EFI Technology Inc. Data Logging System

Hardware Reference Guide

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www.efitechnology.com

Documentation

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Health and Safety

Any hazardous materials used in EFI products are clearly marked with appropriate symbols. Product safety data sheets relating to these materials are available on request.

Field of Use

For the purposes of this document, EFI Technology Inc. understands that the intended Field of Use for this product is Automotive Racing Applications. All other existing or future applications are considered outside of this Field of Use.

Technical Support

EFI Technology Inc. provides a first-line of technical support to its customers with regard to the installation and operation of the Data Logging Systems.

On site support is also available and will be charged on a time and expenses basis or through support contracts established with each customer. This will provide for the following services:

- Support Engineer attendance at all or an agreed to number of races.
- Ongoing system training.
- Assistance with system diagnostics.
- Access to emergency spare components.
- Unlimited telephone technical support.
- Access to restricted EFI web site areas that contain software updates.

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Introduction

Overview

The EFI data logging system is designed for all levels of professional motorsports and available with up to 128MB of memory, 64 analog inputs and 8 digital channels. All analog inputs can be configured as 0-5 volt, strain gauges or thermocouples.

Communications is via CAN, RS232/485 or current loop and interfaces to a wide range of 3rd party engine management systems. A dedicated multi-rate telemetry output and Multicast network server allows each engineer to view customized screen setups.

Expansion boxes can be configured with amplifiers and can be located at strategic locations on the vehicle to help keep signal noise to a minimum.

All analog inputs are 0-5 volt and compatible with most standard chassis sensors. Strain gauge inputs are configurable for gains of: 100, 200, 500 & 1000. Custom settings are available on request.

The system uses the latest Power to Win 9.0 software suite compatible with Win 8/10 64-bit operating systems.

Figure 1 - Level 4.0 Data Logger

More Information

There is a wealth of additional information available on the EFI Technology web site at www.efitechnology.com. You can find, updates to the documentation, free downloads, technical articles, engineering information and much more.

Specifications

Specifications

LCU 4.0 Specifications

Description	Value
Enclosure	Billet 6061
Environmental	EMI O ring seals
Connectors	1 x AS2-18-35 PN 2 x AS2-16-35 SN *
Dimensions	6.2 x 5.6 x 1.8 in
Weight	1.95 lbs
EMI Protection	100V/m > 1GHz
Max Memory	128MB RAM
Voltage Range	9 to 18 volts
Temp Range	-40 to 75 deg C
Analog Inputs	64 Maximum
Resolution	12 Bit ADC
Digital Inputs	8 Hall effect/Magnetic
Internal	3 axis accelerometer
Digital Outputs	4 programmable
Logging Rates	1Hz to 1000Hz
Logging Modes	Sequential & Cyclic
Download	USB 12Mb/sec
Communications	CAN 2.0B 2 x RS 232/485 Current Loop
Beacon Input	32 channels
Switch inputs	4

* The Level 3 LCU is only supplied with 1 expansion connector

System Specification

Typical System

- Logger Control Unit (LCU)
- 2 Junction boxes
- System harness
- Front sensor harness
- Rear sensor harness
- Junction box harness
- Steering wheel dash or LCD dash
- 32 Channel beacon system
- 4 wheel speed sensors
- 48 Analog Inputs
- 8 Digital channels
- 25ft Download cable
- Telemetry system

LCU Specification

- 64MB memory
- 3 Analog cards
- 1 CAN card
- 1 Serial card (3 ports)
- 8 Digital inputs
- 4 Digital outputs
- 4 switch inputs
- USB 12MB/s download port
- 3 accelerometers (longitudinal, vertical & lateral)

Features

- 1000Hz sample rates
- Onboard math functions
- Configurable amplifiers
- Programmable outputs
- Multi rate telemetry
- 3rd party ECU interface
- Telemetry output
- SWD or LCD dash support
- Digital TMS input
- High Speed download

Typical System

The EFI logging system is modular and can be expanded to include options such as tire monitoring system (TMS), multi-rate telemetry, junction boxes etc. A typical system schematic is shown below.

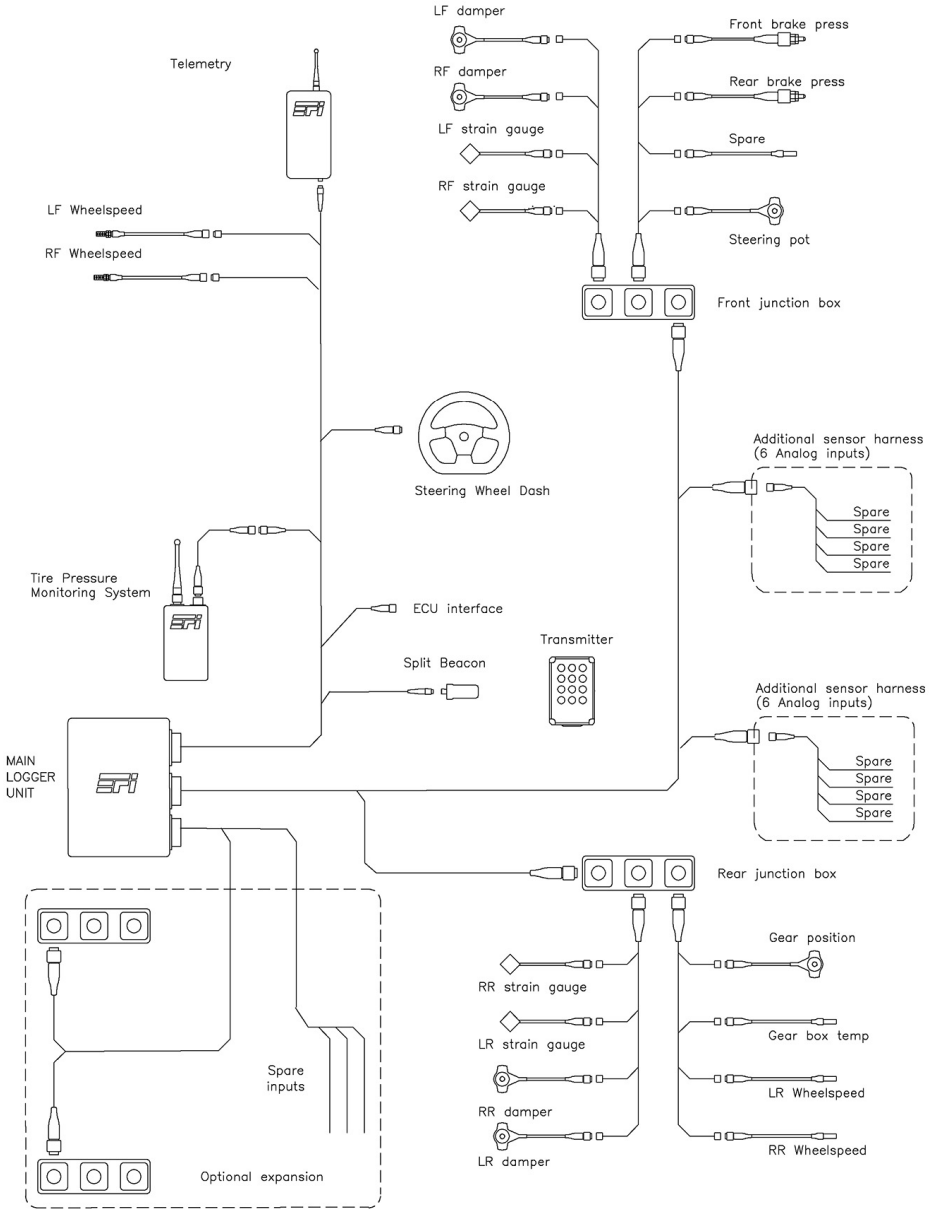

Figure 2 - Typical System

Part Numbers

Item	Part Number
EFI 3.0 LCU	73-048
EFI 4.0 LCU	73-041 *
16MB Memory card	73-104
Analog card	14-106
Amplifier card	14-102
CAN card	73-056
Serial card	73-056
Junction box	73-044
Junction box (internal amps)	73-046
Steering wheel dash	73-003
LCD dash	73-007
Dash backlight kit	62-614
Satellite module	73-028
32 channel beacon receiver	73-052
Beacon transmitter	73-014
6 ft download cable	62-413 **
25 ft download cable	62-414

* includes 16MB of memory as standard.
** 5 pin Fischer connector version.

Connector Information

Autosport Connectors

The EFI Logger System uses Deutsch Autosport AS, harsh environment connectors. The AS series is a range of medium and high density circular connectors designed to meet the stringent requirements of the motorsports industry.

Autosport connectors are manufactured using high strength aluminum alloys with black zinc coated shells. Contacts are copper alloy with gold plating and insulators are made with polyamide and fluorinated silicone.

Autosport connectors are used throughout the EFI logging system, its associated components and harnesses.

Features

- High density arrangements
- Contact sizes 16, 20 & 22
- Positive locking mechanism
- Conductive black zinc finish
- Interfacial and wire sealing
- 100% scoop proof with RFI grounding
- Integral shield and boot location
- In-line and hole mounting styles
- Environmentally sealed
- Standard gold plated contacts
- 5 keyway orientations (color coded)

Contact rating

Contact size	22	20	16
Current rating	5 amps	7.5 amps	20 amps
Max wire dia.	0.4mm	0.6mm	1.2mm

Temperature rating

-55 deg to +175 deg C

Vibration

Greater than 60g RMS in 3 axes

Connector Details

Figure 3 - Autosport Free plug, type 6

Deutsch Autosport connectors use a rotating sleeve to lock the two halves of the connector together. To connect Deutsch Autosport connectors:-

1 Make sure that the two connectors are compatible by checking that the number of contacts and the position of the keyways is the same for both connectors.

2 Align the keyways, and bring the two halves of the connector together.

3 Apply light pressure to the connector as you slowly turn the knurled sleeve.

4 When the latches connect with the sleeve, keep turning until you hear the sleeve click.

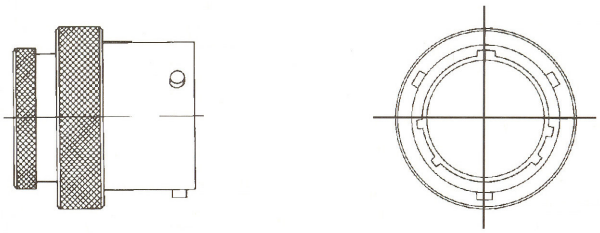

Figure 4 - Autosport Inline receptacle, type 1

The contacts of a Deutsch Autosport connector are labeled on the connector itself. The contact numbers are given on the outside and inside of the connector.

Autosport part numbering

The part number is made up using the AS range reference followed by the style, the shell size, the contact arrangement, the insert type and the shell keyway e.g. AS108-35PN. The modification code is only applicable if a special modification has been made to the connector.

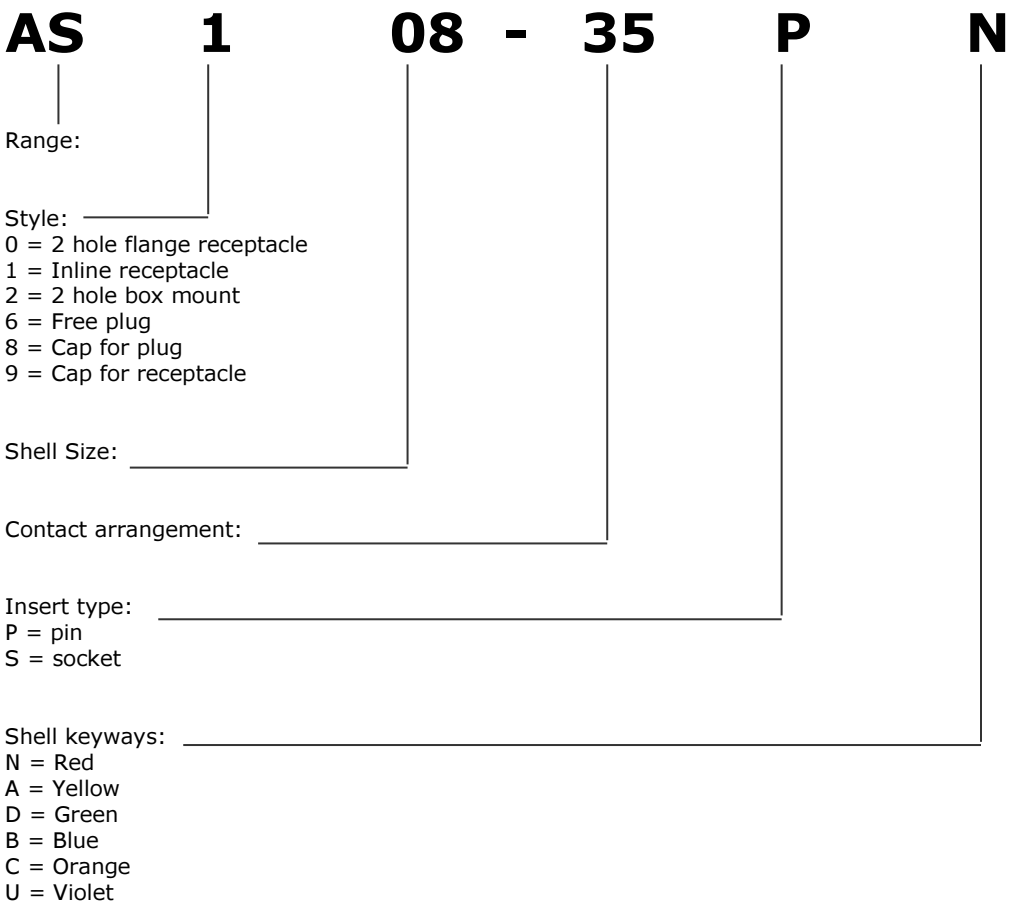

Figure 5 - Connector Part Numbering

Contact arrangements

Deutsch Autosport connector shell size and contact arrangements

The shell size and contact arrangement are shown below. Three sizes of contact are available: sizes 22, 20 and 16. The table below shows which sizes can be fitted.

Shell size	Contacts	Size 22	Size 20	Size 16
08	98	-	3	-
08	35	6	-	-
10	98	-	6	-
10	35	13	-	-
12	04	-	-	4
12	98	-	10	-
12	35	22	-	-
14	97	-	8	4
14	19	-	19	-
14	35	37	-	-
16	08	-	-	8
16	26	-	26	-
16	35	55	-	-
18	32	-	32	-
18	35	66	-	-
20	16	-	-	16
20	39	-	37	2
20	41	-	41	-
20	35	79	-	-
22	21	-	-	21
22	55	-	55	-
22	35	100	-	-
24	29	-	-	29
24	61	-	61	-
24	35	128	-	-

Installation

Connecting the LCU

The majority of vehicles have the negative terminal of the battery connected to the chassis and is commonly referred to as having a negative earth.

Battery connections are usually made through a Master Switch, which may be fitted in either the negative or positive, or both, supply leads from the battery. The Master Switch disconnects all electrical power in an emergency, and is required by the regulations governing most motor sports.

When connecting an MCU you should make sure that:

- the LCU remains powered up when the engine is turned off
- the LCU does not drain the car battery excessively
- the supply voltage to the LCU remains high enough for correct operation

When connecting an LCU to the battery:

- make all connections to, or as near as possible to, the battery terminals
- use a common point for connections to the battery
- keep the wire between the battery terminal and the connection point as short as is possible. Use heavy gauge wire, or braiding for this connection
- use 20-gauge or 22-gauge wire for connections between an MCU, and the connection point

CAUTION: Before making any connections to the battery, make sure you are confident with any harnessing that you have made. Remove power from the LCU before making any alterations.

Power requirements

The LCU needs a supply voltage greater than 10.0 volts to start-up and between 9.0 volts and 18 volts to operate correctly. If the supply voltage is outside the 9.0 volts and 18 volts limits, the LCU will not function correctly.

Depending upon the loads that you have connected and number and type of sensors the current consumption is typically between 1 amp and 3 amps. The battery +VE and battery -VE supply lines are fitted with a 5 amp fuse inside the LCU.

Connections

All system battery connections must only be connected to the battery at one point. Multiple connections to a length of wire or the chassis, will Introduce noise and reduce the integrity of sensor readings.

The optimum installation utilizes common connection points for the positive and negative terminals of the battery. Connecting equipment at a common point reduces the variation in supply voltage as current returns to the battery from other electrical components.

Connection methods

The most common form of electrical system for vehicles consists of a battery an alternator and electric starter motor. Power to the electrical components is made from the battery through a master Switch that isolates the entire vehicle electrical system. Battery power is then directed to secondary switches for all other device connections.

If your vehicle has this type of electrical system, then connect your logging system using the arrangement shown below. Use 20 or 22 gauge twisted wire to the logger system.

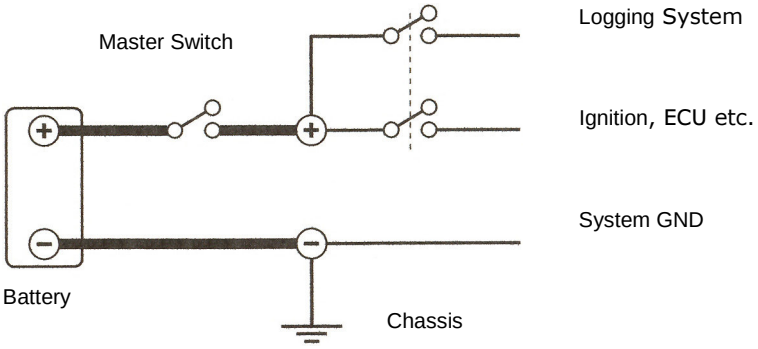

Figure 6 - Battery Connections

Backup battery

Some vehicles fitted with an electrical starter motor may drop the battery to as low as 6 volts during starting conditions. The logging system will not function normally below 9 volts and it may be necessary to install a separate backup battery to maintain sufficient voltage under these conditions.

Battery Connections

The LCU utilizes an internal common input power supply and grounding scheme with redundant connections. The battery connection and pins utilized are listed below.

NOTE: You must fit a backup battery if you are using safety critical or control applications. For further details refer to the section on fitting a backup battery.

Connecting the LCU

The LCU is connected to the battery using 7 pins located on the 66 pin system connector. These battery connections provide all of the power to the LCU and their functions are listed below. It is recommended that at least 2 of the VBATT and 3 of the PWR GND pins are utilized for the battery connection.

Battery connections

Pin	Connection	Function
39	PWR GND	Battery -
40	PWR GND	Battery -
41	PWR GND	Battery -
42	PWR GND	Battery -
-	-	-
61	VBATT	Battery +
62	VBATT	Battery +
63	VBATT	Battery +

The battery input connection is protected by a 5 amp thermal fuse. The input circuit is also protected against reversed battery polarity connections and transient voltages up to 35 volts.

ECU Systems

If your vehicle is fitted with an engine control unit (ECU) you can connect it to the logging system to enable them to share information. Data is typically shared using one of the defined ECU communications interfaces.

It is recommended that the ECU and logging system are connected to the battery using common ground connections. If your vehicle has this type of installation then connect the logging system and ECU using the arrangement shown below.

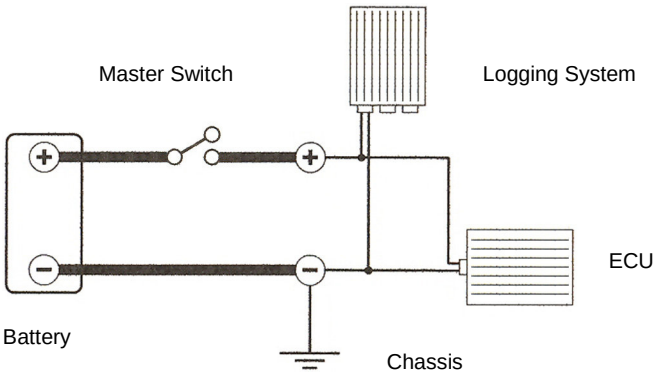

Figure 7 - ECU Connections

Ground loops

The ECU should be connected directly to the negative terminal of the battery but in some cases may be connected inadvertently to chassis ground causing a ground loop causing signal noise and incorrect sensor readings.

Ground loops can also occur if the shell of a connector touches the chassis and it may be necessary to fit rubber insulating material or boots over the connectors.

Testing for ground loops

Ground loops can be avoided by making direct connections to the battery. Before using your System, or if you are having problems with noise appearing in data from sensors, you should test for ground loops.

To test for a ground loop:

1. Disconnect the System connector from the car battery.
2. Measure the resistance between the LCU case and the chassis. If the resistance reading is low, then there is an electrical path to the chassis.
3. Starting with the sensor or junction box that is furthest away from the LCU, unplug ONE component at a time and measure the resistance between the LCU case and the chassis.
4. Repeat step 3 until the resistance reading is infinite.
5. Carefully check the component that you last disconnected for signs of shorting.

If the resistance reading is greater than 10k ohms, then your System is electrically isolated from the chassis. If you are still experiencing noise problems, then you should check that boots are fitted to all connectors, and that no connector is making contact with the chassis through vibration.

Avoiding ground loops

The most common source of a ground loop is a grounded sensor. Ensure that all sensors used are either isolated from the chassis (or engine), or if that is not possible then isolate the shield connection from that sensor.

Installation Information

This section contains general information on how to install the EFI logging system, harnesses and associated equipment into your vehicle.

Harness Installation

The harnesses manufactured by EFI Technology are made from spec 55 military airframe wire that can withstand temperatures up to 150°C. Harnesses are terminated with Deutsch Autosport connectors, are shielded and covered with Raychem heat shrink sleeve unless otherwise specified.

If you are making your own harnesses, then ask EFI for help with selecting suitable wire and connectors. Using poor quality wire and connectors may affect the performance and reliability of your logging System.

CAUTION: Manufacturing your own harnesses may void some of the terms and conditions of your product warranty.

Fitting harnesses

When fitting harnesses to your car, consider the following points:

- Care should be taken when routing wires near the engine. Make sure that your harnesses do not make contact with hot engine components such as exhaust pipes, manifolds, turbochargers or brake components.
- Excessive heat will burn the protective heat shrink layer, and may expose the inner shield and wires. This may lead to intermittent electrical faults and noise.
- When you install your harnesses, make sure that their position will not be affected by localized heating (heat soak) when the car is stationary.
- Remember that brake components frequently get very hot, and it will only be apparent after you have been running your car.

The easiest way to install harnesses is to make all connections to the LCU first, and then work away, towards any junction boxes, auxiliary equipment and sensors. Generally the harnesses become smaller and easier to route further away from the LCU.

Interference

In general, harnesses should not be routed next to sources of electrical interference i.e. ignition coils, plug leads, alternators, fuel pumps, telemetry equipment, especially antennas, and ECUs. If you have to route a harnesses near any of these, try to avoid parallel runs.

Notes

- Allow harnesses to follow their natural curvature. Do not force them around very tight radii.
- When a harnesses passes through a hole in the chassis or bulkhead, make sure that there is no risk of it being cut or damaged.
- When using tie-wraps avoid attaching harnesses to sharp or abrasive objects.

Manufacturing

When making your own harnesses, use a spare length of cable, and route it exactly as the finished harness. Use off-cuts of cable to create branches and carefully mark the main harness where the branches occur. By spending time adjusting your dummy harness, you can achieve the optimum installation for your vehicle.

If you are supplying a harness specification to EFI, take measurements from the dummy harness to create an engineering drawing. Use the following standards when specifying measurements and dimensions to EFI.

Specify all dimensions:-

- to the end of connectors
- to the centerline of transitions
- to end of terminals or lugs

LCU Installation

When installing the LCU you should consider the following points:

- The LCU is resistant to water, but after prolonged exposure, water, oil and fuel may eventually work their way inside the LCU.
- Select a position where the LCU will not be in constant contact with any fluid.
- The LCU must be protected from vibration. Use anti-vibration mounts.
- Make sure that air can flow over the LCU to keep it below +70°C.
- Do not place the LCU near sources of electrical interference e.g. Ignition coils, plug leads, ECUs, alternators and telemetry antenna.

LCU Orientation

Orientation

The LCU contains three identical accelerometers which are used to measure the lateral, longitudinal and vertical accelerations for each of the axes. The vertical accelerometer is a build option and may not be installed in your LCU.

It is particularly important that the lateral acceleration axis is in the correct orientation for the track mapping feature to function correctly in the analysis program. Please refer to the section later in this chapter if you need to change the standard LCU orientation. The standard LCU orientation and acceleration axes are shown in the figure below.

The LCU orientation is shown with the connectors pointing toward the front of the vehicle with the 66 pin system connector located on the right side of the housing.

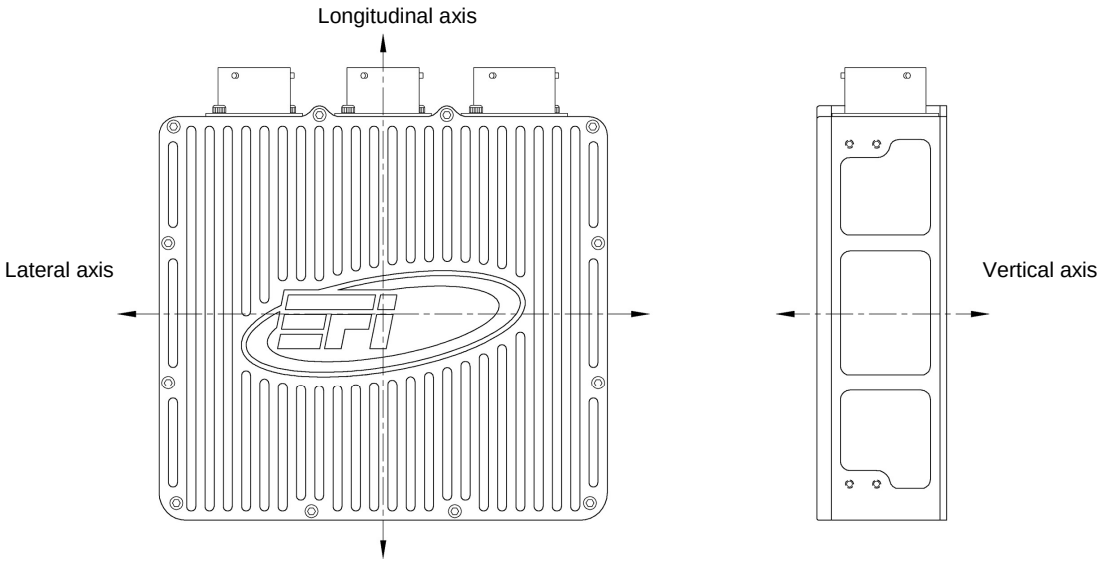

Figure 8 - LCU Orientation

Changing orientation

You can mount the LCU in a different orientation to the standard method. The three axes of acceleration (longitudinal, vertical and lateral) will still be measured, but by a different accelerometer to that used in the standard orientation. The channel names will need to be changed in the Power to Win software to correctly identify each channel.

The accelerometer channel names can be changed in the calibration editor window under channel calibrations, channel parameters using the "Config" program. Please refer to the Help file or contact your EFI representative for further information on re-naming the acceleration channels.

Installing an LCU

- Select a suitable dry location for the LCU.
- Make sure that the area does not exceed 70°C.
- Localized heating effects will add to the ambient air temperature.
- Use the mounting lugs and vibration mounts to secure the LCU.
- When you have installed the LCU make sure that air can flow around it.

CAUTION: The LCU housing acts as a heat sink for its internal electronic components. It is Important that air can flow around the sides of the LCU.

LCU Dimensions

The following diagram shows the overall dimensions and mounting details of the LCU (all dimensions are in inches)

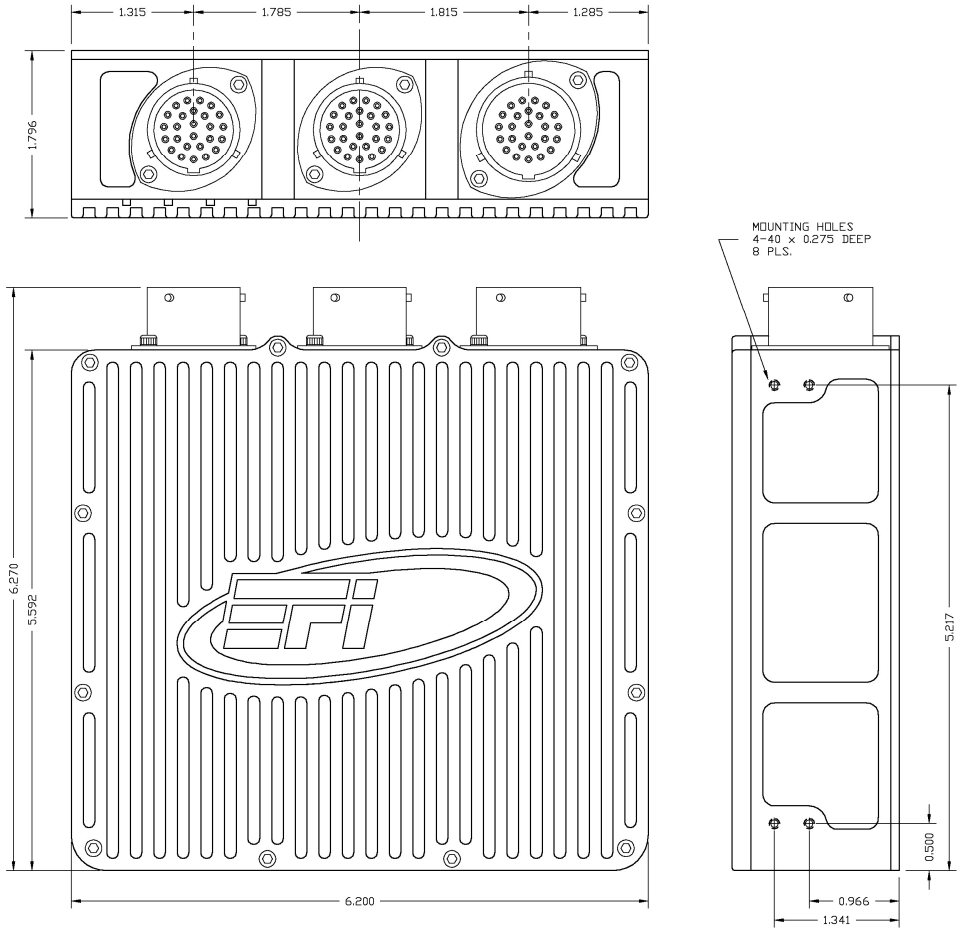

Figure 9 - LCU Dimensions

LCU Connectors

This section covers details about the connectors used on the LCU and the pinout information for each. The figure below shows the position and description of the three main connectors.

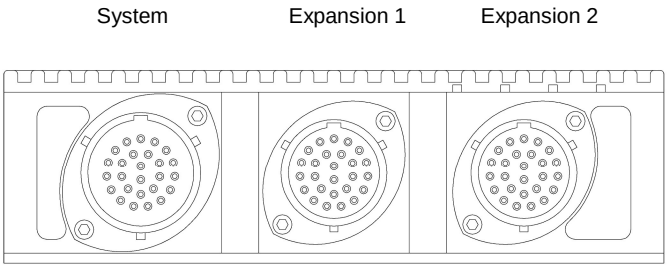

Figure 10 - LCU Connectors

Connector Details

The LCU is usually fitted with three Deutsch Autosport connectors. The connector part numbers and their locations are listed in the table below.

Description	LCU Connector	Mating Connector
System Connector	AS 218-35 PN	AS 618-35 SN
Expansion 1	AS 216-35 SN	AS 616-35 PN
Expansion 2	AS 216-35 SN	AS 616-35 PN *

* The 2nd expansion connector is only fitted on the 4.0 version LCU.

The Logger Unit

Internal channels

The LCU has several internal channels which can be monitored and logged in the same way as the external analog or digital inputs. The battery voltage and box temps should always be logged to keep track of the operating conditions of the LCU at all times.

The available internal channels are listed in the table below.

Channel	Description	ID
Battery	Internal battery (volts)	000
Box temp	Internal case temp (deg C)	002
Lateral G	Lateral acceleration (G)	003
Long G	Longitudinal acceleration (G)	001
Vertical G	Vertical acceleration (G)	063 *

* The internal vertical accelerometer is an optional channel and when installed disables the analog 1 input.

Expansion cards

The LCU is modular and is configured by the addition of interface cards. The LCU has provision for one serial card and up to three analog input cards. The communication card adds 3 serial ports (RS232/RS485) or 2 serial ports and 1 CAN port. Each analog card provides 8 analog inputs to the main LCU.

Slot	Name	Inputs
1	Comms	Serial ports 1-4
2	Analog 1	Analog inputs 7-14
3	Analog 2	Analog inputs 15-17, 50-54
4	Analog 3	Analog inputs 55-62

Additional channel expansion is available using external junction boxes described later in this chapter.

System Connector

System connector pinout

Pin	Name	Description	Pin	Name	Description
1	TXD 1	Telemetry TX	34	AUX1	Auxiliary Output
2	RXD 1	Spare RX	35	ANA3	Analog 3
3	CTS 1 **	RS232 mode	36	BOOT	Boot switch
4	RTS 1	RTS	37	SW4	Switch 4
5	TXD 2	ECU transmit	38	DIG1	Digital 1
6	USB shield	Shield	39	GND	Power ground
7	RXD 2	ECU receive	40	GND	Power ground
8	CTS 2 **	RS232 mode	41	GND	Power ground
9	RTS 2	RTS	42	GND	Power ground
10	USB +	USB high	43	AUX2	Auxiliary Output
11	TXD 3	ADR2 TX	44	ANA4	Analog 4
12	USB GND	Ground	45	SW1	Switch 1
13	RXD 3	Spare	46	DIG2	Digital 2
14	CTS 3 **	RS232 mode	47	12VO	Fused 12 volts *
15	RTS 3	RTS	48	12VO	Fused 12 volts
16	TXD 4	Spare	49	12VO	Fused 12 volts
17	RXD 4	Digital TMS	50	12VO	Fused 12 volts
18	TXD 4-	RS 485	51	AUX3	Auxiliary Output
19	USB -	USB low	52	SW2	Switch 2
20	RXD 4-	RS 485	53	BCN	Beacon
21	CAN +	CAN high	54	VREF	Fused 5 volts *
22	CAN -	CAN low	55	VREF	Fused 5 volts
23	TXD	Dash TX	56	VREF	Fused 5 volts
24	RXD	EFI ECU RX	57	VREF	Fused 5 volts
25	ANA1	Analog 1	58	AUX4	Auxiliary Output
26	ANA2	Analog 2	59	20VO	Fused 20 volts *
27	D2A	D to A Out	60	DIG4	Digital 4
28	SW3	Switch 3	61	VBAT	Battery In
29	DIG3	Digital 3	62	VBAT	Battery In
30	GND	Signal ground	63	VBAT	Battery In
31	GND	Signal ground	64	20VO	Fused 20 volts
32	GND	Signal ground	65	10VO	Fused 10 volts *
33	GND	Signal ground	66	10VO	Fused 10 volts

* Please refer to the section on power supplies for information on the maximum rating for each of the regulated voltage outputs.

** When using the RS232 mode for any of the serial ports the CTS and RTS pins must be connected together.

Expansion Connector 1

Expansion connector pinout

Pin	Name	Description	Pin	Name	Description
1	ANA1	Analog 1 *	34	JBX3	Mux. Input 3
2	ANA2	Analog 2 *	35	JBX4	Mux. Input 4
3	ANA3	Analog 3 *	36	12VO	Fused 12 volts
4	ANA4	Analog 4 *	37	GND	Signal ground
5	ANA5 +	Analog 5	38	GND	Signal ground
6	ANA5 -		39	GND	Signal ground
7	ANA6 +	Analog 6	40	DIG1	Digital 1 *
8	ANA6 -		41	DIG2	Digital 2 *
9	ANA7 +	Analog 7	42	DIG3	Digital 3 *
10	ANA7 -		43	VREF	Fused 5 volts
11	ANA8 +	Analog 8	44	12VO	Fused 12 volts
12	ANA8 -		45	12VO	Fused 12 volts
13	ANA9 +	Analog 9	46	12VO	Fused 12 volts
14	ANA9 -		47	MUX1	Mux. Control 1
15	ANA10 +	Analog 10	48	MUX2	Mux. Control 2
16	ANA10 -		49	MUX3	Mux. Control 3
17	ANA11 +	Analog 11	50	VREF	Fused 5 volts
18	ANA11 -		51	VREF	Fused 5 volts
19	ANA12 +	Analog 12	52	VREF	Fused 5 volts
20	ANA12 -		53	DIG4	Digital 4 *
21	ANA13 +	Analog 13	54	20VO	Fuse 20 volts
22	ANA13 -		55	10VO	Fused 10 volts
23	ANA14 +	Analog 14			
24	ANA14 -				
25	ANA15 +	Analog 15			
26	ANA15 -				
27	ANA16 +	Analog 16			
28	ANA16 –				
29	GND	Signal ground			
30	GND	Signal ground			
31	GND	Signal ground			
32	JBX1	Mux. Input 1			
33	JBX2	Mux. Input 2			

* The Digital and Analog inputs 1 thru 4 on the System connector are common with the same inputs defined on the 1st expansion connector. Connections should only be made to one of the locations.

The Analog –ve input pins are only used as the differential inputs to the internal amplifiers when installed otherwise they can be used as signal grounds.

Expansion Connector 2

Expansion connector pinout

Pin	Name	Description	Pin	Name	Description
1	N/C	Empty	34	JBX3	Mux. Input 3 *
2	N/C		35	JBX4	Mux. Input 4 *
3	N/C		36	12VO	Fused 12 volts
4	N/C		37	GND	Signal ground
5	ANA17 +	Analog 17	38	GND	Signal ground
6	ANA17 -		39	GND	Signal ground
7	ANA18 +	Analog 18	40	DIG5	Digital 5
8	ANA18 -		41	DIG6	Digital 6
9	ANA19 +	Analog 19	42	DIG7	Digital 7
10	ANA19 -		43	VREF	Fused 5 volts
11	ANA20 +	Analog 20	44	12VO	Fused 12 volts
12	ANA20 -		45	12VO	Fused 12 volts
13	ANA21 +	Analog 21	46	12VO	Fused 12 volts
14	ANA21 -		47	MUX1	Mux. Control 1 **
15	ANA22 +	Analog 22	48	MUX2	Mux. Control 2 **
16	ANA22 -		49	MUX3	Mux. Control 3 **
17	ANA23 +	Analog 23	50	VREF	Fused 5 volts
18	ANA23 -		51	VREF	Fused 5 volts
19	ANA24 +	Analog 24	52	VREF	Fused 5 volts
20	ANA24 -		53	DIG8	Digital 8
21	ANA25 +	Analog 25	54	20VO	Fuse 20 volts
22	ANA25 -		55	10VO	Fused 10 volts
23	ANA26 +	Analog 26			
24	ANA26 -				
25	ANA27 +	Analog 27			
26	ANA27 -				
27	ANA28 +	Analog 28			
28	ANA28 –				
29	GND	Signal ground			
30	GND	Signal ground			
31	GND	Signal ground			
32	JBX1	Mux. Input 1 *			
33	JBX2	Mux. Input 2 *			

* The multiplexed analog input pins are common to both of the expansion connectors and must only be connected in one place to each junction box.

** The junction box multiplexer control lines are also common to both of the expansion connectors.

Voltage regulators

The LCU has 5 internal voltage regulators to provide a wide range of supply voltages to the external sensors. Each of the regulators is protected by a thermal fuse. The maximum current rating for each output is listed in the table below.

Regulators

Output	Type	25 deg C	80 deg C
12 volt	fixed	1.6A	800mA
5 volt	fixed	1.6A	800mA
8 volt	adjustable	1.2A	600mA
20 volt	fixed	0.3A	300mA
+/- 15	internal	0.3A	300mA

To preserve the vehicle battery while the charging system is inactive each of the voltage regulators can be controlled by software and activated by any combination of the following conditions.

Enable Conditions

- Engine On
- Vehicle moving
- Logging
- USB connected
- Battery OK
- Switch 3
- Switch 4

Note: To force each regulator output to be permanently active select the "Always On" option.

Expansion cards

All of the analog channels of the internal expansion cards can be configured independently as either 0 – 5 volt or amplified differential inputs. Each of the amplifiers can be also be configured with different gain and offset values.

Each dip switch controls the gain setting for 2 channels. For information about the dip switch settings for gains and offsets please refer to the table below.

Gain Settings

Gain	1	100	200	300	500	600	800	1000	1200
S1		X		X		X	X		
S2			X	X			X		X
S3					X	X	X		
S4								X	X
S5		X		X		X	X		
S6			X	X			X		X
S7					X	X	X		
S8								X	X

X denotes switch is on

Offsets

A single dip switch controls the offsets for all 8 channels on the expansion card. If the switch setting is in the on the position the offset will be 0.5 volts otherwise it is 2.5 volts. The default offset settings are 0.5 volts for thermocouple inputs and 2.5 volts for strain gauges.

Contact your EFI representative for information on the availability of additional gain and offset values.

Digital Inputs

The LCU has eight fixed digital input channels that can be used for measuring sensors that have a digital signal such as wheelspeed sensors, crank pickups etc. The digital inputs are all configured as 0 to 5 volt inputs with fixed 680Ω pull-up resistors.

To improve the signal integrity and avoid noise from electrical interference the digital inputs have hysteresis with a high trigger threshold of 2.6 volts and the low at 2.0 volts. The following diagram shows a sample pickup signal and how it is interpreted by the LCU after signal conditioning.

Voltage thresholds

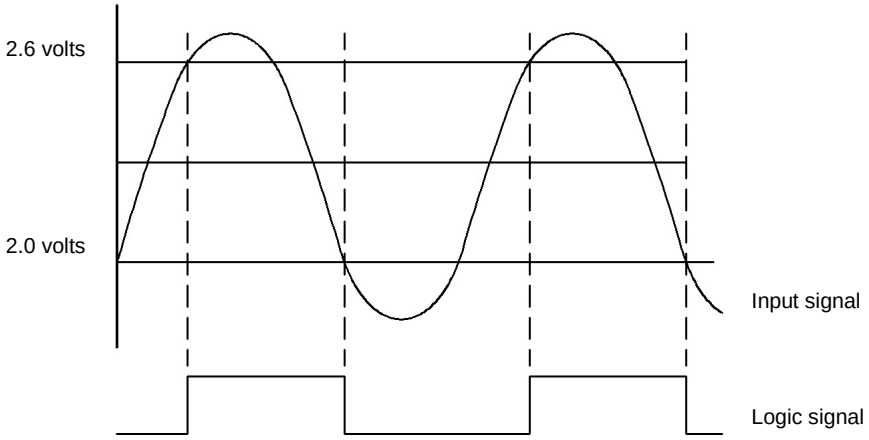

Figure 11 - Digital Inputs

A logic 0 input will only change state to a logic 1 input if the signal voltage rises above 2.6 volts. It will remain at a logic 1 until the signal voltage drops below 2.0 volts.

Magnetic pickups

The use of magnetic pickups or sensors with voltages outside of this range will require an external signal converter to be installed between the LCU and the sensor. (Use the EFI wheelspeed converter, part number 60-591 or equivalent.)

Additional I/O's

The LCU has 4 digital switch inputs. Switches 1 & 2 are used for various dash functions and switches 3 & 4 are under user control. The switch inputs are all located on the 66 pin system connector. Switch functions are listed in the table below.

Switch Inputs

Switch	Pin	Mode	Function
1	45	DASH	Clear Alarm/Fuel Reset
2	52	DASH	Change Page
3	28	USER	User defined
4	37	USER	User defined

All switch inputs are normally 5 volts and active when low.

Auxiliary Outputs

The LCU has 4 programmable auxiliary outputs. These outputs are controlled by software and are activated when a channel reaches a predefined condition and can be RPM qualified.

The auxiliary outputs are active low and have a maximum of 1 amp current sinking capability.

Communications

The LCU has a number of serial communications ports all accessed via the 66 pin system connector. Each port has its own characteristics and functions and can be independently configured by software.

The default configuration for each port is listed in the table below.

Port	Name	Function
P1	TEL	Telemetry system
P2	ECU	ECU interface
P3	ADR	Accident data recorder
P4	TMS	Tire pressure system
P5	DSH	Dash interface
P6	CAN *	CAN 2.0 port
P7	USB	USB download port

* Use of the CAN port requires the optional CAN card to be installed in the LCU.

Port 1 – Telemetry

This port is configured to output data to the telemetry radio system.

- Configurable as RS232 or RS485
- Baud rates up to 38400 bps

Pin	Name	Function	Comment
1	TXD1	Telemetry transmit	LCU to telemetry radio
2	RXD1	Telemetry receive	
3	CTS1	Clear to send	connect to RTS for RS232 mode
4	RTS1	Request to send	

Port 2 – ECU interface

This port is configured for bi-directional communication to a 3rd party ECU system.

- Configurable as RS232 or RS485
- Baud rates up to 57600 bps

Pin	Name	Function	Comment
5	TXD2	ECU transmit	LCU connection to ECU
7	RXD2	ECU receive	ECU connection to LCU
8	CTS2	Clear to send	connect to RTS for RS232 mode
9	RTS2	Request to send	

Port 3 – ADR2 interface

This ports default configuration is for communication with the Delphi accident data recorder.

- Configurable as RS232 or RS485
- Baud rates up to 57600 bps

Pin	Name	Function	Comment
11	TXD3	ADR transmit	LCU to ADR2 connection
13	RXD3	Undefined	
14	CTS3	Clear to send	connect to RTS for RS232 mode
15	RTS3	Request to send	

Port 4 – TMS interface

This ports default configuration is for communication with a digital tire pressure monitoring system.

- Configurable as RS232 or RS485
- Baud rates up to 19200 bps

Pin	Name	Function	Comment
16	TXD4	Undefined	
17	RXD4	TMS receive	TMS to LCU connection
18	CTS4	Clear to send	connect to RTS for RS232 mode
20	RTS4	Request to send	

Port 5 – Dash interface

This port is configured to output data to the SWD or LCD dash.

- Current loop
- Baud rates up to 19200 bps

Pin	Name	Function	Comment
23	TXD	DASH TX	LCU to Dash connection
24	RXD	RX	Spare receiver

Port 6 – CAN interface

This port is a general purpose CAN port and can be used to interface to various devices on the vehicle.

- CAN 2.0 compatible
- Baud rates up to 1Mbps

Pin	Name	Function	Comment
21	CAN +	CAN high	
22	CAN -	CAN low	

* Use of the CAN port requires the optional CAN card to be installed in the LCU.

Port 7 – USB interface

This port is configured to interface to a laptop or PC USB port and is used to monitor the LCU and for downloading logger data.

- USB 3.0 compatible
- Speed 12 Mbps

Pin	Name	Function	Comment
6	Shield	USB shield	
10	USB +	USB high	
12	GND	ground	
19	USB -	USB low	

Download connector

The download connector on the vehicle is used for all communications between your laptop USB port and the LCU. This connection is used for functions such as monitoring your system, sending setups and downloading logged data.

The following figure shows a typical installation using the 19 pin connector.

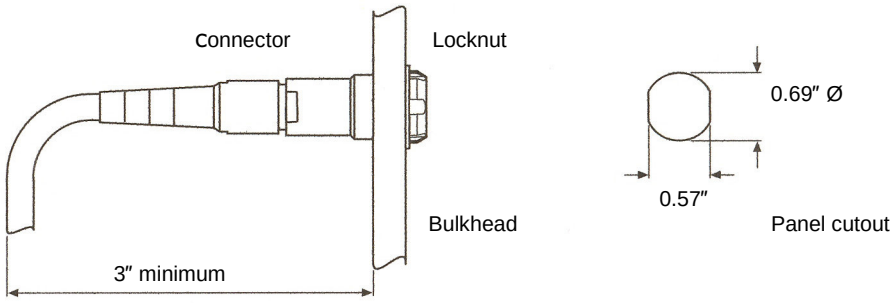

Figure 12 - Download connector

The download connector is usually fitted to the vehicle bodywork in a location that is easily accessed from the outside of the vehicle. An ideal location is behind the driver's area and on the side of the vehicle that is closest to the pit wall.

It is recommended that the download connector is located in an area that will not be exposed to water, dust or track debris. You should allow at least 3 inches behind the mounting panel to accommodate the connector and harness.

The download connection is available as a 5 pin or 19 pin Fischer connector. The 19 pin is commonly used when additional wires are required in the download port to accommodate 3rd party ECU wiring.

Fischer 5 pin Connector

Pin	Name	Function
1		
2	USB +	USB high
3		
4	USB -	USB low
5	GND	USB GND

Fischer 19 pin Connector

Pin	Name	Function
1		
2		
3		
4		
5	ECU GND	Serial port ground
6		
7		
8		
9	USB GND	USB GND
10	USB +	USB high
11	USB -	USB low
12		
13		
14	ECU GND	Serial port ground
15		
16	ECU TXD	ECU to PC serial transmit
17	ECU RXD	PC to ECU serial receive
18		
19		

Download cables

Several versions are available for the download cable. The standard cable is 6 feet long and the optional cable is 22 feet long. The long cable utilizes a built in USB hub and allows the laptop to be connected to the vehicle across the pit wall.

The maximum permissible length of USB cable between the laptop and LCU is 15 feet. Custom download cables up to 50 feet are available by utilizing integrated USB hubs. Please contact your EFI representative for further information.

CAUTION: When manufacturing your own harnesses and download cables be sure to use the correct specification USB wire.

System Expansion

Junction Boxes

The EFI logging system is modular and the number of analog inputs can be expanded by the addition of junction boxes. A maximum of 4 junction boxes can be added to the system each providing 8 analog inputs for a total of 32 additional channels. Junction boxes simplify wiring and can be located at strategic locations on the vehicle to help simplify wiring and help keep signal noise to a minimum.

All analog channels can be configured as 0-5 volt inputs compatible with most standard chassis sensors or a combination of arrangements with differential amplifiers. Amplified strain gauge inputs are configurable with standard gains of: 100, 200, 500 & 1000. Custom settings are available on request.

Dimensions

This section covers details about the box dimensions, connectors used on the junction boxes and the pinout information for each. The figure below shows the position and description of the three connectors.

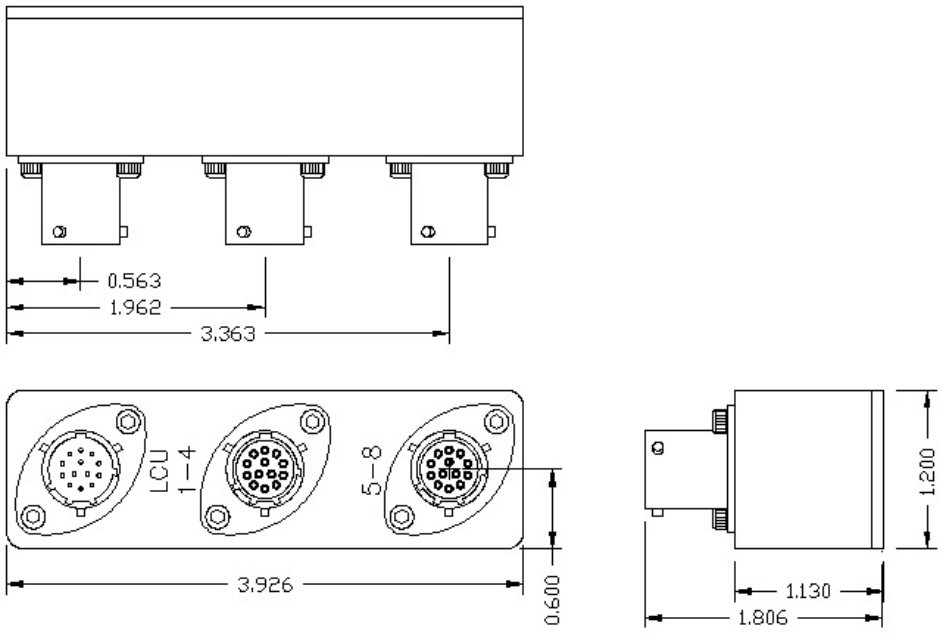

Figure 13 - Junction Box

Connections

The junction boxes are fitted with three Deutsch Autosport connectors. The connector part numbers and their locations are listed in the table below.

Description	JBX Connector	Mating Connector
Logger Connector	AS 210-35 PN	AS 610-35 SN
Analog 1 - 4	AS 210-35 SN	AS 610-35 PN
Analog 5 - 8	AS 210-35 SN	AS 610-35 PN

The logger connector provides power to the junction box and supplies the analog and digital signal connections back to the LCU. The two remaining connectors are used for the analog and digital inputs.

The junction box analog outputs are multiplexed and decoded by 3 control lines that are common throughout the logging system. It is important that each of the junction box outputs is connected to the correct dedicated input pin on the LCU.

Connector Details

Logger Connector

Pin	Name	Description
1	12V	12 volt input *
2	VREF	5 volt input
3	ANO	Analog output
4	MUX1	Mux 1 control line
5	MUX2	Mux 2 control line
6	MUX3	Mux 3 control line
7	DIG1	Digital 1 output
8	DIG2	Digital 2 output
9	DIG3	Digital 3 output
10	DIG4	Digital 4 output
11	N/C	
12	N/C	
13	GND	Signal ground

* The 12V and 5V inputs should be supplied by one of the regulated outputs of the LCU to provide short circuit protection to the junction box.

Signal inputs

Each connector provides 12 volts and 5 volts for sensor power and allows 4 analog inputs to be connected to each port of the junction box.

The digital inputs can also be connected to the junction box input ports but must only be connected in one location in the logging system. Each input port supports 2 digital signals which are passed directly through to the logger connector to simplify vehicle wiring.

Analog 1-4 Connector

Pin	Name	Description
1	12V	12 volts
2	VREF	5 volts
3	ANA1 +	Analog 1 *
4	ANA1 -	
5	ANA2 +	Analog 2
6	ANA2 -	
7	ANA3 +	Analog 3
8	ANA3 -	
9	ANA4 +	Analog 4
10	ANA4 -	
11	DIG1	Digital 1
12	DIG2	Digital 2
13	GND	Signal ground

* The Analog –ve input pins are only used as the differential inputs to the internal amplifiers when installed otherwise they can be used as signal grounds.

Analog 5-8 Connector

Pin	Name	Description
1	12V	12 volts
2	VREF	5 volts
3	ANA5 +	Analog 5
4	ANA5 -	
5	ANA6 +	Analog 6
6	ANA6 -	
7	ANA7 +	Analog 7
8	ANA7 -	
9	ANA8 +	Analog 8
10	ANA8 -	
11	DIG3	Digital 3
12	DIG4	Digital 4
13	GND	Signal ground

Dash Displays

The EFI logging system can use an LCD dash or Steering wheel dash (SWD) to display information to the driver. Both dash options can drive up to 4 additional satellite display modules (one can be a shift lamp module). Dashes are connected to the LCU via the main system harness and both require two remote switches to utilize the various dash functions.

SWD Dash

The Steering Wheel Dash (SWD) is an LED display with 5 programmable channel fields, sequential shift lights, a gear position indicator, 2 bar graphs and 4 warning lamps. One of the channel fields functions as a message center and there are 2 sets of user lamps.

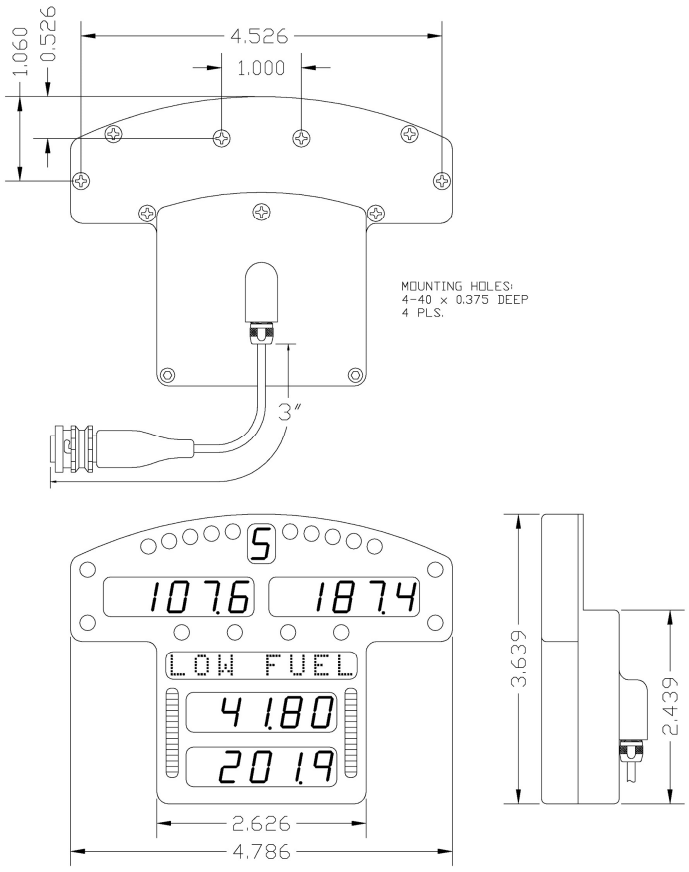

Figure 14 - Steering Wheel Dash

Connections

The SWD is fitted with a flying lead terminated with an Autosport 5 pin connector. The pinout details are shown in the table below.

SWD Connector

Pin	Name	Function
1	12V	12 volt supply *
2	LP23	Lamps 2 & 3
3	LP14	Lamps 1 & 4
4	RXD	Serial input
5	GND	Power ground

* The SWD 12 volt power should not be supplied by one of the regulated outputs of the LCU but directly from the battery. At full brightness the power consumption is approx. 1.5 amps.

Typical SWD Installation

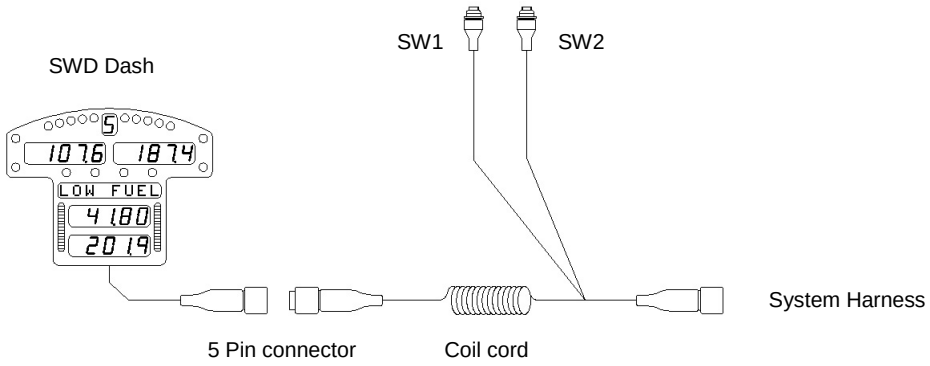

Figure 15 – Typical SWD installation

LCD Dash

This dash is a backlit (optional) LCD display with 6 programmable channel fields and dedicated rpm and fuel bar-graphs. One of the channel fields also functions as a message center. The center fields can display data up to 2 decimal precision with 1 decimal on the outer fields.

The dash can be programmed with a different display setup on each of the 3 pages that are selected by the SW1 input.

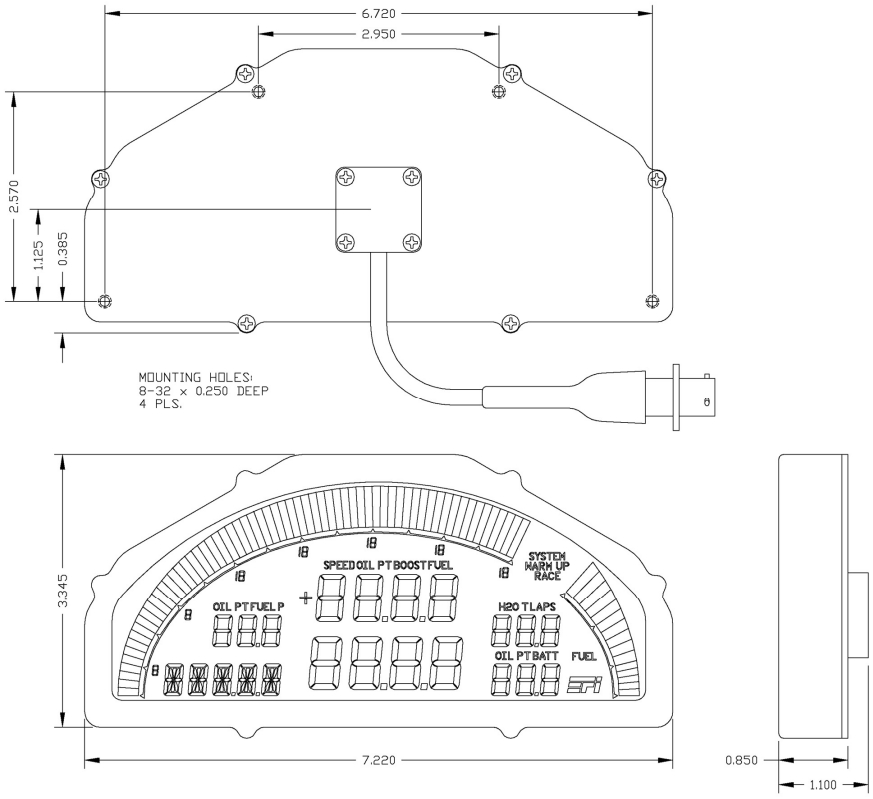

Figure 16 - LCD Dash

Connections

The LCD dash is supplied with an integrated harness for direct connection to the logger system. The pinout details are shown in the table below.

LCD Connector

Pin	Name	Function
1	12V	12 volt supply *
2	SW1	Switch 1
3	SW2	Switch 2
4	SW3	Switch 3
5	SW4	Switch 4
6	AUX1	Auxiliary 1
7	AUX2	Auxiliary 2
8	AUX3	Auxiliary 3
9	AUX4	Auxiliary 4
10	RXD	Serial input
11	N/C	
12	N/C	
13	GND	Power ground

* The SWD 12 volt power should not be supplied by one of the regulated outputs of the LCU but directly from the battery. At full brightness the power consumption is approx. 1.0 amp.

Typical LCD Installation

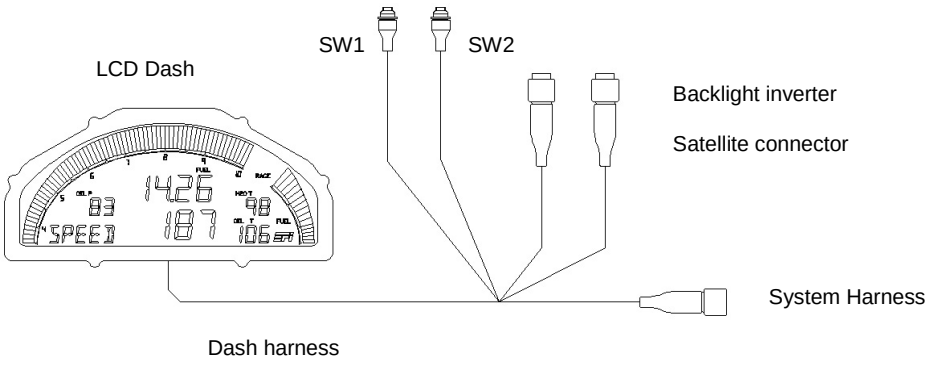

Figure 17 – Typical LCD Installation

Satellite Displays

Each of the dashes can drive up to 4 additional satellite LED displays. Satellites are available as 4 character displays or as a single character with 5 sequential shift lamps. (typically used for gear position).

This section covers details about the satellite dimensions and connectors used. The figure below shows both the standard and gear shift versions.

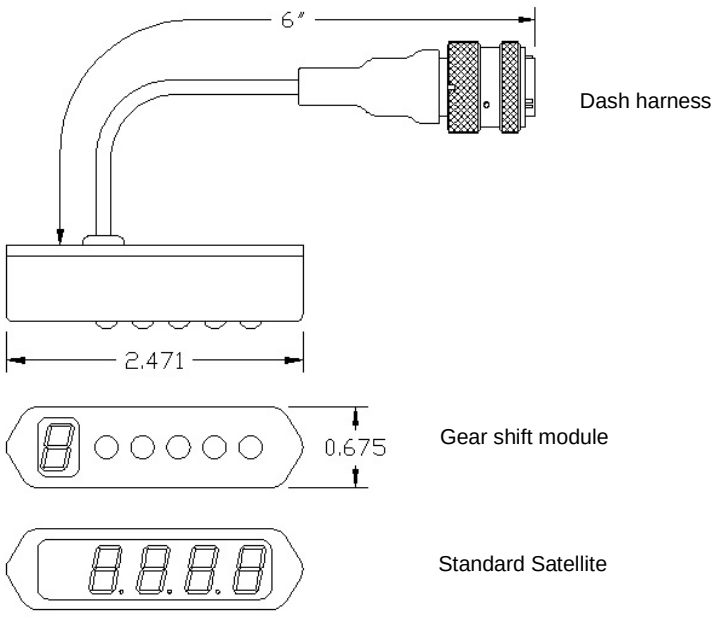

Figure 18 – Satellite Display

Installation

The compact design of the satellite dash modules allows flexibility in choosing mounting locations. Satellites can be used to supplement a standard dash or a number of them can be used to replace a standard dash where space limitations make a standard dash impractical.

As with the standard dash, these satellite displays can be set up to display different data as the driver scrolls through each of the three dash pages.

Connections

Each satellite is supplied with an integrated harness for direct connection to the main dash wiring harness. Several satellites can be connected together on a single assembly to simplify installation. The pinout details are shown in the table below.

Satellite Connector

Pin	Name	Function
1	VREF	5 volt supply *
2	SEL1	Select 1
3	SEL2	Select 2
4	SEL3	Select 3
5	SEL4	Select 4
6	DATA	Data input
7	CLK	Clock signal
8	LAMP1	Lamp 1
9	LAMP2	Lamp 2
10	LAMP3	Lamp 3
11	LAMP4	Lamp 4
12	LAMP5	Lamp 5
13	GND	Power ground

* The 5 volt power should be supplied by the regulated output from the main dash.

Beacon System

The EFI logging system uses a lap beacon system that generates end of lap and lap split timing information for the LCU. The beacon kit consists of a 32 channel infra red detector mounted on the vehicle chassis and a trackside mounted transmitter.

The 32 channel beacon has a split output which is used by the LCU for both lap and split data and a dedicated end of lap (EOL) output for 3rd party ECU connections. An optional lap only, 16 channel beacon is also available.

Receiver

This section covers details of the beacon receiver dimensions, connector used and pinout information. The figure below shows the beacon outline.

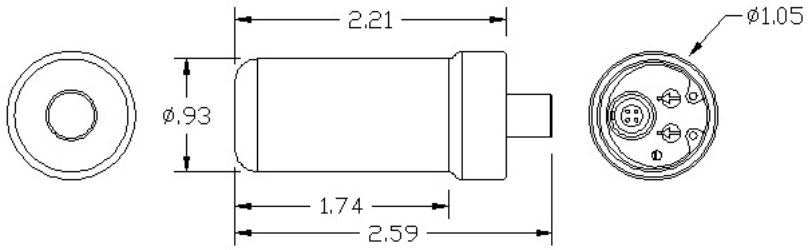

Figure 19 – Beacon Receiver

Specifications

Description	Value
Enclosure	Billet 6061 Aluminum
Connector	Lemo EHG 0B 304
Dimensions	2.21” x 0.93”
Weight	0.09 lb
Field of View	21 degree wide cone
Channels	32
Operating Temp	-40 to +75 deg C continuous

Connections

The beacon detector is fitted with a LEMO 4 pin connector. The pin assignments are listed in the table below.

Pin	Name	Function
1	SPLIT	Lap and split signal
2	GND	Power ground
3	12V	12 Volts
4	EOL	End of Lap signal

The mating LEMO connector part No. is FGG-OB-304.

Installation

When installing the beacon you should consider the following points:

- Make sure that the detector has an unobstructed line of sight view to the transmitter.
- Select a position where the beacon will not be in contact with any fluid or track debris.
- Do not place the detector near sources of electrical interference e.g. ignition coils, plug leads, alternators and telemetry equipment.
- Mount the detector parallel to the ground and perpendicular to the direction of the car's motion.

Operation

Before use always check that the detector and receiver are set to the same channel code. You can verify correct operation by looking at the small LED on the back of the detector which will flash when it receives a valid code from the transmitter.

The receiver has a rotary pot on the back used to set the channel. When the arrow on the rotary pot points towards the small circular indent on the back of the receiver housing channel 0 is selected. There are 16 channels available in both Lap and Split mode: namely 0-9 and A-F. Channel 0 is the most commonly used.

Transmitter

Installation

The beacon transmitter should be mounted on a tripod or similar device at the side of the track. The LED's should be approximately at the same height as the receiver location in the car and have an unobstructed view across the track.

Operation

The beacon transmitter has a knob for setting the current channel which will be indicated in the LED display window. There is also a switch for selecting either lap or split mode.

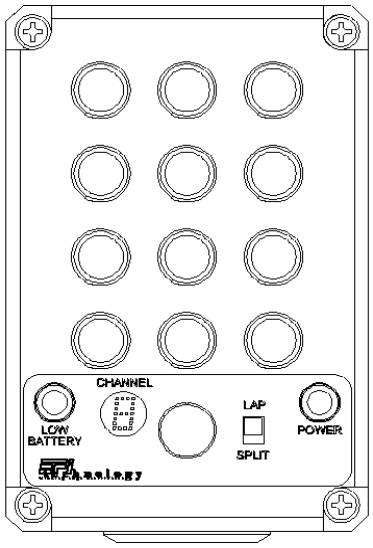

Figure 20 – Beacon Transmitter

General Use

The effective range of the transmitter is directly proportional to the supply voltage. Always ensure that the transmitter battery is fully charged before use and that the low battery warning lamp is not lit.

*The low battery warning is set at 11 volts.

Instrumentation

Connecting Sensors

The EFI data logging system uses an Autosport 5 pin connector standard for all sensor connections. The standard pinout for some different sensor types are given in the table below.

Sensor types

5 pin sensor connections

Pin	Single	Diff	RTD	Therm	Dig
1	N/C	N/C	N/C	N/C	12V *
2	5V	5V	N/C	N/C	5V
3	SIG+	SIG+	RTD+	SIG+	SIG
4	N/C	SIG-	RTD-	SIG-	N/C
5	GND	GND	N/C	N/C	GND

* See the section on voltage regulators for information about the supply current available for each of the regulated outputs.

Excitation

The sensor excitation voltage is typically 5 or 12 volts. The LCU also has an adjustable regulator set nominally at 8 volts and a fixed 20 volt 300mA output available.

Inputs

Differential means that there is a signal +ve and signal –ve input. Single ended means that the signal –ve is common with the signal ground input.

Generally only low current sensors should be used with single ended inputs. These types of input are suited to temperature or pressure sensors where the absolute accuracy is not required.

Mode

Unipolar means that the inputs can only measure positive signals. Bipolar means that the input can measure both positive and negative signals.

Gain

Unipolar channels can be configured with gains from 0 to 8. Bipolar channels can be configured with gains from 0 to 1200.

Types

There are two main types of sensor available, absolute and ratio-metric.

Absolute sensors are usually active sensors, such as accelerometers, which have an internal voltage reference or regulator and are unaffected by drift in the excitation voltage.

Ratiometric sensors, such as potentiometers or strain gauges, are affected by the excitation voltage. If you increase the excitation voltage the output signal will also increase proportionally.

In ratio-metric mode the LCU monitors the excitation voltage and compensates for any drift. This is useful for strain gauges or sensors using high gains where the excitation voltage may be higher to increase the output.

In ratio-metric mode the calibration is unchanged even when the excitation is increased. This means you can decrease the gain and improve the signal to noise ratio.

Sensor Wiring

Wiring information for some different sensor types is given in the following figures.

Connecting a potentiometer

Connect a potentiometer to a single ended input as shown below. If an amplifier is installed it should be configured with a gain of 1.

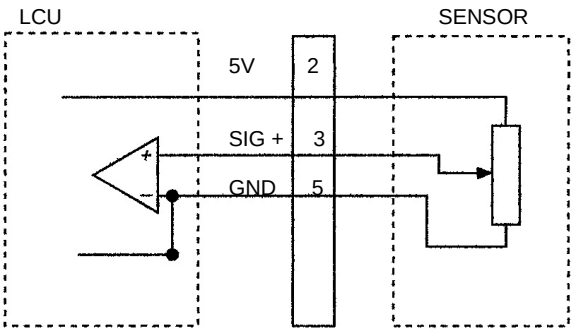

Figure 21 - Connecting a single ended input

Connect a potentiometer to a differential input as shown below.

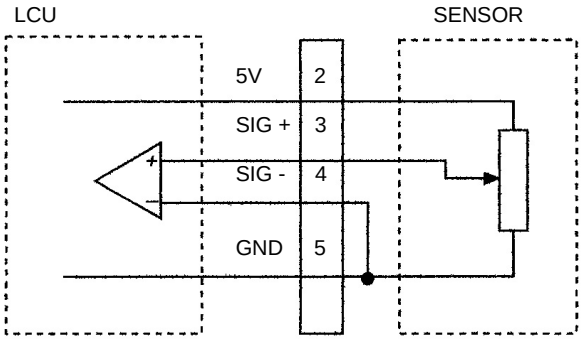

Figure 22 - Connecting a single ended input

Connecting a strain gauge

Connect a strain gauge as shown below. The input amplifier should be configured with a gain from 100 to 1000 and typically with an offset of 2.5 volts.

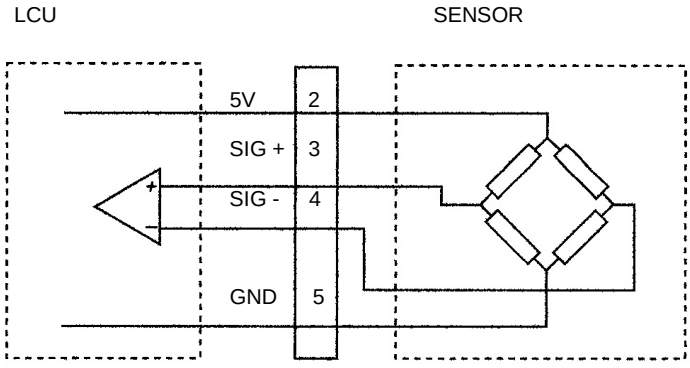

Figure 23 - Connecting a differential input

Connecting an RTD sensor

Connect an RTD as shown below. The input amplifier should be configured with a gain of 100 and use a 3K92 pull-up resistor connected to 5 volts on the input.

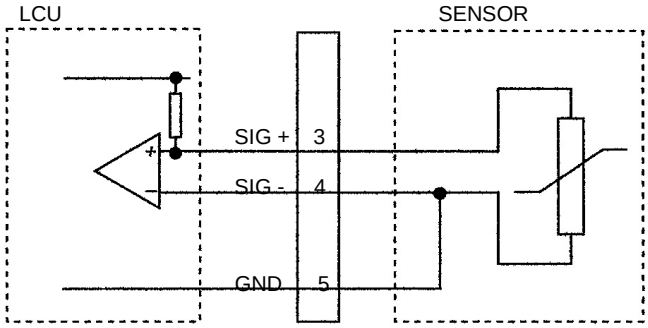

Figure 24 - Connecting an RTD sensor

Connecting a voltage output

Connect 0-5 volt output sensor (e.g. pressure transducer) as shown below. Use either the 5v or 12v excitation voltage as recommended by the sensor manufacturer.

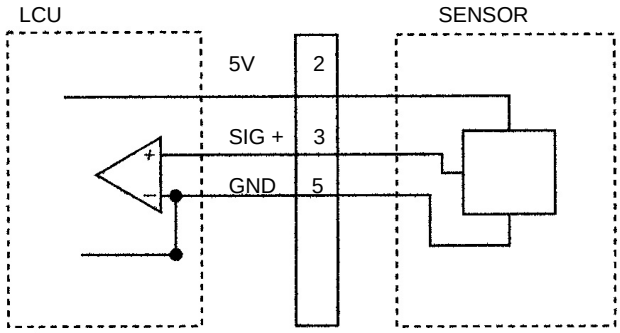

Figure 25 - Connecting a voltage output

Appendix

Contact Information

Address

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Torrance, CA 90503

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Fax 310 793 2514

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support	support@efitechnology.com
sales	sales@efitechnology.com
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EFI Technology Inc. Data Logging System

Hardware Reference Guide

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www.efitechnology.com

Documentation

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For the purposes of this document, EFI Technology Inc. understands that the intended Field of Use for this product is Automotive Racing Applications. All other existing or future applications are considered outside of this Field of Use.

Technical Support

EFI Technology Inc. provides a first-line of technical support to its customers with regard to the installation and operation of the Data Logging Systems.

On site support is also available and will be charged on a time and expenses basis or through support contracts established with each customer. This will provide for the following services:

- Support Engineer attendance at all or an agreed to number of races.
- Ongoing system training.
- Assistance with system diagnostics.
- Access to emergency spare components.
- Unlimited telephone technical support.
- Access to restricted EFI web site areas that contain software updates.

Contents

Table of Figures

Introduction

Overview

The EFI data logging system is designed for all levels of professional motorsports and available with up to 128MB of memory, 64 analog inputs and 8 digital channels. All analog inputs can be configured as 0-5 volt, strain gauges or thermocouples.

Communications is via CAN, RS232/485 or current loop and interfaces to a wide range of 3rd party engine management systems. A dedicated multi-rate telemetry output and Multicast network server allows each engineer to view customized screen setups.

Expansion boxes can be configured with amplifiers and can be located at strategic locations on the vehicle to help keep signal noise to a minimum.

All analog inputs are 0-5 volt and compatible with most standard chassis sensors. Strain gauge inputs are configurable for gains of: 100, 200, 500 & 1000. Custom settings are available on request.

The system uses the latest Power to Win 9.0 software suite compatible with Win 8/10 64-bit operating systems.

Figure 1 - Level 4.0 Data Logger

More Information

There is a wealth of additional information available on the EFI Technology web site at www.efitechnology.com. You can find, updates to the documentation, free downloads, technical articles, engineering information and much more.

Specifications

Specifications

LCU 4.0 Specifications

Description	Value
Enclosure	Billet 6061
Environmental	EMI O ring seals
Connectors	1 x AS2-18-35 PN 2 x AS2-16-35 SN *
Dimensions	6.2 x 5.6 x 1.8 in
Weight	1.95 lbs
EMI Protection	100V/m > 1GHz
Max Memory	128MB RAM
Voltage Range	9 to 18 volts
Temp Range	-40 to 75 deg C
Analog Inputs	64 Maximum
Resolution	12 Bit ADC
Digital Inputs	8 Hall effect/Magnetic
Internal	3 axis accelerometer
Digital Outputs	4 programmable
Logging Rates	1Hz to 1000Hz
Logging Modes	Sequential & Cyclic
Download	USB 12Mb/sec
Communications	CAN 2.0B 2 x RS 232/485 Current Loop
Beacon Input	32 channels
Switch inputs	4

* The Level 3 LCU is only supplied with 1 expansion connector

System Specification

Typical System

- Logger Control Unit (LCU)
- 2 Junction boxes
- System harness
- Front sensor harness
- Rear sensor harness
- Junction box harness
- Steering wheel dash or LCD dash
- 32 Channel beacon system
- 4 wheel speed sensors
- 48 Analog Inputs
- 8 Digital channels
- 25ft Download cable
- Telemetry system

LCU Specification

- 64MB memory
- 3 Analog cards
- 1 CAN card
- 1 Serial card (3 ports)
- 8 Digital inputs
- 4 Digital outputs
- 4 switch inputs
- USB 12MB/s download port
- 3 accelerometers (longitudinal, vertical & lateral)

Features

- 1000Hz sample rates
- Onboard math functions
- Configurable amplifiers
- Programmable outputs
- Multi rate telemetry
- 3rd party ECU interface
- Telemetry output
- SWD or LCD dash support
- Digital TMS input
- High Speed download

Typical System

The EFI logging system is modular and can be expanded to include options such as tire monitoring system (TMS), multi-rate telemetry, junction boxes etc. A typical system schematic is shown below.

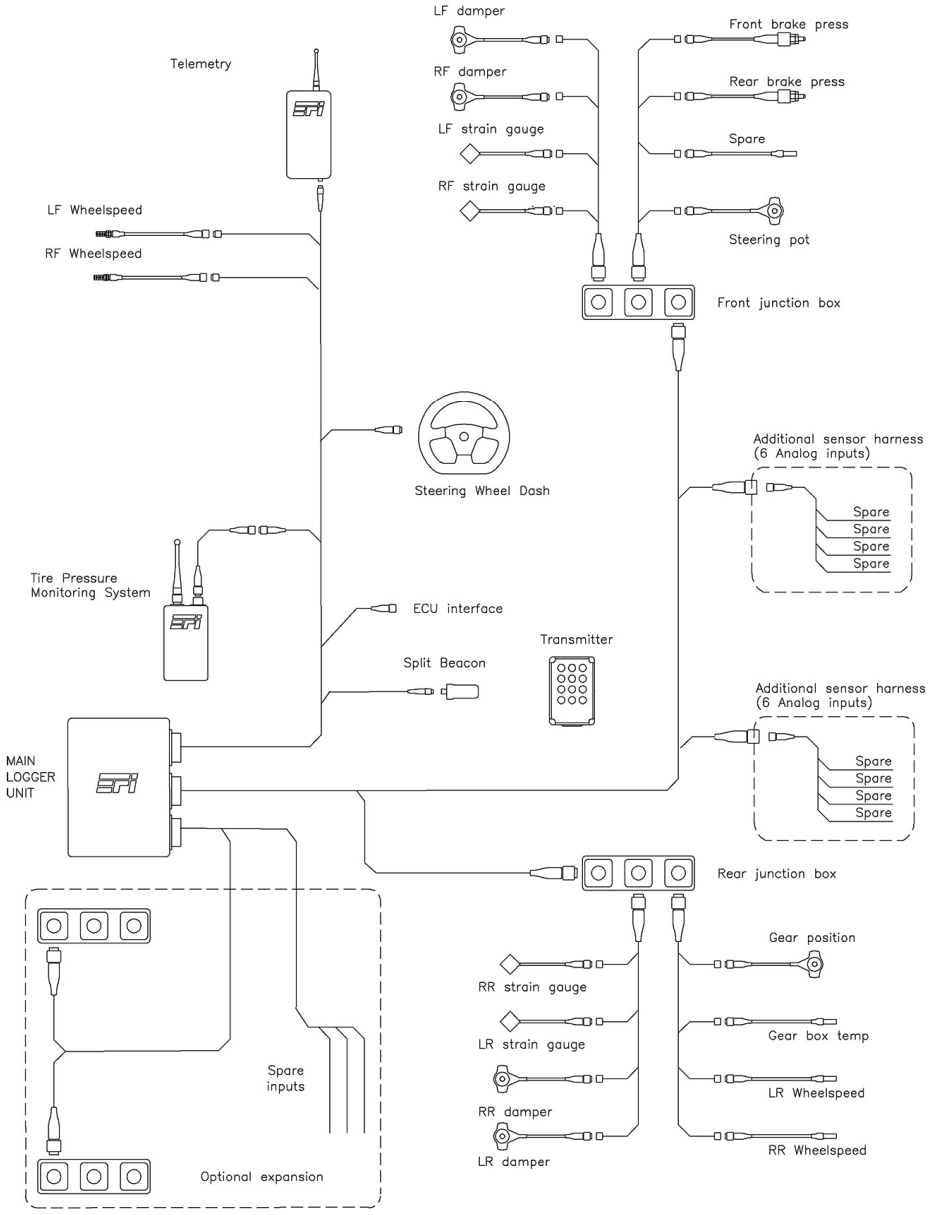

Figure 2 - Typical System

Part Numbers

Item	Part Number
EFI 3.0 LCU	73-048
EFI 4.0 LCU	73-041 *
16MB Memory card	73-104
Analog card	14-106
Amplifier card	14-102
CAN card	73-056
Serial card	73-056
Junction box	73-044
Junction box (internal amps)	73-046
Steering wheel dash	73-003
LCD dash	73-007
Dash backlight kit	62-614
Satellite module	73-028
32 channel beacon receiver	73-052
Beacon transmitter	73-014
6 ft download cable	62-413 **
25 ft download cable	62-414

* includes 16MB of memory as standard.
** 5 pin Fischer connector version.

Connector Information

Autosport Connectors

The EFI Logger System uses Deutsch Autosport AS, harsh environment connectors. The AS series is a range of medium and high density circular connectors designed to meet the stringent requirements of the motorsports industry.

Autosport connectors are manufactured using high strength aluminum alloys with black zinc coated shells. Contacts are copper alloy with gold plating and insulators are made with polyamide and fluorinated silicone.

Autosport connectors are used throughout the EFI logging system, its associated components and harnesses.

Features

- High density arrangements
- Contact sizes 16, 20 & 22
- Positive locking mechanism
- Conductive black zinc finish
- Interfacial and wire sealing
- 100% scoop proof with RFI grounding
- Integral shield and boot location
- In-line and hole mounting styles
- Environmentally sealed
- Standard gold plated contacts
- 5 keyway orientations (color coded)

Contact rating

Contact size	22	20	16
Current rating	5 amps	7.5 amps	20 amps
Max wire dia.	0.4mm	0.6mm	1.2mm

Temperature rating

-55 deg to +175 deg C

Vibration

Greater than 60g RMS in 3 axes

Connector Details

Figure 3 - Autosport Free plug, type 6

Deutsch Autosport connectors use a rotating sleeve to lock the two halves of the connector together. To connect Deutsch Autosport connectors:-

1 Make sure that the two connectors are compatible by checking that the number of contacts and the position of the keyways is the same for both connectors.

2 Align the keyways, and bring the two halves of the connector together.

3 Apply light pressure to the connector as you slowly turn the knurled sleeve.

4 When the latches connect with the sleeve, keep turning until you hear the sleeve click.

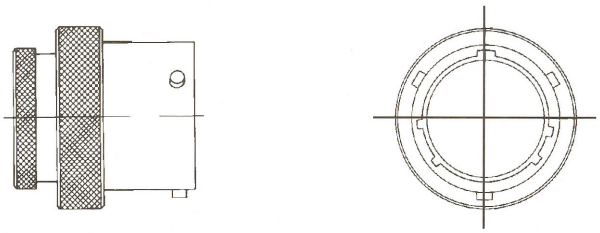

Figure 4 - Autosport Inline receptacle, type 1

The contacts of a Deutsch Autosport connector are labeled on the connector itself. The contact numbers are given on the outside and inside of the connector.

Autosport part numbering

The part number is made up using the AS range reference followed by the style, the shell size, the contact arrangement, the insert type and the shell keyway e.g. AS108-35PN. The modification code is only applicable if a special modification has been made to the connector.

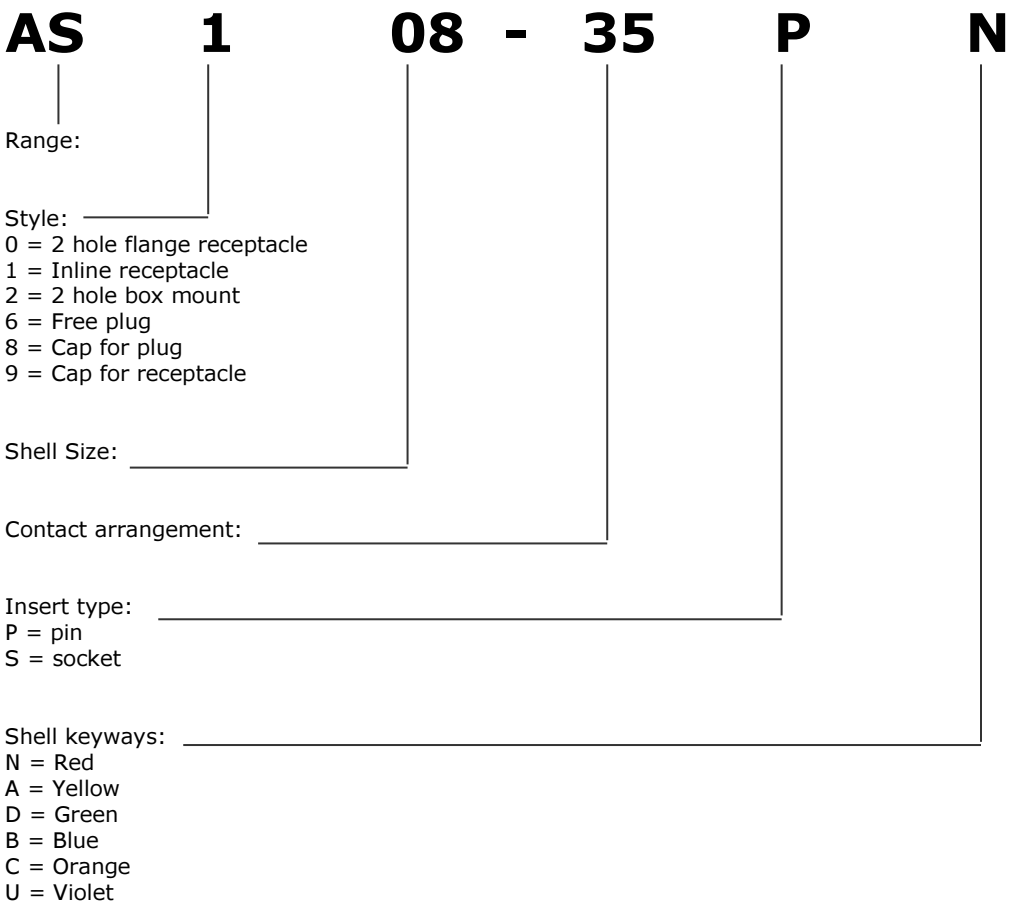

Figure 5 - Connector Part Numbering

Contact arrangements

Deutsch Autosport connector shell size and contact arrangements

The shell size and contact arrangement are shown below. Three sizes of contact are available: sizes 22, 20 and 16. The table below shows which sizes can be fitted.

Shell size	Contacts	Size 22	Size 20	Size 16
08	98	-	3	-
08	35	6	-	-
10	98	-	6	-
10	35	13	-	-
12	04	-	-	4
12	98	-	10	-
12	35	22	-	-
14	97	-	8	4
14	19	-	19	-
14	35	37	-	-
16	08	-	-	8
16	26	-	26	-
16	35	55	-	-
18	32	-	32	-
18	35	66	-	-
20	16	-	-	16
20	39	-	37	2
20	41	-	41	-
20	35	79	-	-
22	21	-	-	21
22	55	-	55	-
22	35	100	-	-
24	29	-	-	29
24	61	-	61	-
24	35	128	-	-

Installation

Connecting the LCU

The majority of vehicles have the negative terminal of the battery connected to the chassis and is commonly referred to as having a negative earth.

Battery connections are usually made through a Master Switch, which may be fitted in either the negative or positive, or both, supply leads from the battery. The Master Switch disconnects all electrical power in an emergency, and is required by the regulations governing most motor sports.

When connecting an MCU you should make sure that:

- the LCU remains powered up when the engine is turned off
- the LCU does not drain the car battery excessively
- the supply voltage to the LCU remains high enough for correct operation

When connecting an LCU to the battery:

- make all connections to, or as near as possible to, the battery terminals
- use a common point for connections to the battery
- keep the wire between the battery terminal and the connection point as short as is possible. Use heavy gauge wire, or braiding for this connection
- use 20-gauge or 22-gauge wire for connections between an MCU, and the connection point

CAUTION: Before making any connections to the battery, make sure you are confident with any harnessing that you have made. Remove power from the LCU before making any alterations.

Power requirements

The LCU needs a supply voltage greater than 10.0 volts to start-up and between 9.0 volts and 18 volts to operate correctly. If the supply voltage is outside the 9.0 volts and 18 volts limits, the LCU will not function correctly.

Depending upon the loads that you have connected and number and type of sensors the current consumption is typically between 1 amp and 3 amps. The battery +VE and battery -VE supply lines are fitted with a 5 amp fuse inside the LCU.

Connections

All system battery connections must only be connected to the battery at one point. Multiple connections to a length of wire or the chassis, will Introduce noise and reduce the integrity of sensor readings.

The optimum installation utilizes common connection points for the positive and negative terminals of the battery. Connecting equipment at a common point reduces the variation in supply voltage as current returns to the battery from other electrical components.

Connection methods

The most common form of electrical system for vehicles consists of a battery an alternator and electric starter motor. Power to the electrical components is made from the battery through a master Switch that isolates the entire vehicle electrical system. Battery power is then directed to secondary switches for all other device connections.

If your vehicle has this type of electrical system, then connect your logging system using the arrangement shown below. Use 20 or 22 gauge twisted wire to the logger system.

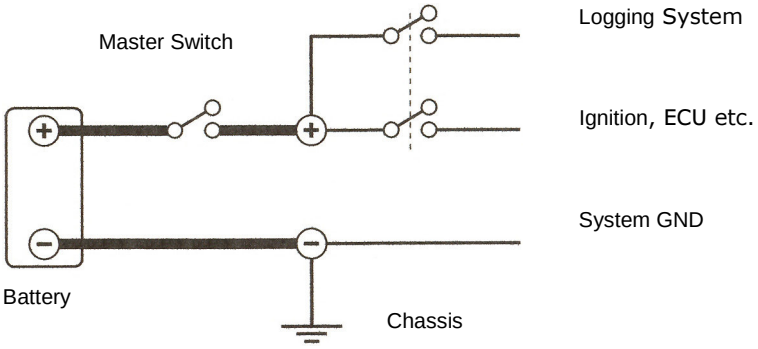

Figure 6 - Battery Connections

Backup battery

Some vehicles fitted with an electrical starter motor may drop the battery to as low as 6 volts during starting conditions. The logging system will not function normally below 9 volts and it may be necessary to install a separate backup battery to maintain sufficient voltage under these conditions.

Battery Connections

The LCU utilizes an internal common input power supply and grounding scheme with redundant connections. The battery connection and pins utilized are listed below.

NOTE: You must fit a backup battery if you are using safety critical or control applications. For further details refer to the section on fitting a backup battery.

Connecting the LCU

The LCU is connected to the battery using 7 pins located on the 66 pin system connector. These battery connections provide all of the power to the LCU and their functions are listed below. It is recommended that at least 2 of the VBATT and 3 of the PWR GND pins are utilized for the battery connection.

Battery connections

Pin	Connection	Function
39	PWR GND	Battery -
40	PWR GND	Battery -
41	PWR GND	Battery -
42	PWR GND	Battery -
-	-	-
61	VBATT	Battery +
62	VBATT	Battery +
63	VBATT	Battery +

The battery input connection is protected by a 5 amp thermal fuse. The input circuit is also protected against reversed battery polarity connections and transient voltages up to 35 volts.

ECU Systems

If your vehicle is fitted with an engine control unit (ECU) you can connect it to the logging system to enable them to share information. Data is typically shared using one of the defined ECU communications interfaces.

It is recommended that the ECU and logging system are connected to the battery using common ground connections. If your vehicle has this type of installation then connect the logging system and ECU using the arrangement shown below.

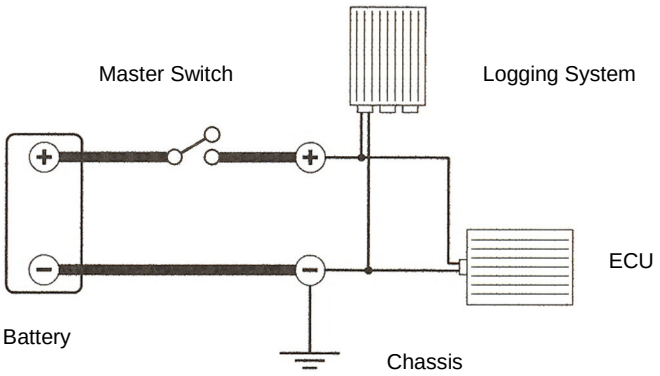

Figure 7 - ECU Connections

Ground loops

The ECU should be connected directly to the negative terminal of the battery but in some cases may be connected inadvertently to chassis ground causing a ground loop causing signal noise and incorrect sensor readings.

Ground loops can also occur if the shell of a connector touches the chassis and it may be necessary to fit rubber insulating material or boots over the connectors.

Testing for ground loops

Ground loops can be avoided by making direct connections to the battery. Before using your System, or if you are having problems with noise appearing in data from sensors, you should test for ground loops.

To test for a ground loop:

1. Disconnect the System connector from the car battery.
2. Measure the resistance between the LCU case and the chassis. If the resistance reading is low, then there is an electrical path to the chassis.
3. Starting with the sensor or junction box that is furthest away from the LCU, unplug ONE component at a time and measure the resistance between the LCU case and the chassis.
4. Repeat step 3 until the resistance reading is infinite.
5. Carefully check the component that you last disconnected for signs of shorting.

If the resistance reading is greater than 10k ohms, then your System is electrically isolated from the chassis. If you are still experiencing noise problems, then you should check that boots are fitted to all connectors, and that no connector is making contact with the chassis through vibration.

Avoiding ground loops

The most common source of a ground loop is a grounded sensor. Ensure that all sensors used are either isolated from the chassis (or engine), or if that is not possible then isolate the shield connection from that sensor.

Installation Information

This section contains general information on how to install the EFI logging system, harnesses and associated equipment into your vehicle.

Harness Installation

The harnesses manufactured by EFI Technology are made from spec 55 military airframe wire that can withstand temperatures up to 150°C. Harnesses are terminated with Deutsch Autosport connectors, are shielded and covered with Raychem heat shrink sleeve unless otherwise specified.

If you are making your own harnesses, then ask EFI for help with selecting suitable wire and connectors. Using poor quality wire and connectors may affect the performance and reliability of your logging System.

CAUTION: Manufacturing your own harnesses may void some of the terms and conditions of your product warranty.

Fitting harnesses

When fitting harnesses to your car, consider the following points:

- Care should be taken when routing wires near the engine. Make sure that your harnesses do not make contact with hot engine components such as exhaust pipes, manifolds, turbochargers or brake components.
- Excessive heat will burn the protective heat shrink layer, and may expose the inner shield and wires. This may lead to intermittent electrical faults and noise.
- When you install your harnesses, make sure that their position will not be affected by localized heating (heat soak) when the car is stationary.
- Remember that brake components frequently get very hot, and it will only be apparent after you have been running your car.

The easiest way to install harnesses is to make all connections to the LCU first, and then work away, towards any junction boxes, auxiliary equipment and sensors. Generally the harnesses become smaller and easier to route further away from the LCU.

Interference

In general, harnesses should not be routed next to sources of electrical interference i.e. ignition coils, plug leads, alternators, fuel pumps, telemetry equipment, especially antennas, and ECUs. If you have to route a harnesses near any of these, try to avoid parallel runs.

Notes

- Allow harnesses to follow their natural curvature. Do not force them around very tight radii.
- When a harnesses passes through a hole in the chassis or bulkhead, make sure that there is no risk of it being cut or damaged.
- When using tie-wraps avoid attaching harnesses to sharp or abrasive objects.

Manufacturing

When making your own harnesses, use a spare length of cable, and route it exactly as the finished harness. Use off-cuts of cable to create branches and carefully mark the main harness where the branches occur. By spending time adjusting your dummy harness, you can achieve the optimum installation for your vehicle.

If you are supplying a harness specification to EFI, take measurements from the dummy harness to create an engineering drawing. Use the following standards when specifying measurements and dimensions to EFI.

Specify all dimensions:-

- to the end of connectors
- to the centerline of transitions
- to end of terminals or lugs

LCU Installation

When installing the LCU you should consider the following points:

- The LCU is resistant to water, but after prolonged exposure, water, oil and fuel may eventually work their way inside the LCU.
- Select a position where the LCU will not be in constant contact with any fluid.
- The LCU must be protected from vibration. Use anti-vibration mounts.
- Make sure that air can flow over the LCU to keep it below +70°C.
- Do not place the LCU near sources of electrical interference e.g. Ignition coils, plug leads, ECUs, alternators and telemetry antenna.

LCU Orientation

Orientation

The LCU contains three identical accelerometers which are used to measure the lateral, longitudinal and vertical accelerations for each of the axes. The vertical accelerometer is a build option and may not be installed in your LCU.

It is particularly important that the lateral acceleration axis is in the correct orientation for the track mapping feature to function correctly in the analysis program. Please refer to the section later in this chapter if you need to change the standard LCU orientation. The standard LCU orientation and acceleration axes are shown in the figure below.

The LCU orientation is shown with the connectors pointing toward the front of the vehicle with the 66 pin system connector located on the right side of the housing.

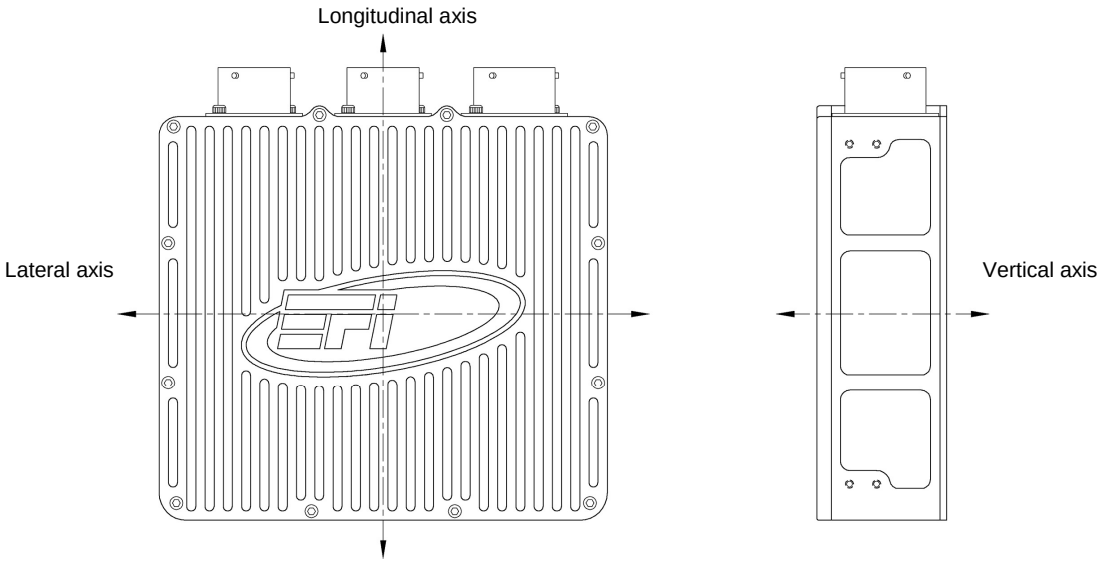

Figure 8 - LCU Orientation

Changing orientation

You can mount the LCU in a different orientation to the standard method. The three axes of acceleration (longitudinal, vertical and lateral) will still be measured, but by a different accelerometer to that used in the standard orientation. The channel names will need to be changed in the Power to Win software to correctly identify each channel.

The accelerometer channel names can be changed in the calibration editor window under channel calibrations, channel parameters using the "Config" program. Please refer to the Help file or contact your EFI representative for further information on re-naming the acceleration channels.

Installing an LCU

- Select a suitable dry location for the LCU.
- Make sure that the area does not exceed 70°C.
- Localized heating effects will add to the ambient air temperature.
- Use the mounting lugs and vibration mounts to secure the LCU.
- When you have installed the LCU make sure that air can flow around it.

CAUTION: The LCU housing acts as a heat sink for its internal electronic components. It is Important that air can flow around the sides of the LCU.

LCU Dimensions

The following diagram shows the overall dimensions and mounting details of the LCU (all dimensions are in inches)

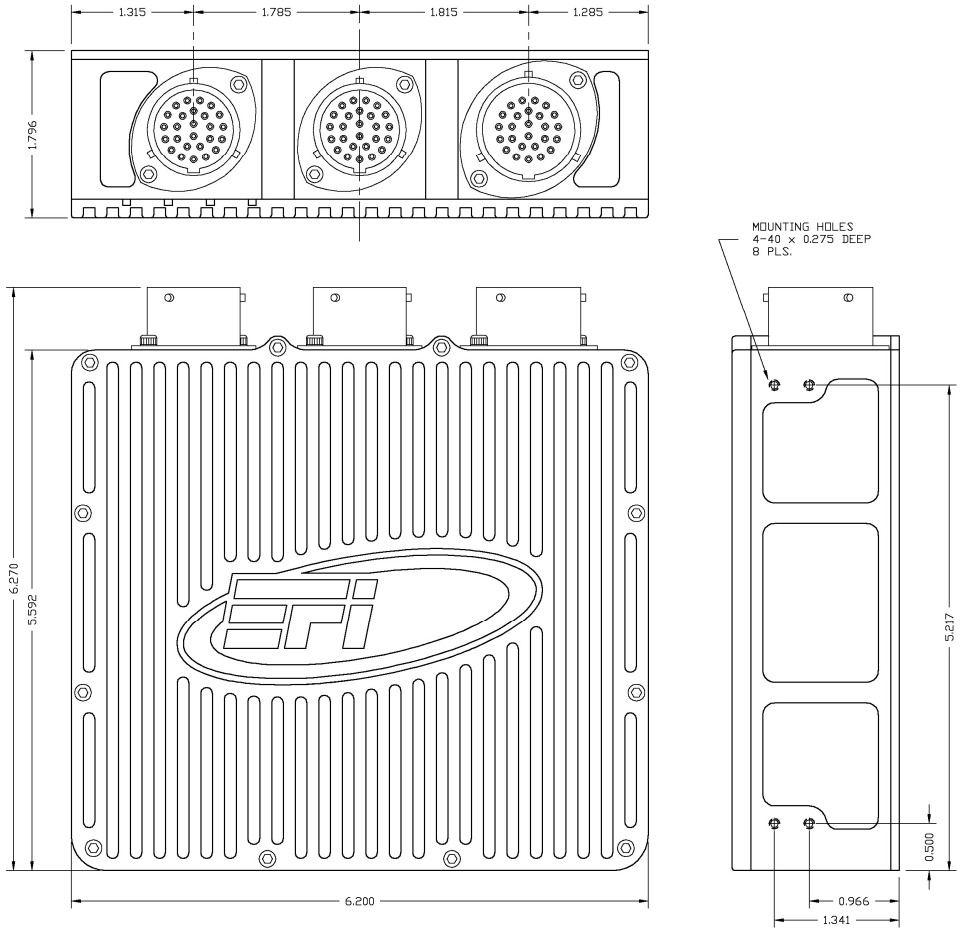

Figure 9 - LCU Dimensions

LCU Connectors

This section covers details about the connectors used on the LCU and the pinout information for each. The figure below shows the position and description of the three main connectors.

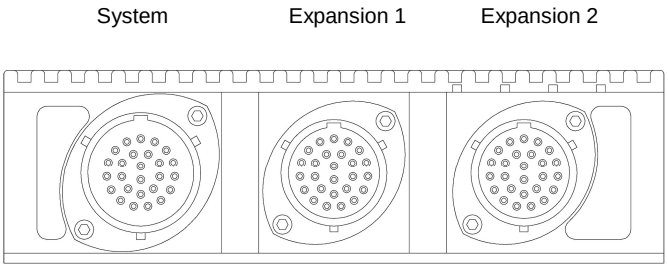

Figure 10 - LCU Connectors

Connector Details

The LCU is usually fitted with three Deutsch Autosport connectors. The connector part numbers and their locations are listed in the table below.

Description	LCU Connector	Mating Connector
System Connector	AS 218-35 PN	AS 618-35 SN
Expansion 1	AS 216-35 SN	AS 616-35 PN
Expansion 2	AS 216-35 SN	AS 616-35 PN *

* The 2nd expansion connector is only fitted on the 4.0 version LCU.

The Logger Unit

Internal channels

The LCU has several internal channels which can be monitored and logged in the same way as the external analog or digital inputs. The battery voltage and box temps should always be logged to keep track of the operating conditions of the LCU at all times.

The available internal channels are listed in the table below.

Channel	Description	ID
Battery	Internal battery (volts)	000
Box temp	Internal case temp (deg C)	002
Lateral G	Lateral acceleration (G)	003
Long G	Longitudinal acceleration (G)	001
Vertical G	Vertical acceleration (G)	063 *

* The internal vertical accelerometer is an optional channel and when installed disables the analog 1 input.

Expansion cards

The LCU is modular and is configured by the addition of interface cards. The LCU has provision for one serial card and up to three analog input cards. The communication card adds 3 serial ports (RS232/RS485) or 2 serial ports and 1 CAN port. Each analog card provides 8 analog inputs to the main LCU.

Slot	Name	Inputs
1	Comms	Serial ports 1-4
2	Analog 1	Analog inputs 7-14
3	Analog 2	Analog inputs 15-17, 50-54
4	Analog 3	Analog inputs 55-62

Additional channel expansion is available using external junction boxes described later in this chapter.

System Connector

System connector pinout

Pin	Name	Description	Pin	Name	Description
1	TXD 1	Telemetry TX	34	AUX1	Auxiliary Output
2	RXD 1	Spare RX	35	ANA3	Analog 3
3	CTS 1 **	RS232 mode	36	BOOT	Boot switch
4	RTS 1	RTS	37	SW4	Switch 4
5	TXD 2	ECU transmit	38	DIG1	Digital 1
6	USB shield	Shield	39	GND	Power ground
7	RXD 2	ECU receive	40	GND	Power ground
8	CTS 2 **	RS232 mode	41	GND	Power ground
9	RTS 2	RTS	42	GND	Power ground
10	USB +	USB high	43	AUX2	Auxiliary Output
11	TXD 3	ADR2 TX	44	ANA4	Analog 4
12	USB GND	Ground	45	SW1	Switch 1
13	RXD 3	Spare	46	DIG2	Digital 2
14	CTS 3 **	RS232 mode	47	12VO	Fused 12 volts *
15	RTS 3	RTS	48	12VO	Fused 12 volts
16	TXD 4	Spare	49	12VO	Fused 12 volts
17	RXD 4	Digital TMS	50	12VO	Fused 12 volts
18	TXD 4-	RS 485	51	AUX3	Auxiliary Output
19	USB -	USB low	52	SW2	Switch 2
20	RXD 4-	RS 485	53	BCN	Beacon
21	CAN +	CAN high	54	VREF	Fused 5 volts *
22	CAN -	CAN low	55	VREF	Fused 5 volts
23	TXD	Dash TX	56	VREF	Fused 5 volts
24	RXD	EFI ECU RX	57	VREF	Fused 5 volts
25	ANA1	Analog 1	58	AUX4	Auxiliary Output
26	ANA2	Analog 2	59	20VO	Fused 20 volts *
27	D2A	D to A Out	60	DIG4	Digital 4
28	SW3	Switch 3	61	VBAT	Battery In
29	DIG3	Digital 3	62	VBAT	Battery In
30	GND	Signal ground	63	VBAT	Battery In
31	GND	Signal ground	64	20VO	Fused 20 volts
32	GND	Signal ground	65	10VO	Fused 10 volts *
33	GND	Signal ground	66	10VO	Fused 10 volts

* Please refer to the section on power supplies for information on the maximum rating for each of the regulated voltage outputs.

** When using the RS232 mode for any of the serial ports the CTS and RTS pins must be connected together.

Expansion Connector 1

Expansion connector pinout

Pin	Name	Description	Pin	Name	Description
1	ANA1	Analog 1 *	34	JBX3	Mux. Input 3
2	ANA2	Analog 2 *	35	JBX4	Mux. Input 4
3	ANA3	Analog 3 *	36	12VO	Fused 12 volts
4	ANA4	Analog 4 *	37	GND	Signal ground
5	ANA5 +	Analog 5	38	GND	Signal ground
6	ANA5 -		39	GND	Signal ground
7	ANA6 +	Analog 6	40	DIG1	Digital 1 *
8	ANA6 -		41	DIG2	Digital 2 *
9	ANA7 +	Analog 7	42	DIG3	Digital 3 *
10	ANA7 -		43	VREF	Fused 5 volts
11	ANA8 +	Analog 8	44	12VO	Fused 12 volts
12	ANA8 -		45	12VO	Fused 12 volts
13	ANA9 +	Analog 9	46	12VO	Fused 12 volts
14	ANA9 -		47	MUX1	Mux. Control 1
15	ANA10 +	Analog 10	48	MUX2	Mux. Control 2
16	ANA10 -		49	MUX3	Mux. Control 3
17	ANA11 +	Analog 11	50	VREF	Fused 5 volts
18	ANA11 -		51	VREF	Fused 5 volts
19	ANA12 +	Analog 12	52	VREF	Fused 5 volts
20	ANA12 -		53	DIG4	Digital 4 *
21	ANA13 +	Analog 13	54	20VO	Fuse 20 volts
22	ANA13 -		55	10VO	Fused 10 volts
23	ANA14 +	Analog 14			
24	ANA14 -				
25	ANA15 +	Analog 15			
26	ANA15 -				
27	ANA16 +	Analog 16			
28	ANA16 –				
29	GND	Signal ground			
30	GND	Signal ground			
31	GND	Signal ground			
32	JBX1	Mux. Input 1			
33	JBX2	Mux. Input 2			

* The Digital and Analog inputs 1 thru 4 on the System connector are common with the same inputs defined on the 1st expansion connector. Connections should only be made to one of the locations.

The Analog –ve input pins are only used as the differential inputs to the internal amplifiers when installed otherwise they can be used as signal grounds.

Expansion Connector 2

Expansion connector pinout

Pin	Name	Description	Pin	Name	Description
1	N/C	Empty	34	JBX3	Mux. Input 3 *
2	N/C		35	JBX4	Mux. Input 4 *
3	N/C		36	12VO	Fused 12 volts
4	N/C		37	GND	Signal ground
5	ANA17 +	Analog 17	38	GND	Signal ground
6	ANA17 -		39	GND	Signal ground
7	ANA18 +	Analog 18	40	DIG5	Digital 5
8	ANA18 -		41	DIG6	Digital 6
9	ANA19 +	Analog 19	42	DIG7	Digital 7
10	ANA19 -		43	VREF	Fused 5 volts
11	ANA20 +	Analog 20	44	12VO	Fused 12 volts
12	ANA20 -		45	12VO	Fused 12 volts
13	ANA21 +	Analog 21	46	12VO	Fused 12 volts
14	ANA21 -		47	MUX1	Mux. Control 1 **
15	ANA22 +	Analog 22	48	MUX2	Mux. Control 2 **
16	ANA22 -		49	MUX3	Mux. Control 3 **
17	ANA23 +	Analog 23	50	VREF	Fused 5 volts
18	ANA23 -		51	VREF	Fused 5 volts
19	ANA24 +	Analog 24	52	VREF	Fused 5 volts
20	ANA24 -		53	DIG8	Digital 8
21	ANA25 +	Analog 25	54	20VO	Fuse 20 volts
22	ANA25 -		55	10VO	Fused 10 volts
23	ANA26 +	Analog 26			
24	ANA26 -				
25	ANA27 +	Analog 27			
26	ANA27 -				
27	ANA28 +	Analog 28			
28	ANA28 –				
29	GND	Signal ground			
30	GND	Signal ground			
31	GND	Signal ground			
32	JBX1	Mux. Input 1 *			
33	JBX2	Mux. Input 2 *			

* The multiplexed analog input pins are common to both of the expansion connectors and must only be connected in one place to each junction box.

** The junction box multiplexer control lines are also common to both of the expansion connectors.

Voltage regulators

The LCU has 5 internal voltage regulators to provide a wide range of supply voltages to the external sensors. Each of the regulators is protected by a thermal fuse. The maximum current rating for each output is listed in the table below.

Regulators

Output	Type	25 deg C	80 deg C
12 volt	fixed	1.6A	800mA
5 volt	fixed	1.6A	800mA
8 volt	adjustable	1.2A	600mA
20 volt	fixed	0.3A	300mA
+/- 15	internal	0.3A	300mA

To preserve the vehicle battery while the charging system is inactive each of the voltage regulators can be controlled by software and activated by any combination of the following conditions.

Enable Conditions

- Engine On
- Vehicle moving
- Logging
- USB connected
- Battery OK
- Switch 3
- Switch 4

Note: To force each regulator output to be permanently active select the "Always On" option.

Expansion cards

All of the analog channels of the internal expansion cards can be configured independently as either 0 – 5 volt or amplified differential inputs. Each of the amplifiers can be also be configured with different gain and offset values.

Each dip switch controls the gain setting for 2 channels. For information about the dip switch settings for gains and offsets please refer to the table below.

Gain Settings

Gain	1	100	200	300	500	600	800	1000	1200
S1		X		X		X	X		
S2			X	X			X		X
S3					X	X	X		
S4								X	X
S5		X		X		X	X		
S6			X	X			X		X
S7					X	X	X		
S8								X	X

X denotes switch is on

Offsets

A single dip switch controls the offsets for all 8 channels on the expansion card. If the switch setting is in the on the position the offset will be 0.5 volts otherwise it is 2.5 volts. The default offset settings are 0.5 volts for thermocouple inputs and 2.5 volts for strain gauges.

Contact your EFI representative for information on the availability of additional gain and offset values.

Digital Inputs

The LCU has eight fixed digital input channels that can be used for measuring sensors that have a digital signal such as wheelspeed sensors, crank pickups etc. The digital inputs are all configured as 0 to 5 volt inputs with fixed 680Ω pull-up resistors.

To improve the signal integrity and avoid noise from electrical interference the digital inputs have hysteresis with a high trigger threshold of 2.6 volts and the low at 2.0 volts. The following diagram shows a sample pickup signal and how it is interpreted by the LCU after signal conditioning.

Voltage thresholds

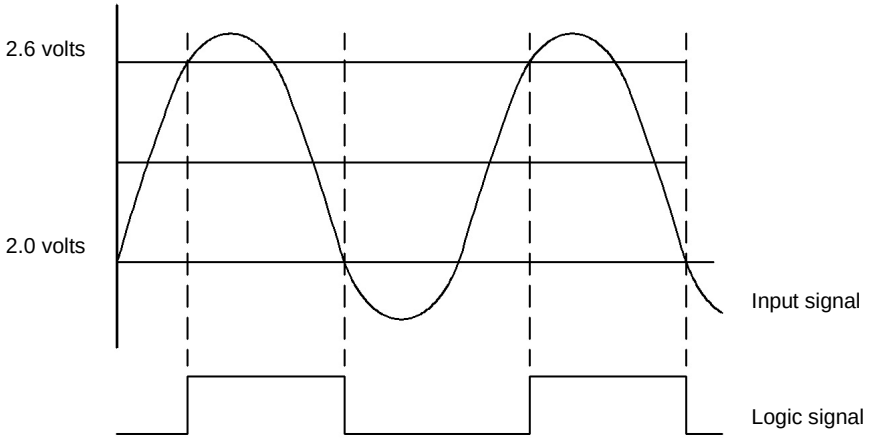

Figure 11 - Digital Inputs

A logic 0 input will only change state to a logic 1 input if the signal voltage rises above 2.6 volts. It will remain at a logic 1 until the signal voltage drops below 2.0 volts.

Magnetic pickups

The use of magnetic pickups or sensors with voltages outside of this range will require an external signal converter to be installed between the LCU and the sensor. (Use the EFI wheelspeed converter, part number 60-591 or equivalent.)

Additional I/O's

The LCU has 4 digital switch inputs. Switches 1 & 2 are used for various dash functions and switches 3 & 4 are under user control. The switch inputs are all located on the 66 pin system connector. Switch functions are listed in the table below.

Switch Inputs

Switch	Pin	Mode	Function
1	45	DASH	Clear Alarm/Fuel Reset
2	52	DASH	Change Page
3	28	USER	User defined
4	37	USER	User defined

All switch inputs are normally 5 volts and active when low.

Auxiliary Outputs

The LCU has 4 programmable auxiliary outputs. These outputs are controlled by software and are activated when a channel reaches a predefined condition and can be RPM qualified.

The auxiliary outputs are active low and have a maximum of 1 amp current sinking capability.

Communications

The LCU has a number of serial communications ports all accessed via the 66 pin system connector. Each port has its own characteristics and functions and can be independently configured by software.

The default configuration for each port is listed in the table below.

Port	Name	Function
P1	TEL	Telemetry system
P2	ECU	ECU interface
P3	ADR	Accident data recorder
P4	TMS	Tire pressure system
P5	DSH	Dash interface
P6	CAN *	CAN 2.0 port
P7	USB	USB download port

* Use of the CAN port requires the optional CAN card to be installed in the LCU.

Port 1 – Telemetry

This port is configured to output data to the telemetry radio system.

- Configurable as RS232 or RS485
- Baud rates up to 38400 bps

Pin	Name	Function	Comment
1	TXD1	Telemetry transmit	LCU to telemetry radio
2	RXD1	Telemetry receive	
3	CTS1	Clear to send	connect to RTS for RS232 mode
4	RTS1	Request to send	

Port 2 – ECU interface

This port is configured for bi-directional communication to a 3rd party ECU system.

- Configurable as RS232 or RS485
- Baud rates up to 57600 bps

Pin	Name	Function	Comment
5	TXD2	ECU transmit	LCU connection to ECU
7	RXD2	ECU receive	ECU connection to LCU
8	CTS2	Clear to send	connect to RTS for RS232 mode
9	RTS2	Request to send	

Port 3 – ADR2 interface

This ports default configuration is for communication with the Delphi accident data recorder.

- Configurable as RS232 or RS485
- Baud rates up to 57600 bps

Pin	Name	Function	Comment
11	TXD3	ADR transmit	LCU to ADR2 connection
13	RXD3	Undefined	
14	CTS3	Clear to send	connect to RTS for RS232 mode
15	RTS3	Request to send	

Port 4 – TMS interface

This ports default configuration is for communication with a digital tire pressure monitoring system.

- Configurable as RS232 or RS485
- Baud rates up to 19200 bps

Pin	Name	Function	Comment
16	TXD4	Undefined	
17	RXD4	TMS receive	TMS to LCU connection
18	CTS4	Clear to send	connect to RTS for RS232 mode
20	RTS4	Request to send	

Port 5 – Dash interface

This port is configured to output data to the SWD or LCD dash.

- Current loop
- Baud rates up to 19200 bps

Pin	Name	Function	Comment
23	TXD	DASH TX	LCU to Dash connection
24	RXD	RX	Spare receiver

Port 6 – CAN interface

This port is a general purpose CAN port and can be used to interface to various devices on the vehicle.

- CAN 2.0 compatible
- Baud rates up to 1Mbps

Pin	Name	Function	Comment
21	CAN +	CAN high	
22	CAN -	CAN low	

* Use of the CAN port requires the optional CAN card to be installed in the LCU.

Port 7 – USB interface

This port is configured to interface to a laptop or PC USB port and is used to monitor the LCU and for downloading logger data.

- USB 3.0 compatible
- Speed 12 Mbps

Pin	Name	Function	Comment
6	Shield	USB shield	
10	USB +	USB high	
12	GND	ground	
19	USB -	USB low	

Download connector

The download connector on the vehicle is used for all communications between your laptop USB port and the LCU. This connection is used for functions such as monitoring your system, sending setups and downloading logged data.

The following figure shows a typical installation using the 19 pin connector.

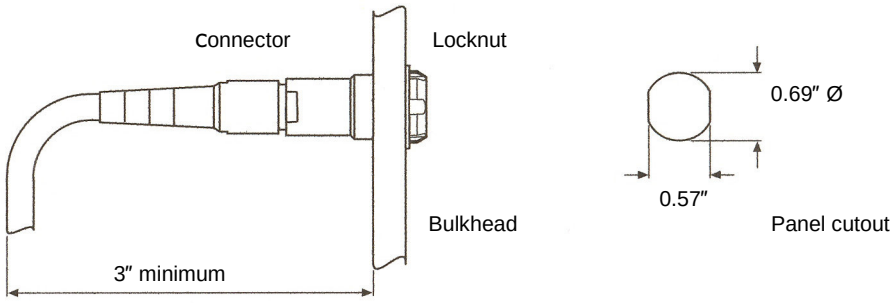

Figure 12 - Download connector

The download connector is usually fitted to the vehicle bodywork in a location that is easily accessed from the outside of the vehicle. An ideal location is behind the driver's area and on the side of the vehicle that is closest to the pit wall.

It is recommended that the download connector is located in an area that will not be exposed to water, dust or track debris. You should allow at least 3 inches behind the mounting panel to accommodate the connector and harness.

The download connection is available as a 5 pin or 19 pin Fischer connector. The 19 pin is commonly used when additional wires are required in the download port to accommodate 3rd party ECU wiring.

Fischer 5 pin Connector

Pin	Name	Function
1		
2	USB +	USB high
3		
4	USB -	USB low
5	GND	USB GND

Fischer 19 pin Connector

Pin	Name	Function
1		
2		
3		
4		
5	ECU GND	Serial port ground
6		
7		
8		
9	USB GND	USB GND
10	USB +	USB high
11	USB -	USB low
12		
13		
14	ECU GND	Serial port ground
15		
16	ECU TXD	ECU to PC serial transmit
17	ECU RXD	PC to ECU serial receive
18		
19		

Download cables

Several versions are available for the download cable. The standard cable is 6 feet long and the optional cable is 22 feet long. The long cable utilizes a built in USB hub and allows the laptop to be connected to the vehicle across the pit wall.

The maximum permissible length of USB cable between the laptop and LCU is 15 feet. Custom download cables up to 50 feet are available by utilizing integrated USB hubs. Please contact your EFI representative for further information.

CAUTION: When manufacturing your own harnesses and download cables be sure to use the correct specification USB wire.

System Expansion

Junction Boxes

The EFI logging system is modular and the number of analog inputs can be expanded by the addition of junction boxes. A maximum of 4 junction boxes can be added to the system each providing 8 analog inputs for a total of 32 additional channels. Junction boxes simplify wiring and can be located at strategic locations on the vehicle to help simplify wiring and help keep signal noise to a minimum.

All analog channels can be configured as 0-5 volt inputs compatible with most standard chassis sensors or a combination of arrangements with differential amplifiers. Amplified strain gauge inputs are configurable with standard gains of: 100, 200, 500 & 1000. Custom settings are available on request.

Dimensions

This section covers details about the box dimensions, connectors used on the junction boxes and the pinout information for each. The figure below shows the position and description of the three connectors.

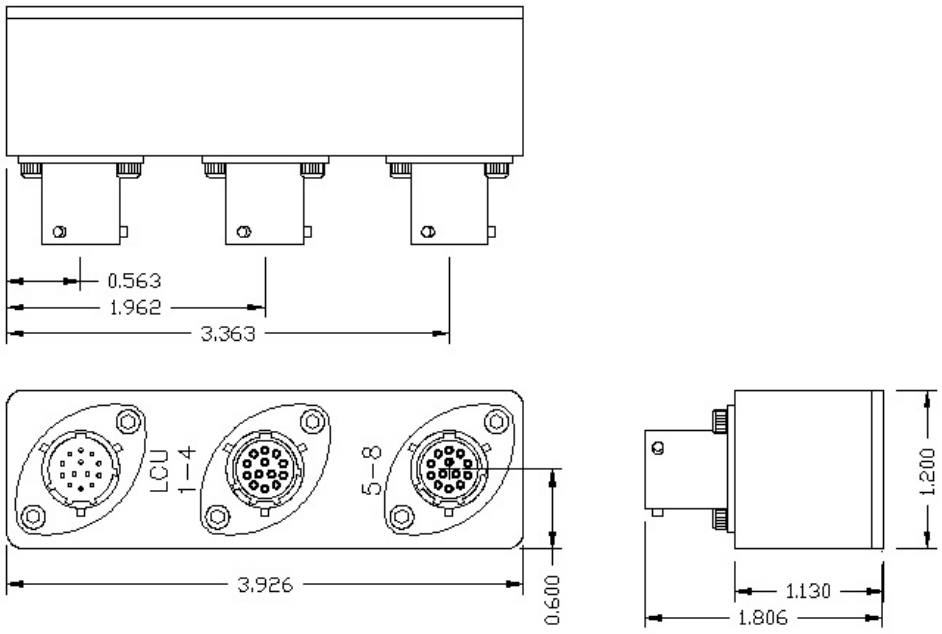

Figure 13 - Junction Box

Connections

The junction boxes are fitted with three Deutsch Autosport connectors. The connector part numbers and their locations are listed in the table below.

Description	JBX Connector	Mating Connector
Logger Connector	AS 210-35 PN	AS 610-35 SN
Analog 1 - 4	AS 210-35 SN	AS 610-35 PN
Analog 5 - 8	AS 210-35 SN	AS 610-35 PN

The logger connector provides power to the junction box and supplies the analog and digital signal connections back to the LCU. The two remaining connectors are used for the analog and digital inputs.

The junction box analog outputs are multiplexed and decoded by 3 control lines that are common throughout the logging system. It is important that each of the junction box outputs is connected to the correct dedicated input pin on the LCU.

Connector Details

Logger Connector

Pin	Name	Description
1	12V	12 volt input *
2	VREF	5 volt input
3	ANO	Analog output
4	MUX1	Mux 1 control line
5	MUX2	Mux 2 control line
6	MUX3	Mux 3 control line
7	DIG1	Digital 1 output
8	DIG2	Digital 2 output
9	DIG3	Digital 3 output
10	DIG4	Digital 4 output
11	N/C	
12	N/C	
13	GND	Signal ground

* The 12V and 5V inputs should be supplied by one of the regulated outputs of the LCU to provide short circuit protection to the junction box.

Signal inputs

Each connector provides 12 volts and 5 volts for sensor power and allows 4 analog inputs to be connected to each port of the junction box.

The digital inputs can also be connected to the junction box input ports but must only be connected in one location in the logging system. Each input port supports 2 digital signals which are passed directly through to the logger connector to simplify vehicle wiring.

Analog 1-4 Connector

Pin	Name	Description
1	12V	12 volts
2	VREF	5 volts
3	ANA1 +	Analog 1 *
4	ANA1 -	
5	ANA2 +	Analog 2
6	ANA2 -	
7	ANA3 +	Analog 3
8	ANA3 -	
9	ANA4 +	Analog 4
10	ANA4 -	
11	DIG1	Digital 1
12	DIG2	Digital 2
13	GND	Signal ground

* The Analog –ve input pins are only used as the differential inputs to the internal amplifiers when installed otherwise they can be used as signal grounds.

Analog 5-8 Connector

Pin	Name	Description
1	12V	12 volts
2	VREF	5 volts
3	ANA5 +	Analog 5
4	ANA5 -	
5	ANA6 +	Analog 6
6	ANA6 -	
7	ANA7 +	Analog 7
8	ANA7 -	
9	ANA8 +	Analog 8
10	ANA8 -	
11	DIG3	Digital 3
12	DIG4	Digital 4
13	GND	Signal ground

Dash Displays

The EFI logging system can use an LCD dash or Steering wheel dash (SWD) to display information to the driver. Both dash options can drive up to 4 additional satellite display modules (one can be a shift lamp module). Dashes are connected to the LCU via the main system harness and both require two remote switches to utilize the various dash functions.

SWD Dash

The Steering Wheel Dash (SWD) is an LED display with 5 programmable channel fields, sequential shift lights, a gear position indicator, 2 bar graphs and 4 warning lamps. One of the channel fields functions as a message center and there are 2 sets of user lamps.

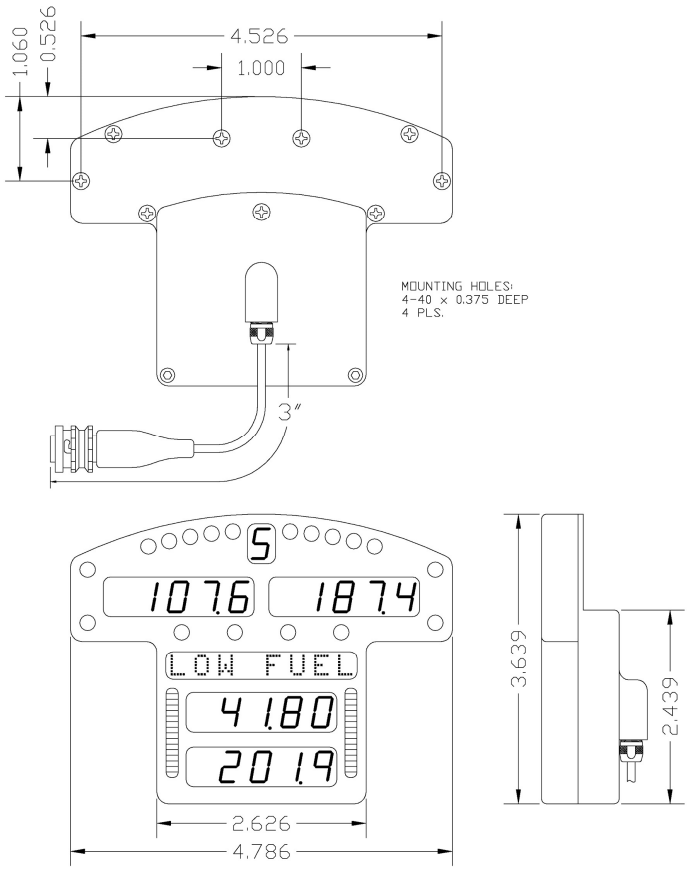

Figure 14 - Steering Wheel Dash

Connections

The SWD is fitted with a flying lead terminated with an Autosport 5 pin connector. The pinout details are shown in the table below.

SWD Connector

Pin	Name	Function
1	12V	12 volt supply *
2	LP23	Lamps 2 & 3
3	LP14	Lamps 1 & 4
4	RXD	Serial input
5	GND	Power ground

* The SWD 12 volt power should not be supplied by one of the regulated outputs of the LCU but directly from the battery. At full brightness the power consumption is approx. 1.5 amps.

Typical SWD Installation

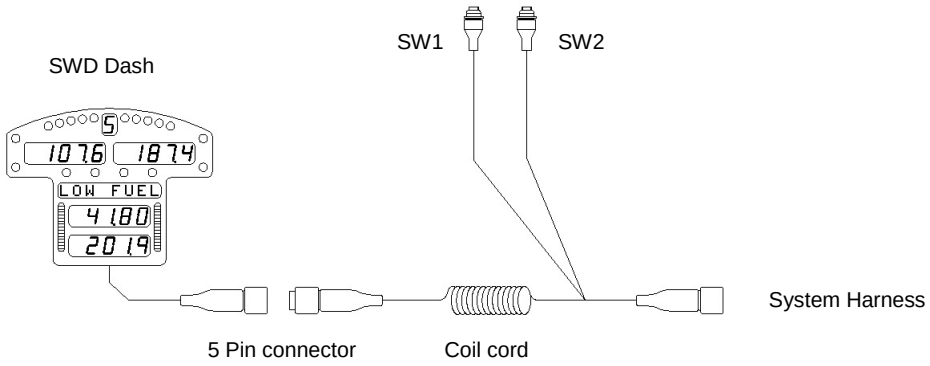

Figure 15 – Typical SWD installation

LCD Dash

This dash is a backlit (optional) LCD display with 6 programmable channel fields and dedicated rpm and fuel bar-graphs. One of the channel fields also functions as a message center. The center fields can display data up to 2 decimal precision with 1 decimal on the outer fields.

The dash can be programmed with a different display setup on each of the 3 pages that are selected by the SW1 input.

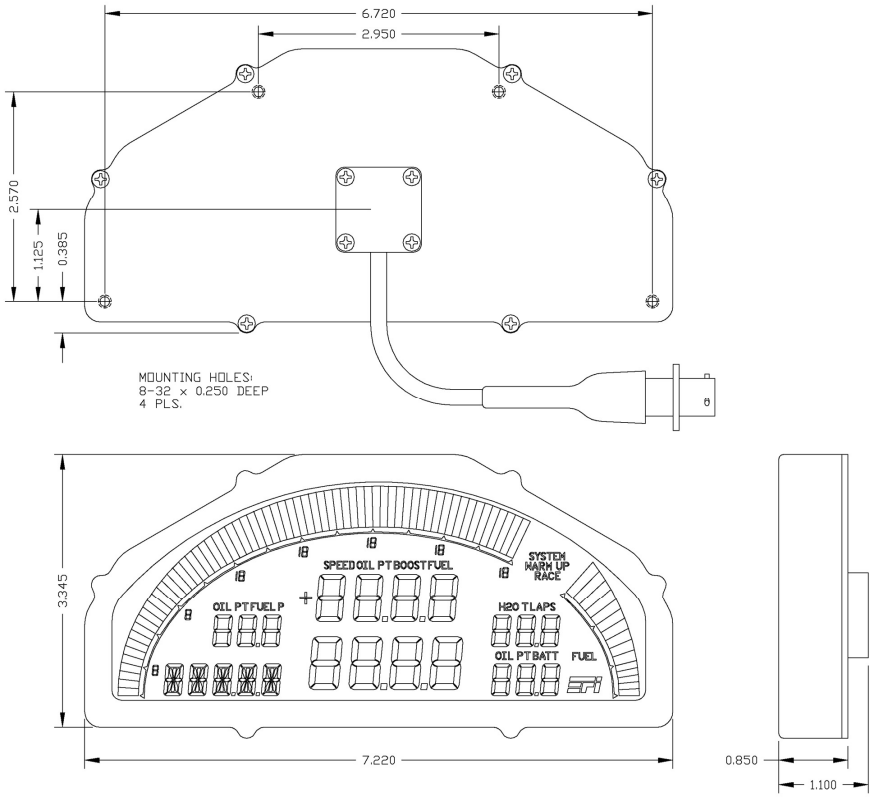

Figure 16 - LCD Dash

Connections

The LCD dash is supplied with an integrated harness for direct connection to the logger system. The pinout details are shown in the table below.

LCD Connector

Pin	Name	Function
1	12V	12 volt supply *
2	SW1	Switch 1
3	SW2	Switch 2
4	SW3	Switch 3
5	SW4	Switch 4
6	AUX1	Auxiliary 1
7	AUX2	Auxiliary 2
8	AUX3	Auxiliary 3
9	AUX4	Auxiliary 4
10	RXD	Serial input
11	N/C	
12	N/C	
13	GND	Power ground

* The SWD 12 volt power should not be supplied by one of the regulated outputs of the LCU but directly from the battery. At full brightness the power consumption is approx. 1.0 amp.

Typical LCD Installation

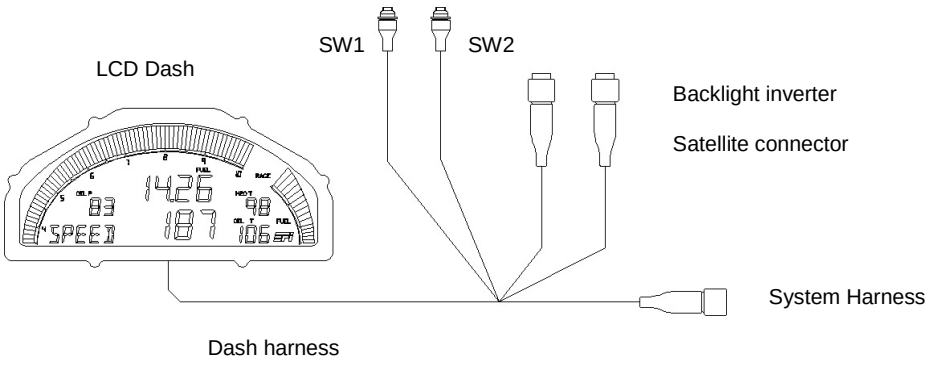

Figure 17 – Typical LCD Installation

Satellite Displays

Each of the dashes can drive up to 4 additional satellite LED displays. Satellites are available as 4 character displays or as a single character with 5 sequential shift lamps. (typically used for gear position).

This section covers details about the satellite dimensions and connectors used. The figure below shows both the standard and gear shift versions.

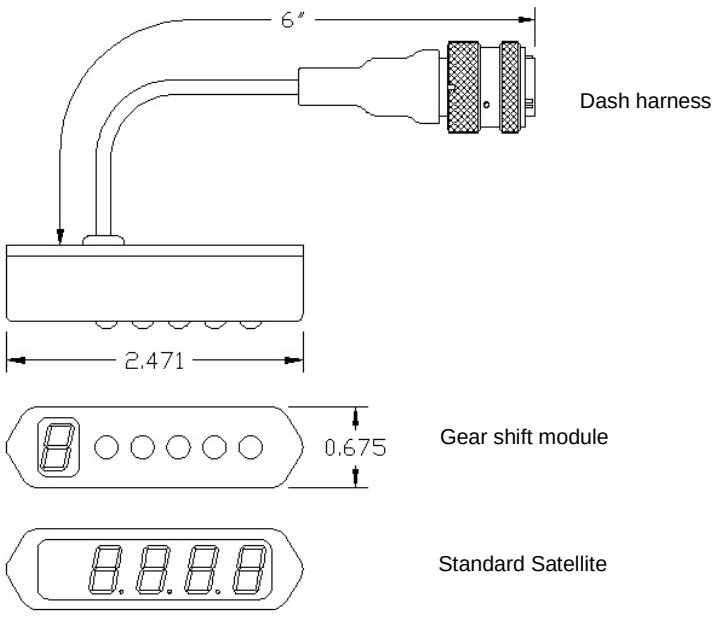

Figure 18 – Satellite Display

Installation

The compact design of the satellite dash modules allows flexibility in choosing mounting locations. Satellites can be used to supplement a standard dash or a number of them can be used to replace a standard dash where space limitations make a standard dash impractical.

As with the standard dash, these satellite displays can be set up to display different data as the driver scrolls through each of the three dash pages.

Connections

Each satellite is supplied with an integrated harness for direct connection to the main dash wiring harness. Several satellites can be connected together on a single assembly to simplify installation. The pinout details are shown in the table below.

Satellite Connector

Pin	Name	Function
1	VREF	5 volt supply *
2	SEL1	Select 1
3	SEL2	Select 2
4	SEL3	Select 3
5	SEL4	Select 4
6	DATA	Data input
7	CLK	Clock signal
8	LAMP1	Lamp 1
9	LAMP2	Lamp 2
10	LAMP3	Lamp 3
11	LAMP4	Lamp 4
12	LAMP5	Lamp 5
13	GND	Power ground

* The 5 volt power should be supplied by the regulated output from the main dash.

Beacon System

The EFI logging system uses a lap beacon system that generates end of lap and lap split timing information for the LCU. The beacon kit consists of a 32 channel infra red detector mounted on the vehicle chassis and a trackside mounted transmitter.

The 32 channel beacon has a split output which is used by the LCU for both lap and split data and a dedicated end of lap (EOL) output for 3rd party ECU connections. An optional lap only, 16 channel beacon is also available.

Receiver

This section covers details of the beacon receiver dimensions, connector used and pinout information. The figure below shows the beacon outline.

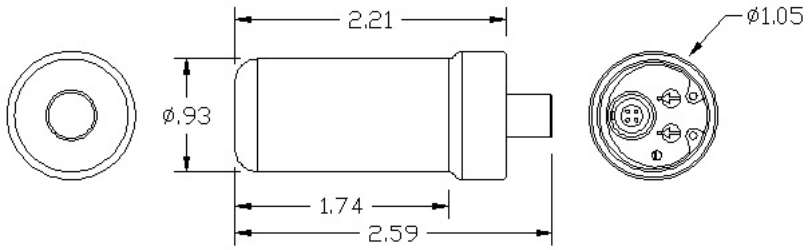

Figure 19 – Beacon Receiver

Specifications

Description	Value
Enclosure	Billet 6061 Aluminum
Connector	Lemo EHG 0B 304
Dimensions	2.21” x 0.93”
Weight	0.09 lb
Field of View	21 degree wide cone
Channels	32
Operating Temp	-40 to +75 deg C continuous

Connections

The beacon detector is fitted with a LEMO 4 pin connector. The pin assignments are listed in the table below.

Pin	Name	Function
1	SPLIT	Lap and split signal
2	GND	Power ground
3	12V	12 Volts
4	EOL	End of Lap signal

The mating LEMO connector part No. is FGG-OB-304.

Installation

When installing the beacon you should consider the following points:

- Make sure that the detector has an unobstructed line of sight view to the transmitter.
- Select a position where the beacon will not be in contact with any fluid or track debris.
- Do not place the detector near sources of electrical interference e.g. ignition coils, plug leads, alternators and telemetry equipment.
- Mount the detector parallel to the ground and perpendicular to the direction of the car's motion.

Operation

Before use always check that the detector and receiver are set to the same channel code. You can verify correct operation by looking at the small LED on the back of the detector which will flash when it receives a valid code from the transmitter.

The receiver has a rotary pot on the back used to set the channel. When the arrow on the rotary pot points towards the small circular indent on the back of the receiver housing channel 0 is selected. There are 16 channels available in both Lap and Split mode: namely 0-9 and A-F. Channel 0 is the most commonly used.

Transmitter

Installation

The beacon transmitter should be mounted on a tripod or similar device at the side of the track. The LED's should be approximately at the same height as the receiver location in the car and have an unobstructed view across the track.

Operation

The beacon transmitter has a knob for setting the current channel which will be indicated in the LED display window. There is also a switch for selecting either lap or split mode.

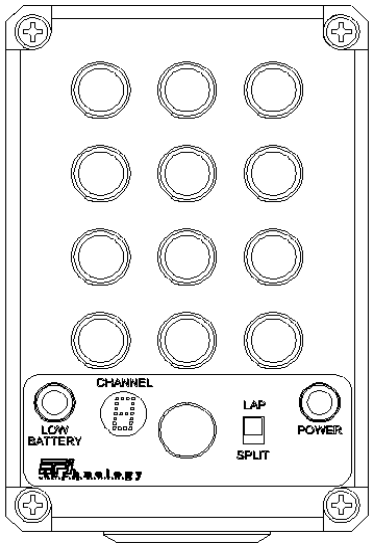

Figure 20 – Beacon Transmitter

General Use

The effective range of the transmitter is directly proportional to the supply voltage. Always ensure that the transmitter battery is fully charged before use and that the low battery warning lamp is not lit.

*The low battery warning is set at 11 volts.

Instrumentation

Connecting Sensors

The EFI data logging system uses an Autosport 5 pin connector standard for all sensor connections. The standard pinout for some different sensor types are given in the table below.

Sensor types

5 pin sensor connections

Pin	Single	Diff	RTD	Therm	Dig
1	N/C	N/C	N/C	N/C	12V *
2	5V	5V	N/C	N/C	5V
3	SIG+	SIG+	RTD+	SIG+	SIG
4	N/C	SIG-	RTD-	SIG-	N/C
5	GND	GND	N/C	N/C	GND

* See the section on voltage regulators for information about the supply current available for each of the regulated outputs.

Excitation

The sensor excitation voltage is typically 5 or 12 volts. The LCU also has an adjustable regulator set nominally at 8 volts and a fixed 20 volt 300mA output available.

Inputs

Differential means that there is a signal +ve and signal –ve input. Single ended means that the signal –ve is common with the signal ground input.

Generally only low current sensors should be used with single ended inputs. These types of input are suited to temperature or pressure sensors where the absolute accuracy is not required.

Mode

Unipolar means that the inputs can only measure positive signals. Bipolar means that the input can measure both positive and negative signals.

Gain

Unipolar channels can be configured with gains from 0 to 8. Bipolar channels can be configured with gains from 0 to 1200.

Types

There are two main types of sensor available, absolute and ratio-metric.

Absolute sensors are usually active sensors, such as accelerometers, which have an internal voltage reference or regulator and are unaffected by drift in the excitation voltage.

Ratiometric sensors, such as potentiometers or strain gauges, are affected by the excitation voltage. If you increase the excitation voltage the output signal will also increase proportionally.

In ratio-metric mode the LCU monitors the excitation voltage and compensates for any drift. This is useful for strain gauges or sensors using high gains where the excitation voltage may be higher to increase the output.

In ratio-metric mode the calibration is unchanged even when the excitation is increased. This means you can decrease the gain and improve the signal to noise ratio.

Sensor Wiring

Wiring information for some different sensor types is given in the following figures.

Connecting a potentiometer

Connect a potentiometer to a single ended input as shown below. If an amplifier is installed it should be configured with a gain of 1.

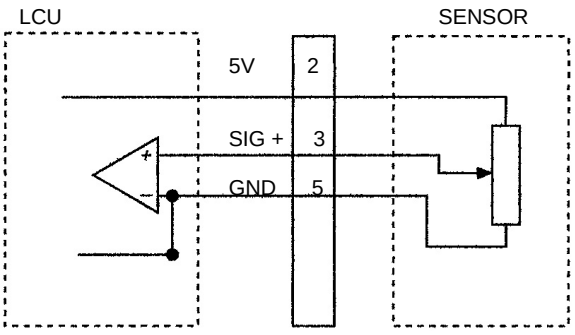

Figure 21 - Connecting a single ended input

Connect a potentiometer to a differential input as shown below.

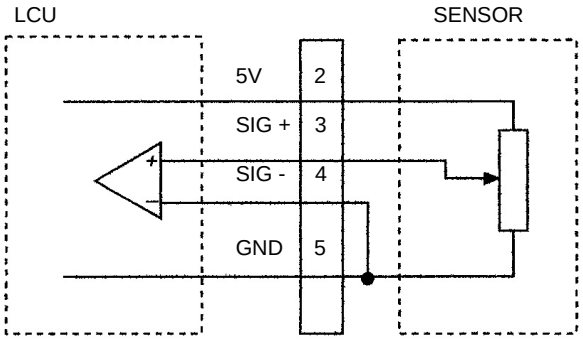

Figure 22 - Connecting a single ended input

Connecting a strain gauge

Connect a strain gauge as shown below. The input amplifier should be configured with a gain from 100 to 1000 and typically with an offset of 2.5 volts.

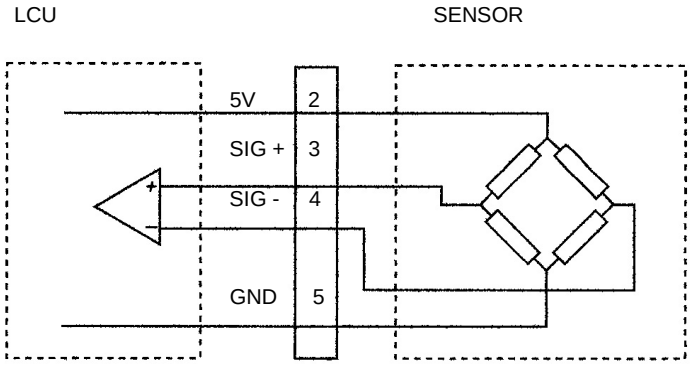

Figure 23 - Connecting a differential input

Connecting an RTD sensor

Connect an RTD as shown below. The input amplifier should be configured with a gain of 100 and use a 3K92 pull-up resistor connected to 5 volts on the input.

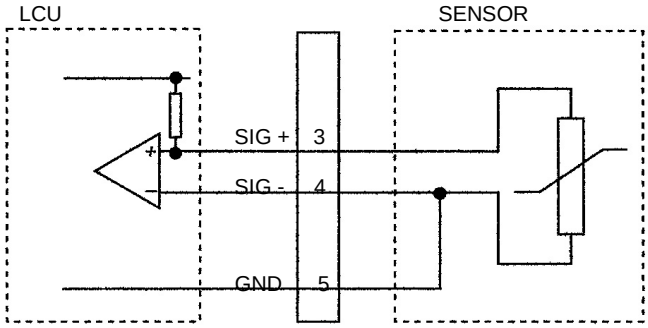

Figure 24 - Connecting an RTD sensor

Connecting a voltage output

Connect 0-5 volt output sensor (e.g. pressure transducer) as shown below. Use either the 5v or 12v excitation voltage as recommended by the sensor manufacturer.

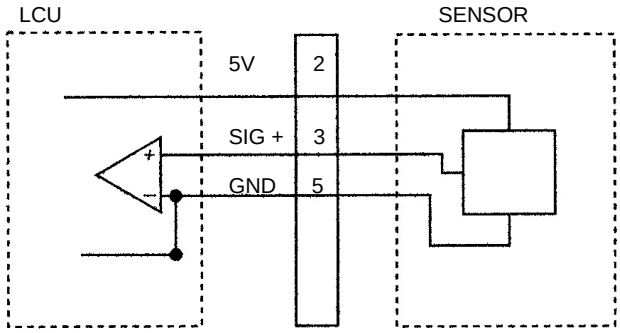

Figure 25 - Connecting a voltage output

Appendix

Contact Information

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