SERVICE TRAINING COURSE MXAD
MULTIPLEX ADVANCED DIAGNOSTICS

ISSUE 2

This publication has been revised from its previous printing as follows:

- The Section "MULTIPLEX ELECTRICAL SYSTEMS" has been revised and is now called simply "MULTIPLEXING"..
- A new Section, "XJ/XK", has been added.
- The "S-TYPE" Section has been revised.
- A new Section, "X-TYPE", has been added.

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INTRODUCTION

Most Jaguar Service Training courses concentrate on the technical details of a specific vehicle system; how the components function and how to determine if the system is functioning correctly. Advanced Diagnostics courses have a different focus; they concentrate on the process used to diagnose faults. They are for professionals who already have practical knowledge and experience in the systems covered by the Jaguar core courses.

We have all developed diagnostic techniques that we use on a regular basis and this course provides the opportunity to examine and further develop these techniques and share them with other technicians.

To get the most from Advanced Diagnostic training, you should practice the structured diagnostic process that will be presented and apply some critical thought to the process that you use. Time spent developing your diagnostic techniques here will be paid back as you solve problems more efficiently at the dealership. Combining the structured diagnostic process with your existing experience will result in:

- More effective troubleshooting
- More “fixed right the first time” repairs
- More confidence in the repair

Most importantly, the enhancement of your diagnostic skills will increase customer loyalty and promote your professional image.

NOTES

MULTIPLEX ADVANCED DIAGNOSTICS

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MULTIPLEXING

Multiplex Networks

Automotive Multiplex System Classification

Multiplex systems are classified as follows:

- Class A transmits up to 10,000 bits of data per second (10 K baud)
- Class B transmits up to 125,000 bits of data per second (10 – 125 K baud)
- Class C transmits over 125,000 bits of data per second (125 K baud)
- Digital data networks transmits over 5.6 million bits of data per second (5.6 M baud)

Communication Protocols

All Jaguar models use 2 multiplex networks (CAN, SCP) consisting of 2 separate circuits (busses) that operate at different speeds and communicate using different protocols (languages). In addition, there are 2 more networks, which are only used for entertainment and telematics systems (ACP, D2B), one using a bus system similar to the CAN or SCP and the second using fiber optics.

The CAN network (Controller Area Network)
The CAN network is a high speed “real time” bus connecting several Powertrain control modules depending on the model.

The SCP network (Standard Corporate Protocol network)
The SCP network is a lower speed bus connecting the body system modules.

The ACP network (Audio Communication Protocol network)
The ACP network is fitted on XJ, XK and S-TYPE vehicles. It is used for the in-car entertainment system, voice and phone.

The D2B network (Digital Data Bus network)
This network is used on the X-TYPE and it is used for the audio, phone and voice systems.

Serial Communications

Additional serial communications circuits allow WDS diagnosis of non-multiplexed control modules via the DLC (Data Link Connector). The additional serial communication links perform the same function as on previous models. The links are often referred to as ISO (International Standards Organization) links because they conform to the ISO 9141 standard and the SAE (Society of Automotive Engineers) standard J1978.

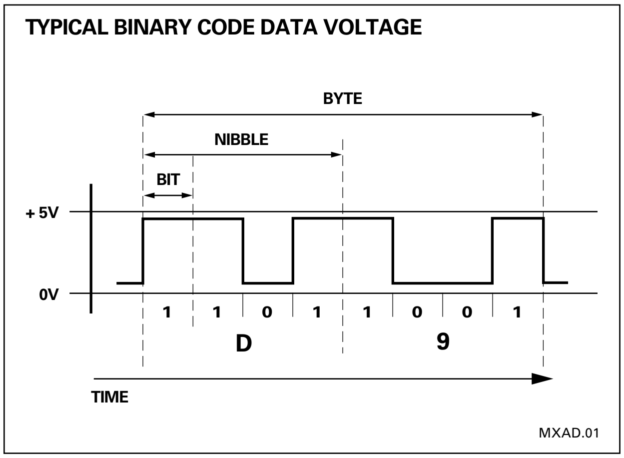
Communication Speed Summary

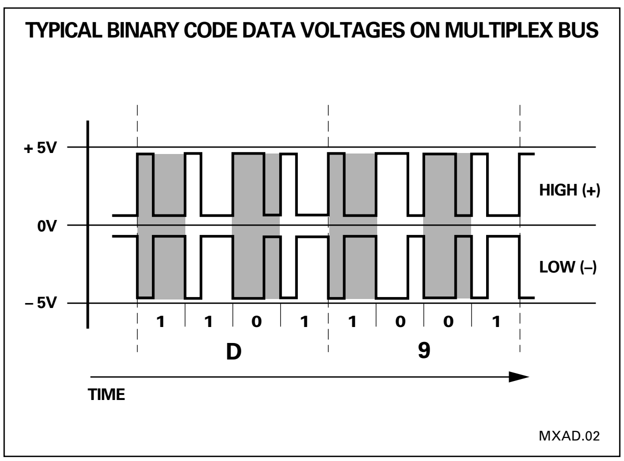
System	Class	Speed
CAN Network	C	500 K baud
SCP Network	B	41.6 K baud
Serial Data Link (ISO 9141)	B	10.4 K baud
D2B Network	N/A	5.6 M baud
ACP Network	A	9.6 K baud

NOTES

MULTIPLEXING

Multiplex Networks (continued)





Data Messages

Data messages are binary code values transmitted as a series of timed voltage signals on the multiplex bus. A five-volt signal is assigned a value of 1 and a zero-volt signal is assigned the value of 0. Each binary code 1 or 0 is called a bit. Four binary code data bits (called a nibble) make up one character. Eight data bits (called a byte) make up two characters.

Jaguar uses a “time divided” multiplex system that distinguishes the serial bits of binary code (1’s and 0’s) by the amount of time that the signal is high or low.

Data Message Transmission

The multiplex bus consists of two wires, one high (+) and the other low (-). When a module transmits a bit, it drives the voltage on one wire high and the voltage on the other wire low. The bus wires are twisted so that the opposing high and low voltages cancel any possible electromagnetic interference.

Binary code values can be converted by a decimal or hexadecimal decoding system so they can be understood as alpha or numeric characters.

Binary	Decimal	Hexadecimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7

Binary	Decimal	Hexadecimal
1000	8	8
1001	9	9
1010	10	A
1011	11	B
1100	12	C
1101	13	D
1110	14	E
1111	15	F

The binary code byte 11011001 translates as D9 when hexadecimal decoded or the number 139 when decimal decoded.

NOTES

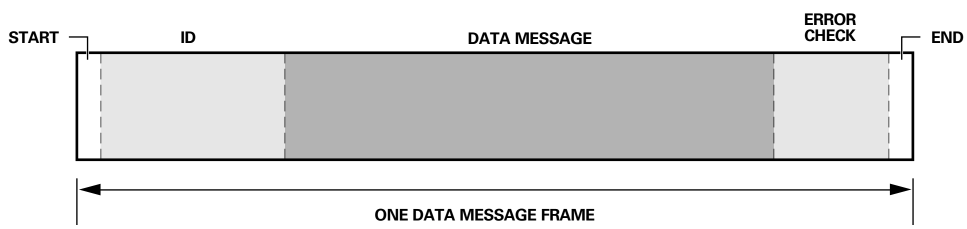
Data Message Frame

Data is transmitted on the bus in a data message “frame”. A frame contains a number of separate parts or fields that contain the following data:

- Start and end of the frame
- Frame identification (ID)
- Data message
- Error checking information

A complete data message frame is a serially transmitted stream of binary data 1’s and 0’s that each module can understand.

TYPICAL DATA MESSAGE “FRAME”



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Multiplex messages are communicated one at a time over the network bus. A bus can be compared to a single lane road and each data message frame to a vehicle. The capacity of the road is much greater than the maximum traffic at any one time so there is little possibility of one message frame colliding with another. In addition, each module constantly watches the network message traffic by monitoring the voltages on the bus. A module will not begin a communication until the bus is clear. If two modules attempt communication at the same instant, a method of “arbitration” assures that the message frame with the highest priority will always be communicated first. The module with the lower priority message frame will stop transmitting and try again when the bus is clear. Only one message frame will be transmitted on the bus at a time.

NOTES

MULTIPLEXING

CAN (Controller Area Network)

The CAN bus is two standard 0.5 mm copper wires twisted as a pair, with 40 twists per meter (39.37 in.). One wire of the pair is designated as CAN high (+) and the other is designated as CAN low (–). Although CAN appears wired as a series circuit, it is parallel because of internal module wiring. However, a fault in the internal wiring or connector can stop the network from communicating across the fault. But, each module will still continue to control its own functions by substituting default information for any missing data messages. Refer to the Electrical Guide Appendix pages for individual module messages.

CAN is called "real time" communication because its speed allows extremely fast response time for controlling time critical operations.

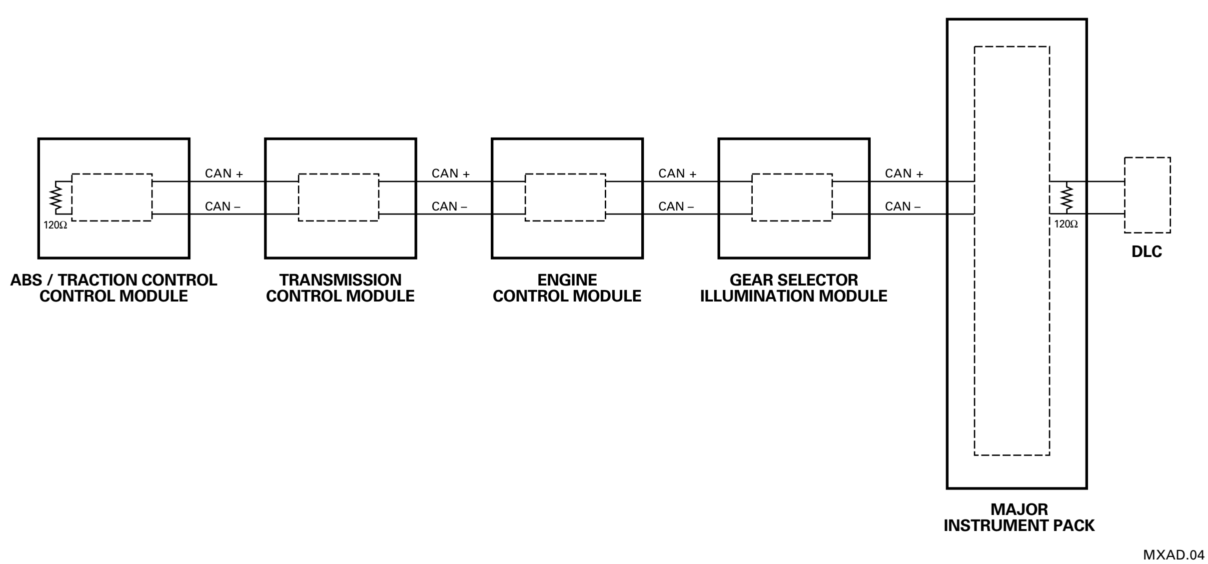
The following control modules communicate directly through the CAN network:
- Anti-lock braking / traction control module (ABS / TCCM)
- Engine control module (ECM)
- Transmission control module (TCM)
- Gear selector illumination module – does not transmit, used only for gear selector position illumination
- Instrument pack (INST)

The CAN network is also connected to the DLC (data link connector) for diagnostics.

CAN does not communicate directly with SCP. However, the INST converts specific message data allowing communication between networks.

NOTE: All modules have fail safe default modes in the event of a network failure.

CAN MULTIPLEX CIRCUIT LAYOUT: XK AND NORMALLY ASPIRATED XJ



CAN Data Message Frames

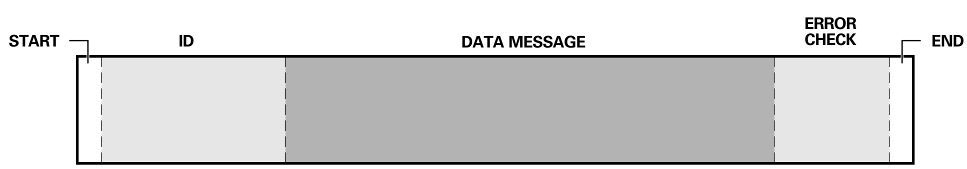
CAN data message frames generally contain more data than SCP message frames. CAN message frames are transmitted at intervals of from 4 to 20 ms depending on the message. The data is available to all modules but is only "used" by those modules that require it.

Each CAN module transmits three types of data message frames.

- Token data message frames (cyclical transmission) – The token message tells the network that the module is "alive."
- Diagnostic data message frames (request transmission) – The diagnostic message is a response to a WDS request for specific diagnostic information.
- Vehicle operation data message frames (cyclical transmission) – The vehicle operation message contains the vehicle operational information from the module.

Modules transmit more than one vehicle operation data frame because the amount of data from the module exceeds the capacity of a single data frame. The ID (identification) field of each CAN message frame not only identifies the transmitting module, it also identifies the type of data and its precise location within the frame's data message field.

TYPICAL CAN DATA MESSAGE FRAME



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Examples of vehicle operation data messages:

The ABS / TC CM transmits three separate vehicle operation data message frames. One message frame contains the data required for traction control and automatic stability control functions, vehicle speed, and distance traveled. Another message contains vehicle speed, distance traveled, traction control and automatic stability control status. The remaining frame contains the individual wheel speed data

The number of separate data frames a module transmits depends on the module design and the amount of data that needs to be transmitted.

The following separate vehicle operation message frames are cyclically communicated on the CAN bus:

- ABS Data
- ABS Data
- ABS Data
- TCM Data
- TCM Data
- ECM Data
- ECM Data
- ECM Data
- INST Data

In addition, one token message is transmitted by each module and each module responds to WDS interrogation with its diagnostic message.

MULTIPLEXING

SCP (Standard Corporate Protocol) Network

The SCP bus is two standard 0.5 mm (0.020 in.) copper wires twisted together with 40 twists per meter (approximately one twist per inch). One wire in the bus is designated as SCP high (+) and the other is designated as SCP low (-). The network is wired as a “star” circuit. This method of wiring keeps the network bus as short as possible and allows the rest of the system to continue communication should one module fail. Bus integrity is maintained by using the vehicle speed data message as a “keep alive” signal. If a module does not receive the “keep alive” message, the module assumes a fault and takes itself off line.

SCP Data Message Frames

Each SCP data message frame is a complete message unit communicating only the data for one action. Messages on the bus are available to all of the modules connected to the bus but are only “used” by a module if required. There are three general types of SCP data messages:

Cyclical messages
Cyclical messages are transmitted on the bus at specified intervals. *VEHICLE SPEED*, *ENGINE RUNNING* and *CHARGING OK* are examples of three separate cyclical messages that are transmitted by the INST at least every 150 ms.

Event messages
Event messages are sent once, or for a specified number of times, when something happens. *KEY IN IGNITION* is a message sent by the BPM. The message is transmitted when the key is put into the ignition switch. When the key is withdrawn from the switch, *KEY NOT IN IGNITION* is sent by the BPM. Event messages are often used to “toggle” a function ON and OFF through other modules.

Request messages
Request messages ask for a specific piece of data. An example of a request message is *REQUEST KEY-IN STATUS* sent by the SLCM, DDCM or PDCM. The BPM then responds with a key status message – either *KEY IN IGNITION* or *KEY NOT IN IGNITION*.

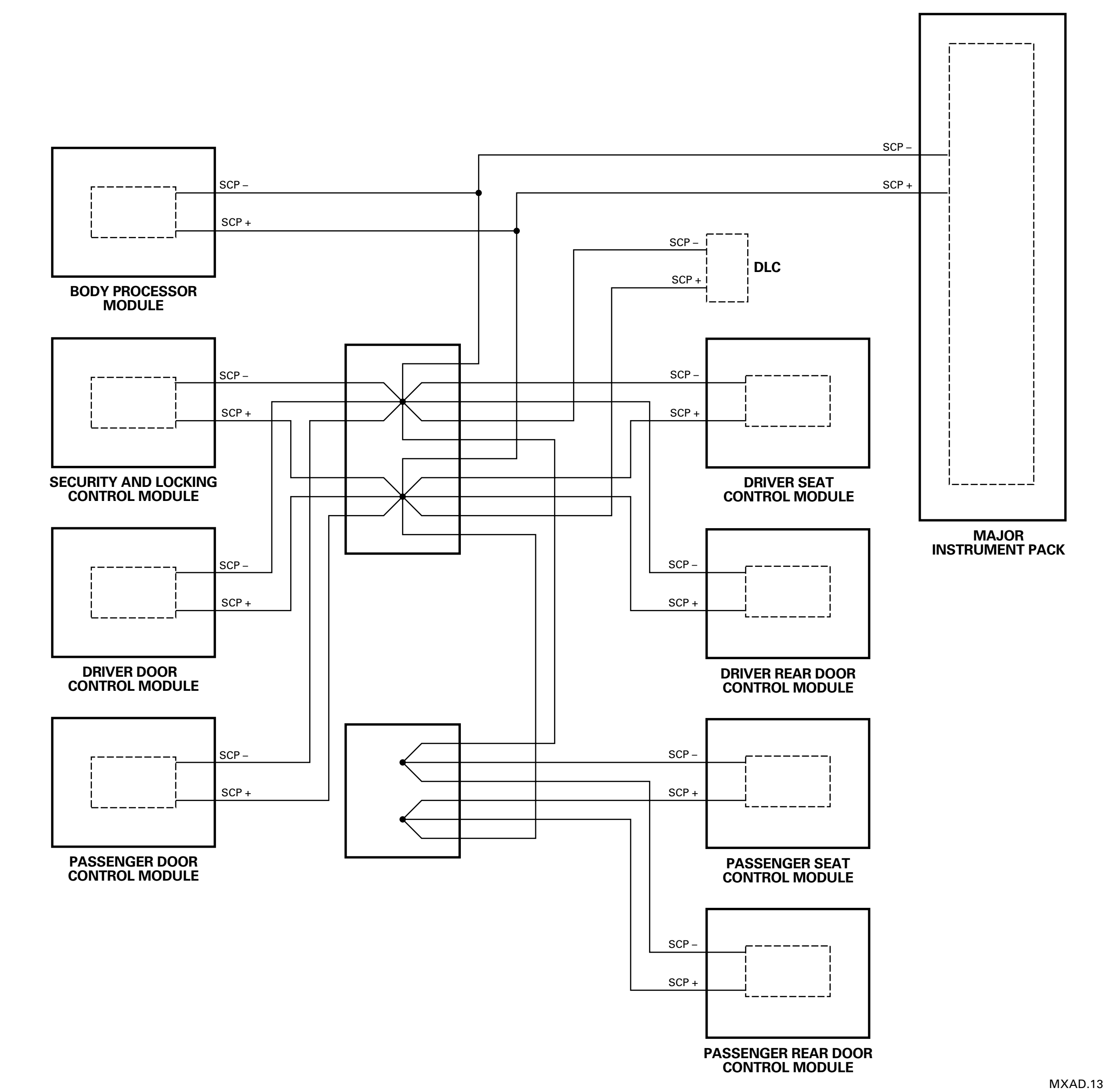
Refer to the applicable Electrical Guide Appendix for individual module messages.

SCP cannot communicate directly with CAN. However, the INST converts specific message data allowing communication between networks.

NOTE: All modules have fail safe default modes in case of a network failure.

NOTES

SCP MULTIPLEX CIRCUIT: XJ



NOTES

MULTIPLEXING

SCP Network (continued)

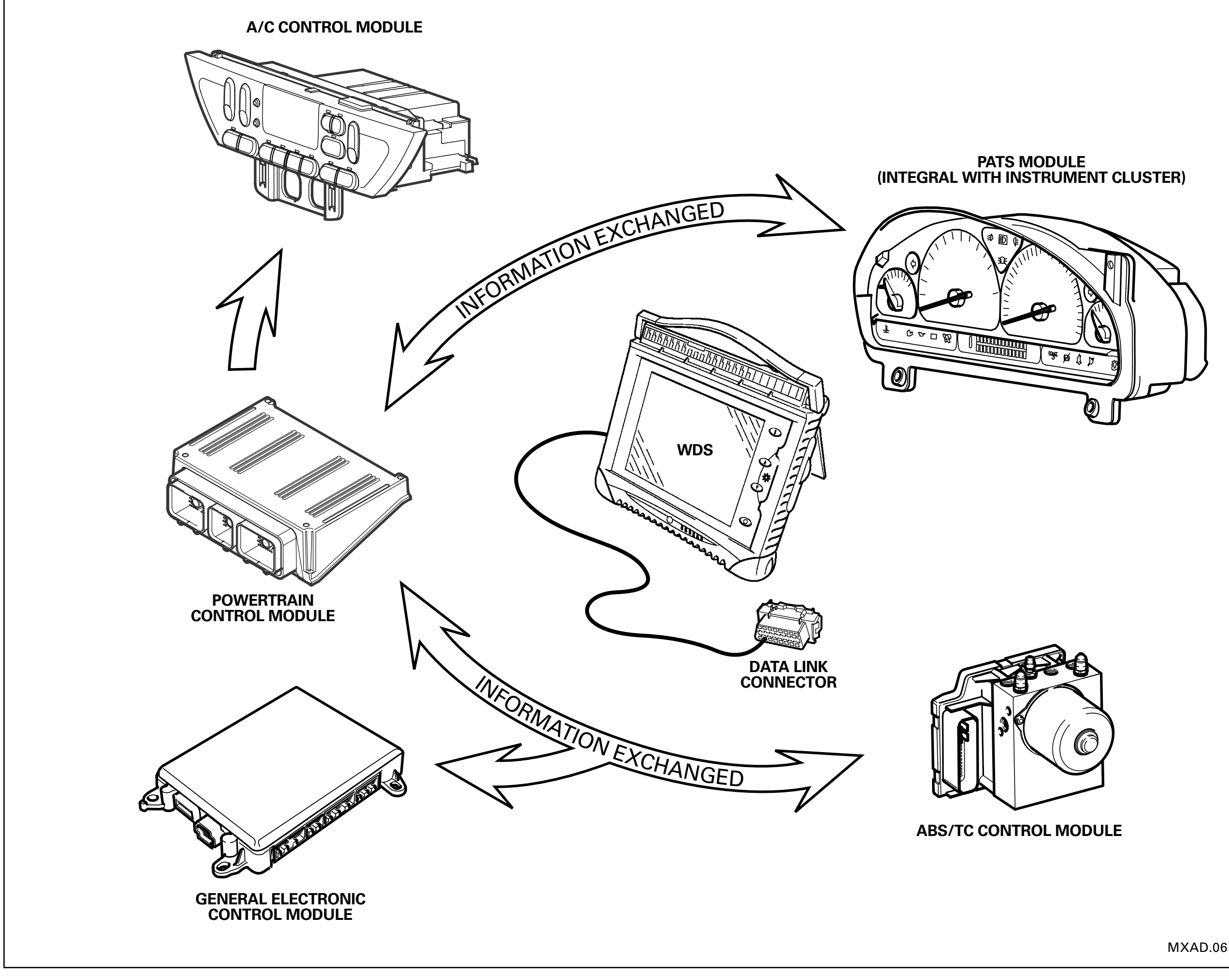
During normal operation SCP networks allow the electronic control modules linked to the network to exchange information directly with each other. For example, on some vehicles the Powertrain Control Module (PCM) supplies the A/CCM with engine temperature information. This allows the A/CCM to consider engine temperature when activating the heater blower motor.

Input data that is received by one control module can be broadcast to any other module through the data bus. An example of this is the Anti-Lock Brake System / Traction Control Control Module broadcasting vehicle speed to the PCM for engine operation strategy, and the suspension module, which uses the information to set correct ride height and firmness for changing driving conditions.

A module may also request information from another module on the network. For example, the PCM requests an all-clear message from the Passive Anti-Theft System (PATS) module before allowing the engine to run.

WDS is used to retrieve DTCs, monitor input and output data, and activate control module outputs on the SCP network.

SCP NETWORK OPERATION

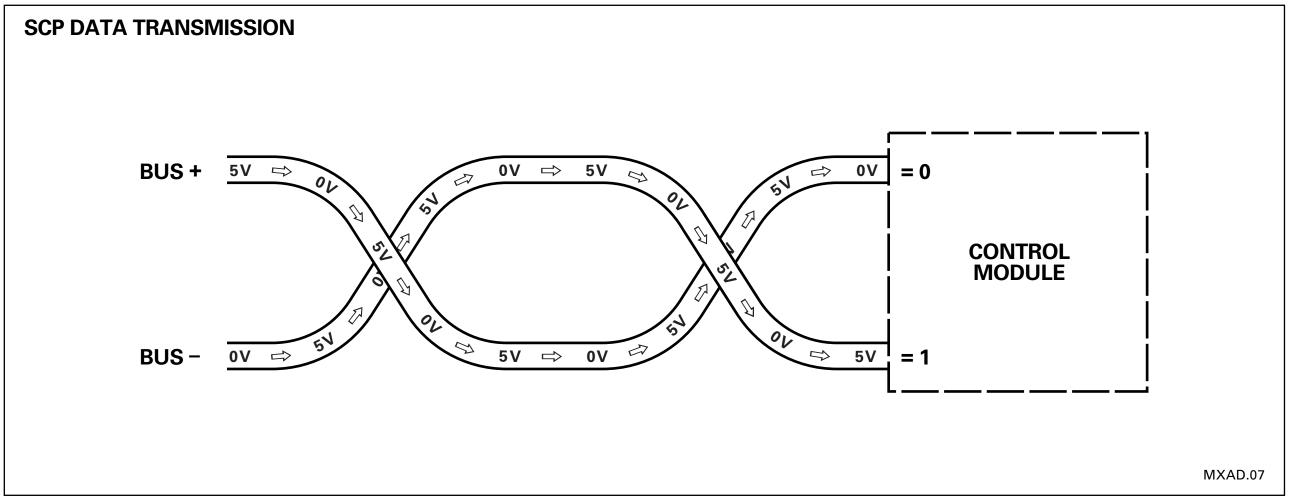


Network Protocol

Standard Corporate Protocol (SCP) enables the network to communicate using electric signals over a data bus. The wires in this data bus are twisted to help resist electromagnetic interference.

- The data bus wires are designed Bus + and Bus – .
- Electrical impulses vary between 5.0 volts and zero volts to represent a digital logic “1” or “0”.
- When there are no messages, Bus + is 5.0 volts and Bus – is zero volts.
- When messages are being sent, the readings are reversed.
- Data bus wires are usually identified in an Electrical Guide wiring diagram as circuits SCP (+) and SCP (-).

NOTE: Wires are not always shown as twisted pair in schematics.



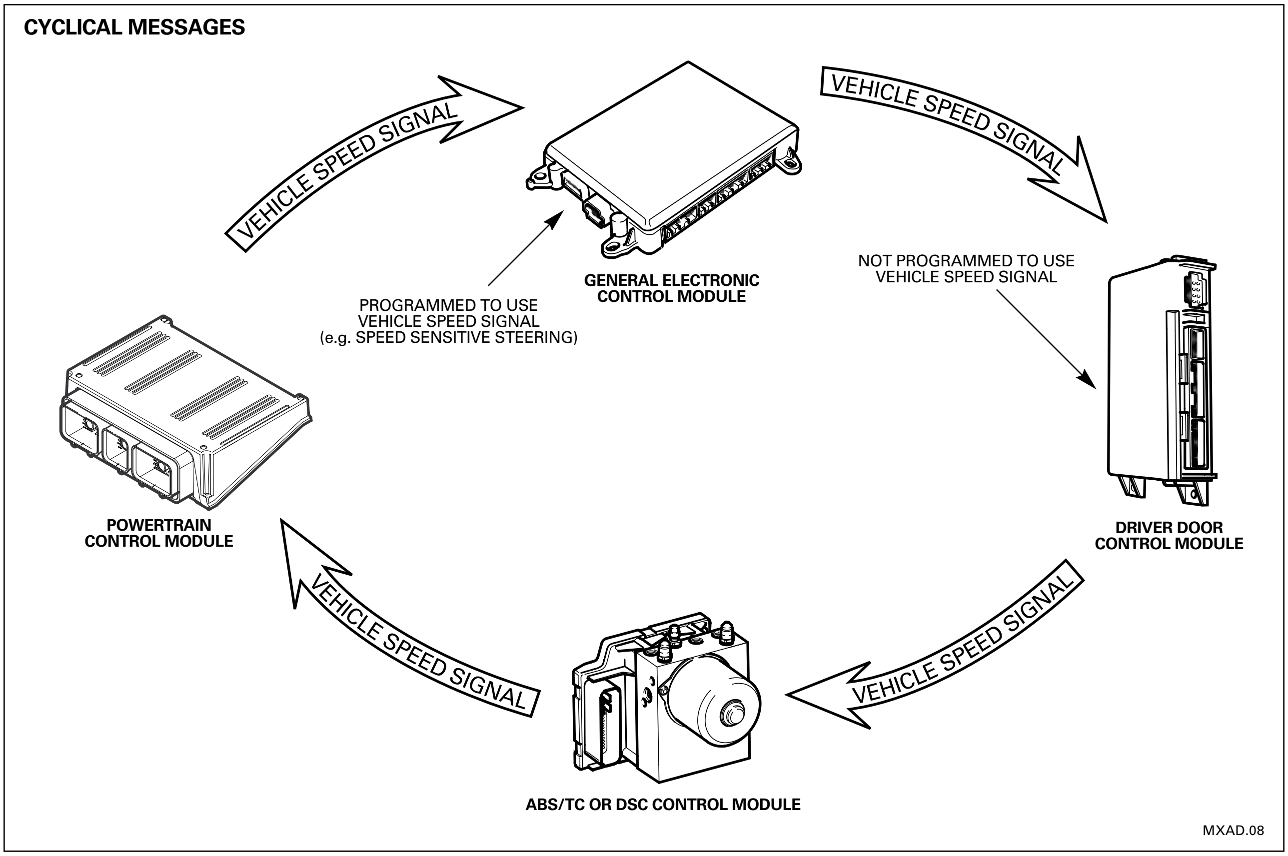
NOTES

MULTIPLEXING

SCP Network (continued)

Cyclical Messages

Each message broadcast on the SCP network is available to all modules, however, the message is only recognized by those modules programmed to use it. This type of message is called a Cyclical Message. For example, the ABS/TC or DSC Control Module broadcasts vehicle speed data at regular intervals over the network. All control modules connected to the network receive the data. But only those control modules that have a use for the data (and have the "Vehicle Speed" address programmed into them) will understand and use the data.

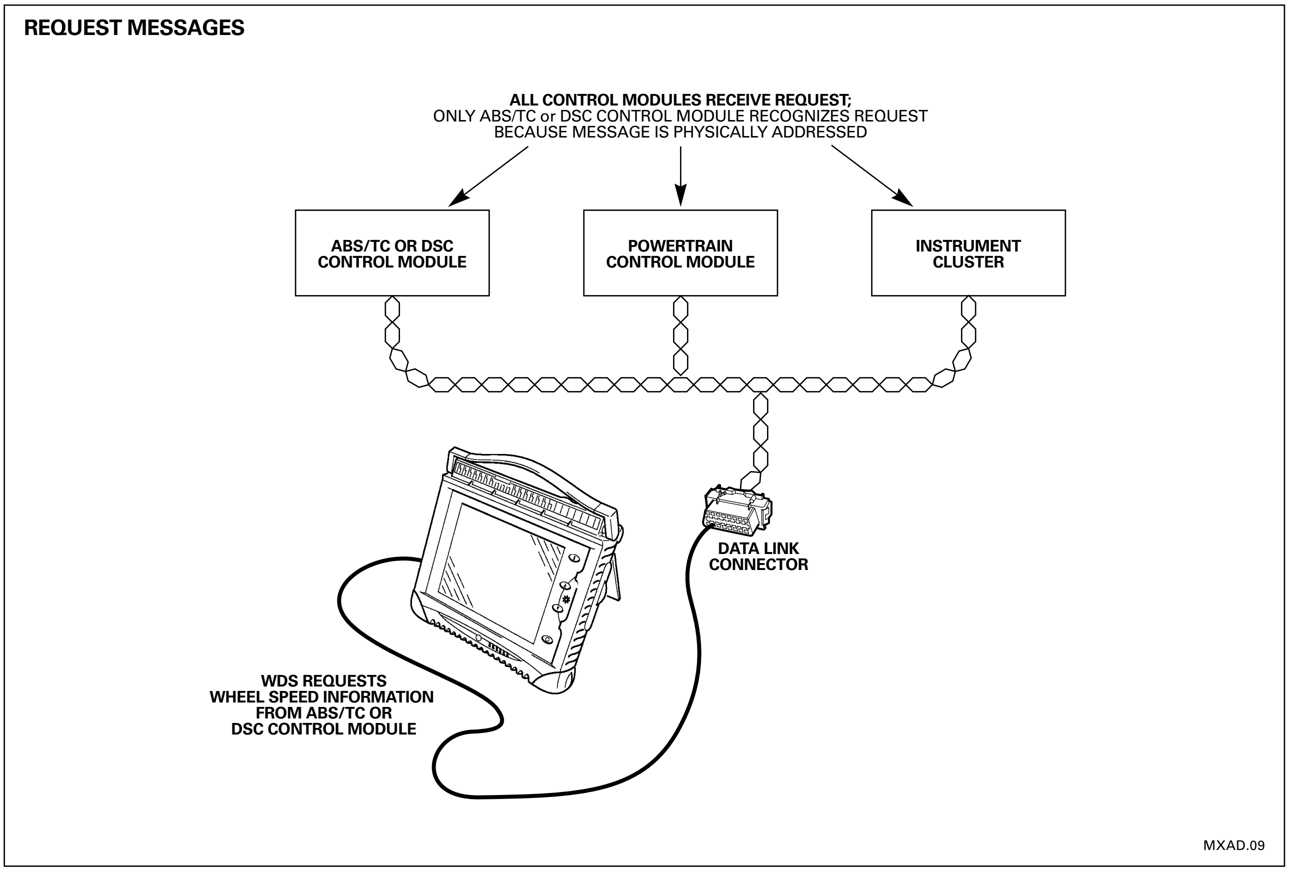


NOTES

Request Messages

When WDS requests a specific piece of data from a control module, an address is attached to the message. The only module that understands the request is the one to which the request is physically addressed.

For example, if WDS requests wheel speed data from the ABS/TC or DSC Control Module, the request will only be understood by the ABS module because of the module address attached to it.

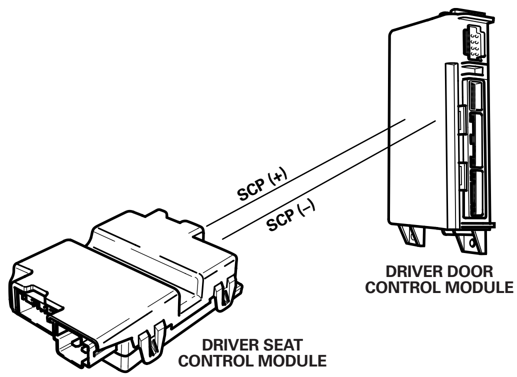


NOTES

MULTIPLEXING

SCP Network (continued)

NETWORK 100% FUNCTIONAL



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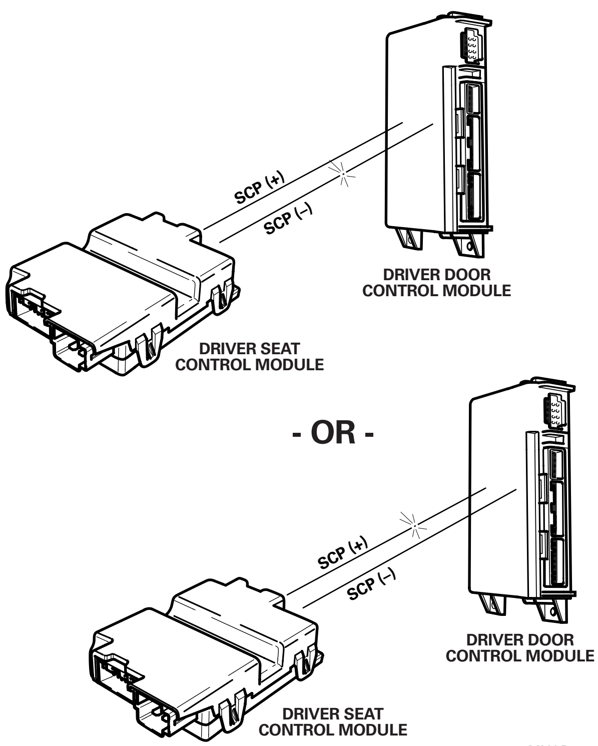
NO CUSTOMER CONCERN, BUT NETWORK DIAGNOSTIC CAPABILITY MAY BE AFFECTED



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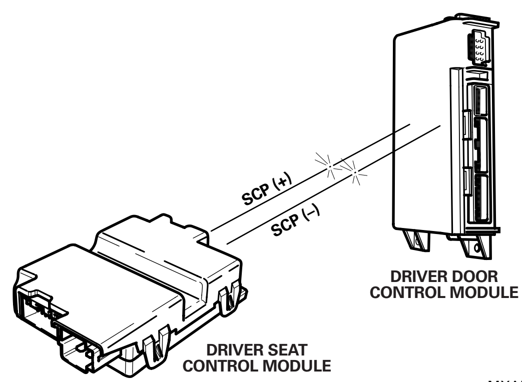
Data Transmission

Data Transmission on the SCP network occurs over a two-wire data bus. Each wire carries a mirror-image of the message on the other wire.

Messages are coordinated by the originating control module so that messages do not “collide” or become jumbled on the network.

If one of the two wires of the data bus is open, the SCP network will often continue to function with no noticeable reduction in capability, and there may be no symptoms that might cause a customer concern.

ONE SECTION OF NETWORK NOT FUNCTIONAL TO MODULE



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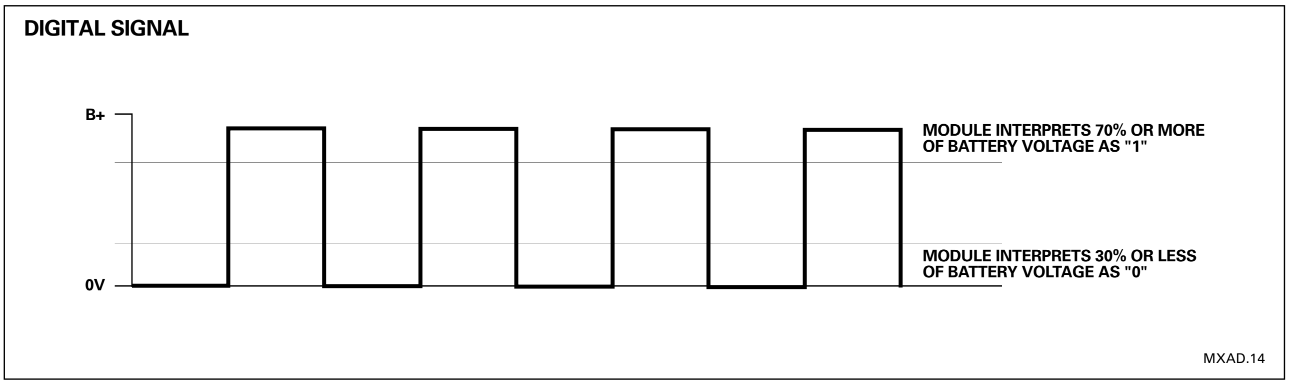
NOTES

Serial Data Link (ISO 9141)

Network Protocol

The Serial Data Link (ISO 9141) uses unique protocol (language) for communication. Serial Data Link protocol consists of electrical pulses. Messages are converted digitally to “1” or “0” depending upon the voltage level of the message signal. A signal of more than 70% of battery voltage is interpreted by the control module as a logic “1”. A signal of less than 30% of battery voltage is interpreted as a logic “0”.

IMPORTANT: The Serial Data Link has a relatively slow protocol speed. Because of this, momentary changes in Input or Output (I/O) states may not be seen on WDS while performing diagnostics. When performing diagnostics on the Serial Data Link, allow time for WDS to display changes in I/O state.



Network Activation

In order to activate the Serial Data Link, WDS must be connected to the 16-pin data link connector (DLC). Once this is done, WDS can communicate on the network. This allows WDS to perform several functions:

- Access and display DTCs.
- Access Parameter Identification Data (PID).
- Initiate active commands.
- Test network communication.

Both continuous and on-demand DTCs are retrieved from one control module at a time.

NOTES

MULTIPLEXING

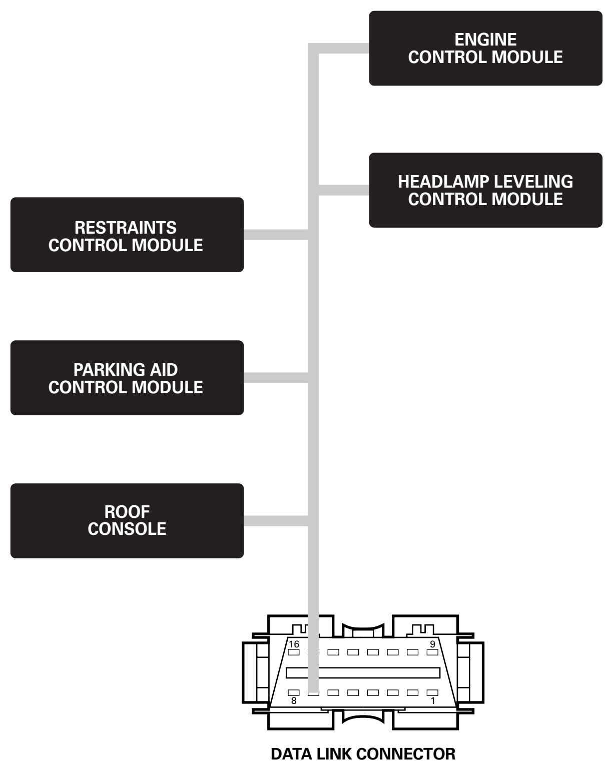
Serial Data Link (ISO 9141) (continued)

The Serial Data Link (ISO 9141) is provided for diagnostic purposes. The Serial Data Link only allows communication between the modules on the network and WDS. This communication will only occur when it is initiated by WDS.

The network contains a series of modules that only send information through the network's single wire data bus when connected to WDS. There is no module-to-module communication on a Serial Data Link.

The Serial Data Link uses a single wire for communication and is only active when connected to a scan tool such as WDS.

SERIAL DATA LINK (ISO 9141) (X-TYPE)



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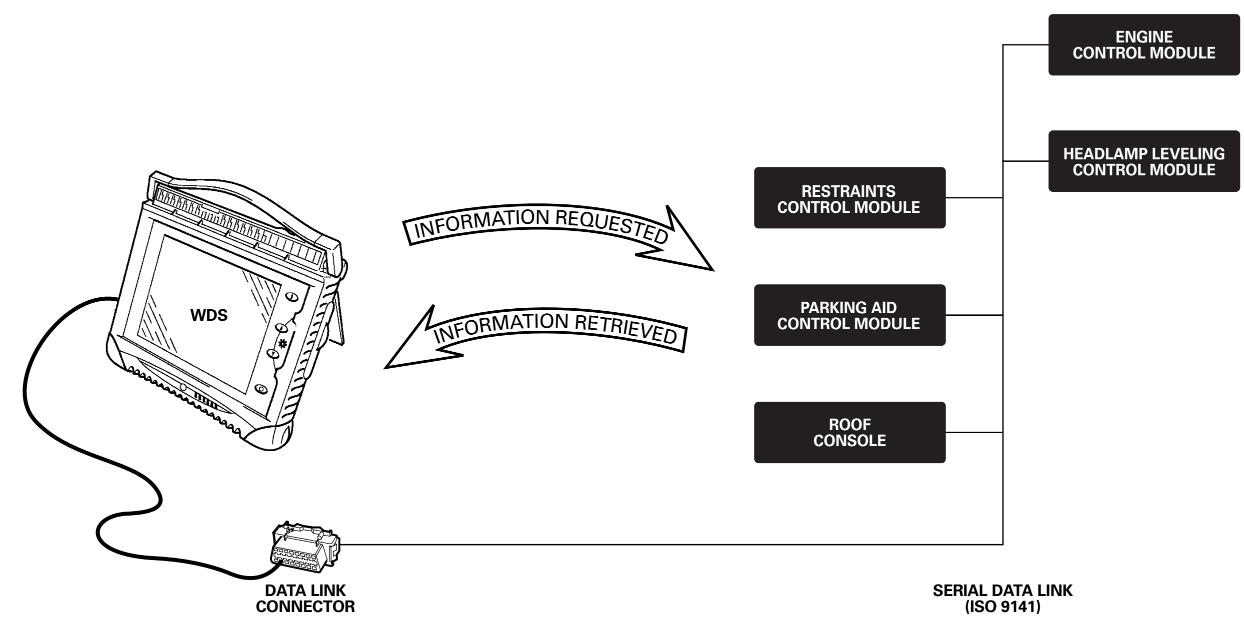
NOTES

In order to activate the Serial Data Link (ISO 9141), WDS must be connected to the 16-pin data link connector (DLC). Once this is done, WDS can communicate on the network. This allows the tool to perform several functions:

- Access and display DTCs.
- Access Vehicle Identification Data (VID).
- Activate components.
- Test network communication.

WDS COMMUNICATION WITH SERIAL DATA LINK (X-TYPE)



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NOTES

MULTIPLEXING

ACP Network

Introduction

The Audio Control Protocol (ACP) network is used on S-TYPE models. This network consists of the Radio Head Unit acting as the control module, with various other audio system-related modules. These are connected by a twisted pair data bus.

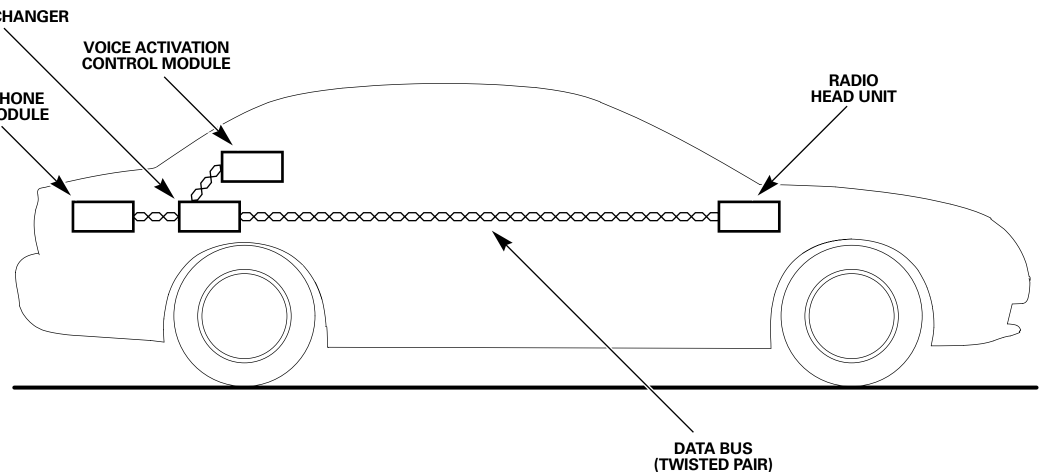
Operation

The Radio Head Unit communicates with other network modules by sending and/or receiving electronic messages on the data bus. The ACP data bus consists of a pair of wires twisted to help prevent electromagnetic interference.

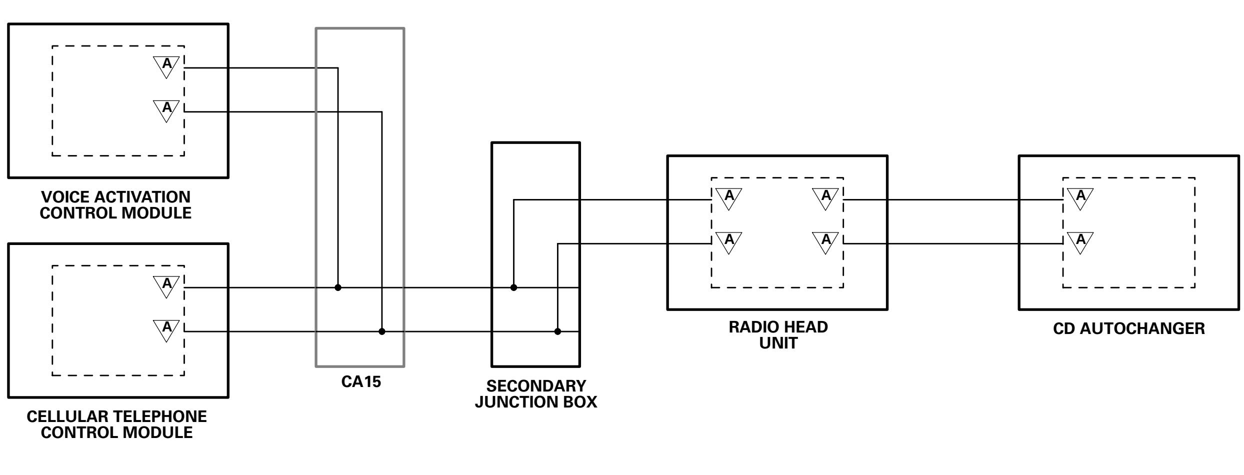
> **NOTE:** Be aware that unlike the SCP network, if either of the data bus wires are open or shorted the ACP network will not operate.

NOTES

ACP NETWORK COMPONENTS (S-TYPE)



ACP NETWORK (S-TYPE)



NOTES

MULTIPLEXING

D2B Optical Network

D2B is the result of an extensive development program whose aim is the realization of an automotive communications and information network. The D2B optical network is based on distributed devices such as head units, CD players, speech control units, telephones, and Internet access. D2B enables complex and distributed functionalities, minimizes electromagnetic interference (EMI) problems, decreases weight and cost to the harness, and achieves a high data rate of up to several Mb/sec.

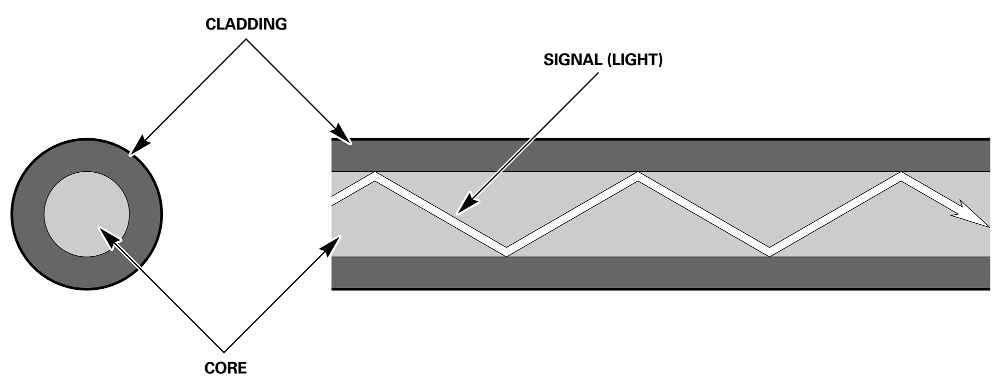
D2B optical network is a synchronous bus with a ring structure in which two devices each build an optical point-to-point link to the closed ring. The head unit serves as a network master and each D2B device is equipped with a network transceiver chip that serves the physical layer.

The optical cabling to interconnect all network devices inside the vehicle consists of Black Optic Fiber (BOF).

The introduction of the D2B optical network on Jaguar models is the first step to enhance the capability of car multimedia applications. The integration of World Wide Web services with an automotive network device such as intelligent traffic guidance is the start of an evolution with technological challenges and new solutions.

Instead of copper cables, this system uses fiber optic cables made of plastic.

FIBER OPTIC CABLE



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In these cables, measurement data and switching signals can travel at the speed of light. Consequently, nodes connected to the “D2B” ring network can transfer much larger amounts of data in a shorter time than in the CAN bus: up to 5.6 million bits are transmitted per second in the fiber optic cable, representing a transmission rate some 60 times faster than CAN transmission in the interior by copper cable. The fiber optic cable therefore carries many more information units in a comparable time, so that even the data of a music CD can be transferred with perfect sound quality.

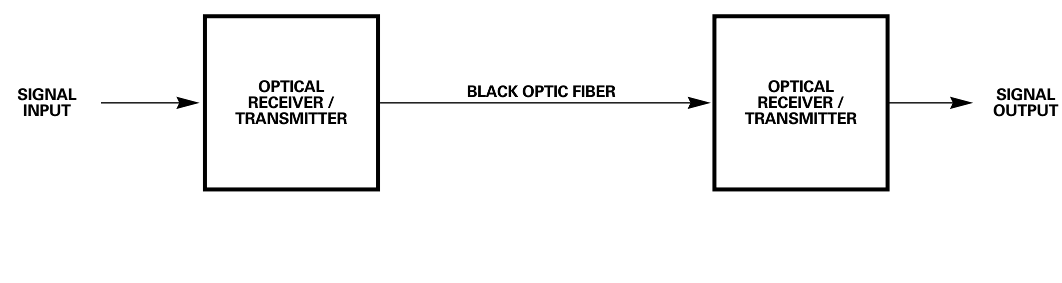
NOTES

Fiber optics is composed of microscopic strands of glass. That glass, though, is a little more special than what's in the windows of your home or car. Information – in the form of bytes of data – can travel through this glass at the speed of light.

The fiber optic strands of glass are enclosed inside tubes, which are protected by several layers, including Kevlar, the same material used in bullet-proof jackets.

In fiber optics, data is converted to light impulses using a transmitter/receiver and travels to another location where another transmitter/receiver converts the light impulses back to data. Its advantages include the ability to transmit data over long distances, low error rates, lightning protection, immunity to radio frequency interference and ease of installation. It also does not carry current, which means it's not dangerous to touch, unlike live electric wires.

FIBER OPTIC DATA TRANSMISSION



NOTES

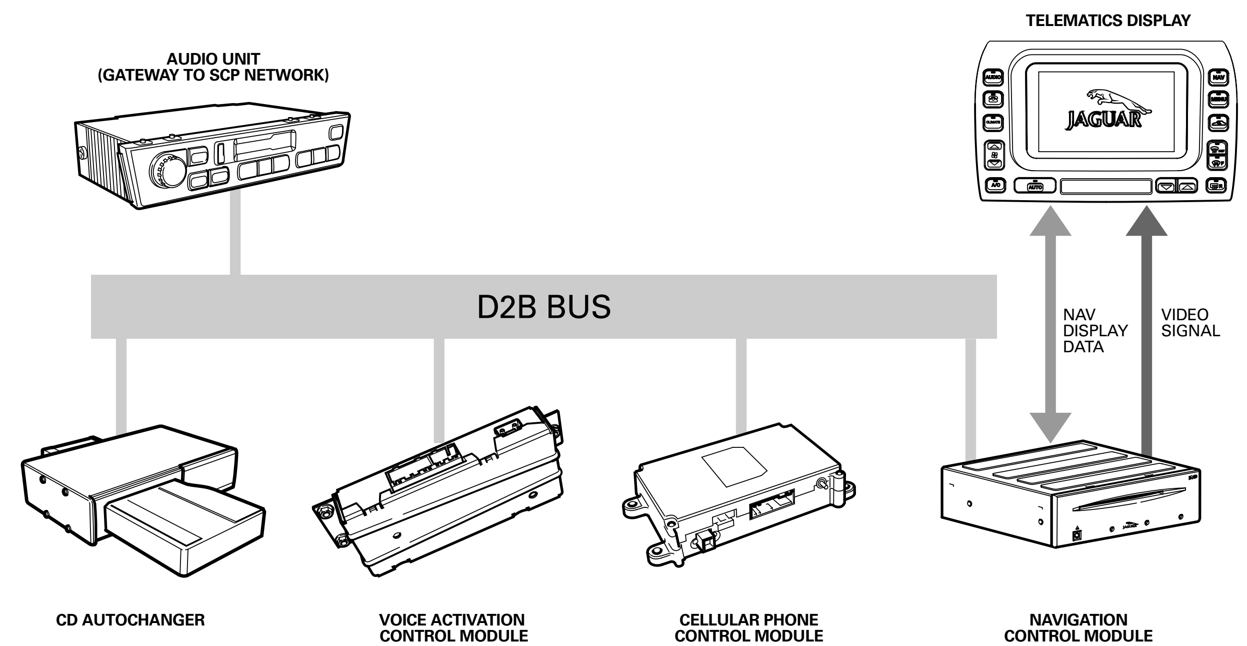
MULTIPLEXING

D2B Optical Network (continued)

Advantages of Fiber Optics

- Large Capacity – can carry hundreds/thousands of times more information than copper
- Electrical Interference – not affected by electromagnetic interference or radio frequency interference. Provides clean communication path in very hostile EMI environments. It is also immune to cross-talk (light radiated from one fiber cannot be recaptured by another fiber)
- Insulation – optical fiber is an insulator the glass fiber eliminates the need for electric currents for the communication path
- Security – cannot be accessed by conventional electrical means such as surface conduction or electromagnetic induction, and is very difficult to access optically. Radio or satellite communication signals can easily be captured for decoding
- Reliability & Maintenance – when properly designed, immune to adverse temperature and moisture conditions. Long life span, no corrosion, intermittent or lost signals, and is not affected by short circuits, power surges, or static electricity
- Versatility – fiber systems are available for most data, voice and video communications.

D2B NETWORK (X-TYPE)



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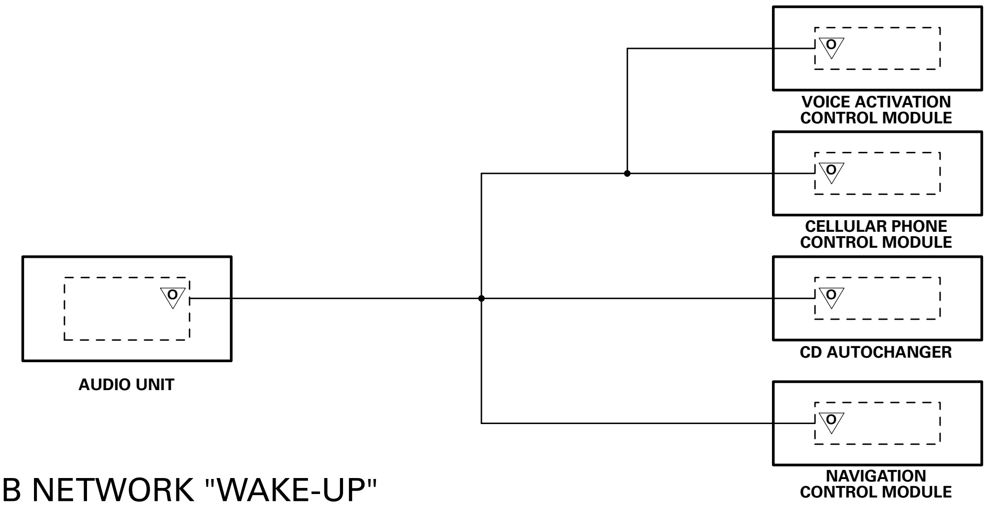
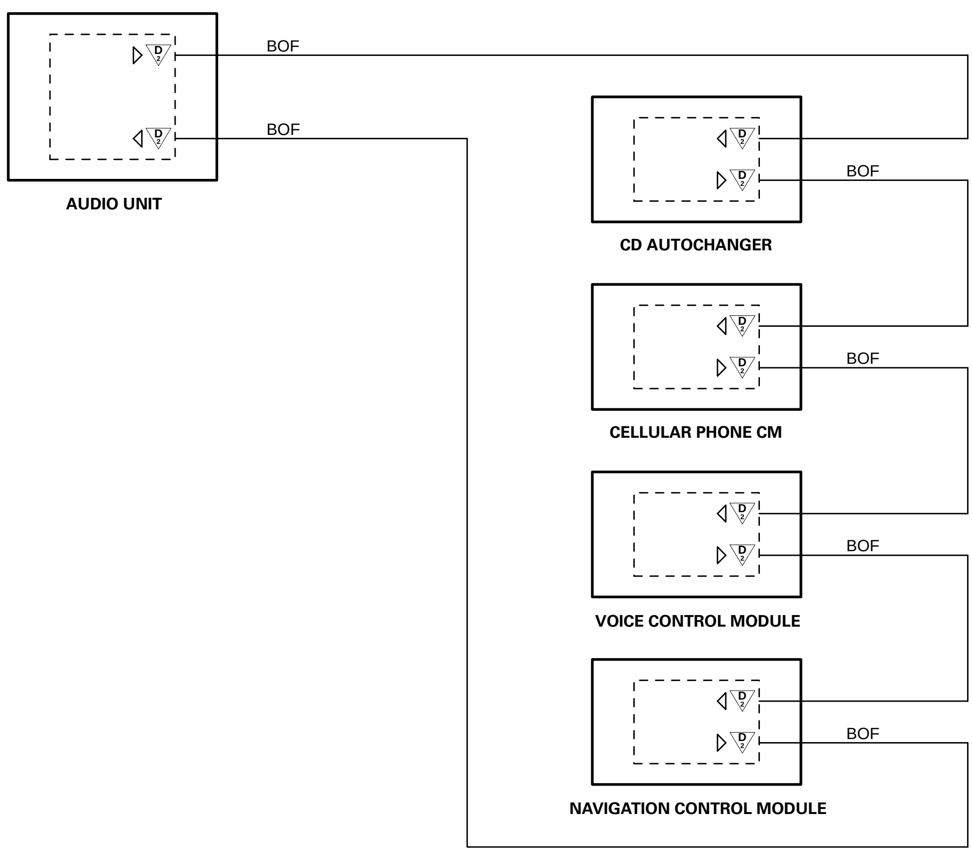
D2B NETWORK (X-TYPE)

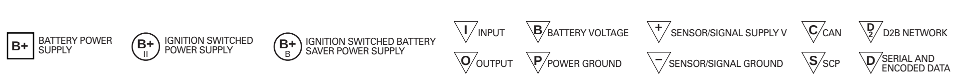


D2B NETWORK "WAKE-UP"



FIVE MODULE (NODE) D2B NETWORK

NOTE: REGARDLESS OF THE NUMBER OF MODULES ON THE D2B NETWORK, THE SEQUENCE FOR MODULE CONNECTION IS ALWAYS AS SHOWN.



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MULTIPLEXING

Multiplexed Control System Harnesses

The major control modules connect to one of two multiplex electrical circuits. One multiplex circuit (CAN network) provides communication between the power train system modules. The second multiplex circuit (SCP network) provides communication between the body systems control modules. Both networks connect to the major instrument pack (INST), which allows communication of certain data between the CAN and SCP networks.

CAN Powertrain Multiplex Harness

The control modules for the engine, transmission and braking systems connect to each other with a two wire "twisted pair" multiplex circuit. The multiplex circuit allows the control modules to share data and systems control responsibility via "real time" high speed data communication. Sensors "owned" by each module and components directly controlled by the module connect with conventional "hard wired" circuits. Refer to page 1.6 for a description of CAN multiplexing.

SCP Body Systems Multiplex Harness

The vehicle body systems control modules are similarly connected, utilizing a separate "twisted pair" multiplex circuit allowing the modules to share data and zoned component control responsibilities via multiplex data communication. Refer to page 1.8 for a description of SCP multiplexing.

CAUTION: Multiplex harnesses require special repair procedures. Refer to the applicable Service Literature for special tools and procedures.

D2B Harness

The D2B Network harness is comprised of a 3.5mm diameter plastic tubing internally lined with a 1mm polymer fiber core. The D2B bus uses two "lines", one acting as an input and the other as the output, to complete the communication ring needed to successfully control all ICE modules or "nodes" on the vehicle.

CAUTION: The D2B harness requires special service and repair procedures. Use the D2B Optical Bus Tester tool #415-S003.

NOTES

MULTIPLEX ADVANCED DIAGNOSTICS

JAGUAR

Service Training Course MXAD

DATE OF ISSUE: 02/15/2002

MULTIPLEX DIAGNOSTICS

Overview

By following the Jaguar five-step Diagnostic Strategy, outlined on pages 2.4 and 2.5, and applying knowledge of the Jaguar multiplexing systems, a multiplex controlled circuit fault can often be easier to diagnose than a fault in a more conventionally controlled circuit.

A number of methods are available to test for problems that may occur. The test methods chosen depend on the vehicle symptoms, the physical layout of the circuits, and the accessibility of test points.

Testing a Multiplex Problem

WDS functions as a diagnostic aid and a DVOM. Each time WDS runs a multiplex component diagnostic routine it automatically tests multiplex circuit integrity to determine if the circuit is capable of communicating a data message. WDS will most often help you to pinpoint the cause of the failure. Because WDS diagnostics are software driven, its efficiency in any diagnostic mode depends on the design of the software that it uses. Most WDS diagnostic modes are excellent. However, a technician with knowledge of the system being tested, an Electrical Guide and a DVOM, can often diagnose a problem as efficiently as the WDS diagnostic function.

Multiplex Symptoms Analysis

Any action controlled through a multiplex system requires the following:

- An input to a module on the multiplex system
- A data message transmitted by a module on the multiplex system
- A data message received by a module on the multiplex system
- An output to a function

The symptoms of a particular multiplex failure cannot always be accurately predicted. Symptoms that may seem unrelated to the failure can occur depending on the state of the modules and the data being transmitted at the time of the failure. It is important to concentrate on the primary failure symptoms to help isolate the fault. Carefully observe the symptoms while performing functional tests. If the symptoms appear to change while testing, perform a “hard reset” of the control modules. A “hard reset” clears any “false” symptoms that might result from testing. Also, perform a “hard reset” after a repair is completed. Then, perform functional tests of the original failed function to verify the repair. Finally, perform a functional test of related functions, looking for any remaining symptoms.

Hard Reset Instructions

A “hard reset” restores the control modules to their default conditions assuring that network communications are synchronized.

XJ vehicles

- Disconnect the negative cable of the battery for at least 60 seconds
- Reconnect the Battery negative cable

XK vehicles

- Open one window fully or open a door
- Disconnect the negative cable of the battery for at least 60 seconds
- Reconnect the Battery negative cable
- Reset the window position memory for the passenger and driver door windows

Professional Electrical Practices

When testing electrical circuits it is important to access the circuits carefully to avoid damaging insulation, conductors, contacts or components. Measurements should be performed carefully. Ensure that the tester is connected to the correct pins. If measurements are not consistent with the expected values, always double check that the tester is correctly connected.

✗ **Back probing sealed electrical connectors** will damage the seal allowing moisture or other contaminants to enter the connector causing corrosion.

✗ **Piercing the insulation of conductors** when performing measurements will damage the conductor, increase the conductor resistance, and allow moisture or other contaminants to enter the connector causing corrosion.

✗ **Circuit powered or self-powered test lights or circuit testers may cause damage to sensitive components.** The best rule is to use only a high impedance digital multimeter when measuring any electrical circuit in the vehicle.

✓ **Periodically calibrate test equipment** and check the resistance of the test leads and adapters to assure that measurements are accurate.

✓ **Use the correct testing adapters** when performing measurements. Using incorrect adapters or probing connectors may damage the plating on the contacts, causing corrosion and increased resistance.

Circuit Failure Testing (Consumer / Function Operates Intermittently)

Because the failure is not always present, intermittent failures can be the most difficult to diagnose. If the system is electronically controlled and its control module is capable of storing DTCs, extract any DTCs as a guide to diagnosis.

It is also vital to gather the following information about any intermittent failure:
- When does the function fail?
- Are any other functions affected?
- Were any other functions in operation at the time of failure?
- Is the failure related to a vibration or bump occurrence?
- Does the failure occur at any specific temperature, time of day, engine or transmission operating condition?

Try to recreate the failure by operating the vehicle under the conditions reported. If the failure can be recreated, follow the general diagnostic procedures.

If the failure cannot be recreated, apply the reported failure conditions to the symptoms in order to determine the probable causes of the failure. Then, carefully examine each of the probable causes. Start with the circuit areas or system components that are the most probable causes of the failure and thoroughly test each one. Apply the “wiggle” test while following the general diagnostic procedures.

NOTES

MULTIPLEX DIAGNOSTICS

Diagnostic Strategy

Problem diagnosis can be time consuming and sometimes frustrating. However, the job will be easier if you apply a logical approach to the task, called a Diagnostic Strategy. The following outlines a Diagnostic Strategy that will help ensure that none of the information necessary for accurate diagnosis is overlooked.

1. **Verify the complaint.**

   Check the accuracy and detail of information on the repair order.

   Confirm the complaint.

   Gather information about the complaint. Identify all of the symptoms – what is working and what isn't, check for MILs, warning lights and driver information display messages.

   Look for additional symptoms.

2. **Analyze the system(s) and identify probable causes.**

   Determine what controls the faulty function.

   Determine if the failure is in the multiplex network or if an input / output to the network failed.

   Determine the data messages that control the function and establish which modules transmit and which modules use the messages.

   Determine if any of the messages are required for other functions.

   Perform functional tests to eliminate probable causes.

3. **Inspect, test and pinpoint the fault.**

   Visually inspect the vehicle and look for obvious faults first.

   Test the circuits and components using WDS or a DVOM as appropriate. Start with the circuits or components that are the most likely cause and the easiest to test.

   Be aware that intermittent faults or symptoms may require recreating the fault conditions while testing: hot condition, cold condition, or "wiggle" test.

NOTES

4. **Perform the repair.**

   Follow the recommended service procedures.

   To avoid a repeat failure, ensure that wiring, connectors, and grounds are in good condition before fitting new components.

   Replace defective components.

   NOTE: After the repair, perform a "hard reset" of the control modules. Refer to page 2.2.

5. **Evaluate the results.**

   Verify that the customer complaint is resolved and that all of the original symptoms have disappeared.

   Confirm that no new conditions were created by performing operational tests of any other systems that are related to the complaint or that were disturbed during the repair.

Three rules for diagnosing multiplex related failures

- Before checking for related faults and symptoms, always "hard reset" the control modules to restore them to their default conditions.
- Always determine if the failure is within the multiplex network or if it is a failed input or output connected to the network before doing further diagnosis.
- For multiplex network failures, use a DVOM to pin point the fault (WDS only checks the multiplex circuit wiring). For input or output failures, use WDS for diagnosis.

NOTES

MULTIPLEX DIAGNOSTICS

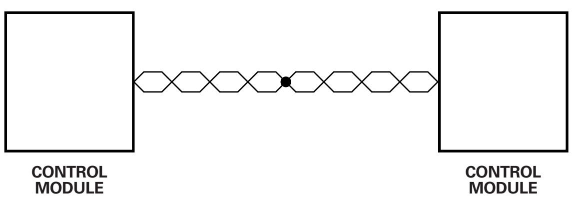
Network Service

All networks basically consist of electronic control modules, connectors, Data Link Connector (DLC) and data bus circuit(s). The only repair that can be performed is wire repair, connector repair or module replacement.

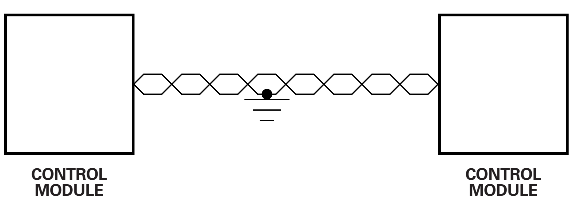
Whenever wire or connector repair is required, always perform the repair using the methods specified in the vehicle workshop manual. NEVER condemn a control module until all of the module's power and ground circuits have been checked. Identify the module power and ground circuits, then check them using a digital multimeter.

- All wire pairs must have at least one twist per inch (to resist electromagnetic interference) and must be twisted to within ten inches of the connected modules.
- Always use correct gauge wire when performing data bus repairs. High resistance in the data bus circuit could result in network concerns.
- Always make crimp wire repairs. Solder repairs are UNACCEPTABLE.
- Use only Jaguar supplied connectors when connector replacement is required. This will ensure the correct fit and help prevent excess resistance in the circuit.

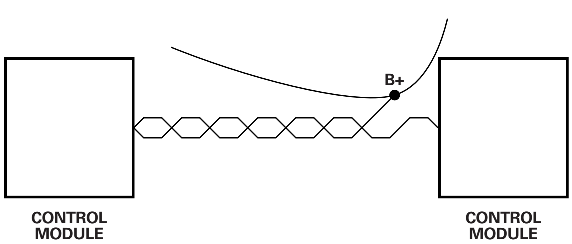
NETWORK FAILURE TYPES



DATA BUS WIRE SHORTED TOGETHER



DATA BUS WIRE SHORTED TO GROUND



DATA BUS WIRE SHORTED TO POWER

MXAD.23

Network Symptoms

In the event a failure of the network occurs, a customer concern may result. The causes of network failure include:

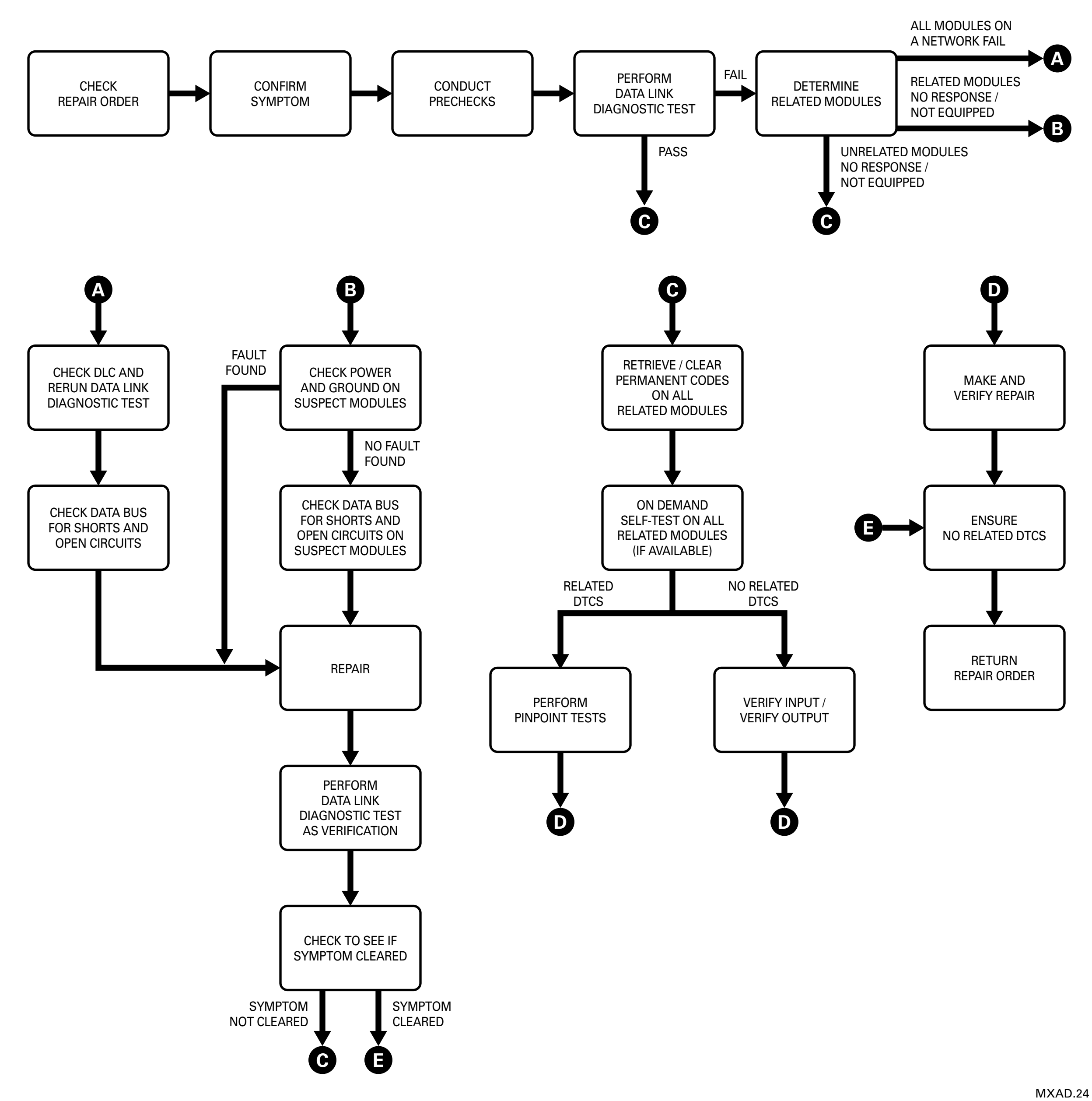
- Data Bus Wires shorted together
- Either Data Bus Wire shorted to ground
- Either Data Bus Wire shorted to power
- Either Data Bus Wire open

Network Service Tips

- Use correct gauge wire.
- Never condemn a module until ground and power circuits have been checked
- Twisted wire pairs require minimum of one twist per inch to within ten inches of modules.
- Use proper wire repair/replacement methods.
- Always refer to JTIS for specific information
- Use only approved replacement electrical connectors

NOTES

NETWORK DIAGNOSIS AND REPAIR JOB AID FLOWCHART



NOTES

MULTIPLEX ADVANCED DIAGNOSTICS

JAGUAR

Service Training Course MXAD
DATE OF ISSUE: 02/15/2002

XJ / XK

CAN (Controller Area Network)

XJ / XK CAN Modules

The following control modules communicate directly through the CAN network:

- Anti-lock braking / traction control module (ABS / TC CM)
- Transmission control module (TCM)
- Engine control module (ECM)
- Gear selector illumination module (does not transmit; used only as a “bridge” for gear selector position lights)
- Instrument pack (INST)

The CAN network is also connected to the DLC (data link connector) for diagnostics.

Refer to the applicable Electrical Guide Appendix for individual module messages

CAN is unable to communicate directly with SCP. However, the INST converts specific message data allowing communication between networks.

NOTE: All modules have fail safe default modes in case of a network failure.

NOTES

CAN Network Troubleshooting

WDS CAN Network Diagnostics

WDS automatically tests the network integrity and communications before running specific diagnostic routines. First, WDS establishes communication with the vehicle via the DLC and begins its automatic test sequence. Once network integrity and communications are both confirmed, WDS begins the specific diagnostic routine. If the network communications and integrity test is failed, PDU directs the user to an appropriate test from the CAN network menu.

CAN Network Failure Modes

The WDS diagnostic routine tests the network wiring but will not pin point an individual module failure. If a network failure is established using WDS, then pin point the fault using the following information and a DVOM.

An open circuit in both the CAN high (+) AND the CAN low (-) wires will stop communications at the open circuit. Modules on either side of the open circuit will continue to communicate with modules on the same side of the open circuit but no data will be cross the open circuit. Modules will continue to operate by substituting default values for the missing data.

CAN modules will communicate only when the CAN high (+) and CAN low (-) are in an acceptable electrical state. The following shows communication possibilities depending on the electrical state of each wire. If all communication is lost on the CAN bus, the modules will continue to function but will substitute default values for any missing data.

Wire	Condition	Communication
CAN high (+)	open circuit	NO
CAN high (+)	short circuit to ground	NO
CAN high (+)	short circuit to B+ voltage	NO
CAN high (+)	short circuit to CAN low (-)	NO
CAN low (-)	open circuit	YES (if CAN high (+) is functioning)
CAN low (-)	short circuit to ground	YES (if CAN high (+) is functioning)
CAN low (-)	short circuit to B+ voltage	NO

NOTES

XJ / XK

CAN Network Troubleshooting (continued)

CAN Network Communications Functional Check

The following procedure confirms that data message communication is possible between all of the control modules connected to the CAN bus without using WDS.

- Switch the ignition ON to position II and observe the MILs.
- Switch the ignition OFF and disconnect the battery negative cable.

  Disconnect the ABS / TC CM.

  Reconnect the battery negative cable and switch the ignition to position II.

  The following warnings should activate:

  XJ and XK with traction control

  MILs: ABS; BRAKE; AMBER

  LEDs: TRAC switch

  Message center display: TRACTION CONTROL FAILURE; STABILITY CONTROL FAILURE

  XK without traction control

  MILs: ABS; BRAKE

  LEDs: ASC switch

  Switch the ignition OFF and disconnect the battery negative cable.

  Reconnect the ABS / TC CM.

  Reconnect the battery negative cable and switch the ignition to position II.

  If the MILs, LEDs, and message center display are inactive, the CAN network is communicating from one end to the other (ABS / TC CM to INST).
- Start the engine and apply the parking brake and foot brake. Move the gear selector through all of the gear positions.

  If the gear selector indicator lights operate correctly, the CAN network is communicating from the TCM to the gear selector module.

CAN Network Integrity Check without WDS

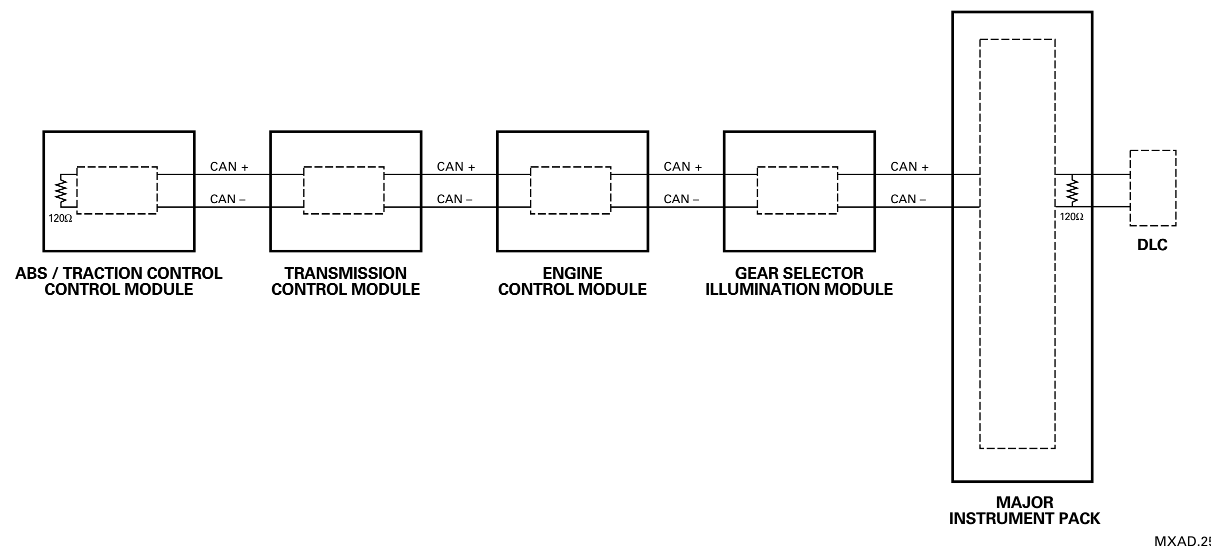
- With the ignition switched OFF, connect a DVOM between DLC pin 6 (CAN high [+]) and DLC pin 14 (CAN low [-]). A reading of 60 $\times$ indicates a good CAN bus:

  $< 60\ \Omega$ indicates a short circuit on the bus

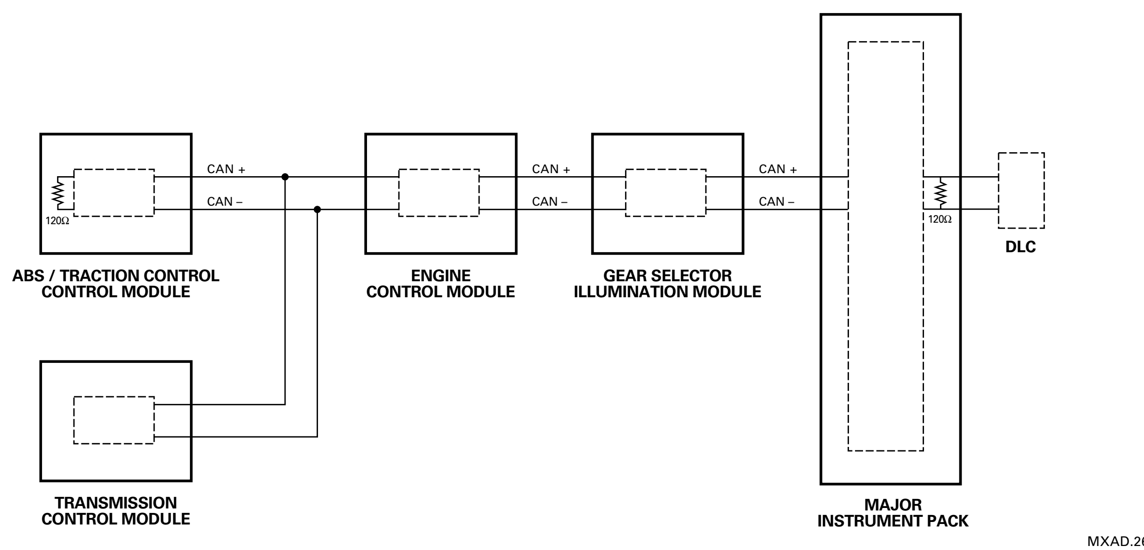
  $> 60\ \Omega$ indicates high resistance on the bus
- Disconnect the DVOM from the DLC and switch to the voltage scale.
- Switch the ignition ON to position II.
- Connect the DVOM between DLC pin 6 (CAN high [+]) and ground. The measured value should be 2.7 V (approx.).
- Connect the DVOM between DLC pin 14 (CAN low [-]) and ground. The measured value should be 2.5 V (approx.).

NOTES

CAN MULTIPLEX CIRCUIT LAYOUT (XK AND NORMALLY ASPIRATED XJ)



CAN MULTIPLEX CIRCUIT LAYOUT (SUPERCHARGED XJ)



NOTES

XJ / XK

SCP Network Troubleshooting

SCP Network Communications Functional Check

The following procedure confirms that data message communication is possible between all of the control modules connected to the SCP bus without using WDS.

– With the doors and windows closed, lock the vehicle using the key.

– Using the key, unlock the vehicle and hold the key in the unlocked position (global open).

  XK8: If both doors unlock, all windows open, and if equipped, the convertible top opens, data messages were communicated between the DDCM, PDCM, BPM and SLCM.

  XJ Series Sedan: If all doors unlock and all windows open, data messages were communicated between the DDCM, DRDCM, PDCM, PRDCM, BPM and SLCM (XJ Series Sedan).

– Switch the ignition to position II, set and recall a seat memory position. Open and close the driver door while watching the door ajar INST warning.

  If the seat memory works, data messages were communicated between DDCM, BPM and DSCM.

  If the door ajar warning is active with the door open and becomes inactive with the door closed, a data message was communicated between the DDCM and the INST.

SCP Network Integrity Check without WDS

– Disconnect the INST and all of the other SCP control modules from the network.

– Connect one control module to the network. With a DVOM, measure the voltage between DLC pin 2 (SCP high[+]) and chassis ground. Then, measure the voltage between DLC pin 10 (SCP low [-]) and chassis ground. The measured values should be as shown below.

– Disconnect the control module.

– Repeat the test with the remaining modules, in turn, until all of the modules and the entire network have been tested.

SCP Network Integrity Check with DVOM

Battery Connected – Key OFF	**XJ**	**XK**
Voltage reading: SCP+ pin 2 to ground	0 Volts	0 Volts
Voltage reading: SCP– pin 10 to ground	5 Volts	5 Volts
Battery Connected – Key ON	**XJ**	**XK**
Voltage reading: SCP+ pin 2 to ground	0.48 Volts	0.48 Volts
Voltage reading: SCP– pin 10 to ground	4.5 Volts, varying	4.5 Volts, varying
Battery Disconnected – Key OFF	**XJ**	**XK**
Ohm meter reading across network: SCP+ pin 2 to SCP– pin 10	4000 – 8000 Ohms	512 Ohms
Ohm meter reading: SCP+ pin 2 to ground	113 – 115 Ohms	420 Ohms
Ohm meter reading: SCP– pin 10 to ground	0.04M Ohms	420 Ohms

NOTES

SCP Control Module Voltage Values (approximate)

	XJ		XK	
Module Connected	**Pin 2 (SCP +) to ground**	**Pin 10 (SCP -) to ground**	**Pin 2 (SCP +) to ground**	**Pin 10 (SCP -) to ground**
INST	0.0 V	5.0 V	0.0 V	4.98 V
BPM	0.0 V	5.0 V	0.0 V	5.01 V
SLCM	0.0 V	5.0 V	0.0 V	4.99 V
PDCM	0.0 V	1.7 V	0.0 V	1.66 V
PRDCM	0.0 V	1.7 V	N/A	N/A
DDCM	2.7 V	1.7 V	0.0 V	1.67 V
DRDCM	2.7 V	1.7 V	N/A	N/A
PSCM	0.0 V	1.7 V	0.0 V	1.66 V
DSCM	0.0 V	1.7 V	0.0 V	1.67 V

NOTE: If a function is activated during testing, the DVOM should show a varying frequency reading on both the SCP high (+) and SCP low (-) lines as the module attempts to communicate.

NOTES

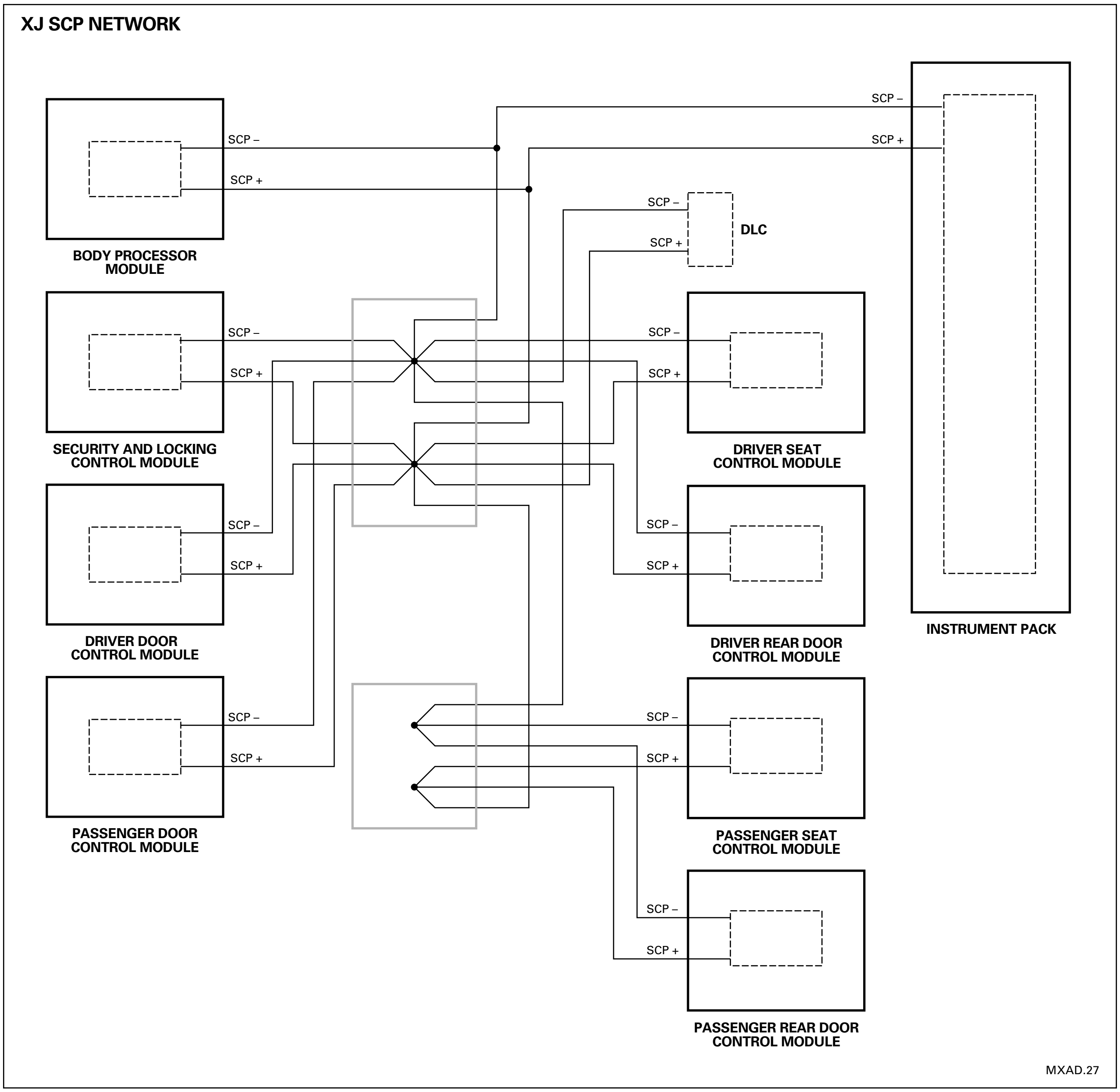
XJ / XK

XJ SCP Modules

The following control modules communicate directly through the SCP network:

- Instrument pack (INST)
- Body processor module (BPM)
- Security and locking control module (SLCM)
- Driver door control module (DDCM)
- Passenger door control module (PDCM)
- Driver seat control module (DSCM)
- Driver rear door control module (DRDCM)
- Passenger seat control module (PSCM)
- Passenger rear door control module (PRDCM)

The network is also connected to the DLC (data link connector) for diagnostics.

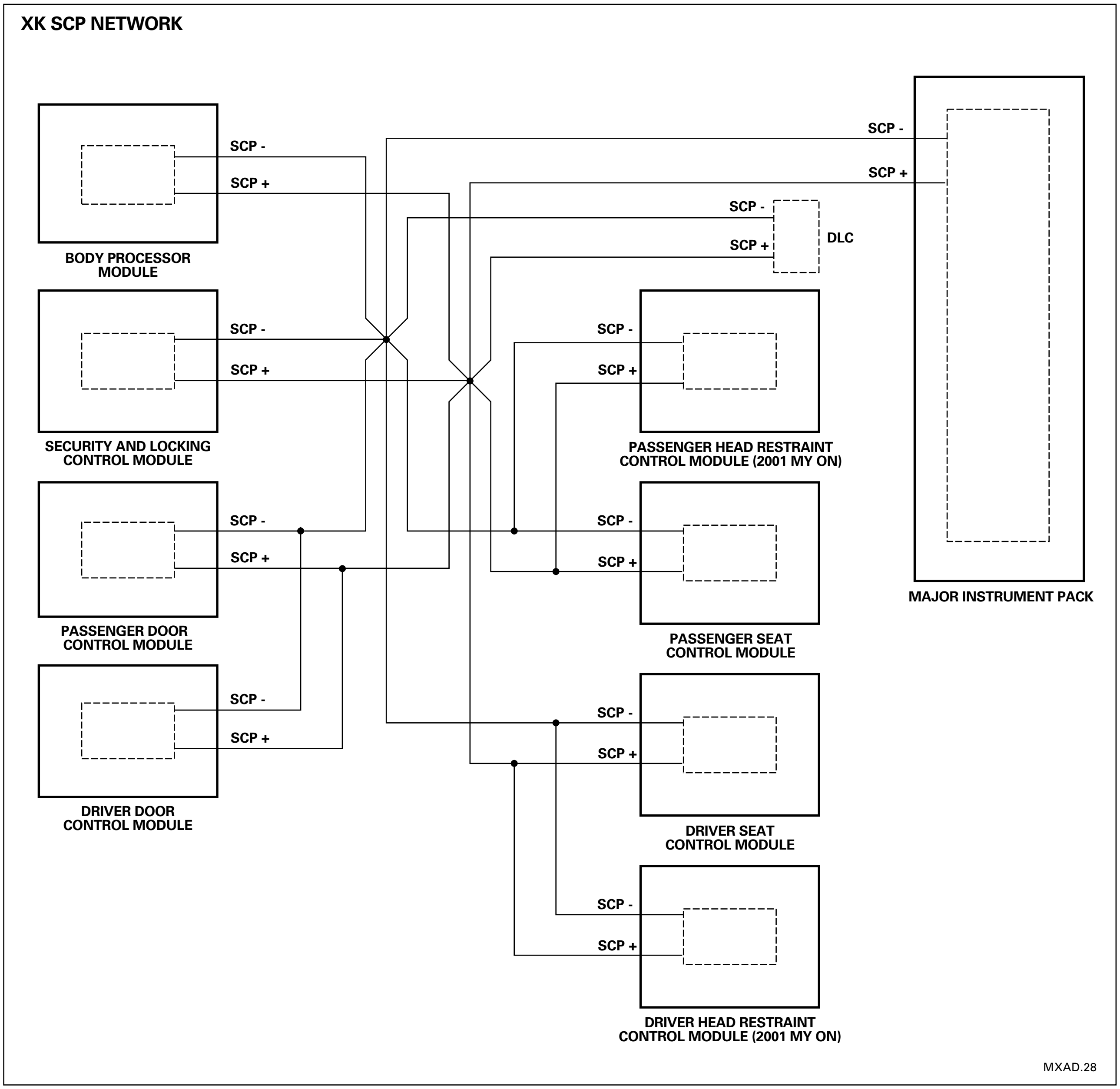


XK SCP Modules

The following control modules communicate directly through the SCP network:

- Major instrument pack (INST)
- Body processor module (BPM)
- Security and locking control module (SLCM)
- Driver door control module (DDCM)
- Passenger door control module (PDCM)
- Driver seat control module (DSCM)
- Passenger seat control module (PSCM)
- Driver head restraint control module (DHRCM)
- Passenger head restraint control module (PHRCM)

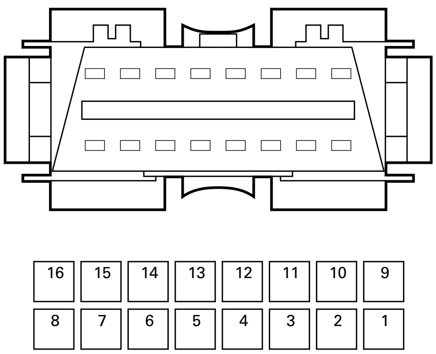
The network is also connected to the DLC (data link connector) for diagnostics.



XJ / XK

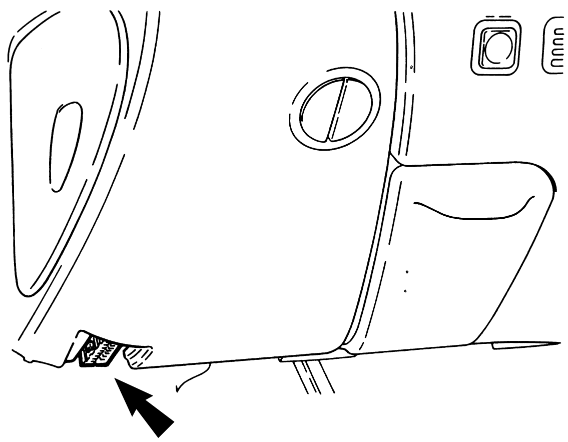
Data Link Connector (DLC)

DATA LINK CONNECTOR (DLC)



MXAD.29

DLC LOCATION (XK SHOWN)



MXAD.30

Both the CAN and SCP busses are directly connected to the DLC. WDS contains hardware and software that allows it to function as a “node,” an additional module added to networks. The software and hardware supports direct communications between WDS and the networks for diagnostics and module programming. In addition, WDS communicates via the DLC with non-multiplexed modules using a Serial Data Link (ISO 9141).

Generic scan tools access the legislated OBD II DTCs and freeze frame information in the ECM via DLC pins 7 and 15.

NOTES

Data Link Connector Pin Out Information

XJ

Pin	Description
CC6-1	Ignition position II switched ground
CC6-2	SCP high (+)
CC6-3	Not used
CC6-4	Power ground
CC6-5	Logic ground
CC6-6	CAN high (+)
CC6-7	ECM OBD II DTC, A/CCM, KTM, Airbag / SRS SPS, serial data
CC6-8	Ignition position I switched ground
CC6-9	Ignition switched B+
CC6-10	SCP low (-)
CC6-11	Not used
CC6-12	ECM programming
CC6-13	ECM programming
CC6-14	CAN low (-)
CC6-15	ECM OBD II DTC, A/CCM
CC6-16	B+ supply

XK

Pin	Description
FC53-1	Ignition position II switched ground
FC53-2	SCP high (+)
FC53-3	Airbag / SRS serial data
FC53-4	Power ground
FC53-5	Logic ground
FC53-6	CAN high (+)
FC53-7	ECM OBD II DTC, A/CCM, KTM, serial data
FC53-8	Ignition position I switched ground
FC53-9	Ignition switched B+
FC53-10	SCP low (-)
FC53-11	Not used
FC53-12	ECM programming
FC53-13	ECM programming
FC53-14	CAN low (-)
FC53-15	ECM OBD II DTC, A/CCM
FC53-16	B+ supply

Network Repair

Because the Serial Data Link (ISO 9141) is a diagnostic network and functions only when WDS is connected, failure of the network should not create a customer concern. However, failure of the network will limit your ability to diagnose several vehicle systems.

After a network repair, perform the Network Test again to verify that the network is operating properly.

NOTES

XJ / XK

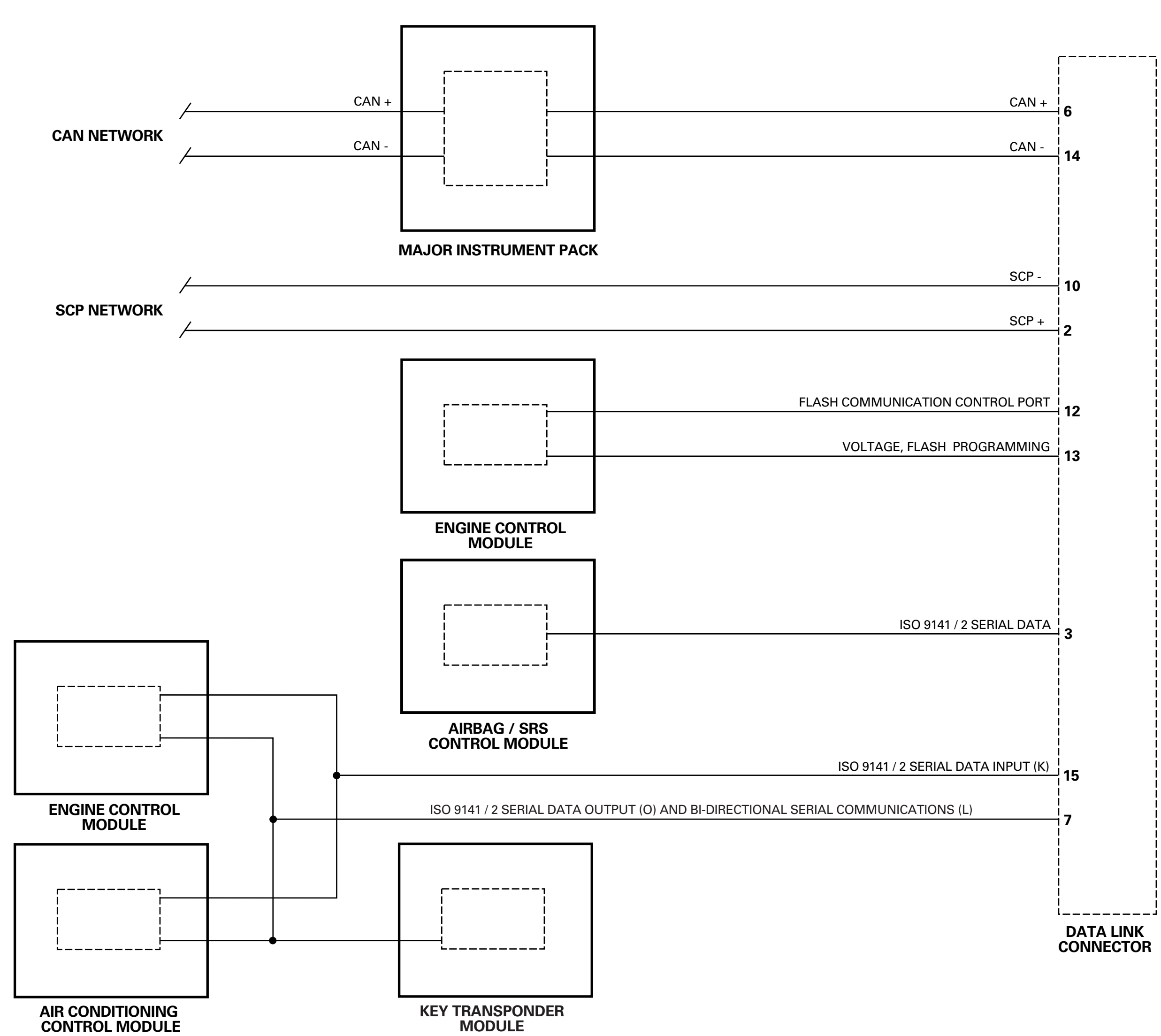
Data Link Connector (DLC) (continued)

The ISO 9141/2 communications links connect the following components to the DLC:

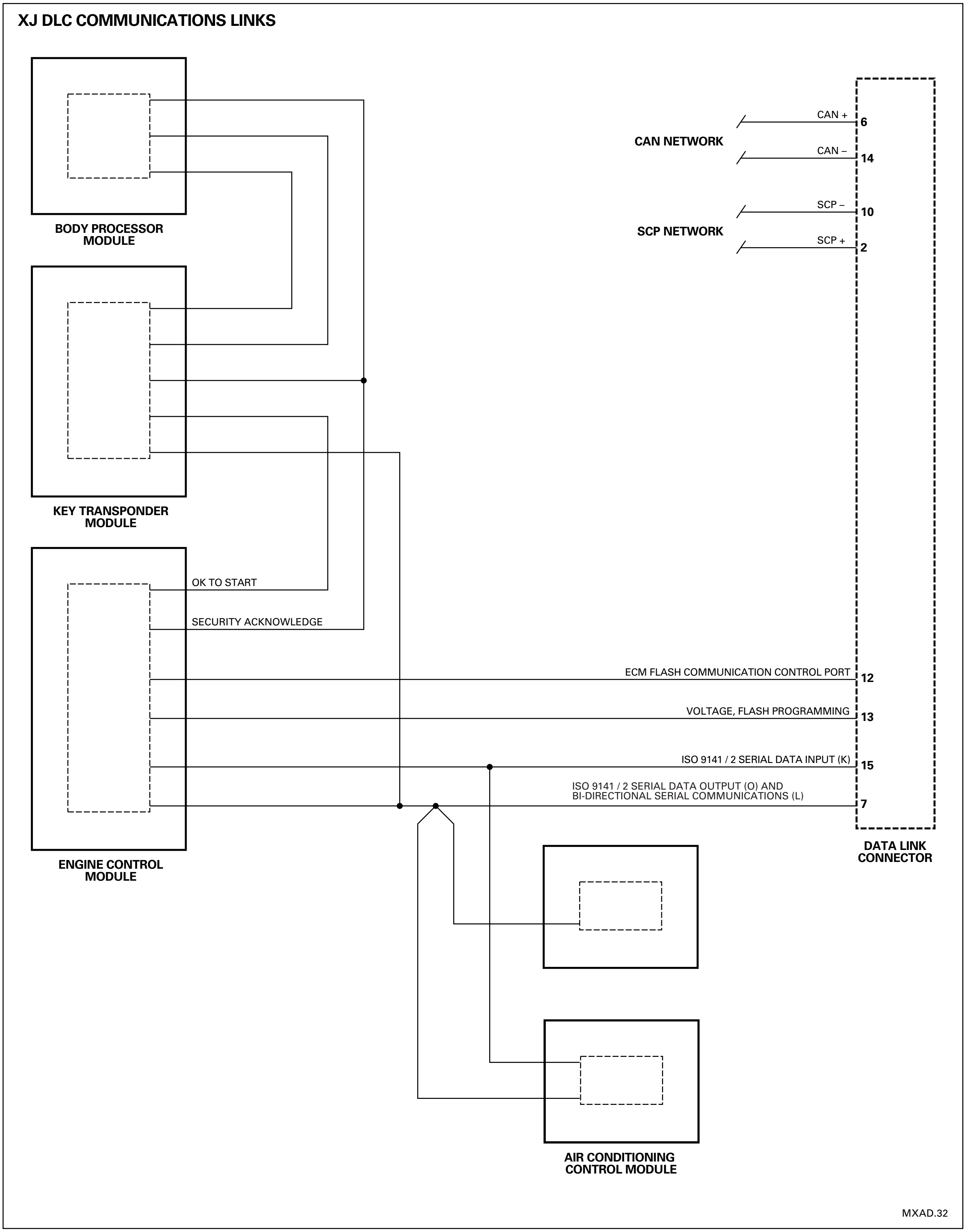
- ECM — Scan tool legislated OBD II DTC / freeze frame connection (this link is also used by WDS for OBD II DTCs and freeze frame data)
- ECM — Module "flash" programming
- A/CCM — PDU diagnostics and programming for pollen / particle filters
- Airbag / SRS CM — PDU diagnostics
- KTM — PDU diagnostics and programming

NOTE: Generic scan tools communicate only with the ECM for OBD II DTCs and legislated freeze frame data.

XK DLC COMMUNICATIONS LINKS



MXAD.31


XJ DLC COMMUNICATIONS LINKS
BODY PROCESSOR MODULE
KEY TRANSPONDER MODULE
ENGINE CONTROL MODULE
OK TO START
SECURITY ACKNOWLEDGE
CAN NETWORK
CAN +
6
CAN –
14
SCP NETWORK
SCP –
10
SCP +
2
ECM FLASH COMMUNICATION CONTROL PORT
12
VOLTAGE, FLASH PROGRAMMING
13
ISO 9141 / 2 SERIAL DATA INPUT (K)
15
ISO 9141 / 2 SERIAL DATA OUTPUT (O) AND BI-DIRECTIONAL SERIAL COMMUNICATIONS (L)
7
DATA LINK CONNECTOR
AIR CONDITIONING CONTROL MODULE
MXAD.32

MULTIPLEX ADVANCED DIAGNOSTICS

JAGUAR

Service Training Course MXAD

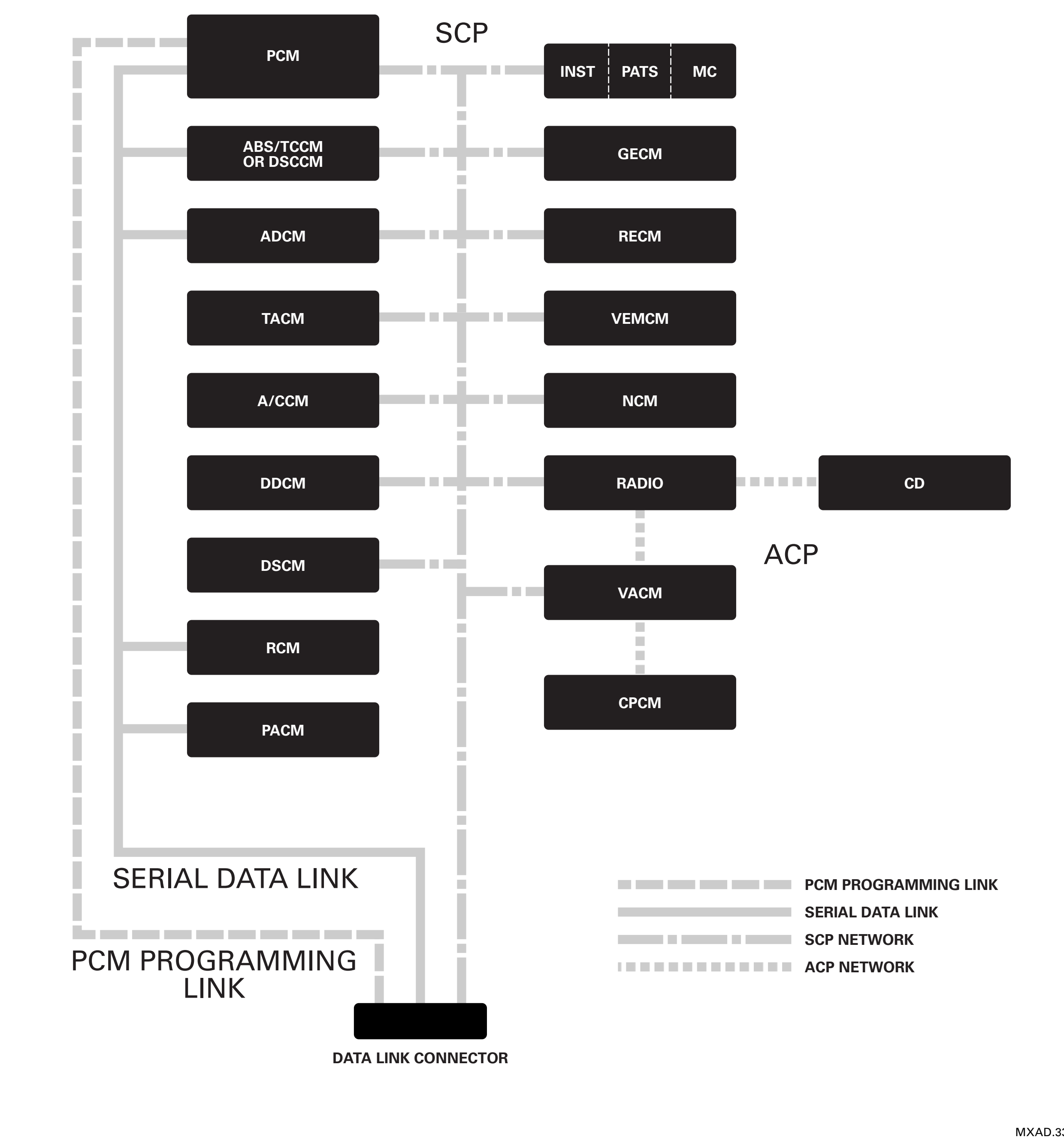
DATE OF ISSUE: 02/15/2002

S-TYPE

Networks

Two networks are used in the S-TYPE: Standard Corporate Protocol (SCP) Network for powertrain and body systems; Audio Control Protocol (ACP) Network for audio and telematics systems. In addition, the required serial data link is used for diagnostic access via the data link connector (DLC).

S-TYPE NETWORK CONFIGURATION



S-TYPE

SCP Network

The Standard Corporate Protocol (SCP) network is the only communication network controlling the driveability of the vehicle and the vehicle body systems. SCP is able to replace the faster Controller Area Network (CAN) for powertrain control because both engine management and transmission control are combined into a single Powertrain Control Module (PCM).

SCP differs from CAN in that not all "messages" have to be "event driven".

Cyclic messages
Some messages, such as those relating to engine management, are "cyclic". Cyclic messages are broadcast repeatedly at a frequency of 50 ms.

Periodic event messages
Other messages are broadcast repeatedly only until a particular result is achieved. For example, during traction control operation, the ABS/TC control module may request a reduction in engine torque. The control module will continue to broadcast this request until it receives the message that the engine torque has been reduced.

Network connection from module to module consists of pairs of twisted wires, similar to previous Jaguar vehicles. Portions of the network wires are shielded to prevent interference on 2000 Model Year vehicles. The primary wire colors are slate (+) and blue (–).

The network will remain operational if one of the bus wires is open circuit, short circuit to ground or short circuit to B+ voltage. In addition, the network will remain operational if some, but not all, control module termination resistors have failed.

SCP Network Integrity Check

Battery Connected – Key OFF	**S-TYPE**
Voltage reading: SCP+ pin 2 to ground	0 Volts
Voltage reading: SCP– pin 10 to ground	5 Volts
Battery Connected – Key ON	**S-TYPE**
Voltage reading: SCP+ pin 2 to ground	0.48 Volts
Voltage reading: SCP– pin 10 to ground	4.5 Volts, varying
Battery Disconnected – Key OFF	**S-TYPE**
Ohm meter reading across network: SCP+ pin 2 to SCP– pin 10	Open Circuit
Ohm meter reading: SCP+ pin 2 to ground	115 – 125 Ohms
Ohm meter reading: SCP– pin 10 to ground	O.L., no continuity

NOTES

SCP Network Troubleshooting

WDS SCP Network Diagnostics

When WDS is used for diagnostics, it automatically tests network integrity and communications before running specific diagnostic routines.

Network integrity and communications tests

WDS tests the CAN and SCP networks separately, indicating the status while testing. CAN is tested first followed by SCP. Test procedures for CAN and SCP follow similar routines. Each network is tested with the ignition OFF, then with the ignition ON. Each module is tested in a sequence that may vary depending on the diagnostic software version. Watch the WDS screen during testing. If WDS fails the network, the communications problem is with the last module shown on the WDS screen.

With the ignition OFF, WDS transmits a "request for identification" message to the first module. If module response is correct, the next module on the network is tested. If module response is missing or incorrect, the test is failed and WDS terminates diagnostics directing the user to an appropriate specific test routine. When all modules have passed, WDS switches the ignition ON and WDS transmits a vehicle speed signal to the ECM. The ECM transmits a CAN vehicle speed message, which is also the module "wake up" call. Each module should respond with an "I'm awake" message. If WDS does not recognize an "I'm awake" message from each module, the test is failed and WDS terminates diagnostics directing the user to an appropriate specific test routine. Because the INST translates the CAN message and transmits it to the SCP modules, the same procedure is used for the SCP network test. When all tests are passed, WDS begins the user specified diagnostic routines.

> **NOTE:** If only SCP high (+) or low (-) is functioning, the system will pass part one of the test and WDS lists the modules that failed to respond.

SCP Network Failure Modes

The WDS diagnostic routine tests the network wiring but will not pinpoint an individual module failure. If a network failure is established by WDS, then pinpoint the fault by using the following information and a DVOM.

An open circuit or a short circuit in an SCP high (+) OR an SCP low (-) wire will not stop communication. Data will still be communicated over the remaining wire using the chassis as ground. However, some data errors may occur.

An open circuit in both the SCP high (+) AND the SCP low (-) wires will stop communication at the open circuit. Modules on either side of the open circuit will continue to communicate with modules on the same side, but no data will cross the open circuit.

SCP modules will communicate only when the SCP high (+) and the SCP (-) circuits are in an acceptable electrical state. The following shows communication possibilities depending on the electrical state of each wire.

Wire	Condition	Communication
SCP high (+) OR SCP low (-)	open circuit	YES (if other SCP circuit is functioning)
SCP high (+) OR SCP low (-)	short circuit to ground	YES (if other SCP circuit is functioning)
SCP high (+) OR SCP low (-)	short circuit to B+ voltage	YES (if other SCP circuit is functioning)
SCP high (+) AND SCP low (-)	short circuit to ground	NO
SCP high (+)	short circuit to SCP low (-)	YES (unless one is also short circuit toground)

S-TYPE

SCP Network

Network Symptoms

In the event the network fails, certain symptoms may occur. Each (with the exception of a single open wire) may result in customer concerns. Symptoms include:

- **Wire shorted to power** – If either Circuit is shorted to power, a complete network failure may occur.
- **Wire open** – With a single wire open, you may be able to enter the DATA LINK DIAGNOSTIC menu and perform tests. However, any information received may be invalid.
- **Both wires open** – If both wires are open near the data link connector, no communications can be established between WDS and the network. However, if both wires are open in one of the branches of the network, only the modules that come after the open will not be able to communicate with WDS.
- **Both wires shorted to ground** – If both wires are shorted to ground, complete network failure will result. All control modules will operate in Failure Mode Effects Management (FMEM). The vehicle will not start. PATS Code 16 will be set.
- **Internal control module failure** – An internal control module failure may result in a complete network failure.

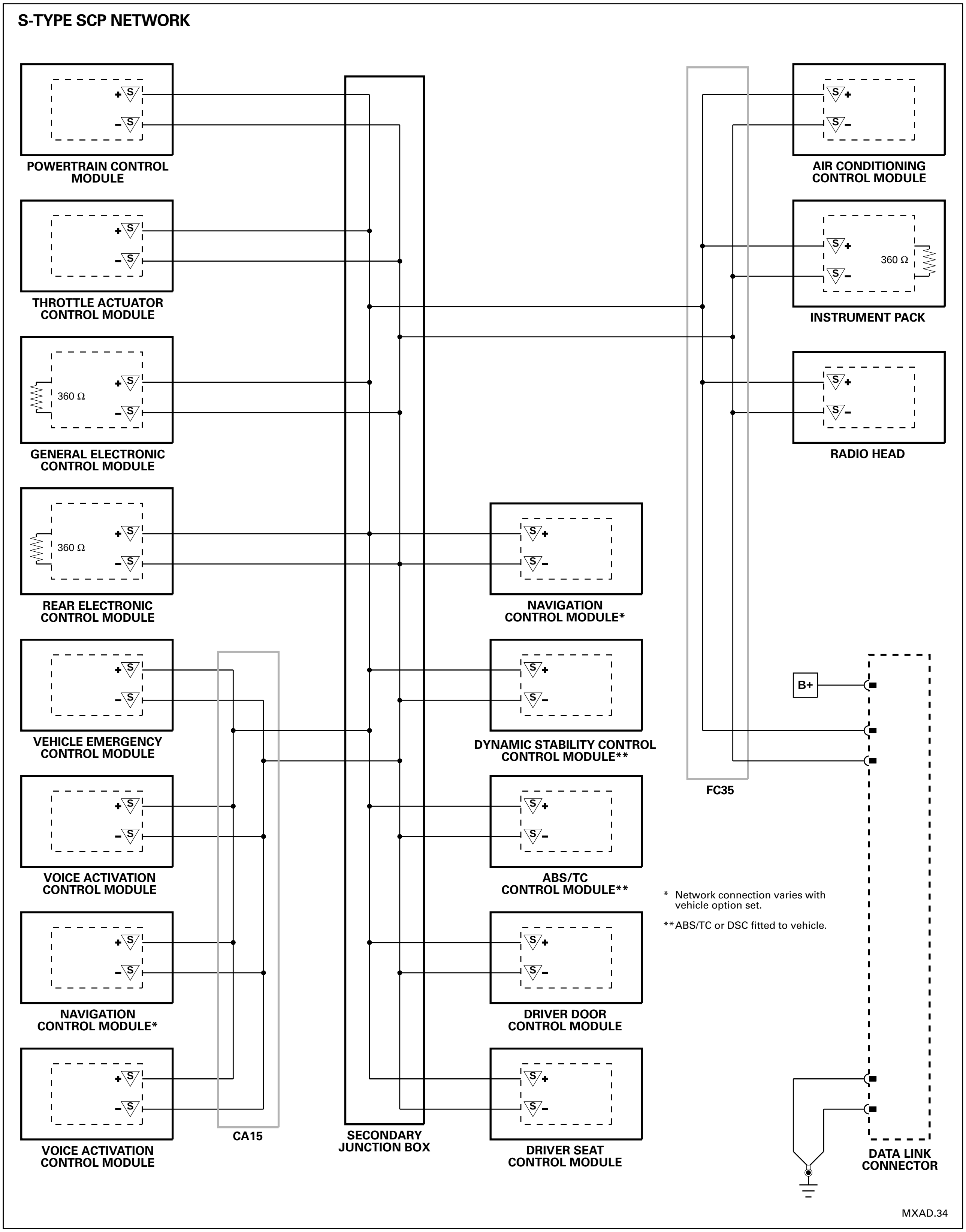
Communication Circuit Wiring Repair

NOTE: If the SCP Circuit is repaired or replaced without following the proper repair procedure, the operation of the network will be degraded.

Both SCP wires must be twisted at a rate of 33-40 twists per meter (3.3 feet) anytime replacement of either circuit is required. The twist must be within 10 centimeters (4.9 inches) of any connector termination point.

The conductor for the SCP Network must be No. 20 AWG wire.

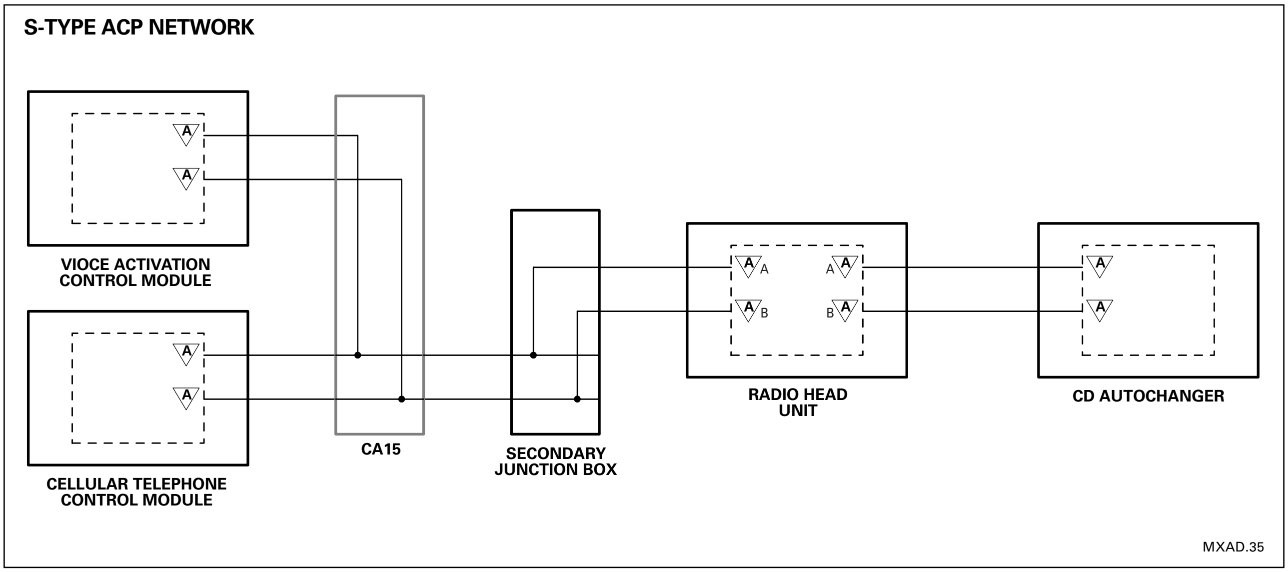
NOTES


S-TYPE SCP NETWORK
POWERTRAIN CONTROL MODULE
THROTTLE ACTUATOR CONTROL MODULE
360 Ω
GENERAL ELECTRONIC CONTROL MODULE
360 Ω
REAR ELECTRONIC CONTROL MODULE
VEHICLE EMERGENCY CONTROL MODULE
VOICE ACTIVATION CONTROL MODULE
NAVIGATION CONTROL MODULE*
VOICE ACTIVATION CONTROL MODULE
CA15
SECONDARY JUNCTION BOX
NAVIGATION CONTROL MODULE*
DYNAMIC STABILITY CONTROL CONTROL MODULE**
ABS/TC CONTROL MODULE**
DRIVER DOOR CONTROL MODULE
DRIVER SEAT CONTROL MODULE
AIR CONDITIONING CONTROL MODULE
360 Ω
INSTRUMENT PACK
RADIO HEAD
B+
FC35
* Network connection varies with vehicle option set.
** ABS/TC or DSC fitted to vehicle.
DATA LINK CONNECTOR
MXAD.34

S-TYPE

ACP Network

The ACP network does not have a specific test to determine the condition of the network. The condition of the network is determined by using WDS.The ACP network produces an AC signal on a DC bias voltage. To check using a DVOM, a voltage of approx. 4.6 volts should be seen on the ACP-A line while a voltage of approx. 0.4 volts should be seen on the ACP-B line.



NOTES

MULTIPLEX ADVANCED DIAGNOSTICS

JAGUAR

Service Training Course MXAD

DATE OF ISSUE: 02/15/2002

X-TYPE MULTIPLEXING

Module Communications Network

The X-TYPE is the most complex Jaguar vehicle to date in terms of both the number of harness variants and the possible combinations necessary to achieve give vehicle specifications. The most significant deviation from the distribution system used for other Jaguar models is the introduction of optical fiber cables to accommodate the transfer of very high-speed, real-time audio data.

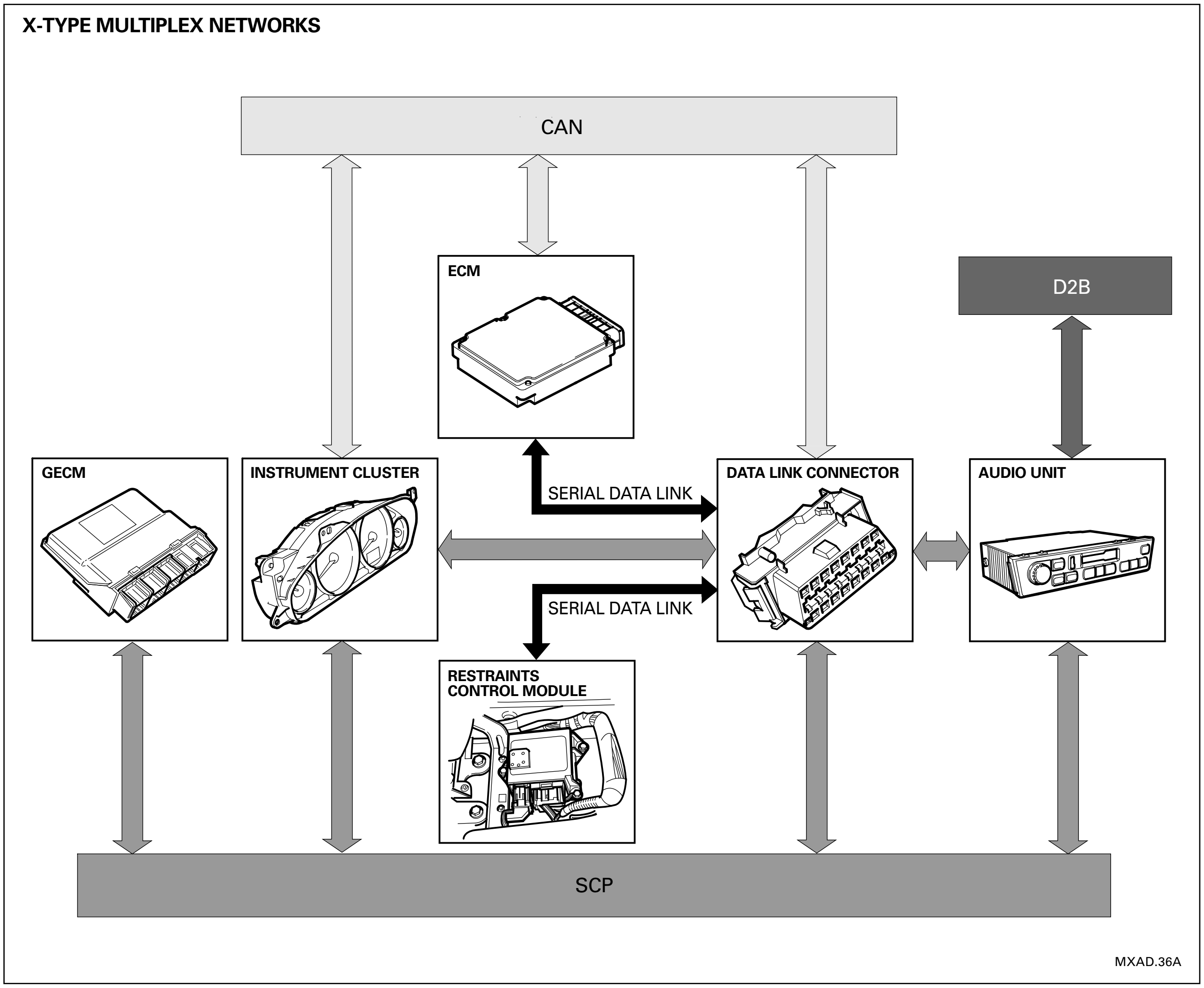
The optical fibers provide an optical network that interfaces to the SCP network via the audio unit. Refer to D2B Network for detailed information.

> **NOTE:** The optical network currently uses a transfer protocol known as D2B. Although this protocol may change in the future, the optical network will be referred to as “D2B” throughout this and other Jaguar technical publications.

SCP, CAN and Serial Data Link (ISO 9141) Networks

The Standard Corporate Protocol (SCP), Controller Area Network (CAN) and Serial Data Link (ISO 9141) networks are configured in a similar way to current Jaguar models to accommodate different data types and flow rates as required for various vehicle features.

NOTES

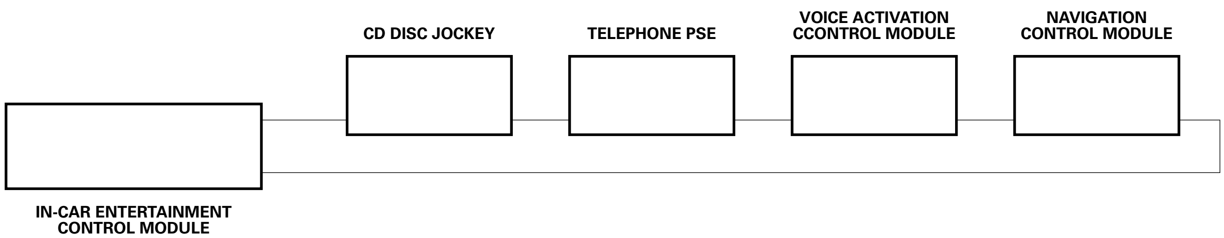

X-TYPE MULTIPLEX NETWORKS
CAN
ECM
D2B
GECM
INSTRUMENT CLUSTER
SERIAL DATA LINK
DATA LINK CONNECTOR
AUDIO UNIT
SERIAL DATA LINK
RESTRAINTS
CONTROL MODULE
SCP
MXAD.36A

X-TYPE

D2B Network

The network is a unidirectional ring with audio signals and command messages traveling in a clockwise direction. The ICE is the master module that manages the network and acts as the gateway to the SCP network. The other modules are slave modules that respond to the wake up command from the ICE.

D2B NETWORK SCHEMATIC



MXAD.36

The wake up command is a separate, hard wired electrical pulse sent from the ICE to the other modules. The ICE sends this pulse in response to the key being turned to the accessory position. This turning triggers the modules to look for the first light signal sent out by the ICE. At the end of this initialization procedure, the modules are ready for full network operation. If any part of this initialization fails, DTCs will be logged.

NOTES

Precautions and Safety

D2B is inherently safe. No laser transmitters are used so the light transmitted around the ring will not cause damage to the human eye. However, the use of laser light pens for fiber tracing or diagnosis may result in an unsafe condition and should be avoided. Always use the correct tools for diagnosis.

During handling of connectors, great care should be taken to ensure that fiber ends are not damaged, scratched or polluted with dirt or dust. The fiber ends must not be touched with fingers, even after hand washing, as the natural oils in the skin will permeate the fiber and may eventually attract dust or cause light loss. This is particularly important if a fiber has to be removed from a connector shell as the fiber end will be even more vulnerable to damage.

Do not use any tools such as a screwdriver to unlatch connectors as the subsequent locking function may be lost.

When a connector is unlatched, immediately place a dust cap over the exposed ends. If any dust is visible on a connector, use only compressed air to remove.

Network Initialization

The network automatically initializes at each key cycle to enter its normal operating state. This initialization is carried out by the ICE, which sends a hard-wired electrical pulse to each of the slave modules. The ICE does this only in response to the key being turned to the accessory position. When the slave modules receive the electrical wake-up signal they will look for a light signal from the preceding module. Each slave module will receive this signal and then transmit it on to the next in the ring. The last slave module in the ring will transmit it back to the ICE. The receipt of this signal allows the ICE to lock the ring. To complete the initialization the ICE sends out the following messages:

- **Set Position**

  The first slave module receives this message, modifies it and transmits it to the next slave. Each slave can see how many times the message has been previously modified and can therefore identify its numerical position in the ring.
- **Report Position**

  On receipt of this message each slave will transmit its position in the ring to the ICE.

This completes the initialization procedure. The modules are now ready to transmit and receive command messages and audio signals.

Module Configuration

During the network initialization procedure the ICE receives a position report from all the slave modules. This tells the ICE how many modules are in the ring. The ICE will compare this figure with the value stored in its configuration memory. This value was entered during the vehicle build process. If the two figures are different a DTC will be logged.

CAUTION: It is important to use WDS to reconfigure the ICE if any extra systems e.g. telephone or CD are fitted or removed at a later date.

NOTES

X-TYPE

D2B Network (continued)

Network Diagnostics

The D2B master module and most of the slave modules can log DTCs in the event of a network failure. These DTCs can then be read by the WDS via the SCP network. The only slave module that doesn't store DTCs is the CDDJ. Any DTCs relating to the CDDJ are stored by the ICE. The following tables show the available DTCs.

DTCs which can be logged by any module

DTC	Description
U2609	D2B electrical wake up pulse width out of specification. Master and slave modules monitor the wake up line and log this DTC if the pulse width is outside the specification 50ms – 110ms.
U2601	Wake up line shorted to ground. Master and slave modules monitor the wake up line during network initialization and log this DTC if the line is shorted to ground for greater than 1 second.

Network Fault Finding

If a master module DTC indicates that a slave module isn't receiving messages from a previous module, there could be a number of possible causes.

- Faulty receiver in the slave module.
- Faulty transmitter in the previous module.
- Faulty optical fiber harness between the slave module and the previous module.
- Optical power loss in the harness between the slave module and the previous module.
- Fault within the slave module.
- Fault within the previous module.

The following procedure should be followed to identify the exact cause:

1. Check for the security and integrity of the network connectors, cables and harnesses where possible without major disruption to trim panels (some may not be easily accessible). This should include the following points:
   – Sharp bending of optical fibers (this should be checked before disturbing any module or connector). Correct engagement of optical connectors.
   – Correct placement of optical connectors (ring order).
   – Correct engagement of electrical connectors.
   – Damage to optical fibers (chafing, abrasion, kinking, cuts, breaks)
   – Correct assembly of optical connectors (backout etc.).
2. Verify the wake up pulse and module power supplies (battery, accessory and ignition).
3. Disconnect the D2B connector from the slave module which identified the fault.
4. Turn the key to the accessory position and check for light pulses at the incoming pin from the previous module.
5. If light pulses are present then the fault is most probably with the receiver of the identifying module or with the module itself. In either case the module should be changed.

6. If no light pulses are present then the fault must lie with the previous module or the optical cable.
7. Reconnect the identifying module and disconnect the previous module. Check for light pulses from the transmitter of this module when the key is turned to the accessory position.
8. If no light is present then the fault must be with the transmitter of this module or the module itself. In either case the module should be changed.
9. If light pulses are present then the fault must be with the fiber optical cable.

Visual (human eye) measurement of optical power loss
Shining a light down a fiber is a useful aid to route tracing and fiber identification, however it must not be used as a method of determining fiber integrity. Excessive light loss in a fiber will cause a network malfunction but the human eye cannot accurately measure light intensity. For this reason a torch or light source should not be used in conjunction with the human eye to infer loss in the fiber. Use the D2B Optical Bus Tester tool #415-S003.

System behavior after network shutdown
If the master module detects a break in the ring it will shut down the network. If this happens, the system will behave as if some of the slave modules are not fitted. The following table shows the responses of the different slave modules.

System response to a break in the ring

Slave System	System Response
Navigation	The navigation system will continue to operate with the exception of audio feedback and voice control which will not be available.
CDDJ	If the CD is selected, the message “CDDJ not fitted” will be displayed.
PSE	If the telephone is selected, the message “Phone not fitted” will be displayed.
VOICE	If the voice command button is pressed, it will behave like an audio mute button as though a voice system were not fitted.

NOTES

X-TYPE

D2B Network (continued)

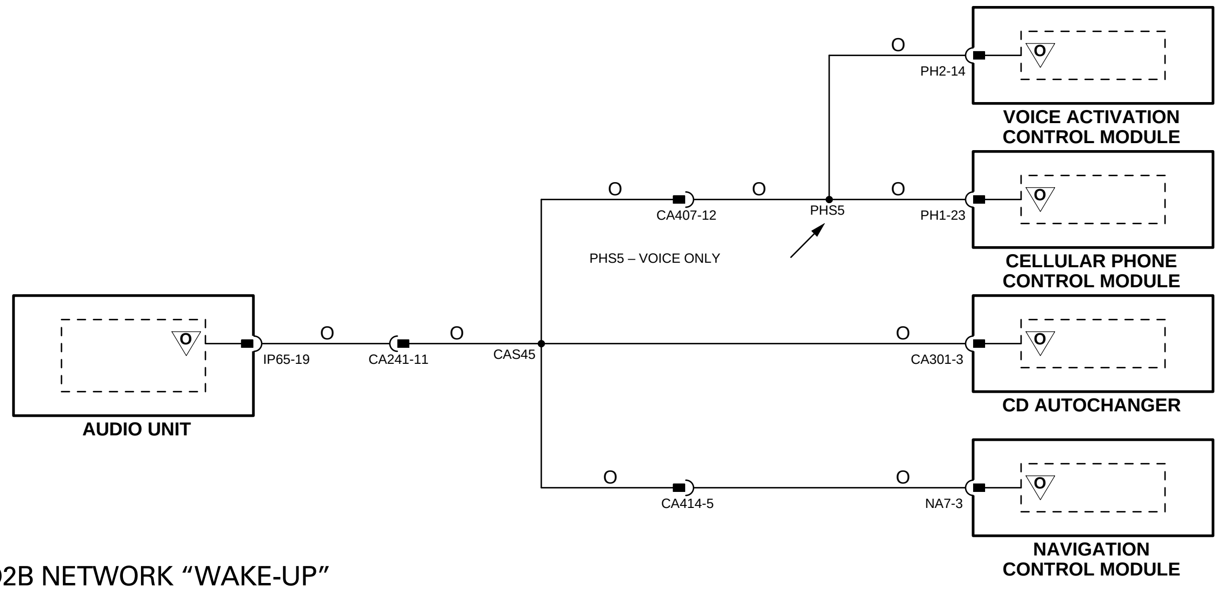
Network Fault Finding

Summary of Ignition Switch Positions I and II and their impact on loss of signal

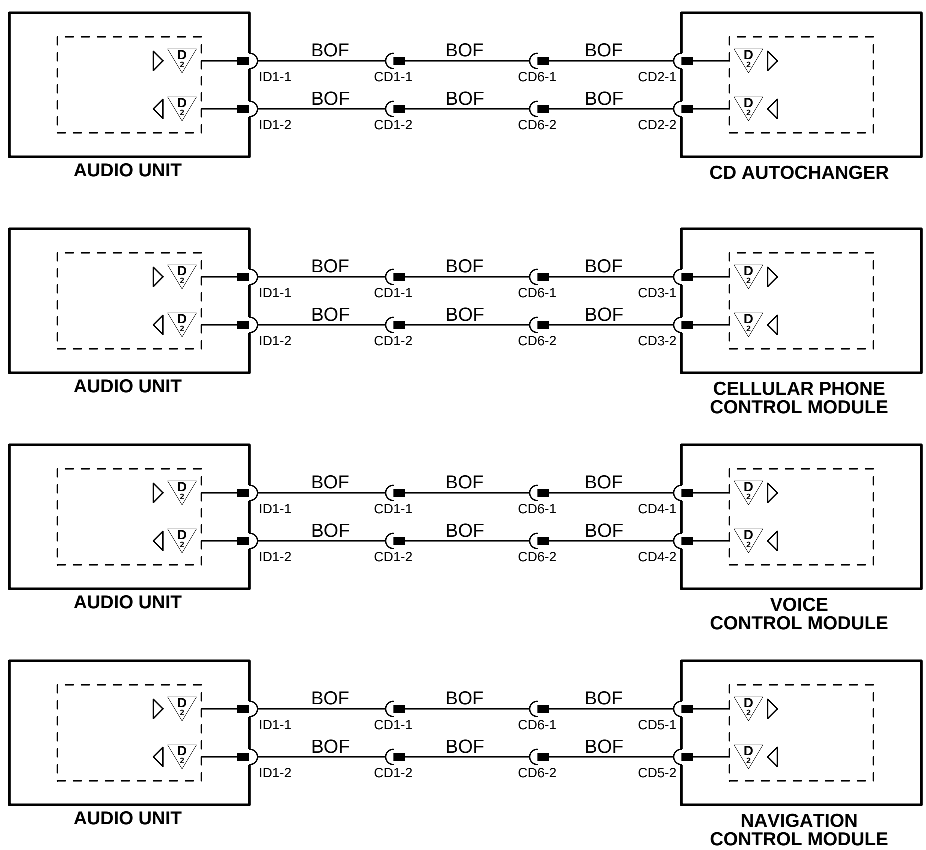
Device Level	AUDIO	CD	PHONE	VOICE	NAV
Loss of wake-up (device operates in bypass modes)	n/a	no operation	in bypass	in bypass	in bypass
Loss of Position I at engine start-up	no operation	n/a	no operation	no effect	no operation
Loss of Position I during operation		n/a	Power Down	no effect	ring dies
Loss of Position II at engine start-up	n/a	n/a	no effect	no effect	n/a
Loss of Position II during operation	n/a	n/a	no effect	no effect	n/a
Loss of Position I and II at engine start-up	n/a	n/a	no operation	no operation	n/a
Loss of Position I and II during operation	n/a	n/a	Power Down	no effect	n/a

NOTES

D2B NETWORK “WAKE-UP” AND TWO-NODE NETWORKS



D2B NETWORK “WAKE-UP”

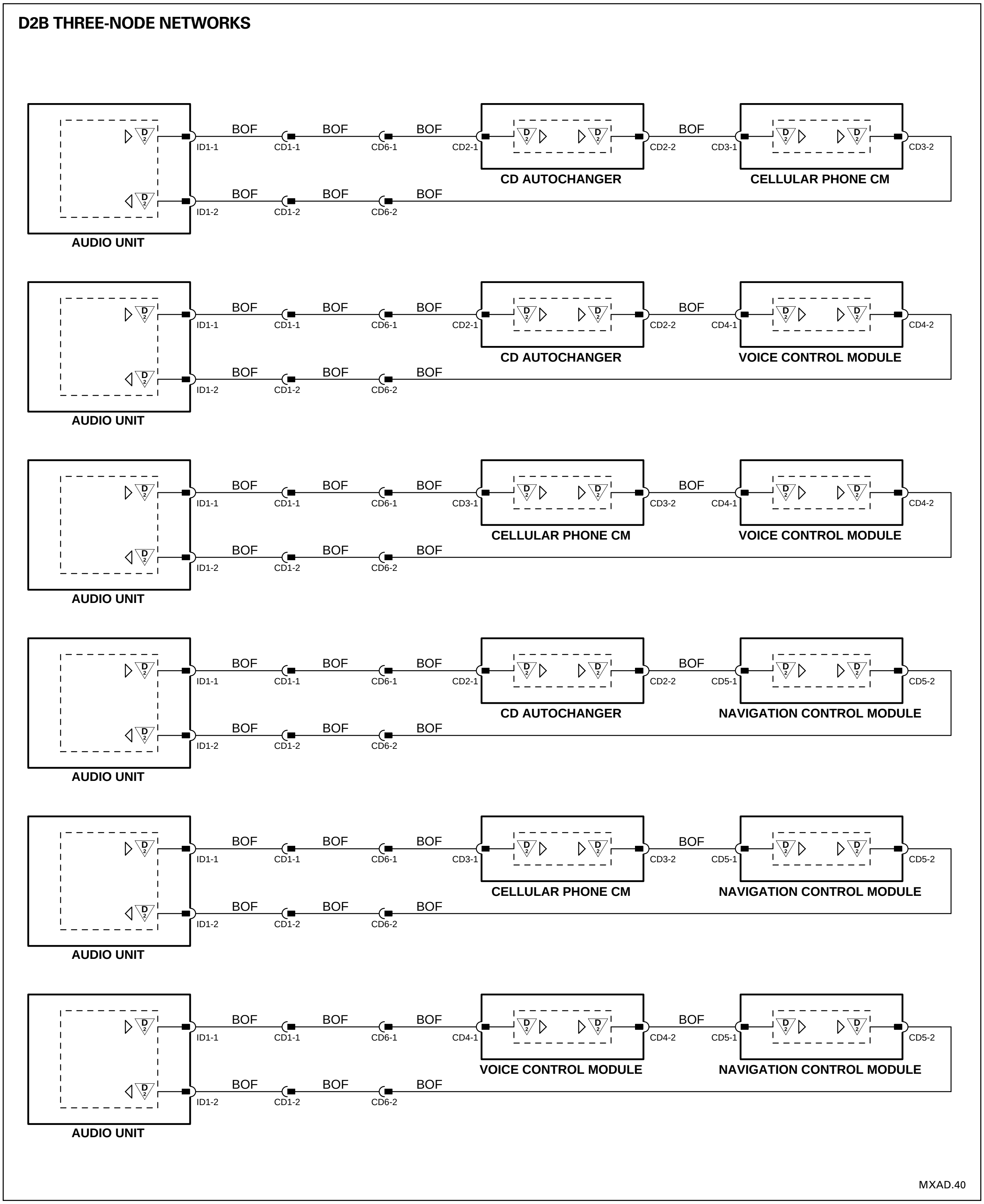


TWO-NODE NETWORKS

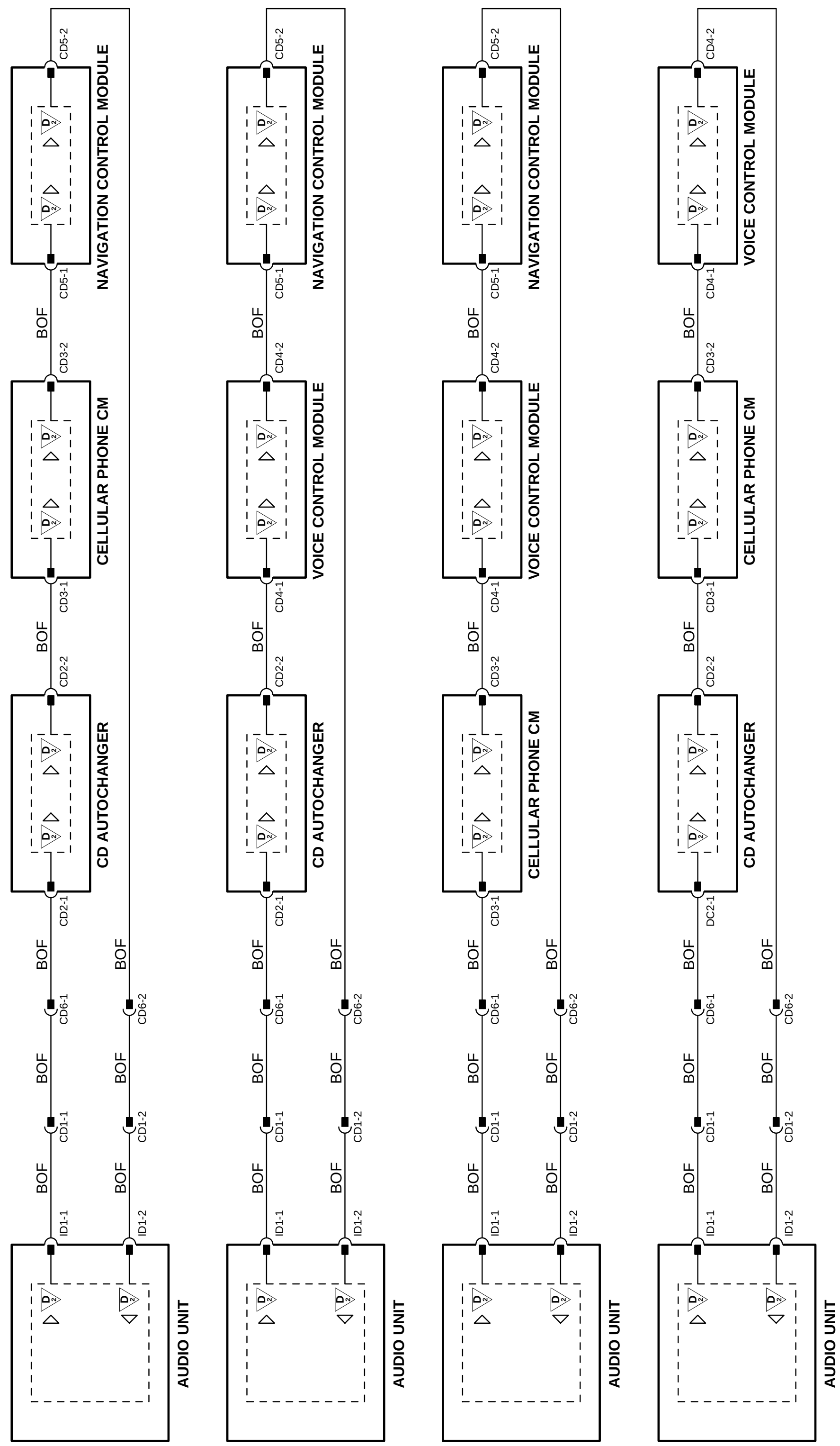
MXAD.38, 39

X-TYPE

D2B Network (continued)



D2B FOUR-NODE NETWORKS



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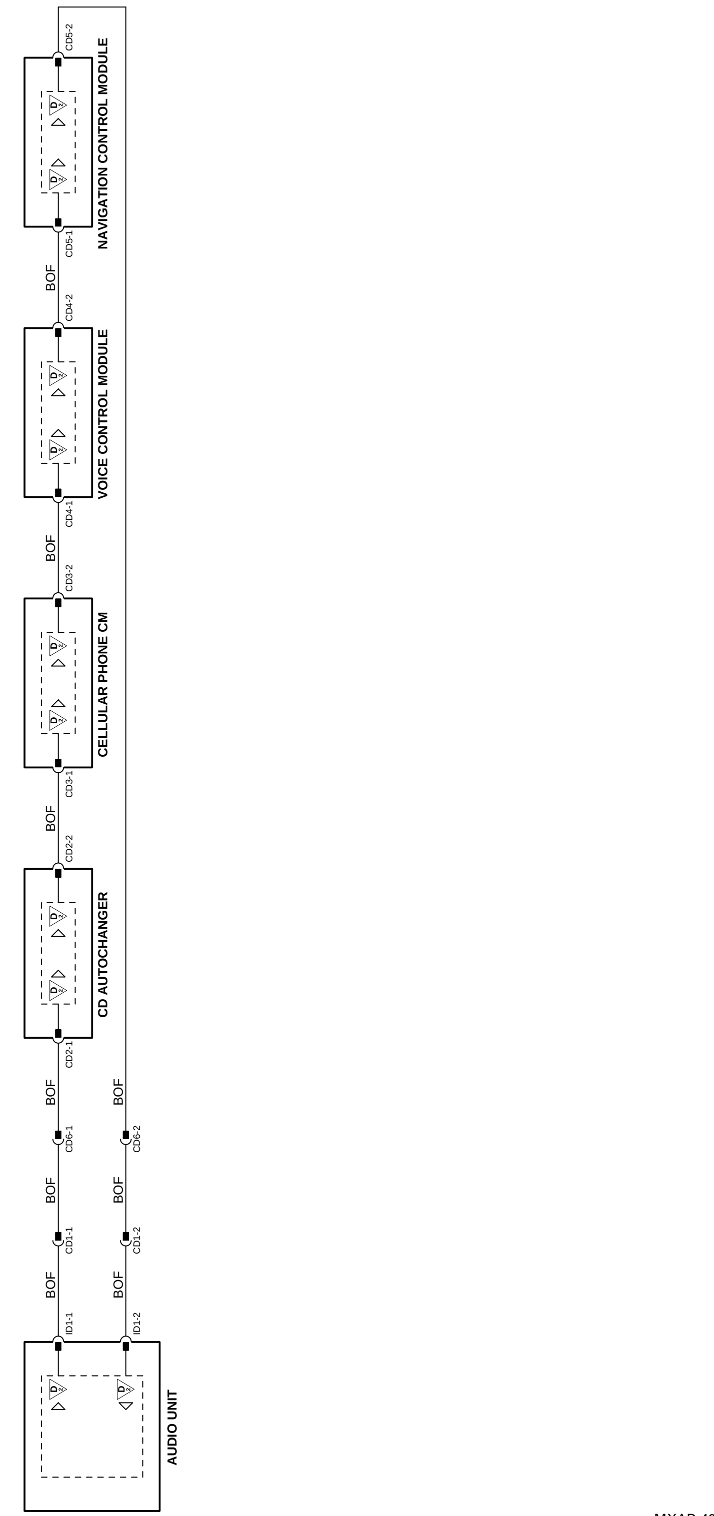
X-TYPE

D2B Network (continued)

D2B FIVE-NODE NETWORK



MULTIPLEX ADVANCED DIAGNOSTICS

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TASK SHEET 1 – DIAGNOSING AND REPAIRING A CUSTOMER CONCERN

Vehicle type ________________ VIN ______________________ Model Year __________________

Customer Concern ____

1. Verify Concern: What do you know?

____

____

____

Symptoms: ____

____

____

2. Analyze the concern: Understand how affected system is supposed to work.

____

____

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____

____

3. Isolate the Concern: Use information available and your understanding of the affected system and then identify probable causes.

____

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____

____

4. Repair Concern: What is needed to fix the symptom?

____

____

____

____

____

5. Recheck Customer Concern: Verify your repair fixed the symptom the customer was concerned about.

TASK SHEET 1 (continued)

Action Plan:

Give yourself/team an "Action Plan" of how you are going to attack this problem. Using the information available and with the aid of the correct wiring diagram, check circuits using WDS or a DVOM and compare results with information on the Data page of the Electrical Guide Figure. Write in all information gathered from vehicle and look at wiring diagram to determine fault area.

Before touching the vehicle explain to the instructor your team's plan of action.

System being worked on ______________________ Electrical Guide Figure ________

CM connector #, pin #, I/O	How and where measured?	Expected Values V, A, Ω, Hz or %	Actual Values V, A, Ω, Hz or %

Demonstrates Competence: Instructor Signature ______________________ Date ____________

TASK SHEET 2 – DTC INPUT/OUTPUT WORKSHEET

Vehicle type ________________ VIN ______________________ Production Date ______________

Research the DTC associated with the symptom and fill in the table with the appropriate information. Use correct scale on multimeter to monitor the input/output for the correct signal.

DTC: ______________________________ Resource: ____________________________________

System ______________________________ Electrical Guide Figure __________________________

Control Module (that DTC is associated with) ____

Fault Description ____

MIL / MESSAGE / WARNING or indication of fault ____

Pin / wire to check for Input: ___________

Correct reading

Active ___________________________

Inactive __________________________

Actual Reading

Active ___________________________

Inactive __________________________

Pin / wire to check for Output: _________

Correct reading

Active ___________________________

Inactive __________________________

Actual Reading

Active ___________________________

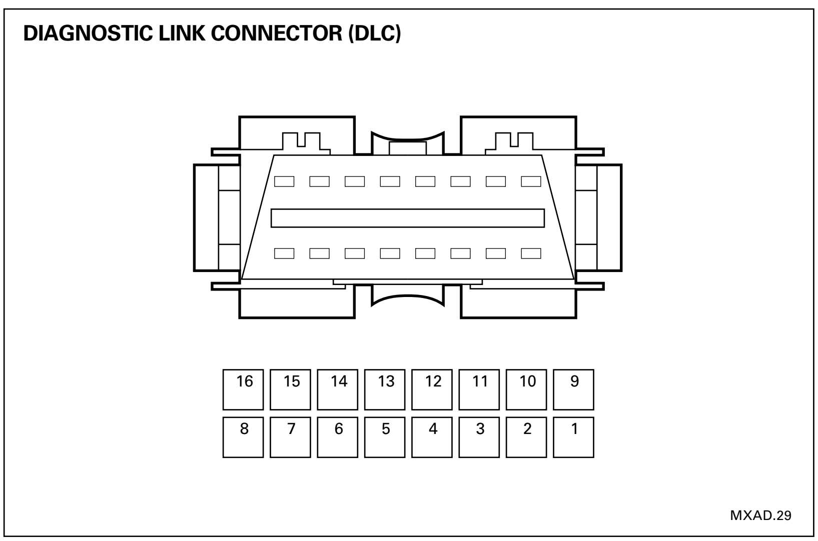
Inactive __________________________

Demonstrates Competence: Instructor Signature ____ Date ____________

TASK SHEET 3 – XK SCP CONTROL MODULE VOLTAGE

XK SCP Control Module Voltage Values (approximate)

Component	Pin 2 (Y) to Ground	Pin 10 (U) to Ground
INST		
BPM		
SLCM		
DDCM		
DHRCM		
DSCCM		
PDCM		
PHRCM		
PSCM		



Demonstrates Competence: Instructor Signature ______________________________ Date ______________

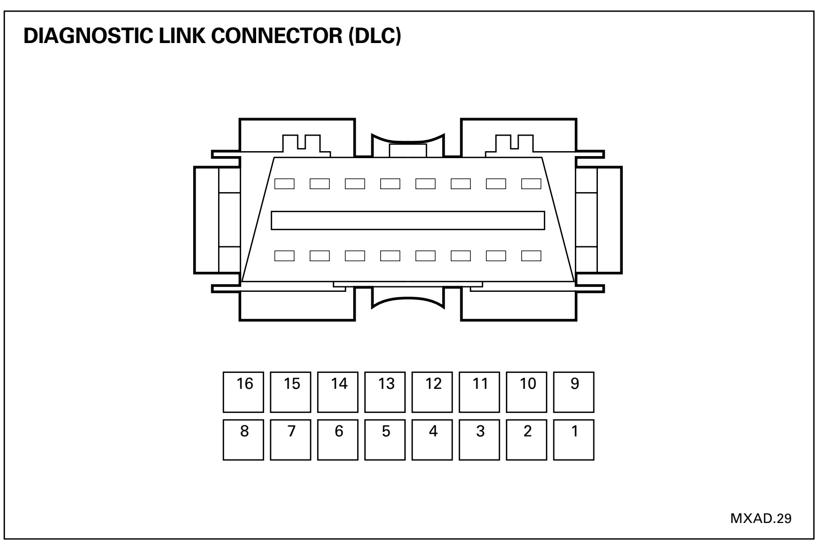
TASK SHEET 4 – S-TYPE VOLTAGE MEASUREMENTS AT DLC

S-Type Voltage Measurements at Diagnostic Link Connector

Take the following voltage measurements at the SCP pins at the diagnostic link connector.

Condition	SCP+ (Pin 2)	SCP – (Pin 10)
Network Intact (Ign OFF)		
Network Intact (Ign ON)		
Network O/C (Ign OFF)		
Network O/C (Ign ON)		
Network shorted together (Ign OFF)		
Network shorted together (Ign ON)		
Network shorted to battery (Ign OFF)		
Network shorted to battery (Ign ON)		
Network shorted to ground (Ign OFF)		
Network shorted to ground (Ign ON)		

Pin 2: SCP+
Pins 4 & 5: Ground
Pin 10: SCP-
Pin 16: B+



Demonstrates Competence: Instructor Signature ____________________ Date ________

TASK SHEET 5 – NETWORK MESSAGES

Using the Electrical Guide Figures and the assigned vehicle, fill in the following table for the indicated systems.

Drivers demand input	**Control Module hard wired to input (include network)**	**Network message is sent to / through (include network)**
Brake application		
Right front window down		
Rear fog lights ON		
Left turn signal		
Traction control OFF		

Demonstrates Competence: Instructor Signature ____________________ Date __________

TASK SHEET 6 – FAULT FINDING

1. Customer concern: REVERSE lamps inoperable (XJ or XK)

   Fault: ______________________________

2. Customer concern: Multiple warnings (XJ or XK)

   Fault: ______________________________

3. Customer concern: Car will not come out of PARK (XJ or XK)

   Fault: ______________________________

4. Customer concern: Engine cranks, no start (S-TYPE)

   Fault: ______________________________

5. Customer concern: Engine cranks, no start (S-TYPE)

   Fault: ______________________________

6. Customer concern: No crank or start (XJ, XK, or X-TYPE)

   Fault: ______________________________

7. Customer concern: CD Autochanger won't work—radio display says not installed (X-TYPE)

   Fault: ______________________________

8. Customer concern: CD Autochanger won't work and no voice directions given from navigation system (X-TYPE)

   Fault: ______________________________

9. Customer concern: ABS/TC Fault (XJ)

   Fault: ______________________________

10. Customer concern: Alarm will not disarm with key transmitter. Alarm sounds when unlocked with key. (XK / XJ)

    Fault: ______________________________

Demonstrates Competence: Instructor Signature ______________________________ Date ______________