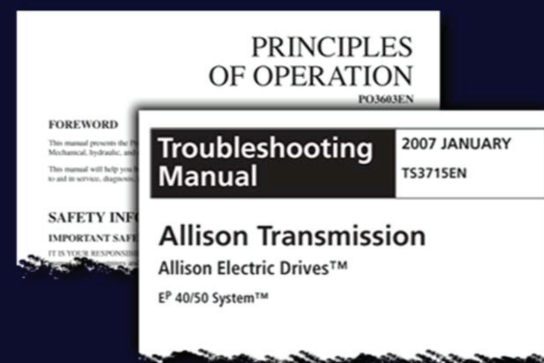
Allison Transmission | Instructor Led Training | ALLISON HYBRID H40/50EP

Electronic Controls

Introduction

- Allison Hybrid Electronic Controls work with the hydraulic system to control and refine shifts.
- Systems evolve over time, but use similar operating principles.
- Reference the General Description section of the Troubleshooting Manual and Section Five o the Principles of Operation Manual for more details.



Publication Number	Publication
TS3715EN	Troubleshooting Manual
PO3603EN	Principles of Operation

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RESOURCES: General Description

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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).

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Section Five

CONTROLLER FUNCTION WITHIN EP 40/50 SYSTEM™ INTERFACE

5–1. CONTROLLERS OVERVIEW

All the controllers interfacing to the EP 40/50 System™ receive inputs, process data, and produce outputs. They work together to operate the EP 40/50 System™, and allow the vehicle Input/Output (I/O) features to work. They run self-diagnostic tests, generate a diagnostic response for active DTCs and record a DTC event in history than can be reviewed.

There are twelve controllers in the EP System:

- TCM
- VCM
- DPIM (EPCU A)
- DPIM (EPCU B)
- DPIM (EPCU 2A)
- DPIM (EPCU 2B)
- ESS (one master)
- ESS (five slaves on ESS local CAN)

Other controllers on the vehicle may include an engine controller, the antilock brake/automatic traction controller, the OEM body controller, and occasionally a PC-based diagnostic tool.

A. Overview of J1939 Data Link Communication

All the EP 40/50 System™ controllers communicate with each other and with other vehicle controllers over a Controller Area Network (CAN). The CAN complies with SAE J1939 protocol. The protocol defines physical integration of the data link in the vehicle, the message content, and the message format.

Physically, the data link is a twisted pair of wires with a shield to reduce interference. There are two 120 Ohm termination resistors at either end of the main trunk of the data link which is called the backbone. There are branches to the backbone wiring that tie the controllers to the data link.

Each J1939 message has a common template called a frame. The frame defines where the message starts, who sent the message, what the message concerns, data parameters, and where the message ends. These messages are sent sequentially over the data link, also known as serial communication. Only one controller is on the data link at a time. This type of data link is therefore called a serial data link. Messages will not collide on the J1939 since only one controller is on the J1939 at a time.

Controllers and messages are assigned varying levels of importance. If two controllers make simultaneous requests to send a message, the more important message is sent. The lesser of the two is asked to wait until the data link is available. The controller that had to wait will still continue to make its request for the data link until its message is sent. The message cannot be dropped until it is sent.

B. Controllers and J1939 Activities

EP 40/50 System™ controllers use the J1939 data link to:

- Receive messages from other controllers as input, such as engine output torque and speed, ABS events, etc.
- Broadcast messages to other controllers such as target engine speed, requested motor torque, etc.
- Load software and calibrations for all EP 40/50 System™ controllers using a translator and a PC loaded the with necessary calibration software.

C. Software and Calibrations

The EP 40/50 System™ controllers have an executable file stored in their permanent memory that contains instructions and data that allows them to perform their respective tasks. Typically the instructions portion of the file is known as the software or program and the data portion is referred to as the calibration.

Calibrations for the EP 40/50 System™ are identified by their System Identification number (SID). It is equivalent to the Calibration Identification Number (CIN) for calibrations in other Allison products that have a TCM or ECU.

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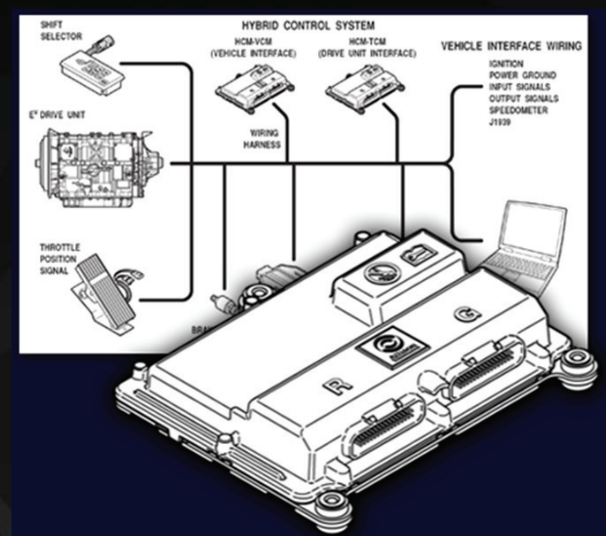
Electronic Controls

Controllers Overview

- **Allison Hybrid H 40/50 EP System utilizes two external controllers – the Transmission Control Module (TCM) and Vehicle Control Module (VCM).**
  - *These controllers enable interface and communication between system components and other vehicle controllers.*
  - *The TCM and VCM are externally identical, but each controller contains its own system software and calibration data.*
  - *Other controllers interfacing with the system might include Engine, Antilock Brake and OEM Body controllers.*



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RESOURCES: TCM/VCM Controller

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63-G0001-001-P

63
This two-digit number identifies that the SID is for use in an E^P 40/50 System™ and the model year of the software. In this case the "3" represents MY2006 software.

G0001
This five-character alphanumeric is the unique identifier for a specific SID. "G" represents a generic SID (a SID that can be used for more than one fleet) and an "S" represents a special SID (a SID that was specifically designed for a particular vehicle or fleet).

NOTE:

If the SID in question is a generic SID, certain Customer Modifiable Constants such as axle ratio, tire size, and maximum output speed will have to be changed using Allison DOC™ For PC (AED)–Service Tool.

001
This three-digit number identifies the software version of the SID. In this example, the "001" means that the SID has never been changed.

P
This alphanumeric character is referred to as the checksum. Once the SID is downloaded to a computer, the system runs a check to make sure that all of the information in the SID has been downloaded. If the results of the check equal the checksum digit, then all of the information from the SID has been properly downloaded.

The E^P 40/50 System™ has seven controllers that are programmed during the calibration process. A SID will have all the files necessary to calibrate the following controllers:

- TCM
- VCM
- EPCUA
- EPCUB
- EPCU2A
- EPCU2B
- ESS

The software and calibration files identified by a SID are downloaded to the E^P 40/50 System™ controllers using the PC-based TCM Reflash tool. Each controller is automatically loaded with the proper software and calibration.

To load the SID onto the TCM Reflash tool, type either the SID or the TCM Assembly Number. It is preferable to use the TCM Assembly Number because the SID can change if the software or calibrations are updated (updating the software or calibrations in a SID changes the software version value, which in turn changes the checksum value). The TCM Assembly Number does not change and is displayed as in the following example:

HEVG0001

HEV
Indicates this is an E^P 40/50 System™ TCM Assembly Number. "HEV" is always used at the beginning of any E^P 40/50 System™ TCM Assembly Number.

G0001
This five-character alphanumeric is the same as in the SID. It is the unique identifier for a specific set of software and calibrations on the E^P 40/50 System™.

5–2. TCM/VCM CONTROLLER

A. TCM and VCM Controller Hardware and Software

The TCM and VCM are identical at a hardware level and have the same base part number. What differentiates the two is that they have different software and calibrations.

During the calibration process, the TCM and VCM are automatically identified. The calibration software installing a SID loads a TCM calibration into the controller that has a battery ground circuit wired to pin 11 of the gray connector and a VCM calibration into the controller that does not have a battery ground circuit wired to pin 11 of the gray connector. Once loaded as a TCM or VCM, the identity stays with the controller even if the calibration is updated later.

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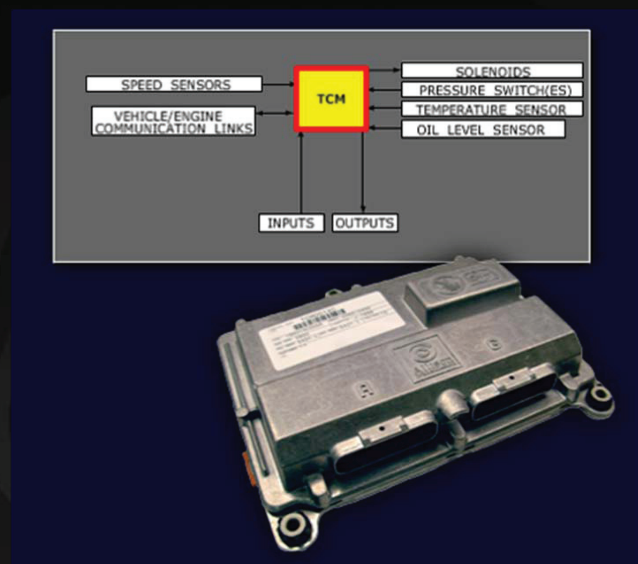
Electronic Controls

Transmission Control Module (TCM)

- The TCM communicates with a variety of components through wiring harnesses.
- The TCM is programmed to perform the following functions:
  - *Adaptive clutch control.*
  - *Torque blending.*
  - *Diagnostic data management.*
  - *Some start-up and shut-down events.*
  - *Oil level routine.*



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that on each component.

B. TCM Function

The TCM is programmed to perform the following:

- Adaptive clutch control
- Torque blending
- Diagnostic data manager
- Some start-up and shutdown events
- Oil level routine

i. Adaptive Clutch Control

Adaptive clutch control uses a closed loop feedback algorithm. The algorithm uses fluid temperature to control the solenoids in a manner that adjusts the clutch fill time and clutch pressure for optimum performance during primary mode shifts (e.g. Mode 1 to Mode 2). The adaptives for fluid temperature can be reset with Allison DOC™ For PC (AED)–Service Tool.

Another part of adaptive clutch control includes logic that compensates clutch pressure for changes in output torque requirement. This logic is used to anticipate and prevent clutch slip as output torque requirements increase. This logic controls the boost solenoid driver (VCM driver) so that effective clutch pressure increases, by increasing main pressure, when output torque requirements increase.

ii. Torque Blending

Torque blending is the process of making both mechanical torque and electrical motor torque available at the output shaft of the drive unit. The split between mechanical and electric torque is continuously adjusted by the TCM.

The torque blending algorithms process information from the E^{P} 40/50 System™ and combines possible torque speed points for the engine with specific points of operation for each motor. The algorithms interpret the current state of operation, the desired operation points, and establishes the most efficient means of attaining desired performance by adjusting engine speed and torque, motor speed and torque, and ESS throughput. Sometimes this means changing from one primary mode to another.

iii. Diagnostic Tests

The TCM contains many self-diagnostic routines that monitor the E^{V} Drive™ sensors, solenoids, and speed ratios to make sure these operational parameters are within programmed boundaries.

Some diagnostic routines run outside the TCM. For example, the DPIM and ESS controllers execute their own diagnostic tests that are not conducted by the TCM. In some cases the ESS or DPIM may perform the programmed system response (e.g. open a relay in the ESS) for the DTC associated with a diagnostic test. These controllers will report that activity to the TCM (and VCM) in order for the DTC to be logged into history and the appropriate dash lamp illuminated or other action taken.

If a diagnostic routine in the TCM sets a DTC the TCM will respond with a designated response that depends upon the specific DTC. Refer to the E^{P} 40/50 System™ Troubleshooting Manual (TS3715EN) for information about specific DTCs.

The TCM will record and retain all diagnostic codes that are logged. The PBSS will only display a list of the last nine logged DTCs, in order of occurrence. If there are more than nine codes logged, then the oldest codes are dropped to make room for active codes.

iv. Start-up and Shutdown

The TCM and VCM work in tandem with the other controllers in the E^{P} 40/50 System™ to perform the start-up/shutdown sequence. Refer to the section pertaining to Electrical Systems in this manual for more information.

v. Oil Level Sensor

The TCM is programmed with software for the Oil Level Sensor (OLS), located off the relay valve body. The OLS can be read using either the PBSS or Allison DOC™ For PC (AED)–Service Tool. Refer to Operator's Manual (OM3491EN) for detailed operating instructions.

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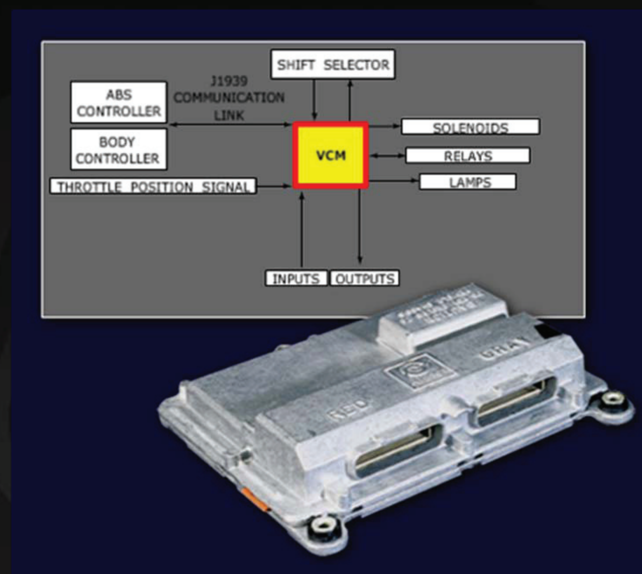
Vehicle Control Module (VCM)

- The VCM controls vehicle functions related to the Allison Hybrid H 40/50 EP System and also communicates with various vehicle auxiliary systems.
- The VCM can control relays, solenoids or lamps.
- The VCM can request another vehicle controller to perform an action via the J1939 datalink.



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RESOURCES: TCM Functions

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In addition to J1939 messages that are used as inputs for the TCM, there are hardwired inputs as well. Some of the inputs listed may have an equivalent J1939 message from another controller. One or the other is used in that situation, not both.

- Ignition sense—detects key switch state
- Drive Unit ID—identifies E^V Drive™ hardware level (similar to TID in other products)
- ECU ID (TCM/VCM)
- C1/C2 Pressure Sense
- Sump Oil Temperature
- E^V Drive™ Output Speed
- ESS Relay Closed
- Accelerator interlock—disables engine response to throttle when active
- Fast Idle—commands higher idle speed when active
- Engine Brake Enable—notifies TCM of the engine brake state
- Auxiliary Function Range Inhibit—inhibits selection to range when auxiliary equipment enabled
- Front Operation—allows vehicle start-up and operation from the driver's compartment
- Remote Shutdown—requests system shutdown
- Oil Level Sensor

D. TCM Outputs

- C1 and C2 Trim Solenoid Drivers
- C1 and C2 Blocking Solenoid Drivers
- DPIM Wake-up Signal
- ESS Wake-up Signal
- Engine Controller Wake-up Signal
- Speedometer Signal (optional)
- Engine Brake Enable (optional)
- Auxiliary Brake Enable Indicator Lamp
- PTO Enable
- Output Speed Indicator—provides an output at a programmed vehicle speed
- Propulsion Inhibits—based upon system diagnostics and operating parameters

E. VCM Functions

The VCM controls vehicle functions related to the E^P 40/50 System™. The VCM also communicates with various vehicle auxiliary systems to limit vehicle movement when an auxiliary system is functioning or to limit auxiliary system operation such as rear door open when vehicle speed inhibits door opening. The VCM can control relays, solenoids, or lamps and can request, via the J1939, another controller to perform an action.

i. VCM Inputs

- Engine Start Request
- Idle Verification
- Shift Selector Inputs
- System Override Requests
- Auxiliary Brake Enable Request
- Electric Mode Request (a special calibration)
- Auxiliary Brake Analog Input

ii. VCM Outputs

- Accelerator Pedal Sensor Supply
- Shift Selector Serial Data Link
- Dash Indicator Lamp Control
- Main Pressure Boost Solenoid Commands
- Reverse Warning
- Propulsion Inhibits Based Upon Diagnostics or Operating Parameters

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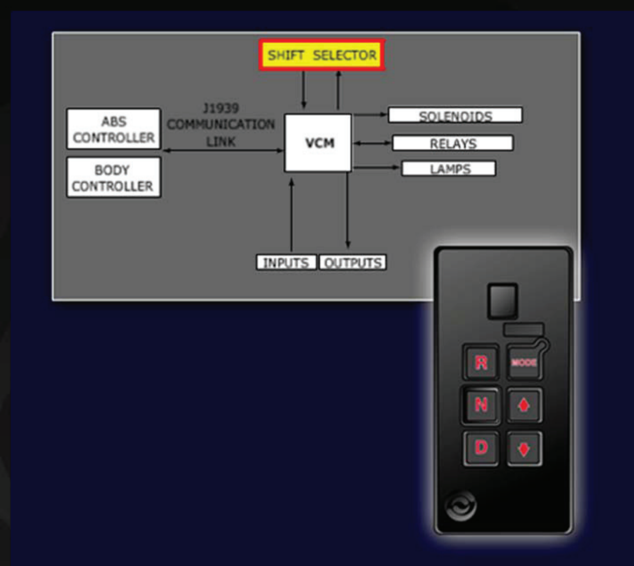
Electronic Controls

Shift Selector

- The Allison Hybrid H 40/50 EP System uses a shift selector that connects to the TCM via a wiring harness.
- Shift selector functions:
  - *Command direction of operation (Forward, Neutral, Reverse).*
  - *Oil Level Sensor Mode.*
  - *Diagnostic Mode.*
  - *Control level of regenerative braking.*



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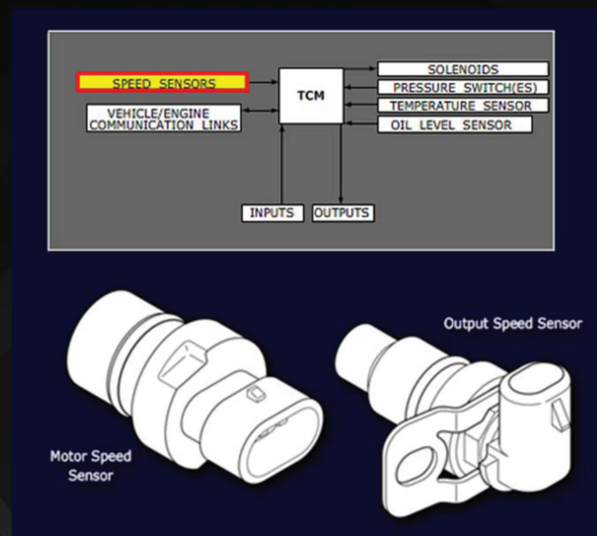
Electronic Controls

Speed Sensors

- **The drive unit uses the following speed sensors:**
  - *Motor speed sensors.*
    - *Two per motor for a total of four.*
    - *Hall effect sensor.*
  - *Output speed sensors.*
    - *Two total located on the output cover.*
    - *Variable reluctance sensor.*



- **Speed sensors provide rpm and direction of rotation signals to the TCM and DPIM.**
  - *Information is also used for adaptive clutch control and diagnostic functions.*

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RESOURCES: Speed Sensor Details

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

2–8. SPEED SENSORS

The E^V Drive™ has six speed sensors, two motor speed sensors for each motor (Figure 2–3) and two output speed sensors (Figure 2–4). Motor speed sensors are Hall effect devices. Output speed sensors are variable reluctance devices. Speed sensors provide rpm and direction of rotation signals to the TCM and the DPIM. Speed sensor information is also used for adaptive clutch control and in the diagnostic process.

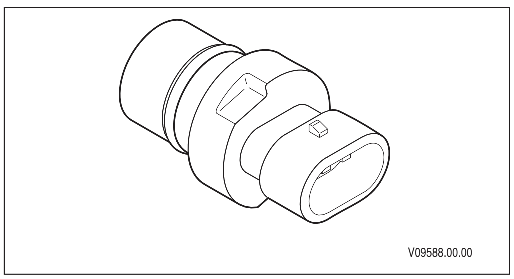

Figure 2–3. Motor Speed Sensor

A. Motor A Speed Sensors

Motor A speed sensors, P1 and P2, are located below the stator housing centerline on each side of the stator housing and close to the stator housing/input housing splitline. Motor A speed sensors are directed at the Motor A tone wheel. The Motor A speed sensors signal Motor A's rpm and direction of rotation to the TCM and DPIM. The Hall effect speed sensors output a variable frequency 11.76V 50 percent duty square waveform.

B. Motor B Speed Sensors

Motor B speed sensors, P3 and P4, are located below the stator housing centerline on each side of the stator housing and close to the stator housing/C1 clutch housing splitline. Motor B speed sensors are directed at the Motor B tone wheel. The Motor B speed sensors signal Motor B's rpm and direction of rotation to the TCM and DPIM. The Hall effect speed sensors output a variable frequency 11.76V 50 percent duty square waveform.

C. Output Speed Sensors

Two output speed sensors are mounted in the rear cover. The output speed sensors are identified as P7 on the E^V Drive™ centerline, and P6 approximately 45 degrees to the right of P7. The output speed sensors output a variable frequency (32 pulses per revolution) variable voltage sine wave.

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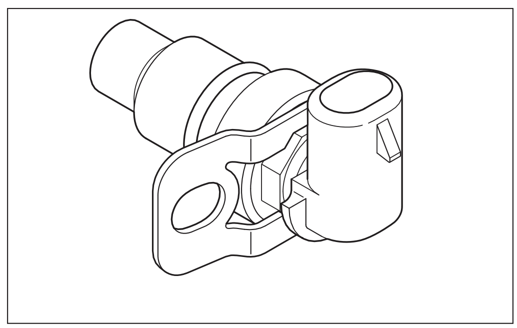

Figure 2–4. Output Speed Sensor

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Solenoids

- **The system uses electromechanical solenoids to control the flow of hydraulic fluid.**
  - *Solenoids are located in the control valve body of the drive unit.*
  - *Fluid flow is controlled by energizing and de-energizing solenoids.*
  - *Solenoid types vary, but the operating theory is the same.*

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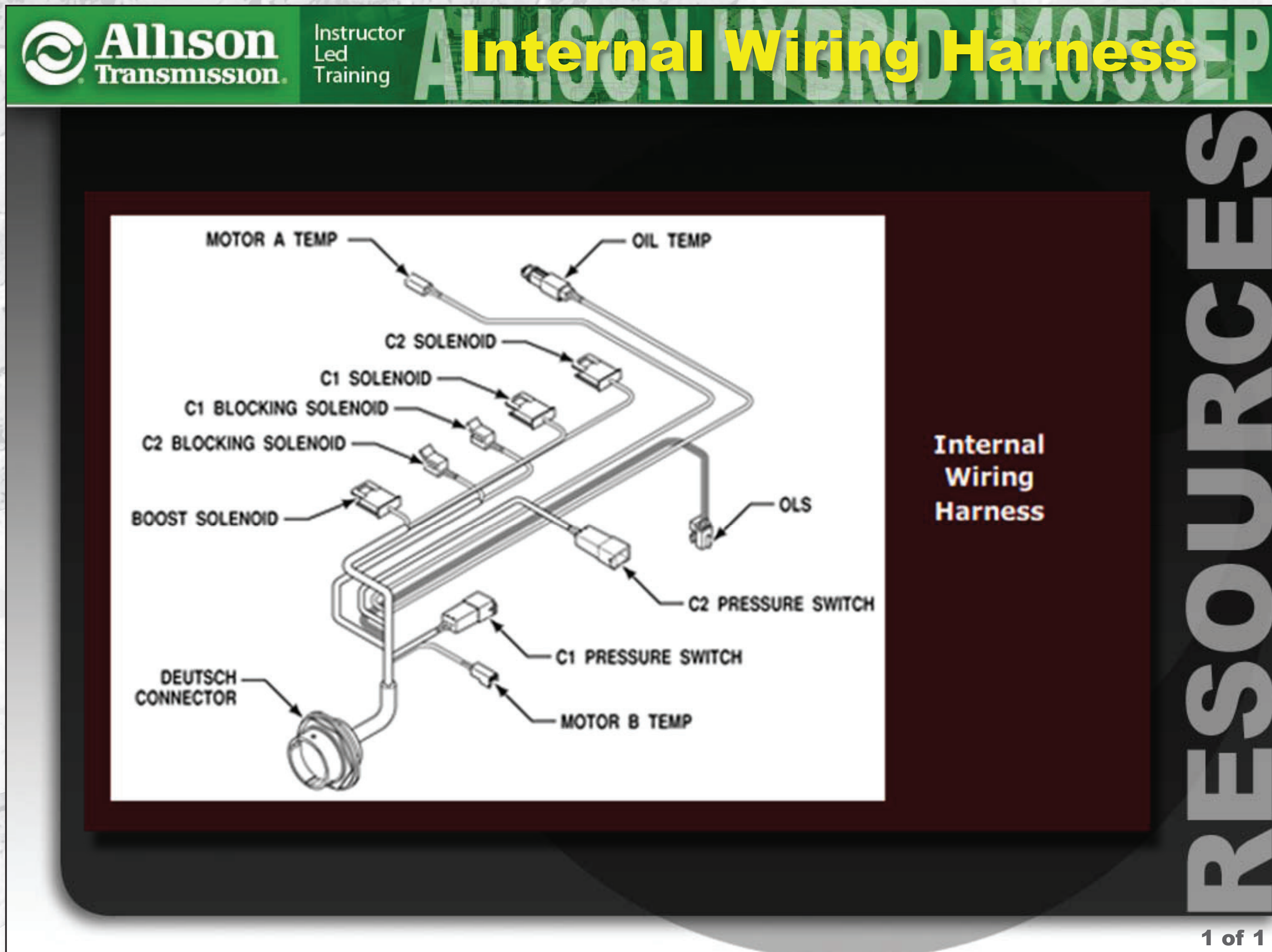
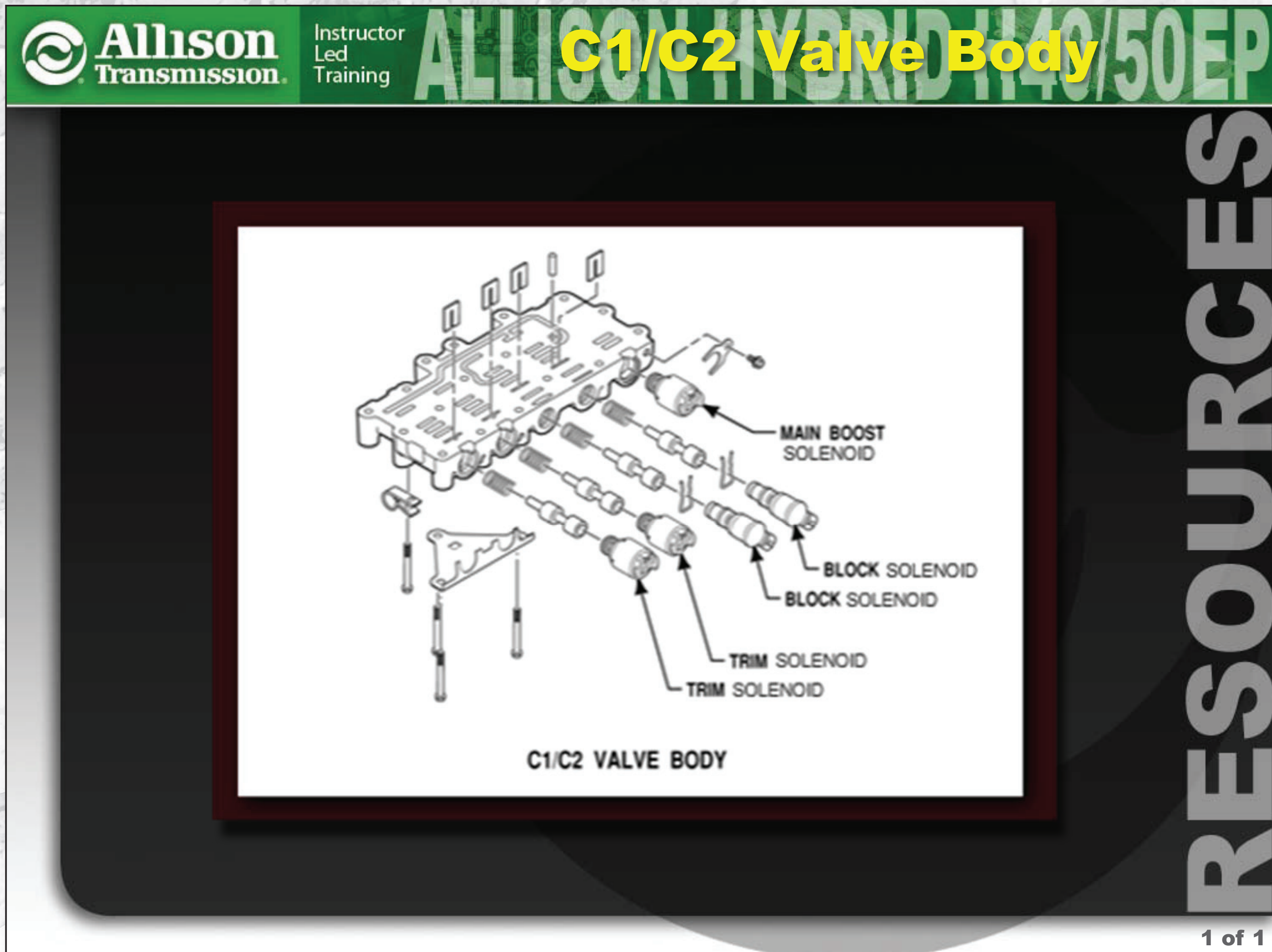
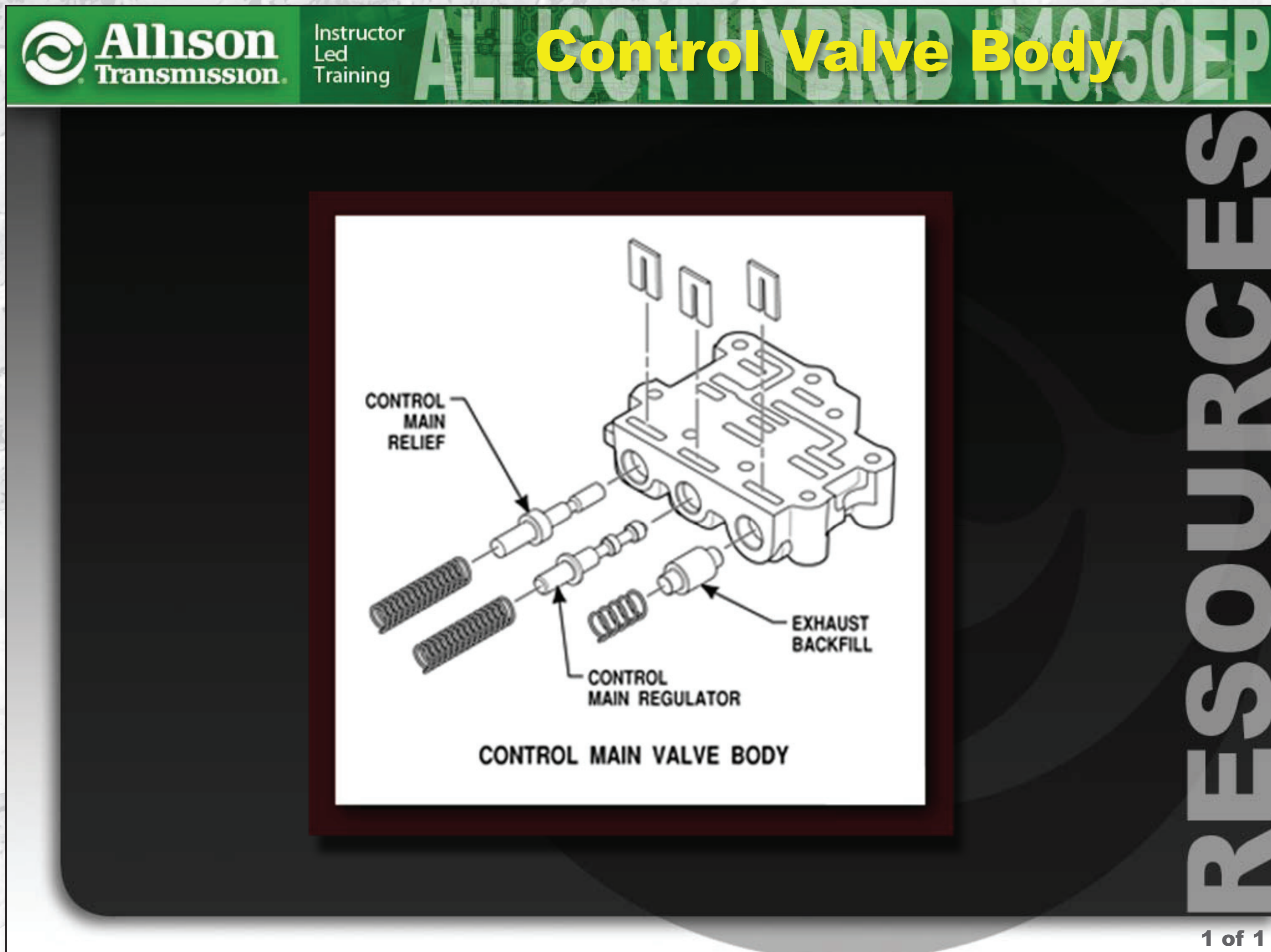
RESOURCES: Internal Wiring Harness



RESOURCES: C1/C2 Valve Body



RESOURCES: Control Valve Body



ELECTRONIC CONTROLS

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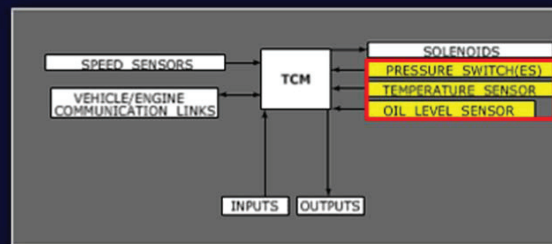
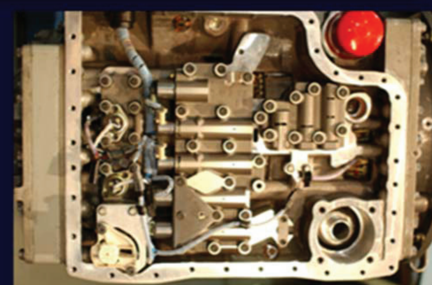
Electronic Controls

Additional System Components

- The C1 and C2 pressure switches provide range verification and diagnostic signals for the TCM.
- The fluid temperature sensor is part of the internal wiring harness.
- Motor temperature sensors are located in Motor A and Motor B.
- The Oil Level Sensor (OLS) is located in the C1/C2 relay valve body and is connected to the internal wiring harness.





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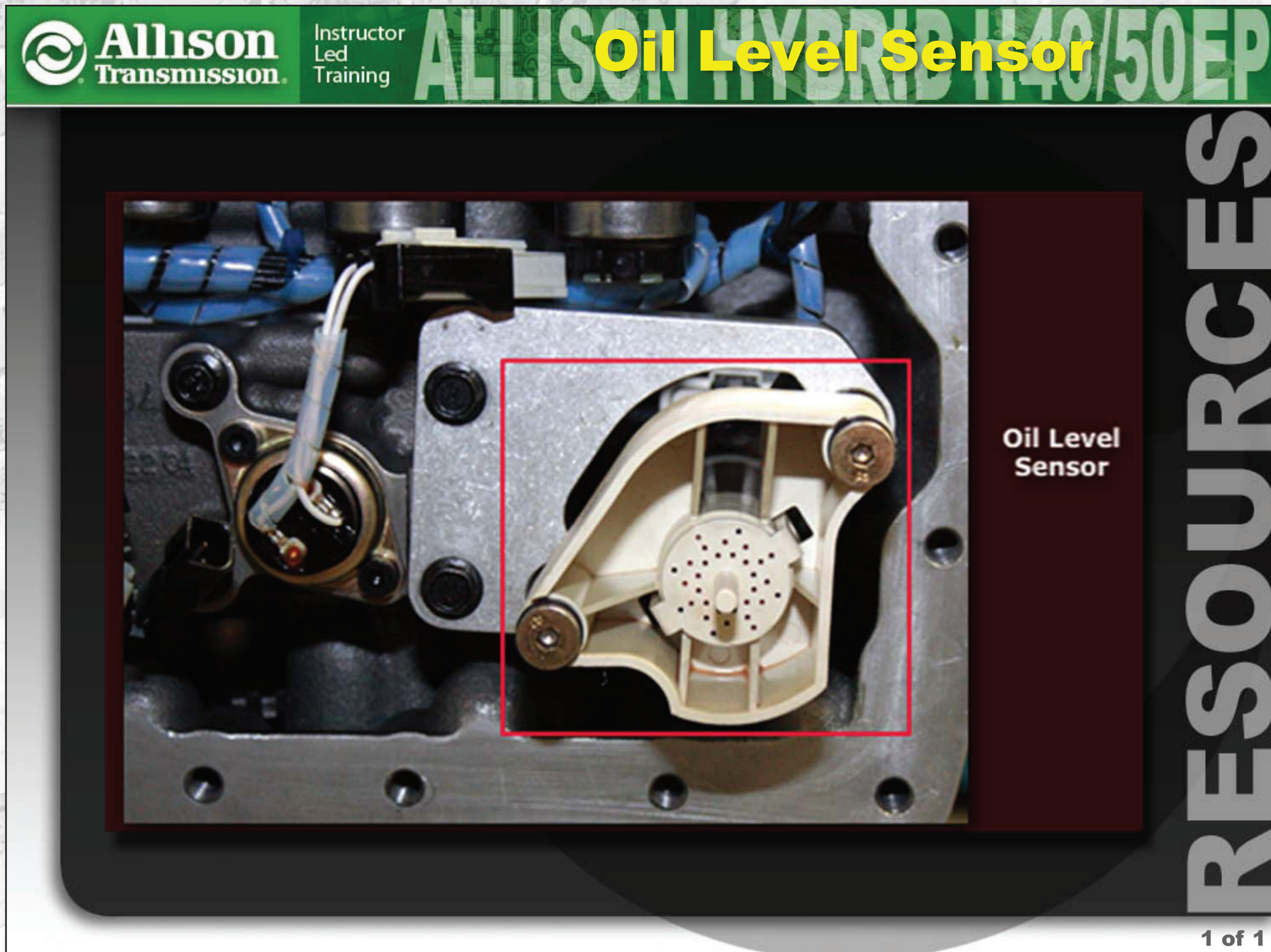
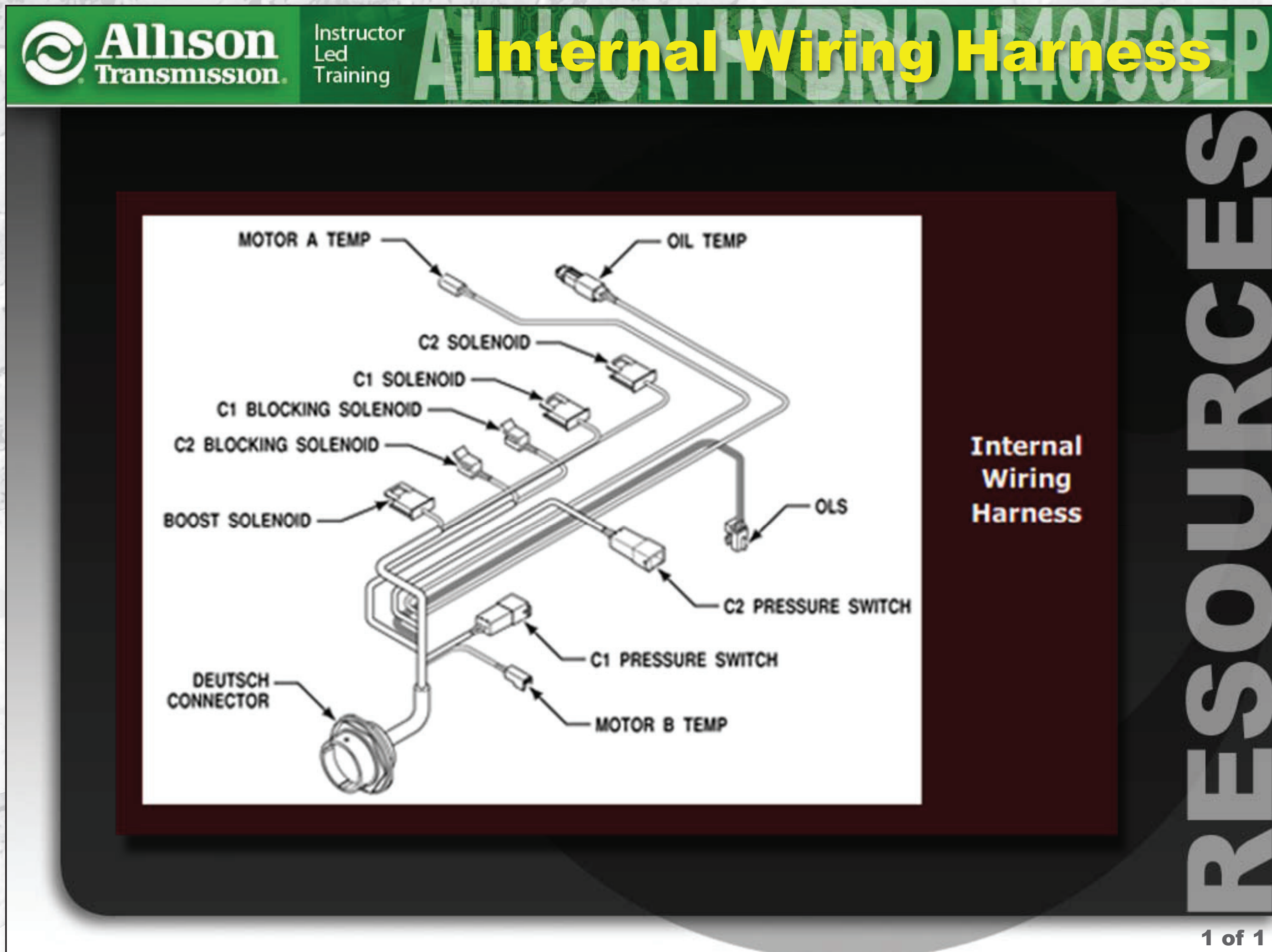
RESOURCES: C1/C2 Pressure Switches

RESOURCES: Fluid Temperature Sensor

RESOURCES: Oil Level Sensor



RESOURCES: Internal Wiring Harness



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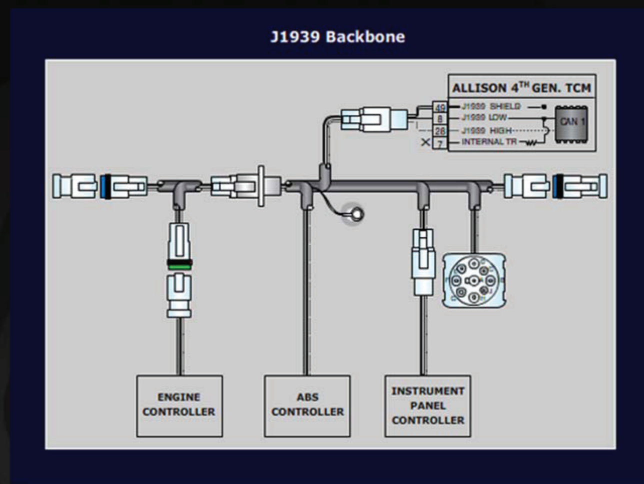
Vehicle Communication Links

- **Communication between the TCM/VCM and other vehicle controllers occurs over a network sometimes called a datalink or Controller Area Network (CAN).**
  - *A variety of items can be communicated on the datalink including throttle position.*
- **The Allison Hybrid H 40/50 EP System uses the SAE J1939 standard for vehicle communication and diagnostics which is faster and more robust than J1708 and J1587 standards.**



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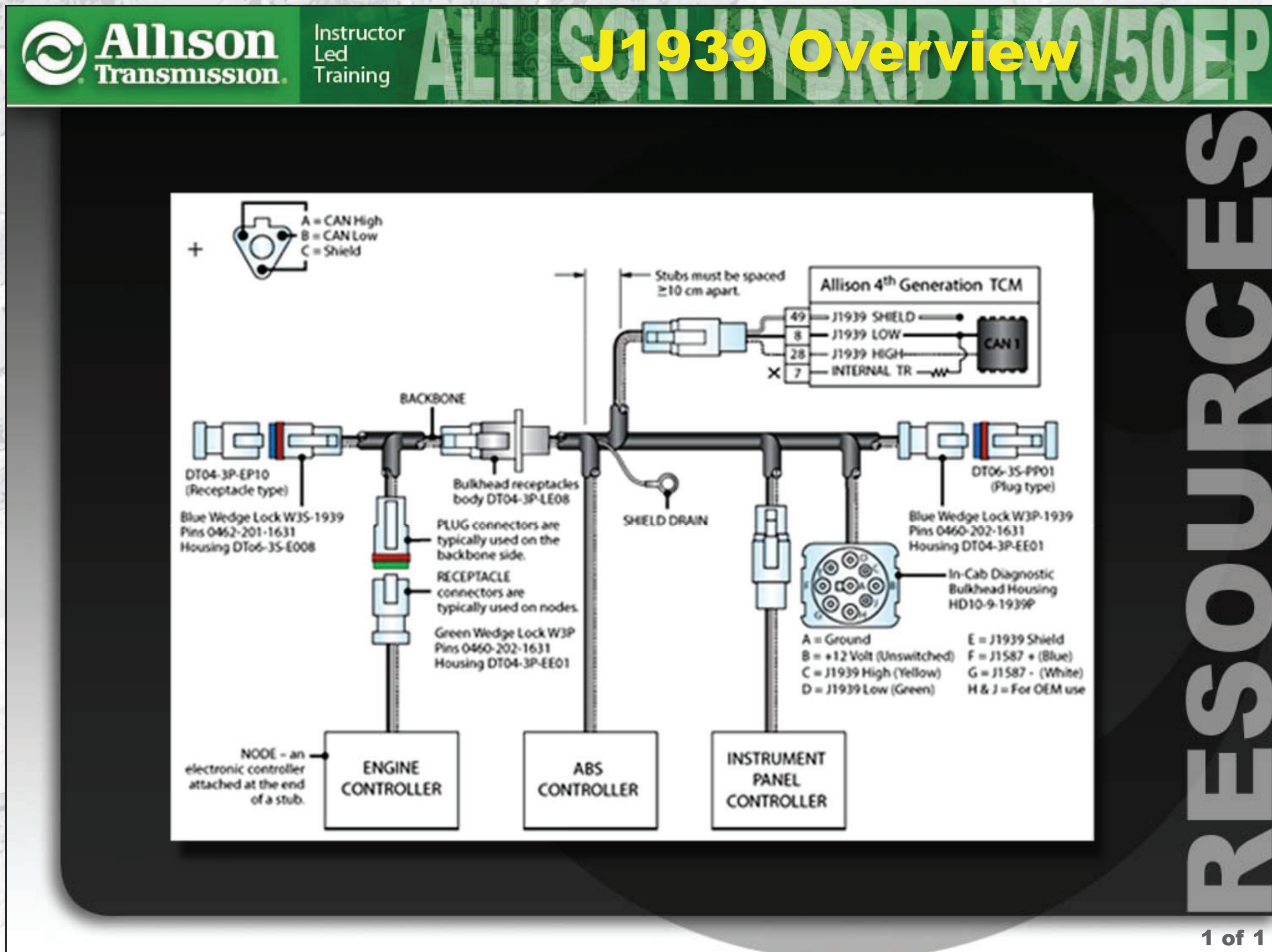
RESOURCES: J1939 Overview



RESOURCES: J1939 Communication

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APPENDIX R—SAE J1939 COMMUNICATION LINK

This Appendix is an overview of how Allison Transmission implements the J1939-based functions.

The Controller Area Network (CAN) de¿ned by SAE J1939 enables the integration of various vehicle components into an overall vehicle system by providing a standard way of exchanging information between these modules in the vehicle. Use of a J1939 network, or datalink, for on-vehicle communication can greatly reduce the amount of wiring in a vehicle, and give many different components and subsystems access to a wider range of information.

Allison uses the J1939 communication link for vehicle operation controls, powertrain interaction, and conveying vehicle management information (Figure R–1).*

Details are found in the Vehicle Function Requirements section of the Datalink Communications Tech Data.

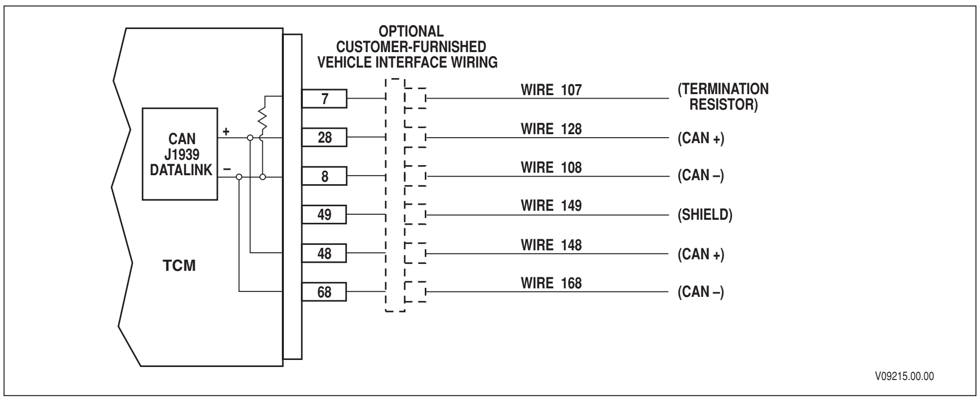

Figure R–1. J1939 Interface Wiring (TCM Pin-Out)

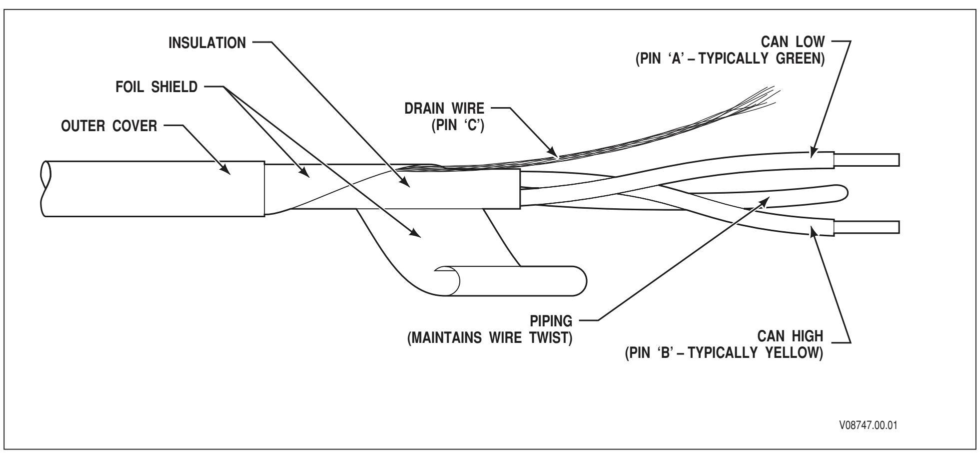

Figure R–2. J1939-11 Twisted, Shielded Pair Cable

NOTE: On Allison 4th Generation Controls Systems, off-board communications are only enabled via J1939.

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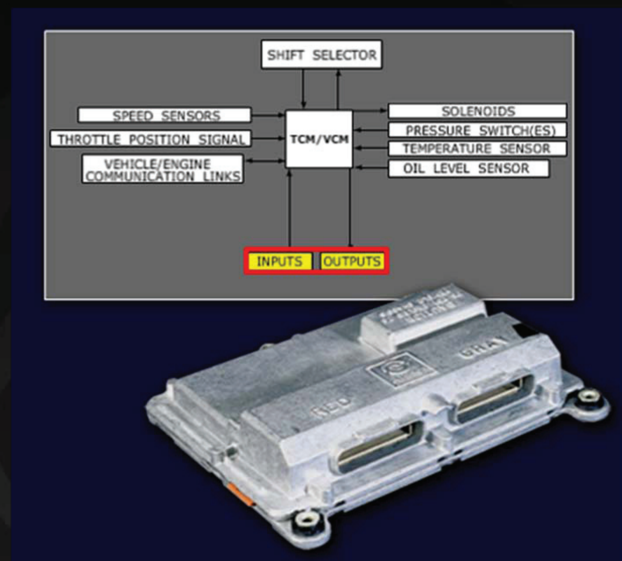
Electronic Controls

Vehicle Interface

- **Vehicle interface wiring connects the TCM/VCM to the vehicle.**
  - *Mandatory and Communication Interface connections are required for basic system operation.*
  - *Optional vehicle and system features (Inputs and Outputs) can also be connected using vehicle interface wiring.*
  - *Some Inputs/Outputs and system components are interfaced on the J1939 datalink.*
- **Reference Allison Tech Data on the Allison Extranet for additional information.**



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RESOURCES: Special Input/Output Functions

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Section Eight

INPUT/OUTPUT FUNCTIONS

8–1. SPECIAL INPUT AND OUTPUT FUNCTIONS

The E^{P} 40/50 System™ is equipped with several special input and output functions to aid in operation of the vehicle.

A. Input Functions

Input functions are special vehicle communications to the system. Input functions are received from outside the system to request some special operation.

Some common input functions are:

i. Range Inhibit

A Range Inhibit inhibits neutral to range operation when vehicle auxiliary equipment is active, such as a wheelchair lift. Range Inhibit may also be used to prevent a neutral to range shift if the brake pedal is not depressed.

ii. Automatic Neutral

Automatic Neutral automatically shifts the E^{V} Drive™ to neutral when specific operating conditions are met. The PBSS displays a flashing **F** if an automatic shift to neutral has occurred.

iii. System Override

System Override temporarily overrides a system shutdown to allow the vehicle to be moved away from imminent danger or from being an obstruction.

iv. Auxiliary Brake Enable

Auxiliary Brake Enable enables regenerative braking and engine exhaust braking. Auxiliary braking is disabled if an ABS active signal is detected.

v. Front Operation Mode 1/Mode 2

Front Operation Mode 1/Mode 2 allows the engine to be started from a position other than the operator's station. Usually used on buses if the engine compartment is far from the operator's station.

vi. Fast Idle

During Fast Idle the VCM increases engine rpm to maintain the speed of engine driven accessories while the E^{V} Drive™ is in neutral.

vii. Fast Idle 2

During Fast Idle 2 the VCM increases engine rpm much higher than normal to maintain the speed of engine driven accessories while the E^{V} Drive™ is in neutral.

viii. Remote Shutdown

Fire emergency engine shutdown prevents a fire suppressant from being dispersed by the cooling fan.

ix. Accelerator Interlock

The Accelerator Interlock disables the accelerator pedal if a vehicle condition, such as the rear door of a bus being open, is such that vehicle movement should be inhibited.

B. Output Functions

Output functions are special communications to the vehicle. Output functions are sent outside the E^{P} 40/50 System™ to request some special operation. Some common output functions are:

i. Range Indicator

The VCM provides a ground signal when a programmed range, such as neutral, is attained.

ii. Output Speed Indicator

The VCM provides a ground signal when a programmed output shaft speed is attained. The output can be used for vehicle control or to control an auxiliary vehicle system, such as preventing a bus's rear doors from opening above a specified speed.

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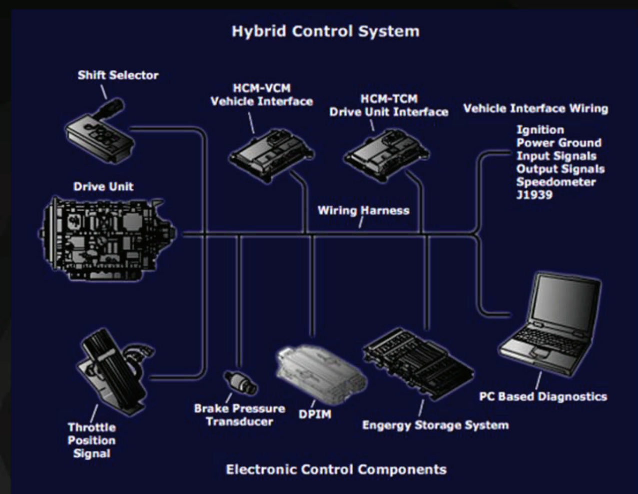
ALLISON HYBRID H40/50EP

Electronic Controls

Wiring Harnesses

- Electronic Control components are connected and communicate through wiring harnesses.
- Internal wiring harness connects components inside the drive unit to the rest of the Allison Hybrid H 40/50 EP System.
- All external wiring harnesses and mating connectors are customer supplied.



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RESOURCES: Wire/Connector Tables

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

WIRE/CONNECTOR TABLES

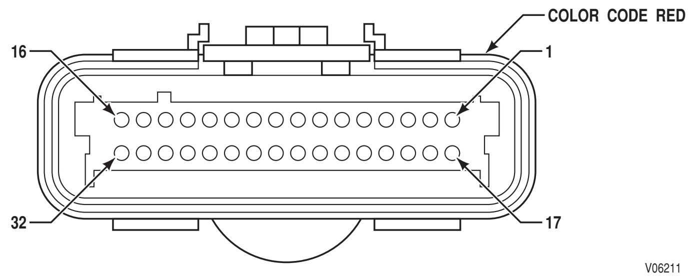

Figure D–1. TCM Connector J2

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
29				
30				

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Electronic Controls

Diagnostic Capabilities

- **TCMs include diagnostic capabilities.**
  - *The TCM records and stores Diagnostic Trouble Codes (DTCs) and other diagnostic information.*
- **The Allison Hybrid H 40/50 EP System also stores Failure Records.**
  - *Failure Records contain a snapshot of system information when certain DTCs are logged.*
  - *The TCM stores the five most recent Failure records.*
  - *Allison DOC™ for PC (H 40/50 EP) software is required to access Failure Record information.*

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RESOURCES: Diagnostic Trouble Codes (DTCs)

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

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

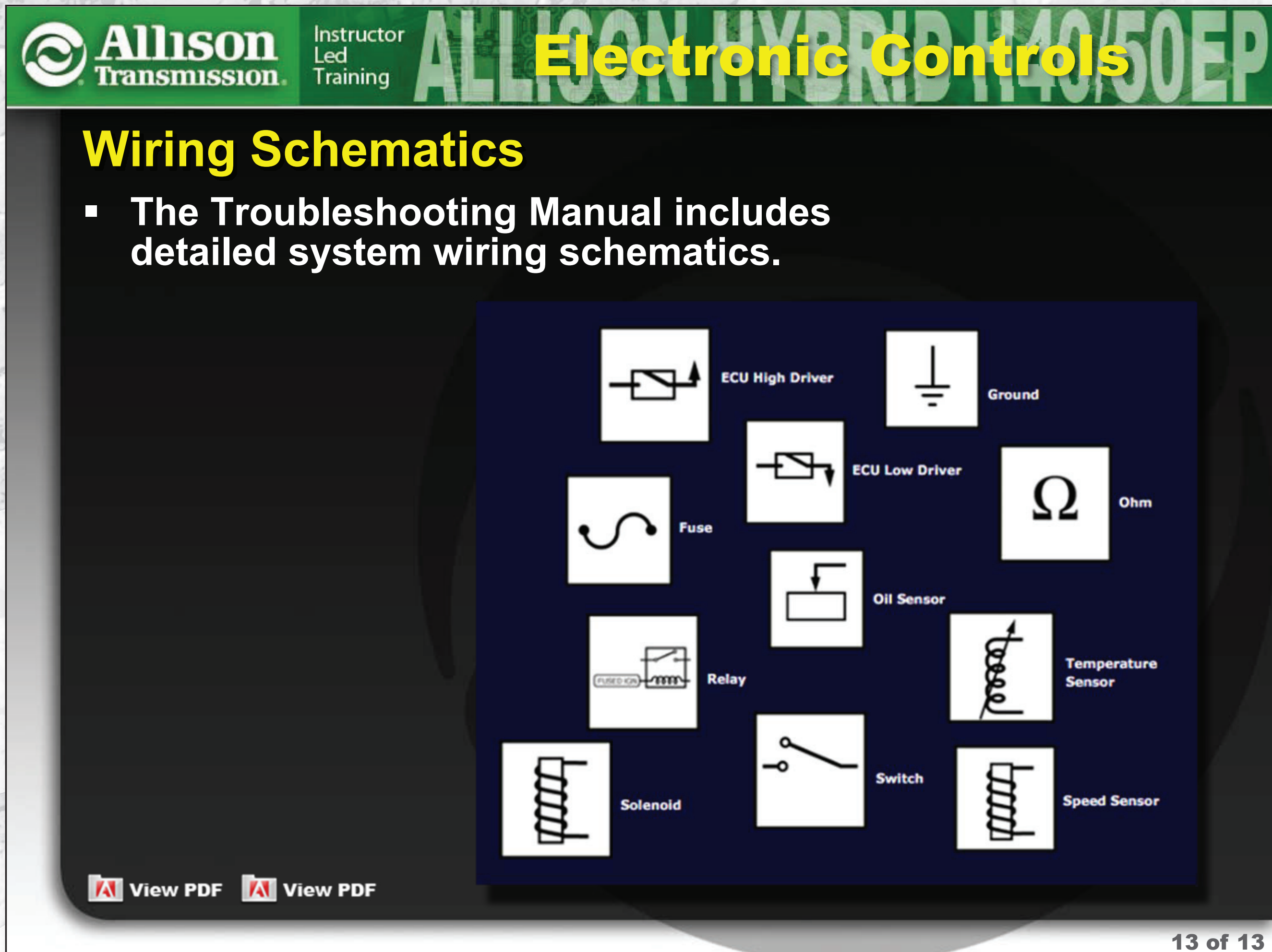
5–2. FAILURE RECORDS

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

Allison Transmission


Allison Transmission
Instructor Led Training
ALLISON HYBRID H40/50EP
Electronic Controls
Wiring Schematics
▪ The Troubleshooting Manual includes detailed system wiring schematics.
ECU High Driver
Ground
ECU Low Driver
Ohm
Fuse
Oil Sensor
Relay
Temperature Sensor
Solenoid
Switch
Speed Sensor
View PDF
View PDF
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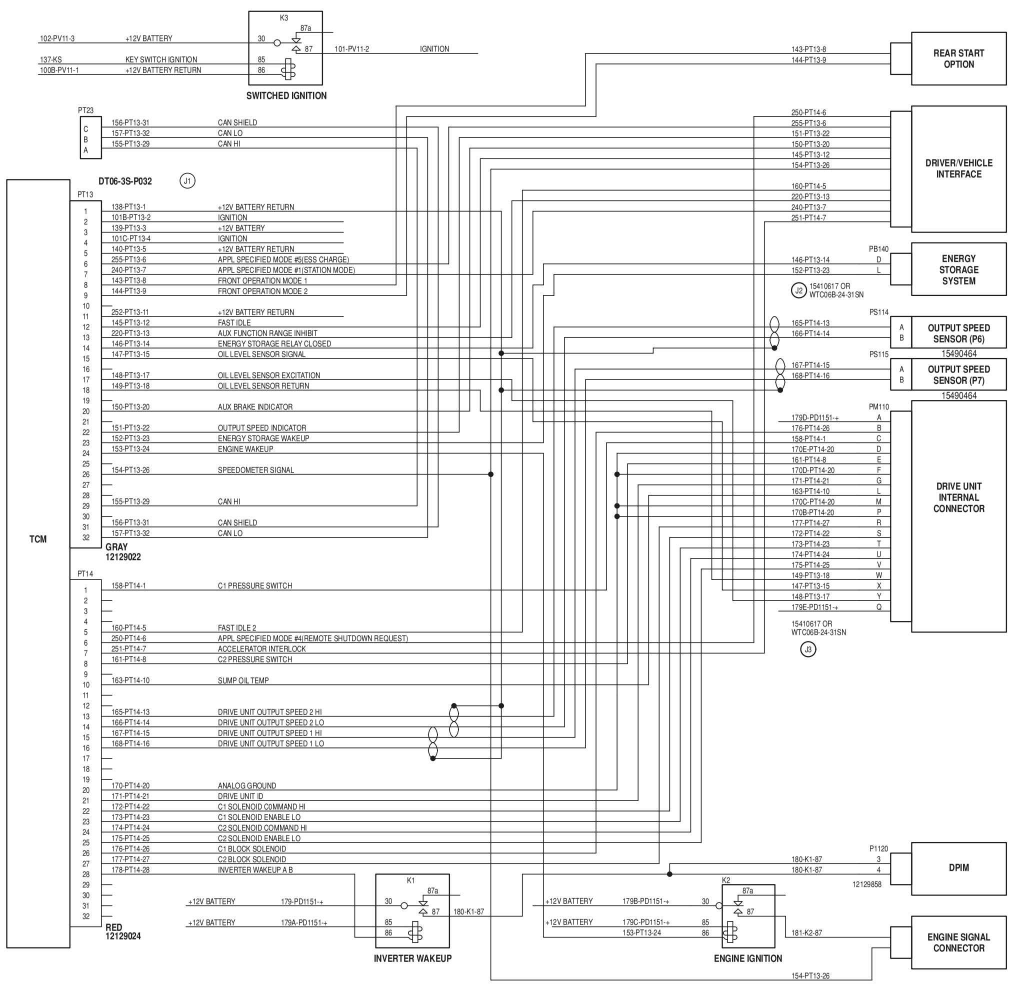
APPENDIX H—E^{P} 40/50 SYSTEM™ WIRING SCHEMATIC



PIN	WIRE NO.*	RECOMMENDED COLOR	CLASS**	DESCRIPTION
PT13-1	138-PT13-1	GREEN	E	+12V BATTERY RETURN
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
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	252-PT13-11		E	+12V BATTERY RETURN
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
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 L0
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

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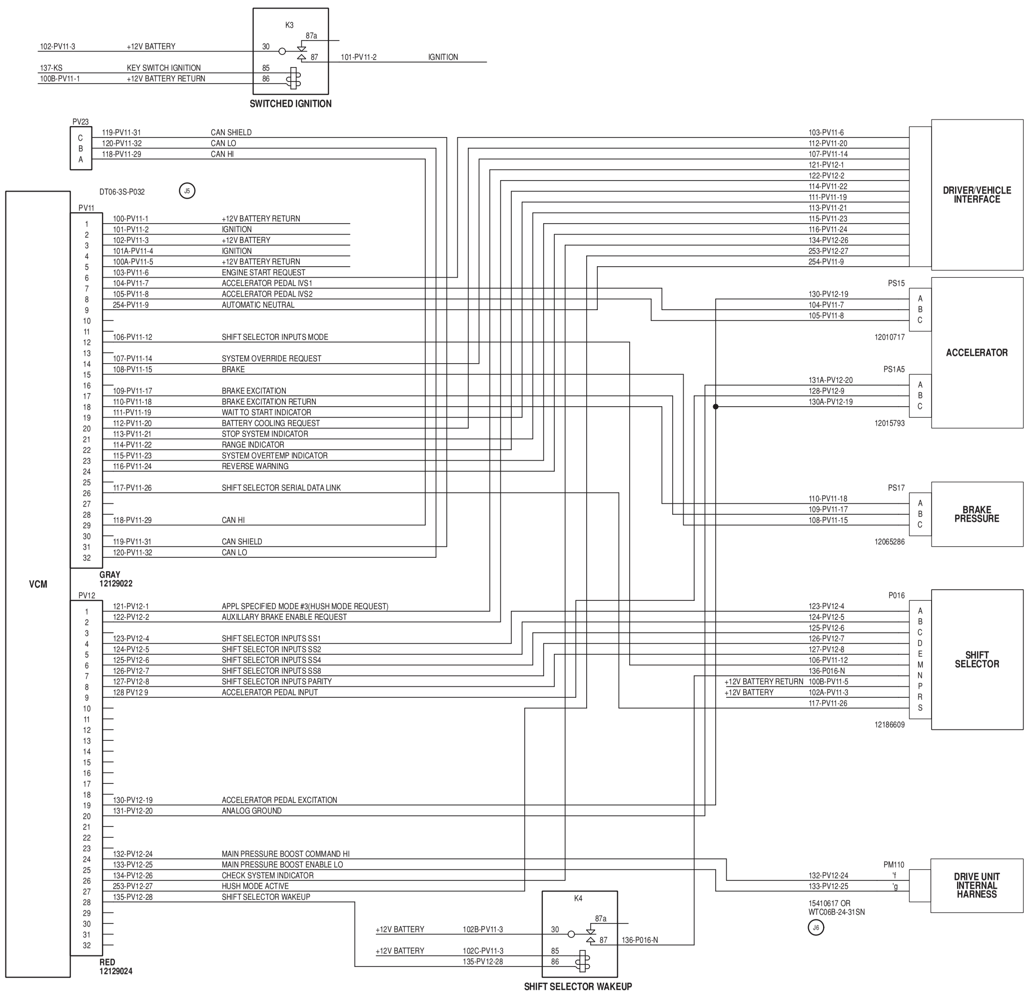
Figure H–1. Allison Electric Drive™ Wiring Schematic—TCM

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-PV11-5	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				
PO16-N	136-PO16-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

Figure H–2. Allison Electric Drive™ Wiring Schematic—VCM

RESOURCES: Wiring Schematics

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

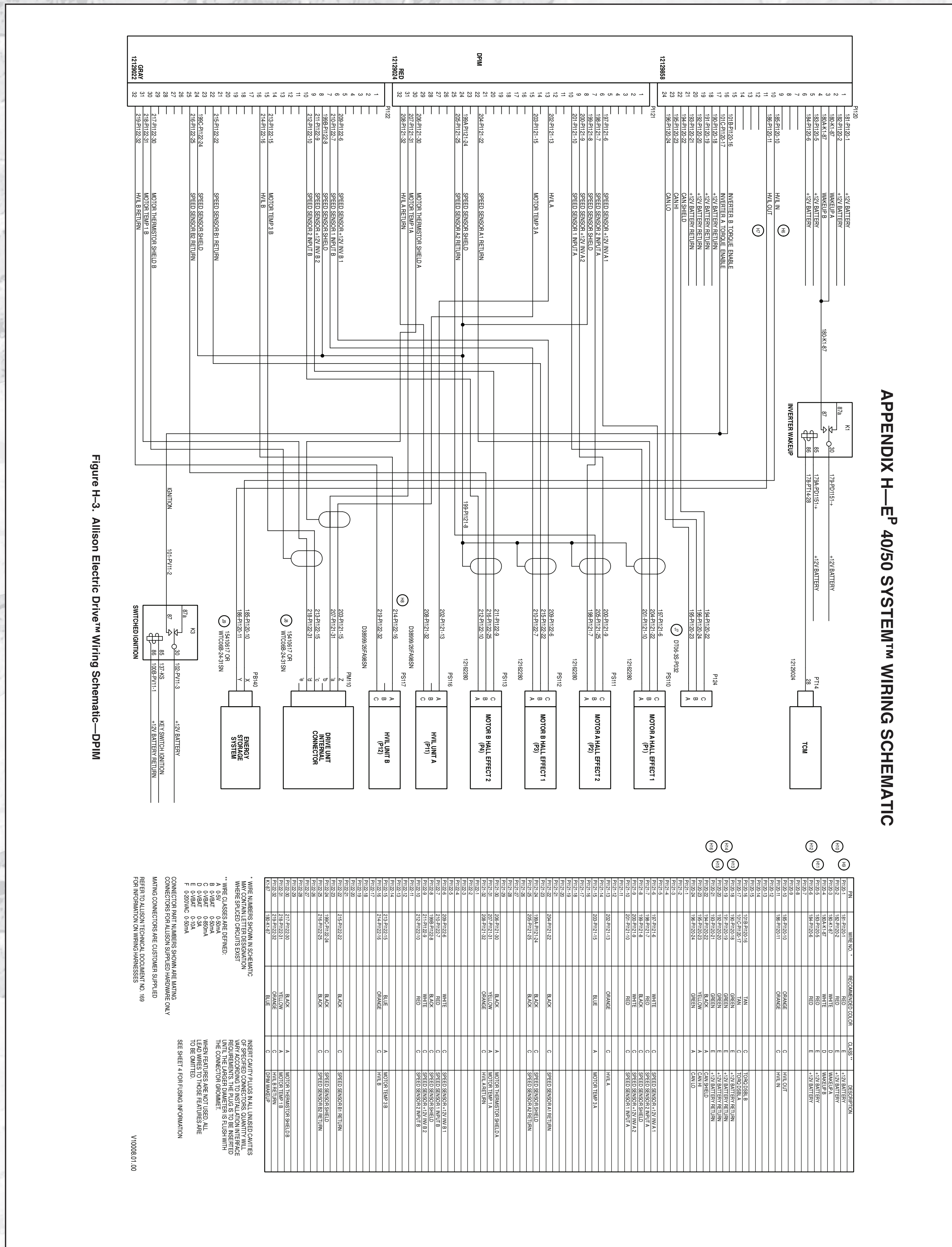
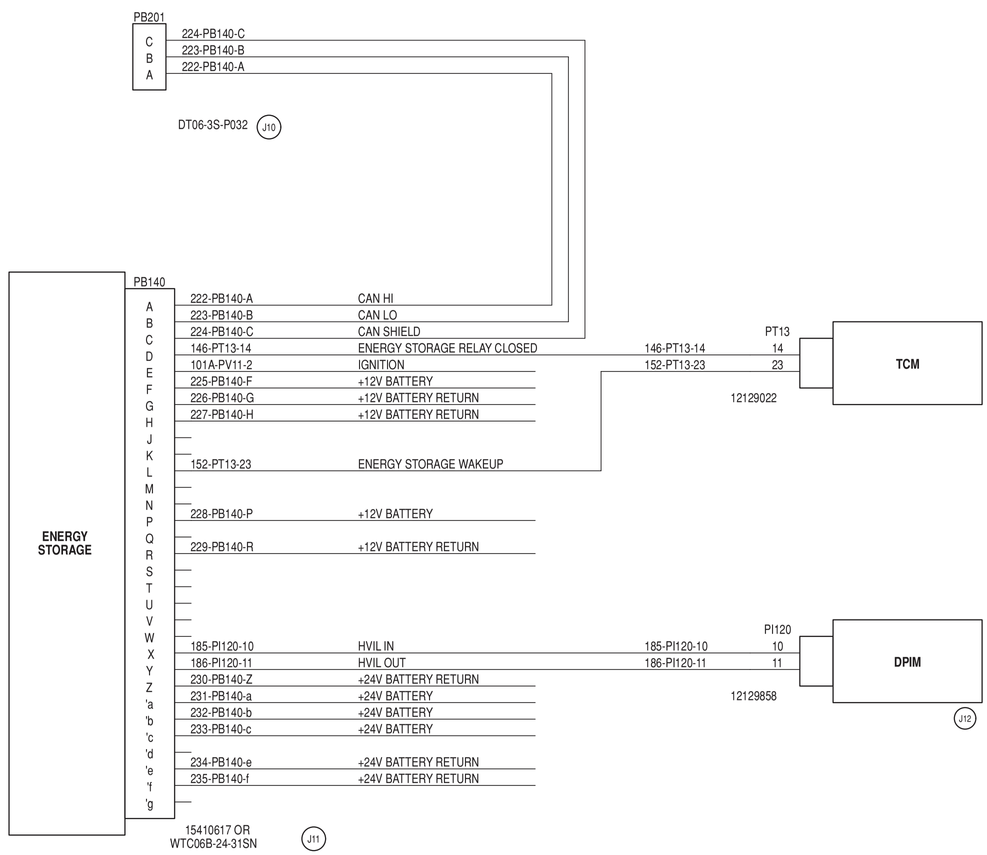


Figure H–3. Allison Electric Drive™ Wiring Schematic—DPIM

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				

* 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

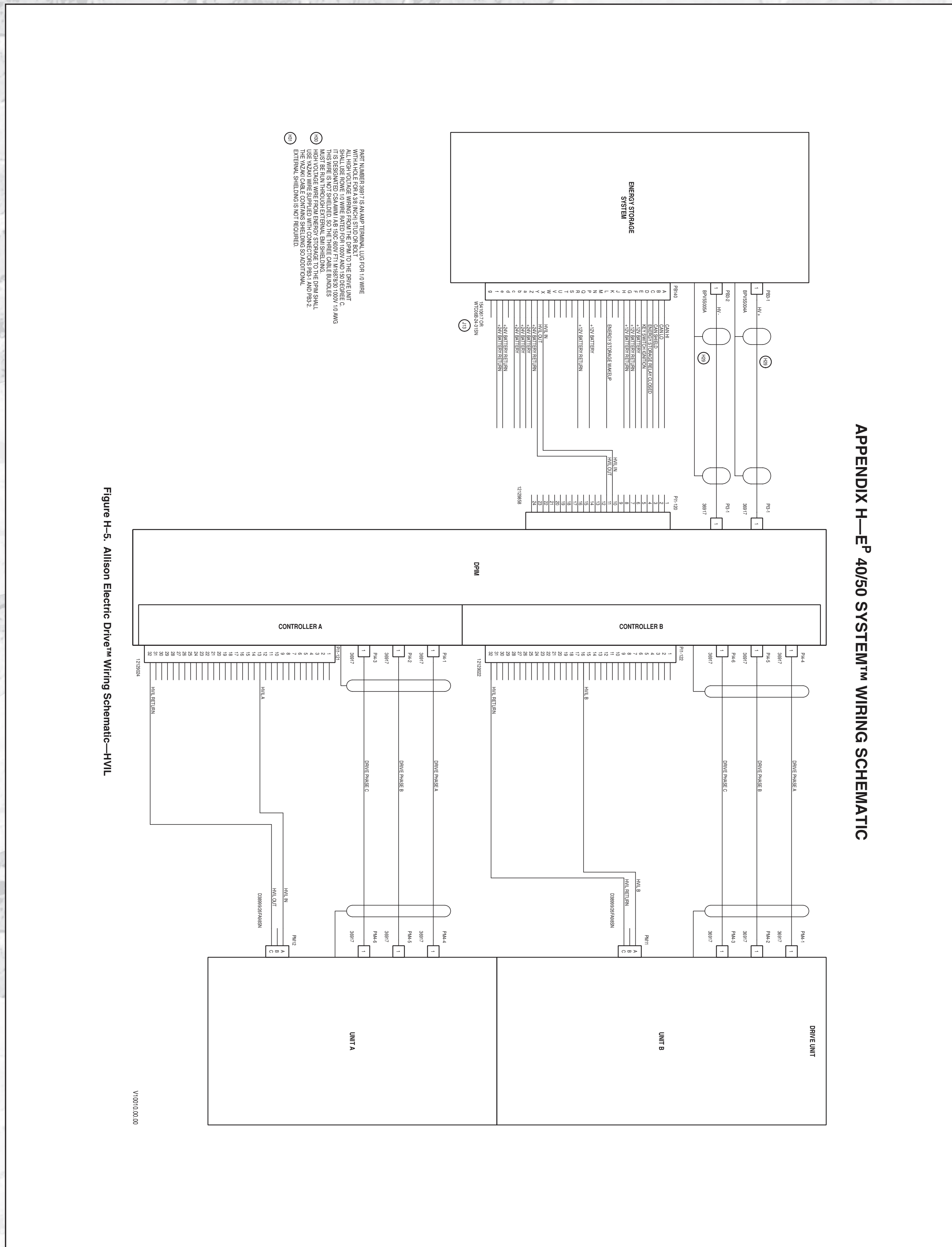


Figure H–5. Allison Electric Drive™ Wiring Schematic—HVIL

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

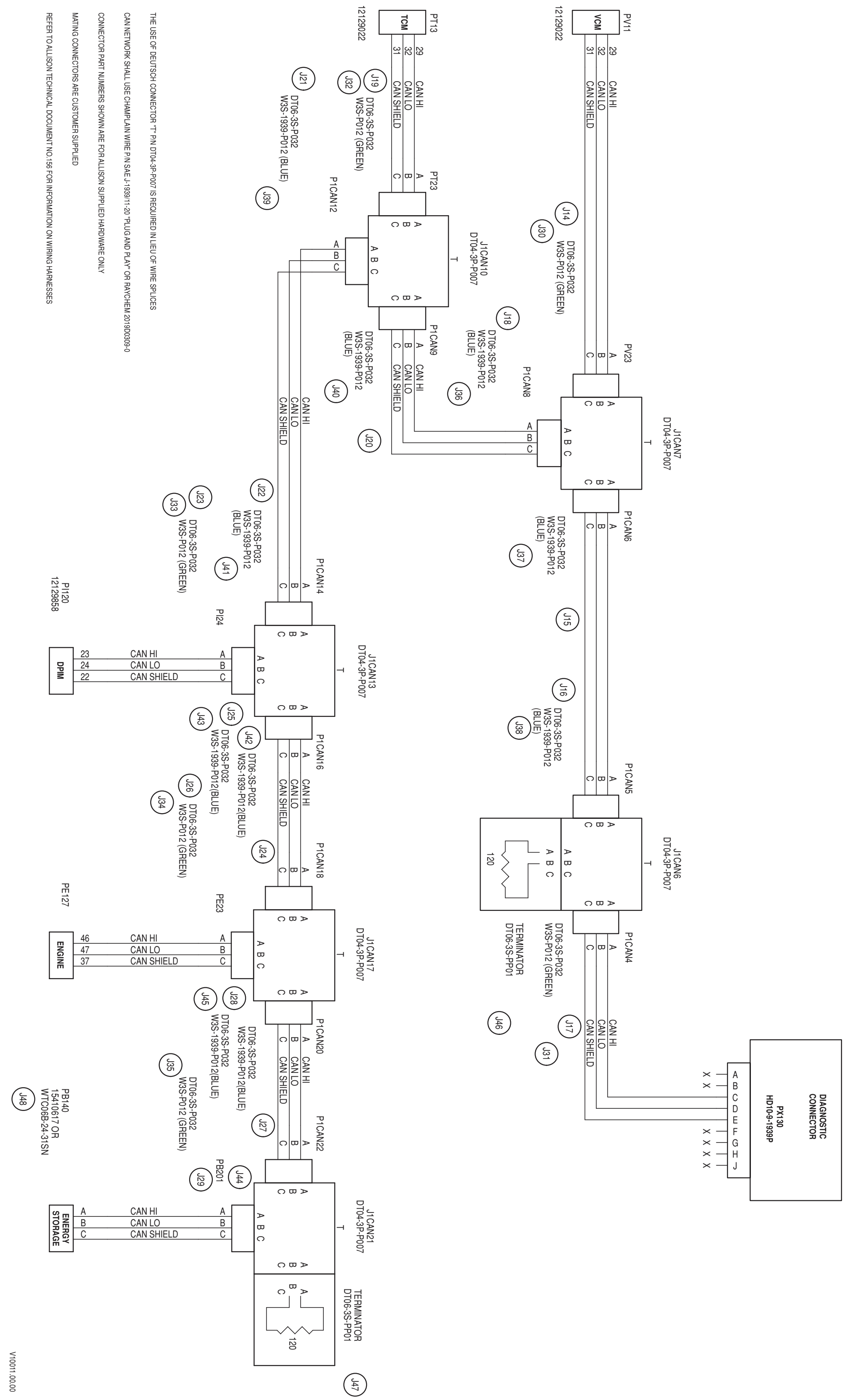
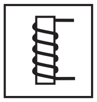
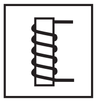


Figure H–6. Allison Electric Drive™ Wiring Schematic—J1939 Backbone (CAN Bus)

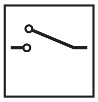
RESOURCES: Schematic Symbols



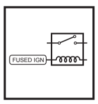
Speed Sensor – circuitry consists of a continuous winding around a core, like an electromagnet. The Electronic Control includes three speed sensors – engine, turbine and output speed sensors.



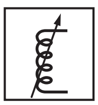
Solenoid – circuitry consists of a continuous winding around a core, like an electromagnet. Solenoids in the WT Electronic Control direct fluid flow to valves that control shifting.



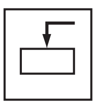
Switch – the system uses this symbol to represent the C3 pressure switch and switches used in the Input Vehicle Interface Harness.



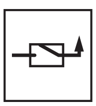
Relay – relays can be wired either Normally Open (N.O.) or Normally Closed (N.C.) The *fused ignition symbol* indicates fused ignition power is provided to the wire.



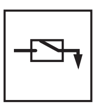
Temperature Sensor – the sump temperature and retarder temperature sensor symbols are the same, represented by the variable resistor symbol.



Oil Level Sensor – optional unit not found on all models.

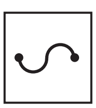


ECU High Side Driver – internal switch in the ECU. When the right conditions exist, the ECU provides positive voltage to the terminal.



ECU Low Side Driver – internal switch in the ECU. When the right conditions exist, the ECU grounds the terminal.

Ground – represents both chassis ground and direct battery ground.



Fuse – two 10-amp fuses are located in the Vehicle Interface Module (VIM).

Ω

- Ohm symbol – this symbol represents “ohms,” which is an expression of a circuit or component’s opposition to electrical flow.