CAN Lambda Module

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2.1 Overview

Air fuel ratio information is essential information that all tuners need. The fuel input, power output and air fuel ratio present in the exhaust form the basis of all fuel tuning. Link CAN-Lambda Modules give users a powerful method of adding multiple oxygen sensors and bringing them into the ECU for monitoring or closed-loop lambda control. CAN-Lambda Modules can be easily added to an existing CAN Bus, then programmed to provide the required oxygen content.

Link CAN-Lambda uses a digital Bosch lambda controller to monitor, control and diagnose Bosch LSU 4.9 Wideband Lambda sensors. Digital wideband offers advantages over analog sensors; no need for calibration, the digital lambda controller is less vulnerable to the electrical noise found in the engine bay of an automobile, specifically noise created by the high temperatures near the exhaust. Transferring the information over a CAN bus means that signals are invariant to any noise encountered on the way to the ECU.

Link CAN-Lambda is easy to configure with Link ECUs, and is also compatible with other aftermarket ECUs, dataloggers and dashboard displays that offer direct support for Link CAN-Lambda modules or configurable CAN.

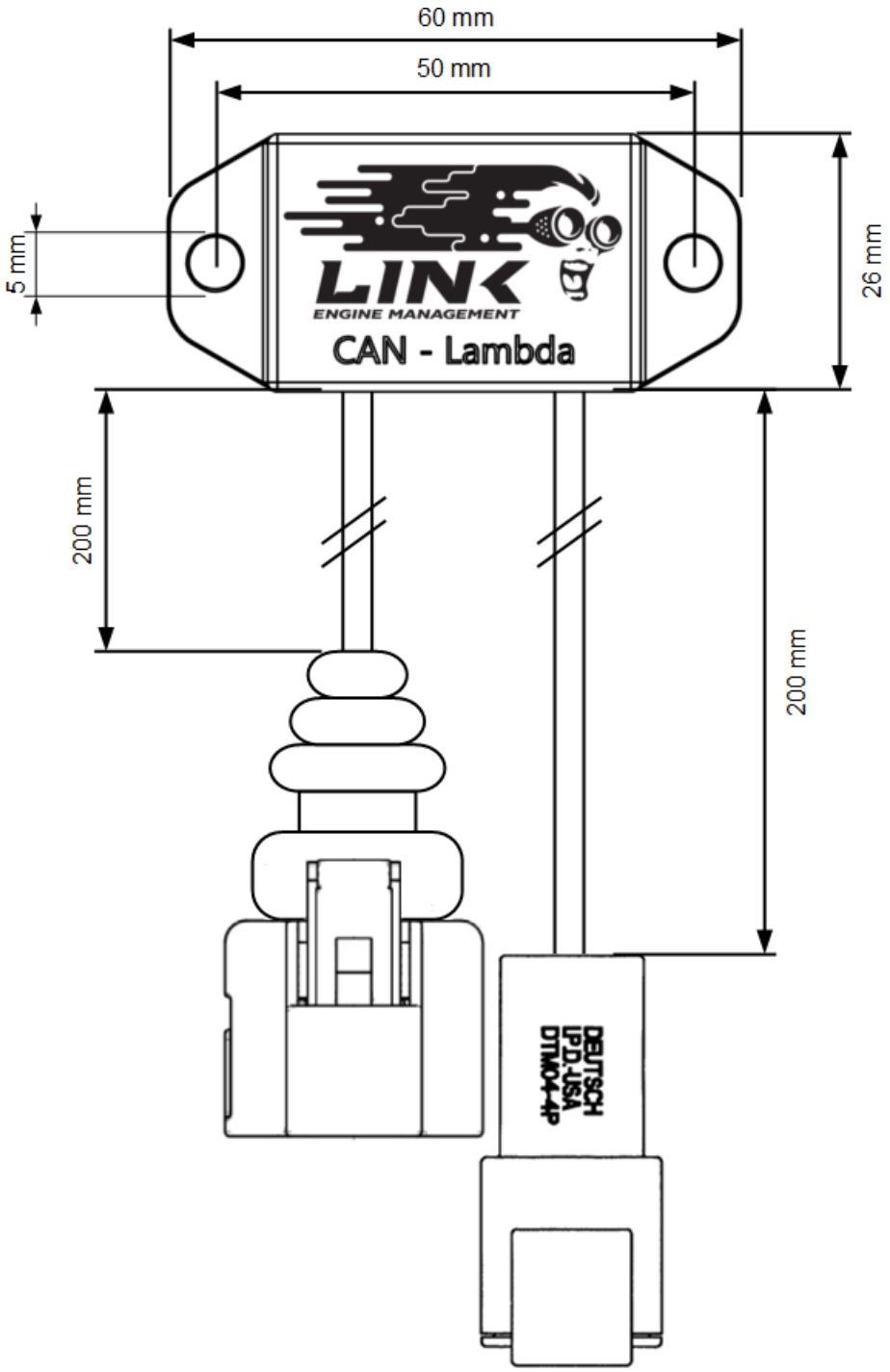
2.2 Features

- CAN bus for bidirectional communication and no signal loss.
- Entirely digital controller and signal processing prevents circuit variation and aging problems.
- Latest Bosch technology OEM grade controller
- Automatic calibration using OEM sensor trim resistor
- Probe temperature compensation
- Fully configurable through existing PCLink Software from version 5.6.2.3098 onward.
- Maintains accuracy through variations in temperature.
- Disable when the engine is stalled by receiving RPM over CAN (optional).
- Exhaust Pressure Compensation by receiving exhaust pressure over CAN (optional).

Note: If exhaust pressure compensation is required, an appropriate pressure sensor must be installed in the exhaust, connected to the ECU and correctly calibrated as **Exhaust Pressure**. If not using exhaust pressure compensation, ensure that **Exhaust Pressure** reads zero at all times.

2.3 Specifications

Dimensions	
Enclosure	60W x 26H x 15D mm
Lead length	200mm
Weight	70g
Input Voltage	
Controller	7.5 - 20.0 V
Sensor	10.8 - 16.5 V
Input Current	
Controller	100 mA
Sensor Heater	8 A
Miscellaneous	
Operating Temp	-20 to 100 °C (-4 to 212 °F)
Sensor	Genuine Bosch LSU4.9
Sensing Range	0.67 - 10 Lambda
Pressure Compensation	0.5 to 2.5 Bar
CAN Frequency	1Mbit/s,500kbit/s,250kbit/s,125kbit/s,100kbit/s
Connectors	
Power Loom	DTM04-4P mates with DTM06-4S
Sensor Loom	Bosch LSU4.9 connector



Technical drawing showing dimensions

3 Installation

For best results ensure that all ***Mounting***, ***Sensor Placement***, ***Wiring*** and ***Setup with Link ECU*** (if applicable) instructions are followed.

3.1 Mounting

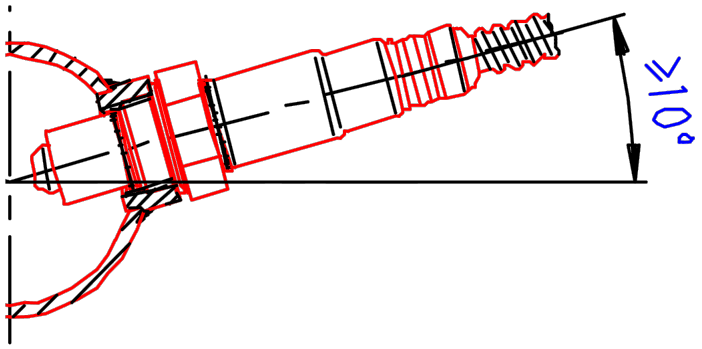
Use the mounting holes to secure Link CAN Lambda modules to flat surfaces.
Try to keep the CAN Lambda module as far from the heat of the exhaust as possible.

Note: Link CAN Lambda module maximum temperature is 100 °C (212 °F)

3.2 Sensor Placement

Note: Only genuine Bosch LSU 4.9 Wideband Lambda sensors are compatible with Link CAN Lambda Modules.

To prevent fluids such as condensation from collecting between the sensor housing and sensor element, Bosch recommends that LSU 4.9 sensors be mounted 10° or more above horizontal.

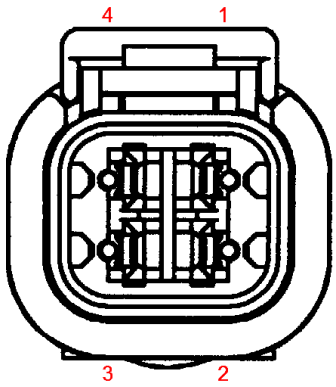


To avoid excessive heat the sensor should be mounted at least 1 meter from the engine exhaust port. Also ensure that the sensor is mounted greater than 1 meter away from the atmospheric end of the exhaust to ensure that readings are not contaminated by oxygen sucked up the exhaust. If the exhaust length is less than 2 meters then it is better to place the sensor closer to the engine.

3.3 Wiring

Power and Communications Connector Pinout:

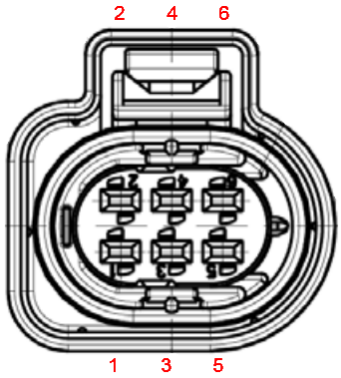
Pin	Description
1	Power
2	GND
3	CAN L
4	CAN H



Front view of connector

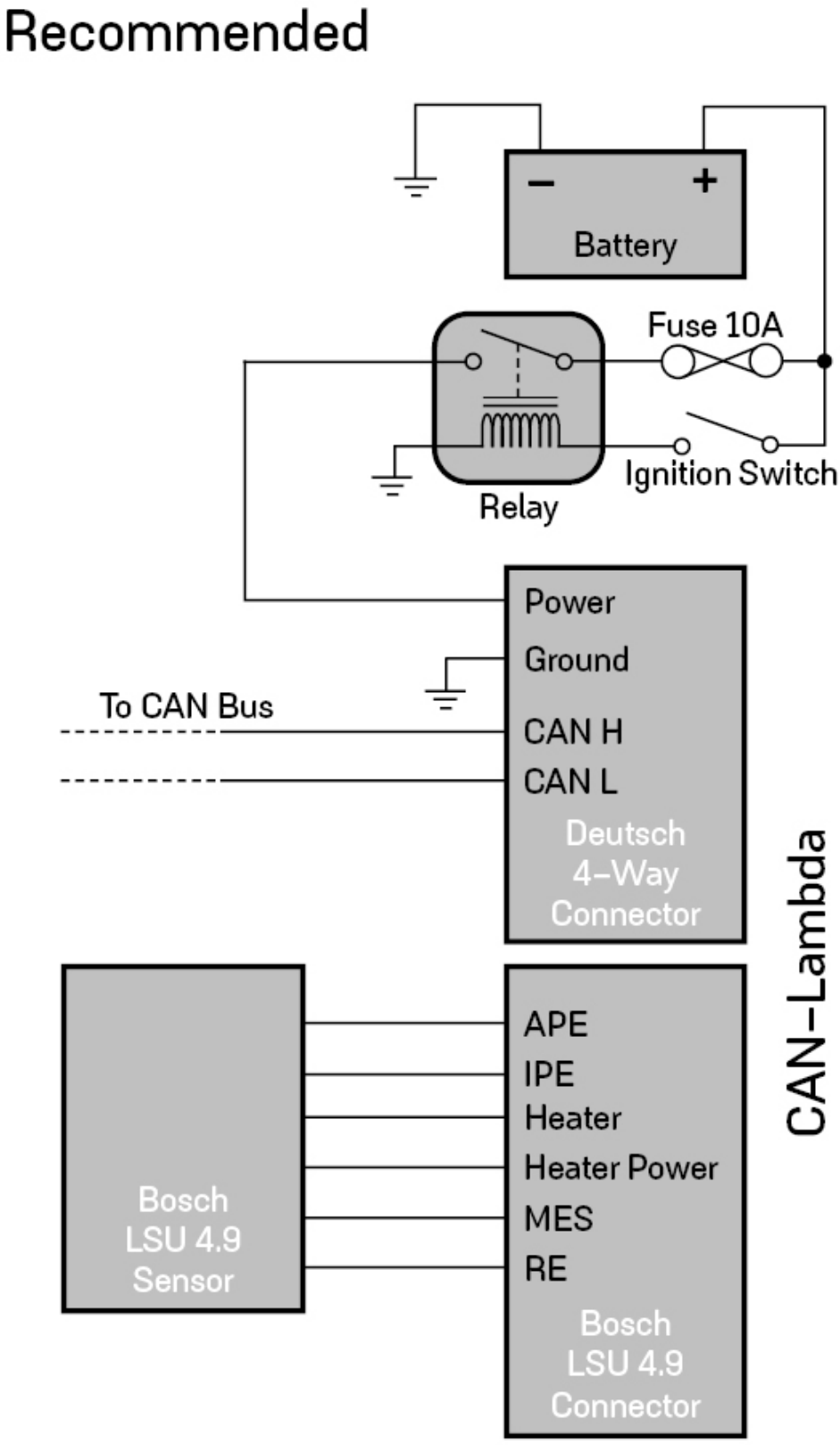
Sensor Connector Pinout:

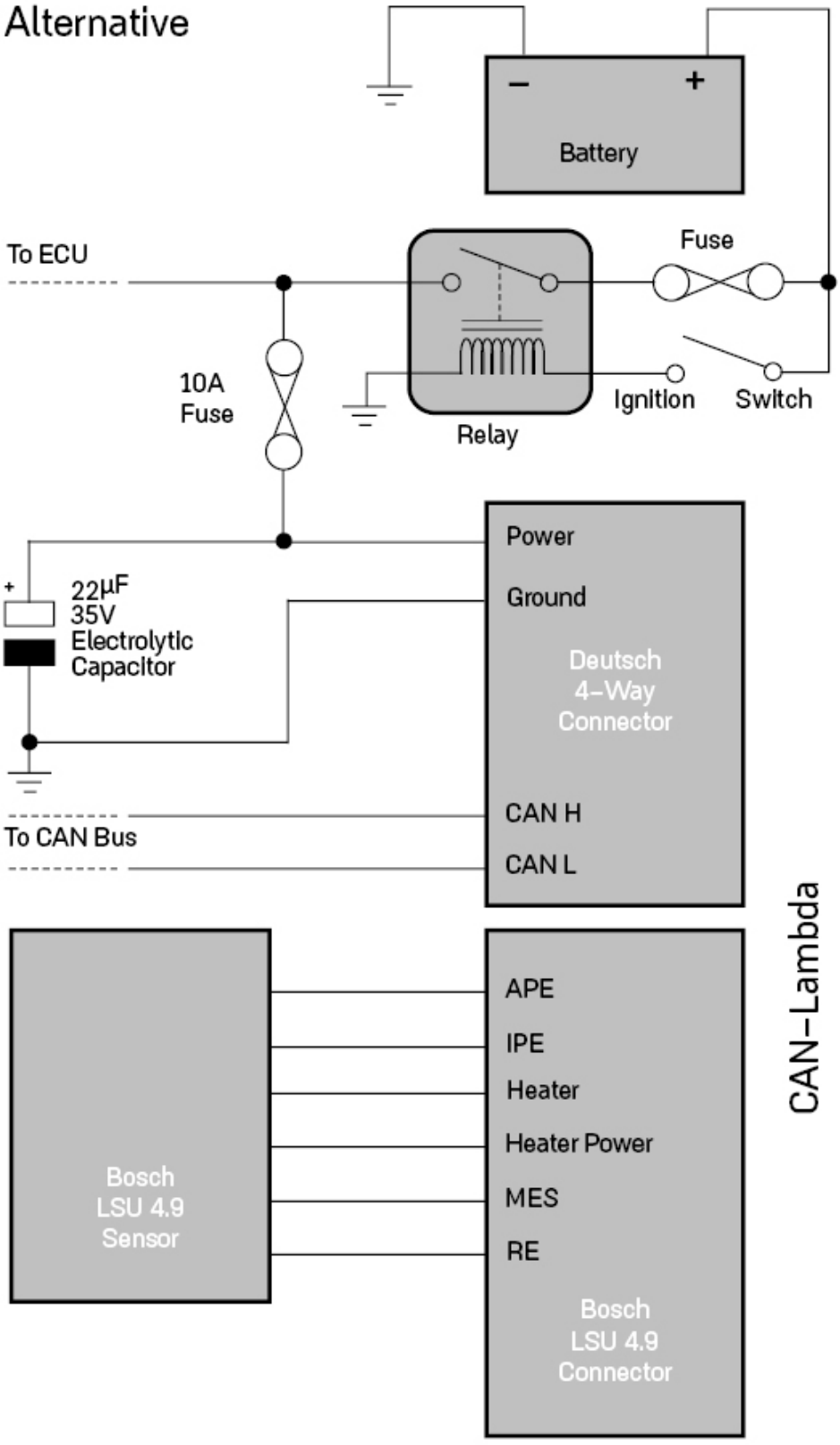
Pin	Description
1	APE
2	IPE
3	Heater
4	Heater Power
5	MES
6	RE



Front view of connector

Wiring:





3.4 Setup with Link ECU

Link CAN Lambda modules allow up to eight wideband oxygen sensors to be measured, displayed and logged. A separate module is required for each oxygen sensor. The modules must be told which sensor they are connected to (eg cyl 1, cyl 2 etc...) so that they can be identified on the CAN bus. All Link CAN-Lambda modules are shipped pre-configured for a single installation. If only one sensor is being used the module requires no configuration.

Programming Instructions:

1. Navigate to ECU Controls > CAN Setup.
2. In the 'Mode' tab ensure the appropriate CAN Module is selected.
3. In the CAN Configuration box:
    1. Set the mode to 'User Defined'.
    2. Ensure the Bit Rate is set to '1 Mbit/s'

4. In the Data box:
    1. Select a free channel and set its Mode to 'Link CAN-Lambda'.
    2. In the CAN ID box, set the ID to 950, leave the format on 'Normal'.

5. Switch to the CAN Devices Tab.
6. Connect a Link CAN-Lambda module to the CAN Bus you selected in step 2.
7. Press the 'Find Devices' button.
8. One or more devices should appear in the list, if they do not go back to one and check your settings, check your CAN Bus and ensure that the device is receiving power.
9. Select the device you wish to change.
   All modules are shipped assigned to Lambda 1, this means you must attach the module you wish to use for Lambda 1 last.
10. Use the parameter column drop down box to reassign the device.
11. Use the bit rate column to change the devices bit rate.
12. Once you are satisfied with the changes, press the 'Send' button.
13. **Cycle power to CAN Lambda Module only - not the ECU** (unplug Deutsch connector for example)
    If you cannot cycle the power to the CAN Lambda Module without also cycling power to the ECU, press the Ok button to close CAN Setup **before** you cycle ECU power.

14. To add more modules repeat steps 6 to 13.

4 CAN Bus Information

Link CAN-Lambda modules are configurable to allow use in a variety of applications and with different CAN Bus bit rates. From the factory, Link CAN-Lambda modules are all configured for:

- Device identifier 0
- 1 Mbit/s bit rate

When using only a single Link CAN-Lambda module, no configuration of the module is required unless the default CAN bit rate of 1Mbit/s is not suitable.

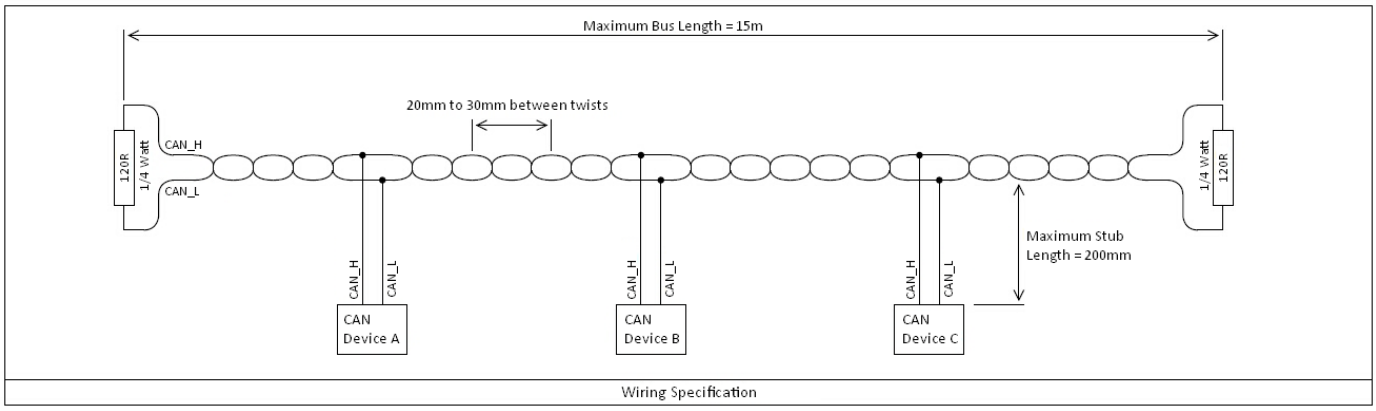
Up to eight Link CAN-Lambda modules can be used on a CAN bus at any one time. As all Link CAN-Lambda modules are configured to device identifier 0 at the time of manufacture, if more than one module is to be used it/they will need to be configured to have a unique device identifier so it can be recognised on the CAN bus. Or if they are desired to be used on a different bit rate CAN bus (eg 500 kBps). When using Link CAN-Lambda modules with Link ECUs this is easily performed using PCLink. This uses the Link ECU as the communication bridge to connect the PC to the CAN bus through the ECU. When using multiple Link CAN-Lambda modules with other manufacturers ECUs or displays, this procedure must first be performed using PCLink and a Link ECU otherwise it can be done manually using a suitable CAN bus tool. Module Configuration is detailed further in following sections.

The receiving ECU or display must be configured using the CAN information supplied in the following sections. Some manufacturers may supply CAN template products for their devices that are pre-configured for use with Link CAN-Lambda modules.

When using Link CAN-Lambda modules with Link ECUs on firmware greater than V5.6.0, the ECU can be easily configured in the ECUs CAN setup as described in the section on ***Setup with Link ECU***. For use with other manufacturers ECUs and displays a custom CAN configuration will need to be set up using the information in the following sections.

4.1 CAN Bus Wiring

A CAN bus consists of a main bus (trunk) with devices individually joined to the bus.
Each end of the bus must be terminated with a 120R resistor (1/4 Watt minimum). There is no CAN terminating resistor in the Link CAN-Lambda Module.
The trunk (main bus) must be a total length of less than 15m.
The two wires of the bus must be twisted together with a rate between 33 and 50 twists per meter. (20mm to 30mm between twists)
Each device needs to be connected into the main bus. The length of the wire used to connect to the bus must be less than 200mm.



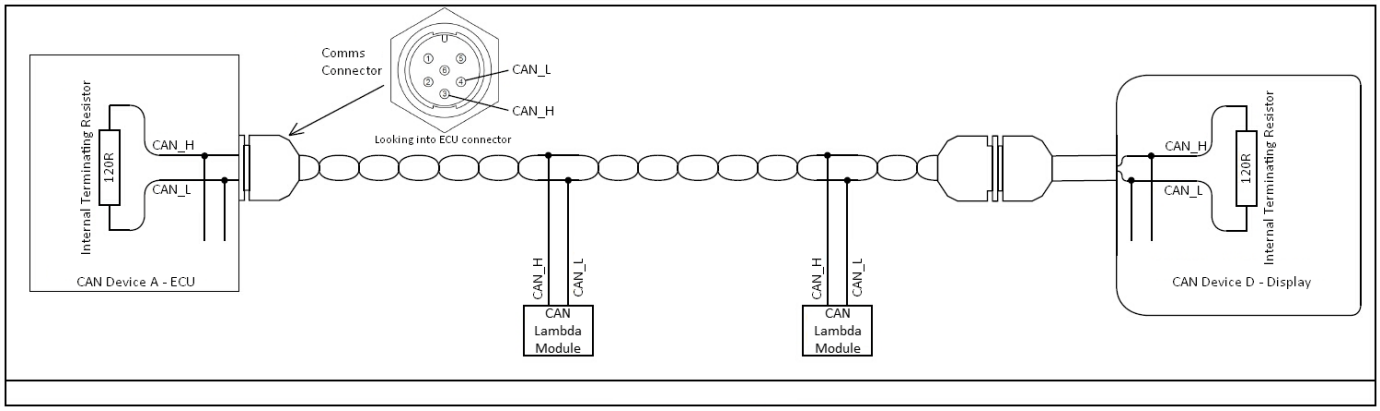
To simplify the installation, the following devices contain terminating resistors:

- Link ECUs.
- DisplayLink. Note that the terminating resister is in the connector of the displays power supply cable.

This means that these devices can **only** be used at the **end** of the bus. If you want to connect these devices to the middle of the bus, please contact your local Link distributor to arrange the removal of the internal resistor.

Example

The following is an example using devices to terminate the bus. Here Link CAN Lambda Modules have been added to the bus.



4.2 Transmitted Information

Link CAN-Lambda modules transmit the following information:

- Lambda value
- Sensor Temperature
- Controller Error Codes
- Controller Status
- Pump Current
- Battery Voltage
- Heater Average Voltage

When connected to a Link ECU using the built in Link CAN-Lambda CAN communication mode, this information is displayed on the following parameters:

- Device identifier 0 (default)
  - Lambda 1
  - Lambda 1 Temperature
  - Lambda 1 Status
  - Lambda 1 Error
- Device identifier 1
  - Lambda 2
  - Lambda 2 Temperature
  - Lambda 2 Status
  - Lambda 2 Error
- Device identifier 2
  - Lambda 3
- Device identifier 3
  - Lambda 4
- Device identifier 4
  - Lambda 5
- Device identifier 5
  - Lambda 6
- Device identifier 6
  - Lambda 7
- Device identifier 7
  - Lambda 8

Information is transmitted on CAN Id 950 + device identifier. Eg device identifier 4 transmits on CAN Id 954. Transmission uses a compound message format (or sometimes called filter byte) with the frame index in Data 0.

CAN Id 950 (0x3B6) + device identifier

<table>
<tr><th>Data 0</th><th>Data 1</th><th>Data 2</th><th>Data 3</th><th>Data 4</th><th>Data 5</th><th>Data 6</th><th>Data 7</th></tr>
<tr><td>50</td><td>Error Code</td><td>Lambda
(High Byte)</td><td>Lambda
(Low Byte)</td><td>Sensor
Temperature
(High Byte)</td><td>Sensor
Temperature
(Low Byte)</td><td>Status</td><td>-</td></tr>
<tr><td>-</td><td>See section on
error codes</td><td colspan="2">x1000 Lambda
(eg 1000 = 1.000 Lambda)</td><td colspan="2">deg C (eg 780 = 780 deg C)</td><td>0 = Off
1 = Disabled
2 = Initialising
3 = Diagnostics
4 = Calibration
5 = Heating
6 = Operating</td><td>-</td></tr>
</table>

Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7
51	-	Pump Current (High Byte)	Pump Current (Low Byte)	Battery Voltage (High Byte)	Battery Voltage (Low Byte)	Heater Voltage (High Byte)	Heater Voltage (Low Byte)
-	-	x1000 mA (eg 1234 = 1.234 mA)		x100 V (eg 1370 = 13.70 V)		x100 V (eg 1370 = 13.70 V)	

4.3 Received Information

Optionally information can be transmitted to the Link CAN-Lambda module. This allows the module to turn off the sensor heater when the engine is not running and perform exhaust pressure compensation.

The built in Link ECU Link CAN-Lambda CAN communication mode automatically sends this information if it is available to all modules.

The Link CAN-Lambda module will wait for two seconds after power up to see if this information is received. If it is not, sensor control will be enabled. IF the information is received, sensor control will not be enabled until engine RPM goes above 400 RPM and disable sensor control when engine speed falls below 10 RPM.

All modules receive this information on the same CAN Id 958 (0x3BE).

Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7
85	-	Engine Speed (High Byte)	Engine Speed (Low Byte)	Exhaust Absolute Pressure (High Byte)	Exhaust Absolute Pressure (Low Byte)	Use Exhaust Pressure	-
-	-	RPM (eg 3000 = 3000 RPM)		x10 kPa (eg 1100 = 110.0 kPa)		0 for no correction	-

Note: Pressure compensation range is 50-250 kPa. Absolute pressure must be used not gauge pressure (ie 0 = absolute vacuum). If a correct pressure value is not sent to the Link CAN-Lambda module Data 6 must be zero to ensure pressure correction is not used.

4.4 Manual Module Configuration

Link CAN-Lambda modules can be manually configured with the following information:

- CAN Bus Bit Rate (1 MBps default)
- Device identifier (0 by default)

Where it is not practical to use a Link ECU and PCLink to configure the Link CAN-Lambda module, it may be configured using a suitable CAN bus analyser tool, or any CAN device that allows transmission of data in the format shown below (eg dash display).

Finding a Link CAN-Lambda Modules Current Device Identifier

To program a module, it must be connected to a CAN bus running at the same bit rate as the module is currently configured. The first step is to determine what device identifier the Link CAN-Lambda module currently uses. This can be performed by finding the CAN Id that it is currently sending its transmit data on. The device identifier currently used is this CAN Id - 950. So, if the Link CAN-Lambda module is currently transmitting data on Id 951, then its device identifier is 1 (951 - 950 = 1). The reason we need to know the current device identifier is so we can address our programming command directly to that device.

Programming a New Device Identifier and Bit Rate

To program a new configuration the following information must be sent to the Link CAN-Lambda module. It is OK to send the same information multiple times. Changes will not be applied until next time power is cycled to the Link CAN-Lambda module.

Send on CAN Id 958 + device identifier (eg send on 959 if current device identifier is 1).

Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7
24	New device identifier	New bus frequency	-	-	-	-	-
-	New identifier between 0 and 7 inclusive	0 = 100 kbit/s 1 = 125 kbit/s 2 = 250 kbit/s 3 = 500 kbit/s 4 = 1 Mbit/s (default)	-	-	-	-	-

Program OK Reply

If the program command is accepted the following reply will be sent on CAN Id 950 + old device identifier (eg if device identifier was 1 before program command, reply will be on CAN Id 951).

Data 0	Data 1	Data 2	Data 3	Data 4	Data 5	Data 6	Data 7
24	New device identifier OK	New bus frequency OK	-	-	-	-	-
-	0 = OK 255 = error	0 = OK 255 = error	-	-	-	-	-

5 Diagnostic Information

When using Link ECU, if using as Lambda 1 (device identifier 0) or Lambda 2 (device identifier 1), internal status and error values will be displayed in PCLink.

Otherwise the CAN information will need to be used to determine problems (See ***Transmitted Information***)

Lambda output defaults to zero when the module is not able to operate correctly.

Status Codes:

Code	Description	Cause
0	Off	Controller turned off
1	Disabled	Controller enabled, but RPM is zero.
2	Initialising	Initialising hardware
3	Diagnostics	Checking sensor
4	Calibration	Calibrating sensor
5	Heating	Heating sensor to operating temperature
6	Operating	Normal Operation

If a fault is detected in operating mode, the module will cycle back to 'Initialising', then run through the setup procedure again, halting at 'Diagnostics' if a fault is found.

Error Codes:

Code	Description	Cause	Solution
1	Ok	Everything Ok	
2 - 15	Internal Error		Contact Link Technical Support
16	Heated too long	Heater current is being applied but temperature not changing.	Check wiring, inspect sensor for damage.
17 - 25	Internal Error		Contact Link Technical Support
26	Battery under voltage	Supply voltage dropped below 10.8V while operating.	Check wiring, check battery. May occur during cranking.
27 - 32	Internal Error		Contact Link Technical Support
33	Open circuit APE-IPE	APE-IPE loop is open circuit	Check wiring, inspect sensor Ensure CAN-Lambda has good clean power supply.
34	Open circuit RE-IPE	RE-IPE loop is open circuit	
35	Open Circuit RComp	Compensation resistor in connector is open circuit	Check wiring, inspect connector. Typical error when no sensor is connected.
36	RComp Invalid	Not open circuit, but compensation resistor is out of range.	Check sensor type, check wiring.
37	IPE short to ground		Check wiring, inspect sensor.
38	RE short to ground		
39	APE short to ground		
40	IPE or APE error	Short or open circuit on IPE or APE	
41	MES under voltage	Short to ground.	
42	MES over voltage	Over 9V.	
43	RE under voltage	Short to ground.	
44	RE over voltage	Over 9V.	
45	IPE under voltage	Short to ground.	
46	IPE over voltage	Over 9V.	

47	APE under voltage	Short to ground.	
48	APE over voltage	Over 9V.	
49	Overheat or pump cell resistance too low	Sensor Failure.	Check Sensor
50	Overheat or Nernst cell resistance too low	Sensor Failure.	
51 - 53	Internal Error		Contact Link Technical Support