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While every effort is taken to ensure correctness, no responsibility will be taken for the consequences of any inaccuracies or omissions in this manual.

16 December, 2005

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 1250°C) 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 -30°C to 150°C.

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)

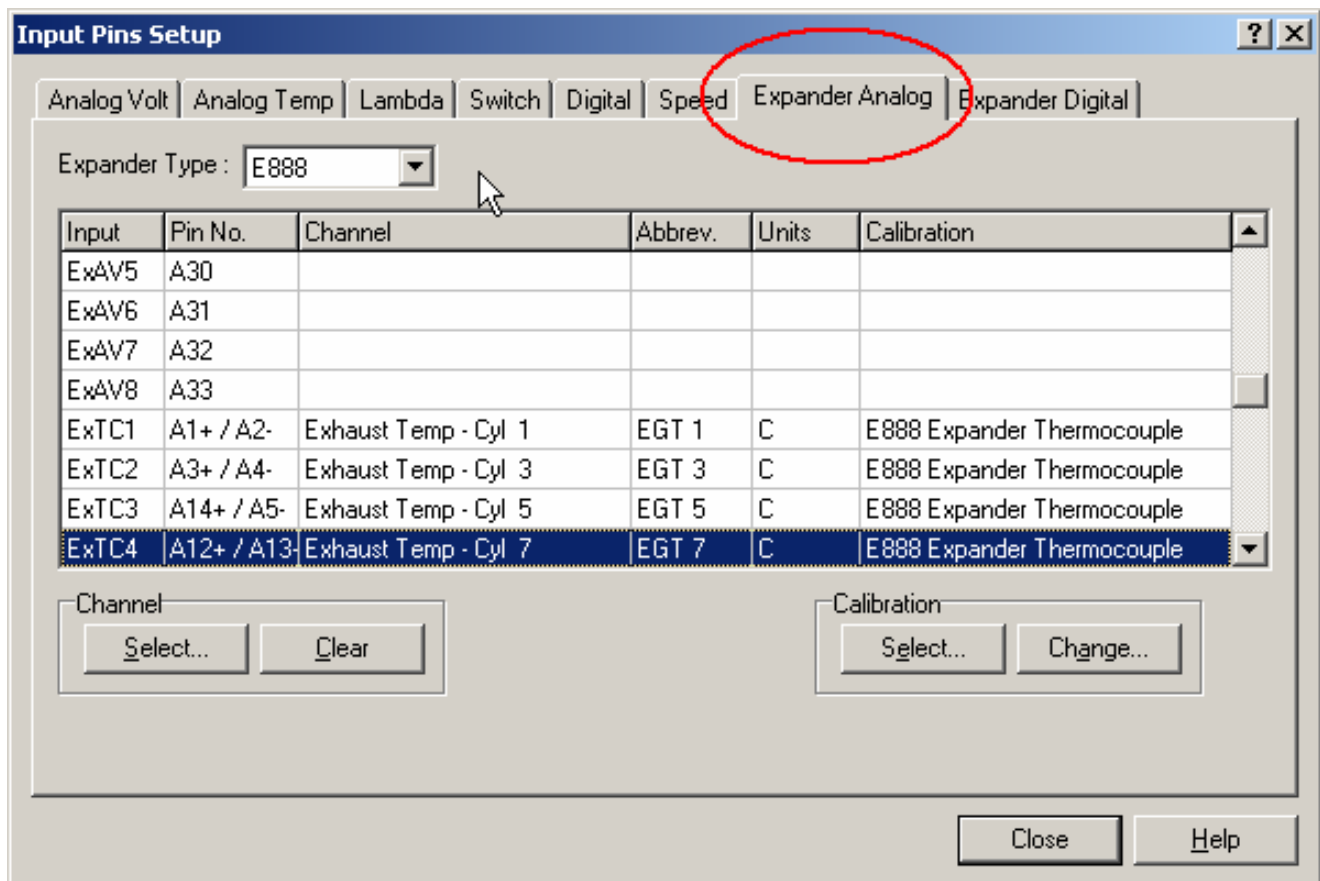
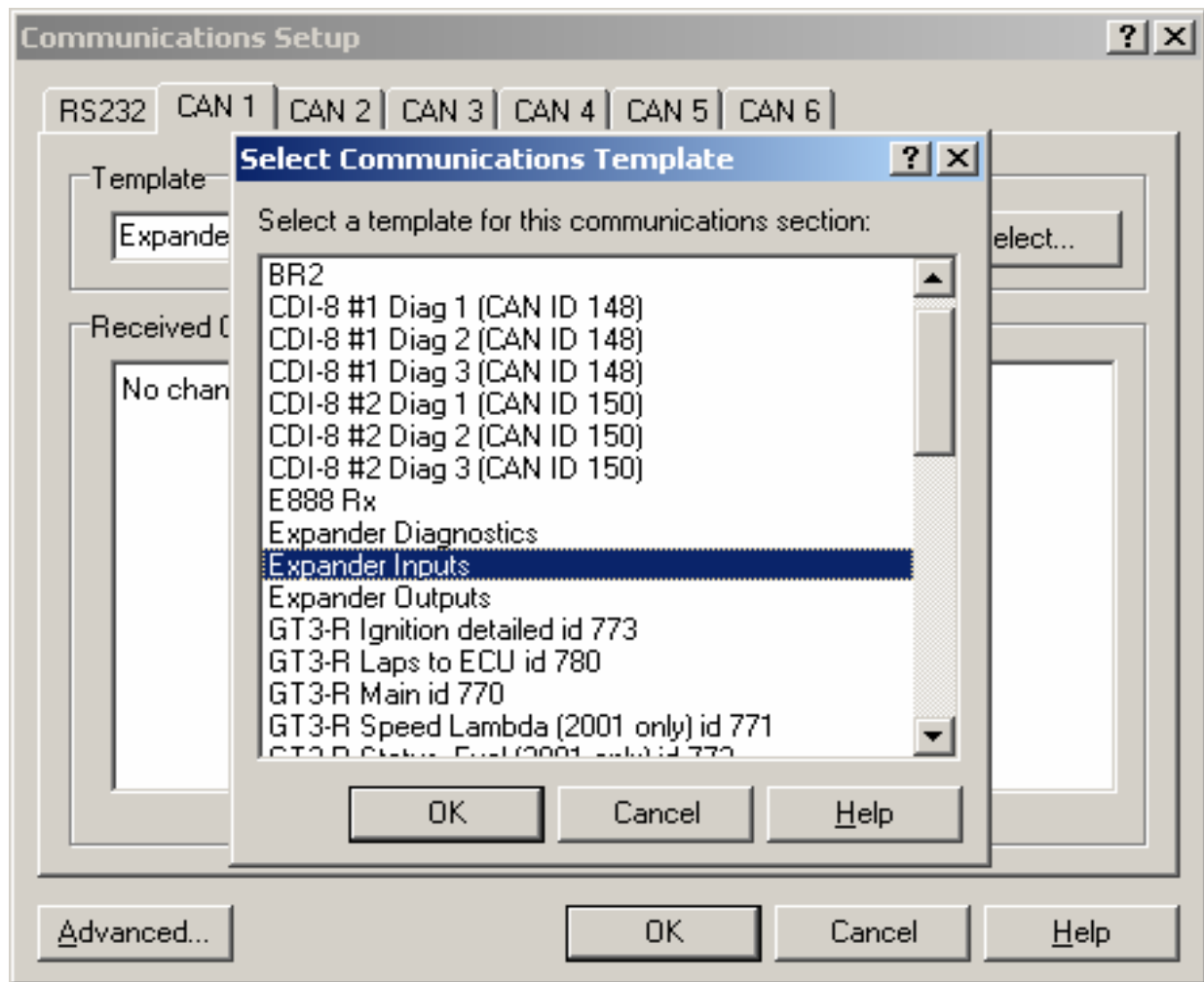
Sensors connected to the E8xx inputs can be configured in the same way as those connected directly to the ADL. This requires that the ADL is upgraded to version 3.1 or later.

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'.

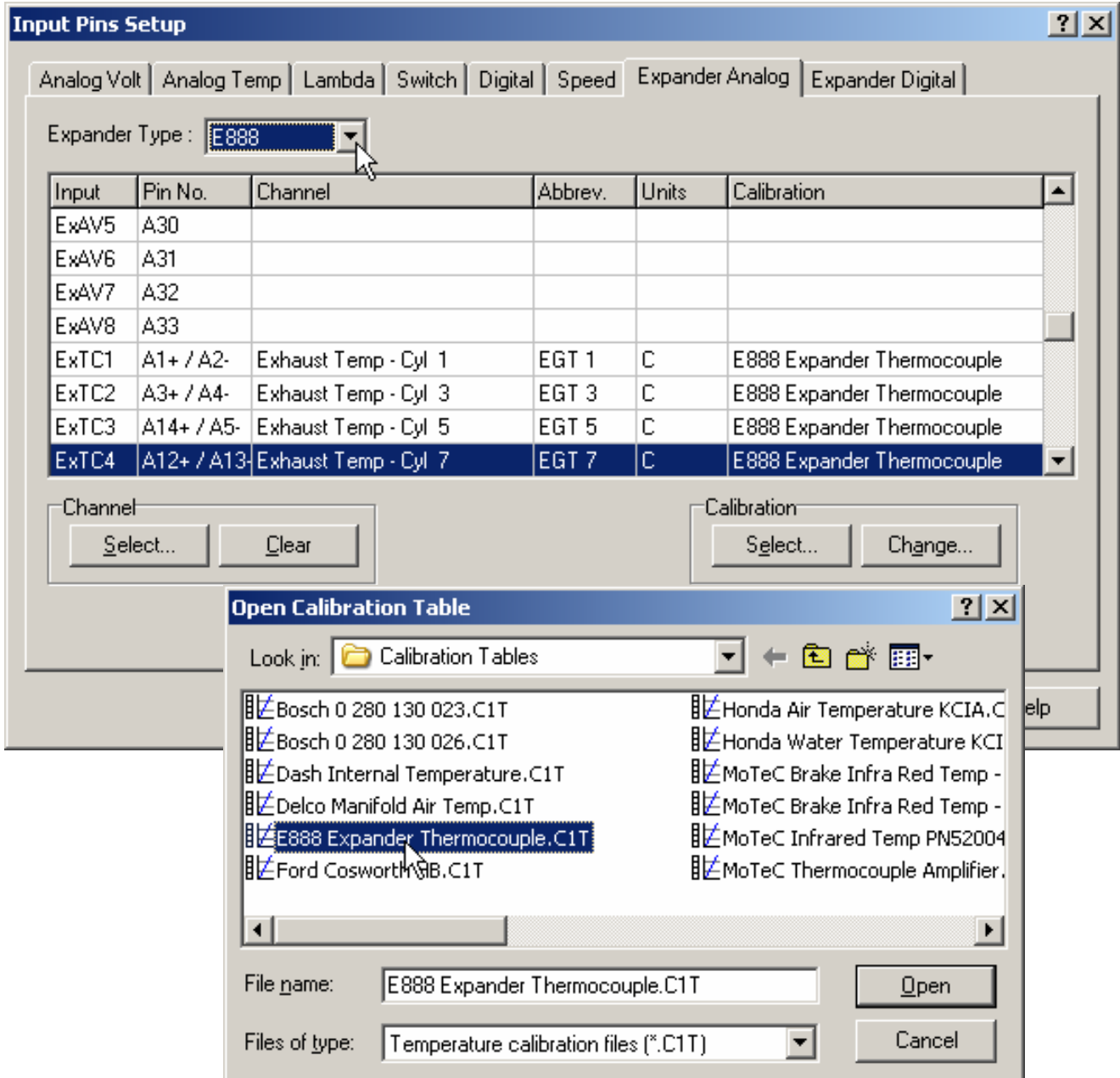
The Expander type can be selected from the drop down list. The list of inputs will then show the input name and pin numbers for that particular expander.

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 PWM1/3/5/7 is 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)

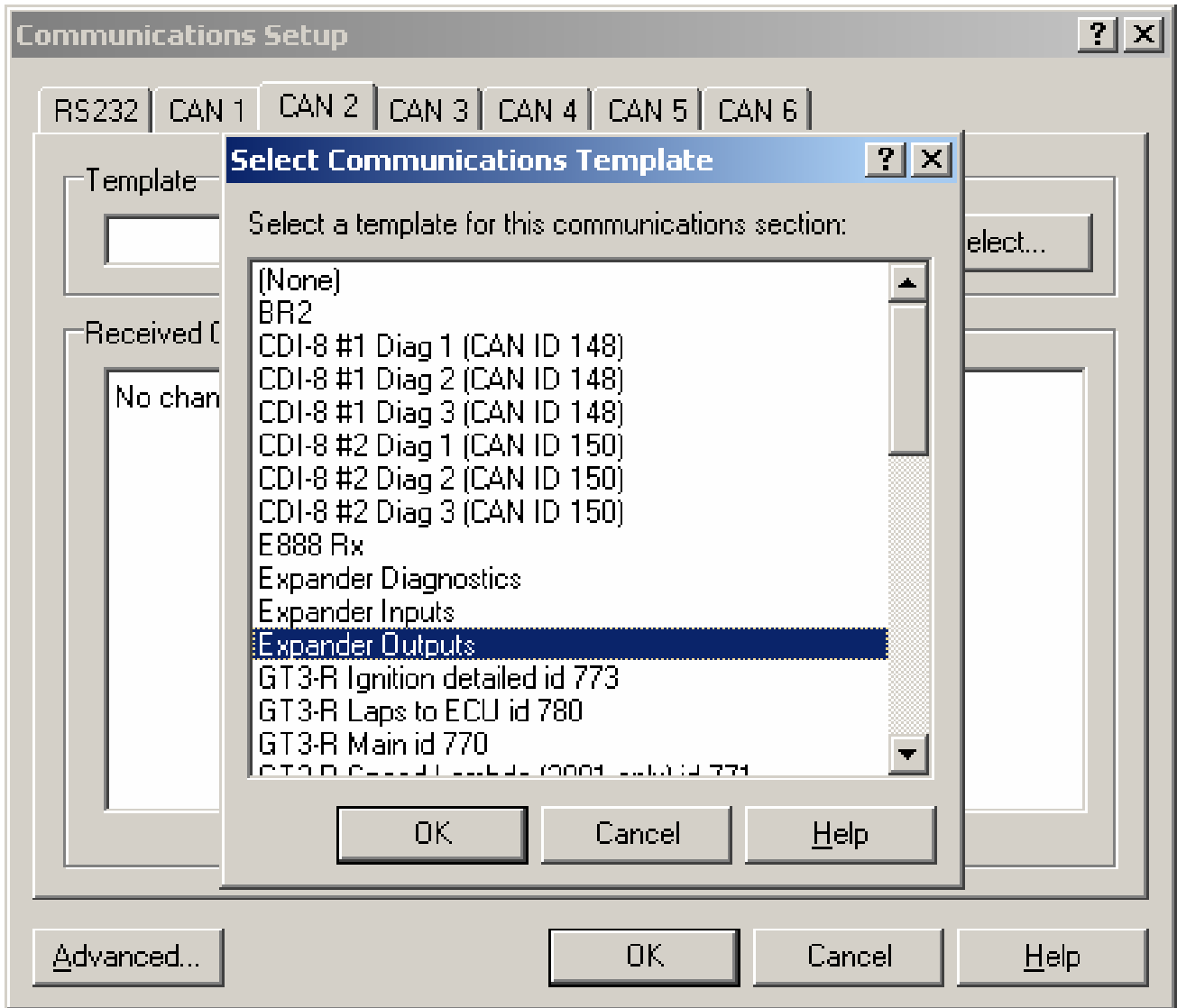
All outputs are disabled until the first CAN message is received.

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

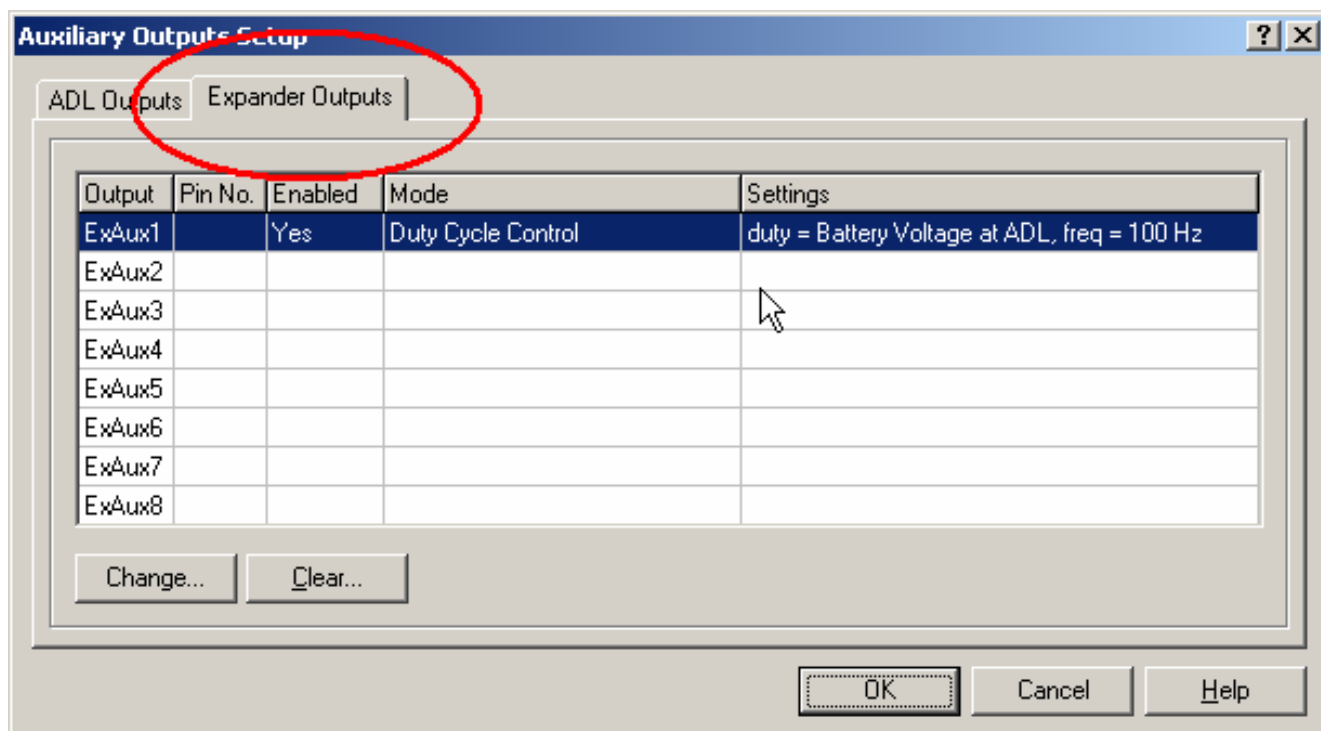
Output Configuration

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.

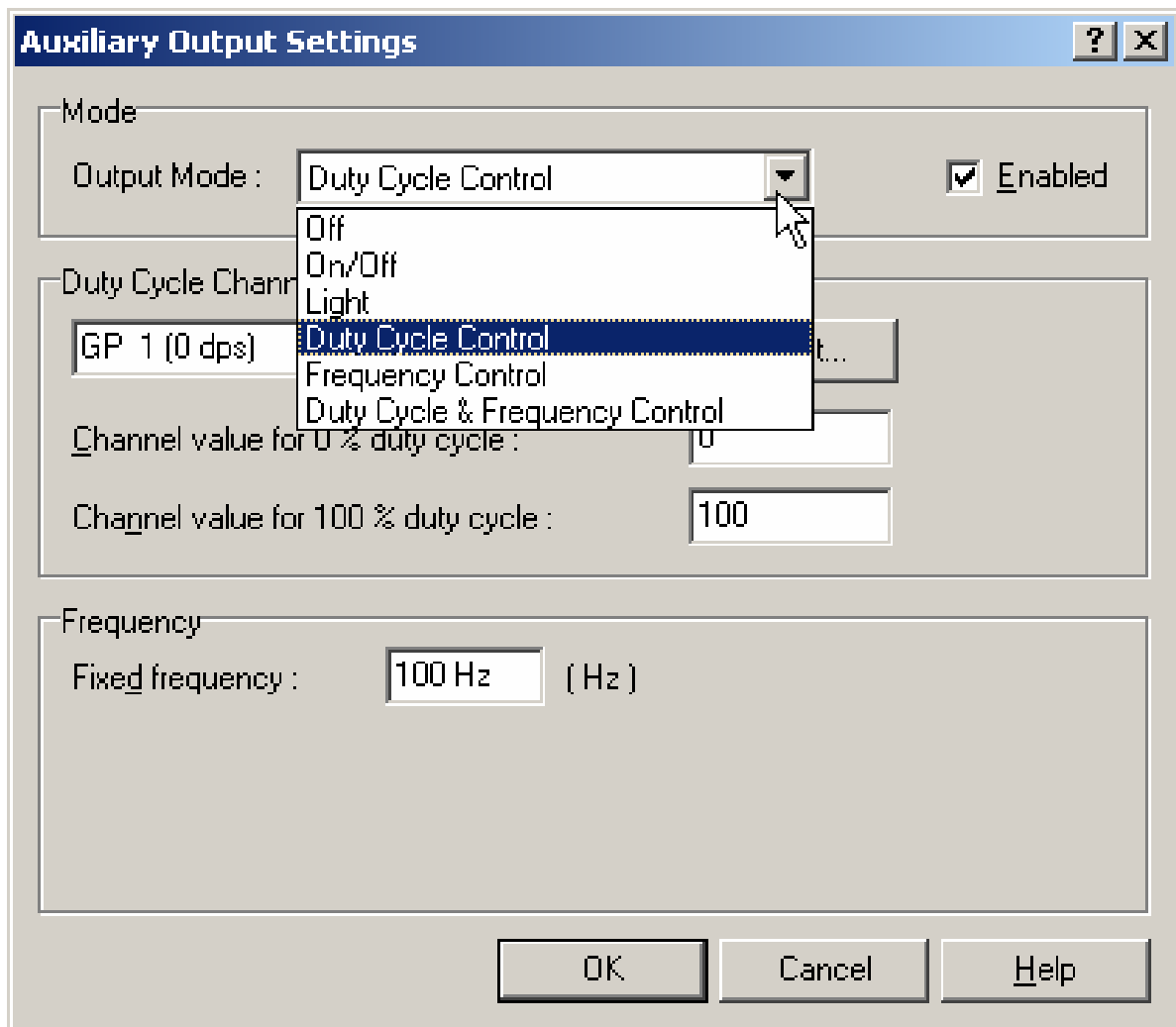


The tab for Expander Output configuration can be found under the Dash Manager menu item 'Functions – Auxiliary Outputs'.



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.

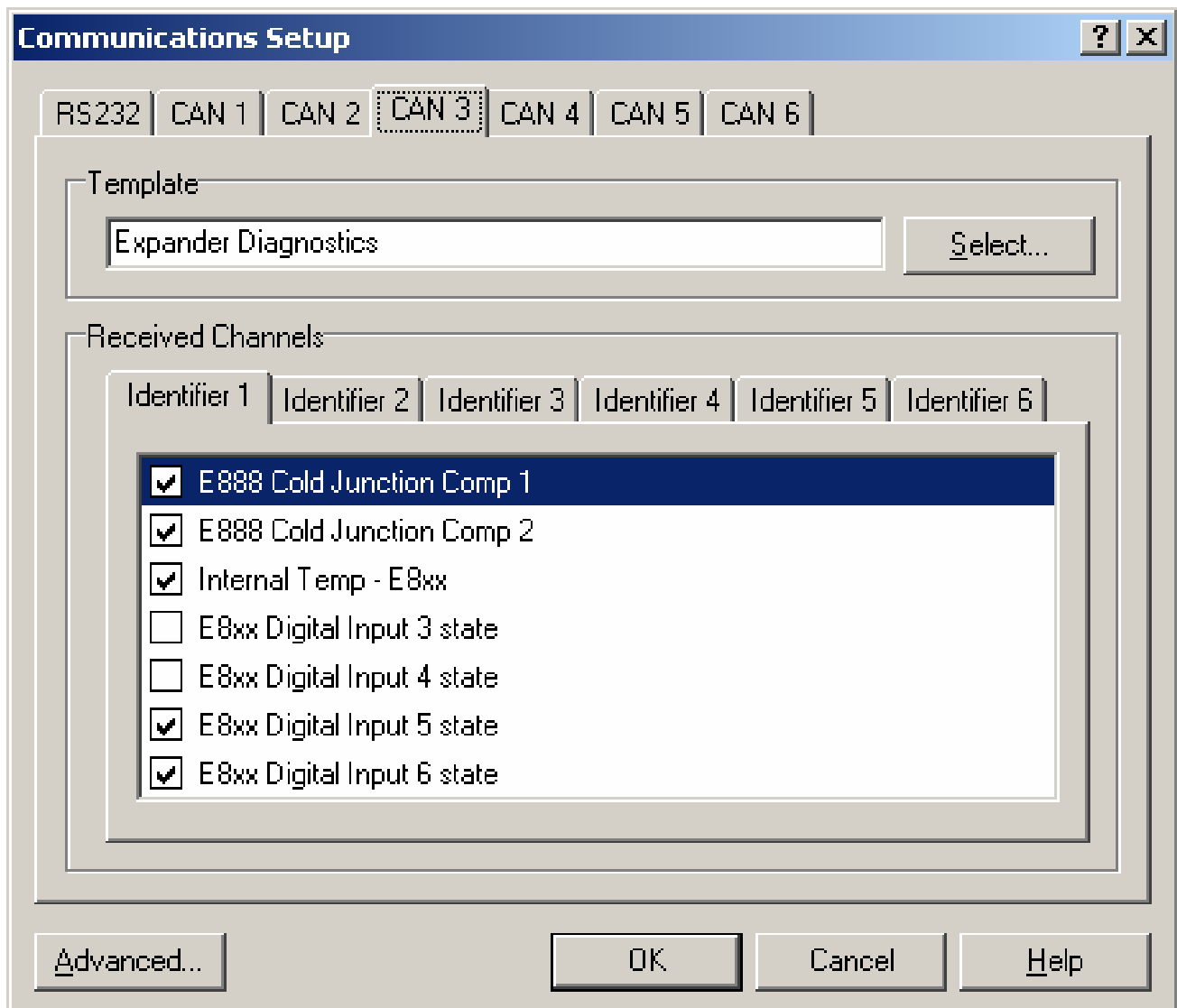
le: Outputs can be on/off, controlled by frequency, duty cycle or a combination of frequency and duty cycle. Note that appropriate control channels will need to be generated for these functions. See the ADL Manual for more details on configuring outputs.



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.

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.

The screenshot shows a software window titled "Test Auxiliary Outputs". It has two tabs: "ADL Outputs" and "Expander Outputs". The "Expander Outputs" tab is active. Below the tabs is a table with the following data:

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

Below the table is a section titled "Aux Output Test Parameters". It contains two input fields: "Duty Cycle" with a value of 50 and a percentage symbol, and "Frequency" with a value of 50 and "Hz". There is a "Set" button next to the frequency field and a "Clear All" button to the right. At the bottom of the window are "Close" and "Help" buttons.

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 <i>external</i> 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

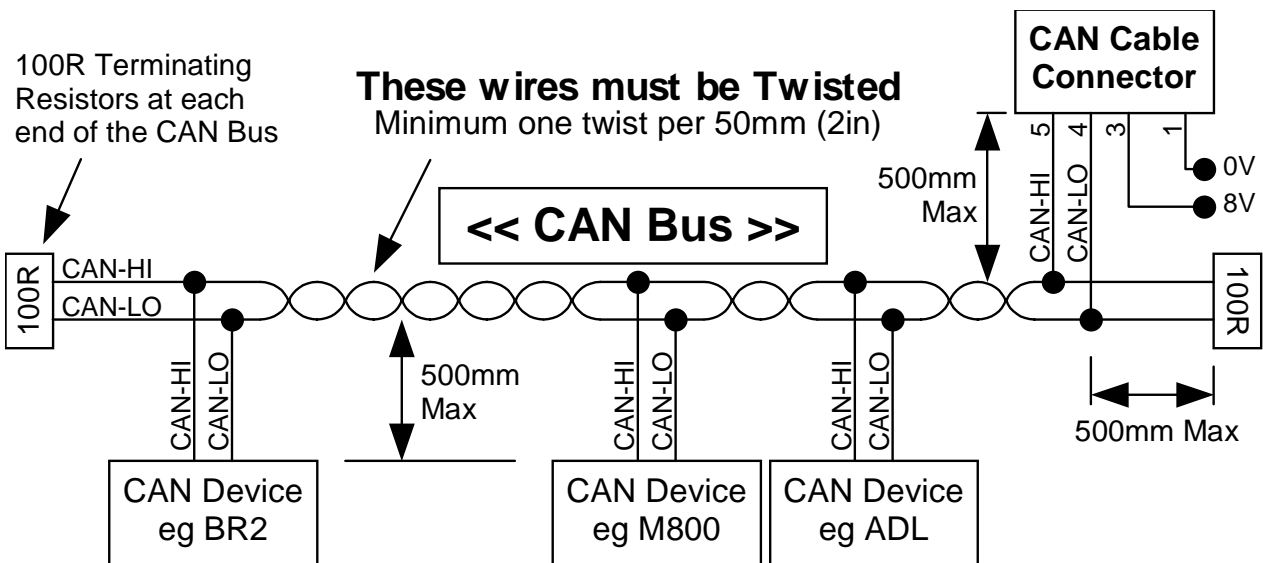
The CAN bus should consist of a twisted pair trunk with 100R (0.25Watt) terminating resistors at each end of the trunk.

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.

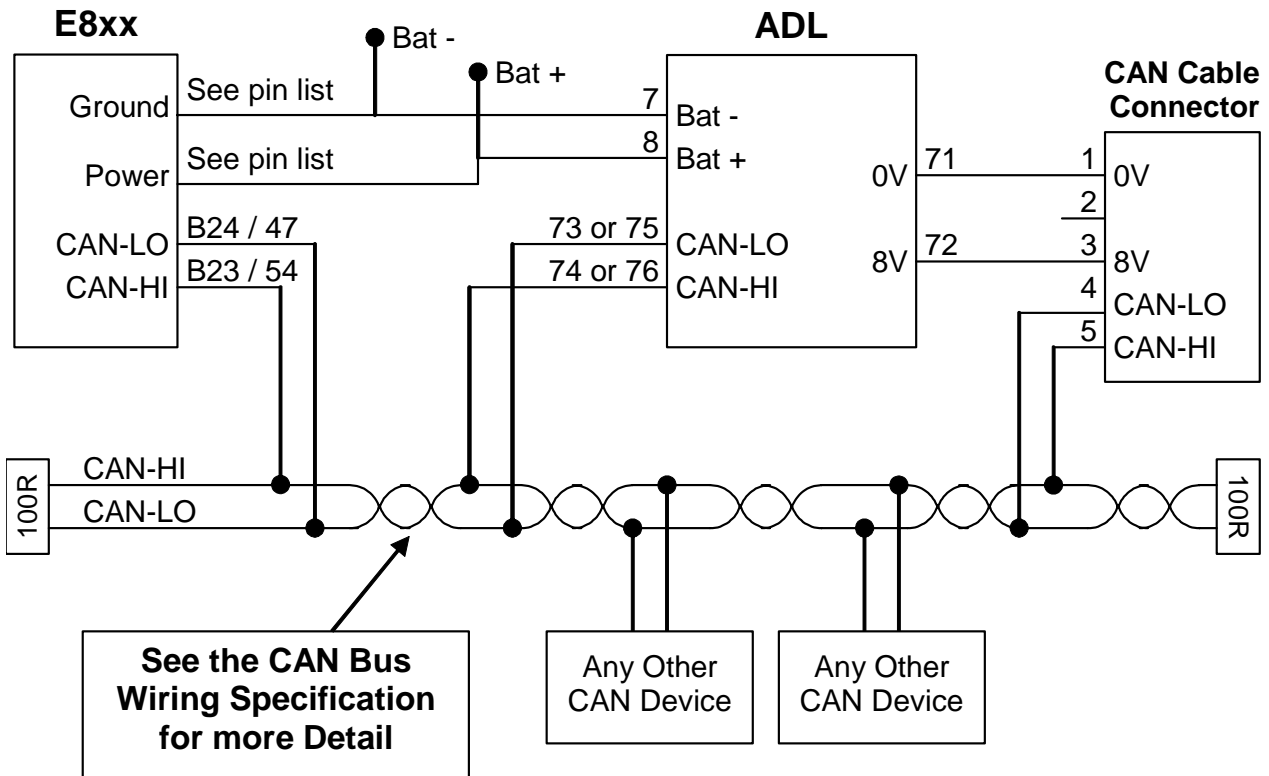
The connector for the CAN Communications Cable may also be connected to the trunk with up to 500mm (20in) of twisted wire and should be within 500mm of one end of the trunk. If desired two CAN Cable connectors may be used so that the **MoTeC** CAN Cable may be connected to either side of the vehicle.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

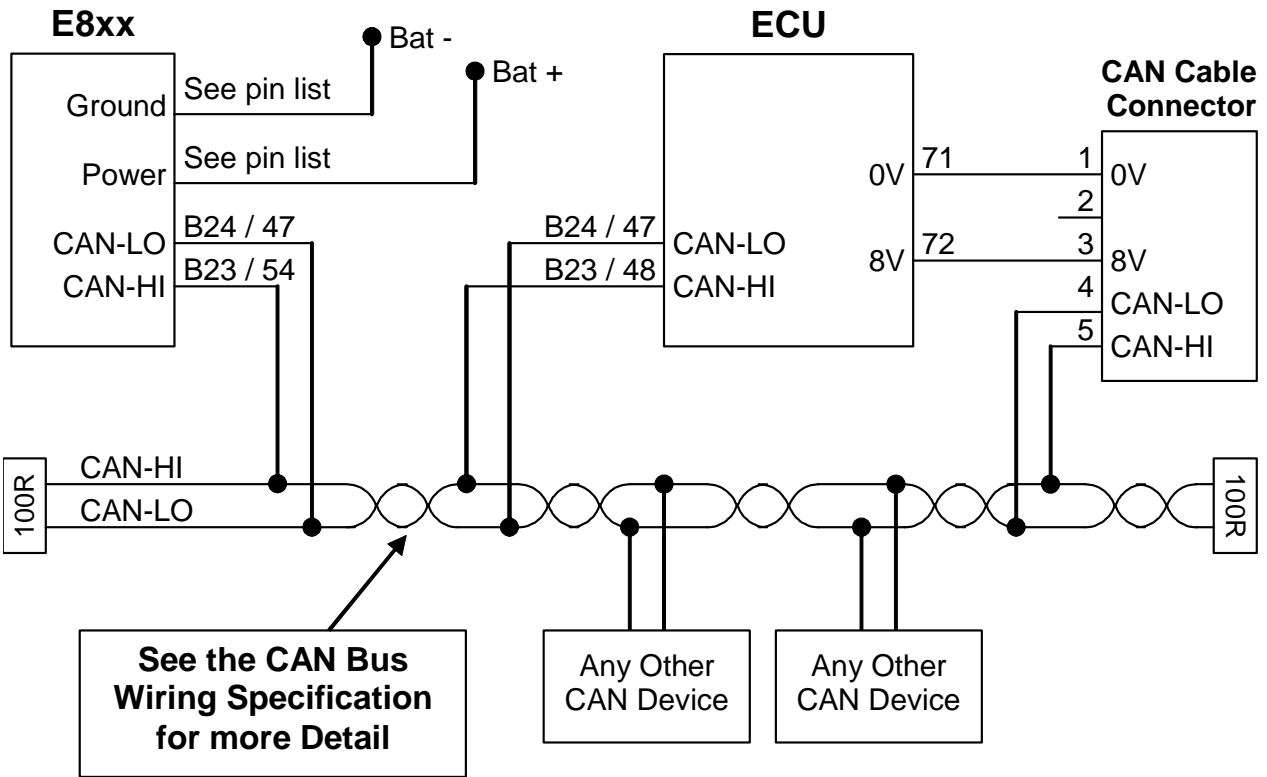
	Bat +	Bat -
E888	A17, B8, B9	A10, A11, B15, B16
E816	28, 29, 30, 37, 38, 39	13, 14, 15, 19, 20, 21, 22

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 H: E816 Pin List by Pin Number

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

Pin	Function (E816B)
1	
2	PWM7
3	PWM6
4	
5	AV11
6	AV10
7	PWM5
8	
9	AV9
10	
11	AV12
12	0V COMMS
13	BATTERY-
14	BATTERY-
15	BATTERY-
16	PWM4
17	CJC2
18	0V
19	BATTERY-
20	BATTERY-
21	BATTERY-
22	BATTERY-
23	DIGITAL IN 1
24	DIGITAL IN 2
25	
26	AV13
27	0V
28	BATTERY+
29	BATTERY+
30	BATTERY+
31	
32	DIGITAL IN 3
33	DIGITAL IN 4

Pin	Function (E816B)
34	PWM8
35	CJC1
36	8V
37	BATTERY+
38	BATTERY+
39	BATTERY+
40	
41	DIGITAL IN 5
42	DIGITAL IN 6
43	
44	AV14
45	8V
46	5V
47	CAN LO
48	
49	PWM3
50	
51	
52	AV15
53	5V
54	CAN HI
55	
56	PWM2
57	AV16
58	AV1
59	AV2
60	AV3
61	PWM1
62	AV4
63	AV5
64	AV6
65	AV7
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

