Metro

P3010
Los Angeles LRV

DATA COMMUNICATIONS
(Train Communication Network - TCN)
WTB/MVB – ETB/ECN

Section 1700
RUNNING MAINTENANCE &
SERVICING MANUAL

LIST OF EFFECTIVE PAGES

Insert latest changed pages; dispose of superseded pages in accordance with applicable regulations.

NOTE: On a changed page, the portion of the text affected by the latest change is indicated by a vertical line.

Total number of pages in this section (1700) is **214** consisting of the following:

Original	0	October 2020
Revision	1	April 2021
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SAFETY SUMMARY

Some of the procedures in this section are preceded by warnings/cautions regarding potential hazards in handling this equipment. These warnings/cautions should be carefully read and understood before proceeding. Failure to observe these precautions may result in serious injury to personnel performing the work and/or bystanders. The key warnings for this equipment are as follows:

Electrical - The electrical equipment described in this section operates at voltages and currents that are extremely dangerous to life. Personnel should closely observe all generally prescribed cautions and warnings before performing any work on the LRV.

Chemicals – Follow safety precautions for handling hazardous chemicals as provided by the manufacturer. The manufacturer's warnings should be closely heeded to avoid personal injury.

Location – Special caution should be taken when accessing or servicing equipment located on the roof and under the car.

Weight – To prevent possible personal injury when attempting to remove or install equipment on the vehicle, adequate support of a lifting device must be used to prevent the equipment from falling. Personnel's failure to heed these warnings could result in severe injury or death and or damage to the equipment.

Contact – Some components in this equipment attain temperatures that can cause severe burns. Closely follow all warnings and recommended procedures for handling these components.

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CHAPTER 1.0

GENERAL DESCRIPTION

1.1 Introduction

The purpose of this section is to describe the LACMTA P3010 LRV Network Systems. The Network System is the communication infrastructure for the Vehicle Management System (VMS). The Network System consists of three types of networks: one designated for vehicle controls (WTB/MVB Networks,), one for fault reporting, media, and surveillance functions (Wired Ethernet – ETB/ECN), and one for wireless vehicle data transfer (Wireless Ethernet – Wi-Fi). Both wired networks are redundant and provide vehicle and trainline communications to all participating vehicle subsystems.

1.2 Acronyms, and Abbreviations

Abbreviation	Definition
AADS	Automatic Announcement Display System
ACK	Acknowledge
ACM	Audio Control Modules
ACP1A	Audio Control Panel 1A
ACP1B	Audio Control Panel 1B
ADU	Aspect Display Unit
APC	Automatic Passenger Counter
APS	Auxiliary Power Supply
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
BCU	Brake Control Unit (Pneumatic)
CCH	Communication Control Head
CCTV	Closed Circuit Television
CCU	Communication Control Unit
CPU	Central Processing Unit
DBEA	Dynamic Brake Effort Achieved
DCU	Door Control Unit
DOPWM	Digital Output Pulse Width Modulation Board
ECN	Ethernet Consist Network (per IEC-61375-3.4 - 2010(E))
ECU	Brake Electronic Control Unit
EEI	Enhanced Ethernet Interface
EEIM	Enhanced Ethernet Interface Manager
EMD	Electrical Medium Distance
ER	Event Recorder
ETB	Ethernet Train Backbone (per IEC-61375-2-5 - 2009(E))
ETH	Ethernet
E-VNC	Ethernet Vehicle Network Controller

Abbreviation	Definition
EXT	Exterior
FDD	Frequency Division Duplexing
GPS	Global Positioning System
HB	Heart Beat
HE	Head End
HVAC	Heating, Ventilation, and Air Conditioning
IEEE	Institute of Electrical and Electronics Engineers, Inc.
INT	Interior
IP	Internet Protocol
KI	KINKISHARYO International, LLC
LACMTA	Los Angeles Country Metropolitan Transportation Authority
LCU	Logic Control Unit
LED	Light Emitting Diode
LFLD	Line Fault Location Detection
LRV	Light Rail Vehicle
LVPS	Low Voltage Power Supply
MDS	Monitoring and Diagnostic System
MIMO	Multiple Input Multiple Output
MVB	Multifunction Vehicle Bus
Nm	Newton Meter
NVR	Network Video Recorder
OSI	Open Systems Interconnection
PA	Public Address
PBED	Propulsion and Brake Effort Delivered
PDM	Process Data Marshaling
PIC	Passenger Intercom
PIS	Passenger Information System
PLU	Propulsion Logic Unit
PoE	Power Over Ethernet
POST	Power On Self Test
PTT	Push-to-Talk
PTU	Portable Test Unit
Qty	Quantity
RIO	Remote Input / Output
RTC	Real Time Clock
RTC	Rail Transit Consultants, Inc.
RTP	Real Time Protocol
SPDT	Single Pole, Double Throw
SPKR	Speaker
TCN	Train Controller Network
TCON	Train Configuration
TL	Trainline
TOD	Train Operator Display
TS	Technical Specifications
T-VNC	TCN Vehicle Network Controller

Abbreviation	Definition
TWC	Train to Wayside Communication
VAC	Volts, Alternating Current
VDC	Volts, Direct Current
VMS	Vehicle Management System
VNC	Vehicle Network Controller
Vu	Voting Unit
WLAN	Wireless Local Area Network
WSS	Wayside Software
WTB	Wired Train Bus
WWAS	Wayside Worker Alert System

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CHAPTER 2.0

FUNCTIONAL DESCRIPTION

2.1 Introduction

The data communication network consists of multiple redundant trainline and vehicle networks, along with a separate wireless data transfer network. There are three types of networks: WTB/MVB, ETB/ECN (Wired Ethernet) and Wireless Ethernet networks.

The WTB/MVB network performs control functions such as Tractive Effort Command, brake blending, load weigh and other control signals. This network is implemented using service proven Gateway and Logic Control equipment. The TCN network (consisting of redundant WTB and MVB modules) conforms with IEC-61375. This network provides a deterministic means of data transmission.

The ETB/ECN network performs communication system, CCTV, diagnostic data, and other applications requiring high bandwidth. The network conforms to IEEE 1473-E, the IEC-61375-3-4 for the Ethernet Consist Network (ECN) (vehicle local Ethernet network), and the IEC-61375-2-5 for the Ethernet Train Backbone (ETB) (train network). When implemented within constraints, this network provides a pseudo-deterministic type of network that operates at significantly higher speeds than the WTB/MVB network.

The Wireless Ethernet network (Wi-Fi) performs train-to-wayside data transfer. The network conforms to IEEE 802.11n. This network provides functionality to initiate automatic and manual data downloads.

Table 2-1 lists the P3010 communications networks and their respective standards. Shown in Figure 2-1 is the P3010 Data Communication network block diagram with all the WTB/MVB devices. This figure also includes the ETB/ECN network but excludes the devices. Shown in Figure 2-2 is the P3010 Vehicle Monitoring and Communication System interconnect diagram with all the ETB/ECN devices.

Table 2-1. Train Communications Network Designations

Network Designation	Description	Applicable Standards
WTB	Wire Train Bus – TCN Trainline Network (between multiple vehicles)	IEC-61375-1 and UIC Code 556
MVB	Multi Vehicle Bus – TCN Local Network (local to each vehicle)	IEC-61375-1
ETB	Ethernet Train Backbone – TCN Ethernet Trainline Network (between multiple vehicles)	IEC-61375-2-5
ECN	Ethernet Consist Network – TCN Ethernet Local Network (local to each vehicle)	IEC-61375-3-4
Wi-Fi	Wireless Ethernet Network	IEEE 80211n

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2.2 Network Architecture

2.2.1 Trainline Network Architecture

The trainline data communication network consists of two types of networks:

- A/B Wire Train Bus (WTB) per the IEC 61375-1 standard
- Redundant two-wire Ethernet networks per IEEE-1473-E, and IEC 61375-2-5

There are four (4) separate networks through the train consist, providing a high level of redundancy and data diversity between coupled vehicles (see Figures 2-4 and 2-5).

2.2.1.1 WTB Network

The WTB network is part of the Train Communication Network (TCN) and performs control functions such as Tractive Effort Command, brake blending, load weigh, and train inauguration and other control signals. The WTB network communicates using the protocol defined in the IEC 61375-1 and UIC Code 556 standards. The WTB network is provided through two redundant networks: Network A and Network B (shown as WTB A/B in Figure 2-4). The use of multiple networks provides a redundant bus topology with failover capability (refer to Section 2.3 for more details on redundancy). Each WTB network provides data at a rate of 1 Mbits/second.

2.2.1.2 Trainline Ethernet Network

The Ethernet system devices communicate using standard TCP/IP and UDP/IP Ethernet protocols, and it is configured per IEC 61375-2-5 standard for the Ethernet Train Backbone (ETB). As with the WTB network, the ETB is provided through two redundant networks: Trainline 1 and Trainline 2 (shown in Figure 2-5 as TL1 and TL2 respectively). The Ethernet network infrastructure, including all the components in the system, are designed to provide data rates of 100 Mbits/second or greater.

Figure 2-5: LA P3010 ETB Trainline Architecture

2.2.2 Vehicle Local Network Architecture

The vehicle local data communication networks consist of two types of networks:

- A/B Multifunction Vehicle Bus (MVB) using the Electrical Middle Distance (EMD medium) physical layer per the IEC 61375-1 standard
- ECN four-wire Ethernet networks per the IEEE-1473-E, and IEC 61375-3-4

2.2.2.1 MVB Network

The MVB network is part of the Train Communication Network (TCN) and performs control functions such as Tractive Effort Command, brake blending, load weigh and other control signals. The MVB network communicates using the protocol defined in the IEC 61375-1 standard. The MVB network is provided through two redundant networks: Network A and Network B (shown in Figure 2-6). The use of multiple networks provides a redundant bus topology with failover capability (refer to Section 2.3 for more details on redundancy). Each MVB network provides data at a rate of 1.5 Mbits/second.

Figure 2-6: LA P3010 MVB Local Network Architecture

2.2.2.2 Local Ethernet Network

The Ethernet Consist Network (ECN) is part of the wired Ethernet network and performs functions that require high bandwidth such as digital video, digital audio, transfer of a large amount of diagnostic data, Portable Test Unit operation, wireless communication, and other functions. The ECN communicates using standard TCP/IP and UDP/IP Ethernet protocols, and it is configured per the IEC 61375-3-4 standard - an Ethernet standard for rail vehicles. The ECN is configured in a redundant ring configuration network (shown in Figure 2-7). The Ethernet network infrastructure, including all the components in the system, is designed to provide data rates of 100 Mbits/second or greater.

NOTE: The WLAN (wireless network switch) is shown in the diagram above since it communicates to the local vehicle devices through the wired Ethernet network

2.2.3 Wireless Network Architecture

The wireless vehicle data transfer network consists of one type of network:

- Wireless Ethernet network per IEEE 802.11n

The wireless network interfaces with the wired Ethernet network through the Ethernet router and performs train-to-wayside data transfer of vehicle diagnostic (e.g. fault) and subsystem specific (e.g. automatic passenger counter) logs. The wireless network communicates using the IEEE 802.11n standard and is provided through a wireless radio with roof-mounted Multiple Input Multiple Output (MIMO) antenna (shown in Figure 2-8). The wireless radio is capable of providing theoretical data rates up to 300Mbits/second based on the connection strength to the wayside server. Actual rates are dependent upon multiple factors, including location from WAP, obstructions, and environmental factors.

NOTE: Discussion of LA Metro Yard/Wayside network equipment is beyond the scope of this document.

2.3 Network Redundancy

The wired communication networks on the P3010 vehicle, WTB/MVB and ETB/ECN, are equipped with line redundancy features to mitigate the impact from interference and cabling issues. The handling of network sensing and switchover differs between the WTB, MVB, ETB, and ECN, but they all share the following commonalities:

- Network health sensing capabilities
- Two independent physical wire connections

2.3.1 WTB Redundancy

The WTB network consists of one master gateway with additional slave gateways. On the P3010 vehicles, the A-Unit gateway in the active car (active cab) within the consist is designated as the master. In the case that the master gateway fails, another gateway on the network will become elevated to the master.

The WTB network is designed with two communication lines: line A and line B (as shown in Figure 2-9). Each gateway transmits on both lines but only receives from one. The gateways monitor the second line for signal quality. A supervisory task is run to determine which line to receive from.

2.3.2 MVB Redundancy

The MVB network consists of one bus master, multiple bus administrators, and slave devices. On the P3010 vehicles, the bus master is the A-end gateway in the active car (active cab) within the consist is designated as the master. The other gateway modules in the consist have bus administrator functionality. If the bus master fails, one of the other gateway modules will become elevated to the master.

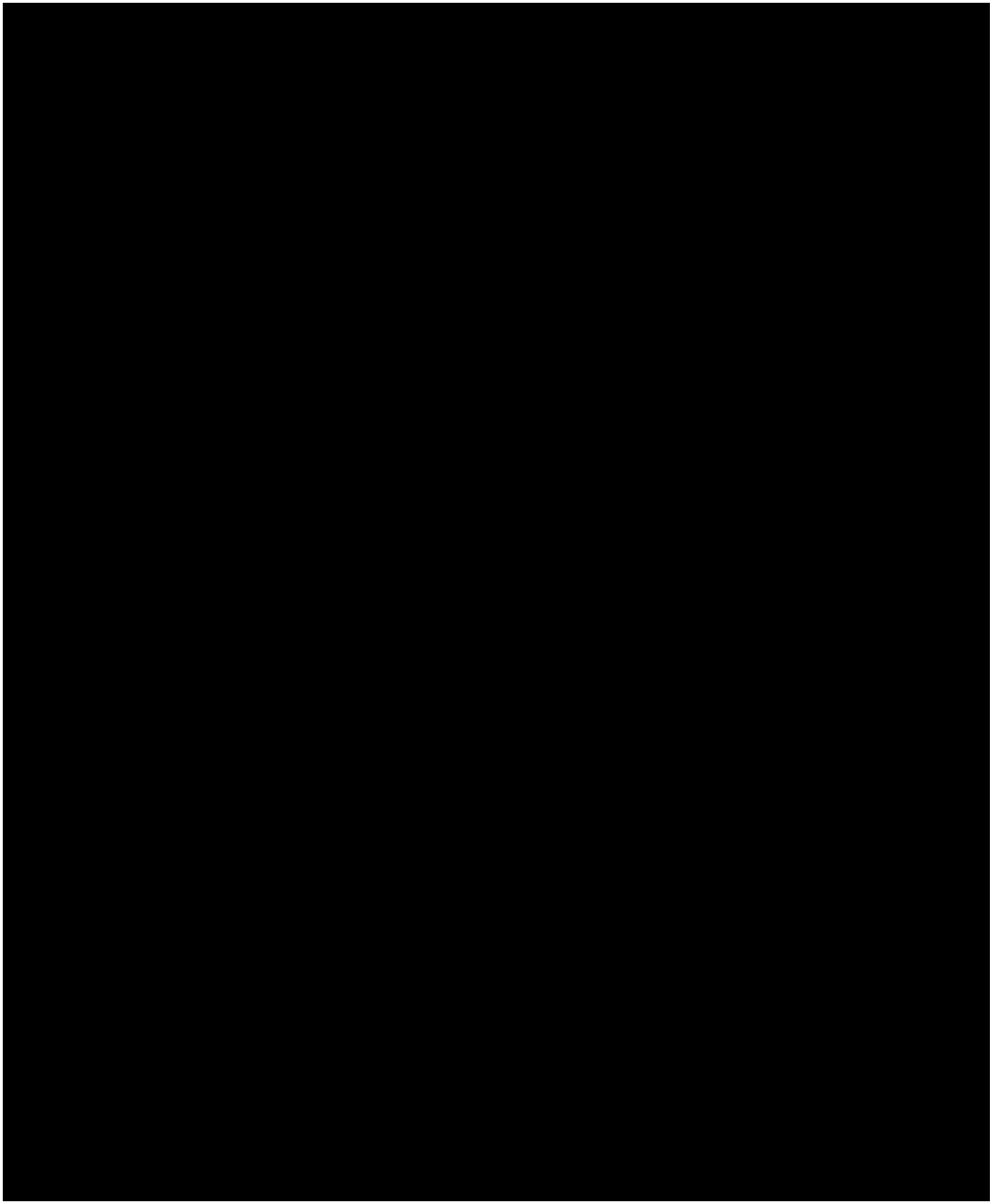
The MVB network is designed with two communication lines: bus line A and bus line B (as shown in Figure 2-10). These lines are provided in a single insulated cable. Each device transmits over both channels (lines) but only receives from one. The secondary line is constantly monitored by each MVB device. A line switchover (receive line) occurs at MVB device based on signal quality and frame overlap.

2.3.3 ETB Redundancy

The ETB network consists of two parallel communication trainlines: TL1 and TL2 (as shown in Figure 2-11). Each module within the panel is designated to a particular communication channel – module 1 communicates on TL1 and module 2 communicates on TL2. One communication line is chosen as the active line while the other remains dormant (as shown in Figure 2-5). If the active line becomes inoperable, the secondary line will take over as the active line.

In order to create an active trainline, one communication trainline is chosen by the Enhanced Ethernet Interface Manager (EEIM) software – TL1 is chosen first by default. A module on that channel within the consist is designated as the master (head-end) while the others remain slaves (repeaters). The master module is chosen based on the first car to host an active cab. Once a master is designated, that module will remain a master until the consist is powered down or the communication line is deemed inoperable.

A switchover to the secondary trainline is deemed necessary when communication is lost between EEI modules of the primary trainline in a multi-vehicle consist. The EEIM software has a built it delay period (88 seconds) which allows for an intermittent module to return to the network. If the delay period is reached, the EEIM software will begin to configure a master on the secondary trainline. Switchover typically takes 3-5 minutes and temporarily impacts Ethernet communication between vehicles in the consist.



2.3.4 ECN Redundancy

The ECN consists of a ring configuration network with redundant cabling between the two sets of articulation-crossing switches: LAN3A-LAN3B and LAN4A-LAN4B (as shown in Figure 2-7). The redundant cabling provides assurance that network traffic will continue to flow in the predetermined switch-routes. The ring configuration provides two directions of travel for network traffic – leaving a fallback option available if one of the two articulation-crossing switch sets become inoperable.

NOTE: The predetermined switch-routes are established at start-up of the vehicle by the Ethernet switches' routing algorithms. Whenever there is a change to the Ethernet network, the switches recalculate the routes.

2.4 WTB/MVB System Description

2.4.1 Introduction

The WTB/MVB system controller is implemented with railway service proven equipment from Saira FAR Systems. The system provides all the required functionality for a fully compliant TCN system with the IEC 61375-1 and UIC Code 556 standards. The system is enclosed in a single 19-inch rack. There are two racks per vehicle, one in each unit cab electric locker. Each rack contains a redundant WTB/MVB Gateway module, a CPU board for gateway controller, and Remote I/O to MVB modules with its own CPU. The RIO CPU is used for Bus Administrator.

The Remote I/O (RIO) boards are used for interfacing with the vehicle digital I/O signals, PWM signal from the master controller and analog signals. These vehicle signals are hardwired to the MVB RIO modules though indication relays. The gateway module is equipped with a Voting Unit (VU) module for complete redundancy applications and "sleep" function, "fritting" unit module on WTB and digital I/O. The WTB/MVB Gateway resides in the same 19-inch rack as the MVB RIO LCU, but each device has an independent power supply.

The WTB functionality is compliant with the standard UIC Code 556 (related to information transmission in the train). The gateways implement the following functions:

- Train inauguration procedure
- Mapping server (11 draft or second edition with automatic detection)
- Process Data Marshaling (PDM)
- Management of static and dynamic properties

2.4.2 MVB Data Packet Types

There are three types of MVB data packets defined in the IEC 61375-1 TCN Standard:

- Process Data
- Message Data
- Supervisory Data

2.4.2.1 Process Data

The PROCESS DATA packets are short, generally time-critical data, which are transferred periodically at fixed projected time intervals. They transfer data for controlling the mobility status of the train such as drive and brake control commands. The maximum transfer time is guaranteed. In general, the PROCESS DATA can also be exchanged via the WTB. Process data packets are transferred without acknowledgement. Reliability is obtained by continuous cyclic repetition of the data. Acknowledgements are not possible in the broadcast method used here in which the number of receivers is not known to the transmitter. The transfer takes place periodically and cyclically; typical bus cycles are 32 ms, 64 ms, 128 ms, to 1024 ms. The ***base bus cycle for the P3010 MVB system is 1 milisecond.*** The Process data packets are deterministic.

2.4.2.2 Message Data

The MESSAGE DATA packets are usually longer but less time-critical data that are only transferred on request. They contain event-controlled data such as diagnostic data and passenger information that are only transferred if an event occurs. The receipt of MESSAGE DATA is acknowledged as different transfer times occur for simultaneous message data transfers. MESSAGE DATA can transfer user information and system data (downloading programs and debugging). In general, these packets can exceed bus limits, and they can also be exchanged via the WTB.

2.4.2.3 Supervisory Data

The SUPERVISORY DATA packets are short telegrams used for polling the status of the individual devices, passing on the bus administrator functionality, inauguration and other supervisory functions. They are used for bus traffic control and are not accessible for users.

2.4.3 P3010 Data Examples

The P3010 MVB carries both subsystem status information and control signals. Both of these data types are transmitted using Process Data packets.

2.4.3.1 Status Information

An example of some status information that are transmitted on the MVB network are:

- Brake Cylinder Pressures
- APS Input Voltages
- Door Status
- HSCB Status

2.4.3.2 Control Signals

An example of some control signals that are transmitted on the MVB network are:

- Carwash command
- HSCB Reset
- PBED Signal
- Vehicle Reset Command

To manage the flow of data, subsystem transmits (source) and receives (sink) on specified ports. All vehicles control signals are transmitted on Port 100.

Figure 2-12 shows an example of input signals (IMP) and output signals (EXP) to/from the TCN Gateway unit.

2.5 ETB/ECN System Description

2.5.1 Introduction

The P3010 Ethernet network follows the Open Systems Interconnection (OSI) reference model which takes advantage of predefined protocols such as TCP/IP and UDP/IP. P3010 Ethernet subsystems are only responsible for the application layer functionality. The Vehicle Monitoring System (VMS), which is run using the MDS computer, interprets the application data that follows the TCP and UDP data.

2.5.2 Adding Reliability to P3010 UDP Messages

Among many things, one of the key differences between TCP and UDP messages is the required acknowledge (ACK) message that is required in the former. This ACK message does provide a means of determining data was received reliably, however, there is an added cost associated with the additional network traffic in terms of both the longer TCP message and the required ACK.

To reduce network traffic, most Ethernet subsystem devices send UDP messages. If reliability is needed, the use of ACK messages is added at the application layer.

2.5.3 P3010 Virtual LANs

The P3010 local vehicle Ethernet Network (ECN) is divided in to three “virtual” networks to separate, secure, and manage the Ethernet network. The following are the three P3010 VLANs:

- 10-dot (general purpose, fault reporting, media)
- 172-dot (surveillance)
- 192-dot (wireless interfacing)

The Westermo Switch sets up and manages the VLANs. Devices on the 172 and 192 networks have a 10-dot translated IP address in order to allow 10-dot devices to monitor their status (e.g. TOD checking the status of the wireless switch).

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2.5.4 Special Topic: Multi-Car Consist Inauguration

When two cars are coupled together, the WTB Gateways communicate information regarding consist configuration. When a valid active cab is present in this multi-vehicle consist, the WTB Gateway A on that car becomes the lead unit. Once the WTB network is established, the number of cars present in the consist and the coupled orientation is transmitted to MDS computers on all the cars. The MDS on the active car will then initialize communication on one of the two Ethernet trainline networks through control of the EEI modules. After the Ethernet trainline network is established, the car numbers in the consist is determined. The car numbers along with their coupled orientation represent the TCON (train configuration) message. This message is sent to the TOD to display the car consist.

2.6 Wireless Data Transfer Description

The VMS provides the infrastructure for the Wireless Data Link equipment and functionality. This equipment consists of an 802.11n Wireless LAN transceiver. The unit is IP67 rated, uses M12 D-Coded connector for the data, and M12 A-Coded connector for the power. It has redundant power inputs and is powered from the vehicle's low voltage power supply and the vehicle battery. This unit is connected to the ECN and can be used by other subsystems if necessary. Figure 2-8 shows the wayside equipment concept.

The wayside software (WSS) consists of a server-side application which resides at the local Metro yard. The server-side software initiates requests for data transfer and manages the the database of transferred files. The LRVs' local Ethernet network is configured to allow connection to the Metro yard network – eliminating the need for a client-side (vehicle) software application.

The WSS will cycle through the following routine for transferring data from the LRVs:

1. WSS enters into a 30s idle state.
2. WSS searches for vehicles connected to the network based on their MDS IP address. The PING function is used.
3. MDS computers which respond to the PING request are added to a list of "connected LRVs".
4. WSS increments through the list of "connected LRVs" one-by-one and checks for new data files for the Automatic Passenger Counter (APC), the Event Recorder (ER), and the MDS fault log (FLOG).
5. Any new files are transferred by the WSS to a temporary directory on the server computer from the vehicle.
6. After transfer, the WSS will check the transferred files against the original files on the vehicle for any errors encountered during the transfer process.
7. After checking the files, the WSS moves the files over from the temporary directory to the dedicated log directory
8. After incrementing through the list of "connected LRVs", the WSS re-enters into an idle state before starting the search and transfer process over again.

2.7 System Components

2.7.1 Network System Components Bill of Material

Item No.	Description	Qty. per Car	Part No. / Drawing No.	Manufacturer
1	12 Ports, Layer 3 Ethernet Switch w/Routing	1	Viper-212	Westermo
2	16 Ports (8 PoE) Layer 2, Managed Ethernet Switch	2	TN-5516-8PoE-T	MOXA
3	16 Ports, Managed Ethernet Switch	3	716M12	N-Tron
4	8 Ports, Managed Ethernet Switch	2	708M12-HV	N-Tron
5	Wireless Radio Transceiver	1	702M12-W	N-Tron
6	Wireless Radio Antenna	1	SMD-W-3K3K3K-WHT-180	Mobile Mark
7	Trainline Interface Module	1	RTC2106	RTC/KI
8	TCN Rack - Includes the following two Modules: • IGW450-MVB Module • LCU-RIO-1 Module	2	000058-MDM001	FAR Systems

2.7.2 TCN Equipment Information

The P3010 vehicle is equipped with two FAR Systems TCNIO-LAP3010 TCN rack mountable units. An overview of the unit is provided in Figure 2-13 along with the associated legend in Table 2-2. The TCN Rack Assembly drawing is provided in Figure 2-14.

NOTE: Some figures in this document may refer to the TCN rack as the TCN controller. These terms are interchangeable and refer to the entire unit. When individual boards are discussed, they are identified by their board names/functions.

TCNIO-LAP3010 contains the following boards:

- WTB Gateway Module
- MVB CPU Board (CPU)
- Digital Input Boards (DI1 and DI2)
- Digital Output Pulse-Width-Modulation Board (DOPWM)
- Analog Input Board (AUX)
- RIO Power Supply

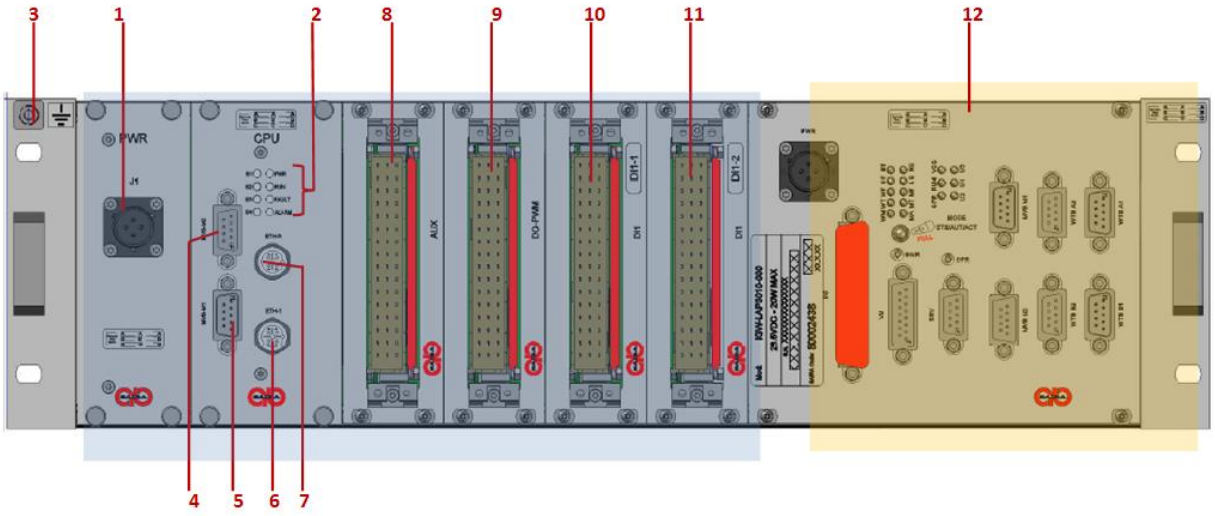

Figure 2-13: TCNIO-LAP3010 Rack Overview

Table 2-2. Legend for RIO Device from Rack Overview

Item No.	Name	Description
1	J1	RIO Power Supply Connector
2	CPU LEDs	
3	Frame Ground screw	
4	MVB-M2	Sub-9-pin connector (female) for MVB-bus MVB connector
5	MVB-M1	Sub-9-pin connector (male) for MVB-bus
6	ETH1	M12 for Ethernet 10/100 base T (for service)
7	ETH0	M12 for Ethernet 10/100 base T (for train network)
8	AUX	DIN41612 connector – Aux Module
9	DO-PWM	DIN41612 connector – DOPWM2 module
10	DI1	DIN41612 connector – DI1-1 module
11	DI1	DIN41612 connector – DI1-2 module
12	IGW device	See description in Table 2-3

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2.7.2.1 WTB Gateway Module

The WTB Gateway connects the wire train buses (WTB) to the MVB buses. The gateway provides the following functions:

- WTB Communication
- TCN inauguration
- MVB Bus Administrator function and communication
- Marshalling (import and export of signals)

An overview of the gateway module is provided in Figure 2-15 along with the associated legend in Table 2-3. Tables 2-4 and 2-5 explain the status LEDs and switch functions, respectively. Power supply characteristics for the Gateway module are provided in Table 2-6 along with the connector pin-out in Table 2-7.

The SRV connector is used to load software to the Gateway module. Table 2-8 provides a pin-out of the connector. The connector type is a DB9 female, 4-40 screw type. Refer to Section 9.2 for the software upload procedure.

NOTE: The VU and I/O connectors are not used for the vehicle network or regular maintenance.

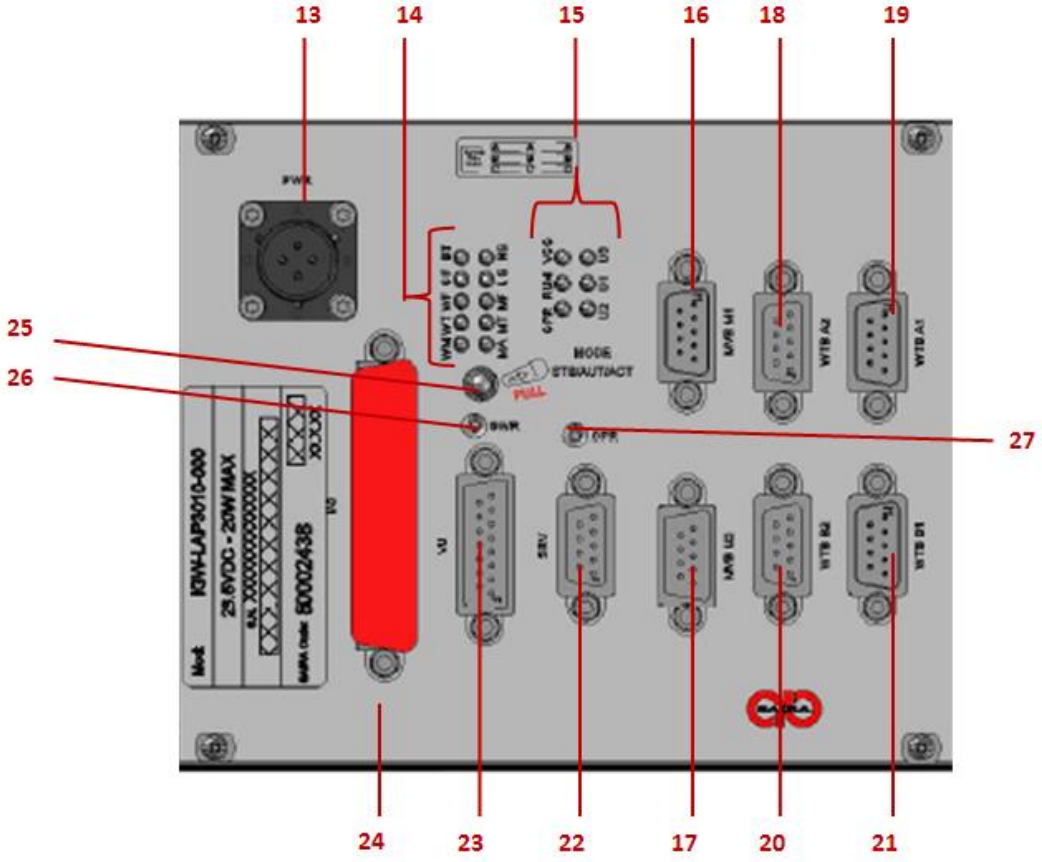


Figure 2-15: TCNIO-LAP3010 TCN Gateway

Table 2-3. Legend for WTB Gateway Device

Item No.	Name	Description
13	PWR	Power Supply Connector
14	Diagnostic LEDs	
15	CPU LEDs	
16	MVB M1	Connector (male) for MVB-bus
17	MVB-M2	Connector (female) for MVB-bus MVB connector
18	WTB-A2	Connector (female) for WTB line A
19	WTB-A1	Connector (male) for WTB line A
20	WTB-B2	Connector(female) for WTB line B
21	WTB-B1	Connector (male) for WTB line B
22	SRV	Service connector
23	VU	Voting Unit connector
24	I/O	I/O Connector
25	MODE switch	
26	Gateway reset	
27	CPU reset	

Table 2-4. TCN Gateway Status LEDs

LED	Function (when LED is illuminated)
VCC	IGW device is correctly powered
RUN	CPU is running
CPR	CPU is resetting
U0	Fritting signal is present
U1	WTB on when the node is endpoint
U2	WTB line(s) is disturbed
WM	IGW is the master of WTB
WT	Traffic on the WTB line
WF	WTB line is faulty
GF	IGW is faulty
BT	Battery is charging
MA	On when the MVB node is the bus administrator
MT	Traffic on the MVB line
MF	MVB line is faulty
US	Flashing long/short when the IGW is active/in stand by
NS	Flashing when the GW is in sleep mode

Table 2-5. TCN Gateway Switch Functions

Switch Name	Function
CPR	Used to issue a manual reset to the CPU
GWR	Used to issue a manual reset to the GW
Mode	There are different types of redundancy, depending on gateway connections and MODE switch status. The MODE switch present on the front panel of the IGW, connected to the ESM board, declares the function mode: AUT (Automatic): the switchover is performed automatically by the VU (Voting Unit) STB (Standby): the unit is forced in stand by ACT (Active): the unit is forced active

Table 2-6. WTB Gateway Module Power Supply Characteristics

Power supply characteristics	Min	Max
Continuous applicable operating voltage	16.8V	36V
Applicable voltage for 100ms without causing malfunctioning	14.4V	40V

Table 2-7. WTB Gateway Power Connector Pin-Out

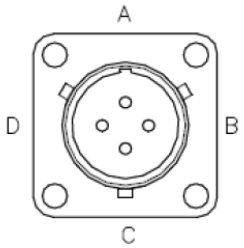
Pin	Signal	Description	Pin
A	FGND	Frame Ground	 (Front View)
B	BATP	Positive Supply Battery	
C	BATN	Negative Supply Battery	
D	-	Not connected	

Table 2-8. SRV Connector Pin-Out

Pin	Name	Direction	Type	Polarity	Description
1	-	NA	NC	NA	-
2	TX	O	RS232	NA	Transmit data
3	RX	I	RS232	NA	Receive data
4	-	NA	NC	NA	-
5	GND	NA	NA	NA	Ground
6	-	NA	NC	NA	-
7	-	NA	NC	NA	-
8	-	NA	NC	NA	-
9	-	NA	NC	NA	-

2.7.2.2 RIO Backplane

Figure 2-16 provides a block diagram of the TCN RIO and backplane. The backplane is part of the TCN Rack enclosure and is responsible for providing an electrical pathway for signals to transfer between the multiple boards within the rack.

2.7.2.3 MVB RIO CPU Module

The main features of the CPU board are as follows:

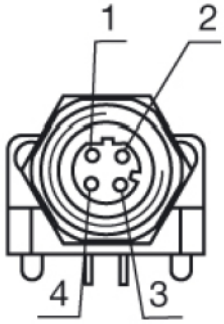
- Freescale MPC5125 microprocessor
- 128MB DDR2 RAM
- 16MB NOR Flash for program storage
- 2GB NAND Flash for data storage
- 64KB non volatile FRA
- Saira MVBCF1 MVB controller
- Two SMSC LAN8700iC-AEZG ethernet controllers
- Dallas DS1302 real time clock

Table 2-9 explains the CPU status LEDs. The pinout for the two M12 Ethernet connectors are shown in Table 2-10. Refer to Section 2.7.2.8 for a pinout of the MVB connectors.

Table 2-9. TCN RIO Status LEDs

LED	Color	Function
RUN	Green	Application Run
Power	Green	Power Supply
Alarm	Red	Alarm Condition
Fault	Red	Fault Condition
Status 1	Yellow	Application depending
Status 2	Yellow	
Status 3	Yellow	
Status 4	Yellow	Reserved

Table 2-10. MVB RIO CPU Module M12 Ethernet Connector Pin-Out

PIN	Signal Name	Direction	Function	
1	TX_P	OUT	Transmit data positive wire	 *Ethernet connector: front view of female receptacle*
2	RX_P	IN	Receive data positive wire	
3	TX_N	OUT	Transmit data negative wire	
4	RX_N	IN	Receive data negative wire	

2.7.2.4 Digital Input Boards

The DI1 modules are dedicated to the monitoring of digital inputs. They have the following features:

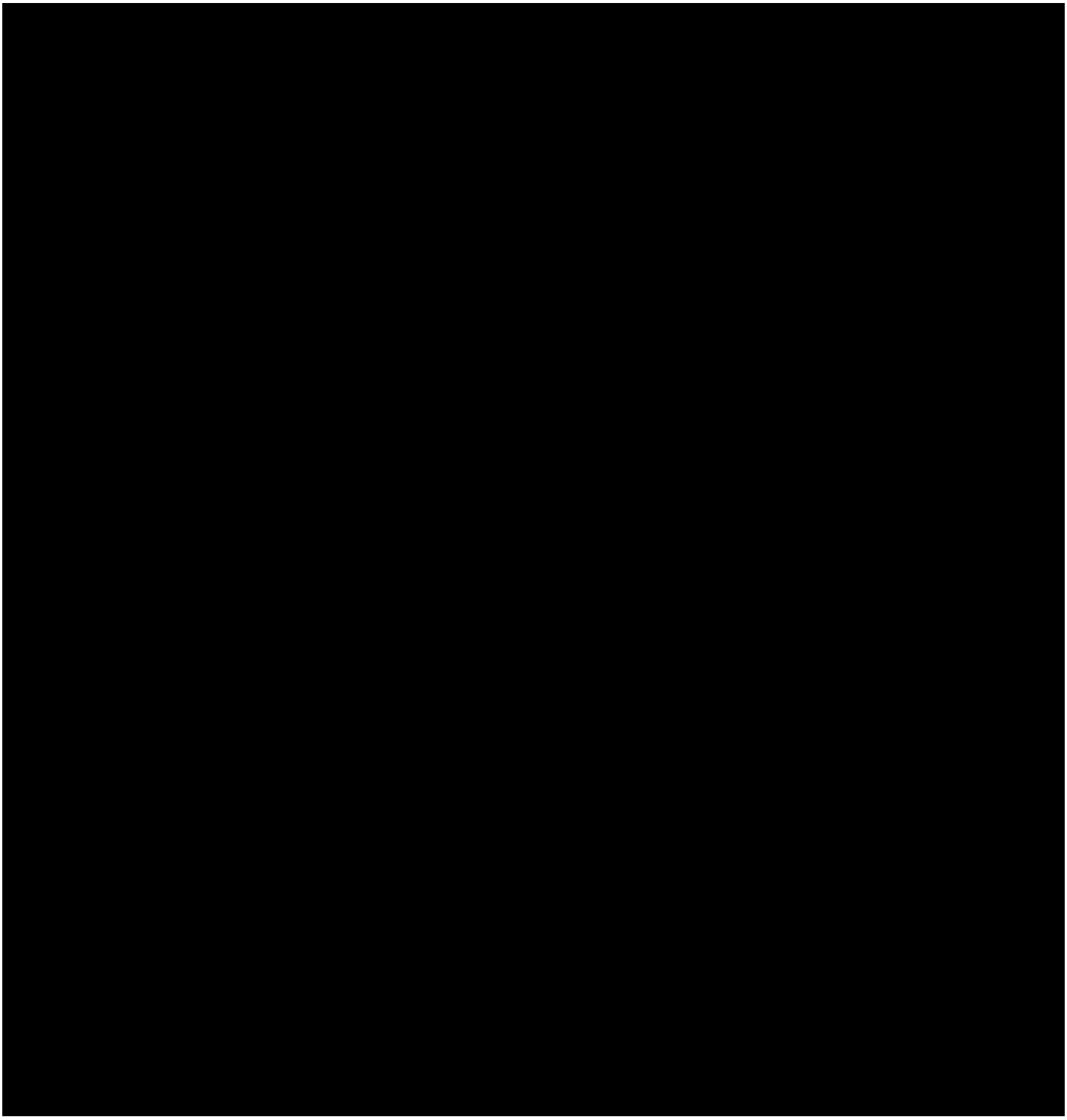
- 24 digital inputs (on 4 galvanic islands): battery referenced
- Self test circuits of each digital input
- Wetting current circuits for each input line

Digital inputs are used for the direct monitoring of battery referenced signals as trainline signals, master controller or other system response. All digital inputs lines have wetting current circuits in order to prevent the oxidation of contacts. Moreover, all the inputs have proper circuits for the testing of the correct functioning of the digital input line that is checked at start-up or periodically on a request basis. The board has a main microprocessor managing the onboard signal acquisition, the interface with master CPU by means dedicated backplane connector signals and all other general functionalities on board.

An example of wiring connection of DI1 module is depicted in Figure 2-17.

The board input lines are grouped and managed on board in 4 separated input insulated groups. Each of it is composed by 6 input lines. In every group the input lines work at same reference potential voltage with galvanic insulation with other groups and the potential of main board processor. For each galvanic group there are 6 input pin (DI01.. DI06) and two pin for input's reference (+Vin, -Vin). Figure 2-18 shows the principle scheme of galvanic insulation for DI-1 module.

The RIO connector pin numbering is shown in Figure 2-19 and the pinout is provided in Table 2-11.



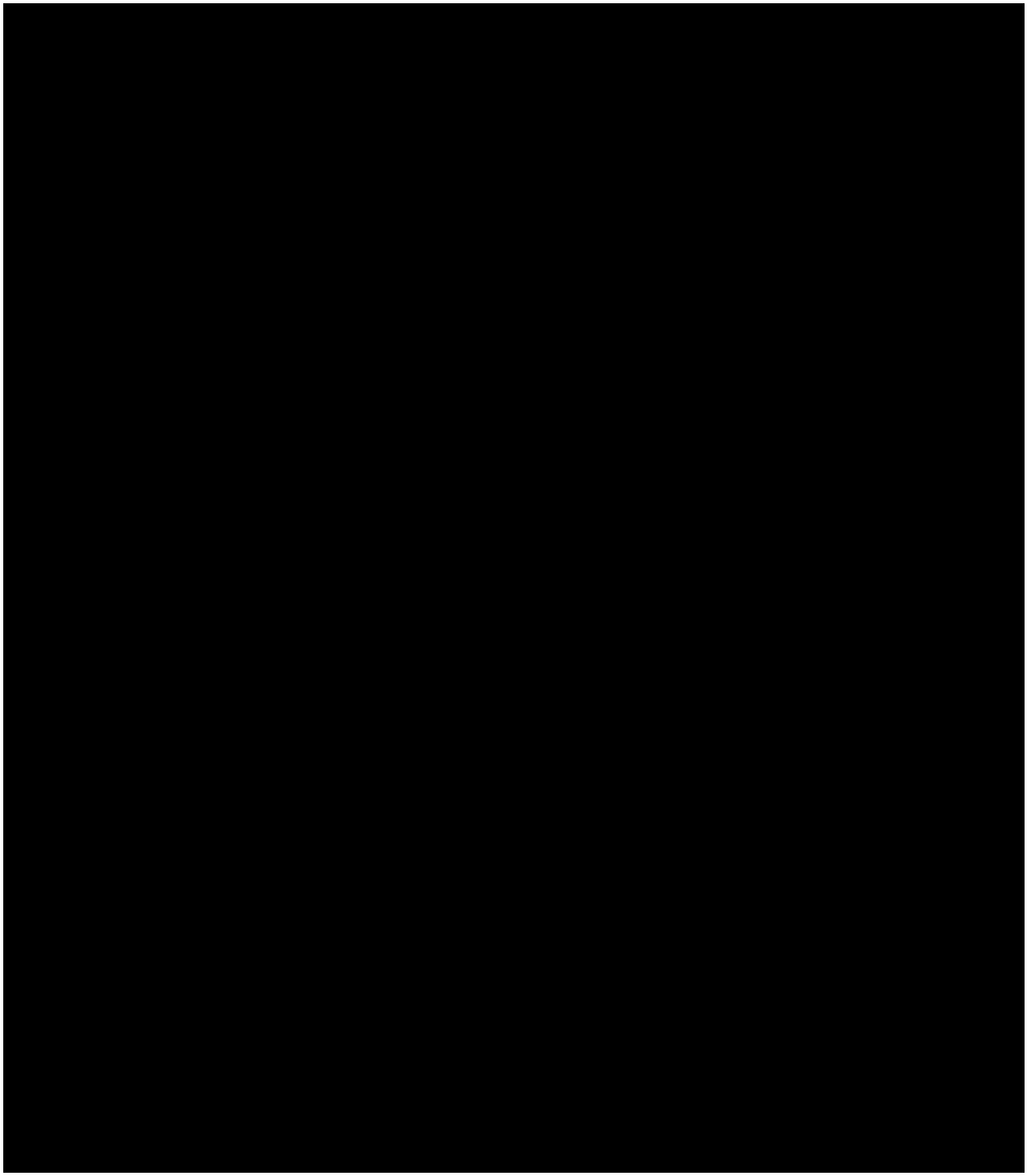


Table 2-11. RIO D1 Board Connector Pin-Out

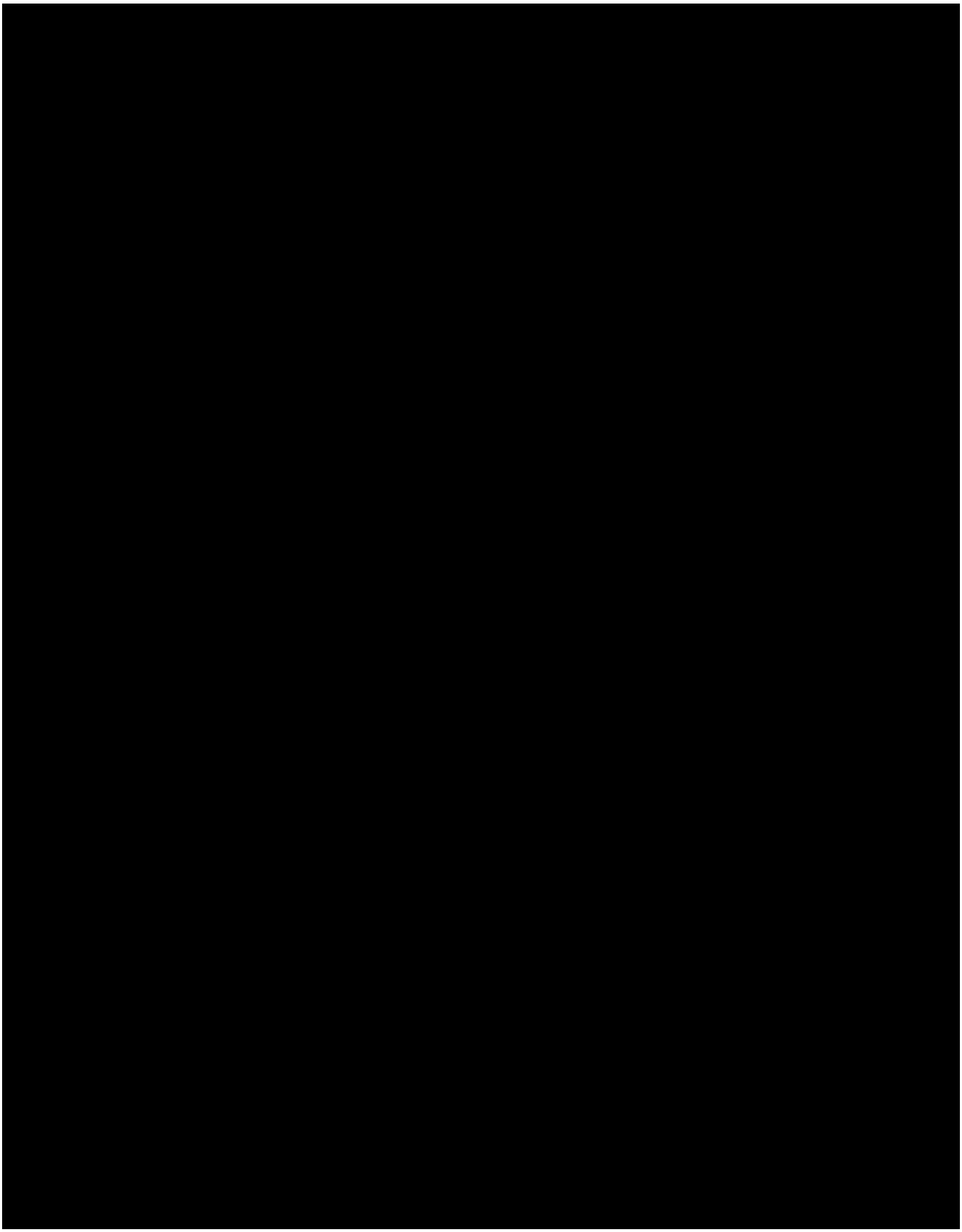
Connector Digital Inputs DI 1			
Pin	Row d	Row b	Row z
2	G1_VIN+	G1_VIN+	G1_GND
4	G1_IN1	G1_IN2	G1_IN3
6	G1_IN4	G1_IN5	G1_IN6
8	G1_GND	G1_GND	G1_GND
10	G2_VIN+	G2_VIN+	G2_GND
12	G2_IN07	G2_IN08	G2_IN09
14	G2_IN10	G2_IN11	G2_IN12
16	G2_GND	G2_GND	G2_GND
18	G3_VIN+	G3_VIN+	G3_GND
20	G3_IN13	G3_IN14	G3_IN15
22	G3_IN16	G3_IN17	G3_IN18
24	G3_GND	G3_GND	G3_GND
26	G4_VIN+	G4_VIN+	G4_GND
28	G4_IN19	G4_IN20	G4_IN21
30	G4_IN22	G4_IN23	G4_IN24
32	G4_GND	G4_GND	G4_GND

2.7.2.5 Digital Output (PWM) Board

The DOPWM module is a digital input I/O module designed to drive, by means of digital output lines, up to 16 loads.

Digital output lines are grouped in 13 groups (Group1: DO01-04, Group2: DO05, …, Group 13: DO16) (see Figure 2-20). Each group is referred to an independent ground and external power supply and are placed on independent galvanic islands. The outputs are driven by a power MOS component and have also a specific circuit for the automatic protection against short circuit. Moreover, it is designed to have 2 PWM input interface but only one channel is mounted.

The 2 PWM input interfaces are on independent galvanic islands. The duty cycle is in the range 5-95%. Outside this range the signal is assumed to be incorrect. The period is 2.057ms ±2%. Check input functionality of each PWM line is done at start-up and maintenance test. The P3010 vehicle uses one of the PWM inputs to read the PWM signal of the PBED (Propulsion and Brake Effort Delivered) from the master controller.



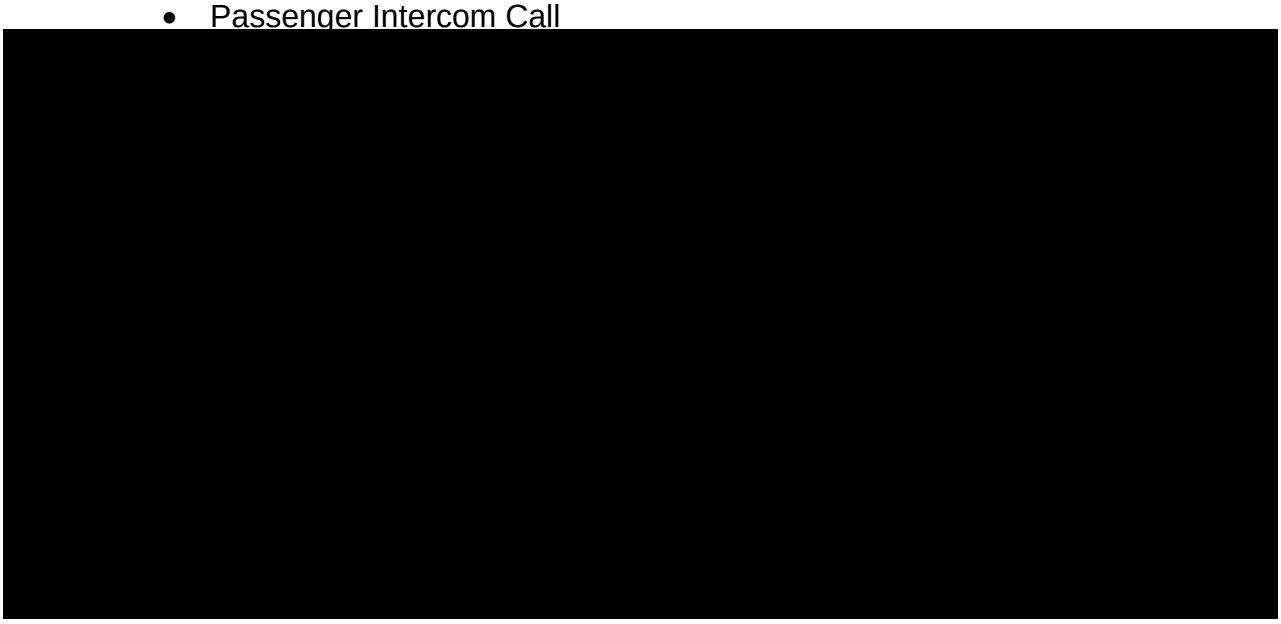
2.7.2.6 Analog Input Board (AUX)

The AUX module is dedicated to the monitoring of analog inputs, frequency inputs, voltage battery and the driving of digital outputs. It has the following features:

- 2 galvanic isolated analog inputs 4-20mA
- 2 galvanic isolated frequency inputs up to 10kHz
- 1 galvanic isolated analog input for battery voltage monitoring
- 2 relay digital outputs

The AUX board provides two relay outputs, SPDT type (single pole, double throw), see Figure 2-21. On the P3010 vehicle, one output relay on the B-Unit TCN rack is used to notify the Network Vehicle Recorder (NVR) of one of the following alarms:

- Emergency Brake
- Emergency Door Release
- Silent Alarm
- Passenger Intercom Call



The Power Supply Board receives battery input and provides insulated internal power to the other boards. The Power supply board supplies the voltages required by the other components of the system. It provides a “clean” power supply to the electronic devices of the gateway, featuring:

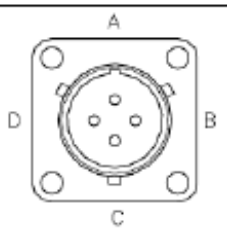
- galvanic isolation
- inrush current protection
- common mode input filtering
- differential mode input filtering
- protection against input polarity inversion
- output current limitation
- protection against output overvoltage

Table 2-12 provides the power supply characteristics and Table 2-13 provides the connector pinout.

Table 2-12. RIO Power Supply Characteristics

Power supply characteristics	Min	Max
Continuous applicable operating voltage	16.8V	36V
Applicable voltage for 100ms without causing malfunctioning	14.4V	40V

Table 2-13. RIO Power Supply Connector Pinout

Pin	Signal	Description	Pin
A	FGND	Frame Ground	 (Front View)
B	BATP	Positive Supply Battery	
C	BATN	Negative Supply Battery : 0Vdc	
D	-	*Not connected*	

2.7.2.8 MVB Cables & Connectors

The connection to the MVB network is realized according IEC61375 (see Figure 2-22). The MVB RIO CPU and WTB Gateway have two DB9 connectors:

- D-Sub-9-pin male (MVB-M1)
- D-Sub 9-pin female (MVB-M2)

Termination of the MVB network is required at the end devices in the MVB daisy-chain bus in order to ensure signal clarity. On the P3010 MVB network, termination of the MVB network occurs at the WTB Gateways. The A-end Gateway has a male MVB terminator and the B-end Gateway has a female MVB terminator (see Figure 2-23).

Pinouts for the male and female MVB connectors are provided in Tables 2-14 and 2-15 respectively. Pin numbering is shown in Figure 2-22.

Table 2-16 provides the recommended specifications for MVB and WTB (Section 2.7.2.9) cables.

Figure 2-22: MVB Network Connection

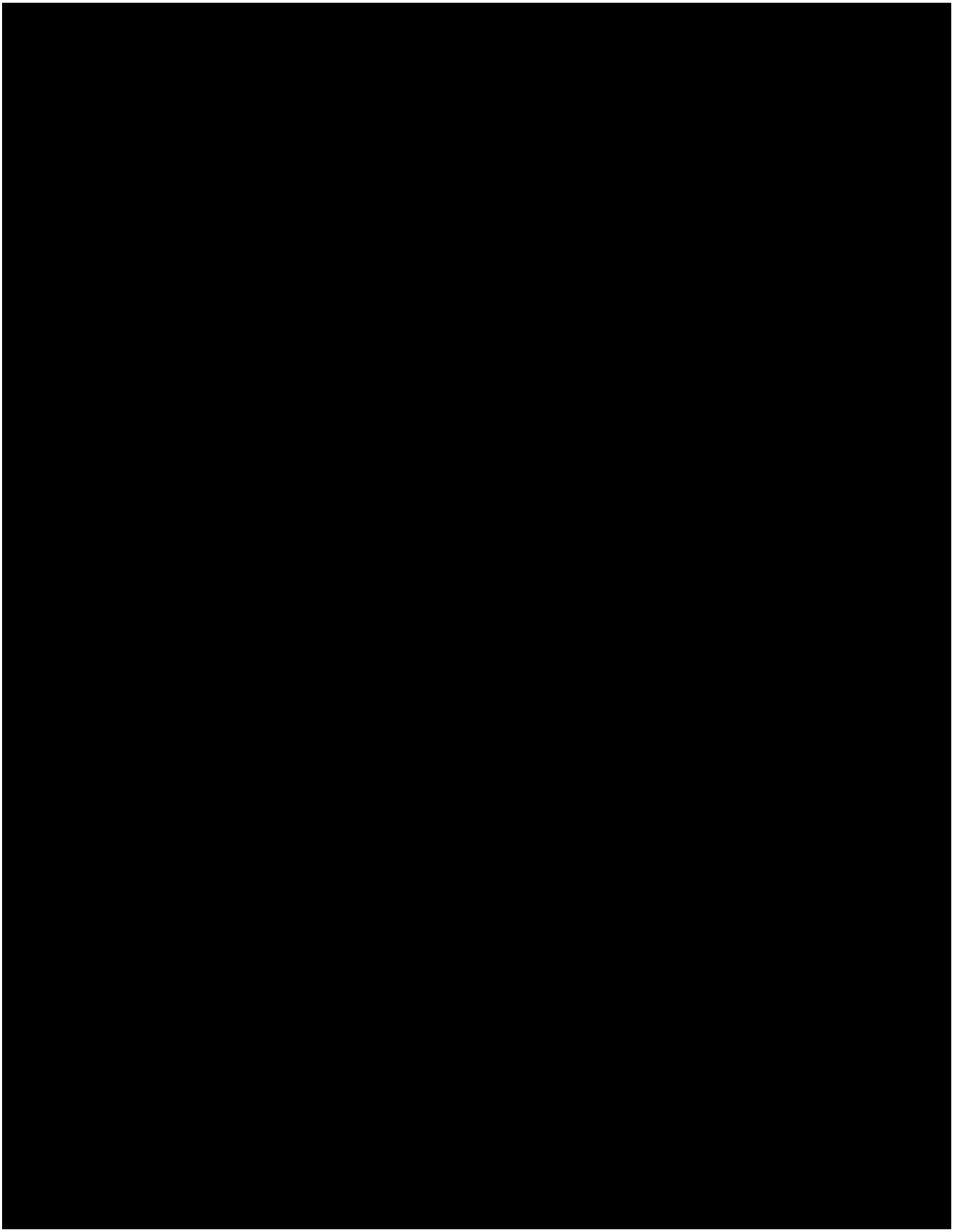


Table 2-15. D-Sub 9-Pin Female MVB-M2 Connector Pinout

PIN	Signal Name	Direction	Function
1	A2.Data_P	I/O	Positive wire Line_A2
2	A2.Data_N	I/O	Negative wire Line_A2
3	-	-	Reserved
4	B2.Data_P	I/O	Positive wire Line_B2
5	B2.Data_N	I/O	Negative wire Line_B2
6	A2.Term_P	-	Positive termination Line_A2
7	A2.Term_N	-	Negative termination Line_A2
8	B2.Term_P	-	Positive termination Line_B2
9	B2.Term_N	-	Negative termination Line_B2

Table 2-16. WTB and MVB Cable Recommendation

Technical data		
Application	WTB	MVB
Dimensions	2 x 0.75 mm^2, shielded	2 x 2 x 0.5 mm^2 twisted pair + 2 x 0.5 mm^2, shielded
Wave impedance f = 0.75…3 MHz		120 ±12 Ω
Wave impedance f = 0,5…2,0 MHz	120 ±12 Ω	
Attenuation f = 1 MHz	≤ 10.0 dB/km	≤12,5 dB/km
Attenuation f = 2 MHz	≤ 14.0 dB/km	≤18,0 dB/km
Transfer impedance f <20 MHz		≤ 20 m Ω /m
Transfer impedance f <30 MHz	≤ 30 mΩ/m	
Voltage rating	300 V	300 V

2.7.2.9 WTB Cables & Connectors

The WTB connectors are two 9 pin male-female connectors (see Figure 2-24). To achieve line redundancy, two pairs of male-female connectors are used. The WTB cables are connected to the WTB Gateways only (i.e. no additional subsystems are connected on this network).

On the P3010 vehicle, each Gateway has four WTB connections – two male-female connector pairs. One cable from each of the two pairs is connected between the A-end and B-end Gateway on the local vehicle. The other cables are wired to the P3010 couplers in order to connect the WTB network among the train consist. Therefore, no WTB terminators are found on the Gateway module.

Pinouts for the WTB connectors are provided in Tables 2-17 through 2-20. Pin numbering is the same as the MVB connectors. Refer to Section 2.7.2.8.

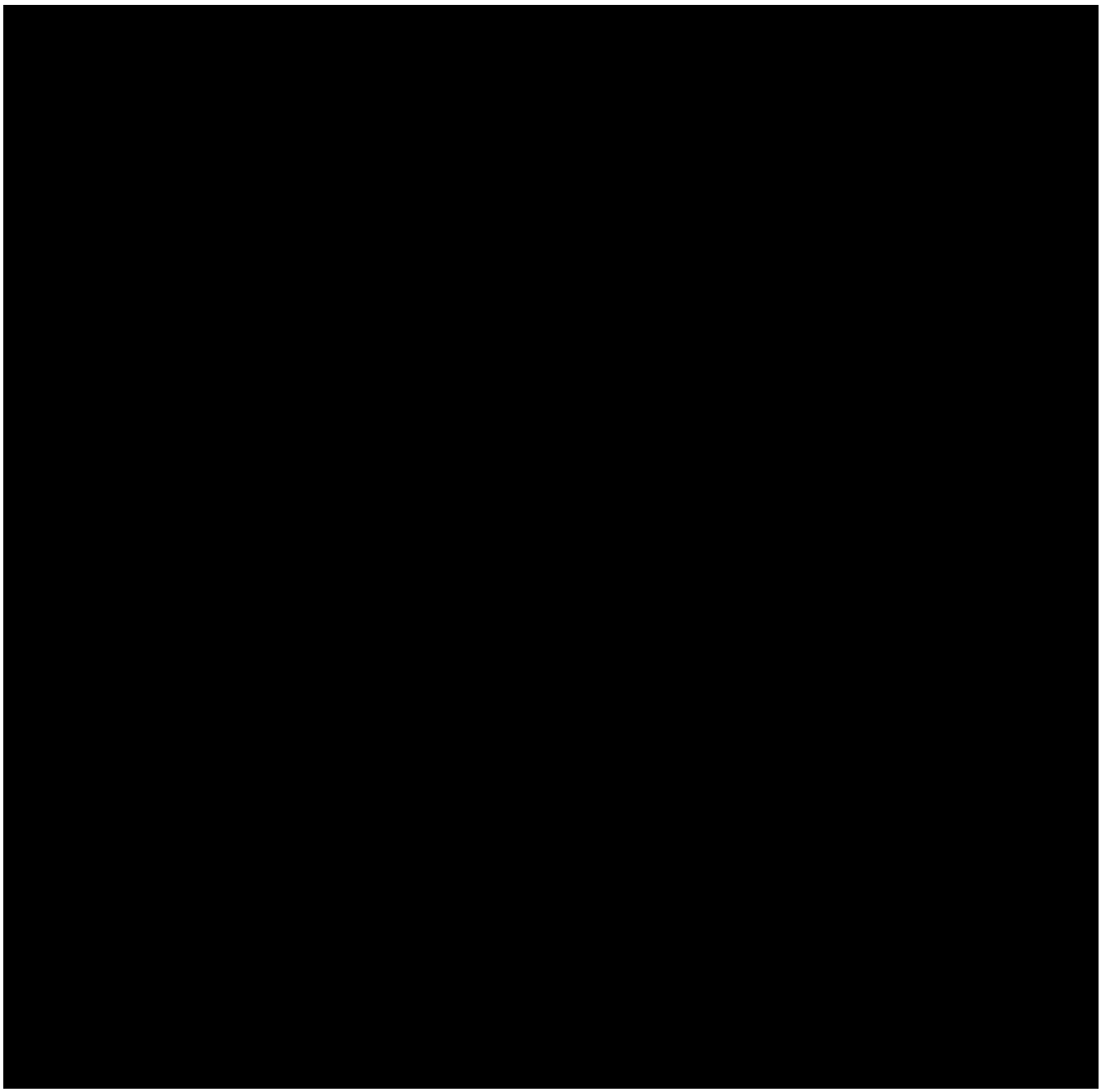


Table 2-18. WTB A2 Female Connector Pinout

Pin	Name	Direction	Type	Polarity	Description
1	A2X	I/O	WTB	NA	A2 positive wire
2	A2Y	I/O	WTB	NA	A2 negative wire
3	-	NA	NC	NA	Reserved
4	-	NA	NC	NA	Reserved
5	-	NA	NC	NA	Reserved
6	A2S	NA	NA	NA	A2 shield
7	-	NA	NC	NA	Reserved
8	-	NA	NC	NA	Reserved
9	-	NA	NC	NA	Reserved

Table 2-19. WTB B1 Male Connector Pinout

Pin	Name	Direction	Type	Polarity	Description
1	B1X	I/O	WTB	NA	B1 positive wire
2	B1Y	I/O	WTB	NA	B1 negative wire
3	-	NA	NC	NA	Reserved
4	-	NA	NC	NA	Reserved
5	-	NA	NC	NA	Reserved
6	B1S	NA	NA	NA	B1 shield
7	-	NA	NC	NA	Reserved
8	-	NA	NC	NA	Reserved
9	-	NA	NC	NA	Reserved

Table 2-20. WTB B2 Female Connector Pinout

Pin	Name	Direction	Type	Polarity	Description
1	B2X	I/O	WTB	NA	B2 positive wire
2	B2Y	I/O	WTB	NA	B2 negative wire
3	-	NA	NC	NA	Reserved
4	-	NA	NC	NA	Reserved
5	-	NA	NC	NA	Reserved
6	B2S	NA	NA	NA	B2 shield
7	-	NA	NC	NA	Reserved
8	-	NA	NC	NA	Reserved
9	-	NA	NC	NA	Reserved

2.7.3 Wired Ethernet Equipment Information

The P3010 Wired Ethernet Network consists of the following equipment:

- Ethernet Switches (8 total)
    - N-Tron 708M12 (2 total)
    - N-Tron 716M12 (3 total)
    - Moxa TN-5516-8PoE-T (2 total)
    - Westermo Viper 212 (1 total)
- Ethernet Cables and Connectors
- ETB (Ethernet Trainline) Equipment (1 Panel)

The following subsections provide additional information on each equipment.

2.7.3.1 N-Tron 708M12 (LAN3A, LAN3B)

The N-Tron 708M12 switches on the P3010 network, shown in Figure 2-25, are responsible for creating a redundant link between the A-end and B-end network devices across the articulation section of the LRV. There are two cables – and therefore two switch ports – that are used as paths to communicate between LAN3A and LAN3B. These switches also provide IP addresses to multiple other subsystems. For example, the Automatic Passenger Counter (APC) and Door Control Unit (DCU) Gateway are provided from these switches. Lastly, Port 5 on both switches is dedicated as PTU connection ports.

Description of the status LEDs are provided in Table 2-21. Figures 2-26 and 2-27 show the power and M12 communication connector diagrams respectively. 708M12 Switch assembly drawing is provided in Figure 2-28.

Figure 2-25: N-Tron 708M12 Ethernet Switch

Table 2-21. N-Tron 708M12 Status LEDs

LED	Color	Description
⏻	GREEN	Power is Applied with no active faults.
	RED	Power is Applied with an active fault.
	OFF	Power is not Applied.
LNK	ON	Link established.
	OFF	No link established.
ACT	BLINKING	Link established, Activity on cable.
	OFF	No link established.

2.7.3.2 N-Tron 716M12 (LAN1A, LAN2A, LAN1B)

The N-Tron 716M12 switches on the P3010 network, shown in Figure 2-29, are responsible for providing IP addresses to multiple subsystems and relating information to/from those devices to other devices on the Ethernet network.

Description of the status LEDs are provided in Table 2-22. Figures 2-30 and 2-31 show the power and M12 communication connector diagrams respectively. 716M12 Switch assembly drawing is provided in Figure 2-32.

Figure 2-29: N-Tron 716M12 Ethernet Switch

Table 2-22. N-Tron 708M12 Status LEDs

LED	Color	Description
⏻	GREEN	Power is Applied with no active faults.
	RED	Power is Applied with an active fault.
	OFF	Power is not Applied.
LNK	ON	Link established.
	OFF	No link established.
ACT	BLINKING	Link established, Activity on cable.
	OFF	No link established.

2.7.3.3 Westermo Viper 212 (LAN2B)

The Westermo Viper 212, shown in Figure 2-33, is a managed switch with routing capabilities. This switch is responsible for creating the three virtual networks (VLANs) which controls and isolates communication among devices on the 10-dot network (i.e. 10.x.x.x), the 172-dot network (i.e. 172.x.x.x), and the 192-dot network (i.e. 192.x.x.x). The switch also provides multiple devices with IP addresses.

Description of the status LEDs are provided in Table 2-23. Tables 2-24 and 2-25 show the power and M12 communication connector diagrams respectively. Westermo Viper Switch assembly drawing is provided in Figure 2-34.

Figure 2-33: Westermo Viper 212 Switch

Table 2-23. Westermo Viper 212 Status LEDs

LED	Status	Description
ON	OFF	Unit has no power.
	GREEN	All OK, no alarm condition.
	RED	Alarm condition, or until unit has started up. (Alarm conditions are configurable, see "WeOS Management Guide").
	BLINK	Location indicator ("Here I am!"). Activated when connected to IPConfig Tool, or when configuring the unit via Web or CLI.
DC	OFF	Unit has no power.
	GREEN	Power OK on DC1 and DC1.
	RED	Power failure on DC1 or DC2.
FRNT *	OFF	FRNT disabled.
	GREEN	FRNT OK.
	RED	FRNT Error.
	BLINK	Unit configured as FRNT Focal Point.
RSTP*	OFF	RSTP disabled.
	GREEN	RSTP enabled.
	BLINK	Unit elected as RSTP/STP root switch.
X1 to X12	OFF	No Link.
	GREEN	Link established.
	GREEN FLASH	Data traffic indication.
	YELLOW	Port alarm and no link. Or if FRNT or RSTP mode, port is blocked.

Table 2-24. Westermo Viper 212 Power Connector Diagram

Power

Pin number	Signal	
No 1	+DC1	
No 2	+DC2	
No 3	-COM	
No 4	-COM	

Table 2-25. Westermo Viper 212 M12 Ethernet Communication Connector Diagram

CON

Pin number	Signal	
No 1	NC	
No 2	TX	
No 3	RX	
No 4	NC	
No 5	GND	

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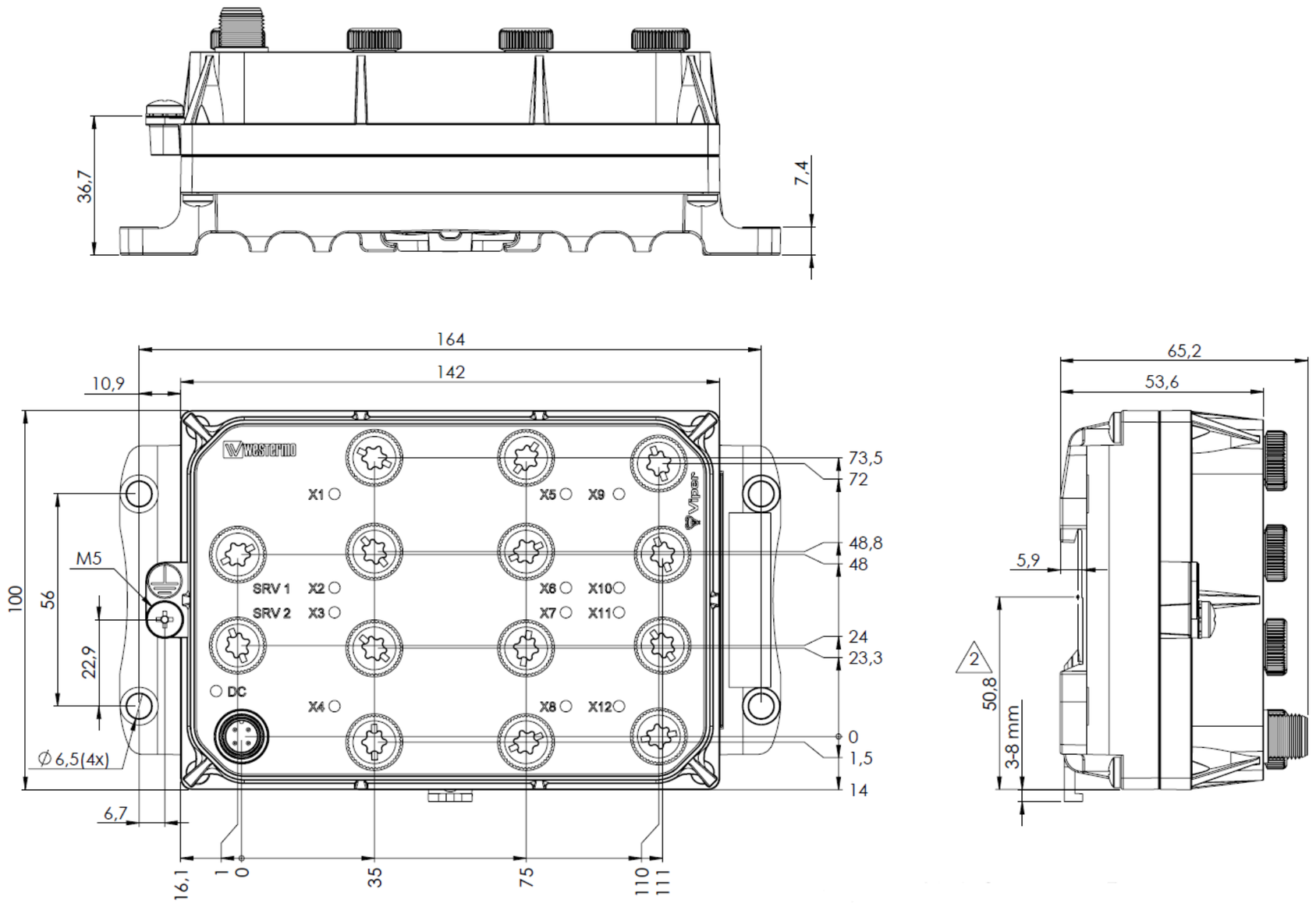

Figure 2-34: Westermo Viper Switch Assembly Drawing

2.7.3.4 Moxa TN-5516-8PoE-T (LAN4A, LAN4B)

The Moxa TN-5516-8PoE-T switches on the P3010 network, shown in Figure 2-35, are responsible for creating a redundant link between the A-end and B-end network devices across the articulation section of the LRV. There are two cables – and therefore two switch ports – that are used as paths to communicate between LAN4A and LAN4B.

These switches are unique in that eight ports on the switch (Ports 1 through 8) are PoE, meaning they are capable of providing power to a device over the standard Ethernet cable. On the P3010 vehicle, the PoE ports are used to power the surveillance cameras.

WARNING

DUE TO THE POE CAPABILITIES, CAUTION MUST BE TAKEN WHEN CONNECTING TO THIS SWITCH. IF A NON-POE ETHERNET COMMUNICATION DEVICE IS CONNECTED TO A POE PORT, THERE IS A RISK OF DAMAGING THE DEVICE.

Description of the status LEDs are provided in Table 2-26. Figures 2-36 and 2-37 show the power and M12 communication connector diagrams respectively. Moxa Ethernet Switch assembly drawing is provided in Figure 2-38.

Figure 2-35: Moxa TN-5516-8PoE-T Switch

Table 2-26. Moxa TN-5516-8PoE-T Status LEDs

LED	Color	State	Description
System LEDs			
PWR1	AMBER	ON	Power is being supplied to power input PWR1.
		OFF	Power is not being supplied to power input PWR1
PWR2	AMBER	ON	Power is being supplied to power input PWR2.
		OFF	Power is not being supplied to power input PWR2.
FAULT	RED	ON	When the corresponding PORT alarm is enabled, and a user-configured event is triggered.
		OFF	When the corresponding PORT alarm is enabled and a user-configured event is not triggered, or when the corresponding PORT alarm is disabled.
MSTR/ HEAD	GREEN	ON	When the TN switch is either the Master of this Turbo Ring, or the Head of this Turbo Chain.
		Blinking	When the TN switch is Ring Master of this Turbo Ring and the Turbo Ring is broken, or it is Chain Head of this Turbo Chain and the Turbo Chain is broken.
		OFF	When the TN switch is neither the Master of this Turbo Ring, nor the Head of this Turbo Chain.

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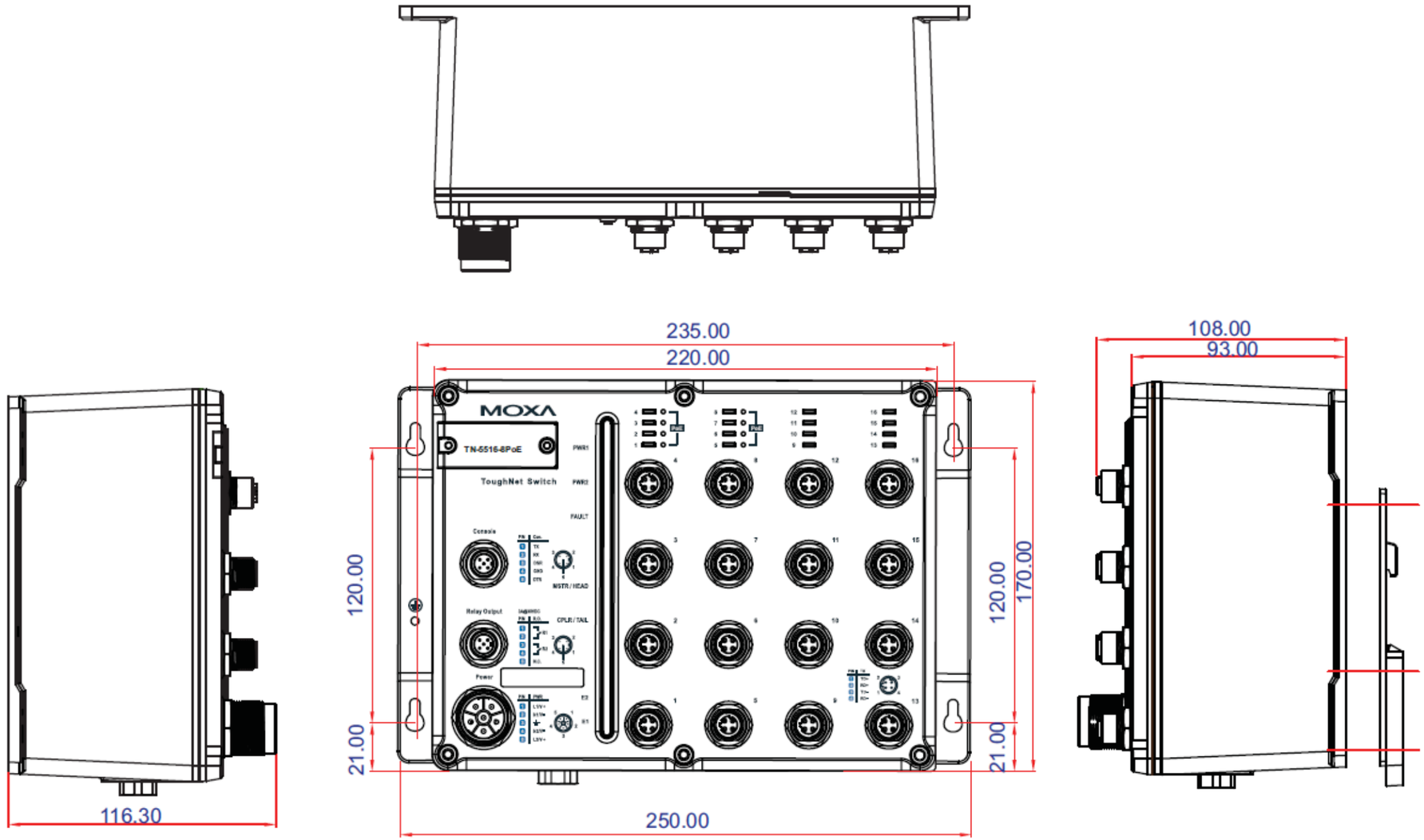


Figure 2-38: Moxa Ethernet Switch Assembly Drawing

2.7.3.5 Ethernet Train Backbone Equipment (EEI Modules)

The P3010 vehicle is equipped with one RTC EEI Panel (see assembly drawing, Figure 2-46) which consist of two redundant EEI modules. The modules are Corinex HD Compact Gateways (see Figure 2-39). The modules use frequency division duplexing (FDD) to communicate with one another among a P3010 consist. The EEI panel, and management software located on the MDS computer, is responsible for providing the Ethernet Train Backbone (also referred to as Ethernet trainline).

Each module has four connectors, as shown in Figure 2-40. The following three connectors are used on the P3010:

- DC Power Connector
- AC Signal Connector
- RJ45 Connector

The DC connector carries 12Vdc to the module to power on the device. The EEI Panel houses two 12Vdc power supplies to individually power each module. The ‘PWR’ status LED on the face of the module will illuminate when the module is powered on.

The AC connector carries the high frequency (2-34 Mhz) Ethernet signal to and from modules within the consist.

The standard RJ45 connector connects the EEI Module to the local vehicle Ethernet network. Additional environmental and vibration protection is added to the RJ45 connector using a water-tight outer housing.

Figures 2-41 and 2-42 show the pin numbering for the DC connector. Figures 2-43 through 2-44 show the pin numbering for the AC connector. The pinout definitions for the AC and DC connector is shown in Table 2-27.

Figure 2-45 shows the physical buttons and status LEDs on the module. Table 2-28 and 2-29 define the physical buttons and status LEDs respectively. The EEI Panel assembly drawing is provided in Figure 2-46.

Figure 2-39: Corinex HD Compact Gateway

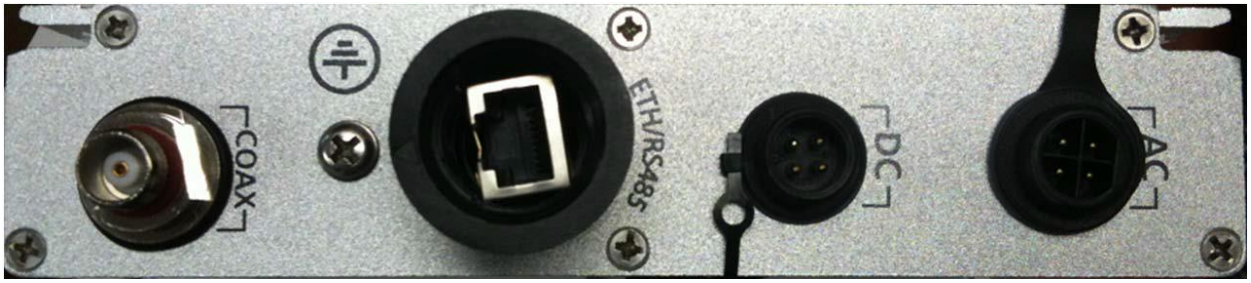


Figure 2-40: EEI Module Connectors (Rear View)

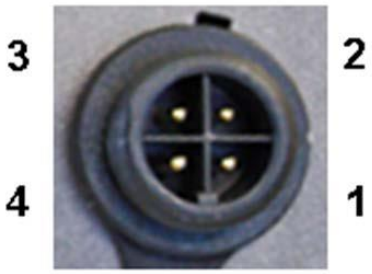


Figure 2-41: AC Module Connector Pin Diagram

Figure 2-42: AC Cable Connector Pin Diagram

Figure 2-43: DC Module Connector Pin Diagram

Figure 2-44: DC Cable Connector Pin Diagram

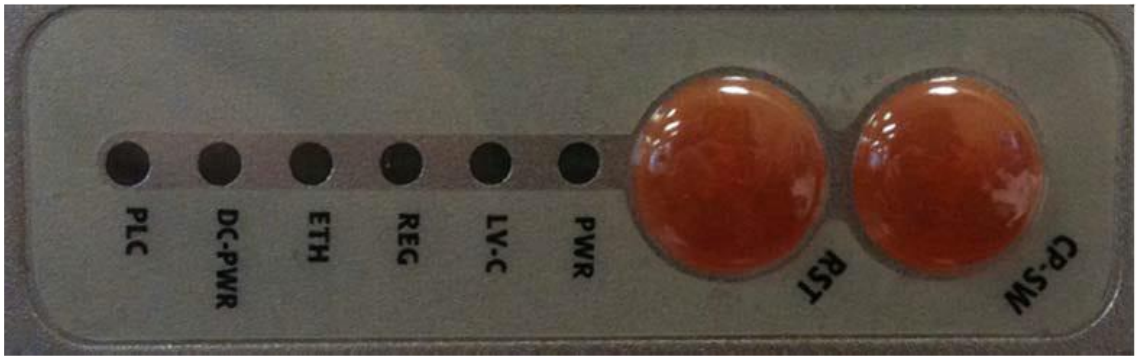


Figure 2-45: EEI Module Status LEDs and Interface Buttons

Table 2-27. AC and DC Connector Pinout

	1	2	3	4
AC	Phase A (Brown/Yellow)	Phase B (Black)	Phase 3 (Grey / White)	Neutral (Blue)
DC	GND	NC	Bt in ⊕ 14.4V	+12V Out

Table 2-28. EEI Module Interface Buttons Definition

Button	Indication	1st function press from 1 to 4 seconds	2nd function press for 10 seconds
RST	N/A	Hardware reset	Factory-default reset
CP-SW	LV-C	Switch coupling mode (LV / Coax) **Optional A**: Switch MAC (PLC / EoC) **Optional B**: Switch RPM (enable / disable)	Switch PTTP mode (enabled/ disable)

Table 2-29. EEI Module Status LEDs Definition

		State			
LED	**Function**	**On**	**Off**	**Alternate 1s**	**Alternating 0.1s**
PWR	Power	Power ON	Power OFF	NA	NA
LV-C*	- Coupling Mode (1st function) - PTTP Mode (2nd function)	Coupling to LV **Optional A**: RPM enabled	Coupling to COAX **Optional A**: RPM disabled	NA	Blinking period to indicate PTTP
REG	- Auto Configuration - Pushbutton (1st and 2nd function)	Auto Configuration is done	-Auto Configuration is not finished -IP is not set	-Auto Configuration is not finished -IP is assigned	Blink from 1s to 4s and after 8s while button is being pressed
ETH	ETH L/A	Eth link established	No Eth link/ETH10 Speed	NA	There is Eth activity
DC-PWR	DC Power	DC Power ON	DC Power OFF	NA	NA
PLC	PLC L/A + Port solver	PLC link established	No device connected to port solver	Some devices are connected to port solver	There is PLC activity

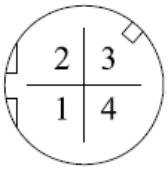
2.7.3.6 Ethernet Cables & Connectors

The P3010 vehicle is equipped with Cat5 twisted-shielded cables. This cable minimizes crosstalk and electrical noise to improve data transfer reliability and efficiency within the Ethernet network.

The cables are connected to devices using M12 Ethernet connectors. There are two types of M12 data connectors used on the P3010 vehicle – 4-pin and 8-pin. Most Ethernet equipment on the P3010 vehicle use the 4-pin type connector, however, some devices such as the Communication Control Unit (CCU) computer use the 8-pin type (SACC-M12MS-8Q). The 4-pin M12 connectors come in both a straight housing (SACC-MSD-4SC) and an angled housing (SACC-MRD-4SC). Most P3010 Ethernet devices use the straight housing, however, some devices such as the Audio Control Modules (ACMs) use the angled housing.

The wiring pinout for the Ethernet cables is provided below in Figure 2-47.

ETHERNET PORT M12 D-CODED (MALE) CONNECTOR
(VIEWED FROM REAR OF CONNECTOR)



PIN	DESCRIPTION	WIRE COLOR
1	Tx+	ORANGE/WHITE
2	Rx+	GREEN/WHITE
3	Tx-	ORANGE
4	Rx-	GREEN

Figure 2-47: Ethernet Cable Pinout

2.7.4 Wireless Ethernet Equipment Information

The P3010 vehicle is equipped with one wireless Ethernet radio (N-Tron 702M12-W) and one wireless antenna (Mobile Mark SMD-W-3K3K3K-WHT-180).

2.7.4.1 Wireless Ethernet Radio

The N-Tron 702M12-W Wireless LAN Transceiver Radio, shown in Figure 2-48, is Multi-Input-Multi-Output (MIMO) compatible to provide reliable data transfer between LA Metro Wayside and the P3010 vehicles. Some of the other key features of the Wireless Radio are the following:

- EN-51055 rail compliant
- IP67 Rated
- IEEE 802.11a,b,g,n compliant

Description of the status LEDs are provided in Table 2-30. Figures 2-49 and 2-50 show the power and M12 communication connector diagrams respectively. N-Tron 702M12-W assembly drawing is provided in Figure 2-51.

Figure 2-48: N-Tron 702M12-W Wireless LAN Transceiver Radio

Table 2-30. N-Tron 702M12-W Status LEDs

LED	Color	Description
	GREEN	Good Signal (user defined)
	ORANGE	Poor Signal (user defined)
	RED	Bad Signal (user defined)
Radio Enabled	GREEN	The radio interface is active
	OFF	The radio interface is off
LNK/ACT	GREEN	LAN Link is present
	FLASHING	Data is active over the ports
	OFF	No Link is present on the LAN port
PWR	GREEN	Power is applied
	OFF	No Power is applied

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2.7.4.2 Wireless Antenna

The Mobile Mark SMD-W-3K3K3K-WHT-180 MIMO Antenna consists of three cables, each with identical throughput and bandwidth (see Figure 2-52). The MIMO system allows different data to be transmitted on different antenna elements. The antenna is IP67 rated which allows it to be mounted on the roof of the P3010 vehicle.

Figure 2-52: Mobile Mark MIMO Antenna

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CHAPTER 3.0

SPECIAL TOOLS AND MATERIALS

3.1 Introduction

No special tools are required. However, there are commercially available tools which aid in maintenance and troubleshooting of the Data Communications equipment. Table 3-1 lists the recommended tools along with a manufacture/model number available. The model listed is for references only – a comparable model can be used as a substitute.

Table 3-1: Recommended Network Tools

Tool	Use	Manufacture/Model
M12 Torque Screwdriver	- Tightening M12 Connectors to 0.4Nm - Removing M12 Connectors	Phoenix Contact TSD 04 SAC – 1208429
M12 Torque Nut	- Used with M12 Torque Scredriver	Phoenix Contact SACC BIT M12-D20 – 1208445
Network Cable Tester	(Model Dependent) - Test Cable Continuity - Test Wiremap (cross connections)	Fluke CableIQ

3.2 M12 Torque Driver

An M12 Torque Driver is recommended for tightening the M12 connectors to the proper value of 0.4Nm (see Figure 3-1). Improperly seated connectors can cause device connectivity issues and improperly torqued connectors can come loose due to the vibrations experienced in a moving LRV. The M12 driver is also handy for removing M12 connectors in hard to reach locations – such as in one of the inner ports on the Ethernet switches.

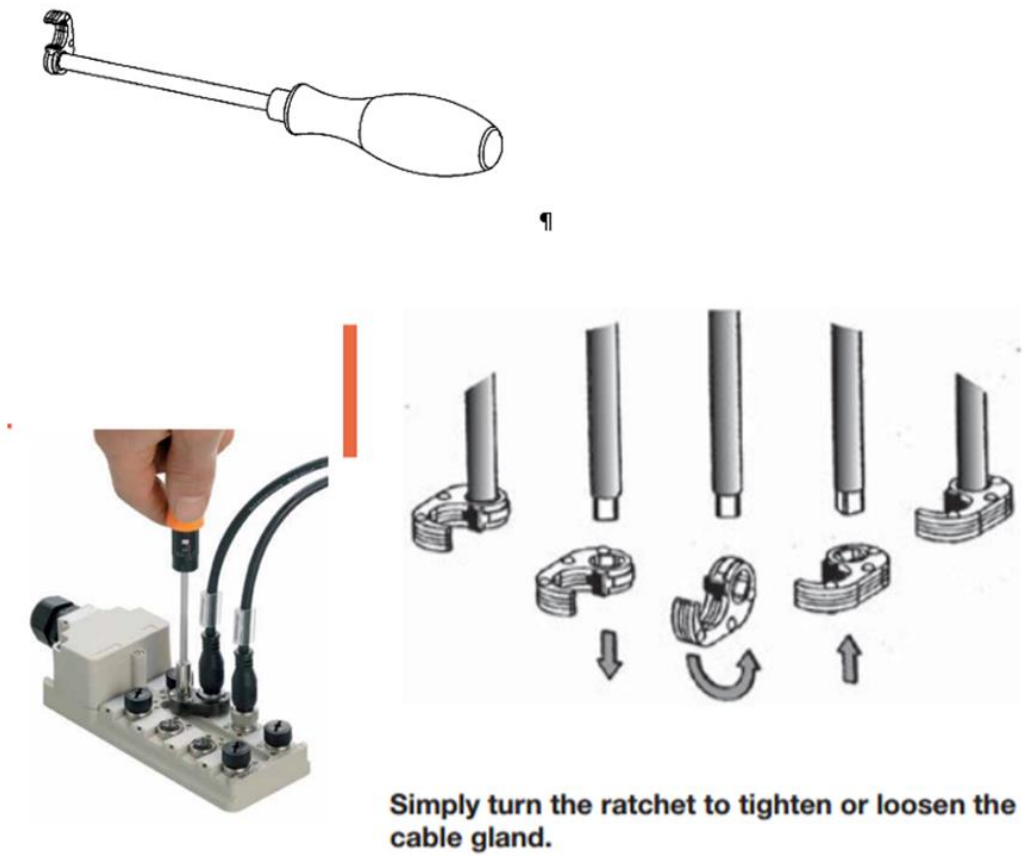

Figure 3-1: M12 Torque Driver

3.3 Network Cable Tester

A network cable tester is recommended for troubleshooting Ethernet connectivity issues. Although there are many manufactures and models which provide additional features, such as the Fluke CableIQ tester shown in Figure 3-2, the key functions of the cable tester that are used to troubleshoot P3010 Ethernet connectivity issues are the following:

- Cable Continuity Test – this test checks the continuity of the Ethernet wires and, model depending, can estimate the location of the wire break
- Wiremap Tests (Cross Connections) – this test checks the connectors for correct pin wiring

Figure 3-2: Network Cable Tester (Fluke CableIQ shown)

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CHAPTER 4.0

SCHEDULED MAINTENANCE TASKS

4.1 Introduction

This chapter provides scheduled maintenance tasks in the form of a quick reference table. A thorough visual inspection should be performed before proceeding. Obvious malfunctions from damage observed during the visual inspection are to be corrected.

4.2 Scheduled Maintenance Index

Table 4-1 is a scheduled maintenance index, which lists maintenance intervals and each maintenance task for the Data Communications (TCN) equipment. The reference column indicates the section of this manual that details these maintenance procedures. Figure 4-1 shows the location of the Real Time Clock (RTC) battery on the TCN MVB CPU Board.

Table 4-1: Scheduled Maintenance

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 1700 TCN Running Maintenance & Servicing Manual Section Reference
10,000 miles	Ethernet Switches	Visually inspect for loose components and secure panel mounting hardware	5.3.2
10,000 miles	WLAN Transceiver	Visually inspect for loose components and wires	5.3.3
60,000 miles	TCN Rack	Visually inspect for loose components and secure panel mounting hardware	5.3.1
60,000 miles	Enhanced Ethernet Interface (EEI) Panel	Visually inspect for loose components and secure mounting hardware	5.3.5
840,000 miles	TCNIO Real Time Clock Battery	Replace the battery (pn: CR2303)	5.3.6 / 6.4.4
2,400,000 miles	WTB Gateway	Reload the WTB Gateway Firmware	8.2

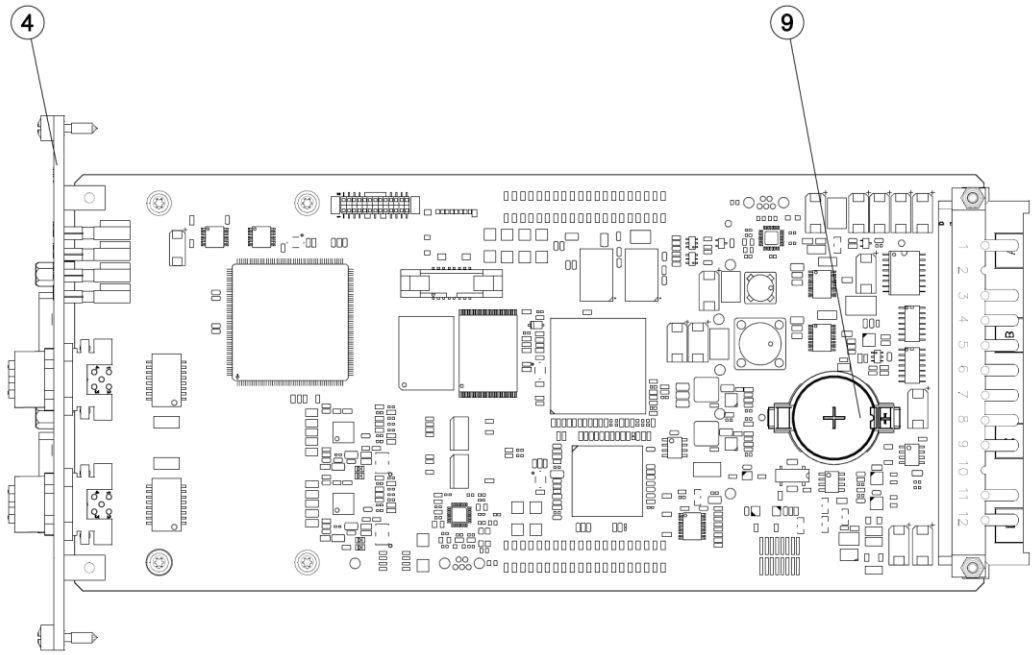

Figure 4-1: TCN MVB CPU Board (callout 4) with the Real Time Clock Battery (callout 9)

CHAPTER 5.0

CORRECTIVE MAINTENANCE

5.1 Introduction

This chapter provides inspection and adjustment procedures for the Data Communications (TCN) equipment.

5.2 Safety Information

WARNING

TO PREVENT ELECTRICAL SHOCK, DO NOT OPEN THE ENCLOSURE UNLESS CONDUCTING A SPECIFIC TASK OUTLINED IN THIS MANUAL.

WARNING

TO AVOID THE POSSIBILITY OF ELECTRICAL SHOCK, DISCONNECT ELECTRICAL POWER FROM THE UNIT BEFORE CONNECTING OR DISCONNECTING CABLES.

WARNING

THIS UNIT CONTAINS HAZARDOUS VOLTAGES AND SHOULD ONLY BE OPENED AFTER TAKING THE APPROPRIATE SAFETY PRECAUTIONS.

WARNING

TO ALLOW GROUND, THE ENCLOSURE FRAME IS PLATED WITH ELECTRICAL CONDUCTIVE MATERIAL, TO AVOID THE POSSIBILITY OF ELECTRICAL SHOCK DO NOT APPLY A DANGEROUS VOLTAGE.

CAUTION

WARRANTIES ARE VOIDED IF THE SEALS ON THE ENCLOSURE ARE BROKEN.

The importance of safe operation and maintenance cannot be over stressed. The following are some important points for maintenance personnel to observe:

1. Wear an insulated hard hat when working on the vehicle roof or any of the roof-mounted components.
2. Wear safety shoes and hard hats when working where objects might fall.
3. Never work on equipment while electrical power is applied unless it is absolutely necessary as part of the maintenance program. Verify that power is removed by checking with reliable equipment.
4. Attach a tag with the name of the person who removed the power from the equipment. That person knows why the power was removed and when it will be safe to restore it. Only the individual whose name appears on the tag or a person who has his approval should remove the tag and restore power.
5. Use proper lifting equipment to remove and replace heavy components. Make sure the components are securely fastened to the lifting device.
6. Never attempt to perform a two-person operation alone. Know and follow emergency procedures.
7. Never take any short cuts that are not clearly defined and approved.

5.3 Corrective Maintenance Procedures

5.3.1 TCN Rack

Visually inspect for loose components and secure panel mounting hardware every 60,000 miles. See Figure 6-3.

5.3.2 Ethernet Switches

Visually inspect for loose components and secure panel mounting hardware every 10,000 miles. See Figures 6-6, 6-7 and 6-8.

5.3.3 WLAN Transceiver

Perform visual inspection of hardware and wires every 10,000 miles. See Figure 6-9.

5.3.4 MIMO Antenna

There is no maintenance needed on the MIMO Antenna

5.3.5 Enhanced Ethernet Interface (EEI) Panel

Visually inspect for loose components and secure panel mounting hardware every 60,000 miles. See Figure 6-11.

5.3.6 Real Time Clock (RTC) Battery

Replace the battery for the Real Time Clock (RTC) every 840,000 miles. See Figures 4-1 and 6-5.

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CHAPTER 6.0

COMPONENT REMOVAL AND INSTALLATION

6.1 Introduction

This chapter provides general guidelines on component removal and installation of the Data Communications (TCN) equipment.

6.2 Safety Precautions

The following statements of warning and caution apply to the handling of the Data Communications (TCN) and appear as appropriate throughout this manual.

WARNING

BEFORE INSPECTING ANY ELECTRICAL EQUIPMENT IN AN ELECTRICAL SYSTEM, MAKE SURE THAT THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO RESERVE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

WARNING

TO PREVENT RECEIVING ELECTRICAL SHOCK WHEN PERFORMING ELECTRICAL TEST, HANDS MUST BE CLEAR OF ELECTRICAL COMPONENTS, CONTACTS AND HOUSING AND THERE MUST BE NO BODILY CONTACT WITH THE WORK BENCH. FAILURE TO HEED THIS WARNING COULD RESULT IN SEVERE INJURY OR DEATH.

CAUTION

WEAR SAFETY SHOES AND HARD HATS WHEN WORKING WHERE OBJECTS MIGHT FALL.

WARNING

USE PROPER LIFTING EQUIPMENT TO REMOVE AND INSTALL COMPONENTS THAT WEIGH 50 LBS. (23 KG) OR MORE. ENSURE THAT THE COMPONENT IS SECURELY FASTENED TO THE LIFTING DEVICE. FAILURE TO HEED THESE WARNINGS COULD RESULT IN SEVERE INJURY OR DEATH TO PERSONNEL AND DAMAGE TO EQUIPMENT.

WARNING

ALL AIR SUPPLY AND/OR ELECTRIC CURRENT TO THESE DEVICES AND/OR ANY COMPONENT PARTS MUST BE CUT-OFF BEFORE THESE DEVICES AND/OR COMPONENT PART ARE REMOVED FROM THE EQUIPMENT ARRANGEMENT.

WARNING

MUCH OF THE EQUIPMENT ON THESE CARS OPERATES AT VOLTAGE AND CURRENT LEVELS THAT ARE HAZARDOUS AND LIFE THREATENING. PROPER PRECAUTIONS SHOULD BE TAKEN AND METRO SAFETY RULES, PRACTICES AND PROCEDURES CLOSELY OBSERVED.

WARNING

INSULATED GLOVES MUST BE WORN AND EXTREME CARE TAKEN TO PREVENT BURNS WHEN HANDLING HEATED PARTS.

WARNING

WHEN REMOVING A COMPONENT OR WIRING FROM THE VEHICLE OR A SUBASSEMBLY, ALWAYS REINSTALL HARDWARE FINGER-TIGHT IN THE SAME LOCATION FROM WHICH IT WAS REMOVED. THIS PRACTICE PREVENTS LOOSE HARDWARE FROM BECOMING LOST, DROPPING INTO THE ASSEMBLY, INTERFERING WITH OPERATIONS, AND/OR CAUSING ELECTRICAL SHORTS.

WARNING

WHEN USING A PTU COMPUTER TO UPDATE SOFTWARE, ALWAYS USE THE DESIGNED PTU PORTS ON THE VEHICLE.

WARNING

TAG ALL WIRES AS THEY ARE REMOVED SO THEY CAN BE RECONNECTED CORRECTLY.

WARNING

INSPECT ALL CONNECTORS AND TERMINALS FOR FATIGUE AND BROKEN WIRING STRANDS.

NOTE: All Ethernet connectors on the P3010 vehicles are M12 connectors and they must be tightened to the appropriate torque value.

6.3 Removal and Installation Standard Shop Practices

The following paragraphs provide mounting hardware and torqueing practices applicable to all installation and removal work of the Data Communications (TCN).

6.3.1 Mounting Hardware

All fastening bolts on the LACMTA P3010 LRV are Grade 5, or higher. When removing any component from the vehicle, replacement fasteners MUST BE Grade 5 or better. See Figures 6-1 and 6-2.

6.3.2 Torquing Practices and Procedures

All safety related fasteners, including truck and brake equipment bolts and all fasteners exposed to fatigue loads must be torqued to a minimum preload equal to 75% of their proof load and torqued striped after torquing by paint or equally approved means. All other fasteners must be torqued so that they do not loosen in service.

6.3.3 Torquing Methods

1. Select the correct wrench and avoid using wrenches that are oversized or undersized for the torque required.

2. Pull the wrench - Pulling is no more accurate than pushing, however, when a part fails unexpectedly, finger and knuckle injuries are prevented.

3. Add the run-down resistance - Tight threads and locknuts produce added resistance to the desired torque. Read the scale on the last rotation or as close to the make-up point as possible, then add the ft-lbs. (or in-lbs.) of resistance to the desired torque to obtain the value required.

4. Don’t stop at set or seizure - When a fastener pops it has seized. Accurate torque settings are not possible before the point of last rotation. To break a set, back off and again apply torque. Lightly lubricate the thread and seat when conditions allow.

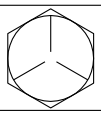
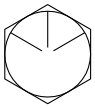
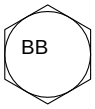
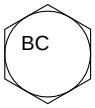
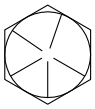
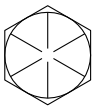
Grade Marking	Specification	Material
 NO MARK	SAE-Grade 1	Low or Medium Carbon Steel
	ASTM-A 307	Low Carbon Steel
	SAE-Grade 2	Low or Medium Carbon Steel
	SAE-Grade 5	Medium Carbon Steel, Quenched and Tempered
	ASTM-A 449	
	SAE-Grade 5.2	Low Carbon Martensite Steel, Quenched and Tempered
	ASTM-A 325 Type 1	Medium Carbon Steel, Quenched and Tempered
	ASTM-A 325 Type 2	Low Carbon Martensite Steel, Quenched and Tempered
	ASTM-A 325 Type 3	Atmospheric Corrosion (Weathering) Steel Quenched and Tempered
	ASTM-A 354 Grade BB	Low Alloy Steel, Quenched and Tempered
	ASTM-A 354 Grade BC	Low Alloy Steel, Quenched and Tempered
	SAE-Grade 7	Medium Carbon Alloy Steel, Quenched and Tempered Roll Threaded After Heat Treatment
	SAE-Grade 8	Medium Carbon Alloy Steel, Quenched and Tempered
	ASTM-A 354 Grade BD	Alloy Steel, Quenched and Tempered
	ASTM-A 490	Alloy Steel, Quenched and Tempered

Figure 6-1: Standard Grade Marking Chart

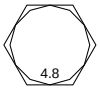
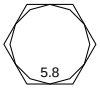
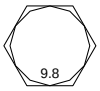
Property Class Marking	Property Class Designation	Material
	4.6	Low or Medium Carbon Steel
	4.8	Low or Medium Carbon Steel, Fully or Parially Annealed
	5.8	Low or Medium Carbon Steel, Cold Worked
	8.8	Medium Carbon Steel, Quenched and Tempered
	A325M Type 1	
	8.8	Low Carbon Boron Steel, Quenched and Tempered
	A325M Type 2	
	A325M Type 3	Atmospheric Corrosion Resistant Steel, Quenched and Tempered
	9.8	Medium Carbon Steel, Quenched and Tempered
	9.8	Low Carbon Boron Steel, Quenched and Tempered
	10.9	Medium Carbon Alloy Steel, Quenched and Tempered
	A490M Type 1	

Figure 6-2: Metric Grade Marking Chart
(Sheet 1 of 2)

Property Class Marking	Property Class Designation	Material
	10.9	Low Carbon Boron Steel, Quenched and Tempered
	A490M Type 2	
	A490M Type 3	Atmospheric Corrosion Resistant Steel, Quenched and Tempered
	12.9	Alloy Steel Quenched and Tempered

Figure 6-2: Metric Grade Marking Chart
(Sheet 2 of 2)

6.3.4 General Guide for Maximum Torque Values

When manufacturer's specifications are not available, Tables 6-1 and 6-2 may be used as a guide to the maximum allowed torque for a given fastener and thread (standard or metric).

Table 6-1. Standard Fastener Torques for LACMTA P3010 LRV

Diameter / Pitch	Force / Torque	Stainless Steel Group 1, 2, 3 Condition CW		Steel Fastener			
				Grade 5		Grade 8	
		A	B	A	B	A	B
1/4 - 20	ft-lbs. Nm kg cm	6 8 80	5 6 60	8 11 110	6 8 80	12 16 165	9 12 120
5/16 - 18	ft-lbs. Nm kg cm	13 18 180	10 14 140	17 23 230	13 18 180	25 34 350	18 24 250
3/8 - 16	ft-lbs. Nm kg cm	24 33 330	18 24 250	31 42 430	23 31 320	44 60 610	33 45 460
7/16 - 14	ft-lbs. Nm kg cm	38 52 530	28 38 390	49 67 680	37 50 510	70 95 970	53 72 730
1/2 - 13	ft-lbs. Nm kg cm	58 78 800	43 58 590	76 103 1050	57 77 790	105 142 1450	80 108 1100
5/8 - 11	ft-lbs. Nm kg cm	115 155 1590	85 115 1190	150 205 2070	125 170 1730	210 285 2900	160 215 2200
3/4 - 10	ft-lbs. Nm kg cm	140 190 1940	105 145 1500	265 360 3660	200 270 2770	370 500 5120	280 380 3870
7/8 - 9	ft-lbs. Nm kg cm	225 305 3110	170 230 2350	430 585 5940	320 435 4430	600 815 8300	450 610 6220
1 - 8	ft-lbs. Nm kg cm	340 460 4700	255 345 3530	640 870 8850	480 650 6640	910 1230 12500	580 925 9400

NOTE A: DO NOT USE LUBRICANT FOR FASTENERS – DRY

NOTE B: TO BE OILED OR WAXED ON THREADS OF FASTENERS - LUBRICATED

Table 6-2. Standard Metric Torques for LACMTA P3010 LRV

	Grade 4.6 (4T)		Grade 4.8		Grade 5.6 (5T)	
Nominal diameter	Dry	Oil	Dry	Oil	Dry	Oil
	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)
M5	2.5	2.1	3.3	2.8	3	2.5
	(25)	(21)	(34)	(29)	(31)	(26)
M6	3.9	3.5	5.6	4.8	5.1	4.3
	(40)	(35)	(57)	(49)	(52)	(44)
M8	9.8	8.5	14	12	12	10
	(100)	(85)	(140)	(120)	(130)	(110)
M10	22	17	27	23	25	21
	(220)	(170)	(270)	(230)	(250)	(210)
M12	37	30	47	40	43	36
	(380)	(300)	(480)	(410)	(440)	(370)
M14	60	46	75	65	68	58
	(620)	(470)	(760)	(650)	(690)	(590)
M16	95	72	120	100	110	90
	(1000)	(730)	(1200)	(1000)	(1100)	(920)
M18	120	100	160	135	150	130
	(1300)	(1000)	(1650)	(1400)	(1500)	(1300)
M20	170	140	230	195	210	180
	(1800)	(1400)	(2300)	(2000)	(2100)	(1800)
M22	240	190	310	265	280	240
	(2500)	(1950)	(3160)	(2700)	(2900)	(2400)
M24	300	245	400	335	360	300
	(3100)	(2500)	(4000)	(3400)	(3600)	(3100)
M27	460	355	580	490	520	440
	(4700)	(3600)	(5900)	(5000)	(5300)	(4500)
M30	630	485	780	660	710	600
	(6500)	(4900)	(8000)	(6800)	(7200)	(6100)

Table 6-2. Standard Metric Torques for LACMTA P3010 LRV (continued)

	Grade 5.8		Grade 6.8 (6T)		Grade 8.8 (7T)	
Nominal diameter	Dry	Oil	Dry	Oil	Dry	Oil
	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)
M5	4.1	3.4	4.7	4	6.2	5.2
	(41)	(35)	(48)	(41)	(63)	(53)
M6	6.9	5.8	8	6.8	10	8.9
	(70)	(59)	(81)	(69)	(110)	(91)
M8	17	14	19	16	25	22
	(170)	(140)	(200)	(170)	(260)	(220)
M10	33	28	38	32	50	43
	(340)	(290)	(390)	(330)	(510)	(440)
M12	58	49	67	57	91	77
	(590)	(500)	(680)	(580)	(930)	(790)
M14	92	78	110	90	150	120
	(940)	(790)	(1100)	(920)	(1500)	(1300)
M16	140	120	170	140	230	190
	(1500)	(1200)	(1700)	(1400)	(2300)	(2000)
M18	200	170	230	190	310	260
	(2000)	(1700)	(2300)	(2000)	(3200)	(2700)
M20	280	240	320	280	440	370
	(2800)	(2400)	(3300)	(2800)	(4500)	(3800)
M22	380	320	440	370	600	510
	(3900)	(3300)	(4500)	(3800)	(6100)	(5200)
M24	480	410	560	470	760	650
	(4900)	(4200)	(5700)	(4900)	(7800)	(6600)
M27	710	600	820	690	1100	950
	(7200)	(6100)	(8400)	(7100)	(11000)	(9700)
M30	960	820	1100	940	1500	1300
	(9800)	(8300)	(11000)	(9600)	(15000)	(13000)

Table 6-2. Standard Metric Torques for LACMTA P3010 LRV (continued)

	Grade 9.8		Grade 10.9		Grade 12.9	
Nominal diameter	Dry	Oil	Dry	Oil	Dry	Oil
	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)	N*m(kgf cm)
M5	6.9	5.9	8.8	7.5	10	8.8
	(71)	(60)	(90)	(77)	(110)	(89)
M6	12	10	15	13	18	15
	(120)	(100)	(150)	(130)	(180)	(150)
M8	28	24	36	31	43	36
	(290)	(250)	(370)	(320)	(430)	(370)
M10	57	48	72	61	84	72
	(580)	(490)	(740)	(630)	(860)	(730)
M12	100	84	130	110	150	130
	(1000)	(850)	(1300)	(1100)	(1500)	(1300)
M14	160	130	200	170	230	200
	(16000)	(1400)	(2000)	(1700)	(2400)	(2000)
M16	240	210	310	270	360	310
	(2500)	(2100)	(3200)	(2700)	(3700)	(3200)
M18			430	370	500	430
			(4400)	(3700)	(5100)	(4300)
M20			610	520	710	610
			(6200)	(5300)	(7300)	(6200)
M22			830	710	970	820
			(8400)	(7200)	(9900)	(8400)
M24			1100	900	1200	1000
			(11000)	(9100)	(13000)	(11000)
M27			1500	1300	1800	1500
			(16000)	(13000)	(18000)	(16000)
M30			2100	1800	2400	2100
			(21000)	(18000)	(25000)	(21000)

6.4 Removal

6.4.1 TCN Rack

1. Open the right side electric locker door located in the A-Unit/B-Unit Cab.

WARNING

BEFORE INSPECTING ANY ELECTRICAL EQUIPMENT IN AN ELECTRICAL SYSTEM, MAKE SURE THAT THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO RESERVE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

2. Disconnect the electrical connectors (5) to the TCN Rack (1). See Figure 6-3.
3. Remove the four M16 x 16 screws (2), M16 lock washers (3), and M16 plain washers (4).
4. Carefully remove the TCN Rack (1).

6.4.2 Power Supply

WARNING

MAKE SURE TO WEAR A GROUNDED WRIST STRAP AND ELECTROSTATIC FREE GLOVES.

1. Unscrew the four screws (7) from PWR module (6). See Figure 6-4.
2. Gently pull the PWR module (6) straight out from the TCN Rack (1) unit to release the PCB from the backplane.
3. Place the PWR module (6) in an electrostatic-free bag.

6.4.3 CPU Module

WARNING

MAKE SURE TO WEAR A GROUNDED WRIST STRAP AND ELECTROSTATIC FREE GLOVES.

1. Unscrew four screws (9) from CPU module (8). See Figures 6-4 and 6-5.
2. Gently pull the CPU module (8) straight out from the TCN Rack (1) to release the PCB from the backplane.
3. Place the CPU module (8) in an electrostatic-free bag.

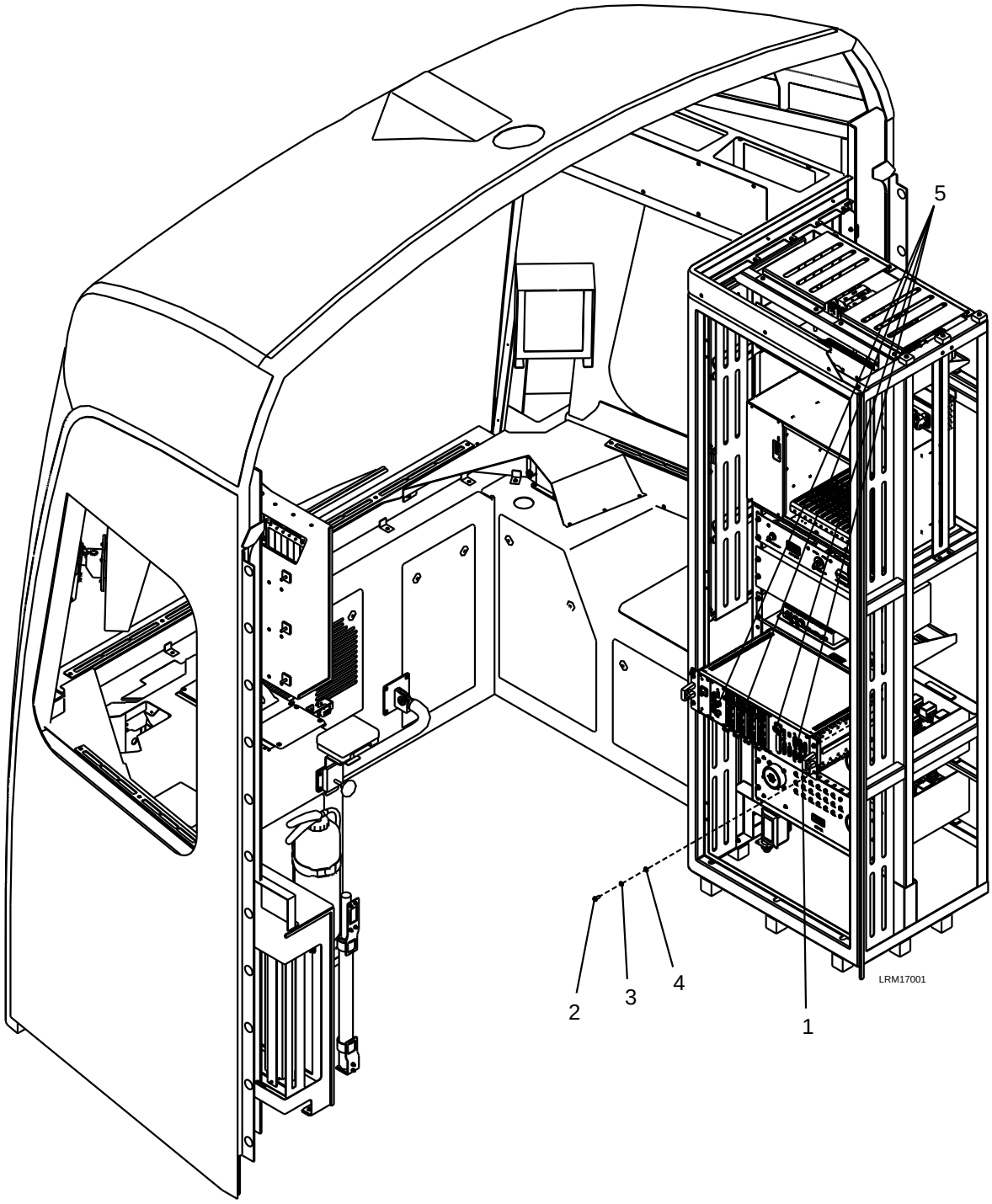


Figure 6-3: TCN Rack
(B-Unit Cab Shown – a Second Rack is Located in A-Unit Cab)

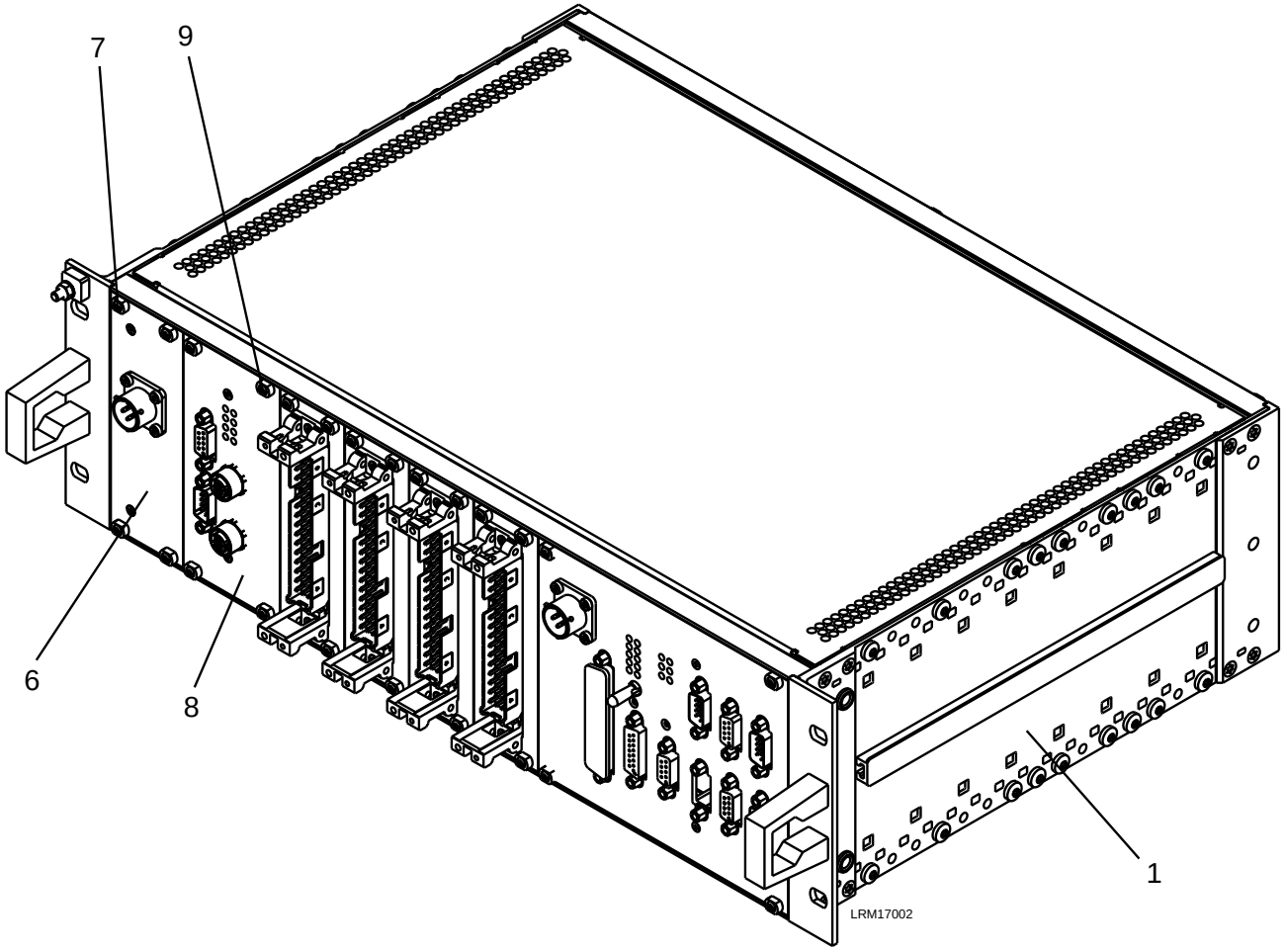


Figure 6-4: Power Supply and CPU Module

6.4.4 Real Time Clock (RTC) Battery

WARNING

MAKE SURE TO WEAR A GROUNDED WRIST STRAP AND ELECTROSTATIC FREE GLOVES.

1. Remove the CPU module (8) using the steps from Section 6.4.3.
2. Gently lift the hold clip and remove the battery (10). See Figure 6-5.

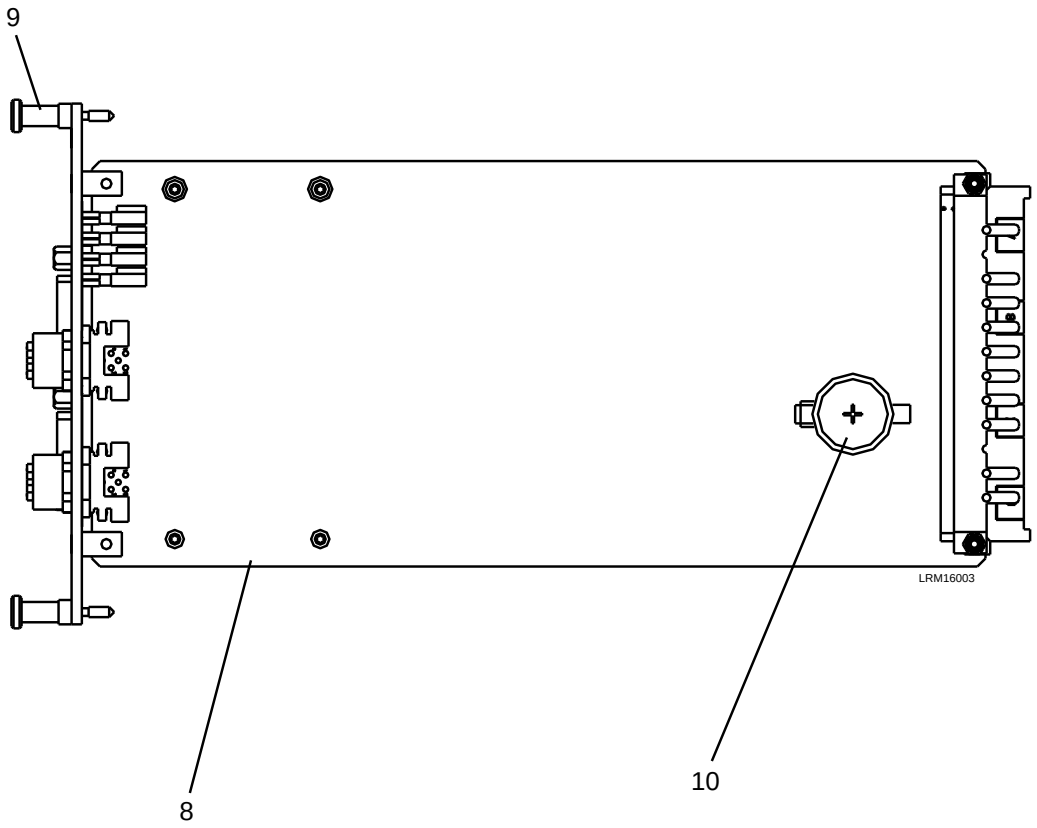


Figure 6-5: Real Time Clock (RTC)

6.4.5 Moxa Ethernet Switch

WARNING

BEFORE INSPECTING ANY ELECTRICAL EQUIPMENT IN AN ELECTRICAL SYSTEM, MAKE SURE THAT THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO RESERVE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

1. Unlock the two locks (5) and lower the cab ceiling panel (6) to access the Moxa Ethernet Switch (1) and disconnect the electrical connections using a Torque Screwdriver for the M12 connections (see Figure 6-6). There are two Moxa Switches on the P3010 – one in the A-Unit ceiling, as shown in Figure 6-6, and one at the same location in the B-Unit ceiling.

2. Remove the four M4 x 20 screws (2), M4 lock washers (3), and M4 plain washers (4).

3. Carefully remove the Moxa Ethernet Switch (1).

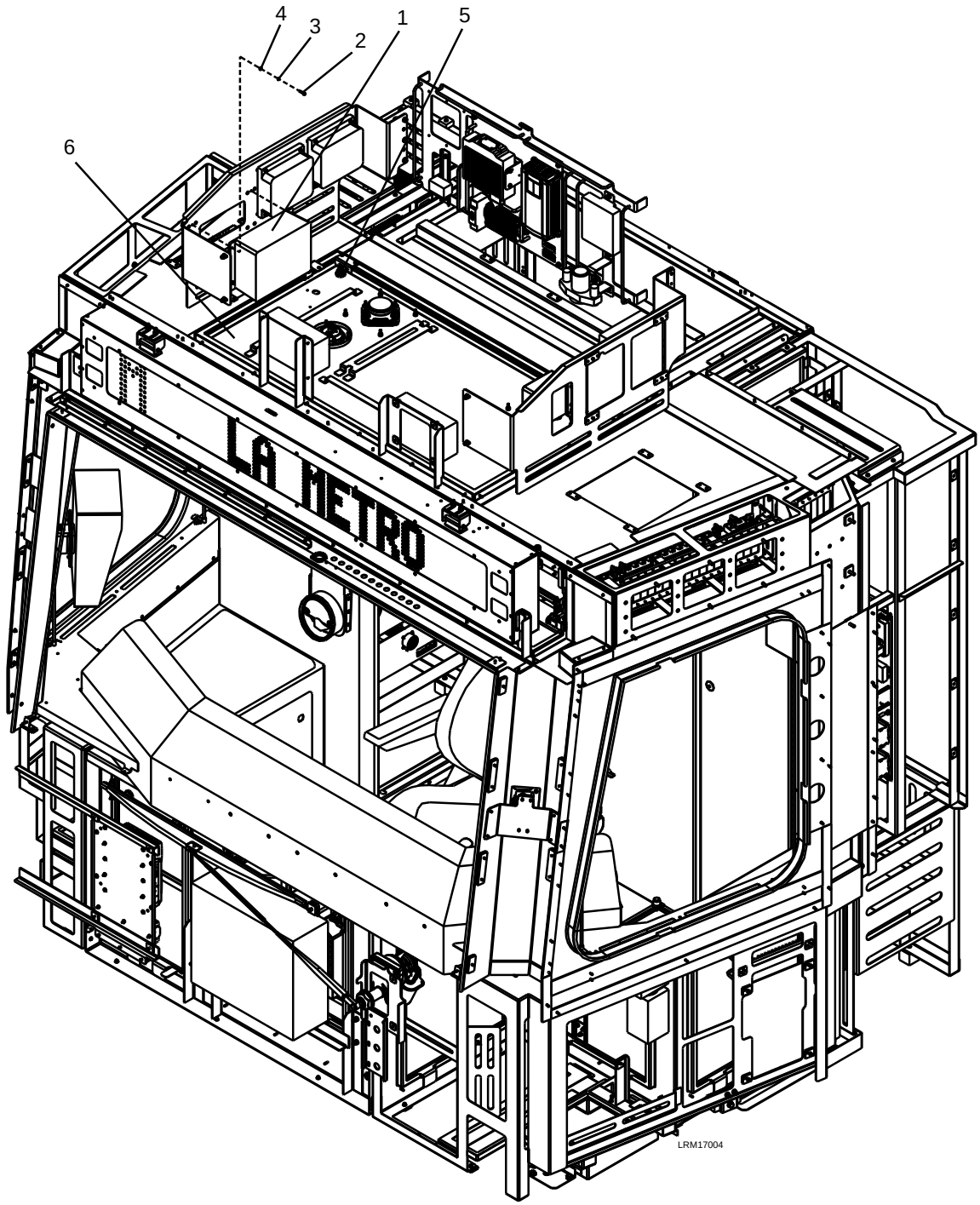


Figure 6-6: Moxa Ethernet Switch (A-Unit)

6.4.6 716M12 / Viper 212 Ethernet Switch

WARNING

BEFORE INSPECTING ANY ELECTRICAL EQUIPMENT IN AN ELECTRICAL SYSTEM, MAKE SURE THAT THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO RESERVE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

1. Unlock the two locks (5) and lower the cab ceiling panel (6) to access the Ethernet Switch (1) and disconnect the electrical connections using a Torque Screwdriver for the M12 connections. See Figure 6-7.

NOTE: There are three 716M12 switches on the P3010 – one in the B-Cab ceiling and two in the A-Cab ceiling. There is one Viper switch located in the B-Cab ceiling.

2. Remove the four M4 x 30 screws (2), M4 lock washers (3), and M4 plain washers (4).

3. Carefully remove the Ethernet Switch (1).

6.4.7 Managed Ethernet (708M12) Switch

WARNING

BEFORE INSPECTING ANY ELECTRICAL EQUIPMENT IN AN ELECTRICAL SYSTEM, MAKE SURE THAT THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO RESERVE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

1. Using a crew key, unlock and open the electric locker door to access the desired 708M12 Switch.

2. Disconnect the electrical connections using a Torque Screwdriver for the M12 connections from the Managed Ethernet Switch (1). See Figure 6-8.

3. Remove the M5 x 16 screws (2), M5 lock washers (3) and M5 plain washers (4).

4. Remove the Managed Ethernet Switch (1).

5. Close and lock the electric locker door using a crew key.

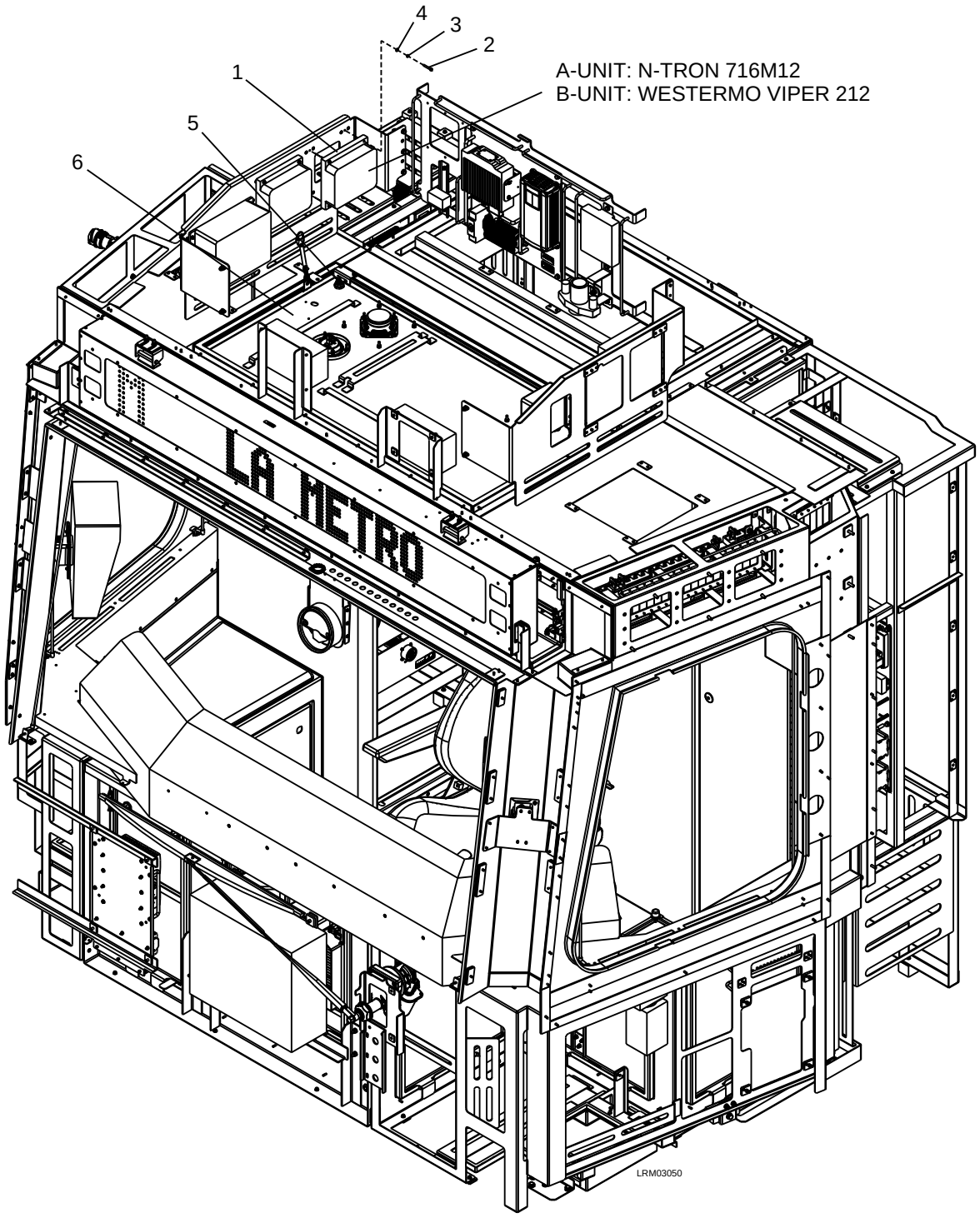


Figure 6-7: 716M12/Viper 212 Ethernet Switch

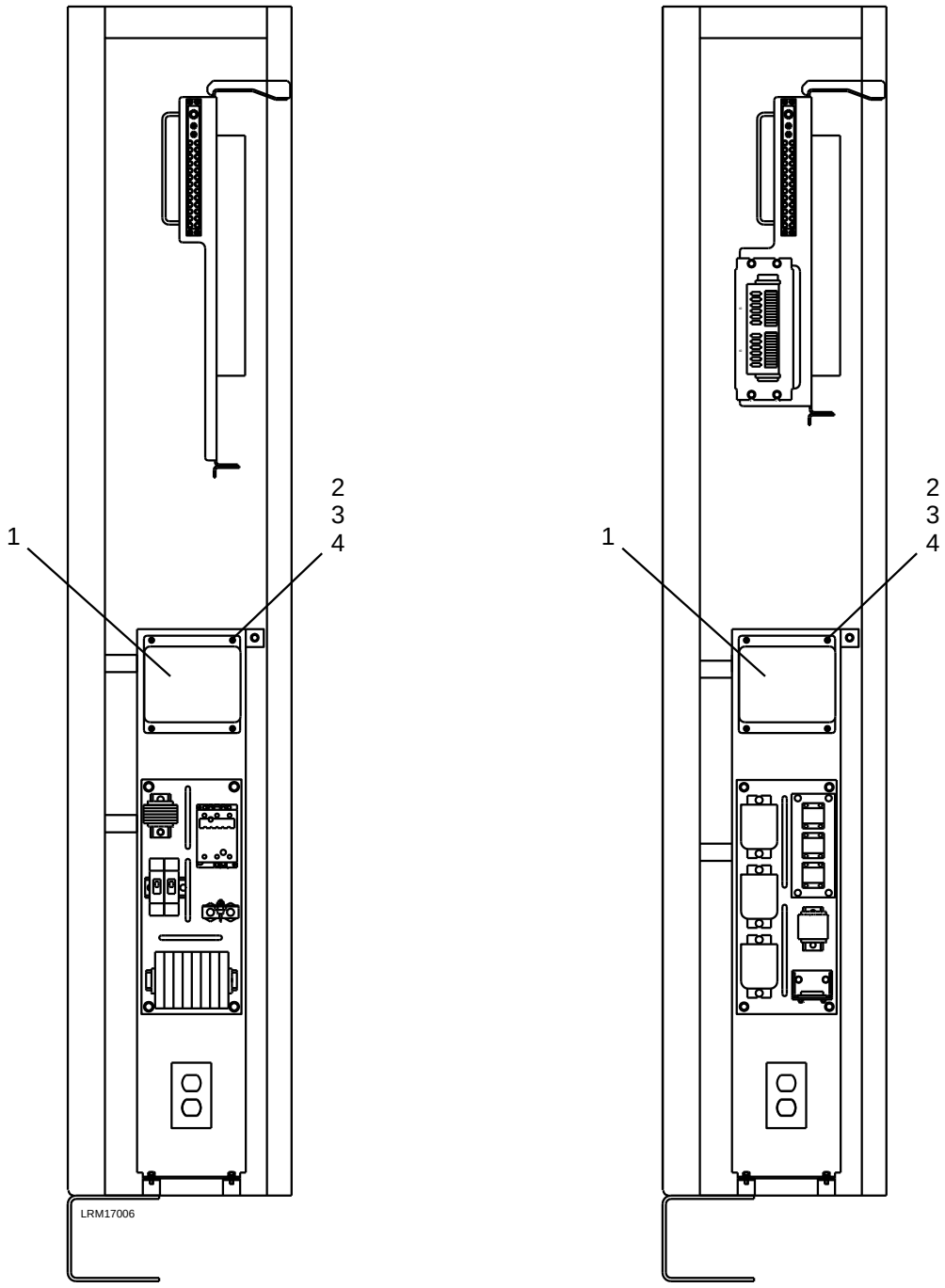


Figure 6-8: Managed Ethernet (708M12) Switch

6.4.8 Wireless Radio Transceiver (WLAN)

WARNING

BEFORE INSPECTING ANY ELECTRICAL EQUIPMENT IN AN ELECTRICAL SYSTEM, MAKE SURE THAT THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO RESERVE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

1. Unlock the two locks (5) and lower the cab ceiling panel (6) located in the B-Unit to access the WLAN Transceiver (1) hardware and disconnect the electrical connections using a Torque Screwdriver for the M12 connections. See Figure 6-9.

2. Remove the six M4 x 12 screws (2), M4 lock washers (3), and M4 plain washers (4).

3. Carefully remove the WLAN Transceiver (1).

6.4.9 Multiple Input Multiple Output (MIMO) Antenna

WARNING

BEFORE INSPECTING ANY ELECTRICAL EQUIPMENT IN AN ELECTRICAL SYSTEM, MAKE SURE THAT THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO RESERVE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

1. Remove the six M4 x 12 screws (4), M4 lock washers (5), and M4 plain washers (6). See Figure 6-10.

2. Remove the cover (3).

3. Remove the electrical connections to the MIMO Antenna (1).

4. Remove the split nut (2).

5. Carefully remove the MIMO Antenna (1).

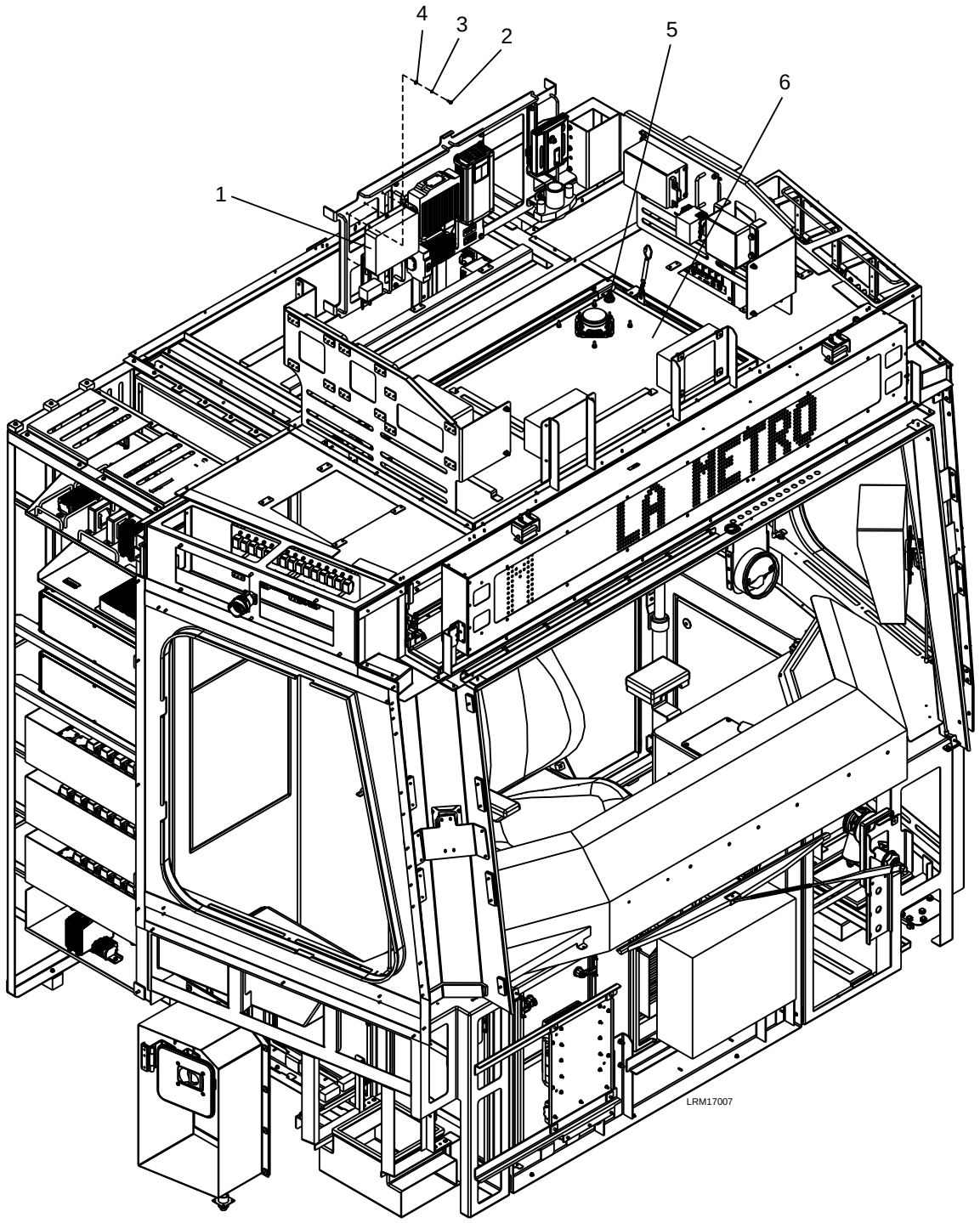


Figure 6-9: WLAN Radio Transceiver (B-Unit Cab)

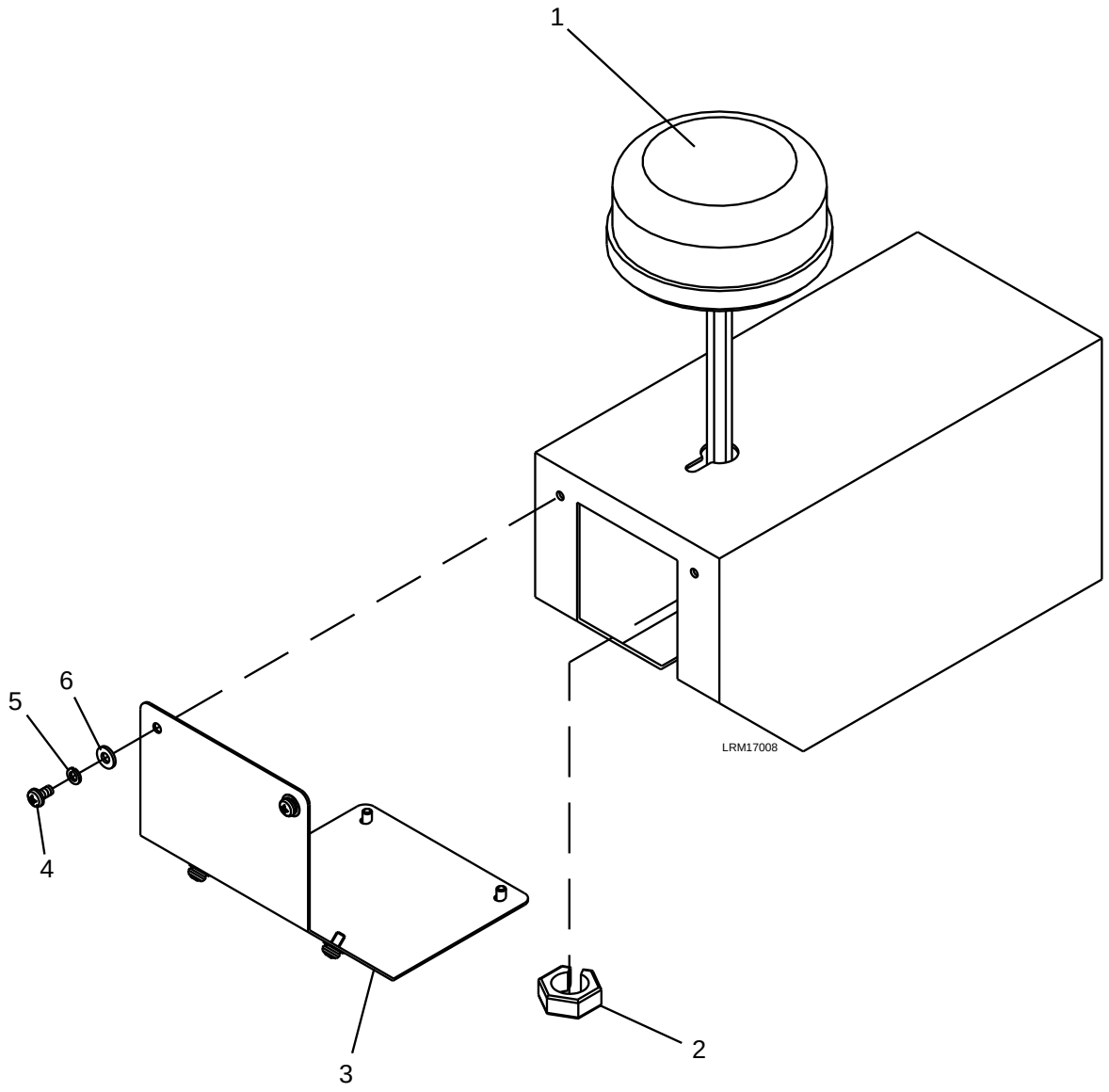


Figure 6-10: Multiple Input Multiple Output (MIMO) Antenna (B-Unit Roof)
(Sheet 1 of 2)

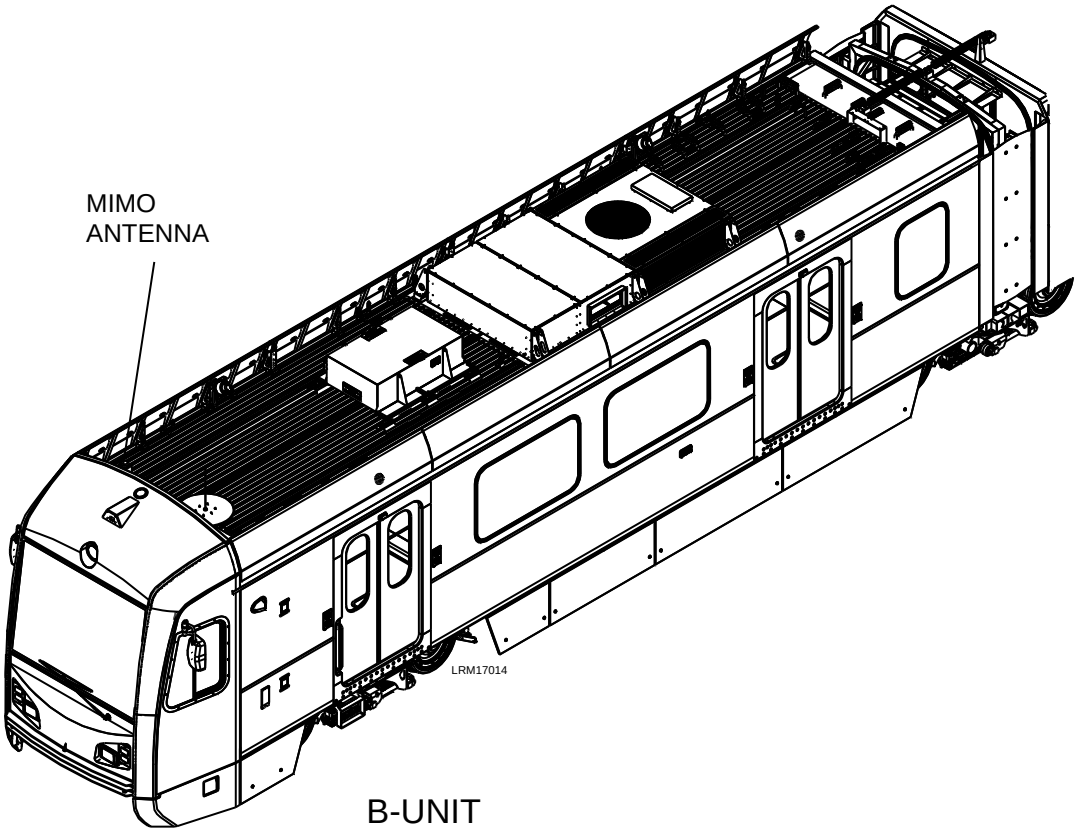


Figure 6-10: Multiple Input Multiple Output (MIMO) Antenna (B-Unit Roof)
(Sheet 2 of 2)

6.4.10 Enhanced Ethernet Interface (EEI) Panel

1. Open the right side electric locker door located in the A-Unit.

WARNING

BEFORE INSPECTING ANY ELECTRICAL EQUIPMENT IN AN ELECTRICAL SYSTEM, MAKE SURE THAT THE CIRCUIT BREAKER IS SWITCHED TO THE OFF POSITION AND THERE IS NO VOLTAGE PRESENT WHERE WORK IS PERFORMED. SPECIAL ATTENTION SHOULD BE PAID TO RESERVE FEED APPLICATIONS TO ENSURE NO VOLTAGE IS PRESENT. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

2. Disconnect the electrical connectors (5) to the Enhanced Ethernet Interface Panel (1). See Figure 6-11.

3. Remove the four M16 x 16 screws (2), M16 lock washers (3), and M16 plain washers (4).

4. Carefully remove the Enhanced Ethernet Interface Panel (1).

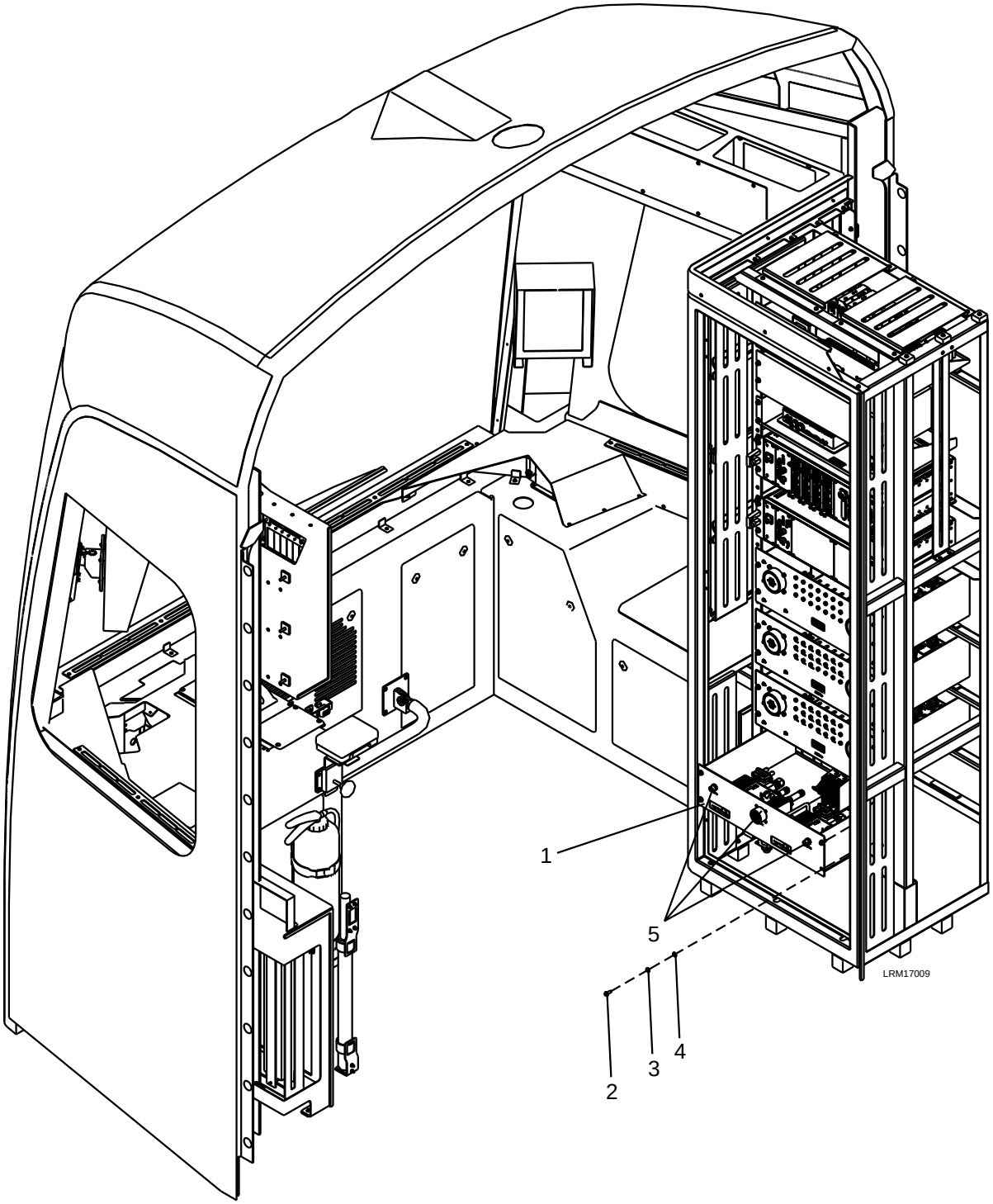


Figure 6-11: Enhanced Ethernet Interface (EEI) Panel (A-Unit)

6.5 Installation

NOTE: With the exception of power supplies and MIMO antennas, all other newly installed equipment needs configured to function correctly on the P3010 vehicle. Refer to chapter 8 for details on configuring equipment.

6.5.1 TCN Rack

1. Open the right side electric locker door located in the A-Unit. See Figure 6-3.
2. Carefully install the TCN Rack (1) aligning the mounting holes.
3. Install the four M6 x 16 screws (2), M6 lock washers (3), and M6 plain washers (4).
4. Tighten the hardware.
5. Connect the following electrical connectors to the TCN Rack (1):

a. J1, MVB-M1, MVB-M2, ETH-1, ETH-2 using a Torque Screwdriver.

b. Torque the M12 connectors to 0.4 Nm, AUX, DO-PWM, DI1-1, DI1-2, PWR, MVB M1, WTB A2, WTB A1, WTB B1, and WTB B2. See Figures 2-15 and 2-16.

6. Close the right side electric locker door located in the A-Unit.

6.5.2 Power Supply

WARNING

MAKE SURE TO WEAR A GROUNDED WRIST STRAP AND ELECTROSTATIC FREE GLOVES.

1. Remove the PWR module (6) from the electrostatic-free bag.
2. Gently push the PWR module (6) straight into the TCN Rack (1) unit to seat the PCB into the backplane.
3. Screw the four screws (7) to secure the PWR module (6). See Figure 6-4.

6.5.3 CPU Module

WARNING

MAKE SURE TO WEAR A GROUNDED WRIST STRAP AND ELECTROSTATIC FREE GLOVES.

1. Remove the CPU module (8) from the electrostatic-free bag.
2. Gently push the CPU module (8) straight into the TCN Rack (1) to seat the PCB into the backplane.
3. Screw four screws (9) to secure the CPU module (8). See Figures 6-4 and 6-5.

6.5.4 Real Time Clock (RTC) Battery

WARNING

MAKE SURE TO WEAR A GROUNDED WRIST STRAP AND ELECTROSTATIC FREE GLOVES.

1. Insert the new battery (10) into the battery holder and confirm retention and orientation. See Figure 6-5.
2. Gently push the CPU module (8) straight into the TCN Rack (1) to seat the PCB into the backplane.
3. Screw four screws (9) to secure the CPU module (8). See Figure 6-4.

6.5.5 Moxa Ethernet Switch

1. Unlock the two locks (5) and lower the cab ceiling panel (6) to access the Moxa Ethernet Switch (1) mounting. See Figure 6-6.
2. Carefully install the Moxa Ethernet Switch (1) on the mounting bracket aligning the mounting holes.
3. Install the four M4 x 20 screws (2), M4 lock washers (3), and M4 plain washers (4).
4. Tighten the hardware.
5. Connect the electrical connections using a Torque Screwdriver. Torque the M12 connectors to 0.4 Nm.
6. Raise the cab ceiling panel (6) and secure.

6.5.6 716M12 / Viper 212 Ethernet Switch

1. Unlock the two locks (5) and lower the cab ceiling panel (6) to access the Ethernet Switch (1) mounting. See Figure 6-7.
2. Carefully install the Ethernet Switch (1) on the mounting bracket aligning the mounting holes.
3. Install the four M4 x 30 screws (2), M4 lock washers (3), and M4 plain washers (4).
4. Tighten the hardware.
5. Connect the electrical connections using a Torque Screwdriver. Torque the M12 connectors to 0.4 Nm.
6. Raise the cab ceiling panel (6) and secure.

6.5.7 Managed Ethernet (708M12) Switch

1. Using a crew key, unlock and open the electric locker door.
2. Align the holes in the Managed Ethernet Switch (1). See Figure 6-8.
3. Insert the four M5 plain washers (4), M5 lock washers (3) and M5 x 16 screws (2) and tighten.
4. Connect the electrical connections to the Managed Ethernet Switch (1) using a Torque Screwdriver. Torque the M12 connectors to 0.4 Nm.
5. Close and lock the electric locker door using a crew key.

6.5.8 WLAN Radio Transceiver

1. Unlock the two locks (5) and lower the cab ceiling panel (6) located in the B-Unit to access the WLAN Radio Transceiver (1) mounting. See Figure 6-9.
2. Carefully install the WLAN Radio Transceiver (1) on the mounting bracket aligning the mounting holes.
3. Install the six M4 x 12 screws (2), M4 lock washers (3), and M4 plain washers (4).
4. Tighten the hardware.
5. Connect the electrical connections using a Torque Screwdriver. Torque the M12 connectors to 0.4 Nm.
6. Raise the cab ceiling panel (6) and secure.

6.5.9 Multiple Input Multiple Output (MIMO) Antenna

1. Carefully install the MIMO Antenna (1) into the mounting hole on the bracket.
2. Install the split nut (2). See Figure 6-10.
3. Install the electrical connections to the MIMO Antenna (1).
4. Install the cover (3) aligning the mounting holes.
5. Install the six M4 plain washers (6), M4 lock washers (5), and M4 x 8 screws (4).
6. Tighten and torque the hardware using the chart in Section 6.3.4.

6.5.10 Enhanced Ethernet Interface (EEI) Panel

1. Open the right side electric locker door located in the A-Unit. See Figure 6-11.
2. Carefully install the Enhanced Ethernet Interface Panel (1) aligning the mounting holes.
3. Install the four M16 x 16 screws (2), M16 lock washers (3) and M16 plain washers (4).
4. Tighten the hardware.
5. Connect the electrical connectors (5) to the Enhanced Ethernet Interface Panel (1).
6. Close the right side electric locker door located in the A-Unit.

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CHAPTER 7.0

TROUBLESHOOTING

7.1 Introduction

This chapter provides troubleshooting procedures for data communications equipment on each network.

Provided below are general P3010 troubleshooting tips which are applicable to Communications and Data Networks equipment along with other subsystems onboard the vehicle.

General Tips

Before fault isolation, perform a thorough visual equipment inspection to determine if a malfunction is being caused by some obvious defect such as a damaged component, defective wiring, etc. Otherwise, fault isolation should follow a logical sequence designed to isolate a malfunction to a single component. Symptoms of a fault are typically identified by a loss of function. The function lost, inoperative or malfunctioning will provide a means to identify a course of troubleshooting. The vehicle schematics will provide information to troubleshoot wiring and connectivity issues. Intermittent connectivity issues are the most difficult to troubleshoot. Ensure that all connectors are properly installed and properly tightened.

Before deciding that a system/subsystem is malfunctioning, check that all related circuit breakers, switches, control devices are set properly for normal operation.

From the TOD, check indicator status. A flashing yellow indicator indicates that there is an Ethernet communications issue with the subsystem that is flashing. The fault could be that the equipment is off line or a connectivity issue. The Vehicle Management button will provide an indication of Ethernet Connectivity. Additionally, a PING test is available from the Network Status button for all Ethernet connected devices.

If the TOD Subsystem indicator is red, this indicates that a fault is being communicated to the Monitoring and Diagnostic System. Check the list of active faults to determine if there is an active fault that impacts the communications equipment or network equipment. Additionally, from the Maintenance Tab, the Fault Log Screen will also provide information on faults that have occurred over time. This screen can provide an indication of intermittent faults that have cleared.

Look for groupings of lost functionality. If an Ethernet Switch is lost, all items connected to that switch would provide an indication to troubleshoot that switch or the signal source to that switch.

Loss of audio functionality indicates that an Acoustic Module maybe malfunctioning or wiring to that module may be the cause. Loss of control functionality i.e. PTT switches, routing switches indicates either a switch function problem or a RIO problem.

7.2 WTB/MVB Troubleshooting

This section provides troubleshooting procedures for the WTB and MVB network. Troubleshooting functions and indications are provided in the subsequent sections. A summarized troubleshooting flowchart incorporating the available tools is provided in Figure 7-1.

NOTE: WTB is a trainline network & MVB is a carline network. If a problem persists after electrically isolating the vehicle, then the issue is on the carline network.

7.2.1 TOD Functions

The TOD is the main source of information when troubleshooting the WTB and MVB network. There are (2) main screens used within the TOD:

- Network Status Screen (Figure 7-3)
- MVB Port Screen (Figure 7-7)

7.2.1.1 Network Status Screen

The MVB Bus Test in the Network Status screen checks for connectivity to all devices on the local vehicle MVB network. When the TOD reports a device has lost MVB communication, running the MVB Bus Test will determine if the device has reconnected to the network or not.

WARNING

THE MVB NETWORK IS CONNECTED IN A DAISY-CHAIN CONFIGURATION, THEREFORE WHEN A CABLE IS DISCONNECTED FROM THE NETWORK AND NOT TERMINATED PROPERLY (E.G. A LOOSE CABLE FALLING OFF A DEVICE), THE MVB BUS TEST MAY DISPLAY MORE THAN ONE DEVICE OFF THE NETWORK FOR ONE CABLE BREAK. IN THIS CASE, THE MVB BUS TEST WILL GIVE THE USER AN INDICATION OF WHERE THE BREAK MAY BE LOCATED.

Follow these steps to access the MVB Bus Test Screen on the TOD:

1. Navigate to the TOD Operating screen homepage.
2. Select the Network Status button located on the Local Indicator Panel (Figure 7-2).
3. Select the MVB Bus Test upper tab within the Network Status Screen (Figure 7-3).
4. Select the refresh button on the MVB Bus Test Screen (Figure 7-4).

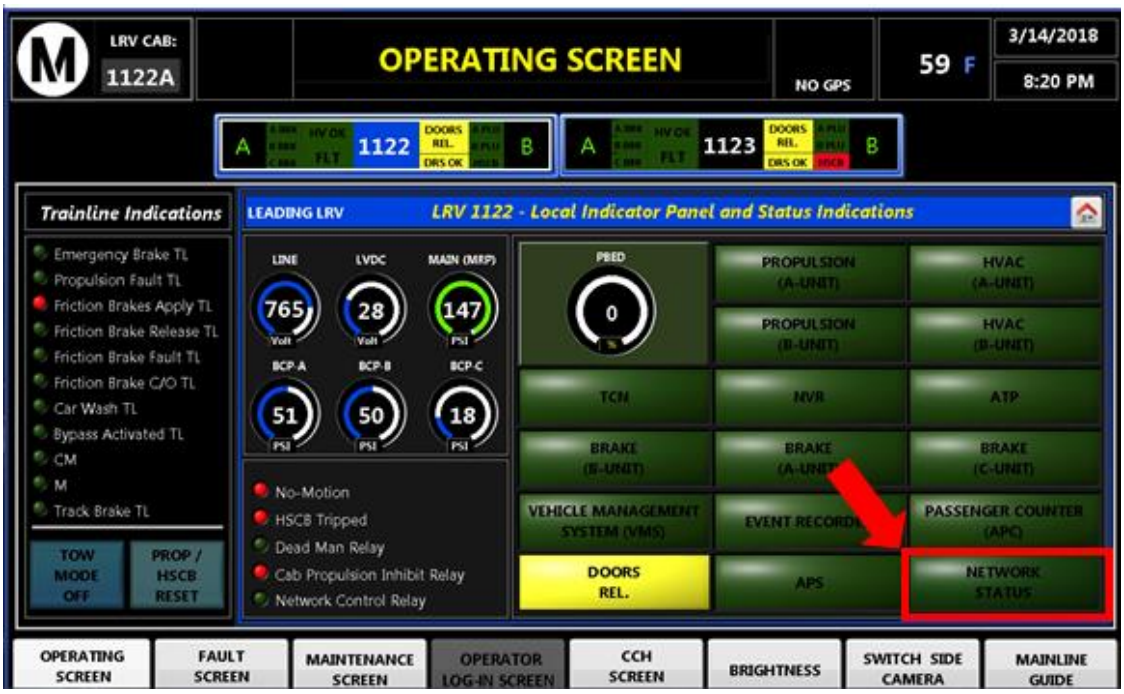


Figure 7-2: TOD Network Status Button on Operating Screen Homepage

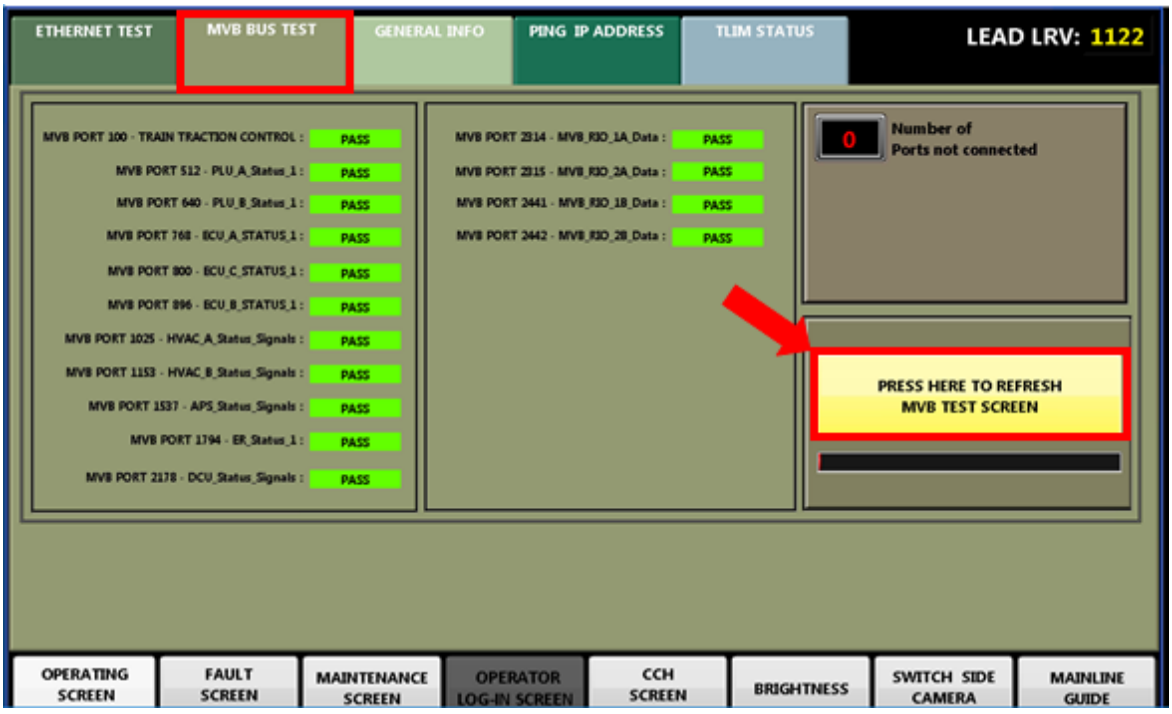


Figure 7-3: TOD MVB Bus Test Screen within Network Status Screen

Figure 7-4: Maintenance Screen Button Located on the TOD

7.2.1.2 MVB Port Screen

The MVB Port screen provides access to subsystem MVB ports which, when clicked upon, displays the MVB data present on the selected port. This screen is primarily used to verify operation of particular subsystems (e.g. APS, HVAC, ect) or signals (e.g. CARWASH_TL, DoorA1A2_State, ect) on the vehicle, as opposed to troubleshooting the WTB/MVB network.

Follow these steps to access the MVB Ports Screen on the TOD:

1. Locate and select the Maintenance Screen button on the TOD menu bar (see Figure 7-4).
2. Enter the code to gain access to the Maintenance Screen at the maintenance level.
3. Locate and select the MVB Ports button on the maintenance screen homepage (see Figure 7-5).
4. Select the desired LRV within the consist to view MVB data (see Figure 7-6).
5. Select the desired MVB subsystem to view port data (see Figure 7-7 for example).
6. View the displayed MVB data (see Figure 7-8 for example).

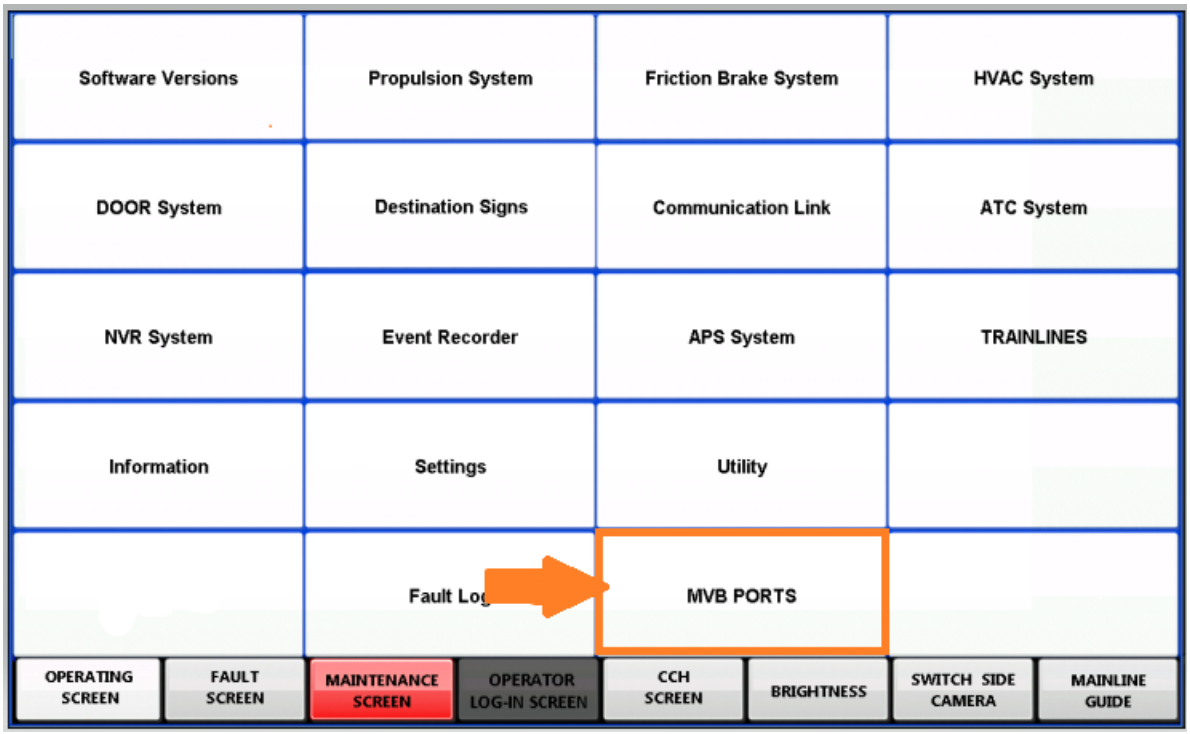


Figure 7-5: MVB Ports Button on the TOD Maintenance Screen Homepage

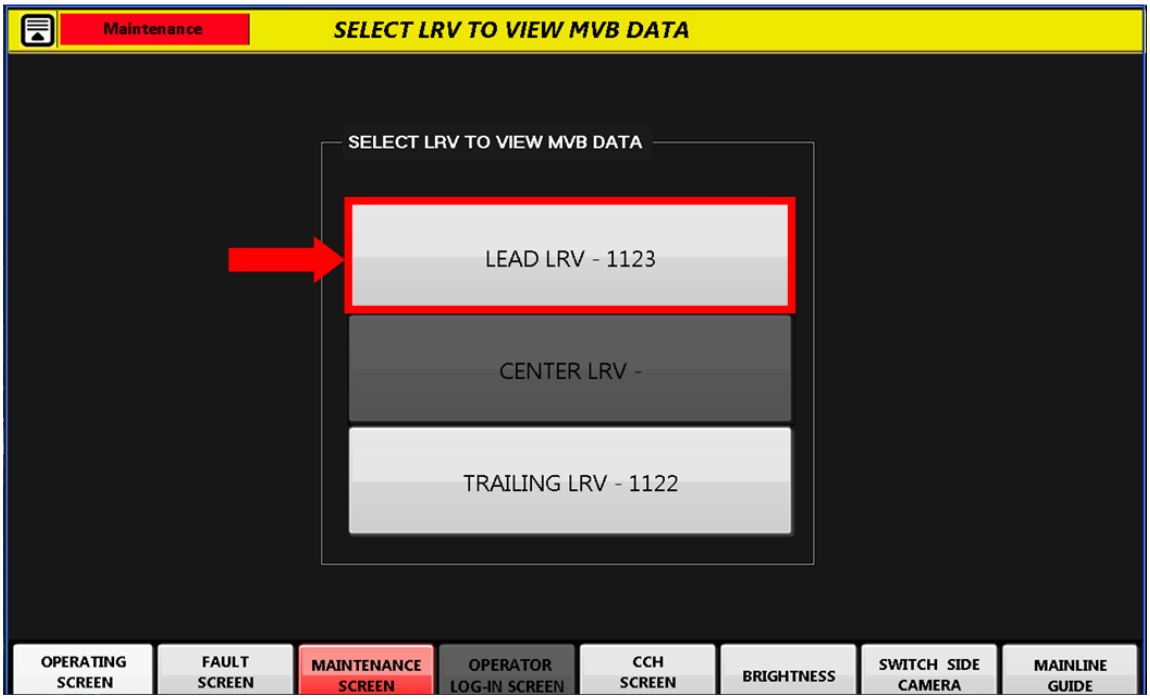


Figure 7-6: LRV Selection Menu Within the MVB Ports Screen

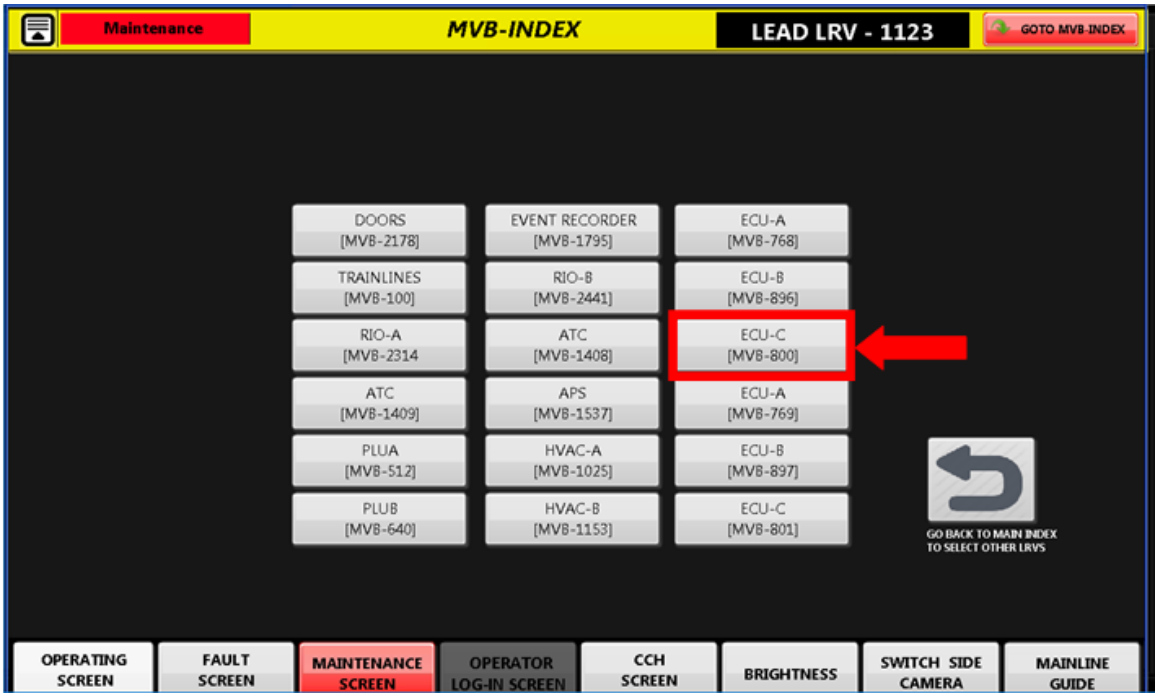


Figure 7-7: Subsystem Buttons Within the MVB Ports Screen (Port 800 used as Example)

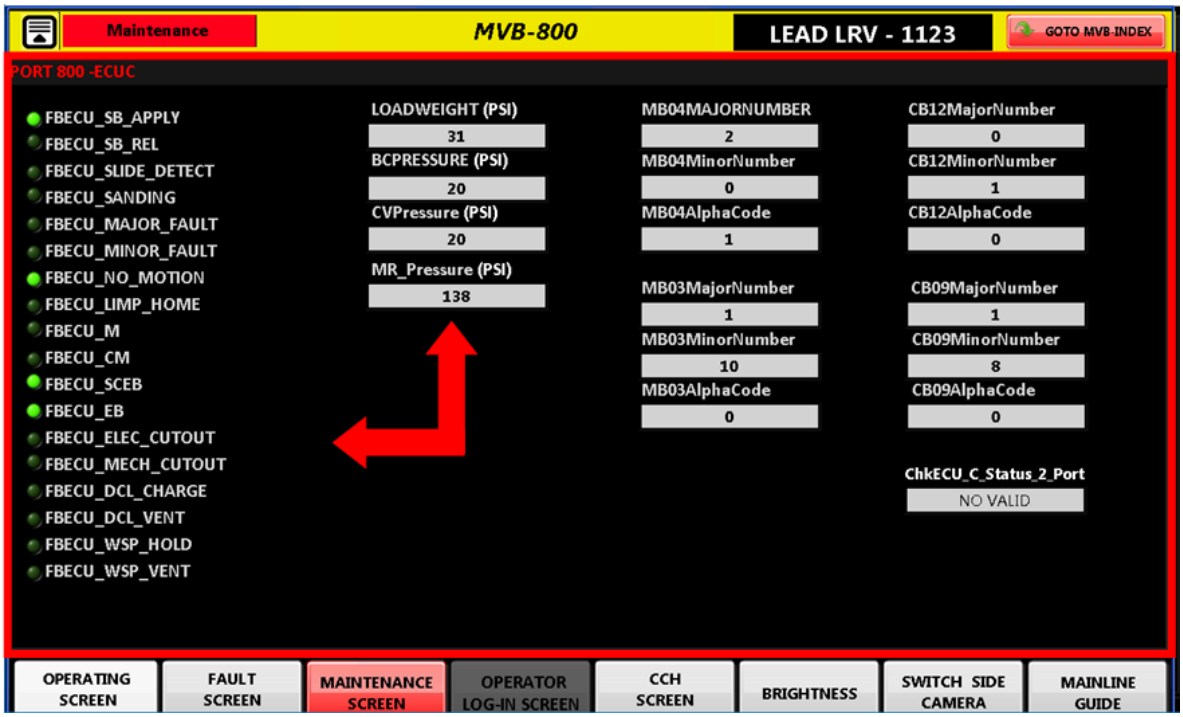


Figure 7-8: Example of Data MVB Data Displayed on the TOD (MVB Port 800)

7.2.2 TCN Equipment Diagnoses

If the source of the WTB/MVB network problem is traced back to one of the TCN racks (e.g. gateway module or input-board), there are (3) additional further troubleshooting steps offered:

- TCN Faults (FAIL Message to MDS)
- TCN Rack Status LEDs
- TCN Self-Tests (accessed using PTU)

7.2.2.1 TCN Faults (FAIL Message to MDS)

Table 7-1 lists the TCN Faults sent to the MDS for display on the TOD. The corrective action is listed to the right of each fault in the tables.

Table 7-1. TCN Fault List

Fault/Status Name	Description of the Fault/Status	Cause of the Fault	Corrective Action
MVB_RIO_AUX_BOARD_DATA_FAULT	AUX Module Data is NOT Available or Invalid	AUX MVB Port Failure – Data Freshness Counter Expired	Check RIO AUX Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace AUX Module
MVB_RIO_AUX_BOARD_SAFE_MODE	AUX Module Reported a SAFE Mode State to the CPU	Internal Hardware Error	Check RIO AUX Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace AUX Module
MVB_RIO_AUX_BOARD_FAULT	AUX Module Reported a Fault State to the CPU	Internal Hardware Error	Check RIO AUX Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace AUX Module
MVB_RIO_PWM_BOARD_DATA_FAULT	PWM Module Data is NOT Available or Invalid	PWM MVB Port Failure – Data Freshness Counter Expired	Check RIO PWM Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace PWM Module
MVB_RIO_PWM_BOARD_SAFE_MODE	PWM Module Reported a SAFE Mode State to the CPU	Internal Hardware Error	Check RIO PWM Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace PWM Module

Table 7-1. TCN Fault List (cont'd.)

Fault/Status Name	Description of the Fault/Status	Cause of the Fault	Corrective Action
MVB_RIO_PWM_BOARD_FAULT	PWM Module Reported a Fault State to the CPU	Internal Hardware Error	Check RIO PWM Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace PWM Module
MVB_RIO_DI1-1_BOARD_DATA_FAULT	DI1-1 Module Data is NOT Available or Invalid	DI1-1 MVB Port Failure – Data Freshness Counter Expired	Check RIO DI1-1 Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace DI1-1 Module
MVB_RIO_DI1-1_BOARD_SAFE_MODE	DI1-1 Module Reported a SAFE Mode State to the CPU	Internal Hardware Error	Check RIO DI1-1 Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace DI1-1 Module
MVB_RIO_DI1-1_BOARD_FAULT	DI1-1 Module Reported a Fault State to the CPU	Internal Hardware Error	Check RIO DI1-1 Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace DI1-1 Module
MVB_RIO_DI1-2_BOARD_DATA_FAULT	DI1-2 Module Data is NOT Available or Invalid	DI1-2 MVB Port Failure – Data Freshness Counter Expired	Check RIO DI1-2 Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace DI1-2 Module
MVB_RIO_DI1-2_BOARD_SAFE_MODE	DI1-2 Module Reported a SAFE Mode State to the CPU	Internal Hardware Error	Check RIO DI1-2 Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace DI1-2 Module
MVB_RIO_DI1-2_BOARD_FAULT	DI1-2 Module Reported a Fault State to the CPU	Internal Hardware Error	Check RIO DI1-2 Module location in the TCN LCU Rack. Remove and Re-insert module in the correct location. Replace DI1-2 Module
WTB_MVB_Gateway_FAULT	WTB Gateway Module MVB Data is Invalid	WTB Gateway Module Internal Error	Replace Gateway in TCN Rack Module

7.2.2.2 Status LEDS

The TCN status LEDs give an indication of operating conditions experienced by the RIO and Gateway modules within the A-Unit and B-Unit TCN racks. Tables 7-2 and 7-3 define the TCN RIO and Gateway LED functions, respectively. Table 7-4 provides the TCN Gateway switch functions.

Table 7-2. TCN RIO Status LEDs

LED	Color	Function	RIOA	RIOB
RUN	Green	Application Run	Flash opposite of S2	Flash opposite of S2
Power	Green	Power Supply	ON	ON
Alarm	Red	Alarm Condition	OFF	OFF
Fault	Red	Fault Condition	OFF	OFF
Status 1	Yellow	Application Depending	ON	OFF
Status 2	Yellow		Flash opposite of RUN	Flash opposite of RUN
Status 3	Yellow		OFF	OFF
Status 4	Yellow	Reserved	OFF	ON

Table 7-3. TCN Gateway Status LEDs

LED	Function	Status * expected	Meaning	Remarks
VCC	Identifies the powering of CPU core of Gateway (GW)	ON*	The CPU core is correctly powered.	
		OFF	GW is not powered	
RUN	Identifies CPU activities	ON*	CPU is working correctly	During normal operation it blinks at high frequency so it seems steady ON with low brightness
		OFF	CPU is frozen	
CPR	Identifies CPU reset status	ON	The GW is in reset state due to a software reset or a hardware low voltage detection	
		OFF*	The GW is in normal operation	

Table 7-3. TCN Gateway Status LEDs (cont'd)

LED	Function	Status * expected	Meaning	Remarks
U0	Identifies fritting signal presence. The fritting is generated according the standard requirement described in IEC61375-2-1. As required in the standard IEC 61375, the fritting is working only in the nodes configured in "END setting"	FLASHING	The fritting is applied. The ON time is about 1 second and corresponds to the presence of 48V fritting voltage.	The fritting is generated according the standard requirement: only applied at END nodes, applied on bus lines A and B, current limited and with rise/ fall time limited in order to avoid interfering with WTB signal
		OFF	No fritting voltage applied	If GW is intermediate node this is the normal operating status
U1	Identifies node topography: END or INTERMEDIATE node. The position of IGW is determined at the end of inauguration phase by inauguration algorithm as described in IEC61375-2-1.	ON	The device is in END NODE or stand-alone	
		OFF	the device is an intermediate node	
U2	Identifies WTB line disturbance. The condition of line disturbed is described in chapter "4.7.2.4.2 Line Disturbance" of IEC61375-2-1	STEADY ON	If steady there is one of the two lines opened	If all the GWs connected in the network have the U2 on steady then somewhere the line (A or B) is open
		OFF*	Both WTB lines work well	
		FLASHING w/irregular frequency	WTB line intermittent disturbance at one line (line A or line B)	If flashing line is connect but disturbance is on going
WM	Identifies the WTB mastership	ON	the gateway is master of WTB network	Normally only a gateway in a network has the WM ON. If two or more gateway in train have this led ON at the same time, it means that the WTB connection is not correctly executed, and the train is divided in two or more segments.
		OFF	the gateway is not the master of WTB network	

Table 7-3. TCN Gateway Status LEDs (cont'd)

LED	Function	Status * expected	Meaning	Remarks
WT	Identifies presence of Traffic on the WTB line	ON	The GW is communicating on WTB network	Normally the LED becomes ON at the end of inauguration.
		OFF	The GW is not communicating on WTB network	LED is OFF when the gateway is in not connected to a WTB network or it is in stand-by mode
WF	Identifies WTB line failures	ALWAYS OFF*	not managed	
GF	Identifies GW internal failures	ON	The GW has detected one of the following conditions: • the battery power voltage out of range (over/under range) • watch dog timeout between ESM and CPU board • failure of ESM internal power supply	During the CPU board boot phase the GF leds is ON, after this phase it switched OFF and it lights ON if failure is detected. In case of watch dog timeout the GW is reboot.
		OFF*	No failure	Normal condition state
BT	Identifies Battery presence	ON*	The external power supply is connected	
		OFF	The external power supply is not connected	
MA	Identifies the ACTIVE MVB node master. The standard requires that two or more bus administrators must be present in an MVB network. The Bus administrator devices exchanged the mastership periodically but only a device can be MVB master at the same time	ON	The GW is the ACTIVE bus administrator	
		OFF	The GW is not the ACTIVE bus administrator	

Table 7-3. TCN Gateway Status LEDs (cont'd)

LED	Function	Status * expected	Meaning	Remarks
MT	Identifies if valid and correct frames are received on MVB line by the GW	ON	the gateway is communicating on MVB network	The gateway counts the number of valid and correct frames received on MVB line.
		OFF	The GW is not communicating on MVB network	LED is OFF when the gateway is in stand-alone. If the GW in connected into an inaugurated network, the led must be ON.
MF	Identifies MVB line failures	OFF*	not managed	
US	Identifies GW status	FLASHING LONG	GW active	
		FLASHING SHORT	GW inactive (ready to switchover)	It is used in redundancy mode (the MODE switch present on the front panel of the GW is AUT)
NS	Identifies GW sleep mode condition.	ON*	normal operation	
		BLINKING	The gateway is in SLEEP mode.	In this state the operating GW moves to low power consumption state. The WTB and MVB bus are down

Table 7-4. TCN Gateway Switch Functions

Switch Name	Function
CPR	Used to issue a manual reset to the CPU
GWR	Used to issue a manual reset to the GW
Mode	There are different types of redundancy, depending on gateway connections and MODE switch status. The MODE switch present on the front panel of the IGW, connected to the ESM board, declares the function mode: AUT (Automatic): the switchover is performed automatically by the VU (Voting Unit) STB (Standby): the unit is forced in stand by ACT (Active): the unit is forced active

7.2.3 MVB Subsystem Communication Faults

The TCN RIOs monitor the polling response from MVB subsystem on the vehicle. If a syubsystem does not respond to a message request for five consecutive poll cycles, a “LOST MVB COMMUNICATION” fault is declared on the TOD and fault log.

- If fault occurs for a single subsystem, this is likely the result of a faulty subsystem
- If fault occurs for multiple subsystems, this is likely the result of wiring

Troubleshooting of MVB communication faults are provided in Table 7-5. A complete list of MVB subsystems which are monitored for

Table 7-5. Lost MVB Communication Fault Troubleshooting

Subsystem	Fault/Status Name	Description of the Fault/Status	Cause of the Fault	Corrective Action
SINGLE	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH (**subsystem**)	TCN RIO did not receive update MVB port information from (**subsystem**)	Verify (**subsystem**) MVB board/control unit is powered and connected to network. Replace MVB board/control unit.
MULTIPLE	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH (**multiple subsystems**)	TCN RIO did not receive update MVB port information from (**multiple subsystems**)	Check MVB wiring and connectors. Verify TCN RIOs and WTB Gateways are connected to network.

Table 7-6. Lost MVB Communication Fault List

Subsystem	Fault/Status Name	Description of the Fault/Status
APS	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH APS
ATCB	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH ATCB
DCU	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH DCU MVB2178
ER	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH ER
ECUA	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH ECUA
ECUB	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH ECUB
ECUC	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH ECUC
HVACA	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH HVACA
HVACB	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH HVACB
PLUA	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH PLUA
PLUB	COMMUNICATION FAILURE	LOST MVB COMMUNICATION WITH PLUB

7.3 ETB/ECN Troubleshooting

This section provides troubleshooting information on the ETB and ECN network.

Reminder: ETB is a trainline network & ECN is a carline network. If a problem persists after electrically isolating the vehicle, then the issue is on the carline network.

Based on the ETB/ECN architecture and component interfaces, this troubleshooting section is broken down into the following subsections:

- ECN Troubleshooting (local vehicle Ethernet network)
- ETB-ECN Interface Troubleshooting (local vehicle Ethernet communication to local vehicle EEI Modules)
- ETB Troubleshooting (vehicle to vehicle EEI module communication)

The order of the material is presented from a local to trainline network approach. This is done in order to gradually introduce tools that are used for troubleshooting. After some familiarity with the P3010 vehicle networks and the available tools, these subsections can be referenced individually.

7.3.1 ECN Troubleshooting

The P3010 offers many tools and functions which aid in troubleshooting the Ethernet network. The tools are introduced in the subsections below. However, the maintainer must understand how to use the tools and interpret the results to draw accurate conclusions.

For devices that are not present on the local Ethernet network, the source of the issue can be narrowed down to one of three issues:

1. Device (malfunction, internal cabling, software configuration)
2. Switch (malfunction, software configuration)
3. Cable (continuity, improperly seated connector)

7.3.1.1 Ethernet HEALTH Message

Ethernet subsystems on the local Ethernet network (ECN) report a HEALTH message to the MDS computer which relays that information to TOD every 10 minutes. If a subsystem does not report the message within the 10-minute window, the subsystems indicator, located on the TOD operating screen, will flash yellow.

This HEALTH reporting is done at the application level, therefore, not all devices report the message. For example, cameras do not report this HEALTH message. If a camera is not connected, an NVR fault is declared. It is important that the maintainer be aware of the operation of the flashing yellow (Ethernet offline) subsystem indication.

The follow devices are responsible for maintaining transmission of the cyclic HEALTH message:

- APC
- APS
- ATC
- CCU
- DCU
- ECUs (A, B, C)
- ER
- HVACs (A, B)
- MDS
- NVR
- PID Controllers (A, B)
- PLUs (A, B)
- TCN RIOs (A & B)
- TODs (RA, LA, RB, LB)

Once a device is reconnected to the network, it may take up to 10 minutes for the flashing yellow indicator to disappear from the TOD screen.

7.3.1.2 TOD Network Status Screen

The TOD Network Status screen provides an Ethernet Test of all the equipment on the local Ethernet network. This test can be performed in full, which tests all the devices (see Figure 7-9), or check the status of an individual device (see Figure 7-10).

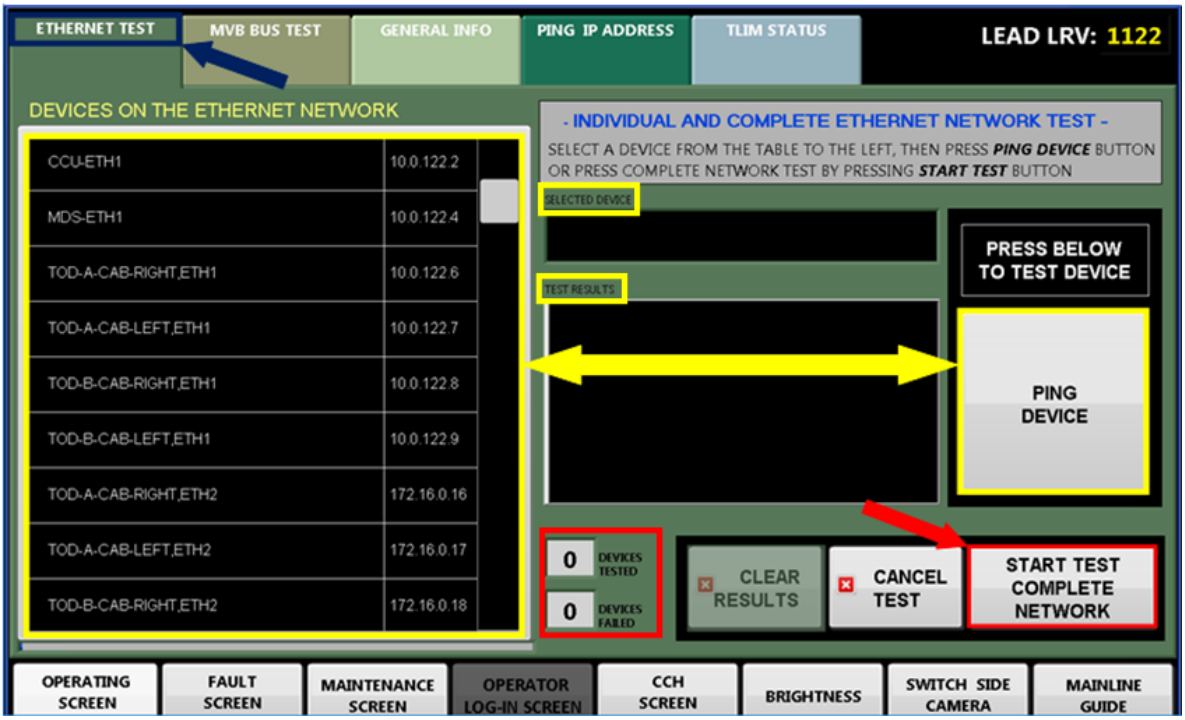


Figure 7-9: Ethernet Test Tab within the TOD Network Status Screen

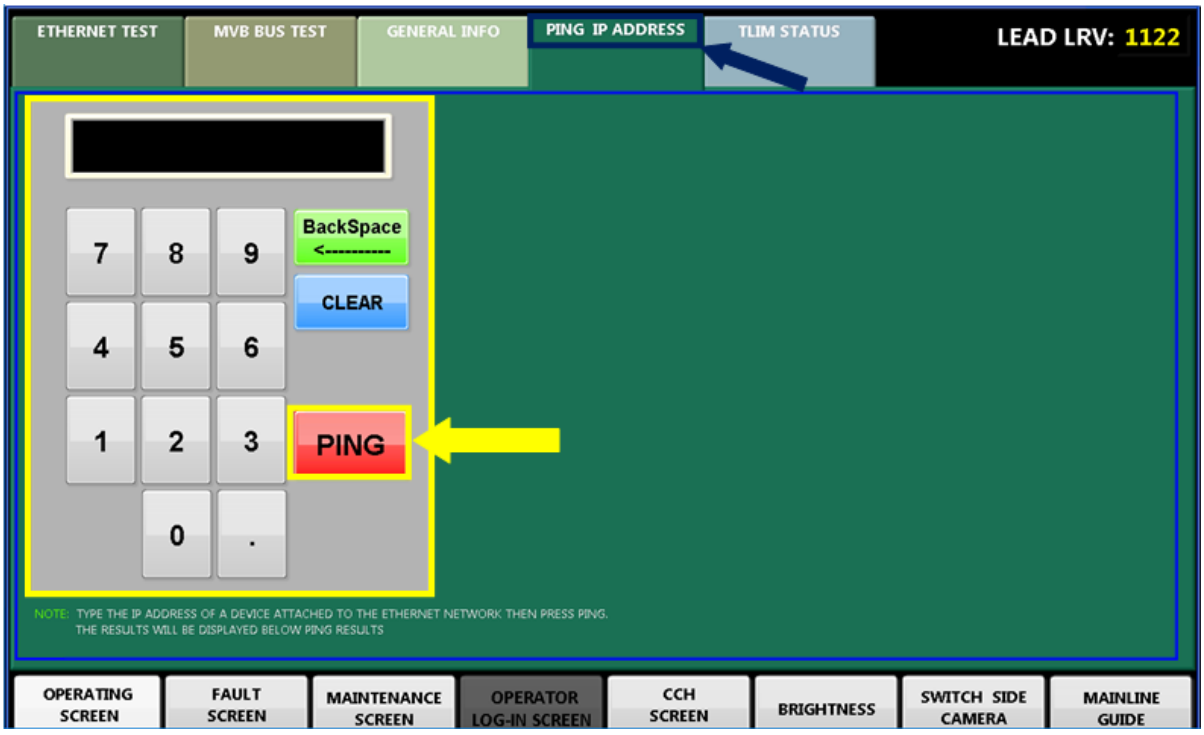


Figure 7-10: Ping IP Addresses within the TOD Network Status Screen

Unlike the MDS HEALTH message, resulting in the presence or absence of a flashing yellow subsystem indicator on the TOD, the Ethernet Test within the Network Status Screen determines if all the P3010 Ethernet devices are connected to the network. Both the Ethernet Test and the individual Ping IP Address option work using the Ping command.

WARNING

THE PING COMMAND OPERATES AT THE NETWORK LAYER. THEREFORE, IT IS POSSIBLE THAT A DEVICE IS POWERED ON CORRECTLY AND RESPONDS TO THE PING COMMAND, BUT A SPECIFIC APPLICATION DOES NOT OPERATE CORRECTLY. FROM A TROUBLESHOOTING STANDPOINT, THE PING TEST SHOULD BE HELD AS THE ETHERNET NETWORK EQUIVALENT OF ELECTRICAL CONTINUITY TESTS (E.G. WIRES TO-AND-FROM THE BATTERY AND LIGHT BULB ARE NOT BROKEN, BUT THE BULB MAY STILL NOT TURN ON).

Further toubleshooting may be required after the device in question successfully passes the Ping Test. In this case, consult the device/subsystem maintenance manual for instructions on reading status LEDs or performing a functional test.

7.3.1.3 Ethernet Switch Status LEDs

Each of the P3010 Ethernet switches provide status LEDs which are viewable without removing any enclosures. Each manufacturer provides a different number of indicators, but the basic three signals are:

- Power
- Connection
- Activity

7.3.1.3.1 Power

If the Power LED is not illuminated, the maintainer would expect to find all the devices connected to that particular switch be absent from the Ethernet network. If physically inspecting the Status LEDs of a switch, it is recommended to first check this LED (Power LED) to ensure the switch is powered on.

7.3.1.3.2 Connection

NOTE: The Connection LED (sometimes referred to as Link LED) may or may not also be integrated into the Activity LED – double check Ethernet Switch model with corresponding table below if unsure.

The Connection LED illuminates if there is an established communication link between the switch port and the end-device. As a method for troubleshooting if a particular Ethernet switch port may be faulty, swap the M12 connector located at the port in question with one which has the connection LED illuminated. If the port in question now illuminates with the newly placed M12 connector (and associated device), the switch port can be ruled out as the cause of no connectivity.

7.3.1.3.3 Activity

NOTE: The Activity LED may or may not also be integrated into the Connection LED – double check Ethernet Switch model with corresponding table below if unsure.

The absence of the Activity LED tells the maintainer that no information is being transmitted/received to/from the end-device. If the Connection LED is present, there is a path for data to flow – indicating there may be an issue with the application on the end-device.

Tables 7-7, 7-8 and 7-9 show the Status LED descriptions for the N-Tron, Westermo, and Moxa switches respectively. Additional component information can be found in the Wired Ethernet Components section (refer to Section 2.7.3).

Table 7-7. N-Tron 708 and 716 Ethernet Switch Status LED Description

LED	Color	Description
⏻	GREEN	Power is Applied with no active faults.
	RED	Power is Applied with an active fault.
	OFF	Power is not Applied.
LNK	ON	Link established.
	OFF	No link established.
ACT	BLINKING	Link established, Activity on cable.
	OFF	No link established.

Table 7-8. Westermo Viper Ethernet Switch Status LED Description

LED	Status	Description
ON	OFF	Unit has no power.
	GREEN	All OK, no alarm condition.
	RED	Alarm condition, or until unit has started up. (Alarm conditions are configurable, see "WeOS Management Guide").
	BLINK	Location indicator ("Here I am!"). Activated when connected to IPConfig Tool, or when configuring the unit via Web or CLI.
DC	OFF	Unit has no power.
	GREEN	Power OK on DC1 and DC1.
	RED	Power failure on DC1 or DC2.
FRNT *	OFF	FRNT disabled.
	GREEN	FRNT OK.
	RED	FRNT Error.
	BLINK	Unit configured as FRNT Focal Point.
RSTP*	OFF	RSTP disabled.
	GREEN	RSTP enabled.
	BLINK	Unit elected as RSTP/STP root switch.
X1 to X12	OFF	No Link.
	GREEN	Link established.
	GREEN FLASH	Data traffic indication.
	YELLOW	Port alarm and no link. Or if FRNT or RSTP mode, port is blocked.

Table 7-9. Moxa Ethernet Switch Status LED Description

LED	Color	State	Description
System LEDs			
PWR1	AMBER	ON	Power is being supplied to power input PWR1.
		OFF	Power is not being supplied to power input PWR1
PWR2	AMBER	ON	Power is being supplied to power input PWR2.
		OFF	Power is not being supplied to power input PWR2.
FAULT	RED	ON	When the corresponding PORT alarm is enabled, and a user-configured event is triggered.
		OFF	When the corresponding PORT alarm is enabled and a user-configured event is not triggered, or when the corresponding PORT alarm is disabled.
MSTR/ HEAD	GREEN	ON	When the TN switch is either the Master of this Turbo Ring, or the Head of this Turbo Chain.
		Blinking	When the TN switch is Ring Master of this Turbo Ring and the Turbo Ring is broken, or it is Chain Head of this Turbo Chain and the Turbo Chain is broken.
		OFF	When the TN switch is neither the Master of this Turbo Ring, nor the Head of this Turbo Chain.

7.3.2 ETB-ECN Interface Troubleshooting

The Ethernet Train Backbone equipment used on the P3010 is called the Enhanced Ethernet Interface (EEI) Panel. The panel contains two EEI modules which provide Ethernet communication between multiple vehicles across the coupler. The local EEI modules must communicate with the ECN in order to provide any local Ethernet data across the trainline Ethernet network.

Presence of an Ethernet Trainline is indicated by the consist display shown on the TOD Operating Screen (see Figure 7-11). NOTE: The consist display is created once both the WTB and ETB is established. The WTB is a hardwired bus which establishes seconds after two vehicles are coupled. On the other hand, the ETB requires an additional minute or two to readjust when the train consist is altered. Therefore, the consist display can be used as a rough guide to determine if the Ethernet Trainline Network has established. To get the actual status of the Ethernet Trainline, viewing the General Info tab within the Network Status Screen on the TOD provides the number of vehicles and vehicle numbers on the ETB (see Figure 7-12).

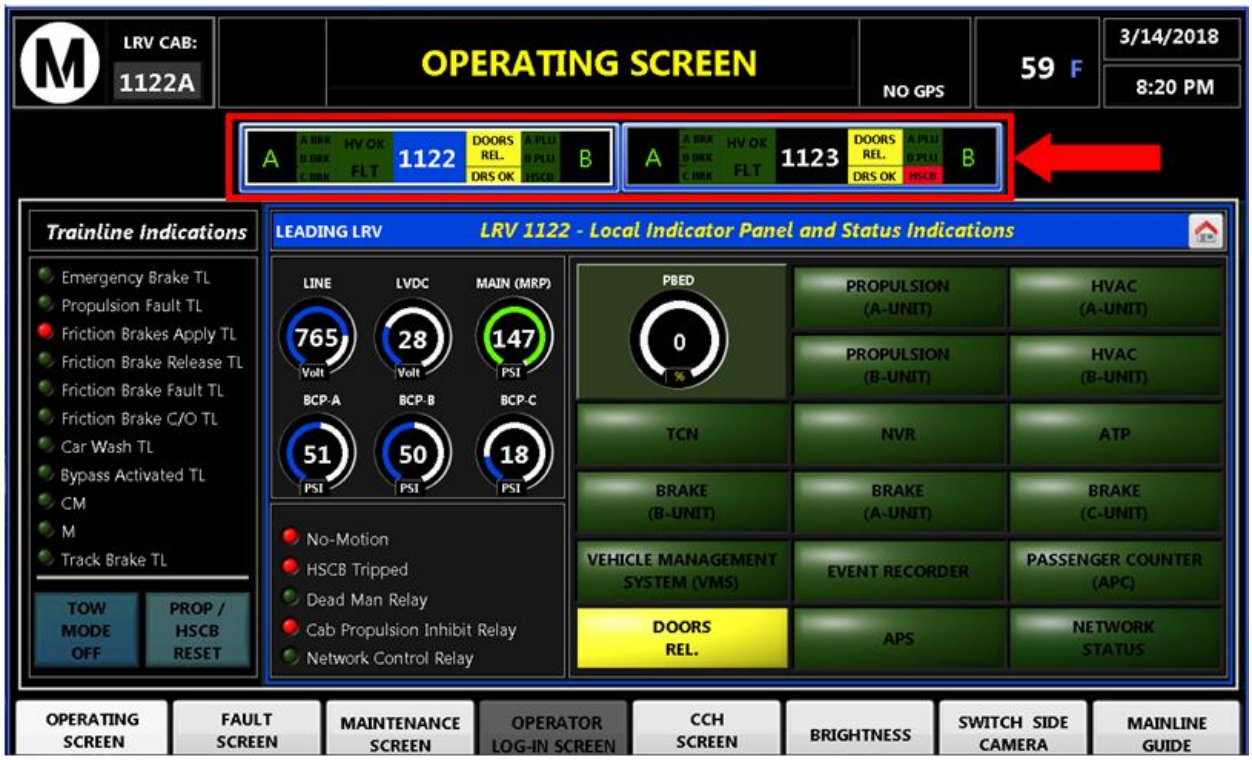


Figure 7-11: Consist Display Located at the top of the TOD Operating Screen

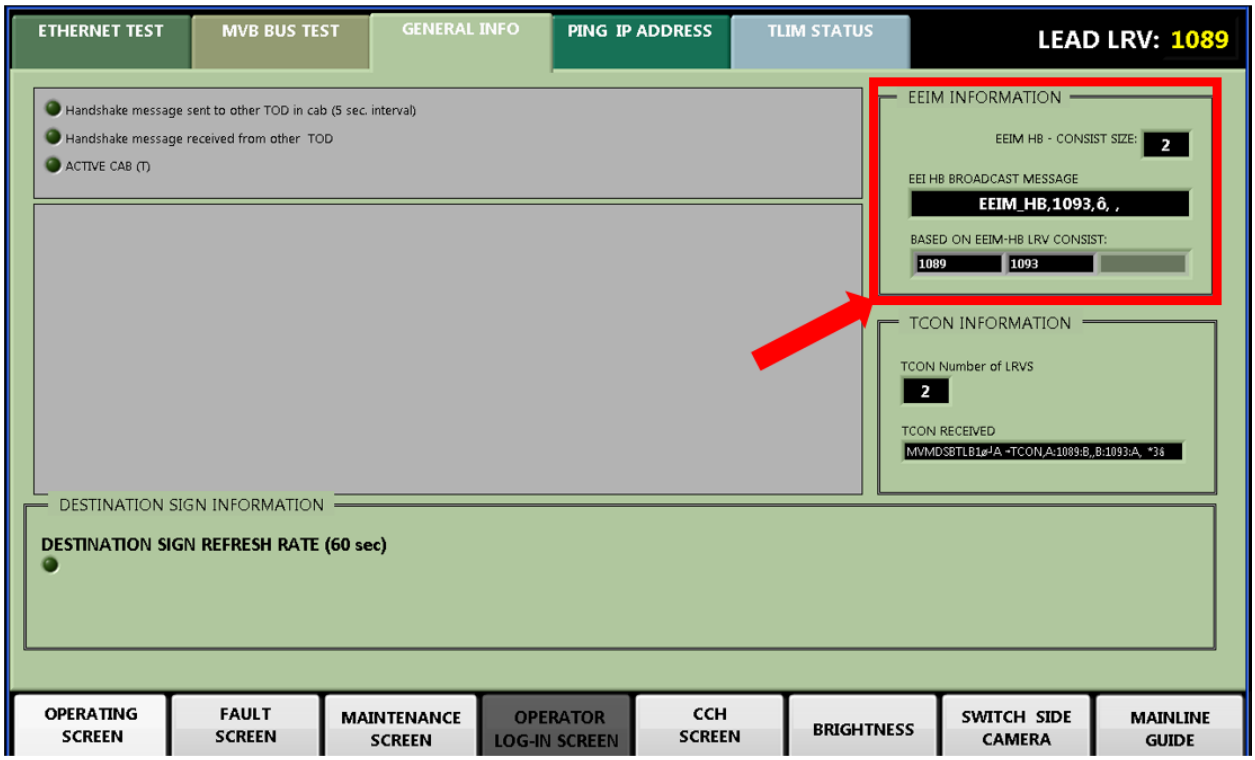


Figure 7-12: EEIM Information with ETB Consist in the TOD Network Status Screen > General Info Tab

If there is no indication of an Established Ethernet Trainline, check the EEI modules on the local vehicle are connected to the local network. This can be done through the Network Status Screen on the TOD – either the Ethernet Test or TLIM Status (see Section 7.3.2.1).

If the device is present, the issue is likely on another vehicle. Perform the same verification on each car in the consist by going onto each car and using a local TOD to determine the affected vehicle.

If the device is not present, check the Status LEDs to verify the module is powered on (refer to Section 7.3.2.2). If the module is powered on, check if the ETH LED is illuminated. If it is, there is an issue with the configuration file on the MDS computer (Refer to Section 8.4 for more details). If the ETH LED is not illuminated, there is an Ethernet connectivity issue.

7.3.2.1 TOD TLIM Status

The TLIM Status menus can be used to determine what local EEI modules are connected to the local Ethernet network and what Ethernet Trainline is active (if in a multi-car consist). Figure 7-13 shows the General Information screen within the TLIM Status screen. The TLIM Status Screen is a subset of the Network Status Push Button.

The contents of Figure 7-13 TLIM-A General Info are enlarged in Figure 7-14 with callouts to key pieces of troubleshooting information. The yellow boxes at the top of the screen in Figure 7-14 show the IP and MAC address of the local EEI module. The red boxes and arrows in Figure 7-14 show the mode type (Master Access / Head End), frequency mode (MODE: 1), and a list of the other EEI modules communicating on the same frequency mode (i.e. the TL1 EEI modules of the trailing cars).

If a particular trainline channel is active (e.g. TL1) but that module in the local car is not a master (e.g. TL1 – repeater mode), the MAC address of the master module will be listed at the bottom of the TLIM General Info screen along with the third car in the consist (when applicable). When that particular trainline is not active, there will not be any MAC addresses listed at the bottom of the TLIM General Info screen, as shown in TLIM-B in Figure 7-13.

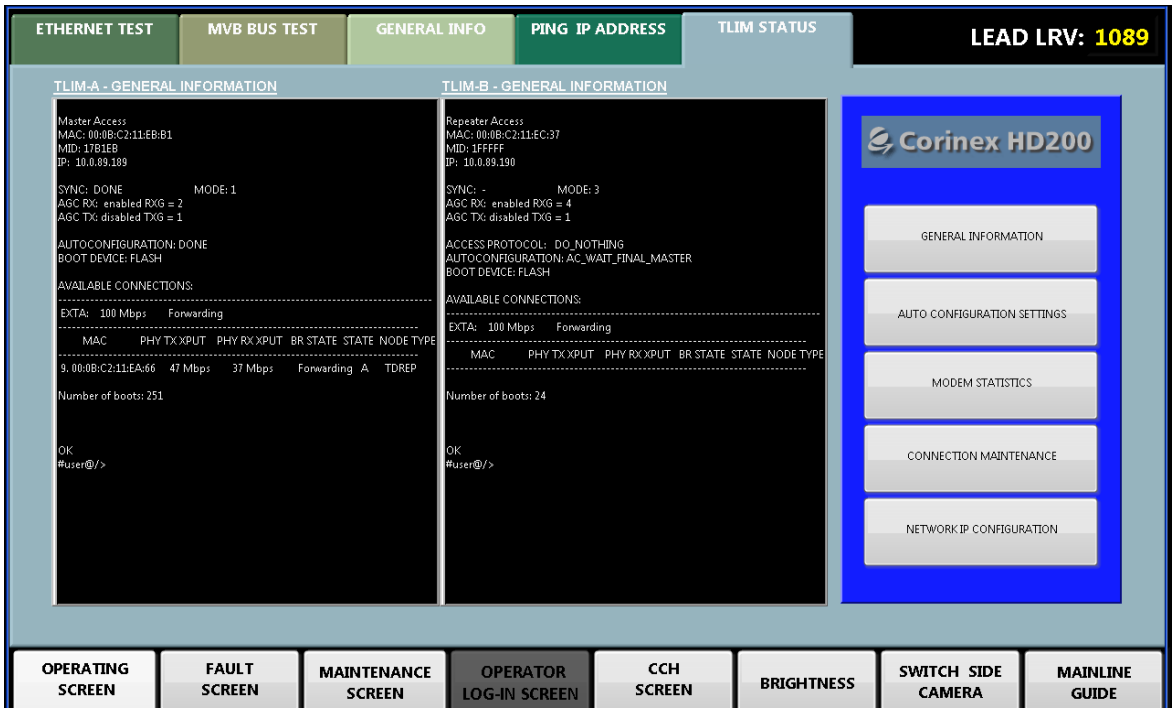


Figure 7-13: TLIM Status Tab within the Network Status Screen of the TOD

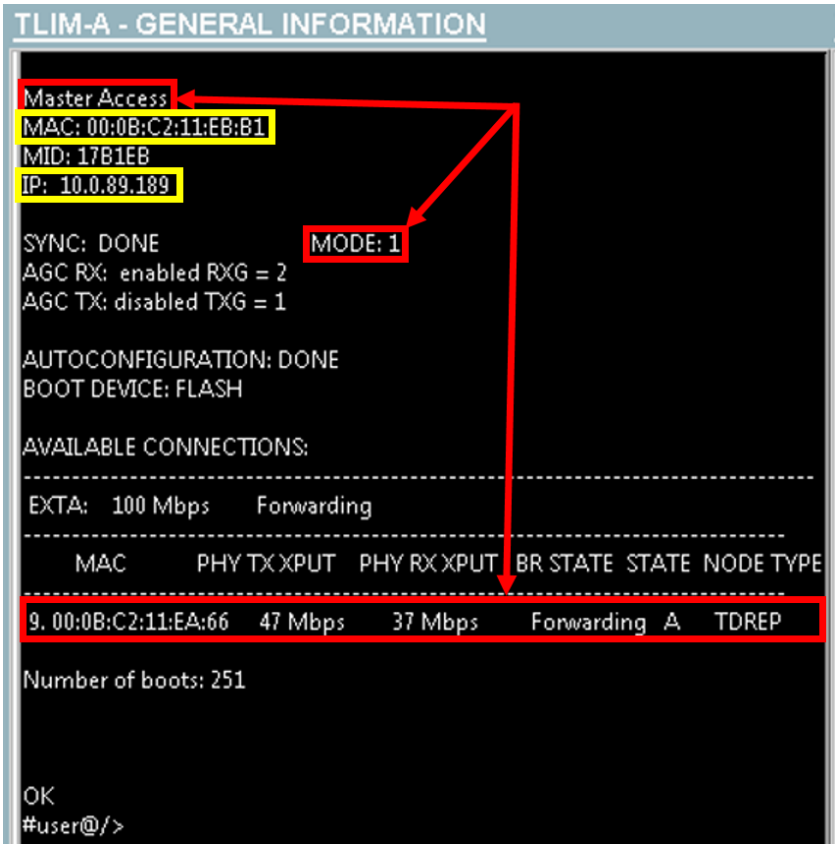


Figure 7-14: TLIM General Information Menu with Callouts

7.3.2.2 EEI Module Status LEDs

Table 7-10 provides the Status LED description for the EEI modules.

Table 7-10. EEI Module Status LED Description

		State			
LED	**Function**	**On**	**Off**	**Alternate 1s**	**Alternating 0.1s**
PWR	Power	Power ON	Power OFF	NA	NA
LV-C*	- Coupling Mode (1st function) - PTTP Mode (2nd function)	Coupling to LV **Optional A**: RPM enabled	Coupling to COAX **Optional A**: RPM disabled	NA	Blinking period to indicate PTTP
REG	- Auto Configuration - Pushbutton (1st and 2nd function)	Auto Configuration is done	-Auto Configuration is not finished -IP is not set	-Auto Configuration is not finished -IP is assigned	Blink from 1s to 4s and after 8s while button is being pressed
ETH	ETH L/A	Eth link established	No Eth link/ETH10 Speed	NA	There is Eth activity
DC-PWR	DC Power	DC Power ON	DC Power OFF	NA	NA
PLC	PLC L/A + Port solver	PLC link established	No device connected to port solver	Some devices are connected to port solver	There is PLC activity

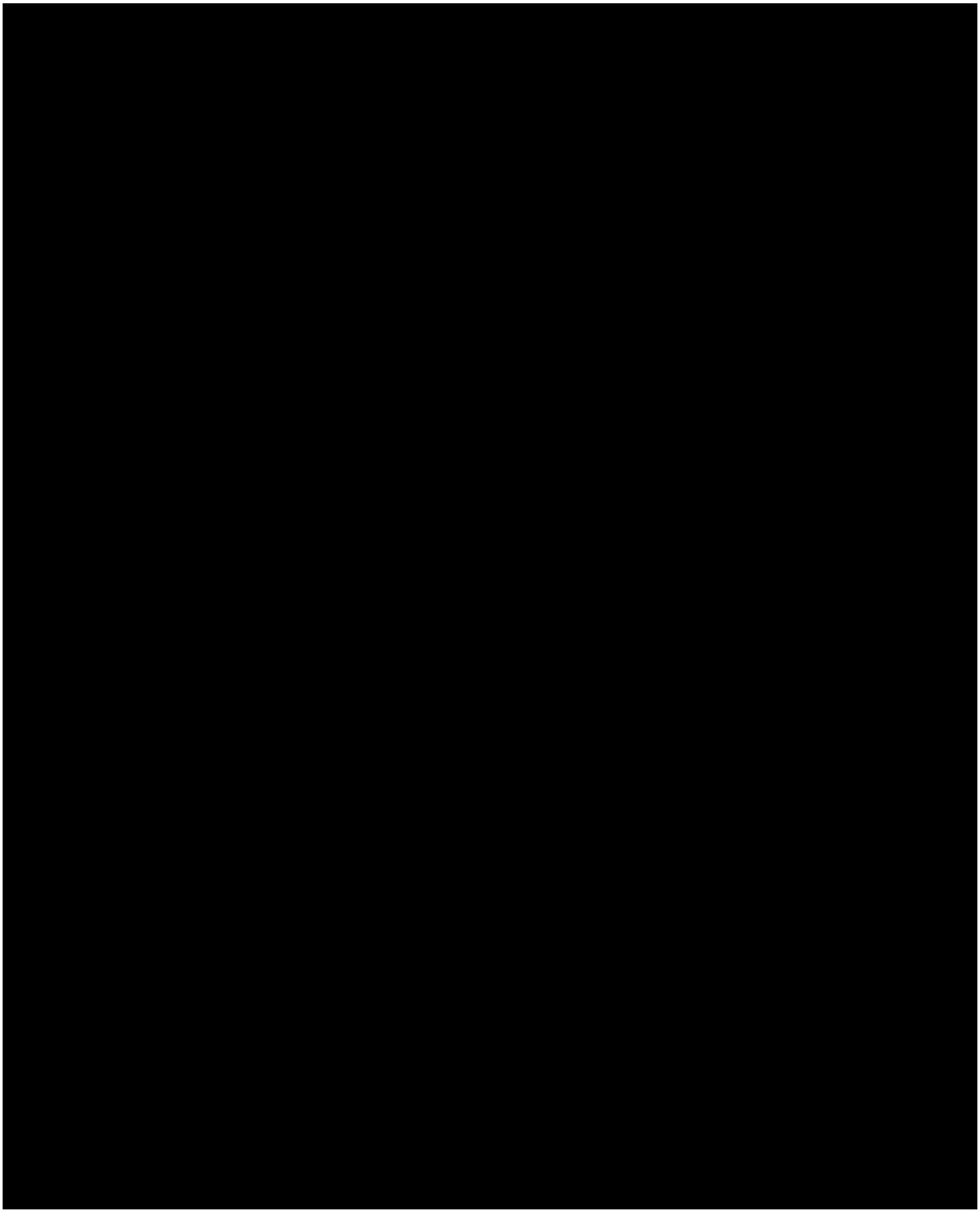
7.3.3 ETB Troubleshooting

If communication between the local EEI modules and Ethernet network is verified for all vehicles in the consist and there is no Ethernet Trainline communication, the issue is likely the ETB connection. All the EEI modules of a given trainline in the consist (i.e. TLA or TLB), are physically connected. Trainline data to and from the EEI modules is sent through the AC connector of the EEI module, out the CN connector of the EEI panel, and to the coupler where it mates with the couple of another vehicle.

Visually inspect the AC connectors of each EEI module for connection. If all connectors are properly fastened, an electrical continuity check is required.

To troubleshoot an Ethernet Trainline individually (i.e. TLA or TLB), turn off all modules not on the desired TL. Doing so will force the only available trainline to be used for communication as opposed to the software automatically selecting a Trainline.

A summary flowchart of the Ethernet Trainline troubleshooting steps are provided in Figure 7-15. This flowchart incorporates troubleshooting of the EEI modules on the local network from Section 7.3.2, as well as EEI-to-EEI communication from Section 7.3.3. Generally, the process is to establish a train network by making an Active Cab by establishing control in the A-Unit cab and check if the TCON (Train Configuration) is correct by observing the train icons at the top of the TOD screen to determine if the train is displayed properly. The next step is to check for a Heart Beat (HB). If there is no HB, then see if the Local Module can be pinged. If not, then fault isolate to the specific EEI Module.



7.3.3.1 EEI Module Isolation Test

This test verifies proper operation of the EEI modules in master mode or head end. As described in Section 2.3.3, the location of the master module is determined by the first car in the consist to host an active cab. This test is to be performed after following the troubleshooting flow chart in Figure 7-15 and resulting in a potential EEI module malfunction.

1. Decide what communication channel to test first – TL1 or TL2.
    - For each EEI panel in the consist, turn off power to the EEI module associated with the channel not under test (e.g. testing TL2 then turn off all TL1 modules)
    - Turn the EEI module off by disconnecting the DC connector located at the rear of the device inside the panel. NOTE: this requires unmounting the EEI panel from the electric locker
2. Power off the train.
3. Create an active cab in a non-intermediate cab of one of the end cars in the consist.
4. Wait a few minutes for the network to establish – approximately 5 minutes.
5. Check the TOD > Network Status > TLIM Status > General Info tab.
    - If the EEI module in the active car under test has successfully booted to HE mode (Head End / Master Access), the module passed the test.
    - If after 5+ minutes the EEI module in the active car under test has not booted to HE / Master Access mode, the module failed the test and needs replaced. There will be no Master Access indication displayed.
6. Repeat steps 2-5 for the other end car in the consist.
7. Reconnect the disconnected EEI module DC connectors.
8. Repeat steps 1-7 for the other communication channel.
9. Screw the EEI panels back in place.

7.3.3.2 Check Configuration File

After following the troubleshooting flowchart of Figure 7-15, if the resolution is to “Check Configuration File”, additional instructions are provided below to guide the maintainer through the configuration file.

1. Follow steps 2-3 in Section 8.4 to connect the PTU to the network and Remote Desktop onto the MDS computer.
2. Follow step 6 in Section 8.4 to verify the EEI_BOOTP_Server directory is present.
3. Follow step 7 in Section 8.4 to verify the DHCP Server is running on the MDS.
4. Follow step 8 in Section 8.4 to verify the contents of the dhcpsrv.ini file.
5. If any changes are made to the MDS computer, follow steps 9-11 in Section 8.4 to save changes.

7.4 Wireless Network Troubleshooting

Detailed troubleshooting of the Wireless network is covered in the Tools and Test Equipment Manual, Section 1400, Wireless Data Transfer. Description of the status LEDs for general physical inspection are shown in Table 7-11.

Table 7-11. N-Tron 70212-W LAN Status LEDs

LED	Color	Description
	GREEN	Good Signal (user defined)
	ORANGE	Poor Signal (user defined)
	RED	Bad Signal (user defined)
Radio Enabled	GREEN	The radio interface is active
	OFF	The radio interface is off
LNK/ACT	GREEN	LAN Link is present
	FLASHING	Data is active over the ports
	OFF	No Link is present on the LAN port
PWR	GREEN	Power is applied
	OFF	No Power is applied

CHAPTER 8.0

SOFTWARE COMMISSIONING

8.1 Introduction

For the life of the P3010 vehicles, there will be times when data communications equipment will need repaired/replaced. In these situations, the equipment placed on the vehicle may need software loaded or updated. This section explains how to load software onto each of the P3010 data communications devices.

8.2 WTB (TCN Gateway)

Unlike most devices on the P3010 vehicle, WTB Gateway software – in the form of an application database file – cannot be loaded via Ethernet connection. Instead, loading this application file requires an RS232 serial connection from the PTU serial port to the Gateway's SRV (service interface, as shown in Figure 8-1).

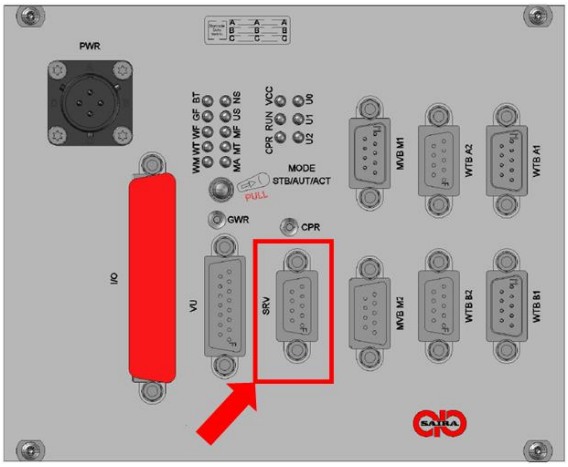


Figure 8-1: WTB Gateway SRV (Service Interface)

Equipment Needed:

- PTU Computer with serial port and terminal emulation program (e.g. HyperTerminal)
- DB9-M to DB9-F straight cable
- P3010 Gateway database application file (software)

Instructions:

1. Connect the PTU to the SRV port on the desired Gateway using the straight serial cable (see Figure 8-1).

2. Verify the desired Gateway Mode Switch is in the ACT position. If the Gateway is not in ACT, place it prior to programming (see Figure 8-2).

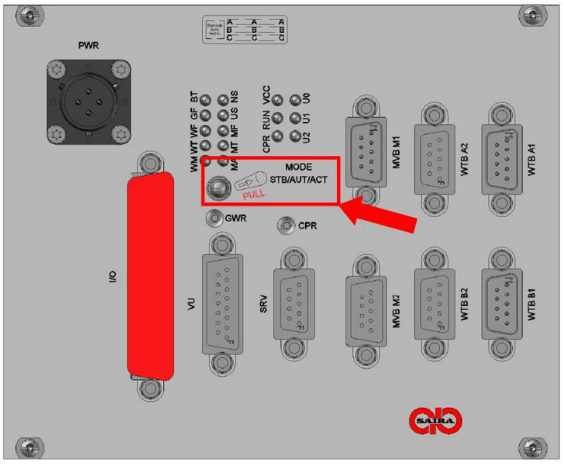


Figure 8-2: WTB Gateway Mode Switch

3. Run the Terminal Emulator program on the PTU.

   - If HyperTerminal is used, select or create a name for the connection profile (see Figure 8-3).

NOTE: If no previous profile for the gateway connection has been made, a name will need to be provided. The name can be chosen arbitrarily – it does not require “P3010 Gateway”.

4. Set the proper COM port based on the placement of the serial cable.

   - One way to check which COM port has the serial cable connected to it is to locate the list of active COM ports within the PTU Control Panel > Device Manager.

5. Set the serial port settings (see Figure 8-4).

   - 9600 bits per second
   - 8 data bits
   - No parity
   - 1 stop bit
   - No flow control

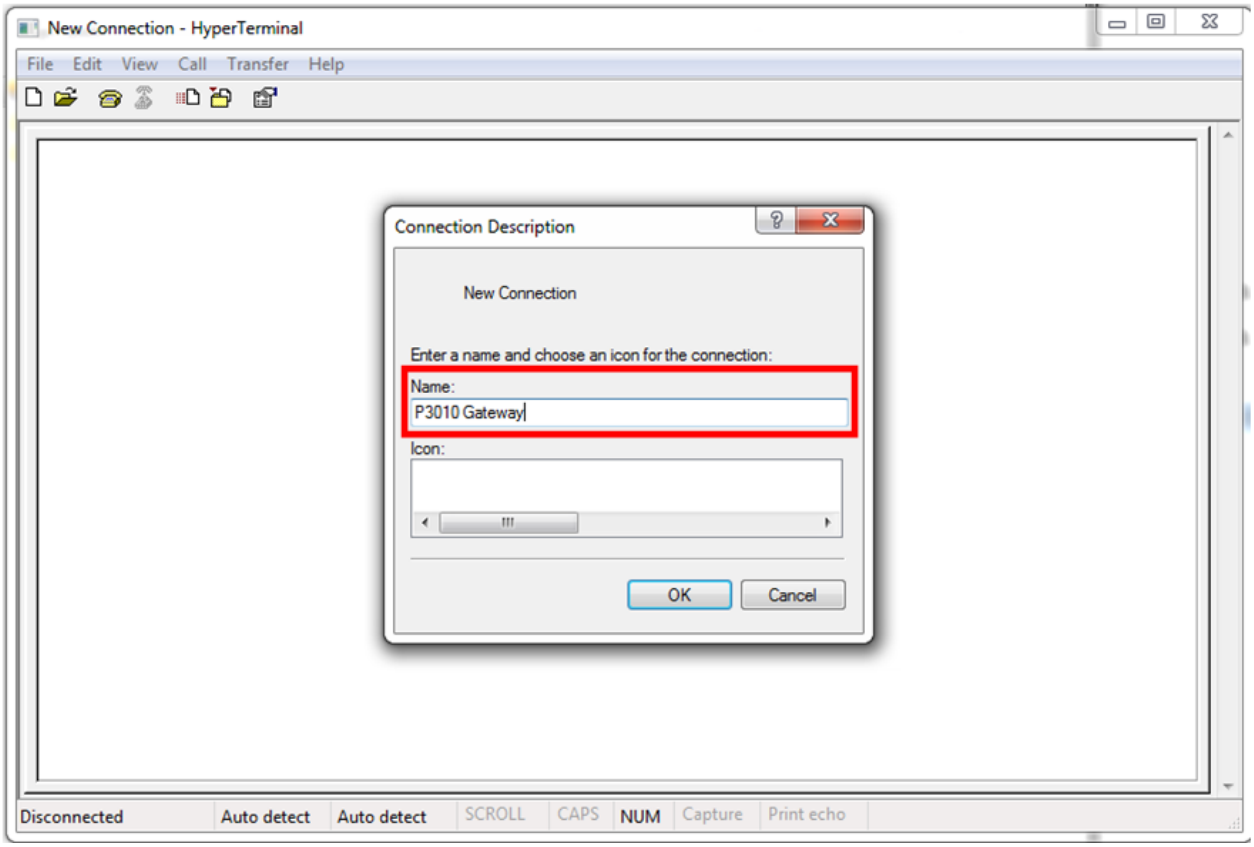


Figure 8-3: HyperTerminal Start-Up Window

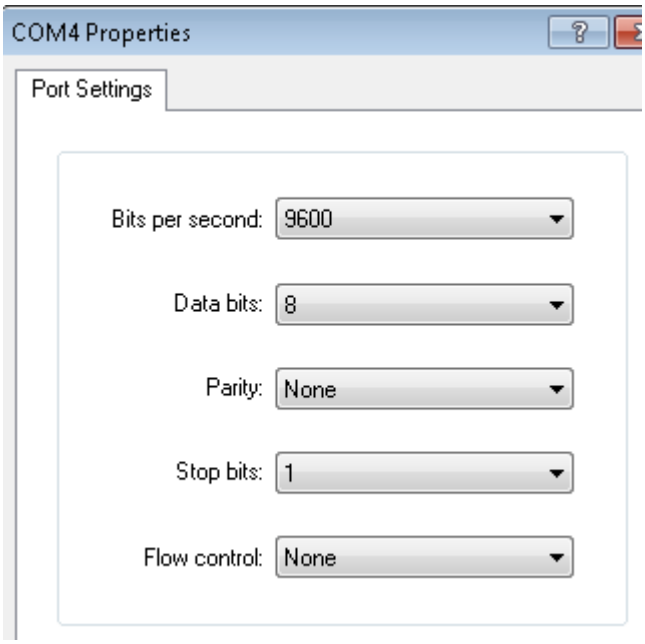


Figure 8-4: Serial Port Settings Used to Communicate with the P3010 WTB Gateway

6. Verify communication to the Gateway is present by viewing the “Hello” message on the Terminal Emulator (see Figure 8-5). If the “Hello” message was not received by the Terminal Emulator, hit enter. After a few retries, if no connection is present, disconnect the serial cable and attempt steps 1-6 again.

NOTE: Pressing “Enter” on the HyperTerminal console may be necessary to receive initial message from Gateway.

```
! 0x8092a74 (tAPPL): Hello !
INTTCN-41-D88-V2.73R- 30/05/2011: TCN- Stack Software

Copyright (C) by F.A.R. Systems Spa
via Tombetta, 95 37135 Verona ITALY
```

Figure 8-5: Message Received from Gateway once Connection is Established

7. Access the TCN Database Menu by entering “dbload” into the Terminal Emulator (see Figure 8-6), followed by the Enter key. This will provide the user with multiple options, including sending the desired application file to the Gateway.

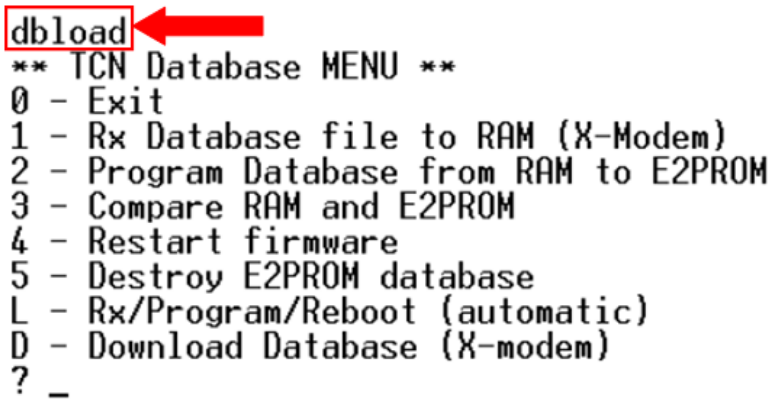


Figure 8-6: TCN Database Menu

8. Select “Rx Database file to RAM (X-Modem)” by entering “1” (see Figure 8-7), followed by pressing Enter key.

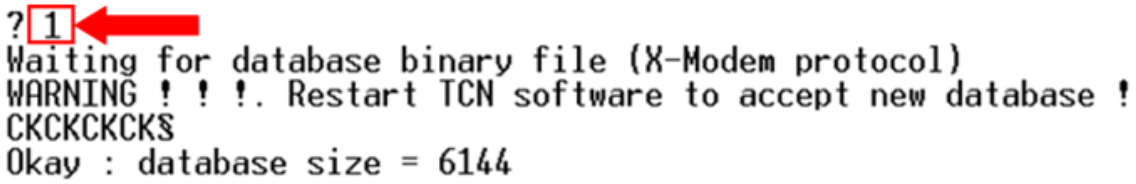


Figure 8-7: Preparing the Gateway to Receive a new Application File

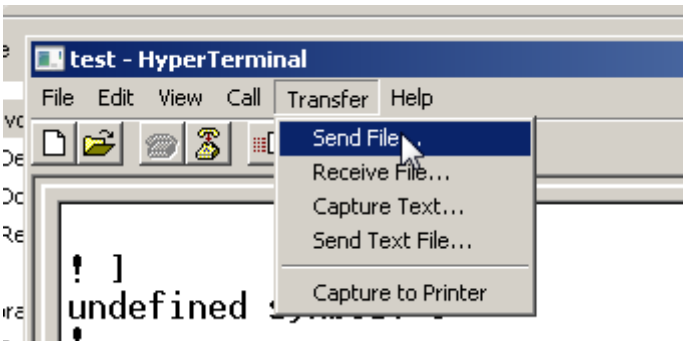


Figure 8-8: To send a file, locate the transfer tab in the top menu bar of HyperTerminal and select “Send File…”

9. Select the application file to transfer (directions written for HyperTerminal). Note that file transfer to the Gateway is time-limited. If the Gateway times out before file transfer is started, the user will need to repeat steps 7 and 8.

NOTE: Make sure the GWA bin file is loaded onto the A-end Gateway and GWB bin file is loaded onto the B-end Gateway.

a. Locate the Transfer tab in the top menu bar and select “Send File…” (see Figure 8-8).

b. Choose the X-Modem transfer protocol from the options provided (see Figure 8-9).

c. Enter the path location for the desired application file by either typing in the path or choosing browse and locating the file within the PTU (see Figure 8-10). The application file is provided as a binary (bin) file type.

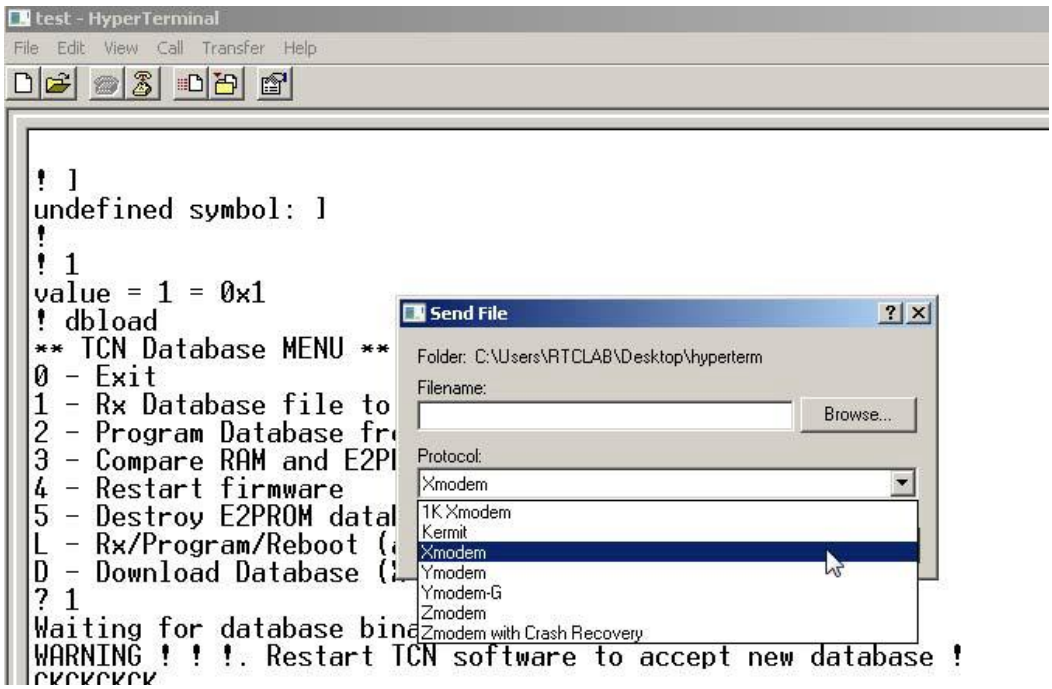


Figure 8-9: Select “X-modem” for the Protocol Transfer Mode (HyperTerminal window shown)

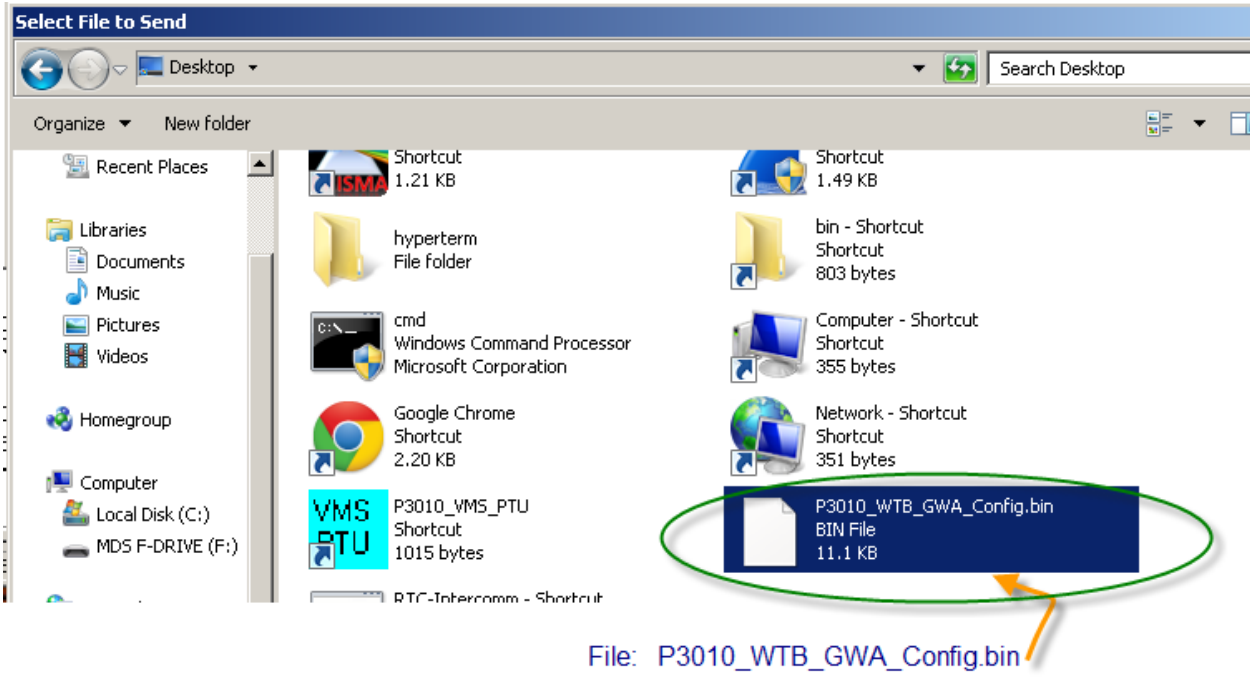


Figure 8-10: Browse for the Application File Located on the PTU

10. Once the file transfer is complete, select “Program Database from RAM to E2PROM” by entering “2” (see Figure 8-11).

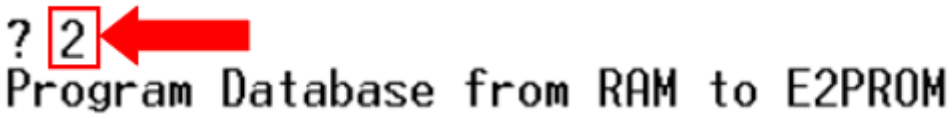


Figure 8-11: Once the file is transferred to the Gateway, press “2” to program the E2PROM

11. Once the E2PROM is programmed, select “Compare RAM and E2PROM” by entering “3” (see Figure 8-12).

    - Verify the comparison returns “Okay”. If not, repeat step 10.

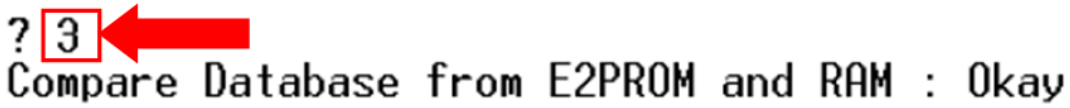


Figure 8-12: Press “3” to Verify the E2PROM Programmed Correctly

12. Select “Restart firmware” by entering “4” (see Figure 8-13).

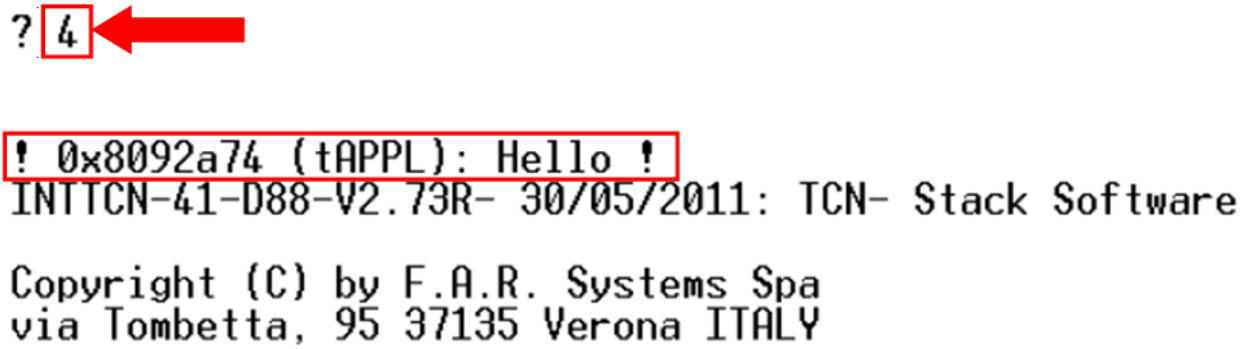


Figure 8-13: Press “4” to Restart the Gateway Firmware

13. Restore the gateway Mode Switch to the correct position.

- Gateway A is in the ACT position
- Gateway B is in the STB position

8.3 MVB (TCN RIO)

Provided below are instructions on how to update the TCN RIO software in the form of an application file. Unlike the WTB Gateway, updates on the RIO are performs via the Ethernet network.

Equipment Needed:

- PTU Computer
- RJ45-to-M12 Ethernet cable
- P3010 MVB RIO Application Software

Instructions:

1. Connect a PTU to the Ethernet network onboard the vehicle using the RJ45-to-M12 Ethernet cable (see chapter 9 for additional information/help).

2. Open up a web browser such as Firefox and type in the IP address of the desired RIO to update.

   - A-end RIO IP Address: 10.0.y.191
   - B-end RIO IP Address: 10.0.y.193

   *y = Vehicle Number – 1000
   For example, car 1132 has a y value of 1132-1000=132

3. Login to the web interface by selecting the Login button at the top-right corner of the screen (see Figure 8-14).

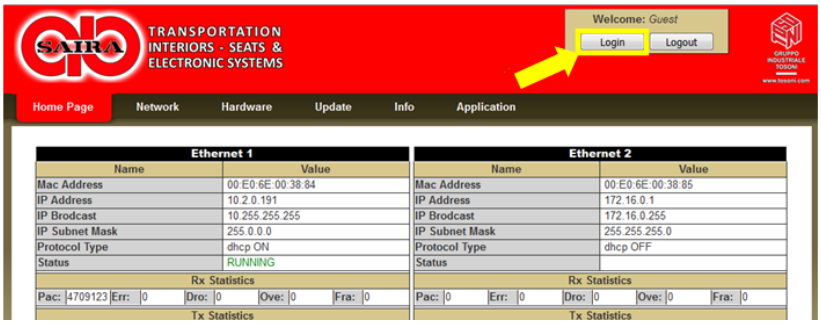


Figure 8-14: TCN RIO Webpage Interface Homepage

4. Once on the login screen, login as the Super Admin (see Figure 8-15).

   - Username: Super Admin
   - Password:

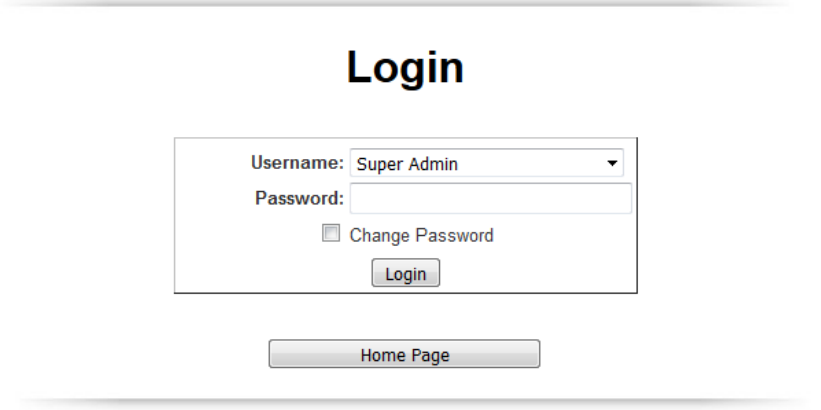


Figure 8-15: TCN RIO Webpage Login

5. Verify successful login by viewing the “Welcome” message above the login button from step 3 (see Figure 8-16).

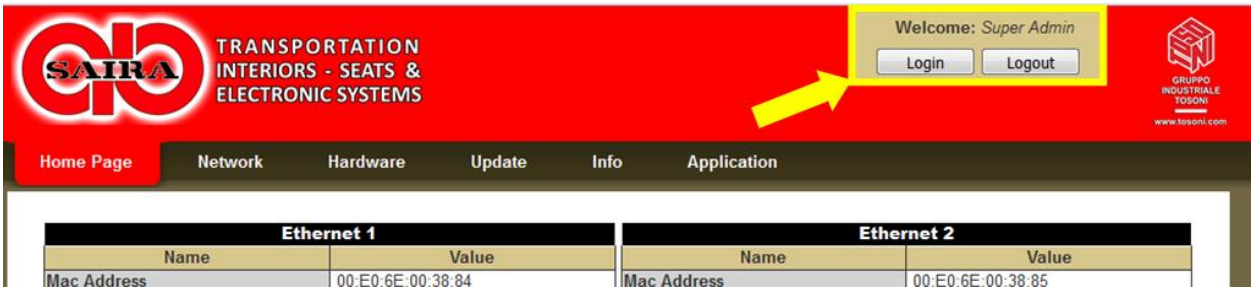


Figure 8-16: Webpage as Super Admin

6. Select the Update tab from the menu bar and choose “Browse” to search the PTU for the desired application file to load onto the TCN RIO (see Figure 8-17).

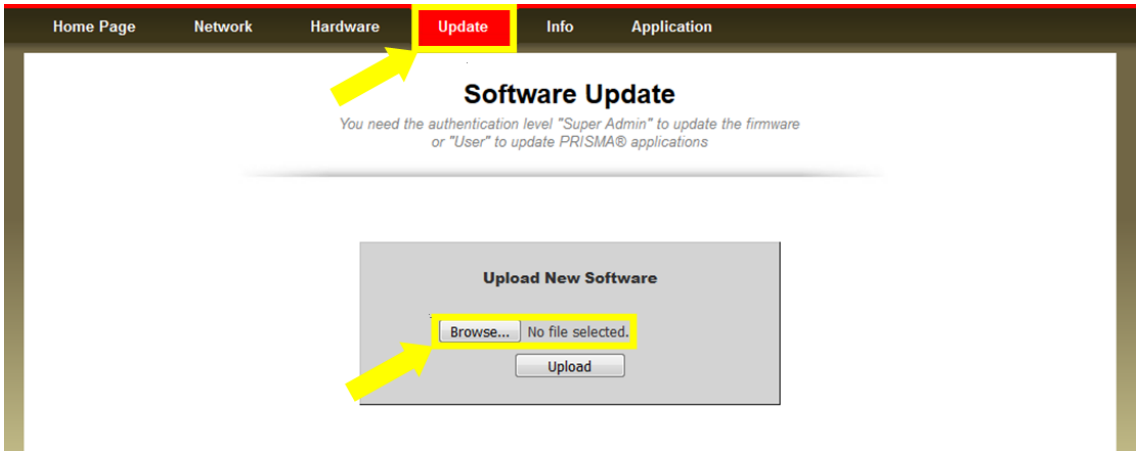


Figure 8-17: Update Option within RIO Webpage (after login as Super Admin)

7. Once the desired file is selected, press “Upload” (see Figure 8-18).

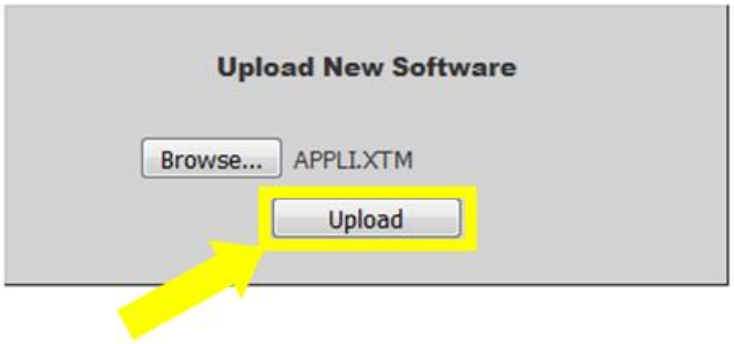


Figure 8-18: Upload Command after File Selected From PTU

8. Press “Save” to start the file transfer to the RIO (see Figure 8-19).

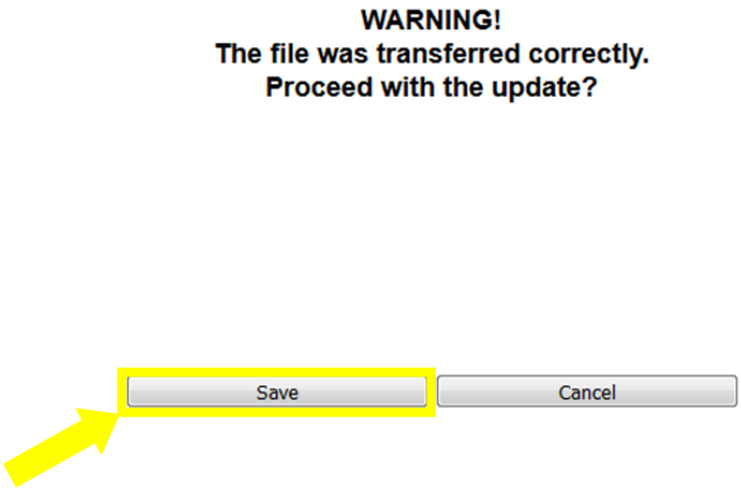


Figure 8-19: Warning Message before Software Updated on TCN RIO

9. The “Device Reboot” message will appear (see Figure 8-20). Let the timer expire and device reboot. Once the device reboots with the new application file, the web homepage will appear.

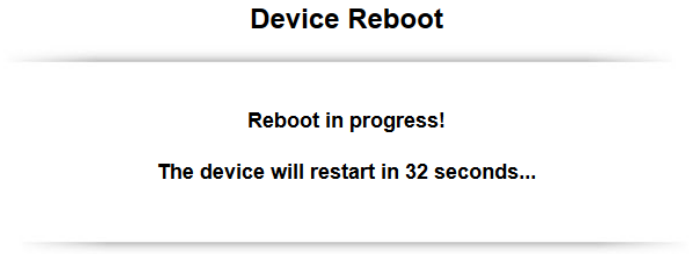


Figure 8-20: Device Reboot Message While Updating Software

8.4 ETB (Ethernet Trainline Modules)

Provided below are instructions on how to set-up the Ethernet Trainline and update the EEIM software. Note the EEIM software resides on the MDS computer but requires the MAC addresses of the EEI modules to be manually entered.

Equipment Needed:

- PTU Computer
- RJ45-to-M12 Ethernet cable
- P3010-EEIM Software

Instructions:

1. Determine what components were replaced:

   - If EEI module or EEI panel (includes two modules) was replaced, the MDS computer will need the MAC address of the EEI module(s) manually entered.

   - If the MDS was replaced or both MDS & EEI panel, the EEIM software will need installed along with supporting files and the MAC addresses of the EEI modules.

2. Connect a PTU to the Ethernet network onboard the vehicle using the RJ45-to-M12 Ethernet cable (see chapter 9 for additional information/help).

3. Remote Desktop onto the MDS computer.

   - IP Address: 10.0.x.4
   - Username:
   - Password:

4. If only the EEI module or panel was replaced, jump to step x. Otherwise, continue on to step 5.

5. **INSTALLING MDS BUNDLE**: The EEIM software is provided with the MDS software bundle. To install the bundle:

a. copy the bundle from the PTU to the MDS F: drive

b. unzip the folder (if the bundle was copied as a .zip)

c. locate the batch file in the bundle and double click to run it (see Figure 8-21)

6. Verify the EEI_BOOTP_Server directory is present on the MDS C: drive (see Figure 8-22).

Figure 8-21: MDS Software Bundle Batch File

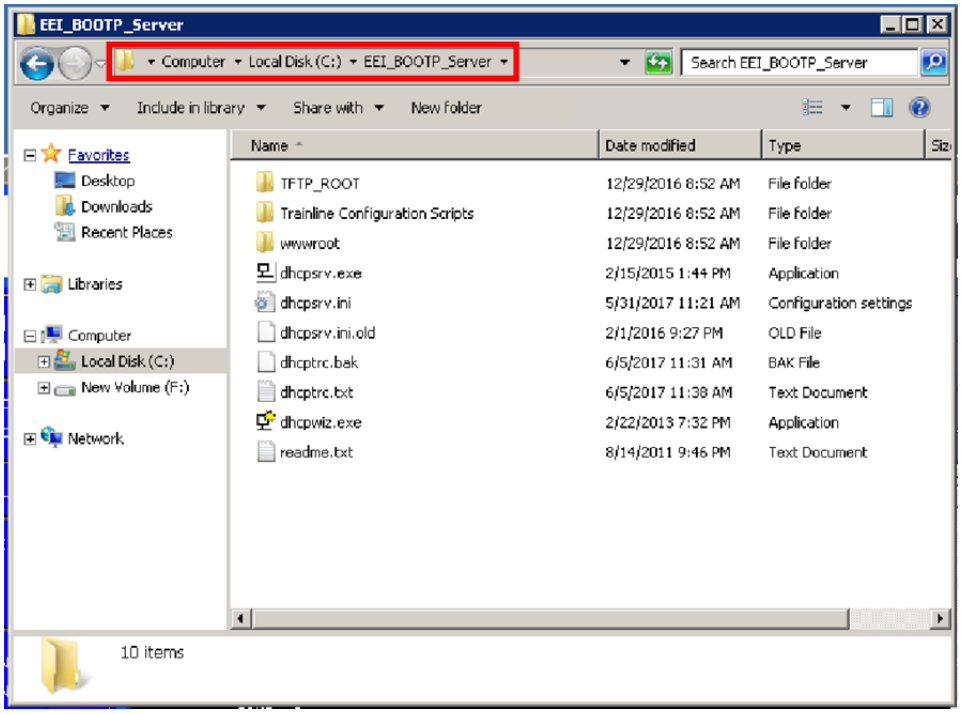


Figure 8-22: EEI_BOOTP_Server Directory on the MDS C: drive

7. Verify the DHCP Server is running on the MDS by checking the application status. Double-click dhcpsrv.exe within the EEI_BOOTP_Server directory and verify the status is set to “Running” (see Figure 8-23).

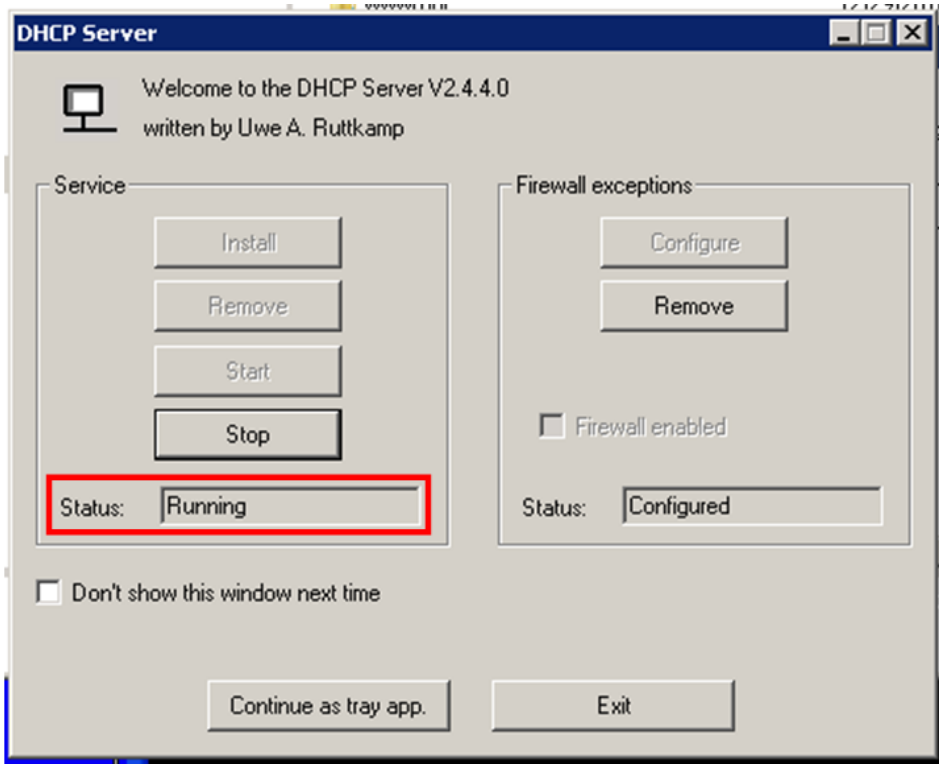


Figure 8-23: DHCP Server (dhcpsrv.exe) Application on the MDS

8. **ADD EEI MODULE MAC ADDRESSES:** To add the EEI module MAC addresses.

a. locate the EEI MAC address printed on the top of the EEI module (see Figure 8-24).

b. identify what module the MAC address belongs to – module #1 or #2 (see Figure 8-25).

c. open up the dhcpsrv.ini in a notepad editor and add the MAC address for the corresponding module (see example in Figure 8-26).

d. verify the INI file contains the correct IP addresses – each IP should be 10.0.x.___ where x is car # - 1000 and ___ is the specific device. ___ should not be modified.

9. Locate and run the DiableEWF.bat file on the MDS C:/P3010/bin folder.

Figure 8-24: EEI Module MAC Address

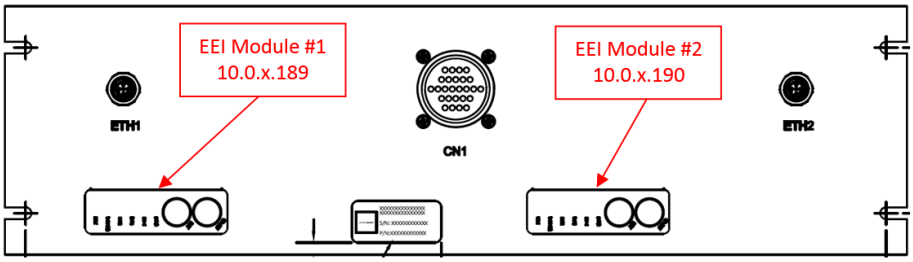


Figure 8-25: EEI Panel with Module Identification

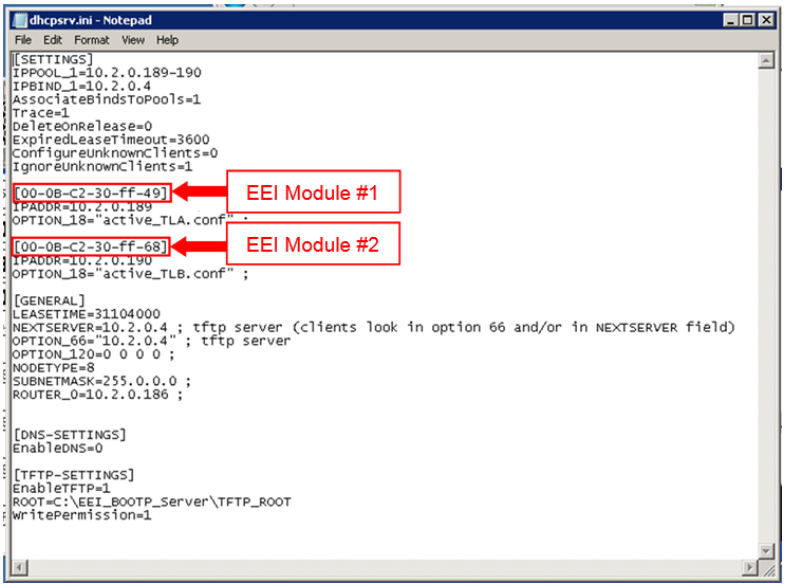


Figure 8-26: INI File with EEI Module MAC Addresses (dhcpsvr.ini)

10. Locate and run the EnableEWF.bat file on the MDS C:/P3010/bin folder.

11. Reboot the MDS.

12. Verify the MDS is communicating with the EEI modules.

    - The TOD Network Status test can be used to determine if communication is present (refer to Section 7.3, ETB/ECN Troubleshooting).

    - The EEIM interface screen, on the MDS, can also be viewed to determine if modules are connected (see Figure 8-27).

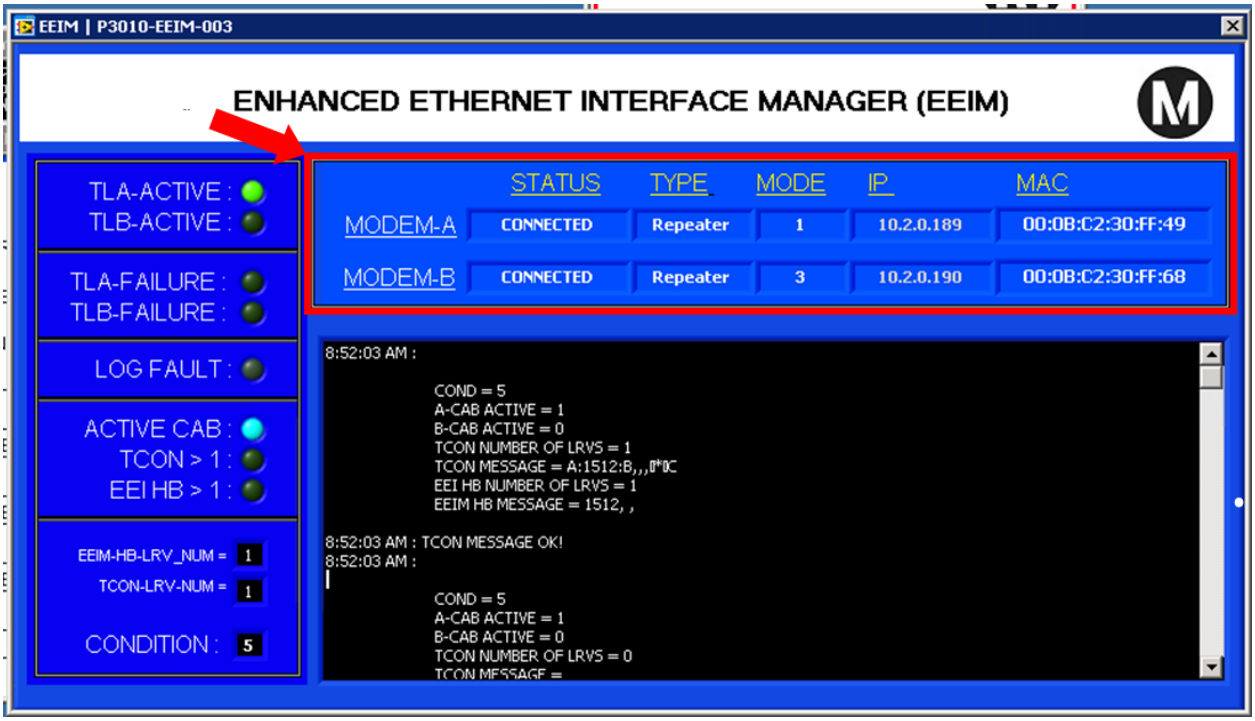


Figure 8-27: EEIM Software Interface Screen on MDS

8.5 ECN (Ethernet Switches)

Provided below are instructions on how to reset and recommission ECN devices (Ethernet switches) via the P3010 Ethernet Utility. Note that if the utility has not been previously installed on the PTU, follow the setup procedure discussed in the *P3010 Ethernet Utility Quick Start Guide* which is provided with the installer.

Equipment Needed:

- PTU Computer
- RJ45-to-M12 Ethernet cable
- P3010 Ethernet Utility (PTU Application)

Instructions: P3010 Ethernet Utility Login

1. Connect a PTU to the Ethernet network onboard the vehicle using the RJ45-to-M12 Ethernet cable (see chapter 9 for additional information/help).

2. Run the P3010 Ethernet Utility Application. The Login Screen will appear once the application is running (see Figure 8-28).

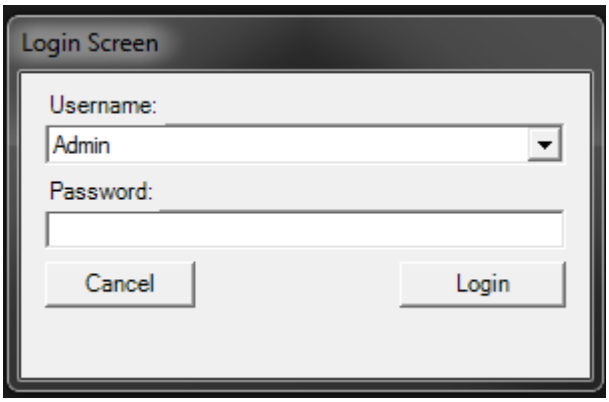


Figure 8-28: P3010 Ethernet Utility Login Screen

3. Login to the application using the following credentials:

   - Username:
   - Password:

4. Enter the LRV number in the top-right corner of the application's main screen and then commit settings (see Figure 8-29).

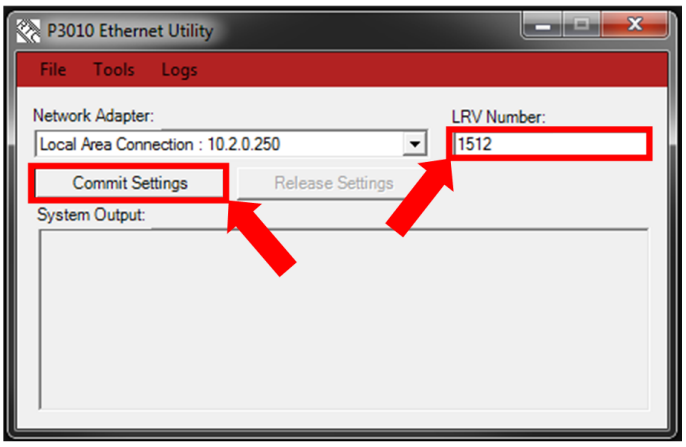


Figure 8-29: P3010 Ethernet Utility Main Screen

Instructions: Resetting Switches

The “Reset Switches” utility provides a quick way to reset all the switches of a desired type. If the entire network needs reset, reset the switches/router in the following order:

1st: N-Tron 702W-M12 switch
2nd: N-Tron 708 & 716 switches
3rd: Moxa Tn5516 switches
4th: Westermo Viper switch/router

NOTE: When resetting the entire network, once the Moxa switches are reset, they must be disconnected from the Westermo switch. Disconnect port 10 on LAN4B.

NOTE: This tool resets all the switches of one specific type (e.g. all N-Tron 708s)

1. Locate the “Reset Switches” option within the tools tab (see Figure 8-30).

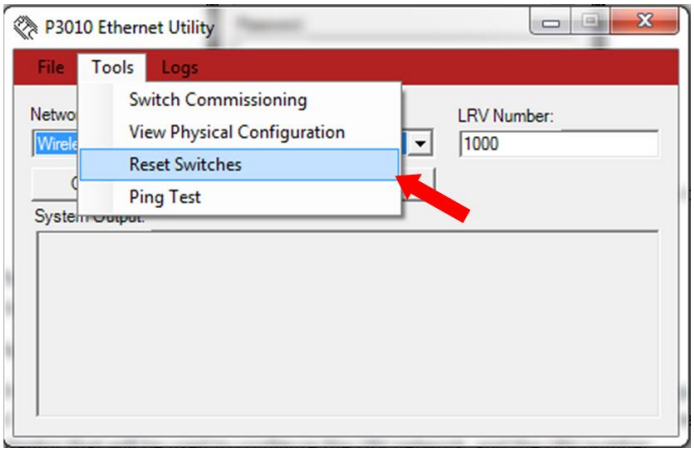


Figure 8-30: Reset Switch Option within Main Screen Tools

2. Select the type of switch to reset.

3. Once the type of switch is selected, press the “Reset” button (see Figure 8-31).

NOTE: The PTU keyboard cannot be used during the resetting process. The application must send commands to the switches via keystrokes.

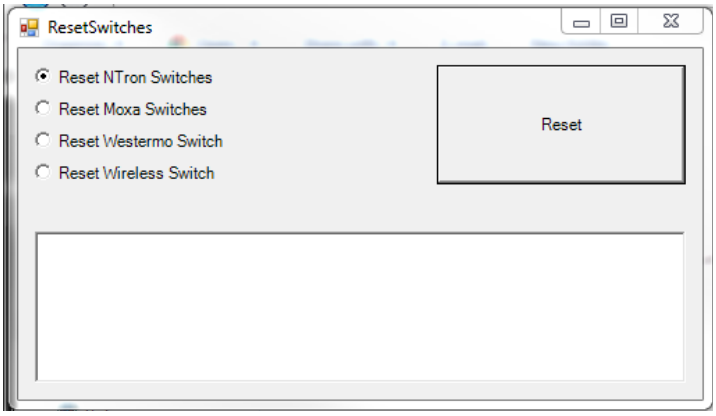


Figure 8-31: Reset Switches Selection Screen

4. Wait until the Reset Switch window declares the reset complete (see Figures 8-32 and 8-33).

   - The reset process is automatic.

   - The application will notify the user upon successful completion of resetting all the switches.

5. Close the Reset Switch window by pressing the “Close” button at the bottom right corner.

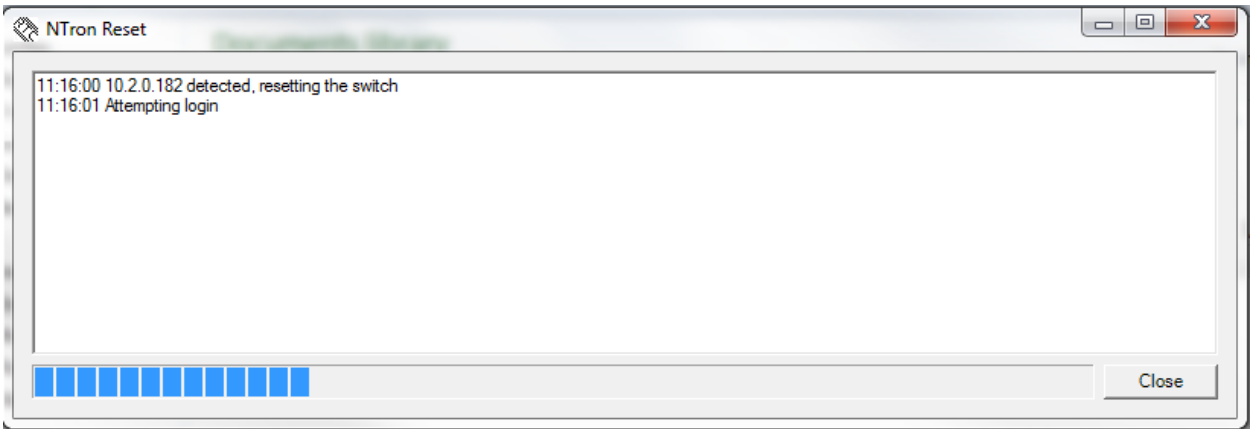


Figure 8-32: Reset Switch Window (in progress)

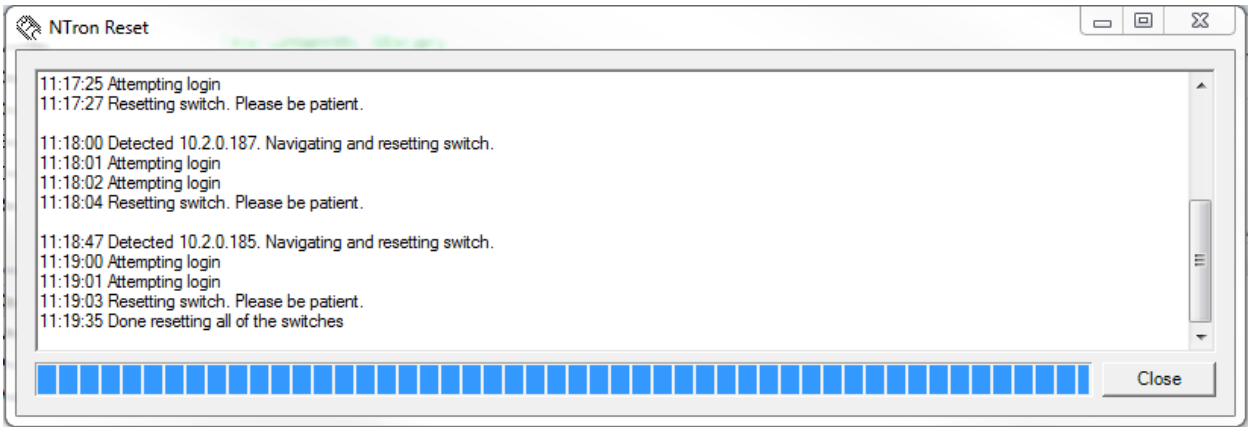


Figure 8-33: Reset Switch Window (complete)

Instructions: Switch Commissioning

The commissioning tool is used for configuring switches and routers on the P3010 network. If the entire network needs configured, configure the switches/router in the following order:

1st: N-Tron 702W-M12 switch

2nd: N-Tron 708 & 716 switches

3rd: Moxa Tn5516 switches

4th: Westermo Viper switch/router

Prior to configuring the network, the user must obtain the MAC addresses of the N-Tron 708 switches, N-Tron 716 switches, and the Moxa Tn5516 switches. The MAC address must be mapped to the respective LAN. The MAC address information is provided on a label placed on each Ethernet switch.

NOTE: If the user is commissioning the two Moxa Tn-5516-8PoE switches, then they will need to disconnect port 15 of LAN 4B. Once the configuration is complete then the user must reconnect port 15 of LAN 4B.

1. Locate the “Switch Commissioning” option within the tools tab (see Figure 8-34).

2. Select the desired switch type and press the “Find Network Devices” button (see Figure 8-35).

3. Determine the MAC address of each switch

   - Check the label provided on each switch if unsure of the MAC address

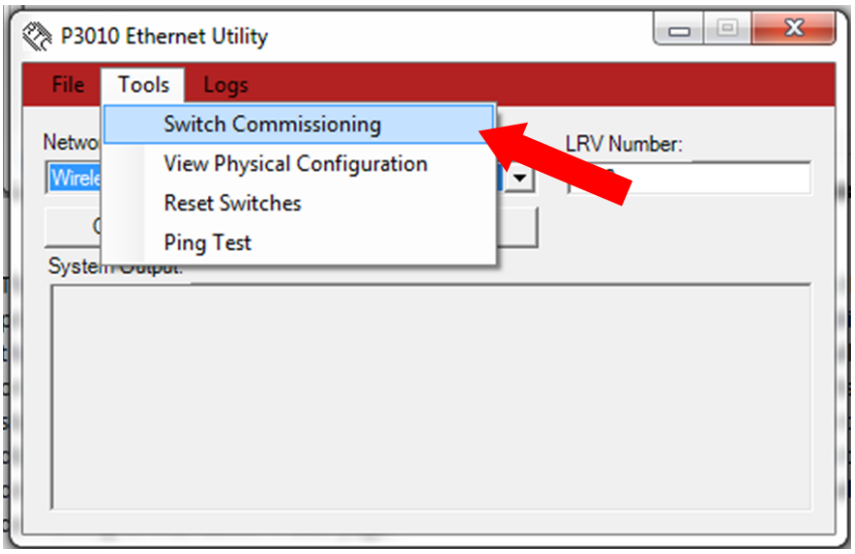


Figure 8-34: Switch Commissioning Option within Main Screen Tools

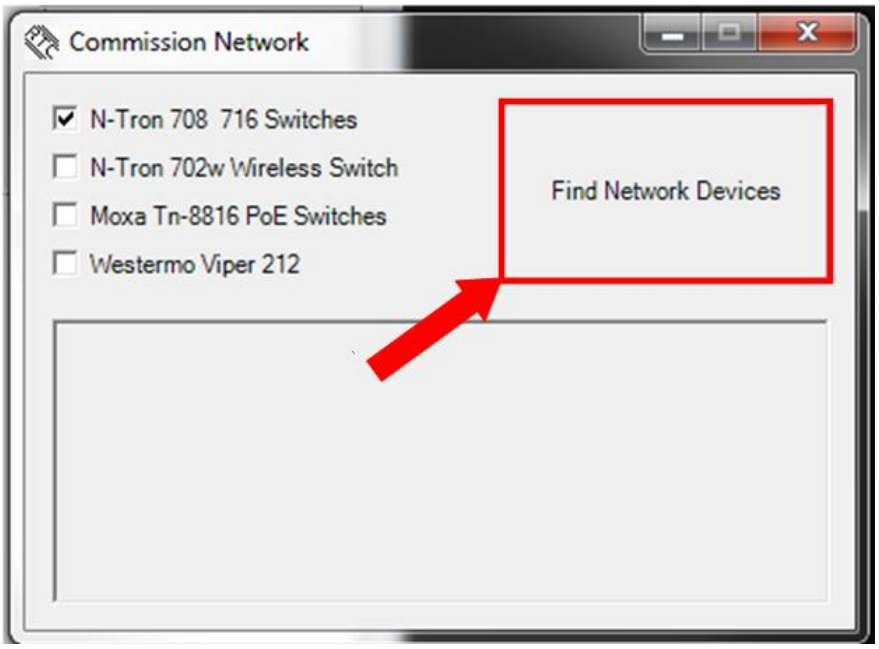


Figure 8-35: Switches Commissioning Selection Screen

4. Associate a MAC address to each switch (see Figure 8-36).

   - Select a switch in the left-hand window
   - Select a MAC address in window to the right

NOTE: If a mistake is made, the user can disassociate a Switch/MAC pairing.

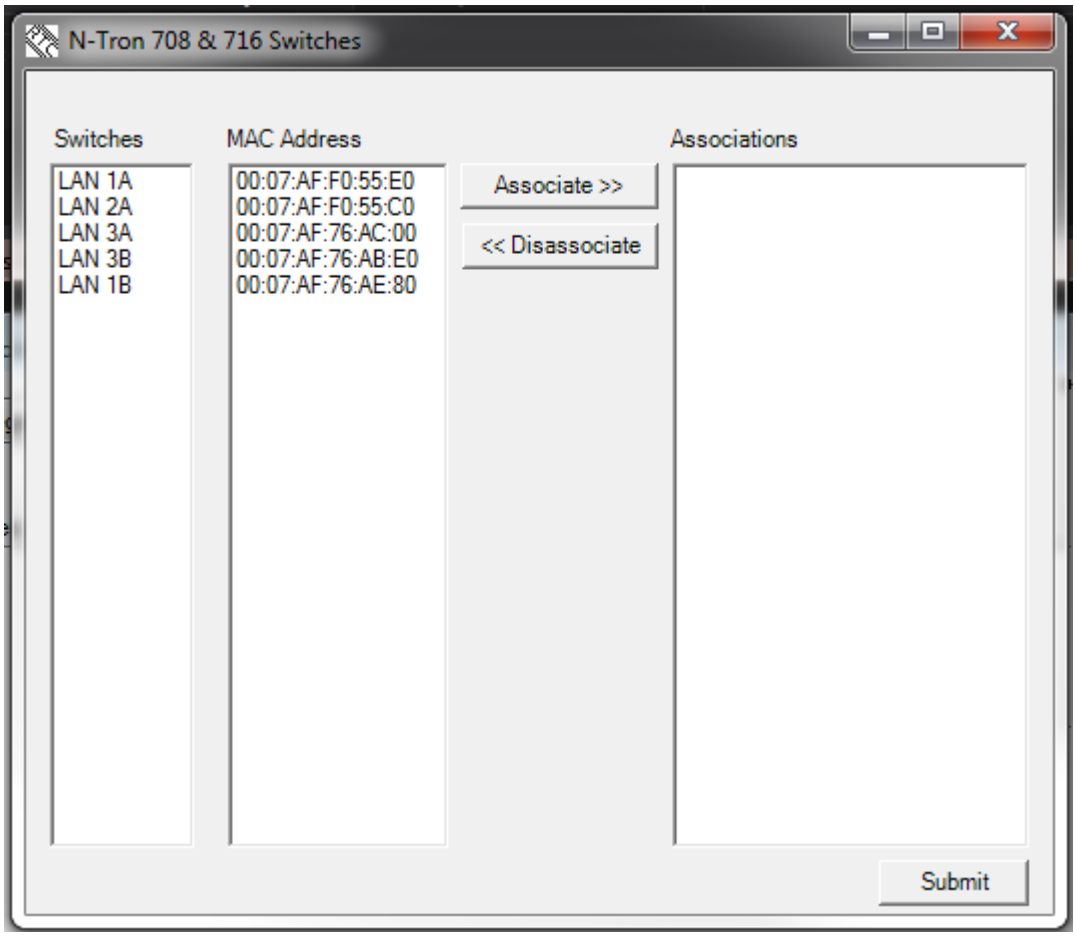


Figure 8-36: MAC & LAN Association Window

5. Once each switch has a MAC address associated with it, press the “Associate” button.

NOTE: The interface is completely automated. Once the window is launched, the application will automatically start configuring the switches based off the information given to it from the Address Association window.

6. Wait until the Switch Configuration window declares the reset complete (see Figure 8-37).

7. Close the Switch Configuration window by pressing the “Close” button at the bottom right corner (see Figure 8-38).

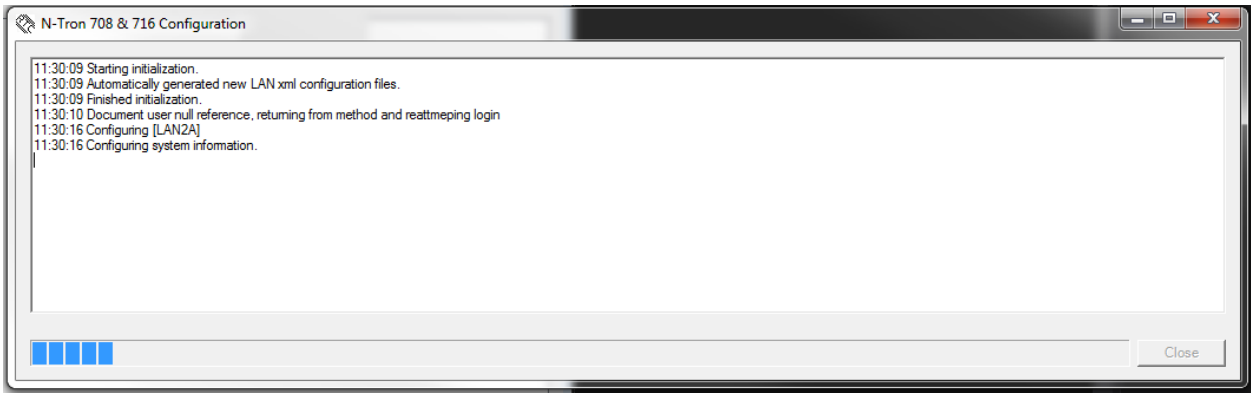


Figure 8-37: Switch Configuration Window (in progress)

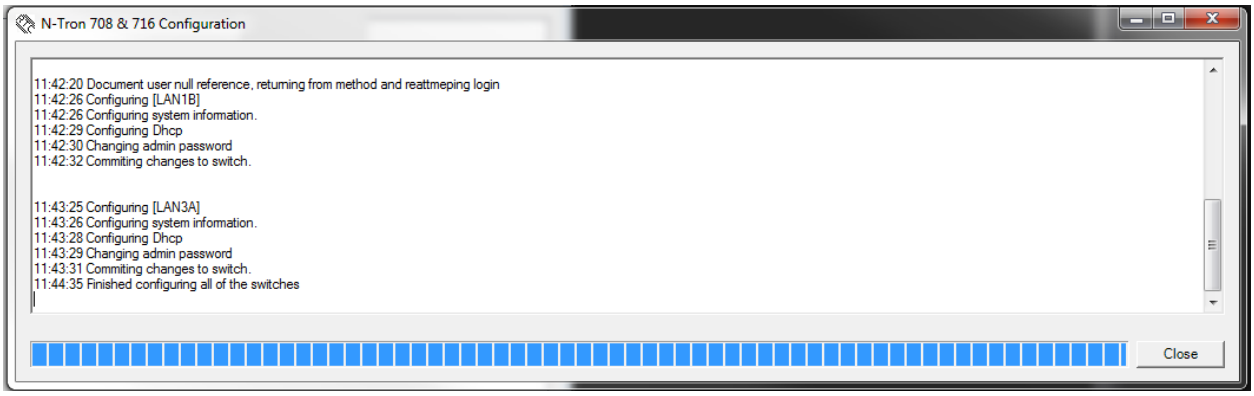


Figure 8-38: Switch Configuration Window (complete)

8. Verify the switches were configured correctly.

   - The TOD Network Status test can be used to determine if communication is present (refer to Section 7.3, ETB/ECN Troubleshooting).

8.6 Physical Configuration Reference Tool

The P3010 Ethernet Utility provides a P3010 Ethernet network configuration reference which allows the user to view the ideal configuration of each Ethernet switch on the LRV.

The user is first required to enter a car number commit the setting, if the user hasn't done so already. After, select the "View Physical Configuration" option within the Tools tab (see Figure 8-39). From here the user can select the desired switch and obtain information regarding the ideal configuration of that switch – what IP address the switch will provide and the P3010 device that connects to it (see Figure 8-40).

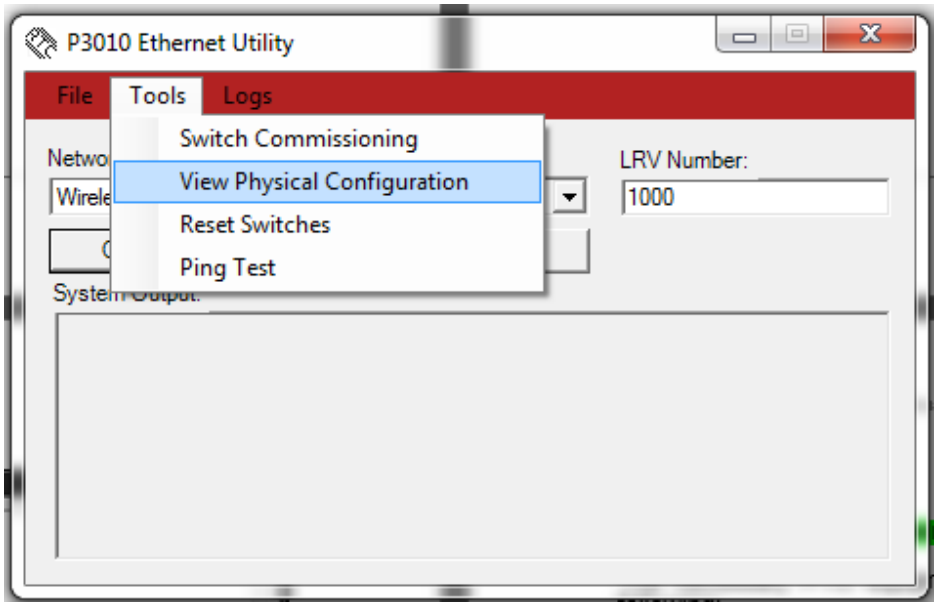


Figure 8-39: P3010 Ethernet Utility Physical Configuration Option in Tools tab

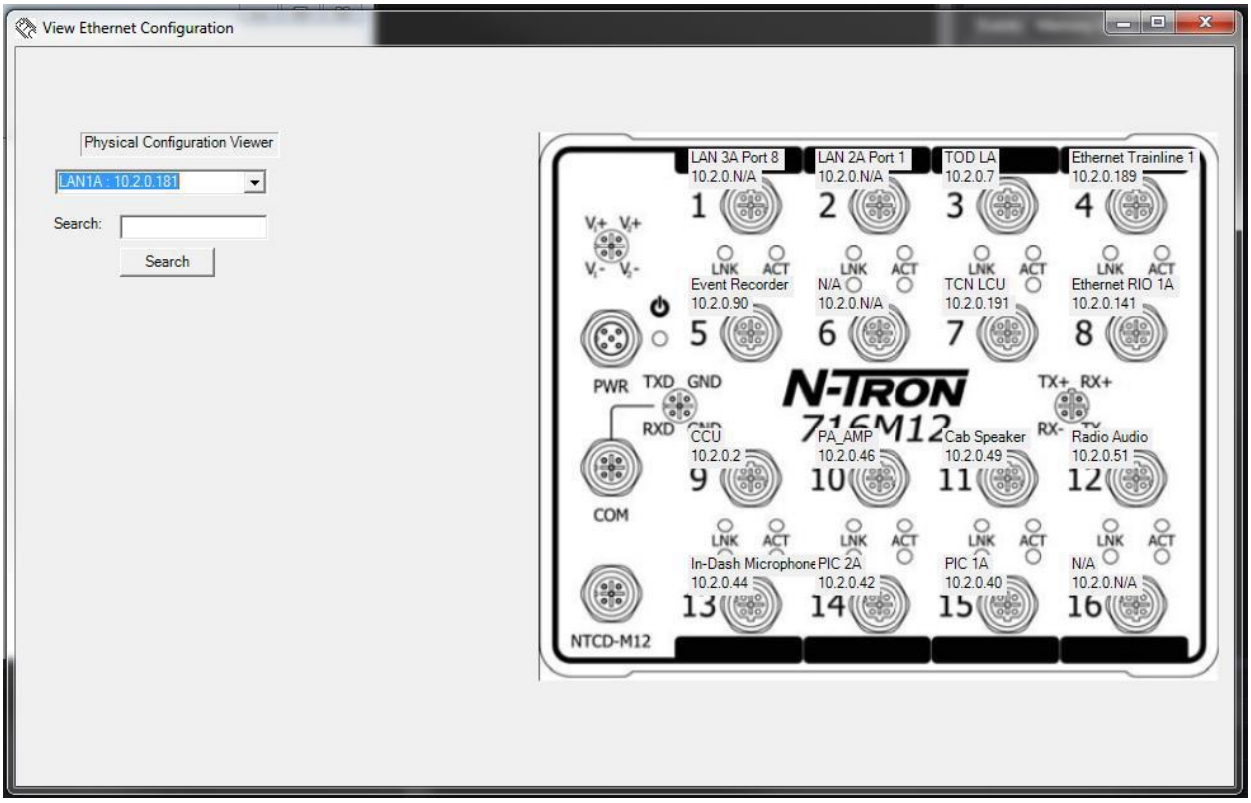


Figure 8-40: P3010 Ethernet Utility Physical Configuration Screen (LAN1A example)

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CHAPTER 9.0

PTU CONNECTION TO THE P3010 ETHERNET NETWORK

9.1 Introduction

Ethernet Network onboard the P3010 LRV. Obtaining diagnostic logs, downloading surveillance footage, and replacing equipment is just a few examples when this will be necessary. This section is dedicated to the connection of PTU's on the P3010 Ethernet Network.

9.2 Necessary Equipment

The necessary PTU equipment to connect to the P3010 Ethernet network are the following:

- PTU Computer
- RJ45-to-M12 Ethernet cable

The user may or may not need additional vendor specific PTU application to complete the desired task.

9.3 Dedicated Connection Points on the Vehicle

There are four dedicated PTU connection ports on the vehicle: one in each cab electric equipment locker and one in the articulation electric locker. The PTU ports in the A-Unit and B-Unit cabs are located on the CCU and MDS panel respectively (see Figure 9-1 and 9-2). The PTU ports in the A-Unit and B-Unit and articulation are direct hook-ups to LAN3A and LAN3B switch respectively.

The PTU ports provide assigned IP (as shown in Table 9-1). Any device that connects to one of those particular ports will receive the associated IP address if the receiving device is set to obtain an IP address automatically (i.e. via DCHP). A static IP address may also be chosen by the user if desired.

Table 9-1. PTU Connection Port Information

Location	Ethernet Switch & Port	IP Address
A-Unit Cab (CCU Panel)	LAN2A – Port 10	10.0.x.250
A-Unit Articulation	LAN3A – Port 5	10.0.x.251
B-Unit Cab (MDS Panel)	LAN2B – Port 6	10.0.x.252
B-Unit Articulation	LAN3B – Port 5	10.0.x.253

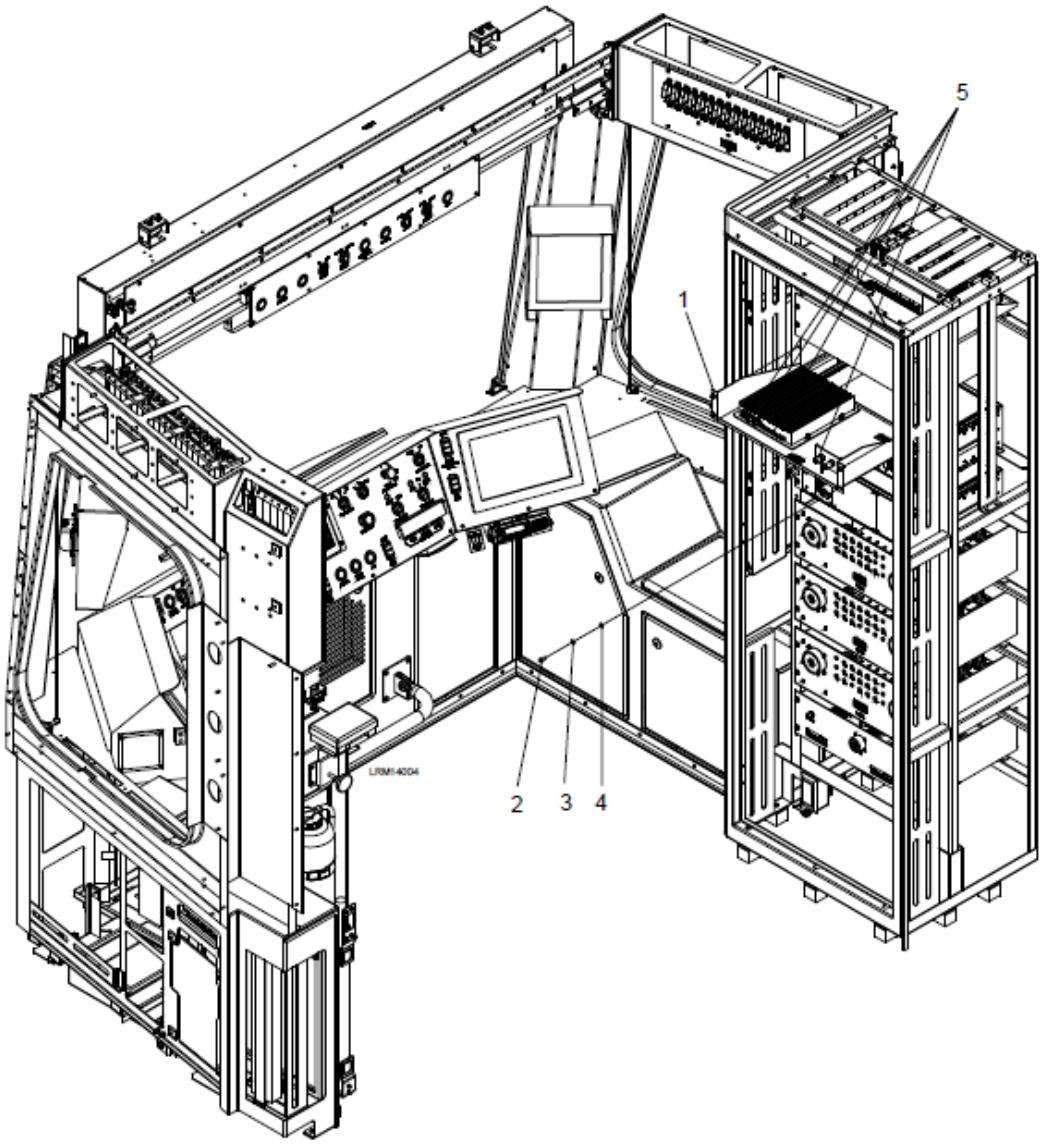

Figure 9-1: PTU Port Located on the CCU Panel (A-Unit Cab)

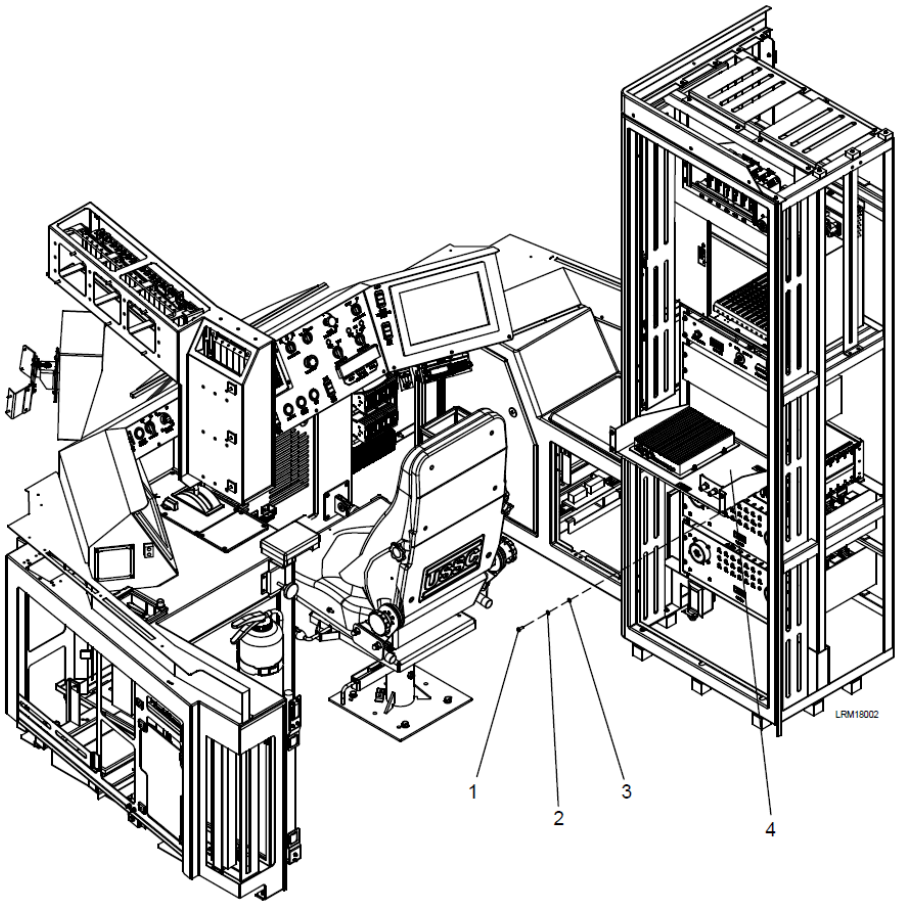

Figure 9-2: PTU Port Located on the MDS Panel (B-Unit Cab)

9.4 Setting Up and Verifying Ethernet Connection

Once the PTU cable is connected to both the PTU and the desired connection port on the vehicle, the Ethernet switch will provide the PTU with an IP address within a few seconds. To verify a PTU is both (a) set to obtain IP address automatically and (b) has received an IP address.

1. Open “Network and Sharing Center” (see Figure 9-3).
2. Click on the Local Area Network Connection link (see Figure 9-4).
3. Click the Properties button within the Local Area Connection Status (see Figure 9-5).
4. Select IPv4 and press the properties button within the Local Area Connection Properties (see Figure 9-6).
5. Verify the PTU is set to “Obtain IP Address Automatically” (see Figure 9-7).
6. Navigate to the Local Area Connection Status screen and select the Details button (see Figure 9-8).

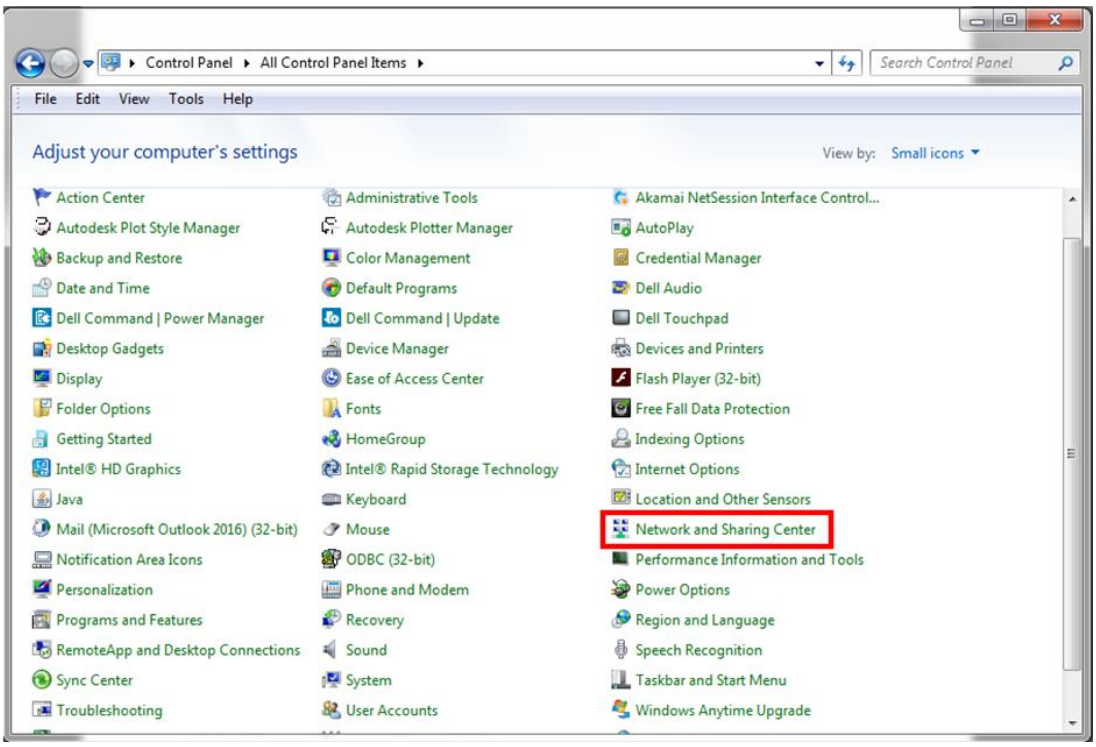

Figure 9-3: Network and Sharing Center within Windows Control Panel

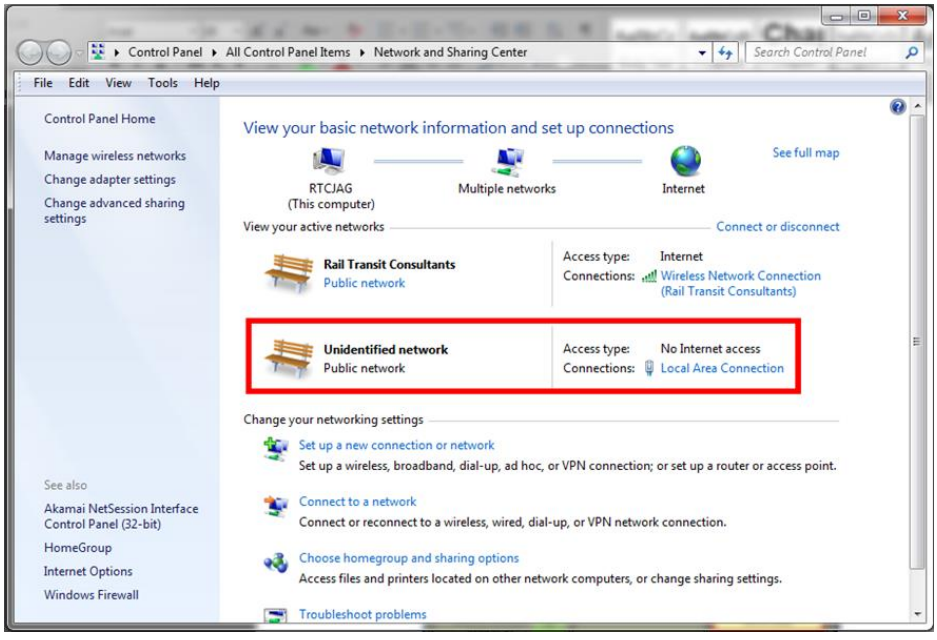

Figure 9-4: Wired Local Area Network Connection

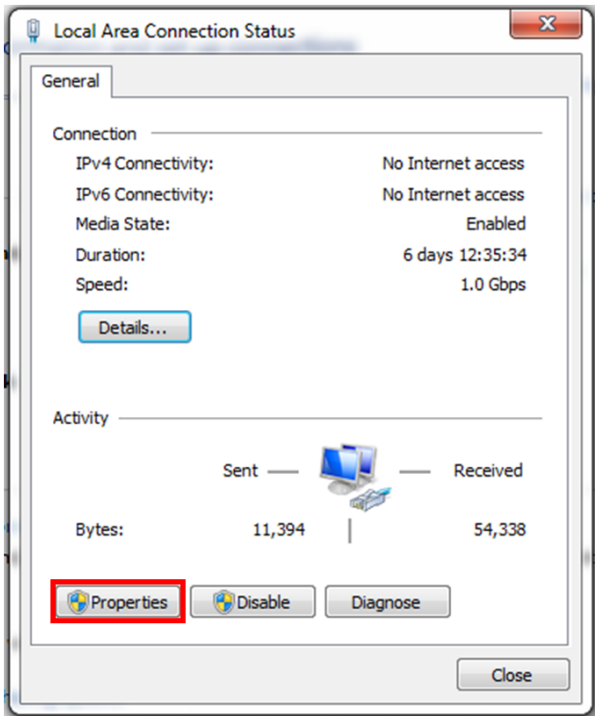

Figure 9-5: Local Area Connection Status (Properties Button)

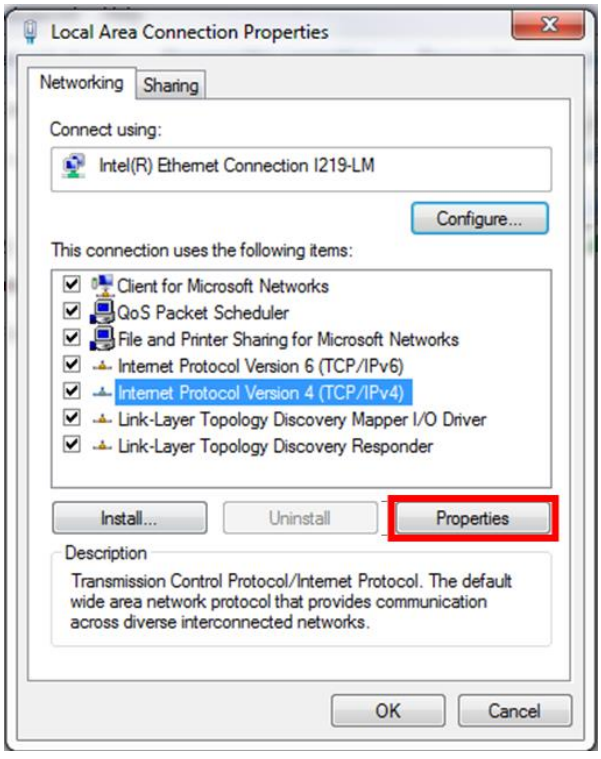

Figure 9-6: LAN Properties Menu

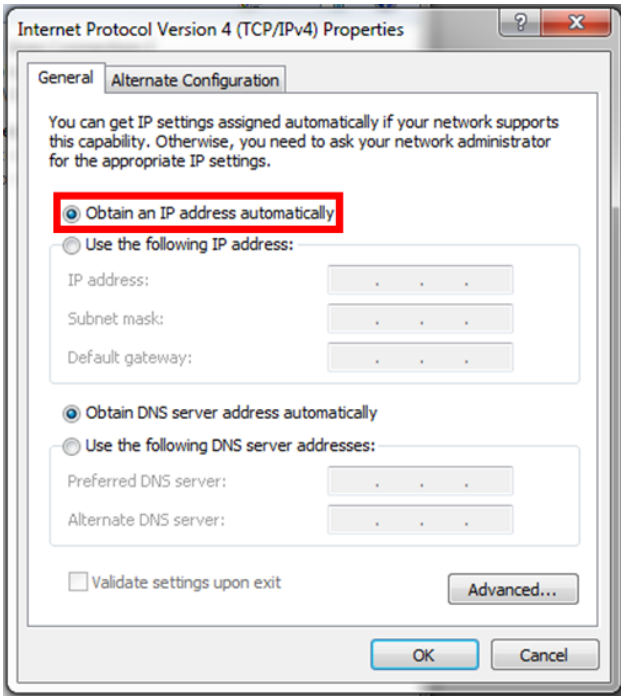

Figure 9-7: DHCP Properties with IPv4

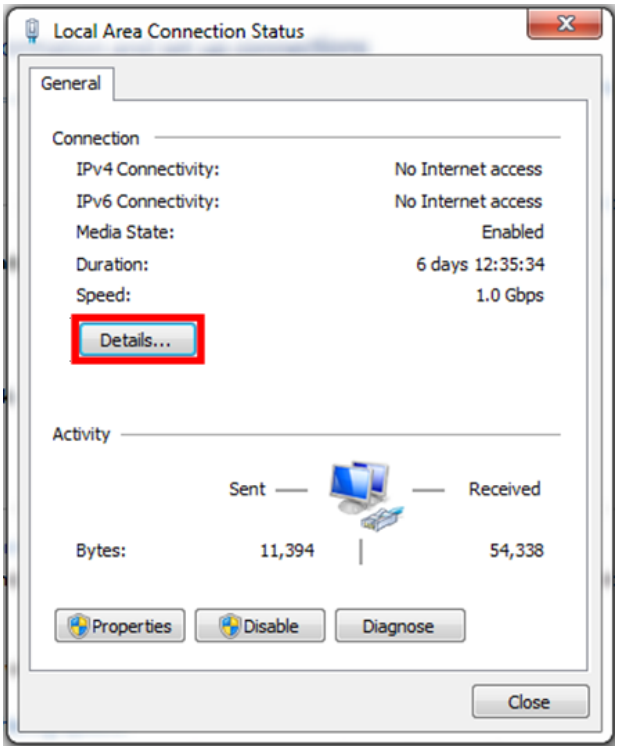

Figure 9-8: Local Area Connection Status (Details Button)

7. Verify the IPv4 address matches the value expected in Table 9-1 (see Figure 9-9).

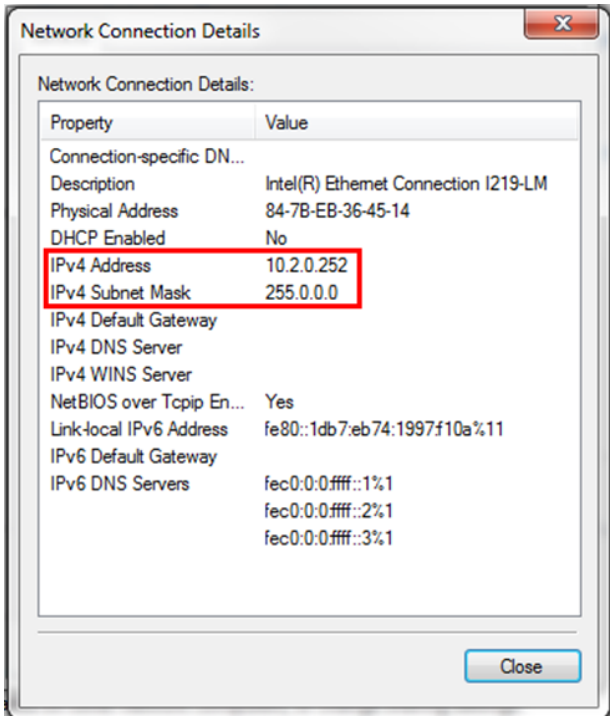

Figure 9-9: Network Connection Details

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APPENDIX A

LIST OF ETHERNET IP ADDRESSES

Table A1-1. IP Address List

IP Assignment	Device Name
10.x.y.2	CCU
10.x.y.4	MDS
10.x.y.6	TOD A-End Right ETH1
10.x.y.7	TOD A-End Left ETH1
10.x.y.8	TOD B-End Right ETH1
10.x.y.9	TOD B-End Left ETH1
172.16.0.16	TOD A-End Right ETH2
172.16.0.17	TOD A-End Left ETH2
172.16.0.18	TOD B-End Right ETH2
172.16.0.19	TOD B-End Left ETH2
10.x.y.21	Side Destination Sign A-End
10.x.y.22	Side Destination Sign B-End
10.x.y.23	PID Controller A-End
10.x.y.24	PID Controller B-End
10.x.y.40	PIC 1A
10.x.y.41	PIC 1B
10.x.y.42	PIC 2A
10.x.y.43	PIC 2B
10.x.y.44	Cab Mic A-End
10.x.y.45	Cab Mic B-End
10.x.y.46	Interior PA Amp
10.x.y.47	AADS Amp
10.x.y.49	Cab Speaker A-End
10.x.y.50	Cab Speaker B-End
10.x.y.51	Radio Speaker A-End
10.x.y.52	Radio Speaker B-End
10.x.y.56	PA Exterior Right
10.x.y.57	PA Exterior Left
10.x.y.70	ECUA
10.x.y.71	ECUB
10.x.y.72	ECUC
10.x.y.75	PLUA
10.x.y.76	PLUB
10.x.y.81	Front Destination Sign A-End
10.x.y.82	Front Destination Sign B-End
10.x.y.83	HVAC A-End
10.x.y.84	HVAC B-End

Table A1-1. IP Address List (cont'd.)

IP Assignment	Device Name
10.x.y.87	DCU
10.x.y.88	ATC
10.x.y.89	APS
10.x.y.90	Event Recorder
10.x.y.92	Automatic Passenger Counter
172.16.0.110	NVR (ETH1)
10.x.y.111	NVR (ETH 2)
10.x.y.112 172.16.0.112	INTERIOR CAMERA 1A (A-End)
10.x.y.113 172.16.0.113	INTERIOR CAMERA 2A (A-End)
10.x.y.114 172.16.0.114	FORWARD VIEW CAMERA (A-End)
10.x.y.115 172.16.0.115	REAR VIEW CAMERA RIGHT (A-End)
10.x.y.116 172.16.0.116	REAR VIEW CAMERA LEFT (A-End)
10.x.y.117 172.16.0.117	CAB VIEW CAMERA (A-End)
10.x.y.118 172.16.0.118	INTERIOR CAMERA 1B (B-End)
10.x.y.119 172.16.0.119	INTERIOR CAMERA 2B (B-End)
10.x.y.120 172.16.0.120	FORWARD VIEW CAMERA (B-End)
10.x.y.121 172.16.0.121	REAR VIEW CAMERA RIGHT (B-End)
10.x.y.122 172.16.0.122	REAR VIEW CAMERA LEFT (B-End)
10.x.y.123 172.16.0.123	CAB VIEW CAMERA (B-End)
10.x.y.124 172.16.0.124	ROOF CAMERA (Not Installed on most LRVs)
10.x.y.141	Ethernet RIO 1A
10.x.y.142	Ethernet RIO 2A
10.x.y.144	Ethernet RIO 1B
10.x.y.145	Ethernet RIO 2B
10.x.y.180	WLAN
10.x.y.181	LAN 1A
10.x.y.182	LAN 2A
10.x.y.183	LAN 3A
10.x.y.184	LAN 4A
10.x.y.185	LAN 1B

Table A1-1. IP Address List (cont'd.)

IP Assignment	Device Name
10.x.y.186	LAN 2B
10.x.y.187	LAN 3B
10.x.y.188	LAN 4B
10.x.y.189	EEI Module ETH1
10.x.y.190	EEI Module ETH2
10.x.y.191	TCN RIO A-End ETH0
10.x.y.193	TCN RIO B-End ETH0
10.x.y.250	PTU Port (A-End Cab)
10.x.y.251	PTU Port (A-End Articulation)
10.x.y.252	PTU Port (B-End Articulation)
10.x.y.253	PTU Port (B-End Cab)

IP ADDRESS CONVERSION:

The IP addresses on the 10-dot network incorporate a car number identifier and a device identifier within the 2nd, 3rd and 4th octets. Figure A1-1 shows a breakdown of the 10-dot IP structure.

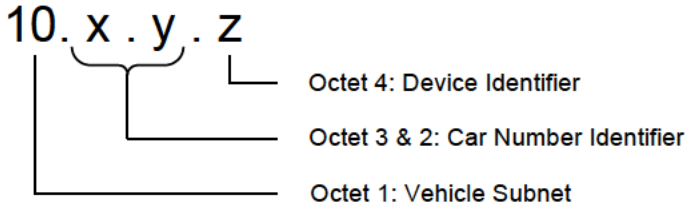

Figure A1-1: IP Address Octet Diagram

NOTE: Figure A1-1 shows the 2nd, 3rd, and 4th octet as x, y, and z, respectively. The letter used to reference a particular octet is not important – only the octet which the letter refers to is. For example, other documentation may use 10.a.b.c. In this case, c is the 4th octet which is the device identifier.

The 4th octet (device identifier) is reserved for specific devices (e.g. .70 corresponds to ECU A). The 2nd and 3rd octet are used to determine what car that device is located on. There is a formal procedure used to calculate the values of the 2nd and 3rd octet which is provided below. Following the formal procedure, a simplified method is introduced which is applicable to all LA Metro's P3010 fleet (P3010 cars 1001 to 1235).

Follow the steps below to calculate the 2nd and 3rd octet (car number identifier) from a P3010 car number. This example will use car number 1197.

Step 1: Subtract 1000 from the desired car number (e.g. 1197 – 1000 = 197)

Step 2: Calculate the 2nd octet by dividing the result from step 1 by 256 and assigning the integer quotient to the 2nd octet (e.g. 197 / 256 = **0**.76953125, where **0** is the integer quotient. Therefore, 2nd octet = 0)

Step 3: Calculate the 3rd octet by multiplying the remainder from step 2 by 256 and assigning the product to the 3rd octet (e.g. 0.**76953125** * 256 = 197, where .**76953125** is the remainder. Therefore, 3rd octet is 197)

Notice that the 2nd octet was the quotient result from the division of **256** (from step 2). The value obtained in step 1 will always be less that 256 for LA Metro's P3010 fleet since the car numbers span from 1001 to 1235. Therefore, the 2nd octet for any 10-dot IP address on a P3010 vehicle will always be **0**. This simplifies the process of obtaining the car number identifier by eliminating steps 2 and 3.

NOTE: For all LA Metro P3010 vehicles, the car number identifier for 10-dot IP addresses can be simplified to the following:

2nd Octet = 0 & 3rd Octet = Car Number - 1000

APPENDIX B

LIST OF MVB PORTS

Table A2-1 lists all the MVB ports used on the P3010 vehicle. Note that not all ports are viewable on the TOD. The TOD displays most of the subsystems' status ports but excludes the command signals. Some subsystems have closed ports which do not provide their information to the MVB RIOs or WTB Gateways, such as the ADU ports – the ADU only communicates with the ATC.

The right-most column (Displayed on TOD MVB Port Screen) lists whether that particular port can be viewed on the TOD using the MVB Ports Screen within the Maintenance Screen. The Source Device column lists the responsible source or producer of data on that port.

Table A2-1. MVB Port List

MVB Port	Source Device	Port Name/Description	Displayed on TOD MVB Port Screen
100	GW A & GW B	Train Traction Control	Yes
101	GW A & GW B	MDS Train Data	No
102	GW A & GW B	AADS Train Data	No
103	RIOA	APC Data	No
150	RIO A	ECU Car Signals 1	No
151	RIO B	MDS Car Signals 1	No
152	RIO A	MDS Car Signals 2	No
153	RIO A	MDS Car Signals 3	No
154	RIO A	MDS Car Signals 4	No
256	GW A	Gateway Command A	No
257	GW A	GW Status A	No
400	GW A	Gateway B Command	No
401	GW B	GW B Status	No
512	PLU A	PLU A Status 1	Yes
640	PLU B	PLU B Status 2	Yes
768	ECU A	ECU A Status 1	Yes
769	ECU A	ECU A Status 2	Yes
800	ECU C	ECU C Status 1ECU B Status 1	Yes
801	ECU C	ECU C Status 2	Yes
896	ECU B	ECU B Status 1	Yes
897	ECU B	ECU B Status 2	Yes
1024	RIO A	HVAC A Command Signals	No
1025	HVAC A	HVAC A Status Signals	Yes
1152	RIO B	HVAC B Command Signals	No
1153	HVAC B	HVAC B Status Signals	Yes
1280	ADU A	ADU A Data 1	No
1408	ATC	Exp ATC Traction Cmd	Yes
1409	ATC	ATC Data 1	Yes
1410	ATC	ATC ADU Data	No
1411	RIO A	Exp ATC Rate Cmd A	No
1412	RIO B	Exp ATC Rate Cmd B	No
1440	ADU B	ADU B Data 1	No
1536	RIO B	APS Command Signals	No
1537	APS	APS Status Signals	Yes
1792	RIO A	ER Command A	No
1793	RIO B	ER Command B	No
1794	ER	ER Status 1	No
1795	ER	ER Status 2	Yes

Table A2-1. MVB Port List (cont'd.)

MVB Port	Source Device	Port Name/Description	Displayed on TOD MVB Port Screen
2176	RIO A	DCU Command Signals A	No
2177	RIO B	DCU Command Signals B	No
2178	DCU	DCU Status Signals	Yes
2304	RIO A	RIO A StId	No
2305	RIO A	RIO A StAux	No
2306	RIO A	RIO A CmdAux	No
2307	RIO A	RIO A StDopwm	No
2308	RIO A	RIO A CmdDopwm	No
2309	RIO A	RIO A StDi1	No
2310	RIO A	RIO A StDi2	No
2311	RIO A	Exp Car A Traction Cmd	No
2312	RIO A	Exp Car A Trainline Cmd	No
2314	RIO A	MVB RIO 1A Data	Yes
2315	RIO A	MVB RIO 2A Data	No
2432	RIO B	RIO B StId	No
2433	RIO B	RIO B StAux	No
2434	RIO B	RIO B CmdAux	No
2435	RIO B	RIO B StDopwm	No
2436	RIO B	RIO B CmdDopwm	No
2437	RIO B	RIO B StDi1	No
2438	RIO B	RIO B StDi2	No
2439	RIO B	Exp Car B Traction Cmd	No
2440	RIO B	Exp Car B Trainline Cmd	No
2441	RIO B	MVB RIO 1B Data	Yes
2442	RIO B	MVB RIO 2B Data	No
8000	RIO A	RIO A Train Data to MDS Port 8000	No
8100	RIO A	RIO A Train Data to MDS Port 8100	No
9000	RIO B	RIO B Train Data to MDS Port 9000	No
9100	RIO B	RIO B Train Data to MDS Port 9100	No

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APPENDIX C

CAB ETHERNET SWITCH IDENTIFICATION

Figure A3-1 and A3-2 show the Ethernet Switch P3010 IDs for the A-Unit and B-Unit cab ceiling.

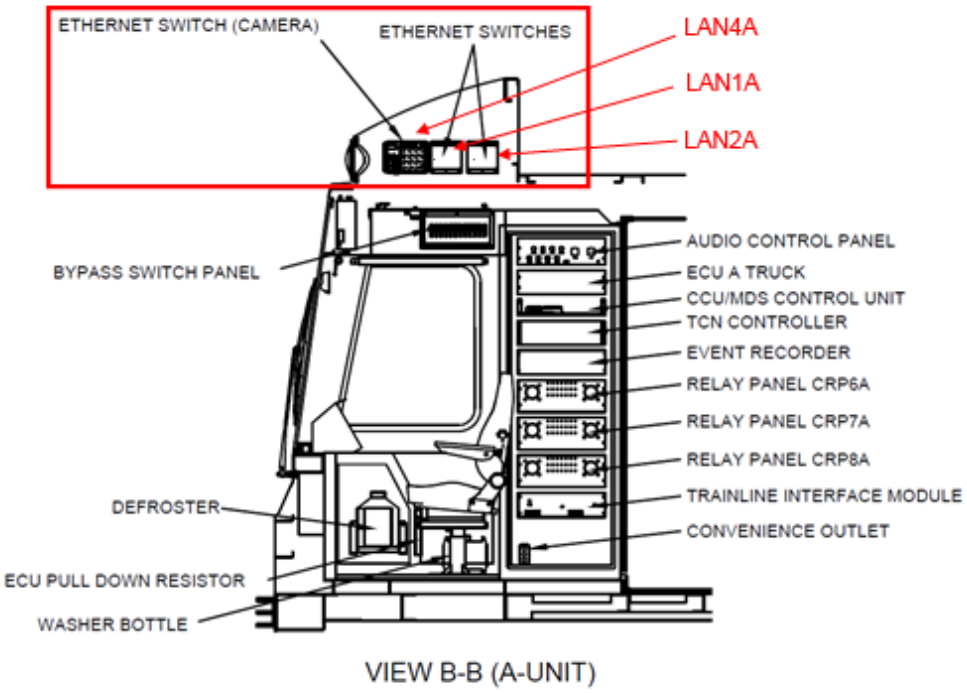

Figure A3-1: A-Unit Cab Ceiling Ethernet Switch IDs

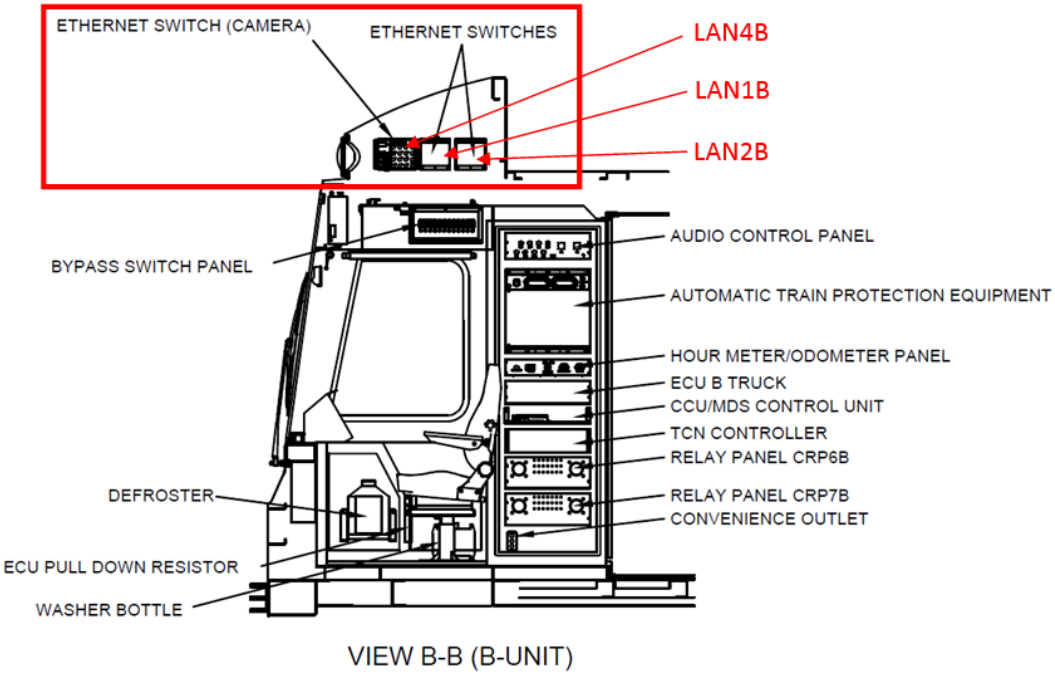

Figure A3-2: B-Unit Cab Ceiling Ethernet Switch IDs

APPENDIX D

TCN MVB CPU MODULE BASE SYSTEM SOFTWARE

The TCN MVB RIO CPU Module requires the Base System Software, *000196-RNT015-02*, installed before it can accept the application software for the P3010 LRV. The Base System Software includes the following:

- Linux Kernal
- Drivers
- FPGA firmware

Not all CPU Modules came pre-installed with this software. In the event that a CPU Module is missing the Base System Software, the CPU module will not connect to the P3010 LRV's Ethernet network.

To install the Base System Software, follow the instructions below:

1. Remove power from the CPU Module.
2. Connect a PTU directly to Ethernet port ETH-1 on the TCN rack.
3. Power on the CPU Module.
4. Set the PTU IPv4 address to **192.168.128.128** with subnet mask **255.255.255.0**

a. Open "Network and Sharing Center".

b. Click on the Local Area Network Connection link .

c. Click the Properties button within the Local Area Connection Status.

d. Select IPv4 and press the properties button within the Local Area Connection Properties.

e. Select "Use the following IP address".

f. Enter the IP address and subnet listed above.

5. Open a web browser and enter the following URL: **http://192.168.128.1**

A webpage similar to the one in Figure A4-1 will display.

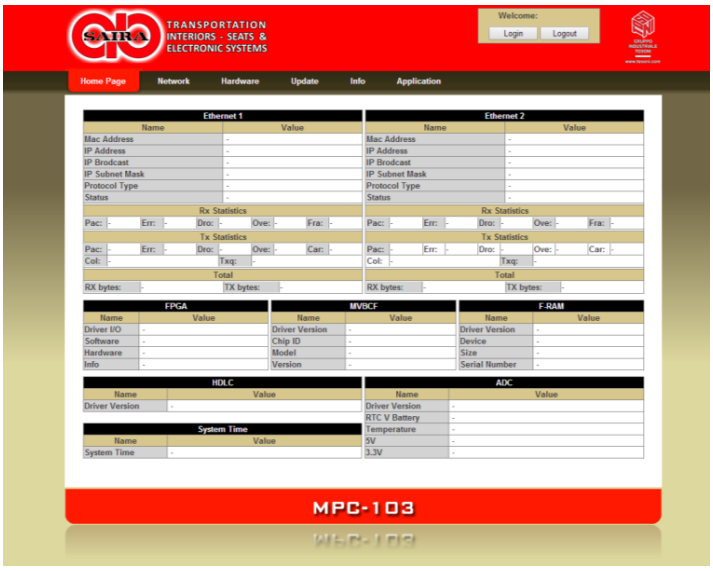

Figure A4-1: Initial Webpage of TCN CPU Module

6. Click the “Login” button in the upper right corner. The login webpage will display, as shown in Figure A4-2.

Figure A4-2: Login Webpage of TCN CPU Module

7. Click on the “Update” tab. The update webpage will display, as shown in Figure A4-3.

Figure A4-3: Updage Webpage of TCN CPU Module (before file transfer)

8. Click the “Select File” button and select the “update.sh” file.
9. Click the “Upload” button.
10. When the file transfer completes, click the “Save” button, as shown in Figure A4-4.

Figure A4-4: Updage Webpage of TCN CPU Module (after file transfer)

11. Wait while the software is being saved, as shown in Figure A4-5.

Figure A4-5: Updage Webpage of TCN CPU Module (after saving file)

12. The CPU Module will reboot, as shown in Figure A4-6.

Figure A4-6: Rebbot Webpage of TCN CPU Module

13. After rebooting, check the version of the Base System Software by clicking on the "Info" tab and viewing the "Flash Image"

The version should be **000196-RNT015-02** – MM dd yyyy – hh:mm:ss UTC.