E888/816

Expander Modules

User Manual

Contents

Introduction

This manual describes the functions and specifications of the E888/E816 expander modules and their configuration for use with a MoTeC ADL. These devices offer additional inputs and outputs into the ADL via a CAN connection.

ECU Manager software is currently being developed that will allow the M800 family of ECUs to read information from the E888/816.

This manual includes information on connecting a single expander unit to an ADL or ADL2. The ADL2 along with the ADL2 Dash Manager software has been designed to easily allow the connection of a second expander.

It is possible to connect a second expander unit to an ADL and a third or even fourth unit to an ADL2 – please contact your MoTeC dealer for details in these situations.

The SDL is capable of reading data from 8 thermocouples when connected to an E888. It cannot read analog voltage inputs.

Overview

The **E888** has the following inputs and outputs:
- 8 Analog voltage inputs (AV 1-8)
- 8 Thermocouple inputs (TC 1-8)
- 2 Cold junction compensation thermistor inputs (CJC 1-2)
- 4 Digital inputs (DIG 1-4)
- 2 Switch inputs (DIG 5-6)
- 8 PWM outputs (Aux 1-8)

The **E816** has the following inputs and outputs:
- 16 Analog voltage inputs (AV 1-16)
- 2 Thermistor inputs (CJC1-2)
- 4 Digital inputs (DIG 1-4)
- 2 Switch inputs (DIG 5-6)
- 8 PWM outputs (Aux 1-8)

The E888 uses the two part 60 pin connector also used by the M400, M600 and M800 ECUs.

The E816 uses a 66 pin Autosport connector, the same as that used by the M880 ECU.

Inputs

E888 Thermocouple Inputs (TC1 – TC8)

The E888 has eight calibrated and compensated type K (-200 to 1250ºC) thermocouple inputs. Thermocouple inputs are calibrated during production. Note that the thermocouples numbered TC1 – TC8 correspond to pins AV9 – AV16 in the Dash Manager Input pins setup.

Cold Junction compensations are performed using external sensors or the E888 internal temperature sensor, according to the following rules:

- If only one of the two external cold junction compensation sensors (CJC1 or CJC2) is present then that sensor is used for compensations on all thermocouple inputs.
- If both of the two external cold junction compensation sensors are present then sensor CJC1 is used for compensations on TC1 to TC4, and sensor CJC2 is used for compensations on TC5 to TC8.
- If neither of the two external cold junction compensation sensors are present then the internal temperature sensor is used for compensations on all thermocouple inputs.

Cold Junction Compensation Inputs (CJC1 and CJC2)

The cold junction compensation inputs are used to measure thermistor (2 wire temperature sensor) temperatures for thermocouple input compensation. If the thermocouple inputs are not in use, or when using the E816, these inputs may be used as general purpose temperature inputs.

CJC1/2 inputs have internal 1K pull-ups, and are calibrated to use Bosch 0 280 130 023/026 sensors to read from -30ºC to 150ºC.

Analog Voltage Inputs (AV1 – AV8 or AV1 – AV16)

The E888 has eight 0-5V analog voltage inputs (AV1 to AV8), while the E816 has sixteen inputs (AV1 to AV16). These are suitable for Potentiometers, voltage output sensors and variable resistance (temperature) sensors (these require an external pull-up resistor to 5V).

Digital Inputs (DIG1 – DIG 4)

DIG1 to DIG4 may be used to measure frequency. The frequency measurement range is approximately 1Hz to 5000Hz. Digital inputs should be pulled to ground as the inputs have an internal 2K7 to 12V pull-up resistor.

Note: Digital Inputs 1 – 4 can only be calibrated to measure frequency. If they are used as On/Off switches, then the status information is available in the CAN template 'Expander Diagnostics' – see below

Switch Inputs (DIG5 – 6)

These can be used to measure and On/Off style switch. The switches should be wired so that the E8xx input is pulled to ground when the switch is activated.

Note: Digital inputs 5 and 6 are not included in the Input Pins setup. Instead they are included in the CAN template 'Expander Diagnostics' – see below.

Input Pin Configuration (ADL)

Sensors connected to the E8xx inputs can be configured in the same way as those connected directly to the ADL. This requires that the ADL is upgraded to version 3.1 or later.

In Dash Manager, go to 'Inputs – Communications' and select an empty CAN tab. Click on 'Select' and choose 'Expander Inputs' from the list.

Tabs for Expander Analog Volt and Expander Digital input pin configuration can be found under the Dash Manager menu item 'Inputs – Input Pins'.

The Expander type can be selected from the drop down list. The list of inputs will then show the input name and pin numbers for that particular expander.

The 16 Analogue Volt and 4 Digital Inputs can now be configured the same way as other ADL inputs by Selecting a channel and then assigning a calibration. See the ADL Manual for more details on configuring sensor inputs.
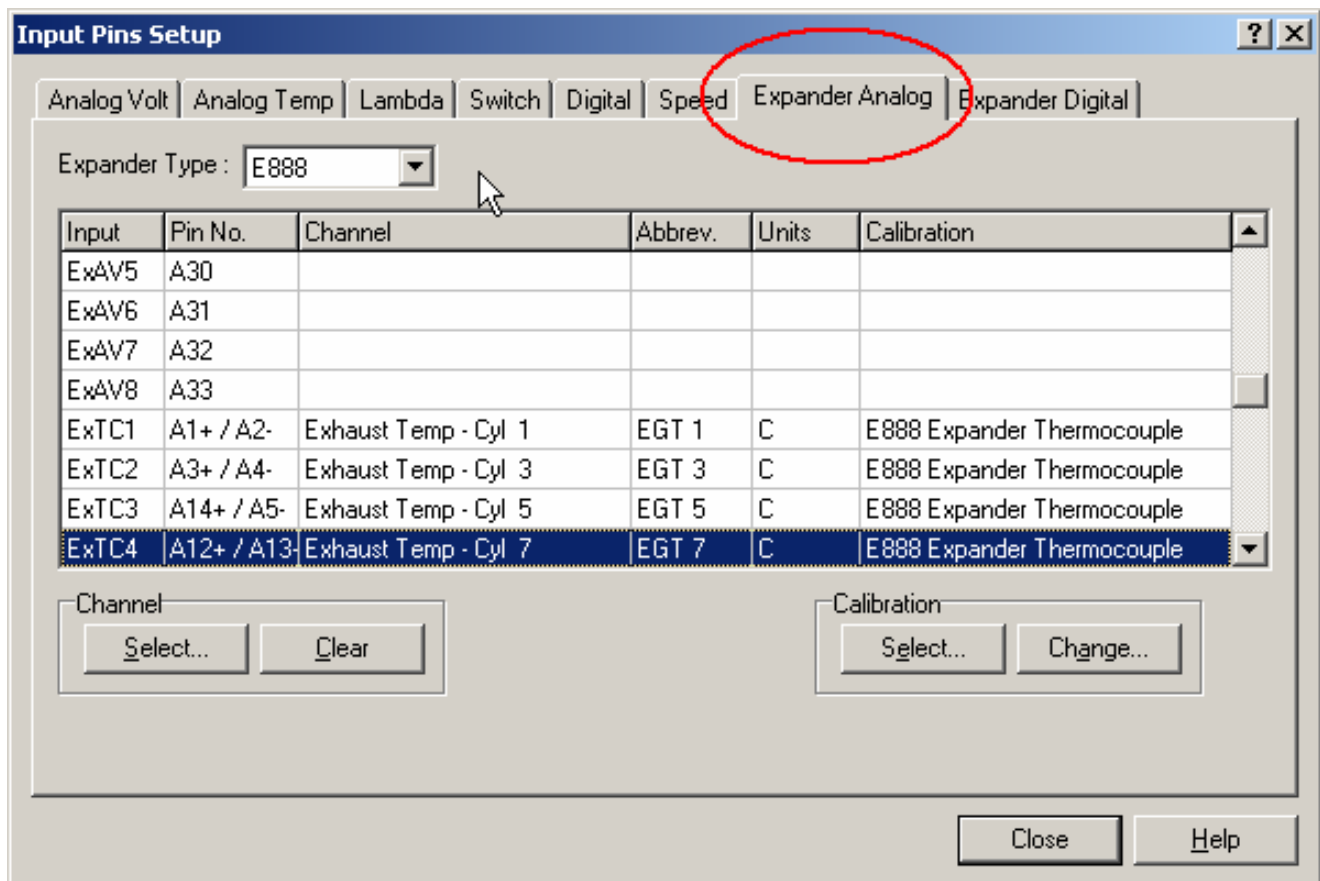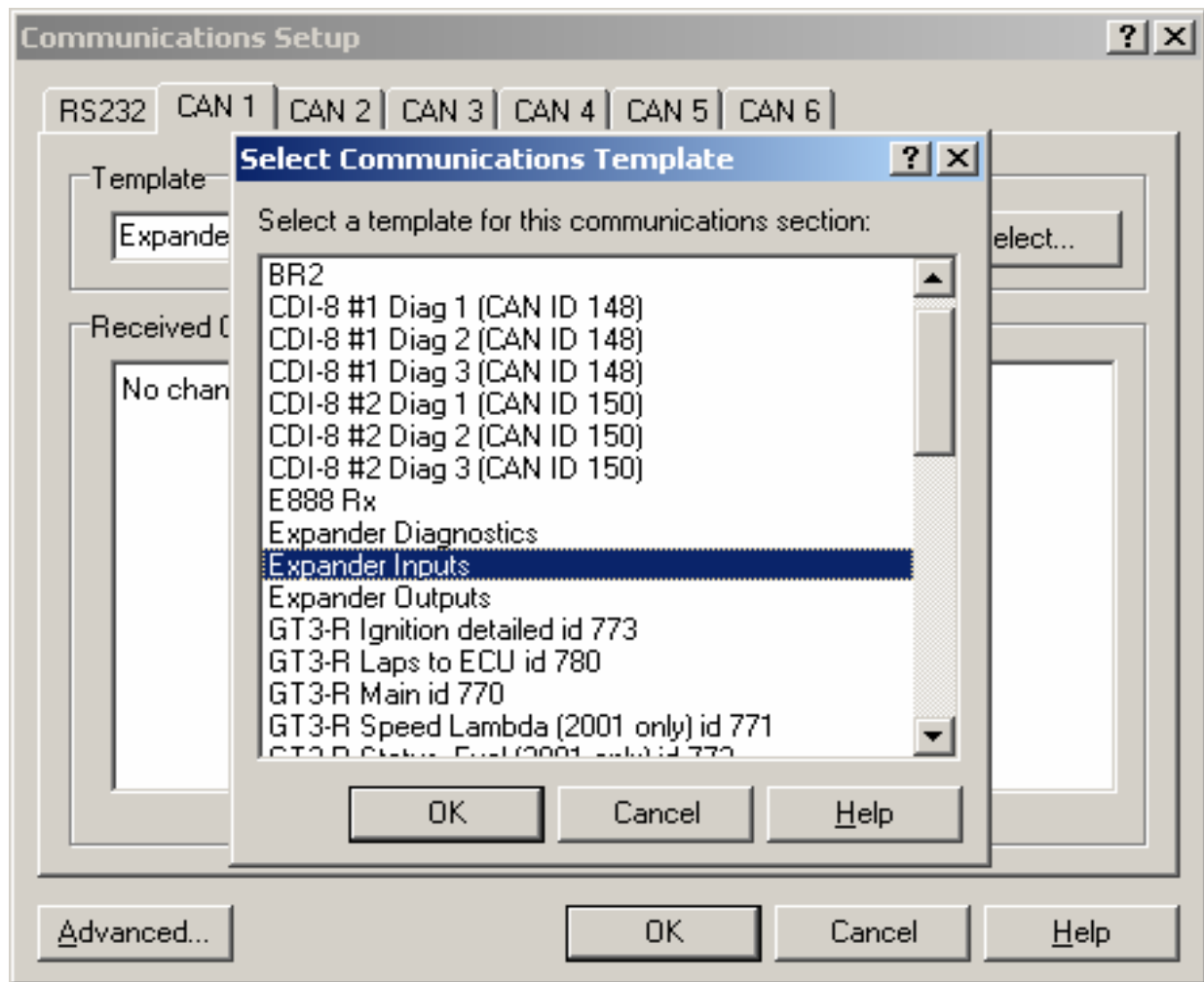
E888 Thermocouples

Thermocouple inputs 1 – 8 correspond to Expander Analog inputs ExTC1 to ExTC8. The calibration used for these inputs is "E888 Expander Thermocouple" and can be found in the 'Select Calibration' list.
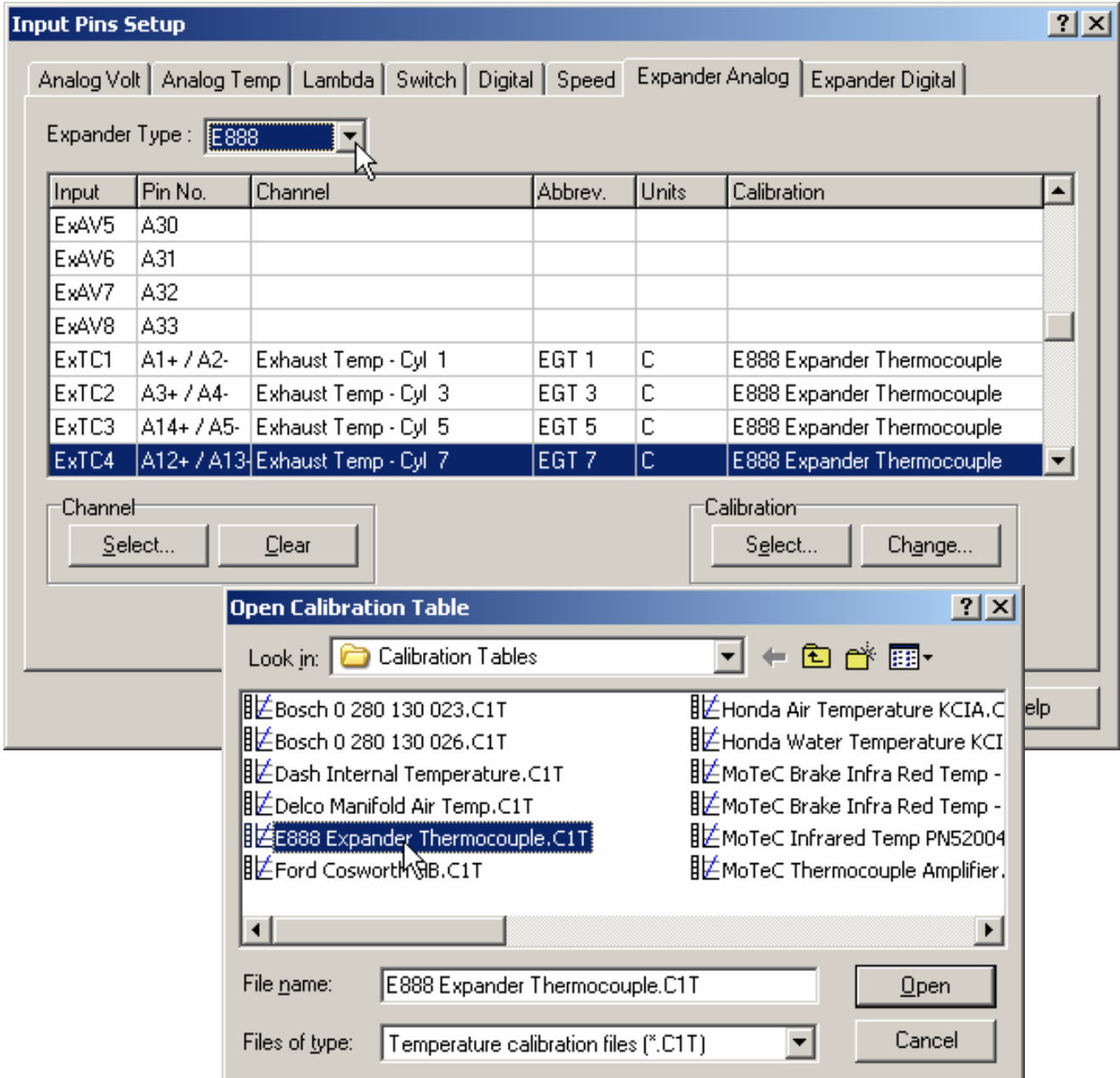
Outputs

Both the E888 and E816 include 8 Auxiliary Outputs that are individually controllable for frequency and duty cycle. They are known as PWM – Pulse Width Modulated – outputs.

The outputs are in two groups (odd and even) with different characteristics as follows:

Duty cycle for PWM1/3/5/7 is adjustable from 0 to 100% in 255 steps.

Frequency for PWM1/3/5/7is adjustable from 8Hz to 5kHz.

Duty cycle for PWM2/4/6/8 is adjustable from 0 to 100% in 20 steps.

Frequency for PWM2/4/6/8 is adjustable from 1Hz to 100Hz.

The PWM outputs each have high and low side drivers. A duty cycle sent to the E888 is the low duty cycle ie:
- an output with 100% duty cycle is pulled low
- an output with 0% duty cycle is pulled high

If the frequency for an output is set to 0, then the output is turned on/off according to the following rules:
- For a duty cycle of 0%, the output is off (ie: pulled high)
- For a duty cycle greater than 0%, the output is on (ie: pulled low)

All outputs are disabled until the first CAN message is received.

Outputs are disabled after no CAN messages have been received for one second.

Output Configuration

Auxiliary Devices connected to the E8xx outputs can be configured in the same way as those connected directly to the ADL. This requires that the ADL is upgraded to version 3.1 or later.

In Dash Manager go to 'Inputs – Communications' and select an empty CAN tab. Click on 'Select' and choose 'Expander Outputs' from the list.

Communications Setup

RS232 | CAN 1 | CAN 2 | CAN 3 | CAN 4 | CAN 5 | CAN 6 |

Template

Select Communications Template

Select a template for this communications section:

(None)
BR2
CDI-8 #1 Diag 1 (CAN ID 148)
CDI-8 #1 Diag 2 (CAN ID 148)
CDI-8 #1 Diag 3 (CAN ID 148)
CDI-8 #2 Diag 1 (CAN ID 150)
CDI-8 #2 Diag 2 (CAN ID 150)
CDI-8 #2 Diag 3 (CAN ID 150)
E888 Rx
Expander Diagnostics
Expander Inputs
Expander Outputs
GT3-R Ignition detailed id 773
GT3-R Laps to ECU id 780
GT3-R Main id 770

OK   Cancel   Help

Received

No chan

Advanced...   OK   Cancel   Help

The tab for Expander Output configuration can be found under the Dash Manager menu item 'Functions – Auxiliary Outputs'.

Output	Pin No.	Enabled	Mode	Settings
ExAux1		Yes	Duty Cycle Control	duty = Battery Voltage at ADL, freq = 100 Hz
ExAux2				
ExAux3				
ExAux4				
ExAux5				
ExAux6				
ExAux7				
ExAux8				
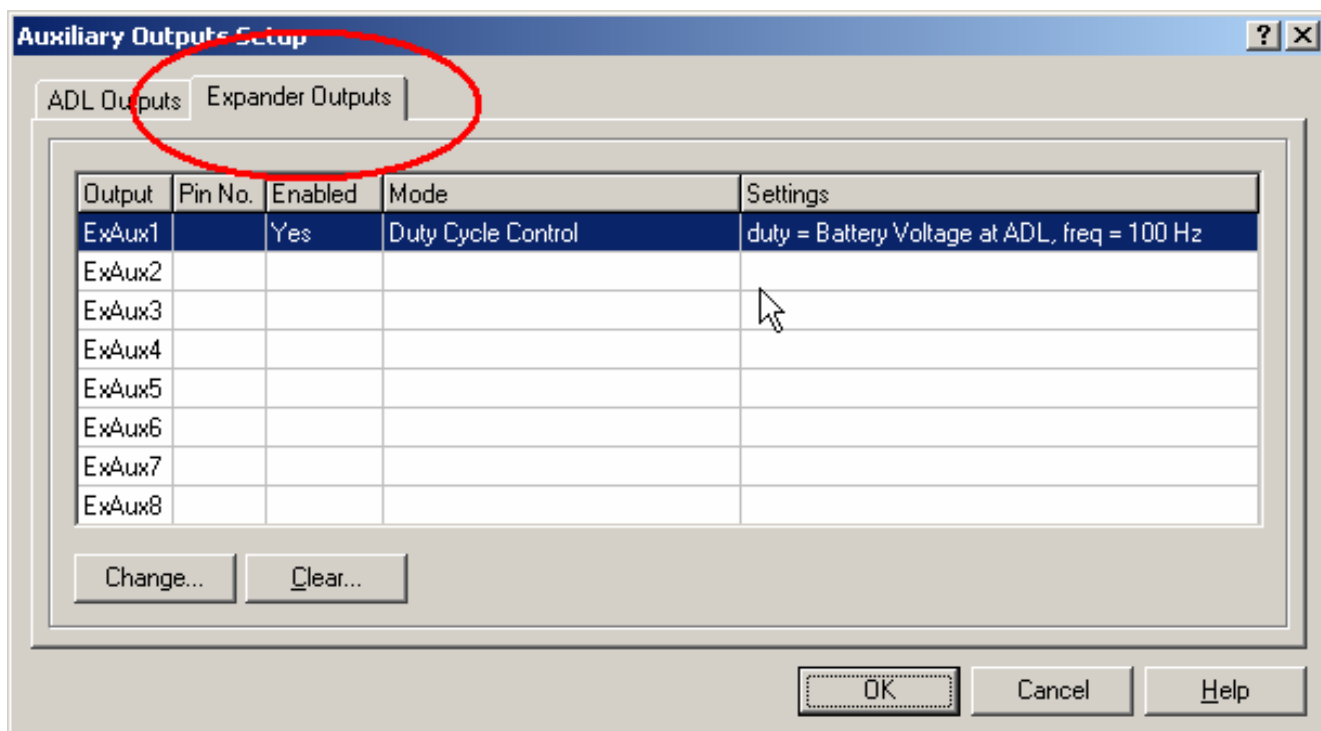
10   Outputs

The E8xx outputs can now be configured the same way as the ADL Auxiliary outputs by selecting an output and then setting the control channels and parameters.

Ie: Outputs can be on/off, controlled by frequency, duty cycle or a combination of frequency and duty cycle. Note that appropriate control channels will need to be generated for these functions. See the ADL Manual for more details on configuring outputs.

Auxiliary Output Settings

Mode

Output Mode : Duty Cycle Control ▼   ☑ Enabled

Off
On/Off
Light
Duty Cycle Control
Frequency Control
Duty Cycle & Frequency Control

Duty Cycle Chann

GP 1 (0 dps)

Channel value for 0 % duty cycle :   0

Channel value for 100 % duty cycle :   100

Frequency

Fixed frequency :   100 Hz   (Hz)

OK   Cancel   Help
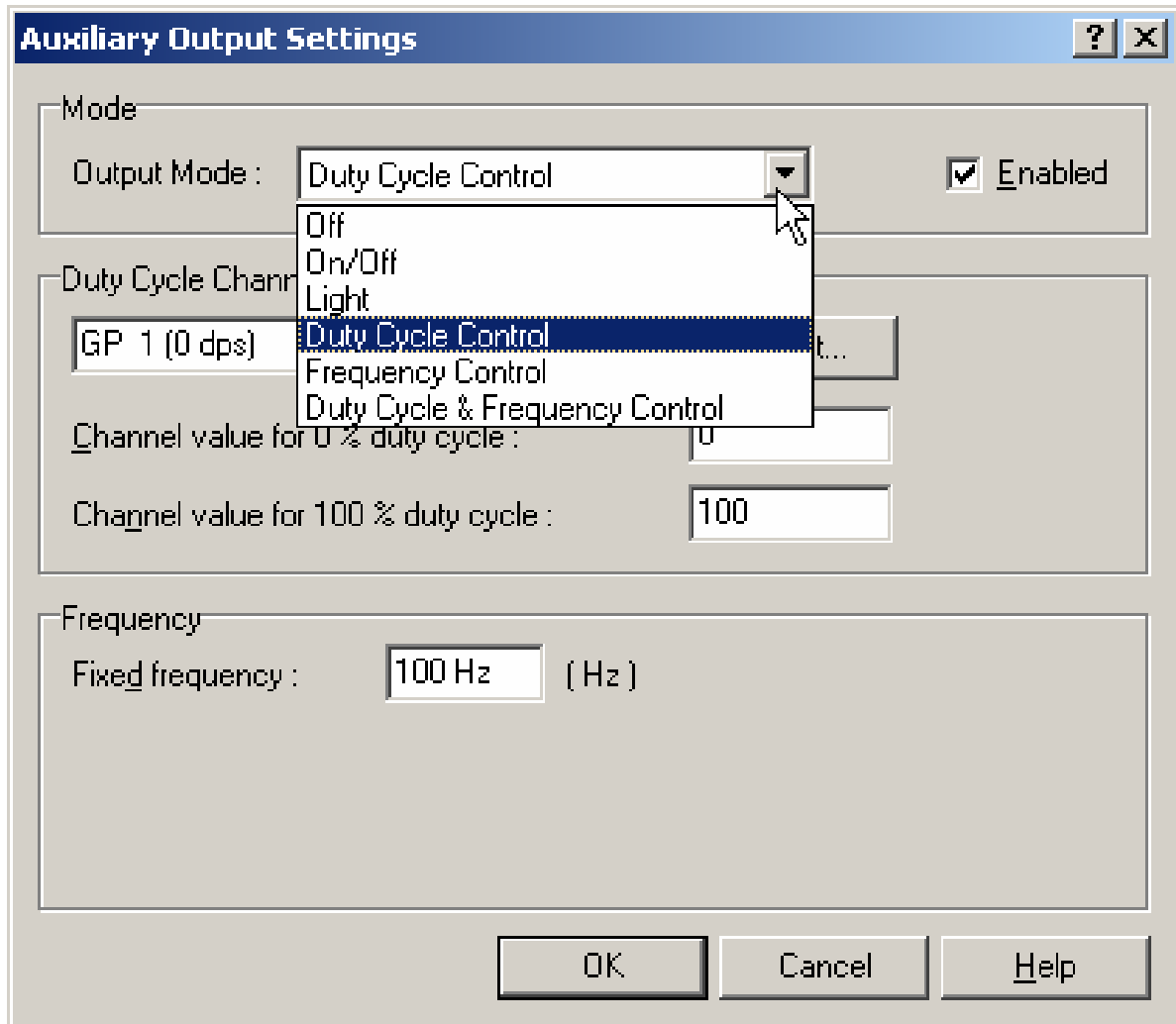
E8xx Diagnostic Information

Additional status information is available from the E8xx along with the state of the 2 Switch Inputs and the temperatures measured on the 2 thermistor inputs. This information can be accessed by selecting an additional CAN template in the Dash Manager communications setup.

Go to 'Inputs – Communications' and click on a blank CAN tab. Then 'Select' the template "Expander Diagnostics".
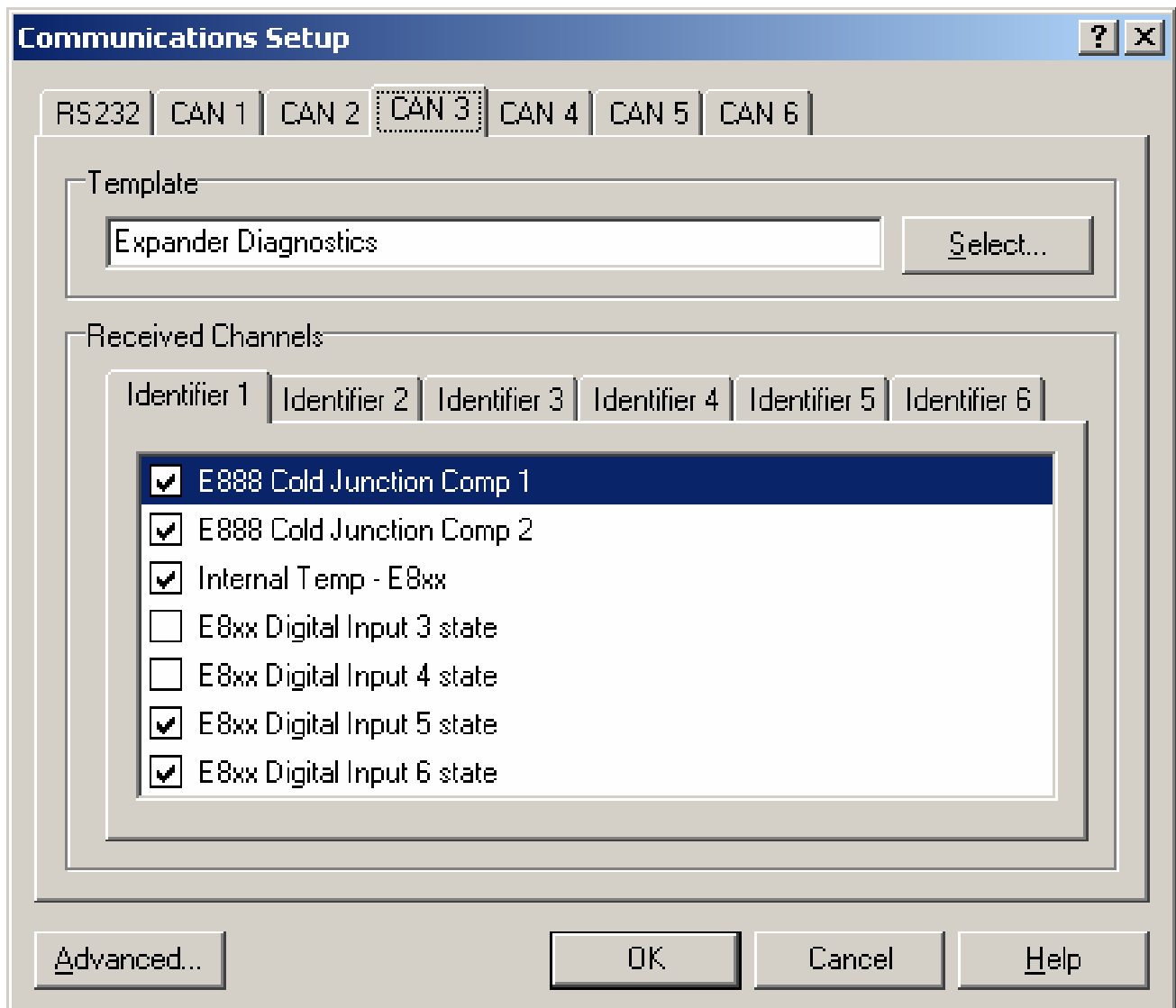
Test Analogue Inputs

It is possible to view the current 'live' voltages on the expander's analogue inputs using a PC connected to the E8xx via an ADL. In Dash Manager select the menu item 'Online – Test – Analogue Inputs'. Then click on the tab 'Expander Analog'. This is very useful for testing wiring and sensors, and even determining which sensors are connected to which inputs.

Test Inputs

Analog Volt	Expander Analog

Input	Value
ExA1	0.000 V
ExA2	0.000 V
ExA3	1.129 V
ExA4	0.000 V
ExA5	0.000 V
ExA6	0.000 V
ExA7	0.000 V
ExA8	0.000 V
ExA9	0.084 V
ExA10	0.120 V
ExA11	0.096 V
ExA12	0.104 V
ExA13	0.108 V
ExA14	0.080 V
ExA15	0.132 V
ExA16	0.084 V

Test Auxiliary Outputs

Similar to the 'Test Analog Inputs' function, this screen allows the Auxiliary Outputs to be tested. In Dash Manager select the menu item 'Online – Test – Auxiliary Outputs' then click on the tab 'Expander Outputs'.

To test an output select the desired output from the list then enter a suitable Duty Cycle and Frequency then click the Start button.

100% duty cycle corresponds to the output fully On (Low Voltage), 0% duty cycle corresponds to the output fully Off (High Voltage). The frequency should be chosen to suit the device.

Test Auxiliary Outputs   ? X

| ADL Outputs | Expander Outputs |

Output

Output	Mode	Duty	Frequency
ExAux1	On/Off	50	50
ExAux2			
ExAux3			
ExAux4			
ExAux5			
ExAux6			
ExAux7			
ExAux8			

Aux Output Test Parameters

Duty Cycle : 50 %   Frequency : 50 Hz   [Set]   Clear All

[Close]   [Help]

Communications

CAN

The CAN bus is used for PC communications during testing, calibration and firmware upgrades, and for communicating to the ADL or M800.

The following data is transmitted by the E888/E816 at 200Hz:
- Thermocouple temperatures
- Analog input voltages
- Digital input frequencies

The following data is transmitted by the E888/E816 at 50Hz:
- Cold junction compensation temperatures
- Digital input states
- Output driver faults
- Internal temperature
- Internal voltages (-5v, 8vAux, 5vAux, Vbat, 4.5v)
- E888 status flags
- E888 firmware version

The following data is received by the E888/E816 from the ADL:
- PWM outputs frequency and duty cycle
- PWM outputs disable

Firmware Upgrades

At times MoTeC may release Firmware upgrades for the E8xx Expander units. Upgrades are performed over the CAN bus using the Dashsend utility with a MoTeC CAN cable.

The Dash Manager installation adds an icon to the Start menu to perform the E888 firmware upgrade.

See the item under 'Start – Programs – MoTeC – E888 and E816 Expander

Appendices

Appendix A: General Specifications

Physical and Environmental

Case Size   99 x 105mm x 40mm

Weight   E888 310g

                       E816 320g

Temperature Range   -10 to 70°C

Power Supply

Operating Voltage   9 – 22V DC

Operating Current   150mA (excluding sensor currents and outputs)

Protection   Battery transient protection

                       Reverse battery protection via **external** fuse

CAN Communications

CAN bus speed   1Mbit/s

No CAN terminating resistor onboard

Appendix B: Input Characteristics

K-Type thermocouple Inputs (E888)

Range   -200 to 1250°C

Resolution   1°C

Accuracy (excluding cold junction errors):

- E888 case temperature 25°C, +/- 2°C Typical

- E888 case temperature -10 to 70°C, +/- 4°C + 2% measured temperature

Filtering   Oversampled for anti-aliasing

Update rate on CAN   100Hz (CAN address 0x0F0 or 0x0F8)

                                  50Hz (CAN address 0x0F4 or 0x0FC)

Analog Voltage Inputs

Range   0 to 5V

Resolution   4.89mV (10bit conversion)

Input Resistance   100Kohms to 0V

Filtering   Oversampled for anti-aliasing

Update rate on CAN   200Hz (CAN address 0x0F0 or 0x0F8)

                                  50Hz (CAN address 0x0F4 or 0x0FC)

Internal Cold Junction Compensation sensor

Resolution   1°C

Accuracy

- E8XX case temperature 25°C, +/- 2°C

- E8XX case temperature -10 to 70°C, +/- 4°C

External Cold Junction Compensation Inputs (Bosch 0 280 130 023/026)

Range   -30 to 150°C

Resolution   1°C

Accuracy -10 to 70degC measured temperature, +/- 1°C + Sensor accuracy

Digital Inputs (Schmitt Trigger)

Pullup resistor   2700 ohms to 5V

Voltage range   0 to 15V

Positive trigger threshold   3.5V max

Negative trigger threshold   1.0V min

Hysteresis   0.5V min

Freq Range (for inputs 1-4)   1Hz to 6kHz

Freq Resolution (for inputs 1-4) 0.1Hz

Minimum Pulse Width   0.05mS

Update rate on CAN   200Hz (CAN address 0x0F0 or 0x0F8)

                              50Hz (CAN address 0x0F4 or 0x0FC)

Appendix C: Output Characteristics

Outputs

Current per output when using the given number of outputs:

- 1 Output   3.2A

- 2 Outputs   2.3A

- 4 Outputs   1.6A

- 8 Outputs   1.1A

Duty cycle resolution (high speed outputs)   255 steps (0-100%)

Frequency Range(high speed outputs)   8Hz to 5kHz

Duty cycle resolution (low speed outputs)   20 steps (0-100%)

Frequency Range (low speed outputs)   1Hz to 100Hz

Appendix D: CAN Wiring – Multiple Device

The CAN bus should consist of a twisted pair trunk with 100R (0.25Watt) terminating resistors at each end of the trunk.

The preferred cable for the trunk is 100R Data Cable but twisted 22# Tefzel is usually OK.

The maximum length of the bus is 16m (50ft) including the *MoTeC* CAN Cable (PC to CAN Bus Communications Cable)

CAN Devices (such as *MoTeC* ADL, BR2 etc) may be connected to the trunk with up to 500mm (20in) of twisted wire.

The connector for the CAN Communications Cable may also be connected to the trunk with up to 500mm (20in) of twisted wire and should be within 500mm of one end of the trunk. If desired two CAN Cable connectors may be used so that the *MoTeC* CAN Cable may be connected to either side of the vehicle. Both connectors must be within 500mm of each end of the trunk.
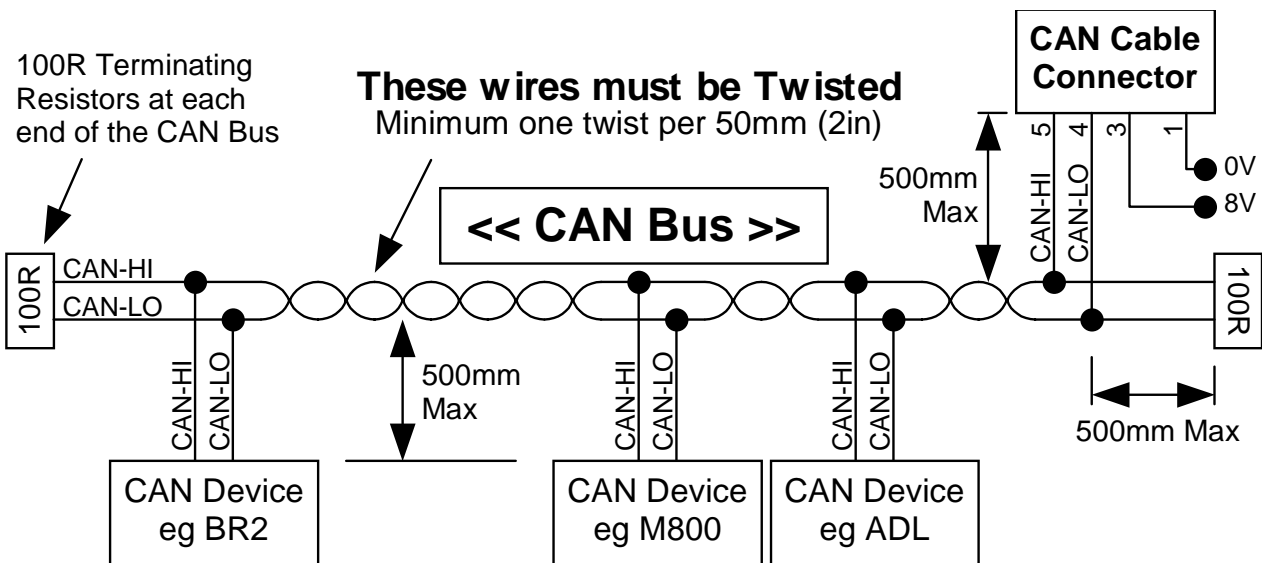
Short CAN Bus

If the CAN Bus is less than 2m (7ft) long then a single termination resistor may be used. The resistor should be placed at the opposite end of the CAN Bus to the CAN Cable connector.

Appendix E: E8xx to ADL Wiring
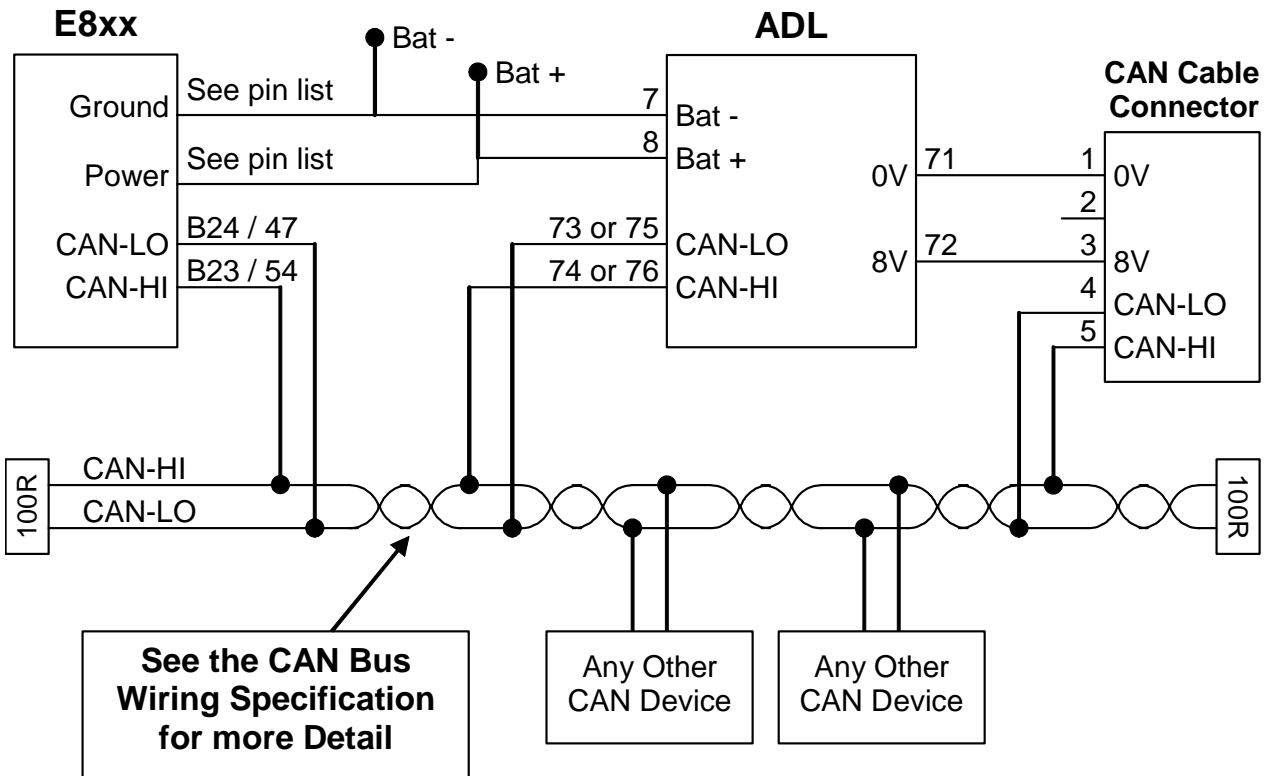
E8xx Power and Ground Wiring

	Bat +	Bat -
E888	A17, B8, B9	A10, A11, B15, B16
E816	28, 29, 30, 37, 38, 39	13, 14, 15, 19, 20, 21, 22

Additional Power and Ground pins are provided to simplify wiring and to meet the current requirements of any devices connected to the PWM outputs.

As a general principle, if no outputs are being used, then wiring one power and one ground pin is sufficient. If the expander outputs are used, then all power and ground pins should be wired up.

Appendix F: E8xx to M800 Wiring

Note that this also applies to the M400, M600 and M880 ECUs.
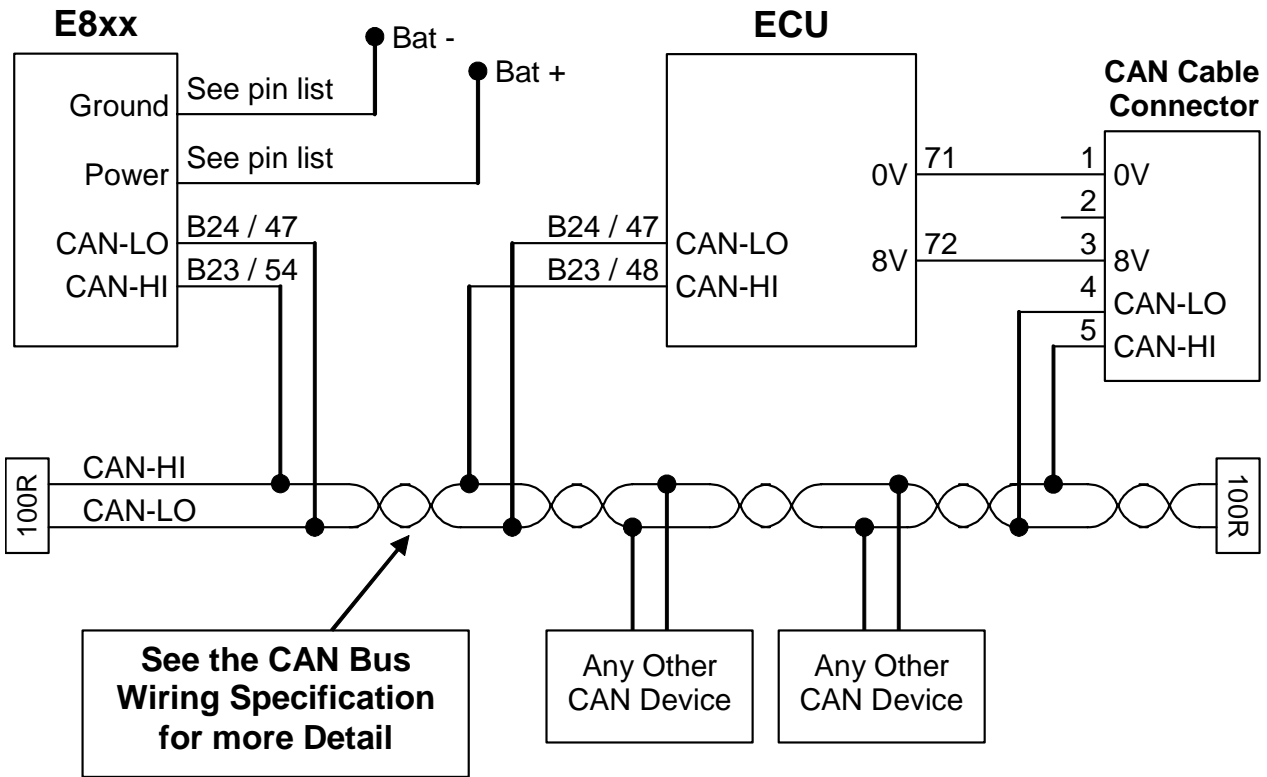
E8xx Power and Ground Wiring

	Bat +	Bat -
E888	A17, B8, B9	A10, A11, B15, B16
E816	28, 29, 30, 37, 38, 39	13, 14, 15, 19, 20, 21, 22

Additional Power and Ground pins are provided to simplify and to meet the current requirements of any devices connected to the PWM outputs.

As a general principle, if no outputs are being used, then wiring one power and one ground pin is sufficient. If the expander outputs are used, then all power and ground pins should be wired up.

Appendix G: E888 Pin List by Pin Number

The E888 uses a 34 + 26 pin connector pair with the following pin-out:

Pin	Function		Pin	Function
A1	TC1+		B1	PWM1
A2	TC1-		B2	PWM2
A3	TC2+		B3	PWM3
A4	TC2-		B4	PWM4
A5	TC3-		B5	PWM5
A6	CJC1		B6	PWM6
A7	CJC2		B7	PWM7
A8			B8	BATTERY +
A9			B9	BATTERY +
A10	BATTERY-		B10	DIG2
A11	BATTERY-		B11	DIG1
A12	TC4+		B12	DIG5
A13	TC4-		B13	PWM8
A14	TC3+		B14	0V COMMS
A15	0V		B15	BATTERY-
A16	8V		B16	BATTERY-
A17	BATTERY+		B17	
A18	TC5+		B18	DIG4
A19	TC5-		B19	DIG3
A20	TC6+		B20	5V
A21	TC6-		B21	0V
A22	AV1		B22	8V
A23	AV2		B23	CAN HI
A24	AV3		B24	CAN LO
A25	AV4		B25	DIG6
A26	TC7+		B26	
A27	TC7-			
A28	TC8+			
A29	TC8-			
A30	AV5			
A31	AV6			
A32	AV7			
A33	AV8			
A34	5V			

Appendix H: E816 Pin List by Pin Number

The E816 uses a 66 pin autosport connector with the following pin-out:

Pin	Function (E816B)	Pin	Function (E816B)
1		34	PWM8
2	PWM7	35	CJC1
3	PWM6	36	8V
4		37	BATTERY+
5	AV11	38	BATTERY+
6	AV10	39	BATTERY+
7	PWM5	40	
8		41	DIGITAL IN 5
9	AV9	42	DIGITAL IN 6
10		43	
11	AV12	44	AV14
12	0V COMMS	45	8V
13	BATTERY-	46	5V
14	BATTERY-	47	CAN LO
15	BATTERY-	48	
16	PWM4	49	PWM3
17	CJC2	50	
18	0V	51	
19	BATTERY-	52	AV15
20	BATTERY-	53	5V
21	BATTERY-	54	CAN HI
22	BATTERY-	55	
23	DIGITAL IN 1	56	PWM2
24	DIGITAL IN 2	57	AV16
25		58	AV1
26	AV13	59	AV2
27	0V	60	AV3
28	BATTERY+	61	PWM1
29	BATTERY+	62	AV4
30	BATTERY+	63	AV5
31		64	AV6
32	DIGITAL IN 3	65	AV7
33	DIGITAL IN 4	66	AV8

Appendix I: E816 Connector

Mating Connector

Deutsch : AS6-18-35SN

Wire

Wire to suit connector : 22# Tefzel, Mil Spec : M22759/16-22

Crimp Tool

Crimp Tool : M22520/2-01

Positioner for Crimp Tool : M22520/2-07

- Note that the Crimp Contacts are type 22D (this is needed to set the crimp tool correctly)

Wire Stripping Tool

The following tool is recommended

Ideal Industries 45-2133 stripping tool with LB1195 wire stop.

Heatshrink Boots

Straight : Racychem 202K153, Hellermann 156-42-G

Right Angle : Racychem 222K153, Hellermann : 1156-4-G