

The Two Common CAN Network Types - Physical Wiring

Twisted Pair with **Shield** - Best Practice

The **CAN+** and **CAN-** wires inside the insulating jacket are twisted and there is a braided **shield** covering the twisted pair to reduce electromagnetic interference (EMI). The **shield** is typically grounded at the engine ECM or negative battery post and must only be grounded at one spot on the vehicle. This wiring is typically only used in very rough applications because of the price and rigidity/inflexibility of the cabling itself. The main issues with this network are too many or too few termination resistors, breaks in wire or insulation due to kinks, and vibration.

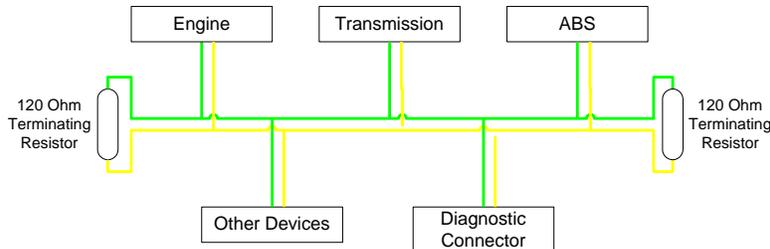
Twisted Pair without **Shield** - Most Commonly Found

The **CAN+** and **CAN-** wires are twisted which provides for good electromagnetic interference however the braided **shield** is omitted. This is the most commonly found CAN network type. The main issues with this network are breaks in the wire and insulation due to kinks, vibration and rubbing, wire and connector corrosion (moisture intrusion), and too many, or too few, termination resistors.

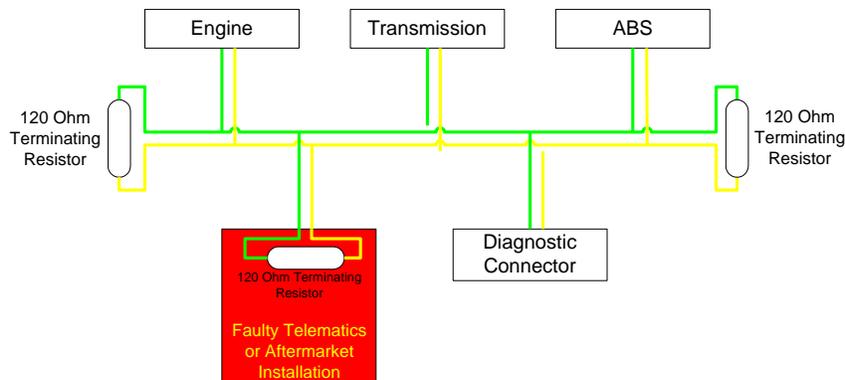
CAN Termination Resistors - Two by Design

By design, there are two terminating resistors on a CAN network, one at both logical ends of the backbone (see images below). Oftentimes aftermarket add-on accessories apply additional terminating resistors to the bus. This can cause issues with databus communications.

Properly Terminated CAN Network with Termination Resistors at Network End Points



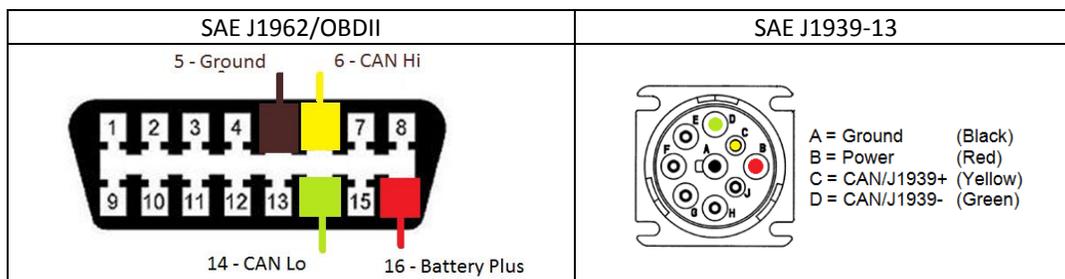
Aftermarket Device Improperly Installed Adding an Additional Termination Resistor



The Two Common CAN Network Connectors

- ✚ The SAE J1962 (OBDII) connector. CAN bus technology (500Kb CAN) was mandated on all vehicles and equipment using this connector starting in 2008. This connector is mainly seen on light-duty vehicles, however it appears on various medium-duty and heavy-duty vehicles and equipment.
- ✚ The SAE J1939 9-pin Deutsch connector. This connector which is mainly black (indicating 250Kb CAN) or green (indicating 500Kb CAN) in color. This connector is typically found on medium and heavy-duty vehicles, industrial-stationary equipment, and off-highway vehicles.

If you encounter another connector, you may need to contact the OEM for the pinouts. **DG Technologies' Product Pinouts and Industry Connectors Reference** (comes with all of DG's DPA products and is available through the Windows "Start" menu) has many connector types and pinouts listed for various vehicles and equipment types.



CAN Network Testing Step 1 (Correct Termination Resistance)

All tests require a standard Volt/Ohm meter, herein referred to as a VOM.

1. Completely power down the vehicle by removing the positive terminal from the battery.
 - a. This step cannot be bypassed as invalid values will affect the test outcome!
2. With VOM set to read resistance (Ohms/ Ω setting), place the red lead on **CAN+** and the black lead on **CAN-** of the connector and note the value.

Value Obtained	Issue	Resolution
Between 54-66 Ohms	Properly terminated network.	Resistance Ok, try Step 2.
Over 120 Ohms	Open circuit or missing a terminating resistor.	Install a terminating resistor at the network end. See OEM literature for terminating resistor location and for further troubleshooting information.
Under 44 Ohms	More than two terminating resistors or wires are shorted together somewhere.	Remove extraneous terminating resistors by reading OEM literature for where the two terminating resistors should have been installed.

CAN Network Testing Step 2 (Shorts to Ground)

1. Completely power down the vehicle by removing the positive terminal from the battery.
 - a. This step cannot be bypassed as invalid values will affect the test outcome!
2. With VOM set to read resistance (Ohms/ Ω setting), place the red lead on **CAN+** and the black lead on the Ground pin and note the value. Then place the red lead on **CAN-** and the black lead on the Ground pin and note the value.

Value Obtained	Issue	Resolution
10k Ohms or Greater	No shorts to ground.	Try Step 3.
Less than 10k Ohms	Wire shorted to ground.	Repair or replace harness. See OEM literature for further testing of individual data bus wiring, and potential replacement of databus segments.

CAN Network Testing Step 3 (Shorts To Power)

1. Reconnect the vehicle battery, ensure ignition is in the ON position, and the diagnostic connector has power.
 - a. With VOM set to read DC voltages (Volts/V setting), place the red lead on Power and the black lead on Ground and ensure the diagnostic connector has roughly 12 or 24 Volts.
2. With VOM set to read DC voltages (Volts/V setting), place the red lead on Power and the black lead on **CAN+** and note the value.
3. With VOM set to read DC voltages (Volts/V setting), place the red lead on Power and the black lead on **CAN-** and note the value.

Value Obtained	Issue	Resolution
0 VDC	Shorted to Power	Repair or replace harness. See OEM literature for further testing of individual data bus wiring, and potential replacement of databus segments.
12 VDC	Shorted to Ground	Repair or replace harness. See OEM literature for further testing of individual data bus wiring, and potential replacement of databus segments.
Other Values	Not Shorted to Power/Ground	Try Step 4.

CAN Network Testing Step 4 (Device Going BUS_OFF)

If you are using a vehicle or equipment that is using the J1939 protocol, please skip to the next section.

To test for CAN controllers transmitting on the databus and leaving the databus (typically 4-10 seconds later) because of a BUS_OFF condition requires a Personal Computer (PC), a Vehicle Diagnostic Adapter (VDA) and special software that:

- ✚ Monitors all CAN network traffic and can understand and query the various ECMs.
- ✚ Can refresh the list of ECMs to see if an address is no longer transmitting.

Refer to various OEM literature on how best to diagnose their CAN network in this regard.

J1939 Network Testing Step 4 (Device Going BUS_OFF)

To test for controllers transmitting on the J1939 databus and leaving the databus (typically 4-10 seconds later) because of a BUS_OFF condition requires a Personal Computer (PC), Vehicle Diagnostic Adapter (VDA) and special software that:

- ✚ Monitors all J1939 network traffic and can understand and query the various ECUs.
- ✚ Can refresh the list of ECUs to see if an address is no longer transmitting.

If you have a Dearborn Group DPA device such as a **DPA 5** or a **DPA 4 Plus**, you can use **DG Diagnostics (MD/HD)** software that is free with purchase of that DPA device. This section shows using that software.

1. Reconnect the vehicle battery and ensure ignition is in the ON position.
 - a. With VOM set to read DC voltages (Volts/V setting), place the red lead on Power and the black lead on Ground and ensure the diagnostic connector has roughly 12 or 24 Volts.
2. Connect DPA device to the vehicle/equipment diagnostic connector and to the PC.
3. Start **DG Diagnostics** by using the shortcut icon on the desktop (select the **MD/HD - Truck** icon). On the **Home** tab, select the correct device and click the **Connect** button.
4. Go to the **Components** tab (see image below). Wait for 30 seconds to ensure all ECUs transmitting are listed (top arrow). Make note of all the ECUs in the list.
 - a. If all ECUs are not transmitting initially, refer to OEM literature on how to diagnose that component.
5. Press the **Reset Lists** button and wait another 30 seconds. Make note of all the ECUs in the list. If an ECU has "disappeared", that controller has gone into a **BUS_OFF** state indicating something is wrong with that ECUs ability to transmit. Refer to the OEM literature on how to diagnose that component.

