COSWORTH

CAN Switch Board

User Guide

www.cosworth.com

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Introduction

The Cosworth CSB is a fully customised CAN Switch Board designed to be light and compact enough to fit onto a steering wheel. The CSB allows complicated steering wheel and connector looms to be reduced in wire count and complexity whilst also providing weight and cost reductions. The CSB has been developed with this in mind allowing for simple integration onto the back of any steering wheel requiring a minimum of only 4 wires.

The CSB supports up to 12 digital switch inputs and 5 analogue inputs, there are also 2 opto-isolated switch input/outputs and 5 LED outputs. The CSB is fitted with a 16 position hex switch allowing simple switching between the 8 preset CAN identification ranges. These 8 addresses are duplicated once without CAN termination and once with CAN termination (120 ohm). The default CAN identification addresses are stored in non-volatile memory and can be changed by using the CSB configuration menu which is available via the RS232 interface.

Hardware

Specifications

Electrical Data

Electrical Data	
Supply Voltage	6.5Vdc to 18Vdc
Supply Protection	Reverse and over voltage
Supply Current	56mA @ 12V
Temperature Range Operating Storage	 -30°C to +60°C -20°C to +70°C

I/O Information

I/O Information	
1x CAN	1Mbit, 512k, 256k, 128k software selectable, with 120Ω selectable termination
5x Analogue Inputs	0-5V range @ 100Hz, with a 1MΩ pull-down resistor.
12x Digital Switch Inputs	0-5V range @ 100Hz, with a 10kΩ pull-up resistor.
5x LED Outputs	5V Anode supply with a 330Ω series resistor.
1x Protected 5V Excitation	200mA @ 25°C 110mA @ 70°C
1x Protected 12V Excitation	Reverse protected
2x Opto-Isolated Outputs	0-VBatt output, with a maximum 100mA load and 0.8Ω resistance.

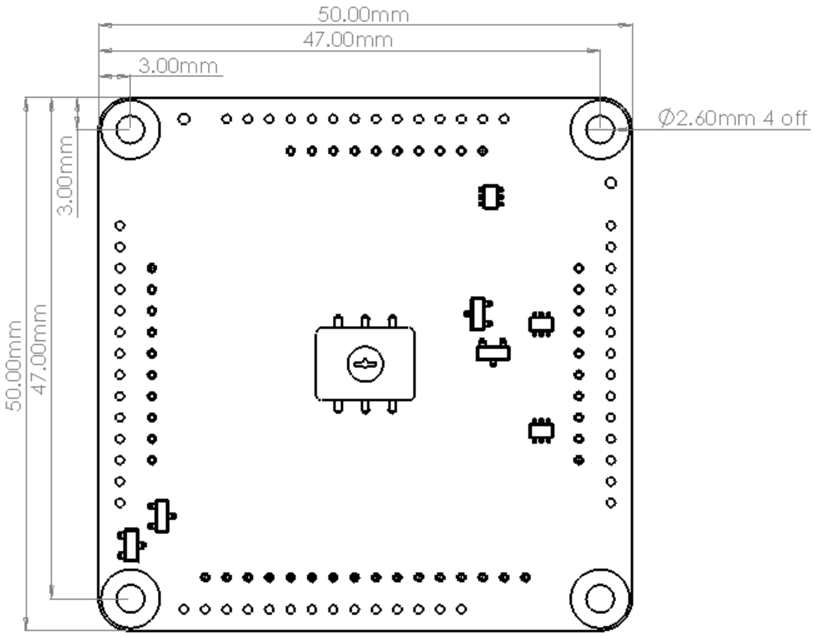
Communication Ports

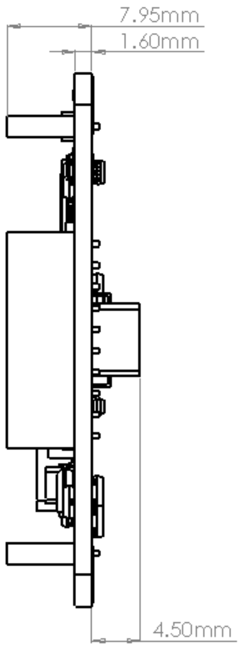
Communication Ports	
1x Serial Port (Debug use only)	RS232

Mechanical Data

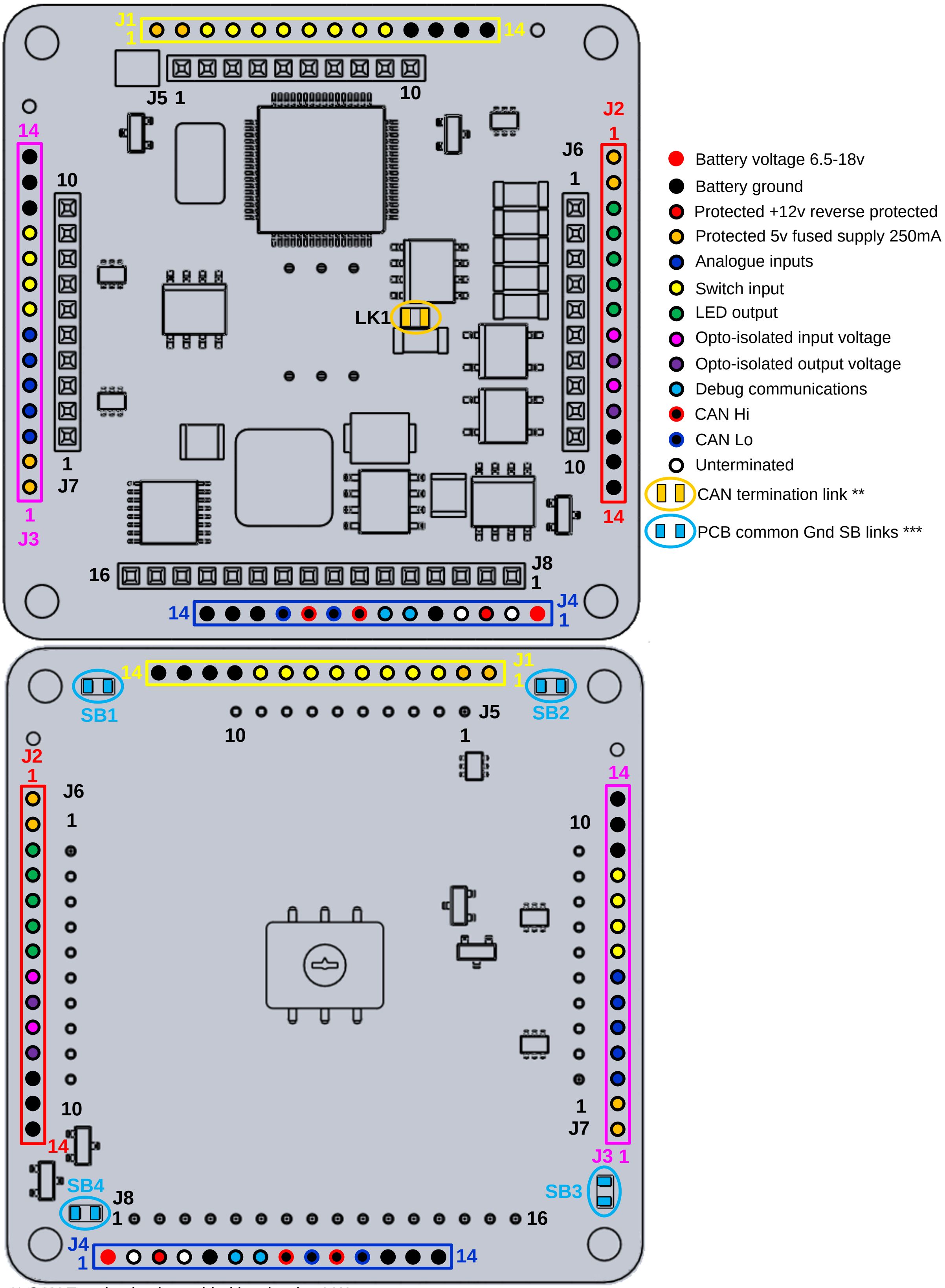
Mechanical Data	
Size (without mating connectors)	50 x 50 x 12.45 mm
Weight	11 grams

Dimensions


50.00mm
47.00mm
3.00mm
Ø2.60mm 4 off
3.00mm
50.00mm
47.00mm


7.95mm
1.60mm
4.50mm

Connector Information



** CAN Termination is enabled by shorting LK1
*** PCB Common Ground made using SB1-4

Solder connections

J1 ADI and Switch Input

Pin	Name	Function
1	+5VPROT	Protected +5V
2	+5VPROT	Protected +5V
3	SW8	Switch input 8
4	SW9	Switch input 9
5	SW10	Switch input 10
6	SW1	Switch input 1
7	SW2	Switch input 2
8	SW3	Switch input 3
9	SW11	Switch input 11
10	SW12	Switch input 12
11	GND	0V
12	GND	0V
13	GND	0V
14	GND	0V

J2 LED and Opto-isolator Outputs

Pin	Name	Function
1	+5VPROT	Protected +5V
2	+5VPROT	Protected +5V
3	LED1	LED 1 output driver
4	LED2	LED 2 output driver
5	LED3	LED 3 output driver
6	LED4	LED 4 output driver
7	LED5	LED 5 output driver
8	OUT-I1	Opto-isolator 1 input voltage
9	OUT-O1	Opto-isolator 1 output voltage
10	OUT-I2	Opto-isolator 2 input voltage
11	OUT-O2	Opto-isolator 2 output voltage
12	GND	0V
13	GND	0V
14	GND	0V

J3 AI and ADI Input

Pin	Name	Function
1	+5VPROT	Protected +5V
2	+5VPROT	Protected +5V
3	AI1	Analogue input 1
4	AI2	Analogue input 2
5	AI3	Analogue input 3
6	AI4	Analogue input 4
7	AI5	Analogue input 5
8	SW4	Switch input 4
9	SW5	Switch input 5
10	SW6	Switch input 6
11	SW7	Switch input 7
12	GND	0V
13	GND	0V
14	GND	0V

J4 System Connector

Pin	Name	Function
1	Batt +	Battery +12V input
2	N/C	Must be left un-terminated
3	PBATT+	Protected battery +12V
4	N/C	Must be left un-terminated
5	GND	0V
6	DEBRX	RS232 serial data PC to PIC
7	DEBTX	RS232 serial data PIC to PC
8	CANH	CAN Hi (Linked with pin 10)
9	CANL	CAN Lo (Linked with pin 11)
10	CANH	CAN Hi (Linked with pin 8)
11	CANL	CAN Lo (Linked with pin 9)
12	GND	0V
13	GND	0V
14	GND	0V

Header connectors

J5 ADI and Switch Input

Pin	Name	Function
1	+5VPROT	Protected +5V
2	SW8	Switch Input 8
3	SW9	Switch Input 9
4	SW10	Switch Input 10
5	SW1	Switch Input 1
6	SW2	Switch Input 2
7	SW3	Switch Input 3
8	SW11	Switch Input 11
9	SW12	Switch Input 12
10	Gnd	Ground

J6 LED and Opto-isolator Outputs

Pin	Name	Function
1	LED1	LED 1 output driver
2	LED2	LED 2 output driver
3	LED3	LED 3 output driver
4	LED4	LED 4 output driver
5	LED5	LED 5 output driver
6	OUT-I1	Opto-isolator 1 input voltage
7	OUT-O1	Opto-isolator 1 output voltage
8	OUT-I2	Opto-isolator 2 input voltage
9	OUT-O2	Opto-isolator 2 output voltage
10	GND	0V

J7 AI and ADI Input

Pin	Name	Function
1	AI1	Analogue input 1
2	AI2	Analogue input 2
3	AI3	Analogue input 3
4	AI4	Analogue input 4
5	AI5	Analogue input 5
6	SW4	Switch input 4
7	SW5	Switch input 5
8	SW6	Switch input 6
9	SW7	Switch input 7
10	GND	0V

J8 System and PIC programming Connector

Pin	Name	Function
1	Batt +	Battery +12V input
2	PBATT +	Protected battery +12V
3	CAN-Term#	CAN Termination
4	GND	0V
5	DEBRX	RS232 serial data PC to PIC
6	DEBTX	RS232 serial data PIC toPC
7	CANH	CANH
8	CANL	CANL
9	GND	0V
10	+5VREF	+5V reference
11	CJB-Pres#	CJB present
12	+5V	PIC +5V supply
13	MCLR	PIC MCLR
14	PGD	PIC Programming PGD signal
15	PGC	PIC programming PGC signal
16	GND	0V

Interfaces

The following is a summary of the MSP interfaces which are controlled by the software.

CAN

There is one CAN port:

Software configurable BAUD rate, with a default of 1MBit.

Software configurable CAN identification (IDs).

Software configurable termination, default to terminated.

Serial

There is one serial port which is configured to operate at a fixed Baud rate of 115k2 Baud, 8 data bits, one stop bit and parity.

The serial port is used to access a menu, from here you can configure the CSB. The serial port is also used to update the code level

Digital Inputs

There are 12 separate digital inputs which are internally pulled-up to the CSB internal +5V supply via a 10k resistor, these are transmitted at 200Hz but can be configured if required.

Analogue Inputs

There are 5 separate analogue inputs with a 0-5V range these are internally pulled to ground via a 1MΩ resistor, these are transmitted at 100Hz but can be configured if required.

Opto-isolator Inputs/outputs

There are 2 separate opto-isolator inputs/outputs these by default are linked to digital inputs 1 and 2 but can be changed to any of the 12 digital inputs these can drive 0-VBatt output, with a maximum 100mA load and 0.8Ω resistance.

Status LEDs

There are a total of 5 status LEDs, each LED can be driven independently.

The brightness of the LEDs can be controlled by 2 methods. There is a day/night setting which sets the base brightness level for day time or night time brightness, the MAX7219 (LED controller/driver) has an additional brightness control which can select any one of 32 (0 to 31) brightness levels. There is a special CAN packet which is used to configure the brightness.

Software Implementation

CAN Communications

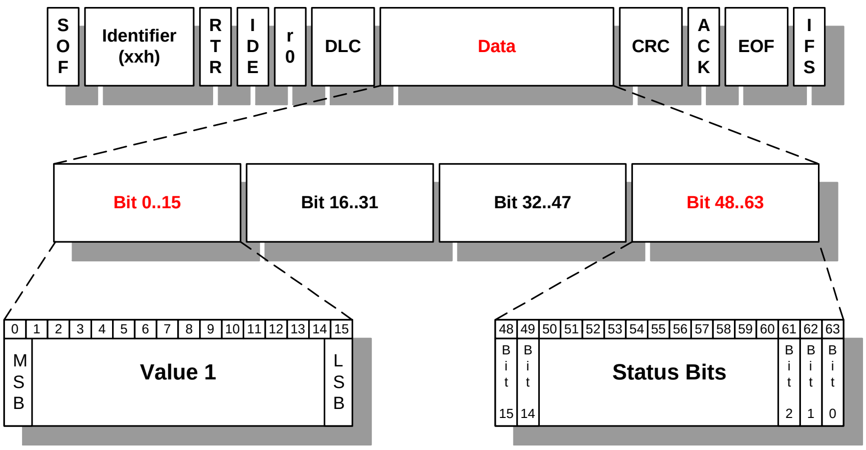
All CAN identifications can be changed using the configuration menu and the values are stored in non-volatile memory.

Notations

Each message is defined in a table as per the example below:-

ID	Xxh		
Dir	Sigma Logger TX / Engine Controller RX		
Rate	1ms*		
Bits	Name	Scaling	Notes
0-15	Value 1		
16-31	Value 2		
32-47	Value 3		
48-63	Status Bits	Bit 48	Status bit 15
		Bit 49	Status bit 14
		…	
		Bit 62	Status bit 1
		Bit 63	Status bit 0

The CAN interface is defined using a bit index from the start of the data field in the message. All multi-bit values are in big-endian format.



Some messages may have 'sub messages' multiplexed in them. In these cases the sub messages are all defined in similar tables and the Rate specified applies to the sub message and not the containing CAN message ID.

Cosworth Validation Word

To enable the CAN stream to be more robust in application, Cosworth implement a number of checks on the validity of the CAN data. The content of this word is only compatible with Pi and Pectel devices.

CAN Address Summary

The following is the CAN address summary:

Description	Address	
Switch Status Transmit and system parameters	CAN IDx+ 0	
Analogue Input 1 to 3	CAN IDx+ 1	
Analogue Input 4 to 5	CAN IDx+ 2	
LED Intensity	Fixed	
LED Control 1	Fixed	
LED Control 2	Fixed	
LED Control 3	Fixed	
Synchronisation packet	Fixed	

CAN Transmission

CAN Switch Status and System Parameter

The following CAN message shows the state of the switch inputs and digital inputs:

Switch / Digital input status
1 = Switch closed, digital input is at 0V.
0 = Switch open, digital input is at +5V.

All switches are treated as momentary. The receiving device is responsible for interpreting the switch presses and performing any logic required for the switch to operate as a latching or multi-state switch.

Switches are de-bounced by ensuring the switch status is the same for 2 consecutive 10mS readings prior to the updated switch status being transmitted over CAN.

This CAN message is constructed differently depending on whether we are operating in CSB or CJB mode.

Digital Switch Inputs 1 to 12

ID	CAN ID + 0		
Dir	CSB to Hyllus/ECU/Sigma		
Rate	200Hz (as default, but can be configured or switched off)		
Bits	Name	Scaling	Notes
0-15	Cosworth Validation Word	U16	
16-23	Software Version Major	U8	
24-31	Software Version Minor	U8	
32-39	Battery Voltage	U8	100mV/bit
40-47	Box Temp	U8	1˚C/bit
48-63	Switch States	Bit 51 - 48	Reserved – set to zero

ID	CAN ID + 0		
Dir	CSB to Hyllus/ECU/Sigma		
Rate	200Hz (as default, but can be configured or switched off)		
Bits	Name	Scaling	Notes
		Bit 52	Switch 12
		Bit 53	Switch 11
		Bit 54	Switch 10
		Bit 55	Switch 9
		Bit 56	Switch 8
		Bit 57	Switch 7
		Bit 58	Switch 6
		Bit 59	Switch 5
		Bit 60	Switch 4
		Bit 61	Switch 3
		Bit 62	Switch 2
		Bit 63	Switch 1

Analogue Input 1 to 3

ID	CAN ID + 1		
Dir	CSB / CJB to Hyllus/ECU/Sigma		
Rate	200Hz (as default, but can be configured or switched off)		
Bits	Name	Scaling	Notes
0-15	Cosworth Validation Word	U16	
16-31	Analogue Input 1	U16	1mV/bit
32-47	Analogue Input 2	U16	1mV/bit
48-63	Analogue Input 3	U16	1mV/bit

Analogue Input 4 to 5

ID	CAN ID + 2		
Dir	CSB to Hyllus/ECU/Sigma		
Rate	100Hz (as default, but can be configured or switched off)		
Bits	Name	Scaling	Notes
0-15	Cosworth Validation Word	U16	
16-31	Analogue Input 4	U16	1mV/bit
32-47	Analogue Input 5	U16	1mV/bit
48-63	Reserved		Must be set to zero

CAN Receive

Failure to Receive CAN Packet

If no CAN packets are received then the LEDs will be pulsed on for ½ second and off for 1½ seconds.

LED Control 1 Receive Packet

The CSB/CJB can receive LED Control messages from 3 separate CAN sources. The contents of the separate CAN packets are ORed together to control the state of the LEDs:

- 1 = LED on
- 0 = LED off

ID	Default 0x731		
Dir	Hyllus/ECU/Sigma to CSB / CJB		
Rate	100Hz		
Bits	Name	Scaling	Notes
0-7	LED Control	Bit 0	Must be set to zero
		Bit 1	Must be set to zero
		Bit 2	Must be set to zero
		Bit 3	LED 5 control request
		Bit 4	LED 4 control request
		Bit 5	LED 3 control request
		Bit 6	LED 2 control request
		Bit 7	LED 1 control request
8–63	Reserved		Must be set to zero

LED Control 2 Receive Packet

This has the same CAN packet parameters as for LED Control 1 (see section 2.5.4.2), the only difference is that the default CAN address is 0x732.

LED Control 3 Receive Packet

This has the same CAN packet parameters as for LED Control 1 (see section 2.5.4.2), the only difference is that the default CAN address is 0x733.

LED Intensity Receive Packet

The LED intensity control packet has the same CAN ID as the Membrane Switch Panel. There is only one CAN ID for this packet, and the packet will be received by all CSB devices who will adjust the brightness of the LEDs accordingly. The position of the hexadecimal switch does not have an effect on this CAN ID.

ID	Default 0x72F		
Dir	Hyllus/ECU/Sigma to CSB		
Rate	1Hz		
Bits	Name	Scaling	Notes
0-7	LED Brightness (0 to 31 to be compatible with MSP), along with indication of Day or Night brightness mode	Bit 0	1 = Day brightness (bright), 0 = night
		Bit 1	Must be set to zero
		Bit 2	Must be set to zero

ID	Default 0x72F		
Dir	Hyllus/ECU/Sigma to CSB		
Rate	1Hz		
Bits	Name	Scaling	Notes
		Bit 3	LED Brightness Bit 4
		Bit 4	LED Brightness Bit 3
		Bit 5	LED Brightness Bit 2
		Bit 6	LED Brightness Bit 1
		Bit 7	LED Brightness Bit 0
8–63	Reserved		Must be set to zero

Test / Configuration Menu

This menu is available at any time by pressing the <Esc> key. All CAN functionality is suspended whilst in this menu. The present values of the parameters are shown in square brackets. The test menu display is shown below:

Test Menu

```
***********************
      Config Menu
***********************
   CSB / CJB Ver 1.1a
***********************

C - CAN Configuration
D - Display Analogue / Digital Channels
H - Hardware Information
L - LED Intensity
O - Opto-isolator Mapping
R - Restore Factory Defaults
T - Test LEDS
U - Update System EEPROM
W - Wheelspeed Configure / Display
X - Exit Config Menu and return to System Mode
? - Display this menu
        Enter selection:
```

When an option is selected which requires user input, each option will be displayed one line at a time with the present value being displayed inside square brackets. If <cr> is pressed then the value is not modified and the next parameter is displayed. The EE will not be updated unless specifically requested from the menu. The following example shows 2 entries in a sub-menu, user input is shown in red:

```
Sub menu configuration
  Parameter 1 [0xf0] : <cr>
  Parameter 2 [0x12] : 0x12<cr>
```

CAN Configuration

When ‘C’ is selected from the main menu the user can display/modify CAN parameters one at a time, as shown below. The configuration can be exited at any time by pressing <Esc>, rather than having to step through the complete list:

```
CAN Configuration
      CAN Baud Rate (1024, 512, 256, 128 kbps) [ 1024 ]  :
      CAN Switch & Sys Tx Rate (Hz) [ 200 ] :
      CAN Analogue 1 to 3 Tx Rate (Hz) [ 200 ] :
      CAN Analogue 4 to 6 Tx Rate (Hz) [ 100 ] :
      CAN Analogue 7 to 9 Tx Rate (Hz) [ 0 ] :
      CAN Analogue 10 to 12 Tx Rate (Hz) [ 0 ] :
      CAN ID0 base [ 0x0c0 ] :
      CAN ID1 base [ 0x140 ] :
      CAN ID2 base [ 0x1c0 ] :
      CAN ID3 base [ 0x240 ] :
      CAN ID4 base [ 0x2c0 ] :
      CAN ID5 base [ 0x340 ] :
      CAN ID6 base [ 0x3c0 ] :
      CAN ID7 base [ 0x440 ] :
      CAN LED Intensity ID [ 0x72f ] :
      CAN LED Control 1 ID [ 0x731 ] :
      CAN LED Control 2 ID [ 0x732 ] :
      CAN LED Control 3 ID [ 0x733 ] :
      CAN Wheelspeed ID [ 0x0c7 ] :
      CAN Sync ID [0x0c8] :
```

Valid transmission rates are 0 (off), 1, 2, 5, 10, 20, 50, 100, 200, 500 or 1000 Hz.

Display Analogue / Digital Channel

From the test menu select 'D' to display all the analogue and digital values. The display should update continuously every 0.5 seconds until the <Esc> key or Control-c is pressed at which point control is returned to the main menu:

```
Switch Status
  12  11  10   9   8   7   6   5   4   3   2   1
   -   -   -   -   -   -   -   -   -   0   0   0

Analogue Input
  12        11        10        9         8         7         6
0.000V    0.000V    0.000V    0.000V    0.000V    0.000V    0.000V

   5         4         3         2         1
0.000V    0.000V    0.000V    0.000V    0.000V

Temperature      Supply Voltage      CSB/CJB Link     Hex Switch
   38.7C            12.306V              CJB               8
```

For the switch status, a '1' shows that the switch is depressed ie, PIC input is at 0V. When the ADI inputs are digital inputs (it is configured as CSB) the analogue inputs 6 to 12 will display '-'. When the ADI inputs are analogue inputs (it is configured as CJB – as shown in the display above) the digital inputs 4 to 12 will display '-'. In CSB configuration, the two wheelspeed inputs act as additional digital inputs (switches 11 & 12).

Hardware Information

When 'H' is selected from the main menu the user should be able to display the following information but only Cosworth production test personnel can change the information via a password:

- Board part number (allow for 16 alpha-numeric characters eg, 25I-620066)
- Board serial number (always numeric from 1 – 65535)
- Board issue (always numeric from 1 to 16)
- Board mod state (always numeric from 0 to 16)

A typical display when 'H' is selected may look as follows where the values in the square brackets are the present values:

```
Hardware Information
  Board Part Number [ 25I-620066 ] :
  Board Serial Number [ 0 ] :
  Board Issue [ 1 ] :
  Board Mod State [ 0 ] :
```

When you exit the Build Information menu and the data has been changed, the user is asked if they want to write the updated parameters to EE.

LED Intensity

When 'L' is selected from the main menu the following message is displayed and the user can change the LED intensity from 0 (dim) to 31 (brightest), in either Day or Night mode.

```
LED intensity
  Day / Night (D or N) [ Day ] :
  Enter Intensity (0 to 31) [ 20 ] :
```

Opto-isolator Mapping

When 'O' is selected from the main menu, the opto-isolators can be configured. When the selected switch input is active (logic low), the selected opto-isolator is enabled by driving the PIC pin low. The menu display is as follows:

```
Opto-isolator Mapping
  Opto 1 mapped to switch (1 to 12) [ 1 ] :
  Opto 2 mapped to switch (1 to 12) [ 2 ] :
```

For the CSB, the opto-isolator can be mapped to switches 1 to 12, for the CJB the opto-isolator can be mapped to switches 1 to 3.

Restore factory default

When 'R' is selected from the main menu, the following factory defaults are restored into the EE:

Description	Default	Options
CAN Baud Rate	1024kbit/sec	1024kbit/sec, 512kbit/sec, 256kbit/sec, 128kbit/sec
CAN Switch & Sys Tx Rate	200Hz	Off, 1Hz, 2Hz, 5Hz, 10Hz, 20Hz, 50Hz, 100Hz, 200Hz, 500Hz, 1000Hz
CAN Analogue 1 to 3 Tx Rate	200Hz	As above
CAN Analogue 4 to 6 Tx Rate	100Hz	As above
CAN Analogue 7 to 9 Tx Rate	Off (CSB) / 100Hz (CJB)	As above
CAN Analogue 10 to 12 Tx Rate	Off (CSB) / 100Hz (CJB)	As above
CAN ID0 Base	0xc0	0 to 0x7fa
CAN ID1 Base	0x140	0 to 0x7fa
CAN ID2 Base	0x1c0	0 to 0x7fa
CAN ID3 Base	0x240	0 to 0x7fa
CAN ID4 Base	0x2c0	0 to 0x7fa
CAN ID5 Base	0x340	0 to 0x7fa
CAN ID6 Base	0x3c0	0 to 0x7fa
CAN ID7 Base	0x440	0 to 0x7fa
CAN LED Intensity ID	0x72f	0 to 0x7ff
CAN LED Control 1 ID	0x731	0 to 0x7ff
CAN LED Control 2 ID	0x732	0 to 0x7ff
CAN LED Control 3 ID	0x733	0 to 0x7ff
CAN Wheelspeed ID	0x0c7	0 to 0x7ff
CAN Synchronisation ID	0x0c8	0 to 0x7ff
LED Intensity Mode	Day	Day, Night
LED Intensity Level	20	0 to 31 (brightest)
Opto-isolator 1	Switch 1	For CSB switches 1 to 12, for CJB 1 to 3.
Opto-isolator 2	Switch 2	For CSB switches 1 to 12, for CJB 1 to 3.
Wheelspeed 1 Type	Passive	Passive, Active
Wheelspeed 2 Type	Passive	Passive, Active

Update System EE

The following values are stored in the PIC EE and should default to the following on a new PIC but they are not change by this command:

Description	Default	Options
Board Part Number	25I-62006	Any alpha numeric character
Board Serial Number	0	Any numeric value (1 to 65535)
Board Issue	1	Any numeric value (1 to 16)
Board Mod state	0	Any numeric value (0 to 16)

Test LEDs

From the test menu select ‘T’ to enter the LED test menu and will display the LED test information

```
LED Test
  LED Select (1 to 5, All) :
  LED Control (On or Off) :
```

Following this, a confirmation message is displayed describing the action carried out.

Wheel speed Configure / Display

The Wheel speed Configure / Display option is only available when configured as CJB. The two wheel speed inputs act as additional digital inputs for the CSB (switches 11 & 12).

From the test menu select ‘W’ to configure the wheel speed inputs for passive or active types and then display the wheel speed information:

```
Wheelspeed Configure / Display
  Wheelspeed 1 configuration (A or P) [ Active ]  :
  Wheelspeed 2 configuration (A or P) [ Passive ] :


          Tooth counts                    Tooth frequency
WS1            3559                           869.6
WS2            3778                           873.4
```

The values for the tooth counts is the number of counts in the time specified in the wheelspeed CAN packet, refer to section **Error! Reference source not found.**. The frequency is the number of pulses in one second. The display should update continuously every 0.5 seconds until the <Esc> key or Control-c is pressed, at which point control is returned to the main menu.

Update System EEPROM

After the user has updated the system parameters they can be written to the EEPROM so they are stored over a power cycle. When ‘U’ is selected from the main menu (and when changes to any EEPROM parameters have been mode) the following message is displayed:

```
Some settings have been changed.
Update System EEPROM? (Y or N) :
```

Exit Test Mode

This option exits the Configuration and returns to normal operational mode. When ‘X’ is selected from the main menu the following message is displayed if the system parameters have been modified:

```
Some settings have been changed.
Update System EEPROM (Y or N) :
```