Chrysler PCI (Programmable Controller Interface)
Module to Module Bus Communication

Legal:
The law requires that every new car and light duty truck sold in the United States be equipped with and support OBD II (On-Board Diagnostics, phase 2). As a result, the vehicle's computer or computers must support any one of three designated protocols:

J1850 Variable Pulse Width (VPW)
This has been adopted by GM and is known as Class 2. This has been adopted by Chrysler and is known as J1850. This is a 10.4 kbps single wire communication system.

J1850 Pulse Width Modulation (PWM)
This has been adopted by Ford and is known as the Standard Corporate Protocol (SCP) and can be seen in Mazda vehicles as well. This is a 41.6 kbps two wire balanced signal communication system.

ISO 9141 and ISO 9141-2 (also known as ISO 9141 CARB)
Seen in some Chrysler and Mazda products, but seems to be more common in Europe. This is a 10.4 kbps single wire communication system.

Chrysler History:
SCI - Serial Communication Interface was Chrysler's OBD I 62.5kbps communication system from 1983 to 1995 (Jeeps 1991-1995). Still in use with 1996 and later vehicles, it is a dedicated high-speed link. It allows scan tool to PCM and TCM communication. Most scan tools communicate with the PCM using this protocol and the TCM through CCD or PCI.

CCD - Chrysler Collision Detection, a module to module 2 wire 7812.5 bps bus communication system introduced in 1989 with a phase out period from 1998 to 2003 (See Figure 1).

PCI - Programmable Controller Interface, a module to module 1 wire 10.4kbps bus communication system introduced in 1998 on LH vehicles *including the scan tool* (See Figure 1). This meets OBD II J1850 requirements.

PCI Communication

This bus system has the capability of supporting up to as high as 32 different modules. When monitoring voltage on the PCI bus wire, it is normally held low and can be driven as high as 7.5 to 8 volts. In other words, when there is no communication, the system is at rest and will show almost 0 volts. This near 0 voltage reading is not an indication that the wire is being grounded because each module on the system is capable of providing its own pull-up voltage for transmitting data. This means that each module is capable of reading and transmitting bus messages (See Figure 2). SAE International published J1850 VPW DC Parameters where it is learned that the Output Low Voltage range on the PCI bus wire is 0 to 1.5 volts and the range for the Output High Voltage is 6.25 to 8 volts. Minimum network resistance can be as low as 315 ohms and as high as 1,575 ohms depending on the amount of modules on the network.

And when it comes to the modules on the network, there are no "slaves or masters" in this communication system as each module connected to the system can independently transmit and receive data. In some applications the Body Control Module (BCM) is a central connection point for the PCI bus and would be better understood as a "hub." This does not make the module a master or a slave in the system, it simply serves as a "hub" in which all PCI bus wires pass thru it (See Figure 3). In other applications the central connection point for the PCI bus is a splice known as a Diagnostic Junction Port (See Figures 4-7).

Each module that is on the network applies a load to the PCI transceiver circuitry and since the PCI network can support up to 32 modules (Figure 3), termination resistors and capacitors are connected in parallel to the transceiver circuit within each module to minimize circuit loading (Figure 2). What is very helpful is that Chrysler has made available the approximate resistance value of the terminating resistor in each module that could be found on the PCI network system (See Figure 8). This information along with the understanding of how each of the module's terminating resistor is grounded in the module and that the modules are connected in parallel to each other, allows for an attainable diagnostic approach should the network develop communication errors such as a P1695 No CCD/J185O Message from the Body Control Module or P1698 No BUS Message from the Transmission Control Module.

A point to consider when diagnosing PCI Faults is the Required Fault Tolerant Modes (8.9.1) where the network must meet the requirements as defined per the following failure modes:

1. Node (Module) Power Loss - All nodes (modules) must continue to meet the network leakage current requirement during a loss of power (or low voltage) condition.
2. Bus Short to Ground - Network data communications may be interrupted but there shall be no damage to any node (module) when the bus is shorted to ground.
3. Bus Short to Battery - Network data communications may be interrupted but there shall be no damage to any node (module) when the bus is shorted to battery power.
4. Loss of Node (Module) Connection to Ground - When a node (module) loses its ground connection, the remaining nodes (modules) shall remain capable of communication

The first diagnostic step is to identify the modules that are on the network of the vehicle being serviced. This can be done with the use of a scanner or a good wiring diagram like the one provided. See Figure 9. This schematic indicates that up to 14 modules can be found on the PCI network plus the Data Link Connector for the scanner.

Using the schematic in figure 9, notice how terminal 2 in the data link connector is wired into the BCM at terminal 14 in the C1 connector. If we check this circuit for resistance, according to SAE, the minimum amount of ohms we can expect to see is 315 ohms and the maximum would be 1,575 ohms depending on the number of modules on the circuit (See Figure 10).

Suppose there is a vehicle that needed to be tested which has 13 modules on the PCI circuit. You determine that there are 2 modules that contain a 3,300 ohm terminating resistor and 11 that contain a 10,800 ohm resistor (See Figure 11). There is a mathematical equation for equivalent resistance in a parallel circuit and it looks like this:

$$\frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4}}$$

Now if you applied this formula to the (2) 3.3k and (11) 10.8k modules it would look like this:

$$\frac{1}{\frac{1}{3300}+\frac{1}{3300}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}} +$$

$$\frac{1}{\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}} = 625 \text{ ohms}$$

To simplify this equation you could set the equation up as follows:

$$\frac{1}{\frac{2}{3300}+\frac{11}{10800}} = \frac{1}{\frac{1}{1650}+\frac{1}{982}} = \frac{1}{0.0006+0.001} = \frac{1}{0.0016} = 625 \text{ ohms}$$

So we have math and theory and now comes reality, putting the meter on terminal 2 of the Data Link Connector as seen in figure 10 where 625 ohms should be observed if all the terminating resistors in each module are good and every module is grounded. This is a quick way to check the integrity of the circuit verifying that all modules can be seen on the PCI bus system.

A short to ground or power takes the entire PCI bus down. A typical technique is to disconnect modules one at a time until the short disappears. With PCI, disconnecting modules doesn't necessarily have to be the first step. In some cases it is very easy to gain access to the BCM as is with a 2001 LH vehicle where the module is located under the driver side dash (See Figure 12). Four of the connectors are very easily accessed while a 5th connector is a bit more difficult as it is located between the Junction Block and the backside of the BCM (See Figure 13).

Figure 13 identifies each connector that plugs into the BCM as well as which connector contains PCI circuits that run through the BCM's BUS bar. An example of making a continuity check across the BUS bar inside the BCM is also shown in figure 13 as well as making individual PCI circuit checks with these connectors unplugged from the BCM. A bad BCM bus bar can be quickly and easily diagnosed with a DVOM as well as any shorts to ground or power on individual PCI circuits. This is a much faster diagnostic step when compared to the typical technique of disconnecting modules one at a time until the short disappears.

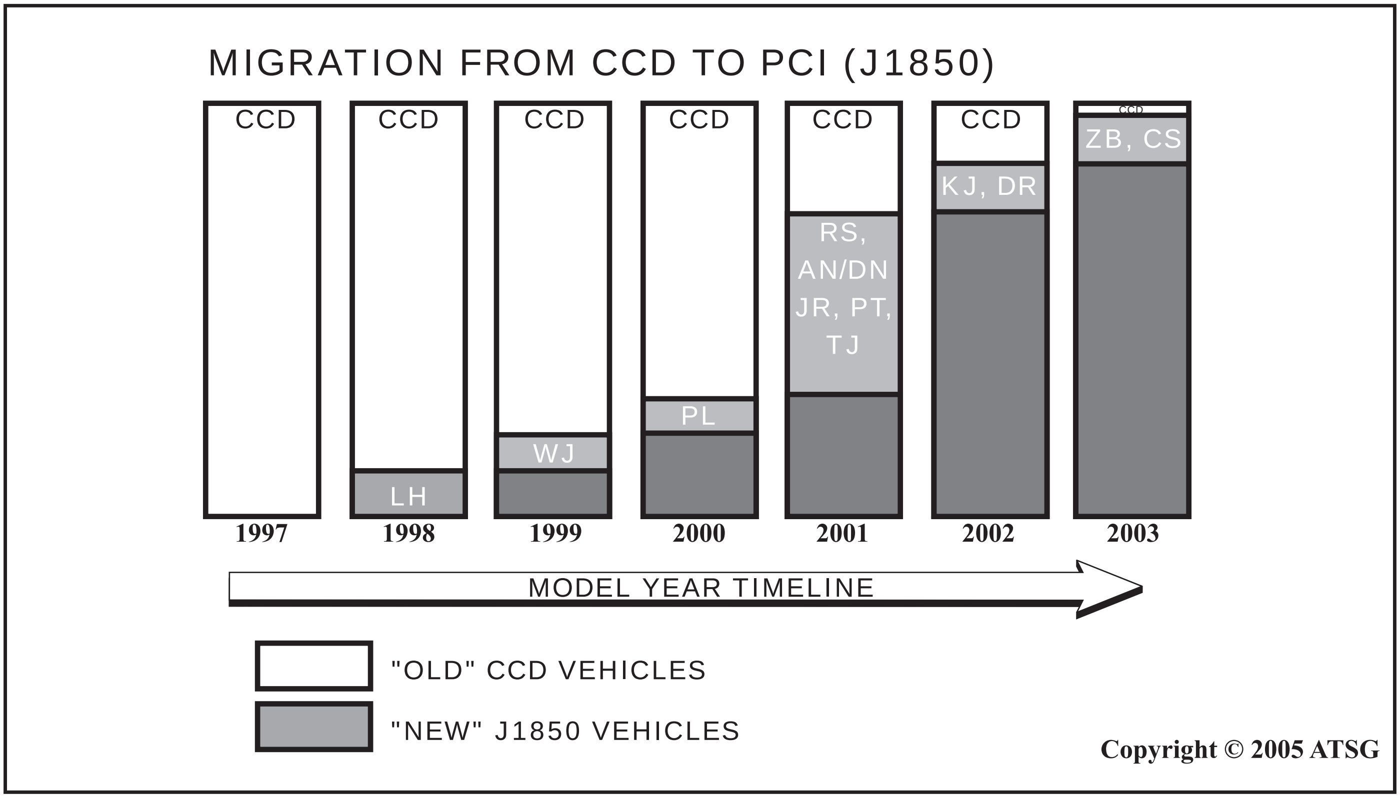
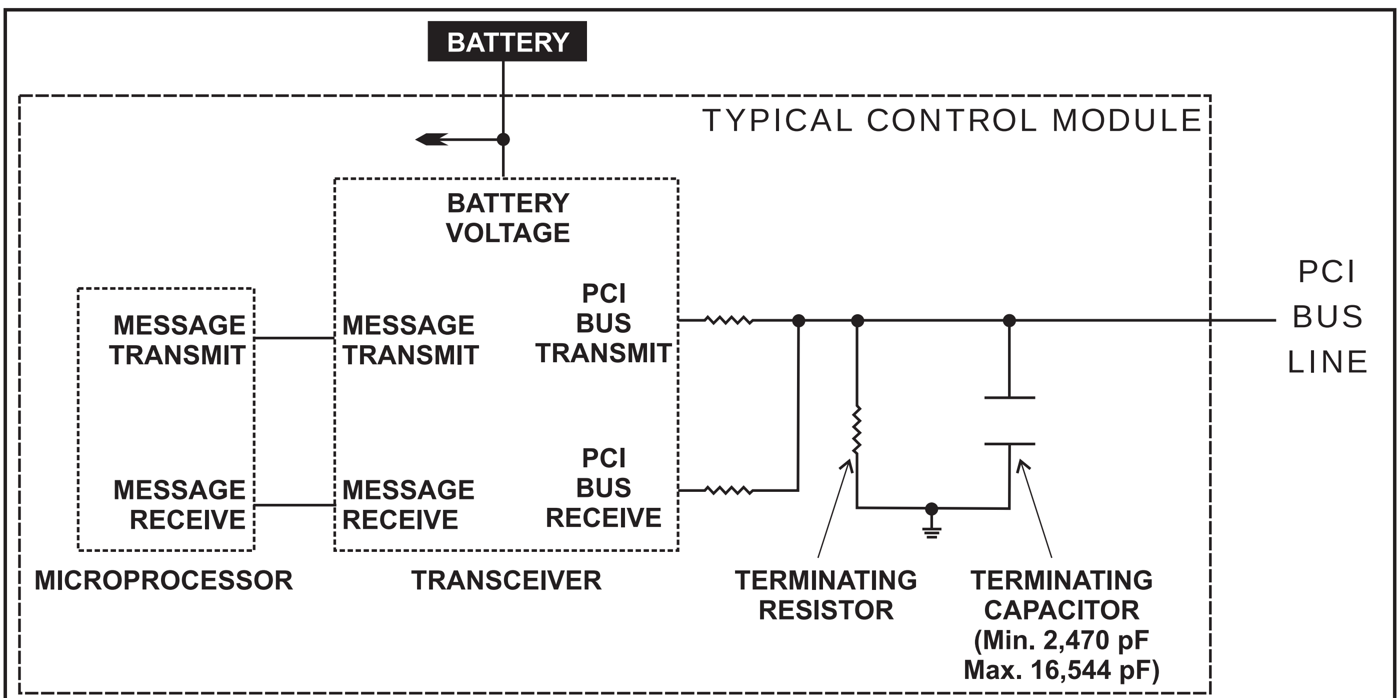


Figure 1



Typical control module showing how it can independently transmit and receive messages over the PCI Bus.

Figure 2

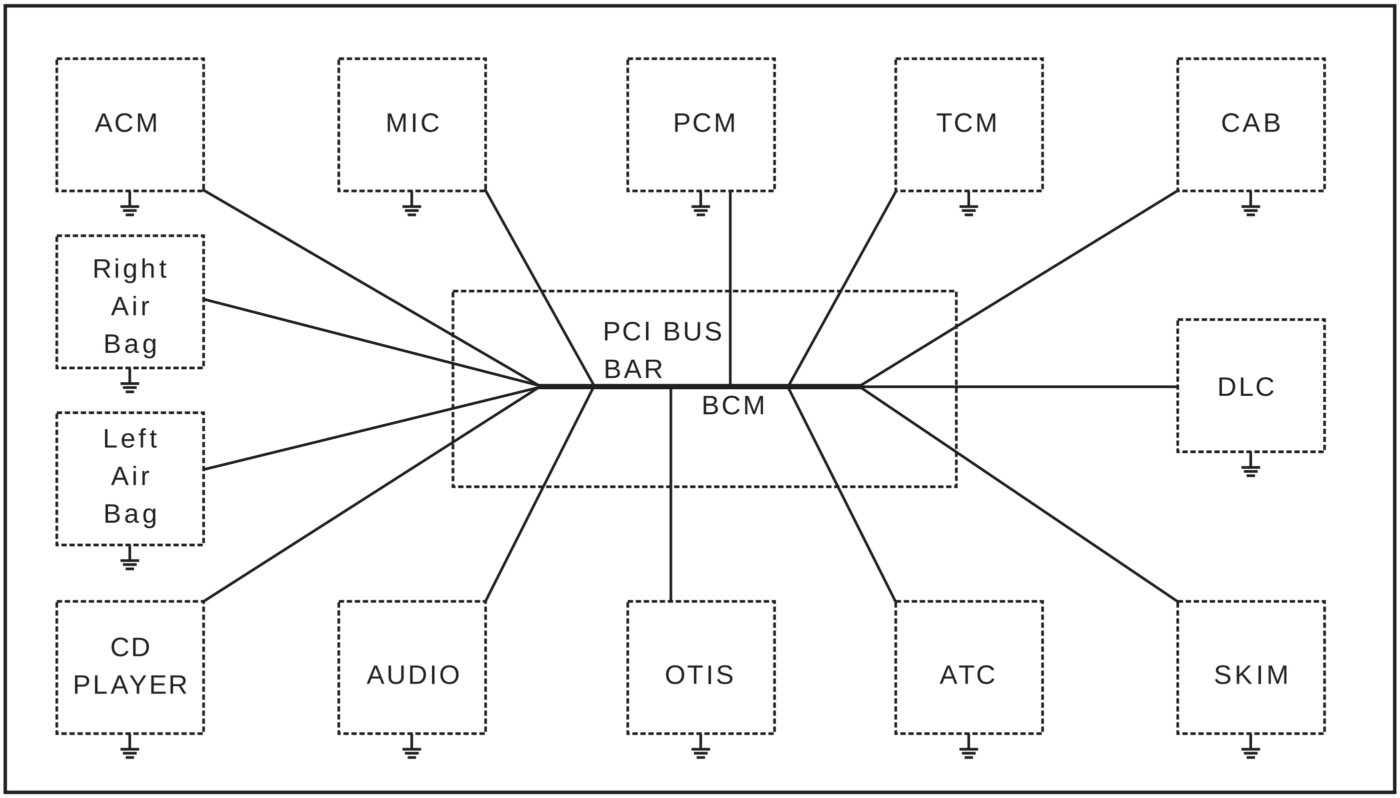


Figure 3

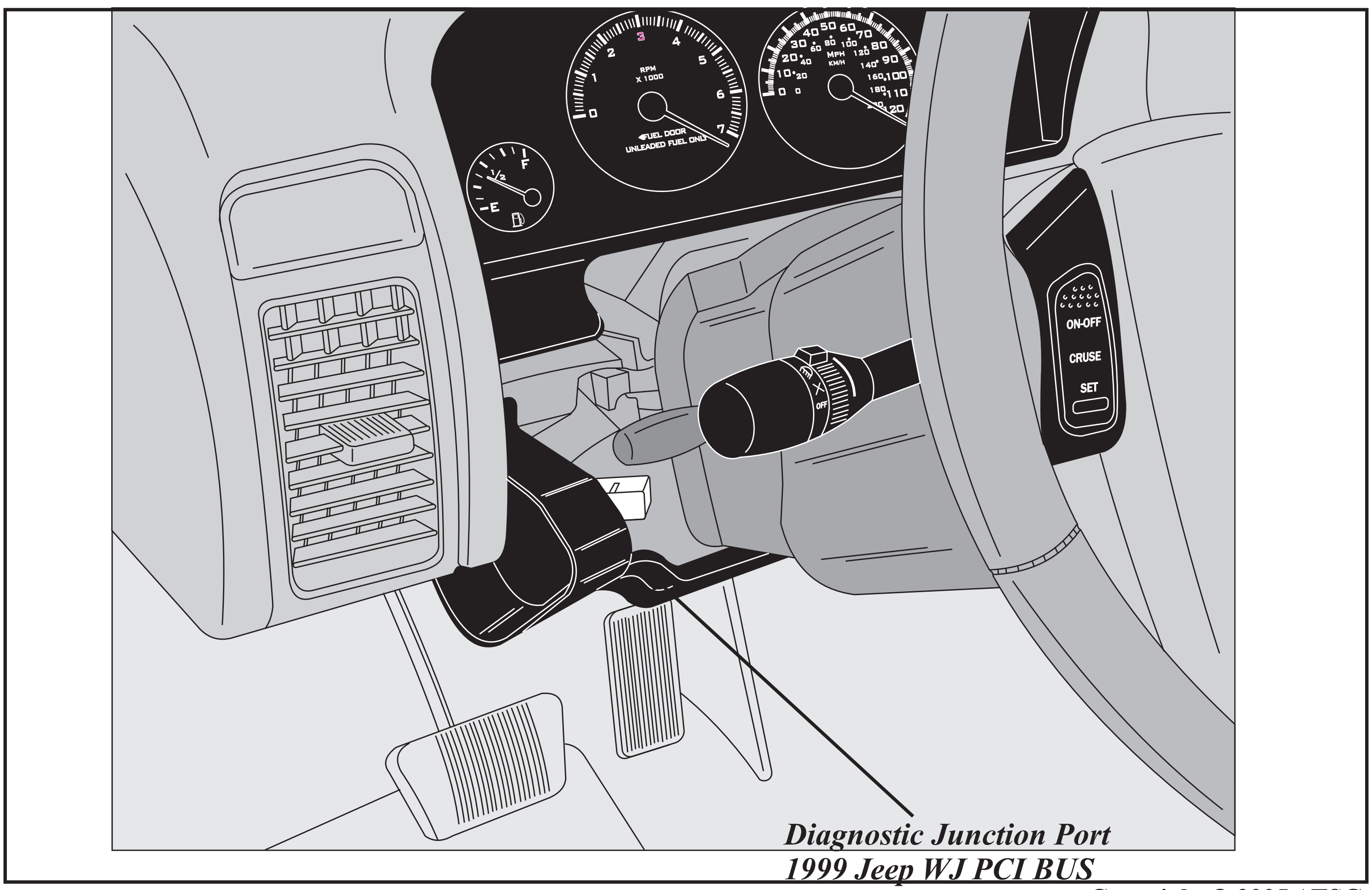


Figure 4

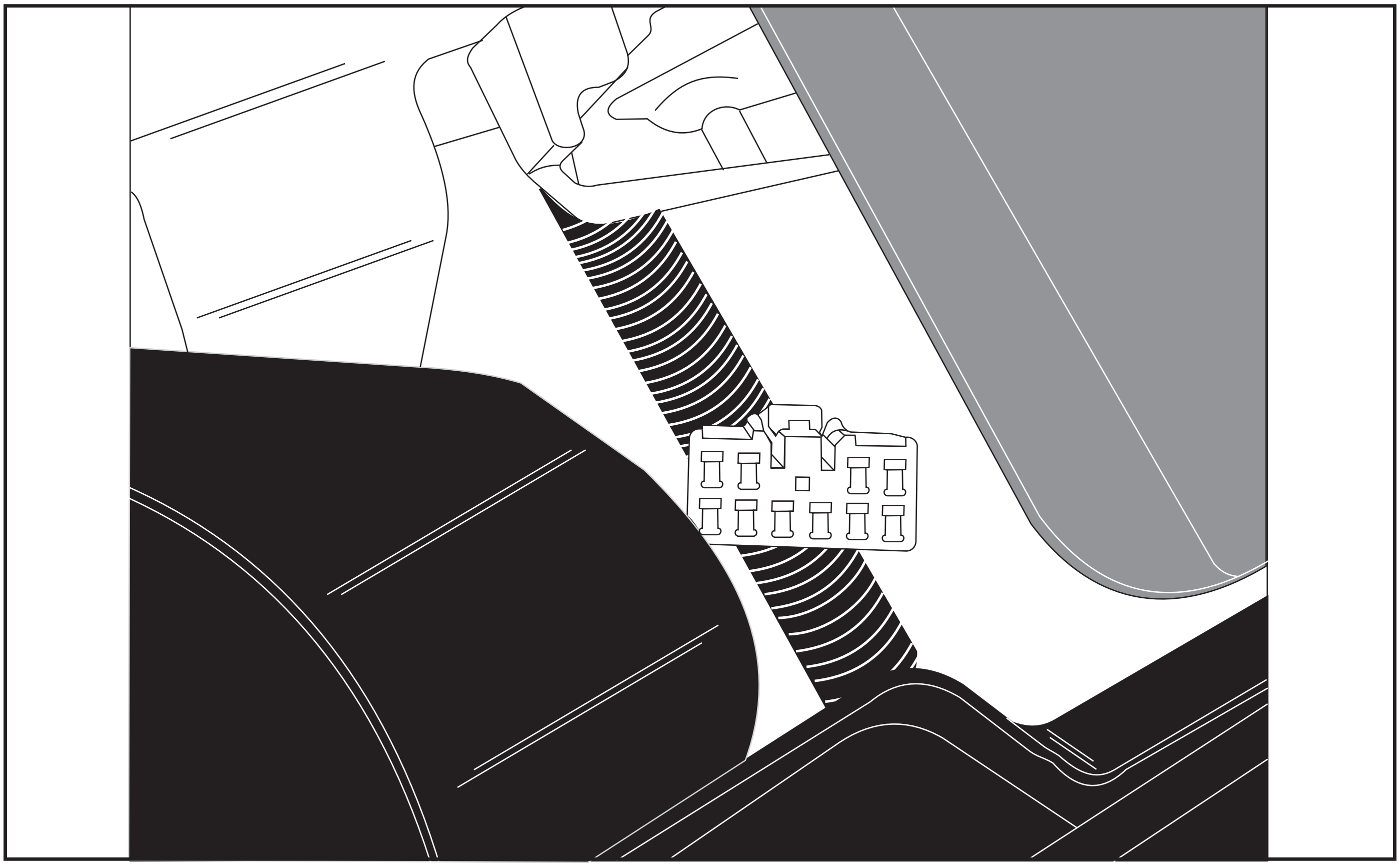


Figure 5

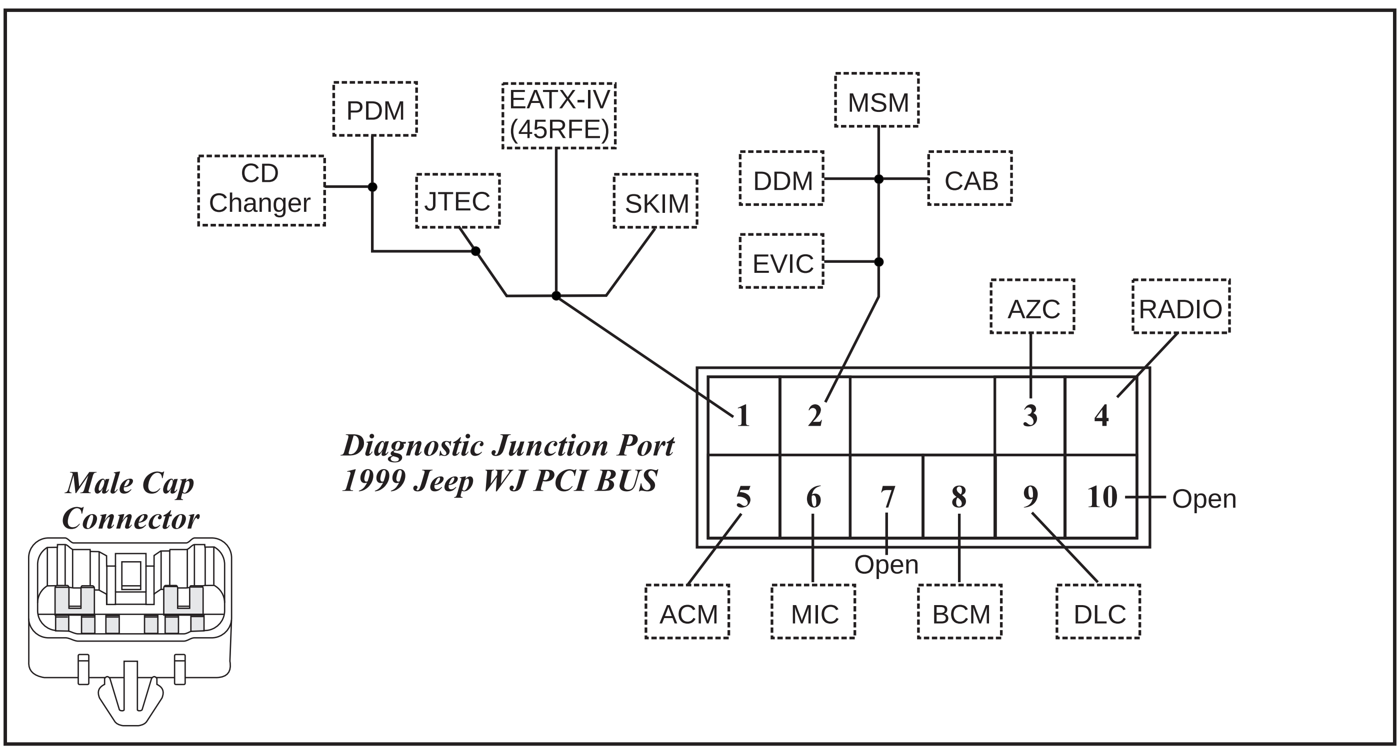


Figure 6

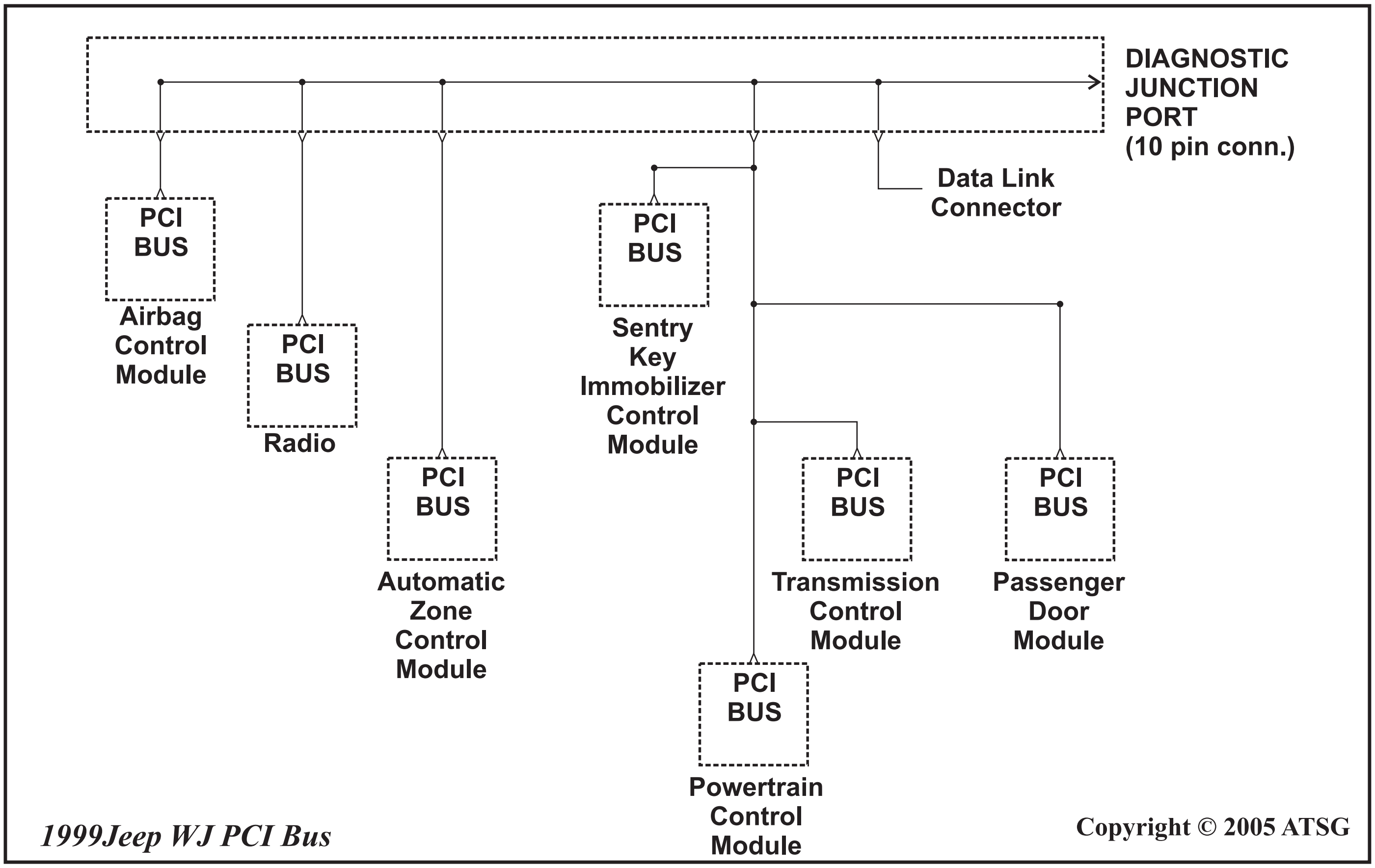

DIAGNOSTIC
JUNCTION
PORT
(10 pin conn.)
Data Link
Connector
PCI
BUS
Airbag
Control
Module
PCI
BUS
Radio
PCI
BUS
Automatic
Zone
Control
Module
PCI
BUS
Sentry
Key
Immobilizer
Control
Module
PCI
BUS
Transmission
Control
Module
PCI
BUS
Passenger
Door
Module
PCI
BUS
Powertrain
Control
Module
1999Jeep WJ PCI Bus
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Figure 7

Module	Approximate Termination Resistance (ohms)	Module	Approximate Termination Resistance (ohms)
Powertrain Control Module (All except 98 LH)	3,300	Body Control Module (All except 2002 WJ)	10,800
Powertrain Control Module (98 LH)	1,100	Body Control Module (2002 WJ)	8,000
Sentry Key Immobilizer Module	10,800	Data Link Connector	Open (11,400 with DRB III Connected)
Transmission Control Module	10,800	Passenger Door Module (99-01)	10,800
Controller Antilock Brake	10,800	Passenger Door Module (2002)	8,200
Radio (Premium)	10,800	Driver Door Module (99-01)	10,800
Compass Mini Trip Computer	10,800	Driver Door Module (2002)	8,200
Left-side Impact Airbag Control Module	10,800	Memory Head Set Module	10,800
Right-side Impact Airbag Control Module	10,800	Electronic Vehicle Information Center (CMTC, Traveler)	10,800
CD Changer	10,800	Automatic Zone Control (HVAC/ATC Control Heads)	10,800
Occupant Restraint Controller	10,800	Transfer Case Control Module	10,800
Mechanical Instrument Cluster (All except 98 LH & WJ)	3,300	Front Control Module	10,800
Mechanical Instrument Cluster (98 LH)	10,800	Rain Sensor	10,800
Mechanical Instrument Cluster (99-01 WJ)	2,400	Adjustable Pedal Module	10,800
Mechanical Instrument Cluster (02 WJ)	1,200	Intrusion Sensor (BUX)	10,800

Figure 8

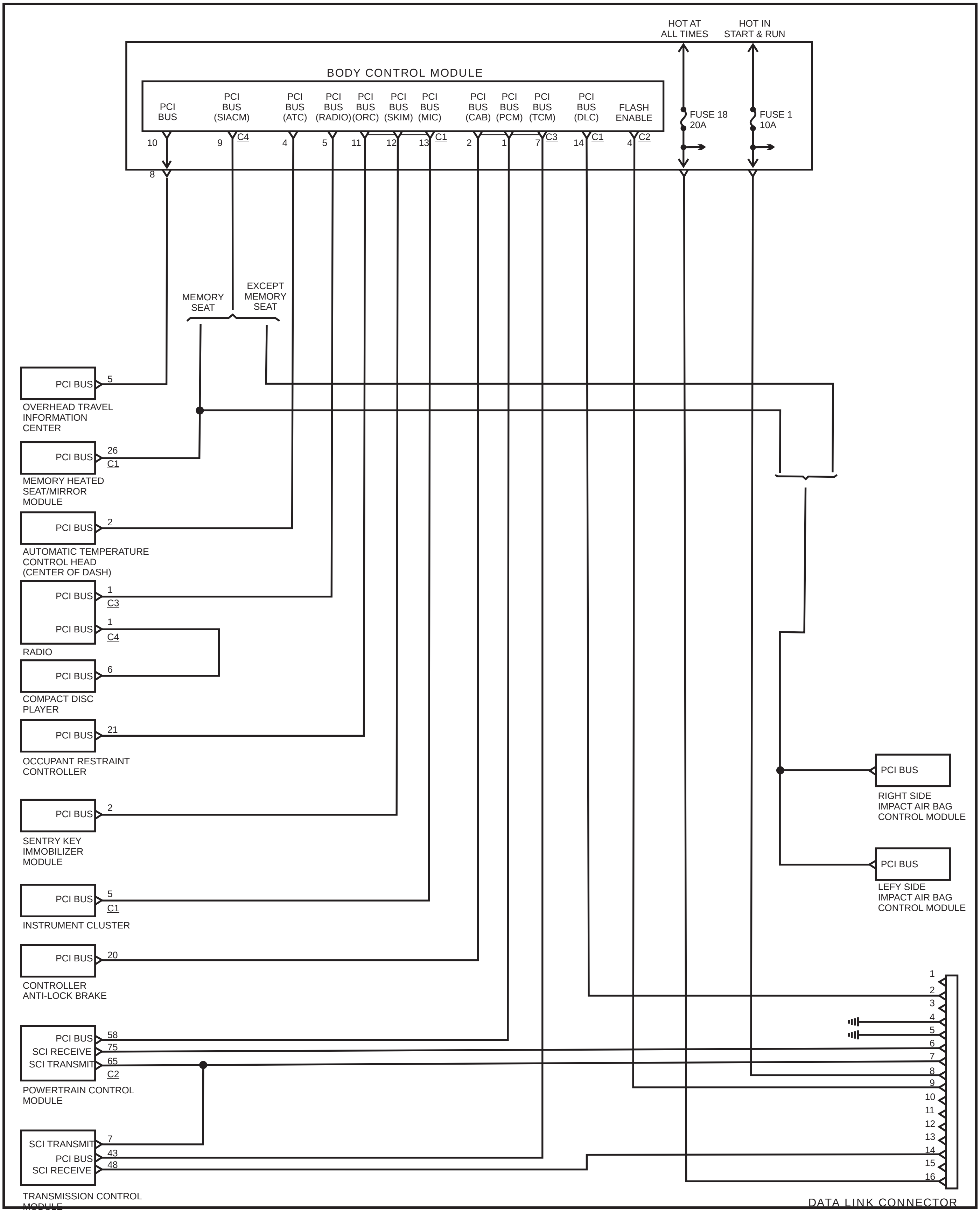

HOT AT ALL TIMES
HOT IN START & RUN
BODY CONTROL MODULE
PCI BUS
PCI BUS (SIACM)
PCI BUS (ATC)
PCI BUS (RADIO)
PCI BUS (ORC)
PCI BUS (SKIM)
PCI BUS (MIC)
PCI BUS (CAB)
PCI BUS (PCM)
PCI BUS (TCM)
PCI BUS (DLC)
FLASH ENABLE
FUSE 18 20A
FUSE 1 10A
MEMORY SEAT
EXCEPT MEMORY SEAT
PCI BUS
OVERHEAD TRAVEL INFORMATION CENTER
MEMORY HEATED SEAT/MIRROR MODULE
AUTOMATIC TEMPERATURE CONTROL HEAD (CENTER OF DASH)
RADIO
COMPACT DISC PLAYER
OCCUPANT RESTRAINT CONTROLLER
SENTRY KEY IMMOBILIZER MODULE
INSTRUMENT CLUSTER
CONTROLLER ANTI-LOCK BRAKE
SCI RECEIVE
SCI TRANSMIT
POWERTRAIN CONTROL MODULE
TRANSMISSION CONTROL MODULE
RIGHT SIDE IMPACT AIR BAG CONTROL MODULE
LEFY SIDE IMPACT AIR BAG CONTROL MODULE
DATA LINK CONNECTOR

Figure 9

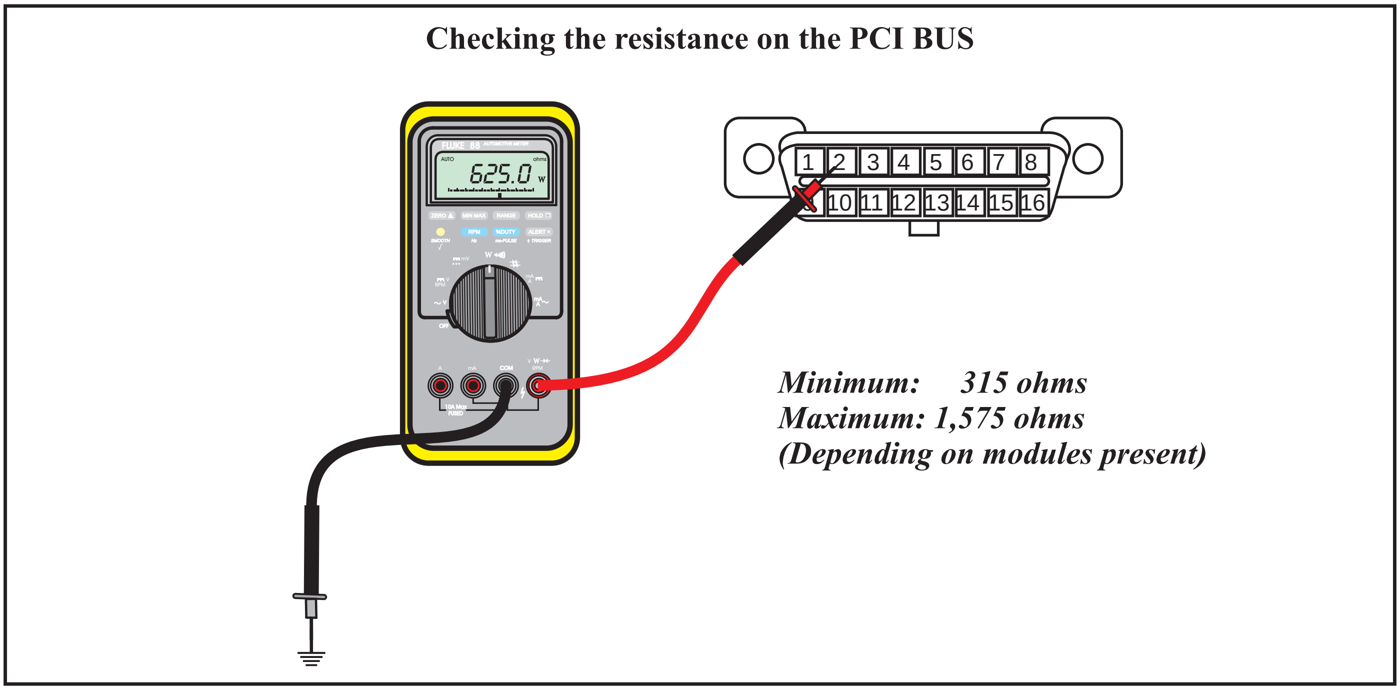


Figure 10

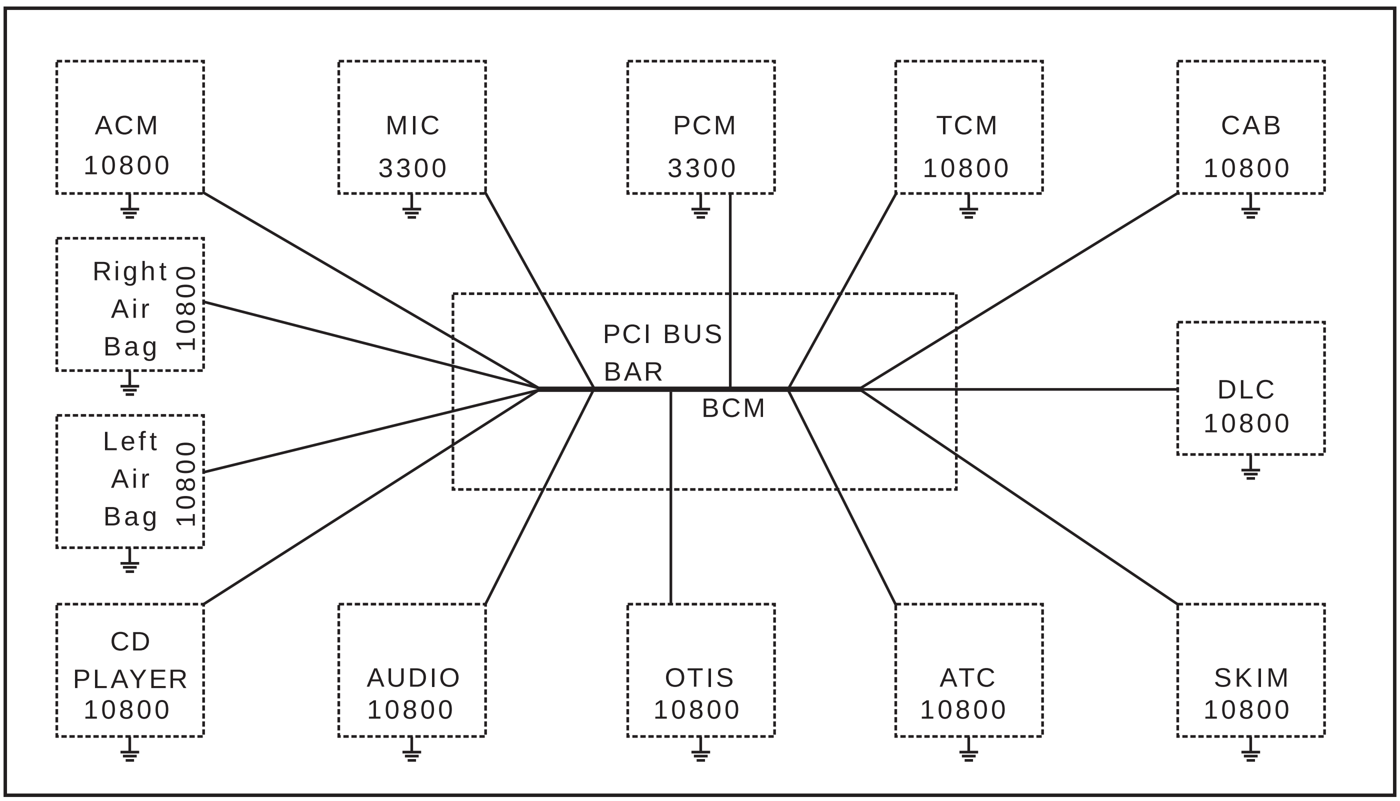


Figure 11

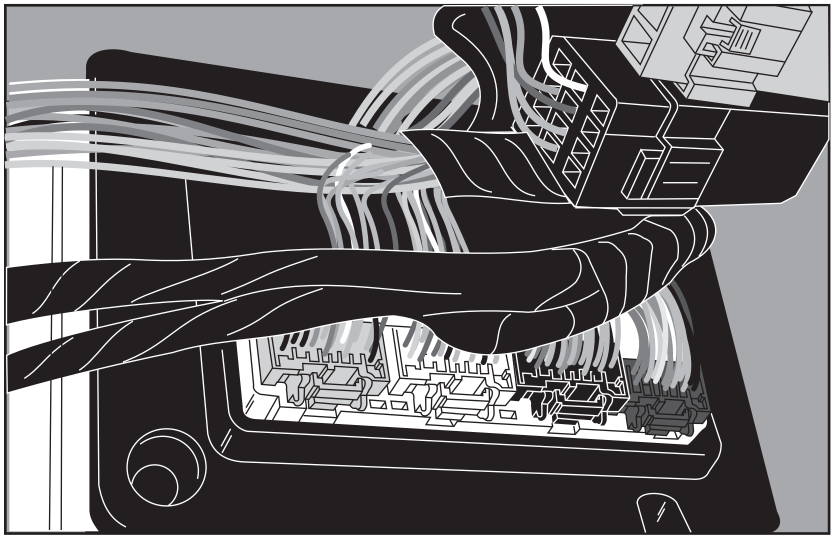
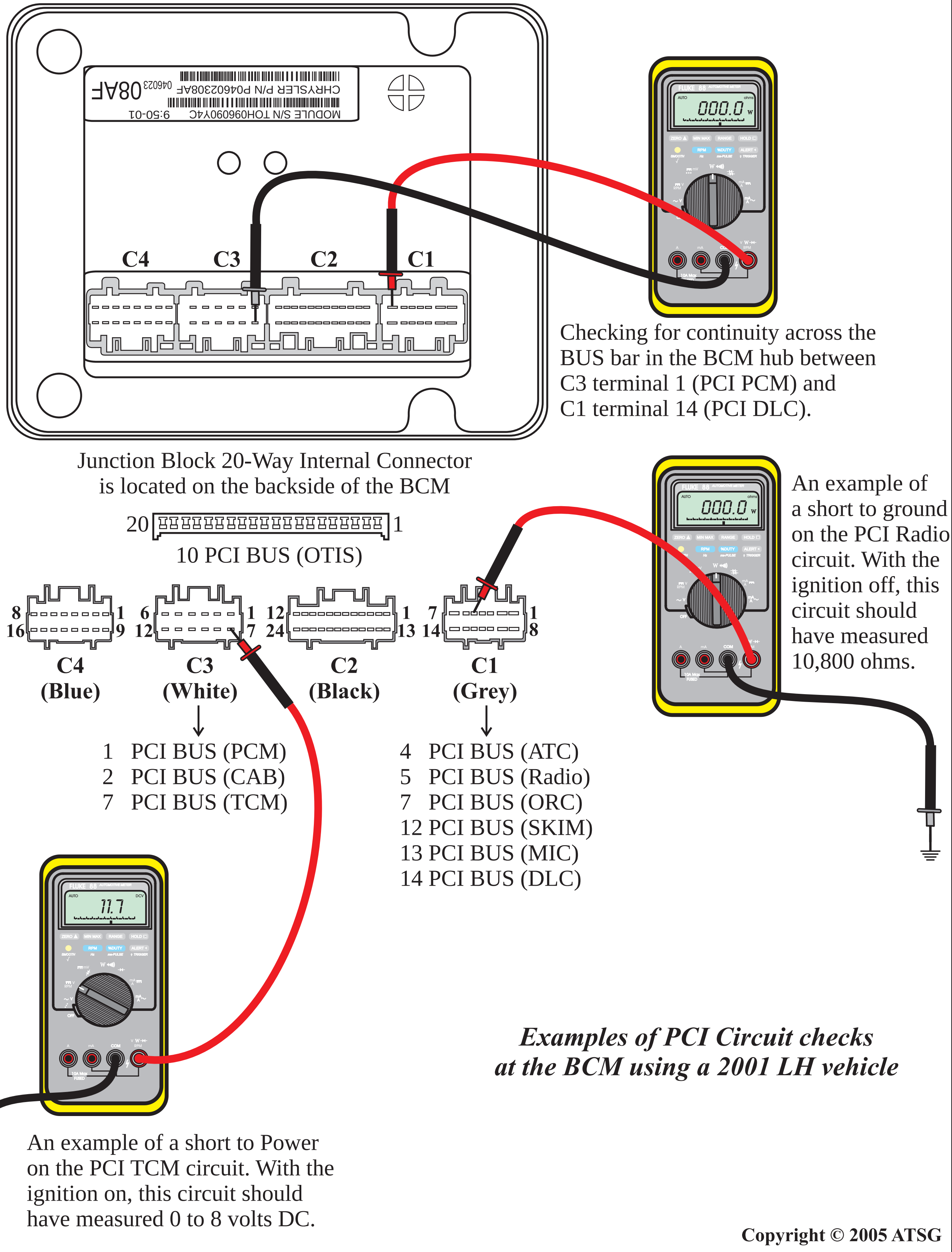


Figure 12



Examples of PCI Circuit checks at the BCM using a 2001 LH vehicle

Figure 13

2004 NEON

PCI BUS QUICK TEST

COMPLAINT: One or more modules not communicating on the PCI Bus or the entire Bus is down.

CAUSE: For individual modules not communicating on the PCI Bus system, suspect that module is either not being powered up, or there is an open PCI bus wire to that module or the module is defective. If the entire system is down, the Bus wire is either shorted to power or ground.

CORRECTION: A quick test that can be performed is to add up all the modules on the Bus and check the resistance of all the modules terminating resistors at the DLC. With this particular vehicle, there are a total of 8 modules on the Bus system (See Figure 14). 2 of the modules have 3,300 ohms while the other 6 have 10,800 ohms. There is a mathematical equation for ***equivalent*** resistance in a parallel circuit where the equivalent resistance is added up and divided into 1 as provided in figure 15. Since we have two 3300 ohm modules and 6 10800 ohm modules, we do not have equivalent numbers to add up to be divided into 1. To acquire that number we would take the two modules that measure 3300 ohms each and the six modules that measure 10800 ohms each and turn them into fractions: 2/3300 + 6/10800. Before they can be added together these fractions need to be simplified: 1/1650 + 1/1800. Now divide the denominator into the numerator and this is what you get: 0.0006 + 0.00056 = 0.00116. It is this number that can be divided into 1 which equals a total of 862 ohms. This is the total resistance of all the modules in the Neon's PCI Bus circuit and should be seen at the DLC terminal 2 (See Figure 16).

If this resistance check shows near 0 ohms the system may be shorted to ground.
If the resistance reads higher, one or more of the modules have lost its ground.
If the resistance checks good, switch your meter to DC volts and turn the ignition on and recheck terminal 2 in the DLC. A minimum of 0 to 1.5 volts to a maximum of 6.25 to 8 volts should be observed. Anything substantially above 8 volts the circuit is shorted to power.

If there is a code specifying the module that is failing, check that module's power source and ground path as well as the terminating resistor at the module itself. Many times, just unplugging and cleaning the connector resolves the problem.

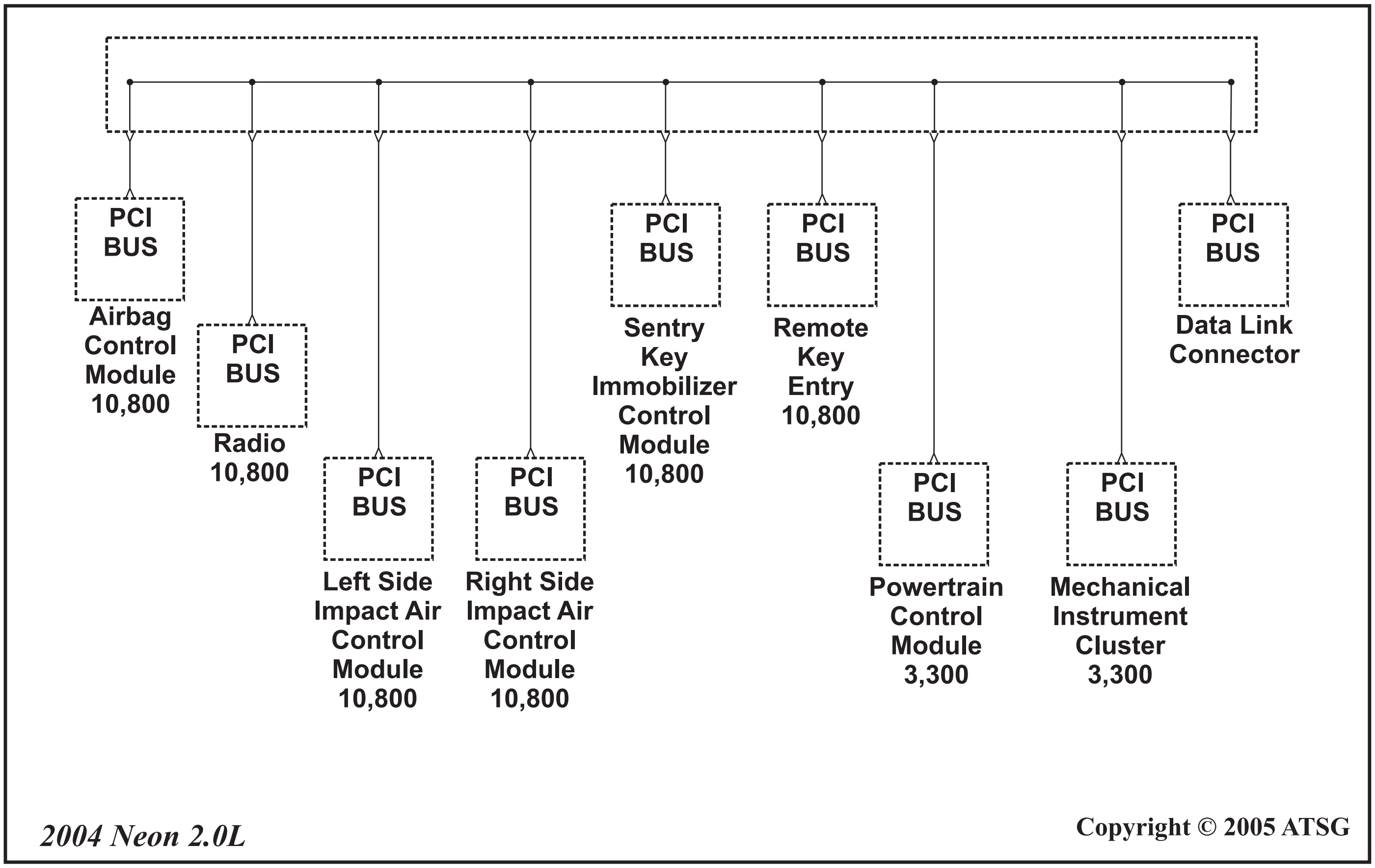


Figure 14

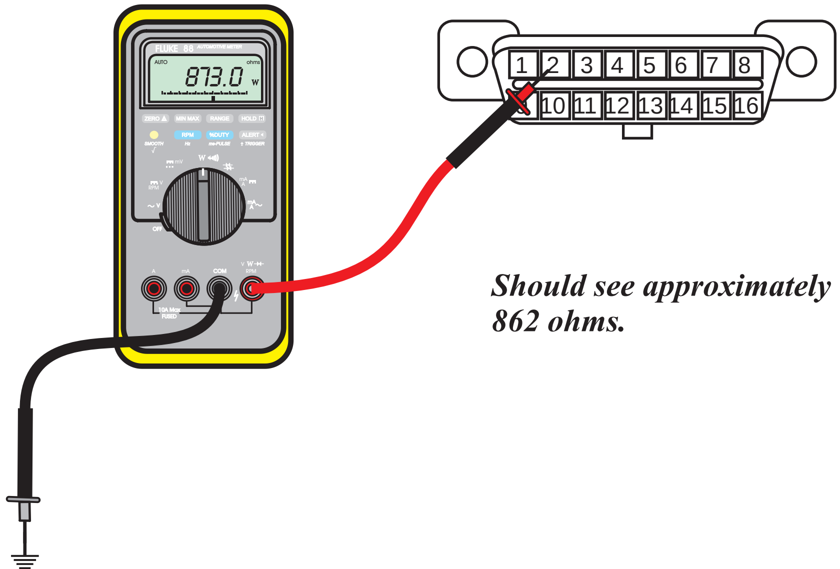
$$\frac{1}{\frac{1}{3300}+\frac{1}{3300}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}+\frac{1}{10800}} = 862 \text{ ohms}$$

To simplify this equation you could set the equation up as follows:

$$\frac{1}{\frac{2}{3300}+\frac{6}{10800}} = \frac{1}{\frac{1}{1650}+\frac{1}{1800}} = \frac{1}{0.0006+0.00056} = \frac{1}{0.00116} = 862 \text{ ohms}$$

Figure 15

Checking the resistance on the PCI BUS



Should see approximately 862 ohms.

2004 Neon 2.0L

Figure 16