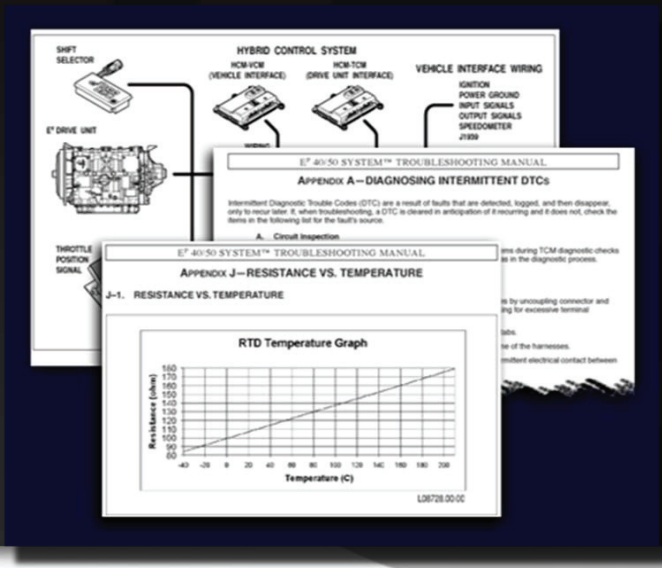
DIAGNOSTICS — USING THE TROUBLESHOOTING MANUAL

Allison Transmission. Instructor Led Training

Using The Troubleshooting Manual

Introduction

- Allison Hybrid H 40/50 EP System Troubleshooting Manual:
  - *Publication number TS3715EN.*
- Shares a similar design and layout to other Allison troubleshooting manuals.



1 of 7

DIAGNOSTICS — USING THE TROUBLESHOOTING MANUAL

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Using The Troubleshooting Manual

Troubleshooting Manual Sections

- **Electrical Safety section:**
  - *Procedures for safely working with the voltages present in the system.*
- **General Description section:**
  - *Overviews Electronic Control system components and operation.*
- **Definitions and Abbreviations:**
  - *Provides descriptions of key terms and acronyms.*
- **Basic Knowledge section:**
  - *Describes basic information technicians need for successful troubleshooting.*

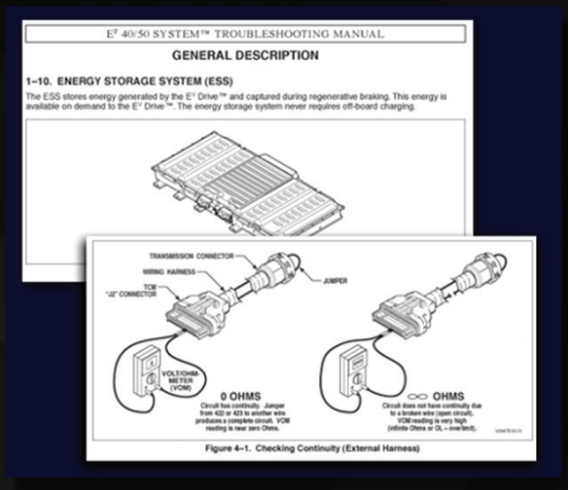

Figure 4–1. Checking Continuity (External Harness)

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2 of 7

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RESOURCES: Electrical Safety

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

E^{P} 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

ELECTRICAL SAFETY

WARNING!

The Allison Electric Drive E^{P} 40/50 System™ uses potentially hazardous electrical energy. All E^{P} 40/50 System™ components are identified with warning labels or symbols (see Figure 1, Figure 2, and Figure 3). DO NOT attempt to service components containing potentially hazardous electrical energy if you are not trained to do so.

All persons working with potentially hazardous electric energy should familiarize themselves with safe electrical work practices. Paragraph f in Electrical Safety section contains references to publicly available documentation that can assist a technician in developing the safe electrical work practices required to service the E^{P} 40/50 System™ electrical system.

E^{P} 40/50 System™ Normal Operating Conditions

ESS Voltage Range: 432–780VDC
DPIM Voltage Range: –350 to +350A

Figure 1. DPIM Warning Label

Figure 2. ESS Warning Label

RESOURCES: General Description

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

E^{P} 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

SECTION 1—GENERAL DESCRIPTION

1–1. E^{P} 40/50 SYSTEM™

The Allison E^{P} 40/50 System™ is a fully automatic, electronically-controlled, fuel efficient and low emission means to provide propulsion for transit buses and medium- or heavy-duty trucks. The E^{P} 40/50 System™ is described as a two-mode compound split parallel hybrid architecture. The following terms define the architecture:

- Two-mode—a low (Mode 1) and a high speed (Mode 2) range.
- Compound Split—engine torque and electric motor torque are continuously blended through an input split (Motor A) and output split (Motor B).
- Parallel—two parallel torque paths available for transmitting engine and motor/generator torque through the transmission as output torque.
- Hybrid—combines an internal combustion (IC) engine with electrical machines to provide propulsion.

The E^{P} 40/50 System™ provides “engine buffering and decoupling” to limit the rate of engine rpm change and to keep the engine operating at its most fuel efficient, low emission tuned, torque-speed points.

An Allison E^{P} 40/50 System™ consists of the following four main components:

- E^{V} Drive™—serves as the vehicle transmission.
- Transmission Control Module (TCM)/Vehicle Control Module (VCM)—a pair of master microprocessor-based controllers that operate together to process data and request action for operation of the E^{P} 40/50 System™ and other vehicle features. The TCM/VCM communicate with other microprocessor-based controllers on a Controller Area Network (CAN) inside and outside the E^{P} 40/50 System™ using an SAE J1939 compliant datalink.
- Dual Power Inverter Module (DPIM)—provides inverter power electronics for E^{V} Drive™ propulsion and for charging the Energy Storage System (ESS).
- Energy Storage System (ESS)—uses advanced Nickel Metal Hydride (NiMH) batteries as the electrical power source for the E^{P} 40/50 System™.

1–2. E^{V} DRIVE™

The E^{V} Drive™ is designed to combine (torque blend) electrical machine torque with engine torque while driving in a forward direction. The E^{V} Drive™ does not have fixed gear ratios as does a typical automatic transmission. The gear ratios, speed ratios, and torque ratios through the E^{V} Drive™ are continuously variable until maximum ratings are reached. The E^{V} Drive™ has three planetary gear sets, two clutches, and two electrical machines (motor/generators).

RESOURCES: Definitions and Abbreviations

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

SECTION 2—DEFINITIONS AND ABBREVIATIONS

2–1. DASH INDICATOR LIGHTS

The electronic control system is programmed to inform the operator of a problem with the EP 40/50 System™ and automatically take action to protect the operator, vehicle, and transmission. To do this, the VCM turns on a **DASH INDICATOR LIGHT** on the instrument panel, which notifies the operator that a Diagnostic Trouble Code (DTC) has been stored.

WAIT TO START—The **WAIT TO START** light is located on the dash panel. This indicator notifies the operator that the vehicle system is not ready to start. The light is extinguished when the vehicle systems are ready for start-up. If the indicator remains illuminated, check the PBSS for diagnostic codes related to the EP 40/50 System™. Continued illumination of this indicator can also indicate vehicle system inhibits.

SYSTEM OVERTEMP—The **SYSTEM OVERTEMP** warning light is located on the dash panel and alerts the operator when any of the EP 40/50 System™ components has reached a thermal limit. Overtemp faults result in reduced performance or a disabled propulsion condition. Check the PBSS for specific diagnostic trouble codes (DTC).

CHECK SYSTEM—The **CHECK SYSTEM** warning light is located on the dash panel and alerts the operator that an EP 40/50 System™ fault has occurred. Vehicle propulsion will not be disabled when **CHECK SYSTEM** is illuminated. Immediately return the vehicle for service. If a fault occurs a Diagnostic Trouble Code for that fault is logged into diagnostic system memory. Check the PBSS for specific DTCs.

STOP SYSTEM—The **STOP SYSTEM** warning light is located on the dash panel and alerts the operator that a EP 40/50 System™ fault has occurred. Faults of this nature automatically disable the propulsion system. The driver will have approximately 30 seconds to move the vehicle to a safe location before the EP 40/50 System™ is disabled. During this time, the **STOP SYSTEM** light will flash. Stop the vehicle immediately and remove it from service. If a fault occurs, a DTC for that fault is logged into diagnostic system memory. Check the PBSS for specific DTCs.

2–2. ALLISON DOC™ FOR PC (AED)

The Allison DOC™ For PC (AED)–Service Tool is the preferred service tool for the EP 40/50 System™. The Allison DOC™ For PC (AED)–Service Tool connects to the J1939 CAN at the diagnostic connector inside the vehicle. The Allison DOC™ For PC (AED)–Service Tool can display logged codes including those related to the ESS. The service tool also has the capability of recording operating conditions for later playback or to display system operating conditions in real-time. Refer to the Allison DOC™ For PC (AED)–Service Tool User Guide GN3727EN for full capabilities of the service tool.

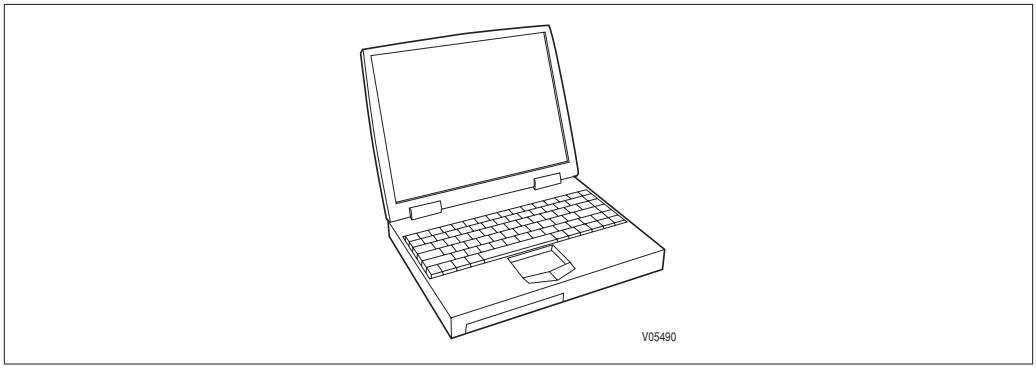

Figure 2–1. Allison DOC™ For PC (AED)

RESOURCES: Basic Knowledge

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E^{P} 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

SECTION 3—BASIC KNOWLEDGE

3–1. BASIC KNOWLEDGE REQUIRED

To service E^{P} 40/50 System™ Electronic Controls, the technician must understand basic electrical concepts. Technicians need to know how to use a volt/ohmmeter (VOM) to make resistance and continuity checks. Most troubleshooting checks consist of checking resistance and continuity, and checking for shorts between wires and to ground. The technician should be able to use jumper wires and breakout harnesses and connectors. Technicians unsure of making the required checks should ask questions of experienced personnel or find instruction.

The technician should also have the mechanical aptitude required to connect pressure gauges or transducers to identified pressure ports used in the troubleshooting process. Pressure tap locations and pressure values are shown in Appendix B.

Input power, ground, neutral start circuitry, etc., can cause problems with electronic controls or vehicle functioning and may not generate a DTC. A working knowledge of E^{P} 40/50 System™ Electronic Controls vehicle installation is necessary in troubleshooting installation-related problems.

Refer to Section 7 for information concerning performance complaints (non-DTC) troubleshooting. A complete wiring schematic is shown in Appendix H. Refer to the Tech Data Book for information concerning electronic controls installation and the Installation Checklist. Reliable transmission operation and performance depend upon a correctly installed transmission. Review the Installation Checklist in the E^{P} 40/50 System™ Tech Data Book for proper installation.

NOTE: ***Allison Transmission is providing for service of wiring harnesses and wiring harness components as follows:***

- ***Repair parts for the internal wiring harness will be available through the Allison Transmission Parts Distribution Center (PDC). Use the P/N from your appropriate parts catalog or from Appendix E in this manual. Allison Transmission is responsible for warranty on these parts.***
- ***Repair parts for the external harnesses and external harness components must be obtained through the vehicle OEM. The OEM is responsible for warranty on these parts.***

3–2. USING THE TROUBLESHOOTING MANUAL

Use this manual as an aid to troubleshooting the E^{P} 40/50 System™ Electronic Controls. Every possible problem and its solution cannot be encompassed by any manual. However, this manual does provide a starting point from which most problems can be resolved.

Once a problem solution is discovered in the manual do not look further for other solutions. It is necessary to determine why a problem occurred. The root cause of a problem as well as the symptom must be corrected to ensure trouble free operation. For example, taping a wire that has been rubbing on a frame rail will not correct the problem unless the rubbing contact is eliminated.

NOTE: ***Information concerning specific items is contained in the appendices located in the back of this manual. The appendices are referred to throughout the manual.***

3–3. IMPORTANT INFORMATION IN THE TROUBLESHOOTING PROCESS

Before beginning the troubleshooting process, read and understand the following:

- Allison recommended wire numbers (i.e. 212) are a combination of the first digit indicating the TCM connector number (i.e. J2) and the last two digits indicating the pin-out information (i.e. 12).
- Shut off the engine and ignition before any harness connectors are disconnected or connected.
- Remember to do the following when checking for shorts and opens:
  - — Minimize movement of wiring harnesses when looking for shorts. Shorts involve wire-to-wire or wire-to-ground contacts and moving the harnesses may eliminate the problem.
  - — Wiggle connectors, harnesses, and splices when looking for opens. This simulates vehicle movements which occur during actual operation.
- When disconnecting a harness connector, be sure that pulling force is applied to the connector itself and **not the wires** extending from the connector.

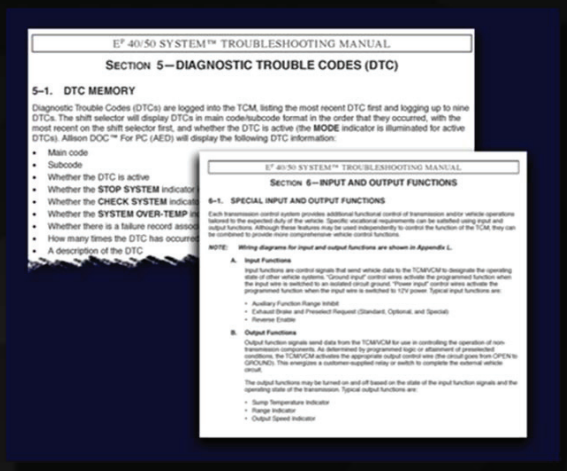
DIAGNOSTICS — USING THE TROUBLESHOOTING MANUAL

Allison Transmission. Instructor Led Training

Using The Troubleshooting Manual

Troubleshooting Manual Sections (cont'd)

- **Wire Check Procedures:**
  - *Describes the procedures used to check harness wires for opens and shorts.*
- **Diagnostic Codes section:**
  - *Provides detailed step-by-step procedures for troubleshooting DTCs.*
- **Input and Output Functions section:**
  - *Provides an overview of how Inputs and Outputs interact with the Electronic Controls.*
- **General Troubleshooting section:**
  - *Describes diagnostic steps to take when DTCs are not logged in the TCM/VCM memory.*


E^3 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

SECTION 5—DIAGNOSTIC TROUBLE CODES (DTC)

5–1. DTC MEMORY

Diagnostic Trouble Codes (DTCs) are logged into the TCM, listing the most recent DTC first and logging up to nine DTCs. The shift selector will display DTCs in main code/subcode format in the order that they occurred, with the most recent on the shift selector first, and whether the DTC is active (the **MODE** indicator is illuminated for active DTCs). Allison DOC™ For PC (AED) will display the following DTC information:

- Main code
- Subcode
- Whether the DTC is active
- Whether the **STOP SYSTEM** indicator
- Whether the **CHECK SYSTEM** indicator
- Whether the **SYSTEM OVER-TEMP** in
- Whether there is a failure record assoc
- How many times the DTC has occurre
- A description of the DTC

E^3 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

SECTION 6—INPUT AND OUTPUT FUNCTIONS

6–1. SPECIAL INPUT AND OUTPUT FUNCTIONS

Each transmission control system provides additional functional control of transmission and/or vehicle operations tailored to the expected duty of the vehicle. Specific vocational requirements can be satisfied using input and output functions. Although these features may be used independently to control the function of the TCM, they can be combined to provide more comprehensive vehicle control functions.

NOTE: *Wiring diagrams for input and output functions are shown in Appendix L.*

A. Input Functions

Input functions are control signals that send vehicle data to the TCM/VCM to designate the operating state of other vehicle systems. "Ground input" control wires activate the programmed function when the input wire is switched to an isolated circuit ground. "Power input" control wires activate the programmed function when the input wire is switched to 12V power. Typical input functions are:

- Auxiliary Function Range Inhibit
- Exhaust Brake and Preselect Request (Standard, Optional, and Special)
- Reverse Enable

B. Output Functions

Output function signals send data from the TCM/VCM for use in controlling the operation of non-transmission components. As determined by programmed logic or attainment of preselected conditions, the TCM/VCM activates the appropriate output control wire (the circuit goes from OPEN to GROUND). This energizes a customer-supplied relay or switch to complete the external vehicle circuit.

The output functions may be turned on and off based on the state of the input function signals and the operating state of the transmission. Typical output functions are:

- Sump Temperature Indicator
- Range Indicator
- Output Speed Indicator

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3 of 7

RESOURCES: Wire Check Procedures

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

EP 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

SECTION 4—WIRE CHECK PROCEDURES

4–1. CHECKING OPENS, SHORTS BETWEEN WIRES, AND SHORTS-TO-GROUND

(Use Digital Volt/Ohmmeter J 34520-A and Jumper Wire Set J 39197)

NOTE: Please refer to Paragraph 3–4 to begin the troubleshooting process.

1. Make sure all connectors are tightly connected and re-check the circuit.
2. Disconnect and inspect all connectors.
3. Thoroughly clean corroded or dirty terminals. If dirty or corroded terminals are the probable cause of the problems, reconnect the clean connectors and operate the vehicle normally. If the problem recurs, proceed with Step (4).

CAUTION: The cleaning solvent must not be chlorine based, contain petroleum distillates, or conduct electricity. The cleaning solvent should evaporate quickly to prevent the possibility of condensation within the connectors. Always blow or shake any excess cleaner from the connector before assembling it to its mating connector or hardware. Cleaner trapped in the connector can affect the connector seal. (Refer to SIL 17-TR-94 for detailed information on the recommended cleaners.)

4. Review the wire numbering system described in Paragraph 3–3.
5. If all connectors are clean and properly seated, determine which wires in the chassis harness are indicated by the DTC.
    a. Check continuity of wires 422 and 423 by performing the following (Figure 4–1):
        (1) Disconnect the red (J2) connector from the TCM and disconnect the harness from the transmission main connector. At one end of the harness, using jumper wire kit J 39197 and connector probes in J 39775-CP, connect wire 422 and 423 to each other, being careful not to distort the terminals. Jumping the wires together creates a circuit between wires 422 and 423.

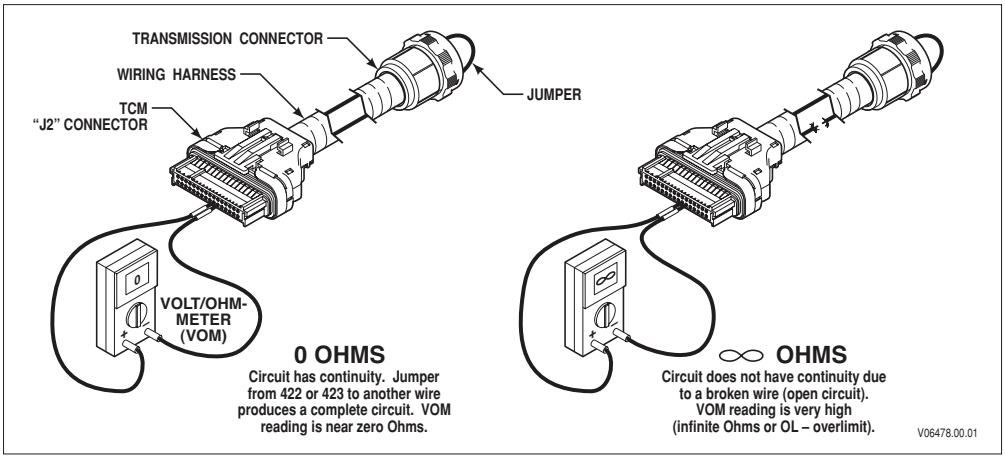

Figure 4–1. Checking Continuity (External Harness)

RESOURCES: Diagnostic Trouble Codes (DTCs)

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

E^{P} 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

SECTION 5—DIAGNOSTIC TROUBLE CODES (DTC)

5–1. DTC MEMORY

Diagnostic Trouble Codes (DTCs) are logged into the TCM, listing the most recent DTC first and logging up to nine DTCs. The shift selector will display DTCs in main code/subcode format in the order that they occurred, with the most recent on the shift selector first, and whether the DTC is active (the **MODE** indicator is illuminated for active DTCs). Allison DOC™ For PC (AED) will display the following DTC information:

- Main code
- Subcode
- Whether the DTC is active
- Whether the **STOP SYSTEM** indicator is lit
- Whether the **CHECK SYSTEM** indicator is lit
- Whether the **SYSTEM OVER-TEMP** indicator is lit
- Whether there is a failure record associated with that DTC
- How many times the DTC has occurred
- A description of the DTC

5–2. FAILURE RECORDS

Failure records contain a snapshot of E^{P} 40/50 System™ information that is stored in the TCM when some DTCs are logged. A limit of five failure records can be stored. When an additional DTC with a failure record is logged, the new failure record replaces the oldest record in the TCM memory. The failure records can only be viewed with Allison DOC™ For PC (AED). The information included in a failure record is listed below:

Table 5–1. Failure Record Data

Data Description
PBSS Range Selected
Range State
Transmission Fluid Level
TCM Ignition Voltage
Sump Fluid Temperature
Accelerator Pedal Percent
Brake Percent
Engine Speed
C1 Blocking Solenoid Command
C1 Solenoid Current
C1 Pressure Switch
C2 Blocking Solenoid Command
C2 Solenoid Current
C2 Pressure Switch
Main Pressure Command
Output Speed
Output Torque
Energy Storage Pack SOC (State of Charge)
Inverter A Motor Speed

RESOURCES: Input/Output Functions

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

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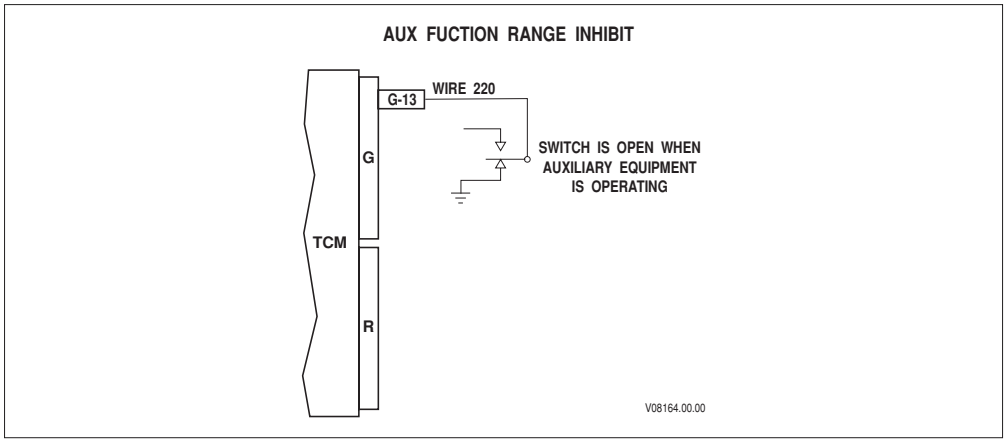
APPENDIX L—INPUT/OUTPUT FUNCTIONS

L–1. AUX FUNCTION RANGE INHIBIT



WARNING! **If this function is enabled in the calibration, the function MUST be integrated into the vehicle wiring. If the function is available in the calibration but will not be used in the vehicle, it MUST be disabled in the calibration.**

DESCRIPTION: When this function is used and an auxiliary vehicle function is active, a neutral-to range shift is inhibited. It will continue to be inhibited until the input signal from the auxiliary vehicle function is turned off.

NOTE: ***This function is active when the input is off (switch open) and is deactivated when the input is turned on (switch closed).***

USES: This function prevents inadvertent range selection when auxiliary equipment, e.g., wheelchair lift, is operating. It may also be used to prevent neutral-to-range shifts unless the brake pedal is depressed.

VARIABLES TO SPECIFY: None

VOCATIONS: Various, not for emergency equipment. Typical uses: transit bus (wheelchair lift), utility truck (outriggers out), and motorhome (door ajar).

SECTION 7—GENERAL TROUBLESHOOTING OF PERFORMANCE

IMPORTANT:

Make the following general checks before beginning specific troubleshooting or removing the system components.

- Are there active DTCs?
- Is the shift selector lever in **N** (Neutral) to allow starting the engine?
- Is the 12/24V battery properly connected and charged?
- Is isolated battery properly connected (if used)?
- Is the fluid level correct?
- Is voltage to the TCM/VCM correct?
- Is the engine properly tuned?
- Is fuel flow to the engine correct?
- Are wheel chocks in place?
- Is air flow to the cooler and radiator unrestricted?
- Is the driveline properly connected?
- Are there signs of fluid leakage under the vehicle? What is the origination point?
- Are hydraulic connections correctly made and not leaking?
- Has the vehicle acceleration rate been changed?
- Are electrical connections correct?
- Are there any other obvious vehicle or hybrid system problems?

After making these general checks use the various sections of this manual to isolate the listed problems. The following charts address specific vehicle complaints. Some complaints involve DTCs, so all troubleshooting checks should involve first checking the system for DTCs.

Performance Complaints

A. Sluggish Vehicle Performance

Use Allison DOC™ For PC (AED) to compare the commanded versus actual engine torque—if the two values are different, check the engine for trouble codes. Check the Battery Charge Limit ID for any conditions that may limit ESS output.

B. PBSS displays a Cat-Eye

Check for loss of wake-up signal to PBSS and check the SDL wiring.

C. STOP SYSTEM light on with no codes and blank fields in DOC where TCM info should be

Possible CAN problem or power/wake-up problem with TCM. Reference the CAN Troubleshooting in Appendix of this manual.

D. CHECK SYSTEM lamp on without a fault code

Likely caused by a system override switch failing to the ON position (triggered by an open circuit or unconnected switch).

E. Rough shifts

With engine running, cycle the vehicle from **F** to **N**. The shift to Neutral cycles the shift solenoids (fully opening the armature), allowing for any possible debris to pass.

F. High engine speed at idle

Part of normal vehicle operation when the ESS SOC is low.

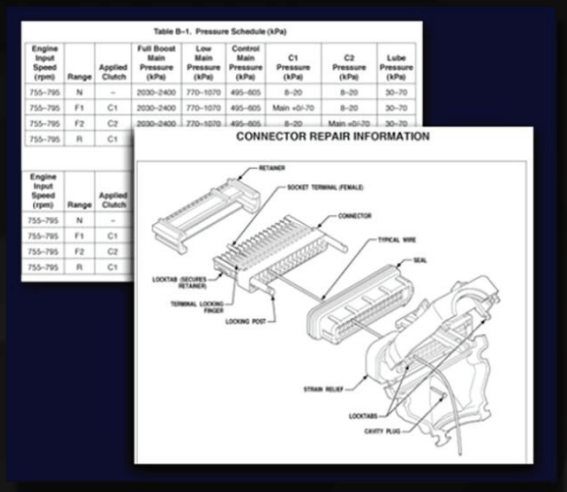
DIAGNOSTICS — USING THE TROUBLESHOOTING MANUAL

Allison Transmission. Instructor Led Training

Using The Troubleshooting Manual

Troubleshooting Manual Appendices

- **Diagnosing Intermittent DTCs:**
  - *Information on identifying, locating and resolving issues that cause intermittent DTCs to be logged.*
- **Main Pressure Check Procedure:**
  - *Helps technicians determine if a transmission malfunction is due to a mechanical or electrical problem.*
- **Solenoid and Clutch Tables:**
  - *Indicates solenoid states and clutch application status during shifts and when ranges have been attained.*
- **Wire and Connector Tables:**
  - *Provides terminal and wire designations for Electronic Control connectors and harnesses.*



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4 of 7

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RESOURCES: Diagnosing Intermittent DTCs

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

E^{P} 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

APPENDIX A—DIAGNOSING INTERMITTENT DTCS

Intermittent Diagnostic Trouble Codes (DTC) are a result of faults that are detected, logged, and then become inactive, only to recur later. If, when troubleshooting, a DTC is cleared in anticipation of it recurring and it does not, check the items in the following list for the fault's source.

A. Circuit Inspection

1. Intermittent power/ground problems — can cause voltage problems during TCM diagnostic checks which can set various DTCs depending upon where the TCM was in the diagnostic process.
2. Damaged terminals.
3. Dirty or corroded terminals.
4. Terminals not fully seated in the connector. Check indicated wires by uncoupling connector and gently pulling on the wire at the rear of the connector and checking for excessive terminal movement.
5. Connectors not fully mated. Check for missing or damaged locktabs.
6. Screws or other sharp pointed objects pushed into or through one of the harnesses.
7. Harnesses which have rubbed through and may be allowing intermittent electrical contact between two wires or between wires and vehicle frame members.
8. Broken wires within the braiding and insulation.

B. Finding an Intermittent Fault Condition

To find a fault, like one of those listed, examine all connectors and the external wiring harnesses. Harness routing may make it difficult to see or feel the complete harness. However, it is important to thoroughly check each harness for chafed or damaged areas. Road vibrations and bumps can damage a poorly installed harness by moving it against sharp edges and cause some of the faults. If a visual inspection does not identify a cause, move and wiggle the harness by hand until the fault is duplicated.

The next most probable cause of an intermittent DTC is an electronic part exposed to excessive vibration, heat, or moisture. Examples of this are:

1. Exposed harness wires subjected to moisture.
2. A defective connector seal allows moisture to enter the connector or part.
3. An electronic part (TCM, VCM, solenoid, or throttle sensor) affected by vibration, heat, or moisture may cause abnormal electrical conditions within the part.

When troubleshooting Item 3, eliminate all other possible causes before replacing any parts.

Another cause of intermittent DTCs is an abnormal environment. The abnormal environment will usually include excessive heat, moisture, or voltage. For example, a TCM that receives excessive voltage will generate a diagnostic code as it senses high voltage in a circuit. The DTC may not be repeated consistently because different circuits may have this condition on each check. The last step in finding an intermittent DTC is to observe if the DTC is set during sudden changes in the operating environment.

Troubleshooting an intermittent DTC requires looking for common conditions that are present whenever the DTC is diagnosed. Use the failure record information from the Allison DOC™ For PC (AED) tool to identify the conditions when the DTC was set.

APPENDIX B—MAIN PRESSURE CHECK PROCEDURE

Checking main pressures helps to determine if a transmission malfunction is due to a mechanical or an electrical problem. Properly making these pressure checks requires transmission and vehicle (or test stand) preparation, recording of data, and comparing recorded data against specifications provided.

WARNING!	**Observe safety precautions during hydraulic pressure check procedures. All personnel must stand clear of the vehicle. Take precautions against movement of the vehicle. Be sure that gauges (vacuum, pressure, tachometer) have extended lines so that they can be read from inside the vehicle.**

1. All transmission fluid level and pressure checks must be made at normal operating temperatures. Check transmission fluid level.
2. Connect a 0–2070 kPa (0–300 psi) oil pressure gauge at the main pressure tap. Use the Allison DOC™ For PC to check engine rpm. See Pressure Schedule Tables for main pressure levels. Record your measurement.
3. With brakes applied, check main pressure with the engine running at 2100 rpm and 800 rpm.
4. Use the Allison DOC™ For PC to command full main boost pressure, repeat previous step and record your measurement.

Table B–1. Pressure Schedule (kPa)

Engine Input Speed (rpm)	Range	Applied Clutch	Full Boost Main Pressure (kPa)	Low Main Pressure (kPa)	Control Main Pressure (kPa)	C1 Pressure (kPa)	C2 Pressure (kPa)	Lube Pressure (kPa)
755–795	N	–	2030–2400	770–1070	495–605	8–20	8–20	30–70
755–795	F1	C1	2030–2400	770–1070	495–605	Main +0/-70	8–20	30–70
755–795	F2	C2	2030–2400	770–1070	495–605	8–20	Main +0/-70	30–70
755–795	R	C1	2030–2400	770–1070	495–605	Main +0/-70	Main +0/-70	30–70

Table B–2. Pressure Schedule (psi)

Engine Input Speed (rpm)	Range	Applied Clutch	Full Boost Main Pressure (psi)	Low Main Pressure (psi)	Control Main Pressure (psi)	C1 Pressure (psi)	C2 Pressure (psi)	Lube Pressure (psi)
755–795	N	–	294–348	112–155	72–88	1–3	1–3	4–10
755–795	F1	C1	294–348	112–155	72–88	Main +0/-10	1–3	4–10
755–795	F2	C2	294–348	112–155	72–88	1–3	Main +0/-10	4–10
755–795	R	C1	294–348	112–155	72–88	Main +0/-10	Main +0/-10	4–10

APPENDIX C—SOLENOID AND CLUTCH TABLES

Normal operation of the transmission requires application of a clutch to attain forward or reverse range. A unique combination of solenoid and shift valve actuation produces clutch application in a given range. Table C–1 lists the transmission range shifts, the clutch that is applied in each range, and the electrical state (On/Off) of each solenoid for each range.

Table C–1. Solenoid Pressurized Clutch Table

Range	Solenoid					C1	C2
	C1	C2	C1 Block	C2 Block	Boost		
F1	X	–	X	–	#	X	–
F2	–	X	–	X	#	–	X
N	–	–	–	–	#	–	–
R	X	–	X	–	#	X	–

X = Solenoid energized or clutch applied.

= Apply boost solenoid to modulated main pressure (0.00 amps = full boost pressure, 0.77 amps = low main pressure)

RESOURCES: Wire/Connector Tables

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

E^{P} 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

WIRE/CONNECTOR TABLES

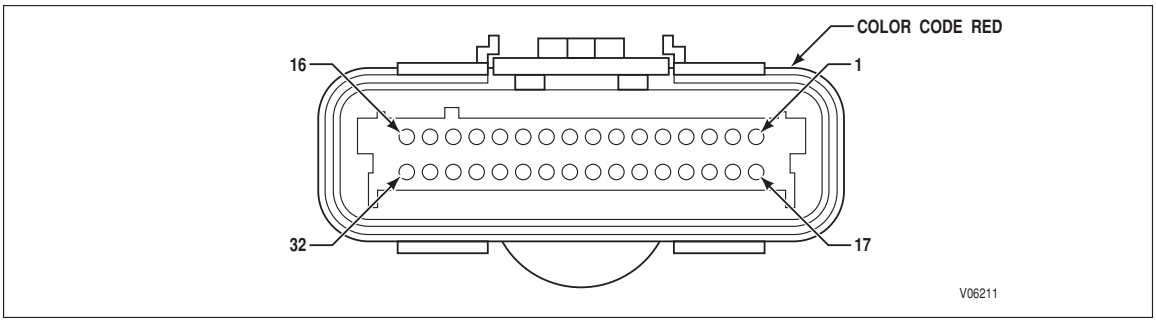


Figure D–1. TCM Connector J2

TCM CONNECTOR J2 (RED)

Terminal No.	Color	Wire No.	Description	Termination Point(s)
1	Blue	158	C1 Pressure Switch	Trans-C
2				
3				
4				
5	Red	160	Fast Idle 2	Vehicle System
6	Green	250	Remote Shutdown Request (application specified mode #4)	Vehicle System
7	Blue	251	Accelerator Interlock	Vehicle System
8	Tan	161	C2 Pressure Switch	Trans-E
9				
10	White	163	Sump Oil Temp	Trans-L
11				
12				
13	White	165	Transmission Output Speed 2 HI	NO2-A
14	White	166	Transmission Output Speed 2 LO	NO2-B
15	White	167	Transmission Output Speed 1 HI	NO1-A
16	White	168	Transmission Output Speed 1 LO	NO1-B
17				
18				
19				
20	Black	170	Analog Ground	Trans-D, F, M, P
21	Pink	171	Trans ID	Trans-G
22	Blue	172	C1 Solenoid Command HI	Trans-S
23	White	173	C1 Solenoid Enable LO	Trans-T
24	Blue	174	C2 Solenoid Command HI	Trans-U
25	Green	175	C2 Solenoid Enable LO	Trans-V
26	Pink	176	C1 Block Solenoid	Trans-B
27	Red	177	C2 Block Solenoid	Trans-R
28	White	178	Inverter Wake-up, A & B	Vehicle System

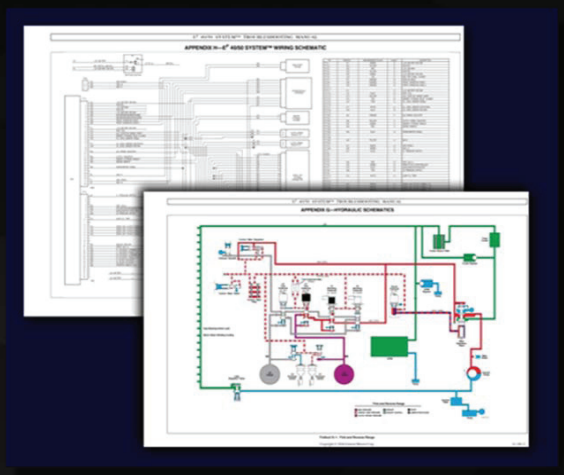
DIAGNOSTICS — USING THE TROUBLESHOOTING MANUAL

Allison Transmission. Instructor Led Training

Using The Troubleshooting Manual

Troubleshooting Manual Appendices (cont'd)

- **Connector Repair Information:**
  - *Lists the special tools and part numbers required when repairing Electronic Control connectors.*
- **Welding on Vehicle:**
  - *Includes warnings and recommended procedures to follow when welding on the vehicle.*
- **Hydraulic Schematics:**
  - *Range-by-range hydraulic system flows.*
- **Wiring Schematics:**
  - *Detailed electrical schematics including component terminal, wire and switching status information.*



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5 of 7

RESOURCES: Connector Repair Information

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

EP 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

CONNECTOR REPAIR INFORMATION

List Of Special Tools Required To Service Wiring Harnesses

Tool Number	Tool Type	Paragraph Reference
23046604	Splice, Sealed (14–16 AWG)	E–7
23046605	Splice, Sealed (18–22 AWG)	E–7
J 25070	Heat Gun	E–7
J 34182	Crimper 1	E–1, E–5, E–6
J 34513	Remover 1	E–1, E–5
J 35123	Crimper (Alternate)	E–2
J 35606	Crimper (Alternate)	E–4
J 35615	Wire Stripper 1	E–2, E–7
J 35689-A	Remover	E–2
J 38125-10	Remover	E–4
J 38125-6	Crimper	E–4
J 38125-7	Crimper	E–2
J 38125-8	Crimper	E–7
J 38582-3	Remover	E–1, E–5
J 38852	Crimper (Alternate)	E–4
J 41194	Extractor/Inserter	E–1, E–5
J 42215	Crimper	E–1

Appendix F—WELDING ON VEHICLE

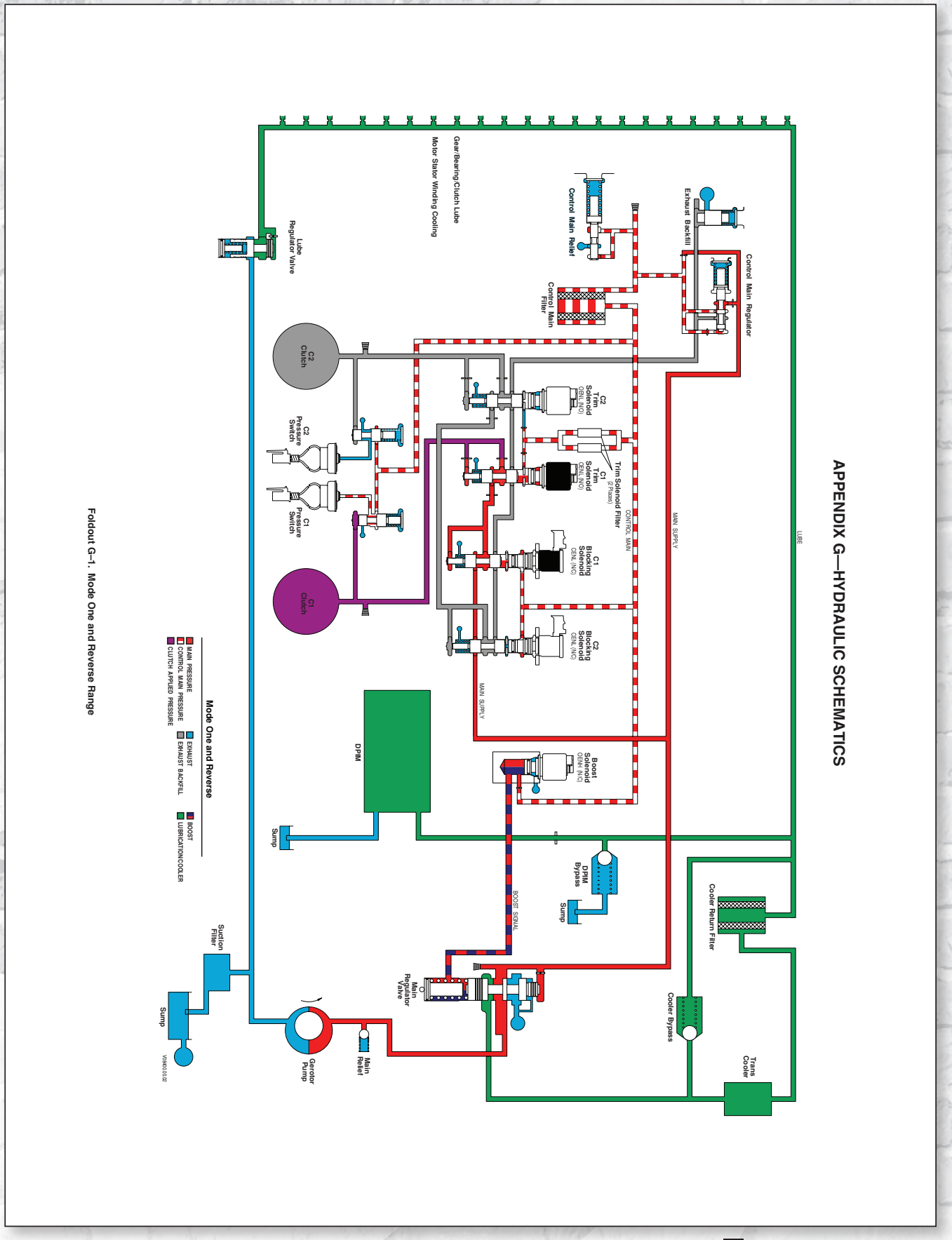
F–1. WELDING ON VEHICLE

When frame or other welding is required on the vehicle, take the following precautions to protect the electronic control components:

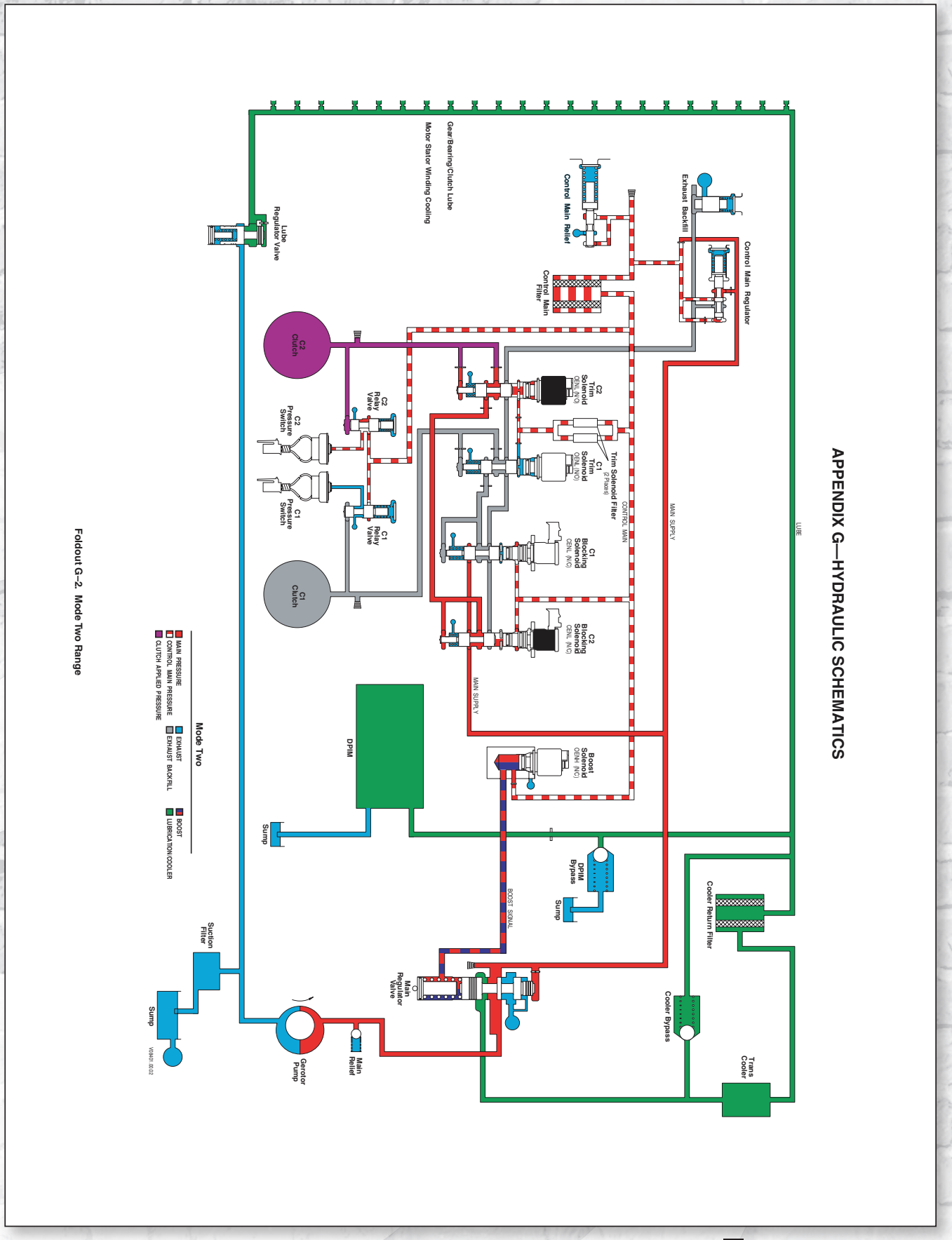
1. Disconnect the wiring harness connectors at the TCM, VCM, DPIM, and ESS.
2. Disconnect the positive and negative battery connections, and any electronic control ground wires connected to the frame or chassis.
3. Cover electronic control components and wiring to protect them from hot sparks, etc.
4. Do not connect welding cables to electronic control components.

CAUTION:	When welding on the vehicle: • DO NOT WELD on the vehicle without disconnecting all control system harness connectors from the TCM, VCM, DPIM, and ESS. • DO NOT WELD on any system components including the DPIM and ESS. • DO NOT CONNECT welding cables to any system components.

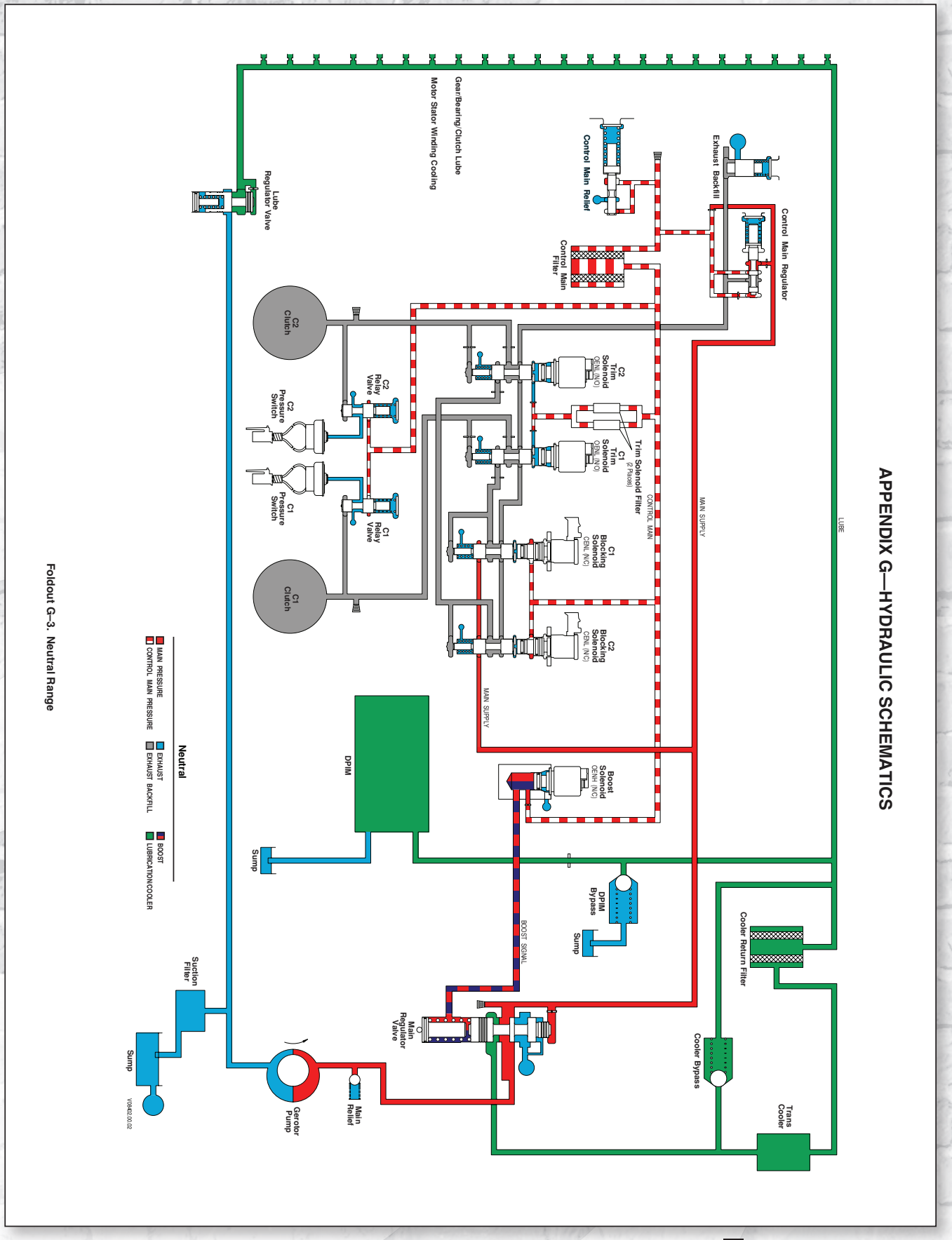
RESOURCES: Hydraulic Schematics



RESOURCES: Hydraulic Schematics

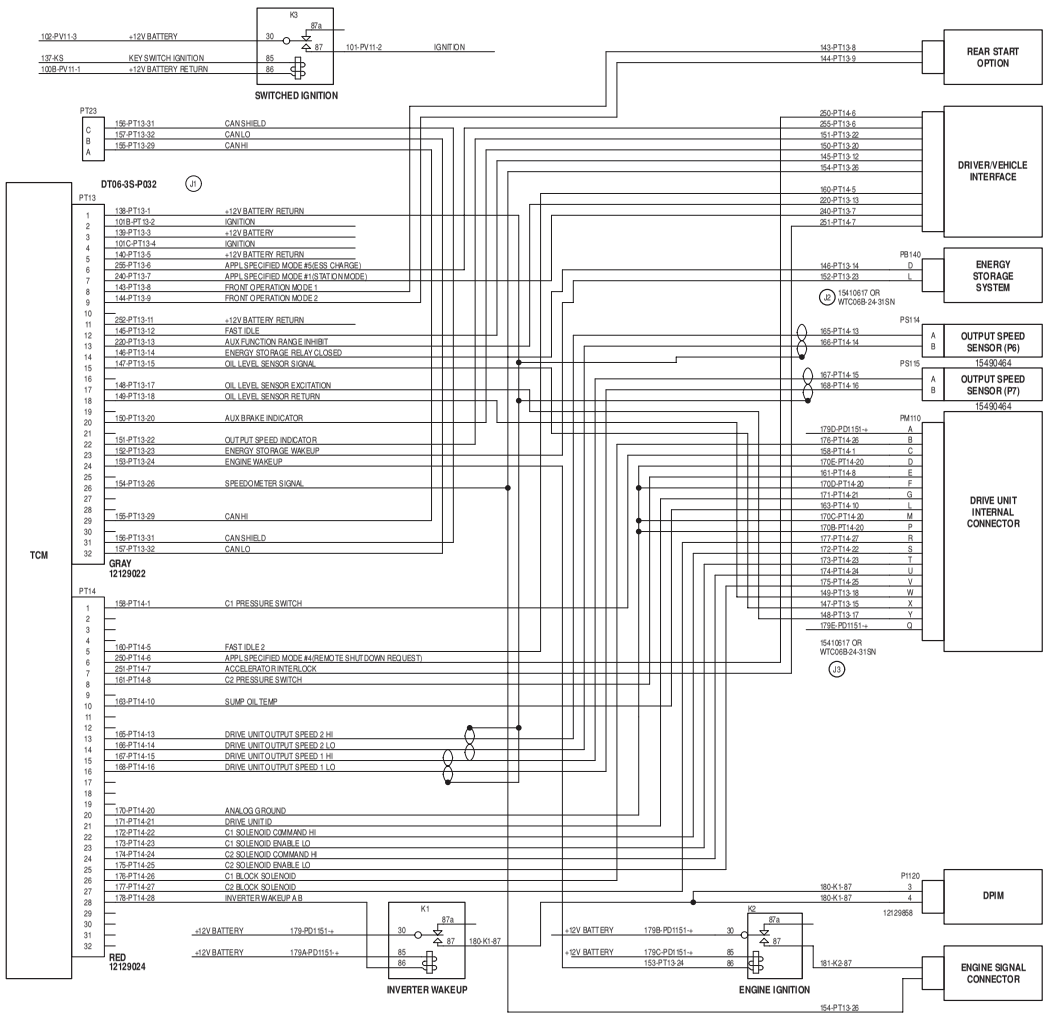


RESOURCES: Hydraulic Schematics



Foldout G–3. Neutral Range

APPENDIX H—E^P 40/50 SYSTEM™ WIRING SCHEMATIC



PIN	WIRE NO.*	RECOMMENDED COLOR	CLASS**	DESCRIPTION	
PT13-1	138-PT13-1	GREEN	E	+12V BATTERY RETURN	H1
PT13-2	101B-PT13-2	YELLOW	D	IGNITION	
PT13-3	139-PT13-3	RED	E	+12V BATTERY	
PT13-4	101C-PT13-4	YELLOW	D	IGNITION	
PT13-5	140A-PT13-5	GREEN	E	+12V BATTERY RETURN	H2
PT13-6	255-PT13-6	TAN	C	ESS PRE-TUNNEL CHARGE	
PT13-7	240-PT13-7	ORANGE	B	STATION MODE	
PT13-8	143-PT13-8	ORANGE	B	FRONT OPERATION MODE 1	
PT13-9	144-PT13-9	ORANGE	B	FRONT OPERATION MODE 2	
PT13-10					
PT13-11	253-PT13-11		E	+12V BATTERY RETURN	H3
PT13-12	145-PT13-12	BLUE	B	FAST IDLE	
PT13-13	220-PT13-13	YELLOW	C	AUX FUNCTION RANGE INHIBIT	
PT13-14	146-PT13-14	TAN	B	ENERGY STORAGE RELAY CLOSED	
PT13-15	147-PT13-15	PINK	A	OIL LEVEL SENSOR SIGNAL	
PT13-16					
PT13-17	148-PT13-17	WHITE	A	OIL LEVEL SENSOR EXCITATION	
PT13-18	149-PT13-18	BLUE	B	OIL LEVEL SENSOR RETURN	
PT13-19					
PT13-20	150-PT13-20	ORANGE	C	AUX BRAKE INDICATOR	
PT13-21					
PT13-22	151-PT13-22	YELLOW	C	OUTPUT SPEED INDICATOR	
PT13-23	152-PT13-23	GREEN	C	ENERGY STORAGE WAKEUP	
PT13-24	153-PT13-24	RED	C	ENGINE WAKEUP	
PT13-25					
PT13-26	154-PT13-26	BLUE	B	SPEEDOMETER SIGNAL	
PT13-27					
PT13-28					
PT13-29	155-PT13-29	YELLOW	A	CAN HI	
PT13-30					
PT13-31	156-PT13-31	BLACK	A	CAN SHIELD	
PT13-32	157-PT13-32	GREEN	A	CAN LO	
PT14-1	158-PT14-1	BLUE	B	C1 PRESSURE SWITCH	
PT14-2					
PT14-3					
PT14-4					
PT14-5	160-PT14-5	RED	B	FAST IDLE 2	
PT14-6	250-PT14-6	GREEN	B	REMOTE SHUTDOWN REQUEST	
PT14-7	251-PT14-7	BLUE	B	ACCELERATOR INTERLOCK	
PT14-8	161-PT14-8	TAN	B	C2 PRESSURE SWITCH	
PT14-9					
PT14-10	163-PT14-10	WHITE	A	SUMP OIL TEMP	
PT14-11					
PT14-12					
PT14-13	165-PT14-13	WHITE	F	DRIVE UNIT OUTPUT SPEED 2 HI	
PT14-14	166-PT14-14	WHITE	F	DRIVE UNIT OUTPUT SPEED 2 LO	
PT14-15	167-PT14-15	WHITE	F	DRIVE UNIT OUTPUT SPEED 1 HI	
PT14-16	168-PT14-16	WHITE	F	DRIVE UNIT OUTPUT SPEED 1 LO	J4
PT14-17					
PT14-18					
PT14-19					
PT14-20	170-PT14-20	BLACK	B	ANALOG GROUND	
PT14-21	171-PT14-21	PINK	B	DRIVE UNIT ID	
PT14-22	172-PT14-22	BLUE	D	C1 SOLENOID COMMAND HI	
PT14-23	173-PT14-23	WHITE	D	C1 SOLENOID ENABLE LO	
PT14-24	174-PT14-24	BLUE	D	C2 SOLENOID COMMAND HI	
PT14-25	175-PT14-25	GREEN	D	C2 SOLENOID ENABLE LO	
PT14-26	176-PT14-26	PINK	C	C1 BLOCK SOLENOID	
PT14-27	177-PT14-27	RED	C	C2 BLOCK SOLENOID	
PT14-28	178-PT14-28	WHITE	B	INVERTER WAKEUP A,B	
PT14-29					
PT14-30					
PT14-31					
PT14-32					
PD1151-+	179-PD1151-+	RED	C	+12V BATTERY	
K1-87	180-K1-87	BLUE	C	DPIM WAKEUP	
K2-87	181-K2-87	BLUE	C	ENGINE WAKEUP POWER	

* WIRE NUMBERS SHOWN IN SCHEMATIC MAY CONTAIN LETTER DESIGNATION WHERE SPLICED CIRCUITS EXIST

** WIRE CLASSES ARE DEFINED AS FOLLOWS:
A 0-5V 0-50mA
B 0-VBAT 0-50mA
C 0-VBAT 0-850mA
D 0-VBAT 0-3A
E 0-VBAT 0-10A
F 0-200VAC 0-50mA

CONNECTOR PART NUMBERS SHOWN ARE MATING CONNECTORS FOR ALLISON SUPPLIED HARDWARE ONLY.

MATING CONNECTORS ARE CUSTOMER SUPPLIED

REFER TO ALLISON TECHNICAL DOCUMENT NO. 169 FOR INFORMATION ON WIRING HARNESSES

INSERT CAVITY PLUGS IN ALL UNUSED CAVITIES OF SPECIFIED CONNECTORS. QUANTITY WILL VARY ACCORDING TO INSTALLATION INTERFACE REQUIREMENTS. THE PLUG IS TO BE INSERTED UNTIL THE LARGER DIAMETER IS FLUSH WITH THE CONNECTOR GROMMET.

THE FOLLOWING WIRE PAIRS TO HAVE 16+/-4 TWISTS PER 300mm (12 IN):
165-PT14-13 AND 166-PT14-14,
167-PT14-15 AND 168-PT14-16.
IT IS RECOMMENDED THAT THESE TWISTED PAIRS ALSO BE SHIELDED.

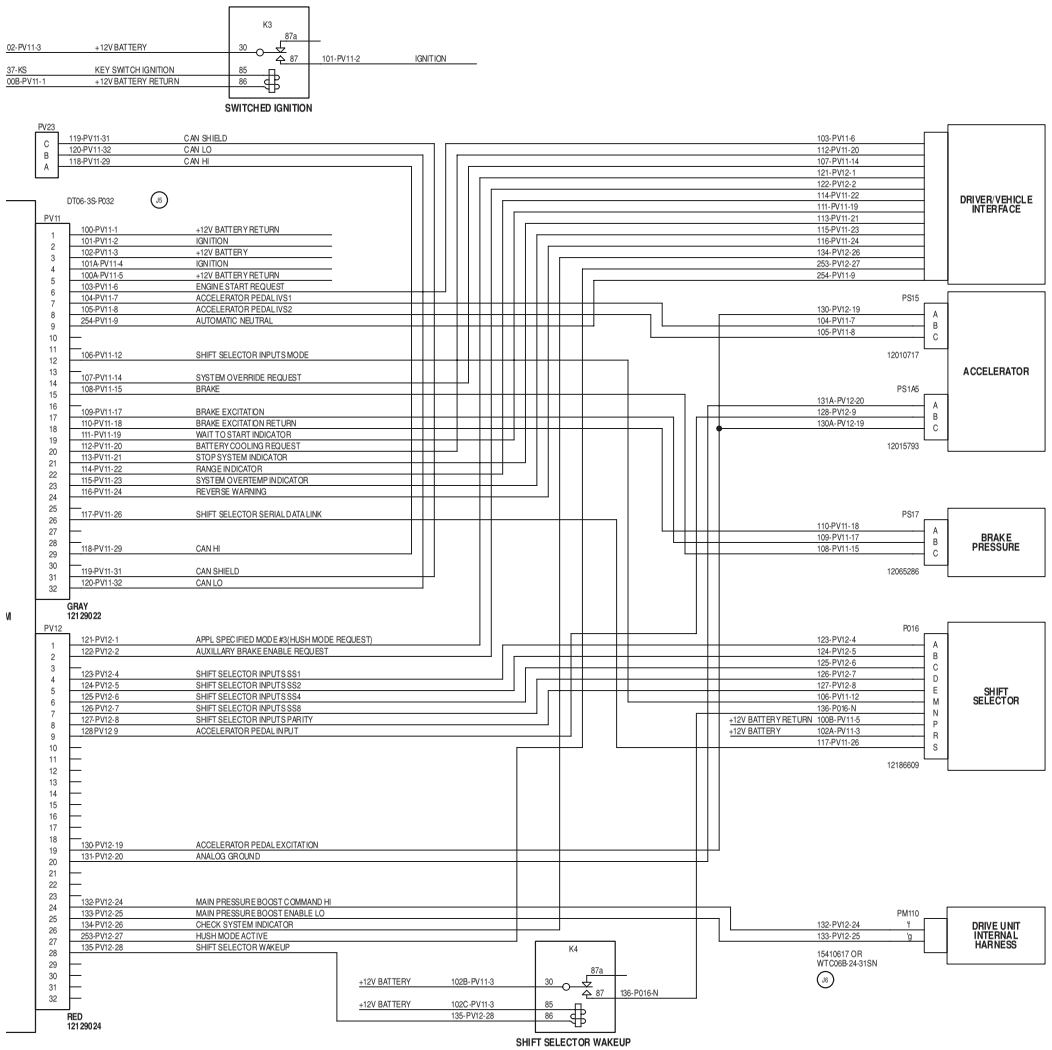
WHEN FEATURES ARE NOT USED, ALL LEAD WIRES TO THOSE FEATURES ARE TO BE OMITTED.

SEE SHEET 4 FOR FUSING INFORMATION

V10006.00.00

Figure H–1. Allison Electric Drive™ Wiring Schematic—TCM

APPENDIX H—E^{P} 40/50 SYSTEM™ WIRING SCHEMATIC



PIN	WIRE NO*	RECOMMENDED COLOR	CLASS**	DESCRIPTION
PV11-1	100-PV11-1	GREEN	E	+12V BATTERY RETURN
PV11-2	101-PV11-2	YELLOW	D	IGNITION
PV11-3	102-PV11-3	RED	E	+12V BATTERY
PV11-4	101A-PV11-4	YELLOW	D	IGNITION
PV11-5	100A-PV 11-5	GREEN	E	+12V BATTERY RETURN
PV11-6	103-PV11-6	WHITE	B	ENGINE START REQUEST
PV11-7	104-PV11-7	ORANGE	A	ACCELERATOR PEDAL IVS 1
PV11-8	105-PV11-8	ORANGE	A	ACCELERATOR PEDAL IVS 2
PV11-9	254-PV11-9	BLUE	C	AUTOMATIC NEUTRAL
PV11-10				
PV11-11				
PV11-12	106-PV11-12	BLUE	B	SHIFT SELECTOR INPUTS MODE
PV11-13				
PV11-14	107-PV11-14	TAN	B	SYSTEM OVERRIDE REQUEST
PV11-15	108-PV11-15	PINK	A	BRAKE
PV11-16				
PV11-17	109-PV11-17	WHITE	A	BRAKE EXCITATION
PV11-18	110-PV11-18	BLUE	B	BRAKE EXCITATION RETURN
PV11-19	111-PV11-19	TAN	C	WAIT TO START INDICATOR
PV11-20	112-PV11-20	ORANGE	C	BATTERY COOLING REQUEST
PV11-21	113-PV11-21	GREEN	C	STOP SYSTEM INDICATOR
PV11-22	114-PV11-22	YELLOW	C	RANGE INDICATOR
PV11-23	115-PV11-23	GREEN	C	SYSTEM OVERTEMP INDICATOR
PV11-24	116-PV11-24	RED	C	REVERSE WARNING
PV11-25				
PV11-26	117-PV11-26	BLUE	B	SHIFT SELECTOR SERIAL DATA LINK
PV11-27				
PV11-28				
PV11-29	118-PV11-29	YELLOW	A	CAN HI
PV11-30				
PV11-31	119-PV11-31	BLACK	A	CAN SHIELD
PV11-32	120-PV11-32	GREEN	A	CAN LO
PV12-1	121-PV12-1	BLUE	B	HUSH MODE REQUEST
PV12-2	122-PV12-2	TAN	A	AUXILLARY BRAKE ENABLE REQUEST
PV12-3				
PV12-4	123-PV12-4	YELLOW	B	SHIFT SELECTOR INPUTS SS1
PV12-5	124-PV12-5	RED	B	SHIFT SELECTOR INPUTS SS2
PV12-6	125-PV12-6	BLUE	B	SHIFT SELECTOR INPUTS SS4
PV12-7	126-PV12-7	GREEN	B	SHIFT SELECTOR INPUTS SS8
PV12-8	127-PV12-8	TAN	B	SHIFT SELECTOR INPUTS PARITY
PV12-9	128-PV12-9	PINK	A	ACCELERATOR PEDAL INPUT
PV12-10				
PV12-11				
PV12-12				
PV12-13				
PV12-14				
PV12-15				
PV12-16				
PV12-17				
PV12-18				
PV12-19	130-PV12-19	RED	A	ACCLERATOR PEDAL EXCITATION
PV12-20	131-PV12-20	BLACK	B	ANALOG GROUND
PV12-21				
PV12-22				
PV12-23				
PV12-24	132-PV12-24	BLUE	C	MAIN PRESSURE BOOST COMMAND HI
PV12-25	133-PV12-25	GREEN	C	MAIN PRESSURE BOOST ENABLE LO
PV12-26	134-PV12-26	PINK	B	CHECK SYSTEM INDICATOR
PV12-27	253-PV12-27	YELLOW	B	HUSH MODE ACTIVE
PV12-28	135-PV12-28	WHITE	B	SHIFT SELECTOR WAKEUP
PV12-29				
PV12-30				
PV12-31				
PV12-32				
P016-N	136-P016-N	RED	B	SHIFT SELECTOR WAKEUP POWER

* WIRE NUMBERS SHOWN IN SCHEMATIC MAY CONTAIN LETTER DESIGNATION WHERE SPLICED CIRCUITS EXIST

** WIRE CLASSES ARE DEFINED AS FOLLOWS:

A	0-5V	0-50mA
B	0-VBAT	0-50mA
C	0-VBAT	0-850mA
D	0-VBAT	0-3A
E	0-VBAT	0-10A
F	0-200VAC	0-50mA

CONNECTOR PART NUMBERS SHOWN ARE MATING CONNECTORS FOR ALLISON SUPPLIED HARDWARE ONLY

MATING CONNECTORS ARE CUSTOMER SUPPLIED

REFER TO ALLISON TECHNICAL DOCUMENT NO. 169 FOR INFORMATION ON WIRING HARNESSES

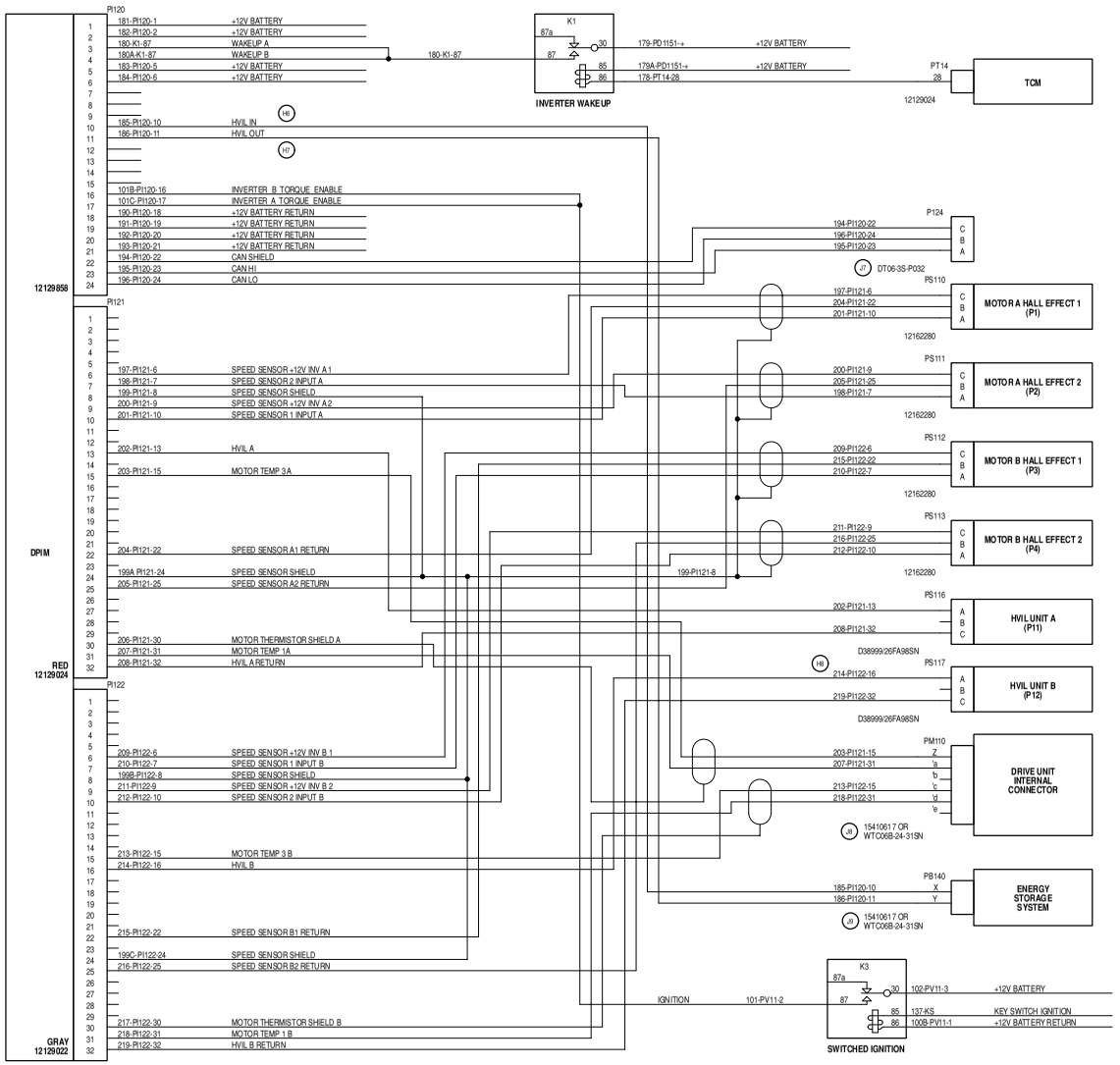
INSERT CAVITY PLUGS IN ALL UNUSED CAVITIES OF SPECIFIED CONNECTORS. QUANTITY WILL VARY ACCORDING TO INSTALLATION INTERFACE REQUIREMENTS. THE PLUG IS TO BE INSERTED UNTIL THE LARGER DIAMETER IS FLUSH WITH THE CONNECTOR GROMMET.

WHEN FEATURES ARE NOT USED, ALL LEAD WIRES TO THOSE FEATURES ARE TO BE OMITTED.

SEE SHEET 4 FOR FUSING INFORMATION

V10007.00.00

APPENDIX H—E^P 40/50 SYSTEM™ WIRING SCHEMATIC



PIN	WIRE NO. *	RECOMMENDED COLOR	CLASS **	DESCRIPTION
P120-1	181-P120-1	RED	E	+12V BATTERY
P120-2	182-P120-2	RED	E	+12V BATTERY
P120-3	180-K1-87	WHITE	D	WAKEUP A
P120-4	180A-K1-87	WHITE	D	WAKEUP B
P120-5	183-P120-5	RED	E	+12V BATTERY
P120-6	184-P120-6	RED	E	+12V BATTERY
P120-7				
P120-8				
P120-9				
P120-10	185-P120-10	ORANGE	C	HVIL OUT
P120-11	186-P120-11	ORANGE	C	HVIL IN
P120-12				
P120-13				
P120-14				
P120-15				
P120-16	101B-P1120-16	TAN	C	TORQ DSBL B
P120-17	101C-P1120-17	TAN	C	TORQ DSBL A
P120-18	190-P120-18	GREEN	E	+12V BATTERY RETURN
P120-19	191-P120-19	GREEN	E	+12V BATTERY RETURN
P120-20	192-P120-20	GREEN	E	+12V BATTERY RETURN
P120-21	193-P120-21	GREEN	E	+12V BATTERY RETURN
P120-22	194-P120-22	BLACK	A	CAN SHIELD
P120-23	195-P120-23	YELLOW	A	CAN HI
P120-24	196-P120-24	GREEN	A	CAN LO
P121-1				
P121-2				
P121-3				
P121-4				
P121-5				
P121-6	197-P121-6	WHITE	C	SPEED SENSOR +12V INV A1
P121-7	198-P121-7	RED	C	SPEED SENSOR 2 INPUT A
P121-8	199-P121-8	BLACK	C	SPEED SENSOR SHIELD
P121-9	200-P121-9	WHITE	C	SPEED SENSOR +12V INV A2
P121-10	201-P121-10	RED	C	SPEED SENSOR 1 INPUT A
P121-11				
P121-12				
P121-13	202-P121-13	ORANGE	C	HVIL A
P121-14				
P121-15	203-P121-15	BLUE	A	MOTOR TEMP 3 A
P121-16				
P121-17				
P121-18				
P121-19				
P121-20				
P121-21				
P121-22	204-P121-22	BLACK	C	SPEED SENSOR A1 RETURN
P121-23				
P121-24	199A-P1121-24	BLACK	C	SPEED SENSOR SHIELD
P121-25	205-P121-25	BLACK	C	SPEED SENSOR A2 RETURN
P121-26				
P121-27				
P121-28				
P121-29				
P121-30	206-P121-30	BLACK	A	MOTOR THERMISTOR SHIELD A
P121-31	207-P121-31	YELLOW	A	MOTOR TEMP 1 A
P121-32	208-P121-32	ORANGE	C	HVIL A RETURN
P122-1				
P122-2				
P122-3				
P122-4				
P122-5				
P122-6	209-P122-6	WHITE	C	SPEED SENSOR +12V INV B 1
P122-7	210-P122-7	RED	C	SPEED SENSOR 1 INPUT B
P122-8	199B-P122-8	BLACK	C	SPEED SENSOR SHIELD
P122-9	211-P122-9	WHITE	C	SPEED SENSOR +12V INV B 2
P122-10	212-P122-10	RED	C	SPEED SENSOR 2 INPUT B
P122-11				
P122-12				
P122-13				
P122-14				
P122-15	213-P122-15	BLUE	A	MOTOR TEMP 3 B
P122-16	214-P122-16	ORANGE	C	HVIL B
P122-17				
P122-18				
P122-19				
P122-20				
P122-21				
P122-22	215-P122-22	BLACK	C	SPEED SENSOR B1 RETURN
P122-23				
P122-24	199C-P1122-24	BLACK	C	SPEED SENSOR SHIELD
P122-25	216-P122-25	BLACK	C	SPEED SENSOR B2 RETURN
P122-26				
P122-27				
P122-28				
P122-29				
P122-30	217-P122-30	BLACK	A	MOTOR THERMISTOR SHIELD B
P122-31	218-P122-31	YELLOW	A	MOTOR TEMP 1 B
P122-32	219-P122-32	ORANGE	C	HVIL B RETURN
K1-87	180-K1-87	BLUE	C	DPIM WAKEUP

* WIRE NUMBERS SHOWN IN SCHEMATIC MAY CONTAIN LETTER DESIGNATION WHERE SPLICED CIRCUITS EXIST

** WIRE CLASSES ARE DEFINED:
A 0-5V 0-50mA
B 0-VBAT 0-50mA
C 0-VBAT 0-850mA
D 0-VBAT 0-3A
E 0-VBAT 0-10A
F 0-200VAC 0-50mA

CONNECTOR PART NUMBERS SHOWN ARE MATING CONNECTORS FOR ALLISON SUPPLIED HARDWARE ONLY

MATING CONNECTORS ARE CUSTOMER SUPPLIED

REFER TO ALLISON TECHNICAL DOCUMENT NO. 169 FOR INFORMATION ON WIRING HARNESSES

INSERT CAVITY PLUGS IN ALL UNUSED CAVITIES OF SPECIFIED CONNECTORS. QUANTITY WILL VARY ACCORDING TO INSTALLATION INTERFACE REQUIREMENTS. THE PLUG IS TO BE INSERTED UNTIL THE LARGER DIAMETER IS FLUSH WITH THE CONNECTOR GROMMET.

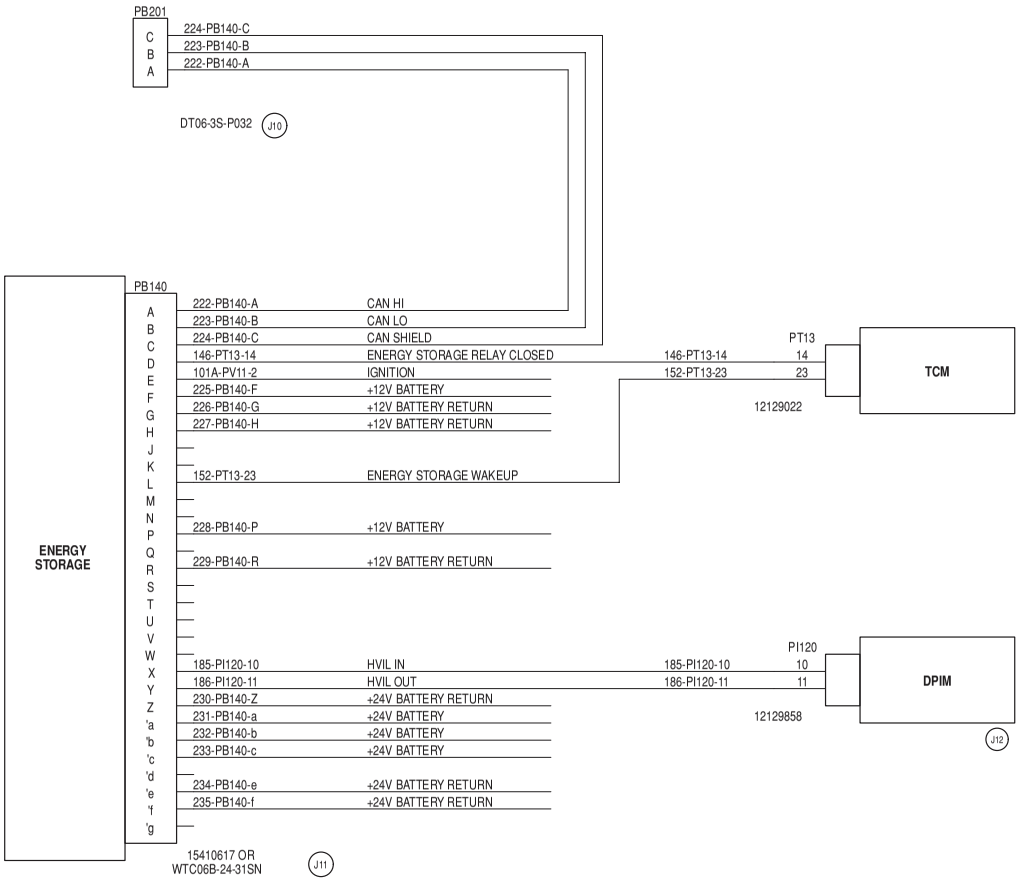
WHEN FEATURES ARE NOT USED, ALL LEAD WIRES TO THOSE FEATURES ARE TO BE OMITTED.

SEE SHEET 4 FOR FUSING INFORMATION

V10008.01.00

Figure H–3. Allison Electric Drive™ Wiring Schematic—DPIM

APPENDIX H—E^{P} 40/50 SYSTEM™ WIRING SCHEMATIC



PIN	WIRE NO.*		CLASS **	DESCRIPTION
PB140-A	222-PB140-A	YELLOW	A	CAN HI
PB140-B	223-PB140-B	GREEN	A	CAN LO
PB140-C	224-PB140-C	BLACK	A	CAN SHIELD
PB140-D	146-PT13-14	TAN	C	ENERGY STORAGE RELAY CLOSED
PB140-E	101A-PB140-E	WHITE	D	IGNITION
PB140-F	225-PB140-F	RED	E	+12V BATTERY
PB140-G	226-PB140-G	BLACK	E	+12V BATTERY RETURN
PB140-H	227-PB140-H	BLACK	E	+12V BATTERY RETURN
PB140-J				
PB140-K				
PB140-L	152-PT13-23	WHITE	C	ENERGY STORAGE WAKEUP
PB140-M				
PB140-N				
PB140-P	228-PB140-P	RED	E	+12V BATTERY
PB140-Q				
PB140-R	229-PB140-R	BLACK	E	+12V BATTERY RETURN
PB140-S				
PB140-T				
PB140-U				
PB140-V				
PB140-X	185-PI120-10	ORANGE	B	HVIL IN
PB140-Y	186-PI120-11	ORANGE	B	HVIL OUT
PB140-Z	230-PB140-Z	BLACK	E	+24V BATTERY RETURN
PB140-a	231-PB140-a	VIOLET	E	+24V BATTERY
PB140-b	232-PB140-b	VIOLET	E	+24V BATTERY
PB140-c	233-PB140-c	VIOLET	E	+24V BATTERY
PB140-d				
PB140-e	234-PB140-e	BLACK	E	+24V BATTERY RETURN
PB140-f	235-PB140-f	BLACK	E	+24V BATTERY RETURN
PB140-g				

H17 H18 H19 H20 H21 H22 H23 H24 H25 H26 H27

* WIRE NUMBERS SHOWN IN SCHEMATIC MAY CONTAIN LETTER DESIGNATION WHERE SPLICED CIRCUITS EXIST

** WIRE CLASSES ARE DEFINED AS FOLLOWS:

A	0-5V	0-50mA
B	0-VBAT	0-50mA
C	0-VBAT	0-850mA
D	0-VBAT	0-3A
E	0-VBAT	0-10A
F	0-200VAC	0-50mA

CONNECTOR PART NUMBERS SHOWN ARE MATING CONNECTORS FOR ALLISON SUPPLIED HARDWARE ONLY

MATING CONNECTORS ARE CUSTOMER SUPPLIED

REFER TO ALLISON TECHNICAL DOCUMENT NO. 169 FOR INFORMATION ON WIRING HARNESSES

INSERT CAVITY PLUGS IN ALL UNUSED CAVITIES OF SPECIFIED CONNECTORS. QUANTITY WILL VARY ACCORDING TO INSTALLATION INTERFACE REQUIREMENTS. THE PLUG IS TO BE INSERTED UNTIL THE LARGER DIAMETER IS FLUSH WITH THE CONNECTOR GROMMET.

WHEN FEATURES ARE NOT USED, ALL LEAD WIRES TO THOSE FEATURES ARE TO BE OMITTED.

FUSING INFORMATION	
PI120 - 1,2,5, AND 6 18GA FUSED AT 10A TOGETHER	DPIM
(ONLY 1 FUSE) TO +12V BATTERY	
PV11 - 3 18GA FUSED AT 10A TO +12V BATTERY	VCM
PT13 - 3 18GA FUSED AT 10A TO +12V BATTERY	TCM
PX130 - B 18GA FUSED AT 10A TO +12V BATTERY	DIAGNOSTIC (CAN)
PM110 - A 18GA FUSED AT 10A TO +12V BATTERY	DRIVE UNIT
PM110 - Q 18GA FUSED AT 10A TO +12V BATTERY	DRIVE UNIT
PO16 - R 18GA FUSED AT 10A TO +12V BATTERY	PBSS
K1 - 30 18GA FUSED AT 10A TO +12V BATTERY	RELAY
K2 - 30 18GA FUSED AT 10A TO +12V BATTERY	RELAY
K3 - 30 18GA FUSED AT 10A TO +12V BATTERY	RELAY
K4 - 30 18GA FUSED AT 10A TO +12V BATTERY	RELAY
PB140 - F 16GA FUSED AT 15A TO +12V BATTERY	ESS
PB140 - P 16GA FUSED AT 15A TO +12V BATTERY	ESS
PB140 - a 16GA FUSED AT 15A TO +24V BATTERY	ESS
PB140 - b 16GA FUSED AT 15A TO +24V BATTERY	ESS
PB140 - c 16GA FUSED AT 15A TO +24V BATTERY	ESS

V10009.00.00

Figure H–4. Allison Electric Drive™ Wiring Schematic—ESS

RESOURCES: Wiring Schematics

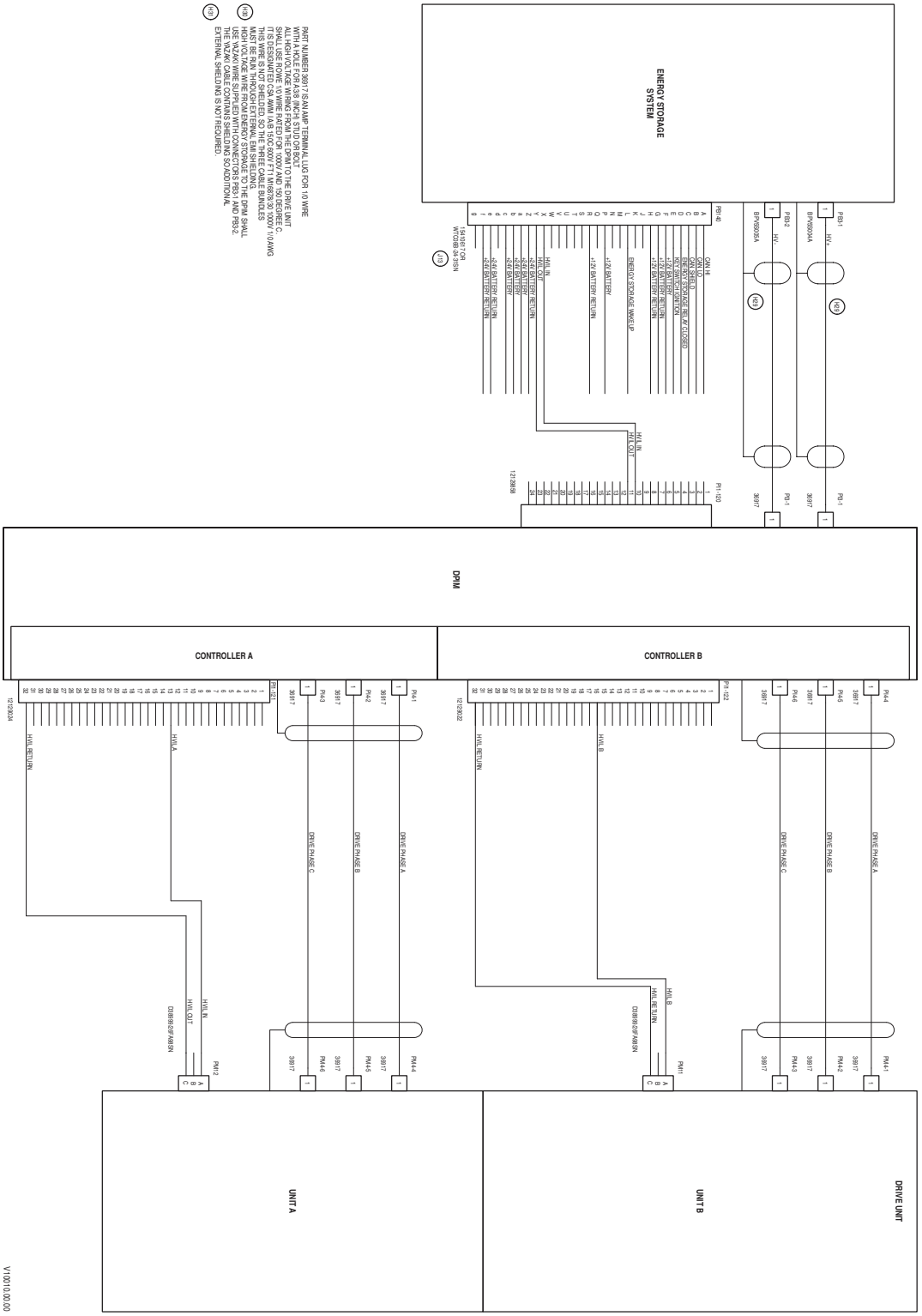


Figure H–5. Allison Electric Drive™ Wiring Schematic—HVIL

V100100.00.00

RESOURCES: Wiring Schematics

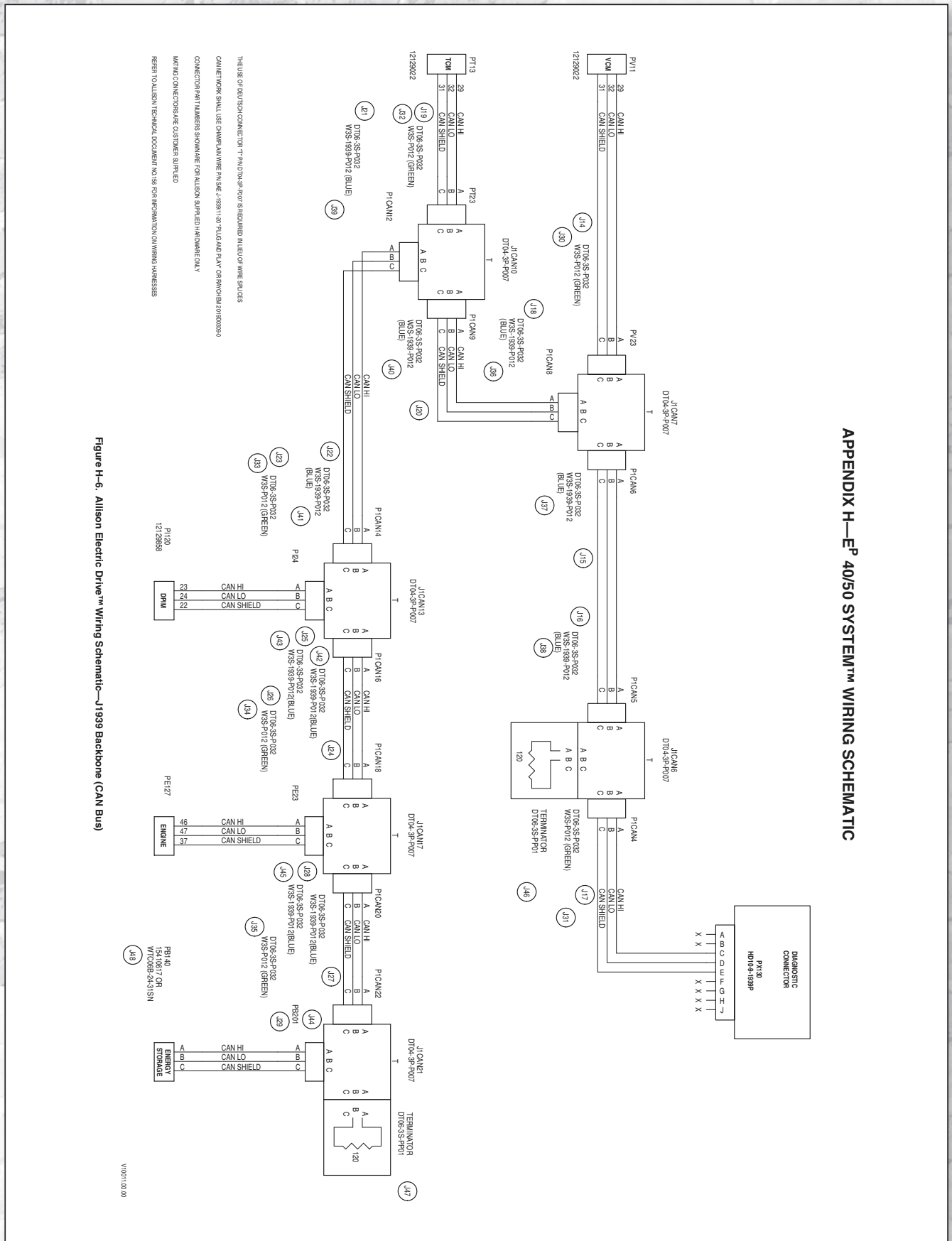


Figure H–6. Allison Electric Drive™ Wiring Schematic—J1939 Backbone (CAN Bus)

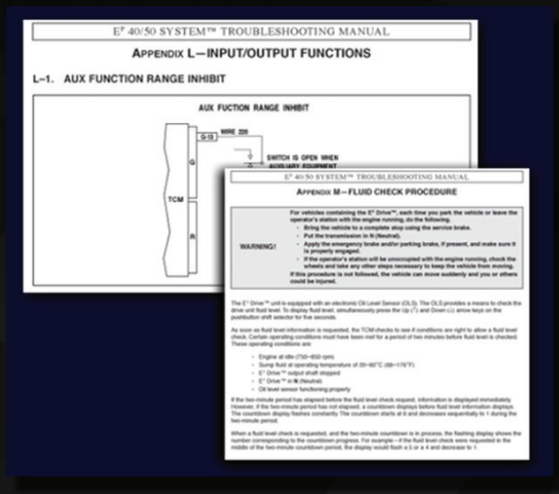
DIAGNOSTICS — USING THE TROUBLESHOOTING MANUAL

Allison Transmission. Instructor Led Training

Using The Troubleshooting Manual

Troubleshooting Manual Appendices (cont'd)

- **Resistance vs. Temperature:**
  - *Information related to solenoid resistance values as related to fluid temperatures.*
- **Electronic Interference:**
  - *Describes potential causes of, system reactions to and recommended repair procedures for externally-generated electronic interference.*
- **Input/Output Functions:**
  - *Includes wiring schematics and operational overview for available Input and Output features.*
- **Fluid Check Procedures:**
  - *Using the Oil Level Sensor to obtain sump fluid level.*



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6 of 7

Allison Transmission.

RESOURCES: Resistance vs. Temperature

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

APPENDIX J—RESISTANCE VS. TEMPERATURE

J–1. RESISTANCE VS. TEMPERATURE

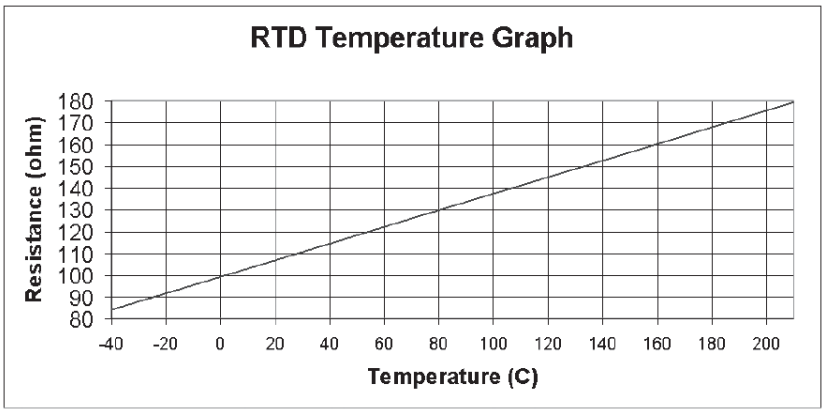


Figure J–1. Temperature vs. Sensor Chart

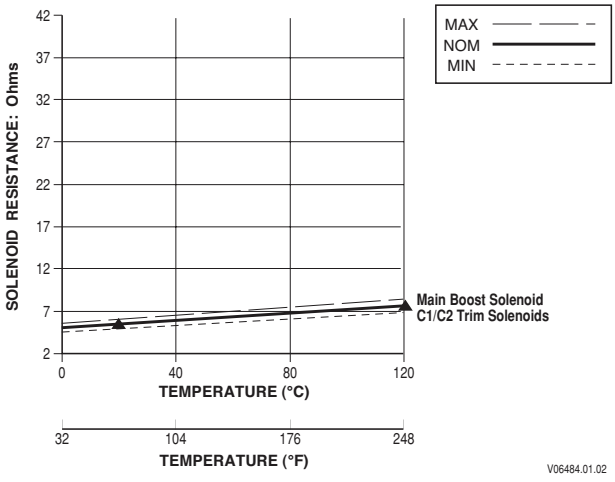


Figure J–2. Solenoid Resistance vs. Temperature Graph

RESOURCES: Electronic Interference

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

EP 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

APPENDIX K—ELECTRONIC INTERFERENCE

K–1. ELECTROMAGNETIC INTERFERENCE (EMI)/RADIO FREQUENCY INTERFERENCE (RFI)

All electrical and electronic systems generate electromagnetic fields that can interfere with other electronic systems. Allison Transmission electronic transmission controls comply with Federal Communications Commission (FCC) regulations and other guidelines concerning emitted radio frequency interference for transportation electronics. The position of Allison Transmission Division of General Motors is that manufacturers and installers of Electromagnetic Interference (EMI)/Radio Frequency Interference (RFI) emitting equipment are responsible for adhering to FCC regulations and other guidelines concerning emitted radio frequency interference for transportation electronics.

Some radio-telephone or two-way communication radios (land-mobile radio), or the manner in which they are installed, can adversely affect vehicle operation or be affected by other vehicle components. Expenses incurred to protect vehicle-related systems from EMI/RFI emissions by radio-telephone or two-way communications radios (land-mobile radio) or to integrate such devices into vehicles are not the responsibility of Allison Transmission.

K–2. GENERAL GUIDELINES FOR RADIO EQUIPMENT INSTALLATION

The following general guidelines for installing radio-telephone or two-way communications radios (land-mobile radio) in a vehicle supplement, but DO NOT replace, detailed instructions provided by the radio equipment manufacturer. Detailed installation instructions are the sole responsibility of the radio equipment manufacturer.

Experience has shown that most EMI/RFI problems can be prevented or eliminated by following the guidelines. If EMI/RFI problems persist after following the guidelines and after ensuring the installation conforms to the guidelines, contact the vehicle and radio equipment manufacturers for additional installation or equipment operation instructions.

A. Transmitter Installation

1. Locate remote radio transmitters as far away from other electronic devices and as near to the side of the vehicle body as possible.
2. Mount transceivers (transmitter and receiver in one box) under the dash so as not to interfere with vehicle controls or passenger movement.

B. Antenna Installation

Each vehicle and body style reacts differently to radio frequency energy. When dealing with an unfamiliar vehicle, test various antenna locations by using a magnetic mount antenna and checking for adverse effects. Antenna location is a major factor in EMI/RFI problems.

C. Antenna Cable Routing

1. Use high quality, 95 percent shield coverage, coaxial (coax) cable. Route the coax well away from any electronic components.
2. Route antenna cables as far away from vehicle wiring as possible to reduce the likelihood of the vehicle wiring acting as an antenna for interference.

D. Radio Wiring and Connector Location

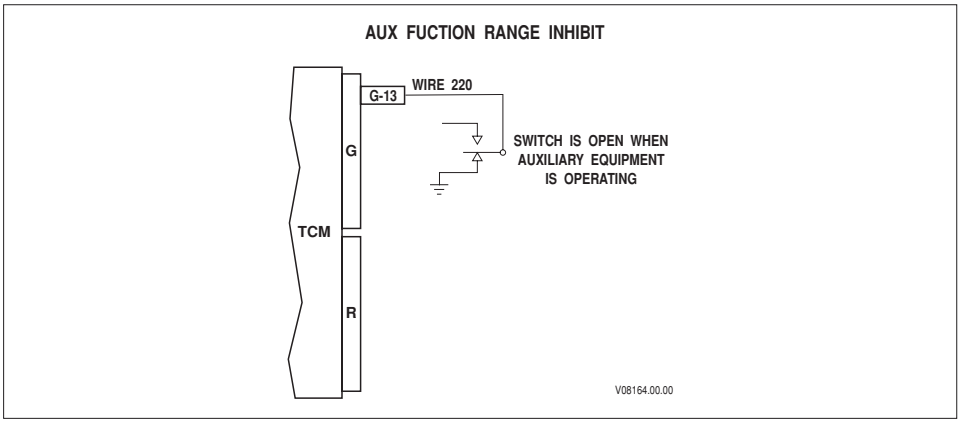
1. Connect transmitter power leads directly to the battery.
2. For transceivers (transmitter and receiver in one box) with ignition control, place a 12V power contactor at the vehicle battery. Drive the contactor coil, through an appropriate in-line fuse, from an ignition circuit not powered during engine cranking.
3. Any negative lead from a handset or control unit must return to battery negative.
4. Connect the positive lead from a handset or control unit directly to battery.
5. Fuse handset or control unit positive and negative leads separately from the transceiver negative and positive leads. Use correctly rated fuses.

RESOURCES: Input/Output Functions

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

APPENDIX L—INPUT/OUTPUT FUNCTIONS

L–1. AUX FUNCTION RANGE INHIBIT



WARNING! **If this function is enabled in the calibration, the function MUST be integrated into the vehicle wiring. If the function is available in the calibration but will not be used in the vehicle, it MUST be disabled in the calibration.**

DESCRIPTION. When this function is used and an auxiliary vehicle function is active, a neutral-to range shift is inhibited. It will continue to be inhibited until the input signal from the auxiliary vehicle function is turned off.

NOTE: ***This function is active when the input is off (switch open) and is deactivated when the input is turned on (switch closed).***

USES: This function prevents inadvertent range selection when auxiliary equipment, e.g., wheelchair lift, is operating. It may also be used to prevent neutral-to-range shifts unless the brake pedal is depressed.

VARIABLES TO SPECIFY: None

VOCATIONS: Various, not for emergency equipment. Typical uses: transit bus (wheelchair lift), utility truck (outriggers out), and motorhome (door ajar).

RESOURCES: Fluid Check Procedure

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

E^{P} 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

APPENDIX M—FLUID CHECK PROCEDURE

WARNING!	**For vehicles containing the E^{V} Drive™, each time you park the vehicle or leave the operator's station with the engine running, do the following.** • **Bring the vehicle to a complete stop using the service brake.** • **Put the transmission in N (Neutral).** • **Apply the emergency brake and/or parking brake, if present, and make sure it is properly engaged.** • **If the operator's station will be unoccupied with the engine running, chock the wheels and take any other steps necessary to keep the vehicle from moving.** **If this procedure is not followed, the vehicle can move suddenly and you or others could be injured.**

The E^{V} Drive™ unit is equipped with an electronic Oil Level Sensor (OLS). The OLS provides a means to check the drive unit fluid level. To display fluid level, simultaneously press the Up (↑) and Down (↓) arrow keys on the pushbutton shift selector for five seconds.

As soon as fluid level information is requested, the TCM checks to see if conditions are right to allow a fluid level check. Certain operating conditions must have been met for a period of two minutes before fluid level is checked. These operating conditions are:

- Engine at idle (625–850 rpm)
- Sump fluid at operating temperature of 20–80°C (68–176°F)
- E^{V} Drive™ output shaft stopped
- E^{V} Drive™ in **N** (Neutral)
- Oil level sensor functioning properly

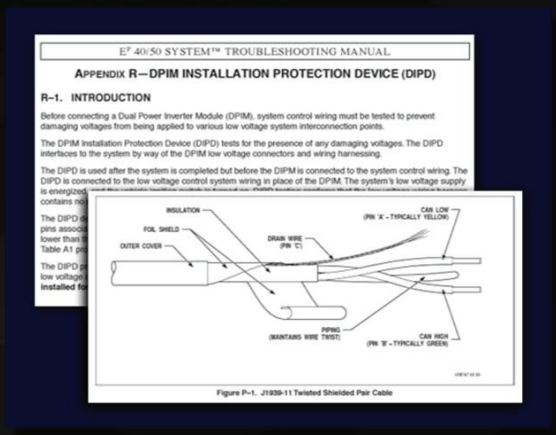
If the two-minute period has elapsed before the fluid level check request, information is displayed immediately. However, if the two-minute period has not elapsed, a countdown displays before fluid level information displays. The countdown display flashes constantly. The countdown starts at 8 and decreases sequentially to 1 during the two-minute period.

When a fluid level check is requested, and the two-minute countdown is in process, the flashing display shows the number corresponding to the countdown progress. For example—if the fluid level check were requested in the middle of the two-minute countdown period, the display would flash a 5 or a 4 and decrease to 1.

DIAGNOSTICS — USING THE TROUBLESHOOTING MANUAL

Troubleshooting Manual Appendices (cont'd)

- **Support Equipment:**
  - *Listing of available auxiliary components and their operation.*
- **Controller Area Network (CAN):**
  - *Includes operational overview and basic diagnostic procedures for J1939 backbones.*
- **DPIM Installation Protection Device (DIPD):**
  - *Description and use of the DIPD.*
- **Battery Pack Installation Protection Device (BIPD):**
  - *Description and use of the BIPD.*


E² 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

APPENDIX R—DPIM INSTALLATION PROTECTION DEVICE (DIPD)

R–1. INTRODUCTION

Before connecting a Dual Power Inverter Module (DPIM), system control wiring must be tested to prevent damaging voltages from being applied to various low voltage system interconnection points.

The DPIM Installation Protection Device (DIPD) tests for the presence of any damaging voltages. The DIPD interfaces to the system by way of the DPIM low voltage connectors and wiring harnessing.

The DIPD is used after the system is completed but before the DIPM is connected to the system control wiring. The DIPD is connected to the low voltage control system wiring in place of the DPIM. The system's low voltage supply

Figure P–1. J1939-11 Twisted Shielded Pair Cable

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RESOURCES: Support Equipment

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

EP 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

APPENDIX N—SUPPORT EQUIPMENT

N–1. GENERAL

Various types of auxiliary components and/or equipment may be required to complete the installation of an EP 40/50 Parallel Hybrid Electric Drive Propulsion System and its options. These items are commonly referred to as "support equipment". Some of the required items are available from Allison as an integral part of the propulsion system, e.g., an output yoke or flange. Other items, such as a Pushbutton Shift Selector (PBSS), are available from Allison, but must be specifically ordered. The remaining support equipment items are available from outside sources. Allison parts may be obtained through your order correspondent at the Allison Parts Distribution Center (PDC). If you do not have an order correspondent, contact PDC per the following:

Allison Transmission
Parts Distribution Center (PDC)
5902 Decatur Boulevard
Indianapolis, IN 46241-9579
Phone: (317) 821-5104

The addresses of suppliers listed in this section are included at the end of the document. This list may not include all sources of support equipment, nor does it constitute approval or recommendation of a particular item or supplier. The reliability and warranty coverage of these components are the responsibility of the supplier.

N–2. LOW VOLTAGE WIRING HARNESS AND CONNECTOR COVERS

The propulsion system controls require the use of wiring harnesses to connect the various system components. Wiring harnesses are available from:

- St. Clair Technologies Inc.

Unused connectors must be sealed with a mating connector and cavity pins, or an appropriate connector cover. Connector covers are available from:

- St. Clair Technologies, Inc.

N–3. HIGH VOLTAGE

A. Wiring

All high voltage wiring (Drive Unit to DPIM and DPIM to ESS) is to be 1/0 cable. Wiring is to be shielded and covered with orange conduit. If orange conduit cannot be used, the cables should be bundled and marked with orange to signify high voltage.

1. Drive Unit to DPIM

To assure compatibility with the seals used at the connections at both the Drive Unit and DPIM ends of these cables, the O.D. must be 15 mm (0.59 inch). See *Section B, Controls Component Installation*, for further details.

1/0 cable that meets all the requirements is made by D&B Industrial Group (Rowe Industries) and is designated: CSA AWM I A/B 150C 600V FT1 M16878/30 1000V 1/0 AWG. This cable, shielding, and conduit is available from:

- PEI Genesis, Incorporated
- Meunier Electronic Supply
- Astro Industries, Incorporated

RESOURCES: Control Area Network (CAN)

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

E^{P} 40/50 SYSTEM™ TROUBLESHOOTING MANUAL

APPENDIX P—CONTROL AREA NETWORK (CAN)

P–1. PHYSICAL LAYER—BASIC DESCRIPTION

The CAN (Control Area Network) physical layer is a two-wire connection using a twisted shielded pair. The two wires are defined as CAN High (typically yellow) and CAN Low (typically green). A termination resistor is applied at both ends of the CAN backbone, between CAN High and CAN Low. Typical bus termination resistors are 120 Ohms, 5 percent, 1/4 watt.

Terminology:

- CAN—Control Area Network
- CAN BACKBONE—The main avenue of communication wiring between the two termination resistor connections
- STUB—The CAN wiring between the CAN BACKBONE and NODE
- NODE—An electronic controller attached to the end of a stub

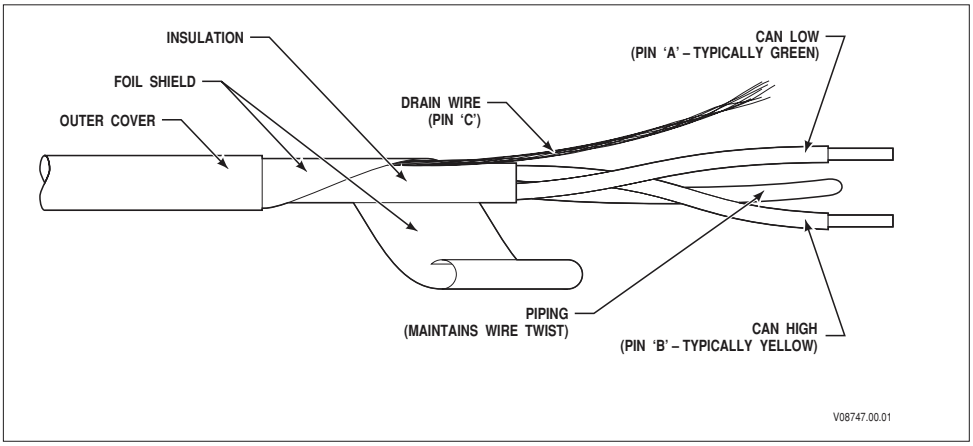

Figure P–1. J1939-11 Twisted Shielded Pair Cable

P–2. COMMON PROBLEMS

OPEN CIRCUITS—A (CAN High) or B (CAN Low) or both, in backbone or in a stub can affect one or multiple controllers on the network.

SHORT CIRCUITS—A (CAN High) or B (CAN Low) to battery, ground, shield or each other. ANY short, ANY location will result in an in-operable datalink (gauges dead, tools will not communicate, DTCs, etc.).

- Incorrectly wired pins on one or more of the controllers.
- Connector seal(s) missing; water intrusion or corrosion

SHIELDING—Effective shielding requires 100 percent coverage of the communication wires, a small opening can render the shielding worthless and susceptible to noise.

RESOURCES: DPIM Installation Protection Device (DIPD)

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

APPENDIX R—DPIM INSTALLATION PROTECTION DEVICE (DIPD)

R–1. INTRODUCTION

Before connecting a Dual Power Inverter Module (DPIM), system control wiring must be tested to prevent damaging voltages from being applied to various low voltage system interconnection points.

The DPIM Installation Protection Device (DIPD) tests for the presence of any damaging voltages. The DIPD interfaces to the system by way of the DPIM low voltage connectors and wiring harnessing.

The DIPD is used after the system is completed but before the DIPM is connected to the system control wiring. The DIPD is connected to the low voltage control system wiring in place of the DPIM. The system's low voltage supply is energized, and the vehicle ignition switch is turned on. DIPD testing confirms that the low voltage wiring harness contains no miswiring, shorts, or grounds that could damage the DPIM.

The DIPD detects the presence of voltage levels, above the maximum allowed on any single pin, or combination of pins associated with the DPIM low voltage system interconnections. In some instances, a voltage significantly lower than the maximum allowable will be considered a failure if that voltage level is indicative of improper wiring. Table A1 provides a listing of the (nominal/maximum) voltage failure set point for each interconnection point.

The DIPD provides a visual indication verifying that no potentially damaging voltages could be applied to the DPIM low voltage system interconnection points. **The DIPD does not prove that a wiring installation is correctly installed for proper ESS operation**.

R–2. FUNCTIONAL DESCRIPTION

The DIPD simulates the 12V sensor supply voltages normally supplied by the DPIM internal circuitry and makes appropriate measurements to ensure this power has not been inadvertently routed to another interconnection point on the DPIM which could be damaged by the application of 12VDC.

The DIPD provides a visual indication of the following:

- Proper low voltage supply and ground connections to the system
- Supply power within proper voltage range
- Proper system initial conditions met
- No improper voltage applied to any applicable pin(s)

NOTE: A failed test turns off or blinks the associated indicator lamp.

When connected and then energized, the DIPD performs a one second illumination test of all indicator lamps.

R–3. OPERATING INSTRUCTIONS

The DIPD connects to the control system by way of three low voltage connectors that are mated to the system harnessing in the same manner as a DPIM. These connectors are designated as J1 (Red, 32-pin), J2 (Gray, 32-pin) and J3 (Black, 24-pin)

All wiring installation and any other construction efforts which could damage system wiring, must be completed throughout the entire vehicle before conducting DIPD testing.

Use the DIPD to test the vehicle low voltage harness installation after any maintenance or modification that affects Energy Storage System low voltage interface wiring.

A. DIPD Test Procedure

DIPD testing requires that a DPIM is not connected to the low voltage wiring harness. If a DPIM is connected, the DPIM must be fully de-energized and the low voltage wiring harness connectors (J1, J2, and J3) disconnected from the DPIM before testing.

RESOURCES: Battery Pack Installation Protection Device (BIPD)

NOTE: This resource link has multiple pages and information changes frequently. Reference the source document for complete, current information.

APPENDIX S—BATTERY PACK INSTALLATION PROTECTION DEVICE (BIPD)

S–1. INTRODUCTION

When installing an Energy Storage System (Battery Pack) potentially damaging voltages must be prevented from being applied to various low voltage system interconnection points.

The Battery Pack Installation Protection Device (BIPD) tests for the presence of any potentially damaging voltages. The BIPD interfaces to the system by way of the Energy Storage System (ESS) low voltage connectors and wiring harnessing.

The BIPD is used after the system is completed but before the ESS is connected to the system wiring. The BIPD is connected to the low voltage control system wiring in place of the ESS. The system's low voltage supply is energized, and the vehicle ignition switch is turned on. BIPD testing confirms that the low voltage wiring harness contains no miswiring, shorts, or grounds that could damage the ESS.

The BIPD provides a visual indication verifying that no potentially damaging voltages could be applied to the ESS low voltage system interconnection points. **The BIPD does not prove that a wiring installation is correctly installed for proper ESS operation**.

S–2. FUNCTIONAL DESCRIPTION

The BIPD detects the presence of voltage levels above or below those allowed on any single pin, or combination of pins associated with the Battery Pack low voltage system interconnections. Table S–1 provides a listing of the maximum, minimum, and failure voltages for each interconnection point.

The BIPD provides a visual indication of the following:

1. Proper low voltage supply and ground connections to the system
2. Supply power within proper voltage range
3. Proper system initial conditions met
4. No improper voltage applied to any applicable pin(s)

NOTE: A failed test turns off the associated indicator lamp.

When connected and then energized, the BIPD performs a one second illumination test of all indicator lamps.

S–3. OPERATING INSTRUCTIONS

The BIPD connects to the system wiring harness in the same manner as the ESS. To ensure a meaningful test all wiring installation and any other vehicle construction that could potentially damage system wiring must be completed before testing with the BIPD.

Use the BIPD to test the vehicle low voltage harness installation after any maintenance or modification that affects Energy Storage System low voltage interface wiring.

A. BIPD Test Procedure

A BIPD test cannot be conducted with the battery Pack connected to the low voltage wiring harness. Disconnect the low voltage wiring harness from the battery pack before conducting a BIPD test.

B. Establish Proper Initial Test Conditions:

Various BIPD display combinations may exist as proper initial system conditions for testing. These displays are evaluated in subsequent operations and may be ignored until initial test conditions are established.

1. Be sure all 12VDC and/or 24VDC power-interrupting devices, power cut-off switches, circuit breakers, etc. are configured for normal system operation of the test system.