VOLVO

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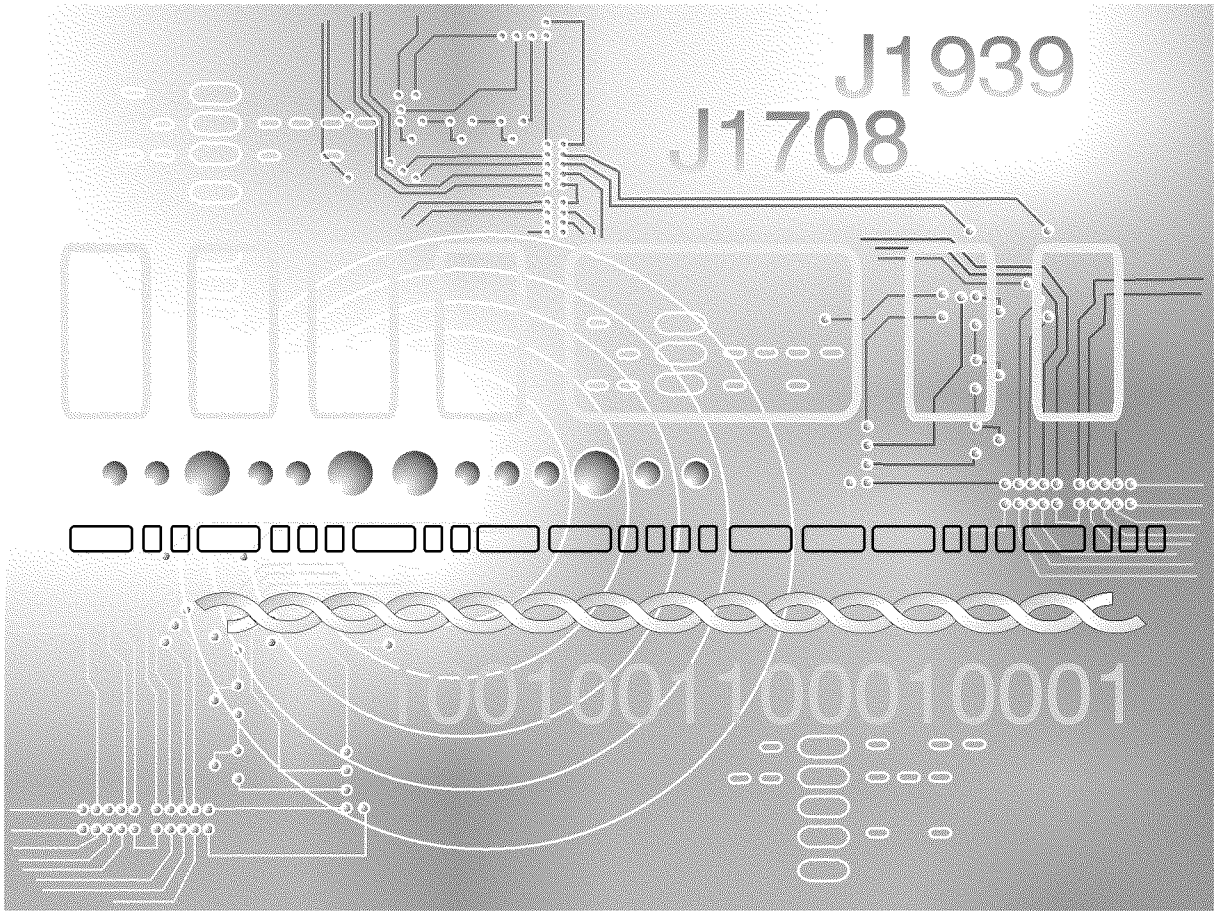
Data links, fault tracing
VN, VHD VERSION2
From build date 11.2002

Data Links, Fault Tracing



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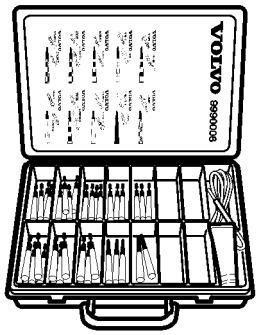

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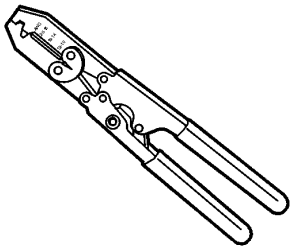

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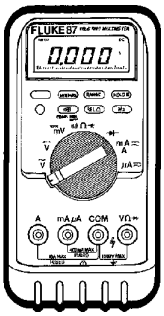

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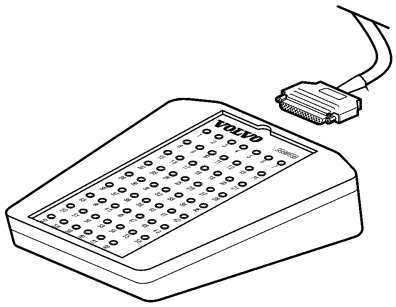

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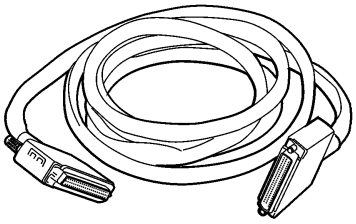

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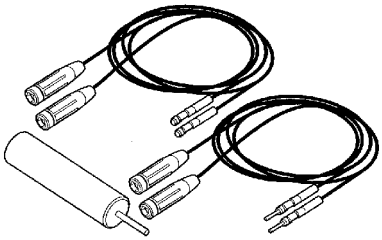

J-42449
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Troubleshooting

Data Links, Fault Tracing

General Troubleshooting Procedures

The control units share information via two different data links “information link SAE J1587/1708” and “control link SAE J1939”

The messages on the SAE J1587/1708 information link are for example, fault codes and warning messages. In some cases the SAE J1587/1708 link also acts as a reserve for SAE J1939. VCADS Pro only communicates on SAE J1587/1708.

SAE J1939 is a faster link which means more data can be transmitted. SAE J1939 is used to transmit data that the system uses for control functions, for example, engine speed (rpm).

Checks:

- “J1708 Information Link, Fault Tracing” page 14
- “J1939 Control Link, Fault Tracing” page 16

- Use Multimeter J-39200 (or equivalent tool) to perform tests.
- When troubleshooting wiring and connectors use breakout boxes/harnesses when available. A list of various breakout boxes/harnesses is included in “Special Tools” page 2.
- Never pierce the wiring insulation with test probes.
- Do not pierce through seals on water-resistant connectors.
- Never insert test probes into connectors. The probes may spread the terminals and cause intermittent faults.
- If breakout boxes/harnesses are not available, contact the metal outer edges of connector terminals as necessary to take readings.
- Consult “VN or VHD Series Electrical Schematics” in Group 37 for vehicle specific wiring and connector information. These schematics include pin-out and vehicle location drawings for connectors.

Visual Inspection

Before beginning electrical checks, visually inspect the wiring and connectors.

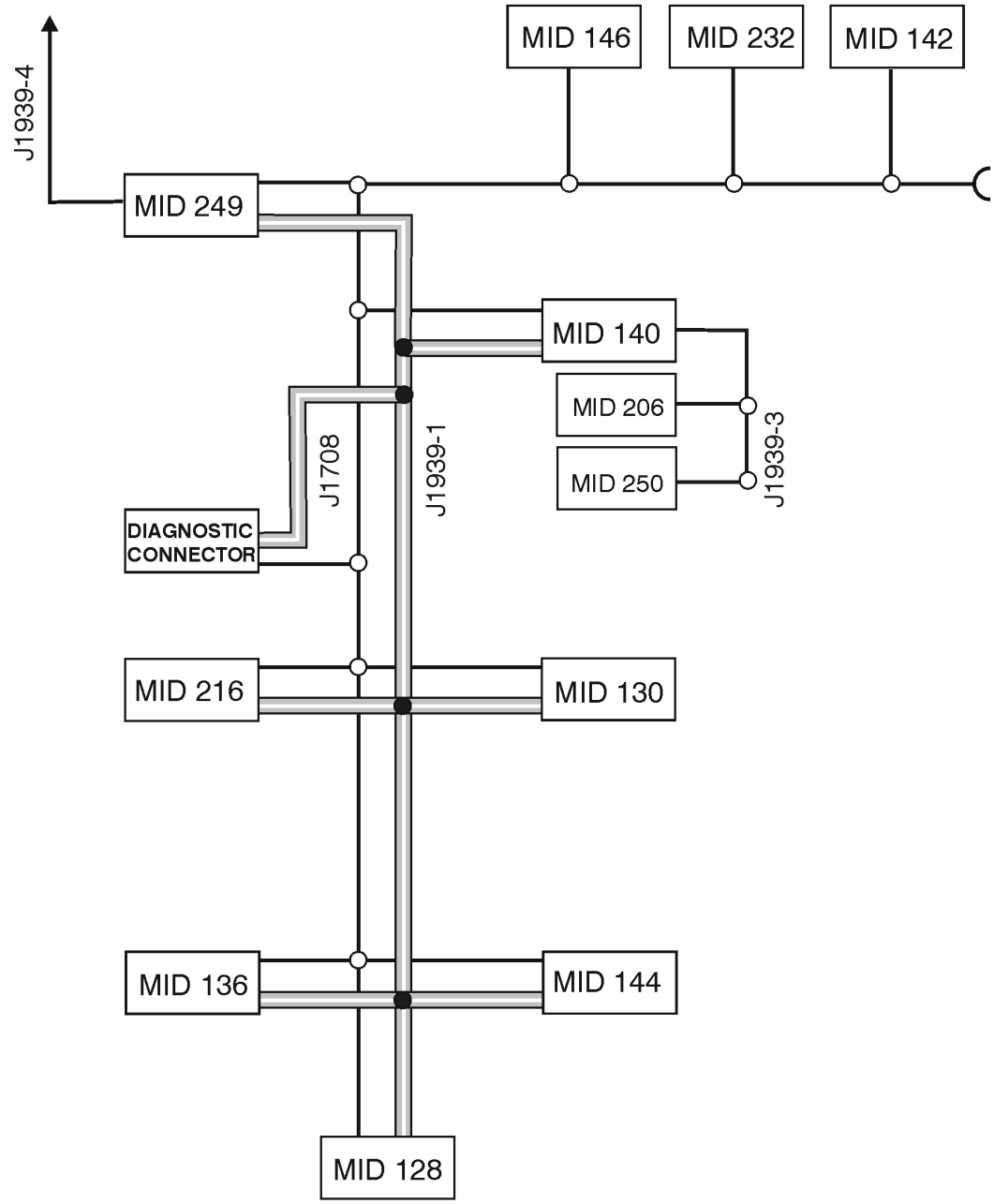
- Inspect for corrosion in wiring or connectors.
- Check that terminal pins are not bent or damaged, and are locked into their connectors and properly crimped.
- Check that the terminal pins make good mechanical contact with their mating pin.
- To help locate intermittent faults, wiggle the wire and connector while testing.

Wiring and Connectors

Troubleshooting data link wiring is no different than troubleshooting any other wiring. A DMM is used to take measurements for resistance or voltage at various points in the circuit. Based on those readings and working with wiring schematics, the technician can narrow the search area until the exact cause of a wiring failure is determined.

For general information about how to troubleshoot the wiring and connectors see "Troubleshooting Wiring and Connectors" found in the "Electrical General, VN and VHD" manual in group 30.

Data links



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Note: Not all modules will be present in every vehicle.

MID 128	Engine ECU
MID 136	Anti-lock Brake (ABS) ECU
MID 140	Instrument Cluster
MID 142	Satellite Communications
MID 144	Vehicle ECU
MID 146	Climate control ECU
MID 206	Radio
MID 216	Lighting Control Module
MID 232	Airbag, control unit
MID 249	Body builder module
MID 250	Steering Wheel Module
J1939–1	Main network SAE J1939
J1939–3	Section of SAE J1939 under the instrument cluster
J1939–4	Section of SAE J1939 under the bodybuilder control unit

SAE J1587/1708

For checking see “J1708 Information Link, Fault Tracing” page 14.

SAE J1587/1708 is used for, amongst other things, transmitting fault code information. Faults which can affect the entire SAE J1587/1708 datalink can create problems when fault tracing, since it can be difficult to communicate with the source in order to carry out tests using VCADS pro. A simple way of checking if VCADS pro is in contact with all control units on the SAE J1587/1708 link is “17034-2 Vehicle information, test”. An indication that there is a problem with SAE J1587/1708 can be that fault codes from a certain control unit can not be corrected.

There are various types of errors that store fault codes for the SAE J1587/1708 link (SID 250). If a control unit is able to store a fault code then the fault more than likely is associated with faulty wiring, connectors or sensors. The fault could be an open-circuit or short-circuit in the cable harness in one or more places. In order to determine an open-circuit in the cable harness, check the voltage levels at each control unit. See “J1708 Information Link, Fault Tracing” page 14.

Fault codes in the SAE J1587/1708 link (SID 250) can also be caused by another control unit not transmitting information. The reason for this can be due to faults in components connected to the other control unit. Therefore, all other fault codes must be corrected before starting the datalink fault tracing process.

List of MID numbers

Note: Not all MIDs will be present on every vehicle.

MID 128	Engine ECU
MID 130	Transmission control unit
MID 136	Anti-lock Brake (ABS) ECU
MID 140	Instrument Cluster
MID 142	Satellite Communications
MID 144	Vehicle ECU
MID 146	Climate control ECU
MID 172	Test tool, ie. VCADS PRO
MID 206	Radio
MID 216	Lighting Control Module
MID 219	VORAD/ACC
MID 232	Airbag, control unit
MID 249	Body builder module (BBM)
MID 250	Steering Wheel Module

SAE J1939

For checking see “J1939 Control Link, Fault Tracing” page 16.

The information on the SAE J1939 control link is used for control functions. Therefore, the diagnostics for SAE J1939 have been developed and supplemented with more fault codes for a more precise reading. The fault codes that are transmitted on the SAE J1587/1708 link are also transmitted, in the event of more serious faults, on the SAE J1939 link.

If control unit A is missing the message from another control unit B, the fault codes PSID 200 - 214 are used to determine from which control unit the message is missing. If control unit B loses contact with the link, other control units can store fault codes indicating control unit B has lost communications.

Example:
If there is an open - circuit on the SAE J1939 link at the vehicle ECU (MID 144), PC connector, the message from the vehicle ECU does not reach the other control units on SAE J1939. The instrument cluster and ABS ECU use the messages from the vehicle ECU. The instrument cluster and ABS ECU store fault codes when the message is not received. The instrument cluster stores fault codes “MID 140 PSID 201 FMI 9” and the ABS ECU stores “MID 136 PSID 201 FMI 9”.

PSID 201 is stored by both the instrument cluster and ABS ECU which indicates that the vehicle control has an interruption in the SAE J-1939 data link. This can be useful in order to find faults on the data link. If there is a fault in the cable harness the fact that there is still contact between certain control units can be used to eliminate sections of the cable harness. In the event of certain errors in the SAE J1939 link the fault codes are stored as a SID 231 message.

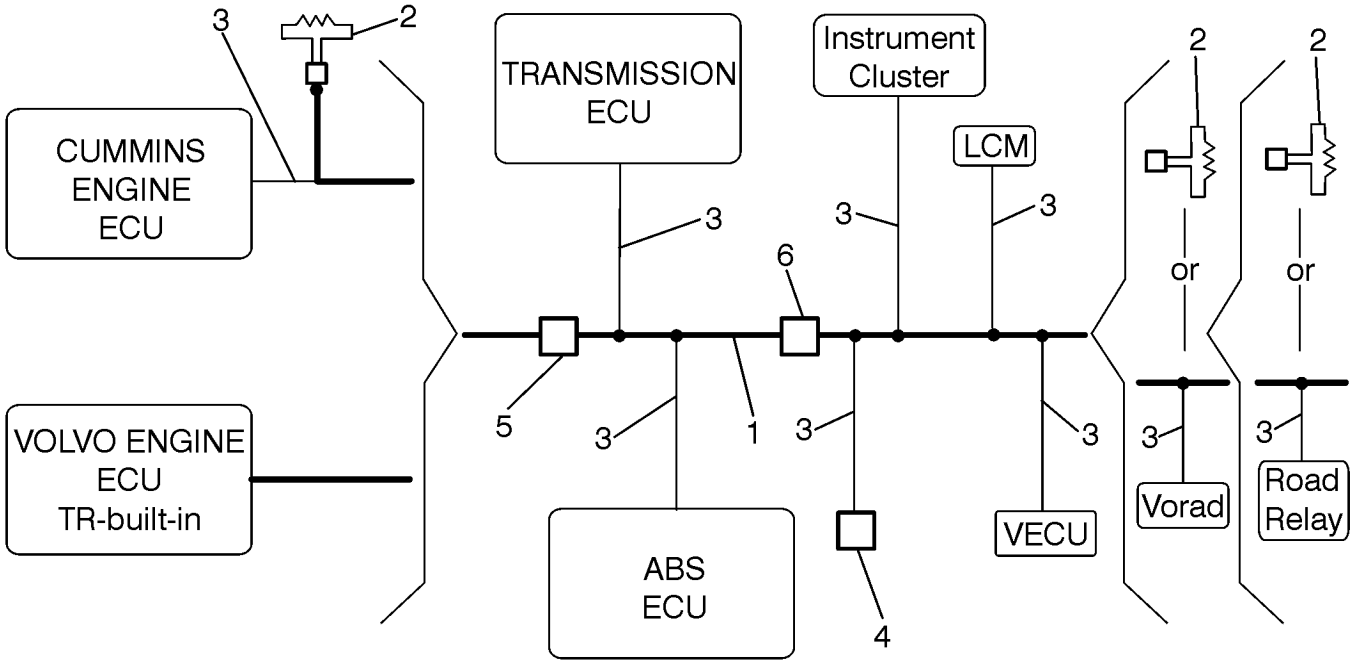
Note: It is important to remember which control units the vehicle is equipped with and which fault codes are stored in each control unit.

Explanation of PSID 200-214

Note: Not all control units will be present on every vehicle.

PSID 200	Open-circuit, bad data, data link, engine control unit (MID 128)
PSID 201	Open-circuit, bad data, data link, vehicle ECU (MID 144)
PSID 202	Open-circuit, data link, instrument cluster (MID 140)
PSID 204	Open-circuit, data link, ABS ECU (MID 136)
PSID 210	Open-circuit, data link, Lighting Control Module(LCM) (MID 216)
PSID 214	Open-circuit, data link, body builder module (MID 249)

Data Link Construction



W3005333

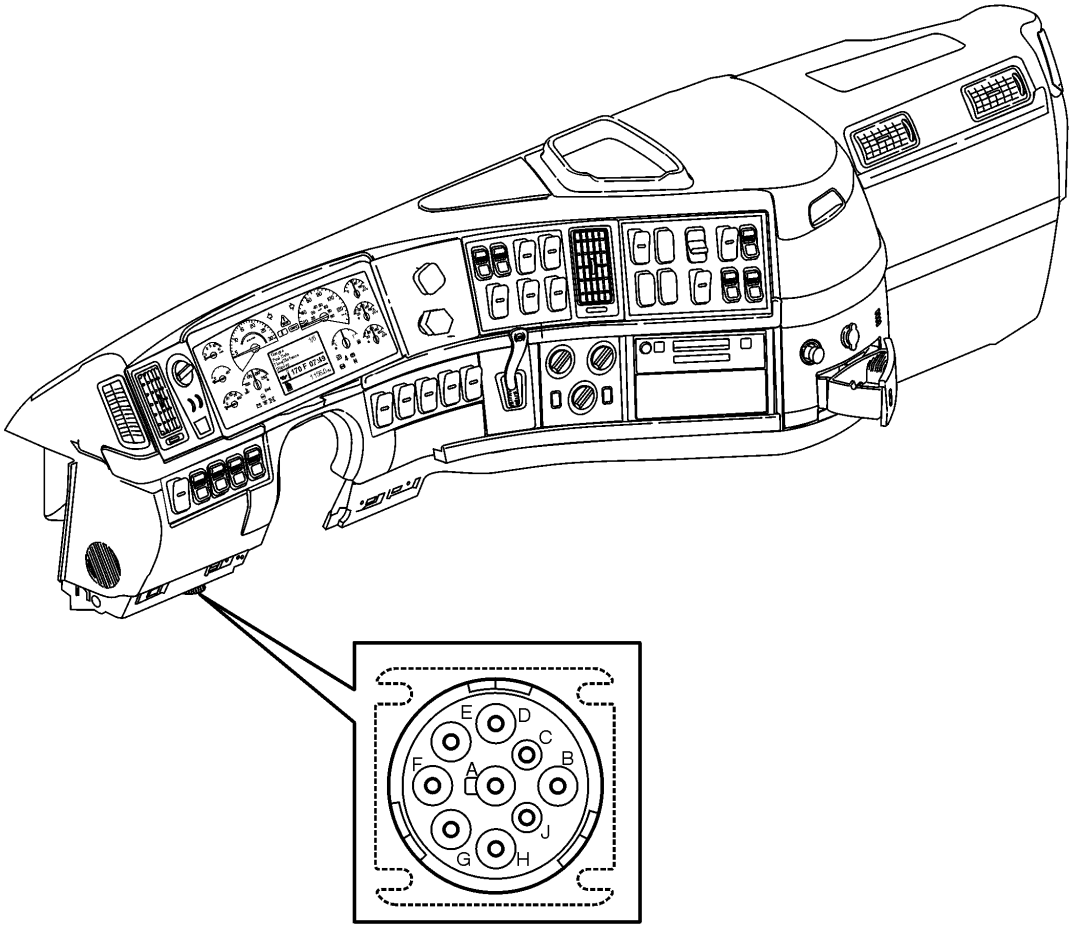
1 Data link backbone
2 Terminating resistors
3 Stub connections for ECUs
4 Diagnostic connector
5 Chassis harness — engine harness in-line connector
6 Chassis harness — cab harness bulkhead pass-through connector

The J1939 Control Data Link consists of a backbone (1), terminating resistors (2) at each end, and stubs spliced out (3) for each ECU on the data link. On vehicles with Volvo engines, the terminating resistor at the engine end is located inside the Engine ECU.

The J1939 Control Data Link complies with SAE standards and consists of 2 twisted wires:

- Wire 406 is yellow in color and carries the Controller Area Network high (CAN_H) digital signal of approximately 2–5 volts.
- Wire 407 is green in color and carries the Controller Area Network low (CAN_L) digital signal of approximately 0–3 volts.

Diagnostic Connector



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9–pin Diagnostic Connector	
Cavity Position	**Circuit Description**
A	0Z (B-)
B	402 (B+)
C	406C (CAN_H, yellow)
D	407C (CAN_L, green)
E	not connected
F	400G (SAE A, 1708)
G	401G (SAE B, 1708)
H	not connected
J	196DR (Ignition)

Note: The J1939 Data Link can be accessed at the 9–pin diagnostic connector.

SID 231 J1939 Data Link Fault

W3005017

The following table lists Failure Mode Identifiers (FMI) that may be helpful in identifying data link problems. Please note the following when troubleshooting data link failures by fault codes.

- The type of FMI that an individual ECU can monitor is dependent on the software in the ECU. All FMIs cannot be recognized by all ECUs.
- The ECU reporting the fault may not be the ECU that is involved at the site of the specific failure. For example, The Engine ECU may report a data link fault that is actually at the VECU. The VECU would not be able to report if the data link is broken between the VECU and data link backbone.

FMI	Description	Note
0	Data valid, but high	
1	Date valid, but low	
2	Data erratic	A
3	Voltage shorted high	
4	Voltage shorted low	
5	Current low or open C	
6	Current high or short C	
7	Mech syst no response	
8	Abnormal freq or PW	
9	Abnormal update rate	B
10	Abnormal change rate	
11	Failure unknown	C
12	Loss of intelligent device	D
13	Out of calibration	
14	Special instruction	

A. **FMI 2, Data Erratic** is given when the ECU does not see any J1939 messages and is *not able* to communicate on the J1939 network. This is typically a result of a problem in the wiring, i.e., shorted high or low, or the ECU may be totally disconnected from the J1939 data link. When an ECU detects this situation, it should set the fault code FMI 2. Other ECUs will also set other fault codes for loss of messages from this ECU.

B. **FMI 9, Abnormal Update Rate** is given when an ECU is seeing messages from a specific ECU on the J1939 network, but needed data is not present. This is typically where the J1939 data link is functioning, and the ECU is communicating, but having a local problem with a sensor.

C. **FMI 11, Failure Unknown** indicates an internal problem in the ECU.

D. **FMI 12, Loss of Intelligent Device** is given when an ECU is expecting to receive messages from another ECU on the network, and the messages are not present. For example, the Engine ECU expects certain messages from the ABS system; FMI 12 is logged if those messages are not there. This fault is probably caused by a physical break (open circuit) in the J1939 wiring, somewhere between the ECUs, or when an ECU is off-line due to a blown fuse or bad component.
Note that the device that logs this fault is NOT the faulty ECU – it has instead detected the fault.

J1939 Data Link Voltage Check

The J1939 Control Data Link operates at the following voltages:

Data Link Wires	Key Position	Measuring Point	Expected Value
Wire 406 (CAN_H, yellow)	On	Pins for Wire 406 (yellow) - Ground	Fluctuating between 2 - 5 Volts
Wire 407 (CAN_L, green)	On	Pins for Wire 407 (green) - Ground	Fluctuating between 0 - 3 Volts
Between Wire 406 and Wire 407	On	Pins for Wire 406 (yellow) - Pins for Wire 407 (green)	Fluctuating between 0 - 5 Volts

It is expected that the voltages quoted in the table above exist on Wire 406 (CAN_H, yellow) and Wire 407 (CAN_L, green) at any point on the data link. Due to the fact that multiple ECUs are both "talking" and "listening" any time the ignition key is on, the voltage reading will have limited troubleshooting value.

J1939 Data Link Resistance Check

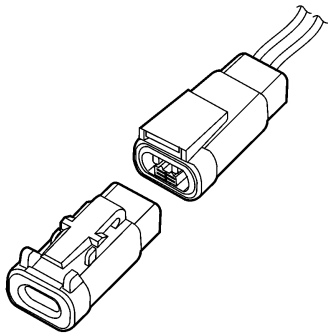
When operating properly, the J1939 Control Data Link has a resistance of approximately 60 Ω between Wire 406 (CAN_H, yellow) and Wire 407 (CAN_L, green) at any point on the data link. Checks can be made at the diagnostic connector, terminating resistors, or any ECU on the J1939 Control Data Link.

Use a DMM to check the resistance at suspected fault locations observing the following points:

- For detailed, vehicle specific schematics see "VN/VHD Electrical Schematics" found in group 37.
- Breakout boxes for some components may exist to aid in troubleshooting. See "Tools" for more information.
- Back probe connectors when possible to avoid pin or socket damage.
- Terminating resistors must remain in the circuit for test.

Function	**Key Position**	**Measuring Point**	**Expected Value**	**If Expected Value Not Correct Check:**
Grounded Circuit Check	Off	Pins for Wire 406 (yellow) - Ground	OL (Infinite Resistance)	Grounded Circuit
Grounded Circuit Check	Off	Pins for Wire 407 (green) - Ground	OL (Infinite Resistance)	Grounded Circuit
J1939 Data Link Resistance Check	Off	Pins for Wire 406 (yellow) - Wire 407 (green)	60Ω	1. Check terminating resistors. See “Terminating Resistor, Checking” page 13. 2. Wiring/connector fault in backbone or stubs. See “Wiring and Connectors” page 4 and “J1939 Data Link Troubleshooting Example” page 18.

Terminating Resistor, Checking



W3005518

Terminating Resistor, 2–pin

Terminating resistors are wired to each end of the J1939 data link to prevent signal reflections. They must remain connected for the data link to function properly. The resistance value of each terminating resistor is 120Ω. When properly installed in the data link, their combined resistance is 60Ω since they are connected in parallel.

The terminating resistor at one end of the J1939 data link is located in the Fuse/Relay Center near the VECU and the other near the engine ECU. On vehicles equipped Volvo engines, the terminating resistor at the engine end is located inside the EECU. On vehicles equipped with Cummins engine, the terminating resistor is located in the harness area just outside of the Engine ECU.

A J1939 stub connection is located at the transmission area in the chassis harness. On vehicles equipped with an electronically controlled transmission (Allison/Autoshift II/Meritor Freedom Line), the connection to the transmission is located at the chassis harness. On vehicles equipped with a manual non-electronically controlled transmission - the connector stub will have an unterminated blanking plug installed.

Only two terminating resistors are used in a vehicle. Never install three in one truck. If more than two terminating resistors exist in the J1939 circuit, damage to the ECU electronics can occur over time. You can easily check to see if you have two resistors by measuring the resistance between circuits 406 and 407, at the diagnostic connector, with the ignition OFF. The correct resistance is 60Ω.

If by chance a vehicle has more terminating resistors installed in the link than required, the resistance value between circuit 406 and 407 will be approx. 40 ohms. This would give an indication to go and check the locations mentioned above and remove the plugs one at a time until the correct resistance reading is obtained. You should then find that you have more than one installed. To fix the problem order a blanking plug and install in the appropriate location, depending on vehicle transmission type.

To check the terminating resistors, the J1939 data link can be accessed at the 9 pin diagnostic connector.

Use a DMM to check the following:

9-pin Diagnostic Connector					
Function	**Key Position**	**Measuring Point**	**Expected Value**	**Note**	**If Expected Value not met, check**
Terminating Resistor Check	Off	Pin D - Pin C	60 Ω		1. If 120Ω, one terminating resistor missing or wiring fault. 2. If >1kΩ, both terminating resistor missing or wiring fault. 3. If OLΩ (infinite), open circuit. 4. If <1Ω, short circuit in data link wires.

3711-21-03-01
J1708 Information Link, Fault Tracing

Other special equipment: J-39200

NOTE!

- During fault-tracing check the relevant connectors. Check for loose connections, contact resistance and oxidation. For a more detailed description of fault-tracing cables and connectors, see separate service information under group 37.
- Do not use the chassis as a ground when taking readings. Use the ground plate in the distribution box.
- For measurement points and adapters see “Signal Indication” for the relevant system.

Additional information

When checking the data link measurement and the values are outside of the given ranges, there are several possible explanations.

1

If the voltage is approx. greater than 5 V DC the data link is possibly shorted to a higher voltage and must be inspected to find the cause.

A wire of higher voltage could be cross connected to the data link via chaffing or pin misalignment at connectors or control units, etc.
A second, but least likely, possibility is that the internal databus of an ecu has failed in some way causing an interruption of messaging on the link. If this is suspected, disconnect the suspect ecu temporarily or either connect a spare ecu to check if the problem goes away.

2

If the voltage is aprrox. less than 2 V DC the datalink is possibly shorted to ground and must be inspected to find the cause.

A wire of lower voltage or ground type could be cross connected to the data link via chaffing or pin misalignment at connectors or control units, etc.

Either one or both of the data link wires are shorted to ground via a rub through (chaff). Inspect the entire data link for possible signs of abrasion. Repair according to guidelines outlined in this manual.

A third, but least likely, possibility is that the internal databus of an ecu has failed in some way causing an interruption of messaging on the link. If this is suspected, disconnect the suspect ecu temporarily or connect a spare ecu to check if the problem goes away.

Checking sub-systems

1

Conditions:

- Measurement box with adapter connected between the relevant control unit and cable harness.
- Measuring voltage using the multimeter with the *MIN / MAX*-function engaged.
- Control unit connected.
- The ignition key in the drive position.

Measuring points	**Desired value**
SAE J1587/1708 A - ground	V ≈ 0 - 5 V DC [1] V_{max} ≈ 5 V DC V_{min} ≈ 0 V DC
SAE J1587/1708 B - ground	V ≈ 0 - 5 V DC [1] V_{max} ≈ 5 V DC V_{min} ≈ 0 V DC
SAE J1587/1708 A - SAE J1587/1708 B	V ≈ 2 - 5 V DC

[1] The voltage must vary within the interval.

Note: The voltage on the information link varies and is dependent on the number of control units and traffic on the information link.

J-39200

3711-21-03-02
J1939 Control Link, Fault Tracing

You must read and understand the precautions and guidelines in Service Information, group 30, "General Safety Practices", before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

Other special equipment: J-39200

NOTE!

- During fault-tracing check the relevant connectors. Check for loose connections, contact resistance and oxidation. For a more detailed description of fault-tracing cables and connectors, see separate service information under group 37.
- Do not use the chassis as a ground when taking readings. Use the ground plate in the distribution box.
- For measurement points and adapters see “Signal Indication” for the relevant system.

Checking sub-systems

1

Conditions:

- Measurement box with adapter connected between the relevant control unit and cable harness.
- Control unit connected.
- Measuring voltage using multi meter J-39200 with the *MIN MAX*-function connected.
- Ignition key in the drive position.

Note: The voltage of the control link varies and depends on the number of control units and the traffic on the control link.

Measuring points	**Desired value**
SAE J1939A - ground	V ≈ 2 - 5 V DC
SAE J1939B - ground	V ≈ 0 - 3 V DC
SAE J1939A - SAE J1939B	V ≈ 0 - 1 V DC

J-39200

2

Conditions:

- Measurement box with adapter connected between the relevant control unit and cable harness.
- Control unit connected.
- Measuring resistance using a multimeter.
- Ignition key in stop position.

Measuring points	**Desired value**
SAE J1939A - SAE J1939B Two terminations	R = 50 - 70 Ω
SAE J1939A - SAE J1939B One termination	R = 100 - 140 Ω

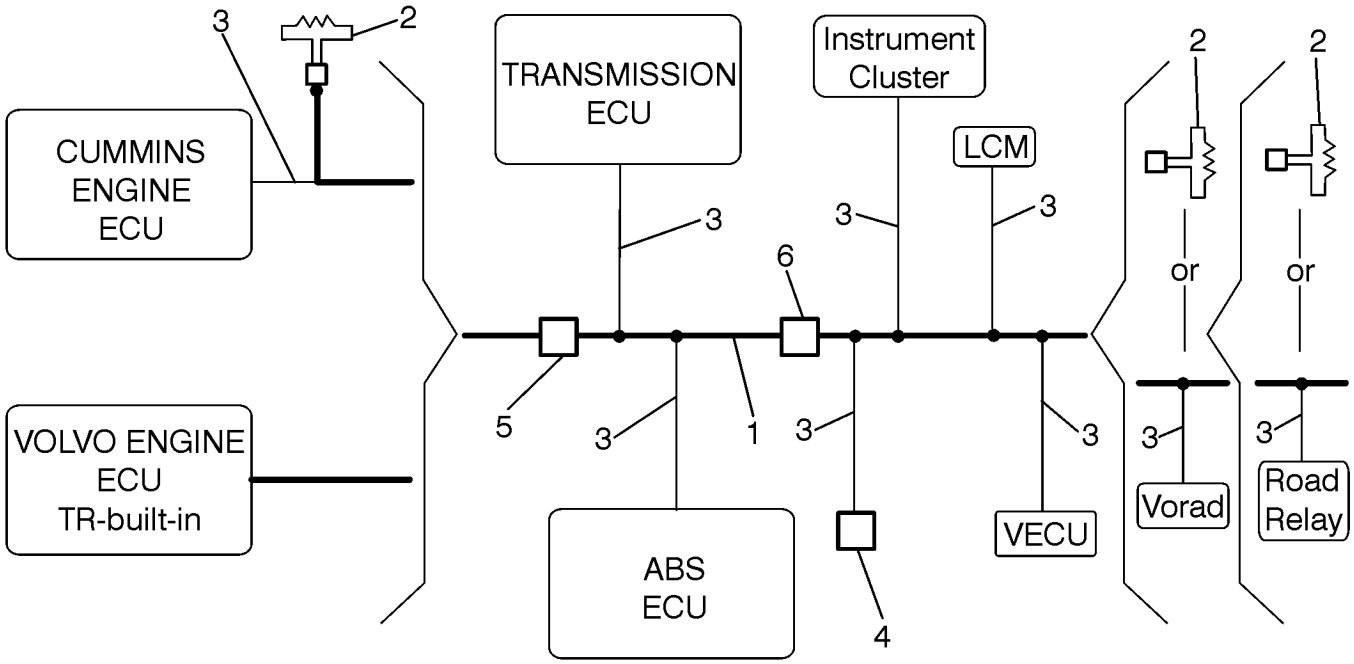
Comments:

When the resistance R ≈ 60 Ω the cable harness is probably fault free from the particular connector to two terminating resistors.

If the resistance R ≈ 120 Ω from the relevant connector then measuring is only conducted to the terminating resistor.

J-39200

J1939 Data Link Troubleshooting Example



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1 Data link backbone
2 Terminating resistors
3 Stub connections for ECUs
4 Diagnostic connector
5 Chassis harness — engine harness in-line connector
6 Chassis harness — cab harness bulkhead pass-through connector

Note: This example is intended as a guide for the logic used to troubleshoot a data link wiring problem. The illustration should be used to help clarify the troubleshooting example. Always refer to vehicle-specific wiring schematics found in Group 37 when performing vehicle troubleshooting.

1
Begin by visually verifying that the two terminating resistors are in place:

1a. One at the engine ecu. Vehicle equipped with the Volvo engine, the terminating resistor is built into the EECU and is not visible. Vehicles with Cummins engines the terminating resistor is located on the engine harness.

1b. One inside the cab, forward of the fuse/relay panel (visible when the fuse/relay cover is removed).

2
Using an ohmmeter with the ignition key switch in the OFF position, check the resistance between circuits 406 (CAN_H, J1939A, yellow) and 407 (CAN_L, J1939B, green) at the diagnostic connector.

2a. If 60 Ω (±10 Ω) resistance is measured, it is likely that the backbone circuit is intact, since the 60 Ω represents the two 120 Ω terminating resistors in parallel. If trouble is still present, it is most likely in one of the ECU stub circuits or at the ECU terminal themselves. Go to Step 6.

2b. If approximately 120 Ω resistance is measured, this indicates that one of the terminating resistors is missing, poorly connected or else there is an open circuit in the backbone at some point. Use the fault codes (if present) to narrow down the likely location based on which ECU's are complaining about missing data from other ECU's. Go to Step 3.

2c. If approximately 40 Ω resistance is measured, there are more than 2 terminating resistors installed. To fix the problem order a blanking plug and install in the appropriate location, depending on vehicle transmission type.

3
Disconnect the Cab-chassis/pass-through connector (item 6) at the bulkhead and re-test the resistance of circuit 406–407 at the diagnostic connector.

3a. If the resistance is the same as that measured in Step 2b, then that means the trouble is likely on the chassis side of the cab-chassis pass-through, since the 120Ω being measured must be teminating resistor located in the cab. Go to Step 4.

3b. If the resistance is greater than what was measured in Step 2b, then the trouble is likely on the cab side of the harness, since the different reading means you can no longer 'see' the engine side terminating resistor. Go to Step 5.

4
With the pass-through (item 6) still disconnected, check the resistance between circuit 406–407 on the chassis harness side of the pass-through, 'looking' towards the engine (120Ω should be present). While shaking/moving the harnesses to look for an intermittent connection, check the following items:

- Check for continuity between all circuit 406 points — pass-though, EECU, terminating resistor, and transmission (if automated/automatic transmission)
- Check for continuity between all circuit 407 points — pass-though, EECU, terminating resistor, and transmission (if automated/automatic transmission)

The 406 and 407 backbone circuits can, also, be disconnected at the engine-to-chassis harness in-line connector (item 5 — located near the starter relay breakout, near the bulkhead) to further isolate whether the problem exists on the 'engine' side or the 'chassis' side.

5
With the pass-through (item 6) still disconnected, check the resistance between circuit 406–407 on the cab side of the pass-through, 'looking' into the cab (120Ω should be present). While shaking/moving the harnesses to look for an intermittent connection, check the following items:

- Check for continuity between all circuit 406 points.
- Check for continuity between all circuit 407 points.

6
Check for continuity between circuit 406 at the diagnostic connector and all circuit 406 point at the ECU's and terminating resistors. All circuit 406 should have continuity to all other ECU's. Perform the same tests for all circuit 407 points.
If continuity is not found at all points, the trouble is most likely in the stub to that ECU, or the ECU connector/terminal itself.

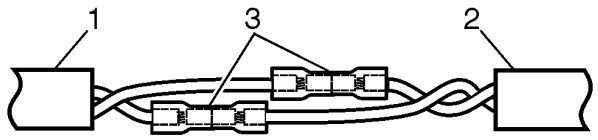
Service Procedures

3711-16-02-02
J1939 Data Link Wiring (Unshielded), Repair

You must read and understand the precautions and guidelines in Service Information, group 30, "General Safety Practices", before performing this procedure. If you are not properly trained and certified in this procedure, ask your supervisor for training before you perform it.

Note: This procedure complies with TMC RP142 “High-Speed Data Link Repair Guidelines.”

Note: Stagger wire cuts and splices to minimize bulges in data link cable.



W3004993

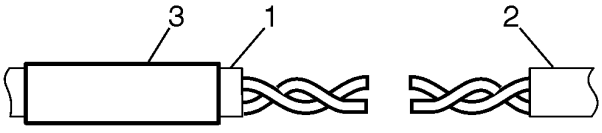
1 Cable bundle, existing
2 Cable bundle, new
3 Heat-shrinkable connector

1
Make certain the vehicles ignition is OFF before beginning this procedure.

2
Remove the data link from the wiring harness as necessary and cut out the damaged section of cable. Note: The replacement section of cable (P/N 982689) must be somewhat longer than the original to allow for staggering of the splices.

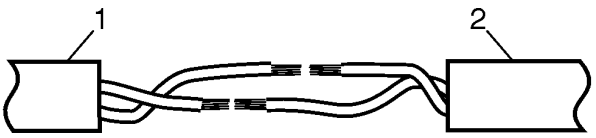
3
Strip approximately 50 mm (2 in.) of cable jacket and shield at each end of the splices to expose the wiring. Use caution not to cut the wire insulation.

4
Slide a piece of heat-shrink tubing over each end of the cut cable bundle to seal the data link after the wires have been spliced. The tubing should be approximately 50 mm (2 in.) longer than the repair area.



W3004994

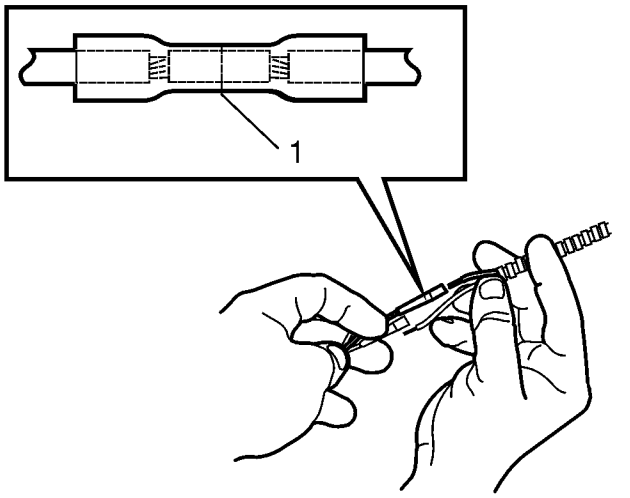
1 Cable bundle, existing
2 Cable bundle, new
3 Heat-shrink tubing



W3004995

1 Cable bundle, existing
2 Cable bundle, new

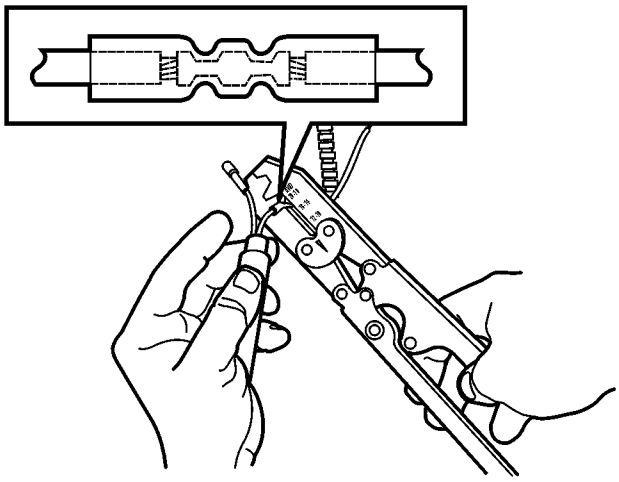
5
Stagger cut the wiring to minimize bulges in the data link cable. Strip approximately 6.3 mm (0.25 in.) of wiring insulation at each wire end. Use caution not to cut the wire strands.



W3004996

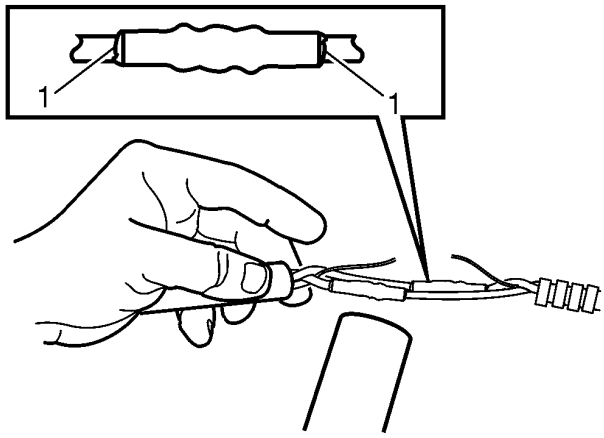
1 Wire stop

6
Observe polarity when connecting the 406 (CAN-H, yellow) and 407 (CAN-L, green) wires. Use a heat shrinkable wiring connector to splice the wires together. Insert each end of the wire into the connector until it hits the wire stop.



W3004997

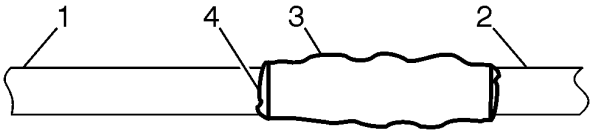
7
Insert the connector into the proper anvil on the crimping tool and crimp. Gently tug on the spliced connection to be sure the wire is secure.



W3004889

1 Visible sealant

8
Use a heat gun to activate the heat shrink. Look for sealant at each end of the connector as evidence of a good application. Note: Do not use an open flame to apply heat shrink.



W3004883

1 Cable bundle, existing
2 Cable bundle, new
3 Heat shrink tubing
4 Visible sealant

9
Center the piece of heat shrinkable tubing installed in step 5 over the entire splice area. There should be approximately 25 mm (1 in.) overlap at each end of the splice area. Starting at the center, use a heat gun to shrink the tubing. Look for sealant at each end of the connector as evidence of a good application. Note: Do not use an open flame to apply heat shrink.

10
After both ends of the cable are spliced, install the data link back into the wiring harness and secure as necessary.

Wire Splice, Solder and Seal

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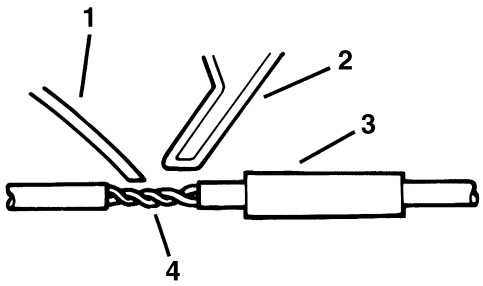


W3000568

Fig. 1: Wire splicing

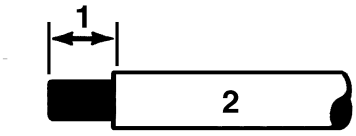
1 Solder
2 Soldering iron
3 Heat shrink tubing with sealant
4 Wires twisted

Soldering Procedure

1
Clean and tin the soldering iron tip.

2
Clean the terminal to be soldered.

3
Strip the wire as necessary to fit the terminal. Do not cut or nick the wire when stripping. Note: The replacement section of cable (P/N 982689) must be somewhat longer than the original to allow for staggering of the splices.

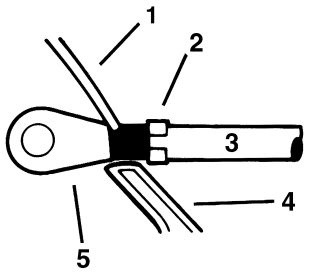


W3000569

1 Strip as necessary
2 Wire

4
Slide a piece of sealant shrink tubing onto the wire.

5
Insert the wire in the terminal and, with a pair of crimpers (as recommended by the connector manufacturer), squeeze the small tabs onto the wire insulation. Not all types of terminals have these tabs. Be certain to use the crimpers recommended by the connector manufacturer. With a blunt instrument, form the bare wire so that it will lay against the soldering area of the terminal.



W3000571

1 Solder
2 Tabs (crimp over wire insulation)
3 Wire
4 Soldering iron
5 Terminal

6

Using the soldering iron, apply heat to the outside of the terminal while holding the solder on the wire on the inside of the terminal. When a sufficient amount of heat has been transferred from the gun through the terminal and into the wire, the solder will be melted by the wire. Melt a sufficient amount of solder on the wire and withdraw the solder and the tip of the iron.

NOTE: Do not hold the terminal with pliers or anything metal during the solder operation, as heat will be conducted away from the terminal.

7

Slide the sealant shrink tubing over the soldered connection, making sure all exposed wire is covered. Heat the tubing with a heat gun to shrink. Shrink until the tubing is tight around the wire and the sealant is visible out of both ends of the tubing.