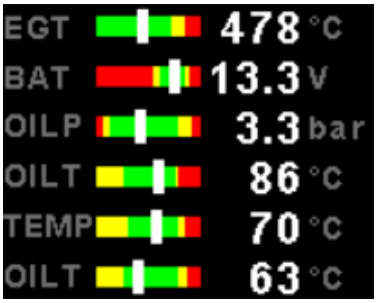
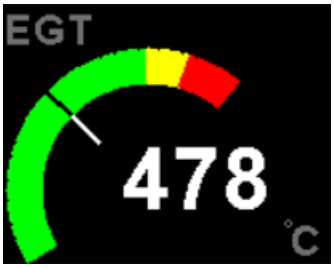
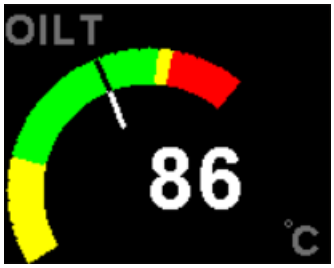
Madman EMS-3

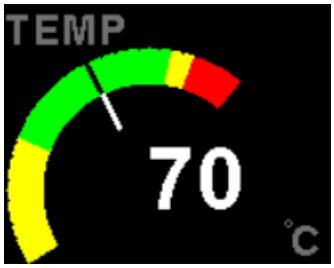
Universal Engine Monitoring System

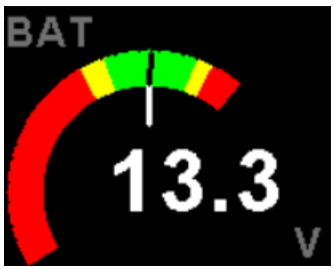
Operating Manual – English 1.05

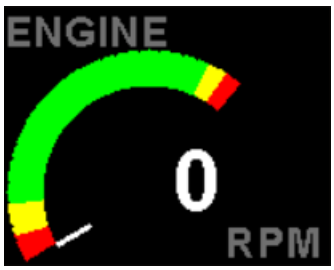


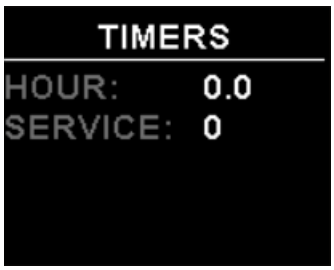


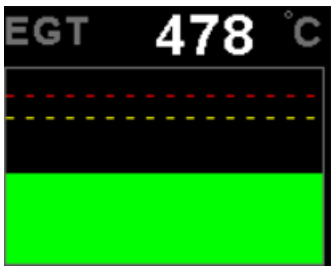


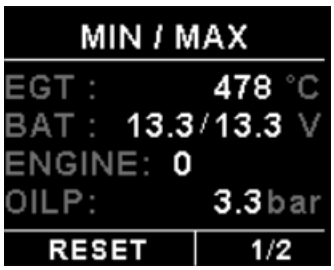












Introduction

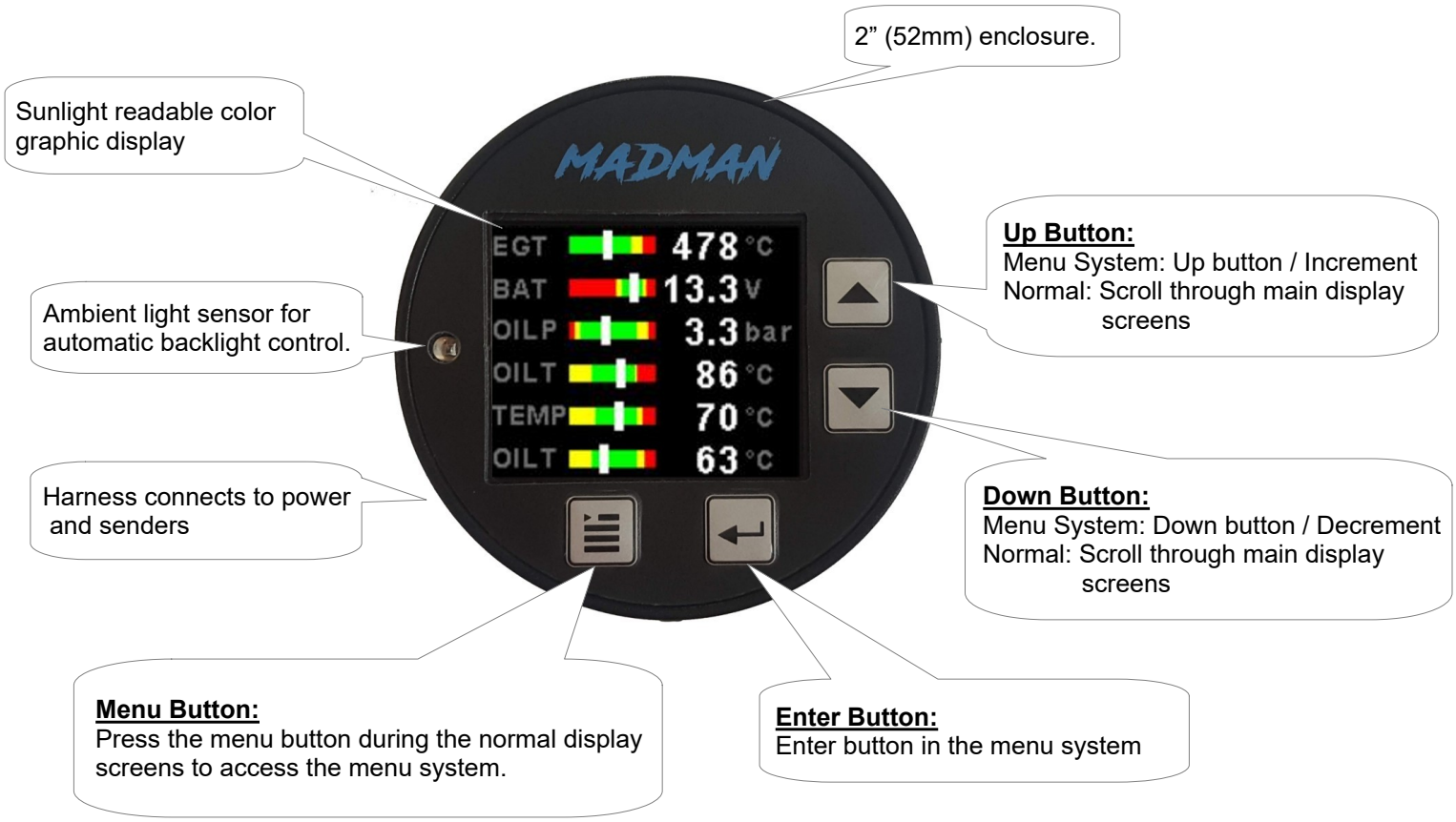
The EMS-3 is a multifunction engine information display and early warning engine monitoring system. It has been specifically designed to monitor crucial vehicle information, and in the event of any engine irregularities, it will alert the driver by means of a visual and audible alarm.

With its array of advanced features, the EMS-3 is an indispensable unit for the discerning vehicle owner. Costly maintenance bills can easily be avoided by the prevention of major engine problems before they occur.

1 Features

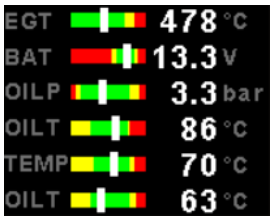
- **Large 1.8” high resolution 160x128, sunlight readable, wide viewing angle, 1000 cd/m2 TFT LCD display**
- **Battery voltage display, the EMS-3 can measure voltages up to 30V (Can be used in 12V and 24V vehicles) and contains a programmable low/high voltage alarm to automatically catch alternator failures, drive belt failures and bad batteries**
- **Hour meter display to determine actual engine running time with 1/10 hour resolution**
- **Built in service interval reminder based on vehicle ignition on time**
- **EGT (Exhaust gas temperature) can be displayed in degrees Celsius or degrees Fahrenheit from -100ºC to 1200ºC (-148ºF to 2192ºF) and contains a user settable high alarm.**
- **Includes an EGT trend graph display**
- **Includes linearization of K or J Type thermocouple probes and is cold junction compensated for greater accuracy**
- **4x Universal analog input channels that can be configured for pressure, temperature or as a generic analog input**
- **Pressure sender measurement with user settable high and low alarm. Pressure sender inputs can be from a Fuel, Oil, Manifold, Turbo Boost or an Auxiliary pressure sender.**
- **Temperature measurement with user settable high and low alarm. Temperature sender inputs can be from an Oil, Coolant or an Auxiliary temperature sender.**
- **Oil Pressure warning alarm from oil pressure senders that have a switch output**
- **Coolant level absence/presence detection by the means of AC signal probe excitation. The EMS-3 can use inexpensive probes such as stainless steel screws to determine the coolant level. The EMS-3 can also be used with float level type sensors. The Coolant level detection circuit also has a programmable switch time to prevent false alarm messages when driving over rough terrain**
- **Fan control output for on/off temperature control**
- **All senders linearized for additional accuracy**
- **Each sensor display can be individually enabled or disabled**
- **Includes an external audible alarm output (The sound can be turned on/off, for example game viewing)**
- **Dual external alarm outputs**
- **Ambient light sensor for automatic or manual backlight control**
- **On-board voltage reversal and over voltage protection for harsh vehicle environments**
- **Standard 2” (52mm) circular enclosure**
- **SMPS (Switch mode power supply) for use in both 12V and 24V vehicles**
- **Maximum values of all readings are recorded**
- **Easy to use menu system for user parameter setup**
- **Field upgradable firmware via the RS232 interface**
- **1 year limited warranty**

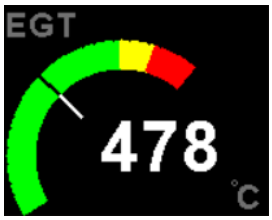
2 Layout

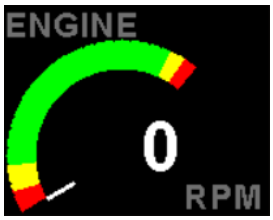


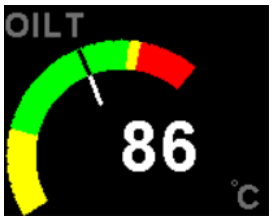
3 Main Displays

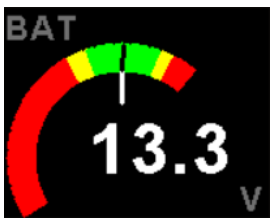
The main display screens can be viewed by pressing the up and down buttons in the normal display mode.

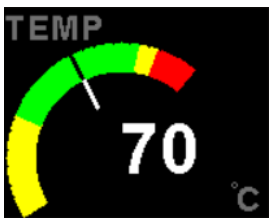


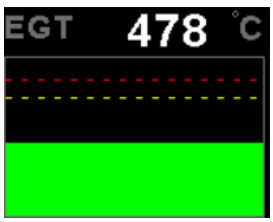


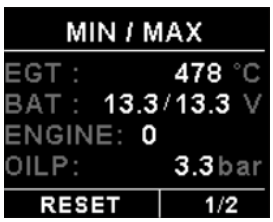












3.1 EGT (Exhaust Gas Temperature) / Pyrometer

Few things will damage or kill a diesel engine like excessive exhaust gas temperatures, yet the EGT gauges are not standard equipment fitted by the diesel engine manufacturers and are only available as an after market add on unit.

The EMS-3 can alert the driver of any situations where the EGT gets too high which could cause irreparable engine and or turbo charger damage. The EGT can be affected by a too rich air/fuel mixture or an air intake problem. Air intake problems could include a blocked/partially blocked air intake, a dirty air cleaner, high water temperatures etc. The EMS-3 EGT gauge could also save on fuel costs as the EGT is directly related to the air/fuel mixture.

The EGT probe can be installed on the exhaust manifold or immediately after the turbo. It is recommended to install the EGT probe before the turbo as temperature differences of up to 200ºC (392ºF) between the inlet and outlet of the turbo has been measured under heavy loads.

Under normal driving conditions the EGT may vary between 250ºC (482ºF) and 650ºC (1202ºF). For most vehicles the alarm limit should be set to 720ºC (1328ºF). Please be aware that pushing the engine hard or driving up a steep hill, could cause the exhaust gas to exceed this temperature. If you have prolonged high EGT then it is recommended to immediately have it checked out by a qualified mechanic.

Madman custom built thermocouple EGT probes are specifically designed for automotive use. The Madman EGT probes can handle temperatures up to 1300ºC (2372ºF).

The EMS-3 can use K-Type or J-Type thermocouples to display the EGT temperature. The EMS-3 contains precision instrumentation electronic circuitry to amplify and linearize the thermocouple sensor. The EMS-3 also has built in cold junction compensation to make the EGT reading as accurate as possible.

3.2 Battery Volts

The EMS-3 can measure the vehicle's battery voltage in the range of 8V to 30Vdc and has built in over-voltage and reverse voltage protection. The EMS-3 contains a programmable low/high voltage alarm to automatically catch alternator failures, drive belt failures and bad batteries.

3.3 Pressure Display

The EMS-3 uses standard automotive pressure senders to display the pressure. The EMS-3 supports 2, 5 and 10 Bar VDO senders, SENDO MPS 2, 5, 7, and 10 bar senders, 0.5-4.5V senders, 4-20mA pressure senders or a custom user definable pressure sender curve.

3.4 Oil Pressure Switch Message

The EMS-3 can also be used to display a warning message from a switch type oil pressure sender. These senders can be of a NO (Normally Open) or a NC (Normally Closed) type sender. **The oil pressure switch uses the analog 4 input channel.**

This message is displayed when there is an oil pressure alarm from the switch (NO/NC) on the oil pressure sender.

3.5 Temperature Display

The EMS-3 uses standard automotive temperature senders to display the temperature. The EMS-3 also contains fail safe temperature inputs to alert the user when the sender has been disconnected or faulty. The EMS-3 supports 120 and 150 VDO senders, a precision temperature sender, Echlin TS920SA or a custom user definable temperature sender curve.

3.6 Coolant Level Detector

The coolant level detector is an engine coolant level early warning system. It uses an AC signal probe excitation to accurately determine the absence/presence of coolant level. The coolant level detector can use inexpensive probes such as stainless steel screws to determine the coolant level. It also features a fail safe input circuit. The coolant level detector can also be used with float level type sensors (These senders must be of a normally open type). The coolant level switch must connect to the vehicles negative supply terminal when the coolant level is at an acceptable level.
The coolant level detector has a programmable switch time. This means that the level alarm from the coolant level switch must be activated for at least the programmed time before an alarm is activated. This prevents false alarm messages when driving over rough terrain etc. The EMS-3 also has a programmable coolant level threshold which allows the user to fine tune the trigger point.

This message is displayed when there is a coolant level problem.

3.7 Service Timer Expired Message

This timer is set in engine hours and it will count down to zero. The purpose of this function is to assist you in determining remaining hours until maintenance will be required.

be A maximum of 9999 hours can be entered as a service interval. An alarm message will displayed and the appropriate alarm output will be activated (if enabled).

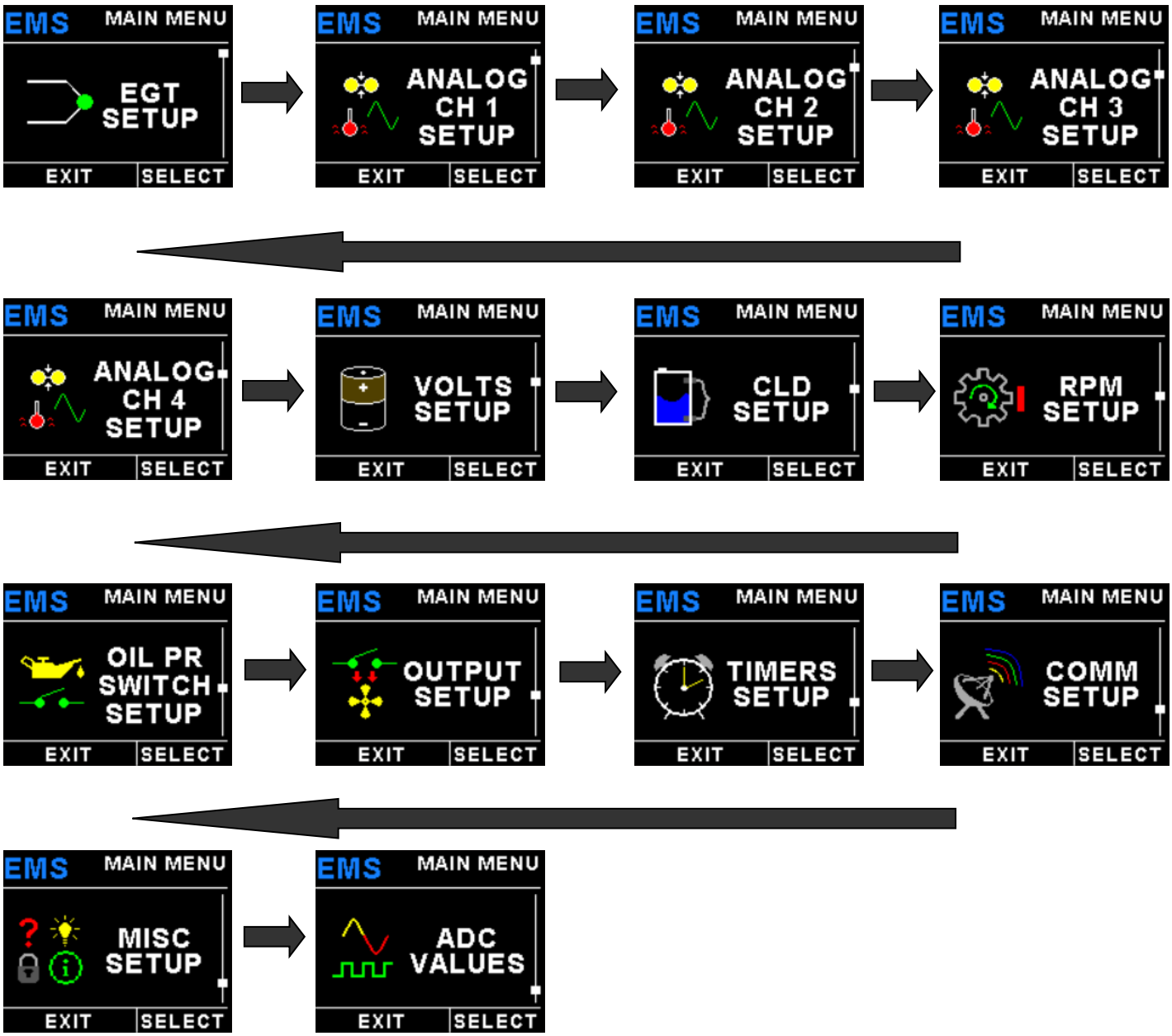
3.8 Hour meter

The hour meter is a useful instrument to display actual engine running time for routine maintenance. The hour meter is displayed as hours and fractional minutes in 1/10 of an hour resolution (increments every 6 minutes). The hour meter can be reset to zero in the “TIMERS SETUP” menu. The hour meter updates its internal minute counter every minute. If the unit is turned on and off for a period of less then a minute, then the hour meter will not increment its internal registers.

The hour meter can be triggered by an ignition on signal or by a rise in battery voltage which signals that the engine is in fact running.

4 Menu System

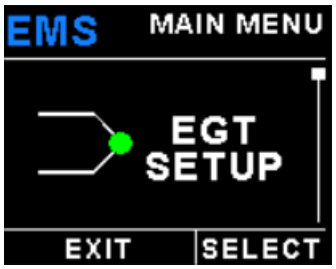
Press the menu button during the normal display mode to enter the menu system. Use the Up / Down keys to navigate through the menu system.



4.1 Exiting the menu system

Press the Menu button to exit the menu system when the “EXIT” soft key is shown. All changes made during navigation of the menu system will be saved in non-volatile memory upon exiting. The instrument will not save any changes if you remove power before exiting the menu system.

4.2 EGT (Exhaust Gas Temperature Setup)



Display:
Select "ON" to enable the EGT display.

Label:
Enter a label to suit your EGT Channel so you can easily identify it.

Display Max:
Select the maximum temperature that you want the EGT bargraph to show. This can give you increased display resolution.

Display Min:
Select the minimum temperature that you want the EGT bargraph to show. This can give you increased display resolution.

High Alarm:
This enables or disables the EGT high alarm.

High Alarm:
Enter the temperature threshold for when the high alarm must be activated. Any temperature above this value will activate the alarm.

High Caution:
Enter the temperature value for the high caution.

Alarm:
Select which output the alarm must activate.

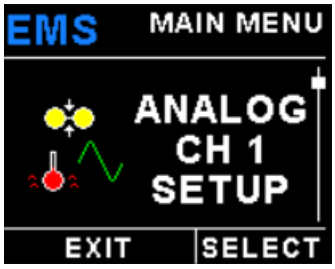
Probe:
Select if you are using a K-type or J-type thermocouple probe.

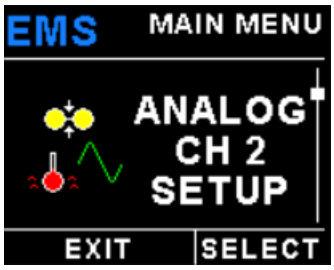
Unit:
Select whether you want the temperature to be displayed in degrees Celsius (ºC) or degrees Fahrenheit (ºF).

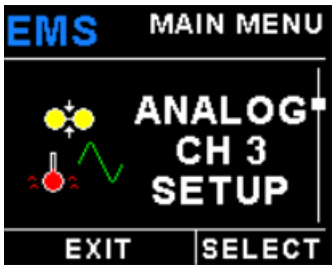
4.3 Analog CH1 to CH4 Setup

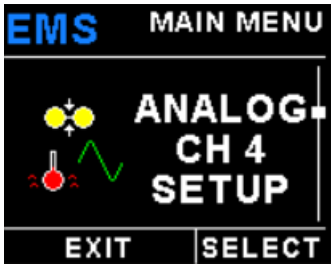
The 4 analog channels are universal analog input channels that can be used for pressure, temperature or as a generic analog input.

Only "CHANNEL 1" Setup is shown below, follow the same steps for Channel 2, 3 & 4









4.3.1 Pressure Setup

Mode:
Select the function for the analog channel. Options are "PRESSURE", "TEMP", "GENERIC" or "OFF".

Type:
Select if you are using a resistive, voltage or current pressure sender.

If the *"RESISTIVE"* pressure sender is selected

In most cases resistive sensors require a biasing voltage to work properly. Inside the EMS3 unit is a small block of DIP switches, The switch associated with the required channel must be in the ON position to enable the sensor to work correctly. By default, CH1 + CH2 are ON and CH3 + CH4 are off. Failure to set the DIP switch will not cause damage but will cause false readings.

Sender:
Select what type of resistive pressure sender you are using. Select *"VDO"* for VDO / resistive senders, *"USER"* for a custom sender.

Model:
Select which VDO pressure sender you are using. A selection between a VDO 2, 5 or 10 Bar can be selected.

If the *"VOLTAGE"* pressure sender is selected

Sender:
Select the type of voltage sender you are using. Select "SENDO" for SENDO senders, "0.5-4.5V" for voltage senders, or "USER" for a custom voltage sender.

Model:
Select which SENDO pressure sender you are using. A selection between a MPS 2, 5, 7 or 10 Bar can be selected.

If the *"CURRENT"* pressure sender is selected

Sender:
Select the type of current sender you are using. Select "4-20mA" for 4-20mA sender or "USER" for a custom 4-20mA sender.

Pressure @ 4mA:
Enter the pressure specified at 4mA output.

Pressure @ 20mA:
Enter the pressure specified at 20mA output.

Menu options for all sender types

If the *"USER"* pressure sender is selected

Calibrate Sender:
If the sender type is set to "*USER"*, then use this menu option to calibrate your pressure sender. See section 4.3.3 for more information.

Label:
Enter a label to suit your pressure channel so you can identify it easily.

Unit:
Select whether you want to display the pressure in Bar or psi.

Display Max:
Select the maximum pressure that you want the bargraph to show. This can give you increased display resolution.

Display Min:
Select the minimum pressure that you want the bargraph to show. This can give you increased display resolution.

High Alarm:
This enables or disables the pressure high alarm.

High Alarm:
Enter the pressure threshold for when the high alarm must be activated. Any pressure above this value will activate the alarm.

High Caution:
Enter the pressure value for the high caution. This is the lower value of the upper yellow band.

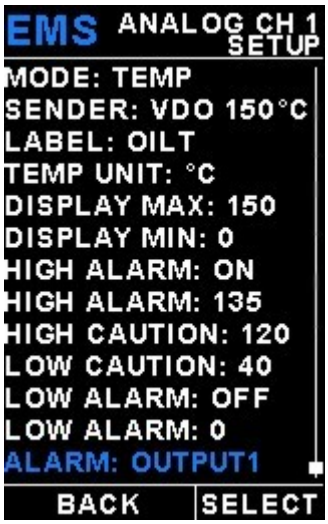
Low Caution:
Enter the pressure value for the low caution. This is the upper value of the lower yellow band.

Low Alarm:
This enables or disables the pressure low alarm.

Low Alarm:
Enter the pressure threshold for when the low alarm must be activated. Any pressure below this value will activate the alarm.

Alarm:
Select which output the alarm must activate.

4.3.2 Temperature Setup



Mode:
Select the function for the analog channel. Options are “PRESSURE”, “TEMP”, “GENERIC” or “OFF”.

Sender:
Select what type of sender you are using. Select *“VDO 120”* for a VDO 120 degree sender, *“VDO 150”* for a VDO 150 degree sender, *“ECHLIN”* for a ECHLIN TS920SA sender, *“LM335”* for the precision temperature sender or *“USER”* for a custom sender.

If the sender type is set to *“USER"*

CALIBRATE SENDER:
If the sender type is set to “*USER”*, then use this menu option to calibrate your temperature sender. See section 4.3.3 for more information.

If the sender type is set to *"LM335"*

LM335:
If the sender type is set to LM335, then use this menu option to calibrate your LM335 precision temperature sender. If recalibration is required then adjust the value until the temperature matches the reference ambient temperature. Please note that the LM335 can only be calibrated in degrees Celsius irrespective if the EMS-3 is setup to display temperature in Fahrenheit.

Menu options for all sender types

Label:
Enter a label to suit your temperature channel so you can identify it easily.

Temp Unit:
Select whether you want the temperature to be displayed in degrees Celcius (ºC) or in degrees Fahrenheit (ºF).

Display Max:
Select the maximum temperature that you want the bargraph to show. This can give you increased display resolution.

Display Min:
Select the minimum temperature that you want the bargraph to show. This can give you increased display resolution.

High Alarm:
This enables or disables the temperature high alarm.

High Alarm:
Enter the temperature threshold for when the high alarm must be activated. Any temperature above this value will activate the alarm.

High Caution:
Enter the temperature value for the high caution. This is the lower value of the upper yellow band.

Low Caution:
Enter the temperature value for the low caution. This is the upper value of the lower yellow band.

Low Alarm:
This enables or disables the temperature low alarm.

Low Alarm:
Enter the temperature threshold for when the low alarm must be activated. Any temperature below this value will activate the alarm.

Alarm:
Select which output the alarm must activate.

4.3.3 Generic Analog Input Setup

Mode:
Select the function for the analog channel. Options are “PRESSURE”, “TEMP”, “GENERIC” or “OFF”.

Calibrate Sender:
Use this menu option to calibrate your generic analog input sender. See section 4.3.3 for more information. Use 2 points if the sensor is linear.

Label:
Enter a label to suit your generic analog input channel so you can identify it easily.

Unit Label:
Enter a unit label to suit your generic analog input channel.

Decimal Point:
Enter the decimal point position.

Display Max:
Select the maximum input that you want the bargraph to show. This can give you increased display resolution.

Display Min:
Select the minimum input that you want the bargraph to show. This can give you increased display resolution.

High Alarm:
This enables or disables the high alarm.

High Alarm:
Enter the threshold for when the high alarm must be activated. Any input above this value will activate the alarm.

High Caution:
Enter the input value for the high caution. This is the lower value of the upper yellow band.

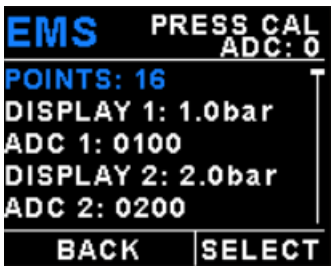
Low Caution:
Enter the input value for the low caution. This is the upper value of the lower yellow band.

Low Alarm:
This enables or disables the low alarm.

Low Alarm:
Enter the threshold for when the low alarm must be activated. Any input below this value will activate the alarm.

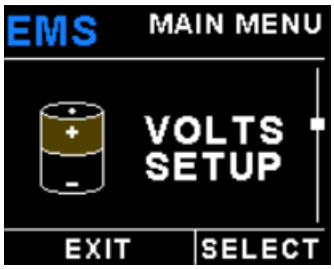
Alarm:
Select which output the alarm must activate.

4.3.4 Calibrating the user defined pressure, temperature and generic senders



1. Enter the number of points that you want to calibrate.
2. Enter the display reading that you want to show when the sender is at that actual display reading.
3. Enter the ADC (analog to digital converter) reading that corresponds to this display reading. The ADC reading is shown at the top of the display if you are applying the actual stimulus from the temperature, pressure or current sender. You can also manually enter this value if the ADC value is known or pre-calculated.
4. Continue entering display and ADC values until all the points have been entered.
5. Verify the above calibration by checking the temperature, pressure or current display versus the actual applied sender stimulus.

4.4 Volts Setup



Display:
Select "ON" to enable the Volts display

Label:
Enter a label to easily identify your Volts reading.

Display Max:
Select the maximum value that you want the volts bargraph to show. This can give you increased display resolution.

Display Min:
Select the minimum value that you want the volts bargraph to show. This can give you increased display resolution.

High Alarm:
This enables or disables the volts high alarm.

High Alarm:
Enter the voltage threshold for when the high alarm must be activated. Any voltage above this value will activate the alarm.

High Caution:
Enter the voltage for the high caution. This is the lower value of the upper yellow band.

Low Caution:
Enter the voltage for the low caution. This is the upper value of the lower yellow band.

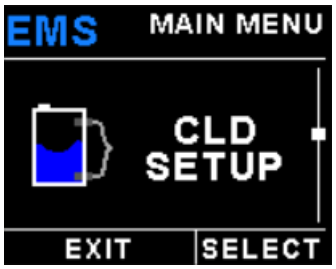
Low Alarm:
This enables or disables the volts low alarm.

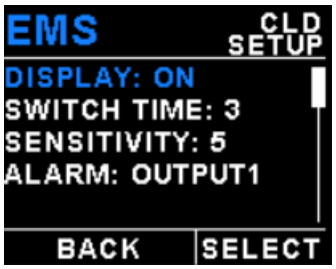
Low Alarm:
Enter the voltage threshold for when the low alarm must be activated. Any voltage below this value will activate the alarm.

Alarm:
Select which output the alarm must activate.

Cal:
Measure the battery voltage with a multimeter and then adjust this value to match that of the multimeters volts reading.

4.5 CLD (Coolant Level Detector) Setup





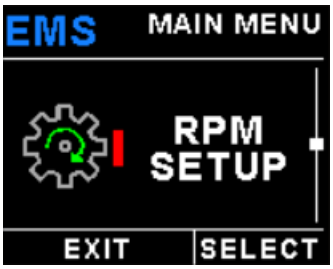
Display:
Select "ON" to enable the CLD display.

Switch Time:
The coolant level has a programmable switch time. This means that the level alarm from the coolant level switch must be activated for at least the programmed time before an alarm is activated. This prevents false alarm messages when driving over rough terrain etc.

Sensitivity:
Adjust the sensitivity to fine tune the trigger point.

Alarm:
Select which output the alarm must activate.

4.6 RPM Setup



Display:
Select if you want the RPM to be displayed in *"RPM", "PERCENT" or "OFF"*.

RPM 100%:
Select the maximum value that you want the RPM to correlate to 100%. This is only shown if *"Percent"* is selected for display.

Display Max:
Select the maximum RPM that you want the RPM dial to show. This can give you increased display resolution.

Display Min:
Select the minimum RPM that you want the RPM dial to show. This can give you increased display resolution.

High Alarm:
This enables or disables the RPM high alarm.

High Alarm:
Enter the RPM threshold for when the high alarm must be activated. Any RPM value above this value will activate the alarm.

High Caution:
Enter the RPM value for the high caution. This is the lower value of the upper yellow band.

Low Caution:
Enter the RPM value for the low caution. This is the upper value of the lower yellow band.

Low Alarm:
This enables or disables the RPM low alarm.

Low Alarm:
Enter the RPM threshold for when the low alarm must be activated. Any RPM value below this value will activate the alarm.

Pulses/Rev:
Enter the number of pulses per rev. For engines with an uneven number of cylinders like three cylinder four stroke engines you can enter values containing fractions (usually 1.5 in this example). Most four stroke engines would generate one pulse for every two revolutions per cylinder. A four cylinder automotive four stroke engine would thus generate 2 pulses per revolution as measured on the coil. Alternatively the W signal from the alternator can be used. Here the onboard diagnostics can be used to get accurate rpm or an external RPM gauge must be used and the pulses/rev calculated from there.

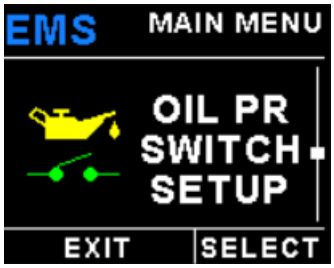
Increment:
Select the step size between successive RPM values eg. if the RPM value is 4003 RPM and the “INCREMENT” is 5 then the actual value shown is 4005 RPM.

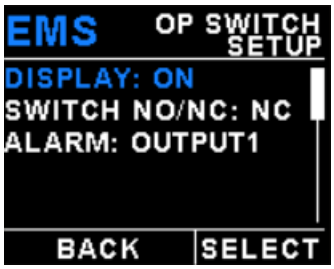
Label:
Enter a label to easily identify your RPM reading.

Unit Label:
Enter a unit label to suit your generic analog input channel.

Alarm:
Select which output the alarm must activate.

4.7 Oil Pressure Switch Setup



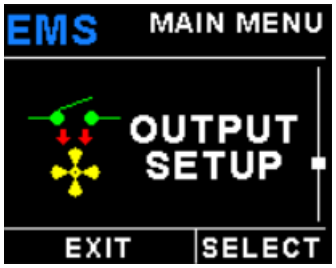


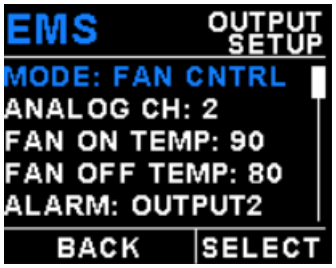
Display:
Select "ON" to enable the Oil Pressure switch display. **The oil pressure switch uses the analog channel 4 input.**

Switch NO/NC:
Select if the pressure switch is normally open (NO) or normally closed (NC) .

Alarm:
Select which output the alarm must activate.

4.8 Output Setup (Fan control)





Mode:
Select "FAN CNTRL" to enable the fan control output.

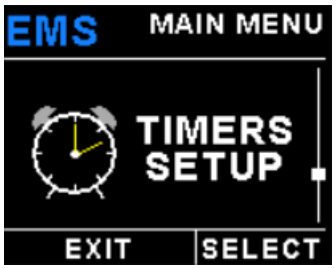
Analog CH:
Select which analog temperature channel the fan control must operate from.

Fan On Temp:
Enter the temperature when the output must switch on.

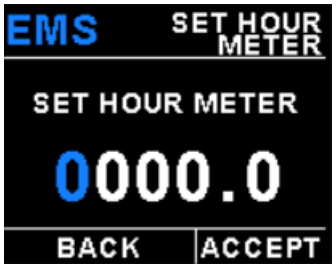
Fan Off Temp:
Enter the temperature when the output must switch off.

Alarm:
Select which output the alarm must activate.

4.9 Timers Setup



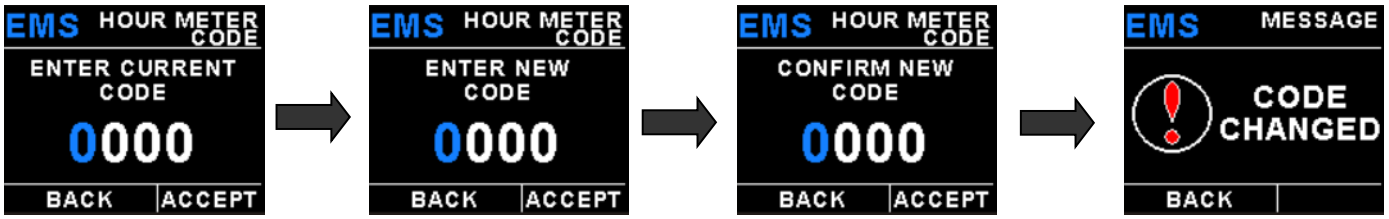
Set Hour Meter:



This function allows you to set the engine hour meter to any value. Typically, you would use this function to set the hour meter to the current known engine time. If the hour meter code is set to another value beside zero, then the user will be prompted to enter the hour meter access code before allowing him to change the hour meter time.

Hour meter Code:

This menu option allows you to change the hour meter access code. You will first be prompted to enter the current code followed by entering in a new code followed by re-entering the new code. If the new code and the re-entered code is the same, then the hour meter access code will be changed. Default code is 0000.



Hour Meter:

Select "ON" to enable the hour meter display

Set Service Timer:

This function allows you to set an engine service timer. This timer is set in engine hours and it will count down to zero.

Alarm:

Select which output the alarm must activate when the service timer reaches zero.

Start:

Select if the EMS-3 must start the hour meter and service timer from power up, from when a pre-selected volts threshold has been exceeded or from when a pre-selected RPM threshold has been exceeded

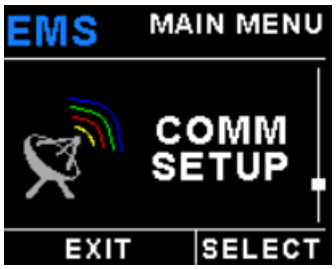
Volts:

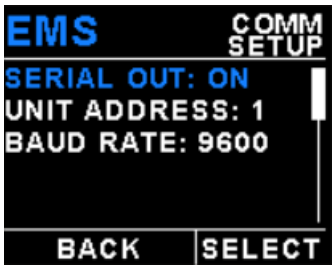
Enter the volts threshold that must be exceeded for the hour meter and service timer to start.

RPM:

Enter the RPM threshold that must be exceeded for the hour meter and service timer to start.

4.10 COMM Setup (Communication Setup)





Serial Out:
Select “ON” to enable the RS232 serial output.

Unit Address:
Enter the EMS-3 unit address.

Baud Rate:
Select the desired baud rate of the serial output.

The transmission format is set to 8 data bits, No parity, 1 stop bit.

4.10.1 Protocol format

STX, Address, Message type, Length, Data payload, Checksum, ETX

STX: Start of text (0x02)

Address: unsigned char (8bit), Unit address (range 0-255)

Message Type: unsigned char (8bit), Specifies the message type

Length: unsigned char (8bit), Length of the data payload (does not include the STX, Address, message type, checksum or ETX)

Data payload: Data

Checksum: unsigned char (8bit), XOR of all bytes starting from the unit address to the end of the data payload. The checksum is seeded with 0xa5. (does not include the STX or ETX)

ETX: End of text (0x03)

Message type=128

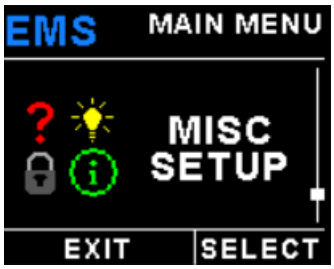
Data Length=29 bytes

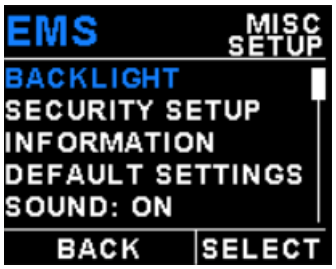
Output Rate=1Hz

Unused channels will read 0

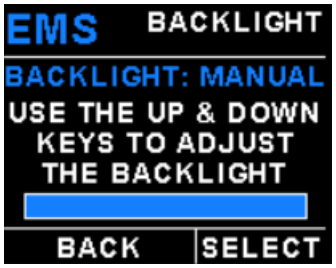
Hour Meter Hours:	Unsigned Int (16 bits), Hour meter hours
Hour Meter Minutes:	Unsigned char (8 bits), Hour meter minutes
Service Time:	Unsigned Int (16 bits), Service time in hours
Volts:	Unsigned Int (16 bits), Volts in 0.1V
Analog Channel Type:	Unsigned Int (16 bits)
	CH4 (4 bits), CH3 (4 bits), CH2 (4 bits), CH1 (4 bits)
	0=Off
	1=Pressure
	2=Temperature
	3 = Generic
Analog Channel 1:	Signed Int (16 bits)
	Pressure in 0.1psi
	Temperature in Degrees C
Analog Channel 2:	Signed Int (16 bits)
	Pressure in 0.1psi
	Temperature in Degrees C
Analog Channel 3:	Signed Int (16 bits)
	Pressure in 0.1psi
	Temperature in Degrees C
Analog Channel 4:	Signed Int (16 bits)
	Pressure in 0.1psi
	Temperature in Degrees C
CJC:	Signed Int (16 bit), Cold junction temperature in Degrees Celsius
EGT:	Signed Int (16 bit), EGT in Degrees Celsius
RPM:	Unsigned Long (32 bit), RPM value
RPM (%):	Unsigned Int (16 bit), RPM value in percentage
CLD:	Unsigned char (8 bits), 0=CLD alarm off, 1=CLD alarm on
Oil Pressure Switch:	Unsigned char (8 bits), 0=Oil Pressure switch off, 1= Oil Pressure switch on

4.11 MISC Setup (Miscellaneous Setup)



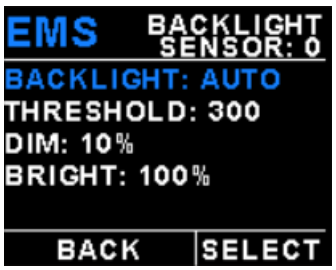


Backlight:



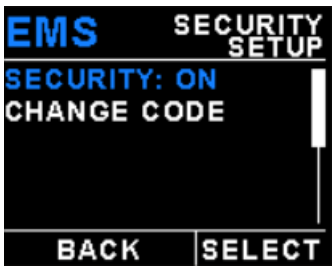
Select manual or automatic backlight control.

Use the Up / Down keys in manual mode to adjust the backlight brightness.

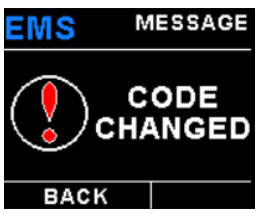


Allow 3 seconds for the display to adjust to the ambient lighting conditions when using the automatic backlight mode. The display will set the backlight to the dim setting if the ambient light is less then the threshold setting, alternatively the display will set the backlight to the bright setting if the ambient light is greater then the threshold setting. The ambient light received is shown as the ADC value in the top header. Use this value to set the threshold value.

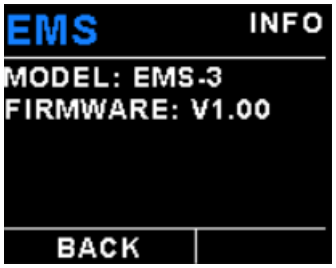
Security Setup:



Select this menu option if you want to password protect the menu system.

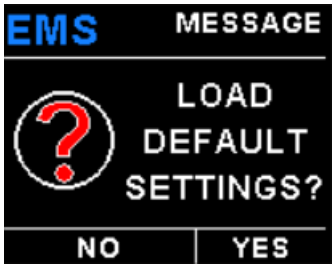


Information:



This menu option displays information about the unit.

Default Settings:

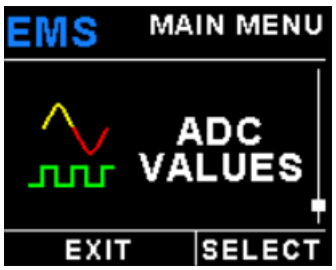


Select this menu option to reset all the settings to factory defaults.

Sound:

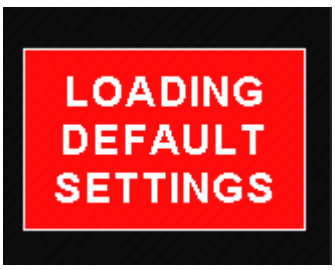
Select "ON" to turn the external buzzer sound on.

4.12 ADC Values



This menu displays the ADC values of the various sensors.

5 Loading factory default settings



Press and hold the Enter and Up button during power up to load the pre-programmed factory default settings. The following screen will be displayed:

Factory default settings can also be loaded in the Miscellaneous setup menu.

6 Error Messages

Unit settings CRC error. Load default settings to restore to factory defaults. If the error message still persists then it could possibly be a non-volatile memory failure in which case the instrument will then have to be returned to the factory.

Internal flash CRC error. The instrument does a firmware check on the program when power is applied to the instrument . If the program is corrupt in any way then the internal flash CRC error will be displayed. Reload the instruments firmware and load default settings. If the error message still persists then it could possibly be an internal flash memory failure in which case the instrument will then have to be returned to the factory.

Hour meter / Service Timer CRC error. Try entering new values for the hour and service timer and see if the error message disappears. If the error message still persists then it could possibly be a non-volatile memory failure in which case the instrument will then have to be returned to the factory.

Calibration constants CRC error. The instrument could possibly have a non-volatile memory failure in which case the instrument will then have to be returned to the factory.

Max Values CRC error. Load default settings to restore to factory defaults. If the error message still persists then it could possibly be a non-volatile memory failure in which case the instrument will then have to be returned to the factory.

7 Specifications

Operating Temperature Range	-10ºC to 60ºC (14ºF to 140ºF)
Storage Temperature Range	-20ºC to 80ºC (-4ºF to 176ºF)
Humidity	<85% non-condensing
Power Supply	8 to 30Vdc
Current Consumption	Approx. 85mA @ 13.8V (backlight highest setting), 35mA @13.8V (backlight lowest setting)
Display	1.8” 160x128 pixel active matrix TFT display. 1000 cd/m2 Sunlight readable with anti-glare coating LED Backlight can be set to automatic or can be manually adjusted
Alarm Outputs	2 Alarm outputs Open collector transistor switch to ground Maximum rating 0.25A (To drive an auto relay, piezo buzzer or LED)
ADC	12 bit
Dimensions	See dimensional drawing below
Enclosure	2” (52mm) ABS, black in color, front mounting. Flame retardant.
Weight	Approx. 110 grams (Instrument excluding cables)
Non-volatile memory storage	100000 write cycles
RPM Input	
RPM input	Range: 0-99999 RPM. Minimum signal for stable display: 5Vpp. Fully A/C coupled, maximum voltage +/- 40V. RF noise filter plus Schmitt trigger based input
EGT Thermocouple	
Type	K-type or J-type
Measurement range	K-Type: -100ºC to 1200ºC (-148ºF to 2192ºF) J-Type: -100ºC to 1100ºC (-148ºF to 2012ºF)
Technology	Fully cold junction compensated using a precision internal temperature reference and built in thermocouple linearization tables
Measurement accuracy	+/- 5 degrees typical over full temperature range, subject to quality of probe used.
Inputs	Differential, can use grounded and isolated probes
Common mode voltage range	-2V to +3V
Analog Input Channels	
Analog Input Channels	4 Channels with dipswitch programmable 1k pullup resistor
Pressure Sender Input	
Pressure Sensors	**Resistive Senders:** The EMS-3 supports resistive type pressure senders. **VDO Resistive Senders:** The EMS-3 supports the VDO 2, 5 and 10 Bar senders. VDO pressure senders used to measure fuel pressure require the fuel isolation kit available from VDO. **4-20mA Senders:** The EMS-3 supports 4-20mA current output pressure senders. **Voltage Output Pressure Senders:** The EMS-3 supports voltage output pressure senders. **SENDO Voltage Output Pressure Senders:** The EMS-3 supports the SENDO MPS 2, 5, 7, and 10 bar senders.

	User defined senders: EMS-3 has a user sender calibration feature that can be customized for senders not listed above.
Oil Pressure switch	NO (Normally Open) or NC (Normally Closed) oil pressure senders supported
Temperature Sender Input	
Temperature Sensors	**Resistive Senders:** The EMS-3 supports resistive type temperature senders. **VDO Resistive Senders:** VDO 120ºC and VDO 150ºC thermistor senders supported. **Echlin Resistive Sender:** Echlin TS920SA (32040) automotive temperature sender **Precision LM335 semiconductor:** Based on ON Semiconductors LM335 temperature sensor **User defined senders:** The EMS-3 has a user sender calibration feature that can be customized for senders not listed above
Volts	
Voltage measurement range	Up to 32Vdc
Voltage resolution	0.1V
Coolant Level Detector	
Coolant level switch	NO (Normally Open) float sensors. Switch connects to vehicles negative supply terminal when coolant level is at an acceptable level
Coolant level detection	2.5KHz AC signal

8 Operating the alarms

The alarm outputs can be used to switch an external alarm indicator. The external alarm switch is an open collector transistor switch to ground with a maximum rating of 0.25A DC which can be used to drive an auto relay, piezo buzzer or LED.

9 Firmware Upgrading

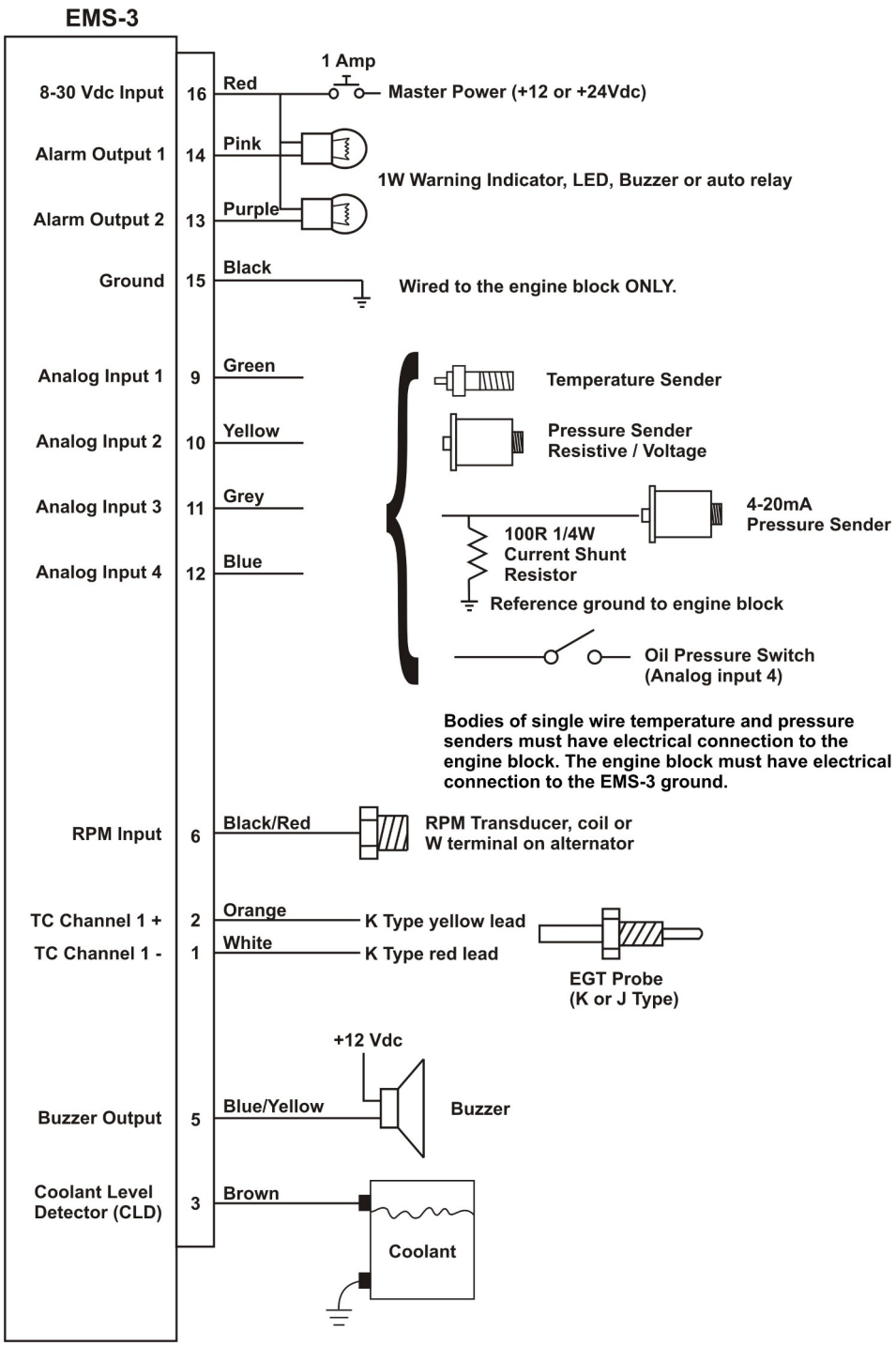
The EMS-3 can be upgraded in the field by connecting the RS232 port to a PC and running the firmware update program.

Please see the Madman EMS-3 firmware upgrading document for more information.

10 Installation

10.1 Connection Diagram

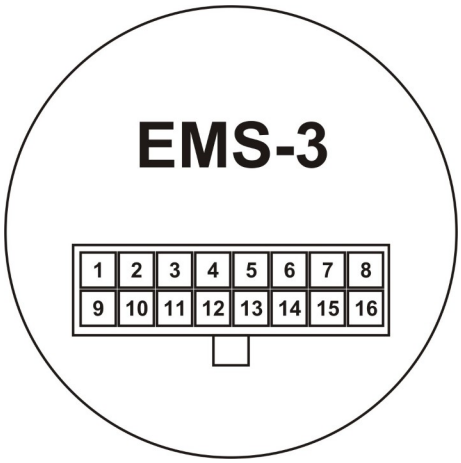
The use of an external 1A fuse is recommended. Connect the supply terminals to your vehicles power supply. The EMS-3 can be used on both 12V and 24V without the use of any pre-regulators. Ensure that the supply voltage will not drop below 8V during operation as this may result in incorrect readings.



Please note: It is essential that a single wire be connected from the minus terminal of the instrument to the engine block. This wire must not be used to share currents with other electrical users as this can affect accuracy of readings.

10.2 Cable connections (Molex Microfit 3.0)

Looking at the rear of the EMS-3 instrument



Pin	Color	Function
1	White	EGT Probe – (K Type Red lead)
2	Orange	EGT Probe + (K Type Yellow lead)
3	Brown	Coolant Level Detector (CLD input)
4	White/Blue	N/C
5	Blue/Yellow	External Buzzer
6	Black/Red	RPM Input
7	Blue/Orange	RS232 Transmit Data (Firmware upgrading) N/C
8	Orange/Black	RS232 Receive Data (Firmware upgrading) N/C
9	Green	Analog Input 1
10	Yellow	Analog Input 2
11	Grey	Analog Input 3
12	Blue	Analog Input 4 / Oil pressure switch
13	Purple	Alarm Output 2 (Open collector) N/C
14	Pink	Alarm Output 1 (Open collector)
15	Black	Ground. Connect the ground to the engine block, and the engine block to the battery negative. Do not connect the EMS-3 ground directly to the battery negative. This must be routed via the engine block.
16	Red	8-30Vdc power via power switch / circuit breaker and fuse.

Note: Some wires might not be populated

DIY installation can be done but it is recommended that a professional automotive installer installs the EMS-3.

You can use any combination of senders with your EMS – those functions that you do not use can be disabled within the menu structure.

When doing the wiring for the unit it is critical that you fit the black earth wire to the engine block – failure to do so will possibly result in erratic readings as other loads are switched on such as lights, fans, indicators etc.

Wire sizes used can be the same as the wires used on the harness supplied. Ensure that all connections are mechanically and electrically secure. Do not solder connections as these can lead to breakages were the solder stops due to the rigidity of the soldered joint. Crimp terminals or twisted wire joints should rather be used.

10.3 Fitting sender units

Notes to Remember:
Apply Loctite thread sealer to pressure and temperature fittings – thread tape may cause electrical connectivity problems

All temp senders and pressure senders and EGT probes us the same 1/8”-27 NPT thread. Generally, adapter kits require NO DRILLING or TAPPING, if your engine does not have an adapter listed, check the text to see if it should then be tapped. Your MadMan supplier or local mechanic should be able to offer this service for a small fee. Some engines make use of M10x1 threads or 1/8” BSP female threads on the oil pressure switch port – it is possible to safely fit the 1/8 NPT brass male Tee piece directly to this thread.

10.4 EGT (Exhaust Gas Temperature)

Some vehicles make use of an EGR (Exhaust Gas Recirculation) system or have removable plates on the exhaust manifold for this purpose – if this is the case then the plates can be removed and tapped to accommodate the EGT probe.

Your Madman supplier should then also have this plate in stock as a listed adapter for that engine. If you have an EGR valve fitted, remove it entirely and disable the diaphragm by removing the wiring loom or vacuum pipe. Use this port of the exhaust for the EGT. If you do not have a port on the exhaust manifold or do not want to disturb it, you will need to drill and tap the manifold. The manifold should be drilled at any suitable point closest to the entrance to the turbo, but still in the manifold, not the turbo housing.

With the engine cold, and idling, drill a pilot hole (4mm) into the manifold – as soon as the drill enters the inside of the manifold, the exhaust gas will escape past the drill bit ejecting the drilling swarf – guard your eyes.

Now drill the hole to 9mm, and immediately thereafter, tap the hole to the required thread (1/8 NPT). The 1/8” NPT thread is a taper thread where the hole gets larger the deeper you tap it, generally the tap should be turned in until 3mm of the thread of the tap remains outside the hole – you can screw the sender in to check for a good fit.

Fit the steel compression fitting to the adapter plate/manifold and tighten the adapter into the manifold/plate with the hex nut section closest to the manifold/plate, leaving the clamping nut (closest to the probe cable) fitted but loose.

Ensure the “olive” is fitted beneath the clamping nut on the compression fitting. Now tighten the clamping nut a bit until the probe is just nipped tight and it cannot move – tighten it another 1/8 turn. Note: it may be necessary to hold the fitting with a second spanner to prevent it from turning deeper into the manifold. It is better to have it too loose and need to tighten it a little more than to overtighten it and break it off.

The braided cable should not be cut as it is very difficult to clean the cable to get to the wires. It is best to roll up the spare cable and tie it up – if both ends are already fitted then roll it in a figure “8” which is easier. The cable can be lengthened using regular copper wire provided the joint is behind the dash and not in the engine bay as the accuracy of the probe will be affected. Madman can supply special cable to lengthen the probe without loss of accuracy. Any loss will be the difference in temperature between the joint in the cable and the location of the EMS unit.

10.5 Coolant Temperature

Notes to Remember:
The body of the temperature sender must form an electrical return path to the engine block (for single connector temperature senders). The temperature sender should preferably be on the hot side (head side) of the thermostat
The temperature sender should always be in contact with water – no water means no temperature measurement, hence the need for the coolant level detector. A low temperature reading does not mean there is water.

There are several ways to fit the temperature sender:
In a spare coolant plug/probe
In a specially made sandwich adapter
In a Madman Delrin plastic hose adapter tube
Directly into a drilled and tapped hole in the aluminium/steel coolant piping/housing

Some engines have unused temperature measurement ports or unused blanked off holes. These are ideal to use for the temperature sender – check your vehicle's installation details on the MadMan web site to see if a plug adapter is available – if we do not list one and you have a spare plug port, please contact us so that we can supply the appropriate adapter.

Some engines do no have any spare ports so we have developed the sandwich adapter which bolts between the water inlet/outlet pipe and the block/head. The sandwich has a port in it to take the temperature sender. Check your vehicles installation details on the MadMan web site to see if a plug adapter is available. If we do not list one, we have either not developed one for your engine yet or it cannot use a sandwich adapter. Either way, please contact us so that we can supply the appropriate adapter.

Some engines have no option of a plug adapter or a sandwich adapter, these engines need an inline metal delrin plastic hose adapter or direct drilling and tapping. The inline Delrin plastic hose adapter has two ports, one for a temperature sender and one for M5 coolant level screw.

A piece of the top coolant hose is cut out and this adapter is inserted in the space, the hoses are clamped to the tube and the temperature sender screwed in. An earth tab is provided to earth the sender to the engine block. Please contact us if you have a need for this type of adapter. We will need to know what the inside diameter of your coolant hose is. Some older engines had large open spaces where it is easy to drill and tap the cooling jacket to fit the probe. Firstly establish that there is enough free space inside the water cavity to accept the length of the temperature sender (30mm) before drilling.

Drill a pilot hole (4mm) into the metal surface – as soon as the drill enters the inside of the cavity, water will escape past the drill bit ejecting the drilling swarf – guard your eyes.

Now drill the hole to 9mm and immediately thereafter, tap the hole to the required thread (1/8 NPT). The 1/8" NPT thread is a taper thread where the hole gets larger the deeper you tap it, generally the tap should be turned in until 3mm of the thread of the tap remains outside the hole – you can screw the sender in to check for a good fit.

10.6 Oil Temperature

You can choose to monitor any oil temperature, It is best to monitor the temperature of a potentially problematic component. If your vehicle has known problems with the gear box then monitor that, and similarly with engine oil etc. It is wise to monitor auto gearbox oil temperatures as these are known to get hot when working hard.

We make use of plug adapters for most gearbox engine and other temperature measurements.

Please check your vehicles installation details on the MadMan web site to see if a plug adapter is available for your gearbox or engine sump. If we do not list one and your application can use this type of adapter, please contact us so that we can supply the appropriate adapter. Some ZF automatic gearboxes will accept a 1/8 NPT temperature probe directly into the original drainplug hole.

10.7 Oil Pressure

Most engines use an oil pressure switch, which is coupled to the oil pressure warning light on the dash display.
Locate this switch on the engine (often nearby the oil filter) and remove the connector and then the switch.

Engines use a variety of thread sizes. Your Madman reseller will have a suitable adapter assembly available to suit your engine. If it is not listed, please let them know and we will make a suitable adapter to suit your application.

You will need to fit the original pressure switch as well as the oil pressure sender to the engine by using a brass Tee piece (available from MadMan) You will need to see which one must be fitted first such that everything can be screwed in tightly. If there is no way that the original pressure switch and new pressure sender cannot co-exist in the space available there are two options:
There may be an adapter pipe available that will effectively move the port away from the engine block to make space for the Tee piece, pressure switch and sender or you can contact us to provide you with a pressure sender that contains both the pressure switch and pressure sender in one unit, which may be easier to fit.

10.8 Coolant Level Detection

The brown wire in the EMS-3 unit connects to a coolant level sensor.

The CLD uses two probes (self tapping screws) and the presence of water/coolant between them to measure water.
The CLD is suitable for plastic coolant tanks, plastic radiator header tanks and can also be installed in the same inline Delrin plastic hose adapter as for the coolant temperature sender. For steel header tanks or copper radiators the mechanical float switch (MCLD) can be used.

CLD Installation in a Plastic Coolant Tank:
Select a suitable place on the plastic coolant bottle / plastic tank that is normally flooded with coolant – choose a spot about 10 to 20 mm lower than the normal level Drill two small holes (1.5mm) about 25mm from each other in the same horizontal plane. Fit small lugs to the brown wire from the EMS and screw the lug to the tank using a 3.5mm self tapping screw. The hole must be small so that the screw is tight – It makes a good water tight seal. Fit a lug to a loose black wire and screw that into the other hole, take the black wire to the same earth point on the engine block as the EMS earth.

CLD Installation in an in-line hose adapter:
Some vehicles have no way of fitting a mechanical float switch and do not have plastic components, these vehicles can use an inline hose adapter in the radiator hose. Select a suitable place in the top coolant hose, close to the engine block that is normally flooded with coolant. Cut the hose here and insert the hose adapter and refit the hose to the other side of the pipe with clamps. Fit the brown wire from the EMS-3 to the pipe. The return path is via the EMS earth wire already installed – no further wiring necessary.

Mechanical Float Switch Installation:
Drill a suitable hole in the metal tank, feed the wires through the hole, ensure that the sealing washer is fitted and tighten the nut, slowly and consistently until if feels tighter than before, then turn it one flat more – if it leaks turn it another flat tighter. The float switch has two black wires, connect any one of these to the engine block and connect the other to the EMS-3 wire directly. If the mechanical float switch is used, the EMS-3 should be set to 5 seconds or any suitable value to prevent false alarms – the shorter the delay the better the safety margin.

10.9 RPM Installation

The RPM inputs can be used with signals from about 5Vpp to as much as 100Vpp. The input is also AC coupled for easy installation. A noise filter is included that results in the input ignoring any high frequency noise signals as long as this is below the detection threshold of about 2.5Vpp.

The input impedance of the rev counter input is approximately 10Kohm. You can use series resistors as well as load resistors for applications that have unusual signals.

A 220Ohm ballast resistor can be connected across the RPM input to ground to reduce noise or secondary pulses on the RPM line.

After you have connected the RPM input terminals to the signal sources you will need to set the number of pulses per revolution under the “RPM SETUP” menus. The calibration itself depends on your engine and what kind of signal you are using.

10.10 Temperature senders

Resistive senders: The EMS-3 supports resistive type temperature senders. The internal pull up resistor dip switch for the resistive temperature sender input must be in the “ON” position.

VDO Resistive senders: The EMS-3 supports the VDO 120ºC and 150ºC thermistor automotive senders. The internal pull up resistor dip switch for the resistive temperature sender input must be in the “ON” position.

Echlin TS920SA resistive senders: The internal pull up resistor dip switch for the resistive temperature sender input must be in the “ON” position.

Most NTC senders require a single wire connected as shown in the installation diagram. The sender is grounded via the engine block. The ground terminal of the gauge input should be connected to the engine block. Some NTC senders have two wires. In this case it is not required that the sender housing itself is connected to the engine block. Wire the second wire to the reference ground terminal.

Precision senders (On Semiconductors LM335): These are senders containing a semiconductor temperature measurement device. They can be used for water or oil temperature. These senders are available in two types: an encapsulated version with a brass housing; a second uncommitted version contains only the sensor itself. This can be conveniently mounted inside an existing sender housing after you remove the original insides of the sender. This is intended to give you a solution for unusual or difficult to obtain senders. The internal pull up resistor dip switch for the resistive temperature sender input must be in the “ON” position.

User defined senders: The EMS-3 has a user sender calibration feature that can be customized for senders not listed above.

10.11 Pressure senders

Resistive senders: The EMS-3 supports resistive type pressure senders. The internal pull up resistor dip switch for the resistive pressure sender input must be in the “ON” position.

VDO Resistive senders: The EMS-3 includes linearisation curves for the VDO 2, 5 and 10 Bar pressure senders. The internal pull up resistor dip switch for the resistive pressure sender input must be in the “ON” position.

4-20mA Pressure Senders: The EMS-3 supports 4-20mA pressure senders. A 100Ohm 1/4W 1% resistor must be connected across the analog input channel to ground. The internal pull up resistor dip switch for the 4-20mA current sender input must be in the “OFF” position.

Voltage output pressure senders: The EMS-3 supports voltage output pressure sender. The EMS-3 also has a 0.5-4.5V sender selection. The internal pull up resistor dip switch for the voltage output pressure sender input must be in the “OFF” position.

Voltage output pressure senders: The EMS-3 includes linearisation curves for the SENDO MPS 2, 5, 7 and 10 Bar pressure senders. The internal pull up resistor dip switch for the 0.5-4.5V sender input must be in the “OFF” position.

User defined senders: The EMS-3 has a user sender calibration feature that can be customized for Resistive, 4-20mA as well as Voltage output pressure senders.

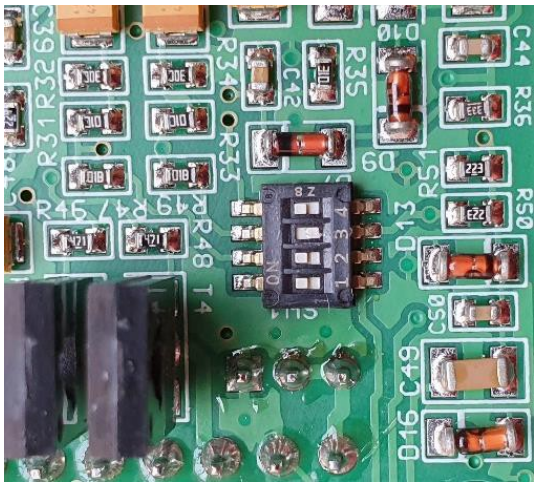
10.12 Senders that are grounded in the engine block

Single wire senders require that their mounting arrangement (thread) has a very good electrical contact with the engine block. Avoid the use of any sealant or tapes as these may cause a bad electrical connection. Further to this it is very important that the engine block has a good electrical connection to the negative supply terminal of the EMS-3. Any voltage drop caused by other equipment on the ground wire will cause incorrect readings. The best way to ensure a good connection is to wire a single connection between the EMS-3 ground terminal (any of these terminals) and the engine block. Do not wire this anywhere else and do not allow any other equipment to use this wire as a current return path.

10.13 Analog Channels Dipswitch settings

The EMS-3 unit has the added ability, over its predecessors, to use both resistance and voltage based sensors. In order to make use of this wider range of sensors, a small bank of on-off switches has been mounted on the input PC board inside the EMS-3 housing to enable sensor compatibility selection. Use a small screwdriver to change the switch direction. By default, CH1 + CH2 are ON and CH3 + CH4 are off. Failure to set the DIP switch will not cause damage but will cause false readings.

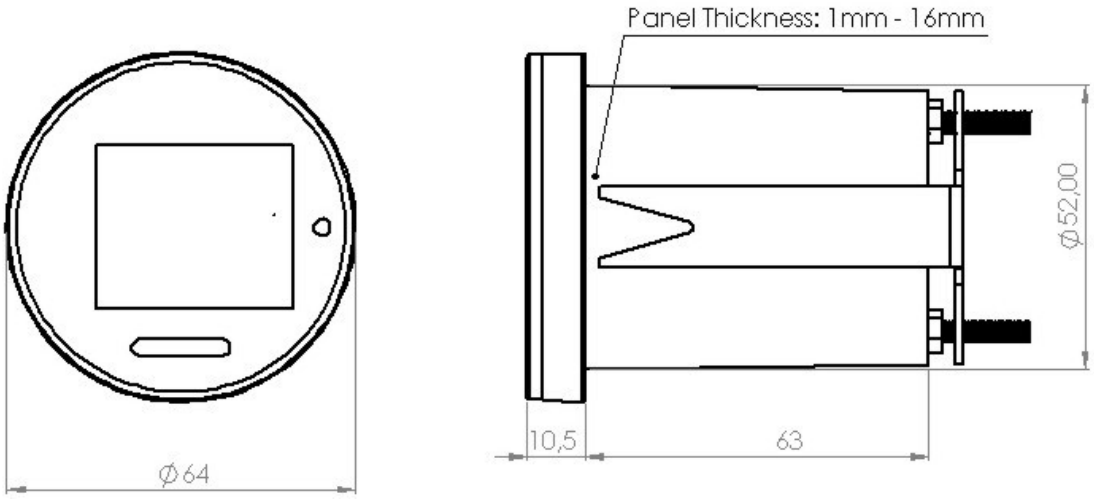
In most cases resistive sensors require a biasing voltage to work properly. The switch associated with the required channel must be in the ON position to enable the sensor to work correctly.



Example: In the image, switch 3 has been switched OFF to enable the use of a voltage based sensor on the Analogue 3 channel.

Dipswitch	Function
1	Analog Input Channel 1 Pull up resistor (On=Enable, OFF=Disable)
2	Analog Input Channel 2 Pull up resistor (On=Enable, OFF=Disable)
3	Analog Input Channel 3 Pull up resistor (On=Enable, OFF=Disable)
4	Analog Input Channel 4 Pull up resistor (On=Enable, OFF=Disable)

10.14 Dimensional Drawing



The drilled mounting hole must have a diameter of 53mm. The maximum panel thickness is 15mm, but the mounting bracket can be modified to accommodate thicker panels.

WARNING: The EMS-3 must not be operated by the driver when the vehicle is moving. All setups must be done prior to driving the vehicle.

11 Cleaning

The unit should not be cleaned with any abrasive substances. The screen is very sensitive to certain cleaning materials and should only be cleaned using a clean, damp cloth.

Warning: The EMS-3 is not waterproof, serious damage could occur if the unit is exposed to water and/or spray jets. Please consult the factory for weatherproof alternatives.

12 Warranty

This product carries a warranty for a period of one year from date of purchase against faulty workmanship or defective materials, provided there is no evidence that the unit has been mishandled or misused. Warranty is limited to the replacement of faulty components and includes the cost of labor. Shipping costs are for the account of the purchaser.

Note: Product warranty excludes damages caused by unprotected, unsuitable or incorrectly wired electrical supplies and or sensors, and damage caused by inductive loads.

13 Disclaimer

Operation of this instrument is the sole responsibility of the purchaser of the unit. The user must make themselves familiar with the operation of this instrument and the effect of any possible failure or malfunction.

IMPORTANT NOTICE:
You must make your own determination if the products sold by Madman Developments (Pty) Ltd are safe and effective for your intended applications. Madman Developments (Pty) Ltd makes no representations or warranties as to either the suitability of any of the products we sell as to your particular application or the compatibility of any of the products we sell with other products you may buy from us or anywhere else, and we disclaim any warranties or representations that may otherwise arise by law. Also, we offer no specific advice on how to install any of the products we sell other than passing along anything that may have been provided to us by the manufacturer or other issues. If you are in need of further information or guidance, please turn to the manufacturer or other reputable sources.

The manufacturer reserves the right to alter any specification without notice.