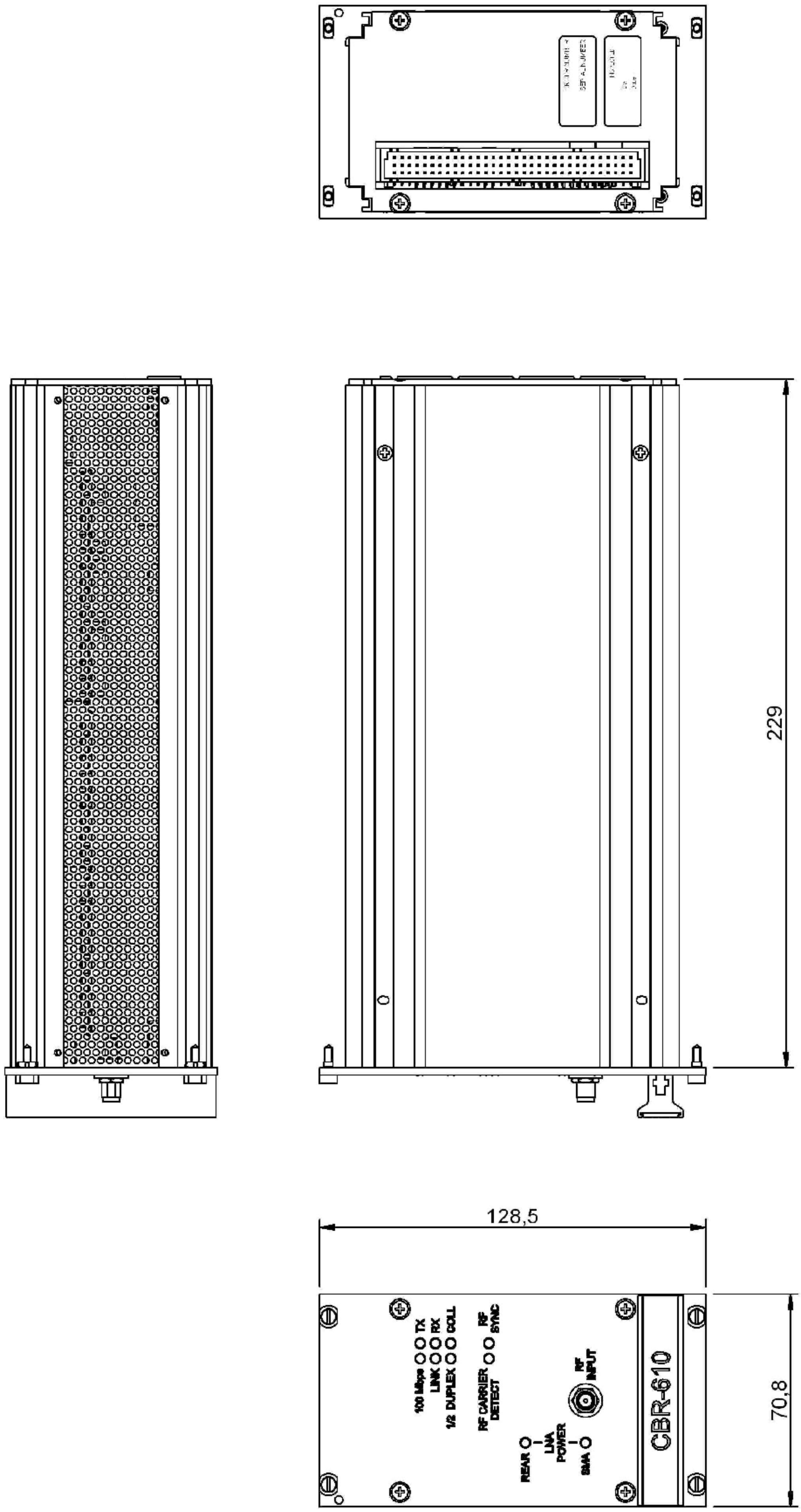
- Complies with the essential protection requirements of 89/336/EEC

Mechanical

- Rack mounted unit, 3U height, 14HP wide
- Weight approximately 1kg

Environmental

- The unit is not sealed and must be protected against moisture
- Operating Temperature 0 to 40°C
- Forced air cooling is required
- Storage Temperature -10 to 70°C



Description	Frequency	Ordercode
CBR-610	Standard 1450-1650MHz	O 030 052 010 000

Description	Frequency	Ordercode
CBR-610	High 1510-1710MHz	O 030 052 010 001
CBR-610	Low 1310-1490MHz	O 030 052 010 003

L-Band Transmitter
CBT-610

The CBT-610 transmitter is a car-based, L-band RF transmitter for telemetry data. Data is transmitted as an approx 2MHz wide signal in the L-band. Three different frequency ranges are available, 1310-1490MHz, 1450-1650MHz and 1510-1710MHz. The unit has 48MB internal memory to support probability based re-transmission strategies.

Telemetry data is primarily transferred to the CBT-610 unit from the on-car host unit via HDLC or ARCNET. Payload RF telemetry data rates of up to 2Mbps are supported. Retransmitted data handshaking for improved lap coverage is not required at many circuits, but may be provided using a small companion UHF modem (the CBX-450).

Application
- High data rate continuous telemetry transmitter.

Electrical
- Supply Voltage 11.5 to 16.0V DC (full RF performance)
- Reverse polarity input protection provided on the supply
- Supply Current operating
  3.5A typical @ 13.8V on high power setting
  1.6A typical @ 13.8V on low power setting
- Supply Current quiescent (RF shutdown) mode <1A
- Frequency range specified in ordercode details (L-band, 2MHz steps)
- Minimum channel spacing 4MHz (6MHz recommended)
- RF output power 50mW to 1W adjustable

Outputs
- One RF output (L-band)
  Typical error corrected payload data rate of 2Mbps

Communications
- Two HDLC interfaces, full duplex with two-way synchronous clocks, up to 8Mbps (can be software configured as one HDLC and one ARCNET, up to 10Mbps)
- One CAN bus interface, up to 1Mbps as standard
- One RS232 interface, up to 57.6kbps

Diagnostics
- Two internal diagnostic temperature sensors
- Two internal RF power sensors (forward and reverse)

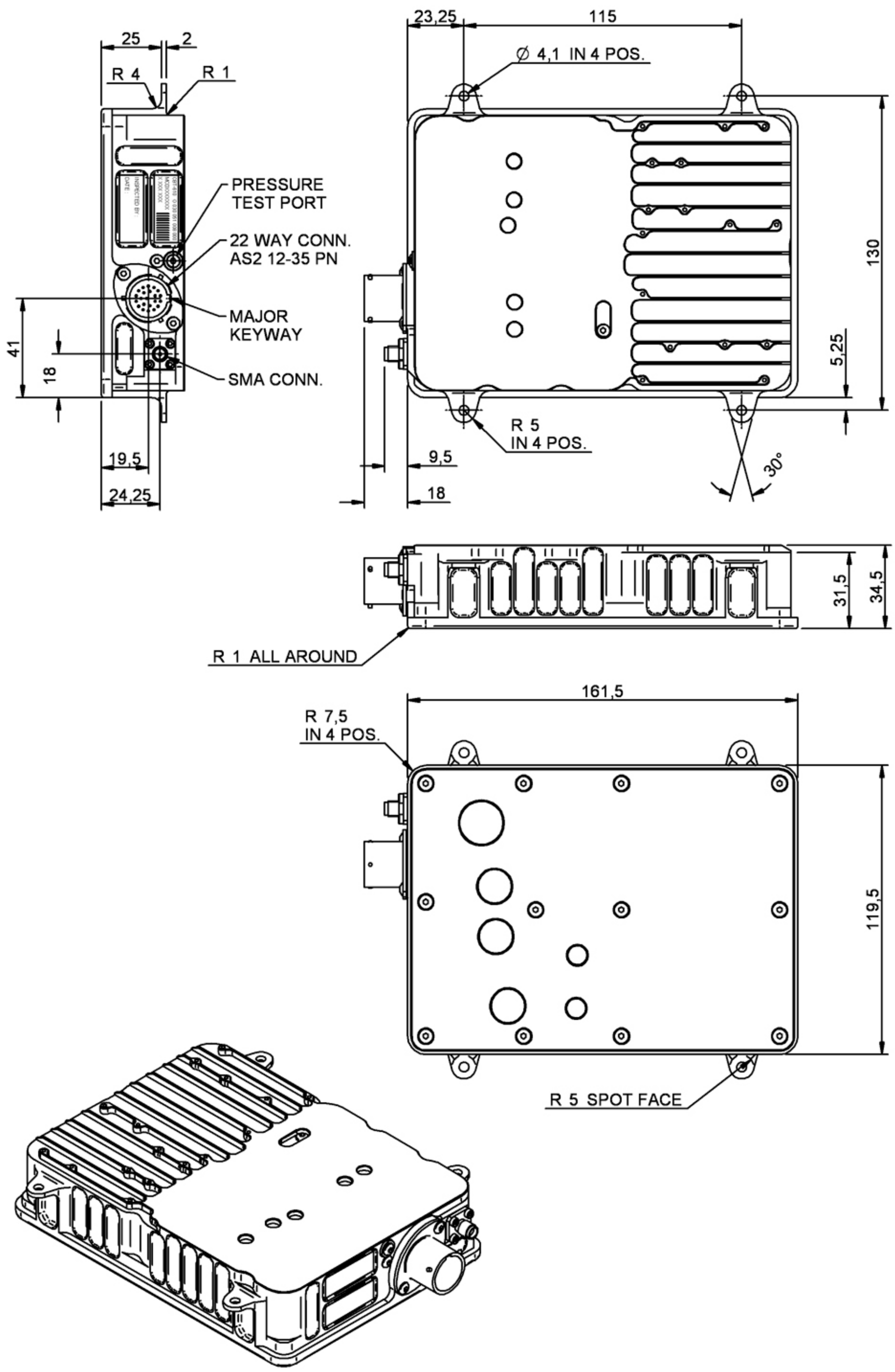
Connection Definition
- Chassis connector AS2 12-35PN
- RF connector 50ohm SMA socket
- For pinout information please consult our Technical Consultancy Department

Mechanical
- Case material magnesium alloy, chromate converted and painted with black epoxy polyester paint
- Weight approximately 508g
- Vibration isolation is recommended

Recommended Service Interval
- One year

Environmental
- Splash resistant to standard motorsport fluids
- Lid is sealed to the case, all through-case fixings sealed with silicone sealant, sealed motorsport connectors
- Maximum humidity 100%
- Minimum operating temperature 0°C

- Internal temperature not to exceed 70°C as measured on the temperature diagnostic, if necessary forced air cooling should be applied
- Storage temperature -10 to 85°C
- Vibration 100 to 1000Hz, all axes, 24hrs



Description	Frequency	Ordercode
CBT-610	Standard 1450-1650MHz	O 030 051 008 001
CBT-610	Low 1310-1490MHz	O 030 051 008 005
CBT-610	High1510-1710Mhz	O 030 051 008 003

L-Band Receiver

CBR-610C

The CBR-610C receiver is a pit-based L-Band receiver for telemetry data for use with the CBT-610 transmitter.

The CBR-610C is designed as a stand alone single receiver complete with all power supplies and air cooling built-in. The CBR-610C is connected directly to an antenna to receive CBT-610 RF data and has a dedicated 100Mbps Ethernet interface for direct TCP/IP connection to a network or PC.

The unit provides a supply to an external mast-head Low Noise Amplifier (LNA).

Application

- High data rate continuous telemetry receiver, decoding 1.85MHz RF bandwidth OFDM signals from CBT-610 (using 74 carriers, 25kHz apart).
- Frequency range 1450–1650 MHz (L-Band), tuneable in 2 MHz steps.
- High-speed DSP performs automatic frequency control and automatic gain control for optimum signal processing, signal correlation, decoding of QPSK, 8PSK or 16PSK data, performs error correction through Turbo Product Code decoding, and also performs data de-scrambling and CRC computation.
- 48MByte memory board for data buffering for improved Ethernet network usage.

Electrical

- Supply Voltage 110V – 240 ac 50-60Hz
- Front panel LEDs to indicate internal +5V, +/-12V supply status.
- Front panel LEDs to indicate Ethernet status, RF carrier detection and synchronisation and LNA power routing.

For programming information please contact our technical consultancy service

Communications

- One 100BaseT full-duplex Ethernet link with two toggle switches to select from a range of IP addresses
- One RS232 serial link, up to 57.6kbps
- One N-Type female for antenna cable connection and LNA power.
- One ‘Stay in Boot’ toggle switch (to allow IP address programming)

Electro Magnetic Compatibility

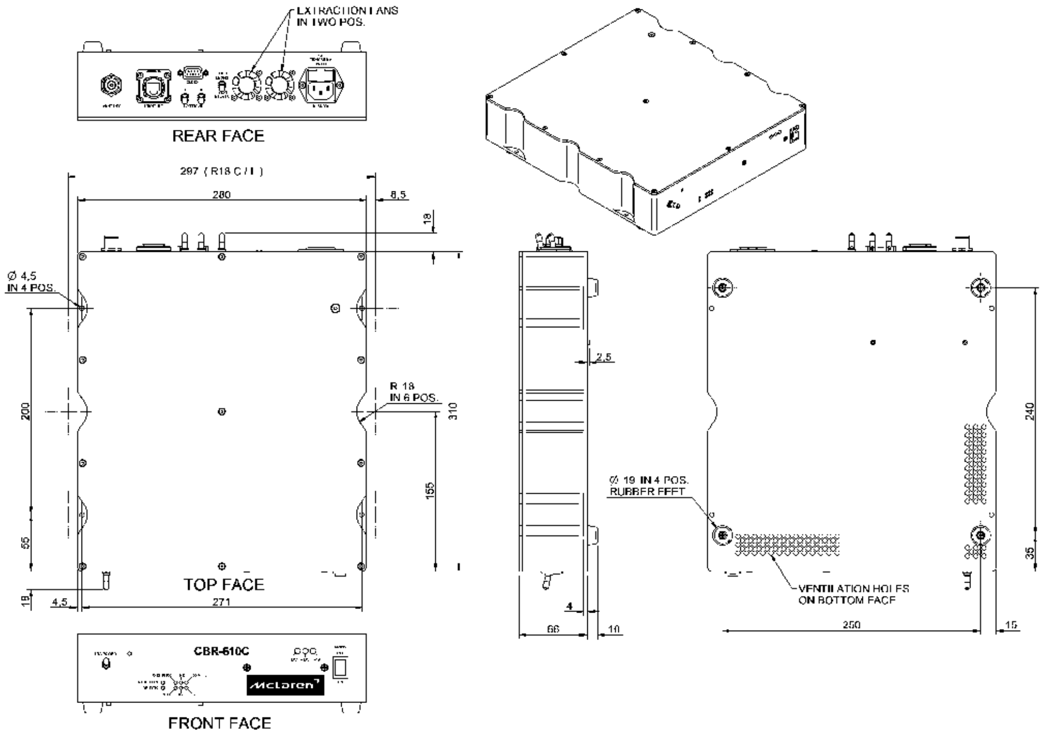
- Complies with the essential protection requirements of 89/336/EEC

Mechanical

- Weight approximately 2kg
- Aluminium case with integral fan cooling.

Environmental

- The unit is not fully sealed and must be protected against moisture
- Operating Temperature 0 to 40°C
- Air vents at rear must be kept clear
- Storage Temperature -10 to 70°C
- The unit is not suitable for mounting in a vehicle



Description	Ordercode
CBR-610C	O 030 052 010 002

3G Radio Modem

CBX-460

The CBX-460 is a 3G modem designed for use in harsh environments such as race cars. It provides a two-way data link between race car and network up to 3.2Mbps, sustained data rates will depend on network.

On-car communications links are through CAN, Flexray and Arcnet. Simulink App development is through the GDE, reprogramming and tuning is handled by System Monitor

Two apps are supported each with a dedicated CAN. The apps are supported by a logger in the BIOS and are built using the GDE.

Application

- Two-way data transfer from car to garage, for use on private or public 3G network. Handshaking companion to CBT-610 or separate telemetry module.

Processor

- Freescale MPC5562 32-bit 130MHz microcontroller
- 16M SRAM
- 512MB logging memory
- Memory management providing application isolation from BIOS.

Communications

- One UMTS radio interface 3.6Mbps upload 7.2Mbps download, frequency bands 850, 900, 1900 and 2100MHz
- One 10Mbps ARCNET
- Either
  - Two 1Mbps CAN + 10Mbps Flexray, or
  - One 1Mbps CAN + 20Mbps Flexray
- Integrated ruggedized SIM holder

Electrical

- Supply Voltage 9 to 16.0V DC
- Power consumption, operating

Connection Definition

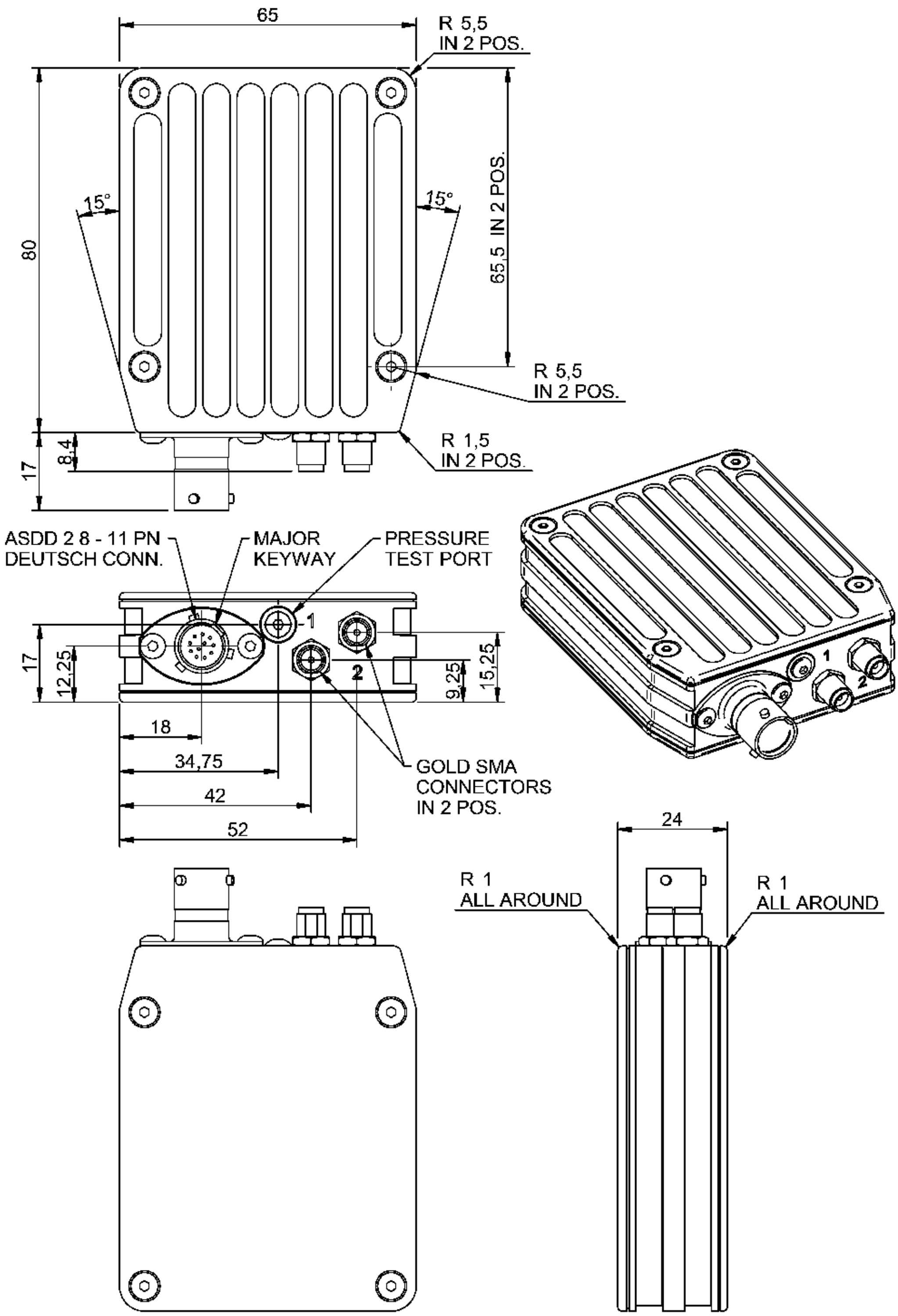
- 11-pin double density Autosport connector
- Two RF SMA socket connectors for 3G antenna (second optional)

Mechanical

- Case material magnesium alloy, chromate converted and painted with black epoxy polyester paint
- Weight approximately 130 g

Environmental

- Splash resistant to standard motorsport fluids
- Lid is sealed to the case, all through-case fixings sealed with silicone sealant, sealed motorsport connectors
- Maximum humidity 100%
- Minimum operating temperature 10°C
- Internal temperature not to exceed 70°C as measured on the temperature diagnostic, if necessary cooling should be applied
- Storage temperature -10 to 85°C
- Vibration 100 to 1000Hz, all axes, 24hrs



Description	Ordercode
CBX-460 2CAN/1FlexRay	O 030 051 013 000
CBX-460 1CAN/2FlexRay	O 030 051 013 001

UHF Radio Modem
CBX-450

The CBX-450 is a high-speed, car-based half-duplex radio modem suitable for a variety of data transfer applications.

A typical application includes data handshaking to ensure best possible circuit coverage with the CBX-610 telemetry system.

All parameter settings of the radio modem can be modified through the interface from a PC.

External connections for modem status and diagnostics are included.

Application

Two-way data transfer from car to garage.

Electrical

- Supply Voltage 9 to 16.0V DC
- Power consumption, operating
  1.8VA typical (Receive)
  6VA typical (Transmit)
  0.05VA typical (when 'DTR' input pin is "0")
- Frequency, 2Mhz wide band centred on 424MHz
- Channel spacing, 25KHz (80 channels)
- RF output power, 10mW to 1W
- Receiver Sensitivity, -116...-110dBm

Communications

- Modem Interface, RS232
- Data speed, 19200 bps

Connection Definition

- Connector A (Red) – Lemo HES1F308XLDP (Power and RS232 communications)
- Connector B (Blue) – Lemo HEN1F308XLNP (programming and status)
- RF connector integral SMA socket, RF output, 50ohm impedance
- For pin numbers please consult our Technical Consultancy Department

Mechanical

- Case material magnesium alloy, chromate converted and painted with black epoxy polyester paint
- Weight approximately 167 g
- Vibration isolation is required

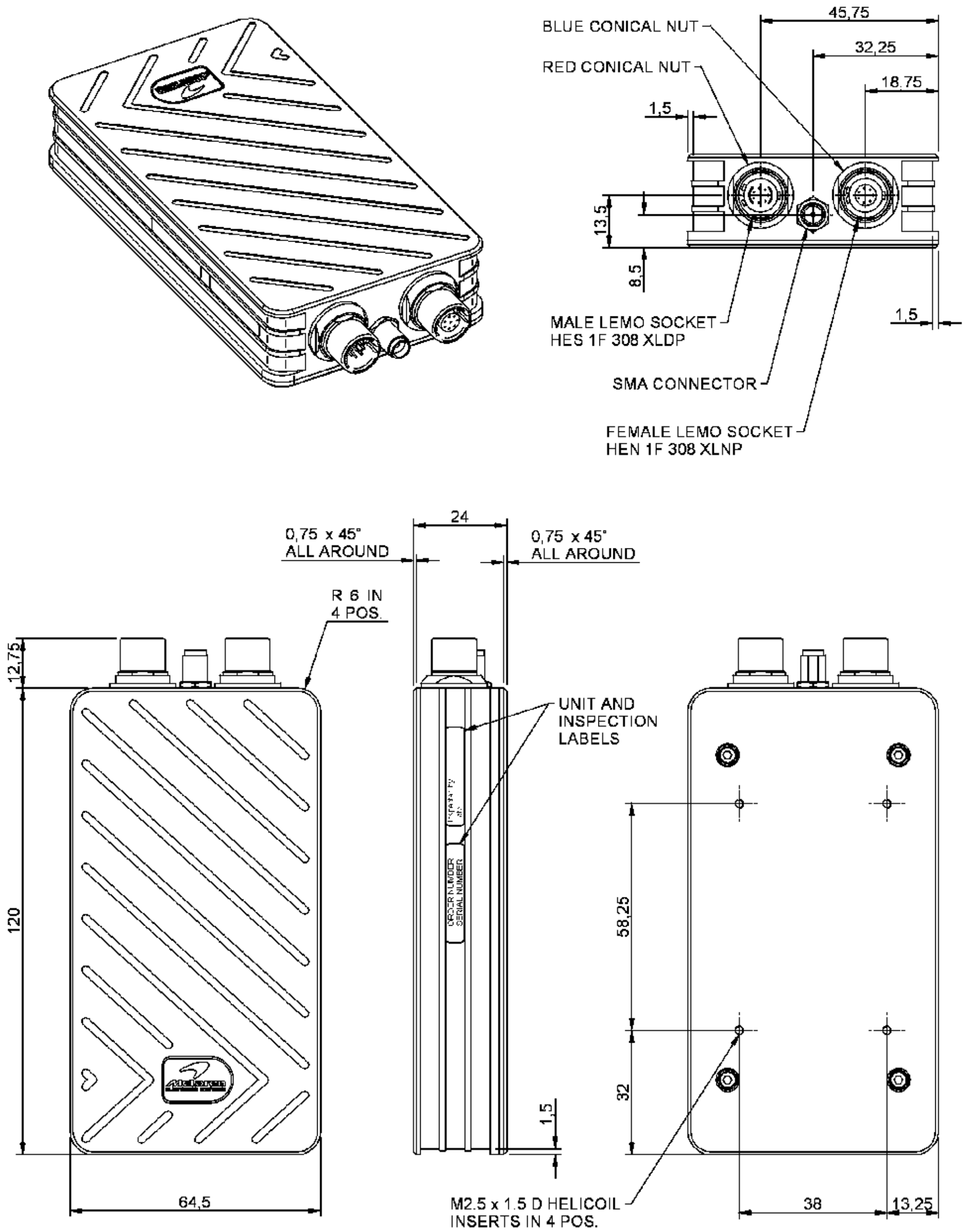
Environmental

- Splash resistant to standard motorsport fluids
- Lid is sealed to the case, all through-case fixings sealed with silicone sealant, sealed motorsport connectors
- Maximum humidity 100%
- Minimum operating temperature 10°C
- Internal temperature not to exceed 70°C as measured on the temperature diagnostic, if necessary cooling should be applied
- Storage temperature -10 to 85°C
- Vibration 100 to 1000Hz, all axes, 24hrs

Additional Details

Equipment Type	Radio Modem
Equipment Model	CBX450
FCC Approval No (if Applicable)	N/A
Use eg (Voice / Data)	Data
Transmission Type	Digital

Programmable	Yes
Deviation	5 kHz
Tuning Range	423 MHz to 425 MHz
Channel Bandwidth	25 kHz
Tuning Steps	25 kHz
Power Output	1 Watt
Power Range	0.1 Watt to 1 Watt
Power Switchable	Yes



Description	Ordercode
CBX-450	O 030 051 005 000

UHF Base Station

CBX-450

The CBX-450 is a high-speed, car-to-pit half-duplex radio modem suitable for a variety of data transfer applications. The high power (10W) transmitter can provide improved coverage in marginal conditions.

A typical application includes data handshaking to ensure best possible circuit coverage with the CBX-610 telemetry system.

All parameter settings of the radio modem can be modified through the interface from a PC.

External connections for modem status and diagnostics are included.

Application

- Two-way data transfer from car to garage.

Electrical

- Supply Voltage 11.8 to 30.0V DC
- Power consumption, operating
  - 1.3VA typical (Receive)
  - 30VA typical (Transmit)
  - 0.05VA typical (when 'DTR' input pin is "0")
- Frequency, 2MHz wide bands centred on 424MHz
- Channel spacing, 25kHz
- RF output power, 1W, 5W, 10W
- Receiver Sensitivity, -116...-110dBm

Communications

- Modem Interface, RS232
- Data speed, 19200 bps

Connection Definition

- Connector – Lemo HGA.1B.308.CLLP

Pin 1	RTS	Pin 5	TxDat
Pin 2	CTS	Pin 6	MODE
Pin 3	GND	Pin 7	Supply
Pin 4	RxDat	Pin 8	N/C

Mechanical

- Case material aluminium.
- Weight approximately 1300g
- This device is intended for off-car installation
- Dimensions 165mm x 138mm x 57mm

Environmental

- Splash resistant to standard motorsport fluids
- Lid is sealed to the case, all through-case fixings sealed with silicone sealant, sealed motorsport connectors
- Maximum humidity 100%
- Temperature range -25°C to +55°C

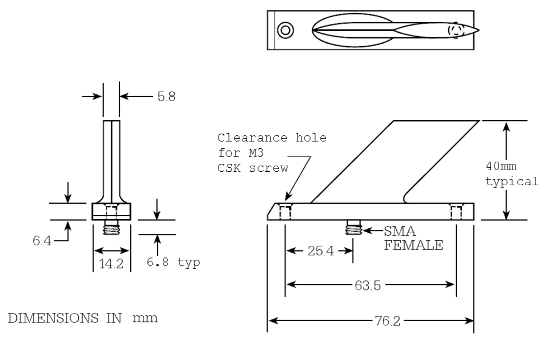
Description	Ordercode
CBX-450 Base Station	O 030 051 005 003

Telemetry Antenna

McLaren Electronics can supply a number of antennas for use with our telemetry systems. The range comprises a compact blade antenna suitable for mounting on a car and a larger colinear dipole antenna for mounting on a mast.

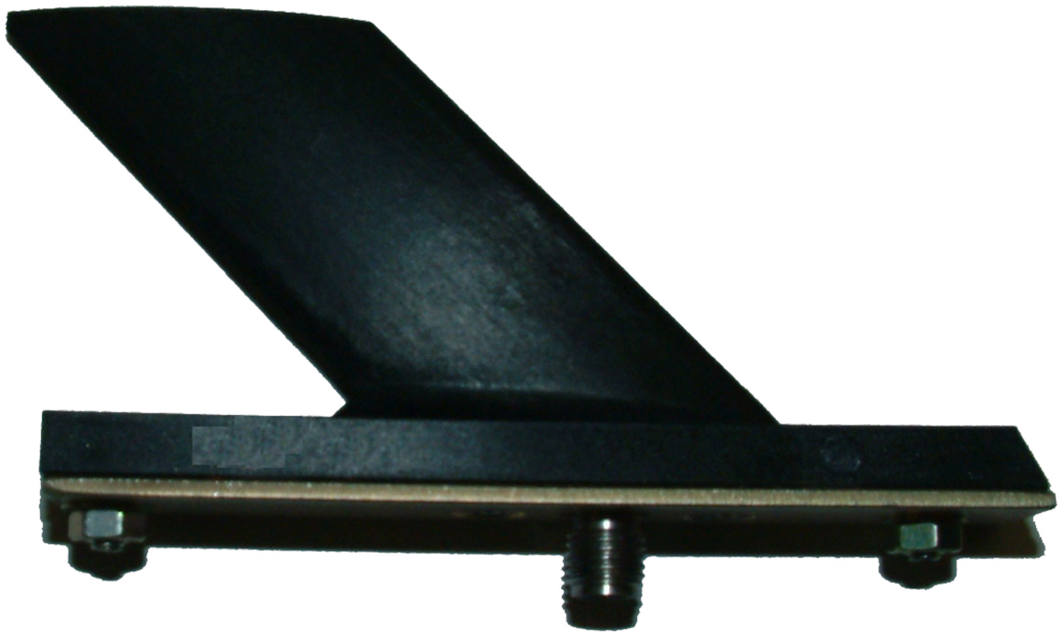
Blade Antenna

- Omnidirectional blade antenna
- Height 40mm
- Weight 28.3g
- Frequency 1.45 to 1.65GHz
- Gain approximately +3 dBi (Exact gain is a function of the ground plane upon which the antenna is mounted)
- VSWR 2.0:1 max, 1.50:1 typical
- Peak power 160W
- Operating temperature -50°C – 150°C



Installation Advice

- The top face of the base should be above or flush with the car chassis
- Both mounting holes must be used
- For optimum performance the metal base of the antenna should connect to a min 100mm dia conductive ground plane, but this is not essential. Securing the antenna to the chassis via conductive inserts which maintain conductivity to the carbon fibre chassis is also acceptable
- RG400/U coax is recommended for connecting the antenna to the transmitter



Description	Ordercode
Blade Antenna	O 030 065 000 000

Dipole Antenna

- Omnidirectional colinear dipole antenna
- Dimensions 1320mm long x 52mm dia
- Weight 2.5kg
- Wind loading 70N maximum @160km/hr
- Gain (max) 8.1dBi
- Power 100W CW
- VSWR<1.5:1
- Horizontal beamwidth 360°
- Elevation beamwidth 14°, between -3dB points
- Lightning protection – will withstand pulse of 2.5x106 A2s. All metal parts DC grounded
- Impedance 50ohm
- RF Termination N Female in the antenna base
- Antenna can be mounted by sliding the lower 60mm of its tubular aluminium base into a suitable sleeve
- Two versions available to cover the upper and lower portions of the telemetry band:
  - 1.45 – 1.55GHz
  - 1.55 – 1.65GHz

Installation Advice (RX application)

- For best results the antenna must be mounted high on a mast with a clear view of the transmit antenna
- An LNA-610 or similar low-noiseamplifier must be used in-line within 1m of the antenna
- S07262BD (Huber and Suhner) or LMR-400 (Times Microwave) cable is recommended for connecting the antenna and LNA to the receiver

Description	Ordercode
Dipole Antenna (1.45 – 1.55GHz)	O 030 065 001 000
Dipole Antenna (1.55 – 1.65GHz)	O 030 065 001 001

GPS Antenna

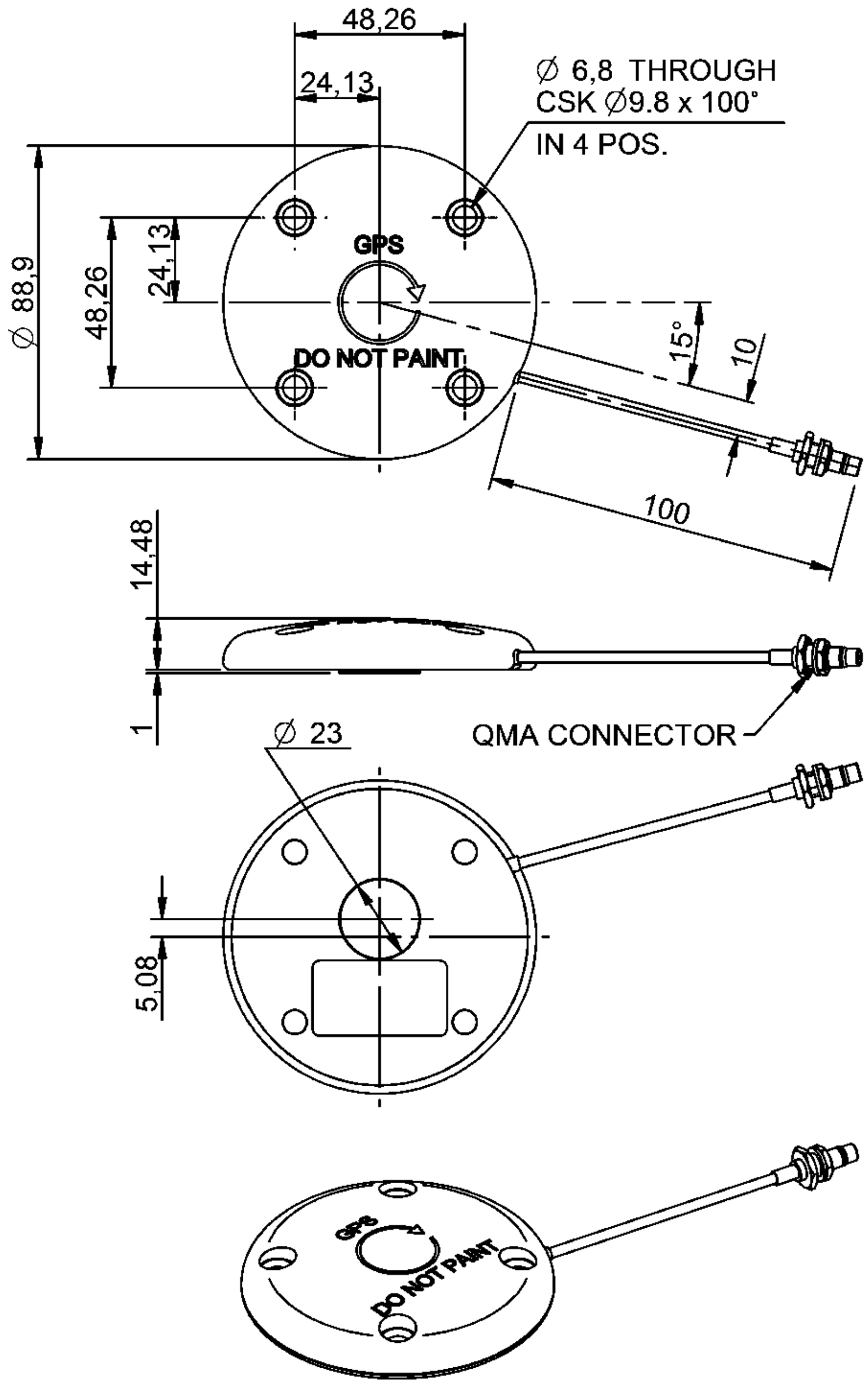
An active L1 GPS antenna operating at 1575.42MHz, this antenna has a spherical radius moulded radome for enhanced protection against rain, ice and lightning strikes.

Electrical

- Frequency 1575.42MHz
- Impedance 50ohms
- Gain (preamp) 26.0dB
- Noise figure 2.8dB
- Voltage +4 to 24 VDC (centre pin +ve)
- Current 25mA

Mechanical and Environmental

- Operating temperature -55°C - +85°C
- Weight 150g
- K02252D coax terminated in QMA bulkhead socket



Description	Ordercode
L1 GPS Antenna	O 030 054 006 000

CBR-610 Receiver Rack

The CBR-610 receiver rack comprises a single, mains-powered subrack suitable for mounting in a 3U high slot in a standard 19” rack. The rack can take up to three CBR-610s (sold separately), two power supply modules (included with the rack) and one RF splitter module (sold separately).

For system cooling, a mains powered 1U high fan tray should be installed directly above the rack and a 1U high vent panel directly below it.

Application

- High data rate continuous telemetry system
- Frequency ranges 1310-1490MHz, 1450-1650MHz and 1510-1710MHz, (L-Band), tuneable in 2 MHz steps.

Mechanical

- Whole system (including Fan Tray and Vent Panel) 5U high and compatible with a standard 19” rack.
- Fully populated weight approx 10.62kg.
- Anodised aluminium, except vent panel mesh (steel)

Environmental

- Rack is not sealed and must be protected against moisture
- Operating Temperature 0 to 40°C
- Storage Temperature +10 to +85°C
- Forced air cooling is required

Connector Definitions

- Please contact our Technical Consultancy Dept.

CBR-610 Receiver Rack

- A mains-powered subrack suitable for mounting in a 3U (5.25”) high slot in a standard 19” rack.
- Includes two power supply units
- CBR-610s, fan tray and splitter module to be ordered separately.
- O 030 052 009 001 fits three Rx and one splitter module

Description	Ordercode
CBR-610 Receiver Rack	O 030 052 009 001
CBR-610 Receiver Rack	O 030 052 009 003

CBR-610 Receiver Module

- Pit-based L-Band telemetry data receiver for use with the CBT-610 transmitter.
- Full details included in separate product summary.

Description	Frequency	Ordercode
CBR-610	Standard 1450-1650MHz	O 030 052 010 000
CBR-610	High 1510-1710MHz	O 030 052 010 001
CBR-610	Low 1310-1490MHz	O 030 052 010 003

RF Splitter Module

- The RF splitter module combines the inputs from the “Truck” and “Garage” antennas and then splits them equally between three RF outputs.

Description	Ordercode
RF Splitter Module	O 030 052 006 000

Power Supply Module

- Each receiver rack is fitted with two power supply modules. Power from the two modules is shared between all of the CBR-610 receiver modules and the RF splitter module. The two modules are identical but their outputs are combined differently within the rack to generate the required supplies.
- Spare modules available using the ordercode below.
- The CBR-610 receiver rack requires a Mains supply in range 187 to 264Vrms, 47 to 63Hz
- Mains current demand of a fully populated CBR-610 receiver rack is typically 0.37Arms at 230Vrms

Description	Ordercode
Power Supply Module	O 030 052 008 000

Fan Tray

- 1U high fan tray for installation directly above the receiver rack.
- Supplied with 1U high inlet vent panel for installation directly below the receiver rack.
- Requires a Mains supply in the range 85 to 264Vrms, 47 to 440Hz.
- Mains supply current demand <0.1Arms at 230Vrms.

Description	Ordercode
Fan Tray	O 030 052 009 002

70dB Attenuator Module

- Optional accessory which fits in place of a receiver or splitter module.
- Connecting a CBT-610 to a CBR-610 via the attenuator allows system testing without radiating RF.

Description	Ordercode
70dB Attenuator Module	O 030 052 011 000

Low Noise Amplifier
LNA-610

The LNA-610 is an "intelligent" mast-head Low-Noise Amplifier for the 600-series telemetry system.

The sensitivity of the telemetry receiver system depends on the ratio of received signal level to thermal noise. A significant source of noise is the feeder cable linking the antenna to the receiver rack. The LNA-610 should be mounted at the top of the mast close to the base of the receive antenna. It amplifies the signal as it leaves the antenna, improving the signal to thermal noise ratio.

The LNA-610 contains a bandpass filter which attenuates signals outside the frequency band used by the 600-series telemetry system to prevent overloading by strong out-of-band signals.

The LNA-610 is able to aid in the diagnosis of receiver system installation faults and detect some faults within itself.

Application
- Mast-head Low Noise Amplifier for 600-series telemetry systems.

Electrical
- Supply range 14.5V to 15.5V
- Supply voltage not to exceed 17V continuous (the unit is protected against transients but not against reverse polarity)
- Supply must be current-limited to 150mA
- The CBR-610 and Splitter modules provide a suitable power supply
- Operating current typically 130mA at 15V

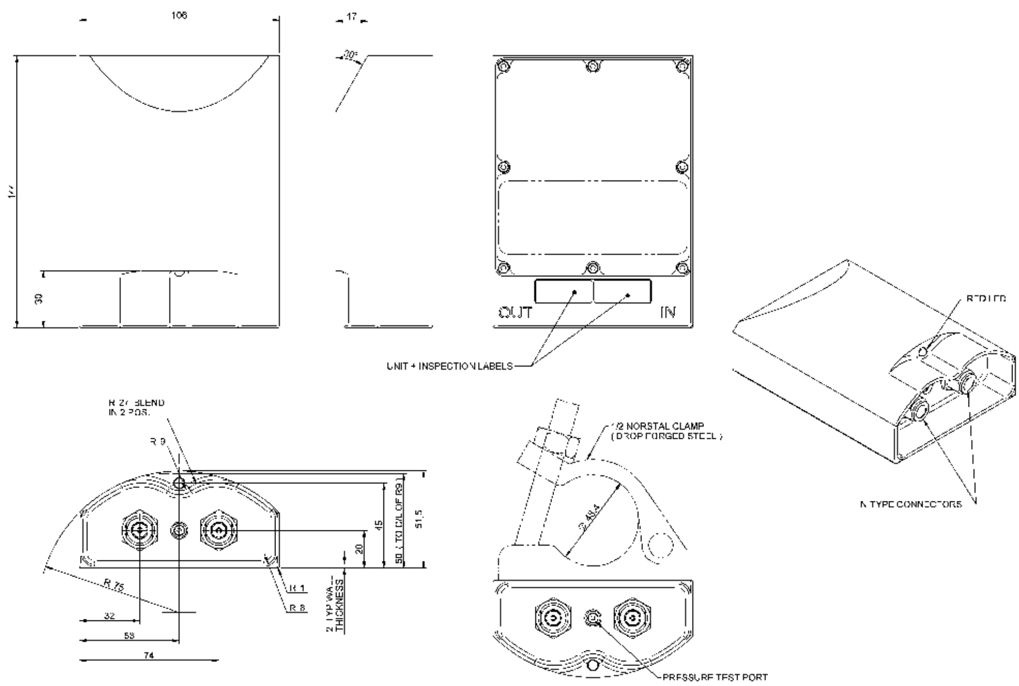
Other Features
- Red LED for diagnostic purposes – intended for outdoor applications, resistant to moisture and UV radiation

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

Connection Definition
- Two N-type sockets

Mechanical
- Weight 1.32kg (including mounting clamp)
- Aluminium, Alocrom 1200 plated and painted white
- Fitted with a drop-forged steel clamp for attachment to a 50mm diameter mast. Should be mounted vertically with the N-type connectors placed at the bottom with the shroud around the connectors to help with weatherproofing

Environmental
- The unit should not be immersed in water but is rainproof.
- Operating Temperature -10°C to +70°C
- Storage Temperature -40°C to +105°C



Description	Frequency	Ordercode
LNA-610	1450-1650MHz	O 030 062 005 000
LNA-610	1510-1710MHz	O 030 062 005 001
LNA-610	1310-1490MHz	O 030 062 005 002

GPS Notch Filter

Interference to GPS reception can occur when the GPS antenna is located within a few metres of an L-band telemetry antenna. This interference can be substantially reduced and in most cases eliminated by inserting a notch filter between the telemetry transmitter output and the telemetry antenna. Interference on the GPS L1 carrier frequency (1575.4MHz) is reduced by the filter's high rejection between 1570 and 1580MHz.

When a notch filter is fitted, transmitter centre frequencies in the range 1552 to 1598MHz (inclusive) must not be used. Attempting to use these frequencies will result in high reflected power levels, a severe reduction in coverage and possible interference to GPS signals.

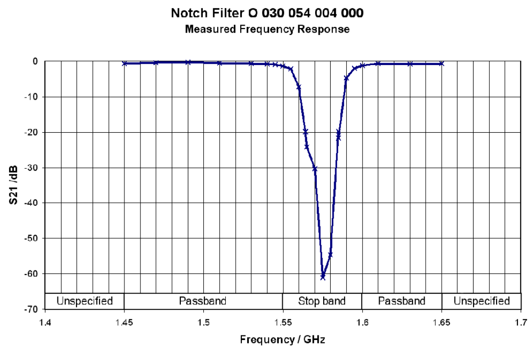
The filter can be located anywhere convenient between the transmitter and the antenna.

Application

- Reduction of interference to GPS reception for 600-series telemetry systems

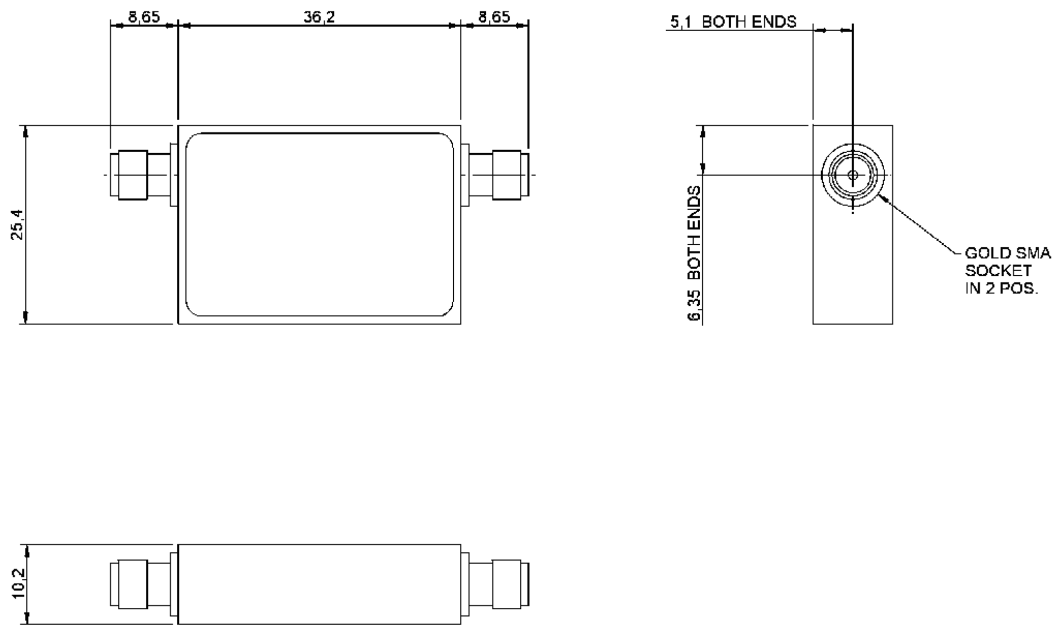
Electrical

- Passband insertion loss 1dB typical
- Passband VSWR 1.5:1 max
- Rejection 1568.4 – 1582.4MHz 20dB min
- Rejection at 1575.4MHz 60dB min
- Input power in passband 2W max



Mechanical and Environmental

- Weight 37g
- Operating temperature -40 to +85°C
- Storage temperature -50 to +125°C



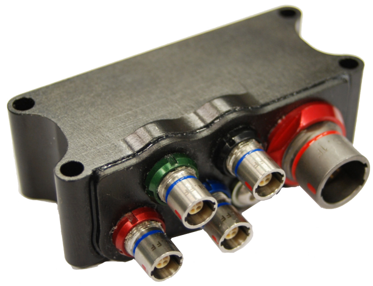
Description	Ordercode
GPS Notch Filter	O 030 054 004 000

Interface Units

Hub Interface Unit
HIU-3

The HIU-3 is a local, micro-processor controlled sensor interface unit. It is small and light, designed to be mounted on the wheel hub, thus reducing the harnessing on the car. The unit can withstand the high radiated temperatures from the brakes whilst the car is stationary and the vibration from the wheels whilst the car is moving.

The data is transmitted to an appropriate control unit (such as the TAG-400 or MCU-300) over a two-wire CAN bus communication link.



Application
- Localised data acquisition.

Electrical
- Supply Voltage 12V to 16V DC (full operation), 7.5V to 11.99V (with some parameter inaccuracies)
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- Current 150mA typical at 13.8V (including typical transducer loads)

Mechanical
- Hard black anodised aluminium
- Weight approximately 55g

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 2004/108/EC

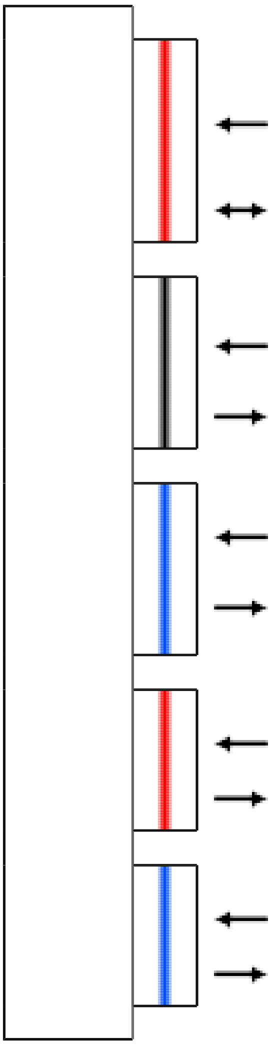
Connection Definition
- Integral, sealed, LEMO series F motorsport connectors

Connector 1	8-way	HES1F308XLDP
Connectors 2 to 5	4-way	HEN.FF.304.SLNP

- For pin numbers please consult our Technical Consultancy service

Environmental
- Splash resistant to standard motorsport fluids
- Lids and screws sealed with silicone sealant, lid o-ring sealed
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Internal Temperature not to exceed 115°C as measured by internal diagnostic sensor. If necessary, cooling for the unit should be applied so the temperature remains within these limits
- Storage Temperature -10°C to +125°C
- Vibration 100 to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended

Connection Definition



Connector 1

- Two Wheel Speed Sensor (DHE)
- Time Synchronous Trigger Input
- 0-5V Analogue input
- CAN Bus

Connector 2

- 0-5V Analogue input
- PT1000 Temperature Input
- Protected battery supply output

Connector 3

- Load Cell Input (or two 0-5V analogue inputs)
- Load Cell Output
- 10V Reference supply

Connector 4

- LVDT Secondary
- LVDT Primary

Connector 5

- LVDT Secondary
- LVDT Primary

Sensor Inputs

- Two LVDT sensor interfaces (12-bit)
- Two 0-5V Analogue inputs (12-bit)
- One differential amplified load cell interface (or two unity gain 0-5V analogue inputs)
- Two DHE wheel speed input
- One PT1000 temperature input (12-bit)

Outputs

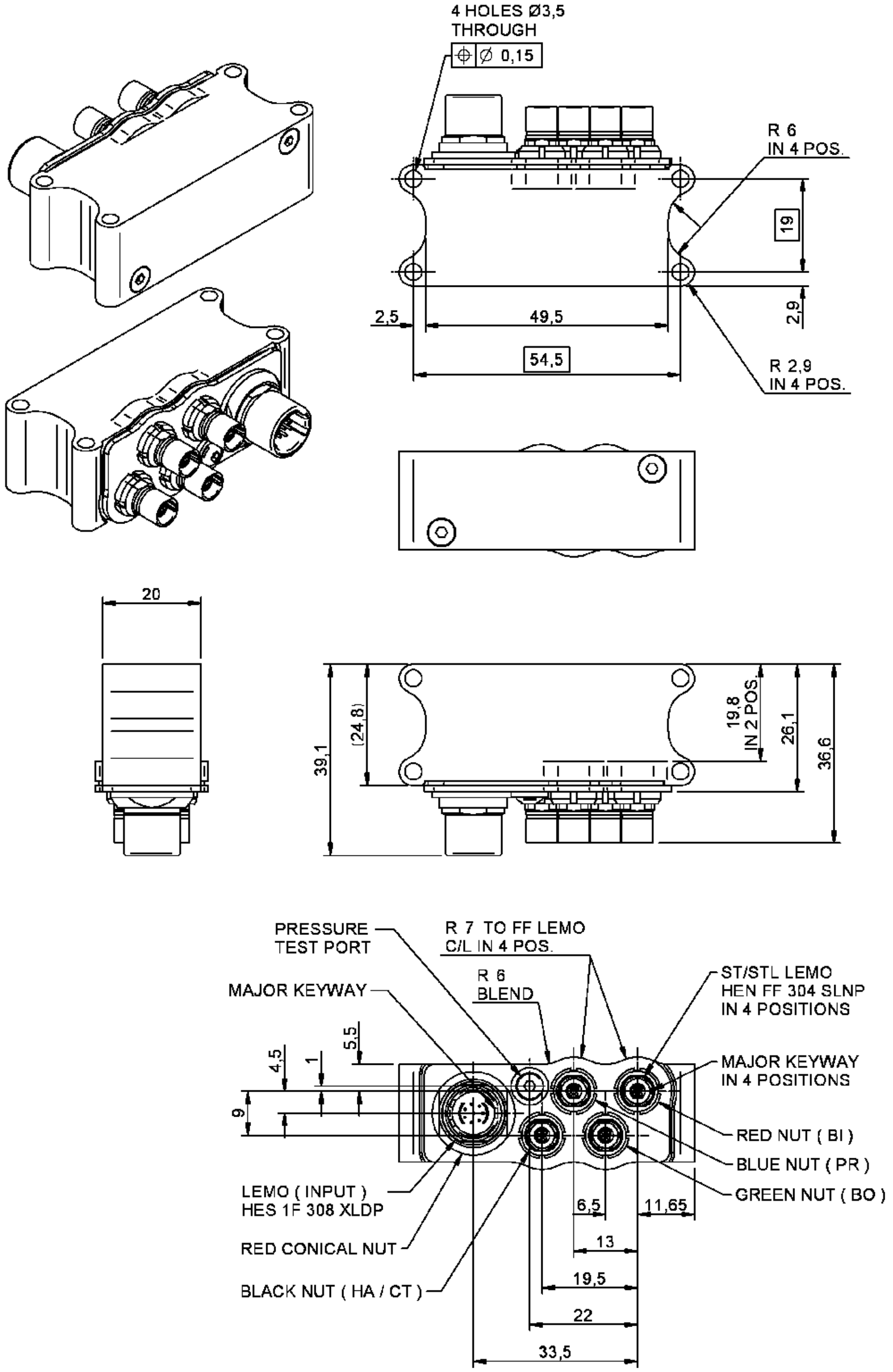
- One protected car supply output rated at 30mA for Hub accelerometer
- One 10V 10mA reference supply for load cell transducer

Communications

- One CAN bus interface, 1Mbaud as standard
- One time synchronous trigger input

Diagnostics

- Internal diagnostic supply voltage and temperature sensor



Description	Ordercode
HIU-3	O 030 110 008 002

LVDT Interface Unit
LIU-4

The LIU-4 provides signal conditioning for four five-wire LVDT positioning sensors. When the LVDT sensors are being used in latency critical control systems, the conditioned signals are passed to the host ECU as four 0 to 5V analogue outputs. Where LVDT sensors are used for diagnostics or where control system speed is less critical, the signal conditioned values can be made available over the CAN bus communications link in order to reduce system harnessing.

A common primary sine wave signal is generated to supply all four LVDT sensors. This prevents beat notes being generated due to stray magnetic coupling when the LVDT sensors are used in close proximity using similar frequencies. The frequency and amplitude of the common primary signal are software programmable. The primary signal to each LVDT is individually buffered such that an overload on one sensor primary does not affect the other.

The four 0 to 5V LVDT signal conditioned analogue outputs are individually software programmable for gain and offset in order to provide more flexibility for the measurement span. LVDT sensor open circuit diagnostics are available through the CAN bus communications link

Application

- LVDT sensor signal conditioning

Features

- Four five-wire LVDT inputs with ratiometric measurement
- Common primary signal, software adjustable frequency between 1kHz to 15kHz, and voltage between 0.5Vrms to 3.0Vrms. Maximum output current 20mArms.
- Software adjustable gain and offset for each signal conditioned output
- Secondary signal input range 1Vrms to 3.5Vrms
- CAN Bus address ID analogue input
- Unit reset input – switch to ground
- Four 0 to 5V LVDT signal conditioned analogue outputs, with separate reference ground input
- Internal 16-bit micro controller, 12-bit resolution ADC, Flash program memory
- LVDT sensor open circuit diagnostics, unit internal diagnostics including internal temperature
- CAN Bus interface, 1Mbaud standard

Electro Magnetic Compatibility

- Complies with the essential protection requirements of EMC Directive 204/108/EC

Mechanical

- Case material hard anodised aluminium
- Estimated weight 105g

Connection Definition

- Integral, sealed, Deutsch high density Autosport series connectors

LVDT connector	23-way	ASDD210-23PN
Main connector	11-way	ASDD208-11PN

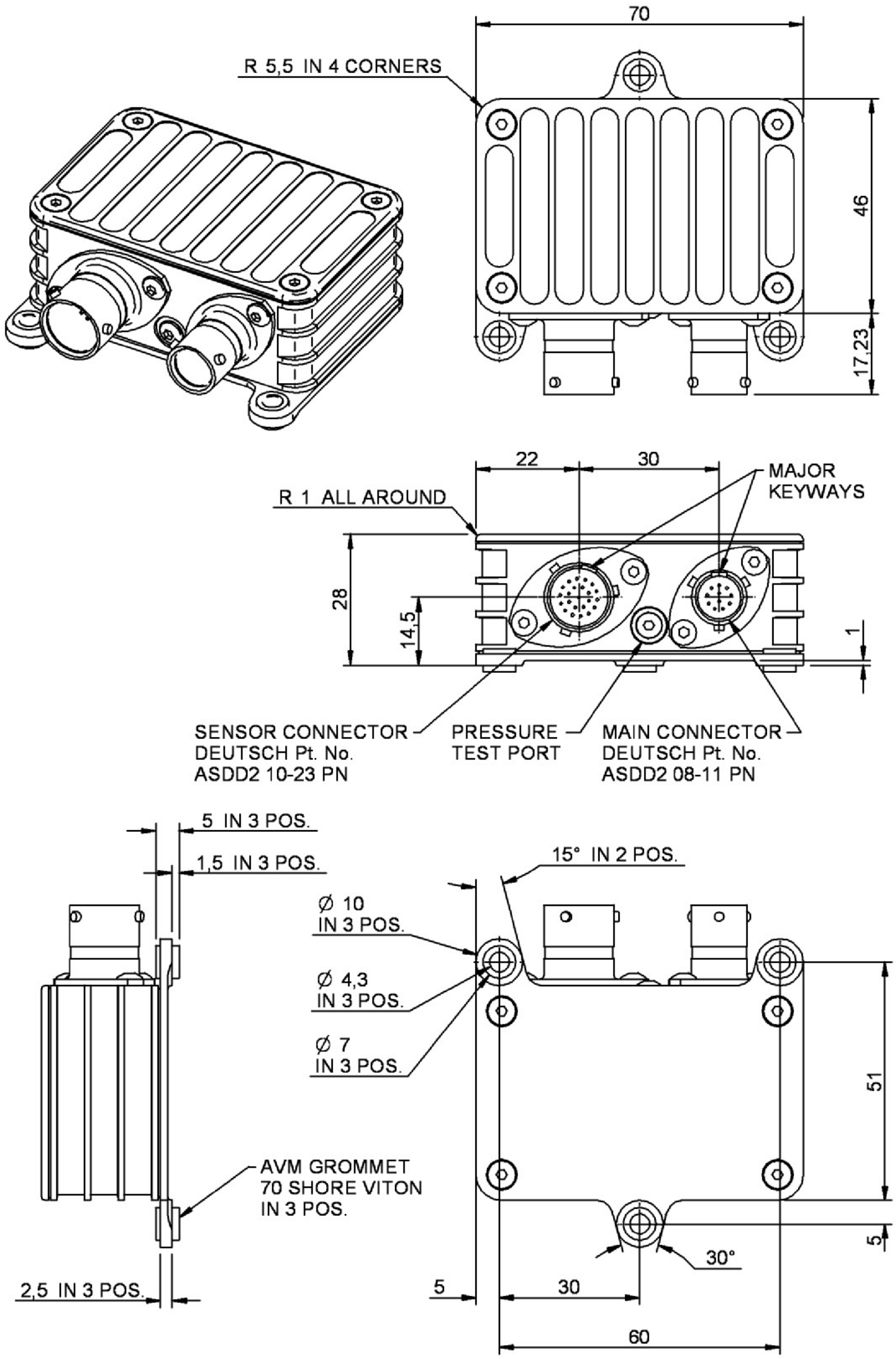
Electrical

- Supply Voltage 7.5V to 16V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- Current 180mA typical at 13.8V (with 10mArms LVDT primary loads)

Environmental

- Splash resistant to standard motorsport fluids
- Lids o-ring sealed, screws sealed with silicone sealant
- Maximum humidity 100%
- Minimum operating temperature 0°C

- Internal temperature not to exceed 85°C as measured by internal diagnostic sensor
- Storage temperature -10°C to 85°C
- Vibration 10 to 2000Hz, all axes, 24 hours



Description	Ordercode
LIU-4	O 030 110 012 000

Sensor Node
SN-320

The SN-320 is an intelligent, microprocessor controlled data acquisition unit. A range of analogue, thermocouple and speed measurements are sampled at rates of up to 10ksps. The results are transmitted back to the host unit via CAN or FlexRay for logging or control.

SN-320 is configured by System Monitor.

Application
- Chassis or engine monitoring.

Electrical
- Supply Voltage 7.5 to 16V DC
- PowerPC data acquisition processor operating at 130MHz, with 1MB Flash and 192kB SRAM on chip

Inputs
- 24 analogue inputs for 0V-to-5V measurement (12 configurable for Pt1000), 12-bit resolution, up to 10ksps
- Four K-type thermocouple inputs, 12-bit resolution
- Six DHE speed inputs
- One RS422 time synchronisation input

Outputs
- Two individual, protected 5V sensor supplies
- One protected 10V sensor supply

Communications
- One CAN interface (up to 1Mbps)
- One dual-channel Flexray interface (20Mbps)

Connection Definition
- Souriau double-density connectors

Connector A (host)	12-way
Connector B (sensors)	26-way
Connection C (sensors)	26-way

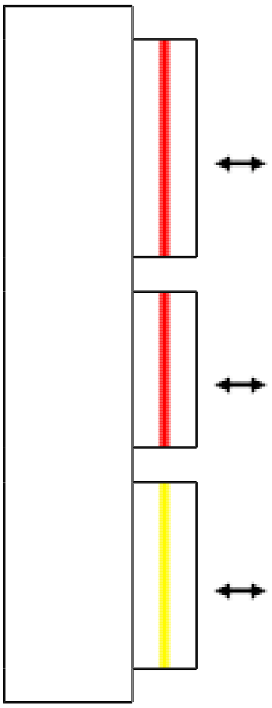
Mechanical
- Case material machined magnesium alloy, painted black (stippled)
- Weight less than 150g

Environmental
- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings and screws sealed with silicone rubber
- Maximum humidity 95% non-condensing
- Minimum operating temperature 0°C
- Internal Temperature not to exceed 85°C as measured by internal diagnostic sensors
- Storage Temperature -10°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

Service
- Recommended service interval 12 months

Connector Diagrams



Connector A

- Unit supply input
- External reset input
- CAN and FlexRay configuration inputs
- Dual-channel FlexRay
- Time synchronisation input

Connector B

- 12 analogue inputs
- Four thermocouple inputs
- Two 5V sensor supply outputs

Connector C

- 12 analogue inputs
- Six DHE speed inputs
- Two 5V sensor supply outputs
- One 10V sensor supply output

Connector A

- Unit supply input
- External reset input
- CAN and FlexRay ID/slot configuration inputs (selection via external resistors to ground)
- CAN
- Dual-channel FlexRay

Connector B

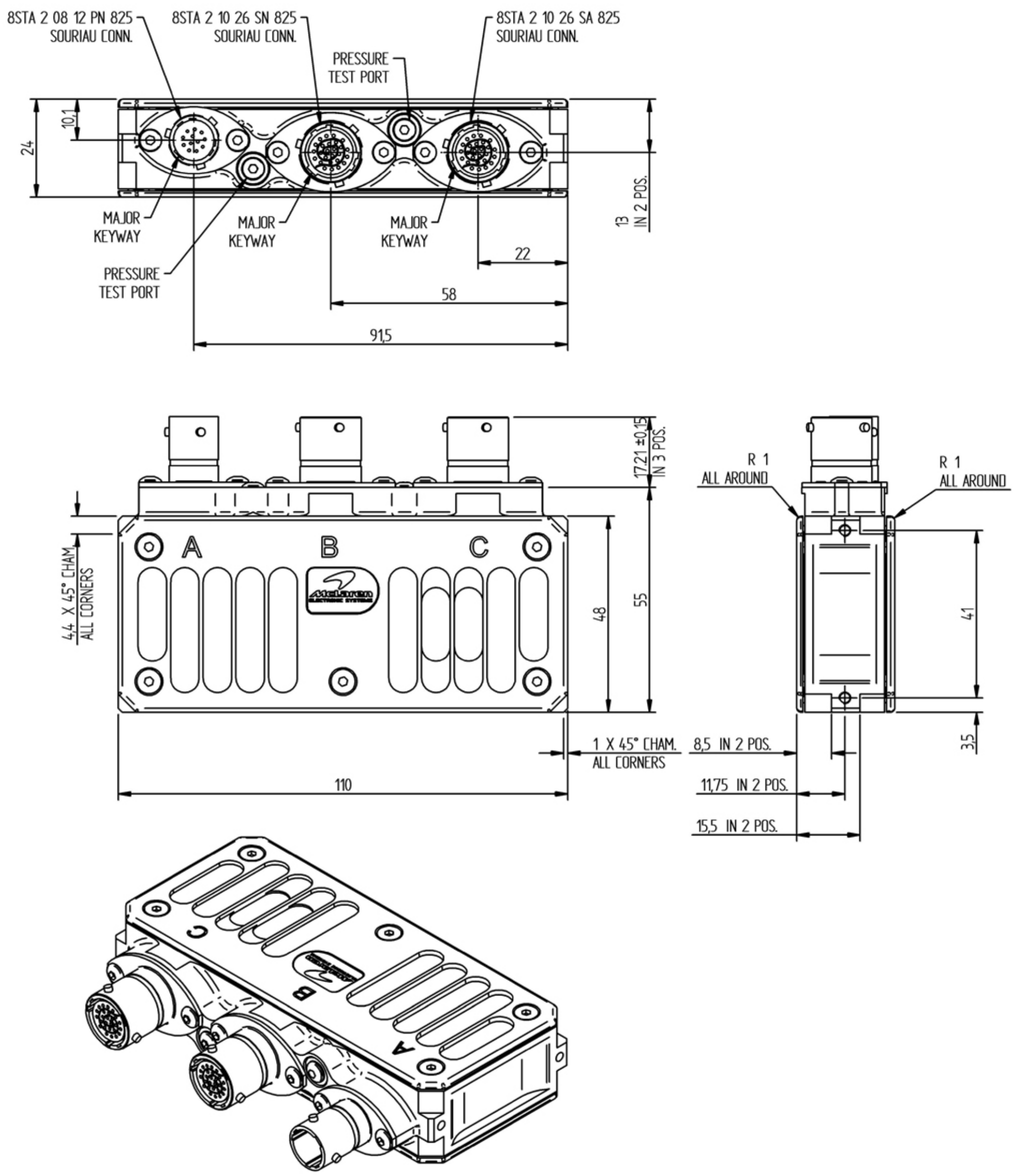
- 12 analogue inputs for 0V-to-5V measurement (six configurable for Pt1000)
- Four K-type thermocouple inputs
- Two individual, protected 5V sensor supplies

Connector C

- 12 analogue inputs for 0V-to-5V measurement (six configurable for Pt1000)
- Six DHE speed inputs
- Two individual, protected 5V sensor supplies
- One protected 10V sensor supply

Diagnostics

- Inputs are checked for out-of-range and open-circuit conditions
- Internal temperatures, unit supply input and sensor supply output voltages are monitored



Description	Ordercode
SN-320	O 030 095 020 000

Sensor Node

SN-32

The SN-32 is an intelligent, microprocessor controlled, data acquisition unit. A range of analogue, speed and thermocouple measurements are sampled at rates of up to 1kHz. The results are transmitted back to the host unit via CAN or HDLC link for logging or control.

SN-32 is configured by System Monitor.

Application

- Chassis monitoring.

Electrical

- Supply Voltage 7.9 to 16.0V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- Supply Current 100mA typical @ 12V
- Data Acquisition processor 80C164
  - 20MHZ
  - On-chip CAN 2.0B controller
  - 2M HDLC sensor bus link
  - 64kbyte Flash ROM
  - 64kbyte SRAM

Service

- Recommended service interval 12 months (internal battery is replaced)

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC

Connection Definition

- Integral, sealed, LEMO series F motorsport connectors

Connector A	22-way	HEN3F322XLNP
Connector B	22-way	HEP3F322XLNP
Connection In	8-way	HES1F308XLNP
Connection Out	8-way	HEN1F308XLN

- For pin numbers please request Product Specification EDD 99-04

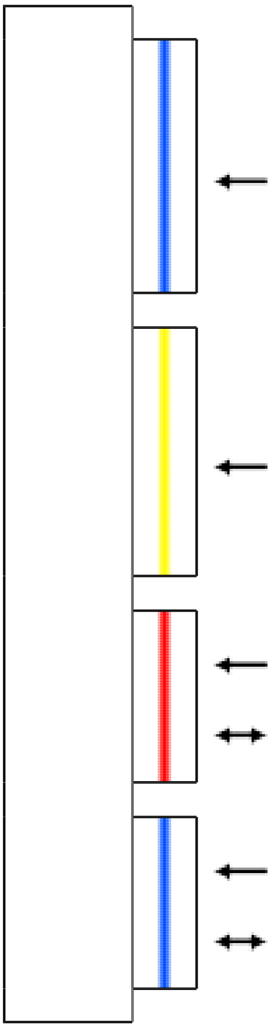
Mechanical

- Case material Magnesium alloy, chromate converted and painted with black epoxy
- Weight less than 150g

Environmental

- Splash resistant to standard motorsport fluids
- Lids and screws sealed with silicone rubber
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Internal Temperature not to exceed 85°C as measured by internal diagnostic sensors
- Storage Temperature -10°C to 85°C
- Vibration 100 to 1000Hz, all axes, 24 hours

Connector Diagrams



Connector A

- 2 DHE Speed Sensors
- 1 K-type thermocouple
- 4 analogue Inputs (12-bit, 1kHz)
- 3 analogue inputs (10-bit, 1kHz)
- 4 analogue Inputs (10-bit, 125Hz)
- 2 analogue Inputs (10-bit, 125Hz)(1)

Connector B

- 2 DHE Speed Sensors
- 1 K-type Thermocouple
- 5 analogue Inputs (12-bit, 1kHz)
- 3 analogue Inputs (10-bit, 1kHz)
- 3 analogue Inputs (10-bit, 125Hz)
- 2 analogue Inputs (10-bit, 125Hz)

Connector In

- Battery Power Inputs
- Sensor Bus
- CAN Bus

Connector Out

- Battery Power Inputs
- Sensor Bus
- CAN Bus

(1)can be configured for Pt1000

Sensor Inputs

- Four DHE Speed Sensors
- Nine analogue (0 to 5V, 12-bit, 1kHz)
- Six analogue (0 to 5V, 10-bit, 1kHz)
- Seven analogue (0 to 5V, 10-bit, 125Hz)
- Four analogue (0 to 5V, 10-bit, 125Hz can be configured for Pt1000 temperature sensors)
- Two K-type thermocouples (uses pairs of input connections)

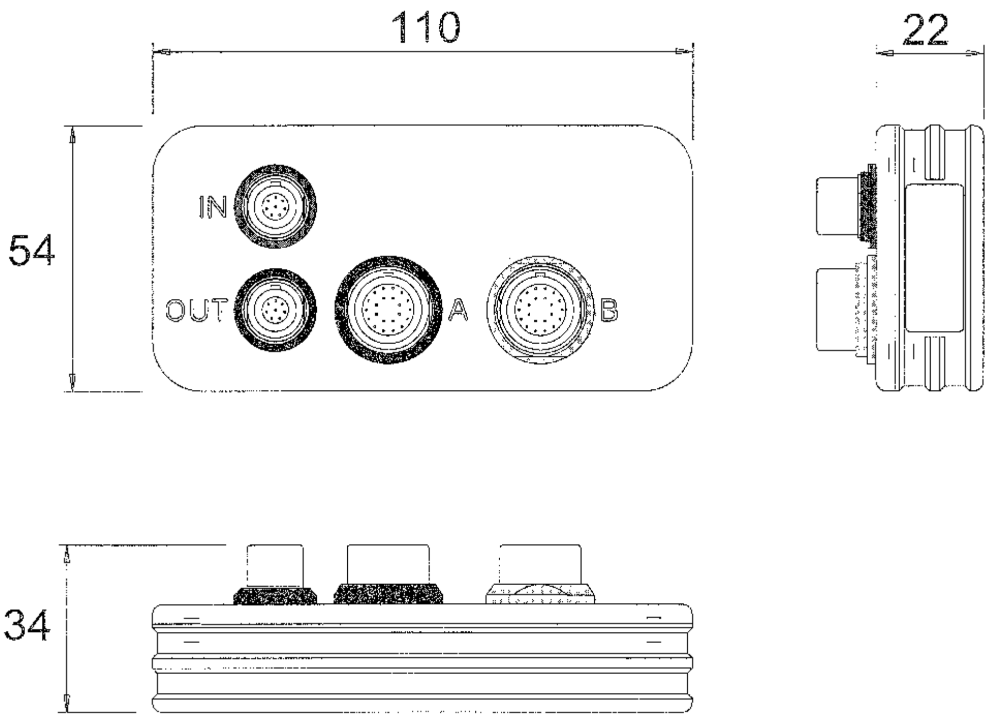
Communications

- One HDLC Sensor bus (2Mbps)
- One CAN 2.0B bus (up to 1Mbps)

Diagnostics

- Sensor readings are checked for out of range and open circuit
- The following internal parameters are monitored:
  - Board temperatures
  - Unit supply voltages
  - External 5V supply voltages and currents

For more details, please request our Product Specification EDD 99-04.



Description	Ordercode
SN-32	O 030 095 006 000

Lambda Measurement
SN-32LT

The SN-32LT is an intelligent, microprocessor controlled, data acquisition and lambda measurement unit for up to 6 wide band UEGO sensors. It is based on the SN-32 sensor node and can be used as part of the DATA*Lab* system or in conjunction with an engine control unit.

SN-32LT has a single Sensor Bus and a CAN communication bus. It does not include heater drivers but has a control output for a separate heater unit.

Application
- Wide-band Lambda measurement.

Electrical
- Supply 7.5V to 16.0V DC
- Supply Voltage not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- Supply Current 250mA typical @12V
- Data Acquisition processor 80C164T
  - 20 MHZ
  - On-chip CAN 2.0B controller
  - 2M HDLC sensor bus link
  - 8M HDLC link to control processor
  - 64kbyte Flash ROM
  - 64kbyte SRAM

Mechanical
- Case material Magnesium alloy, chromate converted and painted with black epoxy
- Weight less than 220g

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

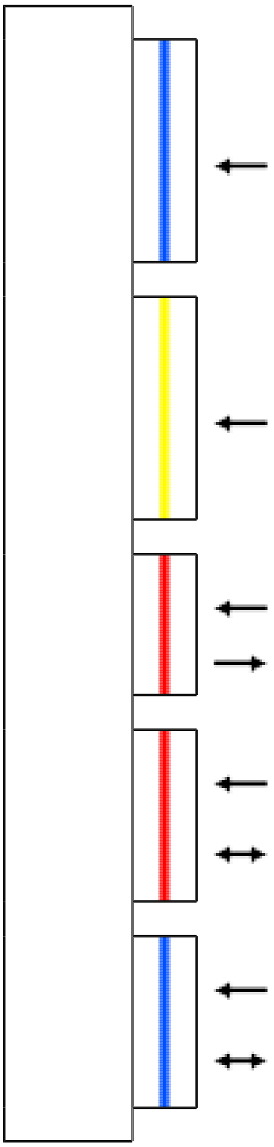
Connection Definition
- Integral, sealed, LEMO series F motorsport connectors

Connector A	22-way	HEN3F322XLNP
Connector B	22-way	HEP3F322XLNP
Connector LAM	22-way	HES3F322XLDP
Connector IN	22-way	HES1F308XLNP
Connector OUT	22-way	HEN1F308XLDP

For pin numbers, please contact our Technical Consultancy Department

Environmental
- Splash resistant to standard motorsport fluids
- Lids and screws sealed with silicone rubber
- Maximum humidity 100%
- Minimum operating temperature 0°C
- Internal temperature not to exceed 70°C as measured by internal diagnostic sensors
- Storage temperature -10 to 85°C
- Vibration 100 to 1000 Hz, all axes, 24 hours

Connector Diagrams



Connector A (Blue ring)

- 2 DHE Speed Sensors
- 5 K-type thermocouples
- 2 analogue Inputs (12-bit, 1kHz)
- 2 analogue Inputs (10-bit, 125Hz)
- 2 analogue Inputs (10-bit, 125Hz)[1]

Connector B (Yellow ring)

- 2 DHE Speed Sensors
- 5 K-type Thermocouples
- 3 analogue Inputs (12-bit, 1kHz)
- 1 analogue Input (10-bit, 125Hz)
- 2 analogue Inputs (10-bit, 125Hz)[1]

Connector LAM (Red ring)

- 6 Lambda probes
- 1 High side Output for Lambda Heater unit

Connector IN (Red ring)

- Battery Power Inputs
- Sensor Bus
- CAN Bus

Connector OUT (Blue ring)

- Battery Power Inputs
- Sensor Bus
- CAN Bus

[1]can be configured for Pt1000

Sensor Inputs

- Six UEGO lambda sensors
- Four DHE speed sensors
- Five analogue (0 to 5V, 12-bit, 1kHz)
- Seven analogue (0 to 5V, 10-bit, 125Hz) four of these can be configured for PT1000 temperature sensors
- 10 K-type thermocouples

Outputs

- One High side driver (0.7A) used to control heater unit

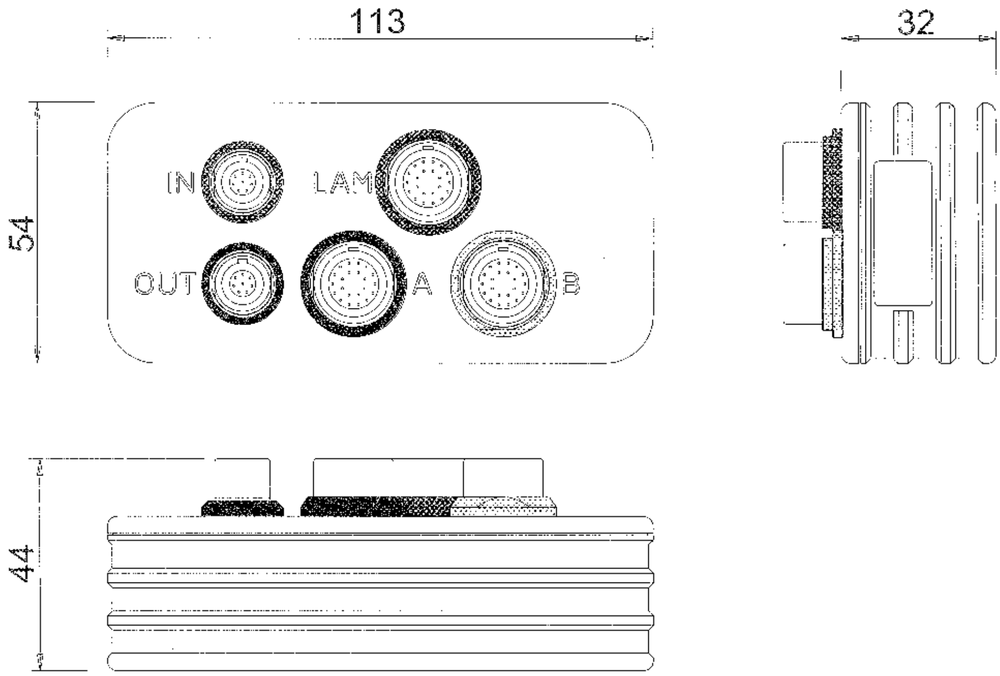
Communications

- DATA*lab* Sensor bus (2Mbps)
- CAN 2.0B bus (up to 1Mbps)

Diagnostics

- Sensor readings are checked for out of range and open circuit
- The following internal parameters are monitored:
  - Board temperatures
  - Unit supply voltages
  - External 5V supply voltages and currents

For more details, please contact our Technical Consultancy Department



Description	Ordercode
SN-32LT	O 030 095 006 004

EDS Interface
Single Channel

The EDS sensor interface unit is to be used with the Micro Epsilon EDS (Eddy Current Displacement) linear stroke sensor. The interface unit provides the excitation voltage for the sensor and converts the signal response into an amplified 0 to 5V output.

Electrical

Electrical parameters when connected to EDS-28-G-CA-U-MOOG Actuator Sensor

- Supply voltage 8 to 16V unregulated
- Reverse polarity protection
- Protection from supply transients
- Supply current 62mA max @10V
- Output voltage 0.5 to 4.5V
- Resolution 10-bit
- Temperature Stability 50ppm @ 85°C (Zero & sull Scale)
- Non Linearity 1.5% Typ, 2.5% Max

Connection Definition

- Connector ASDD206-09PN-HE
- Connection details

Pin 1	Supply
Pin 2	Ground (supply)
Pin 3	Signal
Pin 4	Signal ground
Pin 5	Sensor connection M
Pin 6	Sensor connection M/K
Pin 7	Sensor connection K
Pin 8	Not Connected
Pin 9	Not Connected

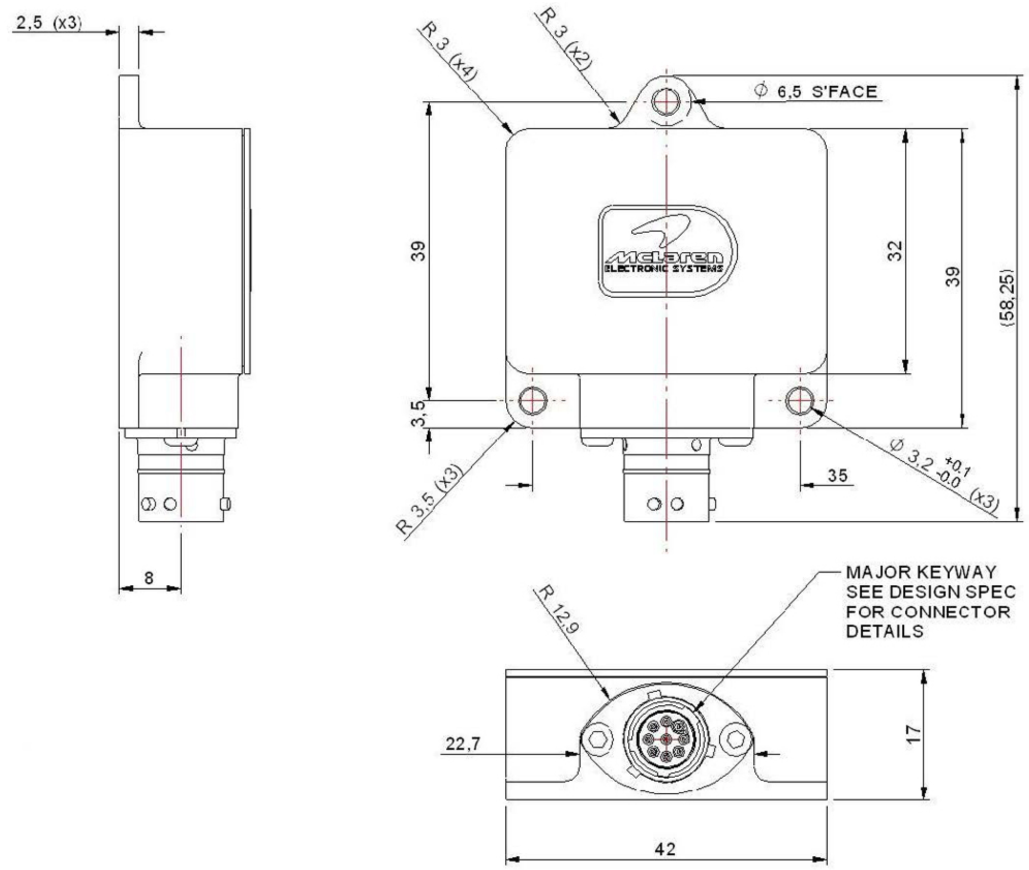
- Sensor cable should be screened and terminated to the shell of the connector.
- Ground return path for the filter capacitors is via the case ground which must be connected to the chassis ground.

Mechanical

- Weight 55g
- Aluminium alloy body and lid with Alocrom 1200 coatings to Mil-C-5541

Environmental

- Operating temperature 0 to +125°C
- Body resistant to standard motorsport fluids
- Vibration 500 to 2000Hz, 20g Peak acceleration
- Maximum humidity 100%



Description	Ordercode
EDS Interface Single Channel	O 030 320 015 000

Thermocouple Interface Unit
TIU-32

The TIU-32 is a 32-channel thermocouple interface unit. Two versions are available, the TIU-32 and the TIU-32C providing output as either 0-5V analogue or via CAN.

Cold junction is provided with the TIU-32 and TIU-32C. In the case of the standard TIU-32 the 32 compensated signals are then multiplexed (32:2) to provide two 0-5V scaled outputs. Channel selection is under the control of a host ECU via 4 channel select pins.

The TIU-32C CAN-linked version is fitted with a microcontroller that samples the analogue signals and scales them accordingly ready for transmission to a control unit via the CAN bus at speeds up to 1Mbps

Application
- Multiple channel temperature monitoring.

Electrical
- Supply Voltage 7V to 17.5V
- Supply Voltage must not exceed 17.5V continuous (the unit is protected against transients and reverse polarity)
- Current 95mA maximum (70mA, typ)

Mechanical
- Case material Magnesium alloy, finished with stippled black epoxy
- Weight less than 155g

Sensor Inputs
- 32 analogue Type ‘K’ thermocouple inputs, -50°C to +1300°C nominal sensor range, cold-junction compensated, open circuit detection (1M pull-up to 160mV)
- Four digital channel select inputs (10k pull-downs), 5V clamp, can be driven from TTL or Moog output

Outputs
- Two 0-5V outputs (16 multiplexed outputs per channel)
- Nominal scale 60mV at -50°C, 230mV at 0°C, 3.944V at 1000°C
- Outputs can be scaled and transmitted via a CAN link at 1Mpbs

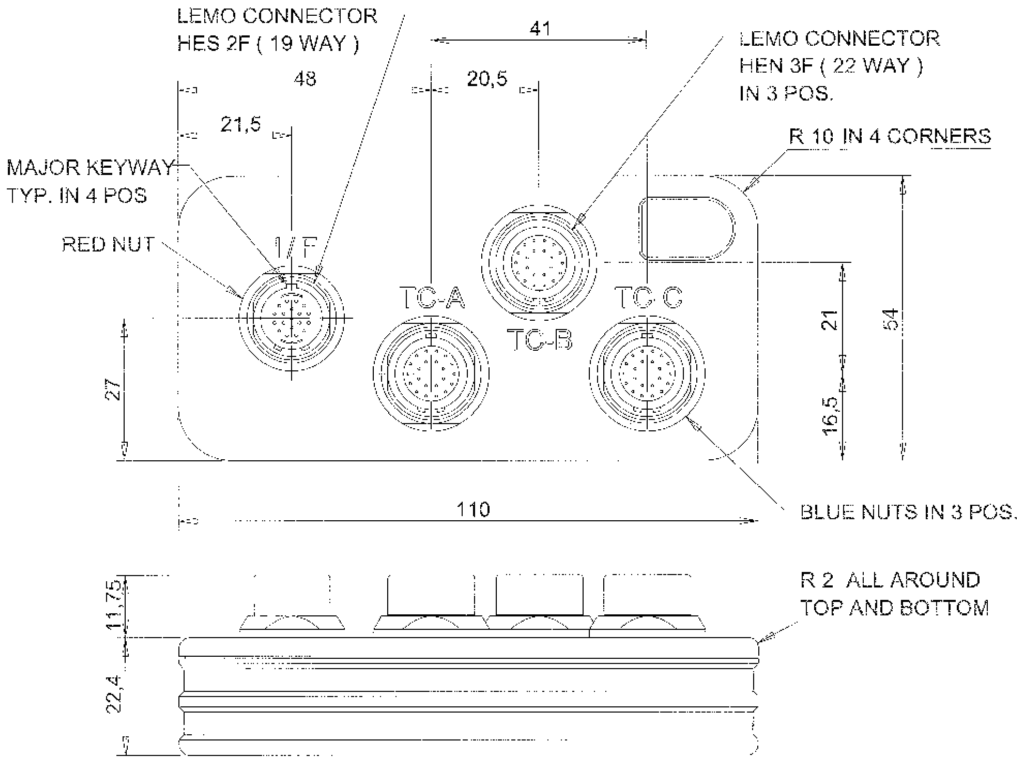
Connection Definition
- Integral, sealed, LEMO series F motorsport connectors

Connector 1	22-way	HEN3F322XLNP
Connector 2	19-way	HES2F319XLDP

- For pin numbers, please contact our Technical Consultancy Service

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

Environmental
- Splash resistant to standard motorsport fluids
- Lid and screws sealed with silicone sealant, lid o-ring sealed
- Maximum humidity 100%
- Operating temperature -50°C to +70°C
- Storage Temperature -50°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours
- Care must be taken to shield the TIU-32 from draughts and sources of direct heat, as uncompensated errors will occur if the unit is subjected to thermal gradients or operated in an unstable ambient temperature.



Description	Ordercode
TIU-32	O 030 095 008 001
TIU-32C (CAN linked)	O 030 095 008 002

Electronics

Sensor Interface Unit
SIU-400

The SIU-400 Sensor Interface Unit is a local interface unit designed to expand the input capacity of a logging or control system.

All sensor data is linked by CAN to a main control unit and so reduces the harnessing while extending the analogue input capabilities of the system.

Application
- Interface to remote sensors, for example, controls on steering wheel.

Electrical
- Supply Voltage 11.0 to 16.0V DC (full operation)
- Supply Voltage not to exceed 17V continuous (unit is protected against transients and reverse polarity)
- Supply Current operating 90mA typical @ 13.8V including typical transducer loads

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC when installed in a screened enclosure

Mechanical
- Weight 135g

Connection Definition
- Connector A : Deutsch ASDD06-09PN
- Connector B : Deutsch ASDD06-09PA
- Connector C : Deutsch ASDD06-09PB

For connection descriptions, please consult our Technical Consultancy service.

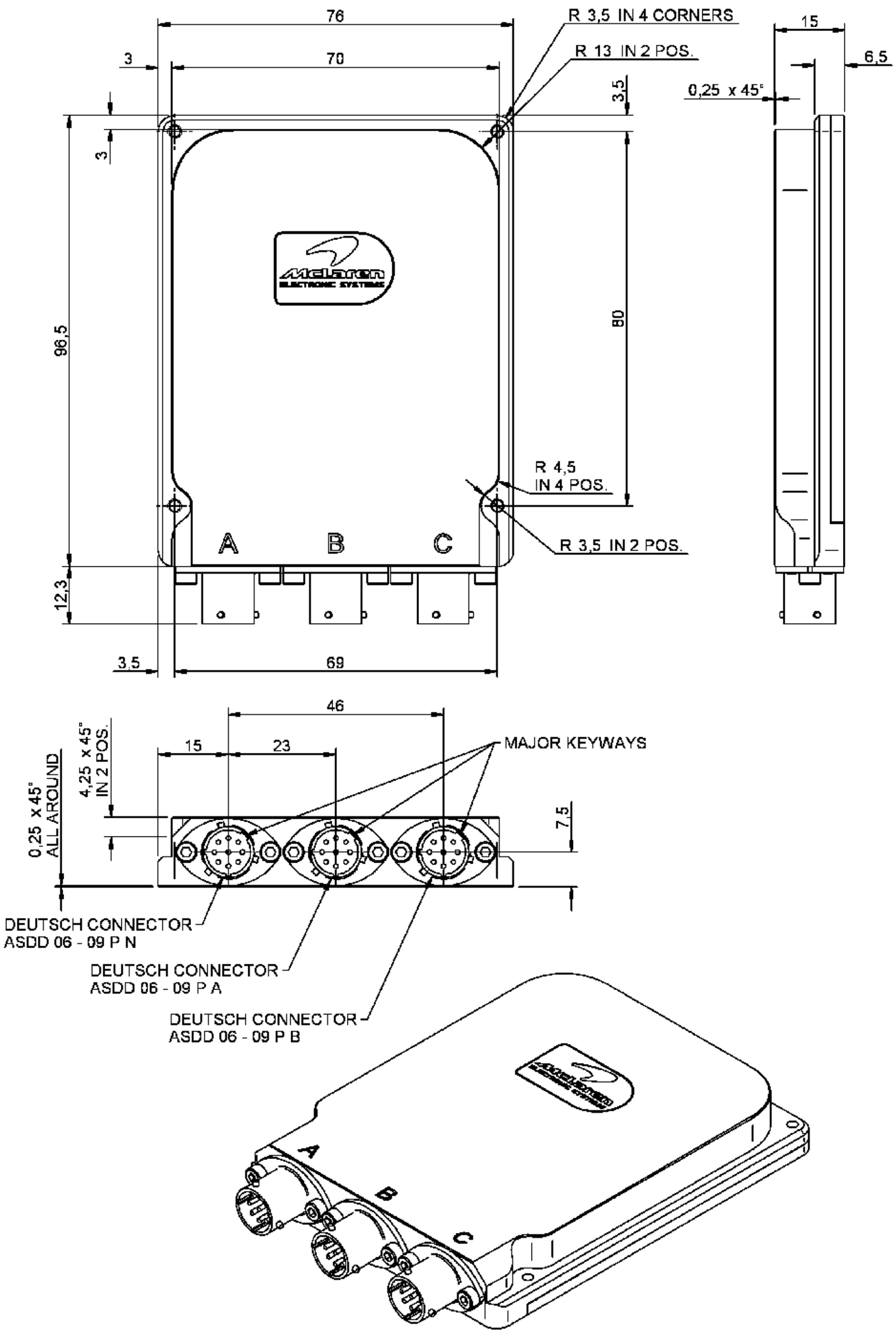
Inputs
- 11 0 to 5V analogue inputs

Outputs
- One 5V 50mA potentiometer supply, (split between three connectors)

Communications
- One CAN bus interface, 1Mbaud as standard

Diagnostics
- One internal diagnostic temperature sensor
- One internal diagnostic 5V potentiometer
- One internal diagnostic car battery supply

Environmental
- Minimum Operating Temperature 0°C
- Board Temperature not to exceed 70°C
- Storage temperature -10 to +125°C
- Vibration 100 to 1000Hz, all axes, 24 hours

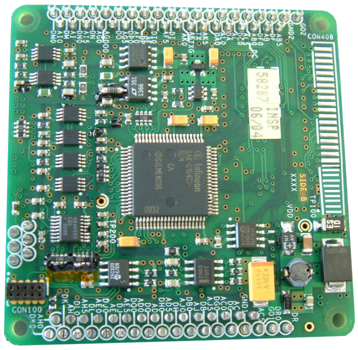


Description	Ordercode
SIU-400	O 030 110 009 000

Electronics

Steering Wheel Interface Unit
SIU-300

The SIU-300 Steering Wheel Interface Unit is a local sensor and switch interface unit designed to become an integral part of an assembly such as a racing car steering wheel. All sensor/switch data is linked by CAN to a main control unit which reduces the harnessing while expanding the analogue and digital input capabilities of the system.



Application
- Interface to remote sensors and switches, for example: controls on steering wheel.

Electrical
- Supply Voltage 11.0 to 16.0V DC (full operation) 7.0V to 11.0V (full operation except external 10V strain gauge supply)
- Supply Voltage not to exceed 17V continuous (unit is protected against transients and reverse polarity)
- Supply Current operating 90mA typical @ 13.8V including typical transducer loads (user defined LEDs off)

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 2004/108/EC

Mechanical
- Weight less than 40g (as a subassembly)
- Main board dimensions 65mm x 65mm

Connection Definition
- O 030 110 006 004 comprises a processor board and interconnection board joined together via a detachable, flexible connection
- O 030 110 006 005 comprises the processor board only without the interconnection board
- For connection descriptions, please consult our Technical Consultancy service.

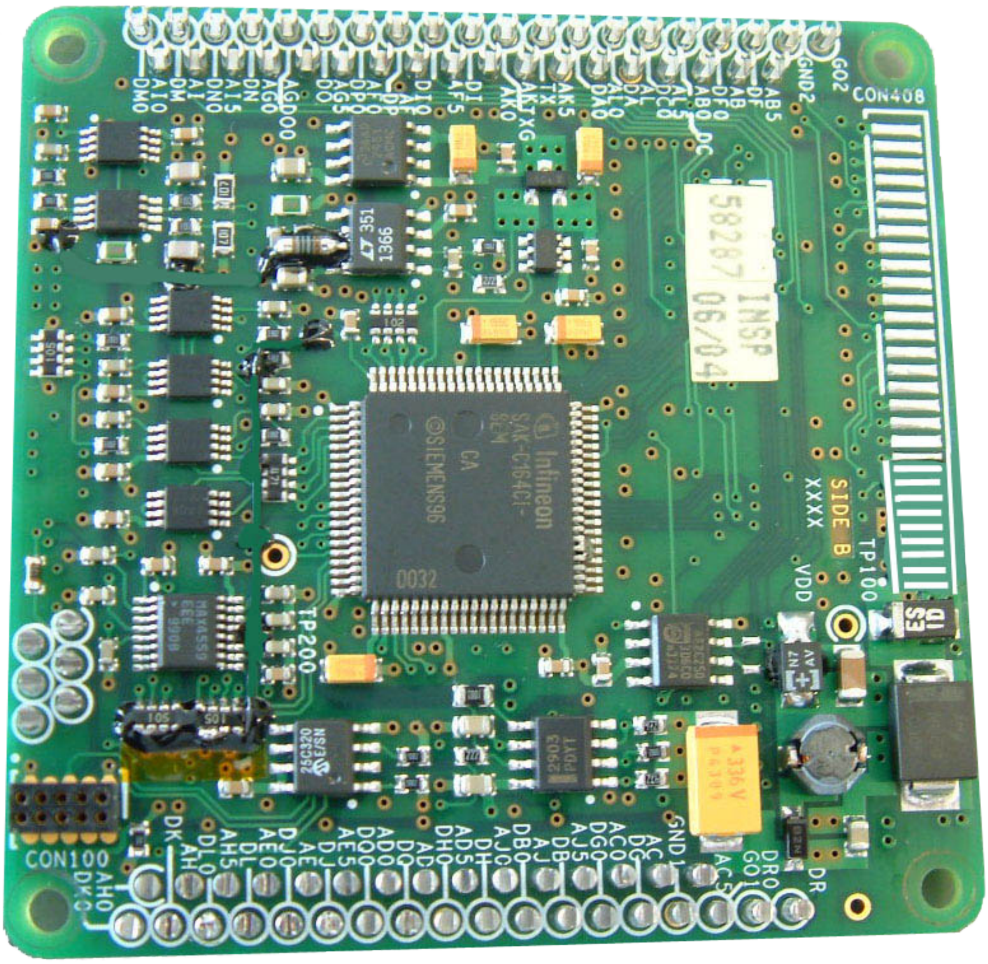
Diagnostics
- One internal diagnostic temperature sensor
- One internal diagnostic 5V output supply
- One internal diagnostic vehicle supply voltage

Inputs
- 18 digital switch inputs
- 11 0 to 5V analogue inputs
- One amplified steering torque strain gauge interface
- One reset input
- Two external switch inputs (not internally sampled) with an internal connection to the external switch output

Outputs
- One 10V output supply for strain gauge transducer
- One 5V supply for potentiometers and transducers
- Three user defined high side LED drivers
- One external switch output

Communications
- One CAN bus interface, 1Mbps

Environmental
- Minimum Operating Temperature 0°C
- Board Temperature not to exceed 70°C
- Storage temperature -10 to +125°C
- Vibration 100 to 1000Hz, all axes, 24 hours



Description	Ordercode
SIU-300 – all boards and flexible interconnector	O 030 110 006 004
SIU-300 – single processor board without flexible interconnect	O 030 110 006 005

Sensor Interface Unit
SIU-3

The SIU-3 three channel CAN interface unit is used to translate the voltage output from up to three sensors and transmit over CAN to the host controller and/or logger.

Application
- Interface to remote sensors.

Electrical
- Supply voltage 8 to 16V unregulated
- This supply is also the unregulated sensor supply
- Regulated sensor supply: 5V±10mV, 50mA max total
- Supply current (without sensors connected) 105mA max (90mA typ at 13.8V)
- Reverse polarity protection

Inputs
- Sensor inputs 0-5V. The output will read 5V for any input 5V or higher

Communications
- 1Mbit/s CAN communications link for configuration and results data
- CAN sampling rate configured by host ECU up to 1kHz
- CAN message identifiers configured by host ECU allowing multiple modules sharing a common bus (a fixed CAN identifier will be required for configuration messages)
- CAN bus link must be terminated using 120ohm resistor

Mechanical
- Weight less than 80g
- Aluminium body hard anodised and dyed black

Environmental
- Resistant to standard motorsport fluids
- Lid sealed with silicon o-ring
- Operating temperature 0 to +115°C
- Storage temperature -10 to +125°C
- Vibration 100 to 1000Hz, all axis, 24hours

Connection Definition
Lemo connector variant O 030 200 010 001
- 3x Interface inputs 4 way Lemo ECN.FF.304.SLM, blue, green and black nut

Pin 1	Sensor supply (unregulated)
Pin 2	Signal
Pin 3	Ground
Pin 4	Sensor supply (regulated)

- Interface output 4 way Lemo ECS.FF.304.SLC, red nut

Pin 1	Supply
Pin 2	CAN +
Pin 3	CAN -
Pin 4	Ground

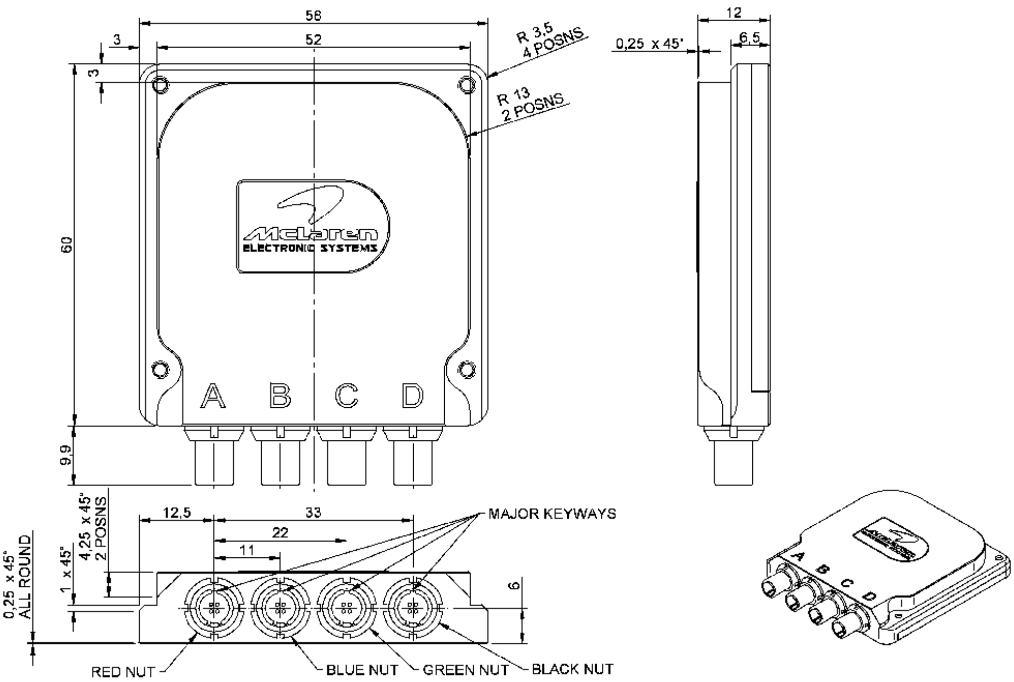
Souriau connector variant O 030 200 010 002

- 3x Interface inputs 8STA0-02-05SA Connectors B, C and D

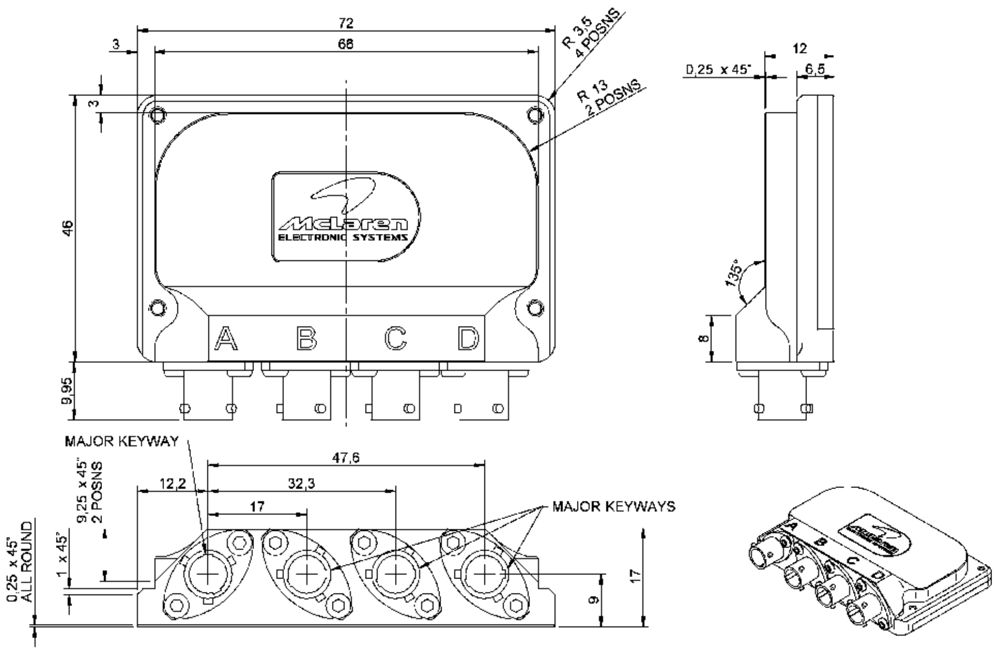
Pin 1	Sensor supply (unregulated)
Pin 2	Signal
Pin 3	Ground
Pin 4	Sensor supply (regulated)
Pin 5	N/C

- Interface output 8STA0-02-05PN Connector A

Pin 1	Supply
Pin 2	CAN +
Pin 3	CAN -
Pin 4	Ground
Pin 5	N/C



Description	Ordercode
Three channel CAN Interface unit with Lemo connectors	O 030 200 010 001



Description	Ordercode
Three channel CAN Interface unit with Souriau connectors	O 030 200 010 002

SENSOR INTERFACE UNIT
SIU-8

The SIU-8 eight channel CAN interface unit is used to convert the analogue voltage output from up to eight sensors and transmit over CAN to the host controller and/or logger.

Application

- Interface to remote sensors.

Electrical

- Supply voltage 8 to 16V unregulated [1]
- Supply current (without sensors connected) 90mA at 12V max [1]
- Reverse polarity protection
- Regulated sensor supply: 5V±25mV, 80mA max total
- Unregulated sensor supply: Same as unit’s supply voltage less 0.5V.

[1] If an operating temperature above 115°C is required, refer to table 1

Inputs

- Sensor inputs 0-5V. Signals outside this range may damage the unit.

Communications

- 1Mbit/s CAN communications link for configuration and results data
- CAN sampling rate configured by host ECU up to TBA
- CAN message identifiers configured by host ECU allowing multiple modules sharing a common bus (a fixed CAN identifier will be required for configuration messages)
- CAN bus link must be terminated using 120ohm resistor

Mechanical

- Weight less than 140g
- Aluminium body hard anodised and dyed black

Environmental

- Resistant to standard motorsport fluids
- Lid sealed with silicon o-ring
- Operating temperature 0 to +125°C
- Storage temperature -10 to +125°C
- Vibration 100 to 1000Hz, all axis, 24 hours

Connection Definition

- Power/CAN 5 way ASL006-05-PN connector (red band)

Pin 1	Supply
Pin 2	Ground
Pin 3	CAN+
Pin 4	CAN-
Pin 5	N/C

- Sensor Connector A ASDD006-09-SN (red band)

Pin 1	Supply Channel 1
Pin 2	Supply Channel 2
Pin 3	Supply Channel 3
Pin 4	Sensor supply (regulated)

Pin 5	Sensor supply (regulated)
Pin 6	Sensor supply (unregulated)
Pin 7	Sensor supply (unregulated)
Pin 8	Ground
Pin 9	Ground

- Sensor Connector B ASDD006-09-SN (red band)

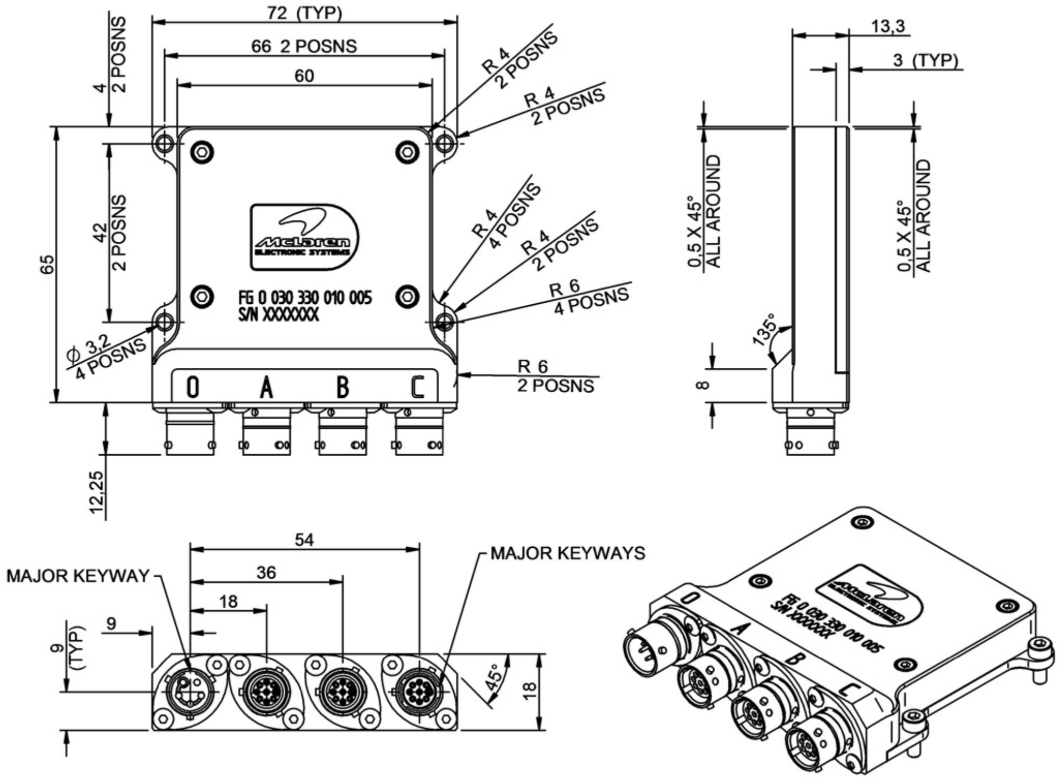
Pin 1	Supply Channel 4
Pin 2	Supply Channel 5
Pin 3	Supply Channel 6
Pin 4	Sensor supply (regulated)
Pin 5	Sensor supply (regulated)
Pin 6	Sensor supply (unregulated)
Pin 7	Sensor supply (unregulated)
Pin 8	Ground
Pin 9	Ground

- Sensor Connector C ASDD006-09-SN (red band)

Pin 1	Supply Channel 7
Pin 2	Supply Channel 8
Pin 3	N/C
Pin 4	Sensor supply (regulated)
Pin 5	Sensor supply (regulated)
Pin 6	Sensor supply (unregulated)
Pin 7	Sensor supply (unregulated)
Pin 8	Ground
Pin 9	Ground

Table 1: Max Voltage and Current Consumption when operating above 115°C

Operating Temperature (°C)	**Max Supply Voltage (V)**	**Max Current Consumption (mA) Excluding Unregulated sensor supply**
115-120	14	80
120-125	10	100



Description	Ordercode
Eight channel CAN Interface unit with Deutsch AS connectors	O 030 200 010 005

Dashboard Displays

Display Module
PCU-8D

The PCU-8D is a lightweight driver display module designed for general motorsport applications. It is designed to connect to a host ECU via CAN and present the driver with information on a 4.3" display and LED lamps. The display is suitable for use in direct sunlight and at night. The text and graphics layout of the screen is user-configurable via PC software. 100 pages are available, and are selectable by CAN message.

Application
- Data display and warning lamps
- Typically installed within the steering wheel, although can also be remotely mounted

Display
- 4.3" backlit LCD display
- Viewable area 95mm x 54mm, 480 x 272 pixel resolution
- Viewable in direct sunlight. Brightness adjustable via CAN message for low-light conditions
- 16 Gauge types for displaying data, including bar tacho, rev lights and variable text
- 100 user-configurable page, selectable by CAN message
- The display is fully customisable; page layout can be configured by PC with text and gauges
- Alarm pages or user-configurable text warnings can be triggered by CAN messages

Communications
- One CAN interface (1Mbps). No internal termination
- One USB interface for configuration only

Unit Inputs
- One reset input (active low with internal pull-up; can be left unconnected if not required)
- One CAN address selection analogue input (connect an external resistor to unit supply ground)

Other Features
- Configuration software tool supplied with the unit

Electrical
- Supply voltage 8V to 16V DC
- Supply current: <0.6A @ 13.8V (screen and all LEDs on)

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 2004/108/EEC

Environmental
- Size: 130mm x 81mm x 22mm
- Weight: <230g
- Splash resistant to standard motorsport fluids
- Lid has a rubber seal, case fixings are sealed with silicone sealant
- Maximum humidity: 95% non-condensing
- Operating temperature: 0°C to +50°C
- Storage temperature: -25°C to +85°C
- Vibration: 100Hz to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended

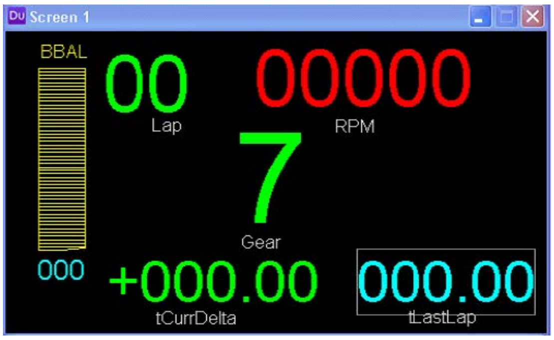
Connection Definition
- Un-terminated flying lead only (no connector fitted), length 300mm
- 28 AWG wire for all wires unless stated
- USB wires are contained within a cable screen, with the other wires coiled round the USB screened cables
- Note the unit supply is required when configuring. The unit cannot be powered by USB
- Wire colours:

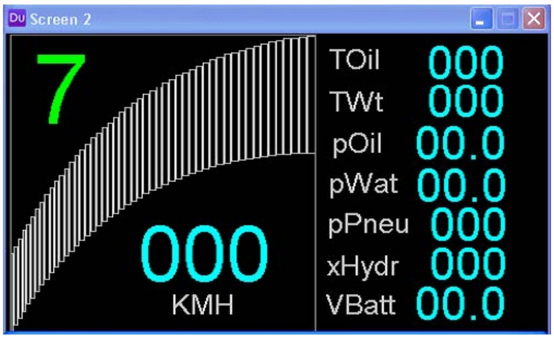
Orange	Unit Supply Positive

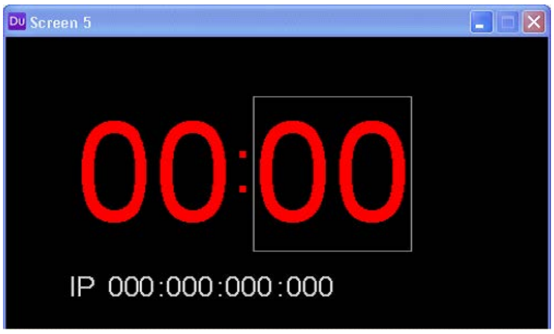
Brown	Unit Supply Ground
White	CAN +
Blue	CAN -
Green	USB+
White	USB -
Red (28 AWG)	USB 5V
Black (28 AWG)	USB Ground
-	USB Screen (internally connected to supply ground)
Grey	CAN address selection input
Yellow	Reset input

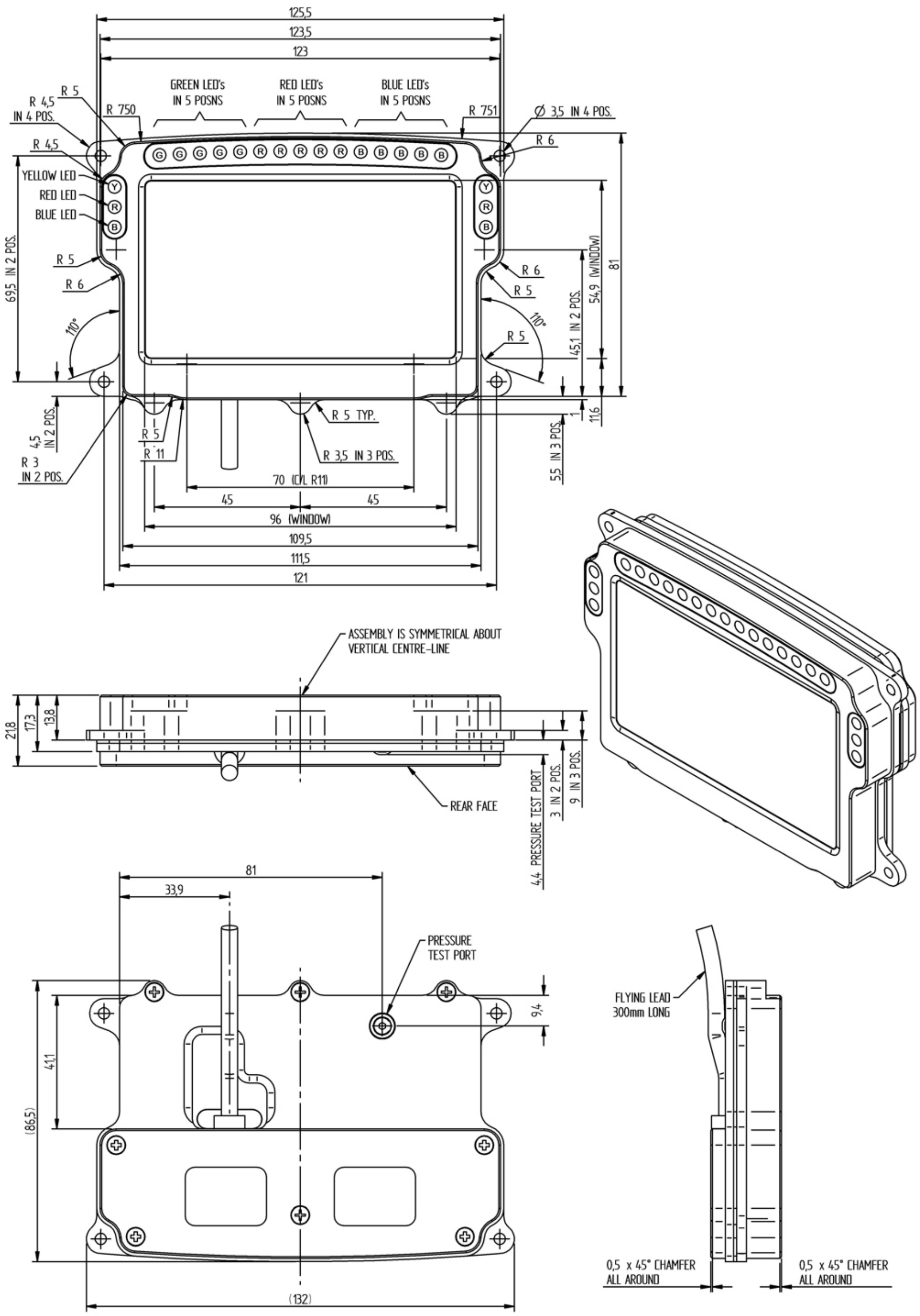
Example Screen Layouts

- The configuration software allows each page layout to be fully customised









Description	Ordercode
Panel Display Unit PCU-8D	O 030 020 011 002

LED Display Module
PCU-6D

PCU-6D is a small, lightweight display module designed to present drivers with the information they require in a clearly-legible and simple format via alphanumeric LED displays and LED lamps.

Diagnostic monitoring of the unit is via a 1Mbps CAN interface, and control may be via CAN or a synchronous serial interface (clock, data, strobe and PWM brightness signals).

Application

- Data display

Display

- Central Numeric Display area:
    - A single digit, fitted centrally, indicating gear number.
    - Size: 14.22mm high by 8mm wide.
    - This is a seven-segment red display with a right-hand decimal point.
- Left and Right Alphanumeric Display areas
    - Two smaller four-character displays flanking the central digit.
    - Each digit is 10.16mm high by 6mm wide.
    - These are alphanumeric ‘starburst’ red LED displays with right-hand decimal points.
- Warning/Marshalling LEDs
    - Two high-intensity red, two high-intensity yellow and two high-intensity blue LED indicators positioned at the extreme left and right of the unit.
- Shift LEDs
    - A horizontal bar of 15 high-intensity LEDs at the top edge of the assembly. The five left-hand LEDs are high-intensity green, the five middle LEDs are high-intensity red, and the five right-hand LEDs are high-intensity blue
- If the unit’s synchronous serial interface is used, the intensity of the warning and shift LEDs is controlled by a PWM brightness input signal, which can be pulse-width modulated at approximately 200Hz to adjust the intensity. Alternatively, if the CAN interface is used for control of the unit, the intensities of these LEDs and the alphanumeric displays may be independently set using CAN messaging.
- When the synchronous serial interface is used, the PWM brightness input signal can be left unconnected, resulting in maximum brightness.
- A grey acrylic circularly-polarised anti-glare front screen covers the alphanumberic and seven-segment LED displays. This enhances the contrast between light from the display and incident light due to polarised filters absorbing back-reflected light.
- The LEDs on the front face of the unit are covered by a grey velvet polycarbonate label with clear windows.

Unit Inputs

- One reset input (active low with internal pull-up; can be left unconnected if not required)
- One CAN address selection analogue input (connect an external resistor to unit supply ground)

Communications

- 1Mbps CAN interface (no internal termination)
- A range of extended (29 bit) and standard (11 bit) CAN IDs are supported
- Synchronous serial interface

Diagnostics

- Internal board temperature
- Supply voltage
- Six warning LED drive voltages

Electrical

- Supply voltage: 7.5V to 16V DC
- Unit is protected against transients
- Supply current:
    - Quiescent (all LEDs off): 70mA typ @ 13.8V
    - Operating (all LEDs on): 0.6A typ @ 13.8V

- Synchronous serial interface input characteristics:
  - Operating input voltage range: 0V to 5V
  - Maximum protected input voltage range: ±16V
  - Input filter time constant: 1µs
  - Input termination: 4.7k# internal pull-up to 5V
  - Input low threshold: 1.0V min
  - Input high threshold: 3.5V max

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 2004/108/EEC

Connection Definition

- Unterminated flying lead only (no connector fitted)
- Wires are 26 AWG (CAN signals are twisted pair)
- Wire colours

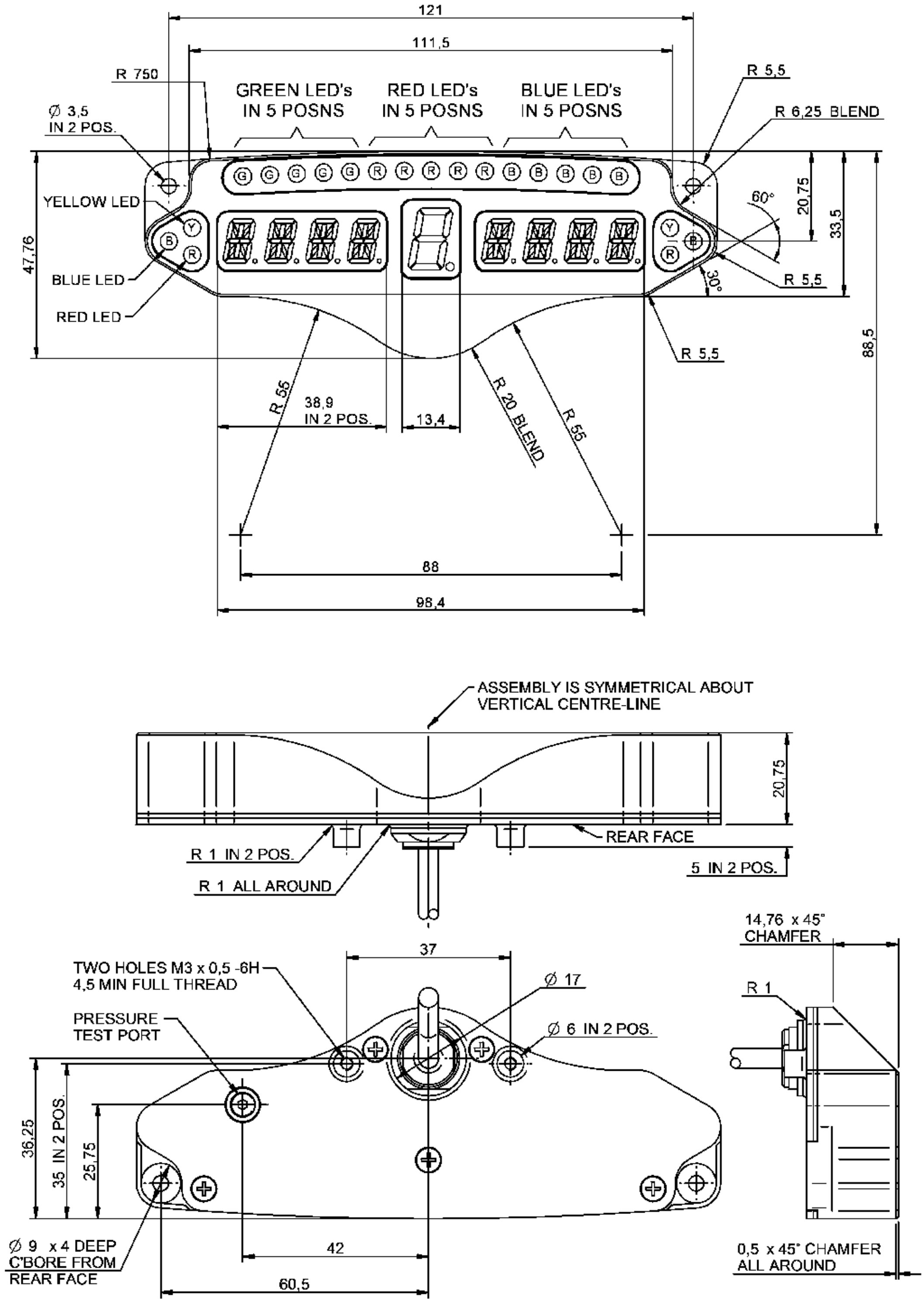
Red	Unit supply positive
Black	Unit supply ground
Green	Reset input
White	CAN port +
Blue	CAN port -
Grey	CAN address selection input
Brown	Serial clock input
Orange	Serial data input
Yellow	Serial strobe input
Violet	PWM brightness input (for warning and shift LEDs only)

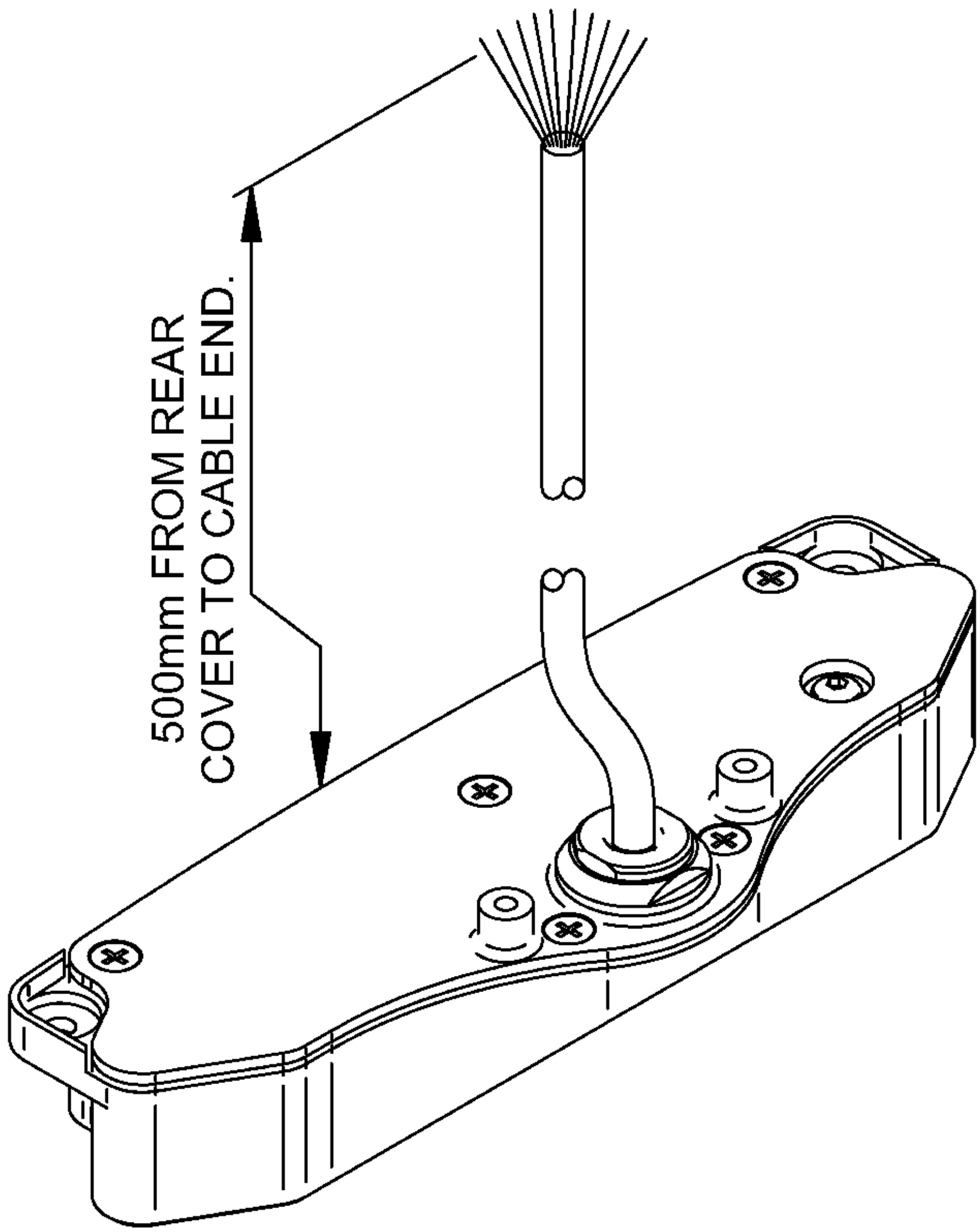
Mechanical

- Hard black anodised aluminium case
- Weight: 130g approx

Environmental

- Splash resistant to standard motorsport fluids
- Lid has a rubber seal, case fixings are sealed with silicone sealant
- Maximum humidity: 100%
- Operating temperature: -10°C to +50°C
- Storage temperature: -25°C to +85°C
- Vibration: 100Hz to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended


121
111,5
R 750
Ø 3,5
IN 2 POS.
GREEN LED's
IN 5 POSNS
RED LED's
IN 5 POSNS
BLUE LED's
IN 5 POSNS
R 5,5
R 6,25 BLEND
YELLOW LED
BLUE LED
RED LED
47,76
60°
20,75
33,5
30°
R 5,5
R 5,5
88,5
R 55
38,9
IN 2 POS.
13,4
R 20 BLEND
R 55
88
98,4
ASSEMBLY IS SYMMETRICAL ABOUT
VERTICAL CENTRE-LINE
20,75
REAR FACE
R 1 IN 2 POS.
R 1 ALL AROUND
5 IN 2 POS.
14,76 x 45°
CHAMFER
37
TWO HOLES M3 x 0,5 -6H
4,5 MIN FULL THREAD
Ø 17
R 1
PRESSURE
TEST PORT
Ø 6 IN 2 POS.
36,25
35 IN 2 POS.
25,75
Ø 9 x 4 DEEP
C'BORE FROM
REAR FACE
42
60,5
0,5 x 45° CHAMFER
ALL AROUND



Description	Ordercode
PCU-6D (unterminated flying lead)	O 030 020 010 004

Display Module
PCU-8

The PCU-8 is a lightweight driver display module designed for general motorsport applications. It is designed to connect to a host ECU via CAN, and present the driver with information on a 4.3" display. The display is suitable for use in direct sunlight and at night. The text and graphics layout of the screen is user-configurable via PC software. Up to 16 pages are available, and are selectable by the driver or triggered by alarm conditions.

Application
- Data display

Display
- 4.3" true colour display
- Viewable area 95mm x 54mm, 480 x 272 pixel resolution
- Ultra-clear display technology viewable in direct sunlight. Brightness adjustable for low-light conditions
- 16 Gauge types for displaying data, including bar tacho, rev lights and variable text
- Up to 16 user-configurable pages, selectable by external input pot/push switches or CAN message
- The display is fully customisable; page layout can be configured by PC with text and gauges
- Alarm pages or user-configurable text warnings can be triggered by CAN messages

Electrical
- Supply voltage 7.5V to 18V DC
- Supply current <0.6A @ 12V (for a typical screen layout)

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 2004/108/EEC

Inputs
- Four General purpose analogue inputs, 0-5V, pull-ups available on request
- Two Hall effect speed inputs, user configurable as two additional analogues if required
- Inputs can be transmitted to other devices via CAN
- One Lap trigger input

Outputs
- One 5V sensor supply

Communications
- One CAN interface, user configurable baud rate
- One RS232 interface
- One USB interface for configuration only

Other Features
- One configuration tool software licence supplied per team purchasing PCU-8s

Environmental
- Size: 123mm x 70mm x 30mm
- Weight: 254g
- Splash resistant to standard motorsport fluids
- Lid has a rubber seal, case fixings are sealed with silicone sealant
- Maximum humidity: 100%
- Operating temperature: -10°C to +50°C
- Storage temperature: -25°C to +85°C
- Vibration: 100Hz to 1000Hz, all axes, 24 hours
- Vibration isolation is recommended

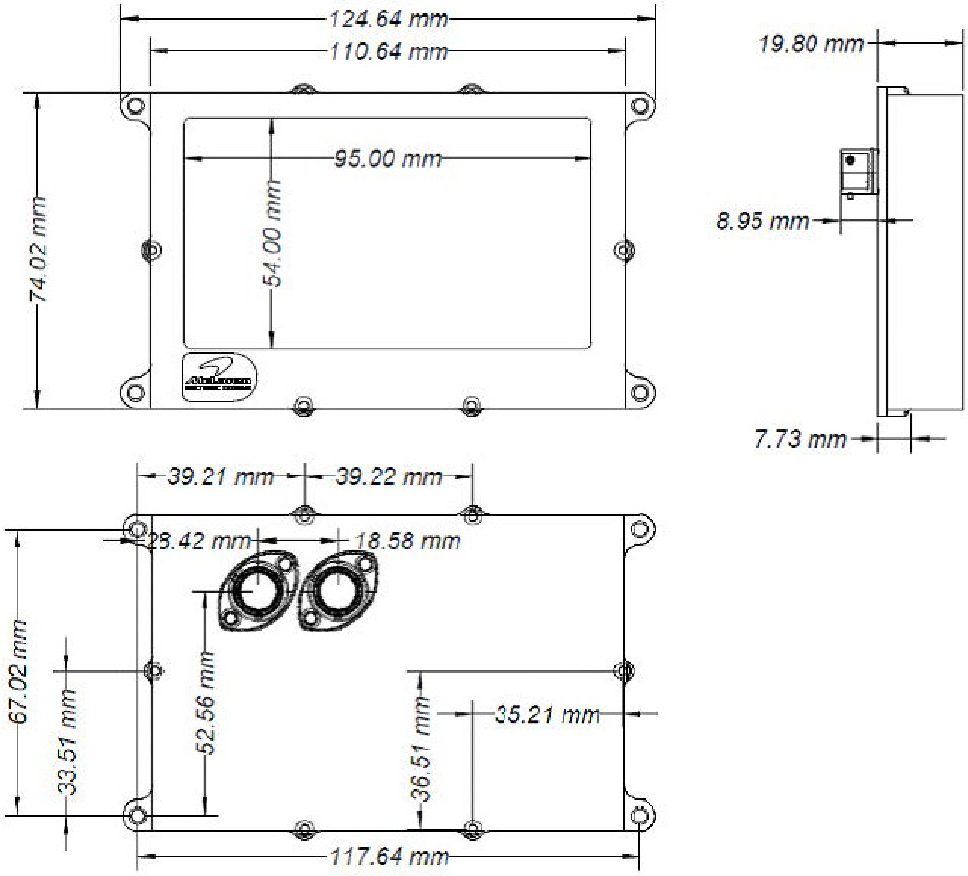
Connection Definition
- Connector 1: AS-DD006-09PN-HE

Pin	
1	+12V Power
2	CAN +
3	USB -
4	USB Power
5	Lap Trigger Input
6	0V
7	CAN -
8	USB +
9	Ground

- Connector 2: AS-DD0006-09SN-HE

Pin	
1	+5V Sensor Power
2	Speed 1/Analogue 7*
3	Analogue 2
4	Analogue 4/Serial Rx*
5	Low Side Driver
6	Sensor Ground
7	Speed 2/Analogue 8*
8	Analogue 1/Page Select Switch*
9	Analogue 3

* Function dependent on usage. Unit will detect type of input and behave accordingly.



Description	Ordercode
PCU-8	O 030 020 011 000

Tyre Pressure Dash Display

The tyre pressure display unit is a combined receiver/display unit for use with MES tyre pressure sensors. The sensors transmit pressure, temperature, battery voltage, serial number and life count data over an RF link to an antenna on the car. Signals from the antenna are passed to the TP display unit were they are decoded and displayed on the LCD screen. The TP display is aimed at racing car applications in which data logging and pit telemetry are not used. The unit is intended to be mounted on the dash and enables the driver to monitor the tyre pressures from the cockpit.

Features

- Four line, 16 character LCD
- Optical sensor to control backlight of LCD
- Pressure status warning LEDs
- Configurable display
- CAN interface
- Unit available with either analogue outputs or external switch and audible warning control lines

Electrical

- Supply voltage 8 to 16Vdc
- Supply current 150mA max @12V typical, 170mA @12V max
- CAN bus 2.0B active, 1Mbps

Mechanical

- Weight less than 0.5lb (without antenna)
- Aluminium alloy housing, anodised and dyed black

Environmental

- Unit sealed with o-rings and screws sealed with silicon rubber
- Maximum humidity 100%
- Operating temperature 10 to +50°C
- Vibration 5 to 2000Hz @ 5g, 2 hours

Connection Definition

- Connector ASDD206-09PN-HE (Audible warning variant)

Pin 1	Supply +ve
Pin 2	Power ground
Pin 3	CAN -
Pin 4	CAN +
Pin 5	Audible control line
Pin 6	External switch
Pin 7	Ground
Pin 8	N/C
Pin 9	N/C

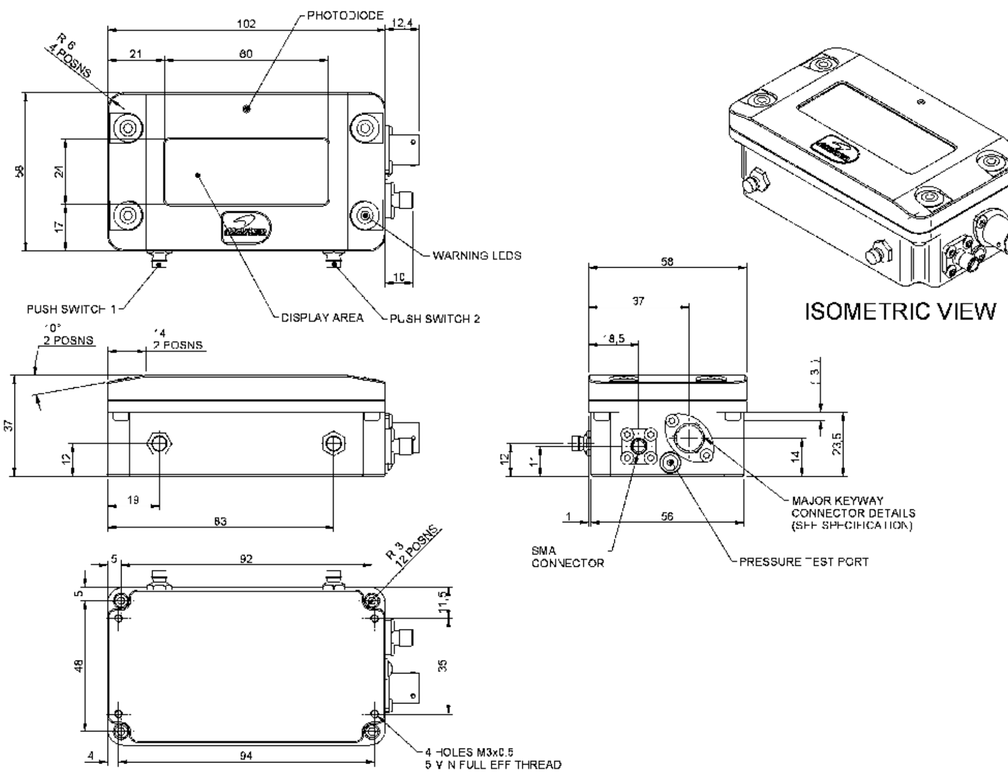
- Connector ASDD206-09PN-HE (Analogue variant)

Pin 1	Supply +ve
Pin 2	Power ground
Pin 3	CAN -
Pin 4	CAN +
Pin 5	Signal ground
Pin 6	Analogue signal 1
Pin 7	Analogue signal 2

Pin 8	Analogue signal 3
Pin 9	Analogue signal 4

- Antenna connector SMA socket

Case	RF ground
Centre	RF in



Description	Ordercode
Tyre Pressure Receiver Dash/Display	O 030 330 046 020
Tyre Pressure Reciever Dash/Display Analogue variant	O 030 330 046 028

Hardware-in-the-loop

Factory HIL

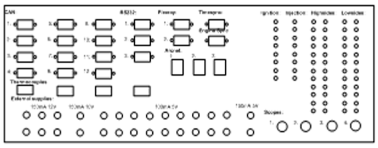
vTAG-RT

The Factory HIL provides a way of simulating the complete functionality of an F1 race car. I/O and simulation models are provided to drive the F1 Standard ECU components to simulate a typical run of the car ie. engine start, pull away and flying lap simulation, including gear shifting.

The HIL can also be used for car model and ECU set-up development. The HIL provides the connectivity for the majority of the I/O of all the current FIA Standard ECU components – TAG-320, 4xHIU-3, Powerbox 2006, CBT-610 and PCU-6D – when combined with the appropriate wiring harnesses, plus optional upgrades for the HSL-500 High Speed Logger.

The HIL is enclosed in a 9U rack including the PSU for the HIL and the car electronics. The units are connected via harnesses, which can be plugged into the back of the rack. The PCU-6D can be mounted on the front of the rack, which also provides connections for all CAN and other communication buses as well as scope outputs for the TAG-320 and Powerbox 2006.

The HIL plant model runs under vTAG-RT, allowing models to be developed in Dymola or Simulink with GDE 8.2 and for ATLAS & System Monitor to be used as front ends.



Application

Full system simulation and car systems testing. The HIL is provided with a simple model that is able to drive the car around a basic circuit profile. The auto driver controls throttle, brakes and gears so that the embedded code in the TAG-320 runs as if it was on a real car.

The model is supplied as a Simulink source code so that it can be extended or replaced with teams own models.

The HIL runs vTAG-RT which provides an identical development environment to the ECU, i.e. it provides a logger which can be set up via System Monitor and monitored with ATLAS.

Processor

- Intel Core i7 2.8GHz processor
- 2GB DDR3 RAM
- 256Mb IDE flash disk

Communications

- One Gigabit Ethernet
- Integrated Gigabit Ethernet switch
- 12 CAN buses

I/O

- 128 x 16-bit 0-5V analog output channels (expandable to 192 channels)
- 32 x 16-bit analog input channels (e.g. +/-10mA Moog drive monitoring)
- 48 x digital I/O channels
- FPGA cards provide generation of crank and cam signals, and monitor TAG-320 ignition/injection timing and high/low side driver outputs. Feedback is provided via front panel LEDs and loads (10% of rated output)

Mounting

Standard harnesses are available for TAG-320, TAG-310B, Powerbox2006, CBT-610, PCU-6D and four HIU-3s (these units are not included). Option upgrades and harness packages are available for a HSL-500 unit. The system as a whole is a 9U rack.

Specification

The Factory HIL provides the following connectivity to the FIA Standard ECU units:

TAG-320

Unit Signal Type	vTAG-RT System Connection	Comment
0-5V Analog Inputs	Direct connection to DAC channel	
0-5V/PT1000 Analog Inputs	Direct connection to DAC, or switchable to two known resistances	Under software control the input can be switched to allow full analog control or resistances equivalent to 0°C or 190°C to be connected to the TAG-320 input
DHE Inputs	Connection to FPGA via signal conditioning	Quadrature encoding of lay/mainshaft signals is provided
Digital Input	Connection to FPGA via signal conditioning	
Crank/Cam Inputs	Connection to FPGAs.	20-2 crank simulation is provided as standard
Thermocouple Inputs	Connection via thermocouple connector on front panel	No thermocouple simulation is provided but signals can be tested via an external thermocouple (or simulator)
Lambda Inputs	A lambda simulation circuit is provided utilising one DAC and one ADC channel for each TAG-320 lambda input	A simulation of a lambda sensor is required to driver the DAC signal appropriately.
Lap Trigger Input	FPGA output gates a DAC generated voltage	
Ignition Outputs	Connection to FPGA via signal conditioning	Connection can to FPGA inputs can be source from Powerbox2006 if fitted. Feedback LED is provided on front panel
Injection Outputs	Connection to FPGA via signal conditioning	Connection can to FPGA inputs can be source from Powerbox2006 if fitted. Feedback LED is provided on front panel
Moog Outputs	Direct connection to differential ADC with load resistor	
High Side Drive Outputs	Connection to FPGA via signal conditioning	Load is 10% of rated channel load. Feedback LED is provided on front panel
Low Side Drive Outputs	Connection to FPGA via signal conditioning	Load is 10% of rated channel load. Feedback LED is provided on front panel
Digital Outputs	Not connected	
Scope Outputs	Connection to ADC/FPGA and via BNC connector on front panel	
Timesync Output	Connection to FPGA via signal conditioning	Allows time synchronisation of vTAG-RT model with TAG-320 in order to allow comparison or data recorded by both
Sensor Supply Outputs	Connection via 4mm jacks on front panel	
Ethernet Communications	Connction to integrated Ethernet switch via breaker driven by digital output	Allow for model based simulation of umbilical disconnection
CAN Communications	Each TAG-320 CAN bus is connected to one vTAG-RT CAN channel. These are available via the front panel, and via a breakout connector on the backplane for extension of the CAN buses	

HIU-3

Unit Signal Type	vTAG-RT System Connection	Comment
Wheel Speed Inputs	Connection to FPGA via signal conditioning	
Brake Temp/Hub Accel Inputs	Direct connection to DAC channel	
Caliper Temp PT1000 Input	Buffered connection to DAC channel	Under software control the input can be switched to allow full analog control.

Unit Signal Type	vTAG-RT System Connection	Comment
Pushrod Load Inputs	Not connected	
Brake Wear LVDT Inputs	Not connected	

PB2006

Unit Signal Type	vTAG-RT System Connection	Comment
Scope Outputs	Connection to ADC/FPGA and via BNC connector on front panel	
High Side Drive Outputs	Connection to FPGA via signal conditioning	Load is 10% of rated channel load. Feedback LED is provided on front panel

CBT-610

Unit Signal Type	vTAG-RT System Connection	Comment
HDLC Comms	None	
CAN Comms	Connection to breakout connector on the backplane	

PCU-6D

Unit Signal Type	vTAG-RT System Connection	Comment
Serial Comms	Direct connection to TAG-320	PCU-6D can be mounted on the Factory HIL front panel
CAN Comms	Connection to breakout connector on the backplane	

Note: The system can be used with or without a Powerbox2006 connected.

Please consult our technical consultancy team for details of HSL-500 unit connectivity and additional HIL resources included in the upgrade packages for each.

Software Included

- Simple Simulink car model (source included)
- Simulink I/O Model (source included)
- Simulink blockset including FPGA functionality to support:
  - 20-2 crank/cam generation
  - Ignition/Injection pulse measurement
  - DHE PWM generation with quadrature for lay/mainshaft
  - DHE discrete tooth generation
  - Switched load state and PWM condition detection
  - Time synchronisation with TAG-320
- Simulink CAN card drivers
- Sample front panel software written in C# (source included)
- System Monitor licence
- One vTAG-RT licence

Software Requirements

Development of code for the Factory HIL vTAG-RT system requires the following:

- GDE v8.2
- vTAG-RT PSP (includes vTAG-RT runtime)
- Mathworks Matlab including the following toolboxes:

  R2008a-R2010b
  - Simulink
  - Real Time Workshop with RTW Embedded Coder
  - xPC Target (required to rebuild I/O model)

  R2011a (or later)
  - Simulink
  - Simulink Coder
  - Embedded Coder

- xPC Target (required to rebuild I/O model)

Description	Ordercode
TAG-320 Factory HIL (Mainframe)	O 030 920 000 005

Harnesses and upgrades	Ordercode
TAG-310 harness set	O 030 920 000 002
TAG-320 harness set + upgrade	O 030 920 000 006
HIU-3 and CBT-610 Harness set	O 030 920 000 012
HSL-500 harness set + upgrade	O 030 920 000 004

Power

Ignition/Injection Powerbox
PB2006

The PB2006 is a combination of three units: an eight-stage ignition unit, an eight-stage single-ended injection unit and a switchmode converter providing a regulated DC rail at 14V from a three-phase permanent magnet alternator input.

Application
- Driving ignition coils and injectors in eight cylinder engines

Electrical
- Main Stabilised Output (IGP) Voltage 14V ±0.2V at 25A (30A max)
- Permanent output (VEMSW) 10A max
- Ignition supply (internal) maximum 14.3A
- Injection supply (internal) maximum 15A
- Emergency switch cuts all power

Inputs
- IGP enable and keep alive inputs
- Three-phase alternator power input
- Alternator output voltage absolute maximum 200V peak
- Max 35A per phase
- Two K-type thermocouple inputs for measuring alternator temperature
- Eight TTL injector triggers (active high)
- Eight ignition triggers (active low, internal 1k pull up to 5V)

Outputs
- Switchable 14V rail and permanent 14V rail. Total current = 36A max
- 21 individual, short circuit protected, 12V sensor supplies
- One short-circuit protected 10V supply
- Seven individual, short circuit protected 5V supplies
- ±12V rails at 1A for torque sensors
- Four high Side Drivers (2x5A, 2x3A)
- Eight-channel TSZ ignition (operating from 14V)
- Eight-channel injection (operating from 14V)
- Total 14V current (internal and external supplies) 57A (64A pk)

Communications
- CAN link with the ECU (1Mbps)

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 2004/108/EEC

Diagnostics
- Current sensor measures total 14V supply current (including injector and ignition)
- Temperature sensors on main, ignition and injection boards
- Diagnostic scope outputs of selected signals
- Selected internal diagnostic measurements and flags available via CAN

Connection definition
- Integral, sealed, military standard connectors

Alternator connector	22 way	AS0-12-35PN-9920
Chassis connector	79 way	AS0 20-35SN-9920
Injector connector	19 way	HEN.2F.319.XLNP
Ignition Connector	10 way	HEP.2F.310.XLNP

Battery Connector	4 way	EHS.2F.304.XLY

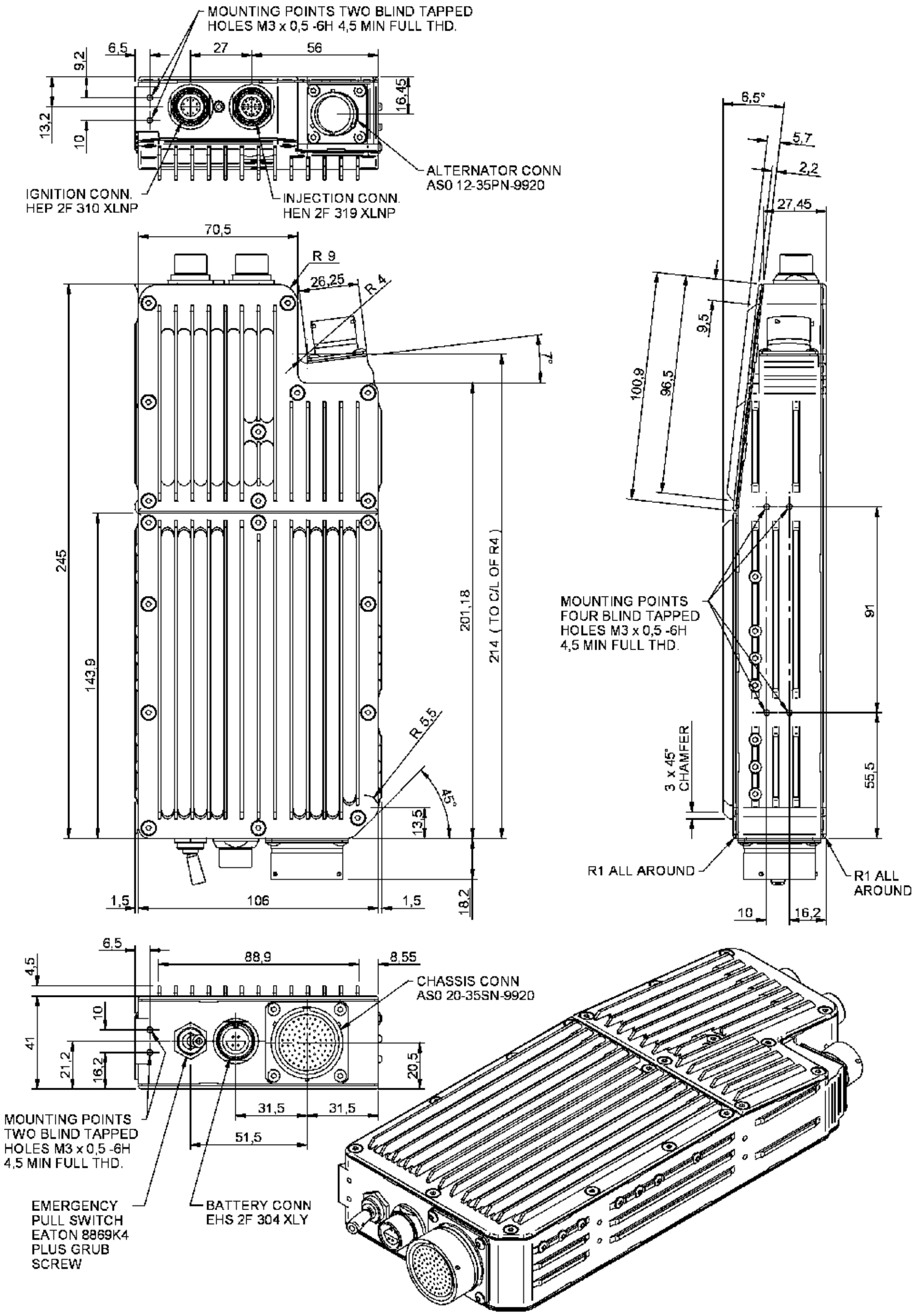
- For pin numbers please contact our technical consultancy department

Mechanical

- Hard black anodised aluminium
- Weight 1420g

Environmental

- Splash resistant to standard motorsport fluids
- Lids and screws sealed with silicone rubber
- Internal temperature not to exceed 70°C as measured by internal diagnostic sensors – care should be taken to prevent overheating if absolute maximum power demand (900W) is sustained for a long period.
- Forced cooling required over fins and side walls
- Storage Temperature -25°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours



Description	Ordercode
Powerbox with Injection and Ignition	O 030 650 029 001

Power Management Unit
PMU-24

The PMU-24 is a power management unit which distributes power from the battery "+12V" line into 22 channels.

The channels are switched directly by the engine control unit, using low-side drivers. The channels form eight groups of variable current capacity, including two high current channels. The overload level for each group can be trimmed via CAN.

One channel provides a "power-hold" function to supply the ECU and any other units whose power-down timing needs to be controlled by the ECU rather than the ignition switch.

All 22 channels' diagnostics are gathered by the local processor and made available via the CAN link.

Application
- Electrical power distribution.

Electrical
- Input voltage 8-16V
- Reverse polarity and transient protection
- Power input via a high-current stud, total current through the unit should not exceed 180A
- Supply input current 10mA max quiescent, 250mA typ operating (unit on, all channels off)

Inputs
- 22 inputs for direct control of the power channels

Outputs
- Divided into eight groups, ranging from 9 to 35A. Each group has a configurable, slow-acting overload trip level and fixed fast short-circuit trip level
- All channels have flyback diode connected to chassis pin

Communications
- CAN link with the ECU (1Mbps)

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

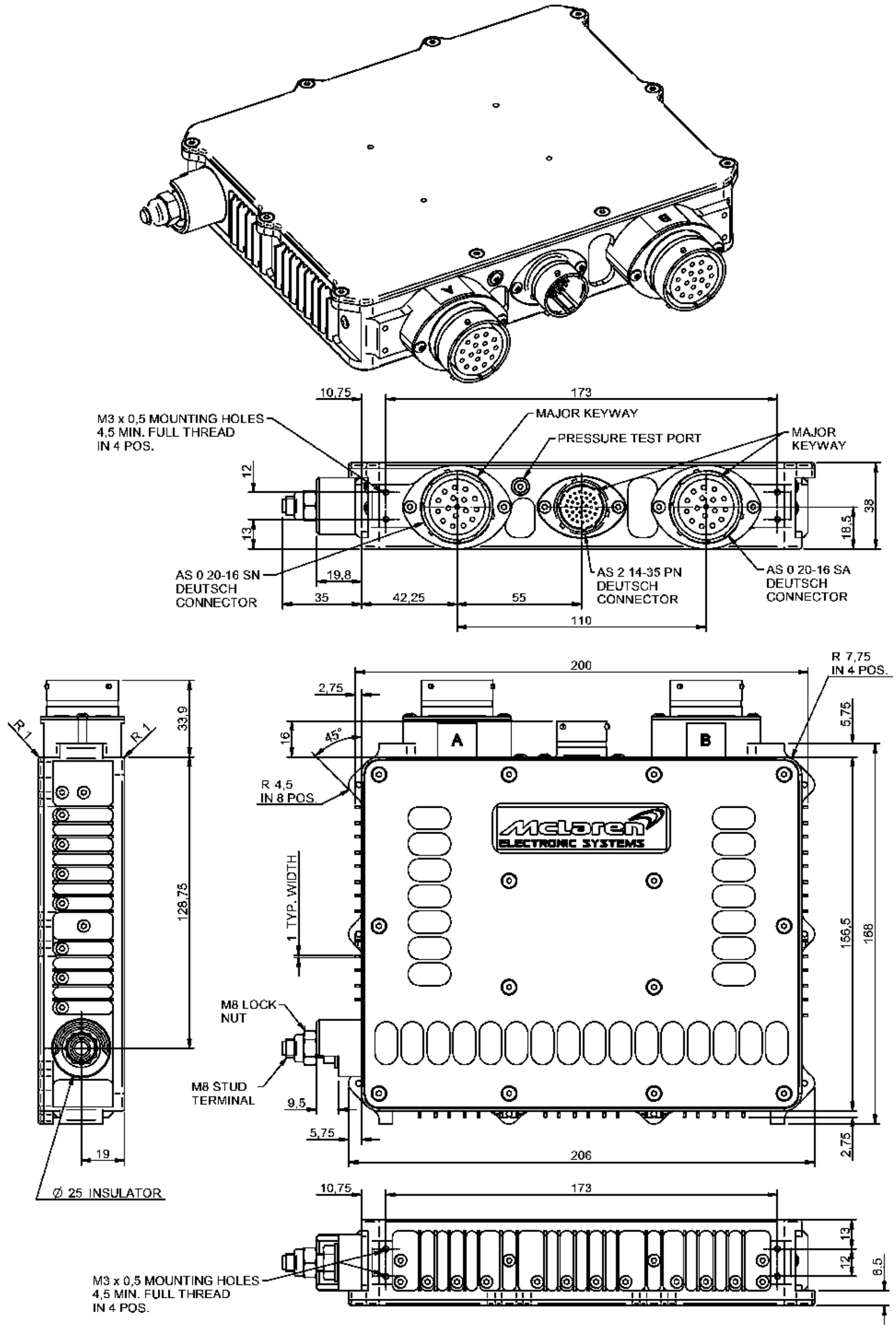
Connection definition
- Integral, sealed, military standard connectors
- High side battery supply via a heavy-duty copper stud on the side panel

Output connector 1	16-way	AS0-20-16SA
Output connector 2	16-way	AS0-20-16SN
Control connector	37-way	AS2-14-35PN

- For pin numbers please contact our technical consultancy department.

Mechanical
- Magnesium alloy, chromate converted and painted with black epoxy
- Two blind-tapped M3 fixing holes are provided at each corner to enable mounting brackets to be fitted
- Weight 1200g

Environmental
- Splash resistant to standard motorsport fluids
- Top and bottom lids sealed with o-rings
- Operating temperature -20 to +60°C
- Additional cooling may be required
- Storage temperature -20 to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours



Description	Ordercode
PMU-24	O 030 071 011 001

Voltage Regulator
DC2

The 30A DC2 rectifier/regulator is for use with 3 phase permanent magnet alternators. It uses “Buck” circuitry which stores and regenerates some of the energy which would otherwise be lost during switching. The output may be set, at the factory, to any voltage between 13 and 14V DC. A signal line is provided to switch off the regulator, for example, to reduce load on the engine. An internal sensor is provided to monitor temperature. The DC2 has a single integral, military standard connector.

Application

- Motorcycles and single seat racing cars.

Electrical

- Output 13.9±0.1V DC (at 25°C and 25A output). Any voltage between 13 and 14V can be set on request
- Current output 25A (typ.), 30A (max*)
- Current demand of regulator circuitry 50mA (typ.), 800µA (quiescent)
- Output impedance <20mohm
- Output voltage thermal drift +4.4mV/°C
- Output voltage h.f. noise <±200mV pp
- Input voltage not to exceed 200V
- Input current not to exceed 35A rms per phase
- Alternator source impedance must exceed 50mohm
- Minimum current for normal regulation 0.5A
- Minimum input voltage for normal regulation 14V (for input between 5 and 14V the output tracks the input; for input below 5V the regulator switches off)
- Temperature output 114.9xV(T)-187.3°C
- Temperature output accuracy 0.5% between 0 and 100°C

* An output of 40A can be achieved with special cooling

Connection Definition

- Integral, sealed, military standard connector AS0-14-35PN-9920

Pins 1 to 4	Input Phase 1
Pins 5 to 8	Input Phase 2
Pins 9 to 12	Input Phase 3
Pins 13 to 20	Regulated DC output
Pins 21 to 34	Ground
Pin 35	Temperature signal V (T)
Pin 36	Temperature ground ref.
Pin 37	Output control line

Phases are interchangeable

The regulator is switched off by connecting the output control line to ground. Ensure that the output control line is not grounded during power up

Mechanical

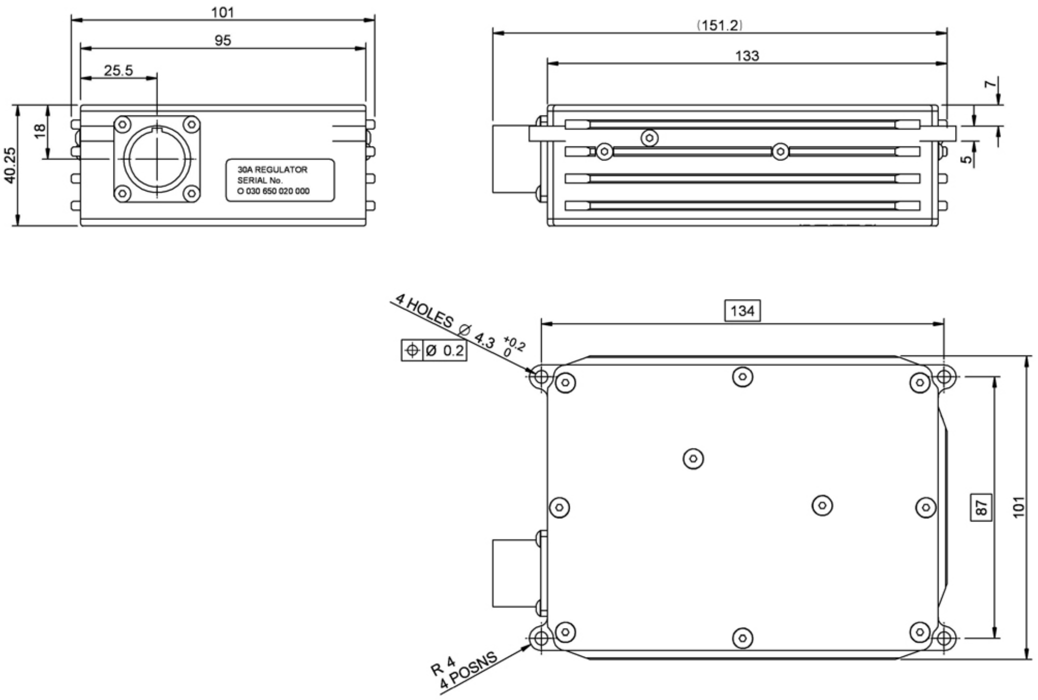
- Case material: see ordercode details, options:
  - Magnesium, chromate converted and painted with black epoxys
  - Aluminium, hard anodised and dyed black
- Weight: see ordercode details

Environmental

- Splash resistant to standard motorsport fluids
- Lids and screws sealed with silicone rubber

- Maximum humidity 100%
- Temperature not to exceed 80°C as measured at the centre of any of the finned walls
- Power Dissipation between 47 and 105W

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. Please contact our technical consultancy service who will be pleased to help.



Description	Material	Weight	Ordercode
DC2 Voltage Regulator	Magnesium	<680g	O 030 650 020 002
DC2 Voltage Regulator	Aluminium	<780g	O 030 650 020 011

Electrical

Voltage Regulator
DC3

The 22A DC3 rectifier/regulator is for use with 3 phase permanent magnet alternators. The design uses a "Buck" switchmode architecture for excellent efficiency.

The output may be set, at the factory, to any voltage between 13V and 15V DC. Two outputs are provided, one unswitched, intended for connection to a 12V lead-acid battery and one switchable under the control of an external input. Internal sensors are provided to monitor main-board temperature and net current from the regulator. The DC3 has a single integral, military standard connector.

Application

- Motorcycles

Electrical

- Peak phase-phase input voltage not to exceed 200V
- Input current not to exceed 25A rms per phase
- Alternator source impedance must exceed 50 mOhm
- Typical output voltages at 25°C:
  - 14.3V at 0A
  - 13.7V at 22A on 14V_SW output
- Voltage can be factory set between 13V and 15V
- Output voltage thermal drift less than -3mV/°C
- When the internally rectified alternator voltage falls below the nominal regulated output voltage, the output voltage tracks the input voltage down to about 5V output
- Current output 22A max
- Current sensor characteristics:
  - Isensed = Vsensor * 6.666 – 3.333
  - Accuracy better than +/-0.5A
- Temperature sensor characteristics:
  - Tsensed = Vsensor * 114.0 - 183.9
  - Accuracy better than +/-1°C over 0 to 100 °C
- Regulator will operate with or without a battery connected to 14V_BAT. Quiescent current drain from battery when alternator stopped is 6mA typical.
- Power Dissipation 58W at 15V 22A output

Mechanical

- Case material: see ordercode details, options:
  - Magnesium, chromate converted and painted with black epoxys
  - Aluminium, hard anodised and dyed black
- Weight: see ordercode details

Connector

- Integral, sealed, military standard connector AS0-14-35PN-9920
- Pin definitions

Pins 1 to 4	Input Phase 1
Pins 5 to 8	Input Phase 2
Pins 9 to 12	Input Phase 3
Pins 13 to 16	14V_BAT (unswitched 14V o/p)
Pins 17 to 20	14V_SW (switched 14V o/p)
Pins 21 to 33	Ground
Pin 34	Current sensor output [1]

Pin 35	Temperature sensor output [1]
Pin 36	Sensor ground ref. [1]
Pin 37	14V_SW_enable [2]

[1] To be left unconnected if feature not required

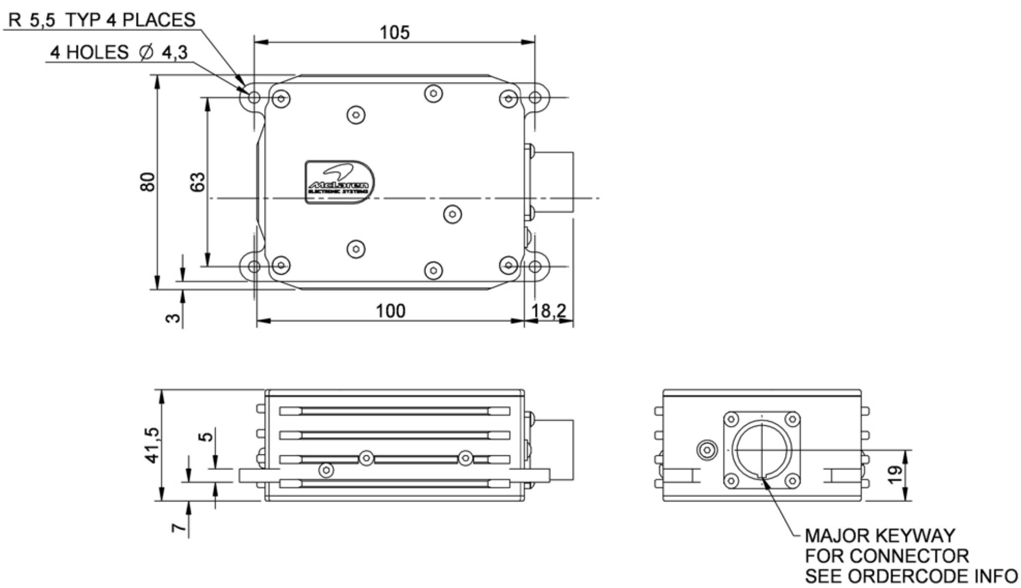
[2] Connect to a 14V_BAT pin to enable switched 14V o/p

Phases are interchangeable

Environmental

- Splash resistant to standard motorsport fluids
- Storage temperature -20°C to + 85°C
- Operating temperature -10°C to + 70°C as measured by internal temperature sensor
- Forced air cooling over the unit is essential
- Lids and screws sealed with silicone rubber
- Maximum humidity 100%

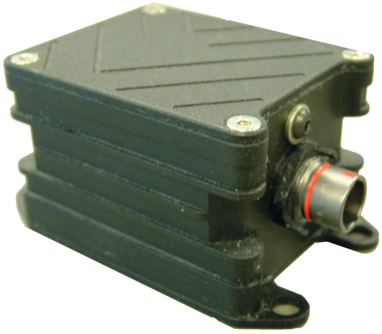
Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. Please contact our technical consultancy service who will be pleased to help.



Description	Material	Weight	Ordercode
DC3 Voltage Regulator	Magnesium	<450g	O 030 650 028 000
DC3 Voltage Regulator	Aluminium	<520g	O 030 650 028 001

Power Supply Unit
PSU-30V

The PSU-30V serves to boost and stabilise the car supply voltage from 14V nominal to 30V stabilised. This is to enable actuators to be driven from a regulated 30V supply instead of the unregulated 14V car supply. For solenoids, this allows faster actuation times.



Application

- Provision of a 30V stabilised voltage supply.

Electrical

- Supply voltage 8V to 16.7V at full rated power
- Supply current quiescent <100mA
- Supply current operating <12.6A at 14V at full rated power
- Supply voltage not to exceed 16.7V continuous (unit has reverse polarity protection and is protected against momentary voltage spikes of either polarity greater than 16.7V)
- Output voltage 30V+0%, -7% at 1A load
- Output current 5A max
- Output impedance 100mohm typ
- Temperature coefficient ±5mV/°C typ
- Current trip providing some protection against momentary short-circuits or short-term overloads
- Output protected against transients

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC

Connection definition

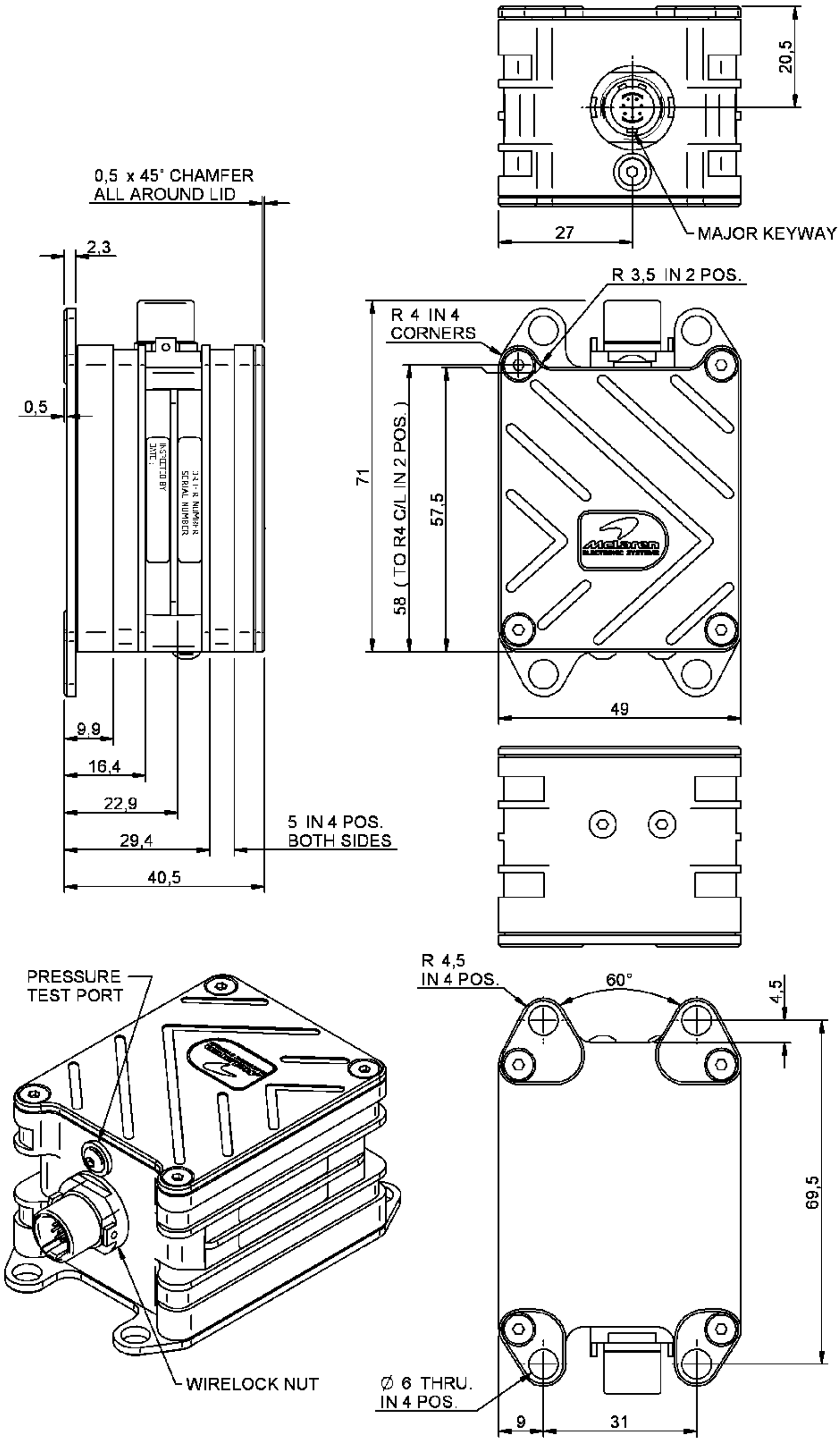
- Integral, sealed, military-standard connector Lemo EHS.1F.308.XLC
- For PIN numbers please contact our technical consultancy department

Mechanical

- Case material magnesium alloy, chromate converted and painted with black epoxy
- Weight 160g

Environmental

- Splash resistant to standard motorsport fluids
- Temperature not to exceed 65°C at the centre of the top lid during operation – modest forced convection is advised
- Storage temperature -400C to +850C
- Vibration 100 to 1000Hz, all axes, 24 hours


20,5
27
MAJOR KEYWAY
0,5 x 45° CHAMFER
ALL AROUND LID
2,3
0,5
R 3,5 IN 2 POS.
R 4 IN 4
CORNERS
71
58 (TO R4 C/L IN 2 POS.)
57,5
49
9,9
16,4
22,9
29,4
40,5
5 IN 4 POS.
BOTH SIDES
PRESSURE
TEST PORT
R 4,5
IN 4 POS.
60°
4,5
69,5
WIRELOCK NUT
Ø 6 THRU.
IN 4 POS.
9
31

Hybrid & EV

E-Motor
120kW / 130Nm

The 120kW E-Motor is a synchronous permanent magnet motor/generator primarily intended for hybrid and electric vehicles. The unit is powered via a high voltage three-phase electrical connection from an inverter, such as McLaren Applied Technologies' MCU-500.

An advanced liquid cooling scheme allows the motor to achieve sustained high power operation given the unit's modest size and weight.

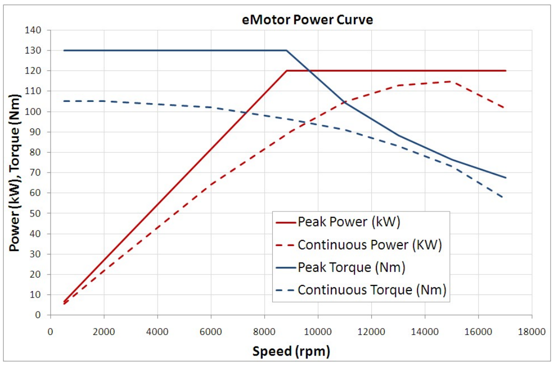
When combined with the MCU-500, and powered from a 535V DC bus, the unit can be controlled via torque and/or speed demands via a CAN bus. The same performance characteristics can be achieved in motor and generator modes of operation.

Key Features

- Permanent magnet synchronous motor
- SPM type
- High power density

Performance

- Power and torque:
  - 120kW / 130Nm (transient)
  - 110kW / 110Nm (continuous)
- Maximum speed 17,000rpm
- Efficiency 96% (120kW, 13,000rpm)



Electrical

- Input type: high voltage sinusoidal three-phase
- Nominal bus voltage 545V
- Maximum bus voltage 630V
- Minimum bus voltage 420V (for full performance)
- Leakage current <15mA

Mechanical

- Case diameter 185mm
- Case length 254mm
- Mass 26kg

Instrumentation and Diagnostics

- One Resolver for commutation

Cooling

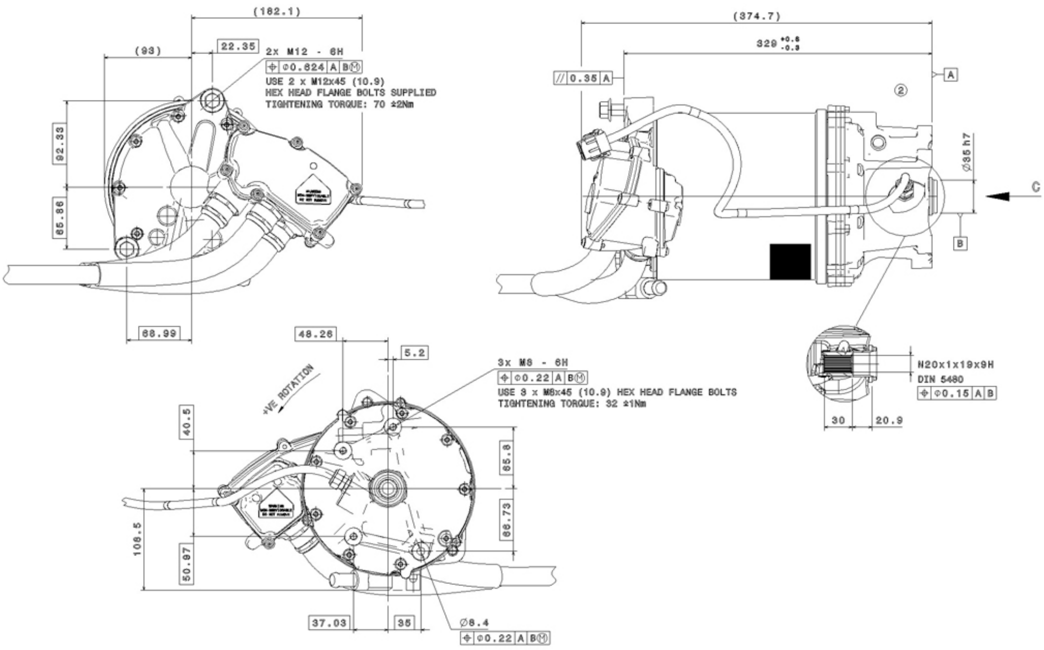
- Max inlet temperature 55°C
- Min flow-rate 20l/min
- Pressure drop 0.6bar @ 20l/min
- Coolant type 50/50 water/glycol
- Max pressure 5bar

Environmental

- Air temperature:

  -20°C to 90°C (operating)

  -20°C to 120°C (static)
- Max motor skin temperature 65°C
- Rated to IP67
- Maximum mounting vibration 30g
- Complies with the essential protection requirements of 89/336/EEC



Description	Ordercode
E-Motor-120kW	O 030 525 000 001

Motor Control Unit
MCU-500 / MCU-510

The MCU-5xx is a combined inverter and DC/DC converter for use in hybrid and electric vehicles, suitable for both automotive and motorsport applications. Permanent magnet synchronous motors of surface or interior types are supported.

A high DC bus voltage coupled with liquid cooling allows for high motor power in a very compact and lightweight unit. The unit is self contained, and designed to be sited adjacent to a high voltage battery assembly. Output terminals provide the high current electrical connection to the motor.

Full synchronous closed-loop motor control is provided, with a target torque demand being received from the vehicle's electronic control unit through a CAN interface. Calibration can be via 3rd party automotive calibration tools that support the industry standard XCP interface or via our System Monitor calibration tool.

This unit is designed and manufactured in-house. Bespoke variants can be provided to suit customer requirements.

Key Features
- Low volume and mass to power ratio
- High power capability
- Motor type: Permanent Magnet Synchronous
  - SPM – supported
  - IPM – supported
- Torque demand supplied through vehicle CAN link
- Delivered torque derived from motor currents and transmitted through vehicle CAN link
- Field weakening supported
- Separate supervisor processor included for safety
- Capacitive discharge circuit included

Inverter
- Maximum current 500A rms
- Maximum DC bus voltage 700V
- DC bus input capacitance 232uF
- Switching frequency 16kHz (switches to 8kHz at low motor speeds)

DC/DC Converter
- Maximum current 250A
- Output voltage 12-16V (selectable via CAN)

Electrical
- Supply voltage 8-16V

External Sensor Inputs
- Two Pt1000 (-50°C to 250°C)
- One Resolver

Internal Diagnostics
- One DC link voltage
- One DC link current
- Three Phase current
- Six Inverter temperatures
- Two cold plate temperature

Communications
- Three CAN interfaces
  - Vehicle interface (500kbps)

    - XCP interface (1Mbps)
    - Motor control monitoring interface (1Mbps)
- Vehicle CAN message protocol defined according to customer requirements

Cooling

- Max inlet temperature 55°C
- Min flow-rate 20l/min (to achieve rated specification)
- Pressure drop 0.5bar
- Coolant type 50/50 water/glycol
- Max pressure 5bar

Mechanical

- Volume 16litre
- Mass 15.8kg
- Dimensions 430mm x 201mm x 214mm

Environmental

- Rated to IP66
- MCU-500 (Automotive specification) meets Automotive Standard REG 2004/101/EC
- MCU-510 (Motorsport specification) complies with the essential protection requirements of 89/336/EEC

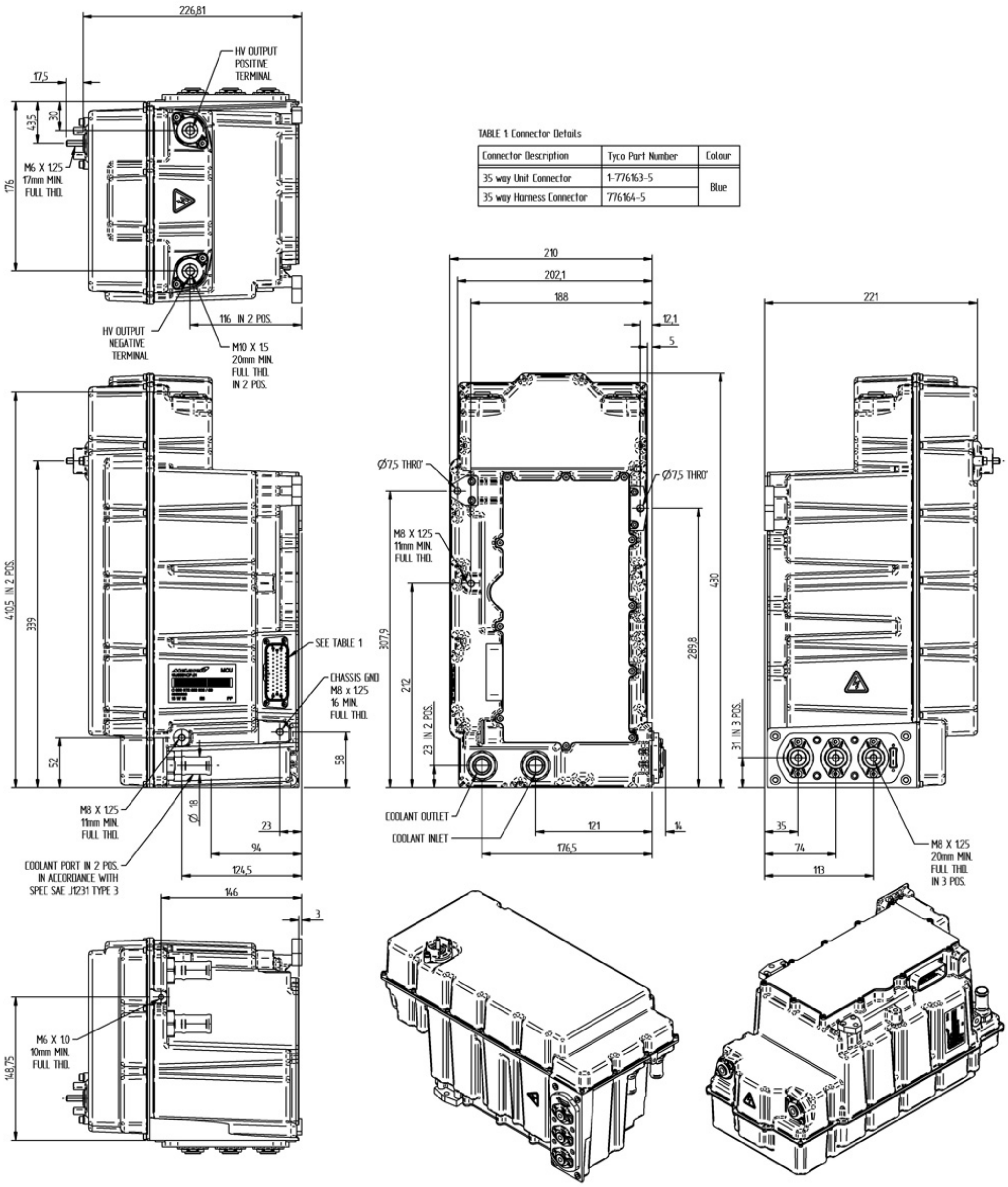


TABLE 1 Connector Details

Connector Description	Tyco Part Number	Colour
35 way Unit Connector	1-776163-5	Blue
35 way Harness Connector	776164-5	

Description	Ordercode
MCU-500 – Automotive Applications	O 030 072 022 000
MCU-510 – Motorsport Applications	O 030 072 022 001

Alternators

Alternator
Permanent Magnet

Permanent magnet alternators can tolerate high ambient temperatures and vibration allowing them to be directly mounted to racing engines. The separate regulator can be mounted in a location where the temperatures and vibration levels are lower. When used together with the DC2 “Buck” regulator, the alternator provides high current, at stable voltage, over a large range of rotation speeds from a very small and lightweight package.

Application

- Single-seat racing cars and motorcycles.

Electrical

- Output three-phase alternating current
- Rectified output current when used with a DC2 regulator 25A (typ.), 30A (max*)
- Rectified output current when used with a PB2006 powerbox 55A (typ), 60A (max)
- Frequency 750Hz on each phase at 15000rpm

A detailed performance chart is shown at the end of this product summary.

*An output of 40A can be achieved with special cooling

Environmental

- Splash resistant to standard motorsport fluids
- Maximum humidity 100%
- Maximum temperature:

Stator	220°C (250°C short term)
Bearings	170°C
Rotor	150°C

Mechanical

- Aluminium alloy body, hard anodised and dyed black
- Maximum speed 18000rpm
- Bi-directional rotation
- Rotor balanced to <0.7gmm at 4700rpm
- Spline to NF-E22-144, Major dia. 9.48mm. Other splines of similar diameter can be provided
- Weight, including cable, is shown on the order details.

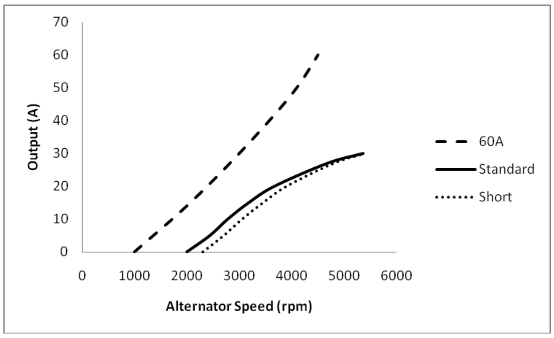
Design and manufacture is in-house, so if our existing designs do no suit your application, we can provide cost effective customised parts to suit even the most demanding application. We can provide special mounting and shaft arrangements and can optimise the output characteristics to suit your application. Please contact our technical consultancy service who will be pleased to help.

Connection Definition

- 55 spec 22AWG cable (four wires for each phase)
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

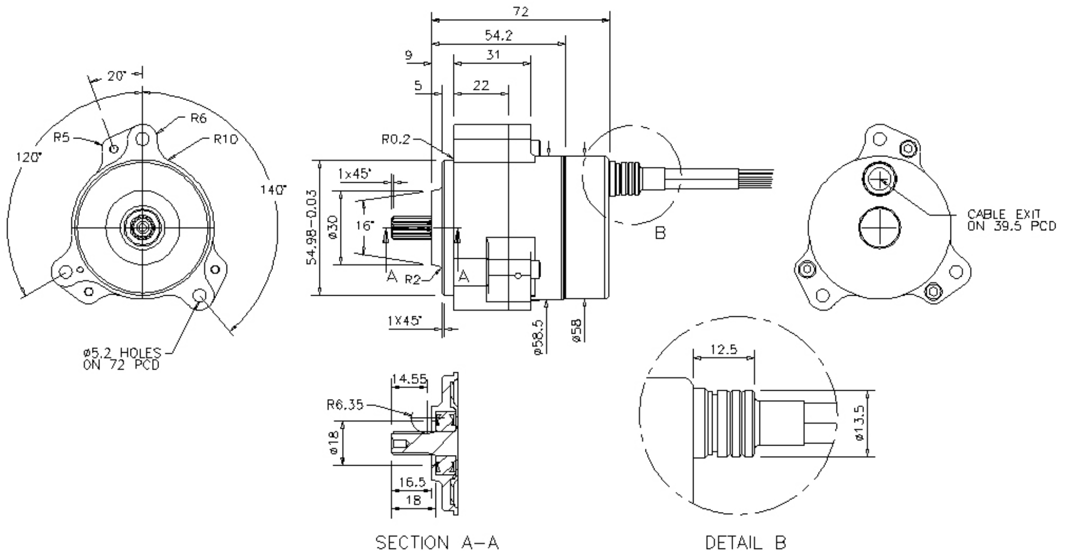
Red wires (4)	Phase 1
Green wires (4)	Phase 2
White wires (4)	Phase 3

Phases are interchangeable

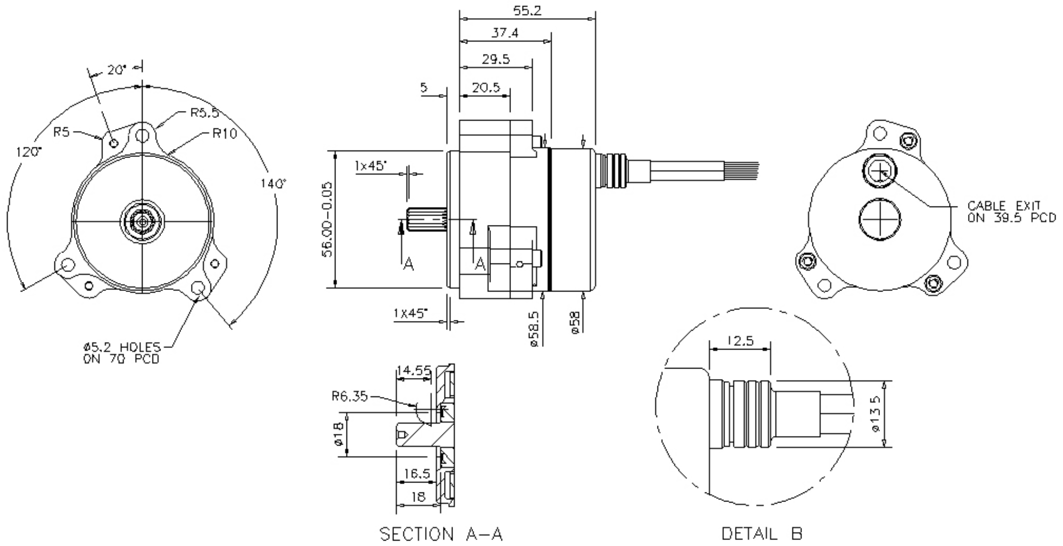


Performance with a DC2 regulator (13.5V into a resistive load with 1500mm cable at 25°C) for short and standard parts, with a Powerbox PB2006 into a resistive load with 1000mm cable at 25°C for the 60A version:

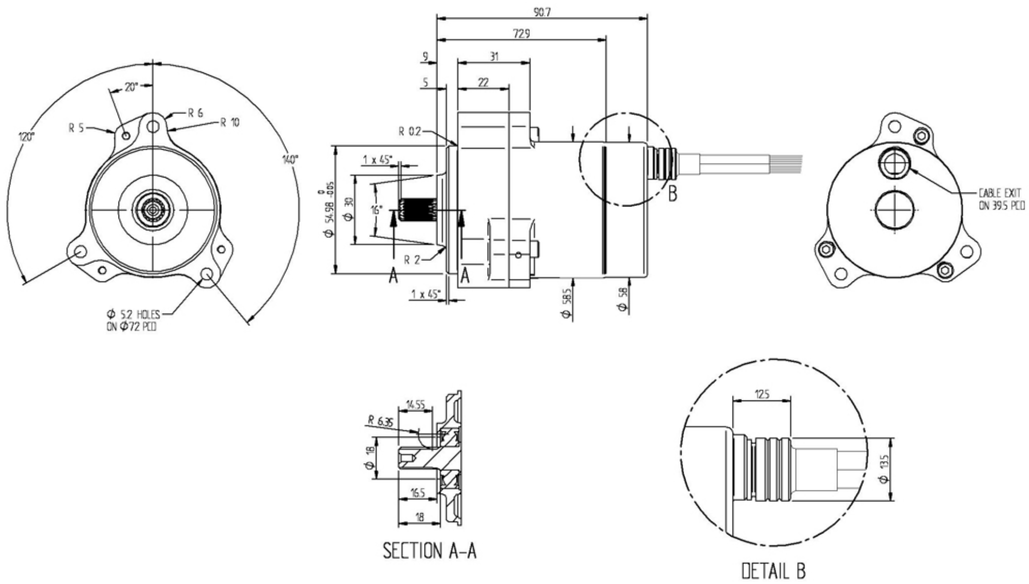
Current (A)		0	5	10	15	20	27	30	48	60
Speed (rpm)	Std	2000	2440	2780	3180	3670	4680	5360		
	Short	2300	2700	3050	3450	3900	4800	5400		
	60A	1000	1250	1750	2100	2400	2800	3000	4000	4500



Description	Cable Length	Weight	Ordercode
Standard Length	1500mm	<900g	O 030 650 017 000



Description	Cable Length	Weight	Ordercode
Short Length	1500mm	<810g	O 030 650 017 011
Short Length	2000mm	<835g	O 030 650 017 016



Description	Cable Length	Weight	Ordercode
60A	1500mm	<1620g	O 030 650 017 035

Bike Alternator
Permanent Magnet

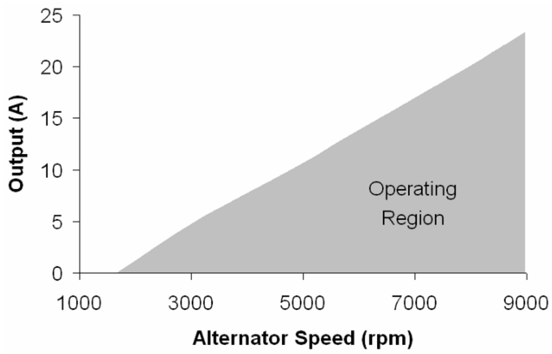
Electrical

Permanent magnet alternators can tolerate high ambient temperatures and vibration allowing them to be directly mounted to racing engines. A separate regulator is required. This can be mounted in a location where the temperatures and vibration levels are lower.

Electrical

- Output 3 phase alternating current
- Cut-in speed 1,700rpm
- Frequency 750Hz on each phase at 15,000rpm

Performance with a DC3 regulator (14V into a resistive load with 1500mm cable at 25°C)



Note: Running outside of the operating region should be avoided.

Current (A)	0	5	10	15	20	22
Speed (rpm)	1700	3100	4800	6400	8000	8600

Cable and Connection Definition

- 55 spec 24AWG cable
- Cable length is shown order details but any length is available on request
- Connection (four wires per phase):

Red wires	Phase 1
Green wires	Phase 2
White wires	Phase 3

Phases are interchangeable

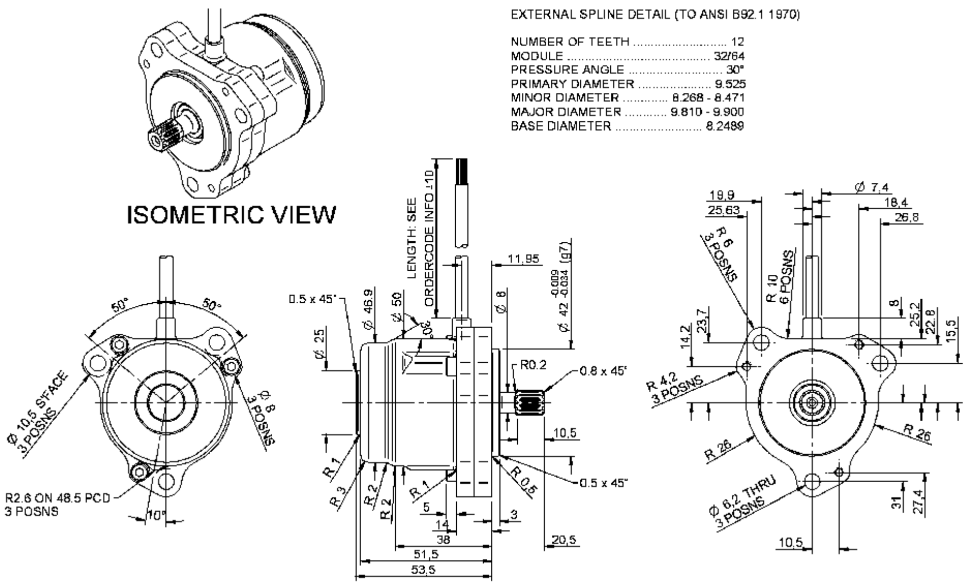
Mechanical

- Weight 460g (excluding cable)
- Aluminium alloy body, hard anodised and dyed black
- Maximum speed 18,000rpm
- Bi-directional rotation
- Polyester cable boss for strain relief to body

Environmental

- Splash resistant to standard motorsport fluids
- Maximum humidity 100%
- Maximum temperature:

Stator	220°C (250°C short term)
Bearings	170°C
Rotor	150°C



Cable Length	Ordercode
1000mm	O 030 650 017 022

Electrical

F-Type Alternator
Up to 90 Amps

The F-Type alternator has a specially wound stator to achieve high power output in a small, low weight package. High current diodes are used in the rectifier and internal fans provide forced air cooling. The output is controlled by a regulator inside the alternator. The units are assembled with stiff brush springs and extra flexible wire to connect the stator to the rectifier. The stator is pegged to the body and all screws are locked. High quality bearings are used to enable the alternators to run at high speeds (up to 18,000 rpm). The standard mounting method is intended for a belt drive, but the alternator may also be driven directly, if required.

Please request our installation datasheet for further details.

Electrical

- Output voltage 13.5V DC
- Nominal output current

High	90A	(cut in speed 2400rpm)
Medium	60A	(cut in speed 1700rpm)
Standard	40A	(cut in speed 1200rpm)

A detailed performance chart is shown on the next page

Mechanical

- Aluminium alloy body
- Maximum speed 18000rpm
- Clockwise rotation
- Weight <2.8kg standard F-Type, <2.9kg strapped F-Type
- Potted elastomer boot for strain relief of cable (where fitted)

For high vibration installations, the strapped F-Type is recommended. The rectifier is strapped to provide improved mechanical support

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. For example:

- Through bored mounting holes
- High-accuracy machining of mounting flanges
- Alternative cable entry locations
- Alternative connectors
- The regulator/rectifier unit may be rotated through 90°, 180° or 270°

Please contact our technical consultancy service who will be pleased to help.

Connection Definition

- 22AWG cable (where fitted)
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Positive power output M6 stud
- Ground connection for power and regulator is through the case. Ensure that the case has a high current, low resistance connection to vehicle ground.
- Cable connection

Black wire	Pin A	Pin 1	Ignition
White wire	Pin C	Pin 3	Lamp

- Connections for the integral connector (where fitted) are shown on the drawings

Environmental

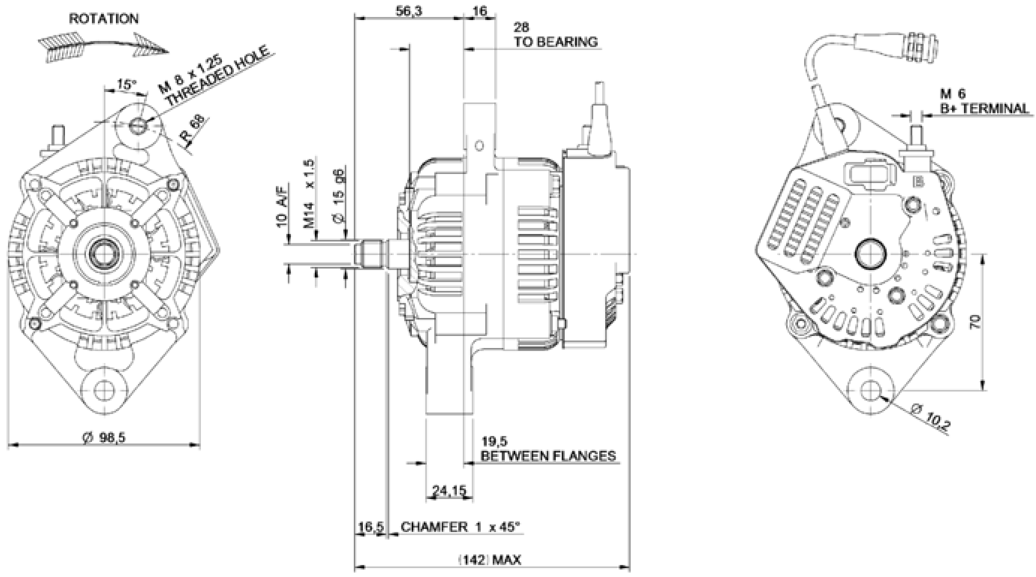
- Splash resistant to standard motorsport fluids
- Viton jacketed cable
- Continuous ambient operating temperature -30 to +90°C

- Maximum ambient temperature 110°C short term, providing the following temperatures are not exceeded:

Stator	200°C
Diodes	180°C
Regulator	115°C
Bearings	150°C

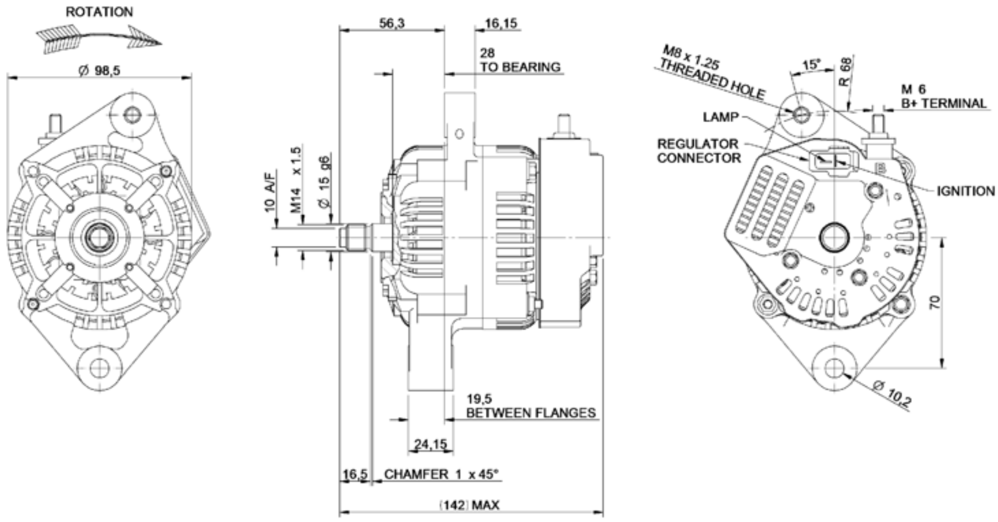
Output in Amps (@13.5V)							
Nominal Current Rating		**Standard 40A**		**Medium 60A**		**High 90A**	
Cut in Speed		**1200rpm**		**1700rpm**		**2400rpm**	
Ambient Temperature		**25°C**	**90°C**	**24°C**	**90°C**	**25°C**	**90°C**
Speed (rpm)	2500	24	18	20	18	5	5
	5000	37	30	51	41	58	56
	7500	42	35	57	50	77	73
	10000	45	38	65	57	90	85
	12500	47	39	67	60	94	92
	15000	48	40	69	61	95	93

McLaren Electronics can service and repair alternators. Please contact our technical consultancy service for more information.

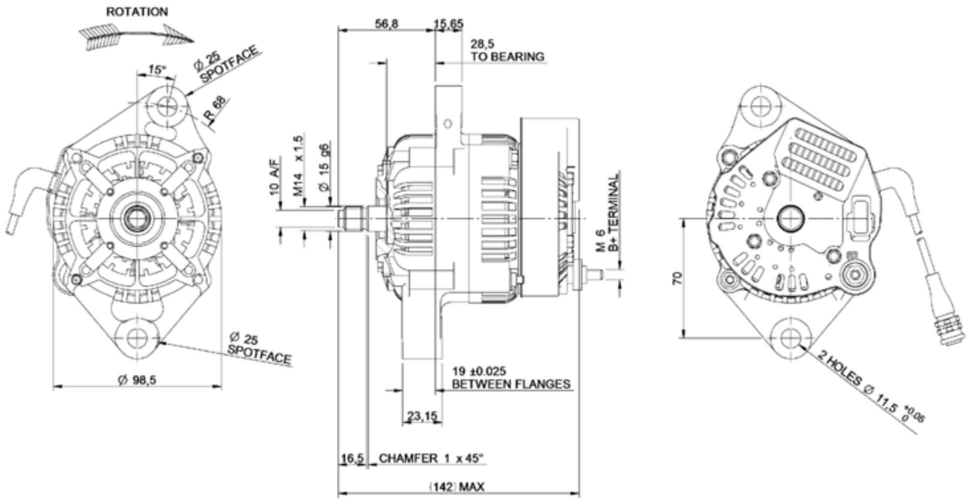


Output	**Cable Length**	**Connector**	**Ordercode**
90A	300mm	ASL-6-06-05-PN-HE	O 030 650 003 008
90A	600mm	None	O 030 650 003 019

Electrical



Ourput	CableLength	Connector	Ordercode
90A	N/A (Integral connector)	6111-2568	O 030 650 003 009



Output	**Cable Length**	**Connector**	**Ordercode**
90A	600mm	None	O 030 650 003 036

F-Type Alternator
Ruggedised (up to 90 Amps)

The F-Type alternator has a specially wound stator to achieve high power output in a small, low weight package. High current diodes are used in the rectifier and internal fans provide forced air cooling. The output is controlled by a regulator inside the alternator. The units are assembled with stiff brush springs and extra flexible wire to connect the stator to the rectifier. The stator is pegged to the body and all screws are locked. High quality bearings are used to enable the alternators to run at high speeds (up to 18,000 rpm). The standard mounting method is intended for a belt drive, but the alternator may also be driven directly, if required.

Please request our installation datasheet for further details.

Electrical

- Output voltage 13.5V DC
- Nominal output current

High	90A	(cut in speed 2400rpm)
Medium	60A	(cut in speed 1700rpm)
Standard	40A	(cut in speed 1200rpm)

A detailed performance chart is shown later in this document.

Mechanical

- Aluminium alloy body
- Maximum speed 18000rpm
- Clockwise rotation
- Weight <2.8kg standard F-Type, <2.9kg strapped F-Type
- Potted elastomer boot for strain relief of cable (where fitted)

For high vibration installations, the strapped F-Type is recommended. The rectifier is strapped to provide improved mechanical support

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. For example:

- Through bored mounting holes
- High accuracy machining of mounting flanges
- Alternative cable entry locations
- Alternative connectors
- The regulator/rectifier unit may be rotated through 90°, 180° or 270°

Please contact our technical consultancy service who will be pleased to help.

Connection Definition

- 22AWG cable (where fitted)
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Positive power output M6 stud
- Ground connection for power and regulator is through the case. Ensure that the case has a high current, low resistance connection to vehicle ground.
- Cable connection

Green wire	Pin A	Pin 1	Ignition
Red wire	Pin B	Pin 2	Sense
White wire	Pin C	Pin 3	Lamp

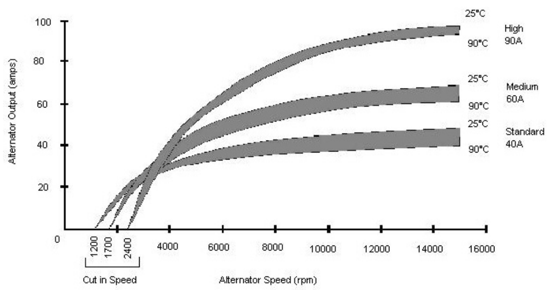
- Connections for the integral connector (where fitted) are shown on the drawings

Environmental

- Splash resistant to standard motorsport fluids
- Viton jacketed cable

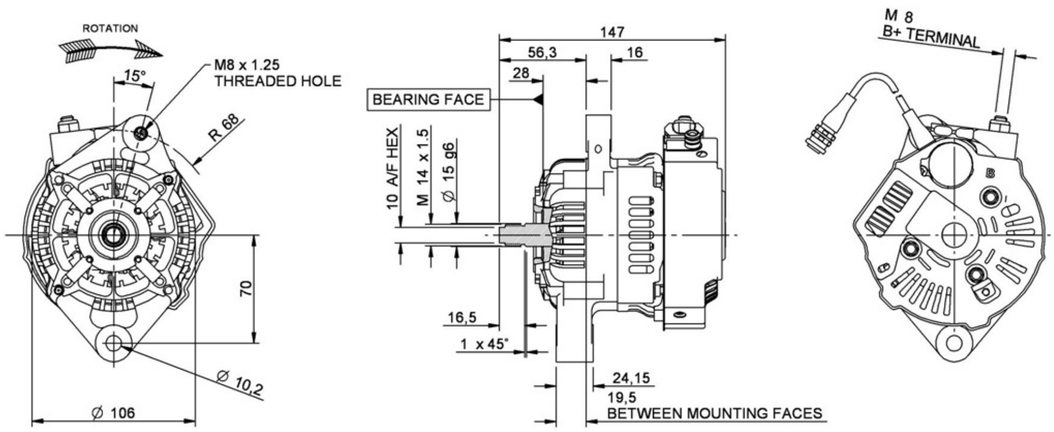
- Continuous ambient operating temperature -30 to +90°C
- Maximum ambient temperature 110°C short term, providing the following temperatures are not exceeded:

Stator	200°C
Diodes	180°C
Regulator	115°C
Bearings	150°C



Output in Amps (@13.5V)							
Nominal Current Rating		Standard 40A		Medium 60A		High 90A	
Cut in Speed		1200rpm		1700rpm		2400rpm	
Ambient Temperature		25°C	90°C	24°C	90°C	25°C	90°C
Speed (rpm)	2500	24	18	20	18	5	5
	5000	37	30	51	41	58	56
	7500	42	35	57	50	77	73
	10000	45	38	65	57	90	85
	12500	47	39	67	60	94	92
	15000	48	40	69	61	95	93

McLaren Electronics can service and repair alternators. Please contact our technical consultancy service for more information.



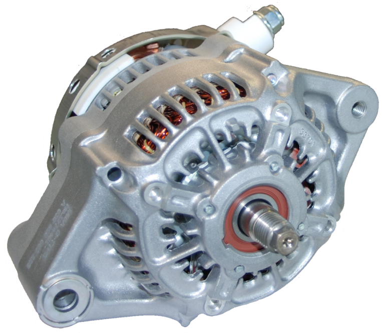
Rectifier	Output	Cable Length	Connector	Ordercode
Strapped	90A	500mm	None	O 030 650 003 038
Strapped	60A	500mm	None	O 030 650 003 048

G-Type Alternator
Up to 180 Amps

This alternator has a specially wound stator to achieve high power output in a small, low weight package. High current diodes are used in the rectifier and internal fans provide forced air cooling. The output is controlled by a regulator inside the alternator. The units are assembled with stiff brush springs and extra flexible wire to connect the stator to the rectifier.

The stator is pegged to the body and all screws are locked. High quality bearings are used to enable the alternators to run at high speeds (up to 18,000rpm). The standard mounting method is intended for a belt drive, but the alternator may also be driven directly, if required.

Please request our installation datasheet for further details.



Electrical

- Output voltage 14.5V DC
- Nominal output current 180A at 10,000 RPM (cut in speed 3500rpm)
- A detailed performance chart is shown on the next page.

Mechanical

- Weight less than 3.2kg
- Aluminium alloy body
- Moulded Polymer rear cover
- Maximum speed 18,000rpm
- Rotation clockwise
- Rectifier strapped

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application.

Please contact our technical consultancy service who will be pleased to help.

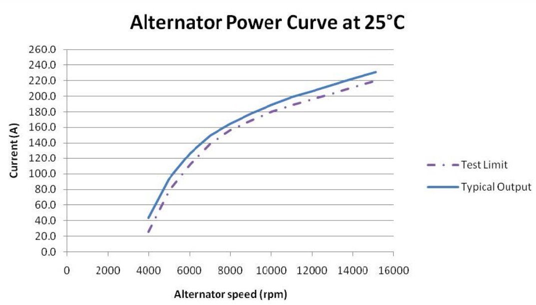
Connection Definition

- Positive power output M8 stud (B+ terminal)
- Ground connection for power and regulator is through the case. Ensures that the case has a high current, low resistance connection to vehicle ground
- Single connection details: Ignition and sense connections are through the power output stud (B+ terminal)

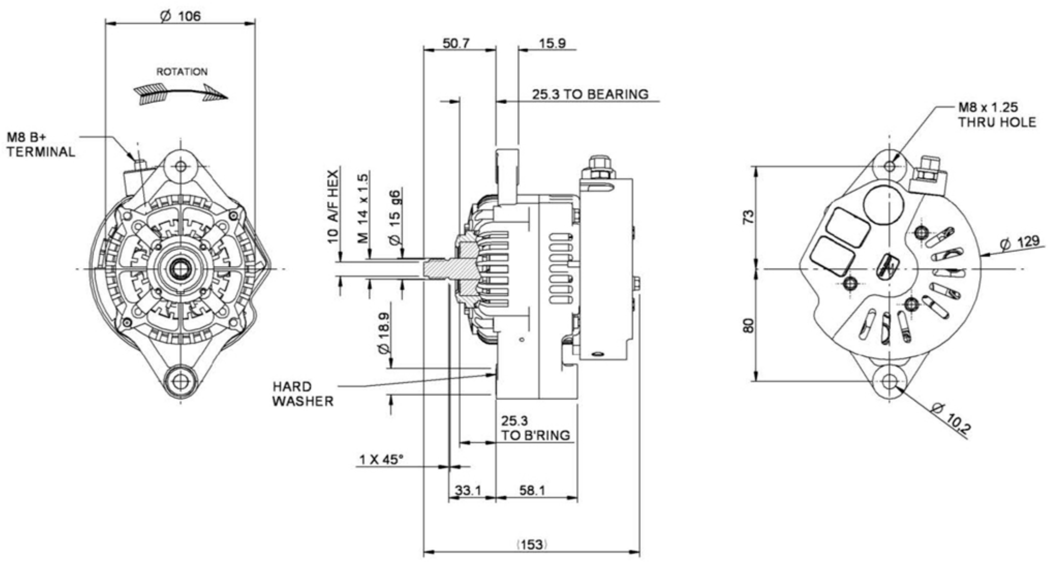
Environmental

- Splash resistant to standard motorsport fluids
- Continuous ambient operating temperature -30 to +90°C
- Maximum ambient temperature 110°C short term. Providing the following temperatures are not exceeded:

Stator	200°C
Diodes	175°C
Regulator	105°C
Bearings	150°C



Speed (RPM)	Voltage	Test Limit (Amps)
5000	13.5	77
6000	13.5	112
7000	13.5	140
8000	13.5	156
9000	13.5	169
10000	13.5	180
11000	13.5	189
12000	13.5	197



Output	Rotation	Connector	Ordercode
180A	Clockwise	None	O 030 650 005 116

G-Type Alternator
Up to 100 Amps

The G-Type alternator has a specially wound stator to achieve high power output in a small, low weight package. High current diodes are used in the rectifier and internal fans provide forced air cooling. The output is controlled by a regulator inside the alternator. The units are assembled with stiff brush springs and extra flexible wire to connect the stator to the rectifier. The stator is pegged to the body and all screws are locked. High quality bearings are used to enable the alternators to run at high speeds (up to 18,000 rpm). The standard mounting method is intended for a belt drive, but the alternator may also be driven directly, if required.

Please request our installation datasheet for further details.

Electrical

- Output voltage 13.5V DC
- Nominal output current

High	100A	(cut in speed 2100rpm)
Standard	55A	(cut in speed 1200rpm)

A detailed performance chart is shown later in this document.

Mechanical

- Aluminium alloy body
- Maximum speed 18000rpm
- Clockwise or anti clockwise rotation available
- Weight <3.2kg
- Potted elastomer boot for strain relief of cable (where fitted)

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. For example:

- Through bored mounting holes
- High accuracy machining of mounting flanges
- Alternative cable entry locations
- Alternative connectors
- The regulator/rectifier unit may be rotated through 90°, 180° or 270°

Please contact our technical consultancy service who will be pleased to help.

Connection Definition

- 22AWG cable (where fitted)
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Positive power output M6 stud
- Ground connection for power and regulator is through the case. Ensure that the case has a high current, low resistance connection to vehicle ground.
- Cable connection:

Green wire	Pin A	Pin 1	Ignition
Red wire	Pin B	Pin 2	Sense
White wire	Pin C	Pin 3	Lamp

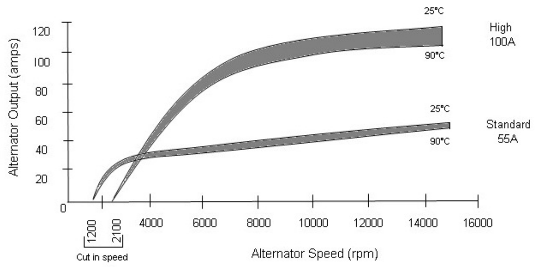
- Connections for the integral connector (where fitted) are shown on the drawings

Environmental

- Splash resistant to standard motorsport fluids
- Viton jacketed cable
- Continuous ambient operating temperature -30 to +90°C

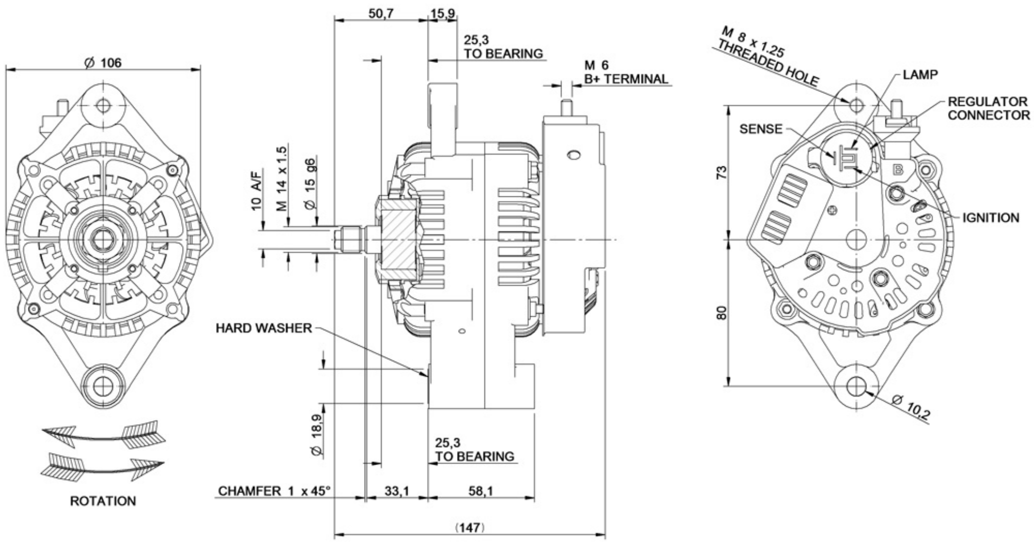
- Maximum ambient temperature 110°C short term, providing the following temperatures are not exceeded:

Stator	200°C
Diodes	180°C
Regulator	115°C
Bearings	150°C



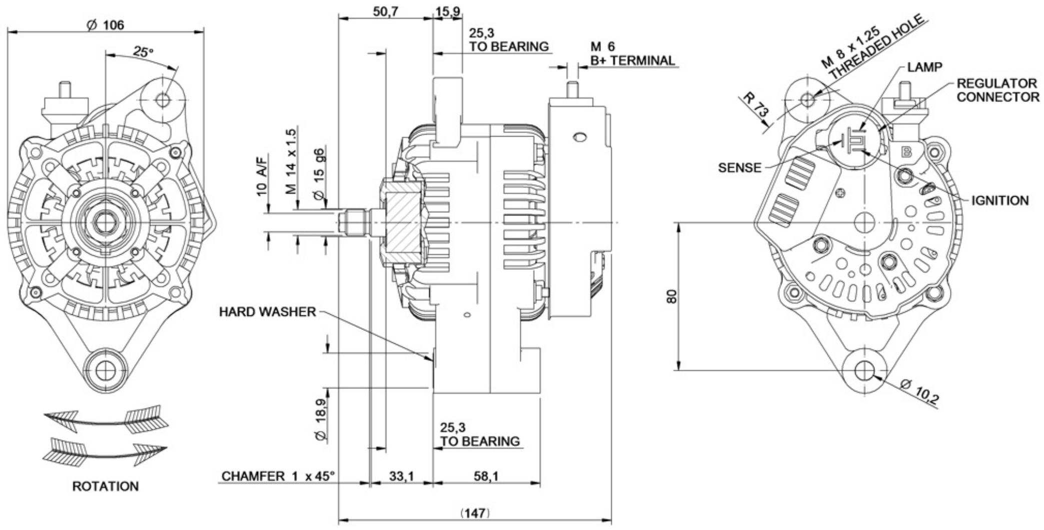
Output in Amps (@13.5V)					
Nominal Current Rating		**Standard 55A**		**High 100A**	
Cut in Speed		**1200rpm**		**2100rpm**	
Ambient Temperature		**25°C**	**90°C**	**25°C**	**90°C**
Speed (rpm)	2500	34	31	23	14
	5000	47	42	72	65
	7500	53	46	92	83
	10000	55	50	100	95
	12500	57	53	110	100
	15000	58	55	115	105

McLaren Electronics can service and repair alternators. Please contact our technical consultancy service for more information.

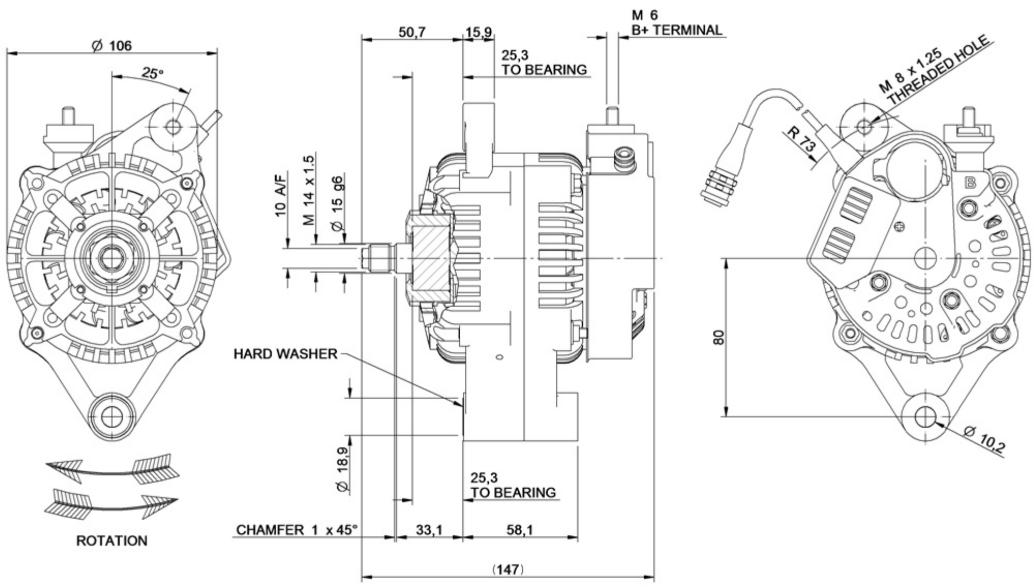


Output	Rotation	Cable Length	Connector	Ordercode
100A	Clockwise	Integral Connector	1300-4245	O 030 650 005 001
100A	Counter clockwise	Integral Connector	1300-4245	O 030 650 005 002

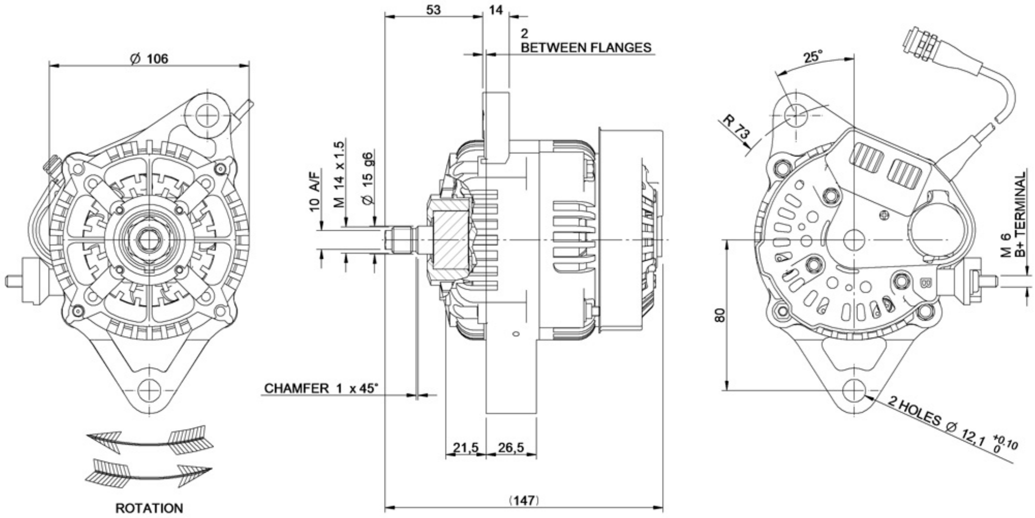
Electrical



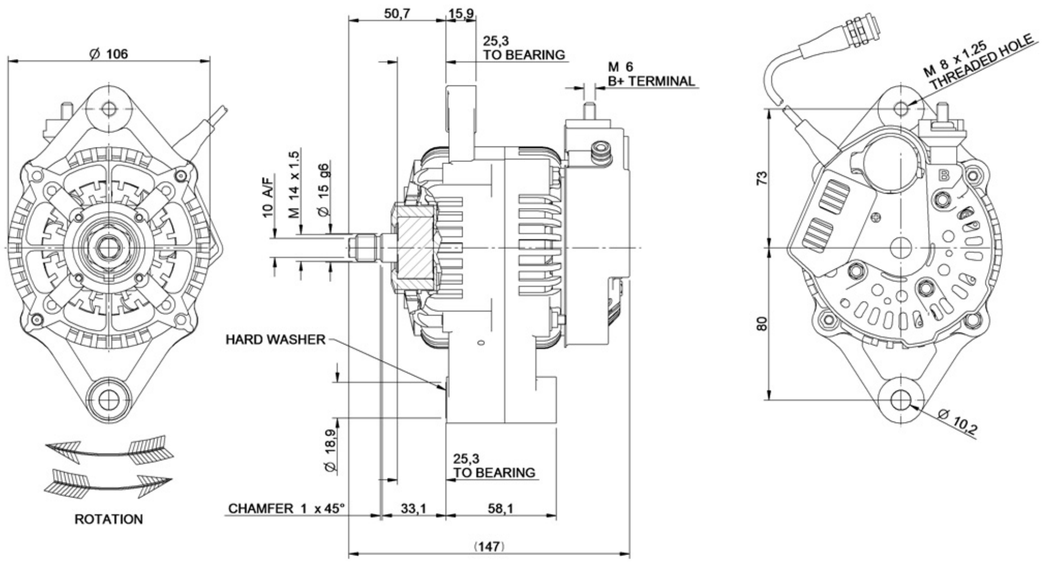
Output	Rotation	Cable Length	Connector	Ordercode
100A	Clockwise	Integral Connector	1300-4245	O 030 650 005 003
100A	Counter clockwise	Integral Connector	1300-4245	O 030 650 005 004



Output	Rotation	Cable Length	Connector	Ordercode
100A	Counter Clockwise	300mm	None	O 030 650 005 005
100A	Counter Clockwise	300mm	ASL-6-06-05PN-HE	O 030 650 005 014
100A	Clockwise	300mm	ASL-6-06-05PN-HE	O 030 650 005 012



Output	Rotation	Cable Length	Connector	Ordercode
100A	Clockwise	500mm	KPSE 6E8 33S DN	O 030 650 005 008

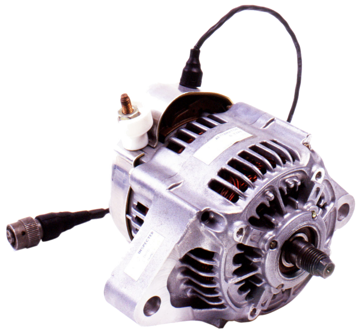


Output	Rotation	Cable Length	Connector	Ordercode
100A	Clockwise	300mm	ASL-6-06-05PN-HE	O 030 650 005 009
100A	Clockwise	300mm	None	O 030 650 005 054
100A	Clockwise	300mm	AS6 8 98PN	O 030 650 005 013
100A	Counter Clockwise	300mm	ASL-6-06-05PN-HE	O 030 650 005 011
100A	Counter Clockwise	500mm	None	O 030 650 005 131

G-Type Alternator
High Output

The G-Type alternator has a specially wound stator to achieve high power output in a small, low weight package. High current diodes are used in the rectifier and internal fans provide forced air cooling. The output is controlled by a regulator inside the alternator. The units are assembled with stiff brush springs and extra flexible wire to connect the stator to the rectifier. The stator is pegged to the body and all screws are locked. High quality bearings are used to enable the alternators to run at high speeds (up to 18,000 rpm). The standard mounting method is intended for a belt drive, but the alternator may also be driven directly, if required.

Please request our installation datasheet for further details.



Electrical

- Output voltage 13.5V DC
- Nominal output current

140A	(cut in speed 3500rpm)
120A	(cut in speed 2500rpm)

- Ignition quiescent current 300mA*

A detailed performance chart is shown later in this document

*If alternator is continuously connected to the battery this quiescent current draw may drain the battery

Mechanical

- Aluminium alloy body
- Maximum speed 18000rpm
- Clockwise or anti clockwise rotation available
- Weight <3.2kg
- Potted elastomer boot for strain relief of cable

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. For example:

- Through bored mounting holes
- High accuracy machining of mounting flanges
- Alternative cable entry locations
- Alternative connectors
- The regulator/rectifier unit may be rotated through 90°, 180° or 270°
- Rectifiers are strapped for resilience to vibration

For high vibration installations, additional strapping of the rectifier is available. Hard-wire back-up of the regulator is also available if requested.

Please contact our technical consultancy service who will be pleased to help.

Connection Definition

- 22AWG cable (where fitted)
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Positive power output M8 stud (B+ terminal)
- Ground connection for power and regulator is through the case. Ensure that the case has a high current, low resistance connection to vehicle ground.
- Cable connection

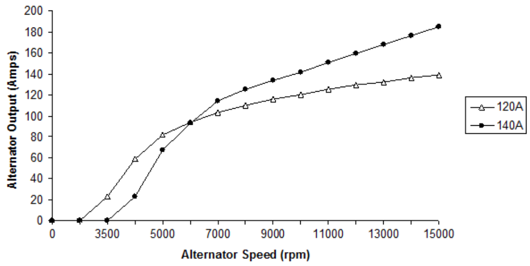
Green wire	Pin A	Pin 1	Ignition
Red wire	Pin B	Pin 2	Sense
White wire	Pin C	Pin 3	Lamp

- Single connection details:
  Ignition and Sense connections for the single connection alternators are through the power output stud (B+ terminal)

Environmental

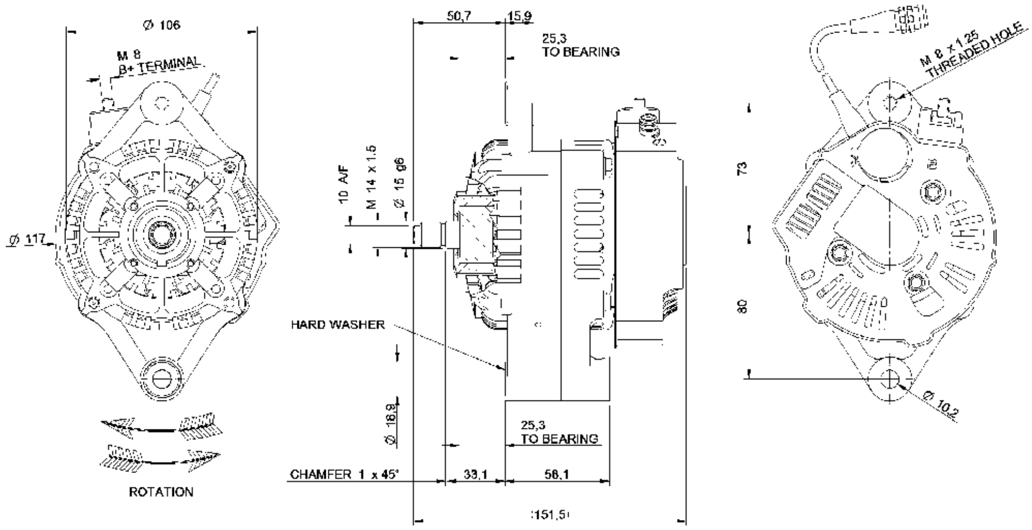
- Splash resistant to standard motorsport fluids
- Viton jacketed cable
- Continuous ambient operating temperature -30 to +90°C
- Maximum ambient temperature 110°C short term, providing the following temperatures are not exceeded:

Stator	200°C
Diodes	175°C
Regulator	115°C
Bearings	150°C

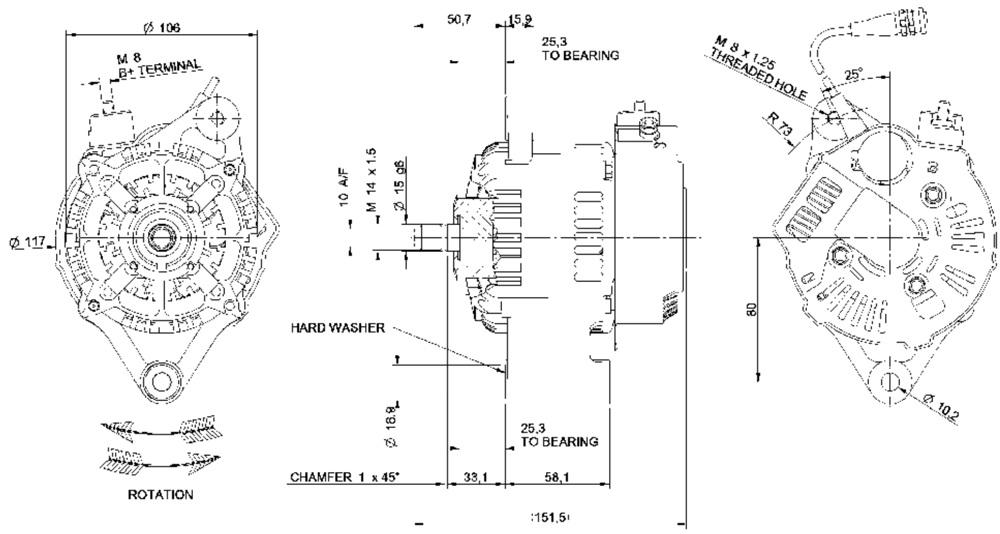


Output in Amps (@13.5V)				
Nominal Current Rating		**120A**	**140A**	
Ambient Temperature		**25°C**	**25°C**	**90°C**
Cut in Speed		**2,500rpm**	**3,500rpm**	**3,600rpm**
Speed (rpm)	3500	23	0	0
	4000	59	23	15
	5000	82	67	59
	6000	94	93	82
	7000	103	114	98
	8000	110	125	111
	9000	116	134	117
	10000	120	141	126
	11000	125	151	132
	12000	129	159.5	140
	13000	132	168	145
	14000	136	176.5	152
	15000	139	185	158

McLaren Electronics can service and repair alternators. Please contact our technical consultancy service for more information.

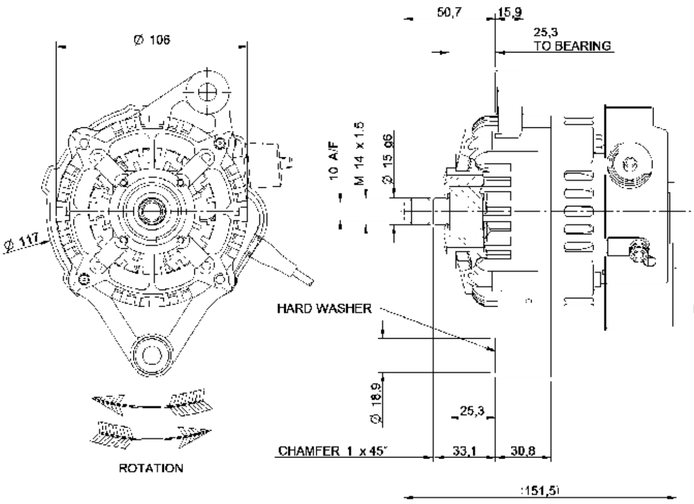


Description	Rotation	Cable Length	Connector	Ordercode
Standard 140A High Output G-Type	Anti-clockwise	300mm	None	O 030 650 005 030
Standard 140A High Output G-Type	Anti-clockwise	300mm	ASL6-06-05PN-HE	O 030 650 005 038
Standard 140A High Output G-Type	Clockwise	300mm	AS6 8-98PN	O 030 650 005 055
Standard 140A High Output G-Type	Clockwise	300mm	ASL6-06-05PN-HE	O 030 650 005 058
Standard 140A High Output G-Type	Clockwise	500mm	None	O 030 650 005 062
Standard 120A High Output G-Type	Clockwise	500mm	None	O 030 650 005 089

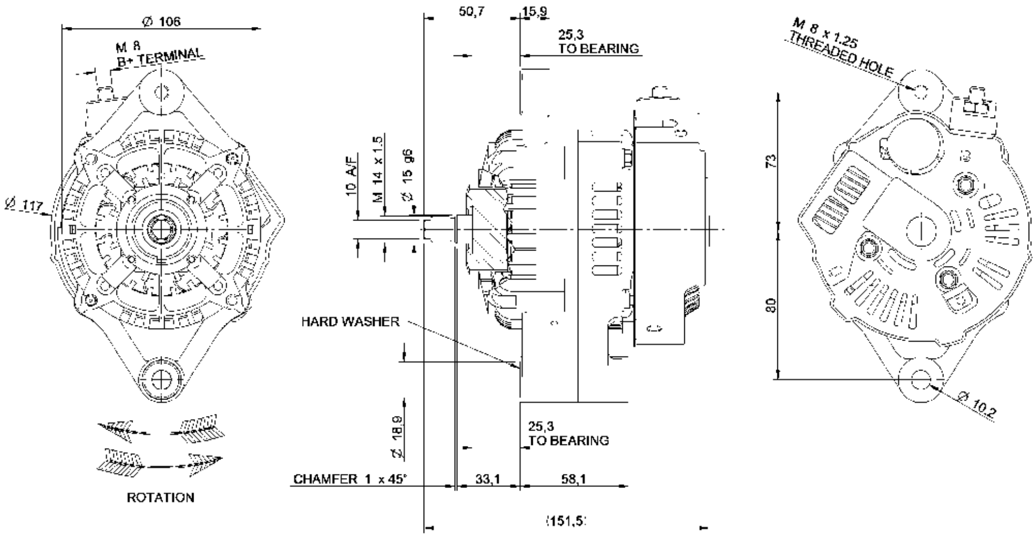


Description	Rotation	Cable Length	Connector	Ordercode
Standard 140A High Output G-Type	Clockwise	300mm	ASL6-06-05PN-HE	O 030 650 005 065
Standard 140A High Output G-Type	Anti-clockwise	300mm	ASL6-06-05PN-HE	O 030 650 005 106

Description	Rotation	Cable Length	Connector	Ordercode
Standard 140A High Output G-Type	Clockwise	1000mm	None	O 030 650 005 098



Description	Rotation	Cable Length	Connector	Ordercode
Standard 140A High Output G-Type	Clockwise	300mm	ASL6-06-05PN-HE	O 030 650 005 059

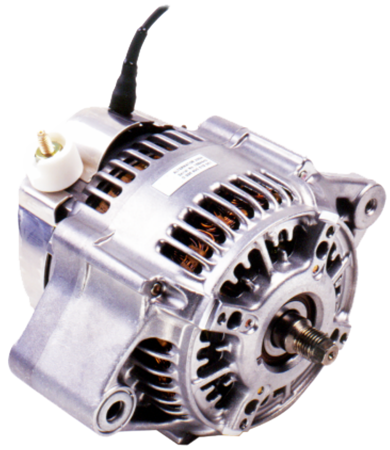


Description	Rotation	Connector	Ordercode
Single connection 140A High Output G-Type	Clockwise	None	O 030 650 005 043

K-Type Alternator
Up to 200 Amps

The K-type alternator has a specially wound stator to achieve high power output in a small, low weight package. High current diodes are used in the rectifier and internal fans provide forced air cooling. The output is controlled by a regulator inside the alternator. The units are assembled with stiff brush springs and extra flexible wire to connect the stator to the rectifier. The stator is pegged to the body and all screws are locked. High quality bearings are used to enable the alternators to run at high speeds (up to 18,000 rpm). The standard mounting method is intended for a belt drive, but the alternator may also be driven directly, if required.

Please request our installation datasheet for further details.



Electrical

- Output voltage 13.5V DC
- Nominal output current

High	200A	(cut in speed 2500rpm)
Medium	165A	(cut in speed 2000rpm)
Standard	110A	(cut in speed 1300rpm)

- Ignition quiescent current 300mA*

A detailed performance chart is shown later in this document.

*If alternator is continuously connected to the battery this quiescent current draw may drain the battery

Mechanical

- Aluminium alloy body
- Maximum speed 18000rpm
- Clockwise or anti clockwise rotation available
- Weight <4.9kg
- Potted elastomer boot for strain relief of cable

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. For example:

- Through bored mounting holes
- High accuracy machining of mounting flanges
- Alternative cable entry locations
- Alternative connectors
- The regulator/rectifier unit may be rotated through 90°, 180° or 270°

Hard-wire back-up of the regulator is also available if requested.

Please contact our technical consultancy service who will be pleased to help.

Connection Definition

- 22AWG cable (where fitted)
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Positive power output M8 stud (B+ terminal)
- Ground connection for power and regulator is through the case. Ensure that the case has a high current, low resistance connection to vehicle ground.
- Cable connection:

Green wire	Pin A	Pin 1	Ignition

Red wire	Pin B	Pin 2	Sense
White wire	Pin C	Pin 3	Lamp

- Single connection

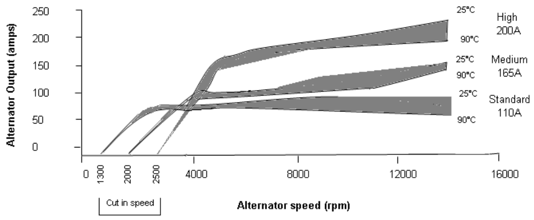
The Ignition and Sense connections for the single connection alternators are through the power output stud (B+ terminal)

Electrical

Environmental

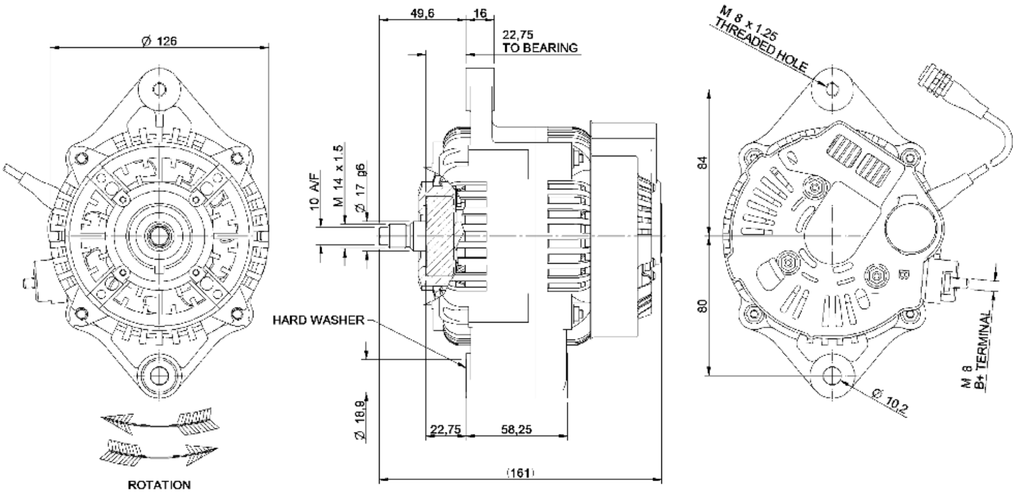
- Splash resistant to standard motorsport fluids
- Viton jacketed cable
- Continuous ambient operating temperature -30 to +90°C
- Maximum ambient temperature 110°C short term, providing the following temperatures are not exceeded:

Stator	200°C
Diodes	175°C
Regulator	115°C
Bearings	150°C

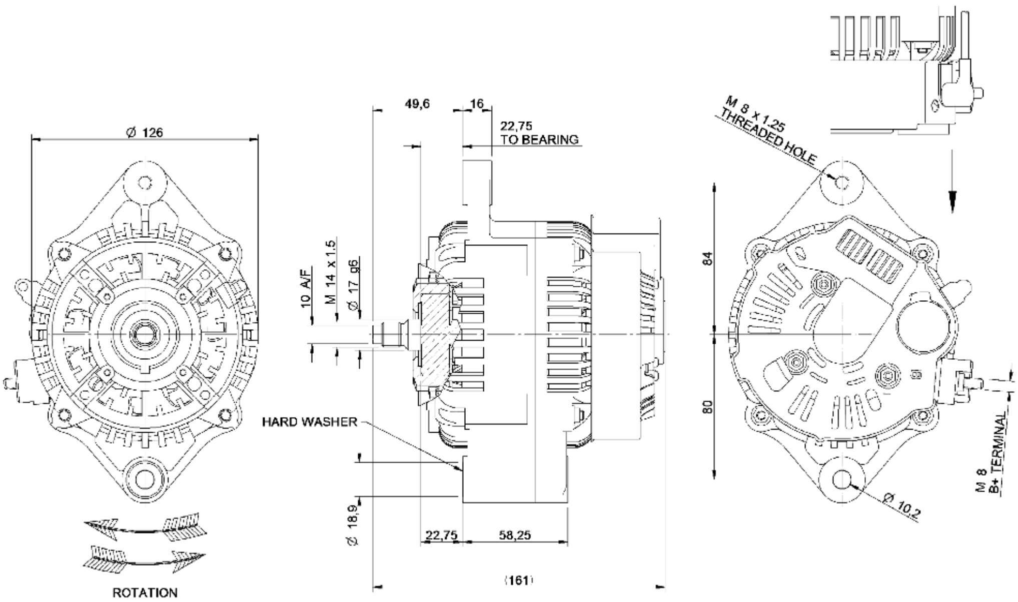


Output in Amps							
Nominal Current Rating		**Standard 110A**		**Medium 165A**		**High 200A**	
Cut in Speed		**1300rpm**		**2000rpm**		**2500rpm**	
Ambient Temperature		**25°C (@13.5V)**	**90°C (@12.5V)**	**25°C (@13.5V)**	**90°C (@12.5V)**	**25°C (@13.5V)**	**90°C (@12.5V**
Speed (rpm)	2500	60	50	20	27	0	0
	3000	80	70	50	55	45	50
	5000	100	90	125	123	135	125
	7500	110	90	148	140	175	155
	10000	120	90	165	147	200	180
	12500	120	90	178	157	220	190
	15000	120	90	190	170	235	200

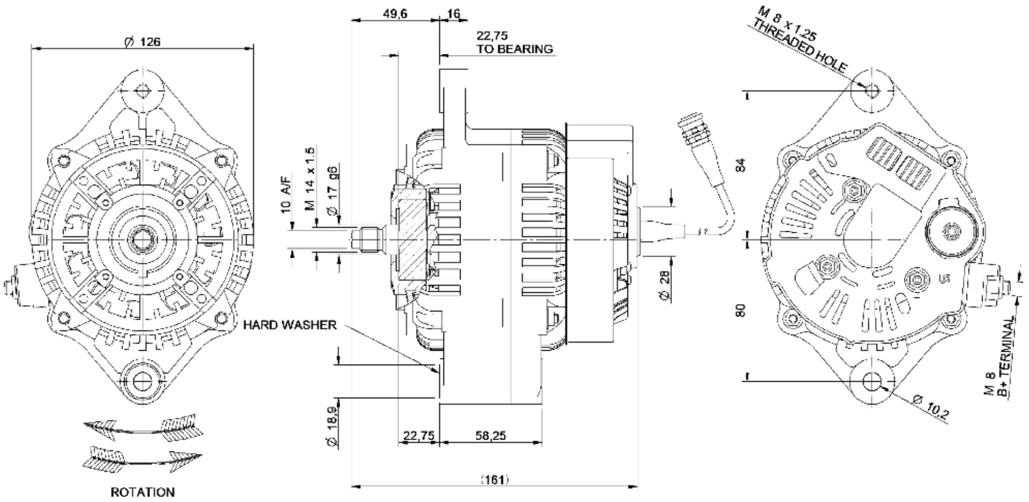
McLaren Electronics can service and repair alternators. Please contact our technical consultancy service for more information.



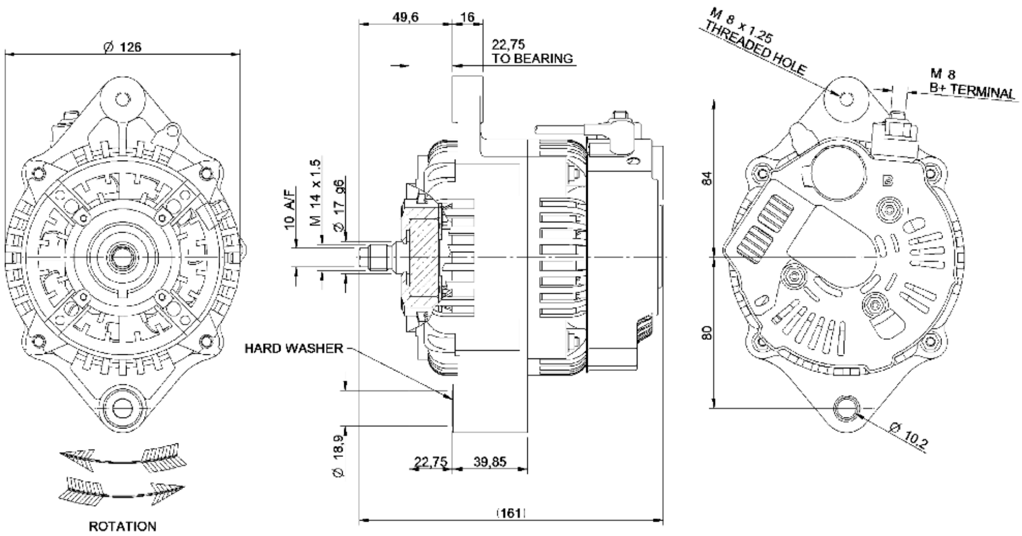
Description	Output	Rotation	Cable Length	Connector	Ordercode
Standard K-Type	110A	Clockwise	300mm	ASL6-06-05PN-HE	O 030 650 013 017
Standard K-Type	165A	Clockwise	300mm	ASL6-06-05PN-HE	O 030 650 013 000
Standard K-Type	200A	Clockwise	300mm	None	O 030 650 013 030
Standard K-Type	200A	Clockwise	300mm	ASL6-06-05PN-HE	O 030 650 013 001
Standard K-Type	165A	Anti-clockwise	300mm	ASL6-06-05PN-HE	O 030 650 013 019
Standard K-Type	165A	Anti-clockwise	300mm	None	O 030 650 013 022
Standard K-Type	200A	Anti-clockwise	300mm	ASL6-06-05PN-HE	O 030 650 013 004
Standard K-Type	110A	Anti-clockwise	300mm	ASL6-06-05PN-HE	O 030 650 013 051
Standard K-Type	200A	Clockwise	500mm	None	O 030 650 013 080



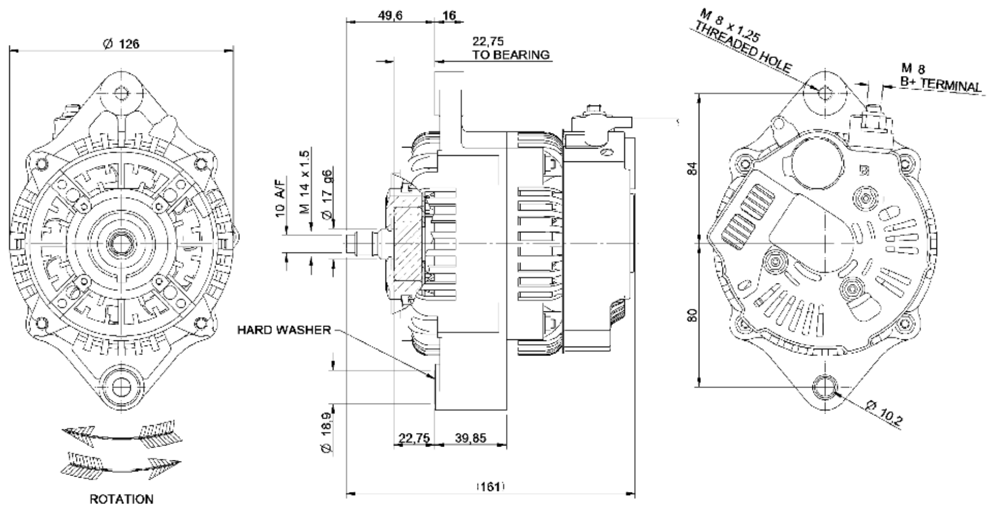
Description	Output	Rotation	Cable Length	Connector	Ordercode
Standard K-Type	165A	Clockwise	500mm	None	O 030 650 013 002
Standard K-Type	200A	Clockwise	500mm	None	O 030 650 013 016



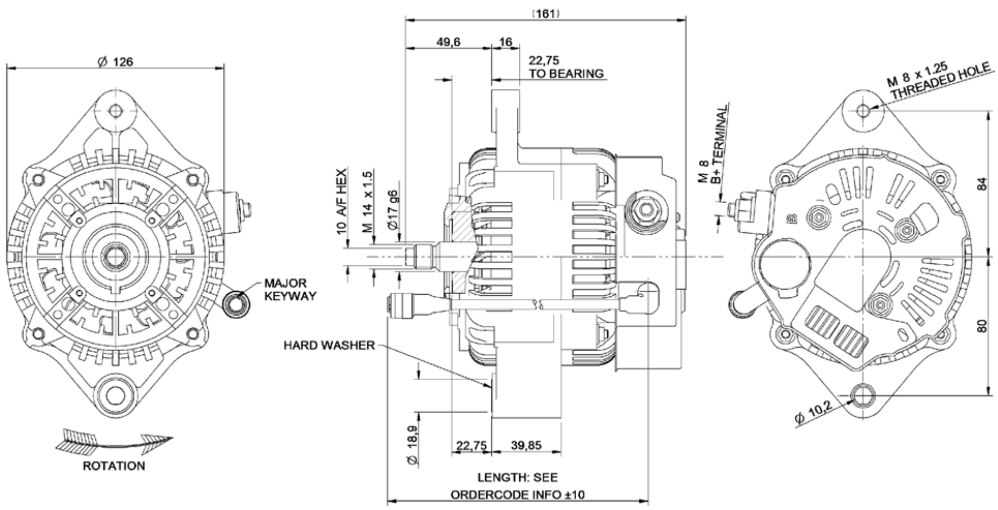
Description	Output	Rotation	Cable Length	Connector	Ordercode
Standard K-Type	200A	Clockwise	300mm	ASL6-06-05PN-HE	O 030 650 013 005
Standard K-Type	200A	Anti-clockwise	300mm	ASL6-06-05PN-HE	O 030 650 013 006
Standard K-Type	165A	Anti-clockwise	200mm	AS6-07-98PB-HE	O 030 650 013 039
Standard K-Type	200A	Anti-clockwise	300mm	AS6-07-98PB	O 030 650 013 050



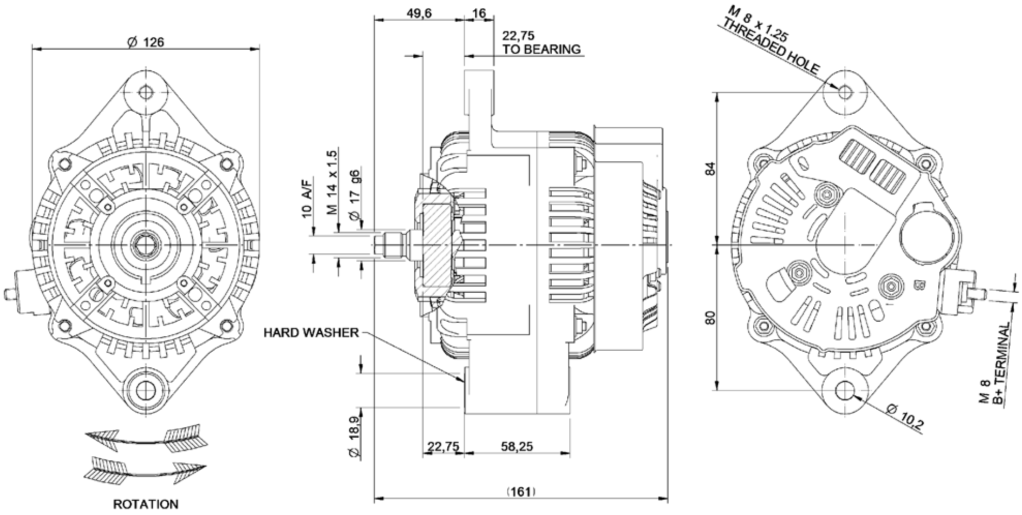
Description	Output	Rotation	Cable Length	Connector	Ordercode
Standard K-Type	165A	Clockwise	500mm	None	O 030 650 013 014
Standard K-Type	165A	Anti-clockwise	500mm	None	O 030 650 013 033
Standard K-Type	200A	Clockwise	500mm	None	O 030 650 013 083



Description	Output	Rotation	Cable Length	Connector	Ordercode
Standard K-Type	165A	Clockwise	500mm	None	O 030 650 013 026
Standard K-Type	165A	Clockwise	600mm	None	O 030 650 013 045
Standard K-Type	200A	Anti-clockwise	500mm	None	O 030 650 013 060
Standard K-Type	165A	Anti-clockwise	500mm	None	O 030 650 013 079



Description	Output	Rotation	Cable Length	Connector	Ordercode
Standard K-Type	200A	Anti-Clockwise	300mm	AS6-07-98PB	O 030 650 013 054
Standard K-Type	200A	Clockwise	300mm	AS6-07-98PB	O 030 650 013 087



Description	Output	Rotation	Connector	Ordercode
Single Connection K-Type	200A	Clockwise	None	O 030 650 013 036

Ignition and Injection Drivers

Ignition Driver Unit
IGN-310

The IGN-310 is a compact inductive ignition drive unit which drives two banks of five ignition coils. The drivers are controlled via direct logic signals from a host ECU and provide fire-by-fire diagnostics back to that unit via CAN. The coils can be run at voltages up to 30V with this unit in order to minimize dwell times for optimum response.

Application
- Driving ignition coils from logic signals from a host ECU.

Electrical
- Ignition Supply Voltage 14 to 30V DC (unit is protected against transient voltage spikes above 30V, sustained operation above 33V may cause permanent damage)
- Supply Voltage 7.5V to 16V
- Supply Voltage not to exceed 17V continuous (unit is protected against transients and reverse voltage protection is provided on the control circuitry)
- Supply Current operating 0.1A typ, 0.2A max
- Inductive ‘flyback’ from the coils can reach 400V or more, so provision of double or reinforced insulation and/or provision of a safety earth should be made to ensure safety wherever the possibility of contact with a live conductor exists.

Inputs
- 10 ignition trigger inputs, configurable via CAN as TTL mode or Open Drain mode
- 14 to 30V Power Supply to power the ignition coils
- 14V Power Supply for the processor and control circuitry

Outputs
- 10 Open Collector outputs for coils
- Two oscilloscope diagnostic

Communications
- One CAN link (1Mbps)

Diagnostics
- Fire-by-fire diagnostics on each injector comprise open circuit, open and short circuit status flags
- The following internal parameters are monitored:
  - Board temperatures
  - Unit and ignition supplies
  - OK threshold
  - Over current threshold
  - Internal 12V supply rail
  - Selected input pull up voltage

Connection definition
- Integral, sealed, military standard connectors

Ignition Bank A connector	8-way	HEN.2F.308.XLNP
Ignition Bank B connector	8-way	HEP.2F.308.XLNP
Main connector	19-way	HEP.2F.308.XLNP

- For PIN numbers please contact our technical consultancy department.

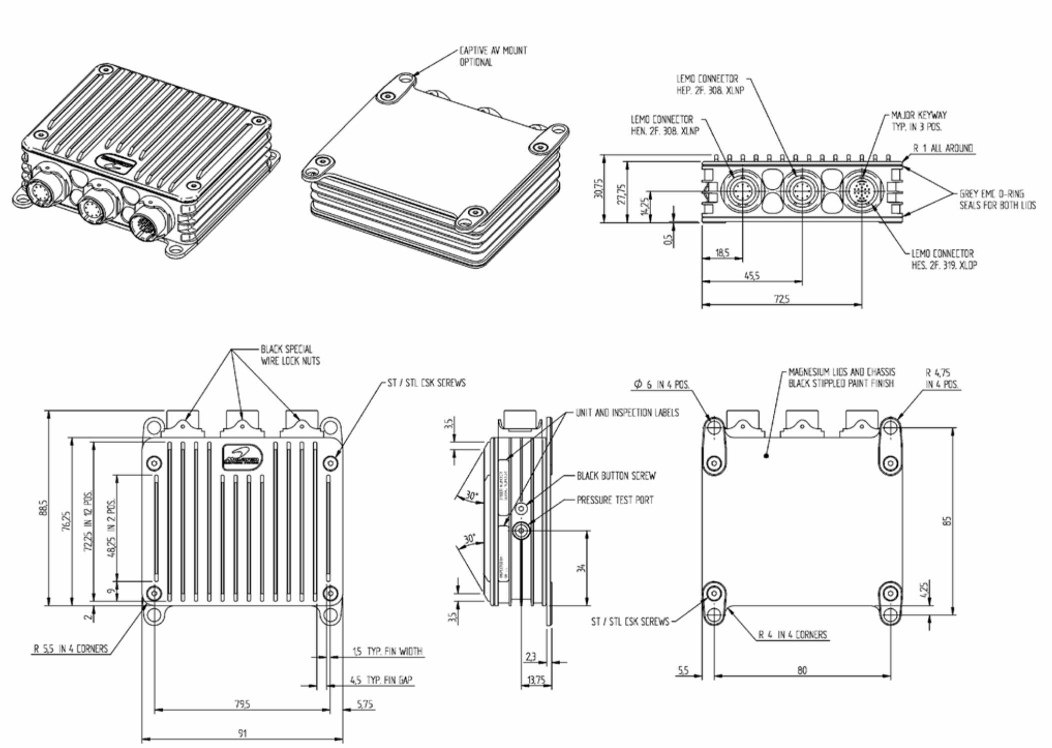
Mechanical
- Case material Magnesium alloy, chromate converted and painted with black epoxy
- Weight less than 220g

Environmental

- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings and screws sealed with silicone rubber
- Mounting lugs are provided, vibration isolation is recommended
- Internal Temperature not to exceed 75°C as measured by internal diagnostic sensors – forced air cooling required
- Storage Temperature -10°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC



Description	Ordercode
IGN-310 Unit	O 030 072 009 001

Injector Driver Unit
INJ-310

The INJ-310 is a compact injection drive unit capable of driving ten fuel injectors at voltages up to 90V, thus catering for the requirements of high pressure solenoid injectors. The unit generates the complex waveforms required to activate the injectors. These waveform characteristics are software configurable via CAN. Injectors are switched on via TTL pulses from the host ECU. A single-chip processor gathers and processes diagnostic information and deals with setting up the injector waveform parameters.

Application
- Driving injectors from logic signals from a host ECU.

Electrical
- Supply Voltage 8 to 14V DC
- Injector Supply Voltage 14 to 90V. Provision of double or reinforced insulation and/or provision of a safety earth should be made to ensure safety wherever the possibility of contact with a live conductor exists.
- Injector Supply Voltage not to exceed 100V continuous (the unit is protected against transients and reverse polarity). Sustained operation above 95V may cause permanent damage due to internal overheating.

Inputs
- 10 TTL injection pulses
- Digital reference ground

Outputs
- 10 injector drives in bridge configuration – both ends of the injector are driven
- Two oscilloscope diagnostic

Communications
- One CAN link (1Mbps)

Diagnostics
- Fire-by-fire diagnostics on each injector comprise open circuit, open and short circuit status flags
- The following internal parameters are monitored:
  - Board temperatures
  - Unit and injector supplies
  - Internal supply rails

Connection definition
- Integral, sealed, military standard connectors

Injector Bank A connector	10-way	HEP.2F.310.XLNP
Injector Bank B connector	10-way	HEN.2F.310.XLNP
Main connector	19-way	HES.2F.319.XDLP
90V Power connector	5-way	HET.0F.305.XDLP

- For PIN numbers please contact our technical consultancy department.

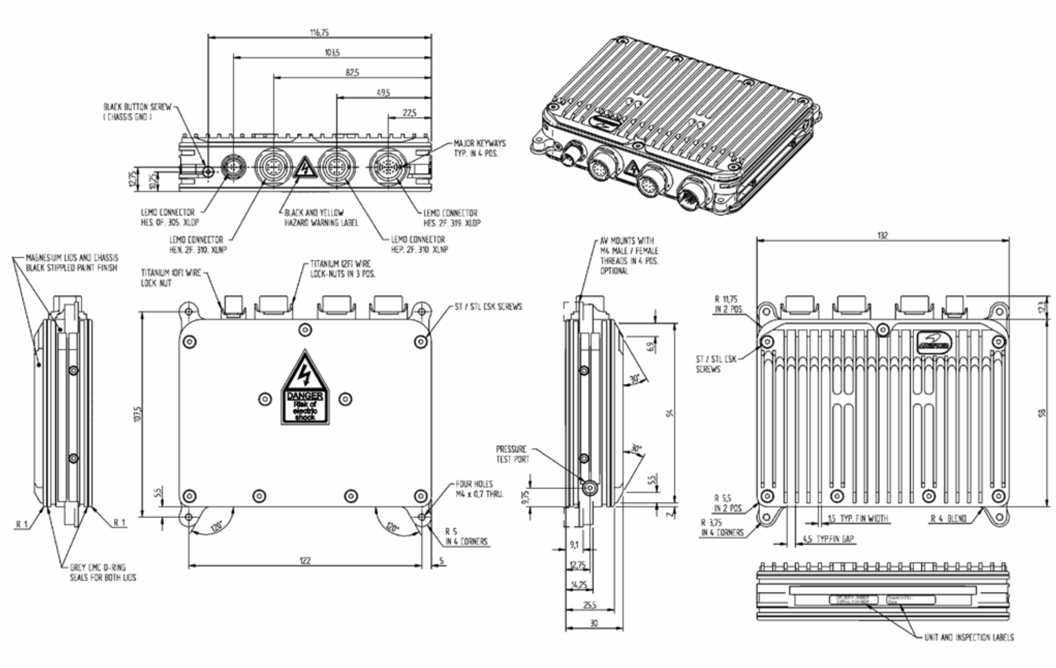
Mechanical
- Case material Magnesium alloy, chromate converted and painted with black epoxy
- Weight less than 430g

Environmental
- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings and screws sealed with silicone rubber
- Mounting lugs are provided, vibration isolation is recommended
- Internal Temperature not to exceed 75°C as measured by internal diagnostic sensors – forced air cooling required
- Storage Temperature -10°C to +85°C

- Operating ambient temperature 0 to +40°C
- Vibration 100 to 1000Hz, all axes, 24 hours

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC



Description	Ordercode
INJ-310 Unit	O 030 072 011 001

Injector Driver Unit
INJ-320

The INJ-320 is a compact injection drive unit capable of driving ten fuel injectors at a nominal 90V, thus catering for the requirements of high pressure solenoid injectors. The unit generates the complex waveforms required to activate the injectors. These waveform characteristics are software configurable via CAN. Injectors are switched on via TTL pulses from the host ECU. A single-chip processor gathers and processes diagnostic information and deals with setting up the injector waveform parameters

Electrical
- Supply Voltage 8 to 14V DC (Engine start capability only below 10.5V)
- Injector drive signals are 90V so appropriate harness insulation and safety earthing must be provided.
- 90V generated internally
- Reverse polarity protection

Inputs
- 10 TTL injection pulses
- Digital reference ground

Outputs
- 10 injector drives in bridge configuration – both ends of the injector are driven
- Two oscilloscope diagnostic

Communications
- One CAN link (1Mbps)

Diagnostics
- Fire-by-fire diagnostics on each injector comprise open circuit, open and short circuit status flags
- The following internal parameters are monitored:
  - Board temperatures
  - Unit and injector supplies
  - Internal supply rails

Application
- Driving injectors from logic signals from a host ECU
- Maximum injection rate is 1000/s (three per cycle for four cylinders at 10,000rpm). 13A peak & 500µs are maximum sustainable values at this rate.

Connection definition
- Integral, sealed, military standard connectors

Injector Bank A connector	10-way	HEP.2F.310.XLNP
Injector Bank B connector	10-way	HEN.2F.310.XLNP
Main connector	19-way	HES.2F.319.XDLP
Power connector	8-way	HES.2F.308.XDLP

- For PIN numbers please contact our technical consultancy department.

Mechanical
- Case material aluminium, black anodised
- Weight approx 1500g (estimated)

Environmental
- Splash resistant to standard motorsport fluids
- Lids sealed with o-rings and screws sealed with silicone rubber
- Mounting lugs are provided, vibration isolation is recommended
- Internal temperature not to exceed 75°C as measured by internal diagnostic sensors – forced air cooling required
- Storage temperature -10°C to +85°C
- Operating ambient temperature 0 to +40°C

- Vibration 100 to 1000Hz, all axes, 24 hours

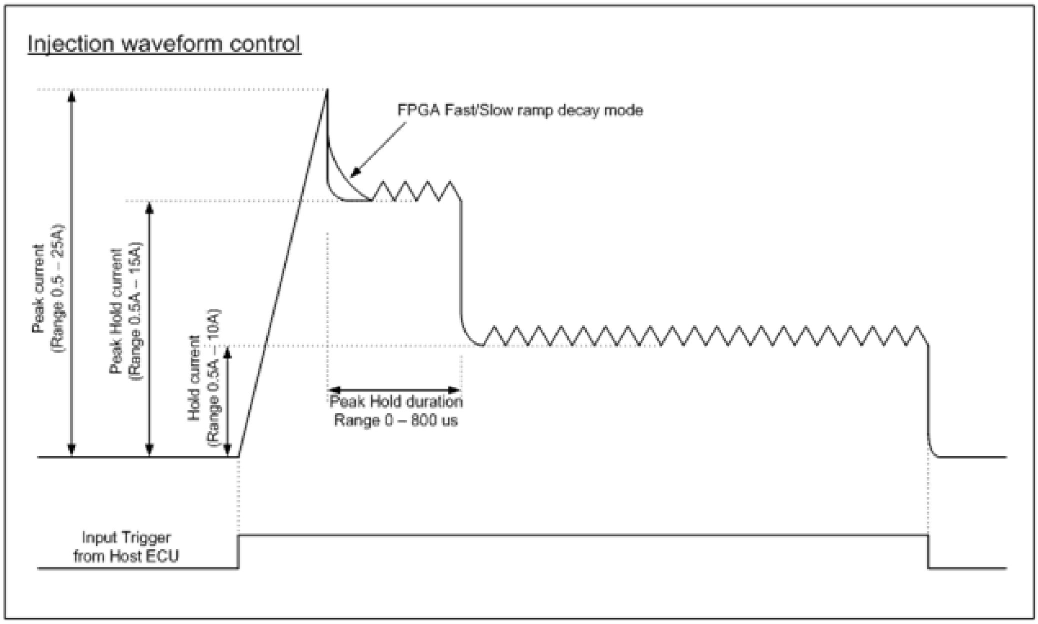
Electro Magnetic Compatibility

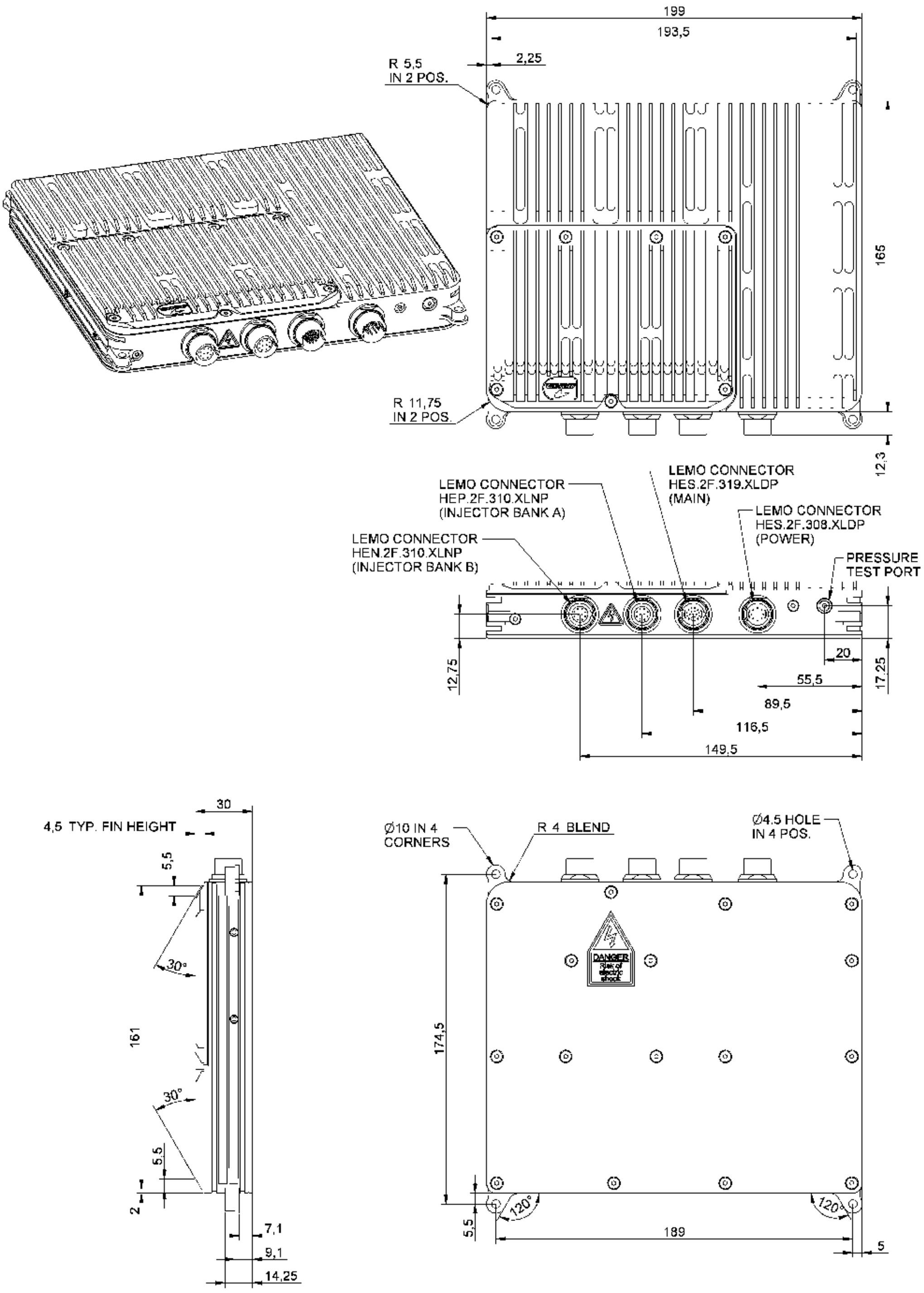
- Complies with the essential protection requirements of 2004/108/EC

Limits on software configuration of waveform

- Peak current – up to 25A
- Peak hold current – up to 15A
- Peak hold duration – up to 800µs
- Hold current – up to 10A

Permissible maximum values will be reduced for multiple injections per fire at high engine speeds in order to prevent over-heating of the 90V internal power supply





Description	Ordercode
INJ-320 Unit	O 030 072 011 003

Ignition Coils

CDI Ignition Coil
20mm Diameter (or greater)

An on-plug coil for use with Capacitive Discharge Ignition (CDI). Design and manufacture is in-house, so we can make the coil to suit your specific application. The information given here is for a typical coil. Many of the parameters can be tailored to a particular installation.

Please contact our technical consultancy service to discuss your requirements.

Application

- Capacitive discharge ignition systems.

Electrical

Typical measurements at 25°C (except where stated otherwise)

- Primary DC resistance 800 to 1000mohm
- Primary inductance 252 to 332µH

The following measurements are made with a power unit consisting of a 0.33µF capacitor, charged to 460V (35mJ) supplying the coil with a peak primary current of 35A. The coil is mounted in an aluminium block to simulate a cylinder head.

- Secondary high voltage (fired off-load*) 26kV typ
- Secondary energy discharged into 2nF load 20mJ typ
- Burn time of open spark > 50µs (burn threshold 100V, at atmospheric pressure)

* Firing the coil off-load should be avoided as it can cause cumulative damage by electrical breakdown.

Cable and Connection Definition

- 22AWG un-screened cable
- Any cable length is available on request
- Various automotive and military standard connectors are available
- Connection

Red wire	Pin A	Pin 1	Primary Switched
Green wire	Pin B	Pin 2	Primary Non Switched
White wire	Pin C	Pin 3	Secondary return

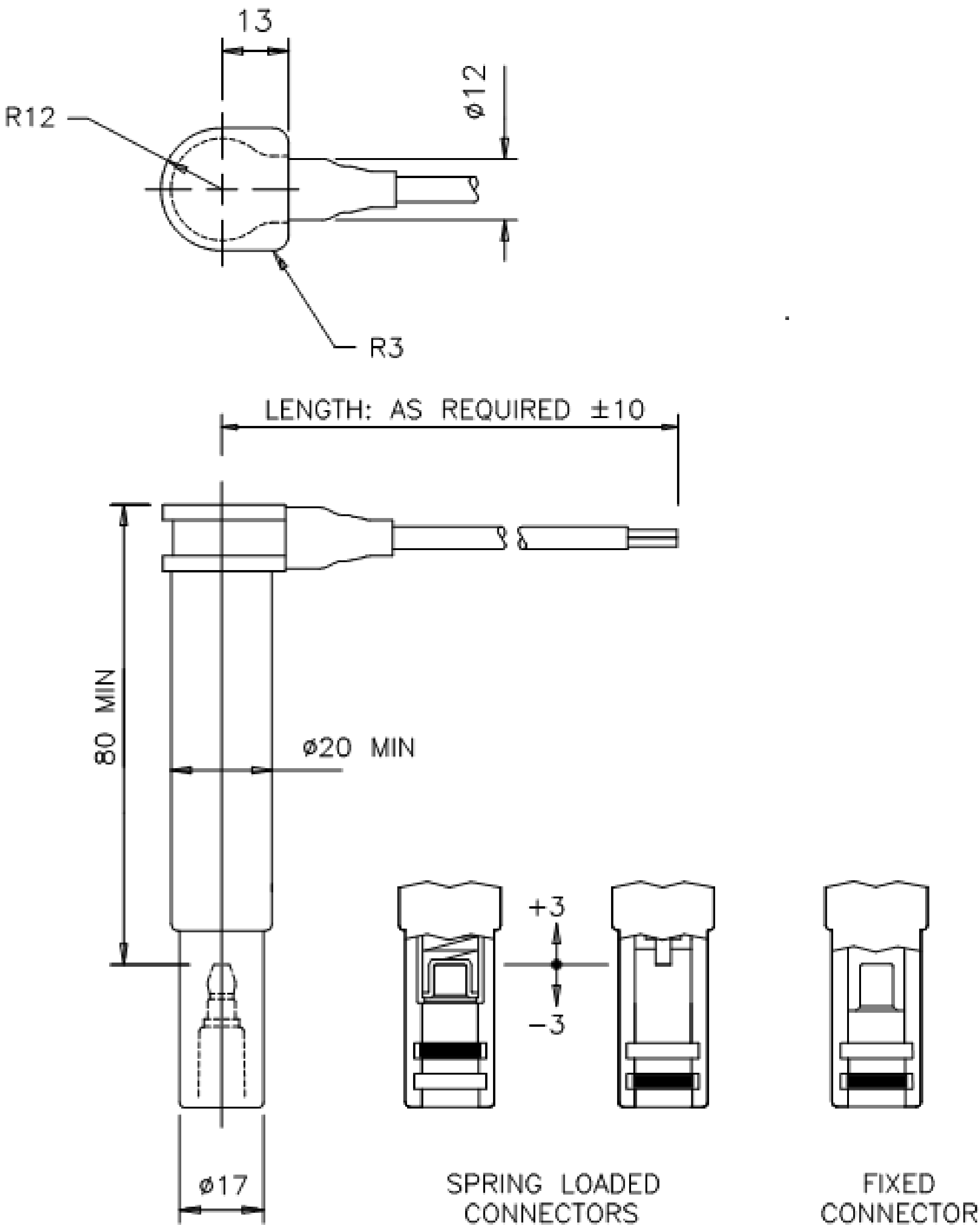
Connect the primary so that “Primary Switched” is negative with respect to “Primary Non Switched” during discharge. The spark plug centre electrode discharge will be negative with respect to ground. The “Secondary Return” allows an ECU to measure the secondary current to confirm proper operation.

Mechanical

- Polyester body
- Minimum diameter 20mm
- Minimum length from top of coil to top of spark plug 80mm
- The body can be made longer and/or wider to suit a specific installation
- HT connection plunger travel 3mm. A fixed HT contact can be provided
- Axial clamping force 35 to 45N
- Weight less than 130g (including 1000mm cable)
- Elastomer boot for strain relief to the coil body
- Fluoro silicone boot or o-rings to seal spark plug

Environmental

- Resistant to standard motorsport fluids
- Operating temperature 0 to +150°C
- Maximum temperature +180°C for 10mins (coil not firing)
- Viton jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis



This drawing is typical and generic.

As each coil design is application specific, no order codes are shown.

Please contact our technical consultancy service to discuss your requirements.

TSI Ignition Coil
16.6mm Diameter

An on-plug coil for use with high current transistorised (inductive) ignition (TSI) as available in all our ECUs. Design and manufacture is in-house, so we can make the coil to suit your specific application. The information given here is for a typical coil. Many of the parameters can be tailored to a particular installation.

Please contact our technical consultancy service to discuss your requirements.

Application

- Transistorised ignition systems

Electrical

Typical measurements at 25°C (except where stated otherwise)

- Primary DC resistance 270 to 290mohm
- Primary DC resistance 270 to 290mohm
- Primary inductance 135 to 155µH
- Primary current up to 25A

The following measurements are made with a power unit operating at 14V supplying 20A with the primary voltage clamped between 350 and 500V and the current collapsing at >5.5A/µs. The coil is mounted in an aluminium block to simulate a cylinder head.

- Secondary high voltage (fired off-load*) 25kV typ
- Secondary energy into 2nF load 18mJ typ
- Burn time of open spark > 650µs (burn threshold 100V, at atmospheric pressure)

* Firing the coil off load should be avoided as it can cause cumulative damage by electrical breakdown

Cable and Connection Definition

- 20AWG un-screened cable
- Cable length 1200mm
- Various automotive and military standard connectors are available
- Connection

Black Wire	Pin A	Pin 1	Primary Switched
White wire	Pin B	Pin 2	Primary Non Switched

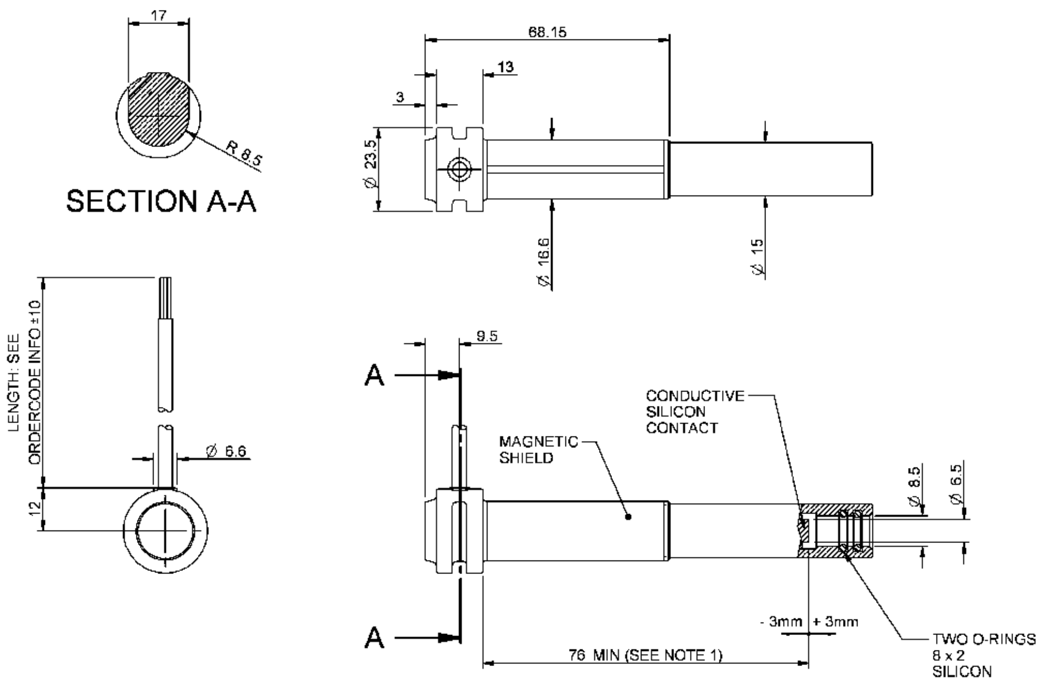
Connect the primary so that “Primary Switched” is positive with respect to “Primary Non Switched” during discharge. The spark plug centre electrode discharge is negative with respect to ground. Screened cable can be provided, the screen is not connected to the coil and should be connected to the ECU.

Mechanical

- Polyester body
- Conductive elastomer contact with either a fixed or spring loaded plunger connection can be provided
- Weight less than 85g (including cable)
- Polyester boss for strain relief to the coil body
- Fluoro silicone o-rings to seal spark plug

Environmental

- Resistant to standard motorsport fluids
- Operating temperature 0 to +150°C
- Maximum temperature +180°C for 10mins (coil not firing)
- DR25 jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis



NOTE 1 - DIMENSIONS TO SUIT CUSTOMERS REQUIRMENTS

This drawing is typical and generic.

As each coil design is application specific, no order codes are shown.

Please contact our technical consultancy service to discuss your requirements.

Lap Triggers

Microwave Receiver
LRX-310B

LRX-310B is a small, lightweight, microwave receiver module with integral antenna. It outputs trigger pulses as it passes through the beam of an LTX-310 Lap Trigger transmitter. The interval between pulses is determined by the transmitter settings and thus by making an appropriate choice of settings and transmitter locations around the circuit, it is possible to identify which particular transmitter the receiver is passing.

The LRX-310B itself cannot distinguish between different transmitter settings. This task must be performed by software in the ECU to which LRX-310B is connected.

Application

- Lap timing when used with compatible ECU and track-side transmitter.

Electrical

Characteristics assume use with an LTX-310 or similar Lap Trigger Transmitter.

- Supply Voltage 5.0±0.25V DC
- Operating frequency 10.6±0.5GHz
- Beamwidth (Between -3dB points) :
  - ±13° horizontal
  - 40° above horizon, 27° below horizon
- Range approximately 25m (when properly aligned)
- Range approximately 82' (when properly aligned)
- Supply current 130mA max with 5.0V supply
- Output characteristics :
  - Impedance <60Ohm (<10mA sink/source)
  - Max voltage outside LTX beam 150mV
  - Max voltage inside LTX beam 4.75 to 5.25V (depending on unit supply voltage)
- Output voltage increases with signal strength as antenna passes through LTX beam
- Output voltage pulses low to <0.15V for 100±10us with interval between pulses determined by LTX setting
- Valid pulse intervals are in the range 456-1576us (36 unique intervals in 32us steps)
- Response time <2ms (Time to first pulse after entering LTX beam)

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 2004/108/EEC

Connector Definition

- EHS 0F 303 XLC case-mounted Lemo socket with male pins

Pin 1	Supply
Pin 2	Ground
Pin 3	Output

Mechanical

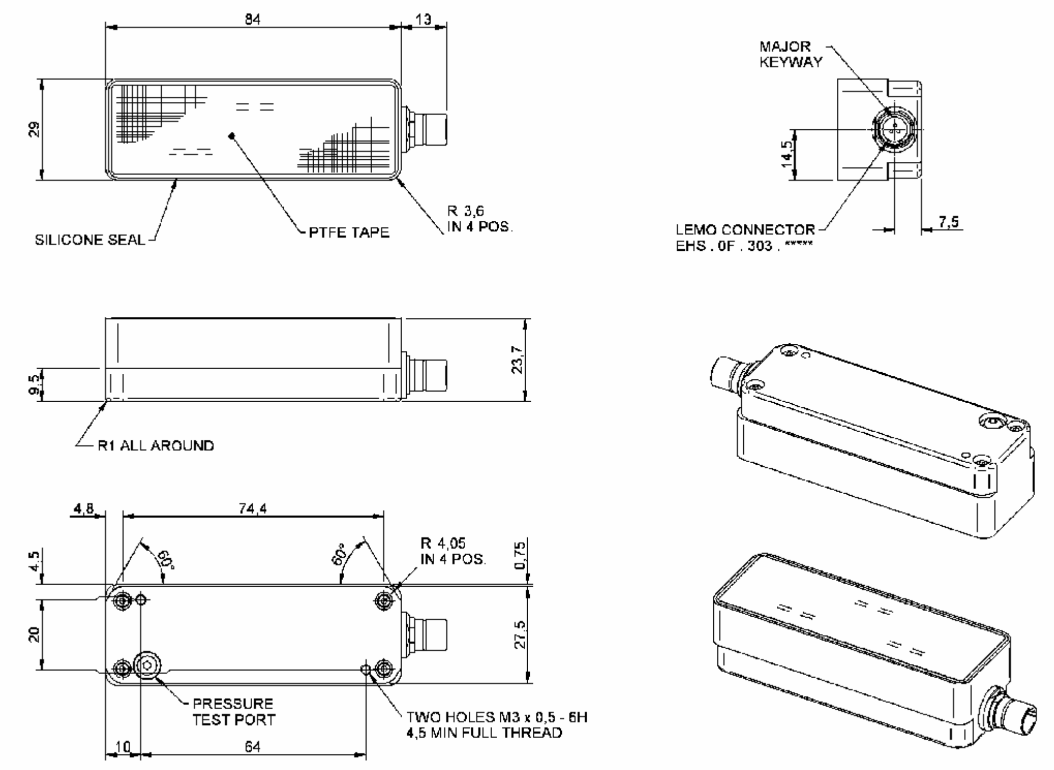
- Case material: aluminium alloy, hard black anodised
- Antenna covered by 75um thick PTFE/fibreglass tape
- Weight approx 80g
- Mounted using two M3 tapped holes on rear of case

Environmental

- Splash resistant to standard motorsport fluids
- Operating temperature 0°C to +60°C
- Storage temperature -25 to +85°C
- Bump tested to ±50g ½ sine 11ms five times per axis
- Random vibration with spectrum below, three axes, 24hrs

100Hz	0.00797 g^2/Hz

200Hz	0.17157 g^2/Hz
300Hz	0.54279 g^2/Hz
650Hz	0.00965 g^2/Hz
1000Hz	0.02080 g^2/Hz



Description	Ordercode
LRX-310	O 030 040 003 000

Microwave Transmitter
LTX-310B

LTX-310B is a self-contained microwave transmitter for use with the LRX-310B receiver. The output is pulse modulated to identify one of 36 channels arranged in six groups of six. The group is set at the factory and you can select one of the six channels in that group from an external rotary switch.

The internal, sealed, lead-acid battery typically produces eight hours of operation. An additional external battery can be connected for longer durations. The unit has a threaded socket for tripod mounting. A key switch is provided to allow unattended operation. LTX-310B is not suitable for mounting in a vehicle.

Application

- Lap trigger timing when used with LRX-310B receiver.

Electrical

- Operating supply 8.0 to 14.4V DC
- Battery charging supply 13.8 to 14.4V DC not to exceed 0.8A (key switch can be on or off)
- LED indicates power on
- Operating centre frequency 10.6 ±0.05GHz
- RF Bandwidth <10MHz
- Output power +14 to +17dBm peak power input to antenna
- Beamwidth 3dB 18° (approx) horizontal and vertical
- Beamwidth 10dB 30° (approx) horizontal and vertical
- Antenna gain 20dBi ±1 dB
- Range approximately 25m (when properly aligned)
- Polarisation linear vertical
- Channel identification by modulation frequency (see Application Note for values

Electro Magnetic Compatibility

The unit has been designed and manufactured such that:

- The electromagnetic disturbance generated does not exceed the level above which radio and other equipment operating outside the RF band used by the LTX-310B cannot operate as intended;It has a level of immunity to the electromagnetic disturbance to be expected in its intended use which allows it to operate without unacceptable degradation of its intended use.
- It has a level of immunity to the electromagnetic disturbance to be expected in its intended use which allows it to operate without unacceptable degradation of its intended use.

A site-specific radio licence should be obtained before the LTX-310B unit is operated outside an electromagnetically sealed environment.

Service

- Recommended service interval 24 months (internal battery is replaced)

Cable and Connection Definition

- Connection ASL0-06-05SN-HE

Pin 1	Battery supply +ve
Pin 2	Ground
Pin 3,4,5	N/C

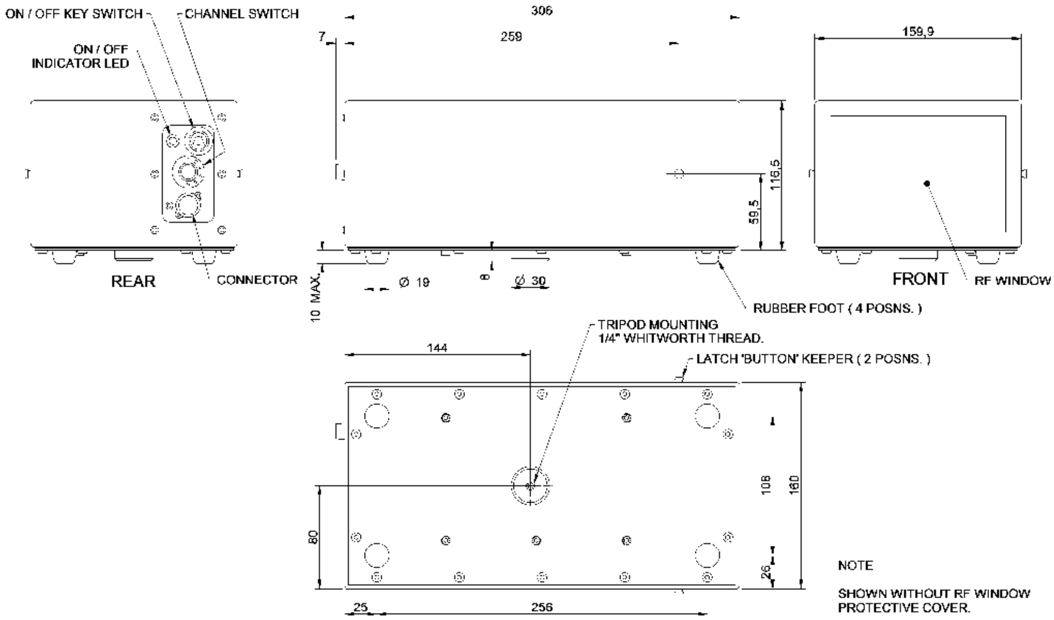
Mechanical

- Case material aluminium alloy, painted black, stippled epoxy polyester
- Antenna cover epoxy glass fibre composite
- Weight 3.6kg including cover and internal battery

Environmental

- Splash resistant to standard motorsport fluids
- Maximum humidity 100%

- Operating temperature 0°C to 50°C
- Storage temperature -20 to 50°C
- Store with battery charged. Top up charge every three months if unit is not being used.



Description	Ordercode
LTX-310B Microwave Transmitter	O 030 030 001 004

Pits

LHE Pits Pedal Control

The output of a Linear Hall Effect sensor is a voltage which changes in direct proportion to the shaft extension. A constant voltage is required across the supply and ground wires of the sensor. The sensor consists of a Hall Effect element and a shaft which houses a magnet. When the position of the shaft changes relative to the sensor, the change in magnetic field in the sensor results in a change in output voltage.

The pits pedal control combines a linear Hall effect sensor with a momentary 'Engine Kill Switch'. This switch can also be used to force 'extended boot' of the TAG-310B on power up.

Electrical

- Supply Voltage 5.0±0.5V
- Supply current 10mA max
- Electrical and mechanical stroke 15mm
- Output voltage at 0mm shaft depression = 4.0625±0.05V (at 25°C)[1]
- Output voltage at 15mm shaft depression = 0.9375±0.05V (at 25°C)[1]
- Output voltage clamped between 0.9375 and 4.0625V
- Independent non-linearity ±2%FSO
- Thermal shift <0.05%FS/K
- Momentary 'Engine Kill' button to force output to 0V
  - Electrical life 500,000 cycles
  - Contact bounce 1ms

[1] Sensor output is ratiometric to the supply voltage, the above parameters assume a precision 5.00V supply

Cable and Connection Definition

- AS008-98PN connector
- Connection
  - Pin A - Supply
  - Pin B - Signal
  - Pin C - Ground

Mechanical

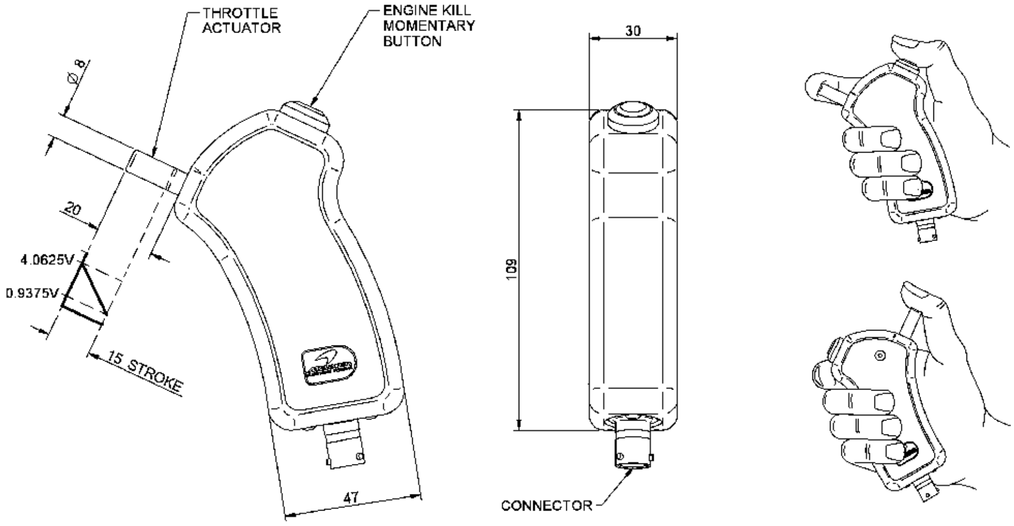
- Weight 250g
- Aluminium alloy body, hard anodised and dyed black
- 316 Stainless steel shaft
- Spring loaded shaft
  - Spring rate 0.39N/mm
  - Force at full shaft extension 10.2N±10%
- 'Engine Kill' button
  - Mechanical life 1,000,000 cycles
  - Operating force 4±1N
  - Total travel 1.5mm

Environmental

- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -40 to +125°C

Notes

- Care should be taken to ensure that the sensor is not placed near to strong magnetic fields, this would result in permanent damage to the sensor.
- Sensor should be kept clear of stray magnetic fields and ferro-magnetic materials during operation.



Description	Ordercode
LHE Pits Pedal Control	O 030 320 009 101

Rainlights

High-Intensity LED Light with CAN
Rainlight 2

The Rainlight 2 is a high-intensity LED based light with CAN connectivity for use at the rear of an F1 car.

The light is activated via a control signal input. Flashing speed and intensity are adjustable and diagnostic information is available via the CAN bus.

Default mode (without CAN link): the light flashes at 4Hz when the rainlight input is switched to supply voltage. The bright period intensity will be at 60% and the dim period intensity will be at 5%.

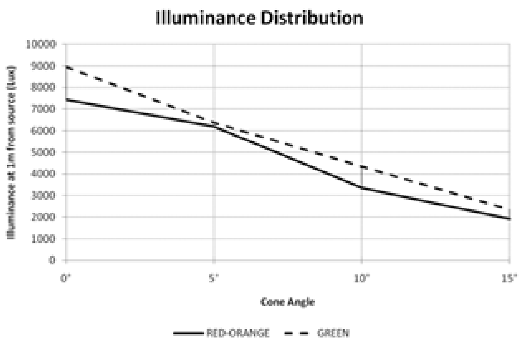
Red-orange and green versions are available.

Electrical

- Supply 10V to 16V dc
- Supply not to exceed 17V continuous (the unit is protected against transients and reverse polarity)
- Current up to 3.0A at 13.8V
- Rainlight input 5V to 16V dc
- Default rainlight flash rate 4Hz, 30% duty cycle
- Default bright period intensity 60%, dim period intensity 5%
- Internal temperature sensor
- 1 Mbps CAN bus for control and diagnostics (a termination resistor is NOT fitted within the unit)

Optical

- LED colour red-orange (617nm wavelength), or green (530nm wavelength).
- Typical maximum light intensity distribution as shown on graph.
- CAN control of brightness and flash rate.



Measurements at 25°C ambient after 30 minutes warm-up in ambient light of 14 lux. Unit temperature was indicated to be approx 58°C during the measurements.

Connection Definition

- Connector ASL006-05PN-HE
- Connection

Pin 1	Supply
Pin 2	Ground
Pin 3	Rainlight Input
Pin 4	CAN+
Pin 5	CAN-

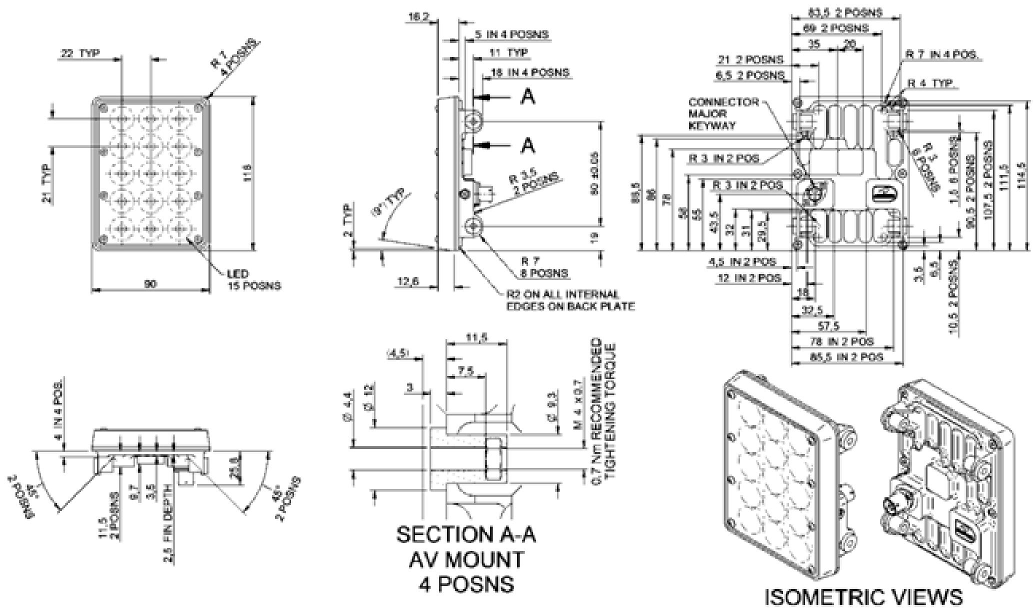
Mechanical

- Aluminium alloy body, hard anodised and dyed black
- Clear polycarbonate lens cover
- Black polyester surround
- Supplied with Q4 Flex-Loc A/V mounts
- Weight <265g

Environmental

- Splash resistant to standard Motorsport fluids
- Maximum humidity 100%
- Operating temperature 0 to +85°C (as measured by the unit's internal temperature sensor)
- Storage temperature -10°C to +85°C
- Shock tested to 50g, 11ms
- Vibration 100 to 1000Hz, 24 hours each axis

100Hz	$0.00797g^2/Hz$
200Hz	$0.17157g^2/Hz$
300Hz	$0.54279g^2/Hz$
650Hz	$0.00965g^2/Hz$
1000Hz	$0.02080g^2/Hz$



Description	Ordercode
Rainlight CAN (Red LEDs)	O 030 970 010 009
Rainlight CAN (Green LEDs)	O 030 970 010 010

Accelerometers

Accelerometer

1-Axis, Thermally-Compensated

The unit is based on micro machined MEMS technology. The unit contains a ±35g sensing element. The element is scaled to optimise the resolution to suit the g range of interest. An internal amplifier provides an output between 0 and 5 volts. The on board microcontroller and temperature sensor are used for offset drift compensation. This unit can be re-calibrated at the factory.

For higher g applications a ±50g sensing element can be fitted and scaled to optimise the resolution.

Sensors

Electrical

- Supply Voltage 8 to 16V unregulated
- Range ±20g
- Output voltage at 25°C

0.5 ±0.10V	Full scale negative
2.5 ±0.05V	0g
4.5 ±0.10V	Full scale positive

- Sensitivity 100mV/g ± 2.5% max at 25°C
- Cross axis sensitivity ±3.5%
- Thermal sensitivity drift
  +0.003 to +0.006%/°C over -20°C to 25°C
  -0.007 to -0.017%/°C over 25°C to +105°C
  -0.004 to -0.025%/°C over 105°C to +125°C
- Zero g drift ±0.2g max over operating temperature range
- Frequency response
  -3dB at 60±5Hz, 2 pole filter
- Output impedance 50#
- Current Consumption <10mA

Cable and Connection Definition

- 24AWG un-screened cable
- Cable length 1000mm
- Connection

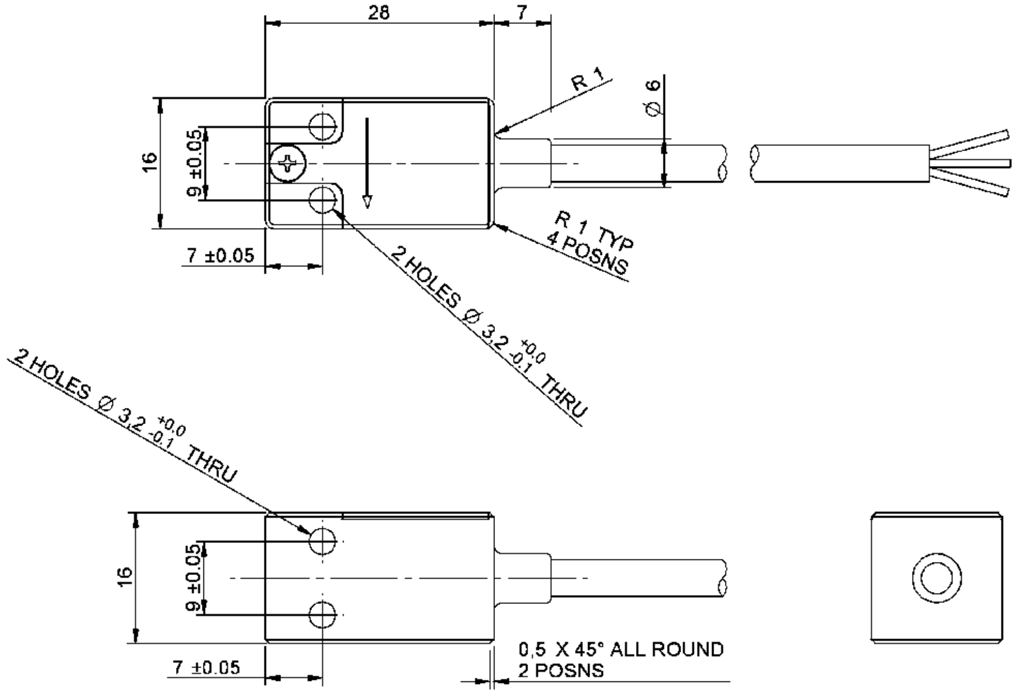
Red wire	Supply
Green wire	Ground
White wire	Signal

Mechanical

- Weight less than 65g (including cable)
- Polyester cable boss for strain relief to the sensor body
- Over range 500g (any axis powered for 0.5ms)

Environmental

- 6AL4V Titanium body and lid
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature 0 to +125°C
- Viton jacketed cable



Range	Element	Cable Length	Ordercode
±20g	±35g	1000mm	O 030 345 006 015

Accelerometer

3-Axis, Thermally-Compensated

Accelerometers are available to measure up to three axes in a single, robust package. The sensing element is a micro-machined MEMS device. An internal amplifier provides an output between 0 and 5 volts. The unit can be offered in ranges up to ±35g. The -3dB point can also be configured to suit the application

Electrical

- Supply Voltage 8 to 16V unregulated
- Range ±6g
- Output voltage (per axis)
  0.5 ±0.075V Full scale negative
  2.5 ±0.05V 0g
  4.5 ±0.075V Full scale positive
- Sensitivity 333.3mV/g ±2.5% max at 25°C
- Thermal sensitivity drift
  +0.003 to +0.006%/°C over -20°C to 25°C
  -0.007 to -0.017%/°C over 25°C to +85°C
- Zero g drift ±0.1g max over operating temperature range
- Frequency response
  -3dB at 60±5Hz over operating temperature range 8 pole Butterworth filter
- Cross axis sensitivity ±3.5%
- Output impedance 50#
- Current Consumption <30mA

Mechanical

- Weight less than 80g (including cable)
- Polyester cable boss for strain relief to the sensor body
- Over range 4000g (any axis)

Cable and Connection Definition

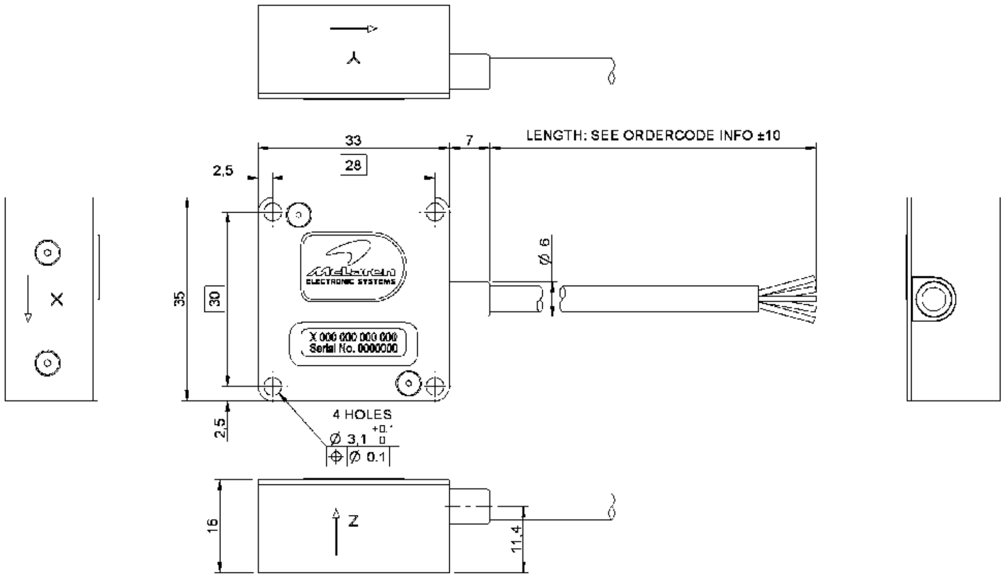
- 26AWG un-screened cable
- Connection

Red wire	Supply
Green wire	Ground
White wire	X axis signal
Yellow wire	Y axis signal
Blue wire	Z axis signal

- Various automotive and military standard connectors are available
- Cable length is shown on the order details but any length is available upon request

Environmental

- Aluminium body, hard anodised and dyed black
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -40 to +85°C
- Viton jacketed cable

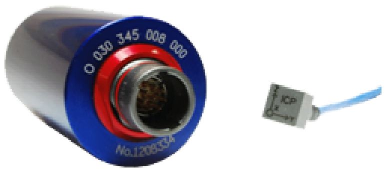


Cable Length	Range g X/Y/Z	-3dB Point Hz	Ordercode
1000mm	±6g/±6g/±6g	60	O 030 345 007 028
1000mm	±10g/±10g/±10g	60	O 030 345 007 029

Vibration Measure System
High-Frequency/High-G

Available with two, three or six channels, the AIU (Accelerometer Interface Unit) is to be used with IEPE (Integrated Electronics Piezo-Electric) accelerometers and harness to provide a high-frequency/high-G signal for the High Speed Logger (HSL-500) or alternative unit.

The AIU provides a constant current source to power the IEPE accelerometer. The voltage output from the IEPE is attenuated and buffered by the AIU to convert the 10V full scale measurement range to an output in the range of 0.5 to 4.5V, biased at 2.5V.



AIU

Application

High-frequency chassis and engine vibration analysis.

Electrical

- Supply Voltage 8 to 16V
- Reverse polarity protection
- Excitation voltage 24±0.2V
- Excitation current 2.45±0.1mA per channel
- Output voltage per channel

0.5 ±0.025V	Full scale negative
2.5 ±0.025V	0g
4.5 ±0.025V	Full scale positive

The above tolerance does not include the sensitivity tolerance and sensitivity drift of the IEPE accelerometer

- Gain fixed at 0.4
- AC coupled
- Filter characteristics:
  - High pass Filter: -3dB at 10Hz
  - Low pass Filter: -3dB at 4.8kHz
  - Output impedance 100#

Environmental

- HE30 aluminium alloy body, anodised and dyed blue
- Splash resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature 0 to +125°C

Six-Channel AIU

Electrical

- Supply current 60mA @ 12V typ

Mechanical

- Weight less than 45g

Cable and Connection Definition

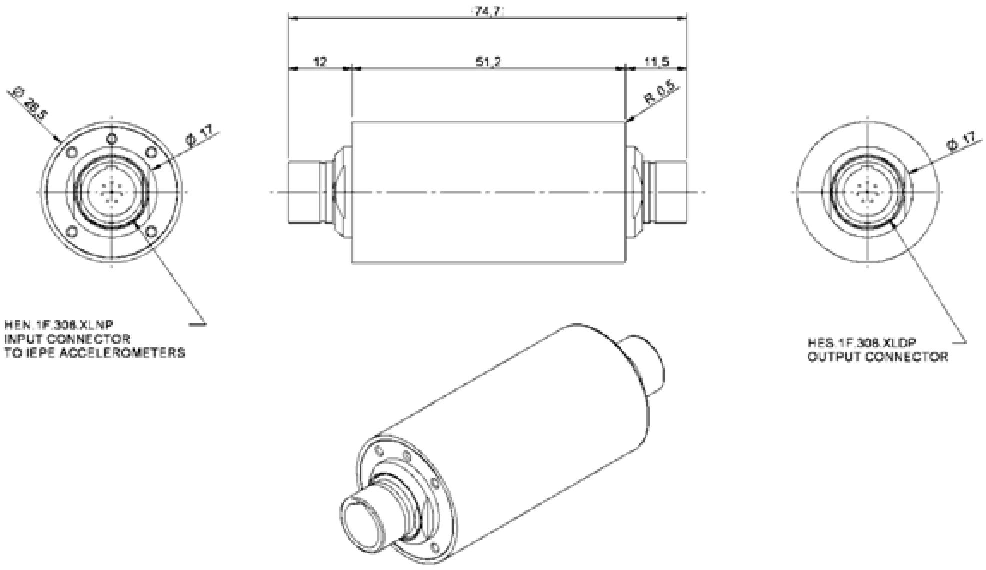
- Output connector: Lemo HES.1F.308.XLDP

Pin 1	Supply
Pin 2	Ground
Pin 3	Output Channel 1
Pin 4	Output Channel 2
Pin 5	Output Channel 3

Pin 6	Output Channel 4
Pin 7	Output Channel 5
Pin 8	Output Channel 6

- Input Connector: Lemo HEN.1F.308.XLNP

Pin 1	Excitation Ground
Pin 2	Excitation Ground
Pin 3	IEPE Channel 1
Pin 4	IEPE Channel 2
Pin 5	IEPE Channel 3
Pin 6	IEPE Channel 4
Pin 7	IEPE Channel 5
Pin 8	IEPE Channel 6



Description	Ordercode
Six-Channel AIU	O 030 345 008 000

Three-Channel AIU

Electrical

- Supply current 37mA @ 12V typ

Mechanical

- Weight less than 35g

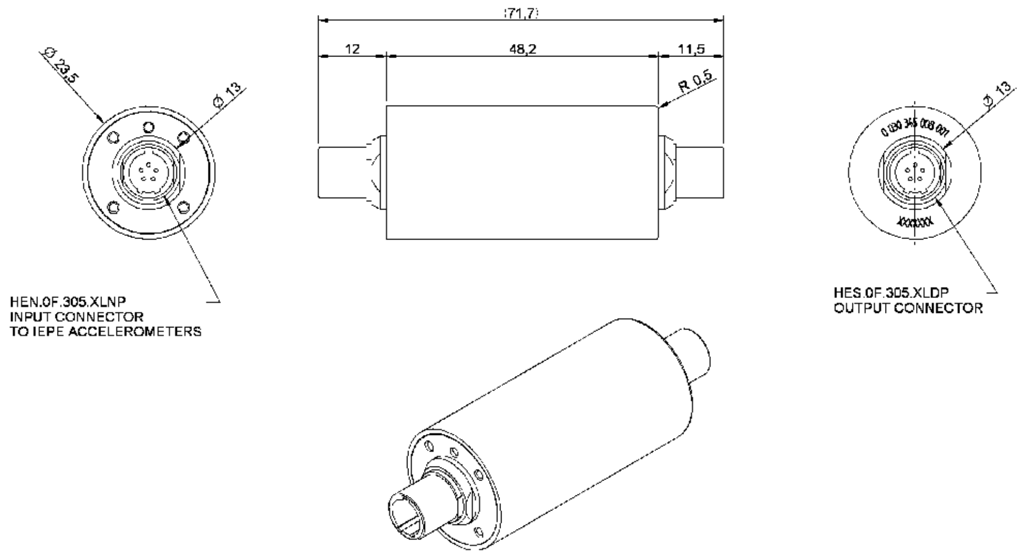
Cable and Connection Definition

- Output connector: Lemo HES.0F.305.XLDP

Pin 1	Supply
Pin 2	Ground
Pin 3	Output Channel 1
Pin 4	Output Channel 2
Pin 5	Output Channel 3

- Input Connector: Lemo HES.0F.305.XLNP

Pin 1	Excitation Ground
Pin 2	Excitation Ground
Pin 3	IEPE Channel 1
Pin 4	IEPE Channel 2
Pin 5	IEPE Channel 3



Description	Ordercode
Three-Channel AIU	O 030 345 008 001

Two-Channel AIU

Electrical

- Supply current 29mA @ 12V typ

Mechanical

- Weight less than 30g

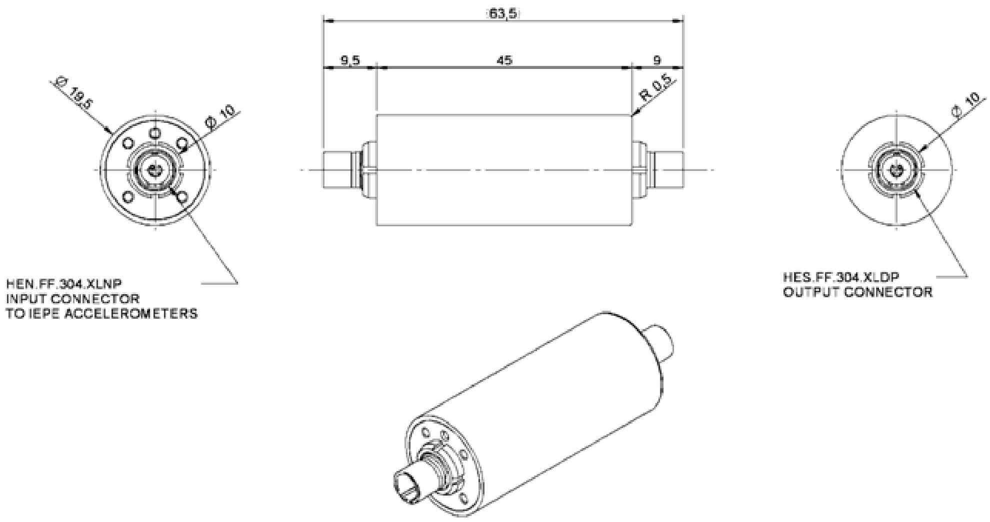
Cable and Connection Definition

- Output connector: Lemo HES.FF.304.XLDP

Pin 1	Supply
Pin 2	Ground
Pin 3	Output Channel 1
Pin 4	Output Channel 2

- Input Connector: Lemo HEN.FF.304.XLNP

Pin 1	Excitation Ground
Pin 2	Excitation Ground
Pin 3	IEPE Channel 1
Pin 4	IEPE Channel 2



Description	Ordercode
Two-Channel AIU	O 030 345 008 002

IEPE - Three-Axis

Electrical

- Excitation voltage 18 to 30 VDC
- Constant current excitation 2 to 20mA
- Output impedance #200ohm
- Output Bias voltage 7 to 11 VDC
- Settling time (within 10% of bias) <3sec

Performance

- Sensitivity: 5mV/g ±20%
- Measurement range: ±1000g
- Frequency range (±5%) Y and Z axis: 2 to 8000Hz
- Frequency range (±5%) X axis: 2 to 5000Hz
- Frequency range (+1dB) X axis: 5000 to 8000Hz
- Broadband resolution 1 to 10000Hz: 0.003g rms
- Non-linearity: #1%
- Transverse sensitivity: #5%

Environmental

- Titanium body
- Operating temperature -50 to +160°C
- Overload limit (shock) ±10000g pk

Mechanical

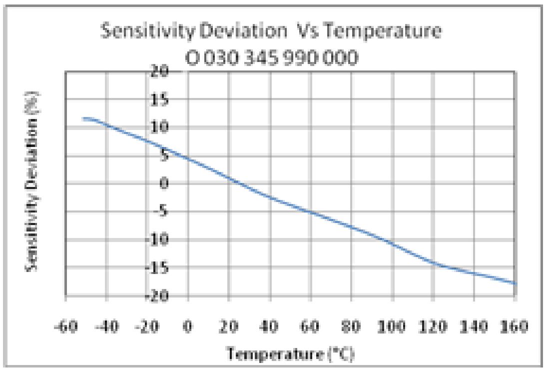
- Weight less than 1g (without cable)

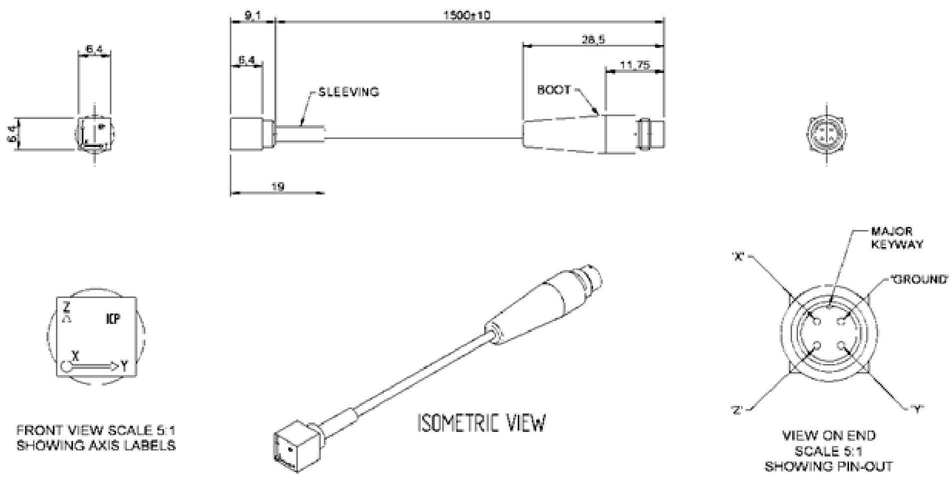
Cable and Connection Definition

- Cable length 1500mm

Interface Harnesses

- Teflon coated cable
- Harness length 1000mm





Description	Ordercode
±1000g three-axis accelerometer	O 030 345 990 000

IEPE - One-Axis

Electrical

- Excitation voltage 18 to 30 VDC
- Constant current excitation 2 to 20mA
- Output impedance #200ohm
- Output Bias voltage 7 to 11 VDC
- Settling time (within 10% of bias) <3sec

Performance

- Sensitivity: 5mV/g ±20%
- Measurement range: ±1000g
- Frequency range (±5%): 2 to 10000Hz
- Frequency range (±10%) 1.5 to 15000Hz
- Frequency range (±3dB) 0.7 to 25000Hz
- Broadband resolution 1 to 10000Hz: 0.003g rms
- Non-linearity: #1%
- Transverse sensitivity: #5%

Environmental

- Aluminium body
- Operating temperature -50 to +120°C
- Overload limit (shock) ±10000g pk

Mechanical

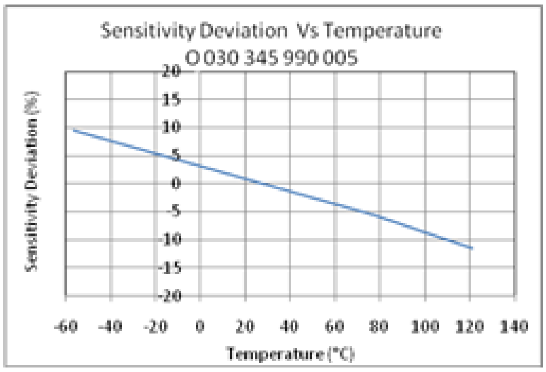
- Weight 0.2g typical

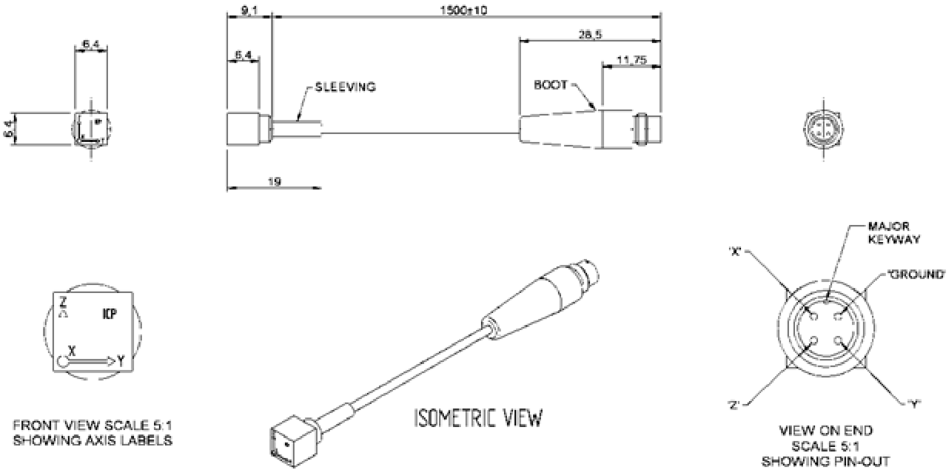
Cable and Connection Definition

- 3-56 Coaxial Jack

Interface Harnesses

- Teflon-coated cable
- Harness length 1000mm





Description	Ordercode
±1000g one-axis accelerometer	O 030 345 990 005

Accessories	Length	Ordercode
AIU6 harness connects two, three-axis accelerometers	1000mm	O 030 345 990 001
AIU6 harness connects six, one-axis accelerometers	1000mm	O 030 345 990 002
AIU3 harness connects one, three-axis accelerometer	1000mm	O 030 345 990 003
AIU2 harness connects two, one-axis accelerometers	1000mm	O 030 345 990 004
AIU3 harness connects three, one-axis accelerometers	1000mm	O 030 345 990 006

Fluid Level

Fluid Level Sensor

The output of the fluid level sensor is a voltage which changes in direct proportion to the level of fluid in the probe. The difference in permittivity between air and the fluid being measured changes the capacitance between the probe's two concentric tubes as the level changes. An RS232 connection to a PC allows the user to calibrate the fluid level and thermal drift compensation. The probe is factory replaceable, allowing the electronics to be re-used should the probe become damaged or if a new probe length is required.

Electrical

- Supply voltage 8 to 16Vdc
- Supply current 30mA max
- Supply reverse polarity protection
- Output Voltage

    0.25 ±0.05V empty
    4.75 ±0.05V full

- Output clamped between 0.1 ±0.05V and 4.9 ±0.05V
- Error condition output 4.95 to 5V
- Output resolution >11-bit
- Output update rate 200Hz
- Independent non-linearity 2%FSO
- Two point level calibration (empty and full) via PC software
- Three point thermal drift compensation (two linear ranges) via PC software

Connection Definition

- 26AWG un-screened cable
- Cable length 1000mm
- Connection

Red wire	Supply
White wire	Signal
Green wire	Ground
Yellow wire	Tx sensor (used for probe calibration only)
Blue wire	Rx sensor (used for probe calibration only)

Mechanical

- Weight examples (including cable)

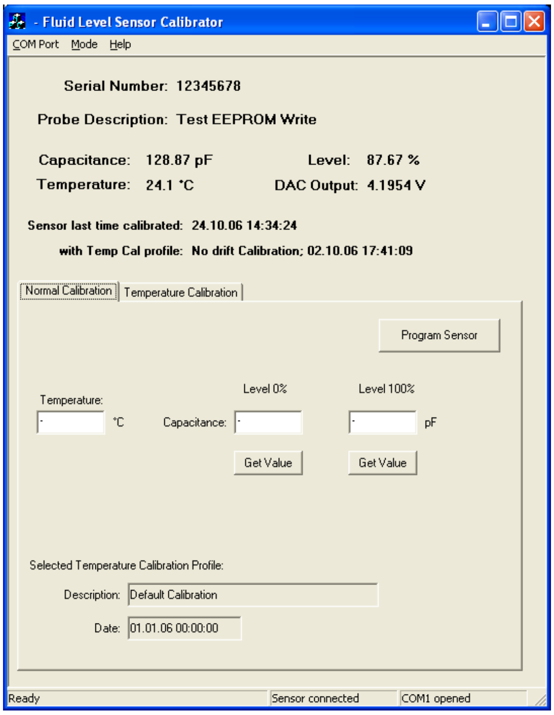
    78g for 100mm measurement range
    126g for 300mm measurement range

- Aluminium alloy sensing head, hard anodised and dyed black
- Factory replaceable titanium alloy probe
- Fluid relative permittivity 1.5 to 3.5 (fuel & oil are typically about 2.2)

Environmental

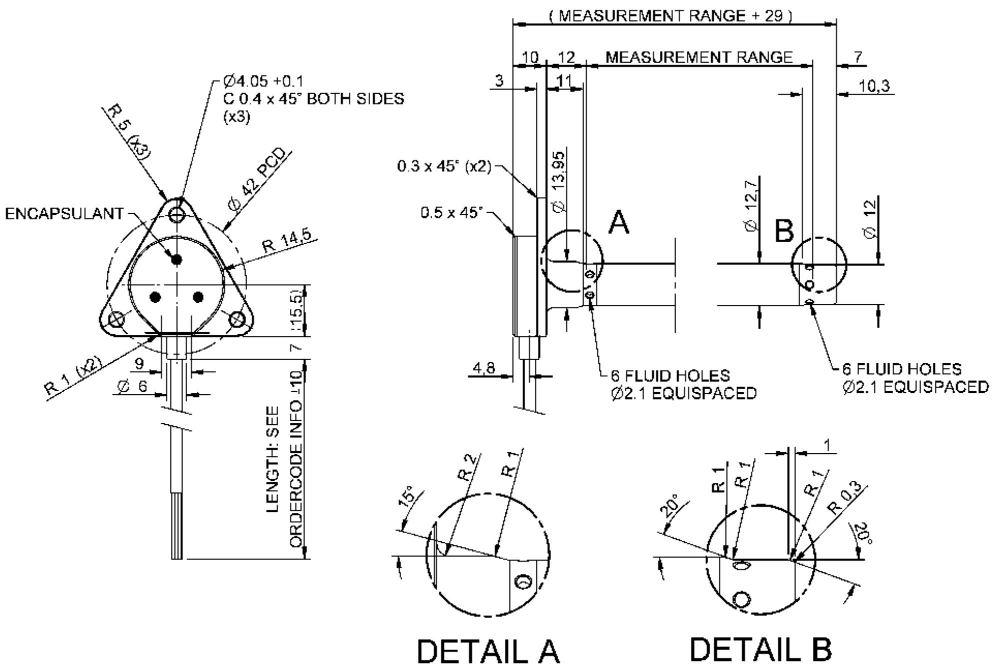
- Maximum humidity 100%
- Viton jacketed cable
- Operating temperature 0 to 150°C
- Vibration 5 to 2000Hz @ 5g, 24 hours per axis
- Shock 50g, ½ sine for 11ms, five times in each axis

Software



Note: Calibration lead O 030 380 990 000 can be ordered separately.

Design and manufacture is in-house so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable lengths, or measurement range. Please contact our technical consultancy service who will be pleased to help.



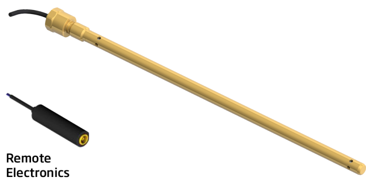
Measurement Range	Ordercode
231mm	O 030 380 001 007

Fluid Level Sensor
with Remote Electronics

The output of the fluid level sensor is a voltage which changes in direct proportion to the level of fluid in the probe. There are no moving parts. The sensor operates by measuring the capacitance between the probe's two concentric tubes. Due to the difference in permittivity between air and the fluid being measured, the capacitance of the probe changes according to the ratio of air and fluid in the probe.

The sensor is calibrated for the particular fluid and measurement range by connection to a PC via RS232. A graphical user interface allows the user to calibrate the sensor by sampling up to 4 calibration points. The GUI also allows the user to apply thermal compensation, up to 4 temperature points.

The electronics can be integrated into the probe head, or remotely mounted where installation temperatures are high.



Electrical

- Supply voltage 8 to 16Vdc
- Supply current <30mA max
- Supply reverse polarity protection
- Configurable output voltage. The recommended voltage settings are:

    0.25 ±0.05V empty
    4.75 ±0.05V full

- Output clamped between 0.1 ±0.05V and 4.9 ±0.05V
- Error condition output 4.95 to 5V
- Output resolution >11-bit
- Output update rate 200Hz
- Independent non-linearity 1%FSO
- Probe length 225mm[1]
- Measurement range 200mm[1]

Mechanical

Probe

- Weight less than 75g (including cable)
- 6AL4V Titanium head, tube and end cap. Electron beam welded assembly.

Remote Electronics

- Weight less than 60g (including cable)
- Aluminium alloy housing hard anodised and dyed black
- Polyester connector carrier cap

Connection Definition

Probe

- Tri-ax cable 200±5mm[1]
- Lemo tri-ax connector (plug)

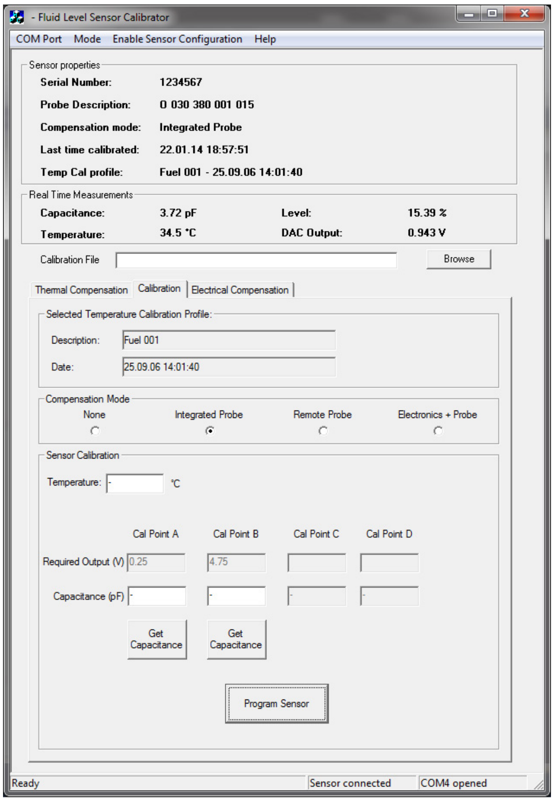
Remote Electronics

- Lemo tri-ax connector (socket) to connect to probe
- 28AWG un-screened cable to connect to Power/Signal/Comms. Cable length 500mm[1]
- Connection:

Wire Colour	Description	Notes
Red	Supply	
White	Supply	
Green	Ground	
Yellow	Tx sensor	Used for probe calibration RS232
Blue	Rx sensor	

Wire Colour	Description	Notes
Black	PT1000+	Used for thermal compensation of fluid, if required
Black	PT1000-	

Software



Environmental

- Maximum humidity 100%

Probe

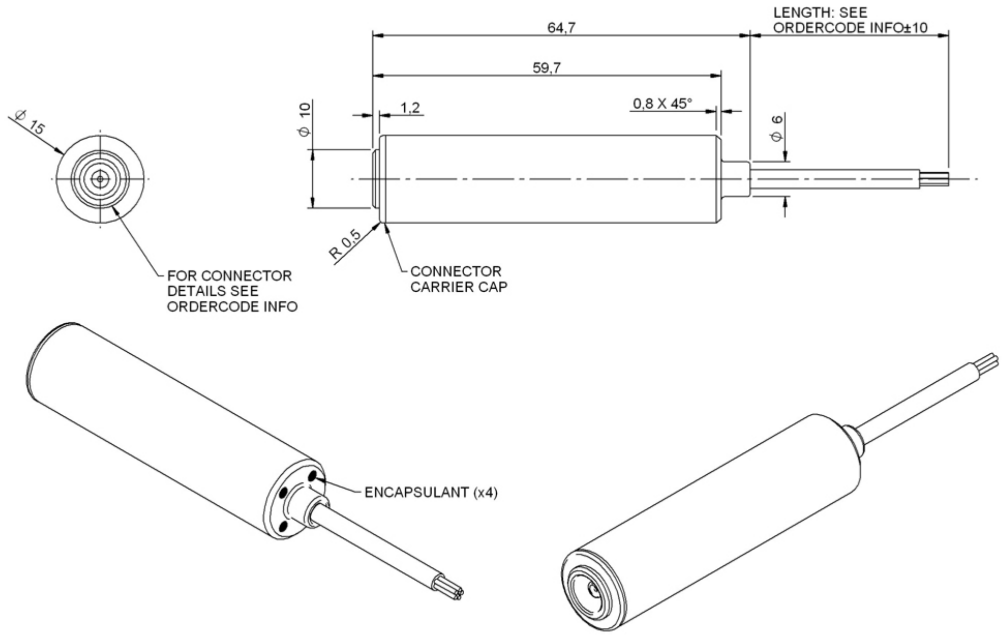
- FEP jacketed cable
- Operating temperature 0 to 175°C
- Vibration 5 to 2000Hz sine sweep @ 5g, 24 hours per axis[2]
- Shock 50g, ½ sine for 11ms, 5 times in each axis[2]
- 6AL4V Titanium head, tube and end cap. Electron beam welded assembly
- Fluid relative permittivity 1.5 to 10

Remote Electronics

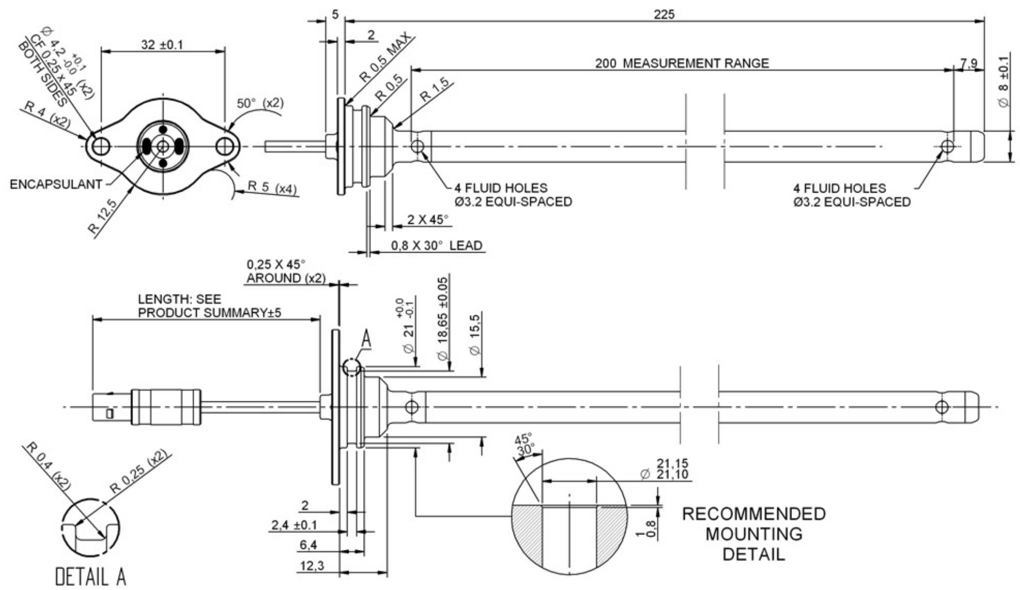
- DR25 jacketed cable
- Operating temperature 0 to 125°C (150°C for short periods of time)
- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Shock 50g, ½ sine for 11ms, 5 times in each axis

[1] If our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable lengths, tip length or measurement range. Please contact our technical consultancy service who will be pleased to help.

[2] It is recommended for probes with tip lengths in excess of 180mm that a point along the lower half of the probe is A/V mounted to protect the part from vibration



Description	Cable Length	Ordercode
Fluid Level Sensor Remote Electronics	500mm	O 030 380 001 012



Description	Tip Length	Measurement Range	Cable Length	Ordercode
Fluid Level Probe	225mm	200mm	200mm	O 030 380 001 016

Gyros

Gyro
1-Axis

Designed to provide high performance operation under harsh operating conditions, the single axis gyro accurately measures angular motion is a compact, lightweight, robust package.

Application

Precision chassis development.

Electrical

- Supply voltage 8 to 16V unregulated
- Reverse Polarity protection
- Supply current 35mA @ 12V
- Start-up supply current 75mA (0-500ms)
- Full scale rate ±300°/s[1]
- Output scale factor 6.67mV/°/s nominal
- Scale factor variation over operating temperature range ±1.40%
- Bias at Zero Angular Velocity 2.50V nominal
- Bias variation over operating temperature range ±30mV (=±4.5°/s), with respect to Signal Ground
- Bias variation over operating temperature range ±40mV (=±6.0°/s), with respect to Power Ground (1000mm long 26AWG Power Ground wire).
- Non linearity ±0.2%FS
- Offset error stability over temperature and life ±10mV (=±1.5°/s)
- Scale factor error stability ±0.7% of FS
- Bias error due to g sensitivity ±0.1°/s/g (0±30g range)
- Sensitivity to cross axis rotation <2% of rate
- Bandwidth 90Hz[2]
- Noise <175 uV#Hz
- Output impedance TBA

Clockwise rotation, when viewed looking down on the face marked ‘top’, will increase the output voltage, as shown in the outline drawing.

[1] Rates available are 300°/s and 75°/s

[2] Bandwidth can be lowered if required. Bandwidth available for the 75°/s rate is 75Hz.

Cable and Connection Definition

- 26 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection

Red wire	Pin A	Pin 1	Supply
White wire	Pin B	Pin 2	Signal
Green wire	Pin C	Pin 3	Power Ground
Blue wire	Pin D	Pin 4	Signal Ground (optional)
Yellow wire	-	-	Filler (only if Signal Ground wire required)

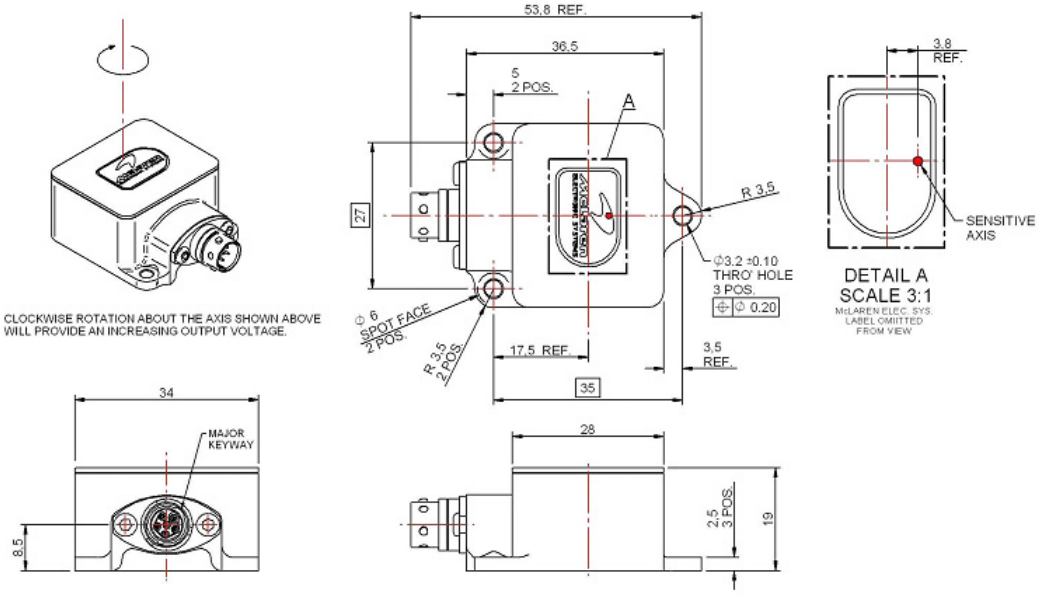
Mechanical

- Weight less than TBAg (including cable)

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Vibration 20Hz to 2kHz @ 8.5g rms
- Shock ½ sine approx, 95g, 1ms
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature 0 to +105°C
- Storage temperature -50 to +110°C
- Aluminium alloy body and lid, hard anodised and dyed black
- Viton jacketed cable



Cable Length	Ordercode
1000mm	O 030 375 000 016

Gyro
3-Axis

Designed to provide high performance operation under harsh operating conditions, the tri-axis gyro accurately measures angular motion in a compact, lightweight, robust package.

Application

- Precision chassis development.

Electrical

- Supply voltage 8 to 16V unregulated
- Reverse Polarity protection
- Supply current 105mA @ 12V
- Start-up supply current 225mA (0-500ms)
- Full scale rate ±300°/s[1]
- Output scale factor 6.67mV/°/s nominal
- Scale factor variation over operating temperature range ±1.40%
- Bias at Zero Angular Velocity 2.50V nominal
- Bias variation over operating temperature range ±30mV (=±4.5°/s), with respect to Signal Ground
- Non linearity ±0.2%FS
- Offset error stability over temperature and life ±10mV (=±1.5°/s)
- Scale factor error stability ±0.7% of FS
- Bias error due to g sensitivity ±0.1°/s/g (0±30g range)
- Sensitivity to cross axis rotation <2% of rate
- 8 pole 60HzBUtterworth filter[2]
- Noise <175 uV#Hz
- Output impedance 50#
- PT1000 temperature output

Clockwise rotation about the axis identified in the drawing, will increase the output voltage, as shown in the outline drawing.

[1]Rates available are 300°/s and 75°/s

[2]Two pole filter available upon request. -3dB point adjustable up to 90Hz.

Connection Definition

- ASDD206-09-PN
- Connection:

Pin 1	Supply
Pin 2	Power Ground
Pin 3	Z axis signal
Pin 4	Signal Ground
Pin 5	PT1000 oupput
Pin 6	PT1000 oupput
Pin 7	X axis signal
Pin 8	Y axis signal

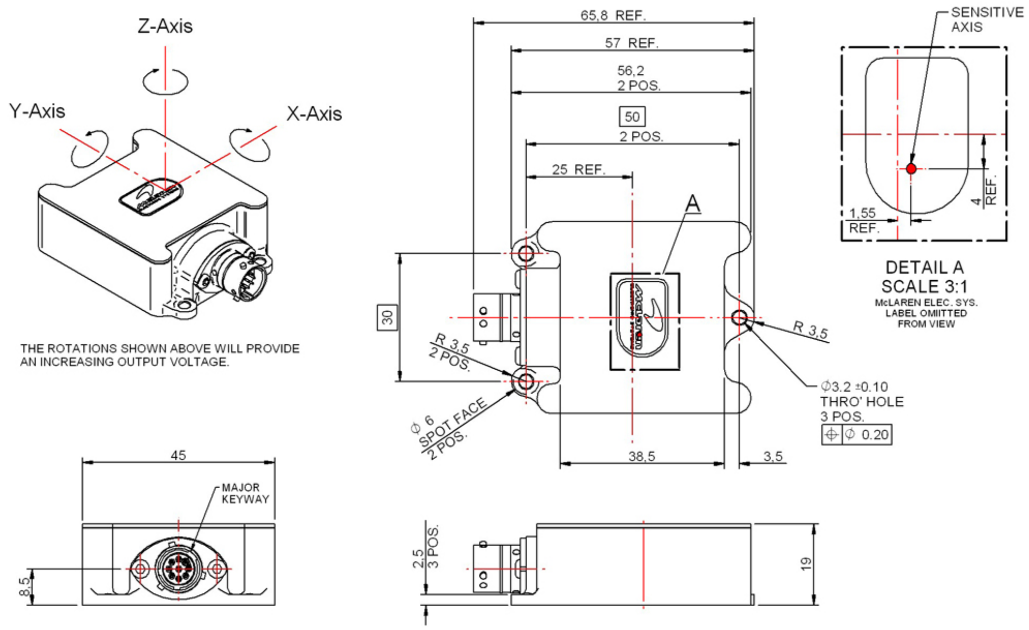
Mechanical

- Weight less than 70g (including cable)

Environmental

- Vibration 20Hz to 2kHz @ 8.5g rms
- Shock ½ sine approx, 50g, 1ms
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature 0 to +105°C
- Aluminium alloy body and lid, hard anodised and dyed black

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.



Connector	Ordercode
ASDD206-09-PN-HE	O 030 375 001 007

Humidity

Humidity Probe

The module contains a humidity sensor with an integral temperature sensor. The humidity is measured using capacitive sensing technology.

Application

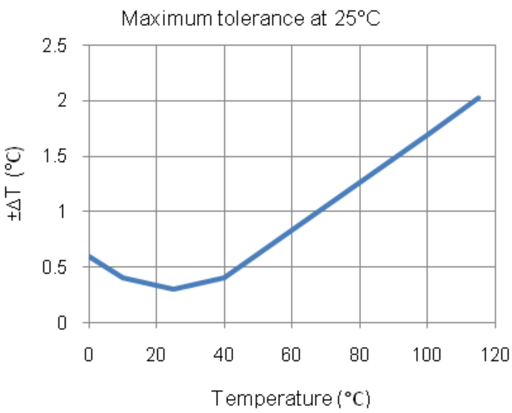
- Humidity measurement

Electrical

- Supply voltage 8 to 16V unregulated
- Supply current 25mA max

Temperature

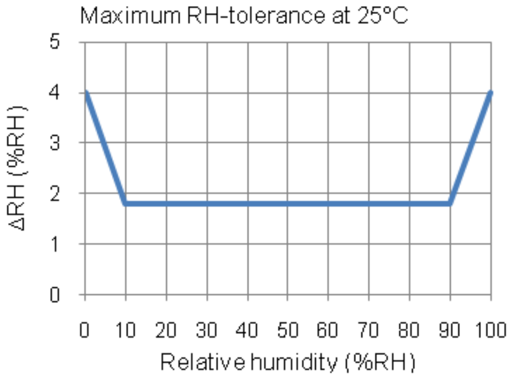
- Resolution: 12bit
- Update rate: 0.5Hz max
- Accuracy:



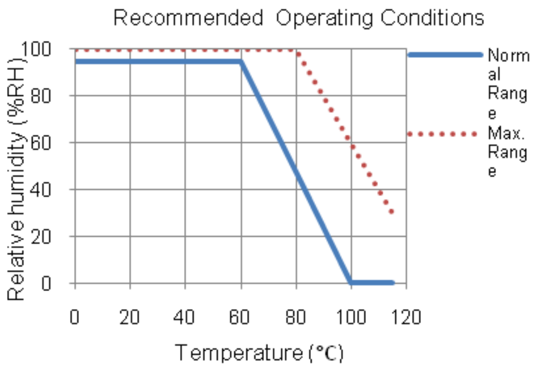
- Measurement range -40ºC to 123.8°C
- Repeatability ±0.1°C typical
- Long term drift < 0.04°C/year
- Response time: 5 to 30s for a 63% step function
- Output 0.25V for -40°C, 4.75V for 123.8°C

Humidity

- Operating range 0 to 100%RH
- Resolution: 12bit
- Update rate: 0.5Hz max
- Output 0.25V for 0%RH, 4.75V for 100%RH
- Accuracy:



- Repeatability ±0.1%RH typical
- Hysteresis ±1%RH typical
- Non linearity ±1%RH typical
- Response time[1] 8s typical
- Long term drift <0.5%RH/year
- Recommended operating conditions: [2]



[1]Time for reaching 63% of a step function valid at 25ºC and 1m/s airflow

[2]A temporary offset may occur if element is directly in contact with moisture.

Mechanical

- Aluminium alloy body, hard anodised and dyed black
- Weight <100g
- Polyester cable boss
- Nose length: shown in order code details – other probe lengths available

Environmental

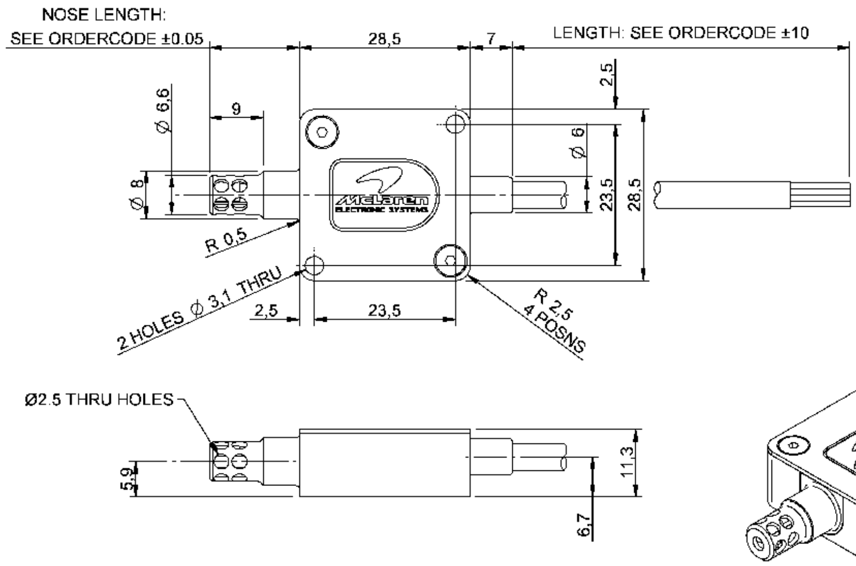
- Body resistant to standard Motorsport fluids
- Maximum humidity 100%
- Operating temperature range 0 to +115°C
- Viton jacketed cable (200°C)
- Humidity sensor may take an offset if exposed to high concentrations of chemical vapours

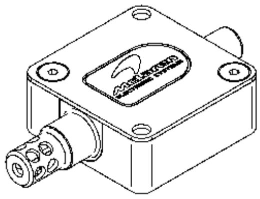
Cable and Connection Definition

- 26AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection

Red wire	Supply
Green wire	Ground
Yellow wire	Humidity output
White wire	Temperature output
Blue wire	N/C

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.





Cable Length	Nose Length	Ordercode
1000mm	15mm	O 030 315 001 000

Lambda

Lambda Measurement
LSU-310

The LSU-310 Lambda Measurement Unit is a dual channel interface for Bosch LSU4.9 Lambda probes. Versions for other types of wideband probes can also be configured, upon request. The Lambda value of each sensor is output as an analogue voltage in the 0 to 5 volt range.

Probe calibration must be stored in the host unit.

The interface does not include Lambda heater control which must be provided external to the unit, where used.

Application

- Wide-band Lambda measurement for ECUs which do not have wide-band Lambda inputs

Electrical

- Supply Voltage 10V to 16V DC
- Transzorb protection allowing short term operation with supply voltage above 16V. Sustained operation above 17.1V may cause damage to the unit
- Reverse voltage protection
- Supply Current 60mA typical (110mA max)

Mechanical

- Case material Aluminium alloy, hard black anodised
- Weight less than 34g

Electro Magnetic Compatibility

- Complies with the essential protection requirements of 89/336/EEC

Environmental

- Splash resistant to standard motorsport fluids
- Lids and screws sealed with silicone rubber
- Unit is splash-proof but should not be immersed in water
- Maximum humidity 100%
- Operating Temperature 0°C to 60°C ambient
- Storage temperature -10 to 85°C
- Vibration 100 to 1000Hz, all axes, 12 hours, random spectrum

Connection Definition

- Integral, sealed, military standard connector HES.2F.319.XDLP

Pin 1	Lambda 1 IP
Pin 2	Lambda 1 VM
Pin 3	Lambda 1 analog output
Pin 4	Output 1 + 2 reference ground output
Pin 5	Lambda 2 analog output
Pin 6	Lambda 2 VM
Pin 7	Lambda 2 UN
Pin 8	Lambda 2 IP
Pin 9	Supply input 14V
Pin 10	Ground
Pin 12	Lambda 1 UN (black)
Pins 11, 13 to 19	NC

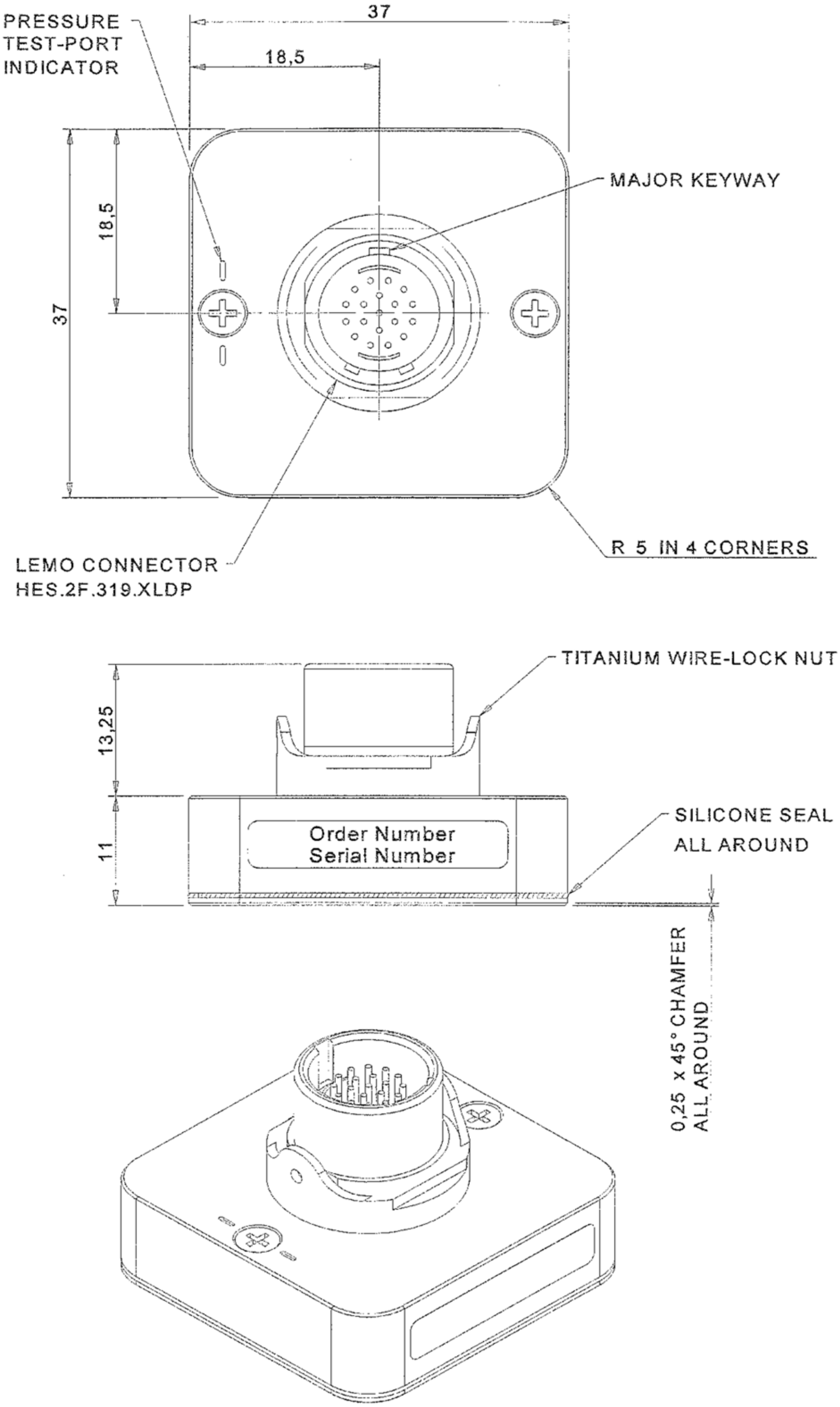
- LUS4.9 green wire (IS) not used

Sensor Inputs

- Two wideband Lambda sensors 0.65# to air

Analogue Outputs

- Two Lambda value analogue outputs 0.164V to 4.686V (0.65# to air)
- Output voltage of 2.25V nominal at #=1.0



Description	Ordercode
LSU-310	O 030 016 010 001

Lambda Sensor

Universal Exhaust Gas Oxygen (UEGO)

The Universal Exhaust Gas Oxygen (UEGO) sensor can measure a wide range of air/fuel mixtures. The sensor is based on ZrO2 cells, held at an elevated temperature by an internal heater element. A current pumps oxygen between the sensing cavity and the exhaust to maintain a constant reference cell oxygen concentration. The measured value of this pumping current corresponds to the air/fuel ratio. Please request our installation datasheet for further details.

Application

- Closed loop, optimised injection based on accurate AFR measurement.

Electrical

- Range 10 to 30AFR (lambda 0.69 to 2.06). Air fuel ratio (AFR) is based on propane Stoichiometric mixture which is 14.57
- Typical accuracy with software correction (Propane fuel, Gas temperature 450°C)

AFR 14.57	±0.005
AFR between 12 & 18	±0.1
AFR <12 or >18	±0.25

- Accuracy without software correction

AFR 14.57	±0.005
AFR between 12 & 18	±0.69
AFR <12 or >18	<±2.3

- Warm up time 30s in air with no gas flow
- Response time (to reach 50% of final value after a step change) 330ms typ.
- Thermal shift <±0.6AFR/100K change in tip temp.
- Ageing shift after 500hrs cycling between 300 & 800°C, 12 to 18AFR

AFR 14.57	±0.01
AFR between 12 & 18	±0.25
AFR <12 or >18	±0.40

- Pumping current must be kept within ±10mA
- Cell supply voltage 450±10mV
- Heater supply voltage 10.5±0.5V
- Heater resistance 2.7 to 3.3 ohm @ 25°C, 9.0 ohm @ 800°C
- Insulation resistance >1Mohm at 100V

Mechanical

- Stainless steel body
- Maximum mounting torque 45Nm
- Weight less than 120g (including cable)

Cable and Connection Definition

- 20 AWG un-screened cable
- Cable length is shown on the order details but any length up to 1050mm is available on request
- Various automotive and military standard connectors are available
- Standard Connection

Orange wire	Pin A	Heater supply +
Yellow wire	Pin B	Heater supply -
White wire	Pin C	Pumping current +
Black wire	Pin D	Pumping current –

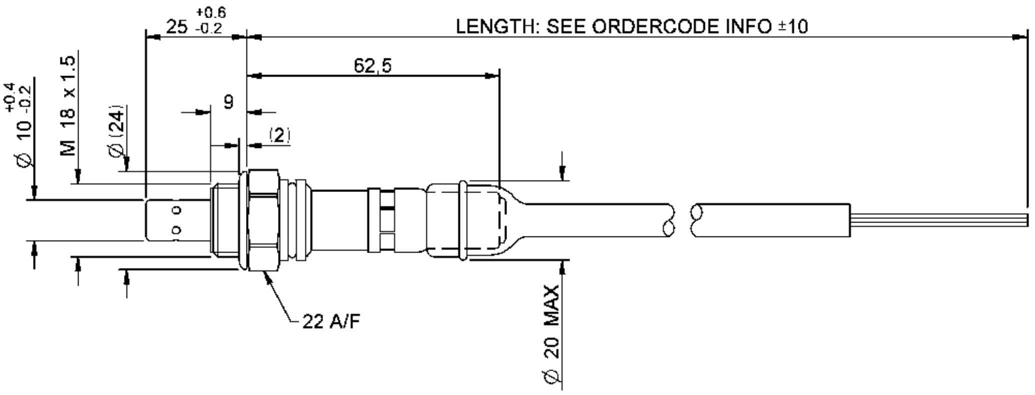
Red wire	Pin E	Cell supply +

Environmental

- Calibration interval 500hrs
- Resistant to standard motorsport fluids
- Average humidity 5 to 10% absolute volume
- Gas temperature 25 to 800°C
- Operating temperature (the heater must be operating correctly to ensure accurate readings)

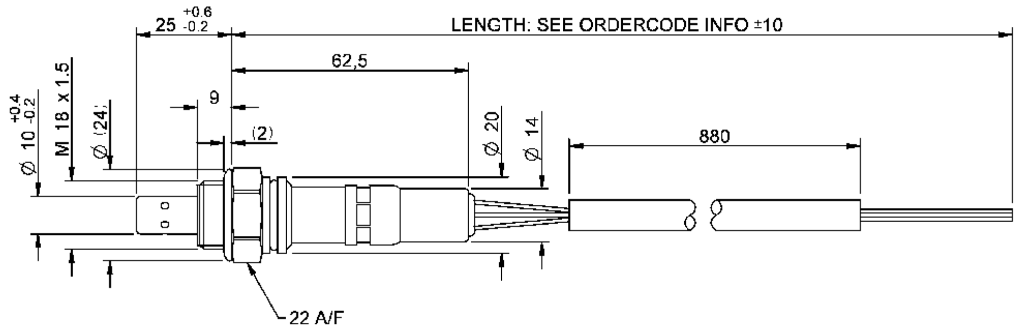
Sensor tip	700 to 900°C
Body at mounting hex	<550°C
Body at cable outlet	<200°C

- Rate of temperature change must not exceed 50K/s
- Temperature shocks must be avoided
- Cable jacket material shown on the order details
- Vibration 200Hz @ 20g 10hrs



Cable Length	Sleeve	Ordercode
430mm	Viton and Nomex	O 030 360 000 009
430mm	Viton only	O 030 360 000 010
430mm	Nomex only	O 030 360 000 012

Soft Washer	Ordercode
Soft washer	O 030 360 990 000



Cable Length	Sleeve	Ordercode
1050mm	Glass fibre (no boot)	O 030 360 000 004

Accessories	Ordercode
Soft washer	O 030 360 990 000

Position (Angular)

Rotary Hall Sensor
Micro

The output of the Micro Rotary Hall-effect sensor is a voltage which changes in direct proportion to the shaft angle. The sensor is non-contact, using Hall elements to determine the angle of a magnet. The magnet is either mounted in a shaft integral to the sensor or can be mounted externally to the sensor. An integral shield is available to reduce interference from nearby ferrous objects and stray magnet fields. Supply voltage is either 5.00V ratiometric or 9..13V. Angular ranges up to 360° and output ranges between 0.2 and 4.8V are available.

Electrical

- Supply Voltage 5.0±0.5V d.c. ratiometric or 9..13V d.c.
- Overvoltage protection 20V
- Reverse polarity protection -10V for 5V supply, -20V for 9..13V supply
- Supply current 16mA max per channel
- Output current 8mA max
- Output load >10kOhm recommended
- Start up cycle 15ms
- Angular range 360° (unless otherwise stated)
- Output voltage 0.2 to 4.8V (unless otherwise stated)
- Independent non-linearity 1.0% FSO max
- Thermal drift
  - 0.3%FSO max (20..150°C) for 5V supply
  - 0.5%FSO max (20..150°C) for 9..13V supply
- Half-voltage position tolerance ±2° max
- Sampling rate 200µs (5kHz)
- Resolution <0.1°
- Shaft rotation direction for a rising or falling output is shown on drawing
- Shaft orientation for half-voltage position is shown on drawing

Cable and Connection Definition

- 55-spec 26AWG unscreened cable
- Cable length 1000mm
- Connection

Red Wire	Supply A
White Wire	Signal A
Blue Wire	Ground A
Orange Wire[1]	Supply B
Yellow Wire[1]	Signal B
Green Wire[1]	Ground B

[1]For two-channel sensors.

Mechanical

- Weight less than 20g (excluding cable)
- Aluminium alloy body, hard anodised and dyed black
- Stainless steel shaft (where fitted)
- Internal shield to prevent interference from stray magnetic fields or nearby ferrous objects (where fitted)
- Polyester cable boss for strain relief to the sensor body

Environmental

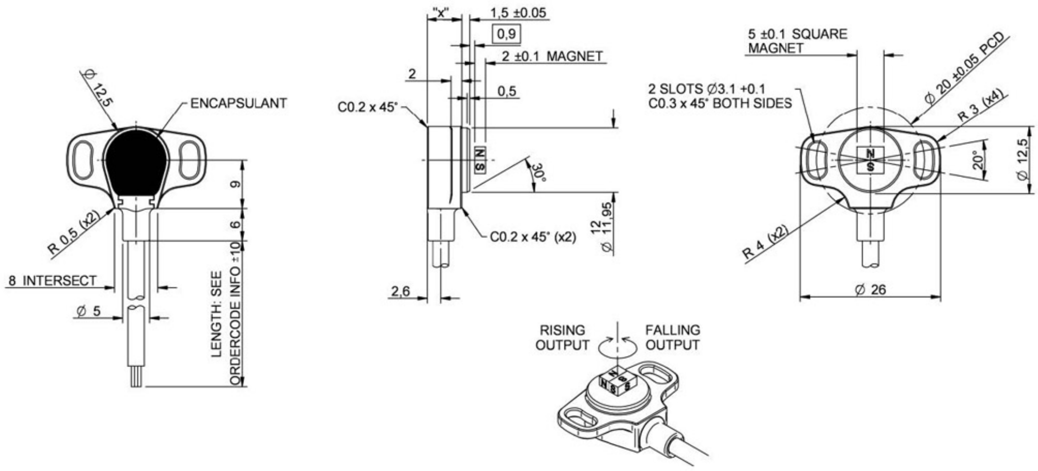
- Resistant to standard motorsport fluids

- Maximum humidity 100%
- DR25 jacketed cable
- Operating temperature -40 to +150°C
- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Shock 50g ½ sine 11ms, 10 times per axis

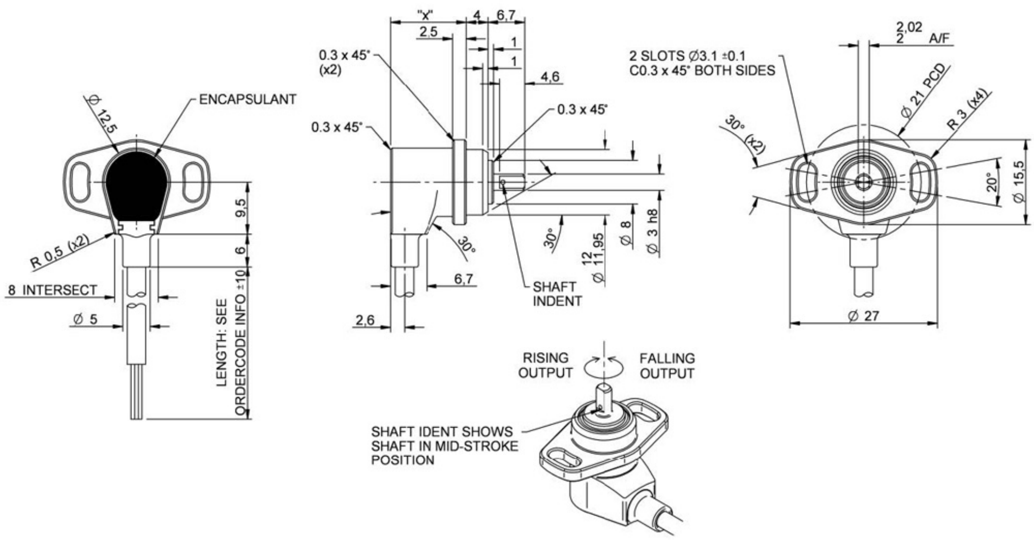
Notes

Stray magnetic fields (>0.1mT) or nearby ferrous objects (<20mm away) may affect the output on sensors without an integral shield.

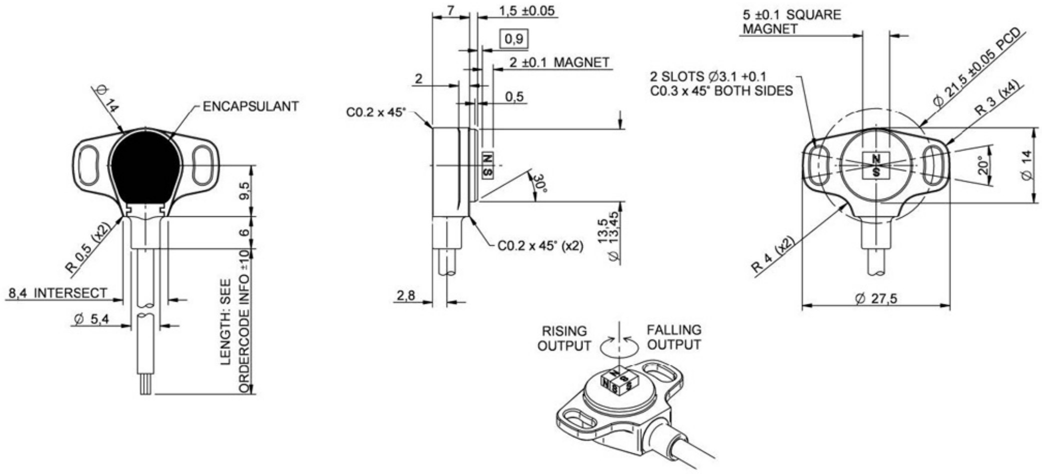
Design and manufacture is in-house, so if our existing designs do not suit your application we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable lengths or angular range. Please contact our technical consultancy service who will be pleased to help.



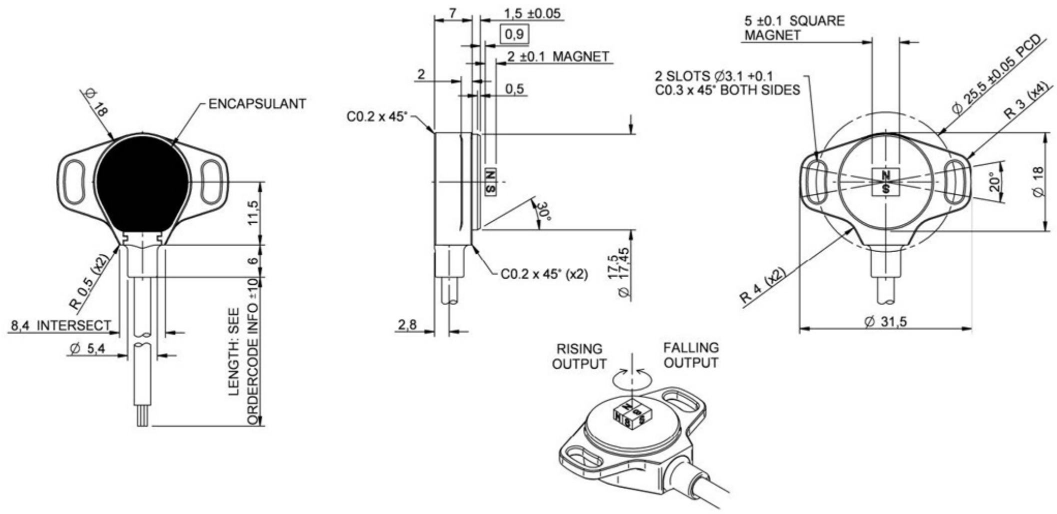
Number of Channels	Supply	Dim X	Ordercode
One	5V	6.5mm	O 030 370 021 001
One	9..13V	10.55mm	O 030 370 021 003



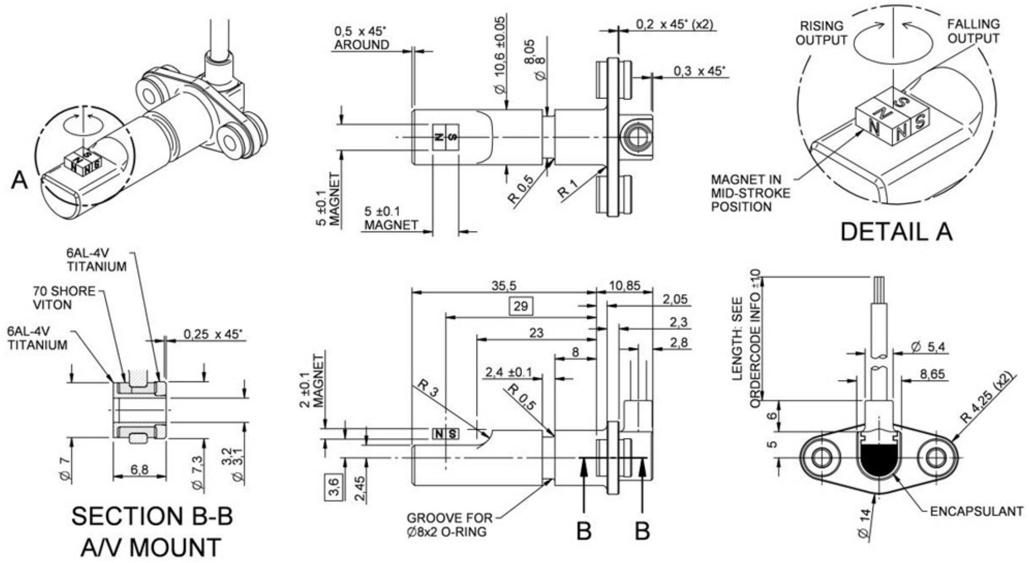
Number of Channels	Supply	Dim X	Ordercode
One	5V	14mm	O 030 370 021 006
One	9..13V	18mm	O 030 370 021 017



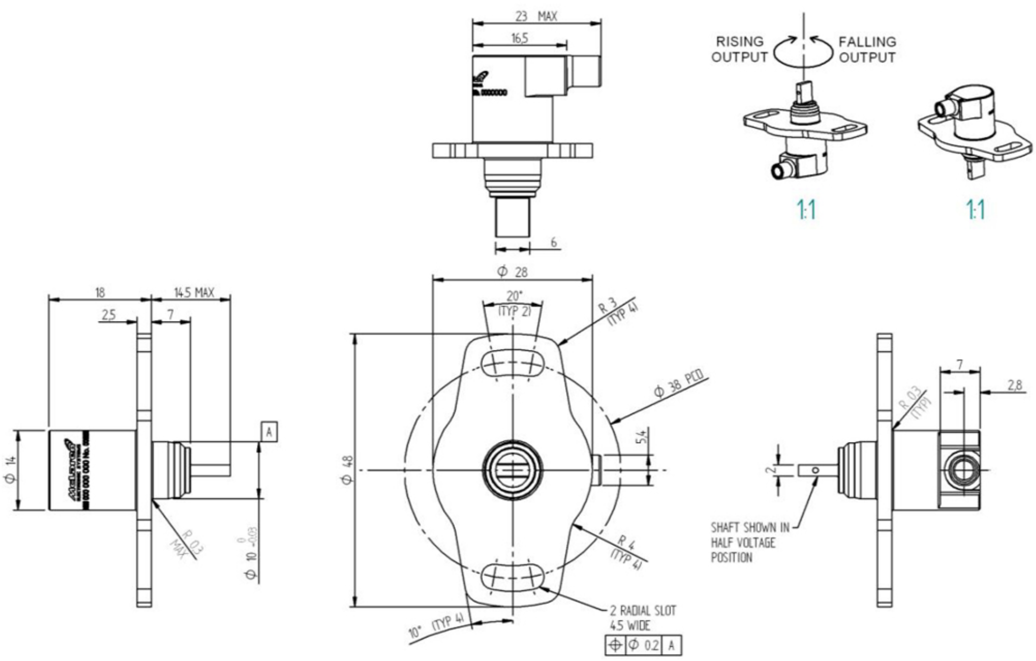
Number of Channels	Supply	Ordercode
Two	5V	O 030 370 021 002



Number of Channels	Supply	Ordercode
Two	9..13V	O 030 370 021 004



Number of Channels	Supply	Ordercode
Two	5V	O 030 370 021 018



Electrical Angle	Number of Channels	Supply	Ordercode
120°	Two	5V	O 030 370 021 056

Accessories	Ordercode
Spare Magnet	O 030 370 990 001

Rotary Potentiometer
Micro (14.3mm diameter)

The output of a rotary potentiometer is a voltage which changes in direct proportion to the shaft angle. A constant voltage is required across the supply and ground wires of the sensor. No internal end stops are fitted, so continuous rotation is possible. Various lengths of electrically active track are available, up to a maximum of 300°. The unit is fully sealed against the ingress of fluids.

Application
- Throttle position, steering wheel angle, gear drum position, accelerator pedal position, clutch pedal/paddle position.

Electrical
- Electrical angle is shown in the order details
- Nominal track resistance 5kohm ±20%
- Nominal resistance temperature coefficient ±400ppm/°C
- Typical wiper current 5µA
- Non-linearity (measured over the central 95% of the electrical angle into an infinite impedance load) ±1%FS typ, ±1.5%FS max
- Insulation resistance >100Mohm @ 500Vdc
- Half voltage position tolerance ±3° typ, ±4.5° max

Viewed from the end of the shaft, clockwise rotation increases the resistance between supply and signal

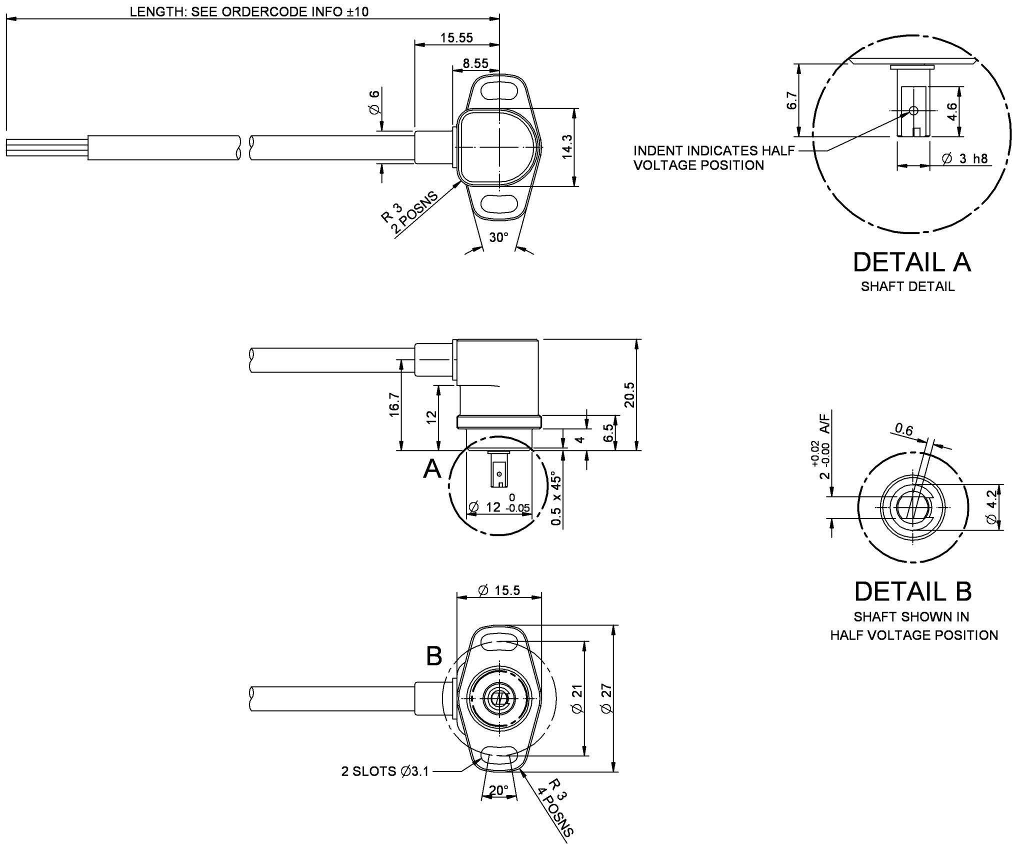
Cable and Connection Definition
- 24 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection

White Wire	Supply
Green Wire	Ground
Red Wire	Signal

Mechanical
- Body Aluminium alloy, anodised and dyed black
- Shaft Stainless Steel
- Shaft seal o-ring
- Maximum operational speed 500rpm
- Minimum rotational life 5 million cycles (over electrical angle), 10,000 cycles (outside electrical angle)
- Weight less than 40g (including cable)
- Polyester cable boss for strain relief to the sensor body

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Electrical angles other than 130° or 300° may be liable to a Non-Recurring Engineering (NRE) charge. Please contact our technical consultancy service who will be pleased to help.

Environmental
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -10 to +150°C
- Viton jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis



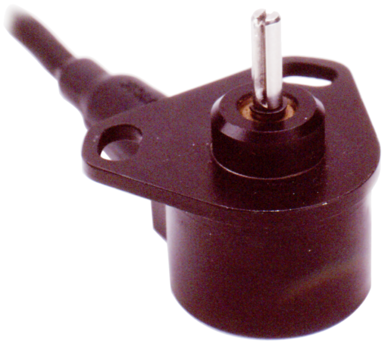
Cable Length	Electrical Angle	Ordercode
1000mm	130 ± 6°	O 030 370 013 005
1000mm	300 ± 3°	O 030 370 013 006

Rotary Potentiometer

Mini (22.5mm diameter)

The output of a rotary potentiometer is a voltage which changes in direct proportion to the shaft angle. A constant voltage is required across the supply and ground wires of the sensor. No internal end stops are fitted, so continuous rotation is possible. The sensors are fully sealed against the ingress of fluids. Various lengths of electrically active track are available, up to a maximum of 348°.

Please request our installation datasheet for further details.



Application

- Throttle position, steering wheel angle, gear drum position, accelerator pedal position, clutch pedal/paddle position.

Electrical

- Nominal track resistance 5kohm ±20%
- Nominal resistance temperature coefficient ±20ppm/°C
- Typical wiper current 5µA
- Non-linearity (measured over the central 90% of the electrical angle) ±0.4%FS typ, ±0.7%FS max
- Insulation resistance >10Gohm @ 500Vdc
- Track length tolerance ±3°
- Half voltage position tolerance ±2° typ, ±4° max

Viewed from the end of the shaft, rotating the shaft in the clockwise direction increases the resistance between supply and signal.

Cable and Connection Definition

- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection

White Wire	Pin A	Pin 1	Supply
Red Wire	Pin B	Pin 2	Signal
Green Wire	Pin C	Pin 3	Ground

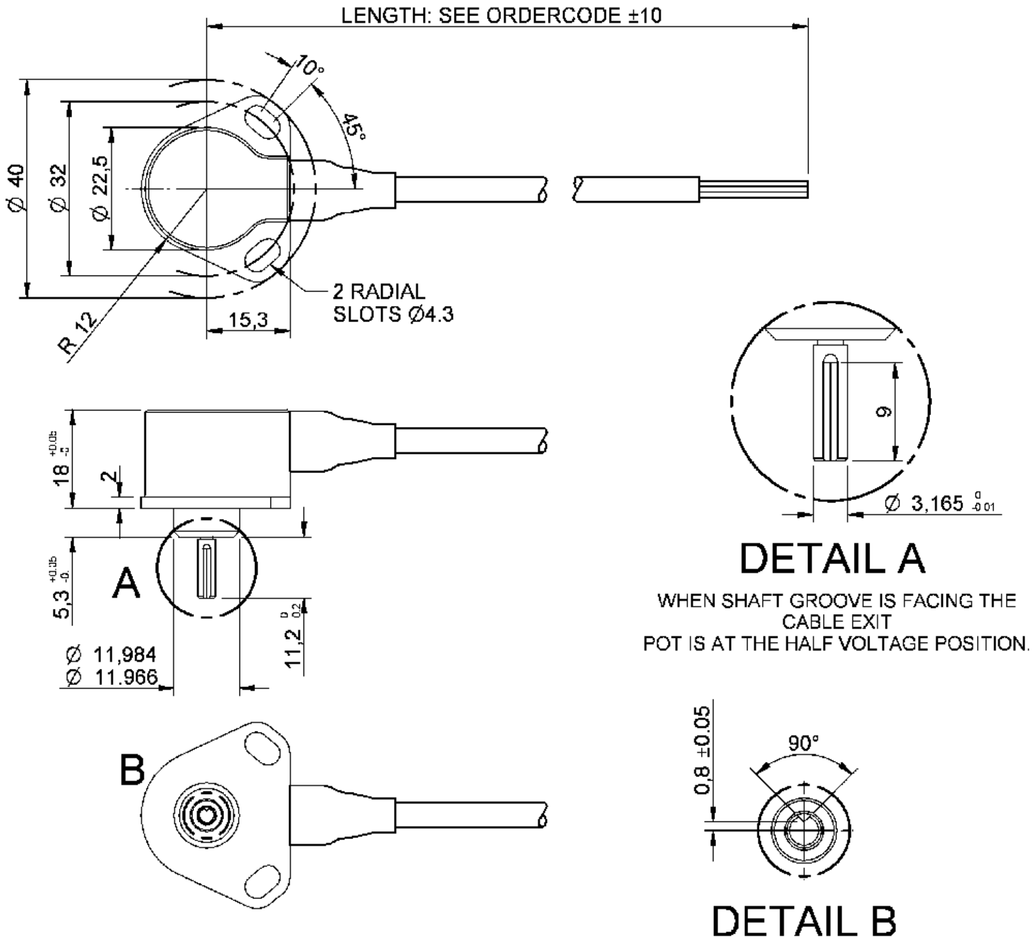
Mechanical

- O-ring shaft seal
- Body aluminium alloy, anodised and dyed black
- Maximum operational speed 120rpm
- Minimum rotational life 100 million cycles
- Weight less than 50g (including cable, where fitted)
- Elastomer boot for strain relief to the sensor body (if cable is fitted)

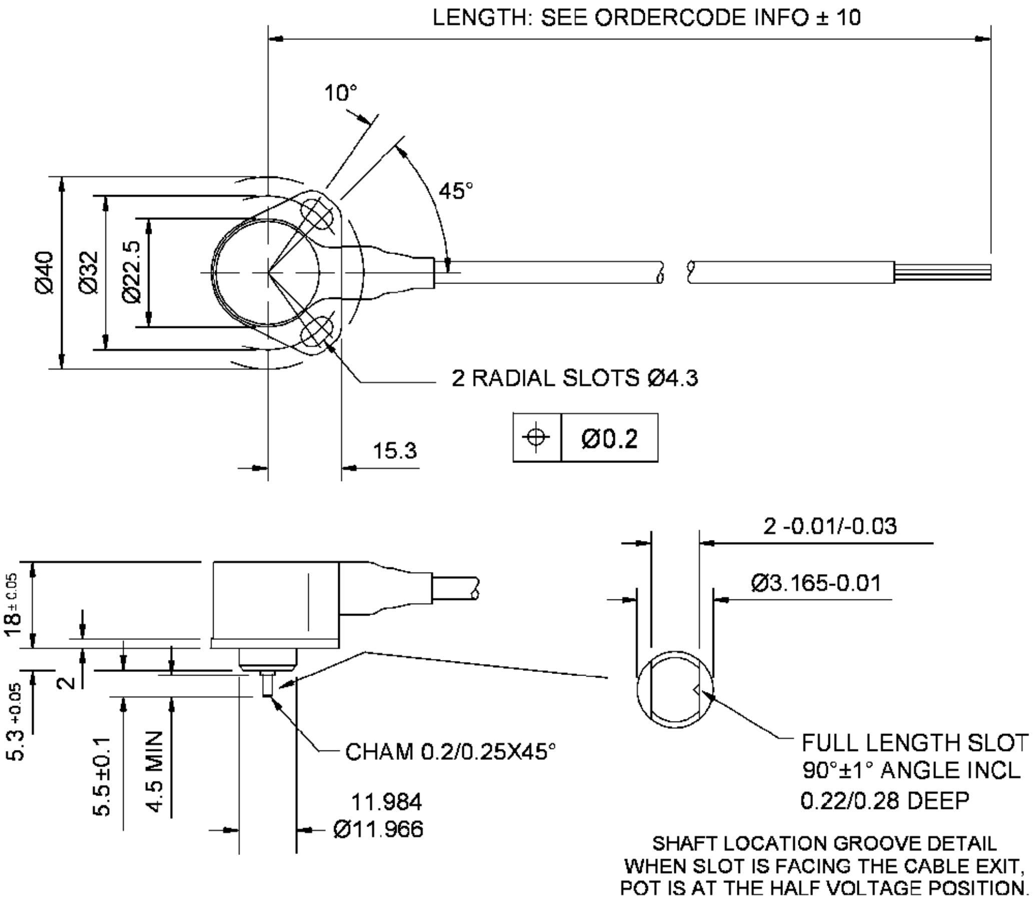
Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Vibration 50Hz to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Viton jacketed cable
- Operating temperature -10 to +150°C



Cable Length	Electrical Angle	Ordercode
1000mm	97.5°	O 030 370 009 008
1000mm	130°	O 030 370 009 002
1000mm	348°	O 030 370 009 042



Cable Length	Electrical Angle	Ordercode
1000mm	97.5°	O 030 370 009 022
1000mm	130°	O 030 370 009 021
1000mm	348°	O 030 370 009 035

Sensors

Position (Linear)

Linear Non-Contact Hall Effect Sensor
Standard (40mm Stroke)

The output of a linear hall sensor is a voltage which changes in proportion to the shaft extension. A constant voltage is required across the supply and ground wires of the sensor. The sensor consists of a Hall Effect element, and a shaft which houses a magnet. When the magnet moves within the sensor, the change in magnetic field changes the output voltage. The gain, offset and thermal drift of each channel is digitally compensated to minimise errors. The gain, offset and compensated temperature range can be modified electronically at the factory. The shaft is sealed to keep out dirt and dust but is not captive in the sensor body.

Various stroke lengths are available, up to a maximum of 40mm.

Sensors

Application

- Clutch and gear selector drum position.

Electrical

- Electrical stroke as specified in the order details
- Maximum Electrical stroke 40mm (for linear output)
- Supply current 10mA (max)
- Output is proportional to supply voltage. The following values assume a precision 5.0V supply:
- Zero offset (shaft within housing) 0.5±0.05V (@25°C)
- Full Scale output (shaft extended) 4.5±0.05V (@25°C)
- Supply voltage not to exceed 8.5V
- Independent non-linearity ±1% typ, ±2% max
- Thermal shift[1] <±0.05%FS/K
- Insulation resistance >100Mohm @ 500Vdc
- Hysteresis due to magnet/shaft rotation ±4% FS typ
- The output decreases as the shaft enters the housing (this can be reversed – please contact our technical consultancy service if this is of interest).

[1]Over compensated temperature range

Cable and Connection Definition

- 24 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

Red Wire	Pin A	Pin 1	Supply
White Wire	Pin B	Pin 2	Ground
Green Wire	Pin C	Pin 3	Signal

Mechanical

- Body aluminium alloy, hard anodised and dyed black
- Shaft stainless steel
- Mechanical stroke as specified in order details
- Shaft is not captive
- Weight (including cable) included in order details
- Polyester boss for strain relief to the sensor body

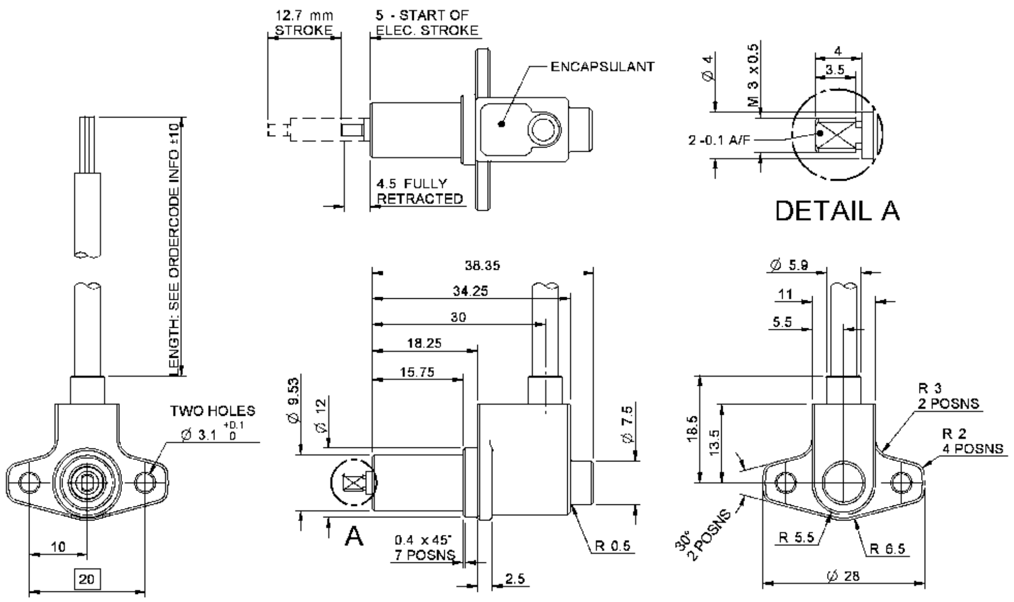
Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

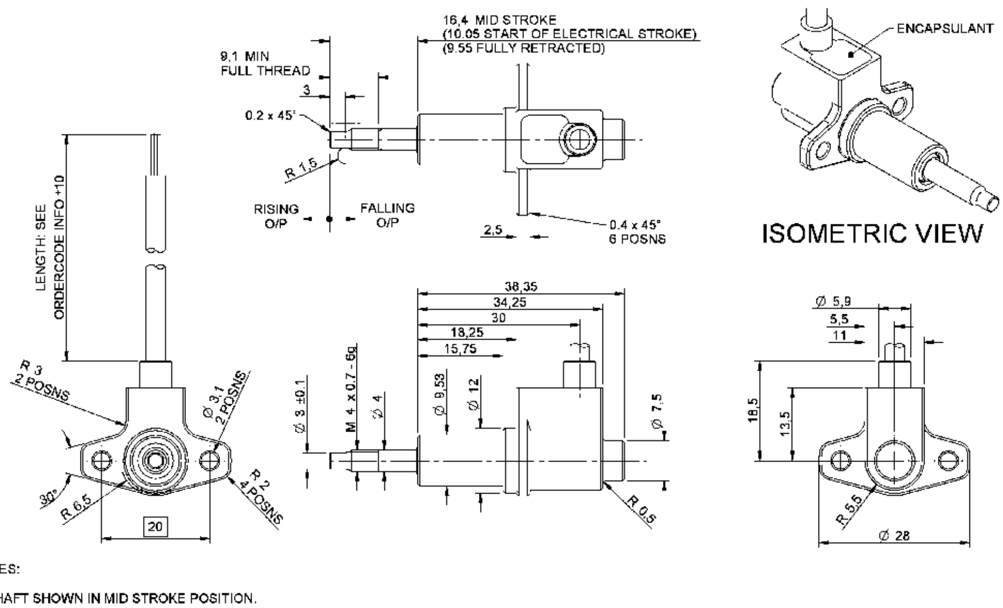
- Shaft sealed by wiper seal
- Resistant to standard motorsport fluids
- Maximum humidity 100%

- Operating temperature -40 to +170°C
- Compensated temperature range +20 to +150°C
- Viton jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

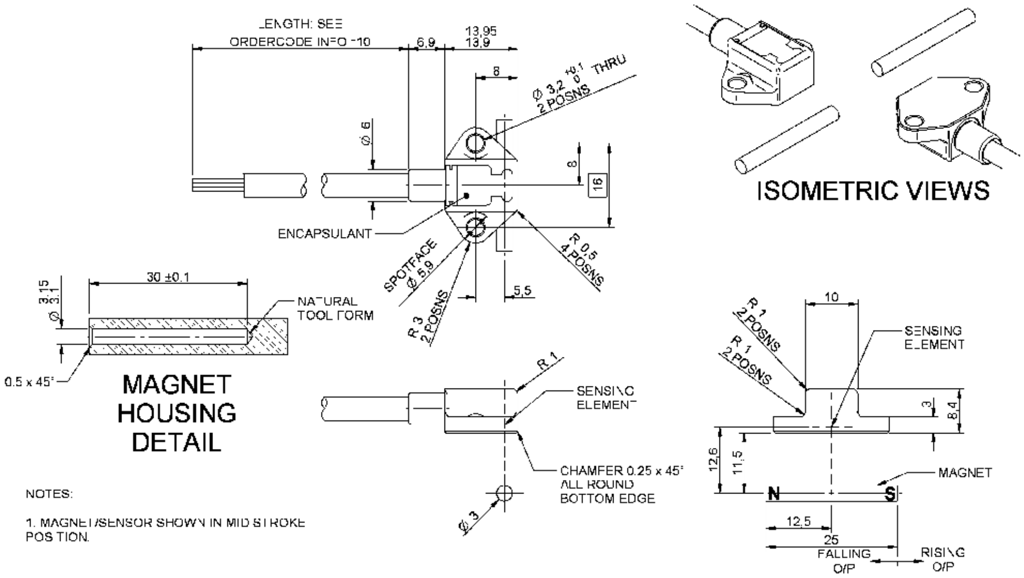
The sensor may be permanently damaged if the shaft is exposed to strong magnetic fields. During operation, the sensor should be kept clear of magnetic fields and ferro-magnetic materials.



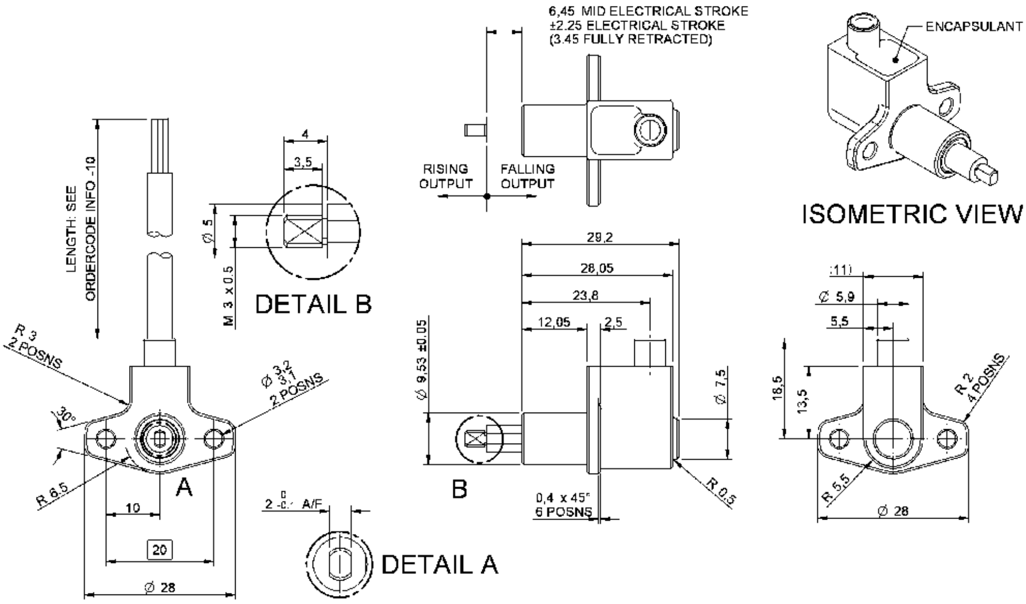
Stroke Length	Weight	Cable Length	Ordercode
12.7mm	80g	1000mm	O 030 320 009 011



Stroke Length	Weight	Cable Length	Ordercode
12.7mm	80g	1000mm	O 030 320 009 043



Stroke Length	Weight	Cable Length	Ordercode
16.0mm	40g	1000mm	O 030 320 009 053



Stroke Length	Weight	Cable Length	Ordercode
4.5mm	80g	1000mm	O 030 320 009 048

Linear Non-Contact Hall Effect Sensor

Twin (25mm Stroke)

The output of a linear hall sensor is a voltage which changes in proportion to the shaft extension. A constant voltage is required across the supply and ground wires of the sensor. The sensor consists of a Hall Effect element, and a shaft which houses a magnet. When the magnet moves within the sensor, the change in magnetic field changes the output voltage. The gain, offset and thermal drift of each channel is digitally compensated to minimise errors. The gain, offset and compensated temperature range can be modified electronically at the factory. The shaft is sealed to keep out dirt and dust but is not captive in the sensor body.

Application

- Clutch and gear selector drum position, throttle position.

Electrical

- Electrical stroke 25mm
- Supply current 10mA (max per channel)
- Output is proportional to supply voltage. The following values assume a precision 5.00V supply:

    Output voltage @ 0mm 0.5±0.05V (@25°C)
    Output voltage @ 25mm 4.5±0.05V (@25°C)

- Output voltage clamped between 01 and 4.9V
- Independent non-linearity ±2% FS
- Thermal shift[1]<±0.05%FS/K
- Insulation resistance >100Mohm @ 500Vdc
- The output increases as the shaft enters the housing (this can be reversed – please contact our technical consultancy service if this is of interest).
- Maximum applied voltage 8.5V

[1]Over compensated temperature range.

Cable and Connection Definition

- 24 AWG un-screened cable
- Cable length 1000mm
- Various automotive and military standard connectors are available
- Connection

Red Wire	Supply A
White Wire	Ground A
Green Wire	Signal A
Yellow Wire	Supply B
Black Wire	Ground B
Blue Wire	Signal B
Brown Wire	Filler – do not connect

Mechanical

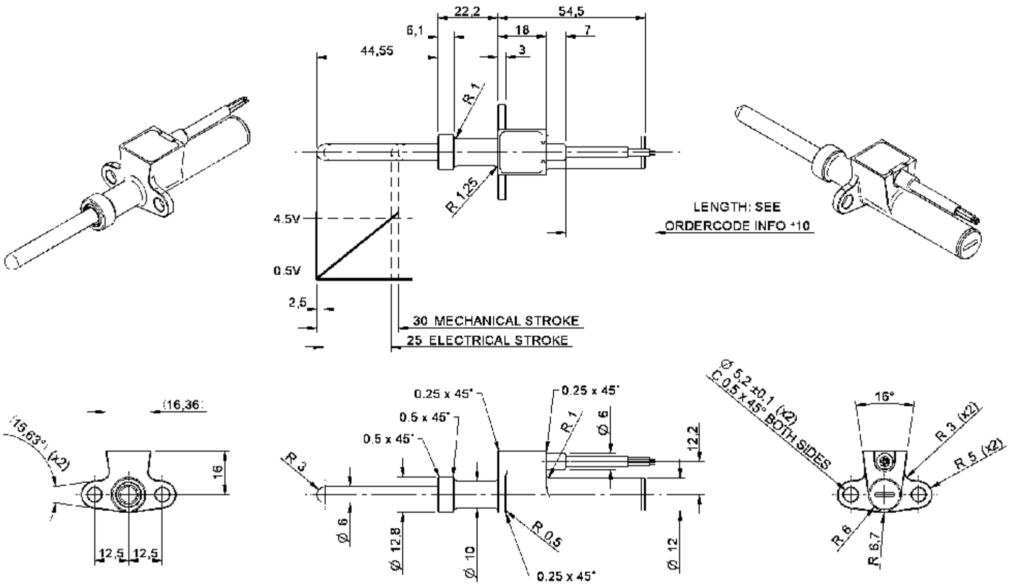
- Mechanical stroke 30mm
- Body aluminium alloy, hard anodised and dyed black
- Shaft 316 stainless steel
- Polyester cable boss for strain relief to the sensor body
- Spring rate 0.39N/mm
- Actuating force at full extension 8.5N±10%
- Weight less than 80g (including cable)
- Polyester cable boss for strain relief to the sensor body
- Shaft anti-rotation feature

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Shaft sealed by wiper seal
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -40 to +170°C
- Compensated temperature range +20 to +150°C
- Viton jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

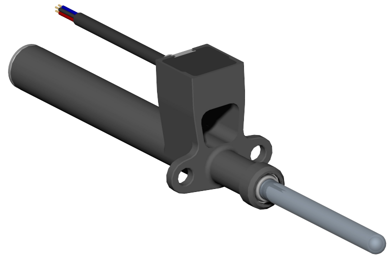
The sensor may be permanently damaged if the shaft is exposed to strong magnetic fields. During operation, the sensor should be kept clear of magnetic fields and ferro-magnetic materials.



Stroke Length	Weight	Cable Length	Ordercode
25mm	80g	1000mm	O 030 320 009 100

Linear Non-Contact Hall Effect Sensor
Twin (50mm Stroke)

The output of a linear hall sensor is a voltage which changes in proportion to the shaft extension. A constant voltage is required across the supply and ground wires of the sensor. The sensor consists of a Hall Effect element, and a shaft which houses a magnet. When the magnet moves within the sensor, the change in magnetic field changes the output voltage. The gain, offset and thermal drift of each channel is digitally compensated to minimise errors. The gain, offset and compensated temperature range can be modified electronically at the factory. The shaft is sealed to keep out dirt and dust but is not captive in the sensor body.



Application
- Clutch and gear selector drum position, throttle position.

Electrical
- Electrical stroke 50mm
- Supply current 10mA (max per channel)
- Output is proportional to supply voltage. The following
- Output is proportional to supply voltage. The following values assume a precision 5.00V supply:
  - Output voltage @ 0mm 0.5±0.05V (@25°C)
  - Output voltage @ 50mm 4.5±0.05V (@25°C)
- Output voltage clamped between 01 and 4.9V
- Independent non-linearity ±2% FS
- Thermal shift[1] <±0.05%FS/K
- Insulation resistance >100Mohm @ 500Vdc
- Hysteresis due to magnet rotation ±4% FS typ
- The output increases as the shaft enters the housing (this can be reversed – please contact our technical consultancy service if this is of interest).
- Maximum applied voltage 8.5V

[1]Over compensated temperature range.

Cable and Connection Definition
- 24 AWG un-screened cable
- Cable length 1000mm
- Various automotive and military standard connectors are available
- Connection

Red Wire	Supply A
White Wire	Ground A
Green Wire	Signal A
Yellow Wire	Supply B
Black Wire	Ground B
Blue Wire	Signal B
Brown Wire	Filler – do not connect

Mechanical
- Mechanical stroke 55mm
- Body aluminium alloy, hard anodised and dyed black
- Shaft 316 stainless steel
- Shaft anti-rotation feature
- Polyester cable boss for strain relief to the sensor body
- Spring rate 0.32N/mm
- Actuating force at full extension 6.9N±10%
- Weight less than 80g (including cable)

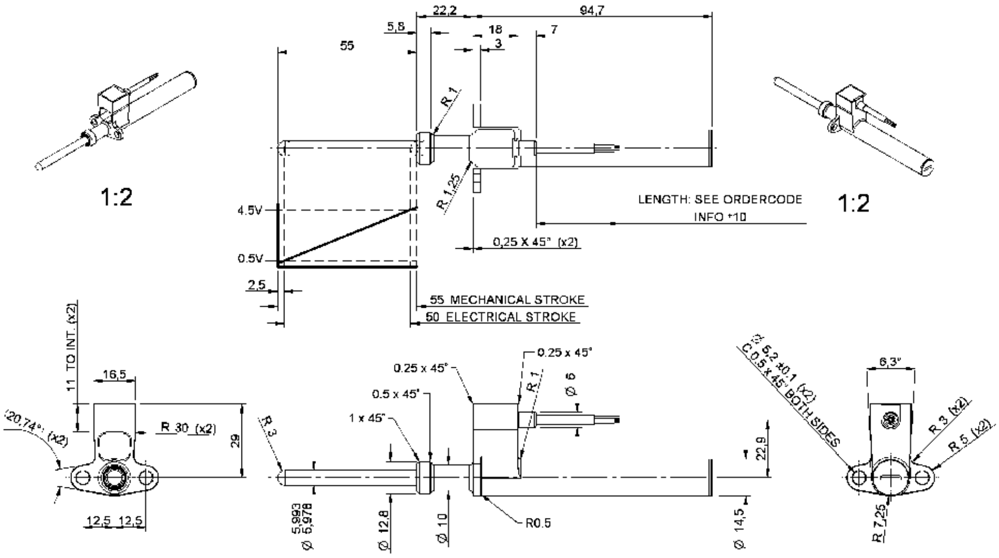
- Polyester cable boss for strain relief to the sensor body

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Shaft sealed by wiper seal
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -40 to +170°C
- Compensated temperature range +20 to +150°C
- Viton jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

The sensor may be permanently damaged if the shaft is exposed to strong magnetic fields. During operation, the sensor should be kept clear of magnetic fields and ferro-magnetic materials.



Stroke Length	Weight	Cable Length	Ordercode
50mm	80g	1000mm	O 030 320 009 076

Linear Potentiometer

9.5mm Diameter

The output of a linear potentiometer is a voltage which changes in direct proportion to the shaft extension. A constant voltage is required across the supply and ground wires of the sensor. The sensing elements are made from conductive plastic with a precious metal wiper. The units are sealed to keep out dirt and dust

Sensors

Electrical

- Electrical stroke range as specified in the table below
- Nominal resistance temp. coeff. 10ppm/°C
- Wiper current <10µA (recommended)
- Independent non-linearity ±0.5%FS

Cable and Connection Definition

- 24AWG 55M spec un-screened cable
- Connection:

Red wire	Supply
Black wire	Ground
White wire	Signal

- Various automotive and military standard connectors are available
- Cable length is shown on the order details but any length is available upon request

Mechanical

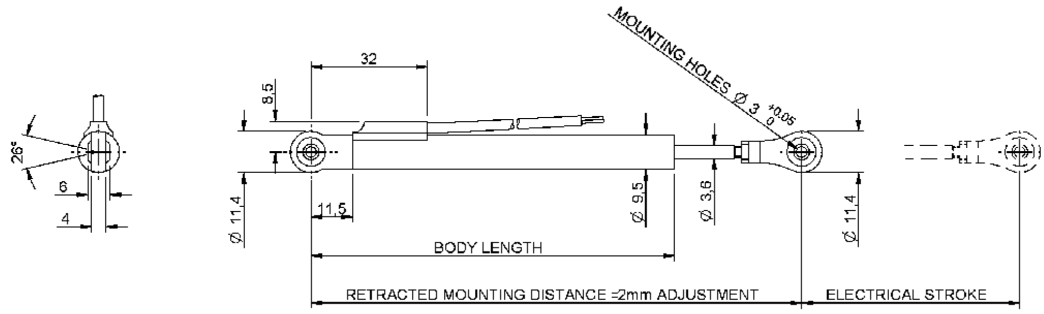
- Aluminium alloy body, anodised and dyed black
- Stainless steel shaft
- Life expectancy >25 million cycles (wiper speed 10m/s max)
- Mechanical stroke = electrical stroke

Environmental

- IP67 sealed
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -30 to +150°C continuous, 175°C short term
- Viton jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

Environmental

Electrical stroke (mm)	**12.5**	**25.0**	**50.0**	**75.0**	**100.0**	**125.0**	**150.0**
Body length (mm)	62.5	75	100	125	153	178	203
Resistance (k# ±20%)	1.25	2.5	5.0	7.5	6.5	10.0	10.0
Retracted mounting distance (mm)	82.5	95	120	145	178	203	228
Weight (grams)	24	26	29	33	37	43	46

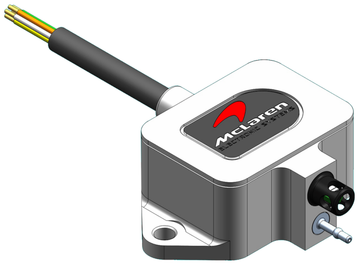


Cable Length	Electrical Stroke	Ordercode
500mm	12.5mm	O 030 320 013 000
500mm	25mm	O 030 320 013 001
500mm	50mm	O 030 320 013 002
500mm	75mm	O 030 320 013 003
500mm	100mm	O 030 320 013 004
500mm	125mm	O 030 320 013 005
500mm	150mm	O 030 320 013 006

Pressure (Aero)

Barometric and Temperature Sensor
Single Channel

The output voltage changes with the absolute pressure applied to the pressure port. The gain, offset and thermal drift of the pressure sensor is digitally compensated to minimise errors and to create a single-ended, amplified output in the 0 to 5 Volt range.



Electrical

- Compensated pressure range 150 to 1150mbar (absolute)
- Supply voltage 8 to 16V unregulated
- Supply current 14mA max
- Output voltage @ 150mbar (absolute pressure) = 0.5V ±0.05V @25°C
- Output voltage @ 1150mbar (absolute pressure) = 4.5V ±0.05V @25°C
- Maximum output voltage 5V
- Non-%FSO max
- %FSO
- Combined thermal zero and sensitivity shift #±1.5
- -3dB point at 100Hz, single pole filter
- Maximum sink / source current 0.45mA

The sensor is protected against short circuit between output and ground but it may be damaged if the output is connected to the supply or if a reverse bias supply voltage is applied.

Cable and Connection Definition

- 55Spec AWG unscreened cable
- Connector - see ordercode details

Pin 1	Red wire	Supply
Pin 2	Green wire	Ground
Pin 3	White wire	Barometric Signal
Pin 4 *	Blue wire	Comms
Pin 5	Yellow wire	PT1000 Signal +
Pin 6	Orange wire	PT1000 Signal -

- Cable length is shown on the order details

* Pin 4 is for manufacturing use only and should not be connected.

Temperature

- Sensing element PT1000
- Nominal resistance: 1000# at 0°C
- Accuracy: ±0.4k typ, ±1.0k max (0 to +70°C)
- Response time 4 sec typ, 10 sec max in still air
- Sensor characterised to 70°C
- PT1000 sensing element tip supported by RTV

Mechanical

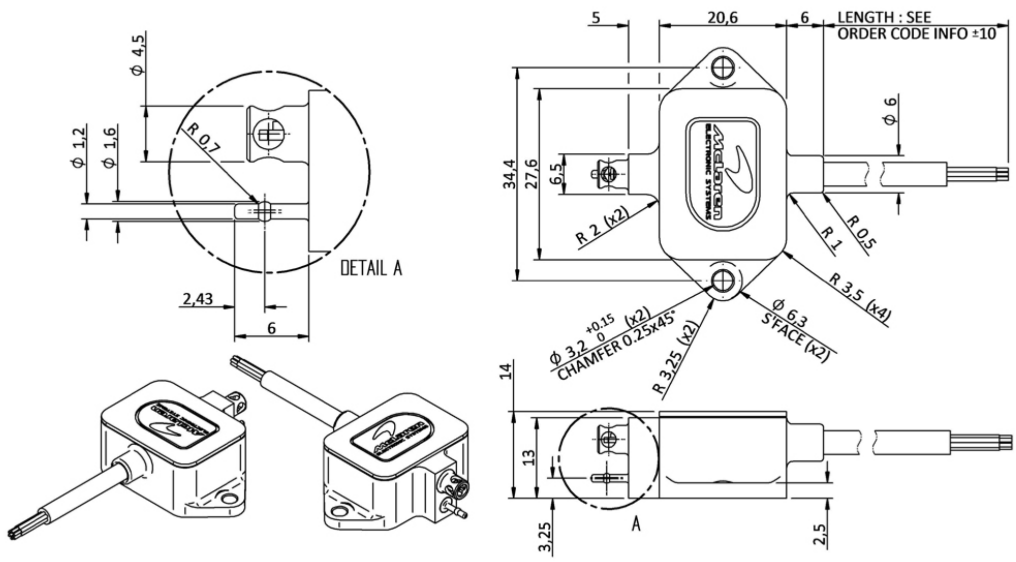
- Weight less than 55g (including cable and connector)
- Aluminium alloy body hard anodised grey
- Sensor is supplied with viton o-ring (where applicable)

Environmental

- Maximum pressure 4000mbar (absolute pressure)
- Pressure media must be a non-corrosive gas

- Sensor body resistant to standard motorsport fluids
- Maximum humidity 100% but water should not be allowed to condense inside the unit
- Operating temperature -40 to +125°C
- Compensated temperature range 0 to 125°C
- DR25 jacketed cable (150°C)
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy for details.



Cable Length	Ordercode
500mm	O 030 330 043 055

Barometric Sensor
1-Channel

The output voltage changes with the absolute pressure applied to the pressure port. The gain, offset and thermal drift of the pressure sensor is digitally compensated to minimise errors and to create a single-ended, amplified output in the 0 to 5 Volt range.

Electrical

- Compensated pressure range 150 to 1150mbar (absolute)
- Supply voltage 8 to 16V unregulated
- Supply current 14mA max
- Output voltage @ 150mbar (absolute pressure)[1] = 0.5V ±0.05V @25°C
- Output voltage @ 1150mbar (absolute pressure)[1] = 4.5V ±0.05V @25°C
- Maximum output voltage 5V
- Non-linearity #±0.5%FSO typ. #±1.0%FSO max
- Hysteresis #±0.5%FSO
- Combined thermal zero and sensitivity shift #±1.5%FSO typical, #±2%FSO max
- -3dB point at 100Hz, single pole filter
- Maximum sink / source current 0.45mA

The sensor is protected against short circuit between output and ground for short periods but it may be damaged if the output is connected to the supply or if a reverse bias supply voltage is applied.

[1] Other pressure ranges available on request

Cable and Connection Definition

- 55Spec 26 AWG unscreened cable
- Connection:

Red wire	Supply
Green wire	Ground
White wire	Signal
Blue wire [2]	Comms
Yellow wire	Filler

- Cable length is shown on the order details

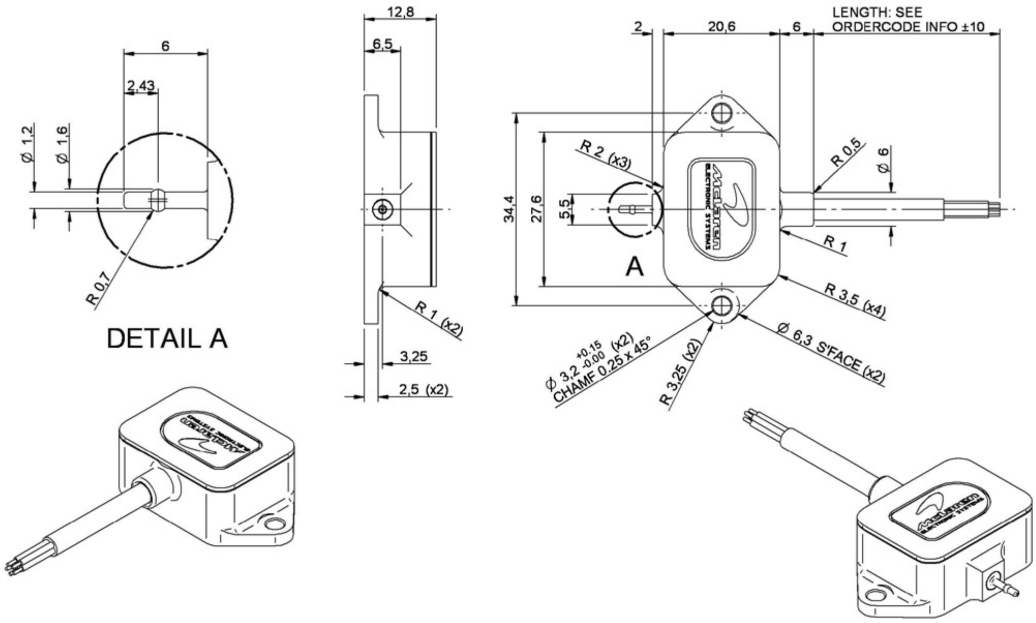
[2] Blue wire is for manufacturing use only and should not be connected

Mechanical

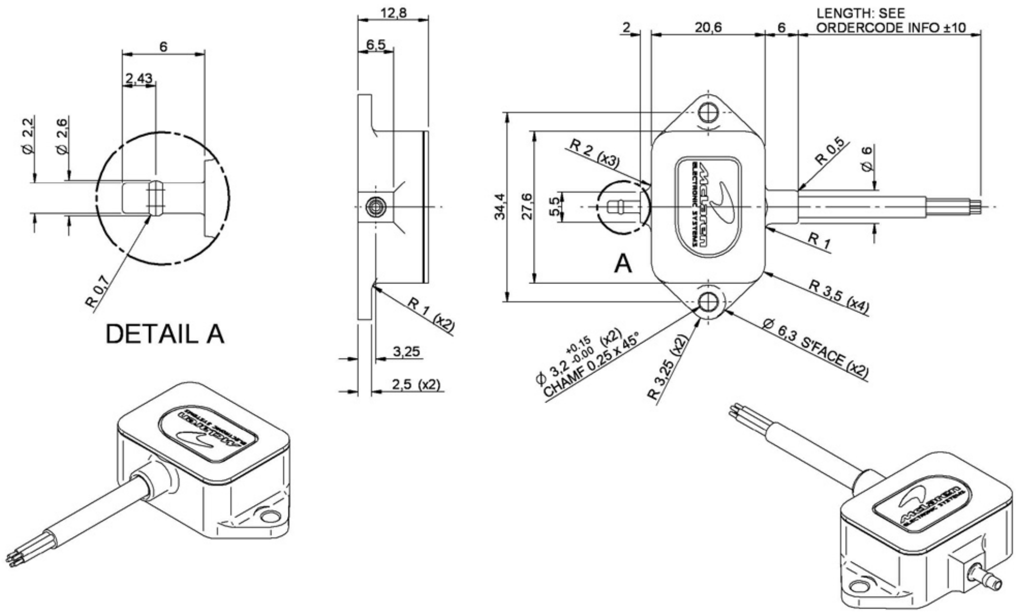
- Weight less than 50g (including cable and connector)
- Aluminium alloy body hard anodised black
- Sensor is supplied with viton o-ring (where applicable)

Environmental

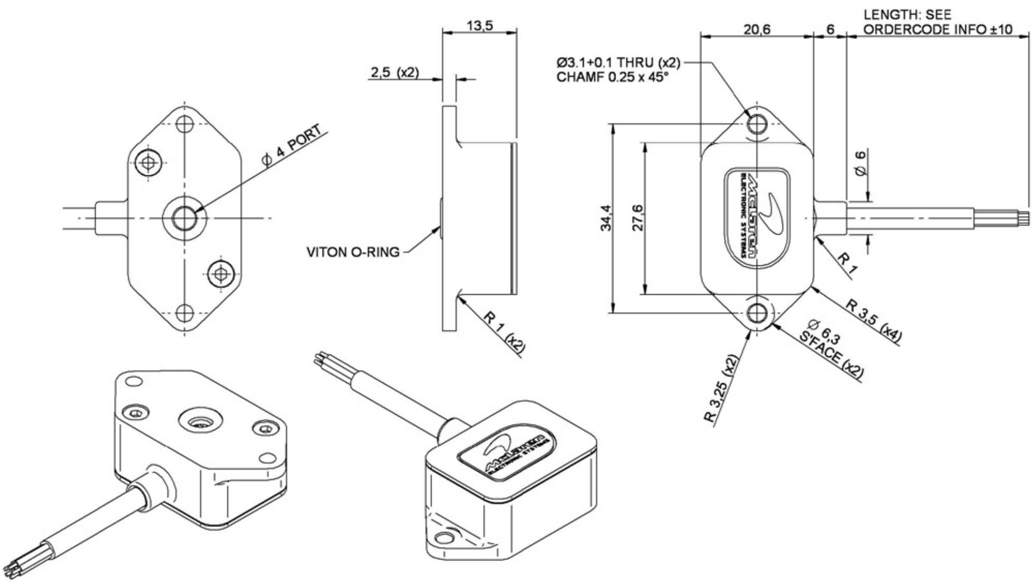
- Maximum pressure 4000mbar (absolute pressure)
- Pressure media must be a non-corrosive gas
- Sensor body resistant to standard motorsport fluids
- Maximum humidity 100% but water should not be allowed to condense inside the unit
- Operating temperature -40 to +125°C
- Compensated temperature range 0 to 125°C
- Viton jacketed cable (200°C)
- Vibration 50 to 2500Hz @ 40g eight hours per axis



Cable Length	Ordercode
1000mm	O 030 330 043 047



Cable Length	Ordercode
1000mm	O 030 330 043 048



Cable Length	Ordercode
1000mm	O 030 330 043 049

Spare O-Ring Seal
O 030 300 990 006

Sensors

Barometric Sensor
4-Channel

The output voltage changes with the absolute pressure applied to the pressure port. The gain, offset and thermal drift of the pressure sensor is digitally compensated to minimise errors and to create a single-ended, amplified output in the 0 to 5 Volt range.

Application

- Absolute pressure measurement of non-corrosive gas, e.g. aerodynamic or cylinder-to-cylinder pressures.

Electrical

- Compensated pressure range 150 to 1150mbar (absolute)
- Supply voltage 8 to 16V unregulated
- Supply current 30mA max
- Output voltage @ 150mbar (absolute pressure) = 0.5V ±0.05V measured at 25°C
- Output voltage @ 1150mbar (absolute pressure) = 4.5V ±0.05V measured at 25°C
- Maximum output voltage 5V
- Non-linearity #±0.5%FSO typ #±1.0%FSO max
- Hysteresis #±0.5%FSO
- Combined thermal zero and sensitivity shift #±1.5%FSO typical, #±2% FSO max
- -3dB point at 100Hz, single pole filter
- Maximum sink/source current 0.45mA

The sensor is protected against short circuit between output and ground but it may be damaged if the output is connected to the supply or if a reverse bias supply voltage is applied.

Other pressure ranges available on request.

Cable and Connection Definition

- 55Spec 26AWG unscreened cable
- Connection details

Red wire	Supply
Black wire	Ground
Orange wire	Pressure Signal A
Yellow wire	Pressure Signal B
Green wire	Pressure Signal C
Blue wire	Pressure Signal D
White wire x 4	Diagnostic - do not connect

- Cable length is shown on order details, but any length is available on request

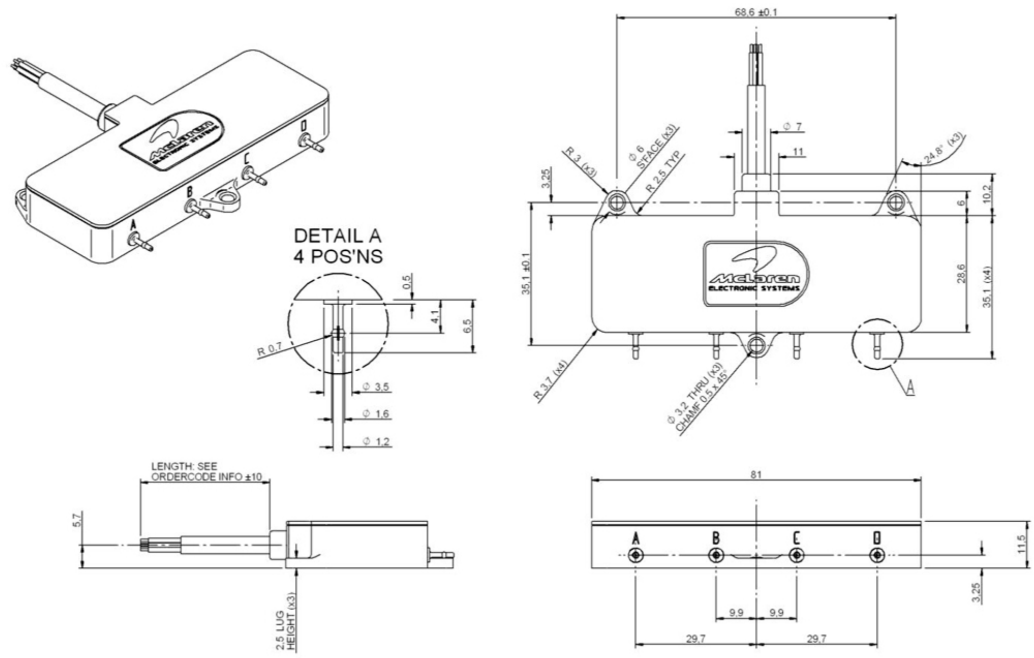
Mechanical

- Weight less than 120g (including cable)
- Aluminium alloy body hard anodised black

Environmental

- Maximum pressure 4000mbar (absolute pressure)
- Pressure media must be a non-corrosive gas
- Body resistant to standard motorsport fluids
- Maximum humidity 100% but water should not be allowed to condense inside the unit
- Operating temperature range -40 to +125°C
- Compensated temperature range 0 to +125°C
- DR25 jacketed cable
- Vibration 50 to 2500Hz @ 40g eight hours per axis

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.



Connector	Cable Length	Ordercode
None	1000mm	O 030 330 043 046

Pressure Module

Entry Level Single-Channel Barometric

The gain, offset and thermal drift of the pressure sensor is digitally compensated to minimise errors and to create a single-ended, amplified output in the 0.5 to 4.5 Volt range. The output voltage changes with the absolute pressure applied to the pressure port.

Electrical

- Compensated pressure range 400 to 1150mbar
- Supply voltage 8 to 16V unregulated
- Supply current 14mA max
- Output voltage @ 400mbar = 0.5V ±80mV over compensated temperature range
- Output voltage @ 1150mbar = 4.5V ±80mV over compensated temperature range
- Maximum output voltage 4.85V
- Overall accuracy ±15mbar over compensated temperature range
- Electrical output impedance 100 ohms
- Frequency response 70Hz

The sensor is protected against short circuit between output and ground for short periods but it may be damaged if the output is connected to the supply or if a reverse bias supply voltage is applied.

Cable and Connection Definition

- 24 AWG unscreened cable
- Connection:
  Red = Supply
  Green = Ground
  White = Barometric Signal
- Various automotive and military standard connectors are available
- Cable length is shown on the order details but any length is available upon request

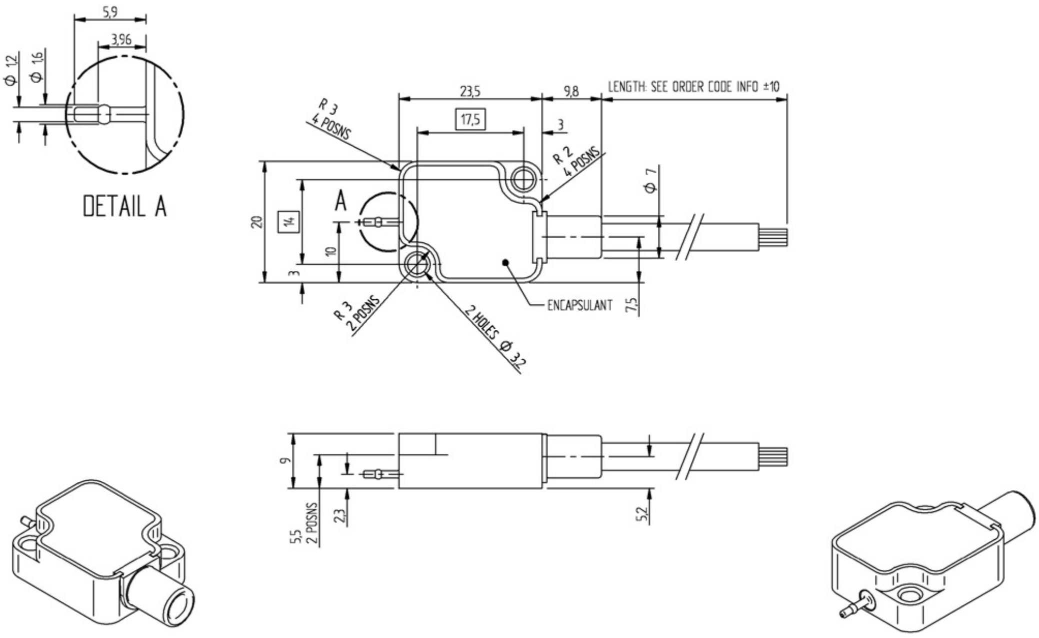
Mechanical

- Weight less than 55g (including cable)
- Aluminium alloy body hard anodised black
- Polyester cable boss for strain relief to sensor body

Environmental

- Minimum pressure 400 mbar
- Maximum pressure 1150 mbar
- Pressure overload 3.6 bar for 300s
- Pressure media must be a non-corrosive gas
- Sensor body resistant to standard motorsport fluids
- Maximum humidity 100% but water should not be allowed to condense inside the unit
- Operating temperature -40 to +125°C
- Compensated temperature range 0 to 85°C
- Viton jacketed cable (200°C)
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

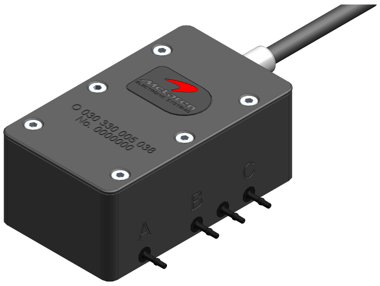
Sensors



Cable Length	Ordercode
1000mm	O 030 330 043 010

Pitot Sensor
3-Channel with CAN O/P

This module is typically used as a Pitot tube sensor. The output voltage changes with the difference in pressure between two ports, it is insensitive to absolute pressure. Pressure measurements are transmitted over CAN to the host controller and/or logger.



Electrical

- Supply voltage 8 to 16V unregulated
- Supply current: 60mA max
- Output at 0mbar (relative to reference port) = 0.5V ±0.075V @ 30°C
- Output at -150mbar (relative to reference port) = 4.5V ±0.075V @ 30°C
- Resolution (11-bit) 2.44mV 0.092mbar
- Combined accuracy <±1.8% FSO over compensated temperature range[1]
- 1MBit/s CAN2.0B communications link for configuration and results data
- CAN sampling rate configured by host ECU up to 1kHz
- CAN message identifiers configured by host ECU allowing multiple modules sharing a common bus (a fixed CAN identifier will be required for configuration messages)
- CAN bus link is terminated with a 120 ohm resistor inside the sensor

[1]<±3.3% FSO for remainder of operating temperature

Cable and Connection Definition

- 26AWG un-screened cable
- Cable length 1000mm
- Connection:

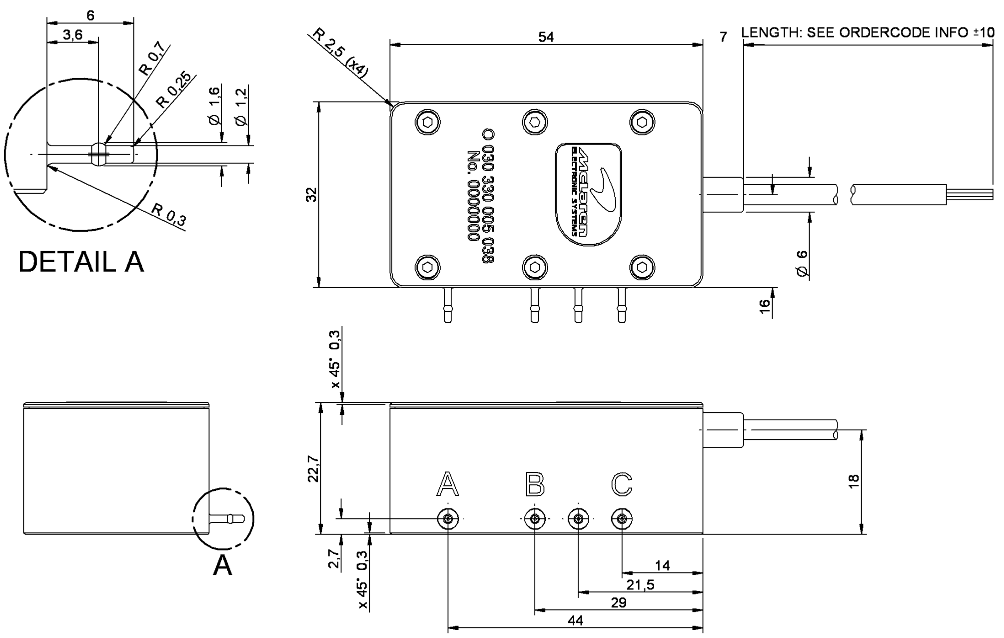
Red wire	Supply
Green wire	CAN +
White wire	CAN -
Black wire	Ground

Mechanical

- Maximum differential pressure two times rated pressure
- Rated pressure -150mbar
- Weight less than 100g including cable
- Aluminium alloy body, hard anodised and dyed black
- Titanium pressure ports

Environmental

- Body resistant to standard motorsport fluids
- Exposure of non-corrosive gas to both '+' and '-' ports. Ports should be sealed when not in use
- DR25 jacketed cable
- Maximum humidity 100%
- Operating temperature 0 to +115°C
- Compensated temperature 30 to +70°C
- Vibration (24hrs per axis)
  - 100Hz, 0.00797g2/Hz
  - 200Hz, 0.17157g2/Hz
  - 300Hz, 0.54279g2/Hz
  - 650Hz, 0.00965g2/Hz
  - 1000Hz, 0.02080g2/Hz

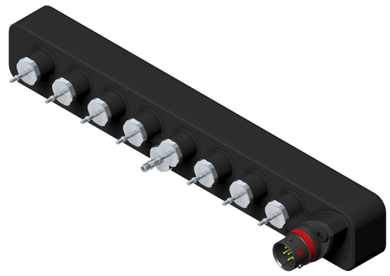


Cable Length	Ordercode
1000mm	O 030 330 005 038

Sensors

Pitot Sensor
8-Channel

This module is typically used for aerodynamic development, whereby pressure tappings can be made across surfaces of wings and aero features of the vehicle. The scaled pressure results are transmitted over CAN to the host controller and/or data logger.



Application

- Aerodynamic development.

Electrical

- Supply voltage 8 to 16V unregulated [1]
- Supply current 80mA max @ 12V [1]
- Output at +68.95 mbar (1 psi) = 0.5V ±0.06V @25°C
- Output at -275.8 mbar (-4 psi) = 4.5V ±0.06V @25°C
- Output voltage represented by an 11-bit integer
- Resolution (11-bit ADC) 2.44mV 0.21mbar
- Combined accuracy <±1.5% FSO over compensated temperature range (<±3.5% FSO for remainder of operating temperature)
- -3dB at 159Hz
- ISO11898 1Mbit/s CAN communications link for configuration and results data
- CAN sampling rate configured by host ECU up to 1kHz
- CAN message identifiers configured by host ECU allowing multiple modules sharing a common bus (a fixed CAN identifier will be required for configuration messages)
- CAN bus link must be terminated using 120ohm resistor
- 3 CAN messages are required to transmit 8 x 11 bit pressure outputs

For each channel, the output changes when the pressure at the port for that channel is higher or lower than the pressure at the REF port.

Connection Definition

- ASX202-06PN Deutsch Connector
- Connetion:

Pin 1	Supply
Pin 2	Ground
Pin 3	CAN +
Pin 4	CAN -
Pin 5	Not connected
Pin 6	Not connected

Mechanical

- Measurement range +68.95 to -275.8 mbar differential
- Maximum differential pressure 2 x rated pressure
- Weight less than 70g
- Aluminium alloy body, anodised and dyed black
- Threaded titanium pressure ports (serviceable)

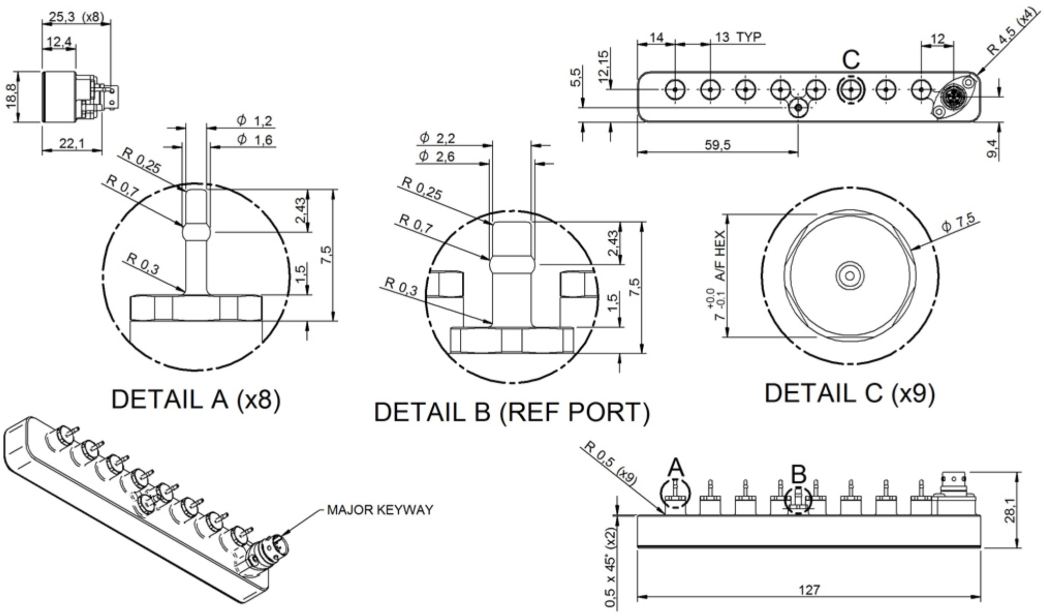
Environmental

- Body resistant to standard motorsport fluids
- Exposure of non-corrosive gas to ports 1-8 only. Reference port is vented to case and should therefore be exposed to dry gasses only. Ref port should be sealed when not in use.
- Maximum humidity 100%
- Operating temperature 0 to +115°C[1]

- Compensated temperature 0 to +70°C
- Vibration (24hrs per axis)
  - 100Hz, 0.00797g^2/Hz
  - 200Hz, 0.17157g^2/Hz
  - 300Hz, 0.54279g^2/Hz
  - 650Hz, 0.00965g^2/Hz
  - 1000Hz, 0.02080g^2/Hz

[1] If an operating temperature above 115°C is required, refer to table below:

Operating Temp (°C)	Max Supply Voltage (V)	Max Current Consumption (mA)
115 - 120	14	70
120 - 125	10	90



Description	Ordercode
CAN Output PIN8 Pitot Sensor	O 030 330 005 060

Pitot Sensor
16-Channel

This multi-channel pressure module is typically used for aerodynamic development, whereby pressure tappings can be made across surfaces of wings and aero features over the vehicle.

Analogue and CAN output variants are available. Scaled pressure results are either transmitted over CAN to the host controller and/or data logger, or are single ended analogue outputs which can be connected directly to most control units and data loggers.

Sensors

Application

- Aerodynamic development.

Electrical

- Supply voltage 8 to 16V unregulated [1]
- Supply current 90mA max @ 12V [1]
- Output voltage represented by a 11-bit integer
- Resolution (11-bit ADC) 2.44mV
- Combined accuracy <±1.5% FSO over compensated temperature range (<±3.5% FSO for remainder of operating temperature)
- -3dB at 159Hz

For each channel, the output will change when the pressure at the port changes with respect to the pressure at the REF port.

[1]If an operating temperature above 115°C is required, refer to table below:

See ordercode for range and output details.

Mechanical

- Maximum differential pressure two x rated pressure
- Weight less than 95g (CAN version), 110g (Analogue version)
- Aluminium alloy body, anodised and dyed black
- Titanium pressure ports
- Other pressure connections and orientations are available upon request

CAN Messaging

- ISO11898 1Mbit/s CAN communications link for configuration and results data
- CAN sampling rate configured by host ECU up to 1kHz
- CAN message identifiers configured by host ECU allowing multiple modules sharing a common bus (a fixed CAN identifier will be required for configuration messages)
- CAN bus link must be terminated using 120# resistor
- Four CAN messages are required to transmit 16 x 11-bit pressure outputs

Environmental

- Body resistant to standard motorsport fluids
- Exposure of non-corrosive gas to ports 1-16 only. Reference port is vented to case and should therefore be exposed to dry gasses only. REF port should be sealed when not in use.
- Maximum humidity 100%
- Operating temperature 0 to +115°C[1]
- Compensated temperature 30 to +70°C
- Vibration (24hrs per axis)
  - 100Hz, 0.00797g^2/Hz
  - 200Hz, 0.17157g^2/Hz
  - 300Hz, 0.54279g^2/Hz
  - 650Hz, 0.00965g^2/Hz
  - 1000Hz, 0.02080g^2/Hz

Operating Temp (°C)	Max Supply Voltage (V)	Max Current Consumption (mA)

115 - 120	14	80
120 - 125	10	100

Connection Definition – Analogue Variant

- Connector A (ASDD0-06-09-PN):

Pin 1	Channel 1
Pin 2	Channel 2
Pin 3	Channel 3
Pin 4	Channel 4
Pin 5	Channel 5
Pin 6	Channel 6
Pin 7	Channel 7
Pin 8	Channel 8
Pin 9	Channel 9

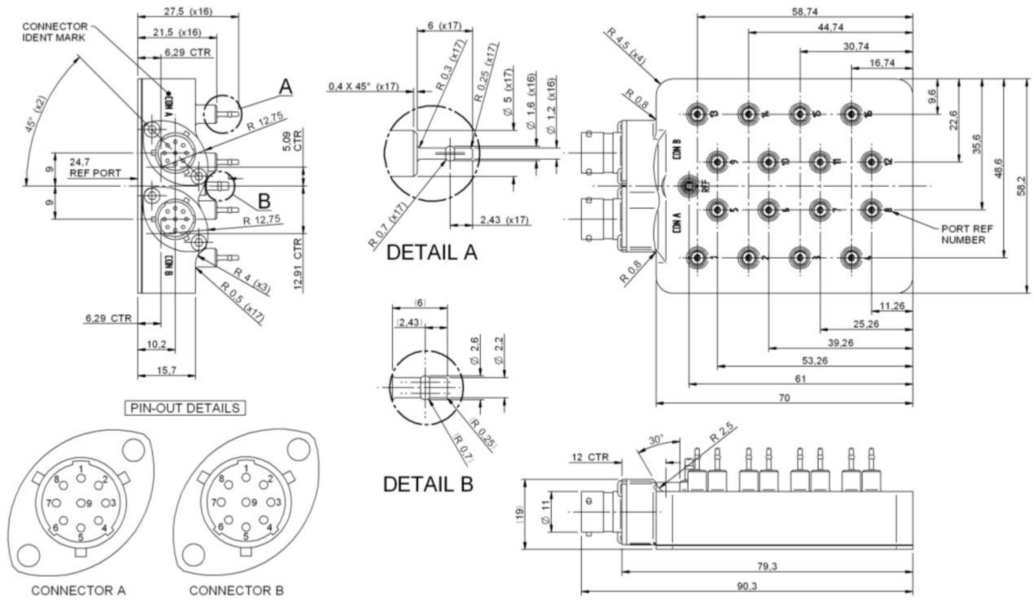
- Connector B (ASDD0-06-09-PA):

Pin 1	Channel 10
Pin 2	Channel 11
Pin 3	Channel 12
Pin 4	Channel 13
Pin 5	Channel 14
Pin 6	Channel 15
Pin 7	Channel 16
Pin 8	Supply
Pin 9	Ground

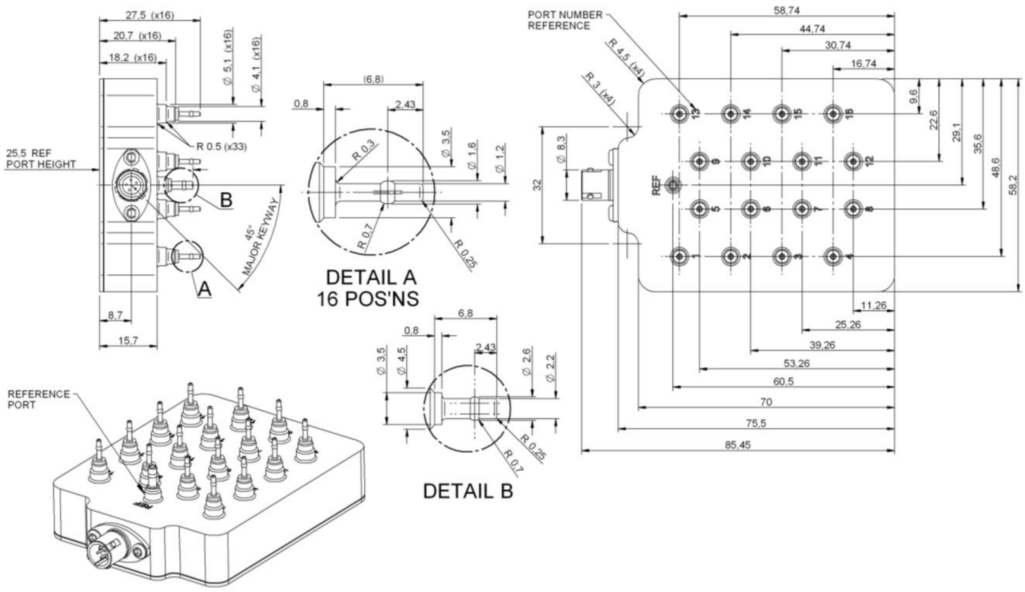
Connection Definition – CAN Variant

- Connector: see ordercode for details

Pin 1	Supply
Pin 2	Ground
Pin 3	CAN +
Pin 4	CAN –
Pin 5	Not connected



Description	Range (mbar)	Output @0.5V±0.1V (@25°C)	Output @4.5V±0.1V (@25°C)	Ordercode
Analogue Output PIN16 Pitot Sensor	0 to -150	0mbar	-150mbar	O 030 330 005 048



Description	Connector	Range (mbar)	Output @0.5V±0.1V (@25°C)	Output @4.5V±0.1V (@25°C)	Ordercode
CAN Output PIN16 Pitot Sensor	STA2-02-05-PN	0 to -150	0mbar	-150mbar	O 030 330 005 028
CAN Output PIN16 Pitot Sensor	STA2-02-05-PN	-172.4 to +172.4 (±2.5PSI)	-172.4mbar	+172.4mbar	O 030 330 005 043
CAN Output PIN16 Pitot Sensor	8STA2-02-05-PA	0 to +344.7 (5PSI)	0mbar	+344.7mbar	O 030 330 005 051
CAN Output PIN16 Pitot Sensor	8STA2-02-05-PA	-172.4 to +172.4 (±2.5PSI)	-172.4mbar	+172.4mbar	O 030 330 005 052
CAN Output PIN16 Pitot Sensor	8STA2-02-05-PA	-34.5 to +34.5 (±0.5PSI)	-34.5mbar	+34.5mbar	O 030 330 005 057

Description	Connector	Range (mbar)	Output @0.5V±0.1V (@25°C)	Output @4.5V±0.1V (@25°C)	Ordercode
CAN Output PIN16 Pitot Sensor	8STA2-02-05-PA	68.95 to -275.8 (+1 to -4PSI)	68.95mbar	-275.8mbar	O 030 330 005 058

Pressure (Fluid)

Pressure Regulator
High-Pressure

A two chamber, diaphragm type fuel pressure regulator. The fuel chamber is separated from the spring chamber by a fabric reinforced, fluoro rubber diaphragm, which is pre-loaded by a compression spring. The spring housing is vented to atmosphere. Connection to the fuel rail is by partitions in the fuel chamber. The regulator is intended for applications requiring pressures in excess of 16barg. For example, to exploit the high pressure capabilities of the TSR2.1 motorsport fuel injector which operates at up to 30barg.

Please request our installation datasheet for further details.

Application

- Fuel pressure control for injector systems

Electrical

- Reflow characteristic, rated and maximum pressures are shown in the order details
- Full reflow >400l/hr
- Rated pressure is calibrated at reflow set point
- Rated pressure accuracy ±25mbar at reflow set point
- Reflow characteristic is the pressure increase due to each 100l/hr reflow above set point
- Sealing pressure (minimum pressure held 5 min after supply has stopped) 4barg
- Regulation accuracy ±80mbar on reflow testing

Mechanical

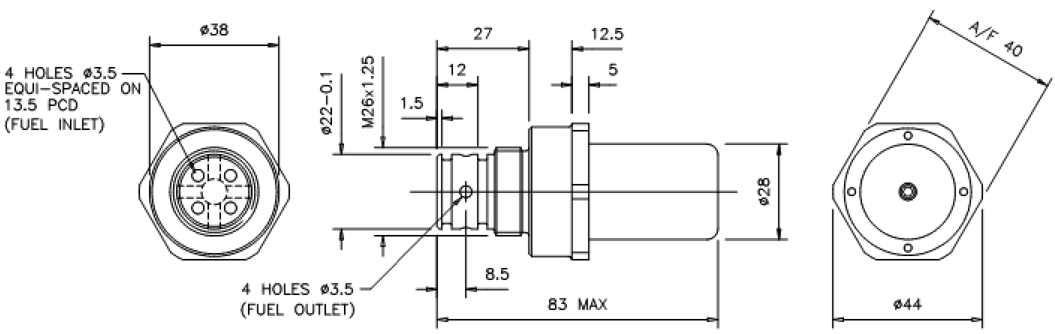
- Body aluminium alloy, hard anodised, dyed black
- Weight is shown in the order details

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application.

Please contact our technical consultancy service who will be pleased to help.

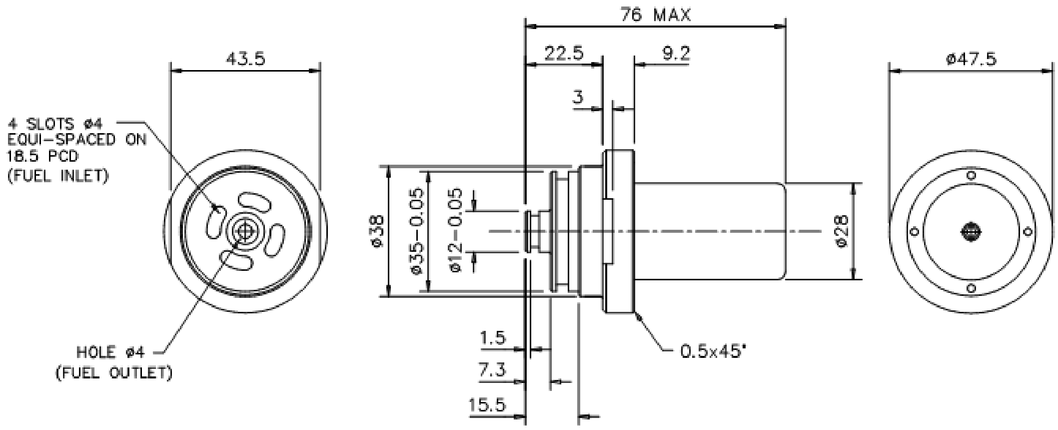
Environmental

- Resistant to standard motorsport fluids
- Operating temperature 0 to +125°C



Rated Pressure	Maximum Pressure	Reflow Characteristic	Reflow Set Point	Weight	Ordercode
16barg	20barg	<70mbar/(100l/h)	110l/h	165g	O 030 510 300 001
30barg	34barg	<180mbar/(100l/h)	110l/h	165g	O 030 510 300 000

Accessories	Ordercode
Set of two o-rings	O 030 510 990 003



Rated Pressure	Maximum Pressure	Reflow Characteristic	Reflow Set Point	Weight	Ordercode
22barg	34barg	<180mbar/(100l/h)	150l/h	175g	O 030 510 300 002
30barg	34barg	<180mbar/(100l/h)	150l/h	175g	O 030 510 300 003

Accessories	Ordercode
Set of two o-rings	O 030 510 990 005

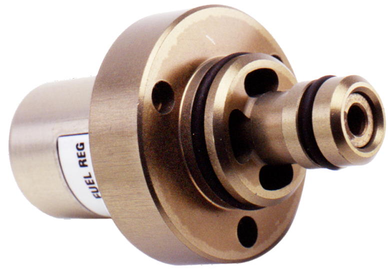
Sensors

Pressure Regulator
Miniature

A two-chamber, diaphragm type fuel pressure regulator. The fuel chamber is separated from the spring chamber by a fabric reinforced, fluoro rubber diaphragm, which is pre-loaded by a compression spring. The spring housing is vented to atmosphere. Alternatively, for turbo charger applications, a version is available in which the vent has a port which may be connected to the manifold to enable the regulator to track manifold pressure.

Connection to the fuel rail is by partitions in the fuel chamber. The regulator is available in two body styles: flanged and round.

Please request our installation datasheet for further details.



Application

- Fuel pressure control for injector systems.

Electrical

- Reflow characteristic, rated and maximum pressures are shown in the order details
- Reflow set point 110l/hr
- Full reflow >400l/hr
- Rated pressure is calibrated at reflow set point
- Rated pressure accuracy ±25mbar at reflow set point
- Reflow characteristic is the pressure increase due to each 100l/hr reflow above set point
- Burst pressure 20barg (exceeding this pressure is likely to damage the regulator)
- Sealing pressure (minimum pressure held 5 min after supply has stopped)

1.5barg	rated pressure 3.5barg
3barg	rated pressure 5.0barg
4barg	rated pressure >=6.0barg

- Regulation accuracy ±80mbar on reflow testing

Mechanical

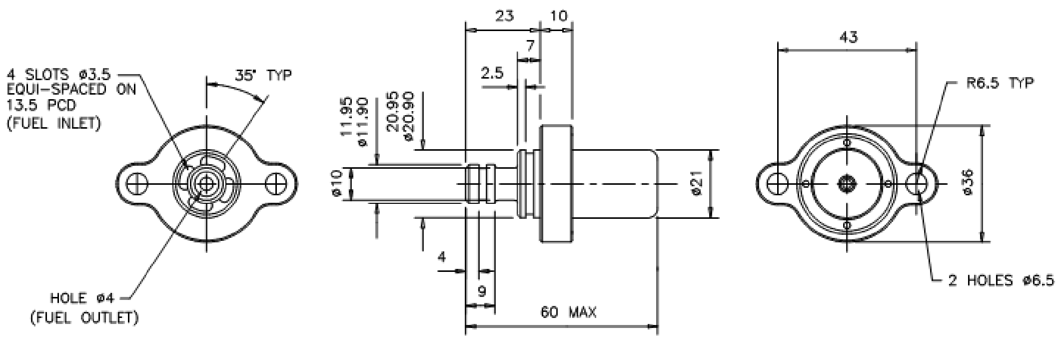
- Aluminium alloy, hard anodised body
- Weight less than 80g (85g with manifold port)

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application.

Please contact our technical consultancy service who will be pleased to help.

Environmental

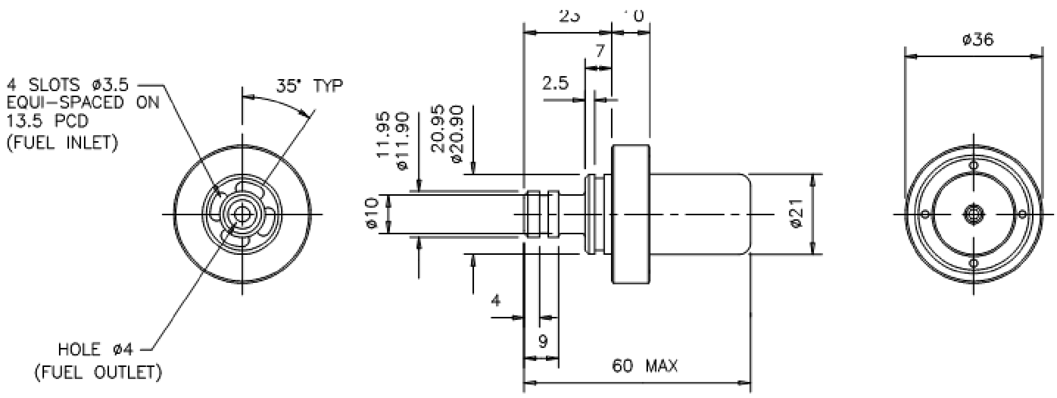
- Resistant to standard motorsport fluids
- Operating temperature 0 to +125°C



Rated Pressure	Maximum Pressure	Reflow Characteristic	Ordercode
3.5barg	5barg	<40mbar/(100l/h)	O 030 510 100 035

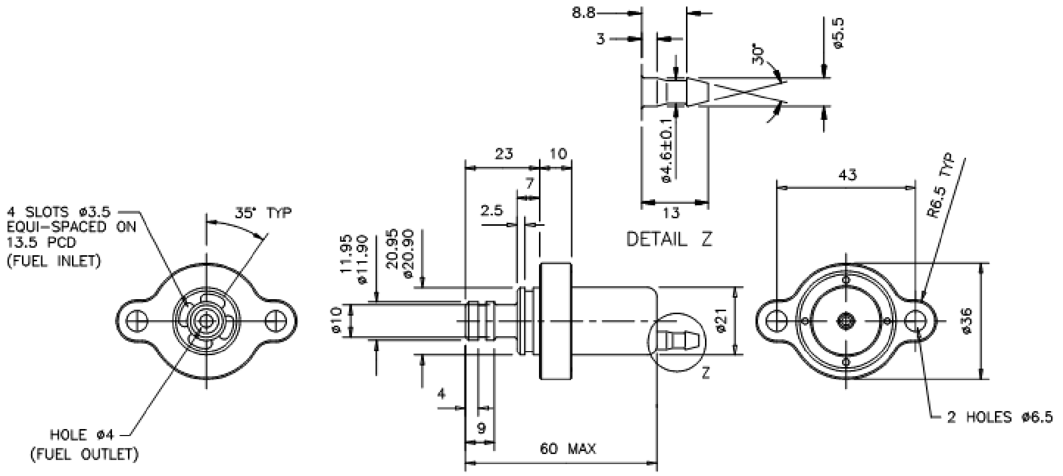
Rated Pressure	Maximum Pressure	Reflow Characteristic	Ordercode
5.0barg	8barg	<50mbar/(100l/h)	O 030 510 100 005
6.0barg	10barg	<60mbar/(100l/h)	O 030 510 100 006
7.0barg	11barg	<70mbar/(100l/h)	O 030 510 100 007
8.0barg	12barg	<80mbar/(100l/h)	O 030 510 100 008
9.0barg	13barg	<80mbar/(100l/h)	O 030 510 100 009
10.0barg	14barg	<90mbar/(100l/h)	O 030 510 100 010
11.0barg	15barg	<100mbar/(100l/h)	O 030 510 100 011
12.0barg	16barg	<100mbar/(100l/h)	O 030 510 100 012
13.0barg	17barg	<110mbar/(100l/h)	O 030 510 100 013
14.0barg	18barg	<120mbar/(100l/h)	O 030 510 100 014

Accessories	Ordercode
Set of two o-rings	O 030 510 990 001



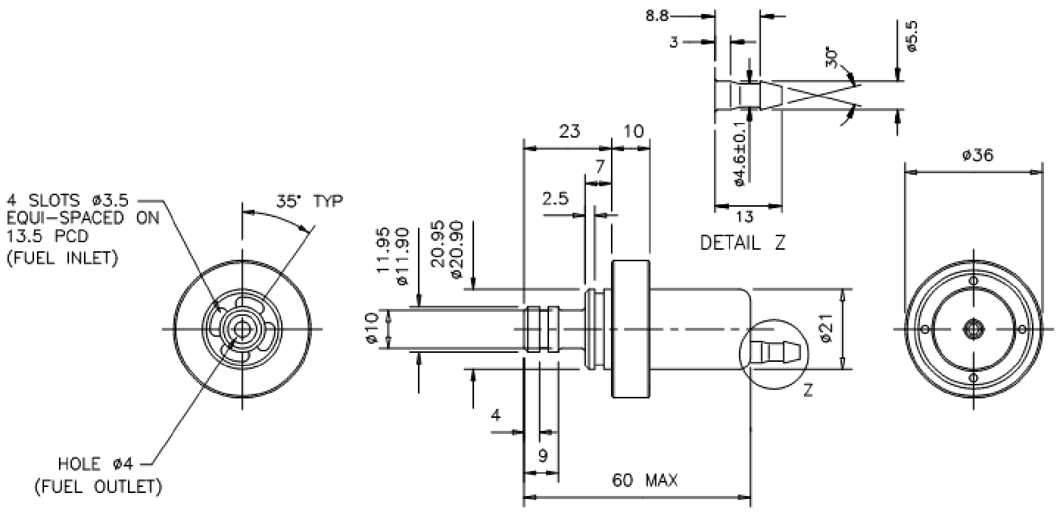
Rated Pressure	Maximum Pressure	Reflow Characteristic	Ordercode
3.5barg	5barg	<40mbar/(100l/h)	O 030 510 100 135
5.0barg	8barg	<50mbar/(100l/h)	O 030 510 100 105
6.0barg	10barg	<60mbar/(100l/h)	O 030 510 100 106
7.0barg	11barg	<70mbar/(100l/h)	O 030 510 100 107
8.0barg	12barg	<80mbar/(100l/h)	O 030 510 100 108
9.0barg	13barg	<80mbar/(100l/h)	O 030 510 100 109
10.0barg	14barg	<90mbar/(100l/h)	O 030 510 100 110
11.0barg	15barg	<100mbar/(100l/h)	O 030 510 100 111
12.0barg	16barg	<100mbar/(100l/h)	O 030 510 100 112
13.0barg	17barg	<110mbar/(100l/h)	O 030 510 100 113
14.0barg	18barg	<120mbar/(100l/h)	O 030 510 100 114
15.0barg	19barg	<130mbar/(100l/h)	O 030 510 100 115

Accessories	Ordercode
Set of two o-rings	O 030 510 990 001



Rated Pressure	Maximum Pressure	Reflow Characteristic	Ordercode
3.5barg	5barg	<40mbar/(100l/h)	O 030 510 200 035
5.0barg	8barg	<50mbar/(100l/h)	O 030 510 200 005
6.0barg	10barg	<60mbar/(100l/h)	O 030 510 200 006
7.0barg	11barg	<70mbar/(100l/h)	O 030 510 200 007
8.0barg	12barg	<80mbar/(100l/h)	O 030 510 200 008
9.0barg	13barg	<80mbar/(100l/h)	O 030 510 200 009
10.0barg	14barg	<90mbar/(100l/h)	O 030 510 200 010
11.0barg	15barg	<100mbar/(100l/h)	O 030 510 200 011
12.0barg	16barg	<100mbar/(100l/h)	O 030 510 200 012
13.0barg	17barg	<110mbar/(100l/h)	O 030 510 200 013
14.0barg	18barg	<120mbar/(100l/h)	O 030 510 200 014

Accessories	Ordercode
Set of two o-rings	O 030 510 990 001
Silicone Tube (one metre)	O 030 399 002 001



Rated Pressure	Maximum Pressure	Reflow Characteristic	Ordercode
3.5barg	5barg	<40mbar/(100l/h)	O 030 510 200 135
5.0barg	8barg	<50mbar/(100l/h)	O 030 510 200 105

Rated Pressure	Maximum Pressure	Reflow Characteristic	Ordercode
6.0barg	10barg	<60mbar/(100l/h)	O 030 510 200 106
7.0barg	11barg	<70mbar/(100l/h)	O 030 510 200 107
8.0barg	12barg	<80mbar/(100l/h)	O 030 510 200 108
9.0barg	13barg	<80mbar/(100l/h)	O 030 510 200 109
10.0barg	14barg	<90mbar/(100l/h)	O 030 510 200 110
11.0barg	15barg	<100mbar/(100l/h)	O 030 510 200 111
12.0barg	16barg	<100mbar/(100l/h)	O 030 510 200 112
13.0barg	17barg	<110mbar/(100l/h)	O 030 510 200 113
14.0barg	18barg	<120mbar/(100l/h)	O 030 510 200 114

Accessories	Ordercode
Set of two o-rings	O 030 510 990 001
Silicone Tube (one metre)	O 030 399 002 001

Pressure Sensor
Micro Amplified

The miniature amplified pressure sensor has been developed and manufactured exclusively for McLaren Electronics by GE Sensing.

The output voltage of this sensor changes with absolute pressure. An internal amplifier creates a single-ended, amplified output in the 0 to 5 Volt range, so the sensor can be connected directly to most control units. The body and diaphragm are impervious to chemical attack by standard motorsport fluids.

The Pressure connection is also available as M8x1.

Please request our installation datasheet for further details.

Application

- Absolute pressure measurement of all media.

Electrical

- Supply voltage 8 to 16V unregulated
- Supply current 5mA max
- Maximum output voltage 4.95V
- Span 4.5V ±0.05V @ 25°C
- Extrapolated zero offset #0.2±0.05V @ 25°C
- Thermal shifts:
  - Sensitivity #±2.5%FSO @ 25°C[1]
  - Zero offset #±2.5%FSO @ 25°C[1]
  - Combined non-linearity, repeatability & hysteresis #±0.25% FSO @ 25°C BSL
- Insulation resistance >100M# @ 50Vdc
- Gain and offset values are measured at 25°C and will be supplied with the sensor

The sensor is protected against reverse bias or short circuit between output and ground but it may be damaged if the output is connected to the supply.

[1]Over-compensated temperature range

Environmental

- Minimum pressure 0 bar
- Max pressure two times rated
- Burst pressure four times rated
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating Temperature -20 to +175°C
- Compensated temperature 0 to +175°C
- Viton jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

Cable and Connection Definition

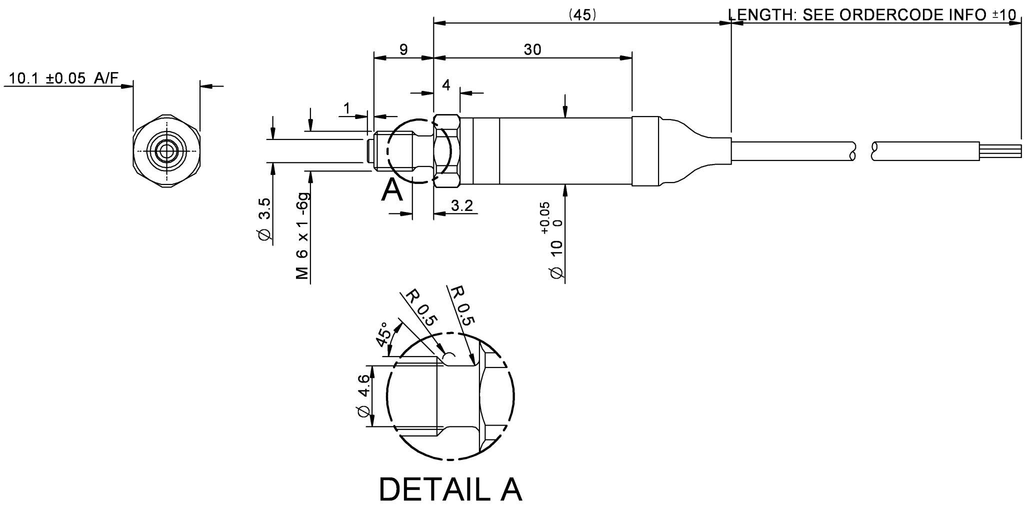
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- 26 AWG screened cable
- Connections:

Red wire	Pin 1	Supply +ve
Black wire	Pin 2	Ground
White wire	Pin 3	Pressure Signal

If our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, pressure fittings, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Mechanical

- Pressure connection also available as M8x1
- Stainless steel body 17-4PH and 316L
- Pressure ranges 5 to 250bar absolute (intermediate ranges available)
- Weight (including cable where fitted) is shown in the order details
- Maximum tightening torque 10Nm



Cable Length	Weight	Ordercode
1000mm	<30g	O 030 330 064 XXX

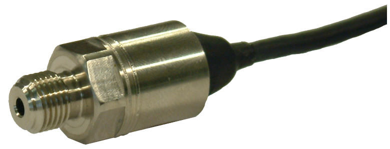
Sensors

Pressure Sensor

High-Temperature Amplified

The output voltage of this sensor changes with absolute pressure. An internal amplifier creates a single-ended, amplified output in the 0 to 5 Volt range, so the sensor can be connected directly to most control units. The body and diaphragm are impervious to chemical attack by standard motorsport fluids.

Please request our installation datasheet for further details.



Application

- Absolute pressure measurement of all media.

Electrical

- Supply voltage 8 to 16V unregulated
- Supply current 5mA max
- Maximum output voltage 4.95V
- Span 4.5V ±0.05V @ 25°C
- Extrapolated zero offset #0.2±0.05V @ 25°C
- Thermal shifts:
  - Sensitivity #2.5%FSO @ 25°C (0°C to 175°C)
  - Zero offset #2.5%FSO @ 25°C (0°C to 175°C)
- Combined non-linearity, repeatability & hysteresis:
  - #0.1%FSO @ 25°C BSL for ranges up to 60bar
  - #0.2%FSO @ 25°C BSL for ranges above 60bar
- Output impedance <100#
- Insulation resistance >100M# @ 50Vdc
- Long term ageing <0.10%FSO/year
- Temperature signal output 2.9V ±0.5V @25°C
- Temperature signal sensitivity 7mV/°C ±1mV/°C
- Gain and offset values are measured at 25°C and will be supplied with the sensor

The sensor is protected against reverse bias or short circuit between output and ground but it may be damaged if the output is connected to the supply.

Environmental

- Minimum pressure zero bar
- Max pressure two times rated (312.5bar max Stainless steel housing, 400bar max Titanium housing)
- Burst pressure three times rated (375bar max Stainless steel housing, 500bar max Titanium housing)
- Resistant to standard motorsport fluids compatible with Stainless steel 316L and Titanium IMI 160 (Titanium can be attacked by Methanol and some cleaning fluids
- Maximum humidity 100%
- Operating Temperature -30 to +175°C
- Compensated temperature -10 to +175°C
- DR25 jacketed cable (unless specified otherwise)
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

Cable and Connection Definition

- 24 AWG screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection (except where stated otherwise):

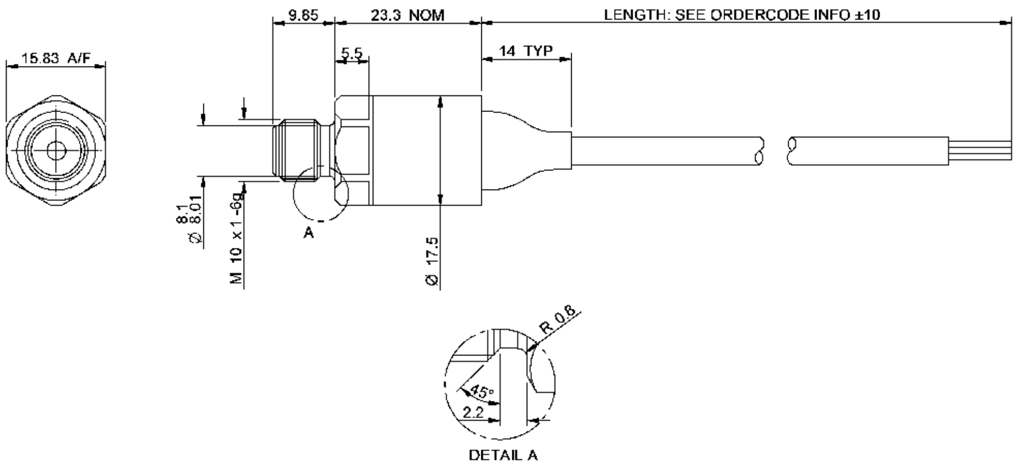
Red wire	Pin A	Pin 1	Supply
Black wire	Pin B	Pin 2	Ground
White wire	Pin C	Pin 3	Pressure Signal
Blue wire	Pin D	Pin 4	Temp. Signal
Screen	Pin E	Pin 5	N/C

The screen is connected to the sensor body. Either the sensor body or the cable screen should be connected to electrical earth but not both as this may create a ground loop.

Mechanical

- Titanium or stainless steel body
- Pressure ranges 1.6 to 250bar (intermediate ranges available)
- Weight (including cable where fitted) is shown in the order details
- Elastomer boot for strain relief to the sensor body

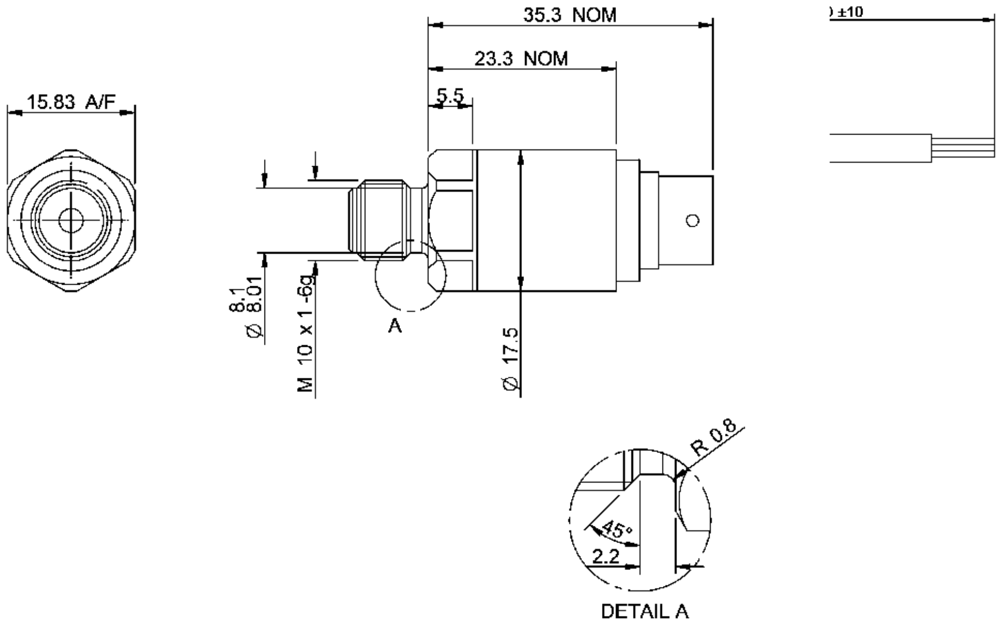
If our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, pressure fittings, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.



Cable Length	Body Material	Weight	Ordercode
1000mm	Stainless Steel	<63g	O 030 330 052 XXX
1000mm	Titanium	<52g	O 030 330 059 XXX

Accessories	Ordercode
O ring	O 030 330 990 000

Various pressure ratings are available up to maximum of 250bar. Please order using the above code stating your required pressure rating. Our technical consultancy service will then advise you of the full order code.



Cable Length	Body Material	Weight	Ordercode
ASH04-05-PN-HE	Stainless Steel	<36g	O 030 330 055 XXX
ASH04-05-PN-HE	Titanium	<25g	O 030 330 058 XXX

Accessories	Ordercode
O ring	O 030 330 990 000

Various pressure ratings are available up to maximum of 250bar. Please order using the above code stating your required pressure rating. Our technical consultancy service will then advise you of the full order code.

Pressure Sensor
High-Temperature Amplified (Minature)

The output voltage of this sensor changes with absolute pressure. An internal amplifier creates a single-ended, amplified output in the 0 to 5 Volt range, so the sensor can be connected directly to most control units. The body and diaphragm are impervious to chemical attack by standard motorsport fluids.

Please request our installation datasheet for further details.

Application

- Absolute pressure measurement of all media.

Electrical

- Supply voltage 8 to 16V unregulated
- Supply current 5mA max
- Maximum output voltage 4.95V
- Span 4.5V ±0.05V @ 25°C
- Extrapolated zero offset #0.2±0.05V @ 25°C
- Thermal shifts:
  - Sensitivity #2.5%FSO @ 25°C (0°C to 175°C)
  - Zero offset #2.5%FSO @ 25°C (0°C to 175°C)
  - Combined non-linearity, repeatability & hysteresis #0.25 FSO @ 25°C
- Output impedance <100#
- Insulation resistance >100M# @ 50Vdc
- Gain and offset values are measured at 25°C and will be supplied with the sensor

The sensor is protected against reverse bias or short circuit between output and ground but it may be damaged if the output is connected to the supply.

Electrical

- Minimum pressure 0bar
- Max pressure two times rated (375bar max)
- Burst pressure four times rated (375bar max)
- Resistant to standard motorsport fluids compatible with stainless steel 316L
- Maximum humidity 100%
- Operating Temperature -10 to +175°C
- Compensated temperature 0 to +175°C
- DR25 jacketed cable (unless specified otherwise)
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

Cable and Connection Definition

- 24 AWG screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection (except where stated otherwise)

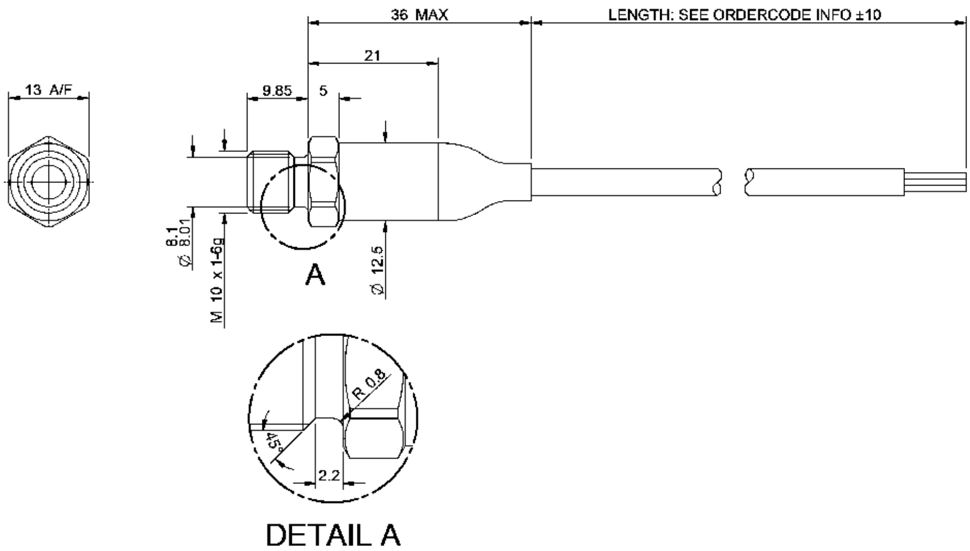
Red wire	Pin 1	Supply
Black Wire	Pin 2	Ground
White Wire	Pin 3	Pressure Signal
N/A	Pin 4	N/C
Screen	Pin 5	N/C

The screen is connected to the sensor body. Either the sensor body or the cable screen should be connected to electrical earth but not both as this may create a ground loop.

If our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, pressure fittings, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Mechanical

- Stainless steel body
- Pressure ranges 1.6 to 345bar (intermediate ranges available)
- Pressure connection also available as M8x1
- Weight (including cable where fitted) is shown in the order details
- Elastomer boot for strain relief to the sensor body

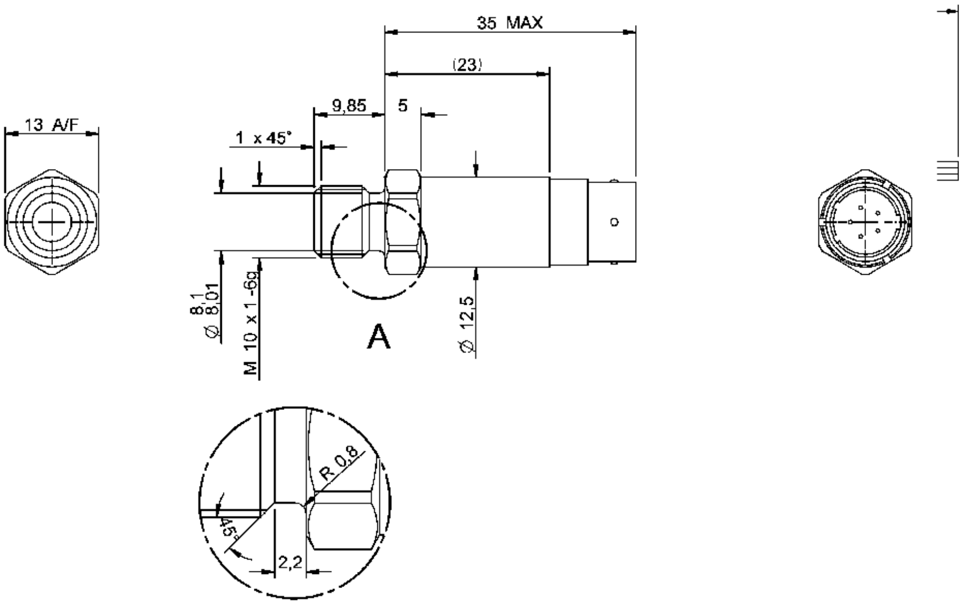


Cable Length	Body Material	Weight	Ordercode
1000mm	Stainless Steel	<58g	O 030 330 054 XXX

Accessories	Ordercode
O-ring	O 030 330 990 000

Various pressure ratings are available up to maximum of 345bar.

Please order using the above code stating your required pressure rating. Our technical consultancy service will then advise you of the full order code.



DETAIL A

Integral Connector	Body Material	Weight	Ordercode
ASH04-05-PN-HE	Stainless Steel	<24g	O 030 330 060 XXX

Accessories	Ordercode
O-ring	O 030 330 990 000

Various pressure ratings are available up to maximum of 345bar.

Please order using the above code stating your required pressure rating. Our technical consultancy service will then advise you of the full order code.

Pressure (Tyre)

Tire Pressure System
NASCAR (High Baud Rate)

The system consists of a set of battery powered sensors, each comprising a pressure sensor, transmitter and antenna, fitted to valves on the wheels. Three types of sensor bodies are available to suit valve stems of interliners and outer tires.

The sensors send data over an RF link, at a high baud rate, to a compact receiver on the car which passes it to the car data logger via CAN. An analog version is also available.

Electrical

Sensor TX

- Pressure range 4.4 to 100psi gauge (0.3 to 6.895 Bar)
- Pressure accuracy ±0.15psi (±10mBar) typical, ±0.3 psi (±20mBar) max
- Pressure resolution 0.06 psi/bit (4mBar/bit)
- On board temperature sensor
- Supply voltage 2.5-3.6V (Internal Lithium Thionyl Chloride battery)
- Life 5x106 transmissions without battery change (assuming operation at 77°F without dynamic loading)

Receiver RX

- Supply voltage 8 to 16Vdc
- Supply current 90mA @ 12V
- CAN bus 2.0B active, 1Mbps
- Recommended CAN card Vector CANcardXL
- Storage capacity 240 sensors

Each sensor transmits a unique encrypted serial number. A data disc is supplied for each sensor containing the 16-bit ID serial number and temperature and pressure calibration points.

RF Specification

- Modulation FM (FSK) encoded serial data
- Nominal frequency 433.92MHz
- Transmission range 49ft (15m)

Message Type 1 (20.4ms duration)
<Serial No>
<Board Temp>
<Pressure>
<TX count>

Message Type 2 (20.4ms duration) <Serial No>
<Vbatt>(measured on full load)
<Thermocouple>
<TX count>

Message Type 3 (20.4ms duration)
> <Serial No>
<TX Life count>
<Thermocouple>
<TX count>

Rate	Pressure Threshold	Nominal Transmission Rate	Message Type
0	<8psi (Gauge)	0	No TX

Rate	Pressure Threshold	Nominal Transmission Rate	Message Type
1	>8psi (Gauge)	4Hz (0.25s)	1, 1, 1, 1, 2, 1, 1, 1, 1, 3 cyclically

Rate 0 applies when the pressure is <1.05 Bar (15.2psi). Sensor does not transmit but continues to sample the pressure. Rates 1-2 apply when the pressure is >1.05Bar (15.2psi) gauge.

Rates quoted are for Vsupply = 3.6V and 77°F. Rates slow down linearly with increasing temperature and reducing Vsupply. Rates are # 0.63 quoted values under combined worst case condition of Vsupply = 2.5V and temperature 275°F.

Mechanical

CAN Receiver RX

- Aluminium case, hard anodised black
- Total weight 0.26lb (0.21lb without the antenna)
- Connector ASL0-06-05-PN-HE
- Connection

Pin 1	Supply
Pin 2	Ground
Pin 3	CAN +
Pin 4	CAN -
Pin 5	N/C

Analogue Receiver RX

- Aluminium case, hard anodised black
- Total weight 0.30lb (0.25lb without the antenna)
- Connector AS2-10-35PN
- Connection

Pin 1	Supply
Pin 2	Analogue 3
Pin 3	N/C
Pin 4	CAN +
Pin 5	CAN -
Pin 6	N/C
Pin 7	Analogue 2
Pin 8	Analogue Ground
Pin 9	Analogue 1
Pin 10	Ground
Pin 11	Analogue 4
Pin12	N/C
Pin 13	N/C

Sensor TX

- Sensor weight 0.11lb
- Sensor lid and body 6AL4V titanium
- Antenna cover polyester
- Approximately five factory battery changes per sensor without compromising reliability
- Assembly torque 47lbf.in (5.3Nm)

Environmental

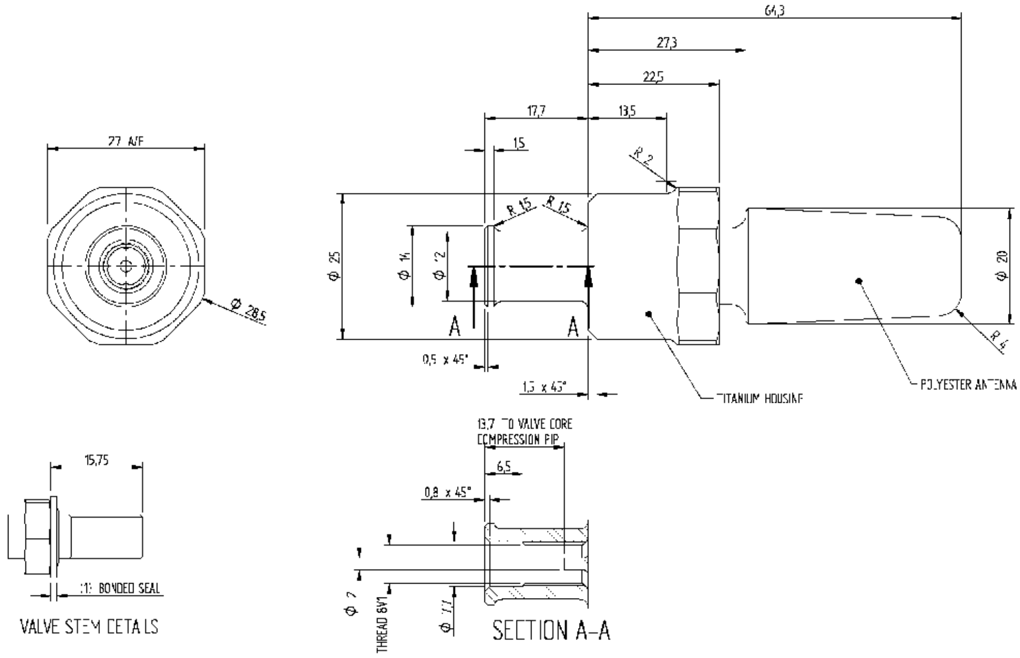
Sensor TX

- Resistant to standard motorsport fluids
- Operating temperature +50 to +275°F
- Vibration 50 to 2500Hz @ 40g eight hours per axis
- Shock 50g(max), 1/2sine for 11ms, five times per axis

Receiver RX

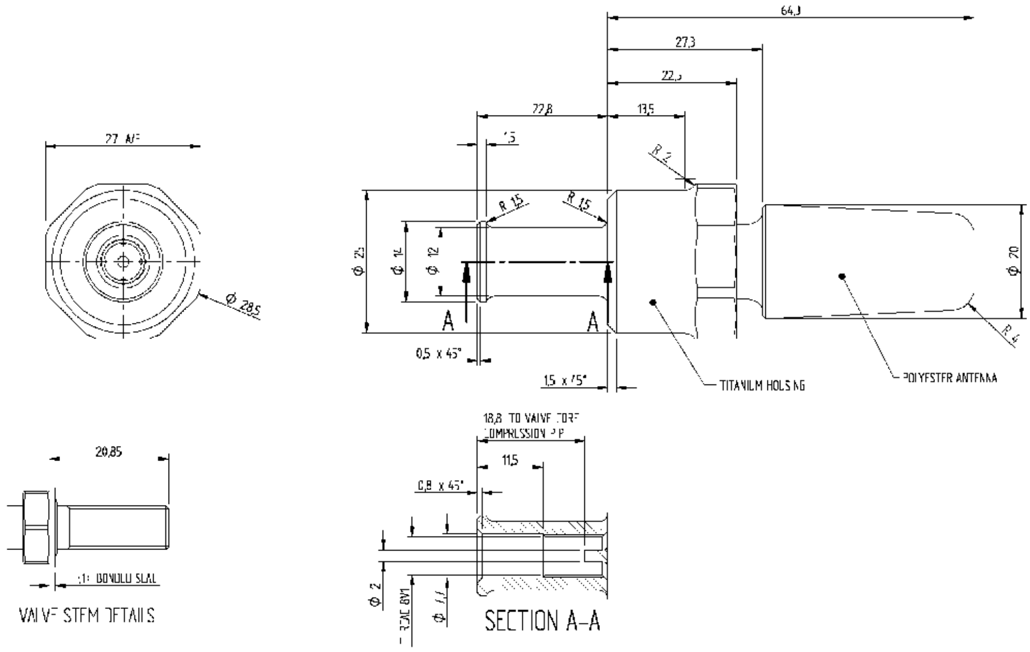
- Resistant to standard motorsport fluids

- Operating temperature +50 to +185°F
- Vibration random spectrum for two hours in one axis



Description	Ordercode
External valve mounted tire pressure sensor for Outer	O 030 330 046 058

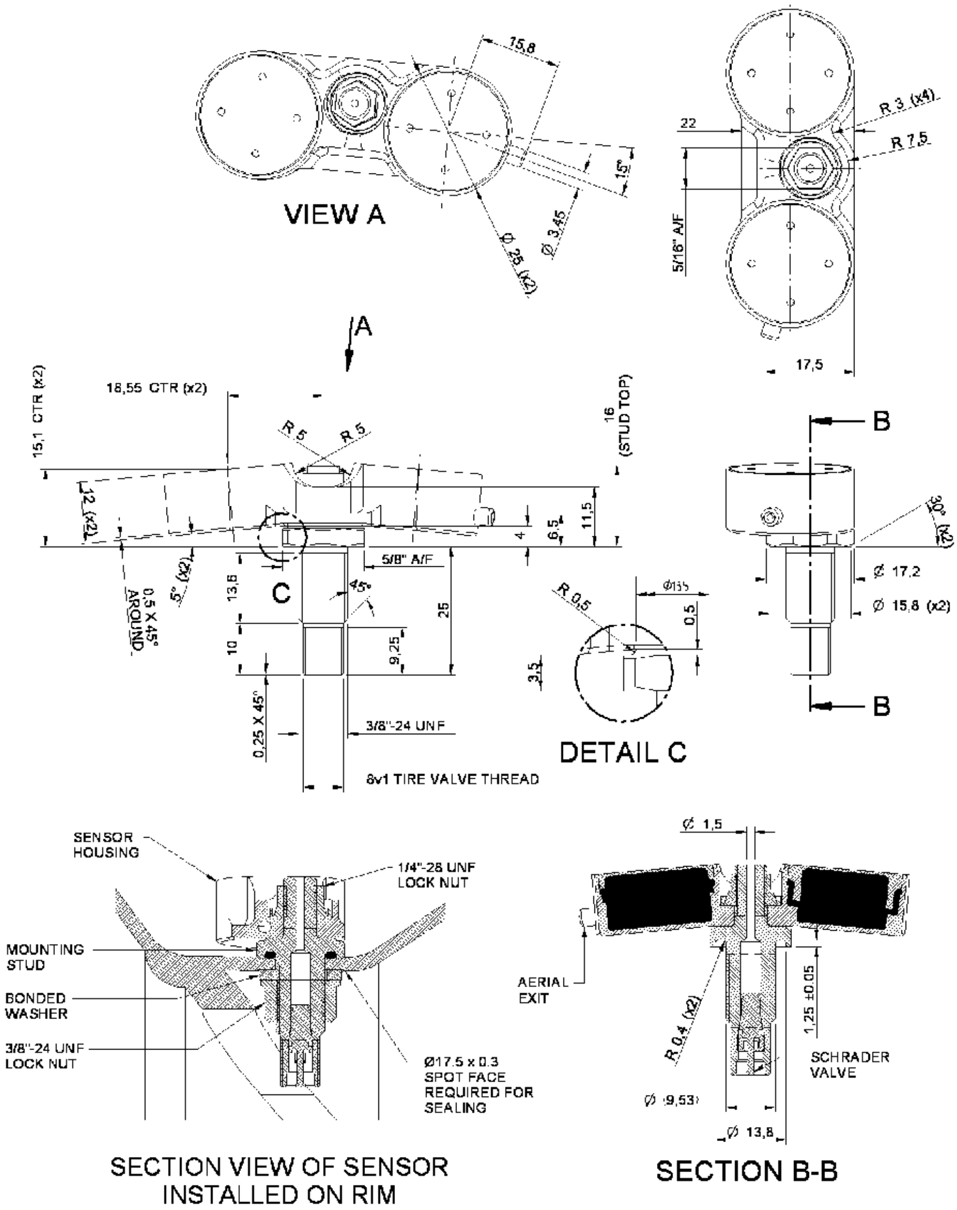
Spare Sensor Parts	Ordercode
Dowty bonded seal for valve mounted sensor	O 030 330 990 016



Description	Ordercode
External valve mounted tire pressure sensor for Interliner	O 030 330 046 057

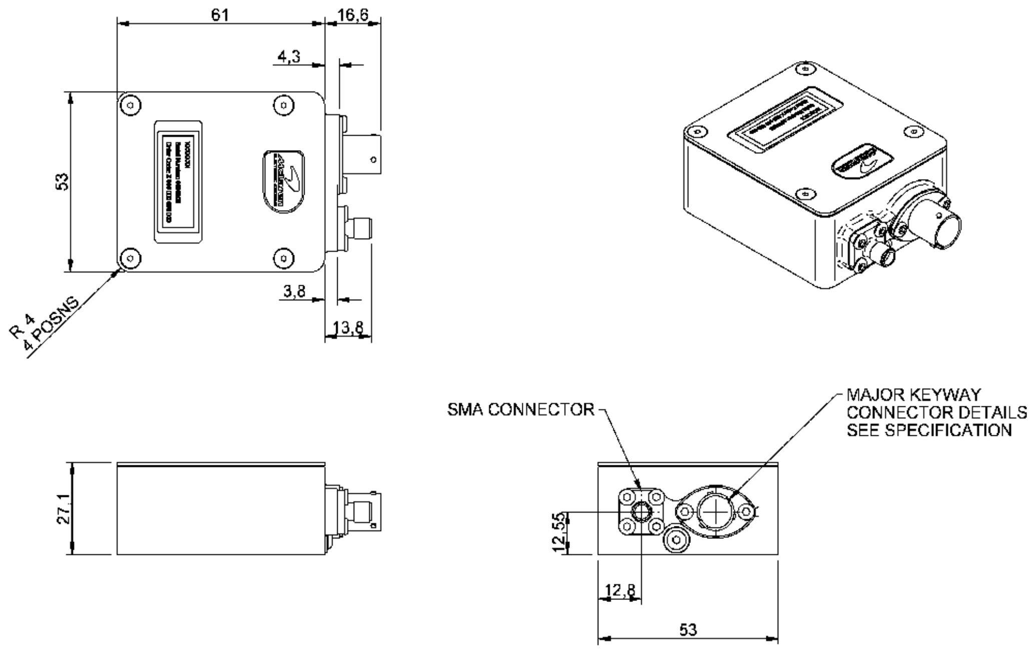
Spare Sensor Parts	Ordercode
Dowty bonded seal for valve mounted sensor	O 030 330 990 016

Sensors

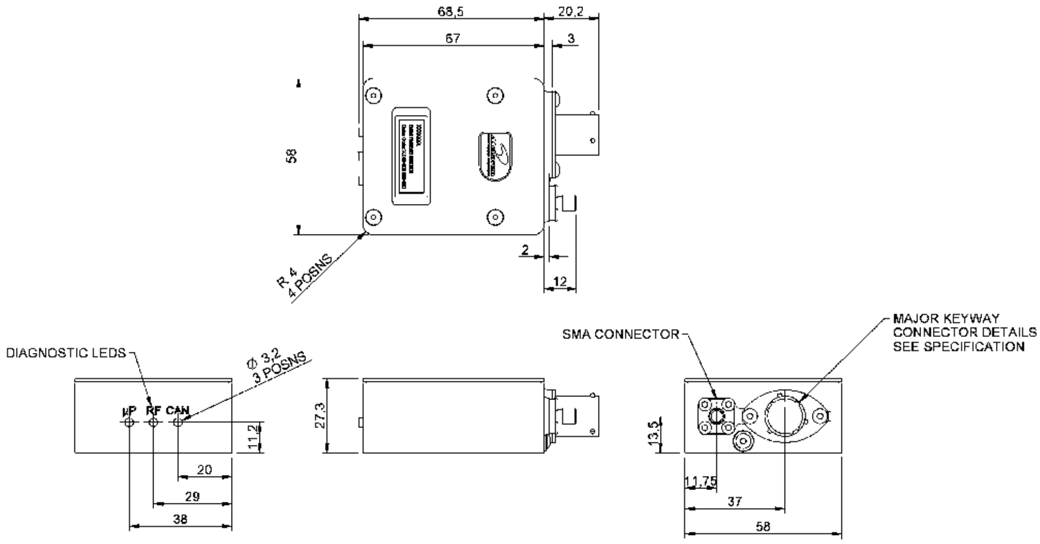


Description	Ordercode
External valve mounted tire pressure sensor for Interliner (includes valve/stud kit)	O 030 330 046 052

Spare Sensor Parts	Ordercode
Valve/stud kit (mounting stud, O ring, 3/8” lock nut, 1/4” lock nut, dowty bonded seal, Schrader valve) for the internal valve mounted tire pressure sensor	O 030 330 990 027



Description	Ordercode
CAN linked tire pressure receiver (with antenna included)	O 030 330 046 059
CAN receiver connection lead (for powering the receiver unit and connecting CAN bus)	O 030 330 990 012



Description	Ordercode
Analog linked tire pressure receiver (with antenna included)	O 030 330 046 060
Analog receiver connection lead (for powering the receiver unit, connecting analogue outputs CAN bus)	O 030 330 990 017

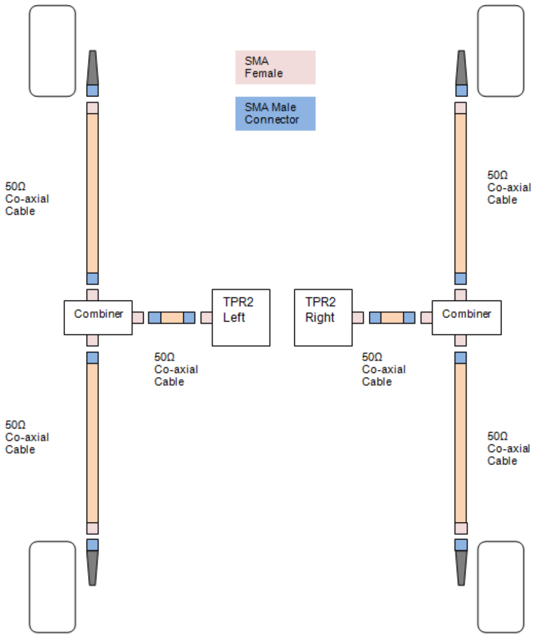
Additional Receiver Parts	Ordercode
Antenna	O 030 330 990 008
Receiver antenna combiner	O 030 330 990 020

Additional Receiver Parts	Ordercode
CANcase (for connecting the receiver to a PC for sensor configuration via USB port)	O 030 330 990 021

Recommended Setup

To minimise the number of message clashes between sensors and to maximize the reception, we recommend the use of an antenna in each corner of the car. The antennas should be located in the wheel arches and positioned either pointing downwards or to the front or back of the car. Ideally the shell of the SMA connector, at the antenna end of the co-axial cable, should be connected to the chassis. It is important that the antenna does not lie against metal, but is pointing away from metal.

Connect the two antennas of the left-hand side to a receiver via a combiner and the two antennas of the right-hand side to a second receiver via a combiner, as shown on the diagram below.



Tyre Pressure and Infra-Red Sensor (High Baud Rate)

The system consists of a powered pressure and temperature sensor with transmitter fitted to a wheel rim. This sends pressure and temperature data over an RF link to a compact receiver on the car. Sampling rates increase automatically when either a change in pressure is detected or when wheel inertia is detected. The system stops transmitting below a threshold pressure to preserve battery life. The receiver sends data to the car control via CAN.

Electrical

- Supply voltage 2.8-3.6V (internal Lithium Thionyl Chloride battery)
- Lifetime[1] > 300,000 transmissions
- Transmission count included in transmitted data
- Battery voltage measured on full load
- Transmission rate: governed by rate of change of pressure and rotation of the wheel. Structured to preserve battery life.

Tyre Pressure

- Pressure range 4.4 to 30psi gauge (0.3 to 2.068 Bar)
- Pressure resolution 0.01 psi/bit (0.69mBar/bit)
- Pressure accuracy ±0.15psi (±10mBar) typical, ±0.3 psi (±20mBar) max

Tyre Temperature (IR Sensor)

- Output voltage

Target -20°C	Output 0.30V
Target +150°C	Output 2.70V

- Compensated temperature range +60°C to +120°C
- Temperature resolution 0.052°C/bit
- Temperature accuracy ±3°C
- Repeatability ±1°C

Board Temperature

- On-board KTY82-210 temperature sensor
- Temperature sensor range -50°C to +150°C
- Temperature resolution 0.17°C/bit

RF Specification

- Compatible with High Baud rate TPR3
- Modulation FM (FSK) encoded serial data
- Nominal frequency 433.920MHz
- Nominal baud rate 64kbps
- Transmission range 15m (typ)
- Each sensor transmits a unique serial number
- All transmitted data is encrypted
- Message content depends on type as follows:

  Message Type 1 (3.7ms duration)
  <Serial No>
  <Board Temp>
  <Pressure>
  <TX count>
  Message Type 2 (3.7ms duration)
  <Serial No>
  <Vbatt>(measured on full load)
  <Tyre temp (IR sensor)>
  <TX count>
  Message Type 3 (3.7ms duration)
  <Serial No>
  <TX Life count>

<Tyre temp (IR sensor)>
<TX count>

Tx Rate	Inertial switch	Pressure	Board Temperature	Nominal Threshold dp/dt (mBar/s)	Nominal Tx rate, Hz(s)	Message type
0	X	<0.3Bar	<40°C	--	0	No TX (Internal sampling of pressure and Board temp at 0.4Hz)
1	X	>0.3Bar	<40°C		0.0167Hz (60.0s)	1, 1, 2, 1, 1, 3 cyclically (Internal sampling of pressure and Board temp at 0.4Hz)
2	LOW	>0.3Bar	>40°C		0.010Hz (10.0s)	1, 1, 2, 1, 1, 3 cyclically (Internal sampling of pressure and Board temp at 0.4Hz)
3	HIGH	>0.3Bar	X		2.0Hz (0.5s)	1, 1, 2, 1, 1, 3 cyclically
4	X	>0.3Bar	X	1.5	2.0Hz (0.5s)	1, 1, 2, 1, 1, 3 cyclically

Rate 0: applies when the pressure is <0.3 Bar gauge and Board Temperature is less than 40°C. Sensor does not transmit but continues to sample the pressure and board temperature.

Rate 1: The IR element will not be enabled to preserve battery life. Therefore the IR measurements when operating in rate1 will not be valid.

Before the sensor changes to a lower Tx rate it will transmit 10 messages at the higher rate.

Rates quoted are for Vsupply = 3.6V and 25°C. Rates slow down linearly with increasing temperature and reducing Vsupply. Rates are # 0.63 quoted values under combined worst case condition of Vsupply = 2.5V and temperature = 135°C.

Data Supplied

The following data is supplied on data disc for each sensor:

- Full 16-bit ID serial number
- Sensor output at two pressure set points measured at two temperature set points

Mechanical

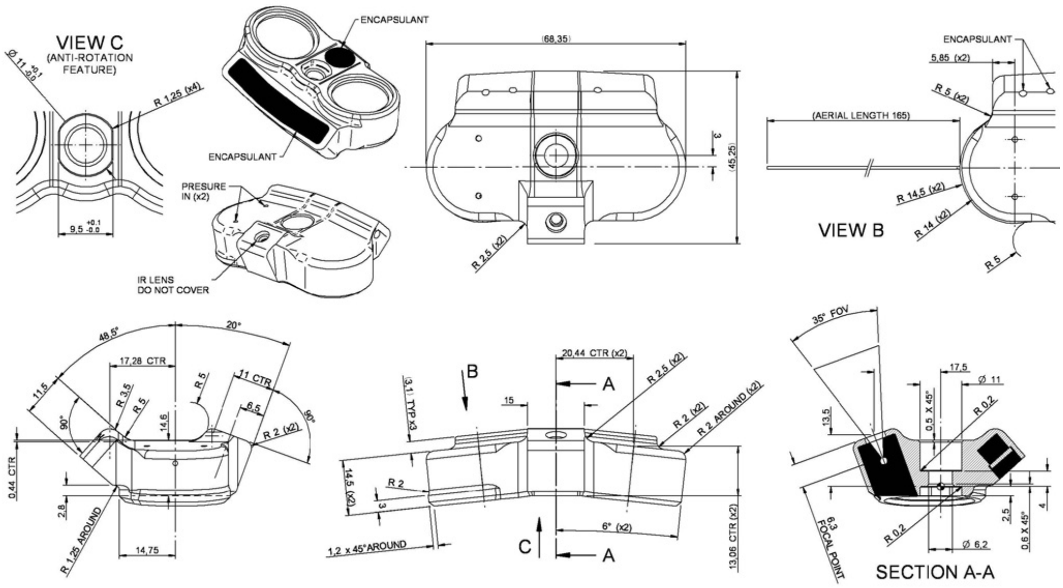
- Sensor incorporates Schrader valve in separate valve stem for tyre inflation
- Sensor weight <45g
- Valve stem 6AL4V Titanium (Ti Nitride coating)
- Sensor housing PEEK GF30
- 3/8UNF stud nut max torque 25Nm (18.4lbf/ft)
- M6 sensor nut max torque 8Nm (5.9lbf.ft)

Environmental

- Resistant to standard Motorsport fluids
- Operating temperature[2] +10 to +135°C
- Vibration 50 to 2500Hz @ 40g eight hours per axis
- Shock 50g(max), 1/2sine for 11ms, five times per axis

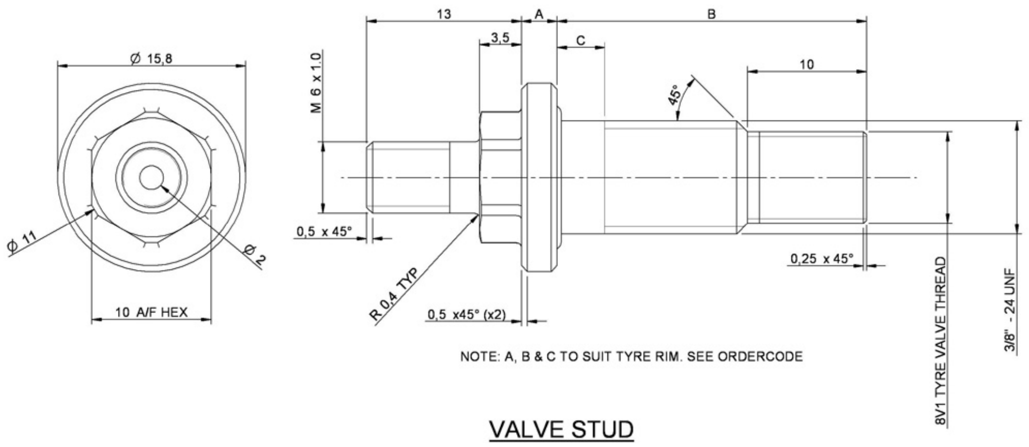
[1] Assuming the sensor is subjected to the following conditions leading to and during a Formula1 race weekend:
Rate0 – 240 Hours
Rate1 – 91 Hours
Rate2 – 4 Hours
Rate3 or 4 – 1 Hour

[2] Absolute maximum operating temperature +150°C. Operating the sensor above 135°C will reduce the life of the battery.

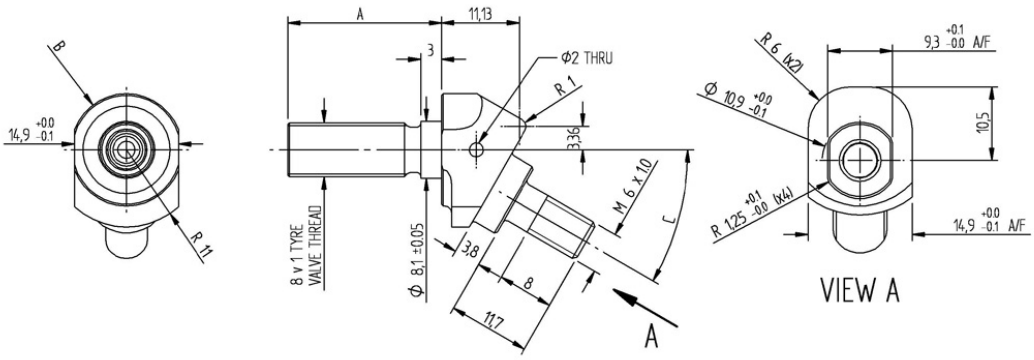


Description	Ordercode
Combined Tyre Pressure and Infra Red Sensor	O 030 330 046 075

Sensor housing and stud designs can be tailored to suit individual wheel rims. The outline drawings shown within this product summary are examples for which other bespoke designs may be based upon. Please contact MESL for further assistance.



Description	Dimension A	Dimension B	Dimension C	Ordercode
Valve stud	3mm	26mm	4mm	O 030 330 990 018



Description	Dimension A	Dimension B	Dimension C	Ordercode
Valve stud kit (O-ring, M6 K-nut, Schrader valve insert)	22mm	Ø16mm	30°	O 030 330 990 023

Tyre Pressure Dash Display

The tyre pressure display unit is a combined receiver/display unit for use with MES tyre pressure sensors. The sensors transmit pressure, temperature, battery voltage, serial number and life count data over an RF link to an antenna on the car. Signals from the antenna are passed to the TP display unit were they are decoded and displayed on the LCD screen. The TP display is aimed at racing car applications in which data logging and pit telemetry are not used. The unit is intended to be mounted on the dash and enables the driver to monitor the tyre pressures from the cockpit.

Sensors

Features

- Four line, 16 character LCD
- Optical sensor to control backlight of LCD
- Pressure status warning LEDs
- Configurable display
- CAN interface
- Unit available with either analogue outputs or external switch and audible warning control lines

Electrical

- Supply voltage 8 to 16Vdc
- Supply current 150mA max @12V typical, 170mA @12V max
- CAN bus 2.0B active, 1Mbps

Mechanical

- Weight less than 0.5lb (without antenna)
- Aluminium alloy housing, anodised and dyed black

Environmental

- Unit sealed with o-rings and screws sealed with silicon rubber
- Maximum humidity 100%
- Operating temperature 10 to +50°C
- Vibration 5 to 2000Hz @ 5g, 2 hours

Connection Definition

- Connector ASDD206-09PN-HE (Audible warning variant)

Pin 1	Supply +ve
Pin 2	Power ground
Pin 3	CAN -
Pin 4	CAN +
Pin 5	Audible control line
Pin 6	External switch
Pin 7	Ground
Pin 8	N/C
Pin 9	N/C

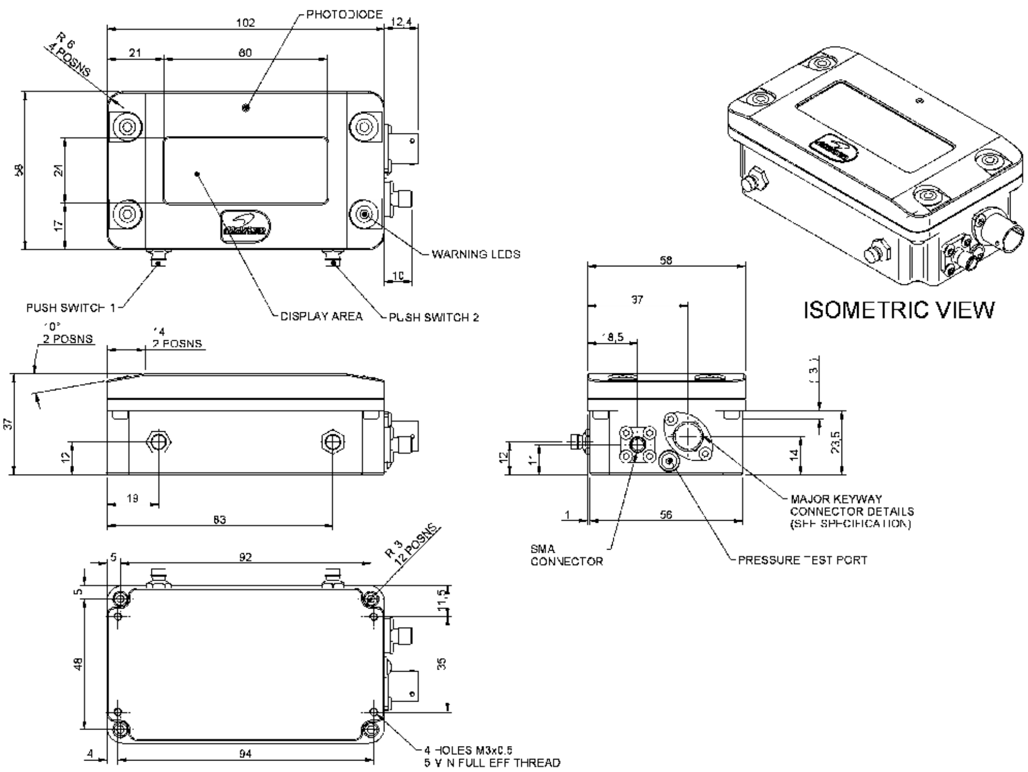
- Connector ASDD206-09PN-HE (Analogue variant)

Pin 1	Supply +ve
Pin 2	Power ground
Pin 3	CAN -
Pin 4	CAN +
Pin 5	Signal ground
Pin 6	Analogue signal 1
Pin 7	Analogue signal 2

Pin 8	Analogue signal 3
Pin 9	Analogue signal 4

- Antenna connector SMA socket

Case	RF ground
Centre	RF in



Description	Ordercode
Tyre Pressure Receiver Dash/Display	O 030 330 046 020
Tyre Pressure Reciever Dash/Display Analogue variant	O 030 330 046 028

Tyre Pressure Receiver
Formula One SECU version

The tyre pressure receiver unit is for use with MESL high baud rate tyre pressure sensors. The sensors transmit pressure, temperatures, battery voltage, serial number and life count data over an RF link to an antenna on the car. Signals from the antenna are passed to the tyre pressure receiver unit where they are decoded and sent to the ECU via CAN to be further processed and scaled.

This variant is for use with the FIA single ECU. The calibration data for the sensors will be stored in the ECU allowing the package of the receiver to be greatly reduced.

Sensors

Application

- Tyre pressure measurement in conjunction with the Microsoft-MES Formula One SECU.

Electrical

- Supply voltage 8 to 16Vdc
- Supply current 35mA max @12V
- CAN bus 2.0B active, 1Mbps

RF Specification

- Modulation FM (FSK) encoded serial data
- Nominal frequency 433.920 MHz
- Nominal baud rate 64kbps
- Transmission range 15m typical

Mechanical

- Weight less than 60g (excluding antenna)
- Aluminium alloy housing, hard anodised and dyed black

Environmental

- Resistant to standard motorsport fluids
- Operating temperature +10 to +85°C
- Maximum humidity 100%
- Vibration random spectrum for two hours in connector axis

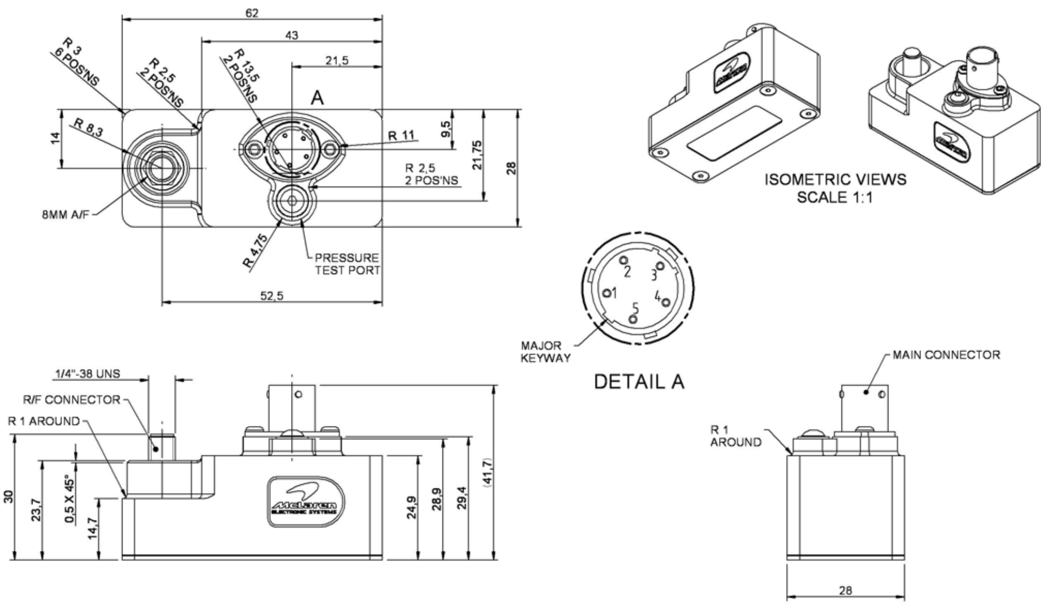
Connection Definition

- Connector ASL2-06-05PN-HE

Pin 1	Supply
Pin 2	Ground
Pin 3	CAN +
Pin 4	CAN -
Pin 5	N/C

- Antenna connector SMA socket

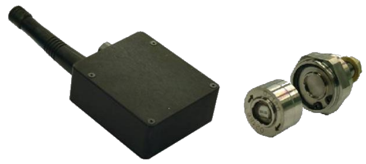
Case	RF ground
Centre	RF in



Cable Length	Ordercode
Tyre Pressure Receiver (High Baud rate) F1 Version	O 030 330 046 067

Tyre Pressure System

The system consists of a powered pressure sensor with transmitter fitted to a wheel rim, this sends data over an RF link to a compact receiver on the car. Sampling rates increase automatically when a change in pressure is detected and the system shuts down below a threshold pressure to preserve battery life. The receiver sends data to the car ECU via CAN. An analogue version is also available.



Electrical

Sensor TX

- Supply voltage 2.5-3.6V (Internal Lithium Thionyl Chloride battery)
- Life 5x10^6 (transmissions without battery change)[*]
- Transmission count included in transmitted data
- Pressure range 4.4 to 30psi gauge (0.3 to 2.068 Bar)
- Pressure resolution 0.01 psi/bit (0.69mBar/bit)
- Pressure accuracy ±0.15psi (±10mBar) typical, ±0.3 psi (±20mBar) max
- Internal KTY82-210 Positive TC sensor for board measurement
- Temperature sensor range -50°C to +150°C
- Temperature resolution 0.17°C/bit
- Battery voltage measured on full load
- Transmission rate: governed by rate of change of pressure and structure to preserve battery life

[*] For the operating temperature range +10°C to +135°C

RF Specification

Rate	Nominal Threshold dp/dt (mBar/s)	Nominal Transmission rate, Hz(s)	Message type
0	-	-	No TX (Internal sampling of pressure at 0.39Hz)
1	-	0.39Hz (2.56s)	1, 2, 1, 3 cyclically
2	1.5	2.0Hz (0.5s)	1

- Compatible with high baud rate TPR3
- Modulation FM (FSK) encoded serial data
- Nominal frequency 433.920MHz
- Nominal baud rate 64kbps
- Transmission range 15m(typ)
- Each sensor transmits a unique serial number
- All transmitted data is encrypted
- Message content depends on type as follows:-

Message Type 1 (3.7ms duration)
<Serial No>
<Board Temp>
<Pressure>
<TX count>

Message Type 2 (3.7ms duration)
<Serial No>
<Vbatt>
<Thermocouple>
<TX count>

Message Type 3 (3.7ms duration)
<Serial No>
<TX Life count>
<Thermocouple>
<TX count>

The thermocouple output will be invalid as no thermocouple is fitted

Rate 0 applies when the pressure is <0.3Bar gauge. Sensor does not transmit but continues to sample the pressure.

Rates 1-2 apply when the pressure is >0.3Bar gauge.

Rates quoted are for Vsupply = 3.6V at 25°C. Rates slow down linearly with increasing temperature and reducing Vsupply. Rates are approximately 0.63 times the quoted values under combined worst case condition of Vsupply = 2.5V and 135°C.

Mechanical

CAN Receiver RX

- Aluminium case, hard anodised black
- Total weight 119g (95g without the antenna)
- Connector ASL0-06-05-PN-HE
- Connections:

Pin 1	Supply
Pin 2	Ground
Pin 3	CAN +
Pin 4	CAN -
Pin 5	N/C

Analogue Receiver RX

- Aluminium case, hard anodised black
- Total weight 139g (115g without the antenna)
- Connector AS2-10-35PN
- Connections:

Pin 1	Supply
Pin 2	Analogue 3
Pin 3	N/C
Pin 4	CAN +
Pin 5	CAN -
Pin 6	N/C
Pin 7	Analogue 2
Pin 8	Analogue Ground
Pin 9	Analogue 1
Pin 10	Ground
Pin 11	Analogue 4
Pin 12	N/C
Pin 13	N/C

Sensor TX

- Standard sensor weight 18g, complete sensor and housing weight 42g
- Valve mounted sensor weight <35g
- Sensor lid, housing and rim housing 6AL4V titanium
- Approximately five factory battery changes per sensor without compromising reliability
- Bespoke designs can be offered to suit the wheel rim profile. Integral to the valve stem and fitted to the rim inside of the tyre, the design can be tailored to the rim to ensure profile is kept to a minimum for ease of tyre mounting.

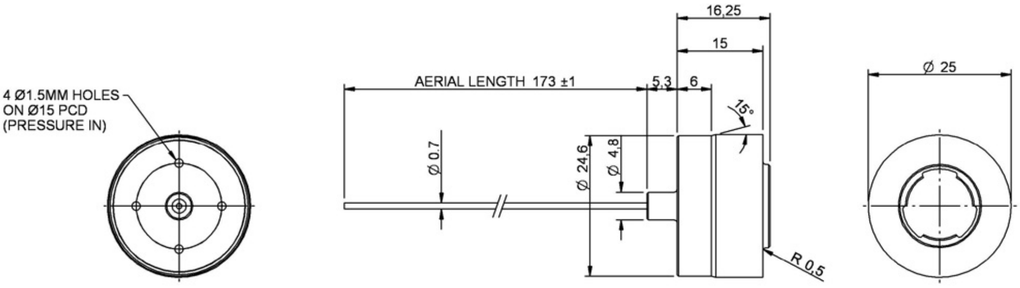
Mechanical

Sensor TX

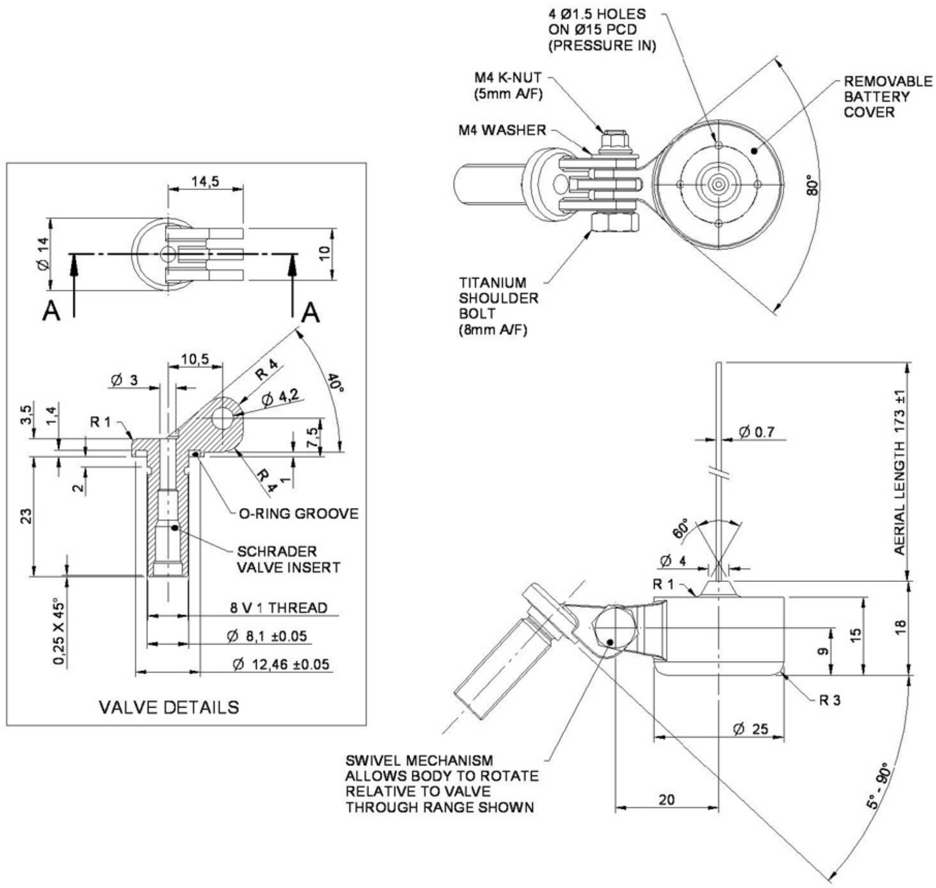
- Resistant to standard Motorsport fluids
- Operating temperature +10 to +135°C
- Vibration 50 to 2500Hz @ 40g eight hours per axis
- Shock 50g(max), 1/2sine for 11ms, five times per axis

Recevier RX

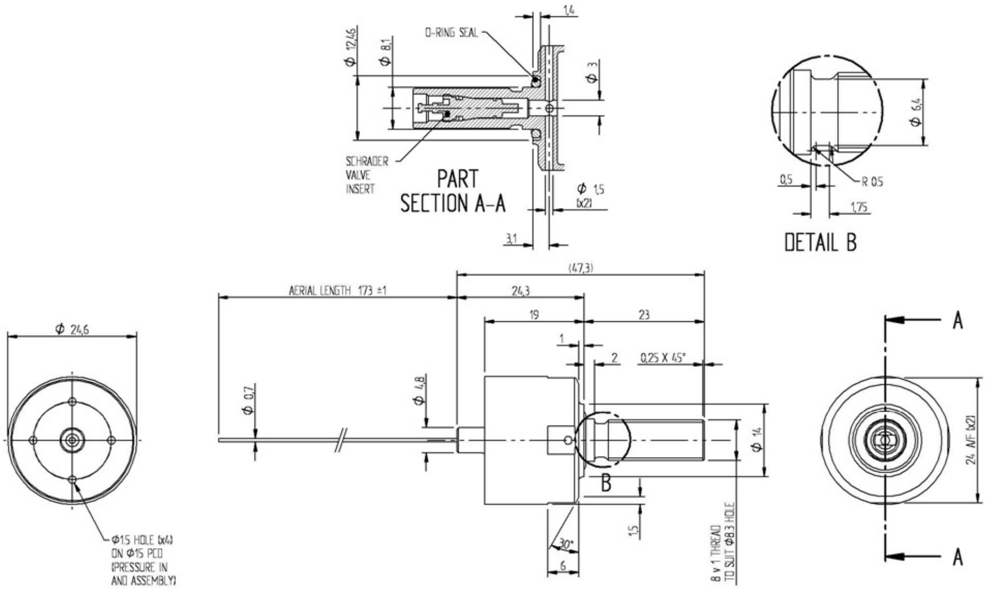
- Resistant to standard Motorsport fluids
- Operating temperature +10 to +85°C
- Vibration random spectrum for two hours in one axis



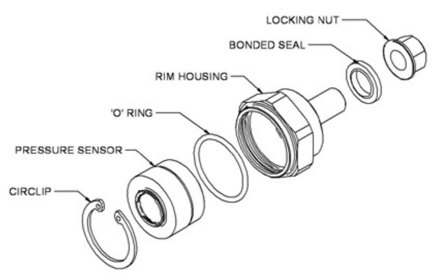
Description	Ordercode
Standard tyre pressure sensor (high baud rate)	O 030 330 046 076
Tyre pressure sensor with humidity measurement (high baud rate)	O 030 330 046 083



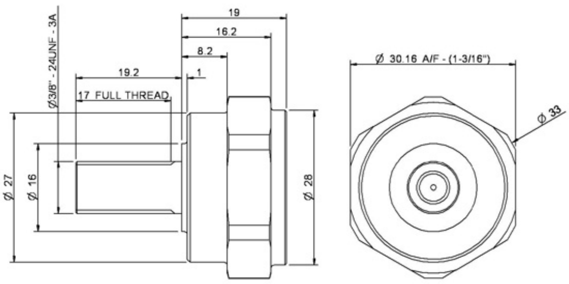
Description	Ordercode
Internal valve mounted adjustable tyre pressure sensor (high baud rate)	O 030 330 046 084



Description	Ordercode
Internal valve mounted tyre pressure sensor (high baud rate)	O 030 330 046 085

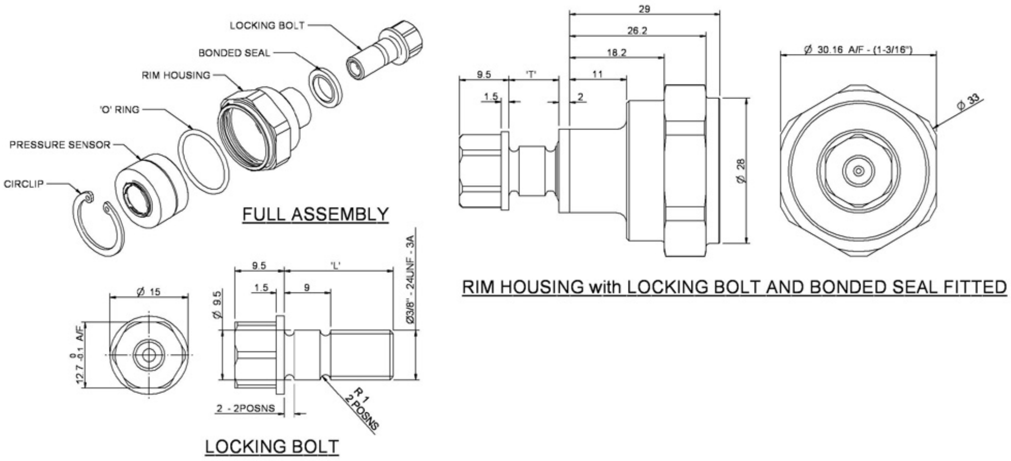


FULL ASSEMBLY



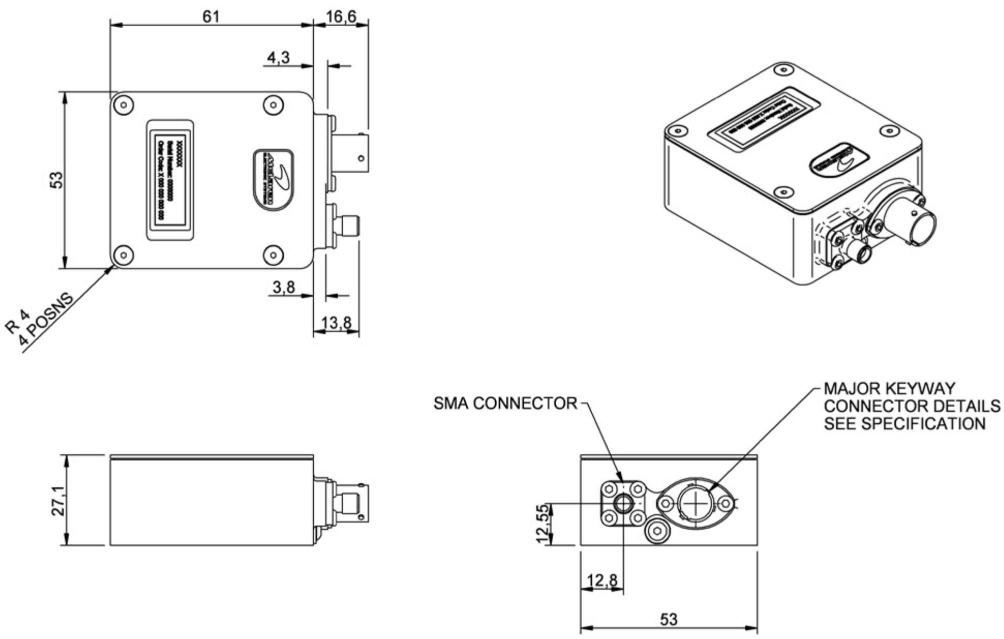
RIM HOUSING

Description	Ordercode
Nut-fixed rim housing (including housing, bonded seal, o-ring, circlip and K nut)	O 030 330 046 004



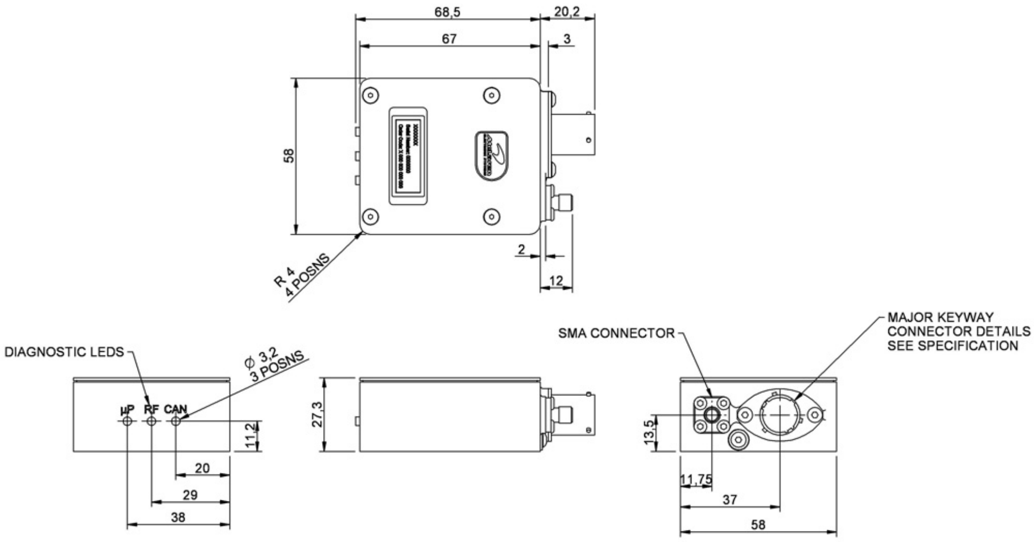
Description	Ordercode
Bolt-fixed Rim Housing Assembly (including housing, bonded seal, o-ring and circlip – bolts to be ordered separately)	O 030 330 046 008
Long locking bolt	O 030 330 990 010
Short locking bolt	O 030 330 990 011

Sensor Sensor Parts	Ordercode
Removal Tool	O 030 330 990 003
Dowty Bonded Seal	O 030 330 990 004
Circlip (for retaining sensor in housing)	O 030 330 990 005
Internal o-ring (for sealing sensor into housing)	O 030 330 990 006
“K” nut (for locking rim housing to rim)	O 030 330 990 007



Description	Ordercode
CAN linked tyre pressure receiver (with antenna included) (high baud rate)	O 030 330 046 081

Description	Ordercode
CAN receiver connection lead	O 030 330 990 012



Description	Ordercode
Analogue linked tyre pressure receiver (with antenna included) (high baud rate)	O 030 330 046 082
Analogue receiver connection lead	O 030 330 990 017

Additional Receiver Parts	Ordercode
Antenna (spare)	O 030 330 990 008
CANcard (for connecting the receiver to a PC for sensor configuration)	O 030 330 990 015

Signal Conditioning

Linear Variable Differential Transformer

AC to DC Converter

The output of a Linear Variable Differential Transformer (LVDT) is an alternating voltage with a magnitude which varies in proportion to the position of a magnetic core within the sensor. The output of the AC to DC converter is a DC voltage, in the 0 to 5V range, which is also proportional to core location. The converter also supplies the AC excitation voltage for the LVDT. The interface is available either as a circuit board for OEM installations or encapsulated in a heatshrink boot.

Application

- Conversion of LVDT output to a linear, DC signal in the 0 to 5V range.

Electrical

The following electrical characteristics are to suit a Schaevitz MHR1000 LVDT (Sensitivity 30mv/v/mm, Stroke ±25.4mm, Secondary to Primary transformer ratio at null 2). The interface can be configured for other LVDTs. Please contact our technical consultancy service if you require this service.

- Supply voltage 10 ±0.4V DC regulator
- Supply current 35mA max
- Output range 4 ±0.2V DC for full stroke of LVDT
- Output for zero displacement 2.5 ±0.1V DC
- Maximum output voltage ±10V DC
- Bandwidth 1kHz (can be adjusted during manufacture)
- Excitation voltage 2.2 ±0.25V rms (other voltages can be supplied)
- Excitation frequency 10kHz ±10% (other frequencies between 20Hz and 20kHz can be supplied)

Zero displacement is at the centre of the LVDT. Output decreases as the cores moves into secondary A and increases as it moves into secondary B.

Mechanical (Encapsulated unit)

- Weight less than 70g including cable
- Elastomer boot for strain relief to the interface body

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Cable and Connection Definition

- Input cable (where fitted) 24 AWG five-core screened
- Output cable (where fitted) 22 AWG three-core screened
- Cable length (where fitted) is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Input Connection:

Red Wire	Pin A	Pin 1	Primary +
Black Wire	Pin B	Pin 2	Primary –
Green Wire	Pin C	Pin 3	Secondary A
Blue Wire	Pin D	Pin 4	Secondary B
White Wire	Pin E	Pin 5	Secondary Centre

- Output Connection:

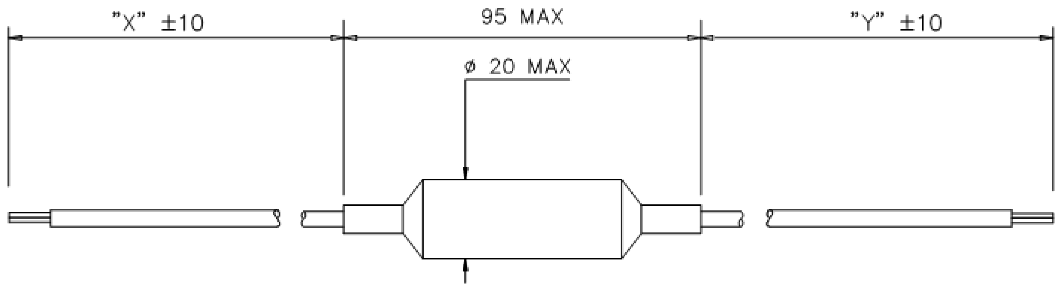
Red Wire	Pin A	Pin 1	DC Supply
Green Wire	Pin B	Pin 2	Output Signal
White Wire	Pin C	Pin 3	Ground

The interface is protected against reverse polarity on the supply.

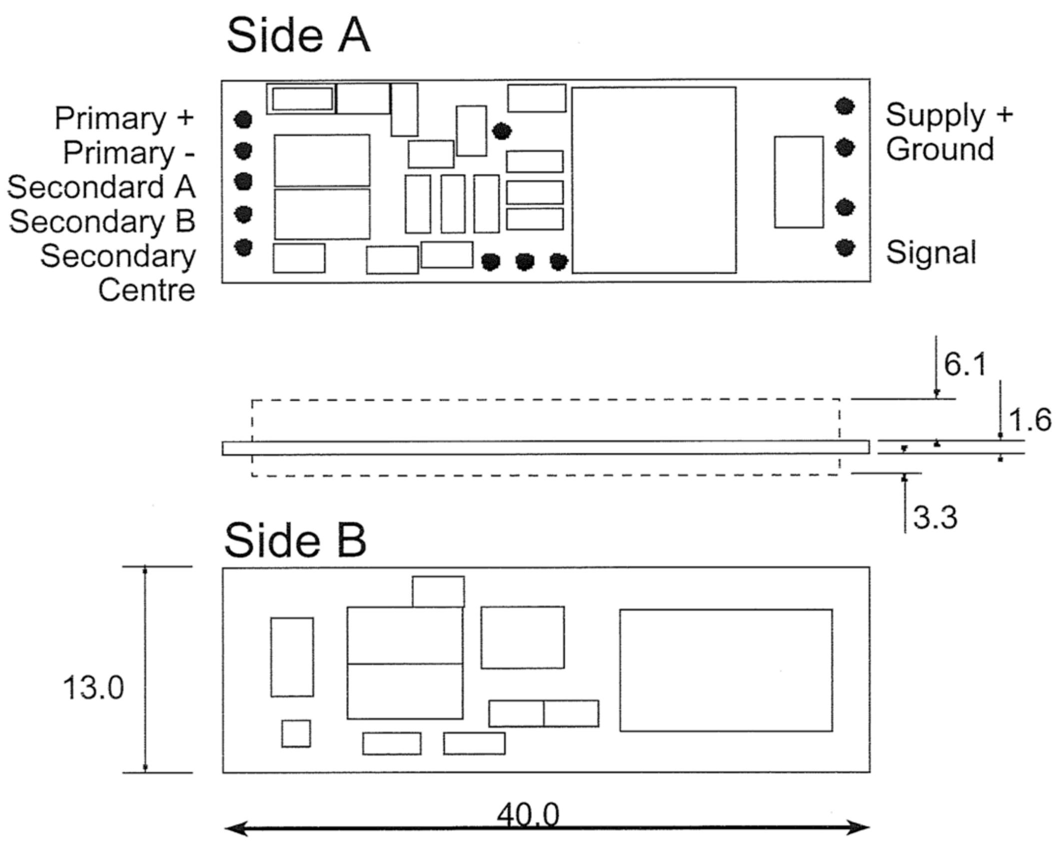
Sensors

Environmental

- Resistant to standard motorsport fluids (encapsulated unit)
- Maximum humidity 100% (encapsulated unit)
- Operating temperature 0 to 70°C
- Storage temperature -20 to +85°C
- DR25 jacketed cable (encapsulated unit)
- Vibration 50 to 2500Hz @ 40g 8hrs per axis



Dim "X"	Dim "Y"	Ordercode
500mm	500mm	O 030 200 002 003



Description	Ordercode
Circuit Only	O 030 200 002 006

Speed

DHE Speed Sensor

9mm

DHE (Differential Hall Effect) sensors give an output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). To improve noise resistance, the sensor has two Hall effect elements and only responds to changes in magnetic field strength corresponding to tooth passing frequencies above 15Hz. As each tooth passes the sensor, the digital state of the output changes.

Please request our installation datasheet for further details.

Application

- Wheel speed
- Cam position sensing (application specific, please contact our technical consultancy service)

Electrical

- Supply voltage 9 to 15V unregulated
- Supply current 5 to 15mA
- Open collector output
- Output current 35mA maximum
- Frequency response 15Hz to 20kHz
- Reverse polarity protection
- Output polarity depends on the rotational direction of the target wheel

Cable and Connection Definition

- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

Red wire	Pin A	Pin 1	Supply
Green wire	Pin B	Pin 2	Signal
White wire	Pin C	Pin 3	Ground

A 2kohm “pull up” resistor can be included on some models (see Application note)

Mechanical

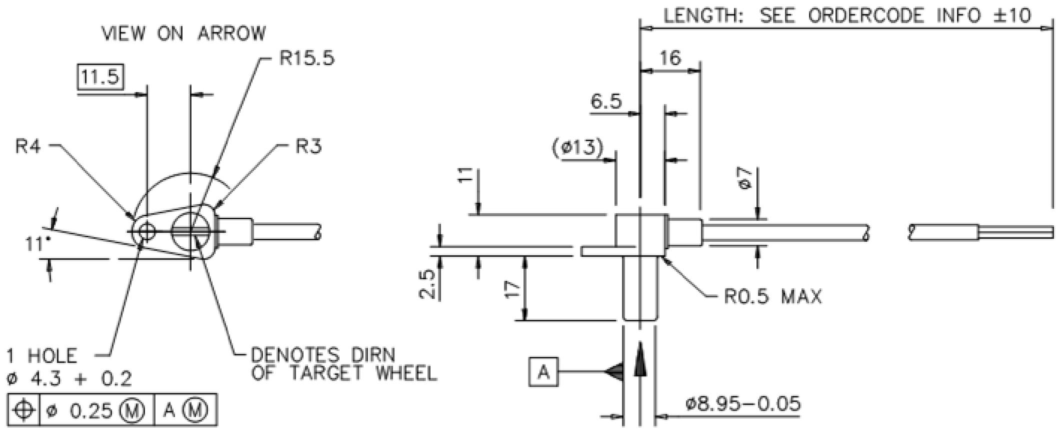
- Air gap 1.5mm maximum
- Body diameter 9mm
- Weight less than 30g (including cable)
- Aluminium alloy body, hard anodised and dyed black
- Polyester cable boss for strain relief to the sensor body

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

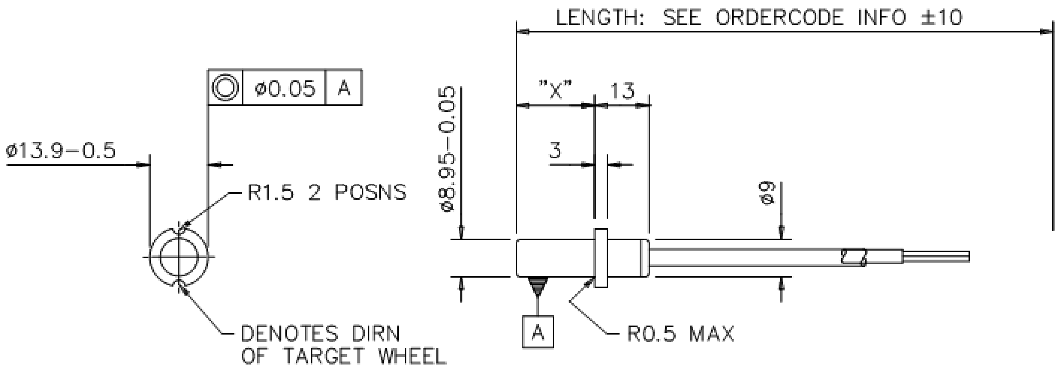
Environmental

- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -10 to +175°C*
- Viton jacketed cable

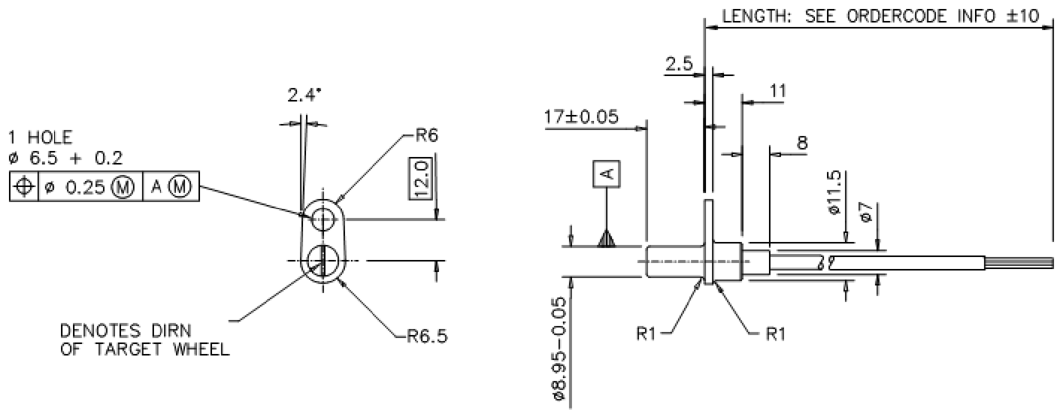
* Functional life of no less than 1000 hours at 175°C



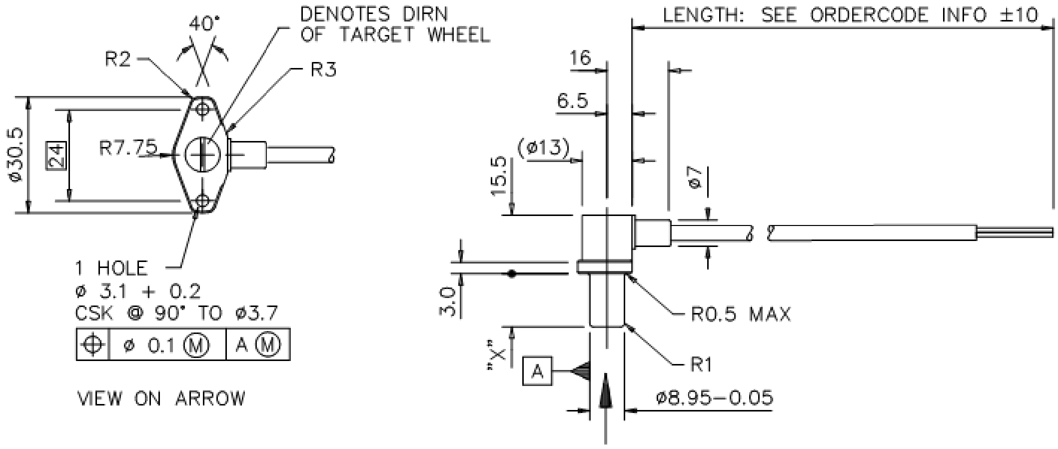
Cable Length	Ordercode
1000mm	O 030 350 000 086



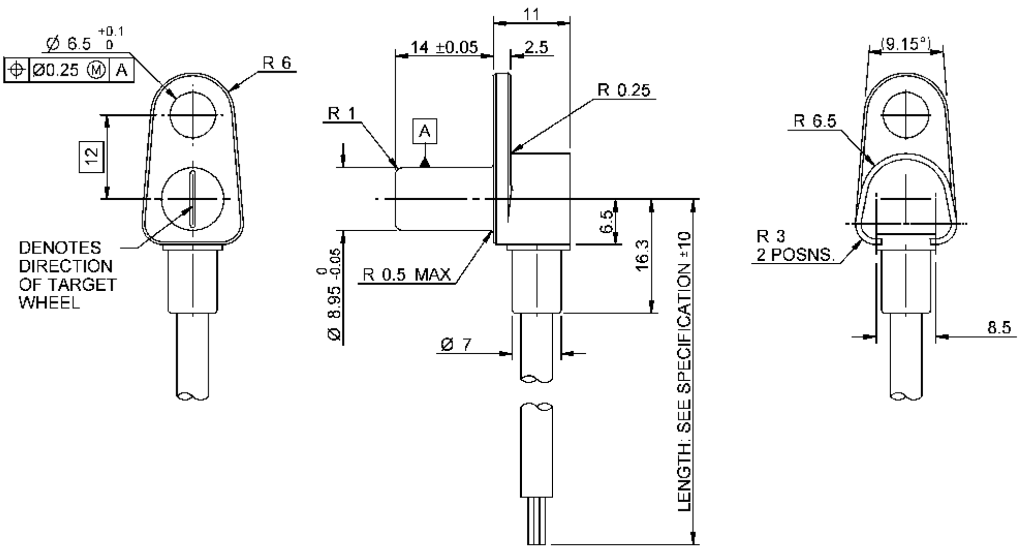
Cable Length	Dim "X"	Ordercode
1000mm	19mm	O 030 350 000 087
1000mm	31mm	O 030 350 000 097



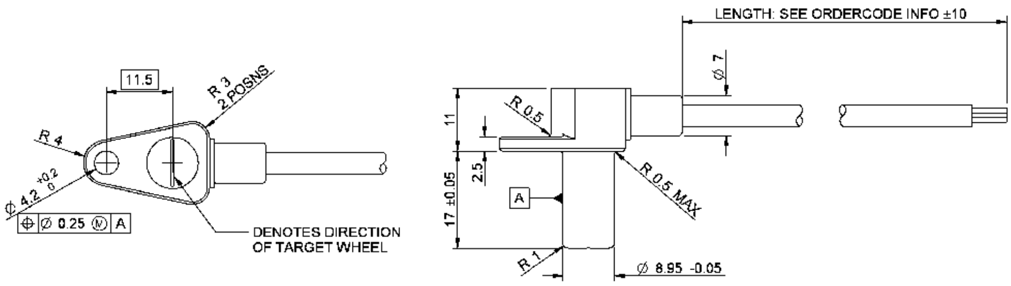
Cable Length	Ordercode
1000mm	O 030 350 000 113



Cable Length	Dim "X"	Ordercode
1000mm	14mm	O 030 350 000 115
1000mm	19mm	O 030 350 000 129



Cable Length	Ordercode
1000mm	O 030 350 000 155

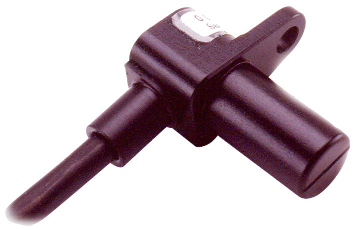


Cable Length	Ordercode
1000mm	O 030 350 000 195

DHE Speed Sensor
10mm

DHE (Differential Hall Effect) sensors give an output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). To improve noise resistance, the sensor has two Hall effect elements and only responds to changes in magnetic field strength corresponding to tooth passing frequencies above 15Hz. As each tooth passes the sensor, the digital state of the output changes.

Please request our installation datasheet for further details.



Application
- Wheel speed
- Cam position sensing (application specific, please contact our technical consultancy service)

Electrical
- Supply voltage 9 to 15V unregulated
- Supply current 5 to 15mA
- Open collector output
- Output current 35mA maximum
- Frequency response 15Hz to 20kHz
- Reverse polarity protection
- Output polarity depends on the rotational direction of the target wheel

Cable and Connection Definition
- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection

Red wire	Pin A	Pin 1	Supply
Green wire	Pin B	Pin 2	Signal
White wire	Pin C	Pin 3	Ground

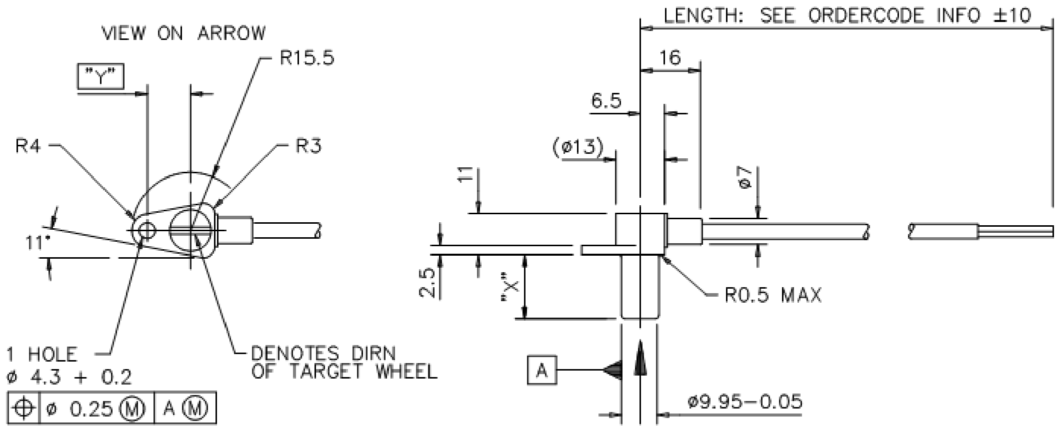
A 2kohm “pull up” resistor can be included on some models (see Application note)

Mechanical
- Air gap 1.5mm maximum
- Body diameter 10mm
- Weight less than 30g (including cable)
- Aluminium alloy body, hard anodised and dyed black
- Polyester cable boss for strain relief to the sensor body

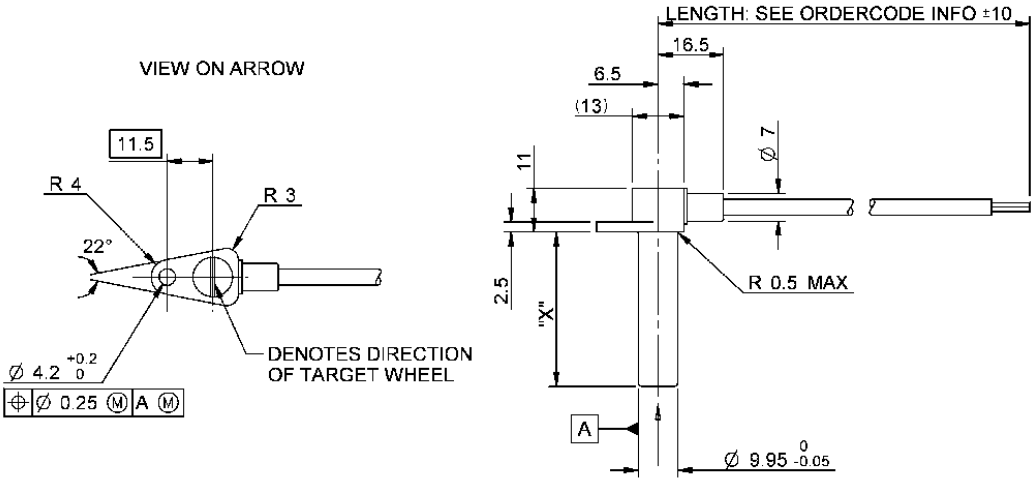
Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental
- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -10 to +175°C*
- Viton jacketed cable

* Functional life of no less than 1000 hours at 175°C

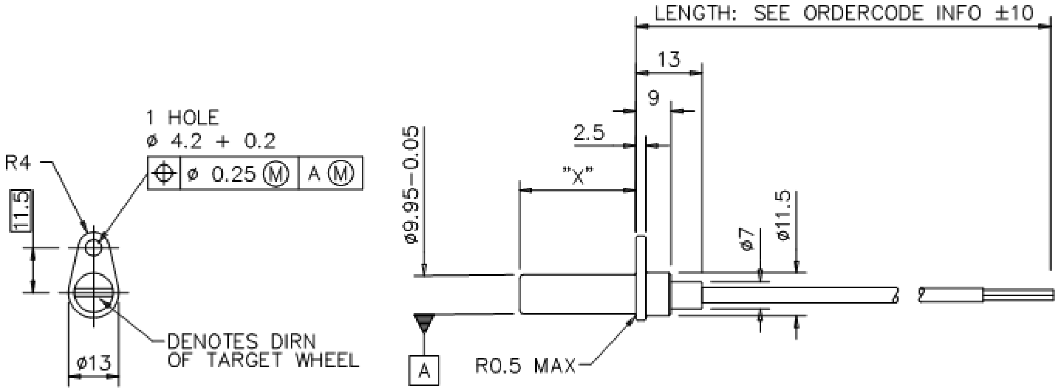


Cable Length	Dim "X"	Dim "Y"	Ordercode
1000mm	17mm	11.5mm	O 030 350 000 141
1000mm	55mm	11.5mm	O 030 350 000 089
1000mm	24mm	11.5mm	O 030 350 000 091
1000mm	24mm	13mm	O 030 350 000 118
1000mm	39mm	11.5mm	O 030 350 000 092

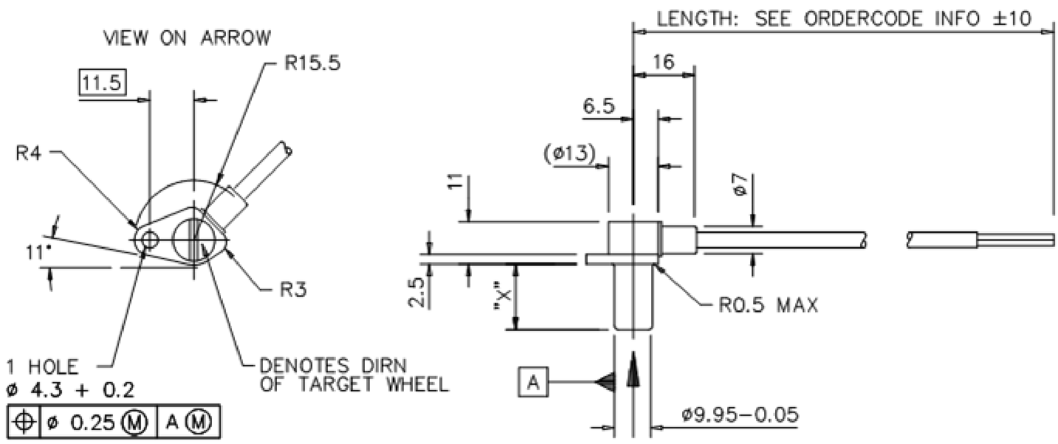


Cable Length	Dim "X"	Ordercode
1000mm	17mm	O 030 350 000 090
1000mm	39mm	O 030 350 000 111
1000mm	49mm	O 030 350 000 148

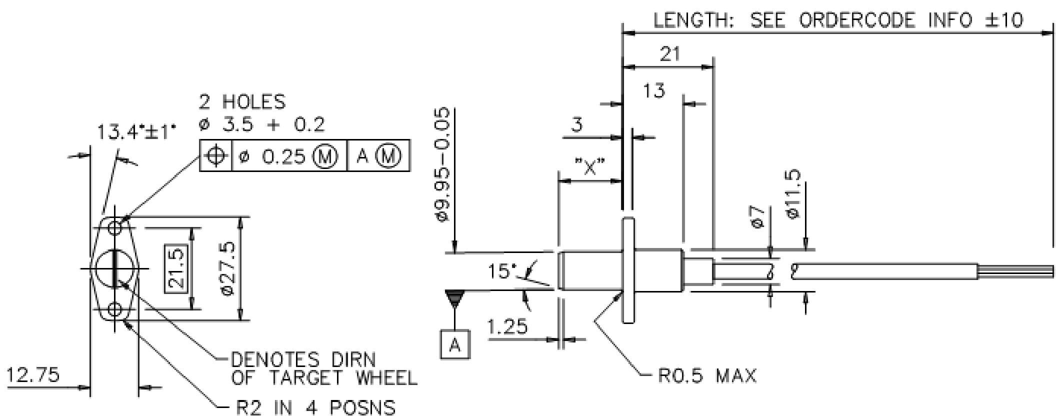
Sensors



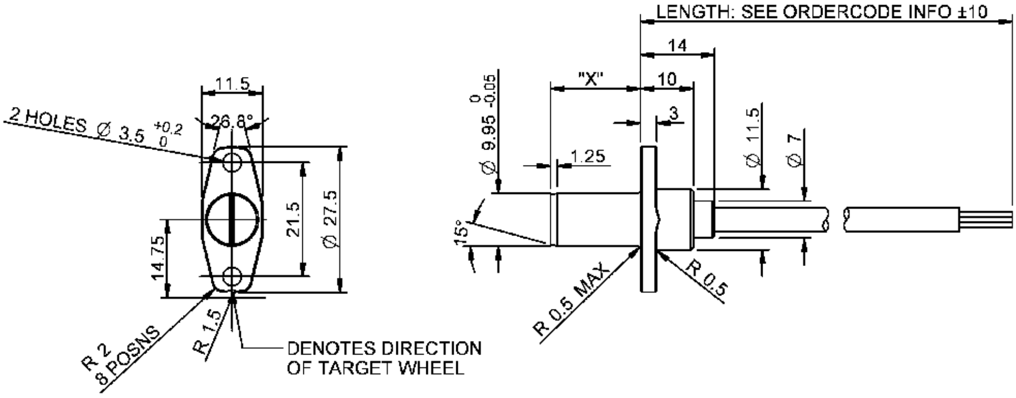
Cable Length	Dim "X"	Ordercode
1000mm	30mm	O 030 350 000 094
1000mm	49.25mm	O 030 350 000 145



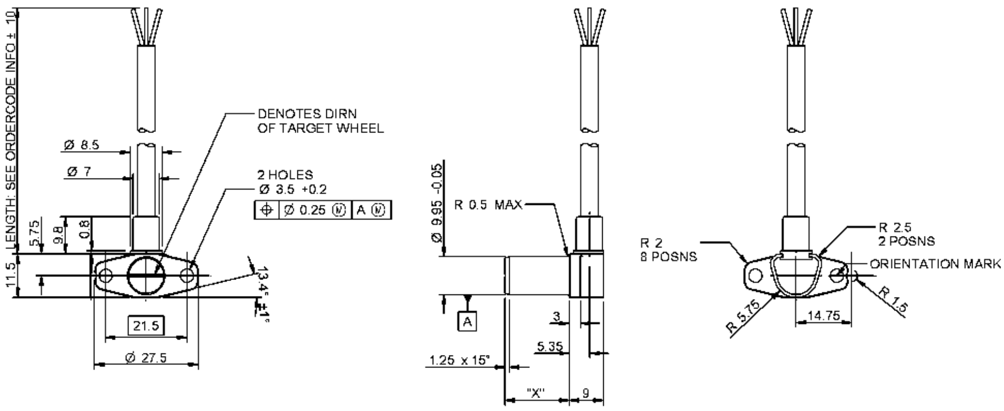
Cable Length	Dim "X"	Ordercode
1000mm	39mm	O 030 350 000 114



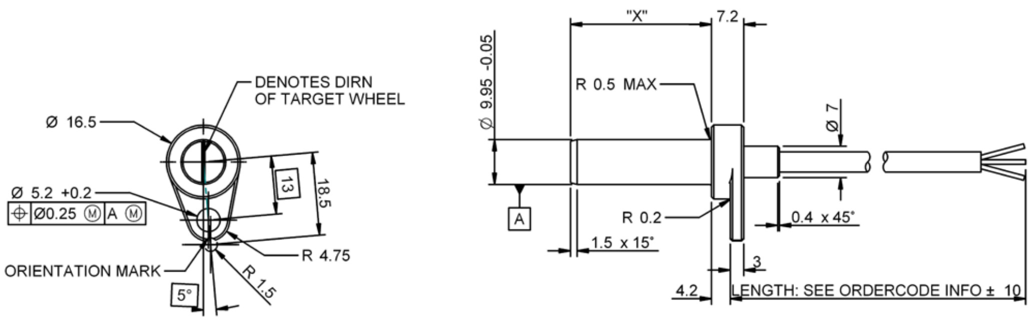
Cable Length	Dim "X"	Ordercode
1000mm	17mm	O 030 350 000 128



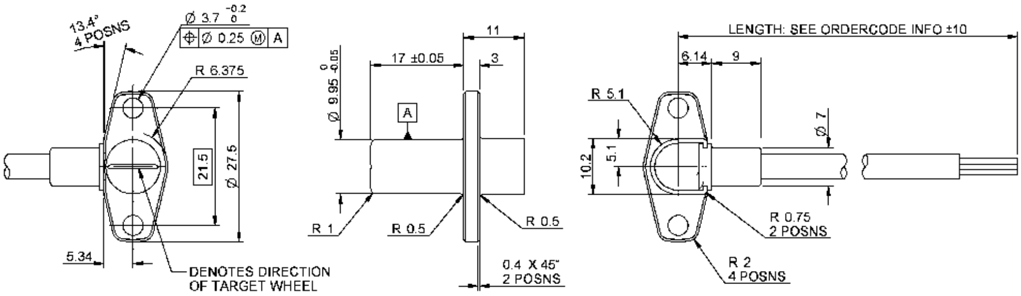
Cable Length	Dim "X"	Ordercode
1000mm	17mm	O 030 350 000 133



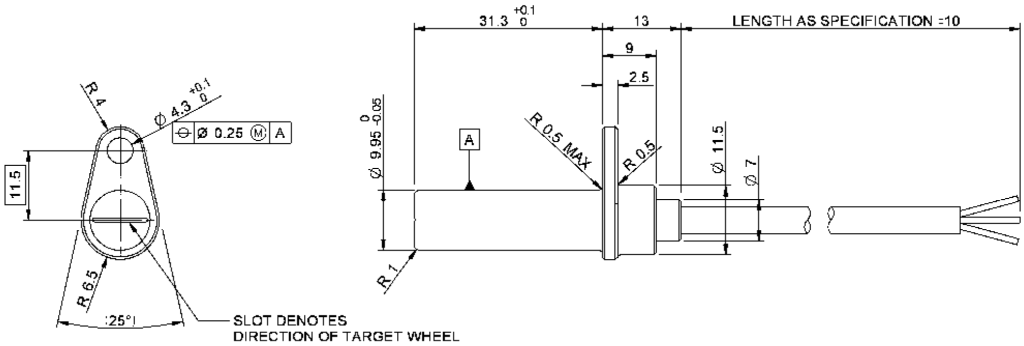
Cable Length	Dim "X"	Ordercode
1000mm	17mm	O 030 350 000 134



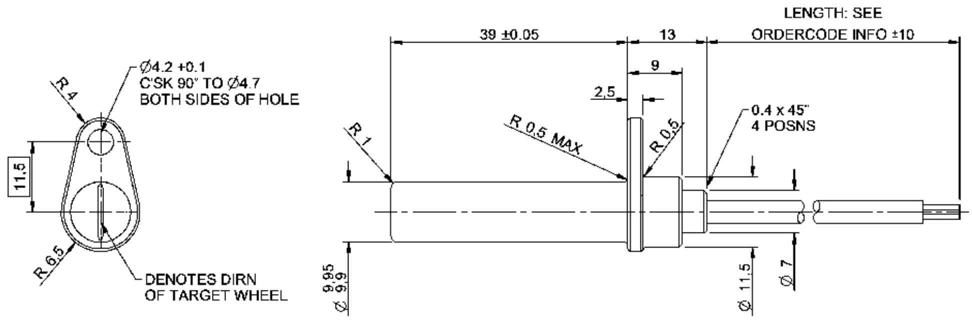
Cable Length	Dim "X"	Ordercode
1000mm	31.5mm	O 030 350 000 138



Cable Length	Ordercode
1000mm	O 030 350 000 157



Cable Length	Ordercode
1000mm	O 030 350 000 168



Cable Length	Ordercode
1000mm	O 030 350 000 255

Sensors

DHE Speed Sensor

11.8mm

DHE (Differential Hall Effect) sensors give an output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). To improve noise resistance, the sensor has two Hall effect elements and only responds to changes in magnetic field strength corresponding to tooth passing frequencies above 15Hz. As each tooth passes the sensor, the digital state of the output changes.

Please request our installation datasheet for further details.

Application

- Wheel speed
- Cam position sensing (application specific, please contact our technical consultancy service)

Electrical

- Supply voltage 9 to 15V unregulated
- Supply current 5 to 15mA
- Open collector output
- Output current 35mA maximum
- Frequency response 15Hz to 20kHz
- Reverse polarity protection
- Output polarity depends on the rotational direction of the target wheel

Cable and Connection Definition

- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

Red wire	Pin A	Pin 1	Supply
Green wire	Pin B	Pin 2	Signal
White wire	Pin C	Pin 3	Ground

A 2kohm “pull up” resistor can be included on some models (see Application note)

Mechanical

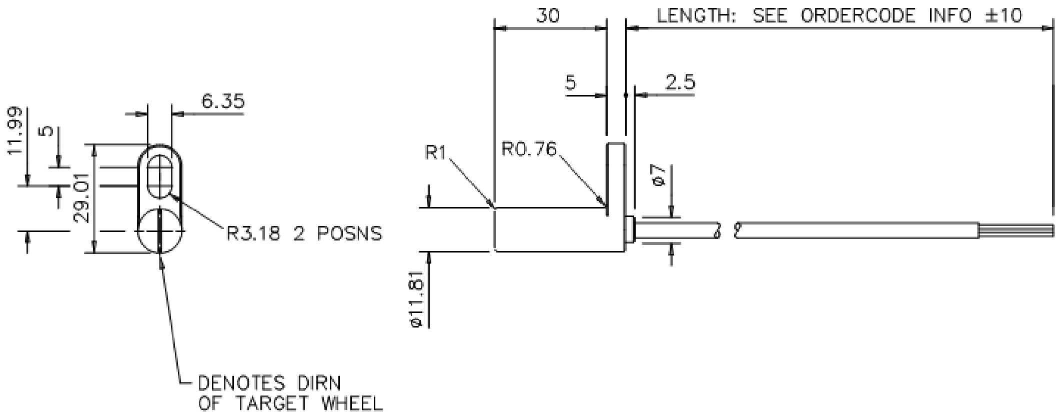
- Air gap 1.5mm maximum
- Body diameter 11.8mm
- Weight less than 30g (including cable)
- Aluminium alloy body, hard anodised and dyed black
- Polyester cable boss for strain relief to the sensor body

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -10 to +175°C*
- Viton jacketed cable

* Functional life of no less than 1000 hours at 175°C



Cable Length	Ordercode
1000mm	O 030 350 000 123

DHE Speed Sensor
3/8-64 UNF

DHE (Differential Hall Effect) sensors give an output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). To improve noise resistance, the sensor has two Hall effect elements and only responds to changes in magnetic field strength corresponding to tooth passing frequencies above 15Hz. As each tooth passes the sensor, the digital state of the output changes.

Please request our installation datasheet for further details.

Application

- Wheel speed
- Cam position sensing (application specific, please contact our technical consultancy service)

Electrical

- Supply voltage 9 to 24V unregulated
- Supply current 5 to 15mA
- Open collector output
- Output current 35mA maximum
- Frequency response 15Hz to 20kHz
- Reverse polarity protection
- Output polarity depends on the rotational direction of the target wheel

Cable and Connection Definition

- 24 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connector ASU603-03PA-HE, ASU603-03PD-HE

Pin 1	Supply
Pin 2	Signal
Pin 3	Ground

- Connector ASL606-05PD-HE, ASL106-05SD-HE, ASL606-05PN-HE

Pin 1	Supply
Pin 2	Signal
Pin 3	n/c
Pin 4	n/c
Pin 5	Ground

Mechanical

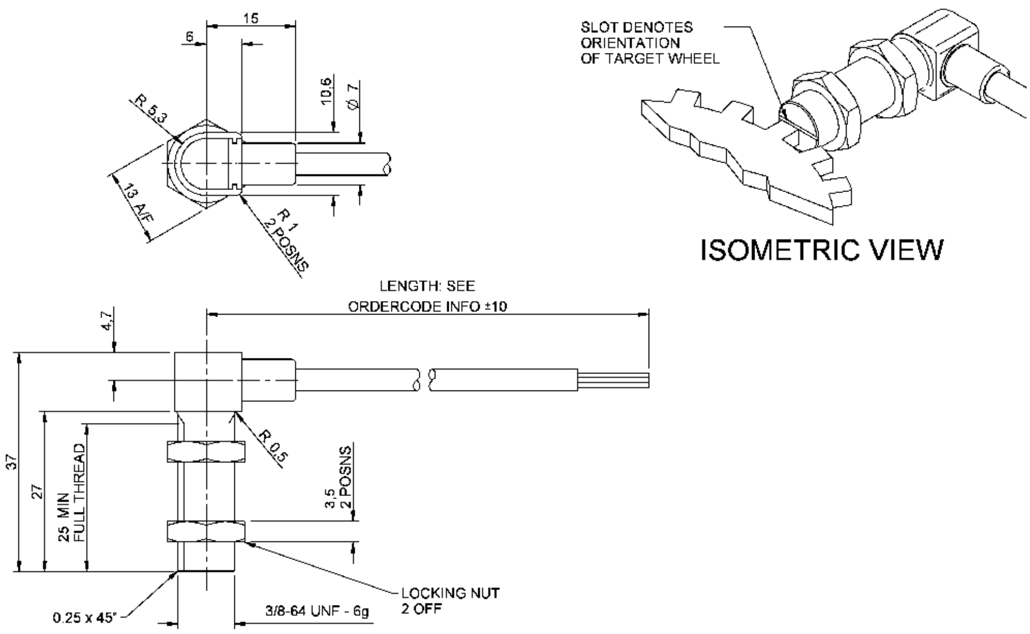
- Air gap 1.5mm maximum
- Body diameter 3/8-64 UNF – 6g
- Weight less than 30g (including cable)
- Aluminium alloy body and locking nuts, hard anodised and dyed black
- Polyester cable boss for strain relief to the sensor body
- Two locking nuts, 3/8-64 UNF – 6H

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -10 to +175°C*
- Viton jacketed cable

* Functional life of no less than 1000 hours at 175°C



Cable Length	Connector	Ordercode
1000mm	None	O 030 350 000 225
250mm	ASL606-05PD-HE	O 030 350 000 226
127mm	ASL606-05PN-HE	O 030 350 000 230
200mm	ASL106-05SD-HE	O 030 350 000 227
250mm	ASU603-03PA-HE	O 030 350 000 219
178mm	ASU603-03-PD-HE	O 030 350 000 258
150mm	ASU603-03-PD-HE	O 030 350 000 220

Inductive Speed Sensor
8mm

Inductive sensors give a voltage output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). The voltage increases with increasing speed and with a reduction of the gap between the sensor and the target. The sensors are suitable for use with interfaces that trigger on threshold or zero crossing. Three different body styles are available: 1) totally closed; 2) eddy current reduction slot for increased sensitivity; 3) exposed core and eddy current reduction slot for maximum sensitivity.

Please request our installation datasheet for further details.

Application

- Cam shaft, crank shaft and gear speed and position sensing. Wheel speed sensing.

Electrical

- Resistance 510 to 630 ohm
- Cut-in speed is shown in the order details
- Cut-in speed is defined as the speed to achieve 400mV pk-pk @ 0.8mm air gap, with a 120mm diameter target wheel (3kohm load and no load values are given)
- Output polarity follows tooth form, that is a rising metal edge on the wheel generates a rising voltage output from the sensor

Cable and Connection Definition

- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

White wire	Pin A	Pin 1	Signal +
Black wire	Pin B	Pin 2	Signal -

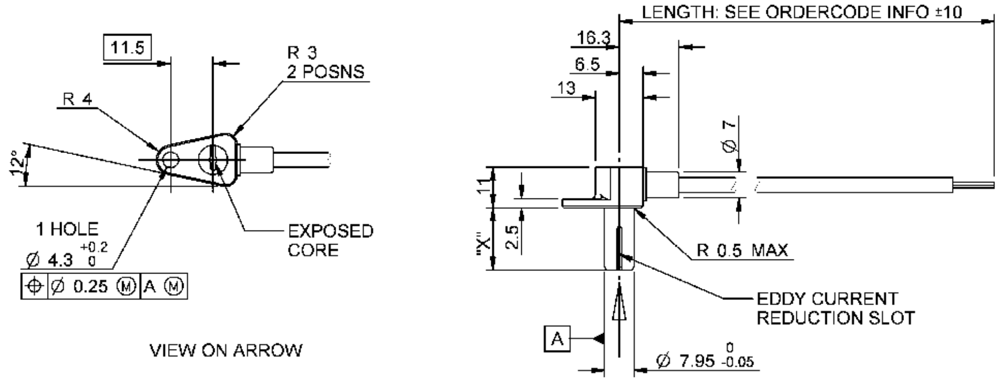
Mechanical

- Air gap 1.0mm (max), 0.8mm (nominal)
- Body diameter 8mm
- Weight less than 25g (including cable)
- Aluminium alloy body, hard anodised and dyed black
- Polyester cable boss for strain relief to the sensor body
- Sensor is axi-symmetric, special orientation is not required

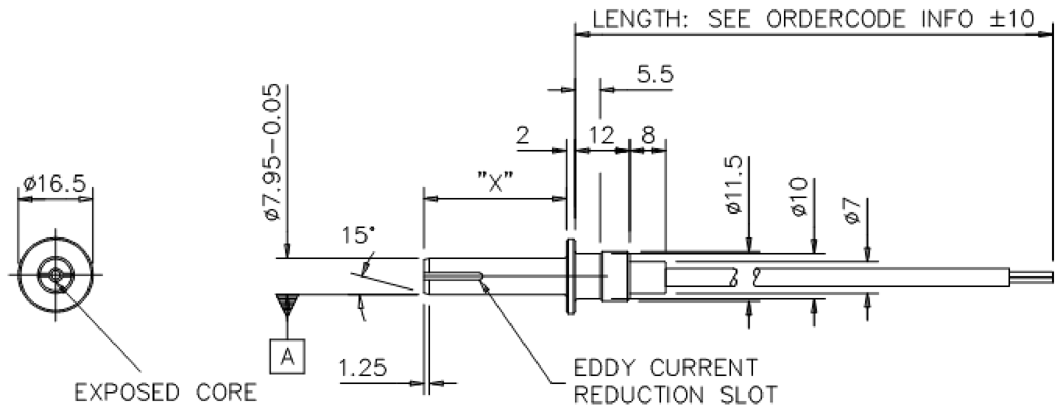
Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Sensor housing and element operating temperature -10°C to + 200°C
- Cable boss maximum operating temperature 150°C
- Viton jacketed cable maximum operating temperature 200°C



Cable Length	Dim "X"	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	17mm	Exposed	80rpm	62rpm	O 030 350 001 127



Cable Length	Dim "X"	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	31.5mm	Exposed	80rpm	62rpm	O 030 350 001 124

Inductive Speed Sensor
9mm

Inductive sensors give a voltage output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). The voltage increases with increasing speed and with a reduction of the gap between the sensor and the target. The sensors are suitable for use with interfaces that trigger on threshold or zero crossing. Three different body styles are available: 1) totally closed; 2) eddy current reduction slot for increased sensitivity; 3) exposed core and eddy current reduction slot for maximum sensitivity.

Please request our installation datasheet for further details.

Application

- Cam shaft, crank shaft and gear speed and position sensing. Wheel speed sensing.

Electrical

- Resistance 510 to 630 ohm
- Cut-in speed is shown in the order details
- Cut-in speed is defined as the speed to achieve 400mV pk-pk @ 0.8mm air gap, with a 120mm diameter target wheel (3kohm load and no load values are given)
- Output polarity follows tooth form, that is a rising metal edge on the wheel generates a rising voltage output from the sensor

Cable and Connection Definition

- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection

White wire	Pin A	Pin 1	Signal +
Black wire	Pin B	Pin 2	Signal -

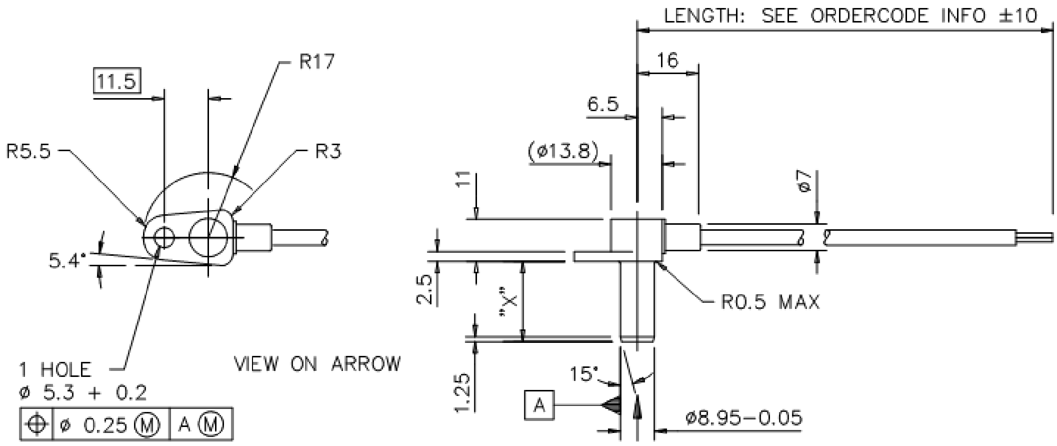
Mechanical

- Air gap 1.0mm (max), 0.8mm (nominal)
- Body diameter 9mm
- Weight less than 25g (including cable)
- Aluminium alloy body, hard anodised and dyed black
- Polyester cable boss for strain relief to the sensor body
- Sensor is axi-symmetric, special orientation is not required

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Sensor housing and element operating temperature -10°C to + 200°C
- Cable boss maximum operating temperature 150°C
- Viton jacketed cable maximum operating temperature 200°C

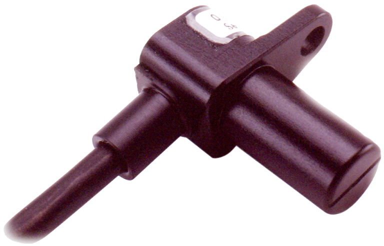


Cable Length	Dim "X"	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	21mm	Closed	180rpm	150rpm	O 030 350 001 130
1000mm	28.8mm	Closed	180rpm	150rpm	O 030 350 001 129

Inductive Speed Sensor
10mm

Inductive sensors give a voltage output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). The voltage increases with increasing speed and with a reduction of the gap between the sensor and the target. The sensors are suitable for use with interfaces that trigger on threshold or zero crossing. Three different body styles are available: 1) totally closed; 2) eddy current reduction slot for increased sensitivity; 3) exposed core and eddy current reduction slot for maximum sensitivity.

Please request our installation datasheet for further details.



Application

- Cam shaft, crank shaft and gear speed and position sensing. Wheel speed sensing.

Electrical

- Resistance 450 to 600 ohm
- Cut-in speed is shown in the order details
- Cut-in speed is defined as the speed to achieve 400mV pk-pk @ 0.8mm air gap, with a 120mm diameter target wheel (3kohm load and no load values are given)
- Output polarity follows tooth form, that is a rising metal edge on the wheel generates a rising voltage output from the sensor

Cable and Connection Definition

- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection

White wire	Pin A	Pin 1	Signal +
Black wire	Pin B	Pin 2	Signal -

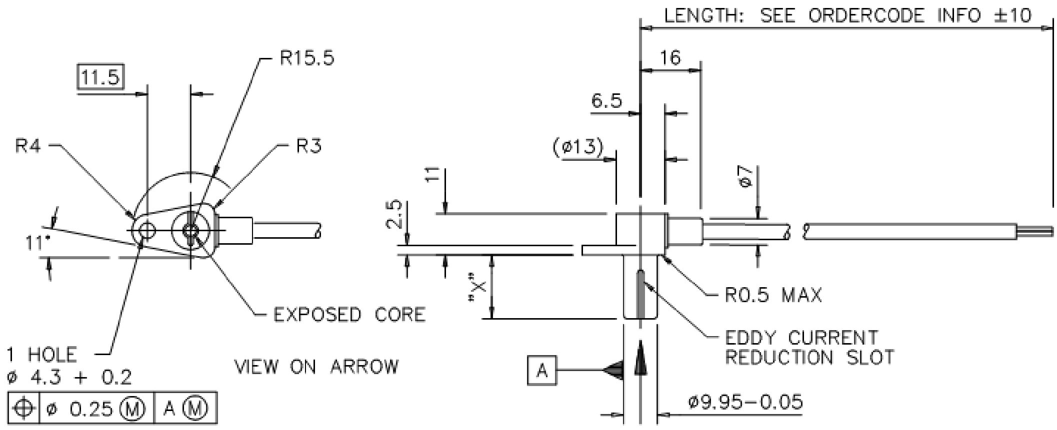
Mechanical

- Air gap 1.0mm (max), 0.8mm (nominal)
- Body diameter 10mm
- Weight less than 30g (including cable)
- Aluminium alloy body, hard anodised and dyed black
- Polyester cable boss for strain relief to the sensor body
- Sensor is axi-symmetric, special orientation is not required

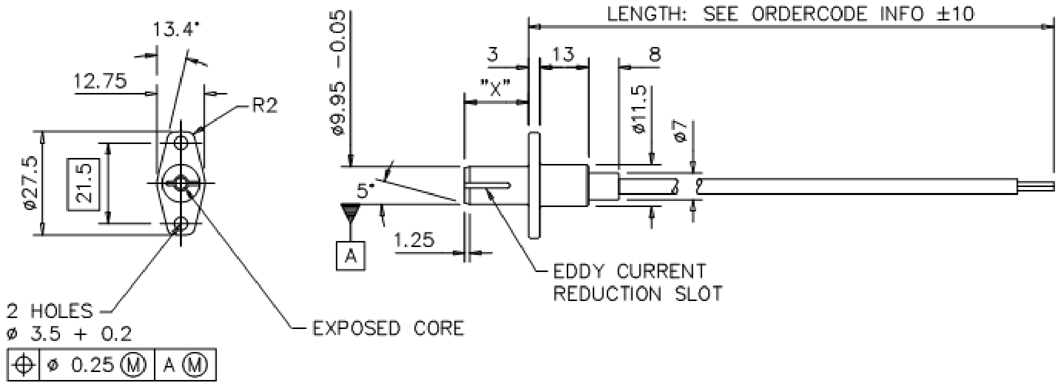
Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

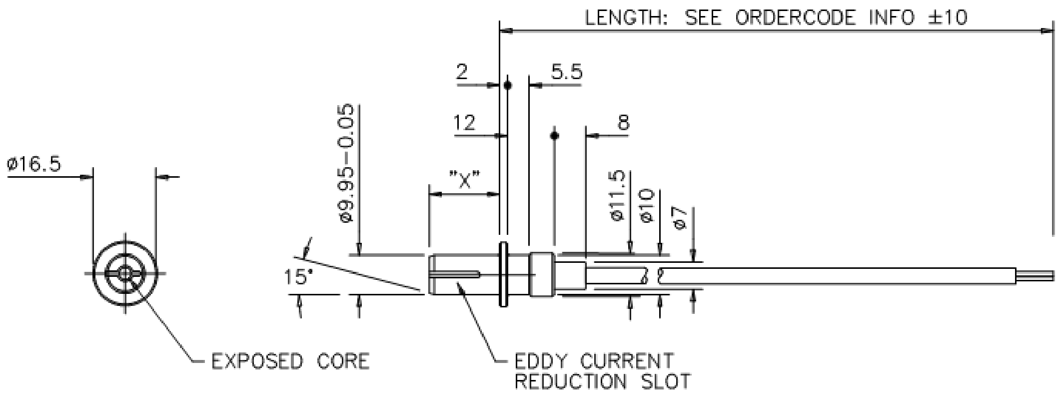
- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Sensor housing and element operating temperature -10°C to + 200°C
- Cable boss maximum operating temperature 150°C
- Viton jacketed cable maximum operating temperature 200°C



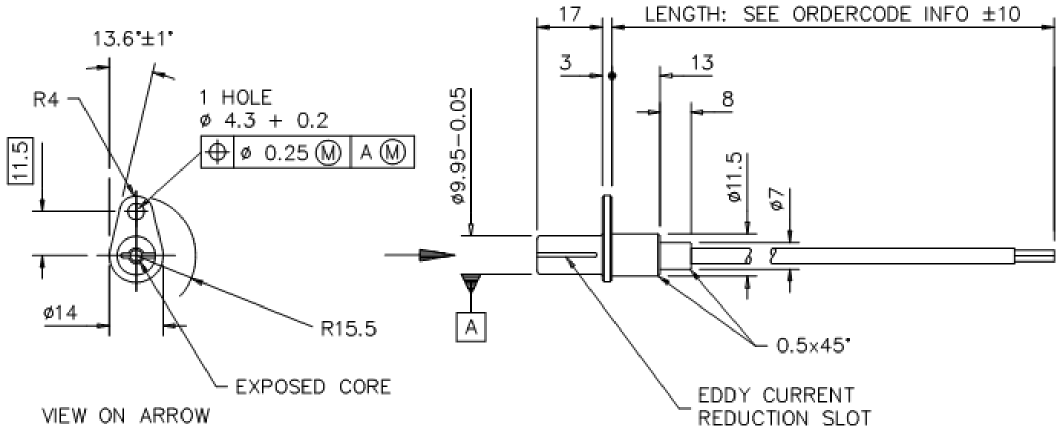
Cable Length	Dim "X"	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	17mm	Exposed	40rpm	31rpm	O 030 350 001 075



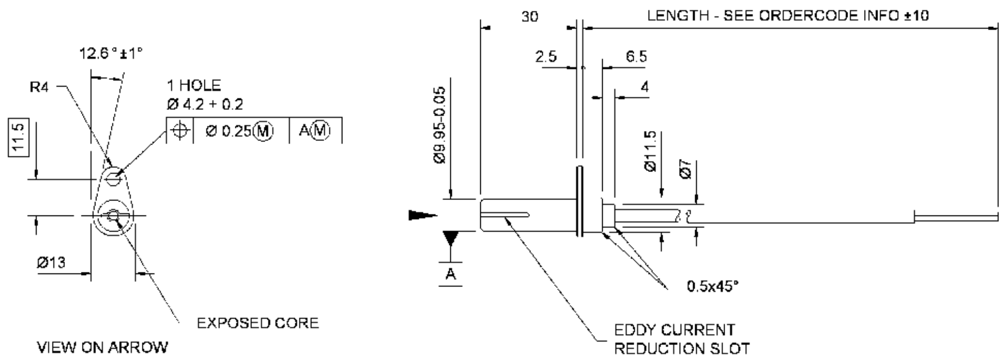
Cable Length	Dim "X"	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	17mm	Exposed	40rpm	31rpm	O 030 350 001 078
1000mm	25mm	Exposed	40rpm	31rpm	O 030 350 001 134



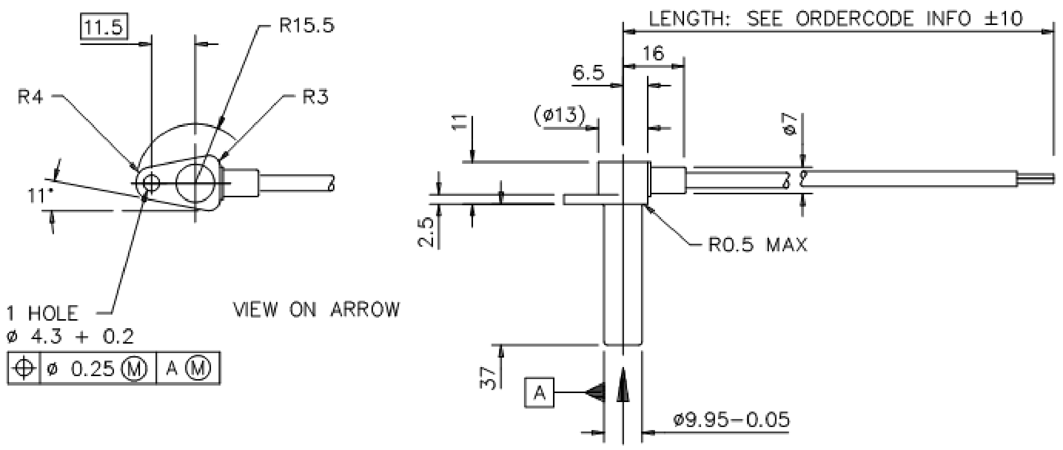
Cable Length	Dim "X"	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	18mm	Exposed	40rpm	31rpm	O 030 350 001 098
1000mm	31.5mm	Exposed	40rpm	31rpm	O 030 350 001 103



Cable Length	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	Exposed	40rpm	31rpm	O 030 350 001 109

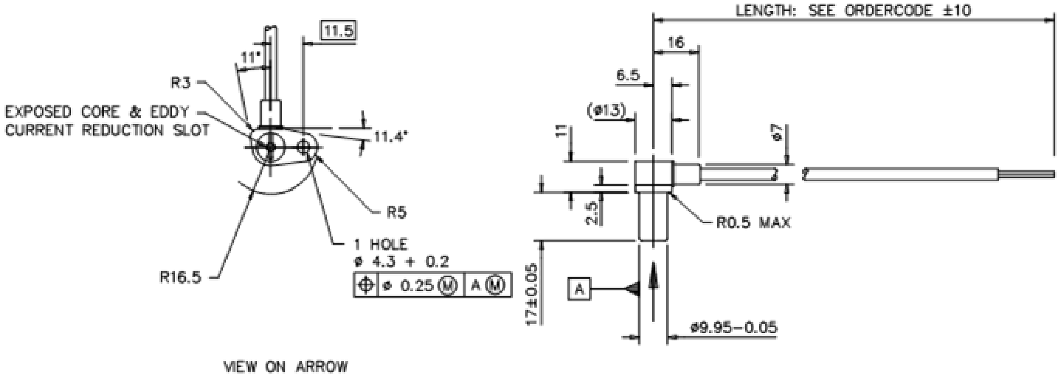


Cable Length	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	Exposed	40rpm	31rpm	O 030 350 001 138

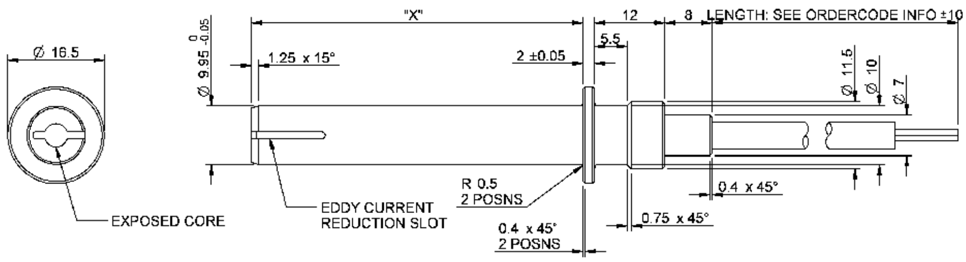


Cable Length	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	Closed	161rpm	88rpm	O 030 350 001 133

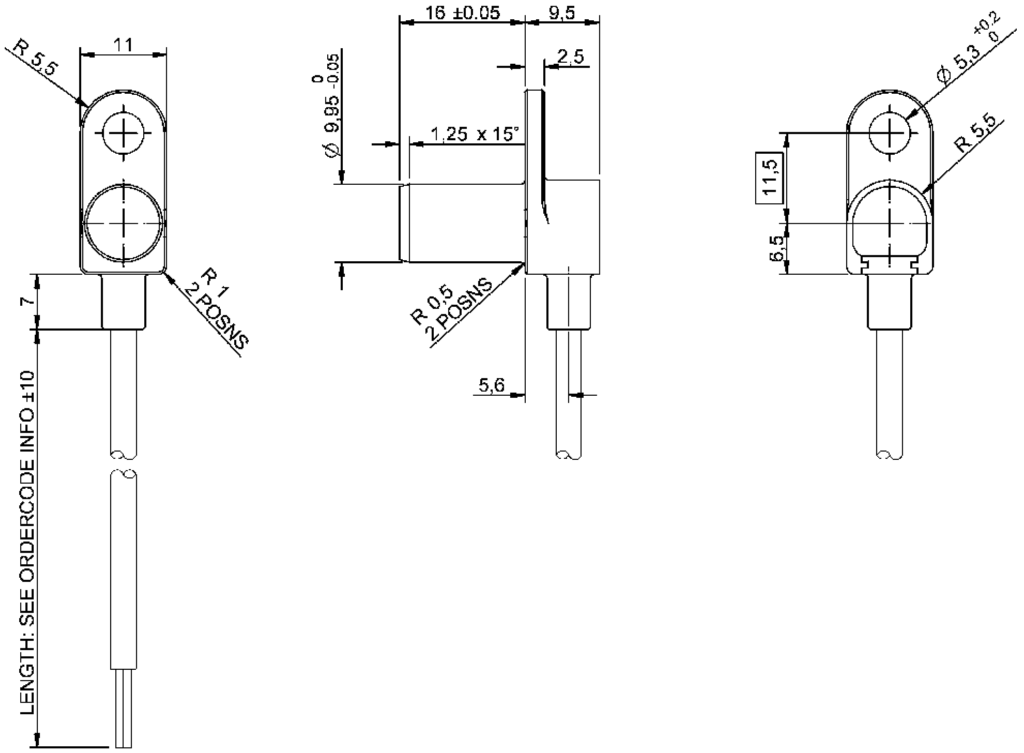
Sensors



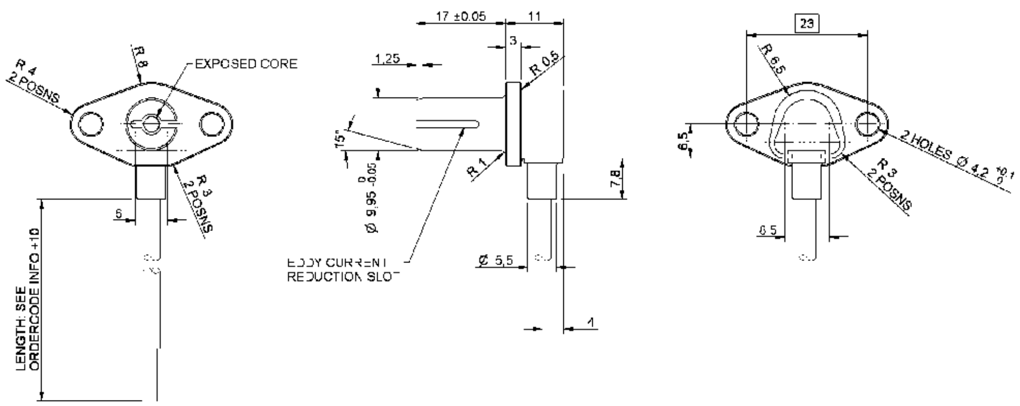
Cable Length	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	Exposed	40rpm	31rpm	O 030 350 001 142



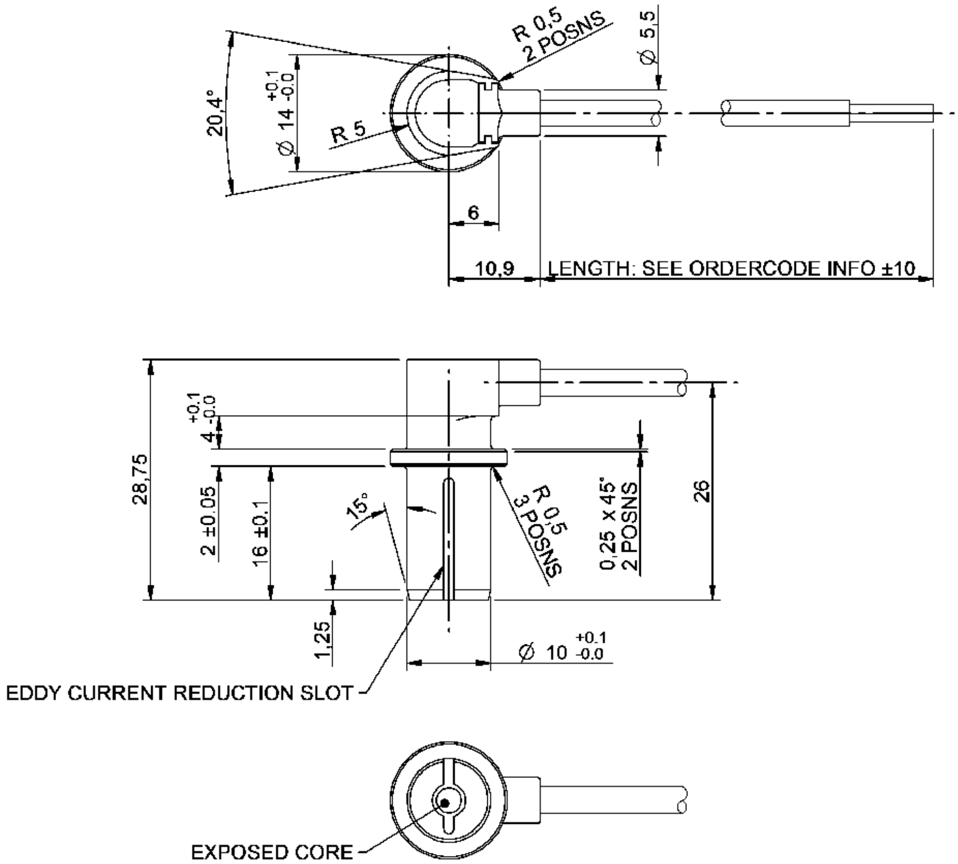
Cable Length	Dim "X"	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	56.5	Exposed	40rpm	31rpm	O 030 350 001 147



Cable Length	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	Closed	161rpm	88rpm	O 030 350 001 215



Cable Length	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	Exposed	40rpm	31rpm	O 030 350 001 253



Cable Length	Body Type	Cut-In Speed (3kohms load)	Cut-In Speed (No load)	Ordercode
1000mm	Exposed	40rpm	31rpm	O 030 350 001 227

Inductive Speed Sensor Interface
Speed Sensor to TTL

The output of an inductive (magnetic reluctance) speed sensor is an alternating voltage in which both the frequency and magnitude depend on target speed. The TTL Interface Adaptor converts this voltage into a TTL logic signal whose frequency corresponds to tooth passing frequency. The magnitude of the output signal from the interface is independent of the tooth passing speed.

Application
- Conversion of inductive sensor output to TTL level logic.

Electrical
- Supply voltage is shown in the order details
- Input voltage threshold is shown in the order details
- Output level TTL compatible
- No load supply current 20mA max
- Maximum output sink current 1mA at 0.8V
- Maximum output source current 100µA at 3.5V

When a rising input voltage exceeds the upper threshold, the output goes from high to low. When a falling input voltage becomes less than the lower threshold, the output goes from low to high.

Cable and Connection Definition
- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Input Connection

White Wire	Pin A	Pin 1	Sensor Signal +
Black Wire	Pin B	Pin 2	Sensor Signal -

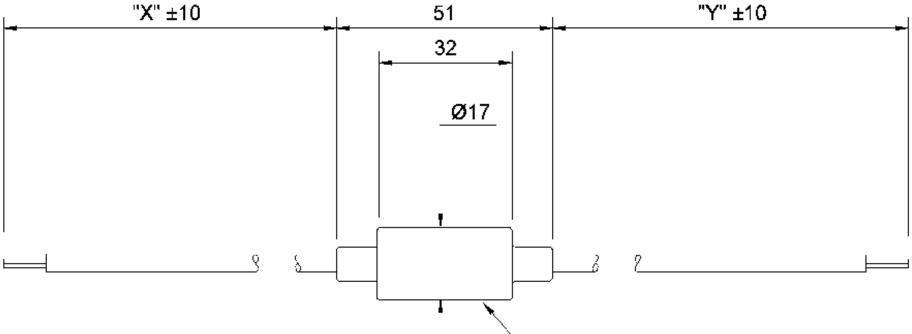
- Output Connection

Red Wire	Pin A	Pin 1	Supply
White Wire	Pin B	Pin 2	Output Signal
Green Wire	Pin C	Pin 3	Ground

Mechanical
- Weight less than 45g including cable
- Body material polyester
- Polyester cable boss for strain relief to the interface body

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Any of our inductive speed sensors can be supplied with this interface already fitted. Please contact our technical consultancy service who will be pleased to help.

Environmental
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -30 to 85°C
- Viton jacketed cable
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

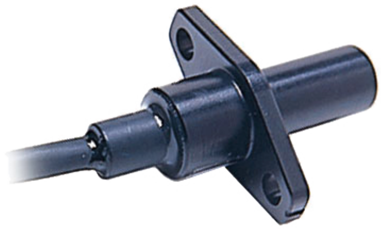


Input Threshold (Upper)	Input Threshold (Lower)	Supply Voltage	Dim "X"	Dim "Y"	Ordercode
+200mV	-200mV	10±0.25V	1000mm	1000mm	O 030 200 006 005
+290mV	-290mV	5±0.2V	1000mm	1000mm	O 030 200 006 007

Zero Speed Sensor
9mm

Hall Effect sensors give an output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). This sensor has a single Hall Effect element and is therefore not orientation dependant. The sensor responds to changes in magnetic field strength by corresponding to tooth passing frequencies down to 0Hz. As each tooth passes the sensor, the digital state of the output changes.

Please request our installation datasheet for further details.



Application

- Wheel speed.

Electrical

- Supply voltage 9V to 15V unregulated
- Supply current 1.5 to 6mA
- Open collector output
- Output current 25mA maximum
- Frequency response 0Hz to 15kHz
- Output polarity is low in the presence of a tooth

Cable and Connection Definition

- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

Red wire	Pin A	Pin 1	Supply
Green wire	Pin B	Pin 2	Signal
White wire	Pin C	Pin 3	Ground

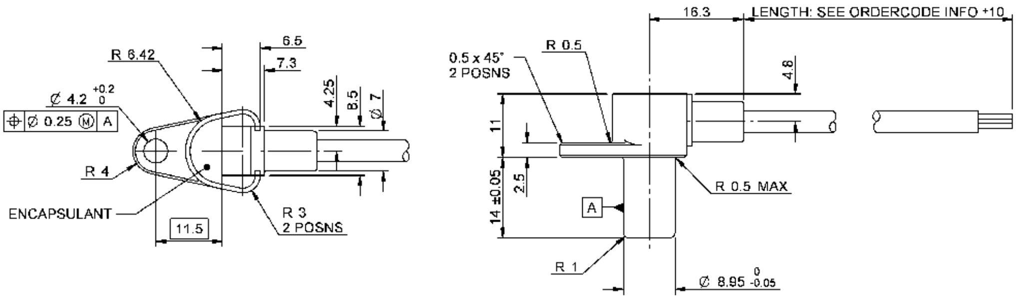
Mechanical

- Air gap 1.0mm maximum (0.8mm recommended)
- Body diameter 9mm
- Weight less than 50g (including cable)
- Polyester cable boss for strain relief to the sensor body

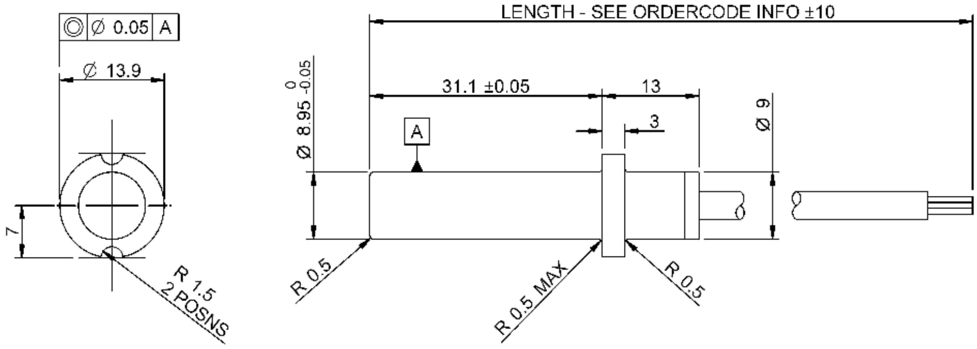
Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -10 to +175°C
- Aluminium alloy body, hard anodised and dyed black



Cable Length	Ordercode
1000mm	O 030 350 008 003

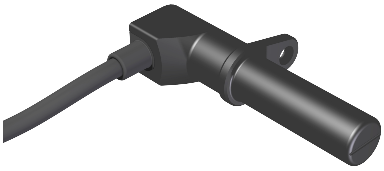


Cable Length	Ordercode
1000mm	O 030 350 008 004

Sensors

Zero Speed Sensor
True Position

The True Position/Zero Speed sensor incorporates a DHE (Differential Hall Effect) sensor. The Hall effect gives an output when subjected to a changing magnetic field. The field is set up by a magnet inside the sensor body and changes when ferromagnetic teeth are passed beneath the sensor (no magnets are required in the target). The sensor responds to changes in magnetic field strength by corresponding to tooth frequencies down to 0Hz.



Application

- Dog position when car is stationary.

Electrical

- Supply voltage 9.5V to 12.5V unregulated
- Supply current <20mA
- Open collector output
- Output current 35mA maximum
- Frequency response 0Hz to 12kHz
- Reverse polarity protection
- Output polarity (referring to the target wheel direction and sensor orientation shown on the outline drawing) - the output of the sensor will fall when the sensor is over the centre of a gap and rise when the sensor is over the centre of a tooth
- Positive duty cycle 35 to 65%
- Duty cycle optimised for wheel direction shown on drawing (but sensor will operate in both directions)

Cable and Connection Definition

- 26AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection

Red wire	Pin A	Pin 1	Supply
Green wire	Pin B	Pin 2	Ground
White wire	Pin C	Pin 3	Signal

Mechanical

- Air gap 0.4mm ±0.05mm
- Body diameter 10mm minimum
- Weight less than 50g (including cable)
- Aluminium alloy body, hard anodised and dyed black
- Polyester cable boss for strain relief to the sensor body
- Trigger wheel geometry (wheel to be supplied by customer)

Pitch	5mm ±0.05mm
Tooth width	3mm min
Tooth depth	5mm (or 3mm if through slot)

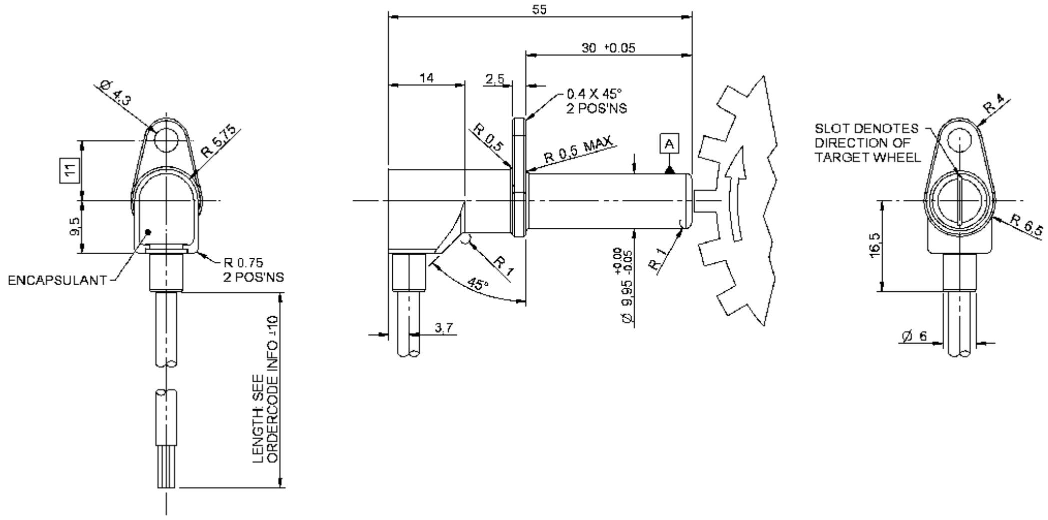
Gaps to have parallel sides (not teeth)

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

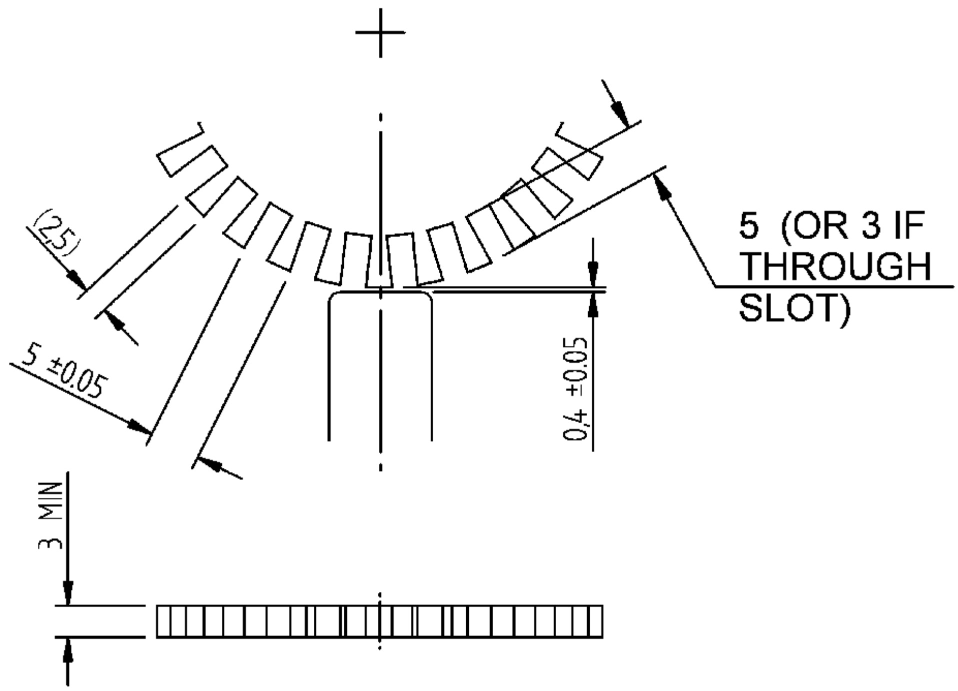
Environmental

- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature 20 to 150°C

- Aluminium alloy body, hard anodised and dyed black
- Sensor will be calibrated and tested using MES standard test wheel unless otherwise specified
- Viton jacketed cable



REQUIRED TRIGGER WHEEL GEOMETRY
(GAPS TO HAVE PARALLEL SIDES)

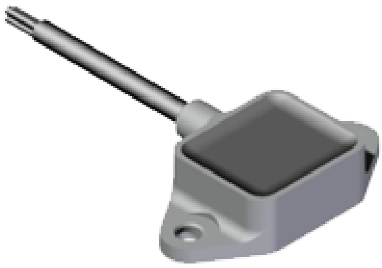


Cable Length	Ordercode
1000mm	O 030 350 010 000

Temperature

Air Box Fire Detector

The air box fire detector uses an optical sensor for the detection of fire in the air box. The sensor output toggles between two states – LOW and HIGH. When the light intensity is above the threshold level the output goes HIGH.



Application

- Fire detection in the air box.

Electrical

- Supply voltage 8 to 16V unregulated
- Supply current < 20mA
- Reverse polarity protection
- Output voltage HIGH=4.0±0.1V, LOW=1.0±0.1V
- Optimum detection angle = 6°
- Turn-on threshold at 25°C = 0.25mW/cm2
- Peak Response = 880nm

Cable and Connection Definition

- 26AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

Red wire	Supply
White wire	Signal
Blue wire	Ground

Mechanical

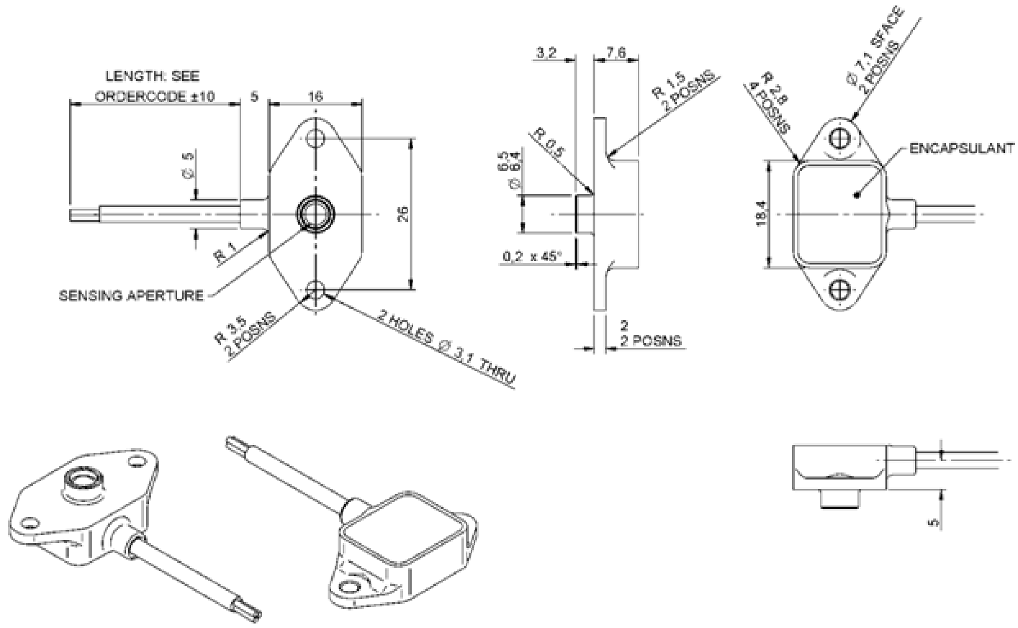
- Aluminium alloy body, hard anodised and dyed black
- Integral cable boss
- Weight less than 30g (including cable)

Design and manufacture is in-house, so if our existing designs do not suit your application we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths.

Please contact our technical consultancy service who will be pleased to help.

Environmental

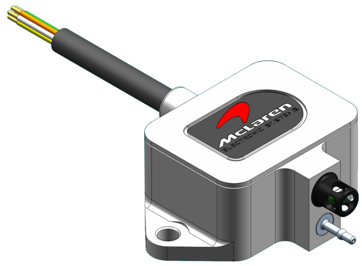
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature 0 to +100°C
- Vibration 100 to 1000Hz, 24hrs per axis
- DR25 jacketed cable



Cable Length	Ordercode
1000mm	O 030 300 034 000

Barometric and Temperature Sensor
Single Channel

The output voltage changes with the absolute pressure applied to the pressure port. The gain, offset and thermal drift of the pressure sensor is digitally compensated to minimise errors and to create a single-ended, amplified output in the 0 to 5 Volt range.



Electrical

- Compensated pressure range 150 to 1150mbar (absolute)
- Supply voltage 8 to 16V unregulated
- Supply current 14mA max
- Output voltage @ 150mbar (absolute pressure) = 0.5V ±0.05V @25°C
- Output voltage @ 1150mbar (absolute pressure) = 4.5V ±0.05V @25°C
- Maximum output voltage 5V
- Non-%FSO max
- %FSO
- Combined thermal zero and sensitivity shift #±1.5
- -3dB point at 100Hz, single pole filter
- Maximum sink / source current 0.45mA

The sensor is protected against short circuit between output and ground but it may be damaged if the output is connected to the supply or if a reverse bias supply voltage is applied.

Cable and Connection Definition

- 55Spec AWG unscreened cable
- Connector - see ordercode details

Pin 1	Red wire	Supply
Pin 2	Green wire	Ground
Pin 3	White wire	Barometric Signal
Pin 4 *	Blue wire	Comms
Pin 5	Yellow wire	PT1000 Signal +
Pin 6	Orange wire	PT1000 Signal -

- Cable length is shown on the order details

* Pin 4 is for manufacturing use only and should not be connected.

Temperature

- Sensing element PT1000
- Nominal resistance: 1000# at 0°C
- Accuracy: ±0.4k typ, ±1.0k max (0 to +70°C)
- Response time 4 sec typ, 10 sec max in still air
- Sensor characterised to 70°C
- PT1000 sensing element tip supported by RTV

Mechanical

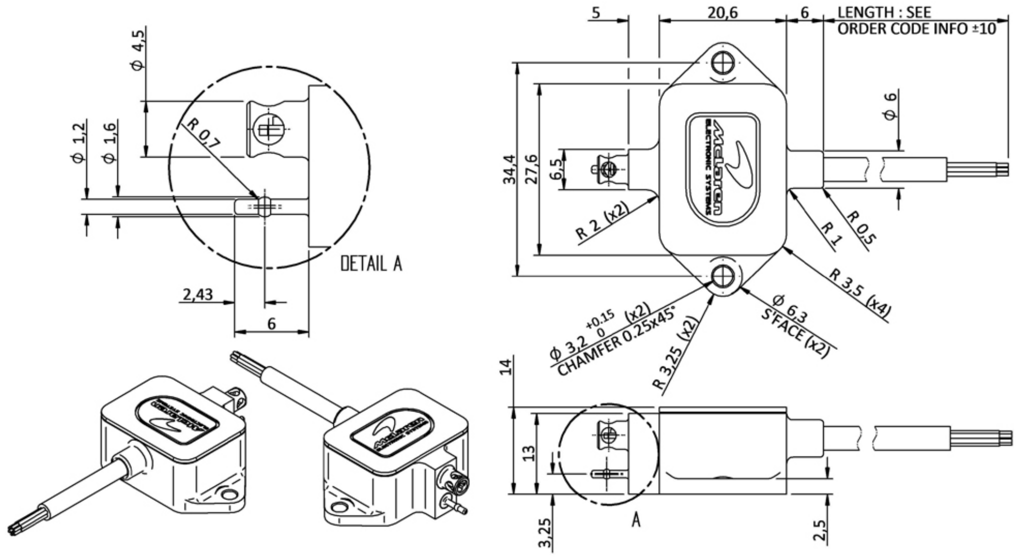
- Weight less than 55g (including cable and connector)
- Aluminium alloy body hard anodised grey
- Sensor is supplied with viton o-ring (where applicable)

Environmental

- Maximum pressure 4000mbar (absolute pressure)
- Pressure media must be a non-corrosive gas

- Sensor body resistant to standard motorsport fluids
- Maximum humidity 100% but water should not be allowed to condense inside the unit
- Operating temperature -40 to +125°C
- Compensated temperature range 0 to 125°C
- DR25 jacketed cable (150°C)
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy for details.



Cable Length	Ordercode
500mm	O 030 330 043 055

Temperature Sensor

16 x 4 Infra-Red Array

The infrared sensor measures temperature at a distance without contacting the target. The integrated infrared module senses the thermal radiation emitted by objects on a 16 x 4 array of sensing points, for measuring the temperature distribution across a surface. These 64 measurement pixels are transmitted via CAN to the host controller or data logging device. The sensor is available in both 35° and 60° field of view options to suit a variety of installations. A software package is provided for viewing live temperature data from the array.

Sensors

Electrical

- Supply voltage 8V to 16V
- Supply current 150mA (max) @ 12V
- Response time after power up 50ms typ, 1s max
- Target temperature range 0 to +300°C
- Unit outputs over CAN: 16 temperature points, 1 ambient temperature, 1 unit power supply diagnostic

CAN Output

- ISO011898 1Mbit/s CAN communications link for configuration and data transmission
- Configurable IR temperature resolution:
  - 14-bit – Transmits 17 messages per frame
  - 9-bit – Transmits 12 messages per frame
- Ambient temperature resolution: 12bit
- Unit supply diagnostic: 8bit
- CAN sampling rate configured by host ECU up to 20Hz
- CAN message identifiers configured by host ECU allowing multiple module sharing a common bus (a fixed CAN identifier will be required for configuration messages)
- The CAN bus link must be terminated using a 120# resistor. No internal CAN termination as standard
- The unit can be supplied with internal termination if required

Cable and Connection Definition

- 26AWG cable
- 1000mm cable length
- Definition:

Red wire	Supply
Black wire	Ground
Blue wire	CAN +
White wire	CAN -

- Bespoke cable lengths and connector terminations available on request

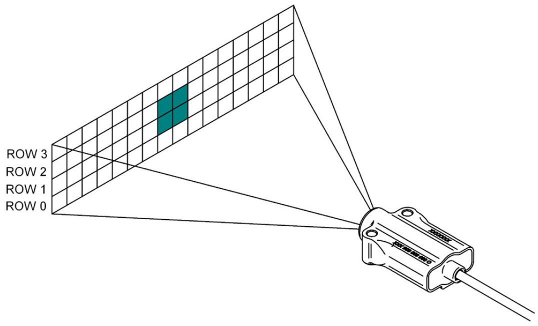
Accuracy

Four central pixels:

- Ta = 20 to 50°C, To = 50 to 160°C
  Typical error 1.5°C

Remaining pixels:

- Ta = 20 to 50°C, To = 50 to 160°C
  Typical error 2.0°C
  Where:
  Ta = Ambient temperature
  To = Target object Temperature



1 Four central pixels
Ta = 0 to 50°C
±1.0 ± 0.03*|To-Ta| °C
Ta = 50 to 85°C:
±2.5 ± 0.03*|To-Ta| °C

Remaining pixels

Ta = 0 to 50°C

±2.0 ± 0.045*|To-Ta| °C

Ta = 50 to 85°C

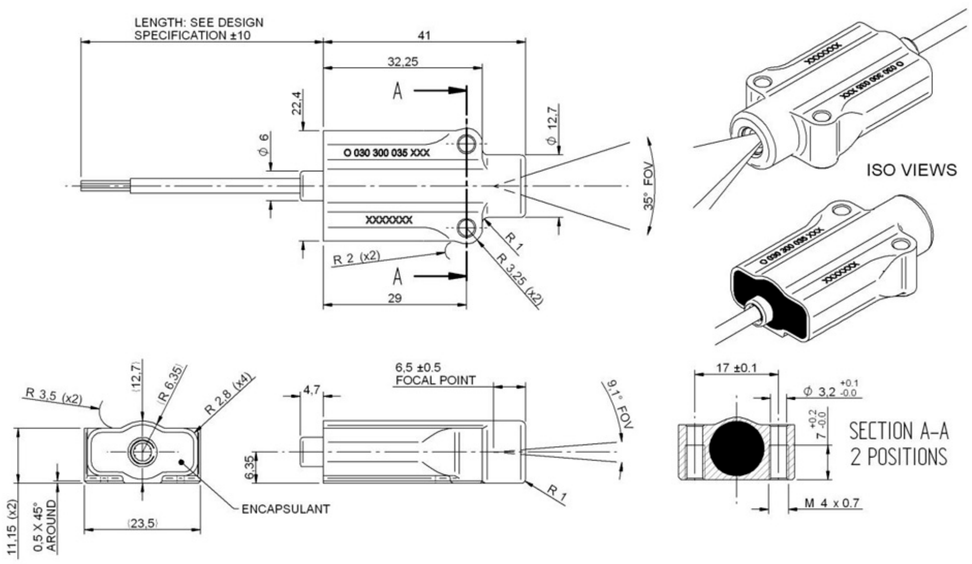
±4.0 ± 0.045*|To-Ta| °C

Mechanical

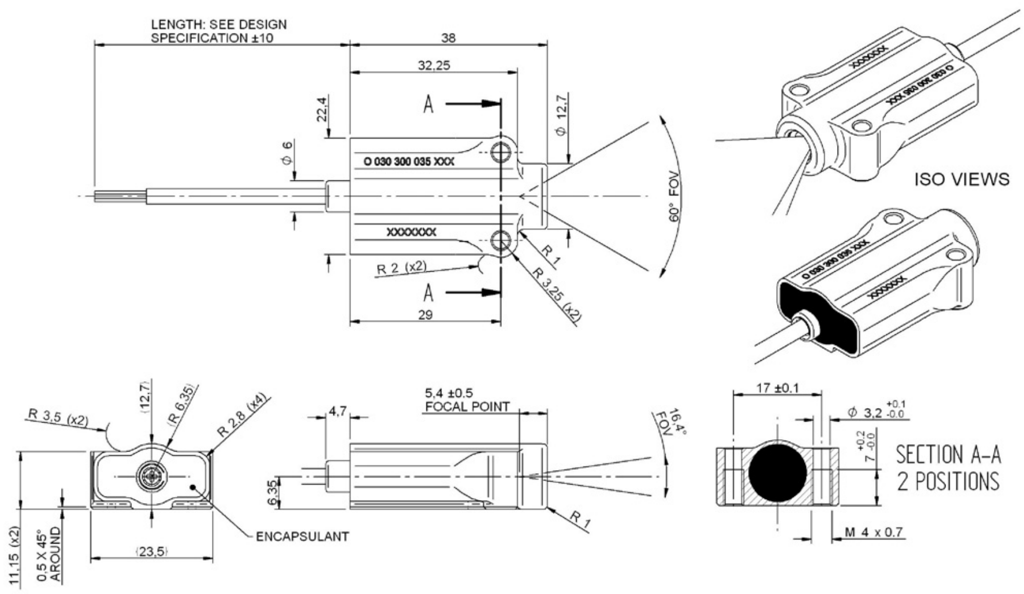
- Weight less than 35g
- DR25 jacketed cable
- Aluminium alloy board hard anodised and dyed black
- Polyester cable boss for strain relief to housing
- Field of view 35° or 60°

Environmental

- Resistant to oil, standard fuel, hydraulic fluid and water. Aggressive cleaning agents should not be used, for example freon or trichloroethylene. Alcohol/pure ethanol and a cotton swab can be used for cleaning the lens. Note the sensor reading will change if the lens becomes scratched or dirty
- Maximum humidity 100%
- Operating temperature -25 to +85°C
- Storage temperature -40° to 120°C
- Vibration 500 to 2000Hz, 20g Peak acceleration, 5mins in all
- Shock 1000g peak acceleration, 0.7ms pulse length, 6 directions



Cable Length	FOV	Ordercode
1000mm	35°	O 030 300 035 000



Cable Length	FOV	Ordercode
1000mm	60°	O 030 300 035 001

Temperature Sensor
Air

Temperature sensors have a well-defined relationship between electrical resistance and temperature, allowing them to measure temperature precisely. Pt100, Pt1000 or NTC elements are available. We recommend the Pt1000 element because its higher resistance makes it less sensitive to the resistance of harness wires and connector contacts. Our control units and data loggers support Pt1000 as standard, but can be modified to support Pt100 and NTC. The sensor element is exposed to the airflow to give the fastest possible response to changes in temperature.

The sensor is very compact and is available in various body types of which the M6 type is exceptionally small.

Please request our installation datasheet for further details.

Application

Inlet air manifold temperature measurement.

Electrical

- Nominal resistance:

NTC	5000 ohm	@25°C
Pt100	100 ohm	@0°C
Pt1000	1000 ohm	@0°C

- Accuracy: ±0.4K typ, ±1.0K max (0 to +70°C)
- Response time 4sec typ, 10sec max in still air

Cable and Connection Definition

- Un-screened cable, gauge as specified in order details
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

White wire	Pin A	Pin 1	Signal+
Black wire	Pin B	Pin 2	Signal-

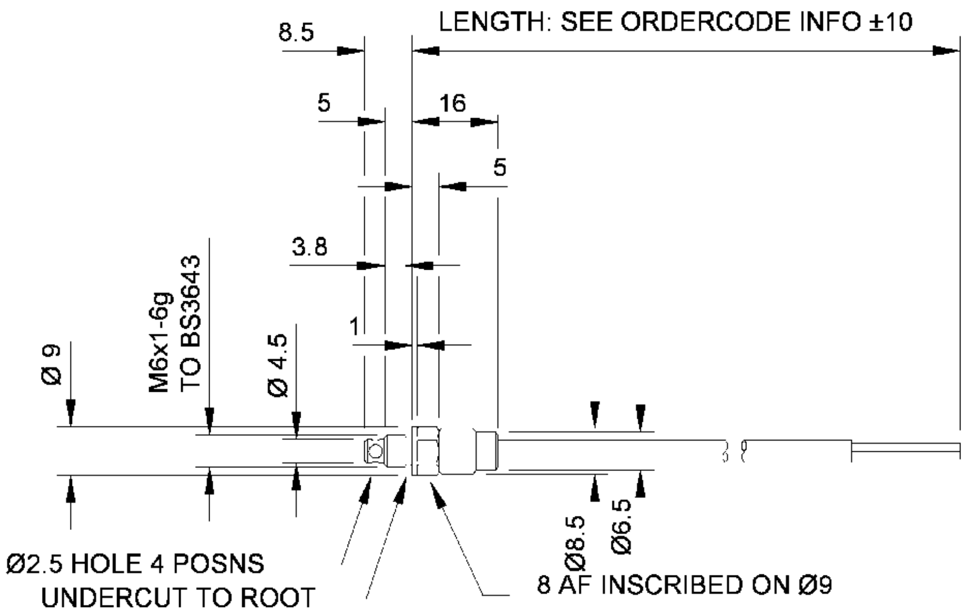
Mechanical

- Body types are aluminium alloy (hard anodised and dyed black), titanium or polyester (see order details)
- Weight (including cable) is shown in the order details
- Polyester cable boss or Elastomer boot for strain relief to the sensor body

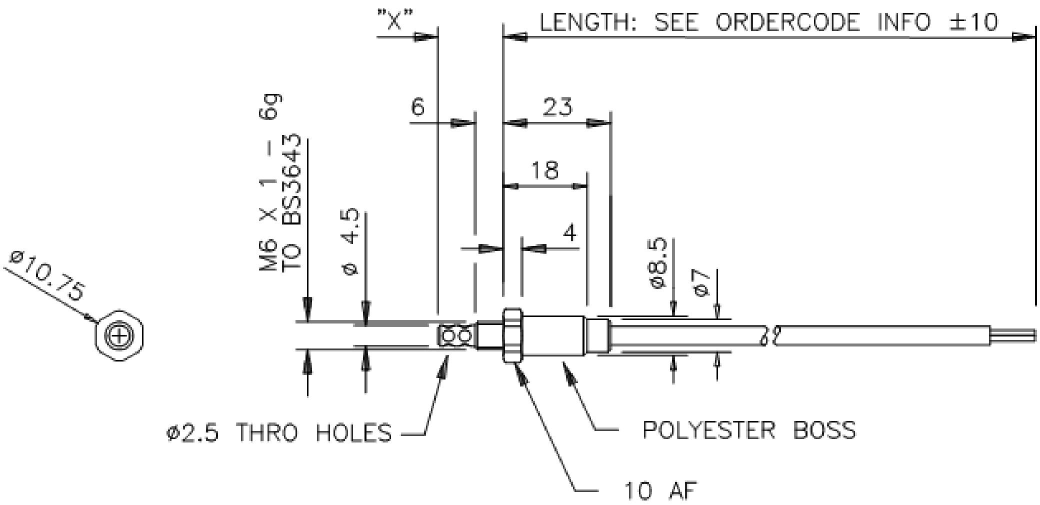
Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Resistant to standard motorsport fluids
- Relative Humidity for NTC elements:
  - Less than 75% average over one year
  - Less than 93% over 56 days in any one year
  - Pt1000/Pt100 elements unaffected by humidity
- Sensor housing and element operating temperature range -25°C to +200°C (sensor characterised to 70°C)
- Cable boss/shrink boot maximum operating temperature 150°C
- Viton jacketed cable maximum operating temperature 200°C
- Vibration 50 to 2500Hz @ 40g 8hrs per axis

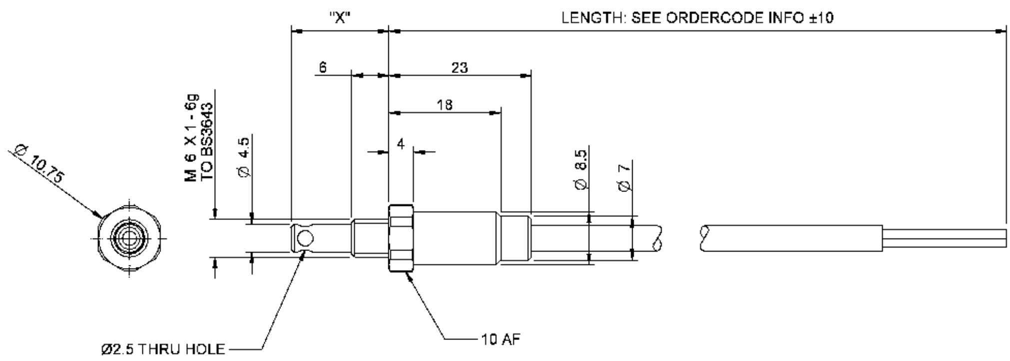


Element	Body Material	Cable Length	Cable Gauge	Weight	Ordercode
Pt1000	Titanium	1000mm	24AWG	40g	O 030 300 021 033



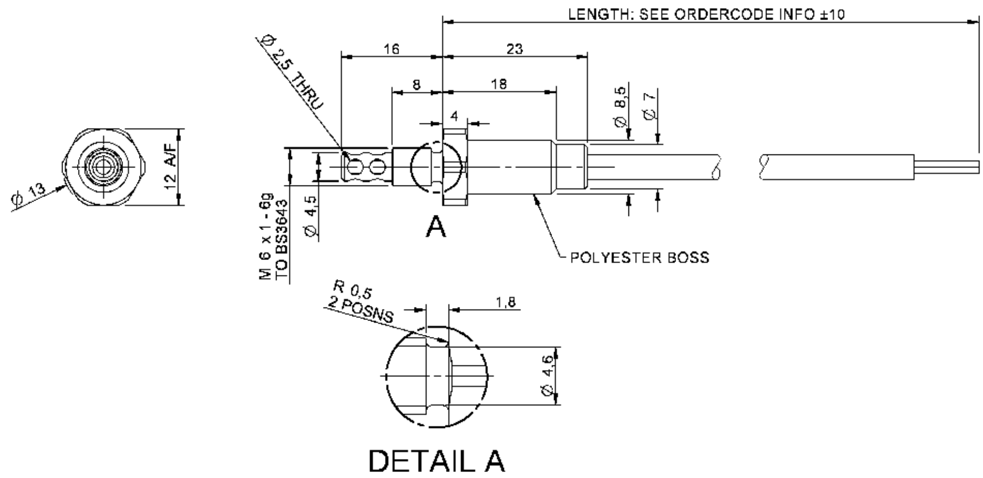
Element	Dim "X"	Body Material	Cable Length	Cable Gauge	Weight	Ordercode
Pt1000	14mm	Titanium	1000mm	22AWG	40g	O 030 300 021 031

Accessories	Ordercode
O-ring	O 030 300 990 000



Element	Dim "X"	Body Material	Cable Length	Cable Gauge	Weight	Ordercode
NTC	15.75mm	Titanium	1000mm	22AWG	40g	O 030 300 021 028

Accessories	Ordercode
O-ring	O 030 300 990 000



Element	Body Material	Cable Length	Cable Gauge	Weight	Ordercode
Pt1000	Titanium	1000mm	22AWG	40g	O 030 300 021 067

Sensors

Temperature Sensor
Air (Extra Small)

Temperature sensors have a well-defined relationship between electrical resistance and temperature, allowing them to measure temperature precisely. The sensor body is made of a thermally conductive material and is as small as possible to produce a rugged device which gives an accurate measurement of temperature with a fast response.

This sensor is small enough to install in traditional thermocouple locations, but has the advantage of straightforward Pt1000 interfacing.

Application

Temperature measurement.

Electrical

- Sensing element Pt1000
- Nominal resistance 1000ohm @ 0°C
- Accuracy:
  ±0.4K typ, ±1.0K max (0 to +100°C)
  ±1.0K typ, ±1.5K max (+100 to +150°C)
- Response time 4sec typ, 10sec max in still air

Cable and Connection Definition

- 26AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection both wires (Signal + and Signal -) are white

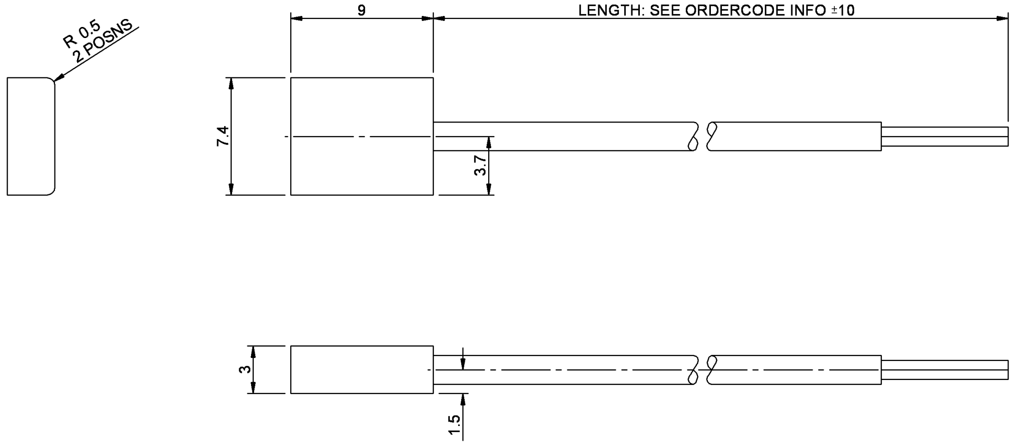
Mechanical

- Aluminium alloy body, hard anodised and dyed black
- Weight less than 45g (including cable)
- Internal joints made with high melting point solder

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Operating temperature -25 to +150°C
- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- DR25 jacketed cable



Element	Cable Length	Ordercode
Pt1000	1000mm	O 030 300 021 084

Temperature Sensor
Fluid

Temperature sensors have a well-defined relationship between electrical resistance and temperature, allowing them to measure temperature precisely. Pt100, Pt1000 or NTC elements are available. We recommend the Pt1000 element because its higher resistance makes it less sensitive to the resistance of harness wires and connector contacts. Control units and data loggers support Pt1000 as standard, but can be modified to support Pt100 and NTC. The sensor body is made of a thermally conductive material and is as small as possible to produce a rugged device which gives an accurate measurement of temperature with a fast response.

Please request our installation datasheet for further details.

Application

Oil, water and fuel temperature measurement.

Electrical

- Nominal resistance:

NTC	5000 ohm	@25°C
Pt100	100 ohm	@0°C
Pt1000	1000 ohm	@0°C

- Response time 4sec typ, 10sec max in still air
- Accuracy:
  - ±0.4K typ, ±1.0K max (-10 to +100°C)
  - ±1.0K typ, ±1.5K max (+100 to +150°C)
  - ±1.5K typ, ±2.0K max (+150 to +200°C)

Cable and Connection Definition

- 22 AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

White wire	Pin A	Pin 1	Signal+
Black wire	Pin B	Pin 2	Signal-

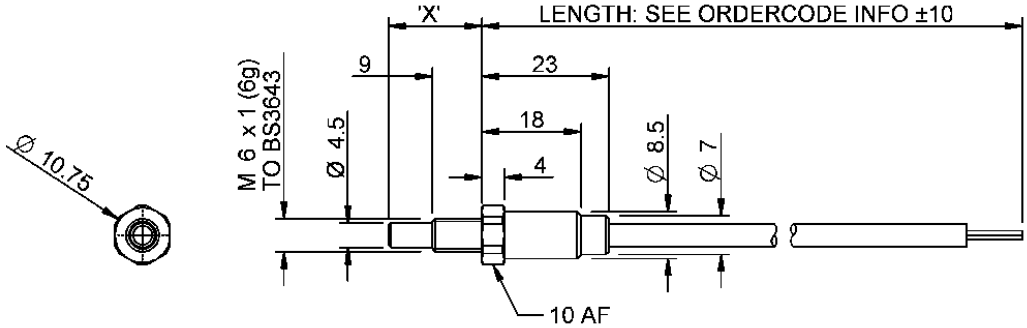
Mechanical

- Body material Titanium 318
- Weight less than 40g (including cable)
- Polyester cable boss or Elastomer boot for strain relief to the sensor body

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

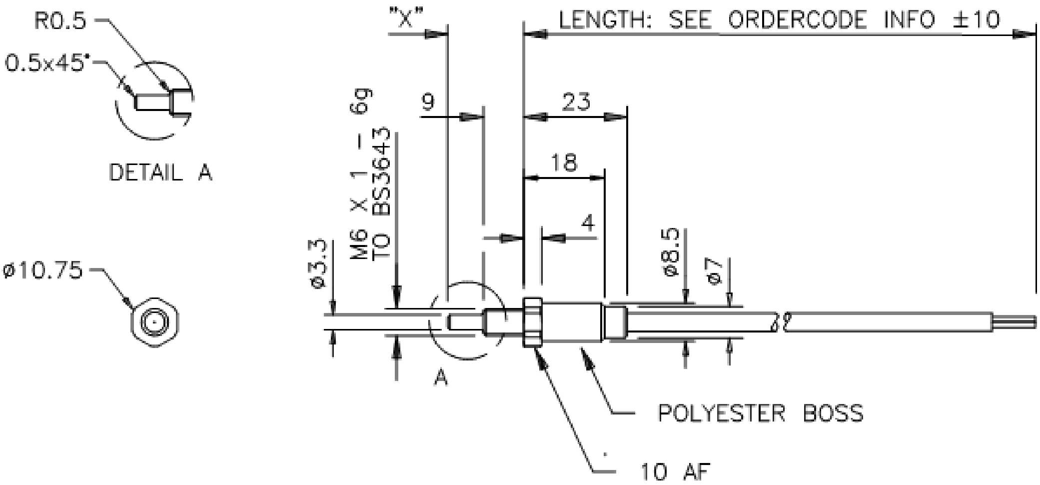
Environmental

- Resistant to standard motorsport fluids (Titanium can be attacked by Methanol and some cleaning fluids)
- Maximum humidity 100%
- Sensor housing and element operating temperature range -25°C to +200°C (sensor characterised to 150°C)
- Cable boss/shrink boot maximum operating temperature 150°C
- Viton jacketed cable maximum operating temperature 200°C
- Vibration 50 to 2500Hz @ 40g 8hrs per axis



Element	Dim "X"	Cable Length	Ordercode
NTC	17mm	1000mm	O 030 300 010 030
Pt1000	17mm	1000mm	O 030 300 010 035

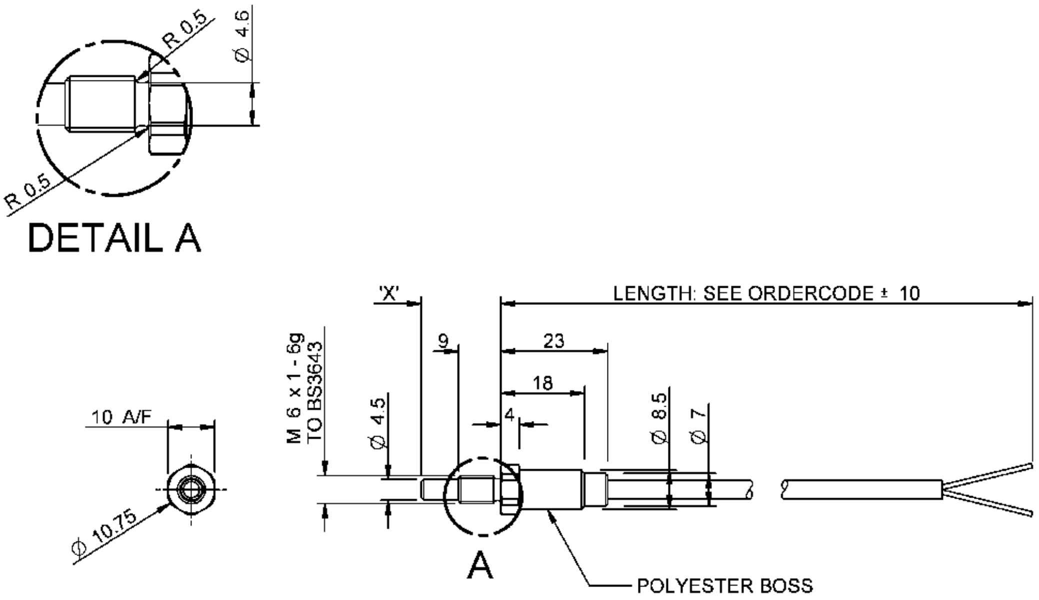
Accessories	Ordercode
Bonded Seal	O 030 300 990 000



Element	Dim "X"	Cable Length	Ordercode
Pt1000	17mm	1000mm	O 030 300 010 040
NTC	17mm	1000mm	O 030 300 010 041

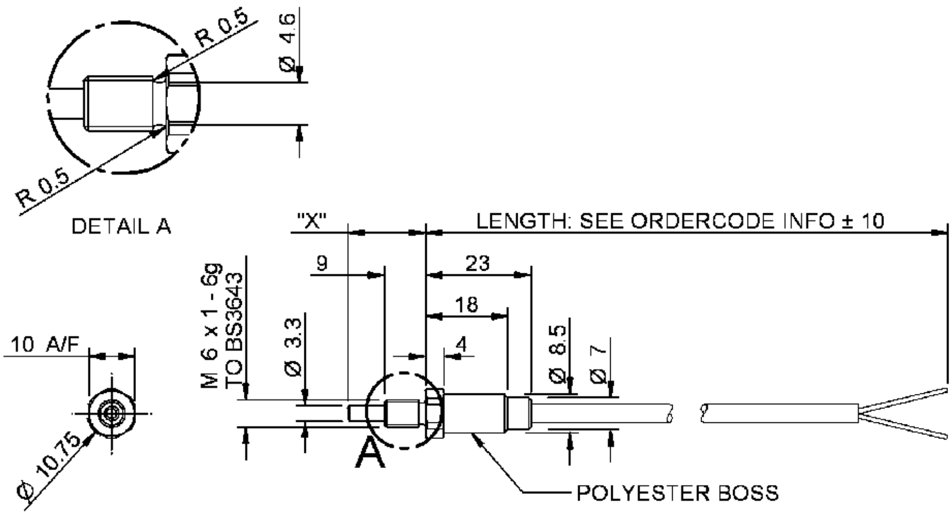
Accessories	Ordercode
Bonded Seal	O 030 300 990 000

Sensors



Element	Dim "X"	Cable Length	Ordercode
Pt1000	17mm	1000mm	O 030 300 010 039

Accessories	Ordercode
Viton O-ring	O 030 300 990 006



Element	Dim "X"	Cable Length	Ordercode
Pt1000	17mm	1000mm	O 030 300 010 046

Accessories	Ordercode
Viton O-ring	O 030 300 990 006

Sensors

Temperature Sensor

Infra-Red (Brake Temperature)

The infra-red sensor measures temperature at a distance without contacting the target. The integrated infra-red module senses the thermal radiation emitted by objects and converts this to an analogue voltage.

Electrical

- Supply voltage 7.5 to 16V
- Supply current 1.5mA (typ), 5mA (max)
- Capacitive load 1000 pF
- Resistive load 10k#
- Output resistance 50#
- Accuracy (based on emissivity of 0.98)
  ±53°C max (object temp 250°C to 850°C)
  ±118°C max (object temp 850°C to 1150°C)
- Typical output voltages at an ambient sensor temperature of 25°C for a target which fills the entire field of view and has an emissivity of 0.98 are shown below:

Target temp (°C)	Typical output (V)
200	1.405
300	1.621
350	1.726
400	1.837
450	1.956
500	2.084
550	2.220
600	2.362
700	2.645
800	2.920
900	3.210
1000	3.515
1100	3.744
1200	3.884

- Target temp = $(49.907095x^6 – 757.591078x^5 + 4691.379611x^4 – 15128.065163x^3 + 26684.745161x^2 – 23906.112709x + 8552.401105) * (1+(0.98 – \#))$
  where:
  x = Output voltage
  # = Emissivity of customer target
  0.98 = Emissivity of MES black body reference
- Carbon emissivity = 0.75
- Steel emissivity = 0.52
- Response time after power up 30ms (typ), 1 sec (max)

Cable and Connection Definition

- 24AWG unscreened cable
- Cable length is shown on the order details but any length is available on request

- Various automotive and military standard connectors are available
- Connections:

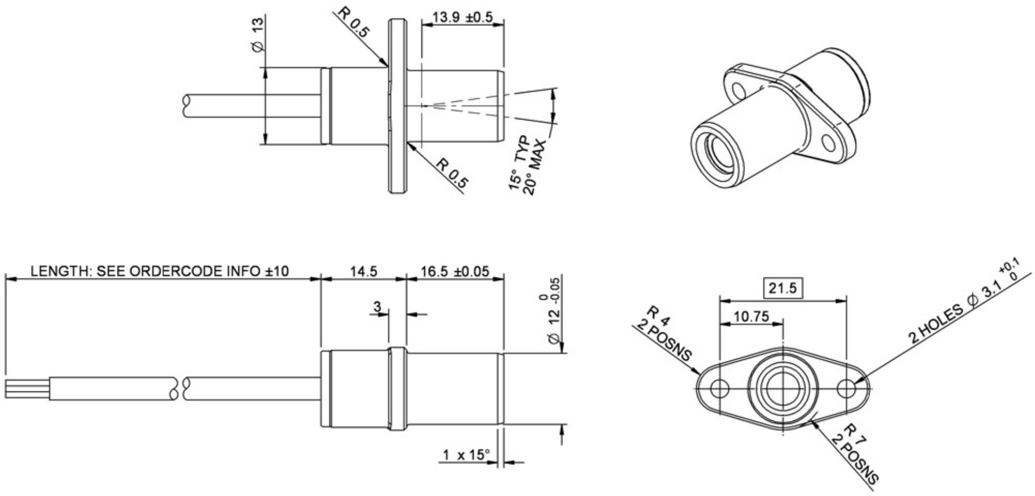
Red wire	Supply	Pin 1
White wire	Signal	Pin 2
Green wire	Ground	Pin 3
N/C	-	Pin 4

Mechanical

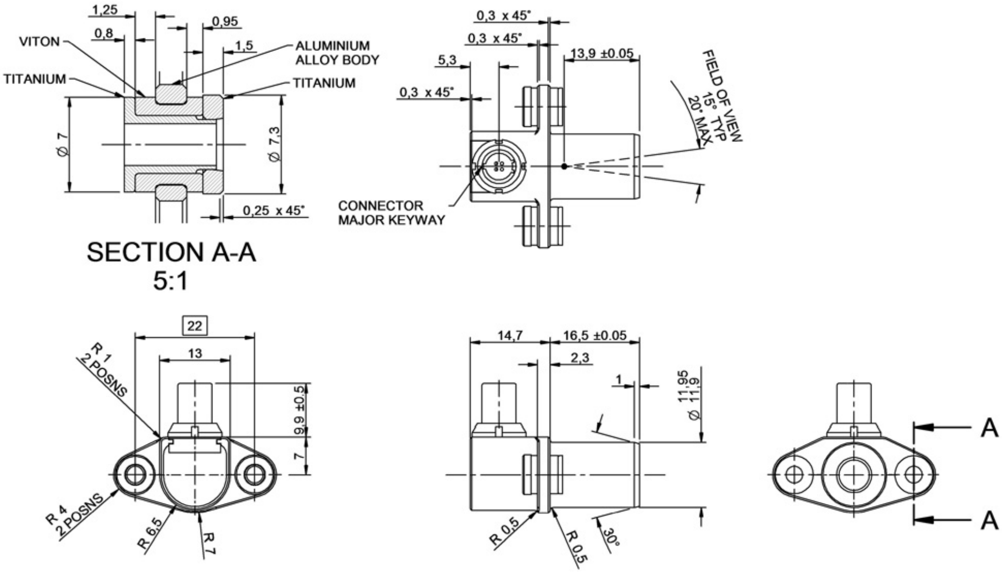
- Weight less than 40g
- Aluminium alloy body hard anodised and dyed black
- Field of view 15° (typ), 20° max
- Optical axis ± 2° max
- Polyester boss for strain relief to the sensor body

Environmental

- Resistant to oil, standard fuel, hydraulic fluid and water. Aggressive cleaning agents should not be used, for example freon or trichloroethylene. Pure ethanol or alcohol and a cotton swab can be used for cleaning the lens.
- The sensor reading will change if the lens becomes scratched or dirty
- Maximum humidity 100%
- Ambient operating temperature -25 to +105°C.
- Target temperature +200 to +1200°C.
- Storage temperature -40° to 125°C
- Viton jacketed cable (200°C)
- Vibration:
  - 500 to 2000 Hz, 20g peak acceleration, five mins in all directions
- Shock:
  - 1000g peak acceleration, 0.7ms pulse length, six directions.



Cable Length	Ordercode
1000mm	O 030 300 030 021



Connector	Ordercode
Integral Connector Lemo ECS.FF.304.SLC	O 030 300 030 043

Temperature Sensor
Infra-Red (Triple)

The infra-red sensor measures temperature at a distance without contacting the target. The three-channel infra-red sensor incorporates three independent thermopile modules, this enables the spread of temperature across the surface of a tyre to be measured.

Application

Tyre temperature measurement

Electrical

- Two target temperature ranges available: -20 to +250°C or -20 to +180°C (to accompany single IR tyre temperature sensor)
- Accuracy[1]: +2.5/-7°C
- Output drift due to ambient temperature variations ±0.25°C max from 45 to 105°C (±4°C outside of this range)
- Typical output voltages (@25°C±2°C) for a target which fills the entire field of view and has an emissivity of 0.98 are shown below[2]:

-20 to +250°C

Target temp (°C)	Typical output (V)	Target temp (°C)	Typical output (V)
-20°C	0.953V	160°C	2.860V
0°C	1.057V	170°C	3.028V
25°C	1.225V (Vref)	180°C	3.201V
40°C	1.346V	190°C	3.379V
60°C	1.531V	200°C	3.563V
80°C	1.745V	210°C	3.753V
100°C	1.985V	220°C	3.947V
120°C	2.251V	230°C	4.147V
130°C	2.394V	240°C	4.351V
140°C	2.544V	250°C	4.561V
150°C	2.699V		

-20 to +180°C

Target temp (°C)	Typical output (V)	Target temp (°C)	Typical output (V)
-20°C	0.803V	90°C	2.230V
0°C	0.880V	100°C	2.431V
10°C	1.062V	110°C	2.645V
20°C	1.168V	120°C	2.872V
25°C	1.225V (Vref)	130°C	3.111V
30°C	1.285V	140°C	3.364V
40°C	1.413V	150°C	3.630V
50°C	1.552V	160°C	3.909V
60°C	1.703V	170°C	4.201V
70°C	1.867V	180°C	4.506V
80°C	2.042V		

[1]Accuracy based on emissivity of 0.98

[2]The sensor reading will change if the lens becomes scratched or dirty.

- Target Temp Transfer Function =

  -20 to +250°C

  $(-0.521508x^6 + 9.59684x^5 – 72.27712x^4 + 286.6215x^3 – 641.638x^2 + 849.76x – 442.17) * (1 + [0.98 – #])$

  -20 to +180°C

  $(-0.211955x^6 + 3.81157x^5 – 28.16153x^4 + 110.6794x^3 – 252.319x^2 + 373.85x – 204.12) * (1 + [0.98 – #])$

  where:
  x = Output Voltage
  # = Emissivity of customer object
  0.98 = Emissivity of MES black body reference.

- Tyre emissivity = 0.95
- Response time after power up 30ms typ, 1sec max
- Supply voltage 7.5 to 16V
- Supply current 15mA (max)
- Capacitive load 1000pF
- Resistive load 10k#
- Output resistance 50#

Cable and Connection Definition

- 28AWG cable
- Cable length is shown on the order details but any length is available on request
- Connection:

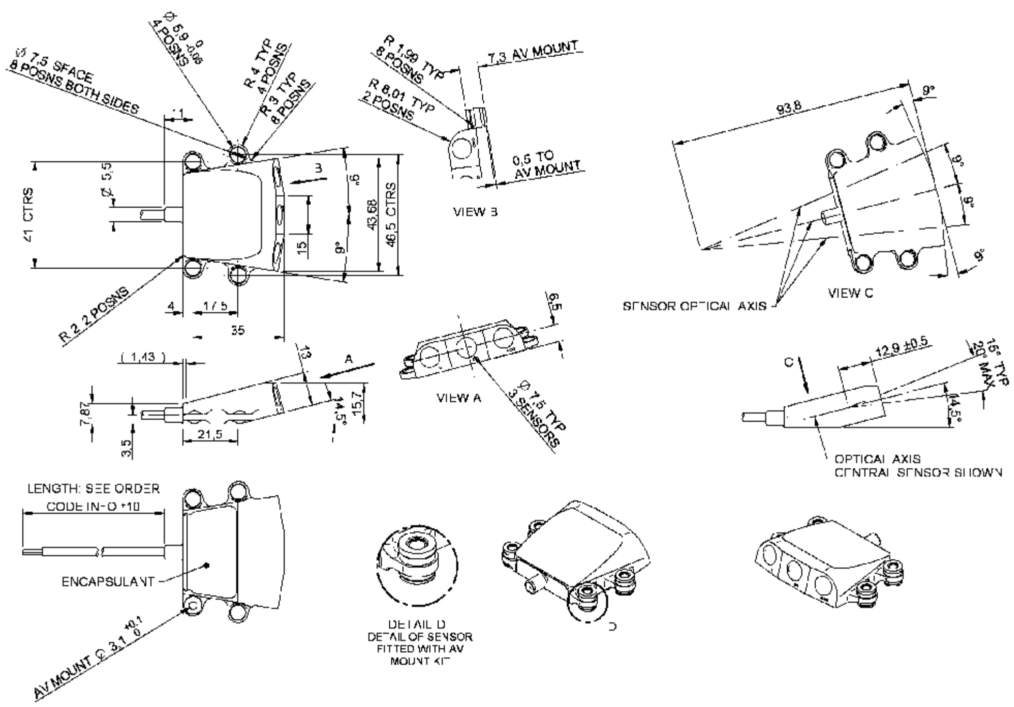
Red	Supply	White	Signal Snr3
Blue	Signal Snr1	Green	Ground
Grey/White	Signal Snr2	Black x2	NC

Mechanical

- Weight less than 140g
- DR 25 jacketed cable
- Aluminium alloy body hard anodised and dyed black
- Polyester cable boss for strain relief to sensor housing
- AV Mount kit (fitted):
  - Four Viton 70 shore AV mounts
  - Four Titanium eyelets
  - Four Titanium retaining caps
- Field of view 15° typ, 20° max per sensor 9° separation between sensors
- Optical axis ±2° max

Environmental

- Resistant to oil, standard fuel, hydraulic fluid and water. Aggressive cleaning agents should not be used, for example freon or trichloroethylene. Alcohol/pure ethanol and a cotton swab can be used for cleaning the lens.
- Maximum humidity 100%
- Operating temperature -25 to +105°C.
- Storage temperature -40° to 120°C.
- Vibration 500 to 2000Hz, 20g Peak acceleration, five mins in all directions
- Shock 1000g peak acceleration, 0.7ms pulse length, six directions.



Temperature Range	Cable Length	Ordercode
-20 to +250°C	1000mm	O 030 300 030 031
-20 to +180°C	1000mm	O 030 300 030 048

Sensors

Temperature Sensor

Infra-Red (Tyre Temperature)

The infra-red sensor measures temperature at a distance without contacting the target. The integrated infra-red module senses the thermal radiation emitted by objects and converts this to an analogue voltage.

Electrical

- Supply voltage 7.5 to 16V
- Supply current 1.5mA (typ), 5mA (max)
- Capacitive load 1000 pF
- Resistive load 10k#
- Output resistance 50#
- Accuracy +2.5 / -7°C from 80 to 180°C (based on emissivity of 0.98)
- Typical output voltages (@25°C±2°C) for a target which fills the entire field of view and has an emissivity of 0.98 are shown below [1]

Target temp (°C)	Typical output (V)
-20	0.803
0	0.880
10	1.062
20	1.168
25	1.225 (Vref)
30	1.285
40	1.413
50	1.552
60	1.703
70	1.867
80	2.042
90	2.230
100	2.431
110	2.645
120	2.872
130	3.111
140	3.364
150	3.630
160	3.909
170	4.201
180	4.506

- Target Temp Transfer Function = (-0.211955x6 + 3.81157x5 – 28.16153x4 + 110.6794x3 – 252.319x2 + 373.85x – 204.12) * (1 + [0.98 – #])
  where:
  x = Output voltage
  # = Emissivity of customer target

0.98 = Emissivity of MESL black body reference

- Tyre emissivity = 0.95
- Target temperature range -20 to + 180°C
- Response time after power on 30ms (typ) 1sec (max)

[1] The sensor reading will change if the lens becomes scratched or dirty

Cable and Connection Definition

- 24AWG unscreened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connections:

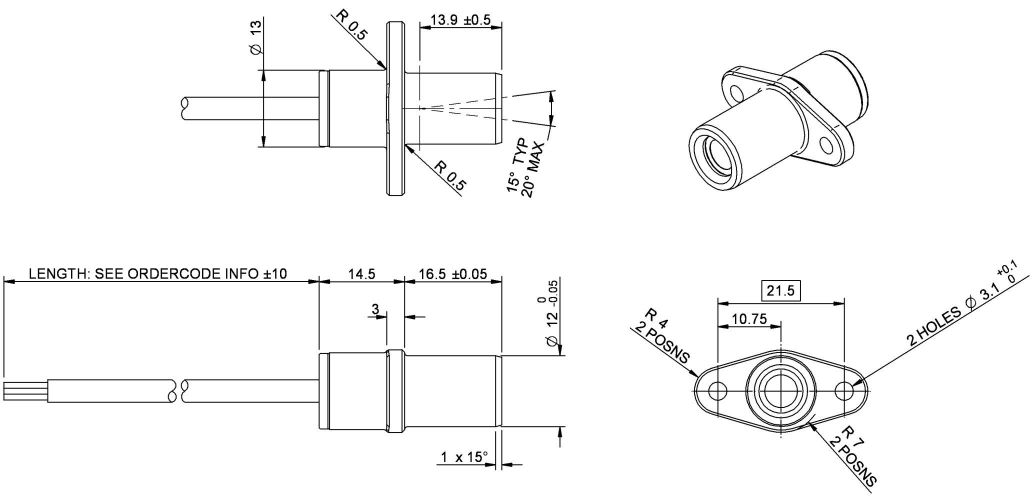
Red wire	Supply
White wire	Signal

Mechanical

- Weight less than 40g
- Aluminium alloy body hard anodised and dyed black
- Field of view 15° (typ), 20° max
- Optical axis ± 2° max
- Polyester boss for strain relief to the sensor body

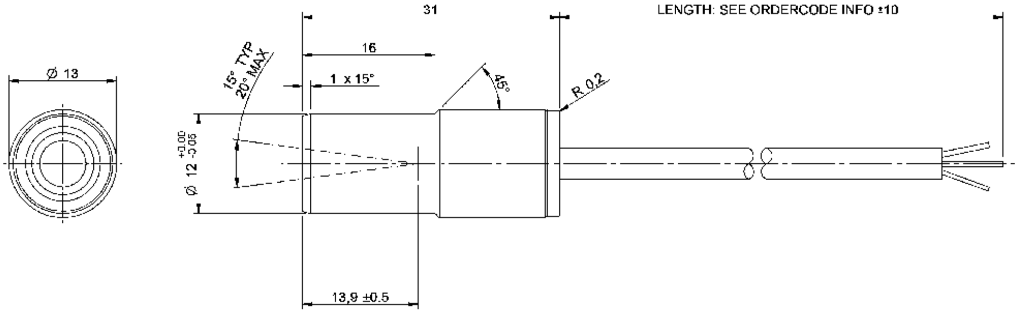
Environmental

- Resistant to oil, standard fuel, hydraulic fluid and water. Aggressive cleaning agents should not be used, for example freon or trichloroethylene. Alcohol and a cotton swab can be used for cleaning the lens.
- The sensor reading will change if the lens becomes scratched or dirty
- Maximum humidity 100%
- Ambient operating temperature -25 to +105°C.
- Storage temperature -40° to 120°C
- Viton jacketed cable (200°C)
- Vibration:
  - 500 to 2000 Hz, 20g peak acceleration, five mins in all directions
- Shock:
  - 1000g peak acceleration, 0.7ms pulse length, six directions.



Cable Length	Ordercode
1000mm	O 030 300 030 037

Sensors



Cable Length	Ordercode
1000mm	O 030 300 030 044

Temperature Sensor
Surface

Temperature sensors have a well-defined relationship between electrical resistance and temperature, allowing them to measure temperature precisely. The sensor body is made of a thermally conductive material and is as small as possible to produce a rugged device which gives an accurate measurement of temperature with a fast response.

This sensor is small enough to install in traditional thermocouple locations, but has the advantage of straightforward Pt1000 interfacing.

Application

Temperature measurement.

Electrical

- Sensing element Pt1000, surface mount
- Nominal resistance 1000ohm @ 0°C
- Accuracy:
  - ±0.4K typ, ±1.0K max (0 to +100°C)
  - ±1.0K typ, ±1.5K max (+100 to +150°C)
  - ±1.5K typ, ±2.0K max (+150 to +200°C) [1]
- Response time 4sec typ, 10sec max in still air

[1] Characterised to 150°C

Cable and Connection Definition

- 28AWG un-screened cable
- Cable length is shown on the order details but any length is available on request
- Various automotive and military standard connectors are available
- Connection:

White wire	Signal +
Black wire	Signal -

Mechanical

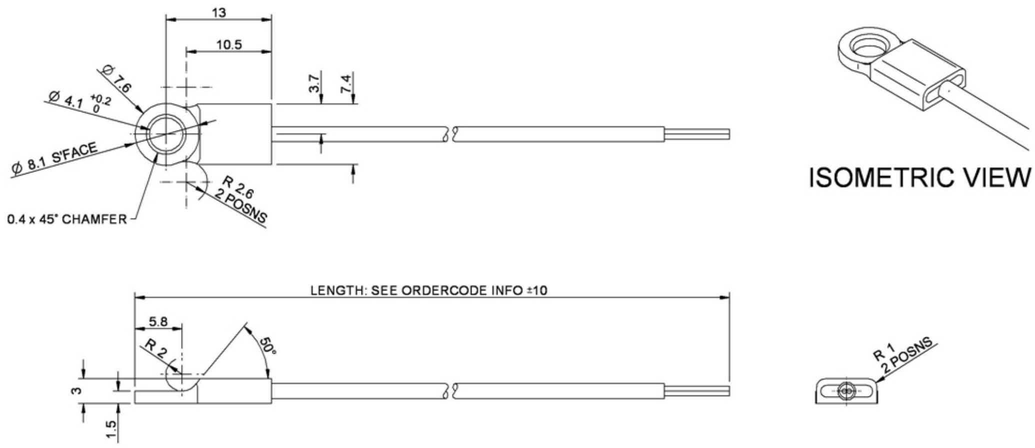
- Aluminium alloy body, hard anodised and dyed black
- Weight less than 15g (including cable)
- Internal joints made with high melting-point solder

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Environmental

- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Vibration 50 to 2500Hz @ 40g 8hrs per axis
- Operating temperature -25 to +200°C [1]
- DR25 jacketed cable (150°C)

[1] Characterised to 150°C



Element	Cable Length	Ordercode
Pt1000	1000mm	O 030 300 021 081

Thermal Camera

The thermal camera allows real-time thermography with 100Hz frame rate via USB 2.0 interface. The camera is lightweight, compact and rugged (IP65). Measurement ranges of -20°C to 100°C, 0°C to 250°C, or 150°C to 900°C are selectable in software. Interchangeable lenses are available with 6°x5°, 23°x17°, 48°x31° and 72°x52° field of view.

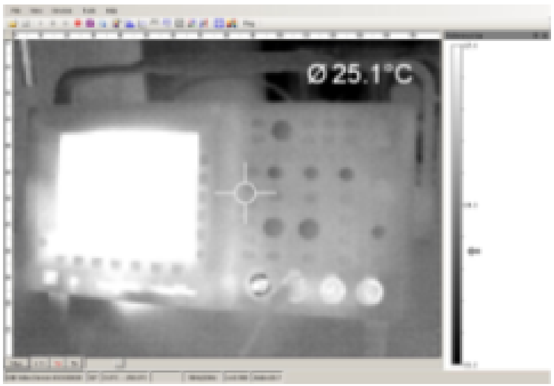
We recommend the EPL-310 as a data logging unit for use with the Thermal Camera.

Electrical

- Supply and operation via USB 2.0 interface (supply 4.75V to 5.25V)
- Supply current 500mA max
- Measurement range selectable in software:
  - -20°C to 100°C
  - 0°C to 250°C
  - 150°C to 900°C
- Lens details:
  - 6°x5° f=35.5mm, 500mm min distance
  - 23°x17° f=10mm, 200mm min distance
  - 48°x31° f=5.7mm, 200mm min distance
  - 72°x52° f=3.3mm, 200mm min distance
- Spectral range 7.5µm to 13µm
- Frame rate 120Hz
- Optical resolution 160x120 pixels
- System accuracy (at 23°C) ±2% or ±2°C, whichever is greater
- Display resolution 0.1°C
- Measurement resolution 0.08°C with 23°x17° lens, 0.1°C with 48°x31° or 72°x52° lens and 0.3°C with 6°x5° lens
- Emissivity 0.1 to 1.0 adjustable in software
- Warm up time 10 minutes

Software

- Software interface shown below:



Connection Definition

Deutsch ASU0-03-05PN

- Connections:

Pin 1	Supply
Pin 2	Ground
Pin 3	Data +
Pin 4	Data –
Pin 5	Not connected

Connector body	Screen [1]

[1] USB cable screen should be connected to connector body.

Mechanical

- Aluminium alloy body, hard anodised and dyed black
- Weight approx. 140g
- 70 shore Viton AV mounts

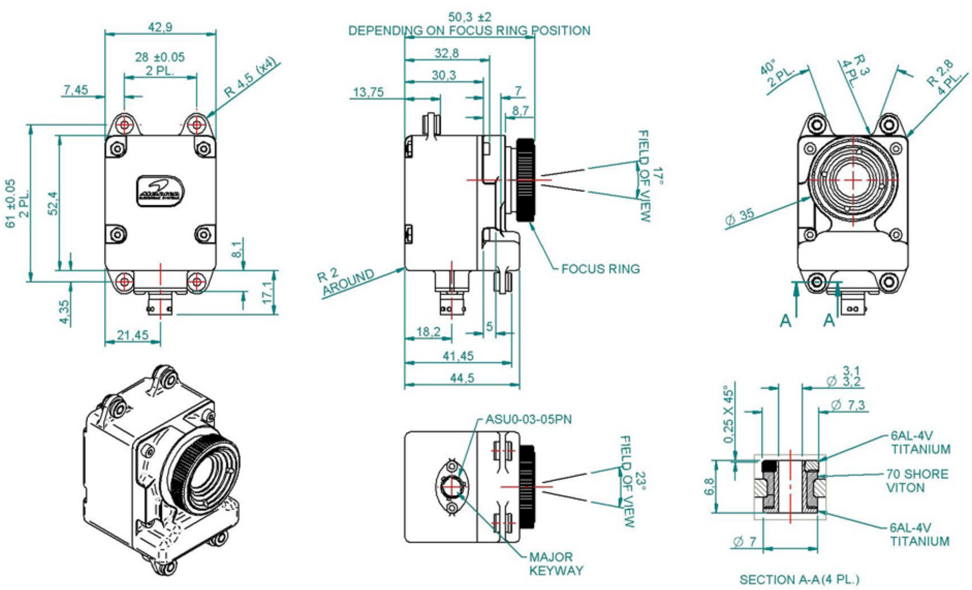
Environmental

- Resistant to standard motorsport fluids
- Operating temperature 0 to 50°C [2]
- Storage temperature -20 to 70°C
- Relative humidity 20 to 80% non-condensing
- Vibration 100-1000Hz random 9.1G_{rms}
- Shock 25G, ½ sine, 11ms

[2] Running outside the operating temperature range will significantly reduce the life of the camera.

Note

You will require an Export Licence to use the Thermal Camera outside of Europe/USA



Lens: Horizontal x Vertical	Ordercode
23° x 17°	O 030 300 033 003

Accessories	Ordercode
6° x 5° lens	O 030 300 990 018
23° x 17° lens	O 030 300 990 019
48° x 31° lens	O 030 300 990 020
72° x 52° lens	O 030 300 990 021
Lens cover for 23° x 17° optic	O 030 300 990 025
PC USB 2.0 test lead 1m length	O 030 300 990 016

Note: Additional lens orders will require the Thermal Camera to be sent back to McLaren Electronics for re-calibration, unless the additional lens is ordered at the time of purchasing the Thermal Camera.

Thermocouple

Air Temperature

This sensor uses a J-type Iron/Constantan thermocouple and is intended for use where a fast response time is required

Electrical

- J-type to BS/EN 60584.1
- Measurement range 20 to 500°C

Cable and Connection Definition

- 24AWG un-screened cable using J type materials
- Cable length is shown on the order details but any length is available upon request
- Connection:

Black wire	Signal+
White wire	Signal-

Mechanical

- Weight less than 50g (including cable)
- Stainless steel body
- Measurement point 1.5mm from tip of probe
- PEEK boss for strain relief to the sensor body

Environmental

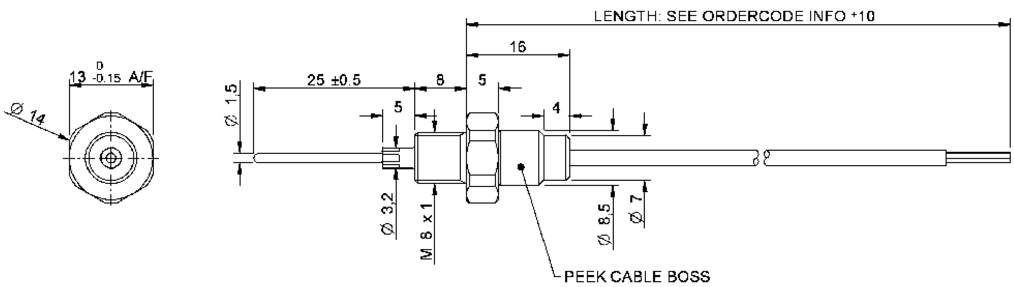
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Continuous operating temperature:

Probe	0 to +500°C
Cable	-10 to +150°C
Cable boss	0 to 230°C

- Maximum short term operating temperature:

Probe	+500°C
Cable	+200°C
Cable boss	+260°C

- DR25 thin wall sleeving
- Vibration 50 to 2500Hz @ 40g 8hrs per axis



Cable Length	Ordercode
1000mm	O 030 300 032 000

Thermocouple
Exhaust Gas

This sensor uses a K-type Chromel/Alumel thermocouple and is intended for use in high-temperature, high-vibration environments. Control units and data loggers support K-type thermocouples. The sensor is short and compact to minimise its susceptibility to vibration.

Please request our installation datasheet for further details.

Application

- Exhaust gas temperature measurement.

Electrical

- K-type DIN 43710
- Measurement range 0 to 1200°C

Cable and Connection Definition

- 24AWG un-screened cable using K-type materials
- Cable length is shown on the order details
- Various automotive and military standard connectors are available
- Connection:

Green wire	Pin A	Pin 1	Signal+
White wire	Pin B	Pin 2	Signal-

Design and manufacture is in-house, so if our existing designs do not suit your application, we can provide cost effective customised parts to suit even the most demanding application. No engineering charges are made for simple modifications such as customer specific connectors, cable protection and cable lengths. Please contact our technical consultancy service who will be pleased to help.

Mechanical

- Stainless steel body
- Measurement point 1.5mm from tip of probe
- Weight specified in ordercode details
- Viton boot for strain relief to the sensor body

Environmental

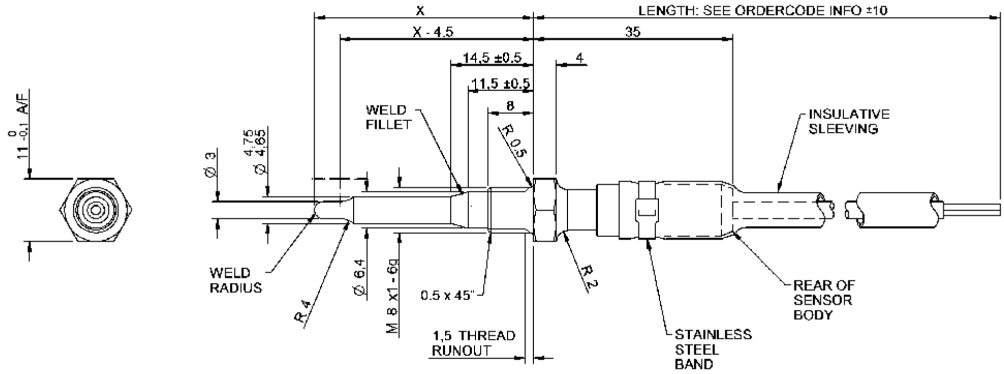
- Resistant to standard motorsport fluids
- Maximum humidity 100%
- Continuous operating temperature:

Probe	0 to 1200°C
Cable	-10 to +200°C

- Maximum short-term operating temperature:

Probe	+1300°C
Cable	+250°C

- Vibration 50 to 2500Hz @ 40g 8hrs per axis



Cable Length	Cable Sleeving	Weight	Dim "X"	Ordercode
1000mm	Textalu 1202	50g	63mm	O 030 300 002 006
1000mm	Textalu 1202	50g	38.5mm	O 030 300 002 011

Temperature is measured 1.5mm from the tip of the sensor.

Sensors

Thermocouple Transmitter

The system consists of a thermocouple transmitter which transmits temperature measurements from a K-type thermocouple to the tyre pressure receiver box.

The transmitter allows a K-type thermocouple to be connected externally via a hermetically sealed connector. The thermocouple output is then transmitted over a wireless link to a standard tyre pressure sensor receiver unit. The sensor housing has been designed so that it can be fitted to a standard tyre pressure sensor rim housing.

Application

- Monitoring temperature.

Electrical

- Supply voltage 2.5-3.6V (Internal Lithium Thionyl Chloride battery)
- Life 280 hours of transmissions
- Sensor only transmits if thermocouple connected
- Measurement range 20 to 450°C (using K-type thermocouple)
- Thermocouple resolution >0.2°C/bit
- Internal KTY-13 Positive TC sensor for board temperature measurement

Nominal rate per sensor		**Number of sensors**	**Mode**
Tx	**Rx**		
0	0	-	Thermocouple disconnected
0.42	0.42	1	Thermocouple connected
	0.41	2	
	0.40	3	
	0.39	4	

Collisions between messages cause the reception rate to reduce as more sensors are used.

Receiver CAN specification

- Reception requires receiver type O 030 330 046 024
- Refer to tyre pressure user interface manual for details of CAN message specification and the scalings required to obtain the necessary voltages:
  - All thermocouple related voltages are available in CAN_OBJECT_Raw
    Set Vref = Raw (internal) sensor temperature
    Vthermo = Raw tyre pressure
  - Then calculate :
    $Vcomp = U0 + U1*Vref + U2*Vref^{2}$
    $Vcorr = (Vthermo - k) / m + Vcomp$
  - Measured thermocouple temp T is given by:
    $T = C0 + C1*Vcorr + C2*Vcorr^{2}$

RF Specification

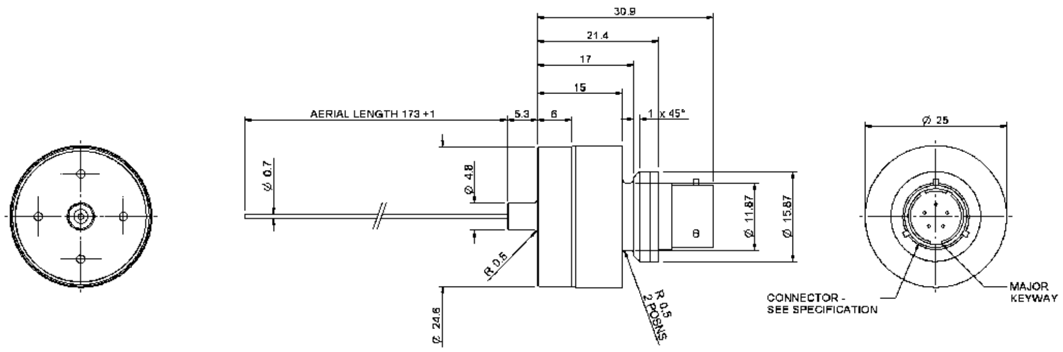
- Modulation FM (FSK) encoded serial data
- Nominal frequency 433.920MHz
- Transmission range 15m (typ)
- Each sensor transmits a unique serial number
- All transmitted data is encrypted
- Transmitted data format as follows:

  Message content
  Message Type 1 (20.4msec duration)
  <Serial No>
  <Board Temp raw ADC 11-bit>
  <Thermocouple raw ADC 1/Text2-bit>
  <Txcount>

Message Type 2 (20.4msec duration)
<Serial No>
<Vbatt raw ADC 10-bit>
<Thermocouple raw ADC 12-bit>
<Txcount>
Message Type 3 (20.4msec duration)
<Serial No>
<TX Life count 10-bit>
<Thermocouple raw ADC 12-bit>
<Txcount>

Calibration

- Each sensor is provided with five cal constants: U0, U1, U2, m, k which are unique to the sensor
- A further three constants@ C0, C1, C2 are provided but these are the same for all sensors of this design.



Description	Ordercode
Thermocouple Transmitter	O 030 330 046 021

Thermocouple Interface Unit
TIU-32

The TIU-32 is a 32-channel thermocouple interface unit. Two versions are available, the TIU-32 and the TIU-32C providing output as either 0-5V analogue or via CAN.

Cold junction is provided with the TIU-32 and TIU-32C. In the case of the standard TIU-32 the 32 compensated signals are then multiplexed (32:2) to provide two 0-5V scaled outputs. Channel selection is under the control of a host ECU via 4 channel select pins.

The TIU-32C CAN-linked version is fitted with a microcontroller that samples the analogue signals and scales them accordingly ready for transmission to a control unit via the CAN bus at speeds up to 1Mbps

Application
- Multiple channel temperature monitoring.

Electrical
- Supply Voltage 7V to 17.5V
- Supply Voltage must not exceed 17.5V continuous (the unit is protected against transients and reverse polarity)
- Current 95mA maximum (70mA, typ)

Mechanical
- Case material Magnesium alloy, finished with stippled black epoxy
- Weight less than 155g

Sensor Inputs
- 32 analogue Type ‘K’ thermocouple inputs, -50°C to +1300°C nominal sensor range, cold-junction compensated, open circuit detection (1M pull-up to 160mV)
- Four digital channel select inputs (10k pull-downs), 5V clamp, can be driven from TTL or Moog output

Outputs
- Two 0-5V outputs (16 multiplexed outputs per channel)
- Nominal scale 60mV at -50°C, 230mV at 0°C, 3.944V at 1000°C
- Outputs can be scaled and transmitted via a CAN link at 1Mpbs

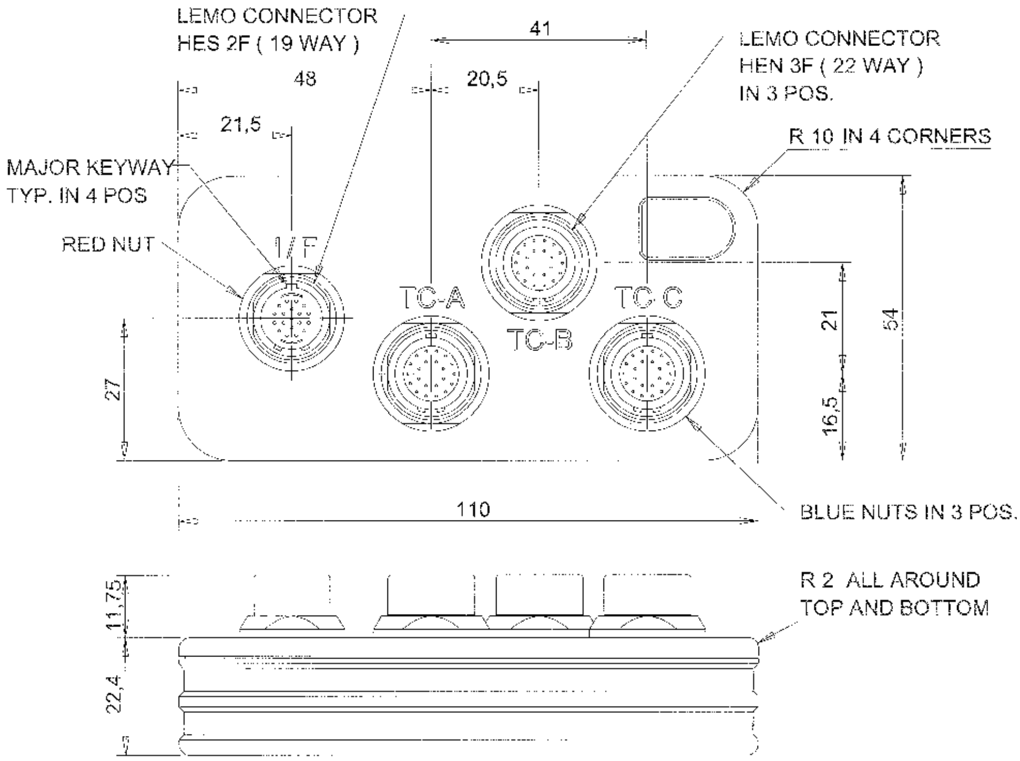
Connection Definition
- Integral, sealed, LEMO series F motorsport connectors

Connector 1	22-way	HEN3F322XLNP
Connector 2	19-way	HES2F319XLDP

- For pin numbers, please contact our Technical Consultancy Service

Electro Magnetic Compatibility
- Complies with the essential protection requirements of 89/336/EEC

Environmental
- Splash resistant to standard motorsport fluids
- Lid and screws sealed with silicone sealant, lid o-ring sealed
- Maximum humidity 100%
- Operating temperature -50°C to +70°C
- Storage Temperature -50°C to +85°C
- Vibration 100 to 1000Hz, all axes, 24 hours
- Care must be taken to shield the TIU-32 from draughts and sources of direct heat, as uncompensated errors will occur if the unit is subjected to thermal gradients or operated in an unstable ambient temperature.



Description	Ordercode
TIU-32	O 030 095 008 001
TIU-32C (CAN linked)	O 030 095 008 002

Torque

Absolute Strain Gauge System
Wireless

The Absolute Strain Gauge System uses a low power radio link to transfer up to two digitised strain measurements to a stationary antenna mounted nearby. The signals are passed to a receiver where they are decoded and output as CAN bus messages and analogue outputs.

The full system consists of the following components:

- Strain gauge receiver with antenna
- Transmitter with antenna

The following customer provided equipment is required to configure the system:

- Recommended CAN card Vector CANcardXL
- PC with RS232 interface and terminal emulator software
- PC with RS232 interface to run the calibration GUI for the transmitter, if re-calibration is required

Application

- Measurement of strain.

Electrical

Receiver

- CAN interface
- Two analogue outputs
- Antenna supplied
- Supply +8 to +16 VDC
- Max positive torque 4.75±0.15V (clips at 4.9V)
- Zero torque 2.5±0.15V
- Max negative torque 0.25±0.15V (clips at 0.1V)
- Max deviation of output from 20°C to 125°C:
- Max deviation of output from 20°C to 125°C:
    - Standard system = ±7% of full scale
    - Thermally compensated system = ±3.5% of full scale

Transmitter

- CAN interface
- Available with internal ½ AA Sulfuryl Chloride battery, which can be renewed by user, no need to return to MESL, or external battery
- Battery life 24 hours (typ) of continuous transmission
- Two channels
- Gauge circuit specification for each channel:
    - Balanced and modulus compensated full bridge
    - 1kohm gauges
    - Gauge factor # 2
- Pt1000 connection if thermal compensation is required
- RS232 interface for calibration
- Antenna supplied
- Message transmission rate up to 1kHz
- RF Specification:
    - Nominal frequency 433.920MHz
    - Modulation ASK encoded serial data

Each transmitter has a unique encrypted serial number. The system can be supplied with calibration data programmed into the transmitter.

Mechanical

Receiver

- Black anodised aluminium case
- Weight 115g
- Resistant to standard motorsport fluids

- 434 MHz helical antenna, approx 79mm long x 15mm diameter, with SMA female connector
- Shock 50g (max), ½sine for 11ms, five times per axis

Transmitter

- Black aluminium body
- Operating temperature +10°C to 125°C
- Polyester cable bosses for strain relief where fitted

Connection

Receiver

- AS2-10-35PN Connector
- Antenna 25SMA-50-2-6/111 NE

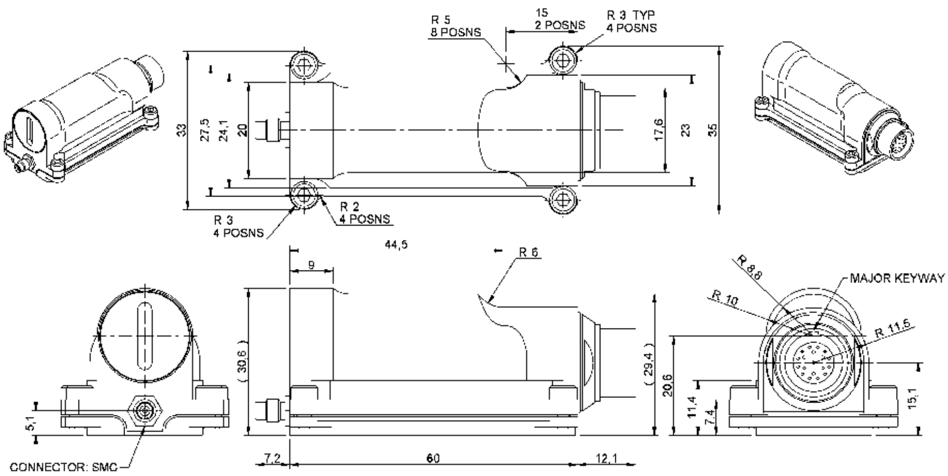
Internal Battery Transmitter

- EHN-2F-319-XLM Connector
- Antenna connector via case-mounted bulkhead SMC socket

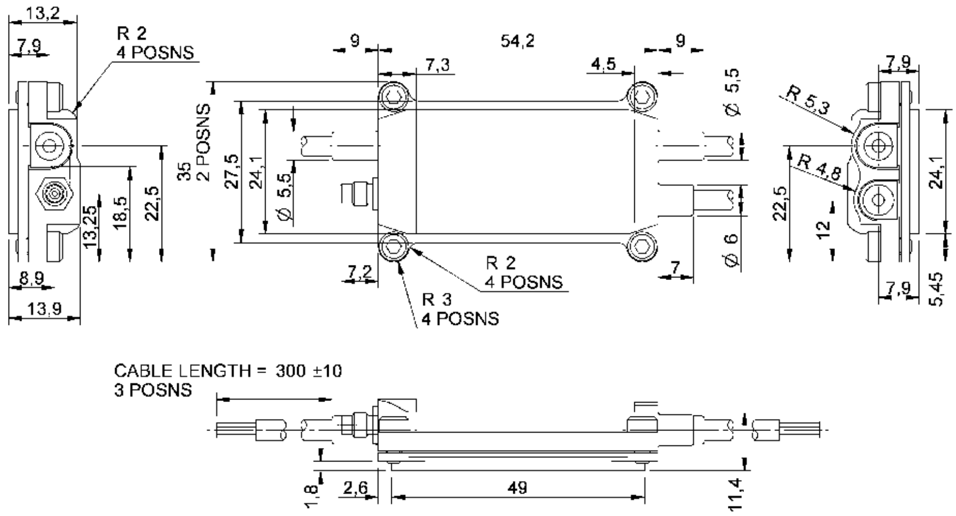
External Battery Transmitter

- 28AWG un-screened cable
- Cable length 300mm
- DR25 jacketed cable
- Antenna connector via case-mounted bulkhead SMC socket

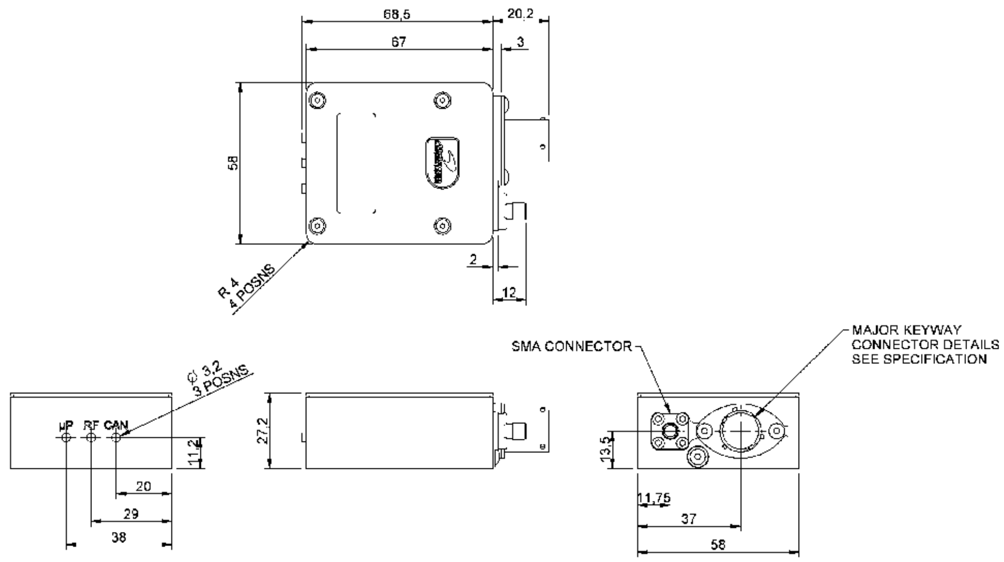
For pin-out details contact MESL



Description	Ordercode
ASGT with internal battery	O 030 205 006 003
Spare battery	O 030 205 990 001
Transmit antenna	O 030 205 990 003



Description	Ordercode
ASGT with external battery	O 030 205 006 004
Transmit antenna	O 030 205 990 003



Description	Ordercode
Drive plate receiver	O 030 205 005 000
Receiver ANA/CAN/PWR connection cable	O 030 205 990 000
1.5m antenna extension cable	O 030 205 990 004

Sensors

Drive Plate Torque System
NASCAR

The Drive Plate Torque System uses a low power radio link to transfer digitised strain measurements from a rotating wheel hub to a stationary antenna mounted nearby. The signals are passed to a receiver where they are decoded and output as CAN bus messages and analogue outputs.

The system is intended to be installed on a single vehicle. The system works with a hub transmitter on each drive wheel.

The hub transmitter can be fitted for testing and removed for race trim. When fitted back onto the same hub for further testing no additional calibration is required. A cover is provided to protect the contacts when in race trim.

Application

- Measurement of strain on drive plate

System Configuration

The full system consists of the following components:

- Two strain gauge receivers
- Two receiver antennas
- Two wheel hubs fitted with strain gauges,LH & RH
- Two hub transmitters

The following customer provided equipment is required to configure the system:

- CAN Bus Protocol Analyser (capable of sending user defined messages)
- PC with RS232 interface and terminal emulator software

Electrical

Receiver

- CAN interface
- Analogue output
- Antenna supplied
- Supply +8 to +16 VDC
- Max positive torque 4.75±0.15V (clips at 4.9V)
- Zero torque 2.5±0.15V
- Max negative torque 0.25±0.15V (clips at 0.1v)
- Max deviation of output from 20°C to 125°C:
    - Standard system = ±7% of full scale
    - Thermally compensated system = ±3.5% of full scale

Transmitter

- Internal ½ AA Sulfuryl Chloride battery, can be renewed by user with no need to return to MAT
- Battery life 24 hours (typ) of continuous transmission
- RS232 interface for calibration
- Internal antenna
- Sampling rate 100Hz

Wheel can be fitted and removed with transmitter in place. A cover is supplied for the gauge contacts when the transmitter is not in place.

Each hub transmitter has a unique encrypted serial number. The system can be supplied with calibration data already programmed into the transmitter.

Mechanical

Receiver

- Black anodised aluminium case

Transmitter

- Black polyester body
- Operating temperature +10°C to 125°C

Drive Plate

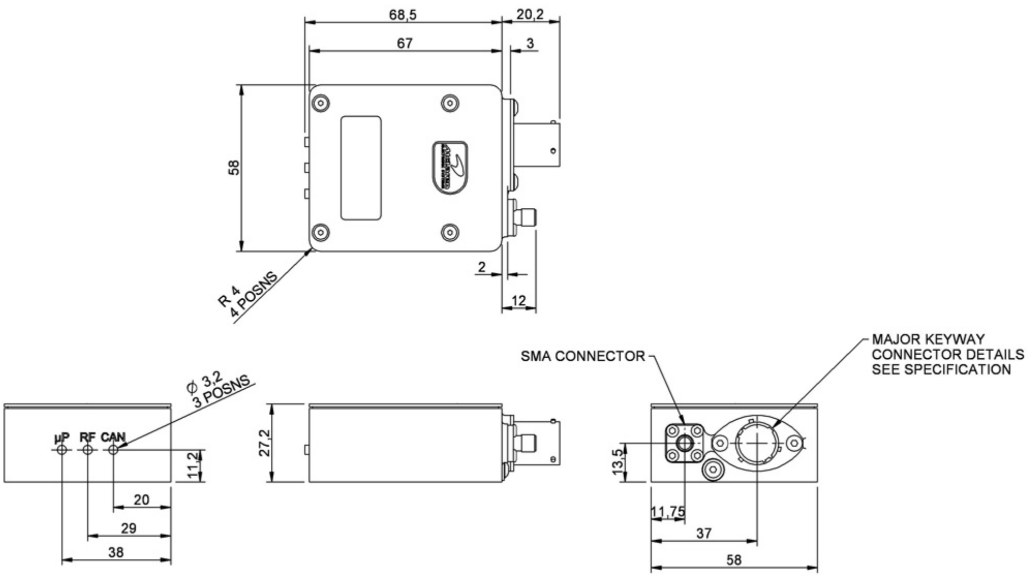
- Customer to supply drive plates to MAT
- Wheel hubs to be individually numbered
- Service covers allows drive shaft to be serviced while the plate remains on the car
- MAT can provide a balanced and thermally compensated full bridge gauge circuit on the hub

Connection

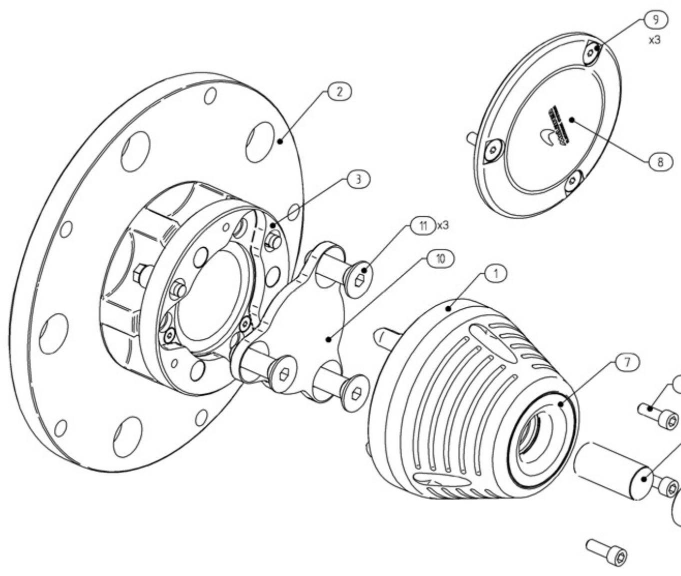
Receiver

- AS2-10-35PN Connector

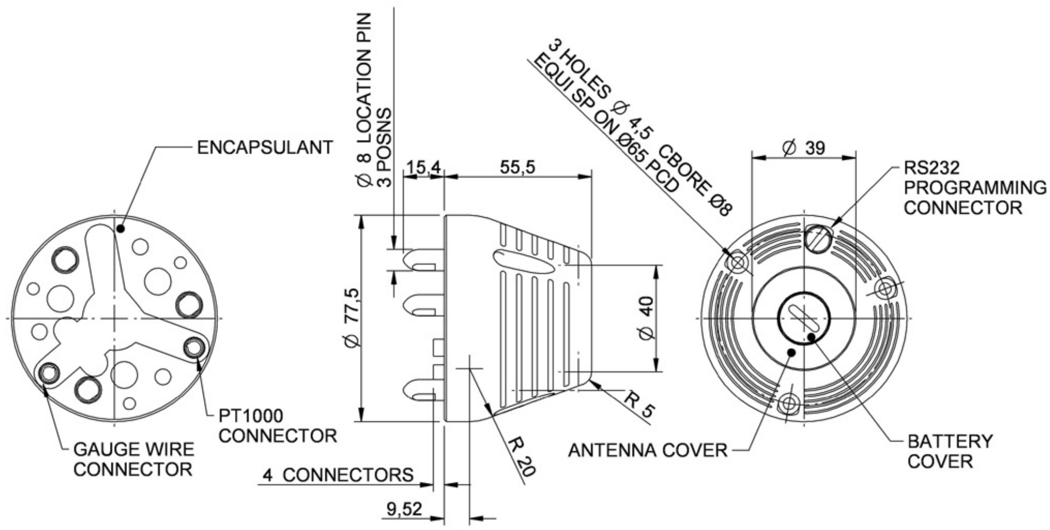
Pin 1	Supply +ve
Pin 2	RS232 In
Pin 3	Screen
Pin 4	CAN+
Pin 5	CAN-
Pin 6	NC
Pin 7	NC
Pin 8	Signal Ground
Pin 9	Analogue Signal
Pin 10	Power Ground
Pin 11	RS232 Out
Pin 12	NC
Pin 13	RS232 Ground



Description	Ordercode
Drive plate receiver	O 030 205 005 000
Receiver ANA/CAN/PWR connection cable	O 030 205 990 000
1.5m antenna extension cable	O 030 205 990 004



ITEM	DESCRIPTION
1	HUB TRANSMITTER
2	DRIVE PLATE
3	HUB CAP
4	BATTERY COVER
5	BATTERY
6	TRANSMITTER MOUNTING SCREWS
7	ANTENNA COVER
8	CONTACT COVER
9	CONTACT COVER SCREW
10	SERVICE COVER
11	SERVICE COVER RETAINING SCREWS



Description	Ordercode
NASCAR Wheel Hub transmitter	O 030 205 006 000
RS232 programming cable	O 030 205 990 001
Spare battery	O 030 205 990 002

Wireless Strain Gauge System
AC Coupled

The AC coupled wireless strain gauge system uses a low-power radio link up to two transfer digitised strain measurements to a stationary antenna mounted nearby. Signals from the antenna are passed to a receiver where they are decoded and output as CAN bus messages.

The strain measurements are also available in analogue output form.

The system consists of a strain gauge transmitter and external battery unit, a receive antenna and a tyre strain receiver. The strain gauge elements are provided by the customer and are not deliverables.

Sensors

Application

- Measurement of strain gauge on the car, e.g. tyre strain gauge.

Electrical

SGT Transmitter

- 10-bit resolution
- Accuracy ±1% RO
- Non-linearity ±1% RO
- Hysteresis ±1% RO
- Repeatability ±1% RO
- Nominal resistance 120ohm ±2%
- Temperature effect on zero balance ±0.3% RO/°C
- Temperature effect on zero output ±0.2% RO/°C
- Sample rate 5000 samples/s on each channel
- Bandwidth 0.1Hz – 2.5kHz
- RF characteristics:
  - Nominal centre frequency 433.92MHz
  - Transmission bandwidth 2MHz

The transmitter has three operating modes: sleep, standby and full rate

Each transmitter will be factory configured with a ‘corner ID’ corresponding to the location where it will be fitted.

SGR Receiver

- Supply voltage 8 to 16Vdc (unit is protected against reverse polarity and transients)
- Supply current 105mA typical @ 12V
- RF input 50ohm
- CAN bus 2.0B active, 1Mbps
- RS232 57.6kbps for configuration
- Three diagnostic LEDs on case: processor status, CAN Busy and RF channel
- Configurable parameters: corner ID, receiver attenuation setting and CAN base ID

SGT-B External Battery Unit

- CR2 battery
- 3.0V nominal voltage

Connection

SGT Transmitter

- Strain gauge connector ECN FF 304 XLM
- Antenna connector via case-mounted bulkhead SMC socket
- Battery connector FGN FF 304 YLC

SGT-B Battery Unit

- FGN FF 304 XLM

SGR Receiver

- Main unit connector AS2-10-35PN
- Antenna connector 25SMA-50-2-6/111 NE

For pin-out details, please contact MESL.

Mechanical

SGT Transmitter

- Black anodised aluminium case
- Weight 33g including flying lead
- Resistant to standard Motorsport fluids

SGT-B Battery Unit

- Black anodised aluminium case
- Weight 35g including battery
- Resistant to standard Motorsport fluids

SGR Receiver

- Black anodised aluminium case
- Weight 115g
- Resistant to standard Motorsport fluids
- 434 MHz helical antenna, approx 79mm long x 15mm diameter, with SMA female connector

Environmental

SGT Transmitter

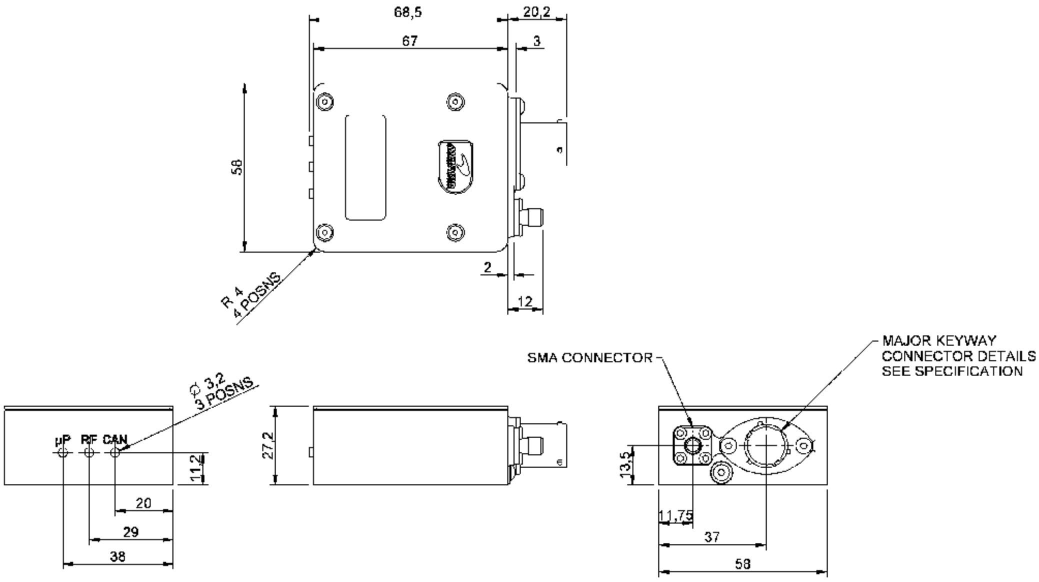
- Resistant to standard Motorsport fluids
- Operating temperature 0 to + 85°C
- Storage temperature 0 to + 85°C
- Vibration 40 to 2500Hz @ 40g 8hrs per axis
- Shock 50g(max), 1/2sine for 11ms, five times per axis

SGT-B Battery Unit

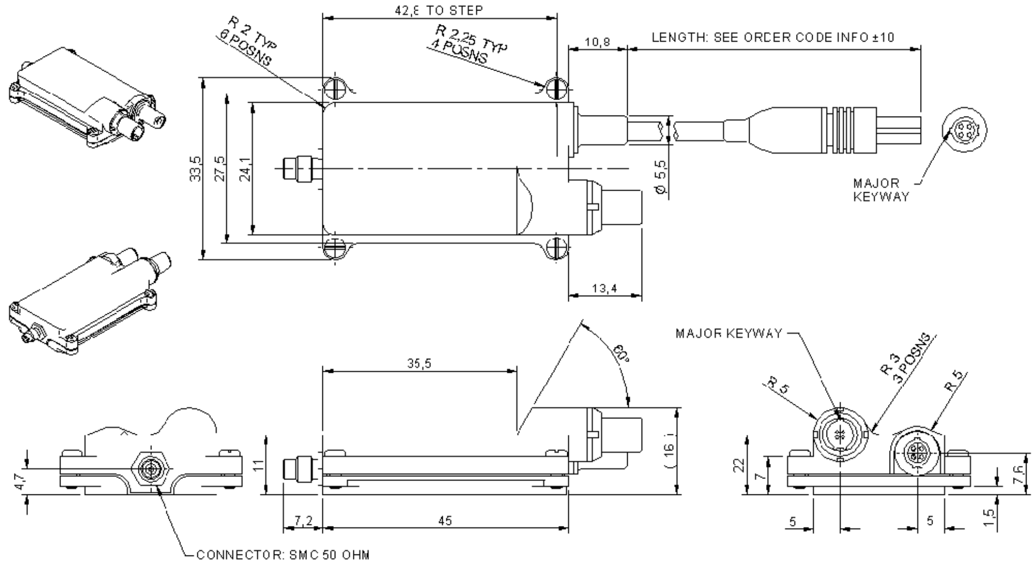
- Operating temperature 0 to + 85°C (battery life may be reduced by up to 20% at low temperatures)
- Storage temperature 0 to + 85°C
- Vibration 40 to 2500Hz @ 40g 8hrs per axis
- Shock 50g(max), 1/2sine for 11ms, five times per axis

SGR Receiver

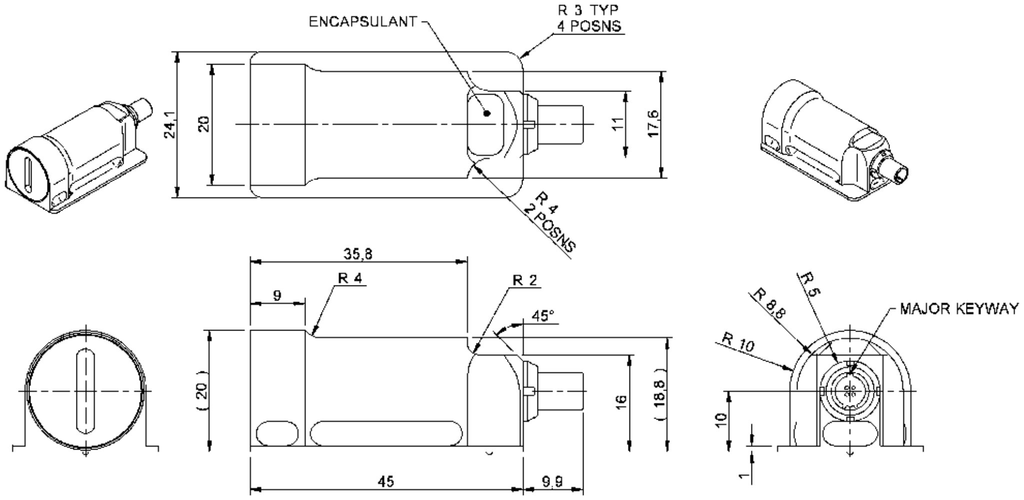
- Operating temperature 0 to + 85°C
- Storage temperature -20 to + 85°C
- Vibration random spectrum for two hours in one axis



Description	Ordercode
SGR strain gauge receiver	O 030 205 007 000
Receiver ANA/CAN/PWR connection cable	O 030 205 990 000
1.5m antenna extension cable	O 030 205 990 004



Description	Ordercode
SGT strain gauge transmitter	O 030 205 008 000
Transmit antenna	O 030 205 990 003



Description	Ordercode
SGT-B external battery pack	O 030 205 008 001
Spare battery	O 030 205 990 005

Calibration

System Monitor
Vehicle Tuning and Configuration Tool

System Monitor is a software package for configuring and tuning automotive control systems. It has built-in support for motor sport systems and can be tailored to support third party control units.

System Monitor not only allows you to tune data for your program versions, but also manages those versions on disk, allowing them to be located quickly for programming or modification

Familiar controls and extensive use of menus and accelerator keys make System Monitor easy to set up and to use, both at the track and at the test bed.

System Monitor supports configuration of logging for the ATLAS display and analysis software and both applications can run on the same PC.

Programming/Tuning

- Programming of unit with program and data versions
- Tuning of unit by modification of editable parameters including 1 and 2D maps
- Live tuning with verification; integrity checks to ensure synchronisation between System Monitor and the unit
- On-track tuning when linked by a suitable RF data connection to the unit
- Display of measurement parameters for live feedback
- Data Wizard to compare and merge data versions
- Management of program and data versions stored on disk
- Can be used with PUMA for automated tuning

Diagnostics

- Monitoring of unit errors and events
- Virtual parameters derived from measurements by user defined mathematical functions
- User definable alarms triggered by measurement conditions
- Configuration and uploading of engine and chassis history reports
- Enter a message and send it directly to the unit
- Read and display an area of memory on the unit

Configuration

- Configuration of parameter data to be logged in memory on the unit
- Configuration of parameter data to be transmitted over telemetry
- Programming of sensor and actuator calibration data
- Configuration of CAN transmit and receive messages
- Configuration of analogue and digital signals from MESL units.

Extendibility

- ActiveX interface provides functions for communication with unit, allowing creation of both custom measurement displays and unit commands
- Extensive on-line help with context sensitive links to the application

Scalability

- Supports multiple application programs on the same control unit
- Supports multiple control units

What you need

- An ASAP2 file for each application program which will run on the unit. This describes the editable (configurable) and measurement parameters
- A hex file for each application, containing the program code and base data
- A link between the PC and the control unit. This can be either Ethernet, HDLC or CAN

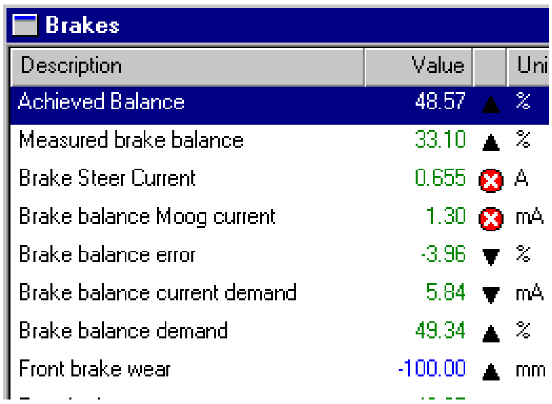
Getting started

- Create a program version and data version for each application; these are more compact and faster to open and compare than the ASAP2 and hex files
- Create a project, linking together a program and data version for each application plus the screen layouts and other configurations you will make

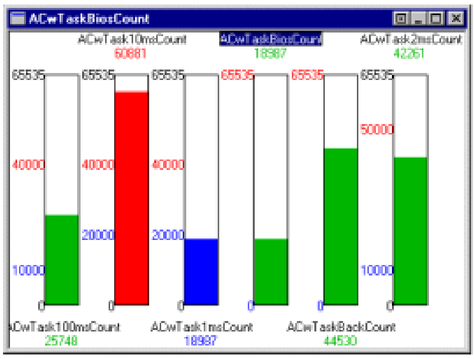
- In the Parameter Explorer, find the editable and measurement parameters for all applications

Monitoring

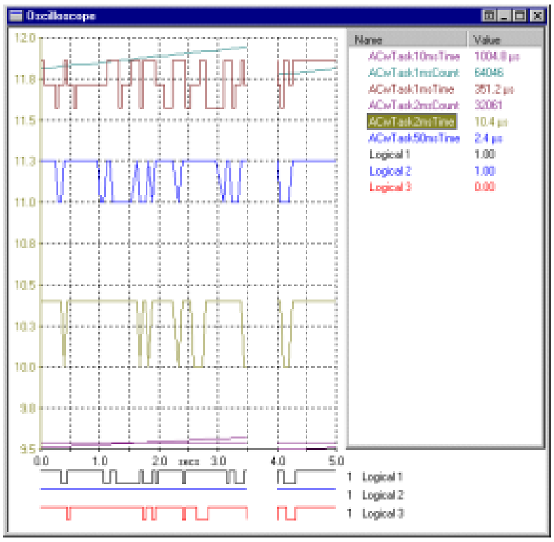
- Program the unit with each of the program and data versions you have created
- Create windows displaying measurement parameters



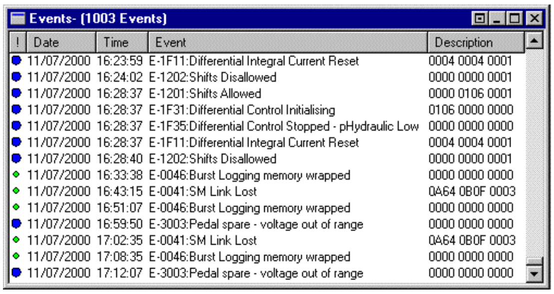
- Create custom displays with the grid window, showing measurement values or freeform text in any cell
- Display bar and dial graphs for visual feedback.



- Show changes over time with the oscilloscope window



- System Monitor requests and receives on-line data from the unit, allowing you to observe the behaviour of each application as it runs
- Create windows for diagnostics showing errors, events and areas of memory
- Show changes over time with the oscilloscope window

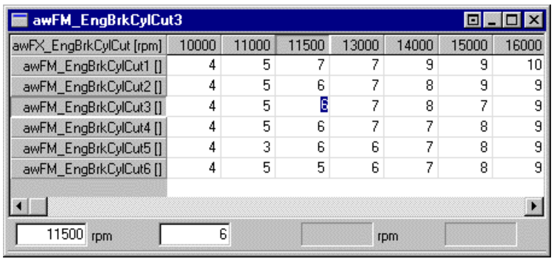


Events- (1003 Events)

!	Date	Time	Event	Description
	11/07/2000	16:23:59	E-1F11:Differential Integral Current Reset	0004 0004 0001
	11/07/2000	16:24:02	E-1202:Shifts Disallowed	0000 0000 0001
	11/07/2000	16:28:37	E-1201:Shifts Allowed	0000 0106 0001
	11/07/2000	16:28:37	E-1F31:Differential Control Initialising	0106 0000 0000
	11/07/2000	16:28:37	E-1F35:Differential Control Stopped - pHydraulic Low	0000 0000 0000
	11/07/2000	16:28:37	E-1F11:Differential Integral Current Reset	0004 0004 0001
	11/07/2000	16:28:40	E-1202:Shifts Disallowed	0000 0000 0001
	11/07/2000	16:33:38	E-0046:Burst Logging memory wrapped	0000 0000 0000
	11/07/2000	16:43:15	E-0041:SM Link Lost	0A64 0B0F 0003
	11/07/2000	16:51:07	E-0046:Burst Logging memory wrapped	0000 0000 0000
	11/07/2000	16:59:50	E-3003:Pedal spare - voltage out of range	0000 0000 0000
	11/07/2000	17:02:35	E-0041:SM Link Lost	0A64 0B0F 0003
	11/07/2000	17:08:35	E-0046:Burst Logging memory wrapped	0000 0000 0000
	11/07/2000	17:12:07	E-3003:Pedal spare - voltage out of range	0000 0000 0000

Tuning

- Create windows showing scalar, 1-axis map, 2-axis map, array and string parameters

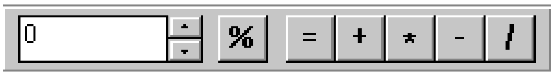


awFM_EngBrkCylCut3

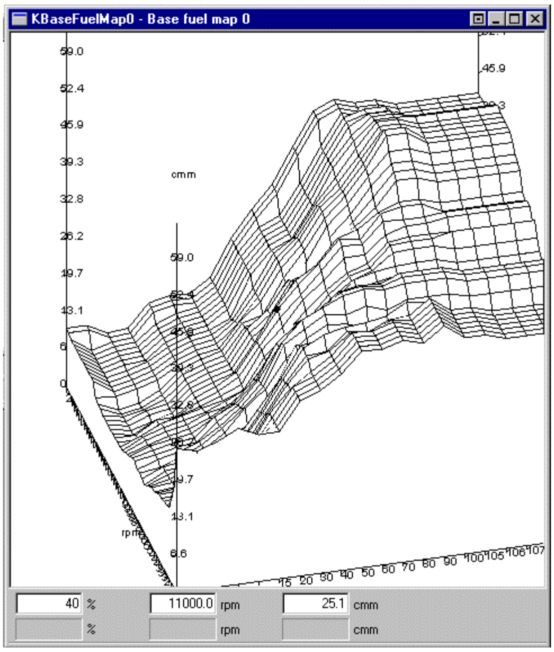
awFX_EngBrkCylCut [rpm]	10000	11000	11500	13000	14000	15000	16000
awFM_EngBrkCylCut1 []	4	5	7	7	9	9	10
awFM_EngBrkCylCut2 []	4	5	6	7	8	9	9
awFM_EngBrkCylCut3 []	4	5	6	7	8	7	9
awFM_EngBrkCylCut4 []	4	5	6	7	7	8	9
awFM_EngBrkCylCut5 []	4	3	6	6	7	8	9
awFM_EngBrkCylCut6 []	4	5	5	6	7	8	9

11500 rpm 6 rpm

- Change values by simply typing or by using the maths bar (eg +10%)



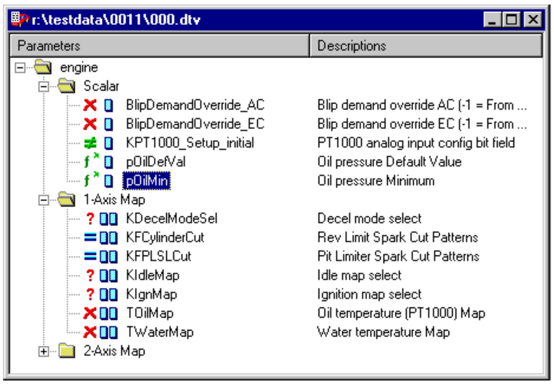
- 1 and 2 axis maps can be viewed as Graphs. Change values by dragging points on the graph.



- Send changes to the unit as they are made or download all changes later
- Make adjustments easily using the rotary controls on the VE-81 Adjustment board, connected via the serial port
- System Monitor detects when the contents of its edit buffer differ from the contents of the live tune RAM on the unit

Version Management

- Save your tuned data versions to directories reserved for each application
- Compare your tuned data with the base version or with tuned data from earlier program versions



- Select and merge parameters from earlier data versions
- Print reports for easy reference

Compare 0025003 with 0025000

Compare different values, different sizes, different data types, different definitions for
d:\helpdemo\engine\0025003.dtv
d:\helpdemo\engine\0025000.dtv

KFIgnBase Base Ignition Map [°CA]

CommonAxis Throttle [%]

CommonAxis Revs [rpm]	2.5	5.0	7.5	10.0	15.0	20.0	25.0	30.0	35.0	40.0	45.0	50.0	55.0	60.0	65.0	70.0	
800	23.8	24.4	35.5	30.0	28.8	25.1	28.0	28.8	30.8	34.5	31.4	33.9	35.4	38.6	37.1	35.6	38
1500	17.4	24.4	35.5	30.0	28.8	25.1	28.0	28.8	30.8	34.5	31.4	33.9	35.4	38.6	37.1	35.6	38
2000	14.8	20.1	35.5	30.0	28.8	20.0	24.0	28.8	30.8	34.5	31.4	33.9	35.4	38.6	37.1	35.6	3
2500	10.5	18.2	24.7	22.5	17.1	16.5	19.3	23.5	30.8	34.5	31.4	33.9	35.4	38.6	37.1	35.6	[illegible]
3000	4.9	13.2	15.3	13.6	12.0	13.6	15.9	18.8	30.8	30.8	31.4	33.9	35.4	35.0	37.1	35.6	38
3500	4.1	14.2	17.7	15.4	15.0	15.8	17.1	18.5	31.9	31.8	33.2	38.2	39.3	40.4	38.8	37.1	39
4000	9.6	20.8	31.2 -5.2	29.4 -4.9	29.5 -4.9	32.4 -5.4	35.7 -6.0	32.4	38.8	39.2	41.0	42.8	42.9	43.0	39.9	44.7	46
4500	16.1	26.6	39.5 -6.6	41.4 -6.9	37.8 -6.3	41.5 -6.9	43.2 -7.2	37.9	39.5	39.6	43.2	48.5	49.8	51.2	51.7	48.5	53
5000	18.4	28.8	37.7 -6.3	37.0 -6.2	32.0 -5.3	34.7 -5.8	34.9 -5.8	29.5	39.9	35.3	34.0	33.2	34.4	35.4	36.2	37.0	36.
5500	16.7	30.1	37.4 -6.2	37.2 -6.2	31.8 -5.3	35.0 -5.8	35.5 -5.9	29.9	41.9	38.9	37.9	35.2	36.1	37.0	39.3	41.7	41
6000	16.1	32.9	39.4 -6.6	40.9 -6.8	41.3 -6.9	40.7 -6.8	41.7 -7.0	35.1	43.1	42.8	43.0	41.4	42.4	43.3	46.4	51.0	4
6500	15.9	34.3	42.7 -7.1	46.0 -7.7	44.2 -7.4	42.4 -7.1	43.4 -7.2	36.4	44.7	47.8	44.6	40.8	41.4	41.3	44.3	47.6	4
7000	16.0	36.2	37.8	38.8	38.2	35.6	34.6	33.7	48.4	44.5	39.6	35.3	35.5	34.9	34.9	34.8	
7500	16.6	37.3	37.6	38.0	37.3	34.8	34.0	33.1	44.7	43.1	41.5	38.3	36.0	34.0	34.4	35	
8000	17.5	39.9	39.2	39.3	40.6	39.4	39.0	37.9	49.2	48.3	42.6	41.3	41				

Custom Commands

- Write your own commands and interfaces to help in your development process

Data Analysis

ATLAS

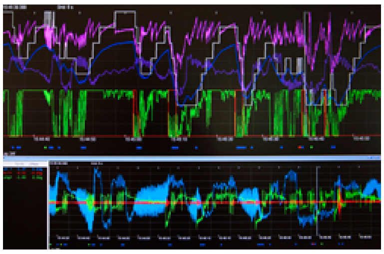
Advanced Telemetry Linked Acquisition System

ATLAS is a software package which is used to obtain, display and analyse data from control systems such as those used within motorsport and automotive applications.

Familiar controls and extensive use of the mouse, menus and accelerator keys make it easy to set up and to use

ATLAS is used by the professional data analyst working with data acquired by telemetry or uploaded from a data logger. ATLAS is appropriate for an individual data analyst or for many engineers all monitoring telemetry together.

ATLAS is equally suitable for analysis of either lap or open road based data.



Software

Features

- Highly customizable, Workbook containing Pages and Displays
- Graphical Timeline for easy navigation through data
- View, analyse and compare live telemetry data with uploaded logged data
- Checks for automated monitoring of engine and chassis
- Fast data handling to deal in real-time with the large quantities of data
- Highly customizable

Timeline

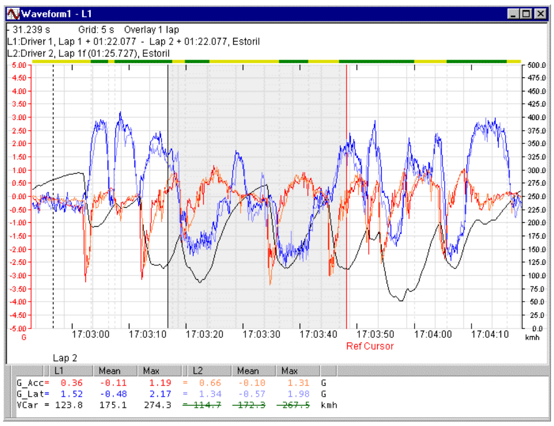
ATLAS has several features to help you navigate through your data. The **Graphical Timeline** acts as a specialised scroll bar with the following features:

- Shows: Out lap, Timed laps and In lap
- The data currently on view is highlighted on the Timeline so you can easily see where you are
- Mouse operations allow quick and easy lap selection
- Linkable displays, enabling the same period of time to be shown, even when scrolling
- Distance and Time modes are supported

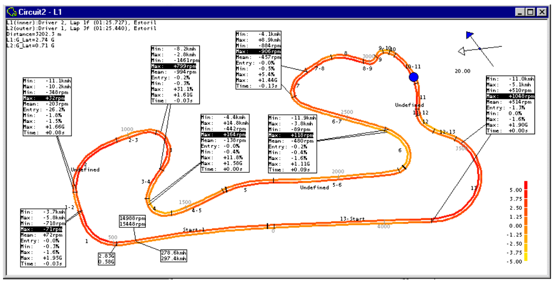
Displays

Several types of display are provided to give you different views of your data:

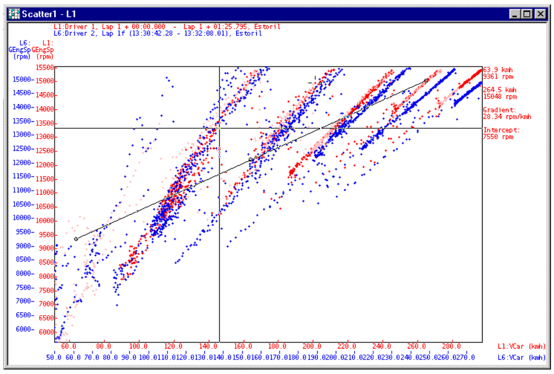
- **Waveform:** shows several parameters as waveforms in an oscilloscope format.



- On-screen controls for: parameter layout; lap offset adjustment; navigation and data selection
- Traces can be hidden or flashed
- Gradient and reference cursors
- Automatic and manual scrolling
- **Circuit:** shows the location of the car on a map of the circuit. This display can be extensively customised to show data at various selected points on the track. ATLAS includes an easy to use facility to generate the circuit map from recorded data.



- **Bar:** shows parameters as simple bar graphs
- **Numeric:** shows parameters as text
- **Scatter:** shows the relationship of pairs of parameters in a cross plot.



Many displays can show data in real time as it is received by telemetry. Other displays can be updated automatically as each lap is completed.

You can Zoom in to magnify the view in the Waveform and Scatter displays

Other displays allow you to analyse your data:

- **Loadmap:** shows a 3D plot of one parameter against another. The third dimension is indicated by a colour and shows the proportion of time spent with both parameters in the specified ranges.
- **Histogram:** shows the distribution of a parameter against time
- **Summary:** shows statistics on selected parameters for the whole session arranged by lap, section or segment
- **FFT:** performs frequency analyses on the data. The results can be shown as Fast Fourier transforms, Transfer functions or Correlations
- **Map:** shows logged data superimposed on a 3D wire frame of a 2D map
- **InPlace:** allows you to run ActiveX controls within the ATLAS environment. The Active X controls have full access to the data and can be manipulated by the standard ATLAS menus.

Parameters

ATLAS handles each item of incoming data as a parameter. The value of the parameter is displayed and analysed by including it in a Display:

- Parameters are selected in a browser or dragged from another display.
- Parameter properties allow you to control how a parameter is displayed: they may be either local to a single display or global to the whole workbook.

Analysis

As well as the special analysis displays (Loadmap, Histogram, Summary and FFT), ATLAS offers the following analysis features:

- **Functions:** (also known as Maths Channels) allow you to combine parameter values and perform calculations on them. A sophisticated function editor is provided.
- **Checks:** allow you to check the state of the car or engine automatically
- **Markers:** pinpoint the time when something interesting happens: they can be placed by hand or automatically by a check or an ActiveX command

Software Interfaces

ATLAS can be used to in conjunction with other Windows® applications:

- ATLAS is ActiveX compliant and most ATLAS commands are available to this interface
- The InPlace Display can be used to run other applications within ATLAS
- Session data can be Exported and Imported in various formats including MATLAB
- A third-party Session DLL allows you to write drivers to access other data formats
- Constants, used in functions, can be read from an external application such as a spreadsheet

Recording

ATLAS includes controls to record data from data loggers either directly (by wirelink) or in real time (by telemetry):

- ATLAS supports both narrow and wide band telemetry
- Wide band telemetry can be used in Burst mode (all the stored data is transmitted at one point on the circuit) or Retransmission mode (all the stored data is continually retransmitted and ATLAS uses later transmissions to fill-in drop outs and errors)
- ATLAS supports high speed wirelinks via 100Mbps Ethernet
- Ethernet telemetry allows you to view data at a test bed without any radio telemetry equipment
- Telemetry can be replayed
- The ATLAS package includes Data Servers. These run on a dedicated PC which accepts incoming data and broadcasts it on a network to the PCs running ATLAS
- A special Data Server is available to accept data from a Weather Station and to include it with session data
- Direct CAN logging.

Optional Product Extensions

Several optional ATLAS extensions are available:

- Remote Data Server (RDS): Provides the ability to daisy chain two or more data servers remotely. For example, to transmit and transfer live telemetry data between track and factory locations.
- vTAG Server: This control sits within ATLAS and enables users to run MATLAB (Simulink) simulations against ATLAS data.

Licensing

ATLAS is licensed by a hardware device. This can take the following forms:

- USB dongle
- Site Licence by Ethernet

ATLASLite

Advanced Telemetry Linked Acquisition System (Lite)

ATLAS*Lite* lets you obtain, display and analyse data from motorsport and automotive control systems. Familiar controls and extensive use of mouse menus and accelerator keys make it straightforward to use.

Workbook

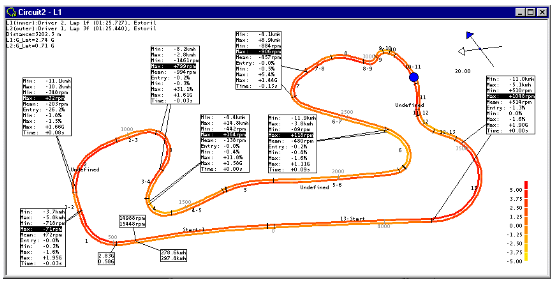
- ATLAS*Lite* exploits a Workbook concept for managing and customising displays and analysis pages.

Graphical Timeline

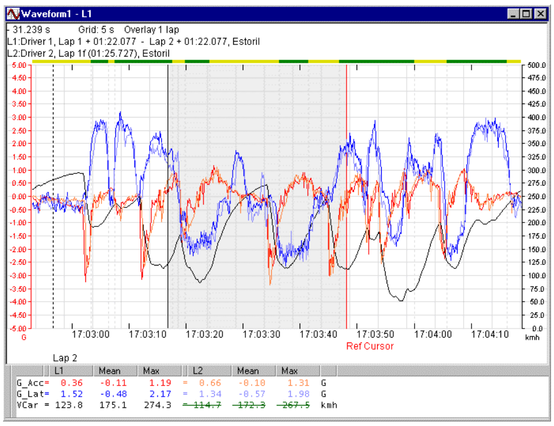
- Shows: Out lap, Timed laps and In lap
- Highlights where data on view is in the session
- Mouse selectable lap or part of lap
- Time-linked displays
- Distance and Time modes

Displays

- **Circuit:** shows the location of the car on a map of the circuit. ATLAS*Lite* includes an easy to use facility to generate the circuit map from recorded data.



- **Waveform:** displays up to 32 parameters as waveforms in an oscilloscope format.
-



  - On-screen controls for: parameter layout; lap offset adjustment; navigation and data selection
  - Traces can be hidden or flashed
  - Gradient and reference cursors
  - Automatic and manual scrolling
- **Bar:** shows parameters as simple bar graphs
- **Numeric:** shows parameters as text
- **Scatter:** shows the relationship of two pairs of parameters in a cross plot

You can **Zoom** in to magnify the view in the Waveform and Scatter displays

Other displays allow you to analyse your data

- **Histogram:** shows the distribution of a parameter against time
- **Summary:** shows statistics on selected parameters for the whole session arranged by lap, section or segment
- **FFT:** performs frequency analyses on the data. The results can be shown as Fast Fourier transforms, Transfer functions or Correlations

Parameters

ATLAS*Lite* handles each item of incoming data as a parameter.

- Parameters are selected in a browser or can be dragged from another display
- Parameter properties allow you to control how a parameter is displayed: they may be either local to a single display or global to the whole workbook

Recording

ATLAS*Lite* includes controls to record data from data loggers directly using CAN or 100Mbps Ethernet

Analysis

ATLAS*Lite* offers the following additional analysis features:

- **Functions:** (also known as Maths Channels) allow you to combine parameter values and perform calculations on them
- **Checks:** allow you to check the state of the car or engine automatically
- **Markers:** pinpoint the time when something interesting happens: they can be placed by hand or automatically by a check

Software Interfaces

ATLAS*Lite* can be used in conjunction with other Windows® applications: Text sessions may be imported for analysis and display

Licensing

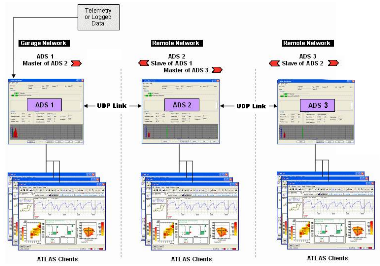
ATLAS*Lite* is licensed by a hardware device. This can take the following forms:

- Parallel port dongle
- USB dongle
- Ethernet card

Remote Data Server
RDS

The Remote Data Server (RDS) enables live telemetry to be viewed simultaneously in different parts of the world. Several Remote Data Servers can be daisy chained together so that live telemetry data can be analysed at the track, factory and at the engine supplier

Often the available internet bandwidth available from a racetrack is limited, so it is not possible to get all the data back to the factory as quickly as might be desired. The RDS ensures that most recent data arrives first and then older data is backfilled when there is available bandwidth



Software

Main Features

The Remote Data Server provides the following features:

- Forward telemetry data as it is received from car
- Supports transfer of missing data offloads
- Manage usage of available bandwidth so that most recent data is sent first
- As bandwidth becomes available, RDS will backfill any earlier holes in the current run.
- Compression of data packets for more efficient use of internet link

Requirements

The Remote Data Server is part of ATLAS and requires that it is installed at both ends of the network.

Description

The Remote Data Server (RDS) is a feature of the ATLAS Data Server and allows one to connect to another over a local network or the internet. The Data Servers form a chain typically two or three links long, with the first Data Server reading data from the car via Ethernet or telemetry and subsequent Data Servers receiving data through the chain. Each Data Server can support two slave Data Servers for more complex configurations.

Each Data Server on the chain distributes data live to the local clients so that they behave as if they were all in the same garage, but not require a direct connection.

Security is provided by only allowing one of two IP addresses to connect to the master Data Server.

At the end of a run the session file will be closed so that it can be accessed immediately, if there are any holes in this file then they will be filled in a separate copy as soon as bandwidth is available.

SQL Race

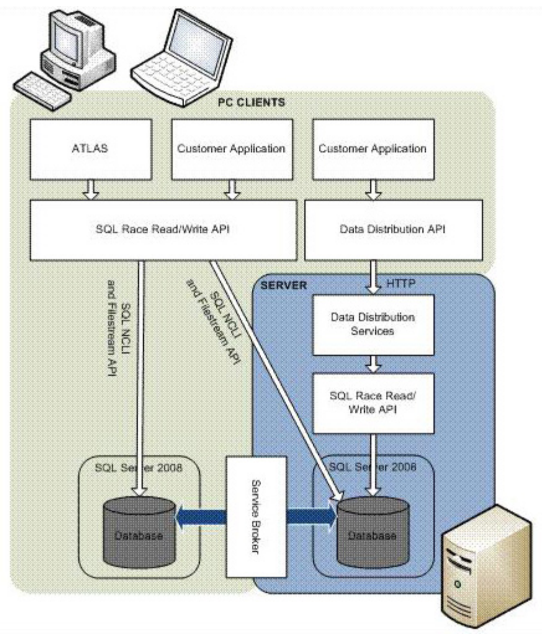
In professional motorsport, many megabytes of data are logged per lap and analysed in depth by different engineers and specialists at the track and at the factory. On-car data is further enriched by simulation data.

SQL Race is an API (Application Program Interface) for Microsoft SQL Server® 2008. It provides the building blocks to store and manage immense volumes of track, simulation and set-up data in its many different formats. It does this in a fast, efficient and user-friendly way while still allowing access through custom and standard methods.

Main Features

SQL Race provides the following advantages:

- Storage of data received at rates of many Msamples/s can be achieved; thousands of times faster than writing directly to a database.
- Storing data received from data loggers, simulation tools or test rigs in real-time. Data may be real-time, out-of-sequence or post-event (offline).
- Retrieval of data as a set of converted samples ready for display or analysis in a fast and memory efficient manner.
- Seamless association and merging of data across runs.
- Automatic merging of samples across multi-frequency periodic and non-periodic data.
- Attachment of constants, maps, videos and documents to the run data.
- Efficient synchronisation of data between databases.
- User friendly access to data via SQL Server or C# API.



Fast Data Access

The essence of SQL Race is its ability to provide fast access to large quantities of time series data. Users may be viewing hundreds of parameters and hundreds of thousands of sample points and must be able to navigate quickly through the data with ease. SQL Race supports a rich set of data logging modes in real-time and offline. These include:

- Fixed frequency logging rates up to 1GHz
- Synchro logging, or near-regular rate logging. This can be used for logging at fixed points on an engine cycle or the near regularity of a heart rate.
- Irregular logging, typically where many parameters are collected at a single time point.
- Scaled and unscaled data, in which each parameter has an associated conversion function that takes the raw logged value to an engineering value.
- Variable rate logging, where a parameter may be made up of several channels, each logged at a different frequency and under different conditions. SQL Race will intelligently merge all channels.

- Out-of-order data storage. Telemetry systems and disparate wireless data sources cannot guarantee continuous coverage, but a user's requirement is to always be able to see most recent data, so a backfill is necessary. Data is available for read as soon as it is received and any merging tables are updated automatically.

Run Associations

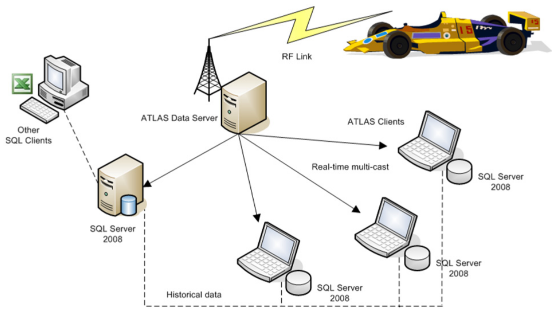
Often there are multiple sources of data either from multiple loggers on a car or because diagnostic data is collected from the environment or rigs. Each run has a GUID (Globally Unique Identifier) and these GUIDs or collections of GUIDs may be opened together to create a super run in which all the runs are presented as one.

Attachments such as constants, data maps, notes, and videos may be associated with the whole run, a set of laps or specific time e.g. a wing setting for the first stint of a race or the time at which a video was recorded

GUIDs may also be used to make associations between SQL Race runs and custom data that has its own schema, enabling tight coupling between all the electronically storable information about a run, whether it be the data from a probe, the vehicle/rig parts list, or other source.

Data Distribution

The Data Distribution API is based on SQL Server Service Broker and provides a way of keeping a run in-sync on multiple databases. A race team may have databases located at their factory, engine supplier and at the race or test track



These databases may be managed by different organisations with their own IT policies. It is neither desirable nor practical to share a single database so the runs must be copied to each database. Furthermore there maybe confidential items in the data that are private to the engine or chassis side of the team. The API addresses these problems by:

- Synchronising on named columns
- Using signatures to compare datasets which provides a quick check that the data is the same with out the need to send a copy.
- Handle synchronisation across databases with different schemas.
- Restricting access "Allowed" parameter groups.

SQL Race Queries

Although logged data samples are highly compressed, row-set providers facilitate querying the data through SQL queries, thus allowing Excel and other reporting tools to access the data without going through the API

Viewing SQL Race Data with ATLAS

ATLAS is a separate product to SQL Race but integrates loggers, telemetry systems and simulation tools as data sources. The primary task of ATLAS is data viewing and comparing data from one or more runs both real-time and historic data

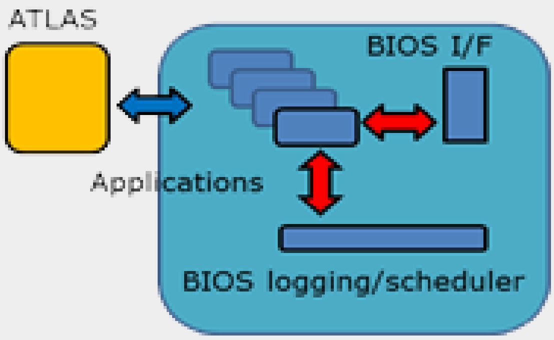
SQL Race enables ATLAS to analyse greater sets of runs and to search for trends and patterns in collections of runs

Software

vTAGserver

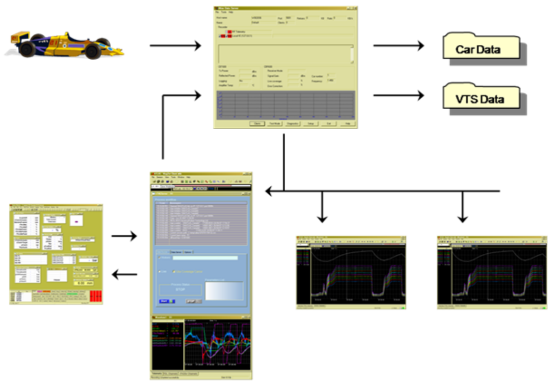
vTAGserver is a computational framework that runs on a standard PC that allows fast analysis with complex models using either telemetry or recorded data from ATLAS .

vTAGserver sits as an in-place control inside an ATLAS installation and is fed live telemetry data. This data is fed into the models and processed information is sent back to the ATLAS Data Server to be broadcast to all connected users.



In this way, simulations are simultaneously available to all users who are connected. The models are normally created using Embedded Matlab, Simulink or Dymola, although C-coded functions are also supported.

vTAGserver is part of the vTAG suite of products that also includes: vTAG-RT, a real-time version with a hard real-time operating system, suitable for HIL systems and driver-in-the-loop simulations, and vTAG-310, a software emulator allowing simulation of several McLaren Electronics' electronic control units including the TAG-310B, as used in Formula One.



Features

- Simulink code generation
- Dymola (modelica)
- GDE block set
- Supports nine Applications and BIOS
- Tunable parameter editing via System Monitor
- Data visualisation through ATLAS

Example applications

vTAGserver may be used to simulate a car or powertrain in order to supplement measured parameters from sensors with virtual sensor readings. It may also be used to derive performance and condition indices from complex data sets.

By broadcasting the outputs from vTAGserver to all ATLAS clients who are attached to a garage or factory network, users are able to access real and derived data seamlessly and in real-time, where telemetry is available.

Programming

vTAGserver is programmed with System Monitor. Each application may be programmed separately or from a single System Monitor project. System Monitor allows any of the tuneable parameters to be edited either on-line or offline.

Once programmed, vTAGserver will autoboot from cold to its previously programmed.

Real-time processing

vTAGserver is designed to operate in real-time when high rate telemetry is available. The system may also be used to process historical data, for example, straight after a cable upload. Once a (telemetry) data stream has stopped, and any missing data is retrieved in an upload, vTAGserver can re-run processing on all received data to fill any gaps.

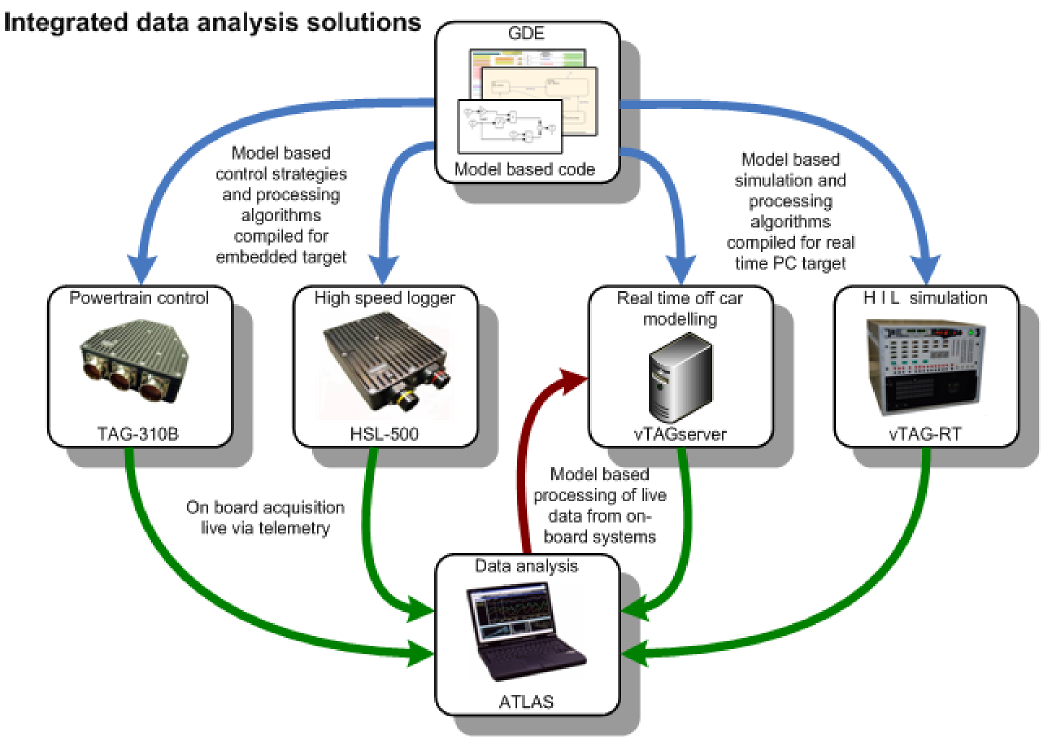
In order full utilisation of multiple processor cores on the host PC, vTAGserver allows each application to run concurrently in a separate execution thread.

Modelling

vTAGserver differs from the maths channels found in ATLAS and other standard data viewers in its ability to deal efficiently with complex systems with multiple inputs and outputs.

vTAGserver applications are normally built using Simulink and Embedded Matlab in conjunction with GDE 8.2 and the vTAG Platform Support Package which provides building blocks within Simulink to enable interaction with ATLAS parameter data.

When custom vTAG applications are built in Embedded Matlab and Simulink, a new Program Version (.pgv) file is produced which contains a compiled .dll with the code necessary to process and calculate results from incoming data.



Software

Development Tools

Graphical Development Environment
GDE v8.2

The GDE forms part of the integrated data analysis systems provided by McLaren Electronics.

The GDE facilitates model based embedded code generation. The entire system application code can be auto-generated from models developed with tools from The MathWorks.

The Graphical Development Environment (GDE) provides the automated build environment to generate code tailored to MES' ECUs, and block libraries which allow the configuration of parameters, the logging of signals, generation of errors and events plus other MES ECU specific control.

The GDE uses Matlab, Simulink, Real-Time Workshop and Embedded Coder Version (R2008a and later).

Features

- Simulation and code generation environment
- System Monitor supported file generation
- Generation (via System Monitor) of downloadable files
- Different MES system targets are supported through Platform Support Packages

Optional Features

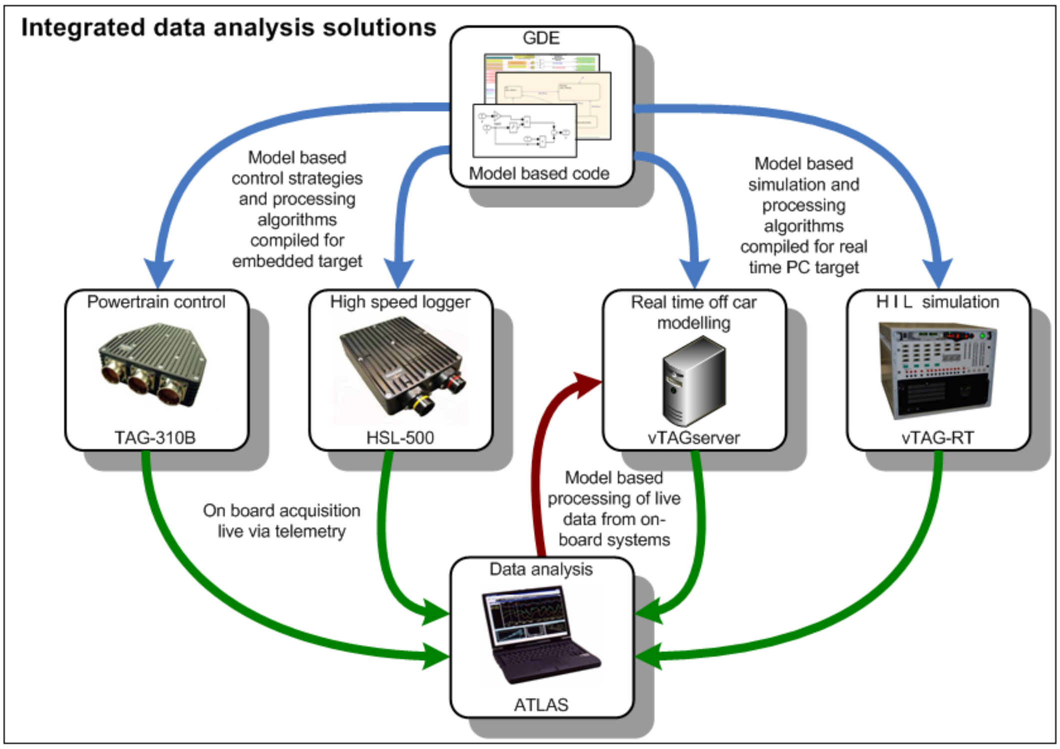
- XML driven automatic assembly of application models from component models. An XML driven Data Dictionary for configurable data may be used
- Automatic generation of HTML/XML documentation containing models browsable using Microsoft Internet Explorer.

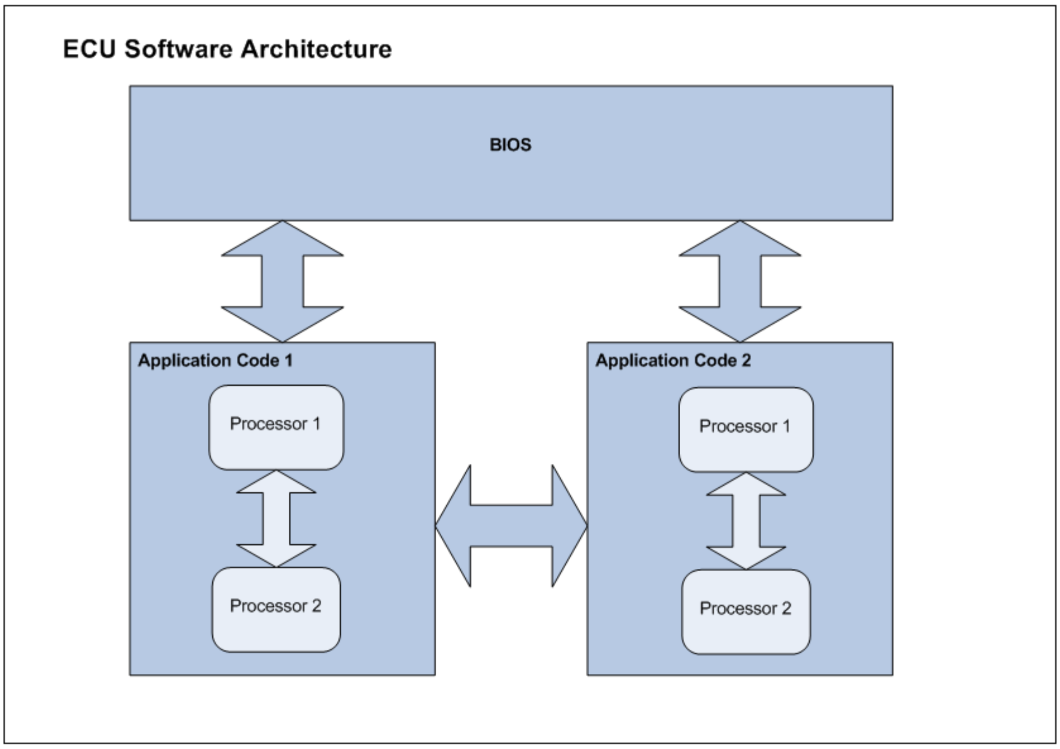
Supported Targets

GDE v8.2 Platform Support Packages are currently available for the following targets:

- TAG-310 (FIA Formula One Standard ECU)
- TAG-320 (Engine control unit - check availability)
- TAG-400 (Engine control unit)
- HSL-300 (High speed logger)
- HSL-500 (High speed logger)
- CIU-100 (Control interface unit - check availability)
- vTAGserver
- vTAG-RT

Support for other MES systems can be implemented as required





Code Overview

Each supported MES system provides the ability to run one or more customer applications, on top of a MES provided BIOS. The BIOS, provided by MES, provides I/O, logging and task scheduling support for the application code.

The GDE provides the ability to generate an entire application from a single Simulink model.

The application supports multitasking at the rates supported by the target (typically, but not limited to 1ms, 2ms, 5ms, 10ms, 50ms, 100ms background and initialisation). Additionally, where supported by a target, an engine synchronous task rate is provided.

Where a target provides the ability for the application to run across multiple ECUs and processors, the GDE will produce a single downloadable file containing the code for all ECUs processors. The division of application functionality between processors within the ECUs is determined by the model designer, and is controlled through the layout of the Simulink model.

Simulink Model Layout

A standard template Simulink model is provided for each target which shows the top level layout required for that target. The system is divided down into processor applications in each ECU through the model hierarchy. This is illustrated in the adjacent image, which shows one application (TAG310App1) divided across two processors (AP and CP) in a single ECU. For each processor the division of code between task rates is handled through the allocation of sample times to the Simulink blocks.

At the top level of the model a setup block is provided which contains information needed during code generation, such as the application version number, and definitions of inter application and inter processor memory areas.

Platform Support Packages

For each supported MES target system, a Platform Support Package is available which provides the necessary files to tailor the GDE for that system, an example top level model, and blocks to support target specific features

Optional Features:

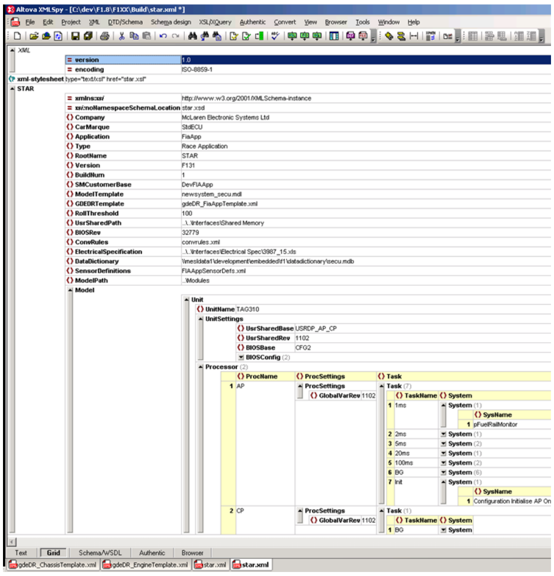
Automatic model assembly

In order to increase the maintainability of the Simulink models, a method of assembling an application model from a number of component model subsystems is available. This allows work on different sections of the code to be carried out in parallel.

An XML file is used to define the contents of the model.

Using this system allows component models to be moved between task rates or between processors by simply editing the XML file.

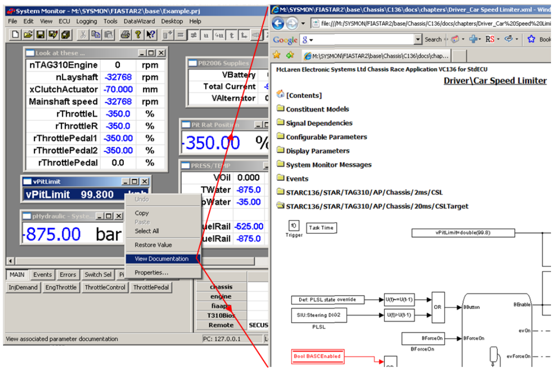
The system also allows the use of template model subsystems, where one source subsystem is used multiple times within the application, with each instance varying. This can be achieved by placeholder substitution of parameter names (e.g. for wheel speed processing, replace a key string in the source model by FL, FR, RL, or RR), or by model substitution. For the latter case, each source subsystem may contain any number of placeholder subsystems, into each of which another source subsystem may be placed, controlled by the XML configuration file. During model assembly, when the placeholder subsystem is substituted, it is possible to carry out parameter name substitution under the control of the XML file.



Automatic Documentation

For models which have been assembled using automatic model assembly, an option is available to allow the generation of HTML based documentation. This documentation contains images of every Simulink and Stateflow subsystem/state. The HTML document may be browsed with Microsoft Internet Explorer in a similar way to browsing a model in Simulink; i.e. double-clicking on a subsystem will open a new window showing the contents of that subsystem. No installation of Matlab is required to browse the documentation

By distributing the documentation with the GDE generated program version files, System Monitor is able to open the relevant model subsystem for any configurable or measurable parameter via a context menu.



Requirements

Matlab R2008a to R2010b, with the following Toolboxes:

- Simulink
- Real-Time Workshop
- Real-Time Workshop Embedded Coder
- Stateflow (optional) + Stateflow Coder

Or Matlab R2011a or later with the following Toolboxes:

- Simulink
- Simulink Coder
- Embedded Coder
- Stateflow (optional)

C compiler as required for the target platform (details available on request).

vTAG

The vTAG simulation environment forms part of the integrated data analysis systems provided by McLaren Electronics.

vTAG provides the framework to support the execution of model based embedded code on PC based hardware. The entire system application code can be auto-generated from models developed with tools such as Simulink and Dymola.

vTAG applications can be used in the vTAGserver environment to analyse and enrich the data received from embedded control units.

In the vTAG-310 environment entire systems can be modelled allowing Software-In-The-Loop (SIL) development of control systems.

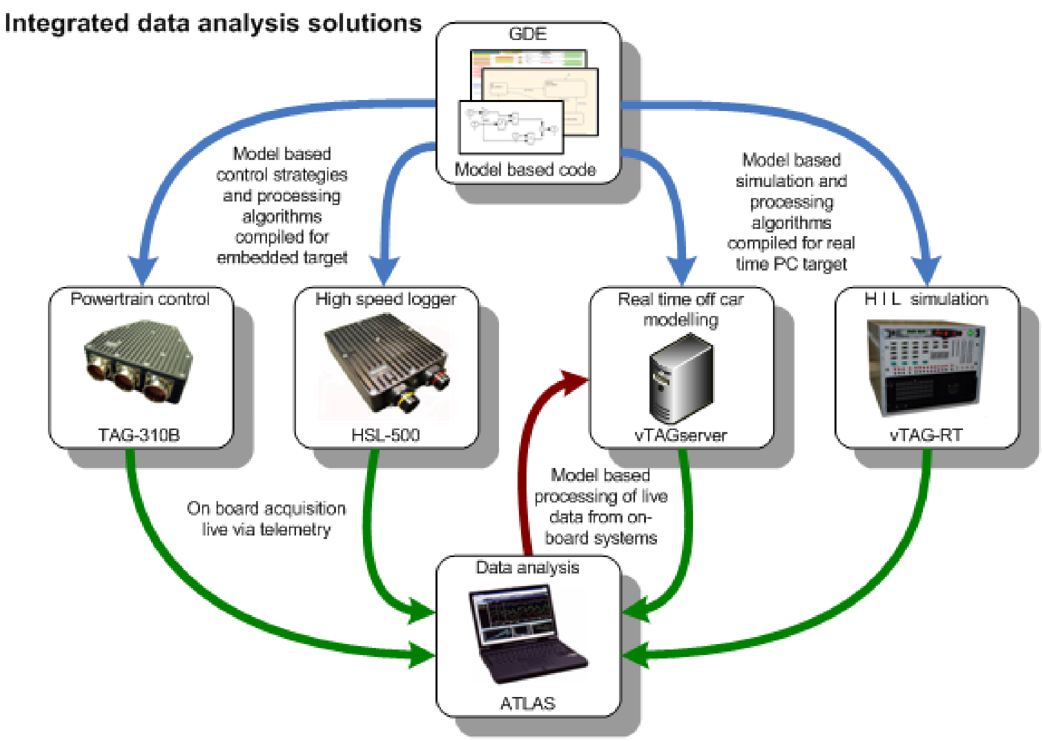
In the vTAG-RT environment vTAG applcations are run in hard realtime allowing creation of Hardware-In-The-Loop (HIL) test equipment and vehicle simulators.

Features

- Simulation and code generation environment
- Configuration of system using System Monitor
- Logging of data using ATLAS
- Integration with ATLAS client allowing processing of existing data
- Integration with ATLAS DataServer allowing enrichment of telemetry data stream to clients
- Multithreading system allows utilisation of multi-core processors

Environments

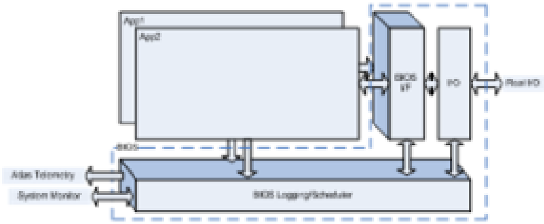
- vTAGserver – Offline processing of logged data. Real-time processing of live telemetry data
- vTAG-310 – Windows PC based simulation of entire systems
- vTAG-RT – PC hardware running RTOS for hard realtime simulation



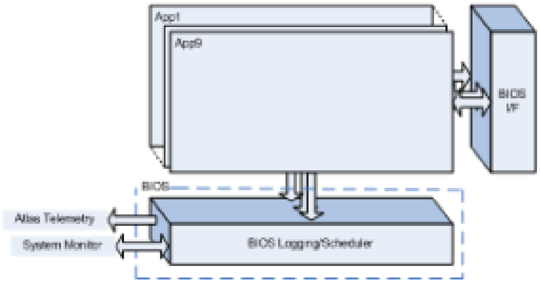
System Architecture

The vTAG system provides an environment which is very similar to that in the real ECUs provided by McLaren Electronics.

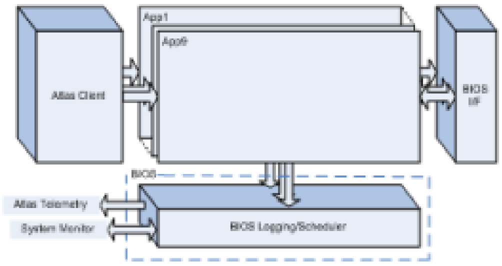
The real ECUs incorporate a BIOS which controls the unit’s I/O, logging, scheduling and communications and, depending on the ECU, support up to three applications. Parameters are passed between the BIOS and the applications via the BIOS interface.



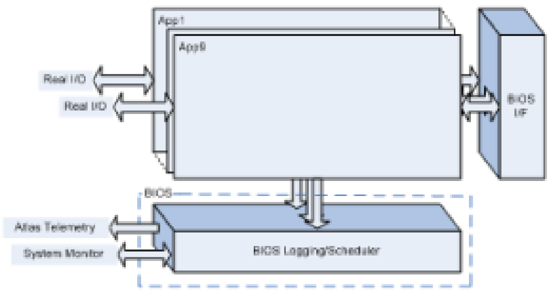
In vTAG-310, the I/O layer is removed and support for up to nine applications is provided. Typically the additional applications would be used for plant models (eg engine or car simulation) which will be able to exchange I/O parameters via the BIOS interface.



In vTAGserver, data for the applications is sourced from ATLAS using Simulink blocks from the GDE toolbox. The vTAG simulation can be run within ATLAS by the user and the resulting logged data written to disk by the ATLAS client. Alternatively, the vTAG simulation can be run automatically when live data is available and the results sent via Ethernet telemetry to an ATLAS DataServer running the vTAGserver recorder. vTAG data will then be sent by the DataServer to all clients along with the original data stream. This allows data from vTAGserver to appear as if it had come from the live data source.



vTAG-RT provides an environment similar to vTAG-310, except that the PC hardware used is dedicated to the task and runs the OnTime RTOS-32 realtime operating system. This is the same RTOS which is used by MathWorks for their xPC product and so it is possible to use xPC I/O board drivers under vTAG-RT allowing a wide variety of interface cards to be used. The operating system provides hard realtime execution. Additionally, execution may be synchronised to an external source allowing multiple vTAG-RT systems to run in sync, or a vTAG-RT to be synchronised to a connected ECU.



vTAG Kernel

The vTAG Kernel provides the core executable for the system. It provides the equivalent of an embedded system's boot code, and provides basic Ethernet communications for connecting to System Monitor. The vTAG kernel runs inside the vTAG-310 Windows application, or within the ATLAS vTAGserver in-place control. In vTAG-RT the kernel runs directly on the target system under the RTOS.

vTAG BIOS

The vTAG BIOS provides all the communication, task scheduling and logging for the system. Up to nine vTAG applications may be run by the BIOS. To take advantage of PCs with multiple processor cores the BIOS allows each application to run in a separate thread.

Logging at rates up to 1kHz is provided. The signals to be logged are selected using System Monitor and may be logged at different rates in each of eight channels. Channel start/stop triggers can be configured individually allowing complex event based multirate logging of signals.

vTAG Applications

vTAG applications can be built from Simulink models using GDE 8.2 with the vTAG Platform Support Package. This allows Simluink models to be built into code that is tailored to running on the vTAG system. Other platform support packages are available to allow code to be built for real ECUs. The same models can be used on either vTAG or real ECUs with minimal changes.

To build applications using Dymola the Dynamic Model Integrator (DMI) is used and is capable of using Dymola's code export or binary export capabilities

Interapplication Communications

vTAG applications can communicate with each other by several methods:

Shared Memory several shared memory areas can be defined to allow applications to read/write from common predefined areas.

External Reference using GDE 8.2's Measurement Read blocks implicit connectivity can be achieved. At initialisation for any signal Measurement Read block which does not have a corresponding write block in that application, the BIOS will search the other applications for that signal and use it if found.

Development Products

For Simulink vTAG-310/vTAGserver applications

- GDE 8.2
- vTAG Platform Support Package

For Dymola vTAG-310/vTAGserver applications

- Dynamic Model Integrator (DMI)
- Visual C++ Express (2005/2008)

For vTAG-RT applications the vTAG-RT extension must be specificed in addition. If DMI and GDE are used on a single PC, then only one vTAG-RT extension is required for both.

Runtime Products

For vTAG-310

- ATLAS
- System Monitor
- vTAG-310

For vTAGserver (local client processing only)

- ATLAS
- System Monitor
- vTAGserver

For vTAGserver (live data processing)

- ATLAS
- ATLAS DataServer
- ATLAS VTS recorder
- System Monitor
- vTAGserver

For vTAG-RT

- System Monitor

vTAG-RT

vTAG-RT is a computational framework that runs on a standard PC and uses a real-time operating system to run a hardware-in-the-loop (HIL) system.

vTAG-RT's origins are the Electronic Control Units (ECU) of professional motor–sport where building highly configurable model based applications is key. vTAG-RT enables the tools used to develop ECU control models to also be used to monitor, tune and develop the plant model inside the HIL system.

vTAG-RT runs on RTOS-32 allowing the Mathwork's xPC block sets to be used to manage all I/O within the Simulink models.

The Graphical Development Environment (GDE) provides the automated build environment and a block library to allow the configuration of scalars and maps, the logging of signals, error and events plus some signal conditioning blocks.

Software

Features

- Real-Time HIL environment
- 1, 2, 5, 10, 50, 100ms, engine synchronous and background tasks
- Simulink code generation
- GDE block set
- Supports nine Applications and BIOS
- Tune editing via System Monitor
- Powerful data logger
- Data visualization through ATLAS

Programming

vTAG-RT is programmed with System Monitor. Each application may be programmed separately or from a single System Monitor project. System Monitor allows any of the tuneable parameters to be edited either on-line or offline.

Once programmed, vTAG-RT will autoboot from cold to its previously programmed state within a few seconds.

Logging

The logger inside the vTAG-RT BIOS is optimised to collect large amounts of data with the minimum use of memory and communications bandwidth. The logger includes:

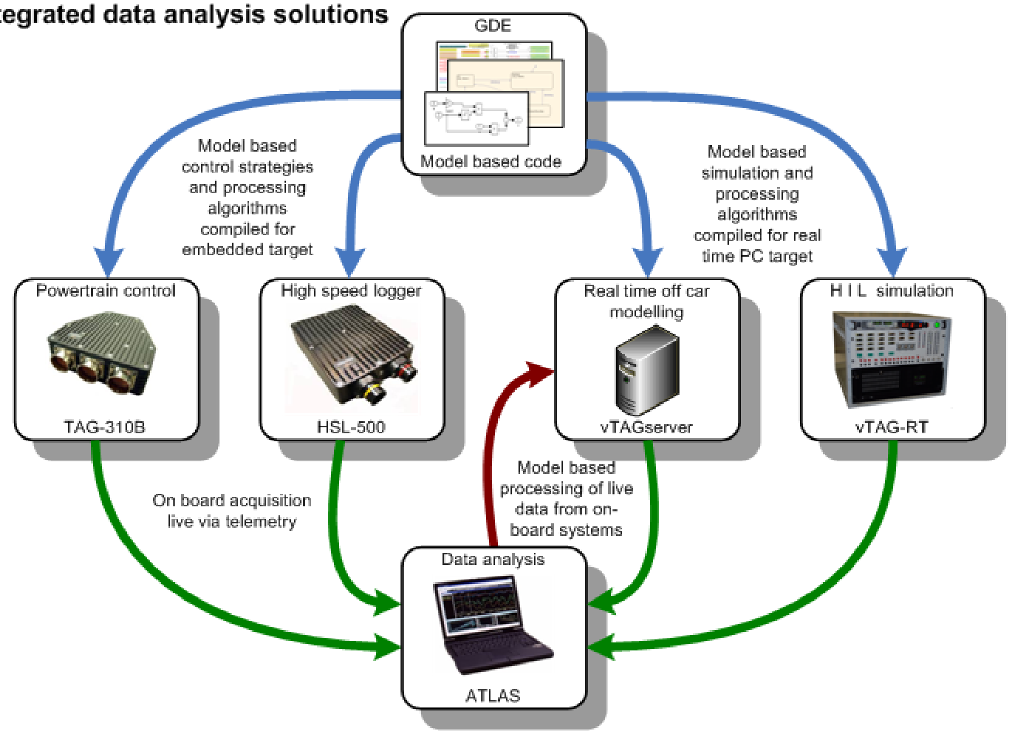
- 1Hz to 1kHz fixed frequency logging rates
- Engine synchronous logging and optional periodic log of everything.
- Trigger channels with pre and post triggers to enable data to be logged at different frequencies under different conditions
- Data packing, so that floating point engineering values maybe packed into smaller data types to save space.
- Data compression to pack constant or near constant data. This is particularly useful where switch positions need to be logged at a very high frequency, but where their values seldom change.

Logged data is sent live to ATLAS for analysis.

Extendibility

vTAG-RT is highly extendable as it makes no specific requirements of bus or system architecture. Mathwork's xPC provides a wide range of blocks for PC I/O cards. Custom blocks can also be written for new cards.

Integrated data analysis solutions



Software

Application Notes

Accelerometers and Gyros

Application Note

Accelerometers

McLaren Applied Technologies offer accelerometers which for motion analysis. The sensing element is a MEMs device based on the principle of differential capacitance technology. These are available in one, two or three axis versions. The single axis part is particularly small and suitable for wheel hub acceleration measurement.

Principle of Operation

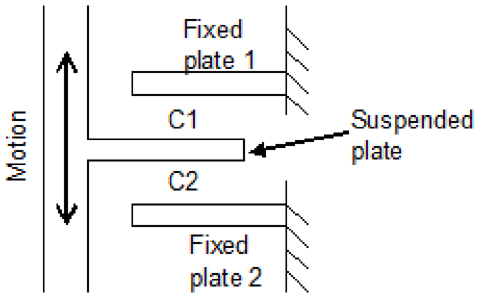


Figure 1

The sensing element of the accelerometer consists of two fixed plates attached to the substrate and a suspended plate.

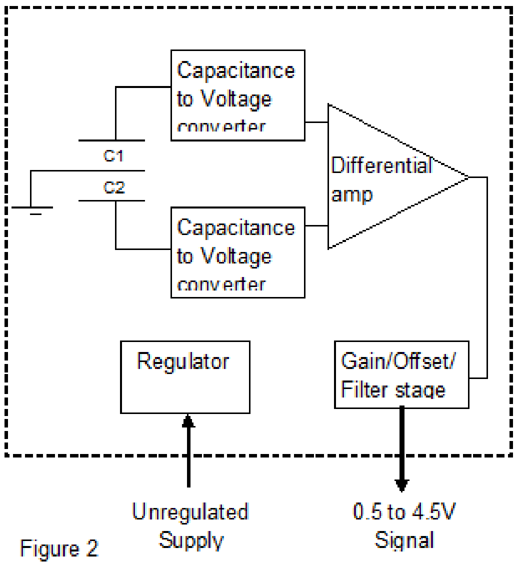


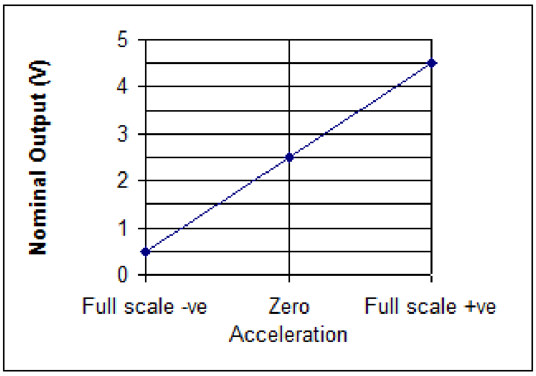
Figure 2

When the unit moves in the direction as marked in figure 1, the displacement of the suspended plate with respect to the two fixed plates changes, resulting in a change in capacitance of C1 and C2. An increase in C1 will result in a decrease in C2 and vice versa. Due to the small capacitances involved, in order to reduce noise and thermal drift and increase the resolution a differential system is employed. The signal from the element is then further processed to obtain a filtered and amplified linear output.

Sensor Output

In order to prevent interference from higher frequency oscillation, the frequency range of the output signal is sharply attenuated by an active DC filter. On the standard accelerometer the -3dB point is set to 40Hz with a roll off of 40dB/dc, however this can be changed to suit customers requirements. Alternatively an eight-pole Butterworth filter is also available.

Documentation



The nominal output is 0.5V for full scale negative acceleration, 2.5V for zero acceleration and 4.5V for full scale positive acceleration. Each sensor is individually calibrated. The parameters are supplied with the sensor and can be used to manually or automatically minimise any remaining sensor error.

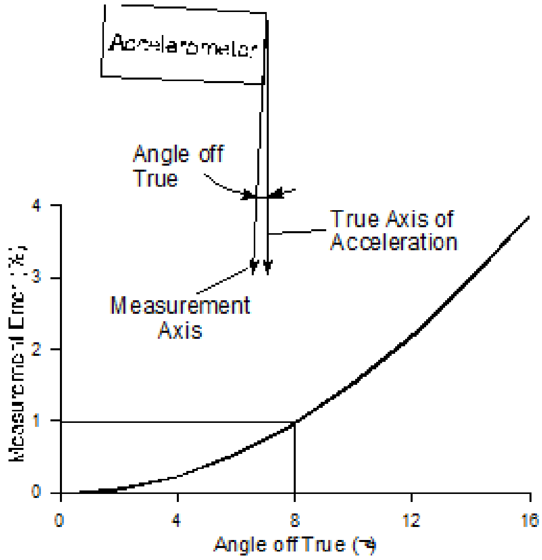
Sensor Design

The sensor is assembled into a sealed, anodised aluminium body, which makes it very robust and resistant to standard motorsport fluids.

Accelerometer Installation

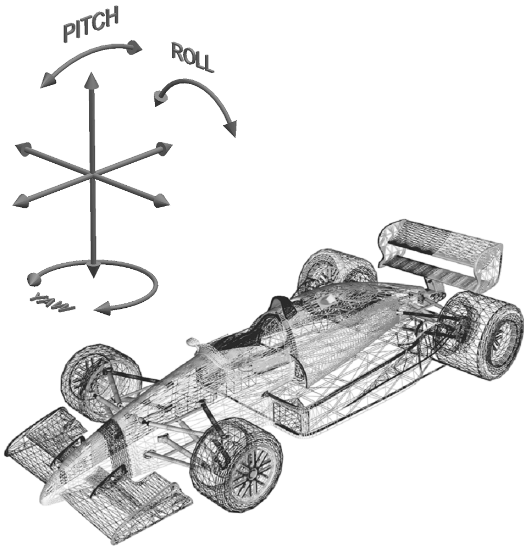
To give an accurate representation of movement, the accelerometer must be rigidly attached to the object being monitored. McLaren Applied Technologies accelerometers have through holes to enable them to be securely fastened to a surface.

The measurement axis of the sensor should be in line with the axis of the motion being measured. Any angular misalignment will give an error which is proportional to the cosine of the angle. For small angles the error is negligible, but it increases rapidly as the angle increases. For example, a misalignment of 8° will give an error of 1%.



Gyros

McLaren Applied Technologies offer gyroscope sensors for use in the development of vehicle dynamics.



Principle of Operation

The gyroscope sensor is a solid state device based on the Coriolis effect to measure angular rate. The sensor consists of a micro-machined vibrating silicon element, which provides an analogue output proportional to the rate of change of angular position about its sensing axis. The silicon element design is based on the principle of a shell resonator whereby a silicon ring is mounted to a substrate by radial spokes. This design of resonator is more resilient to shock and vibration than beam oscillators whereby the suspended silicon beam is mounted vertically with legs supporting the element mass. The Gyros are available to measure a single axis or three axis.

Gyro Output

At zero angular velocity the sensor has an output voltage of 2.5V ±0.1V. The sensitivity of the unit (10mV/°/sec) allows for an output range 10 x 200 = ±2V (i.e. 0.5 to 4.5V).

The sensor design incorporates a 100kohm load resistor internally.

Alternators

Application Note

Alternators

McLaren Applied Technologies offers a selection of alternators to meet varying needs. The F, G and K-series have wound rotors with internal intelligent rectifier/regulator units. For the most demanding motorsport applications, where size and weight must be cut to a minimum, we can supply permanent magnet alternators with separate switched mode rectifier/regulator units.

All models offer excellent power outputs for their size and weight, up to a massive 200 amps in the K-series.

Wound Rotor Alternators

Wound rotor alternators are available in three sizes: F, G and K. These are based on state of the art production units and have specially wound stators to achieve a high current output. High current diodes are used in the rectifier to match the current output. The ignition circuit may be isolated, while the alternator is being driven, to reduce the load on the engine.

To make the alternator suitable for the high vibration levels encountered in the motor sport environment, they have the following features:

- Brush springs are stiffer than standard
- Extra flexible wire is used to connect the stator to the rectifier
- The stator is pegged to the body
- All screws are locked.

The battery terminal is designed for easy disassembly and re-assembly to facilitate engine strip downs. High quality bearings are used to enable the alternators to run at high speeds (up to 18,000 rpm).

Cooling is assisted by two fans fitted to the rotor spindle inside the alternator body, one at the front and one at the rear. The airflow is sufficient to keep even the highest output models operating reliably at ambient temperatures up to 90°C. The standard mounting method is intended for a belt drive, but the F, G and K alternators may be driven directly, if required.

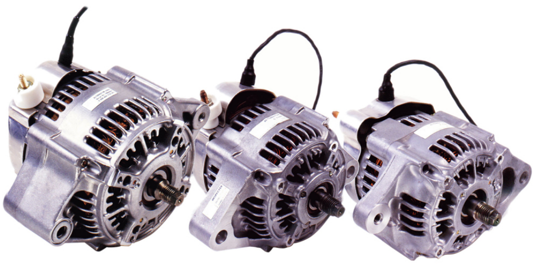
All alternators are tested to ensure that they produce the specified output and a test report is supplied with each one.

Documentation

Comparison of Wound Rotor Alternators

The following table ranks the alternators by their output current capacity. The relationship between operating speed and output is shown in detail in the Product Summaries.

There is some overlap between the ranges. The F-series is the smallest. The G and K-series offer anti clockwise as well as clockwise rotation and have a sense terminal for direct connection to the battery which can improve voltage stability.



K G F

Comparison of Wound Rotor Alternators			
Series	**F-Type**	**G-Type**	**K-Type**
Available Ranges of Maximum Current Output (A)			200
			165
		140[1]	
		120[1]	
			110
	90	100	
	60		
	40	55	
Body Diameter (mm)	99	105	126

Overall Length (mm)	143	144	161
Max weight (kg)	2.8	3.1	4.9
Note 1: High output variant			

Design Variants

Wound rotor alternators are available in several variants which affect the output power, the mounting arrangements and the connection arrangements.

Standard alternators can be modified to suit special requirements. Examples of modifications we have made in the past include:

- Accurately bored mounting holes
- High accuracy machining of mounting flanges
- Alternative locations of cable entries
- Alternative connectors

If our standard designs or their variants do not meet your needs, we can design an alternator to suit. Please contact our technical consultancy service who are ready to discuss your requirements.

Batteries

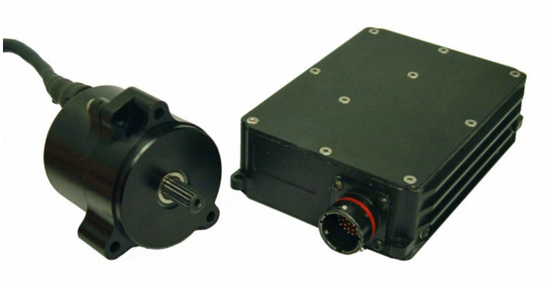
For applications where Lithium-ion batteries or large capacity battery banks are used, please consult our technical consultancy service to discuss your requirements.

Permanent Magnet Alternators

The advantages of the permanent magnet design over the wound type are:

- Smaller size and lower weight for a given output power
- High operating speeds
- Low inertia
- No brushes
- High operating temperature

Permanent magnet alternators are most suitable in situations where weight and overall dimensions must be minimised (e.g. motorcycles and single seat racing cars). Permanent magnet alternators can tolerate high ambient temperatures and vibration, allowing them to be directly mounted to racing engines. Drive is direct, usually via a gear, taking advantage of their small size, and high temperature resistance. Permanent magnet alternators can be supplied for belt drives, if required.



Permanent magnet alternators require a separately mounted, electronic, switched-mode regulator/rectifier unit. This has the advantage that the regulator may be placed in a cooler location in the vehicle.

Even the most efficient permanent magnet alternators generate some heat. Permanent magnet alternators are typically located where there is limited natural airflow, in which case it may be necessary to pipe air to the alternator. This may be, for example, a low pressure bleed from the air-box. Alternatively an open structure may be used which takes full advantage of the available airflow.

McLaren Applied Technologies permanent magnet alternators are the result of an extensive development programme, during which the magnetic and electrical circuits were optimised to operate with a “Buck” regulator – the DC2 or DC3. When used together, the alternator and regulator provide high current, at stable voltage, over a wide range of rotation speeds, from a very small and lightweight package.

Voltage Regulators

Alternators with permanent magnet rotors need a different kind of regulator to that fitted on a wound rotor alternator. In a wound rotor alternator, the output voltage depends on the magnetic field strength of the rotor. This is controlled by the excitation voltage supplied to the rotor by the regulator. With a permanent magnet rotor the field strength is fixed so this method cannot be used. The alternator has a three-phase output in which the voltage and frequency depend on the speed of rotation.

McLaren Applied Technologies have developed regulators which maintain the required voltage by drawing power from the alternator, as and when required, rather than dumping excess energy as heat. This system is more efficient than those using shunt or series pass circuits, so the package can be smaller and it is more likely that forced air cooling will not be required.

The 30A DC2 and the 22A DC3 regulators are optimised for use with McLaren Applied Technologies permanent magnet alternator. Both use “Buck” circuitry which stores and regenerates some of the energy which would otherwise be lost during switching.

The output may be set, at the factory, to any voltage between 13 and 15V DC. A signal line is provided to switch off the regulator remotely, for example, to reduce load on the engine. All the cabling from the voltage regulator to the alternator and to the vehicle electrical system is via a single, integral, military specification connector.

Although McLaren Applied Technologies regulators are very efficient, they do generate some heat and, in some circumstances a flow of cooling air may be required. The case is used as a heat sink and has small fins to increase its ability to lose heat. Ideally, air flow should be along the fins. For optimum performance, the temperature of the case should be monitored and no permitted to exceed the temperature stated in the Product Specification. An internal temperature sensor is provided for this purpose. Temperature can be reduced by improving the cooling, or by reducing the electrical load.

The input to the regulator from the alternator must not be allowed to exceed 200V p-p or the regulator may be damaged. If there is no electrical load on the alternator/regulator, e.g. during engine tests, the voltage may rise to unacceptable levels at high operating speeds. To prevent this, a dummy load should be fitted.

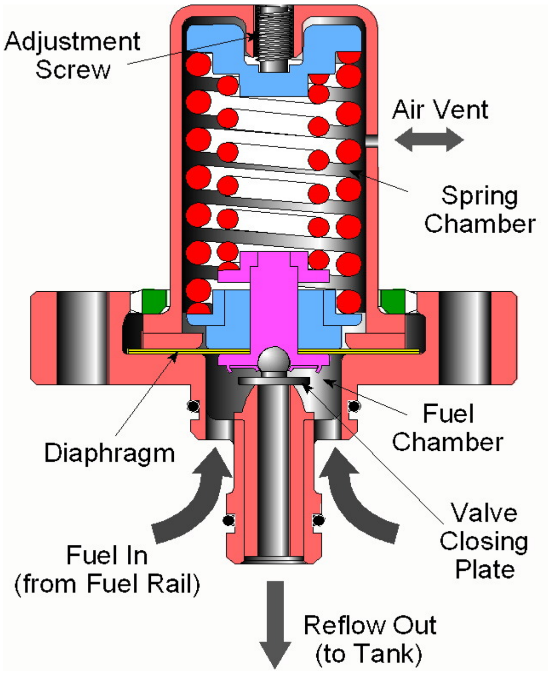
Please contact our technical consultancy service for advice on installing and using our regulators.

Fuel Pressure Regulators

Application Note

The fuel pressure regulator controls the pressure of the fuel supply to the injectors in a fuel injection system. It is typically located in the fuel rail, downstream of the injectors.

Principle of operation



The regulator operates on hydro-mechanical principles. It consists of a fuel chamber and a spring chamber. These are separated by a fabric reinforced, fluoro-rubber diaphragm which carries the valve closing plate. The valve is held shut by a compression spring chosen for the specified pressure rating. When the pressure in the fuel rail exceeds the regulator set point pressure, the valve closing plate begins to lift off the outlet nozzle. The excess pressure is relieved by permitting fuel to flow back to the fuel tank reflow). Once open, the valve continually adjusts to regulate the fuel rail pressure.

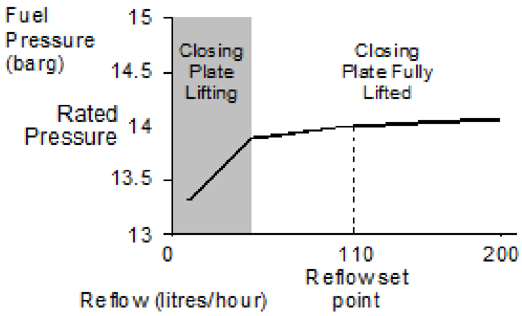
Design

All of our fuel pressure regulators have a lightweight aluminium body, which is hard anodised to give it a rugged finish. The internal components are machined from stainless and carbon steels and are hardened, ground and polished, where necessary, to ensure smooth and reliable operation. The spring chamber of every one of our regulators has a small hole that vents to atmosphere. This prevents the build up of back pressure on the diaphragm, which could otherwise affect the performance of the regulator. Alternatively, the spring chamber can be fitted with a manifold pressure reference port. When left unconnected, this acts in the same way as the vent hole. When the port is connected to the inlet manifold, the pressure in the spring housing will follow any changes in the manifold pressure. Intended mainly for use in turbo-charger applications, this feature allows the fuel pressure to track changes in manifold pressure.

Performance

The performance characteristic of a fuel pressure regulator breaks down into: the valve opening phase, when the closing plate begins to lift, and the valve open phase, when the closing plate is fully lifted. Once the valve is open, the spring rate of the compression spring determines the reflow gradient. This reflow gradient ranges from the order of 30 mbar per 100 l/hr for our 3.5barg regulator to a maximum of 180 mbar per 100 l/hr for our 30barg regulator.

Each of our fuel pressure regulators is individually calibrated to achieve a reflow of 110 litres per hour at its rated pressure. The adjustment screw is sealed after calibration and should not be moved or calibration will be lost.



Documentation

Ignition Coils
Application Note

Requirements of an Ignition System

In a petrol engine, the combustion of an air/fuel mixture is initiated by an electrical spark. Accurate and reliable ignition is essential for optimum performance and minimal emission. Misfires reduce the engine's power output and can lead to damage in the exhaust ports, exhaust pipes and catalytic converter.

The spark, needed to ignite the air/fuel mixture in the combustion chamber, is generated by applying a high voltage to the electrodes of a spark plug. The voltage required to generate a suitable spark depends on the compression ratio of the engine, the quality and ratio of the air/fuel mixture and the spark plug construction.

More than 12kV is usually needed to ignite a mixture. In special cases, a few kV may be sufficient, whilst a highly compressed or lean mixture may require more than 30kV. As a rule of thumb, approximately 25kV should suit most applications.

As soon as the spark is generated, a conductive plasma is established between the electrodes of the spark plug and a reduced voltage of about 100V is all that is needed to maintain the spark. The duration or "burn time" of the spark, and its related energy, depend mainly on air/fuel ratio and the mixture preparation, which in turn is dependent on the inlet design, the air flow velocity and the type of fuel.

As in all systems, not all of the available electrical energy is passed into the spark/plasma - a significant amount is lost as heat.

It is difficult to measure the available energy in the spark/plasma. No commonly accepted industry standard exists, which makes the comparison of energy data almost impossible.

The maximum electrical energy available at the beginning of the ignition process can be easily measured, but this value can vary from approximately 25mJ to several hundred mJ and means very little in terms of the overall performance of the ignition coil. Comparing this maximum available energy with the energy required to ignite a mixture (1mJ or even less) indicates how much care must be taken in interpreting energy levels. McLaren Applied Technologies has defined a measurement method which allows comparison between the different coils that we make, but we do not imply that this is the only possible method of measurement.

Types of Ignition System

Petrol (and alcohol) engines mainly use one of two ignition types:

- Capacitor Discharge Ignition (CDI)
- Transistorised Ignition (TSI)

Both ignition systems have advantages and disadvantages, which should be carefully considered in each application. Both technologies were introduced many years ago, but continuous refinement has ensured that they are still suitable for the most sophisticated road and motorsport engines.

Capacitor Discharge Ignition

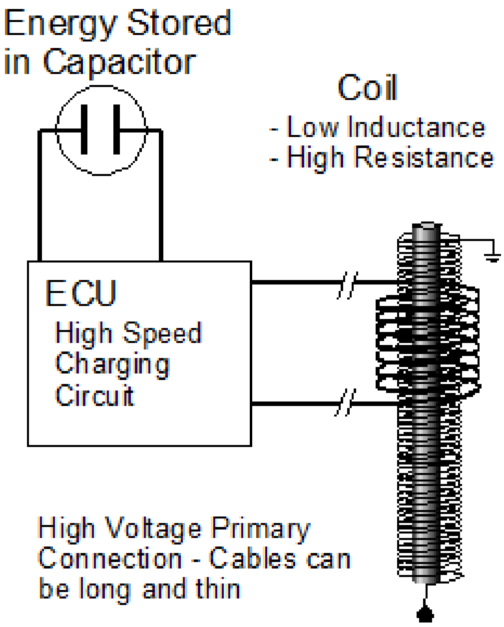
In a CDI system, the energy for the spark is generated by an electronic circuit which stores energy at several hundred volts in a capacitor. At the moment of ignition, this energy is transferred from the capacitor to the ignition coil. Because the combustion chamber is under pressure at the moment of ignition, the coil has to transform the capacitor voltage up to several thousand volts in order to generate a spark. This requires a coil with a winding ratio of approximately 500:1 and good magnetic coupling between the primary and secondary windings. The inductance of the coil can be low as the CDI coil does not store energy.

Most CDI systems charge a capacitor up to approximately 400V, resulting in a stored energy of approximately 50mJ. This historical value of 400V is based on the typical voltage capability of the storage capacitors available when CDI systems were first introduced. The TAG CDI system operates at up to 600V, which reduces the size of the capacitor required to achieve the same stored energy (Energy= $\frac{1}{2} CV^2$). This higher operating voltage also allows coils to be smaller, as the step up ratio can be lower.

A bulky and heavy electronic package is required to charge the necessary 50mJ into the storage capacitor in the short time between successive ignitions. However, McLaren Applied Technologies CDI system makes use of an advanced, fast, switch-mode power supply to generate 600V in the very short time of 500µs. As a result, we are able to integrate CDI electronics into the same small space envelope that is used for TSI.The transfer of energy from the storage capacitor to the CDI transformer coil happens very quickly - typically 30 to 50A flow between the capacitor and the coil. Because of the high charging voltage of at least 400V, this current can be achieved with thin inter-connection wires without any major performance loss.

The voltage generated and fed to the spark plug (the secondary voltage) follows this fast energy transfer. This results in a very rapid voltage increase (approx 10kV/µs) making CDI insensitive to shunt resistance (e.g. wet spark plugs).

Furthermore, the interaction of the magnetic field of the CDI coil with the surrounding engine metal (the Eddy Current Effect) is also limited as the secondary voltage generation does not (primarily) depend on the flux change in the magnetic field. However, this fast energy transfer limits the burn time to approximately 50-80µs. With CDI, burn time is very difficult to extend; neither an increase of energy stored in the capacitor nor higher inductance coils will extend the burn time by any significant margin. To overcome these limitations, experimental systems have been developed in which an initial "fast" spark is generated by a CDI and the burn time is extended by feeding energy to the plasma from a separate voltage source. Such a system allows very long burn time combined with the advantage of insensitivity to shunt resistance. However, the resulting system is complex and is not commercially available.



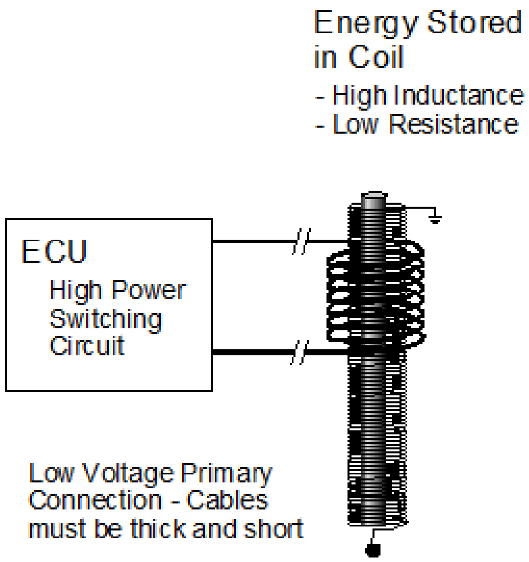
Transistorised Ignition

The working principle of a TSI system is very simple. Voltage is connected to an ignition coil which results in a current flow and magnetic energy storage in the coil. When the current is switched off, the collapse of the magnetic field in the primary coil induces a voltage in the secondary coil. The ratio of the number of turns in the primary and secondary coils means that the output voltage is much higher than the input voltage. The resulting spark has an extended burn time (approximately 500µs to 1ms) as induction keeps the current flowing for as long as possible.

TSI, in its original form, was used long before CDI. Initially it used a mechanical contact breaker to switch off the current. This mechanical switch placed a limit on the voltage generation within the coil as the current had to be limited. In addition an ignition condenser (capacitor) had to be used to slow down the switch off process to prevent unacceptably short life span of the contact breaker. The seemingly simple task of replacing the contact breaker with a transistor was a major technical challenge. The transistor had to pass 6 to 8A but it also had to withstand approximately 400V. Fifteen years ago, this was such a major challenge for the semiconductor industry that only a few companies could reliably manufacture these parts, and then at a very high cost. Today, transistors are readily available which will withstand 25A at 600Volts and more.

Ignoring the protection and diagnostic circuitry of transistorised ignition (which can be implemented on a single silicon chip for mass market applications) the circuitry is a single transistor. This means the electronic design is simple, but the design of the coil is much more complex. The maximum energy available to the spark (ignoring losses) is the energy that can be stored in the coil at the moment of ignition. This energy equals $\frac{1}{2} LI^2$ (where “L” is the inductance of the coil and “I” is the current flowing through it). Energy can be increased by increasing the inductance of the coil or by increasing the current or both. Inductance depends on the magnetic circuit and the number of turns of the coil winding. The current is limited by the resistance of the coil and the voltage available. Increasing the number of turns in the coil has two effects: it increases electrical resistance reducing the current and it increases inductance. A high inductance coil is very slow to charge which limits the number of sparks per minute. This is the reason that CDI was developed for high speed engines.

Documentation



Comparison of CDI and TSI

In a CDI system, the coil only acts as a voltage transformer - energy is stored in a capacitor in the drive electronics. This has the following implications:

- Coil inductance can be low
- Switching rate is very high
- Primary voltage is high so connecting cables can be thinner and longer
- Fast increase in secondary voltage and insensitivity to shunt resistance leads to a very precise and repetitive combustion
- Magnetic circuit design is not critical
- Burn time is short
- EMI is limited by low inductance and short burn time

Engines that do not need a long burn time, will usually show their best and most consistent power output when using a CDI system.

In a TSI system, the coil stores energy as well as acting as a voltage transformer. This has the following implications:

- Coil inductance must be relatively high
- Switching rate is limited by time to charge the inductance.
- Primary voltage is low and current is high so connecting cables must be thick and short
- Magnetic circuit design is critical and can be affected by location in the engine
- Burn time is long
- EMI is severe in high performance systems

The transient response of a racing engine may benefit from the long burn times available with TSI. Whilst it should always be possible to generate a good mixture at full engine load (characterised by high air flow and long injection pulses), this may not always be the case at part load. Part load is often considered to be of little interest to a racing engine, but valuable time is often lost if a driver cannot effectively change gears or stabilise the car with the throttle; both of which are heavily dependent on crisp engine response.

After thousands of hours of designing effective coils for both CDI and TSI systems, McLaren Applied Technologies can offer similar sized coils for either application.

High voltage and insensitivity to shunt resistance are most easily achieved using CDI technology. If your engine does not rely on extended burn time, a CDI system will allow smaller coils, easier installation with potential longer lead length and faster voltage increase. Where the ECU demands the use of TSI, some of the potential gain of a CDI system can be recovered by fast, low inductance coils, running at higher current levels of approximately 25A (compared to mass market coils which usually operate at about 10A).

Electro-Magnetic Compatibility (EMC)

In automotive technology, the ignition system is the major source of electro-magnetic compatibility problems. Any change in electrical charge causes radiation and the electrical spark, required for ignition, generates electro-magnetic noise . An ignition system, particularly one for fast burn racing engines, has very rapidly changing electrical charges so the radiation is high. Radiation suppression elements can be integrated into a coil, but they dissipate energy and reduce the effectiveness of the ignition system. To minimise the effects of radiated noise, care has to be taken in selection of ignition systems and the layout of the electrical wiring.

TSI systems, based on large and heavy ignition coils, common in mass market road car applications, are least demanding in this respect. Mass-market coils are usually high inductance and made for low current operation and normally include suppression resistance. As a result, the current and voltage build up is slow and the resulting electro magnetic radiation is limited. Very high engine speed cannot be achieved with these coils and power output may be below optimum.

CDI coils tend to radiate more energy than these mass market TSI coils as CDI coils are designed to allow very fast voltage increase. However, radiation is limited, as the coil acts as a voltage transformer and radiation only occurs during the short burn time.

The most demanding are the high current, low inductance TSI coils that radiate quite severely and for a relatively long time. They often demand a fully screened electrical wiring system and may require radiation suppression elements.

Custom Coil Construction

McLaren Applied Technologies can design and manufacture coils of all types, with and without integrated radiation suppression. Our design can be optimised to be used with our own ECUs or any third party control unit. We can supply coils for distributor and distributorless ignition systems, for on-plug or chassis installation.

Coils can be supplied with cable protection, using military specification sleeving and strain relief boots, or simply bare, insulated primary wire connections.

Supported by our in-house harness design and manufacture team, coils can also be assembled into a loom ready for installation. Several different types of spark plug or HT cable connections are available. The most common are: fixed connector, spring loaded plunger, spring loaded cap, M4 sawtooth and screw thread.

Lambda Sensors

Application Note

To optimise combustion, advanced engine control systems need fast, accurate and reliable information about the air/fuel ratio (or lambda) in the exhaust. This guarantees that the engine is operated most efficiently, and gives the most power, under all driving conditions.

McLaren Applied Technologies offer the NGK UEGO (Universal Exhaust Gas Oxygen) Sensor for this precision task as it has proven its performance and reliability in all of our engine control applications.

Principle of Operation

The Universal Air-Fuel Ratio (AFR) Heated Exhaust Gas Oxygen (UEGO) sensor has been developed to measure a wide range of air/fuel mixtures. (Note: lambda is 1 when AFR is 14.57 which is the stoichiometric mixture based on propane fuel).

The UEGO sensor is based on Zirconium Dioxide cells, which are held at an elevated temperature by an internal heater. The sensor has two cavities: one for sensing and one for reference. The sensing cavity is linked to the exhaust gas by a diffusion aperture and the reference cavity is linked to the sensing cavity by a much smaller aperture. A small, constant pumping current transfers oxygen from the sensing cavity to the reference cavity. A second pumping current pumps oxygen between the sensing cavity and the exhaust in order to maintain a constant reference cell oxygen concentration. The measured value of this current gives the air/fuel ratio (AFR).

When measuring lean mixtures, excess oxygen in the exhaust diffuses into the sensing cavity. This leads to an increase in the oxygen concentration in the reference cavity which is brought back to its fixed level by adjusting the measured pump current to transfer oxygen from the sensing cavity back to the exhaust gas. The measured value of the pump current indicates the amount of excess oxygen in the exhaust.

Rich mixtures result in an increase of carbon monoxide and hydrogen being diffused into the sensing cavity. From there they diffuse into the reference cavity, where they deplete the oxygen concentration. The measured pump current is adjusted to pump oxygen from the exhaust into the reference cavity to restore the oxygen level. The current required to do this is a measure of the concentration of carbon monoxide and hydrogen.

Use with Engine Control Units

The accuracy of UEGO sensors is extremely high at an exact stoichiometric burn, i.e. when the pumping current is zero. For non-stoichiometric conditions, the pump current can vary by up to ±15% between otherwise identical sensors. These variations can be compensated for using the calibration data supplied with each sensor.

For maximum accuracy, each sensor is calibrated at two lambda values, 0.75 and 1.25. The calibration data is available in computer readable form and can be loaded into any of our systems. Our measurement system uses the calibration data to compensate for any given sensor slope, at lean and rich values of lambda, between the calibration points for a specified fuel type.

The UEGO sensors can be connected directly to our Engine Control Units (ECUs) TAG-400, TAG-300 and TAG-210. If your ECU does not include a built in interface for this probe, then you can add our lambda measurement sensor node, SN-32LT.

The sensor must be powered up when the engine is running so that the heater will maintain the minimum operating temperature. If the operational temperature is exceeded, sensor function will be impaired, causing large calibration errors, as well as possible heater element damage. The UEGO sensor is not resistant to temperature shocks, so it should not be subjected to cold-fluid cooling or similar.

Lap Triggers

Application Note

Optical Lap Trigger System

The optical system consists of the LTX-400 transmitter and the LRX-400 receiver.

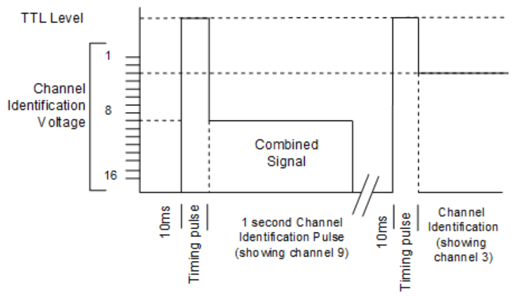
The LTX-400 transmitter has an array of infra-red emitters which produces a focussed beam to give an operating range of about 30m in optimum conditions. LTX 400 is powered by an external battery connected via a flying lead. LTX-400 transmits one of 256 codes, selected by switches inside the unit. The codes are split into 16 groups and each group is split into 16 channels. The LRX-400 receiver is set, by an internal switch, to respond to only one of the 16 groups, signals from other groups are ignored. When a matching group code is detected, the LRX-400 outputs a TTL level pulse as well as an analogue voltage to identify which of the 16 possible transmitter channels was transmitted by the LTX-400. An LED on the rear of the LRX-400 indicates when a transmission from the selected group has been detected.

LRX-400 can discriminate between up to 16 different lap triggers, transmitting different channels, around the track. For example, transmitters could be placed on the start/finish line, in the pit lane and at other key locations to create timing split points and speed traps.

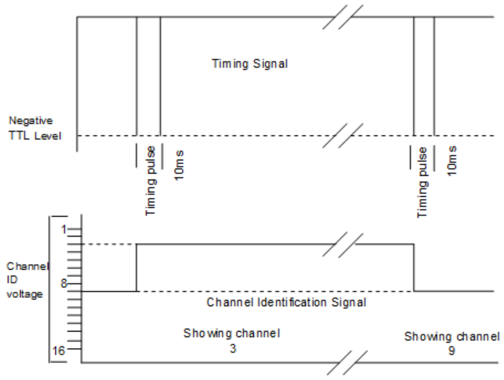
LRX-400 is a compact, cylindrical unit that can be readily accommodated on a car. It has a wide dynamic range and integrated filters to minimise interference from sunlight or other heat sources. It should be mounted in the car in such a position that it has a clear and direct view of the transmitter as it passes. If a window is used, it must be transparent to infra-red at 875nm. If possible, the mounting should be in a location which does not get wet or dirty.

Two variants of the LRX-400 are available which either combine the timing pulse and channel identification voltage on a single output or provide two separate outputs. In each case the channel identification voltage has 1 of 16 values according to the channel code received from the transmitter.

In the **Combined Output Version** a short (10ms), TTL level, active high, digital pulse is superimposed on the channel identification voltage when a valid lap-trigger signal of the selected group code has been received.



In the **Separate Output Version** the timing output is a short (10ms), TTL level, active low, digital pulse which indicates that a lap-trigger signal from the selected group has been received. The channel identification voltage is output continuously on a separate wire and only changes if a signal is received from a differently coded transmitter using the same group.

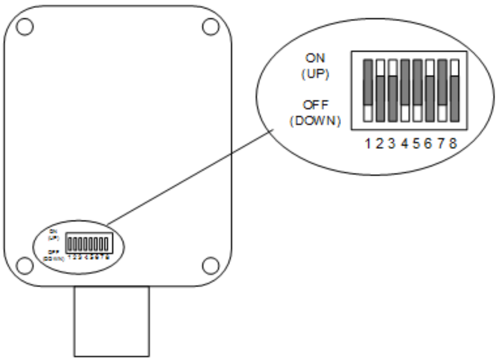


Setting up the LRX/LTX-400 system

Transmitter – LTX-400 needs to be set up to send a code which corresponds to the desired group and channel. The settings are by a DIL switch inside the unit. The switch is accessed by removing the rear lid of the unit (held by four screws). The switch is at the bottom of the board near to the tripod mount and is marked with the ON position and the individual switch numbers. When replacing the lid, use a new O-ring and sealing washers.

Documentation

Switches 1 to 4 define a group number (from 1 to 16). Table 1 lists the switch positions for each group. Switches 5 to 8 define a channel number, which is used to identify the LTX-400 to the receiver. LRX-400 generates an analogue output corresponding to the channel number. Table 2 lists the switch positions for each channel as well as the LRX-400 channel identification voltage.



To avoid interference, ensure that no other team at the circuit is using the same group as you.

Receiver – LRX-400 needs to be set up to receive the same group as is being transmitted by the LTX-400. Remove the screw on the back of the receiver with an Allen key and use a small Phillips screwdriver to turn the recessed PCB mounted switch inside. Rotate the switch clockwise to select from group 1 to 16. The switch has no stop, the two arrows on the back cover show the allowable movement. Set an LTX-400 transmitter to the desired group and point it at the receiver. Rotate the switch slowly until the LED on the receiver flashes at approximately 1Hz. This indicates the receiver is correctly set to receive that group. Replace the cover screw with its sealing washer.

Table 1: Optical Transmitter Group Setting

Group	Switch 1	Switch 2	Switch 3	Switch 4
1	Off	Off	Off	Off
2	Off	Off	Off	**On**
3	Off	Off	**On**	Off
4	Off	Off	**On**	**On**
5	Off	**On**	Off	Off
6	Off	**On**	Off	**On**
7	Off	**On**	**On**	Off
8	Off	**On**	**On**	**On**
9	**On**	Off	Off	Off
10	**On**	Off	Off	**On**
11	**On**	Off	**On**	Off
12	**On**	Off	**On**	**On**
13	**On**	**On**	Off	Off
14	**On**	**On**	Off	**On**
15	**On**	**On**	**On**	Off
16	**On**	**On**	**On**	**On**

Table 2: Optical Transmitter Channel Switching

Channel	Channel Identification Voltage (V)	Switch 5	Switch 6	Switch 7	Switch 8
1	4.562	Off	Off	Off	Off
2	4.287	Off	Off	Off	**On**
3	4.012	Off	Off	**On**	Off
4	3.737	Off	Off	**On**	**On**
5	3.462	Off	**On**	Off	Off

Documentation

Table 2: Optical Transmitter Channel Switching					
Channel	**Channel Identification Voltage (V)**	**Switch 5**	**Switch 6**	**Switch 7**	**Switch 8**
6	3.187	Off	**On**	Off	**On**
7	2.912	Off	**On**	**On**	Off
8	2.637	Off	**On**	**On**	**On**
9	2.362	**On**	Off	Off	Off
10	2.087	**On**	Off	Off	**On**
11	1.812	**On**	Off	**On**	Off
12	1.537	**On**	Off	**On**	**On**
13	1.262	**On**	**On**	Off	Off
14	0.987	**On**	**On**	Off	**On**
15	0.712	**On**	**On**	**On**	Off
16	0.437	**On**	**On**	**On**	**On**

Microwave Lap Trigger System

The microwave lap trigger system consists of the LTX-310B transmitter and the LRX-310B receiver.

In the LTX-310B transmitter, a specially selected horn antenna gives a focussed narrow beam of microwaves at 10.6GHz. Careful choice of the E and H plane pattern minimises multipath effects caused by scattering from the ground and other objects. The LTX-310B has an internal sealed battery that provides approximately eight hours operation when fully charged. An external battery can be connected for longer operation.

LTX-310B modulates the transmitted microwave beam at one of 36 possible frequencies, allowing six teams to each operate up to six LTX-310Bs at the same track. The group code for each team is set at the factory by an internal switch. An external 6 position rotary switch selects a channel which allows the receiver to discriminate between different transmitters on the same group code. LTX-310B has a key locked power switch, preventing accidental deactivation.

The LRX-310B receiver is a small X-band microwave module with a specially-designed waveguide antenna in a small, lightweight assembly, ideally suited for car mounting. It can be mounted by applying self adhesive hook and loop or Dual-Lock type fasteners to any face other than the front.

The slotted waveguide antenna covers the entire front face of the LRX-310B. The antenna is most sensitive perpendicular to the front face which should have an unobstructed line-of-sight path to the transmitter. The receiver may be mounted behind a window which is transparent to radio at 10.6GHz. Kevlar, glass-fibre, polyethylene and PTFE are suitable window materials. Carbon-fibre or metal are unsuitable. To prevent distortion of the RF beam shape, the thickness variation across the RF window should be less than 0.5mm.

Maximum detection range is approximately 25m. To achieve this, it is important to match the polarisation of the transmitter and receiver antennas to within ±30°. If the transmitter is mounted with its feet downwards, then the receiver must be mounted with its long axis horizontal.

LRX-310B outputs trigger pulses as it passes through the beam of an LTX-310B transmitter. The pulse repetition interval is inversely proportional to the modulation frequency and the amplitude of the pulses is proportional to the strength of the received signal. LRX-310B detects any of the 36 channels transmitted by LTX-310B and does not need to be set up. The transmitter channel is identified from the Pulse Repetition Interval shown in Table 3.

Table 3: Microwave System Settings		
Transmitter setting		**Receiver Output**
Factory Switch Group Setting	**Rotary Switch Channel Setting**	**Pulse Repetition Interval μs**
1	1 2 3 4 5 6	1575 1543 1513 1479 1447 1416

Documentation

Table 3: Microwave System Settings		
Transmitter setting		**Receiver Output**
Factory Switch Group Setting	**Rotary Switch Channel Setting**	**Pulse Repetition Interval µs**
2	1 2 3 4 5 6	1383 1351 1319 1289 1256 1224
3	1 2 3 4 5 6	1192 1160 1127 1096 1064 1032
4	1 2 3 4 5 6	1000 968 936 904 872 840
5	1 2 3 4 5 6	808 776 744 712 680 648
6	1 2 3 4 5 6	616 584 552 520 488 456

Linear Position Sensors

Application Note

Linear position sensors are used for precision measurement of linear displacement. Typical applications are: sequential gear drum position, throttle position for “drive by wire”, clutch paddle/position and suspension travel measurement. McLaren Applied Technologies offers four types of linear position sensor using different technologies. These are:

- Linear Potentiometer
- Linear Hall Effect sensor
- Level Sensor
- Ride Height Sensor

Linear Potentiometers

Principle of Operation

The sensing element of a linear potentiometer is a conductive track. A wiper, attached to the operating shaft, contacts the track. As the shaft is moved, the resistance between one end of the track and the wiper changes in a linear manner. Typically, a constant voltage is supplied across the ends of the conductive track and the potentiometer is used as a voltage divider. When used in this way, the voltage at the wiper is proportional to the shaft position.

Sensor Design

The sensing element consists of a stable, precision wire base track with a high resistivity conductive plastic bonded to it. The wiper contacts the plastic part of the track. This arrangement gives stability over a wide range of temperature and humidity as most of the current flows through the precision wire base element. This reduces the effect of wear compared to an all plastic construction.

The bodies of the linear potentiometers are anodised aluminium and the shafts are stainless steel. The sensors are sealed to keep out dirt and dust but the seals are not intended to prevent the ingress of fluids under pressure. The shaft is captive and cannot be removed from the body.

Linear potentiometers are available in the following styles:

- Unsprung long stroke (27-252mm)
- Unsprung short stroke (12.5-150mm)
- Sprung

Unsprung Potentiometers

The shaft and body have spherical bearings (“Rose joints”) for mounting. Ideally, the sensors should be mounted using the spherical bearings and not supported anywhere else. The spherical bearings can accommodate a movement of ±12° (15mm square) and ±13° (9.5mm diameter). Unsprung potentiometers can be supplied with threaded studs instead of spherical bearings, if required. This type of mounting should only be used if the Installation can guarantee linear motion, otherwise there is a risk that the shaft will bind. The shaft, with the bearing attached, is free to rotate. The bearing on the body can be rotated so the relationship between the plane of the bearing and the cable outlet can be adjusted. Provision is made to adjust the length of the shaft by 4mm.

Sprung Potentiometer

The spring is installed so that the captive shaft is normally fully extended.

A dual, sprung version is available to give redundant outputs for critical applications. The dual version has two tracks, two shafts and two springs. A single cable and connector is used with a separate output signal wire for each track. The supply and ground connections are common. However, a version in which the electrical connections are totally independent can be supplied on request.

Sprung potentiometers are typically used to follow a contour on a moving component. The contour should be smooth and should not apply side loads to the potentiometer shaft.

The potentiometer body should be rigidly fixed. However, in high vibration environments, such as direct mounting on an engine or gearbox, a resilient or anti-vibration mounting should be used. Even with such a mounting, sprung potentiometers are susceptible to bouncing when there is excessive vibration.

Linear Hall Effect Sensors

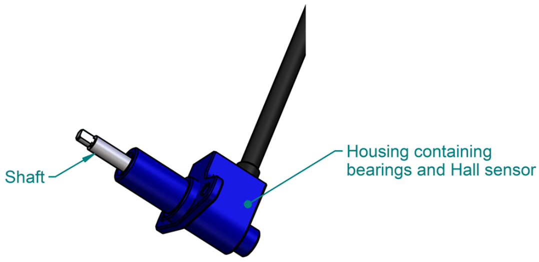
Principle of Operation

The linear Hall effect sensor consists partly of a Hall element and a magnet housed within the sensor shaft. The Hall element monitors the field magnitude along the magnet. With the element stationary, a linear movement of the shaft/magnet assembly causes a change in the magnitude of the magnetic field at the element face and hence generates an output voltage which can be seen at the signal wire of the sensor. By using the linear portion of the magnet, the sensors output voltage is proportional to the magnet (and shaft) position. The sensor is a three-wire device and requires no signal conditioning.

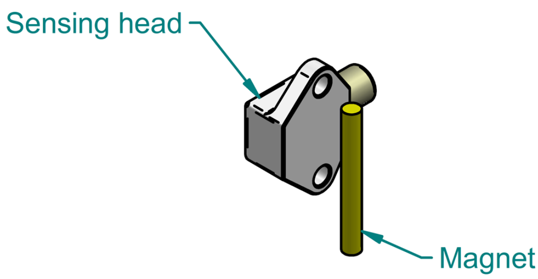
Sensor Design

The sensor can be supplied in three different formats:

- An all-in-one package to replicate a standard potentiometer. The shaft can be captive or non-captive within the housing. Lip seals are also available, depending on housing style and size.
- The sensing head can be supplied separately from the shaft to be remotely mounted inside the actuator assembly.
- The sensing element can be packaged into a small sensing head and fitted remotely to the side of a housing as shown below.



Housings and shafts can be designed to suit specific applications. The sensors can be supplied with flying leads or fitted with a connector if requested.



Installation

The linear Hall sensor is programmable and the stroke position and voltages can be adjusted according to customer requirements. Please contact our Technical Consultancy Department for further details. Typical programming parameters give an output from 0.5 to 4.5V over the full stroke length. A linear output is seen for stroke lengths up to 40mm.

A precision 5V supply is required.

Failure Modes

The operation of the sensor can be severely affected if the sensor is exposed to ferro-magnetic sources and permanent damage may be caused by large magnetic fields.

Shaft rotation during operation can cause repeatability errors of up to 4% max.

Level Sensor

Principle of Operation

The sensor is based on a capacitive principle, having an outer tube and inner core which act as electrodes. When the probe is empty the dielectric will be air which has a relative permittivity of 1. When the probe is filled with fluid, the relative permittivity can be anything between 2 to 3 depending of the type of fuel used. The capacitance is directly proportional to the height of the fluid which makes the relationship between capacitance and height linear. Installation

The probe is supplied with a Graphical User Interface (GUI) which the user can use to calibrate the sensor in empty and full conditions with the actual fuel or oil to be measured.

Laser Ride Height Sensors

Principle of Operation

The Laser ride height unit incorporates a photo diode which emits a pulsed light source. The response time of the reflected beam is used to calculate displacement.

Sensor Design

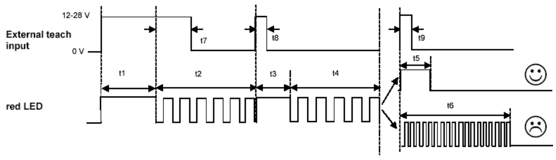
The unit is housed in an anodised aluminium body which is sealed to prevent the ingress of dirt and fluids. The optical lens must be kept clean at all times to ensure correct functionality, any contamination or damage to the lens will result in a change in output.

Installation

The measurement range is configurable via an external teach function, this enables a range to be configured down to 10mm within the original measurement range (50 to 500mm). The procedure for the teach function is defined below.

Procedure for teaching a new measurement range:

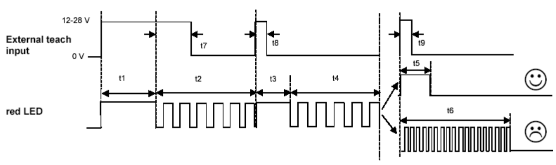
Teaching the sensor via the external teach input. There is no time limit. The sensor may be taught at any time.



Time	Description of Timing Functions	Value	Comment
t1	Minimum hold time to enter teach mode	5s	Using the external teach input, it may be used at any time.
t2	Maximum waiting time after teaching the first position.	60s	If no “High signal at Teach input” during this interval, the sensor will leave the teach mode without any changes.
t3	LED on as response for the first position.	approx. 3s	
t4	Maximum waiting time after teaching the second position.	60s	If no “High signal at Teach input” during this interval, the sensor will leave the teach mode without any changes.
t5	LED on and “OK” response after the second position.	approx. 3s	
t6	LED Blinking for “NOT OK response” after teaching the second position	approx. 5s	
t7	Maximum hold time after LED starts blinking for teaching a new range.	8s	
t8	Minimum pulse lengths on external teach input for first position.	30ms	
t9	Minimum pulse lengths on external teach input for second position.	30ms	
t14	Minimum blinking time for the reset to factory settings with external teach input.	10s	
t15	Minimum high time of the external teach input after the LED stops blinking for reset to factory settings.	0.2s	

Procedure reset measurement range to factory default:

Teaching the sensor via the external teach input. There is no time limit. The sensor may be taught at any time.



Time	Description of Timing Functions	Value
t1	Minimum time (=High signal at input “Teach In”) to enter teach mode.	This value must be >= 5s
t14	Minimum blinking time for the reset to factory settings with external teach input.	This value must be >= 10s
t15	Minimum high time (=Low signal at input “Teach In”) of the external teach input after the LED stops blinking for reset to factory settings.	This value must be >= 0.2s

Pressure Sensors

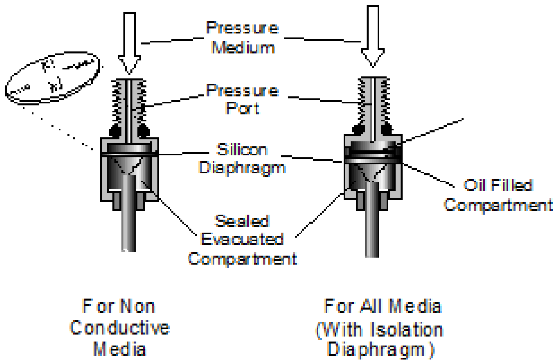
Application Note

McLaren Applied Technologies offers pressure sensors which incorporate strain gauges on a silicon diaphragm.

Principle of Operation

The pressure sensing element is formed by diffusing semi-conductor strain gauges directly into the silicon diaphragm. Strain gauges are elements which change their resistance when they are deformed. The strain gauges are connected together to form a Wheatstone Bridge circuit. When pressure is applied to the diaphragm, it deforms and stretches or compresses the strain gauges, which causes an imbalance in the bridge circuit, and a change in the output voltage.

The sensors are “absolute” gauges which means that the back of the diaphragm is evacuated and sealed.



Pressure Media

The simplest pressure sensors in the McLaren Applied Technologies range use a sensor element in which the silicon diaphragm is directly exposed to the medium being measured. This construction allows high sensitivity and good dynamic response, at a reasonable cost. However, this construction cannot be used with electrically conductive media.

Most automotive oils and fuels are not electrically conductive and sensors with unprotected diaphragms can be used. Water is not acceptable with this type of sensor unless it is very pure. Trace quantities of water can be tolerated, but the sensor should not be used to measure water pressure.

Unprotected sensors may be used for measuring intake (manifold) air pressure, but care should be taken to prevent condensed water accumulating inside the sensor. If you are in any doubt about the fluids you are using, contact our technical consultancy department, or use a sensor specified for “all media”. Sensors for use with all media are constructed with a metal isolation diaphragm to separate the silicon diaphragm from the medium being measured. Pressure is transmitted to the silicon diaphragm by oil sealed in the compartment between it and the isolation diaphragm.

Body Material

McLaren Applied Technologies pressure sensors are constructed in either 316 stainless steel or Titanium. Where an isolation diaphragm is used, it is the same material as the body. 316 stainless steel is non magnetic and is resistant to chemical attack by the fluids generally found in the automotive and motorsport industries. Titanium is lighter but it is susceptible to attack by certain cleaning solvents and by methanol.

Pressure Rating

The Product Summaries quote three pressure ratings for each sensor. These are defined as follows:

Rated Pressure is the pressure which gives full scale output. The sensor will operate above this pressure without any permanent damage, provided the maximum pressure is not exceeded, but is not guaranteed to meet its specified characteristics.

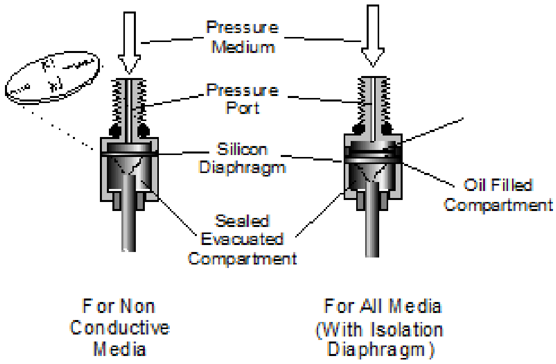
Maximum Pressure is the maximum pressure that the sensor can withstand before it permanently deviates from its specification.

Burst Pressure is the highest pressure at which the sensor diaphragm and isolation header can be guaranteed to remain intact. Above this pressure the medium may burst through past the sensor backshell.

If there are shock waves or rapid fluctuations in the fluid (for example near an oil pump), a “snubber” is recommended. This is a restriction, between the sensing element and the pressure source. The snubber damps out the pressure shocks which reduces the risk of damage to the sensor diaphragm and reduces the possibility of false readings due to transients. Some of our sensors incorporate an internal snubber as standard. All other models can be supplied with a snubber as an option.

Five-Wire Sensors

In a five-wire sensor, connections are made directly to the sensing element, there are no active components. The strain gauges are arranged in a Wheatstone bridge circuit which has four wires. A fifth wire is brought out of the sensor with an output proportional to temperature.



The output of five-wire sensors is in the mV range and varies with fluctuations in the supply voltage. This means that the control unit, to which the sensor is connected, needs to provide a very stable and accurate supply voltage and must include an accurate, stable, differential instrument amplifier with a high input impedance. Some of our control units, and the SN-6 sensor nodes of the DATALab system, incorporate these features, so they can be connected directly to five-wire sensors.

Temperature Compensation

Pressure sensors made from silicon have a very linear response, but the output is affected by changes in temperature, so thermal compensation is necessary. McLaren Applied Technologies pressure sensors include internal temperature compensation components which are individually trimmed to minimise thermal sensitivity. The unwanted thermal sensitivity can be reduced still further by measuring the temperature of the sensor, using the output from the fifth wire and using this additional information to correct the sensor output externally.

This active temperature compensation is done by converting the pressure and temperature outputs of the sensor to digital values and using the values to look up the corrected value of pressure. Active compensation eliminates practically all thermal influences. As a bonus, the temperature at the sensor is available as a measured variable of limited accuracy.

The conversion and calculation require sophisticated circuitry and it is not current practical to incorporate this within the sensor body. However, McLaren Applied Technologies have pioneered the application of active compensation by providing the necessary circuitry within our control units. This is a very cost effective solution, which results in outstanding pressure sensor accuracy. The sensor prices are kept to a minimum without increasing the cost of our control unit.

Amplified Sensors

McLaren Applied Technologies can supply an amplified version of each type of pressure sensor. These provide a more robust signal which is required where there are high levels of electro-magnetic interference or to connect to a device which does not have the appropriate input conditioning circuitry.

The amplifier converts the mV output of the sensor into a single-ended, amplified signal in the 0 to 5 Volt range. The amplifier circuit also stabilises the excitation supply for the sensor. This means that amplified pressure sensors can be connected directly to most ECUs, or even a simple voltmeter, as the amplification and signal processing is built into the sensor/amplifier package.

In the sensor for non-conductive fluids, the amplifier is packaged as a sealed unit in the sensor cable. It is not integrated into the sensor body because the amplifier electronics cannot tolerate as high a temperature as the sensor itself. This should be considered when selecting the length of cable between the amplifier and the sensor, and when locating the amplifier in the vehicle.

In the sensors suitable for all media, the amplifier is integrated into the sensor body without compromising the operating temperature range of the sensor. The high temperature variant of this sensor can operate at up to 175°C.

To avoid ground loops, and to minimise the effects of electromagnetic interference, it is best to run a ground wire from the sensor amplifier to the ECU rather than relying on the vehicle frame to complete the circuit.

The temperature of the sensor is brought out as a signal on a dedicated wire and may be used for active compensation.

Testing and Calibration

Each sensor is calibrated at a range of seven pressures and six temperatures across its operating range. The results are printed out in graphical and tabular form and supplied with the sensor. This data is also available in a computer readable form which can be loaded directly into McLaren Applied Technologies' control units or data logging systems. The amplified sensors are also supplied with gain and offset values calculated to fit the response at the temperature specified in the Product Summary. Gain and offset values at other temperatures can be supplied on request.

Selecting a Sensor

The easiest way to select a sensor is to choose the ones that will meet your technical requirements at the lowest cost. We suggest you make your decisions in the following order:

- Pressure measurement range
- Media to be measured – the amplified pressure sensors are suitable for all media, whereas the modules are only suitable for use with non-corrosive gas
- Material – Titanium is lighter than stainless steel but is susceptible to attack by some cleaning solvents and by methanol.
- Operating Temperature – Make sure the operating temperature is appropriate for your installation.
- Connector – Certain models are available with integral connectors. Other types have a flying lead.
- Mounting – Flanged versions of certain models are available.

Tyre Pressure Systems

The Tyre Pressure Systems are used as a safety device for puncture detection and also as a tyre development tool.

The sensor transmission is activated with pressure, so if installed to tyres in the garage in a static environment will transmit at the lowest rate to conserve battery life. During use, the transmission rate increases if the rate of change of pressure increased (dt/dp).

The standard receiver sends data to the car control via CAN. An analogue version is also available. For racing car applications in which data logging and pit telemetry are not used, the Tyre Pressure Dash/Display displays information received from the tyre pressure receivers on an LCD screen so that the driver can monitor tyre pressures from the cockpit. The NASCAR Tire Pressure system has a higher pressure range due to higher operating pressures.

Pressure Sensor Modules

Pressure modules consist of a cost-effective sensor element and signal conditioning electronics packaged into a rugged aluminium housing.

McLaren Applied Technologies offer the following types of module:

- Barometric pressure modules
- Manifold pressure/temperature
- Differential pressure

Because modules use exposed silicon components, they are only suitable for measuring non-aggressive, non-conductive fluids.

The Barometric pressure modules use absolute pressure elements housed within anodised aluminium bodies, with a variety of pressure port connections and sizes being available. Single or multi-channel arrangements can be manufactured and are typically used for air box pressure and aerodynamic pressure tappings.

They have a measuring range of 600mBar with the gain and offset being programmable at our factory depending on the customer requirements.

The Manifold pressure module houses an absolute pressure sensor. As an option, a precision temperature sensor can be included in the package. The module can be sealed to the mounting surface with O-rings.

The Differential pressure module houses a differential pressure sensor which is typically used with a pitot tube to measure air speed for aero-dynamic development. The module has pressure port connections to both sides of the diaphragm and measures the difference between two ports, it is insensitive to absolute pressure. Various pressure ranges are available. The Differential pressure module is available in a single, three-channel or 16-channel configuration. The three channel and 16-channel parts are available with 0-5V output or CAN output.

16-channel Differential Pressure module CAN matrix

CAN Communuication

The CAN bus will run at 1Mbps and will be configured for 11-bit message identifiers.

Between three and six message objects will be implemented; one global configuration message object, one production configuration message (for production test programming of the serial number etc) and up to four data message objects. The number of data message objects will depend upon the mode of operation. In non-multiplexed message mode four objects will be required, in full multiplexed mode one message object will be used. Split multiplexed mode will use two objects for the data transmission.

The CAN message ID for each of the message objects is defined as an offset from a base CAN message ID except for the production configuration message which will have a fixed ID.

At power up the unit configures the global configuration message object using a base CAN message ID (wDefaultCANBaseID) provided from the EEPROM stored configuration data (nominally 0x130).

The Pin-16 will not transmit any data unless either sent a global configuration message or set to run autonomously.

In order to set up the PIN-16 units they must each be sent a global configuration message to define (amongst other things) a CAN base ID (wGlobalCANBaseID) for the data message. This step may be bypassed by setting the autonomous boot bit in the configuration offcar.

Multiple PIN-16s running on the same CAN bus can then transmit data independently.

Each PIN-16 on the CAN bus checks any incoming global configuration message against its own unique unit serial number and will only act on the message if the serial number contained within the configuration message matches its own.

Once configured each unit will begin transmitting the output data message at the requested rate.

Where multiple PIN-16s communicate over a common CAN link the host sends configuration messages to each PIN-16 in turn. PIN-16s that receive a configuration that does not contain their serial number will ignore the message.

Message Object		Message Object Number	Dir	CAN Message Identification	Message Length (in bytes)
CAN_OBJECT_0	Production Configuration Message (Required for production test only)	0	RX	-	8
CAN_OBJECT_1	Global configuration message	1	RX	wDefaultCANBaseID	8
CAN_OBJECT_2 CAN_OBJECT_3 CAN_OBJECT_4 CAN_OBJECT_5	Output Sampled Data	2 3 4 5	TX	Offsets from GlobalCfgCANBaseID. Dependent upon if muxed messaging is in use	8

Object 0: Production Configuration message object

Used only at the build stage

Object 1: Global configuration message object

RX, CAN Msg ID#		**wDefaultCANBaseID**	
Description: Global Configuration Message			
Byte	**Generic**		
0	PIN-16 Serial Number (32-bit)	Serial number Low	LSB
1			MSB
2		Serial number High	LSB
3			MSB
4	Message Configuration byte	Bit 0 = Autonomous Boot (1=Enable) Bit 1 = Muxed Messaging (bMuxed) Bit 2 = Split Muxed Messaging (bSplit) Bit 3..5 = Transmission Rate (See Table below) Bits 6..7 = Spare	
5	Can Base Address Identifier (wGlobalCfgCANBaseID) (11-bits)	CAN Base ID (LSByte)	
6		Bits 0..2 = CAN Base ID (MS 3 bits) Bits 3..7 = Spare	
7	Spare		

Autonomous Boot

If the bAutonomous boot bit is set the unit will store the configuration into the EEPROM and use it, during the next power cycle, instead of waiting for a configuration message before starting to transmit the data. To return to non-autonomous use the unit must be sent another global configuration message without the bAutonomous bit set. This allows the unit to be configured off car in systems where a configuration message is not possible or not required.

Muxed Messaging

If the bMuxed Messaging bit is set the unit will output the CAN messages using the same CAN message identifier. The message data format will be indicated by the first 3 bits of byte 0.

Split Muxed Messaging

If the bMuxed messaging bit and the bSplit Muxed messaging bits are set the unit will split the CAN data across two messages so that a higher data rate can be achieved.

Transmission Rate

The transmission rate determines the frequency of the sample data output message.

The Unit will cycle through the Message Numbers in turn at the rate requested, using the message objects available. It will be set via the transmission rate code:

Rate Code	Transmission rate	Comments
0	Off (unit dormant)	
1	1 kHz	Non-muxed Only
2	500 Hz	Non-Muxed / Split Muxed Only
3	200 Hz	
4	100 Hz	
5	50 Hz	
6	20 Hz	
7	1 Hz	

In Non-muxed mode (bMuxed=0) the transmission rate is equal to the message frequency.

In split muxed mode it is twice the message frequency, and in full muxed mode it is four times the message frequency.

If the transmission rate requested is too fast with the mode requested the unit will select the fastest speed available.

If the unit is requested to operate with a transmission rate of 1 kHz and non-multiplexed messaging it will not be compatible with configurable CAN which requires a minimum time between CAN messages of greater than or equal to 2ms.

Serial Number Interrogation

A unit with a programmed serial number will not respond to any messages that do not contain the correct serial number. A unit may return from the field with an unrecorded serial number.

If the unit has been configured in autonomous mode the unit will output the sampled data from power up and this data can be examined to determine the programmed serial number.

However, If the unit is not autonomous the forgotten serial number can still be recovered by sending the unit a global configuration message with a zero serial number. If the unit has not received a valid configuration message since reset it will respond to the message containing a zero serial number as if the correct serial number had been supplied. The output data message (mux value 3) containing the serial number can then be examined to determine the correct serial number.

Object 2: Output Sampled Data message object

The data message object is transmitted at the rate set by the transmission rate code

TX, CAN Msg ID#				**wGlobalCfgCANBaseID**				
Description: Output Sampled Data Message (Muxed) (bMuxed = 1, bSplit=0)								
Can Id			**Msg Num**	**Parameter**	**Data size**	**Start bit**	**End bit**	**Scaling**
bMuxed = 0 bSplit = 0	**bMuxed = 1 bSplit = 0**	**bMuxed = 1 bSplit = 1**						
BaseCanId +0	BaseCanId +0	BaseCanId +0	0	Mux Value	2	0	1	Mux Value=0
				Pitot 0	11	2	12	11-bit 0-5v
				Pitot 1	11	13	23	11-bit 0-5v
				Pitot 2	11	24	34	11-bit 0-5v

TX, CAN Msg ID#				wGlobalCfgCANBaseID				
Description: Output Sampled Data Message (Muxed) (bMuxed = 1, bSplit=0)								
Can Id			**Msg Num**	**Parameter**	**Data size**	**Start bit**	**End bit**	**Scaling**
bMuxed = 0 bSplit = 0	**bMuxed = 1 bSplit = 0**	**bMuxed = 1 bSplit = 1**						
				Pitot 3	11	35	45	11-bit 0-5v
				Pitot 4	11	46	56	11-bit 0-5v
				Config	6	57	61	
				Coherency bit	1	63	63	
BaseCanId +1	BaseCanId +0	BaseCanId +1	1	Mux Value	2	0	1	Mux Value=1
				Pitot 5	11	2	12	11-bit 0-5v
				Pitot 6	11	13	23	11-bit 0-5v
				Pitot 7	11	24	34	11-bit 0-5v
				Pitot 8	11	35	45	11-bit 0-5v
				Pitot 9	11	46	56	11-bit 0-5v
				Unit Supply	6	57	62	312.7 mv/bit
				Coherency bit	1	63	63	
BaseCanId +2	BaseCanId +0	BaseCanId +0	2	Mux Value	2	0	1	Mux Value=2
				Pitot 10	11	2	12	11-bit 0-5v
				Pitot 11	11	13	23	11-bit 0-5v
				Pitot 12	11	24	34	11-bit 0-5v
				Pitot 13	11	35	45	11-bit 0-5v
				Pitot 14	11	46	56	11-bit 0-5v
				Unit Temperature	6	57	62	2.25 °C/bit
				Coherency bit	1	63	63	
BaseCanId +3	BaseCanId +0	BaseCanId +1	3	Mux Value	2	0	1	Mux Value=3
				Pitot 15	11	2	12	11-bit 0-5v
				Serial Number	32	13	44	
				Code Version	16	45	60	
				Spare	2	61	62	
				Coherency bit	1	63	63	

Data Coherency Bit

Each Data message contains a coherence bit. This bit is toggled after each message set has been transmitted. The host can use this bit to ensure that all the data was measured during the same sequential scan of the Pitot inputs.

3-Channel Differential Pressure Module CAN Matrix

CAN Communication

The PIN-3 will communicate to a host unit via CAN. The CAN bus will run at 1Mbps and will be configured for 11-bit message identifiers. Four message objects are implemented; one configuration message object, two data message objects and one configuration message (for production test programming of the serial number).

Where multiple PIN-3s communicate over a common CAN link the PIN-3s are supplied from the same switched supply and start up together. The host unit must be configured with the PIN-3 serial numbers (via configurable data).

The host then sends configuration messages to each PIN-3 in turn. PIN-3s that receive a configuration that does not contain their serial number will ignore the message

The CAN message ID for each of the message objects is defined as an offset from a base CAN message ID except for the configuration message which will have a fixed ID. At power up the unit configures the configuration message object using a base CAN message ID (wDefaultCANBaseID) provided from the configuration data (nominally 0x130).

In order to set up the PIN-3 units they must each be sent a configuration message to define (amongst other things) a CAN base ID (wGlobalCANBaseID) for the data message.

Multiple PIN-3s running on the same CAN bus can then transmit data independently.

Each PIN-3 on the CAN bus checks any incoming global configuration message against its own unique unit serial number and will only act on the message if the serial number contained within the configuration message matches its own. Once configured each unit will begin transmitting the output data message and the diagnostic data message, if enabled, at the requested rate.

In order to provide a reference to the PIN-3 for input sampling and message transmission, the Sampled Data output message can be transmitted as a remote frame (If selected in the global configuration message). Its transmission time is therefore dictated by the host unit. The transmit interrupt from the CAN controller is then used as the reference point for input processing which is timed to be complete by the next remote frame request. In the absence of a remote request (expected every 1ms (nominal)) a default timer will initiate the sampling and message transmission at 1.2ms (nominal) intervals. The response time for the remote frame request will be approx 300 ms.

Message Object		**Message Object Number**	**Dir**	**CAN Message Identification**	**Message Length (in bytes)**
CAN_OBJECT_0	Global configuration message	0	RX	wDefaultCANBaseID	8
CAN_OBJECT_1	Production Configuration Message (Required for production test only)	1	RX		8
CAN_OBJECT_2	Output Sampled Data	2	TX	wGlobalCfgCANBaseID	8
CAN_OBJECT_3	Diagnostic Data (if enabled in CAN_OBJECT_0)	3	TX	wGlobalCfgCANBaseID + 1	8

Object 0: Global configuration message object

RX, CAN Msg ID#		**wDefaultCANBaseID**	
Description: Global Configuration Message			
Byte	**Generic**		
0	PIN-3 Serial Number (32 Bit)	Serial Number Low	LSB
1			MSB
2		Serial Number High	LSB
3			MSB
4	Message Configuration byte	Bit 0 = Diagnostic data enable/disable (1 = Enable) Bit 1 = Remote Frame enable/disable (1 = Enable) Bits 2..4 = Transmission Rate (See Table below) Bits5..7 = Spare	
5	CAN Base Address Identifier (wGlobalCfgCANBaseID) (11-bits)	CAN Base ID (LSByte)	
6		Bits 0..2 = CAN Base ID (MS 3 bits) Bits 3..7 = Spare	
7	Spare		

Documentation

Diagnostic Data

If the Diagnostic Data bit is set to 0 then no diagnostic data transmission will occur. If set to 1 the PIN33 will transmit the Diagnostic message at the requested transmission rate (1000ms nominal)

Serial number recovery

Should the serial number identification label becomes removed or dislodged from the PIN-3, the unit can be sent a serial number of zero in the Global Configuration message. The unit will treat the message as if the correct serial number is supplied, the diagnostic data can be enabled and the electronic copy of the serial number can then be recovered from the unit.

Transmission Rate

The transmission rate determines the frequency of the sample data output message and the diagnostic data message (if enabled).

If the Remote frame option is configured then the transmission rate time is increased by 20% and used to define the time between automatic transmissions of the message in the absence of a remote frame request receipt.

Rotary Position Sensors

Application Note

Rotary position sensors are used for precision measurement of angles. Typical applications are: throttle position, steering wheel angle, gear drum position, accelerator pedal position and clutch pedal/paddle position. McLaren Applied Technologies offers two types of rotary position sensor using different technologies. These are:

- Potentiometer
- Non-Contact Hall Effect

Potentiometer

The sensing element of a rotary potentiometer is a circular track made of conductive plastic. A wiper, attached to the operating shaft, contacts the track. As the shaft is rotated, the resistance between the end of the track and the wiper changes in a linear manner. Typically, a constant voltage is supplied across the ends of the conductive track and the potentiometer is used as a voltage divider. When used in this way, the voltage at the wiper is proportional to the shaft angle.

The drawings in the Product Summaries show the relative position of the shaft and the centre of the electrically active part of the track (the “Half Voltage Position”). This information is important because the potentiometers do not have internal end stops to give a location datum for the track.

Sensor Design

Rotary potentiometers have robust, black anodised, aluminium bodies. No internal end stops are fitted and all models offer 360° continuous rotation. Various lengths of electrically active track are available, up to a maximum of 348°.

Three size ranges are available

- Standard
- Mini
- Micro

Several mounting styles are offered in the Standard range using either a flange on the body or a thread concentric with the shaft. The threaded model is usually used for steering wheel angle measurement with a gear drive to the steering wheel shaft. Flanges are available with rotation adjustment, with lateral adjustment, or with no adjustment. Some of the adjustable flanges incorporate a notch which can locate with a dowel to lock the adjustment. Some models have leaf springs incorporated into the shaft to help isolate the potentiometer from vibration.

For applications where space is at a premium, the more compact Mini and Micro models are available.

All ranges have a shaft seal which prevents the ingress of dust and dirt. This seal is splash resistant but will not prevent the ingress of fluids if the potentiometer is immersed.

A twin output version of the Mini potentiometer is available. This has two independent wipers operating on separate tracks deposited onto a common substrate. Each track has separate supply and signal wires.

On all models the angle of the cable outlet relative to the body can be changed.

Non-Contact Hall Effect

The Non-Contact Hall Effect sensor consists of a stationary Hall element, a shaft and a magnet. When the angular position of the element changes relative to the magnet, the change in magnetic field sensed at the element results in a linear change in the output voltage from the sensor. The sensor has an internal voltage regulator and can therefore be connected to a battery supply.

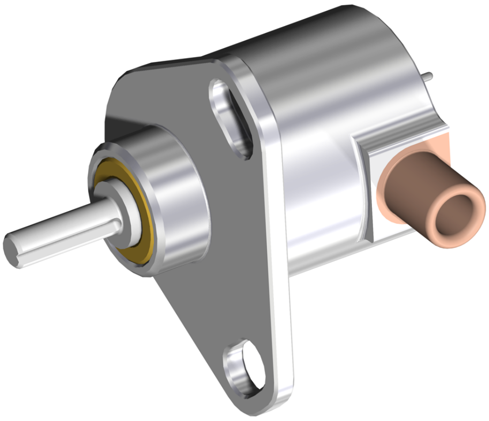
The sensors are available with an electrical angle of up to 360°.

Sensor Design

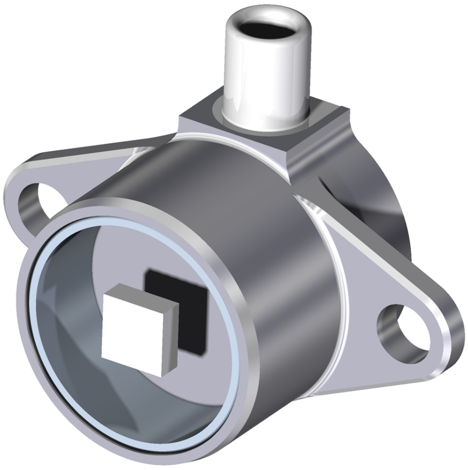
Non-Contact Rotary Hall Sensors have robust, hard anodised black, aluminium bodies. An o-ring seal is provided on the stainless steel shaft to prevent ingress of dust and dirt. This seal is splash resistant but will not prevent the ingress of fluids if the sensor is immersed.

There are no wiping contact parts, as in a conventional potentiometer, therefore minimising electrical noise, wear and the possibility of contact bounce. No internal end stops are fitted and all models offer 360° continuous shaft rotation. The sensor is dimensionally similar to the miniature potentiometer, and can replace it in some applications.

The sensors can be supplied as an all-in-one package, with the shaft mounted into a bearing inside the sensor housing.



Alternatively the magnet can be remotely mounted from the sensing assembly so it can fit inside the actuator assembly.



The following parameters can be programmed to meet specific application requirements: start/end voltage, half voltage position, shaft rotation relating to rising or falling output voltage.

The sensor can be reprogrammed after encapsulation, for example to change the measurement angle. This enables adjustments to be made at the factory if required by the customer.

The standard version of the Non-Contact Rotary Hall Sensor is a single element output. Also available, on request, are the options to have dual elements configured with a twin output (dual redundancy) with either a common or separate Supply and Ground.

It is important that the sensor is not exposed to strong magnetic fields, which would cause permanent damage to the sensor. The sensor should be kept clear of any stray magnetic fields and ferro-magnetic materials during operation. The housing incorporates ferromagnetic shield to prevent interference from stray magnetic fields.

Speed Sensors

Application Note

McLaren Applied Technologies offers four types of speed sensor for automotive applications:

- Inductive
- Differential Hall Effect (DHE)
- Zero Speed Hall Effect
- True Position Zero Speed

All types give an output when subjected to a changing magnetic field. The field is provided by a permanent magnet inside the sensor body and is modified by the motion of a ferromagnetic toothed wheel. Magnets are not required in the target wheel. As each edge of a tooth passes the sensor, the magnetic field changes causing a change in the sensor output.

Comparison of Inductive and DHE Sensors

Although they measure similar parameters and are a similar size and shape, these sensors are not interchangeable. The DHE and Zero Speed Hall Effect sensors give an open collector switched output while the inductive sensor gives a voltage pulse output with a magnitude which changes with speed over a large range.

In practice, the three sensors may be used in similar applications. Where the precise timing of a pulse, rather than the pulse rate is important, for example, in engine timing applications, an inductive sensor gives more accurate results. With appropriate packaging, inductive sensors can be used at very high temperatures and we can supply a version able to operate at up to 290°C (designed for turbochargers).

For other applications, the DHE or Zero Speed sensors may be used. They are less expensive that the inductive sensors, and the electrical interface is easier to implement. However, Hall sensors include active electronics that place a practical limit on the maximum operating temperature.

Speed, Angular Position and Torque

Speed is measured by counting the number of times that a target wheel tooth edge passes the sensor in a given time period. Since the number of teeth on the wheel is fixed, it is easy to calculate the average speed over the period.

To measure the relative position of two shafts, or the twist in a shaft (which is a measure of torque), two target wheels and two sensors are used. Each wheel has its own sensor and the relative rotational angle of the wheels is measured in terms of the time delay between the sensor pulses. To avoid ambiguity, at least one of the wheels must have either only one tooth or a “missing tooth” to act as a reference.

The sensor can also be used to measure the absolute angle of the target wheel on, for example, a crankshaft. In high speed 4 stroke engine timing applications it is important to use a wheel with a number of teeth equal to half the number of cylinders (e.g. a 5 tooth wheel for a 10 cylinder engine). The pulse from the sensor gives the ECU a timing reference for each cylinder. To ensure that the ECU timing is in phase with the mechanical timing, a single tooth wheel is placed on the cam shaft, and its position is measured by a separate sensor.

Cut-in Speed

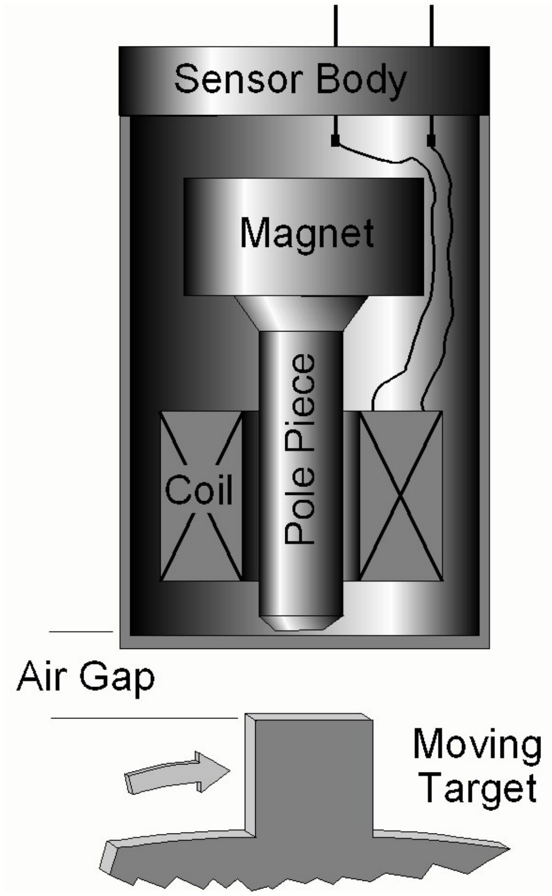
The Zero Speed Hall Effect sensor can be used for low speed measurement, whereas the Inductive and DHEs have minimum detection frequencies. This is discussed in the following notes for each type.

Inductive Sensors

Inductive (magnetic reluctance) speed sensors are lightweight and very robust, which makes them particularly suited to demanding motorsport applications. Typical applications are cam and crank shaft position/speed and wheel and turbo shaft speed measurement.

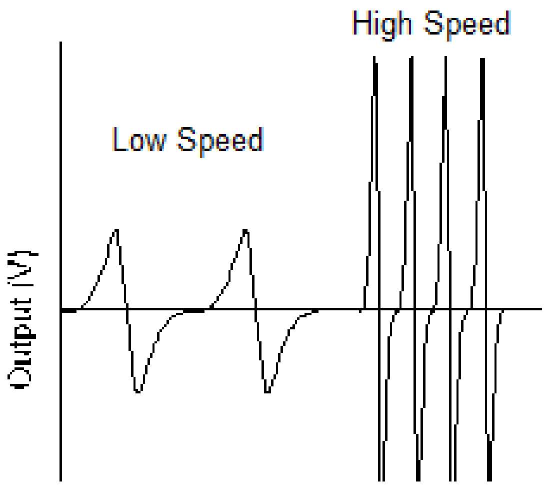
In-house design and manufacture allows our sensor design team to provide very cost effective customised parts to suit even the most demanding application. We have optimized the magnetic circuit, formed by the sensor and its target, to achieve high sensitivity in a very small package.

Principle of Operation



In an inductive sensor, the magnetic field around a permanent magnet changes if a ferrous target (e.g. a toothed wheel) is moved in front of the sensor. The change is sensed by the voltage generated in a coil of wire in the magnetic field. The coil and magnet are integrated in the sensor body for ease of installation.

The magnitude of the induced voltage increases with the speed of movement of the ferrous object (i.e. the target wheel speed). The voltage decreases as the distance (air gap) between the end of the sensor and the moving target gets larger.



Our interface circuits accept the voltage output and convert it to produce a switched pulse output suitable for speed and position measurement. These circuits trigger when the voltage output passes through a threshold (typically 200mV). The detection level can be set lower, but the sensor would be more susceptible to noise. The output of the sensor has to exceed the detection voltage before motion can be detected. Since this voltage depends on the speed of the target, inductive sensors are unable to detect very low speeds.

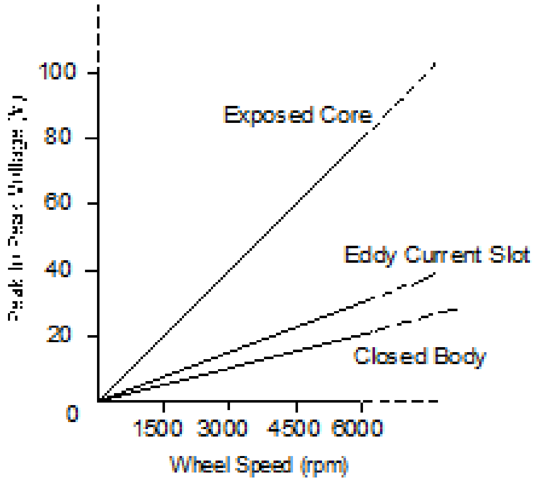
Selecting the Sensor, Target Wheel and Interface Electronics

McLaren Applied Technologies design and manufacture a wide range of inductive sensors and can assist in selecting the right part and defining the most suitable target wheel. We can estimate the cut-in speed (i.e the lowest detectable speed) and confirm the estimate by testing with a sample target wheel.

As a complete system supplier, we can advise on suitable electronic interfaces as well as offering fully integrated interface solutions. We can also offer a discrete interface to condition the sensor signal to provide a TTL compatible output. This can be packaged as an encapsulated unit integrated into the sensor cable.

Sensor Design

Our inductive sensors are available in a range of engine mounting configurations and special versions are available to operate up to 290°C (for high temperature applications such as turbo speed measurement)



The connecting cables on our sensors are not screened. This is because, if not correctly installed, the screen can act as an antenna and can increase the noise level rather than suppressing electromagnetic interference. However, any sensor can be supplied with a screened cable, if required.

Three types of sensor body are offered to suit the most demanding applications:

- A totally closed design that ensures that the electromechanical assembly is fully encased, masking it particularly suitable for very high temperature applications.
- A design with a small slot introduced into the body to suppress eddy currents. Eddy currents impede the rate of change of magnetic flux through the sensor. By suppressing them, high speed sensitivity and position measurement accuracy are significantly improved.
- A body with the magnetic core exposed through the end-face of the sensor body. The air gap between the sensor and the target can be reduced, yielding greater low speed sensitivity and position measurement accuracy, whilst maintaining the improved high speed performance gained from an eddy current reduction slot.

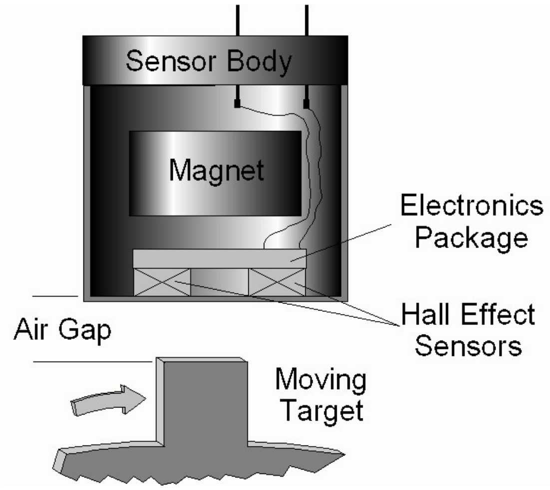
If the sensor is installed in such a way that it is surrounded by metal (e.g. when inserted into a casting) the eddy current reduction slot will have little effect and the closed body type is recommended.

Hall Effect Sensors (Differential, Zero Speed and TPZS)

Hall Effect speed sensors are lightweight, reliable and very robust which makes them particularly suitable for demanding motorsport applications. Typical applications are wheel speed and camshaft position measurement. Under special circumstances relative shaft positions can also be measured (please contact our technical consultancy department if you wish to do this).

As the design and manufacture is in-house we can provide very cost effective customised parts to suit even the most demanding application.

Principle of Operation for the DHE



A Hall effect element is a small sheet of semiconductor material arranged with a constant current flowing across it. In a magnetic field, a voltage, which is proportional to the field strength and at right angles to the current flow, is generated across the element. The magnetic field is supplied by a permanent magnet in the sensor, a magnetised wheel is not needed.

Differential Hall Effect

The differential version has two Hall effect elements and only responds to changes in magnetic field strength. This arrangement is relatively immune to interference, but it cannot detect static fields. This limits its operation to speeds which give a switching frequency greater than the minimum operating frequency quoted in the Product Summary. This design allows for relatively large operating air gaps. The sensor has an open collector output with a 10nF filter capacitor between output and ground. Typically an external pull up resistor is used on the sensor output but a 2kohm “pull up” resistor can be included on some models to convert to TTL output levels.

This resistor and capacitor give an R/C charge characteristic on the rising edge of the sensor output. If the resistor is too large, especially in higher frequency applications, the signal may not reach the threshold levels required to trigger the control unit. For this reason we recommend triggering on the falling edge which is not subject to the same R/C characteristic.

The output switches to “high” as the leading edge of the tooth passes the sensor and remains high until the trailing edge passes, when it switches “low”. If the sensor is rotated through 180°, the switching polarity is reversed.

Zero Speed Hall Effect

The Zero Speed Hall Effect incorporates a single hall probe. This means that the sensor is not orientation dependent with regard to the target wheel. Furthermore, it can detect wheel rotation down to 0Hz. However, this design is less tolerant of large operating air gaps between the sensor and the target wheel than the differential Hall effect version. The recommended air gap is 0.8mm (1.0mm maximum).

The sensor has an open collector output with a 2.2nF filter capacitor between output and ground. The sensor shows a low output in the presence of a tooth.

The cables on our sensors are not screened. This is because, if fitted incorrectly, the screen can act as an antenna and can increase the noise level rather than suppressing electromagnetic interference. However, all models can be supplied with a screen, if required.

True Position Zero Speed

Designed for use with the F1 SECU for quadrature measurement, speed and position can be derived for gearbox applications.

Documentation

Temperature Sensors

Application Note

McLaren Applied Technologies offers several types of temperature sensors using different technologies for different applications. These are:

- Thermistor
- Thermocouple
- Infra Red

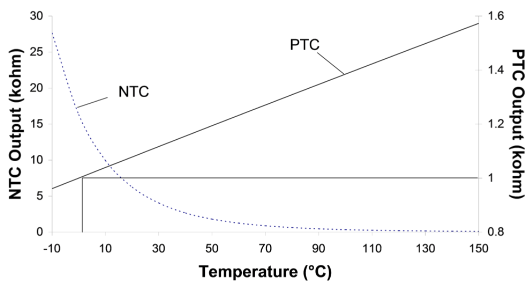
Thermistors

Themistors (thermally sensitive resistors) are available in two types:

- NTC (Negative Temperature Coefficient) resistance decreases with rising temperature
- PTC (Positive Temperature Coefficient) resistance increases with rising temperature

In both types, the electrical resistance changes with temperature according to a defined curve.

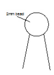
Output of NTC and Pt1000 Thermistors



Temp (°C)	Resistance (ohm)		Temp (°C)	Resistance (ohm)	
	NTC	Pt1000		NTC	Pt1000
-10	27665	960.9	80	629	1308.9
0	16325	1000.0	90	458.8	1347.0
10	9950	1039.0	100	340.0	1385.0
20	6245	1077.9	110	255.6	1422.9
30	4029	1116.7	120	194.7	1460.6
40	2663	1155.4	130	150.4	1498.2
50	1802	1194.0	140	117.4	1535.8
60	1244	1232.4	150	92.65	1573.1
70	876	1270.7			

NTC

The NTCs used by McLaren Applied Technologies are polycrystalline metal oxide ceramic. These precision NTC elements have a very tight measuring tolerance in a small package, which results in a fast and accurate response.



Near room temperature, these devices offer the greatest sensitivity to temperature differences – an order of magnitude greater than PTCs or thermocouples. The nominal resistance of the NTC thermistors used in McLaren Applied Technologies sensors is 5kohm at 25°C. However, the resistance decreases very rapidly with temperature, making them less suitable for accurate high temperature measurements. Furthermore, the low resistance at higher temperatures makes the sensors sensitive to the resistance of the harness and connector contacts.

Because of their high output, NTCs can interface with simple electronic interface circuits as used in mass market control systems. Our systems have high sensitivity inputs which do not need the high output of an NTC sensor. However, our systems can interface to NTC sensors, if required.

The Temperature-Resistance function for NTC thermistors is defined as follows:

Temperature (K) = 1 / (A + B*ln[R] + C*[lnR]3)

R = Resistance of sensor (ohm)
A = 1.28735 x 10-3
B = 0.2357532 x 10-3
C = 94.95448 x 10-9

PTC

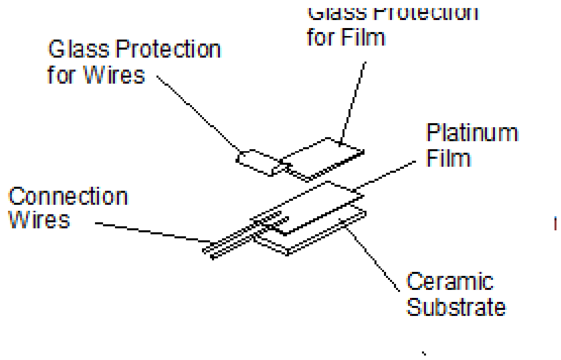
Platinum (Pt) thermistors are the most stable temperature sensors in common use today. They are constructed from a platinum film deposited onto a ceramic substrate. Platinum has been used to measure temperature for over 100 years. It offers high reliability, long term stability, and rapid response. It is also insensitive to vibration and thermal shock.

The resistance varies with temperature in a precise fashion. Between 0 and 600°C, this response can be expressed as an exact mathematical function. Pt elements are normally supplied with a base resistance of either 100 ohm (Pt100) or 1000 ohm (Pt1000), measured at 0°C.

The Resistance-Temperature transfer function for Pt1000 sensors is defined as follows:

Sensor Resistance (ohm) = 1000 * (1 + ((3.90802x10-3 * T) – (0.5802x10-6 * T2)))

T = Temperature (°C)



Application of NTCs and PTCs

To measure resistance, an electric current has to flow through the element. This generates heat, resulting in errors. To minimize such errors, the measuring current needs to be kept low (typically less than 1mA). The wires joining the sensing element to the measuring device have their own resistance, which may vary in unpredictable ways, and so cause further errors. By selecting the sensor resistance to be as large as possible, both self-heating and lead wire resistance errors can be minimized.

Pt100s exhibit such a small resistance change with temperature that they tend to be overly sensitive to cable length and connector contact resistance changes. McLaren Applied Technologies offers temperature sensors of all three types, ie NTC, Pt100 and Pt1000. We recommend the use of Pt1000 devices for highest accuracy and stability. All of our ECUs support Pt1000s as standard, but can be modified to support NTCs and Pt100s.

Sensor Design

In automotive applications, the temperature of a gas (typically air) or a liquid (typically oil, water, fuel, etc.) needs to be measured. Gases and liquids have very different thermal characteristics, so each medium requires a different sensor design in order to make accurate temperature measurements.

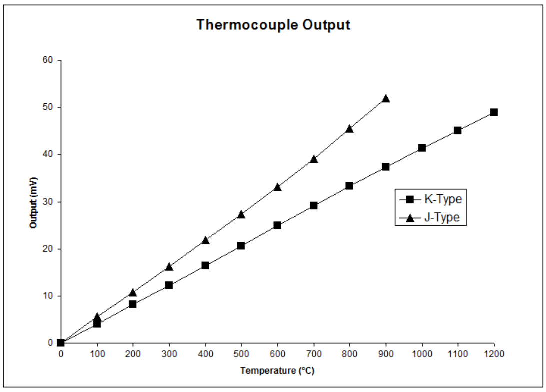
Heat conducted into the sensor from the surrounding medium alters the temperature of the sensing tip. Because gases are poor heat conductors and have a very low thermal mass, air temperature sensors must also have a very low thermal mass. This minimizes errors in measurement and allows a rapid response to changes in air temperature.

McLaren Applied Technologies air temperature sensors achieve this by exposing the sensor element tip directly to the air flow, without compromising ruggedness or reliability. Both screw-in and flange mount body styles are available. Sensors with a flange mount body can be aligned in the air stream to exploit the planar symmetry of the Pt elements. This is most important for low velocity air flows, for example if the sensor is located at the end of a manifold pipe.

With screw-in devices, the point at which the screw thread will tighten cannot be defined exactly. Any error due to misalignment of the element in the air flow is minimized by careful attention to the design of the sensor housing.

The fluids used in automotive applications are often aggressive and turbulent. The sensing element must be isolated from the medium, so the sensor element is encapsulated at the tip of a thermally conductive housing. This tip is made as small as possible to ensure minimal thermal mass – reducing error and response time. This package offers a very rugged and accurate method of measuring fluid temperature.

Thermocouple



A thermocouple consists of a pair of metals, with different thermopotentials, which are welded together to form a junction. This junction can be very small, so a thermocouple is easily manufactured into a small package. When the junction is heated, a voltage is generated which increases with increasing temperature. Thermocouples are usually used to measure very high temperatures, such as exhaust gas, but may also be used for lower temperatures. MESL offer both K-type (Chromel/Alumel) and J-type (Iron/Constantan) thermocouples. The output voltages from these two types of thermocouple are shown below.

Temperature (°C)	Output (mV)	
	J-Type	**K-Type**
0	0	0
100	4.095	5.629
200	8.137	10.779
300	12.207	16.327
400	16.395	21.848
500	20.640	27.393
600	24.902	33.102
700	29.128	39.132
800	33.270	45.494
900	37.325	51.877
1000	41.269	
1100	45.108	
1200	48.828	

For optimum performance the Chromel/Alumel thermocouple wires should be terminated to Alumel and Chromel contacts within a connector. Thermocouple compensating cable must be used in the harness to connect to the interface electronics. If copper or copper alloy contacts are used in intermediate connectors, errors may be introduced which will depend on the temperature difference across the connector pair. These errors will be negligible if the connector is kept isothermal.

Interface Electronics

The junction is the point of temperature measurement. The other end of each sensor wire needs to be connected to specialised electronics for reference cold junction compensation. Because the output voltage changes by just a few microvolts per degree, well designed and well filtered electronics are required, particularly if used close to an ignition system.

Sensor Design

McLaren Applied Technologies thermocouple sensors are mainly for the measurement of high temperature (up to approx 1250°C). The element is surrounded by a stainless steel tube. The diameter of the steel tube has been selected as a compromise between mechanical robustness (particularly important when measuring exhaust gas temperature) and short response time. The steel tube is electrically isolated from the thermocouple as required by most cold junction compensation circuits.

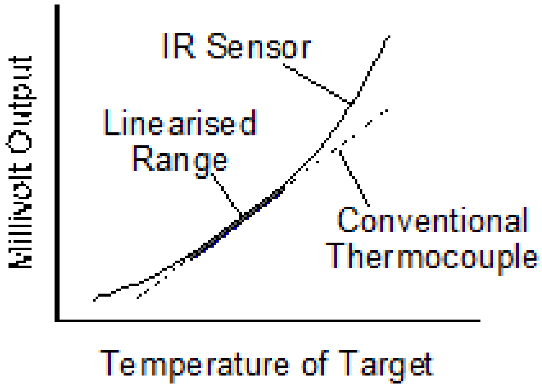
Infra Red

Infra-red sensors measure temperature by detecting the heat radiated from a target which may be some distance away. Such a non-contact measurement can be used in applications where direct contact with the medium is difficult, e.g. when measuring the temperature of rotating parts such as a tyre or a brake disc.

Principles of Operation

The Infra-red sensor is a thermoelectric device which converts radiated heat energy into an electrical potential. The output is non-linear (although it is continuous and repeatable).

0-5V Output: Over the specified target temperature, the sensor gives an output in the 0-5V range.

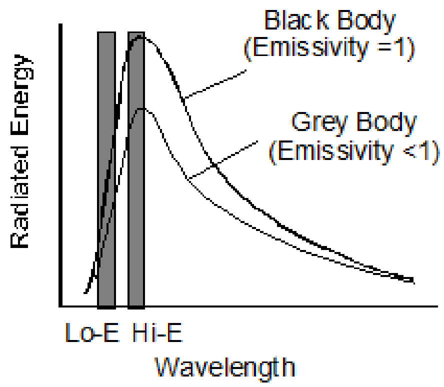


MAT Infra-red sensors obtain all their power from the energy radiated from the target so, in order to minimise errors, the leakage current drawn by the attached measuring device must not exceed 10nA.

Emissivity

Different materials have a different emissivity, i.e. they radiate different amounts of energy even when held at the same temperature. Emissivity values are in the range 0 to 1. A perfectly reflecting surface has an emissivity of 0. Such a surface acts like a mirror in that it reflects an image of its surrounds rather than emitting its own radiation.

A perfect black body has an emissivity of 1. This kind of surface does not reflect at all, it emits energy in a characteristic way which depends entirely on its temperature.



All real objects have a lower emissivity than an ideal black body and therefore radiate less energy. Shiny metal surfaces have a low emissivity, in the region of 0.05 to 0.2, whilst non-metals, organic materials and coated metals typically have high emissivity, in the range of 0.8 to 0.95. McLaren Applied Technologies offers Infra-red sensors suitable for the high emissivity range of 0.8 to 0.98.

Emissivity is difficult to measure accurately and it can change with the temperature of the target surface. This affects the relationship between the temperature of the surface and the amount of energy it radiates. Unless the sensor reading is interpreted to take the emissivity into account, this appears as a measurement error. The sensors are sensitive to wavelengths which are much longer than those of visible light, so the colour of the target has little effect.

Please contact McLaren Applied Technologies for assistance in determining the emissivity of your target medium.

Failure Modes

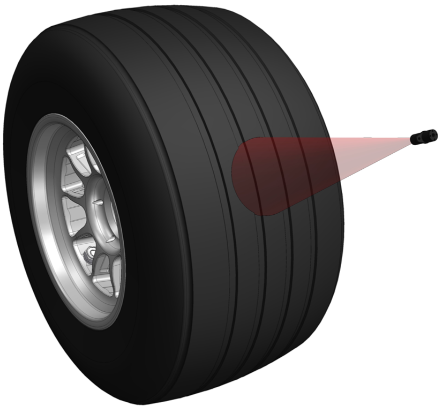
The sensor reading will change if the sensitive face becomes dirty or scratched, and care should be taken to clean the sensors with a suitable, non-aggressive substance. An air purge system can be supplied which may be used to force air through the linearised output sensor to prevent the accumulation of debris in dirty environments. For both types of I/R temperature sensor the narrow field of view also allows the sensor to be positioned some distance from the target.

Failure of the sensor may be induced by over temperature of either the sensor or the target, or by static discharge (if not properly grounded). The mounting arrangement should minimise vibration and prevent the impact of debris on the sensor.

If an Infra-red sensor is pointed at a very high temperature target, the internal circuits may be overloaded, causing permanent damage. Please contact McLaren Applied Technologies if you intend to use an Infra-red sensor in a situation where the target temperature may exceed the temperature stated in the Product Summary.

Applications

Due to its small size and ruggedness, this sensor is ideal for tyre and brake disk temperature measurement.



Installation Notes

Alternators

Installation Note

Electrical Connections

The electrical connections to the F, G and K-type alternators are shown in the diagram.

The power output is from the B+ terminal. Use a cable, large enough to carry the current output of the alternator, to connect this terminal to the vehicle electrical system. The terminal should be tightened to 4Nm max for M6 terminals, 6Nm max for M8 terminals.

The return circuits for the alternator output and for the internal electronics of the regulator are both via the alternator body, so it is essential to provide a low resistance connection to ground (usually the vehicle frame). If rubber or polymer anti-vibration mountings are used, a cable must be fitted to connect the alternator to ground.

The excitation coils in the rotor draw current from the vehicle battery via the Ignition (IG) connection. IG should be disconnected when the engine is not running, otherwise it will slowly drain the battery.

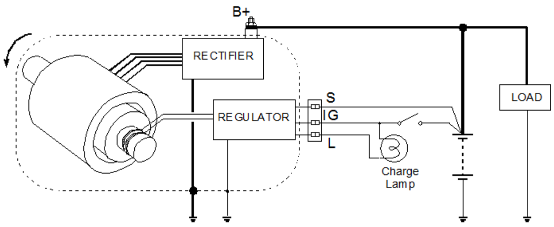
When IG is disconnected, the excitation coils are not magnetised and the alternator does not deliver any current. IG may be disconnected while the alternator is being driven: the alternator will not be damaged and the load on the engine is decreased.

The Sense (S) connection, where fitted, should be connected to the vehicle battery via a dedicated wire which is not connected to any other circuit. This ensures that the regulator, inside the alternator, monitors the voltage at the battery and continually adjusts to keep it constant. If the sense wire is connected to the alternator B+ terminal, the battery voltage will be less than 13.5V because the alternator will not compensate for the voltage drop caused by the resistance of the wires joining the alternator to the battery.

On F-type alternators, the Sense connection is internally connected to the B+ terminal and is not available externally.

On single connection G and K-type alternators, the Ignition and Sense connections are through the power output (B+) terminal.

The Lamp (L) connection is for the charge indicator lamp which should be connected as shown. The lamp is lit when the alternator output voltage is less than the battery voltage (i.e. the battery is not charging). The maximum current that the alternator can drive through the lamp is 250mA. The lamp is not necessary for proper operation of the alternator and may be left unconnected.



Mechanical

F, G and K-type alternators are uni-directional. Ensure that the alternator is rotated in the direction shown in the relevant Product Summary.

F-type rotor moment of inertia: 0.693x10-3kgm2

G-type rotor moment of inertia: 1.04x10-3kgm2

K-type rotor moment of inertia: 2.20x10-3kgm2

Torque and efficiency curves are available on request.

Axial Loading

F, G and K-type alternators must not be subjected to direct axial loading during installation, for example by press fitting a shaft adaptor. If a direct drive is required, the shaft can be modified to accept a suitable key on request.

Pulley Mounting

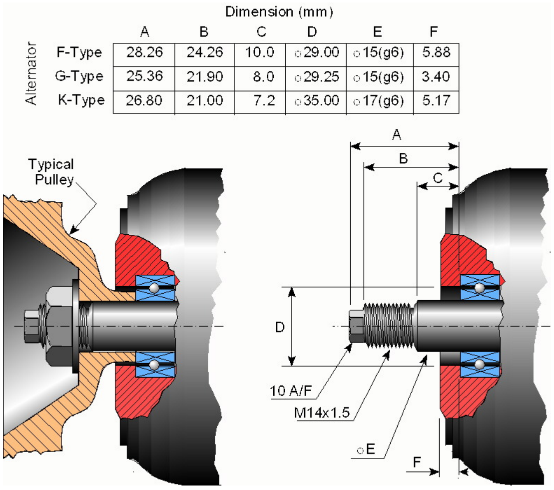
The recommended method of mounting a pulley to an F, G or K-type alternator is shown in the drawing.

The pulley hub should be a close sliding fit on the rotor shaft. To prevent the pulley spinning, it is clamped against the inner race of the shaft bearing.

A 10A/F hex is provided on the end of the shaft to lock the rotor in place while tightening the retaining nut. Alternatively, a pneumatic impact wrench may be used.

Documentation

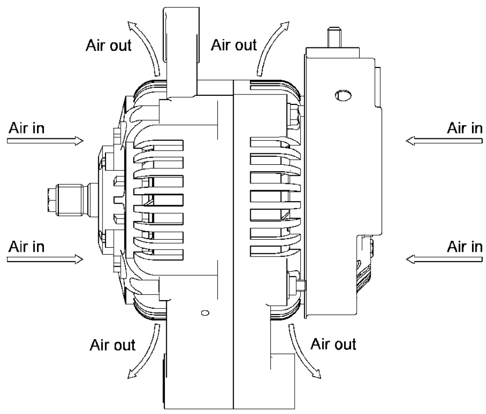
Alternator Type	Dimension (mm)					
	A	**B**	**C**	**D**	**E**	**F**
F-Type	28.30	24.80	10.80	Ø29.20	Ø15(g6)	5.88
G-Type	25.40	22.00	8.0	Ø29.30	Ø15(g6)	3.40
K-Type	26.85	21.85	7.2	Ø35.20	Ø17(g6)	5.17



Air Flow Through Alternators

F, G and K-type alternators are air cooled. Air enters the alternator from the front and rear and exits at the side as shown in the diagram.

Sufficient air flow should be maintained to ensure that the maximum operating temperatures are not exceeded.



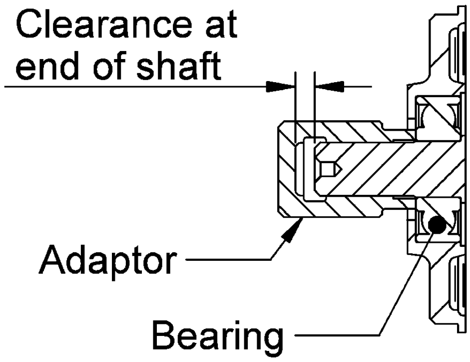
Permanent Magnet Alternators

Permanent magnet alternators are designed to be directly mounted to an engine. Drive is via a spline. Radial and axial loading should be avoided and the drive should be concentric to the alternator shaft.

The shaft dimensions are shown in the Product Summary.

The hub, shaft or adaptor that carries the mating spline should be seated on the inner race of the alternator front bearing. It must not bottom out on the end of the shaft and clearance should be left to prevent this.

Documentation


Clearance at
end of shaft
Adaptor
Bearing

Fuel Pressure Regulators

Installation Note

General

The regulators are designed to be mounted in machined ports as shown in the diagrams. Ensure that the inner surfaces of the port are machined to a suitable finish to form a pressure tight seal and that the port and regulator are clean before assembly.

Where a manifold pressure reference port is provided, it should be connected to the vehicle intake manifold using flexible tubing. Clips may be used to secure the tubing.

Note that the o-rings separate the inlet and outlet flows as well as preventing leakage to the outside.

New o-rings should be used every time the regulator is fitted. O-rings and flexible tubing are available as accessories, see the relevant Product Summary for the order code.

Miniature

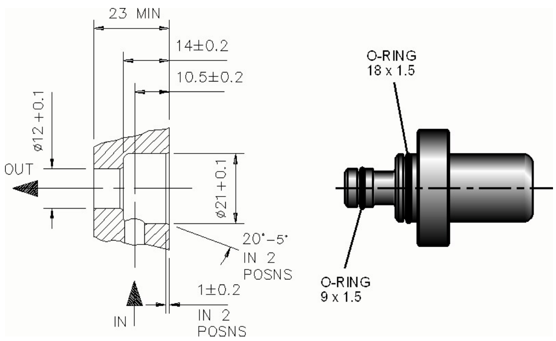
The miniature regulator is available with or without a flange. The flanged type is held in place with two M6 screws, 43mm apart, on the centre line of the regulator. Ensure that the threaded holes for the screws do not break into the inlet channel. The version without a flange should be held in place with a clamp or circlip of at least the same strength as the flange.

High Pressure

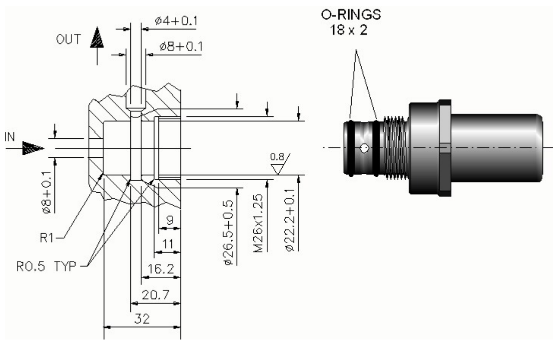
The high pressure regulator is available threaded or suitable for clamping. The version without a thread should be held in place with a clamp or circlip. The threaded type is screwed directly into the machined port.

- Mounting torque 15Nm max
- Spanner 40 A/F

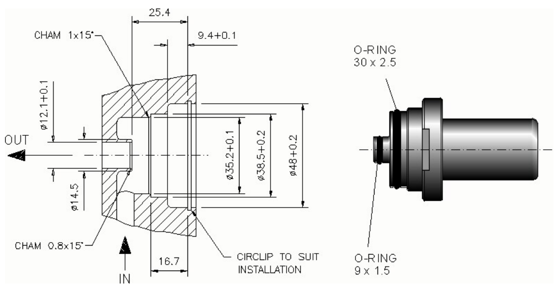
Recommended Installation Miniature Type



Recommended Installation High Pressure Type Threaded



Recommended Installation High Pressure Type Clamped



Gyros

Installation Note

Installation

The gyro installation should not be exposed to vibration frequencies >2kHz, or permanent damage to the sensor may be caused. For applications where high frequency vibration is present, AV mountings should be used to isolate the unit and provide a roll off at around 2kHz.

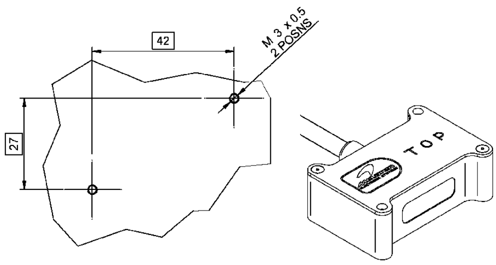
- M3 x 0.5 mounting screws, of appropriate length, should be used
- Torque 2.5Nm (max)

We do not recommend rigidly clamping the cable close to the exit from the housing, as this may induce unwanted output shifts due to sensitive axis mis-alignment.

Single-Axis Gyro

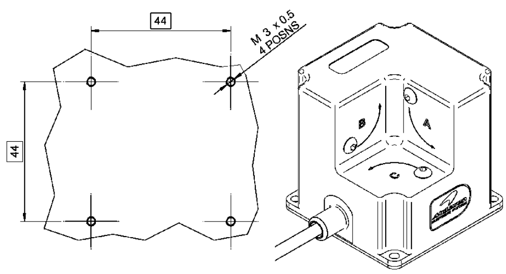
The sensor sensitive axis is vertical when mounted in the recommended orientation. The sensor output voltage swing will be reduced if the sensors sensitive axis is inclined from the upright position.

Mounting the sensor 180° from the recommended orientation will reverse the output from the sensor.



Three-Axis Gyro

The sensitive axis of each gyro are perpendicular to the labelled face (A, B and C), as shown. Mounting the particular axis of this sensor 180° from the recommended orientation will reverse the outputs from the relevant gyro and could cause other axis to reserve also.



Documentation

Lambda Sensors

Installation Note

Installation

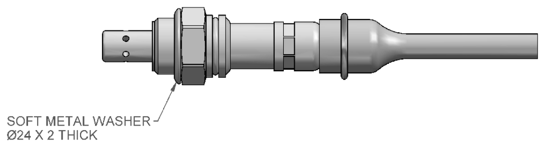
The sensor should be mounted as shown in the diagram. A new soft washer should be used every time the sensor is fitted. The washer is available as an accessory. Please refer to the relevant Product Summary for the order code.

- Mounting torque 45Nm max
- Spanner 22 A/F

Operation

The sensor must be powered up when the engine is running, so that the heater will maintain the minimum operating temperature limit. If the operational temperature is exceeded, sensor function will be impaired, causing large calibration errors as well as possible heater element damage. The UEGO sensor is not resistant to temperature shocks, so it should not be subjected to cold-fluid cooling, etc.

Recommended Installtion



Documentation

Linear Position Sensors

Installation Note

Unsprung Potentiometer – 15mm Square and 9.5mm Diameter

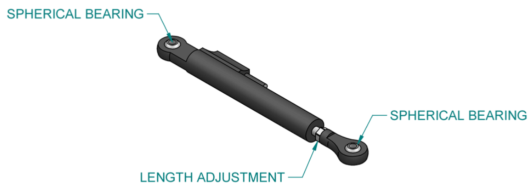
Unsprung potentiometers should be mounted using only the spherical bearings and not supported anywhere else. The mounting arrangement must ensure that the movement of the sensor is straight and does not bind. The spherical bearings can accommodate a movement of ±12°. Provision is made to adjust the length of the shaft by 4mm. The shaft, with the bearing attached, is free to rotate. The bearing on the body can be rotated so the relationship between the plane of the bearing and the cable outlet can be adjusted.

Sprung Potentiometer

Sprung potentiometers are typically used to follow a track on a moving component. The track should be smooth and should not apply side loads to the potentiometer shaft. The potentiometer body should be rigidly fixed. However, in high vibration environments, such as direct mounting on an engine or gearbox, a resilient or anti vibration mounting should be used. Even with such a mounting, sprung potentiometers can be susceptible to bouncing when there is excessive vibration.

The single track sprung potentiometer can be installed with an o-ring to seal it to a housing. Note that the potentiometer shaft seal does not resist pressure. The o-ring is not available from McLaren Applied Technologies.

Recommended Installation for Linear Potentiometer



Linear Hall Effect

The shaft of the sensor can be removed from the housing to assist ease of assembly. The body should be rigidly mounted to a gearbox or engine or similar.

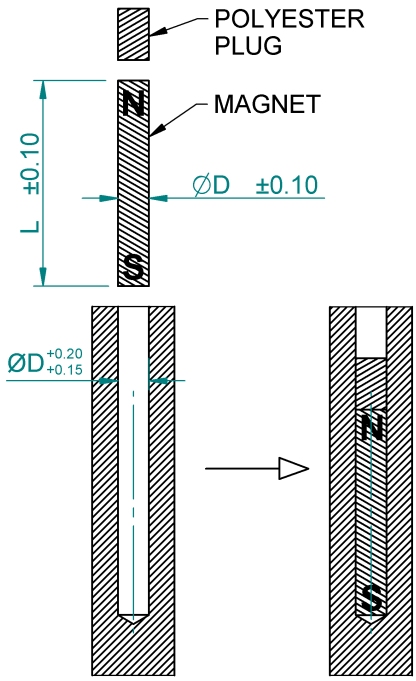
The bodies can be designed with a seal to prevent dirt ingress to the shaft and brushes in dusty environments.

Where possible the shaft should not be free to rotate as this may introduce hysteresis errors.

The sensor should be kept clear of moving ferrous objects or magnetic fields which may interfere with or distort the field produced by the measurement magnet.

Documentation

Typical Magnet Installation



Pneumatic Valve

Installation Note

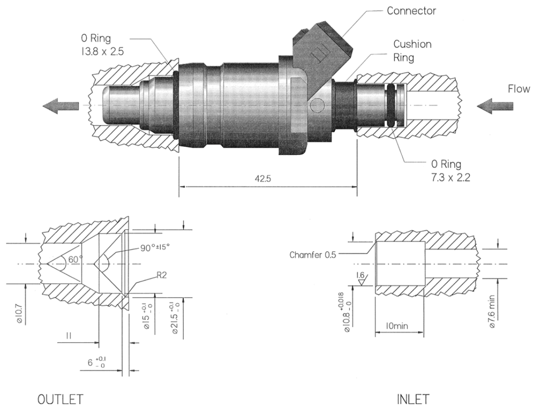
Installation

The valve is mounted by locating it between an inlet and an outlet port which should be machined as shown in the diagram. The o-rings and Cushion ring are supplied with the injector and should be fitted as shown. New rings should be used whenever the valve is installed.

Operation

A set consisting of two o-rings and a cushion ring is available as an accessory. Please see the relevant Product Summary for the order code.

Recommended Installation



Pressure Sensors

Installation Note

Threaded

- Threaded sensors are designed to be screwed directly into a port, machined as shown in the drawing. A new o-ring should be used each time the sensor is installed. The o-rings are available as accessories (please see the relevant Product Summary for the ordercode).
- Various pressure fittings are available on request. Please contact our Technical Consultancy department for further details.

O-Rings

- O 030 330 990 009 - M6 - 200-008 (4.47x1.78mm)
- O 030 330 990 000 - M10 – 202-510 (8x1.6mm)

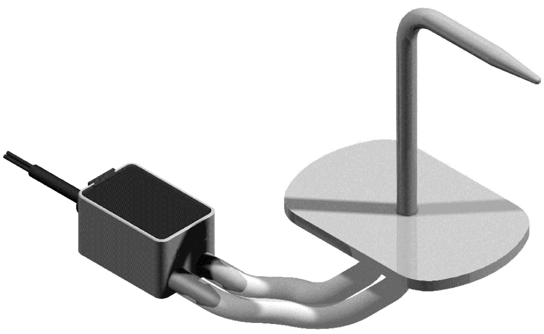
Mounting Torque

- M6 – 5Nm (max)
- M10 – 10Nm (max)

Typical threaded sensor with o-ring seal

Typical pressure module with manifold connection

Typical pitot sensor



Installation

The tyre pressure sensor is available in a number of variations to suit most wheel mounting configurations.

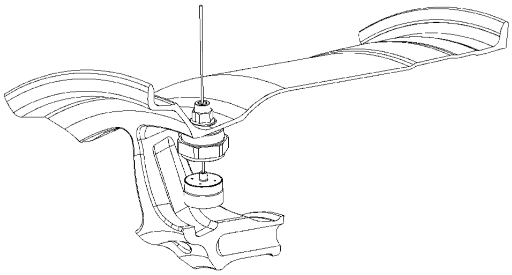
Documentation

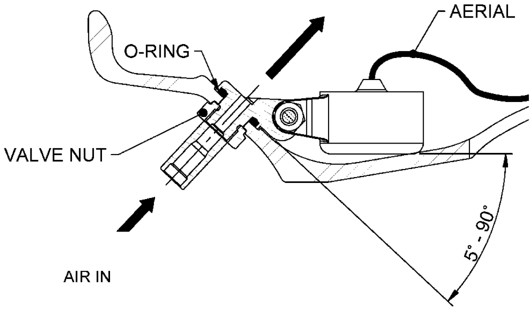
These designs enable the sensor to be fitted to either the inside or outside of the wheel rim or alternatively directly to the valve. The various designs are shown below.

External Rim Mounting

The rim housing is mounted to the rim external to the tyre and is sealed using a bonded seal. The housing remained fitted to the rim at all times.

The standard sensor can then be inserted into the housing which is sealed using an o-ring and secured in place with a circlip. This design enables the tyre to be fitted and balanced without the sensor fitted.



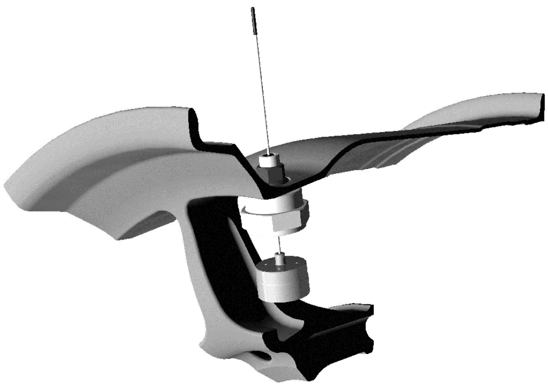


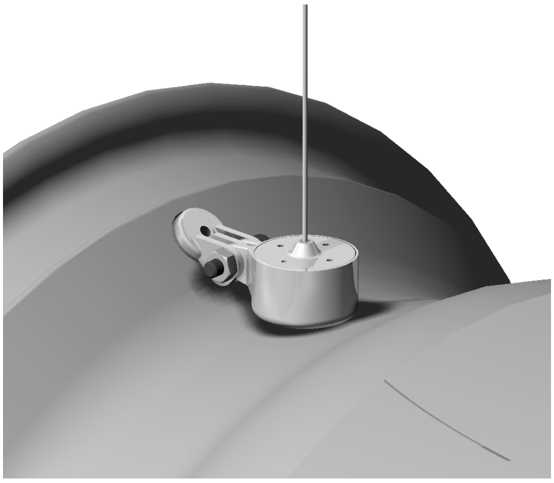
SECTION SHOWING INSTALLATION
ON WHEEL - (VALVE INTERNALS REMOVED)

Valve Mounted Adjustable

The sensor housing incorporates the tyre inflation valve and is mounted to the wheel rim inside the tyre.

The sensor is hinged at the valve stem which enables the angle to be set to suit the rim profile.

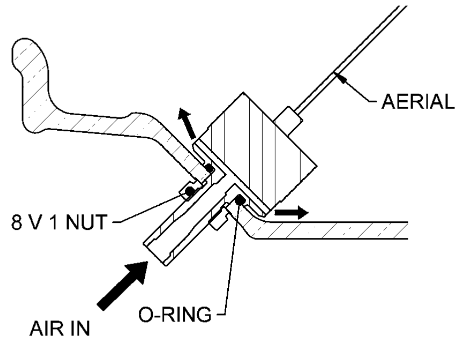




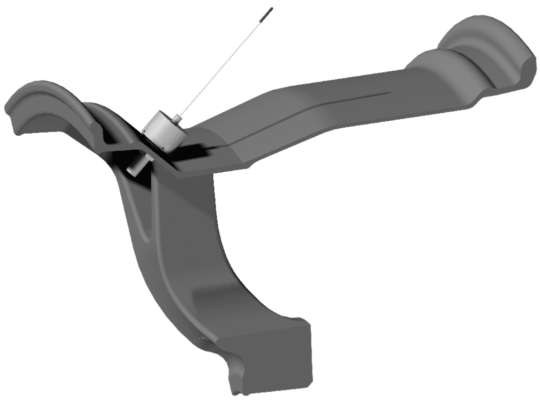
Valve Mounted

The sensor housing is situated directly behind the tyre inflation valve mounted to the wheel rim inside the tyre.

Cross drilled holes within the sensor housing enable the tyre to be inflated through the valve.



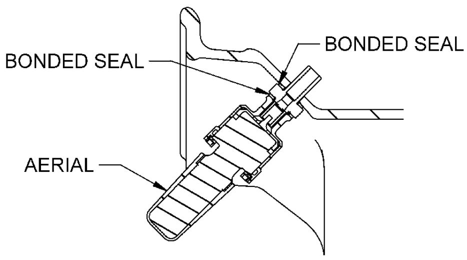
SECTION SHOWING INSTALLATION ON WHEEL
(VALVE INTERNALS REMOVED)



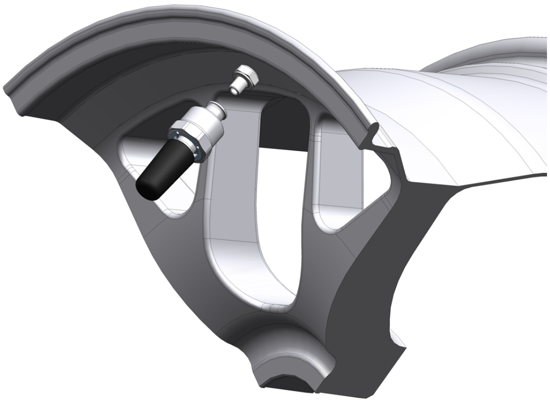
NASCAR Sensor

This sensor has been designed for use where it is not possible for the sensor or aerial to be positioned inside the tyre, this may be due to the rim profile or the addition of an interliner tyre. The sensor housing is mounted directly only the existing valve stem where a compression pip depresses the valve pressurising the sensor.

It is important that the correct valve length is used, this can be controlled by use of a spacer to ensure that the sensor seals against the bonded seal. The antenna cover must not be used to tighten the sensor.



SECTION SHOWING INSTALLATION ON WHEEL
(VALVE INTERNALS REMOVED)



Documentation

Rotary Position Sensors

Installation Note

Adjustment

The standard range of potentiometers offers various angular or lateral adjustment possibilities depending on the design. Some models have provision for a dowel to be inserted to lock the potentiometer into position. Note that the holes on the non-adjustable model are not in line.

The Micro pot can be adjusted by 20° and the Mini Pot by 10°. These models do not have provision to be fixed with a dowel.

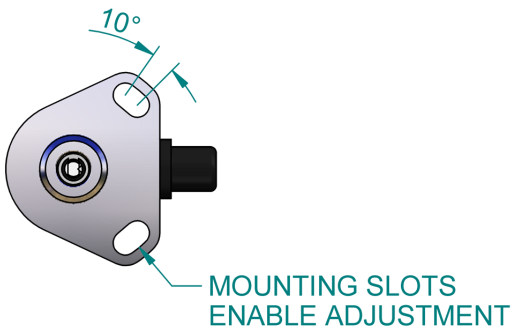
Vibration

In high-frequency, high-vibration environments, such as engine or gearbox mounting, a resilient or anti-vibration mount and coupling should be used to isolate the sensor. For example, a hard plastic block (e.g. 3mm thick Nylon 66) may be used to provide the necessary isolation.

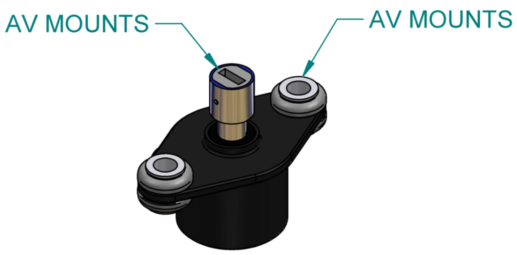
Half-Voltage Position

The drawings in the Product Summaries indicate the relative position of the shaft and the centre of the electrically active part of the track (the “Half Voltage Position”). This is necessary because the potentiometers do not have internal end stops.

Mini Potentiometer Installation



AV Mounted Mini Potentiometer Installation



Speed Sensors

Installation Note

Inductive sensors

Inductive sensors are axi-symmetric, so the rotational orientation with respect to the target wheel is not important.

Enclosed body sensors may be immersed in hot oil as well as other fluids typically used in motorsport. Sensors with an eddy current reduction slot or an exposed core should not be immersed in hot oil but they resist other fluids.

If an inductive sensor with an eddy current reduction slot is installed in such a way that it is surrounded by metal, the effect of the eddy current reduction slot is much reduced and a smaller air gap may be necessary.

Differential Hall Effect (DHE) Sensors

It is important to install DHE sensors correctly in relation to the target wheel. The teeth of the wheel should pass the two Hall effect elements in a straight line. Deviation from this ideal orientation will not generally stop the sensor from working, but it will reduce sensitivity, making the device more susceptible to noise and possibly requiring a decrease in the air gap. The correct orientation is indicated on the outline drawings in the Product Summaries and, in most cases, is also marked on the sensor body. If the sensor is rotated through 180° the polarity of the output is reversed.

Zero Speed Hall Effect Sensors

The Zero Speed Sensors have a single Hall probe, so the rotational orientation with respect to the target wheel is not important. Good target wheel concentricity is required, to ensure that the maximum operational air gap is not exceeded.

Clamped Sensors

Sensors without mounting holes should be clamped or held by a circlip or similar. DHE sensors should be prevented from rotating. Clamps and clips are not available from McLaren Applied Technologies.

Target Wheel Design

The following specification has been found to give good results with our sensors. However, other designs can give acceptable results. For specific assistance, please contact our technical consultancy department.

For Inductive Sensors:

- Use steel of a carbon content less than 0.15%
- Wheel thickness #3mm
- Tooth height #3mm

For high speed applications a minimum length of tooth may be required, depending on the details of the application.

For Hall Effect Sensors (DHE, Zero Speed and TPZS):

- Use steel of a carbon content between 0.10% and 0.15%
- Optimum wheel pitch = 5mm

The target wheel pitch may be > 5 mm, contact our technical consultancy department for specific assistance.

- Tooth width to space ratio = 1:1
- Tooth height > 5mm

Air Gap

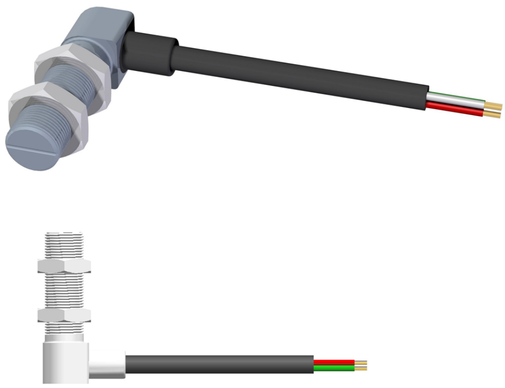
For Inductive Sensors, an air gap of 0.8mm is recommended. The air gap should not exceed 1mm.

For DHE Sensors, the air gap should not exceed 1.5mm.

For Zero Speed Sensors, an air gap of 0.8mm is recommended. The air gap should not exceed 1mm.

For True Position Zero Speed Sensors, an air gap of 0.4mm is recommended.

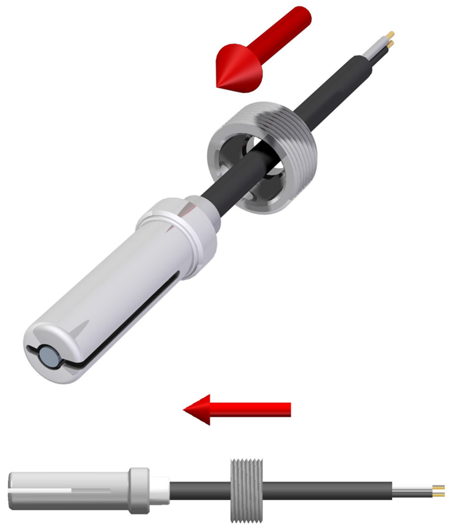
The following images illustrate a selection of housing styles and sealing methods. These can be designed to suit specific applications.



DHE SPEED SENSOR -
3/8"-64 UNF THREADED VARIANT

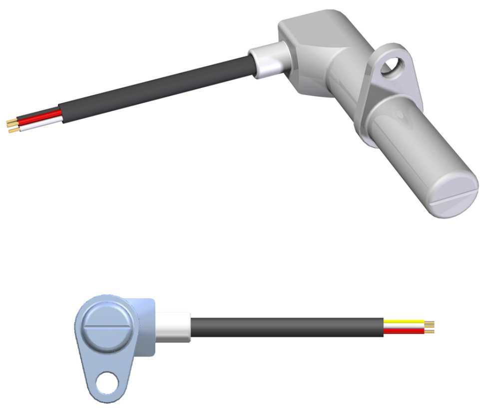
DHE SPEED SENSOR -
SADDLE MOUNT VARIANT

Documentation



OPEN BODIED INDUCTIVE SPEED SENSOR - CLAMP VARIANT

CLOSE BODIED INDUCTIVE SPEED SENSOR - TWIN FLANGE VARIANT



TRUE POSITION ZERO SPEED SENSOR - 90° CABLE EXIT - SINGLE FLANGE VARIANT

Temperature Sensors

Installation Note

Air Temperature Sensors

McLaren Applied Technologies' air temperature sensors expose the sensor element tip directly to the air flow. Sensors with a flange mount body can be aligned in the air stream to exploit the planar symmetry of the sensor element. This is most important for low velocity air flows, for example if the sensor is located at the end of a manifold pipe.

With threaded devices the point at which the screw thread will tighten cannot be defined exactly. However, the design of the sensor housing ensures that errors due to misalignment of the element in the air flow are minimized.

- Mounting Torque:
  7.1 to 8Nm (M10)
  5.3 to 6Nm (M6)
- Spanner:
  14mm A/F (M10)
  10mm A/F (M6)

Fluid Temperature Sensors

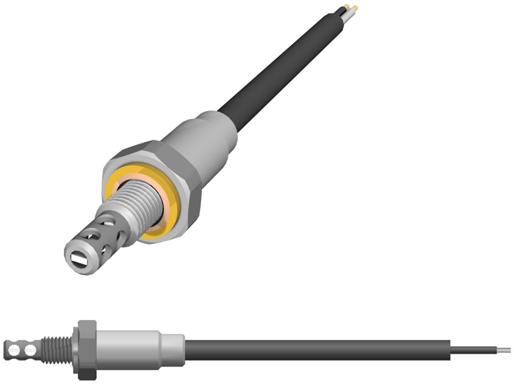
Fluids used in automotive applications are often aggressive and turbulent. The sensing element must be isolated from the medium, so the sensor element is encapsulated at the tip of a thermally conductive housing. This tip is made as small as possible to ensure minimal thermal mass – reducing error and response time. The rotational orientation of the sensor has no effect on the reading.

- Mounting Torque 5.3 to 6Nm
- Spanner 10mm A/F

Either type of sensor can form a seal in its installation port, if required. Use a new seal whenever the sensor is installed or reinstalled. The seals are available as accessories; please see the relevant Product Summary for the order code.

Air and Fluid Installation

The following images illustrate a selection of housing styles and sealing methods. These can be designed to suit specific applications.

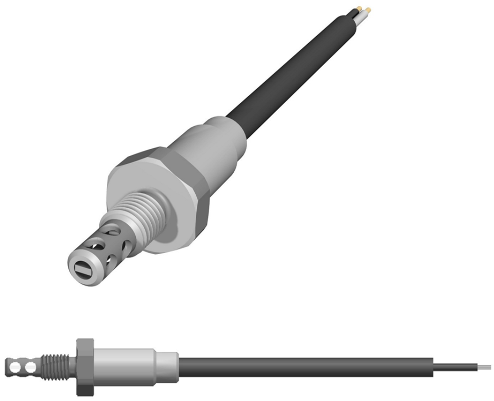


AIR TEMPERATURE SENSOR - BONDED SEAL

AIR TEMPERATURE SENSOR - O RING SEAL

Documentation

AIR TEMPERATURE SENSOR - PLUG-IN VARIANT



AIR TEMPERATURE SENSOR - M6 THREADED VARIANT

FLUID TEMPERATURE SENSOR - M6 THREADED VARIANT

Exhaust Thermocouples

The sensing element is sealed in a stainless steel tube and is 1.5mm from the end of the tube. The length of the probe should be chosen to place the sensing element at the point in the gas flow where temperature is to be measured. The connection wires should be kept short and away from sources of electro magnetic radiation, such as ignition systems.

A soft copper washer may be used to provide a gas tight seal.

- Mounting Torque 12.5Nm max
- Spanner 11.3mm A/F (1/4BSF, 3/16BSW)

EXHAUST GAS TEMPERATURE SENSOR

Infra-Red

Infra-red sensors include lenses which focus the radiated energy onto the sensing element. For accurate measurement it is important to place the sensor so that its field of view is completely covered by the object to be measured. If the field of view includes objects outside the target area an error will be introduced.

The field of view of the sensor is 15° typ, 20° (max).

The sensor should be installed in such a way that the lens does not become dirty and the sensor is positioned far enough away from the target to ensure that the maximum operating temperature of the sensor is not exceeded.