Metro

P3010
Los Angeles LRV

EVENT RECORDER

Section 1600
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Insert latest changed pages; dispose of superseded pages in accordance with applicable regulations.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 (1600) is **84** consisting of the following:

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PAGE	CHANGE NO.	PAGE	CHANGE NO.
i	5		
ii through iv	0		
v	5		
vi through x	0		
1-1 through 1-6	0		
2-1 through 2-5	0		
2-6 through 2-9	5		
2-10	0		
3-1 through 3-2	0		
4-1 through 4-2	0		
5-1 through 5-8	0		
6-1 through 6-2	0		
7-1 through 7-6	0		
8-1 through 8-8	0		
9-1 through 9-2	0		
I-1 through I-2	0		
A-1 through A-15	0		
A-16 through A-26	5		

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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. Metro shop rules and procedures govern all maintenance work performed on the LRVs. 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.

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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TABLE OF CONTENTS

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

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LIST OF TABLES

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CHAPTER 1.0

GENERAL DESCRIPTION

1.1 Introduction

The event recorder rack (Saira Far Systems - Model: RER103-LAP3010-001) interfaces with the Ethernet (ETH) and MVB networks to record signals from the LRV and store them to the crash hardened memory module. See Figure 1-1. The Event Recorder (ER) is connected to the Multifunction Vehicle Bus (MVB) and the Ethernet networks (ETH) and is located in the A-unit cab locker of the LRV.

The event recorder consists of the following modules:

- Power Supply Board
- CPU Board (with Real Time Clock Battery)
    - EXP Board
    - EMD Board
- Crash Hardened Memory Module

Figure 1-1 shows the front of the Event Recorder Rack. All electrical connections are located on the front of the ER with the power supply located on the far left. This power supply is only for the ER rack and powers both the ER CPU and the Crash Hardened Memory Module (CHMM). The ER CPU is located directly to the right of the power supply and the CHMM is on the far right. The CHMM is mounted to the frame of the rack internally with a cover plate in front of the space it occupies.

Figure 1-1: Event Recorder Rack

1.2 Acronyms and Abbreviations

ATP	Automatic Train Protection
CHMM	Crash Hardened Memory Module
CPU	Central Processing Unit
ER	Event Recorder
ETH	Ethernet
IEEE	Institute of Electrical and Electronics Engineering
LED	Light Emitting Diode
LRV	Light Rail Vehicle
MDS	Monitoring and Diagnostic Systems
MVB	Multifunction Vehicle Bus
POST	Power On Self-Test
PTU	Portable Test Unit
RER	RER103-LAP3010-001 – Saira Electronics Model Number
RIO	Remote I/O
RTC	Real Time Clock
TCN	Train Control Network
TOD	Train Operators Display
USB	Universal Serial Bus

1.3 Event Recorder Description

The Event Recorder (Saira Far Systems – Model: RER103-LAP3010-001) is a standalone system with its data sourced from the MVB and ETH networks. The Event Recorder is housed in its own stand-alone 19-inch rack and is powered by its own power supply. The event recorder application runs on a dedicated processor located in the event recorder rack. The processor has direct connections to both the Ethernet and MVB networks for the ability to sink and source data from the networks. The CHMM is also located in this rack. Data is transferred from the event recorder processor to the CHMM via the backplane of the standalone event recorder rack.

1.4 System Functions

The functionality of the ER in each LRV of a consist will become automatically activated when the Transfer Switch is moved to the ON position and a direction is selected indicating an active train. The ER system time and date are also updated from the master clock during this time. Time originates from the Monitoring and Diagnostic System (MDS). Once the Transfer Switch is moved to the OFF position and has timed out, the ER will automatically turn off. Data is not recorded unless a direction is selected.

1.5 Interfaces to Other Equipment

All signals not originating from sub-systems are wired to the TCN rack RIO (MVB Remote I/O) which is provided by SAIRA/FAR Systems. The TCN rack is a standalone system and has its own processor. This processor is only responsible for sourcing the RIO inputs on a data port on the MVB. The Event Recorder then sinks desired data from the corresponding data port on the MVB and stores it to the CHMM.

1.6 CPU LED Functions

There are eight (8) LEDs that indicate CPU function, see Table 1-1 below:

Table 1-1. CPU LEDs

LED	Color	Function
RUN	Green	Application Run
PWR	Green	Power Supply
ALARM	Red	Alarm Condition
FAULT	Red	Fault Condition
S1	Yellow	ER state indication
S2	Yellow	
S3	Yellow	
S4	Yellow	PTU connection

The four (4) state LEDs indicate the status of the Event Recorder (ER), see Table 1-2 below:

Table 1-2. State LEDs

	Status 1	Status 2	Status 3	RUN	ER Status
ER State	Off	Off	Off	Off	Boot in Progress
	Off	Off	Off	Blinking	DISABLE
	Steady On	Steady On	Steady On	Steady On	POST
	Steady On	Off	Off	Blinking	IDLE
	Off	Fast blinking	Off	Blinking	RECORDING
	Off	Off	Slow Blinking	Blinking	MAINTENANCE

1.7 USB LED Functions

There are six (6) LEDs that indicate USB function, see Table 1-3 below:

Table 1-3. USB LEDs

Label	Description	Color
L1	USB Stick inserted and recognized	Green (about 10 sec after insertion)
L2	Data download in progress	Blinking Green
L3	Download completed, Remove of USB Stick	Green
L4	USB error status	Yellow
L5	USB error status	Yellow
L6	USB error	Red
NOTE: L4, L5 and L6 combinations are discussed more fully in the troubleshooting portion of this manual. When download is complete L3 is on while L1 and L2 are off.		

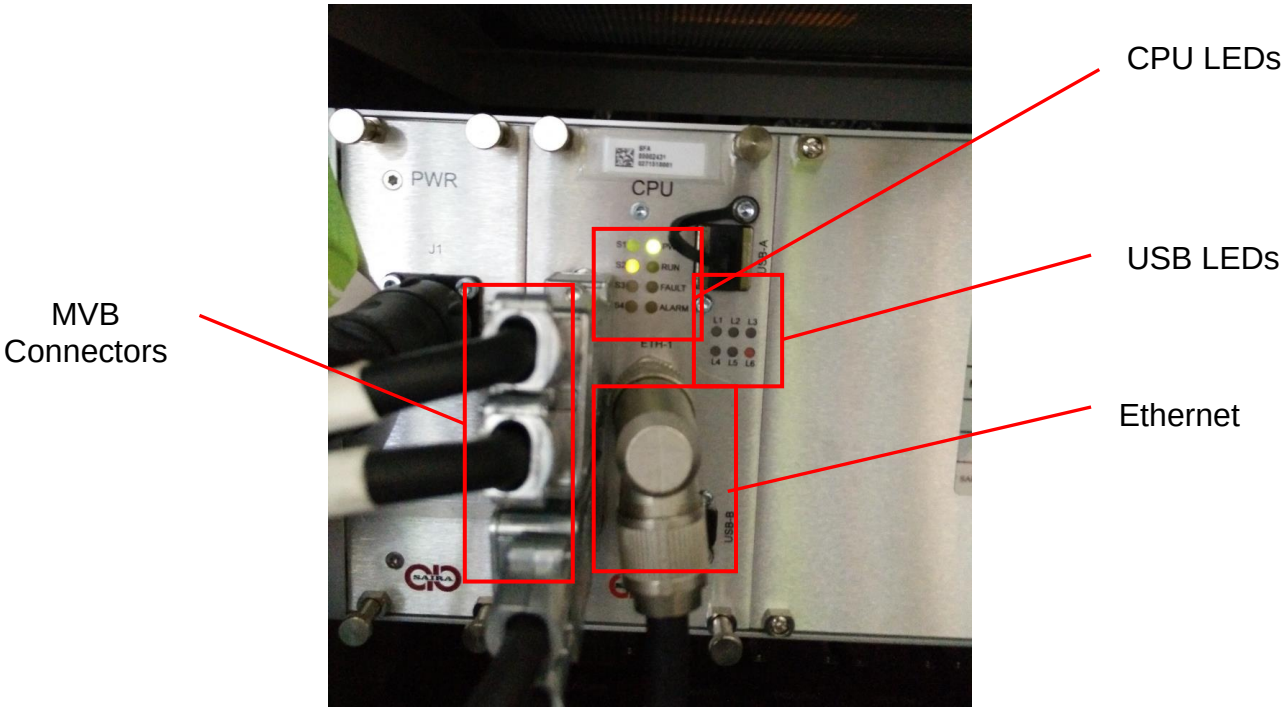

Figure 1-2: CPU Board

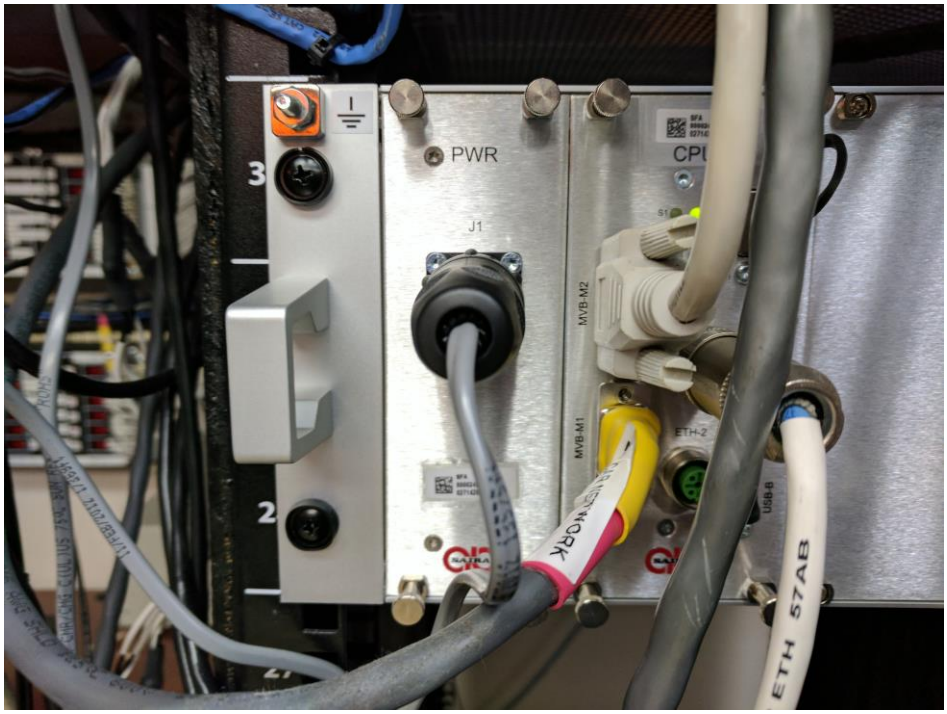

Figure 1-3: Power Board

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CHAPTER 2.0

FUNCTIONAL DESCRIPTION

2.1 Introduction

Event Recording signals are sourced from network variables available on the MVB or Ethernet networks. See Figure 2-1. All required signals are obtained using the TCN I/O (Train Control Network) as well as utilizing signals from other subsystems. The TCN I/O sources all of the wired signals to the MVB/WTB including signals with no other connections such as PBED (directly from the master controller) which operates the LRV. Signals are obtained from the MVB or Ethernet networks. An integrated Event Recorder consisting of a CHMM is used as well as a processor to gather collected signals. The ER is powered from a dedicated circuit breaker located in the A-Cab low voltage circuit breaker panel. This circuit breaker is labeled Event Recorder. It is sourced from the battery low voltage control circuit. A PTU is typically used to extract data utilizing an Ethernet PTU port. A USB port is also provided on the ER for data transfer to a memory stick.

The Event Recorder's (RER103) principal function is to record data coming from the network interfaces as Ethernet Interface and MVB Process Data variables. The Event Recorder is equipped with a Crash Hardened Memory Module (CHMM) compliant with the crashworthiness requirements of IEEE Std. 1482.1-1999, Standard for Rail Transit Vehicles Event Recorders and FRA 49 CFR 229. By means of this memory it is possible to store the train track parameters such as: equipment diagnostic data, operative driving data, dynamic data as well as identification data. A specifically designed memory management system is required in order to guarantee the integrity of the stored data.

The CHMM is removable in case of accident and can be read in laboratory with simple tool and a laptop PC. An integrated Flash memory (mirror memory) is also used to store the recorded data and allows rapid download. The Event Recorder is also equipped with two USB interfaces, one for the download and storage of the recorded data on a USB Memory Stick and a mini USB interface for service.

The Nominal supply Voltage is 28.5Vdc.

2.2 Event Recorder CPU

The Event Recorder has a dedicated processor with multiple connections. The CPU has MVB connections and an Ethernet connection. A spare Ethernet connection is provided on the ER for downloads of event data via the PTU. Any open Ethernet port on the LRV can be used to access Ethernet connected devices. Additionally, for local downloads of event data, an USB port is provided on the ER CPU.

2.3 Crash Hardened Memory Module (CHMM)

The CHMM is FRA and IEEE 1482.1 compliant. It is enclosed by a crash proof housing to preserve data collected by the ER in the event of an accident/incident. The CHMM is connected to its own processor that stores the desired monitored data and is tamper-proof and self-contained.

2.4 Data Storage

The ER maintains a record of monitored signals and parameters and stores it to memory. Data is stored on the CHMM. The module is built to withstand an accident/incident and meets the standards for crashworthiness by IEEE 1482.1-1999. The CHMM is non-volatile, ensuring memory protection during battery failure. Events are time stamped when written to the CHMM. Data is sampled every time there is an event. This means that a state change in any of the recorded signals will trigger an event. Events are sampled at the rate that they occur. The samples are limited to the interval that MVB is updated. This provides an accurate account of the controlling network values. To save memory in the CHMM only state changes are stored. Signals such as speed are excluded from state change sampling since the state continuously changes, it will however be recorded with other signal state changes. If there are no state changes a data entry of all variables is stored every minute.

The storage of the data retrieved are stored in two separate memories:

- Crash memory
- Mirror Memory with capacity of 2GB

Both memories are organized as circular buffers in order to keep always stored the most recent data when the full memory storage is occupied. Mirror memory provides a fast access for the download of the stored data, while crash memory recording is kept for juridical purposes in case of accident. Both memories furthermore provide a security check during recording to ensure the integrity of stored data.

Data is stored in a circular buffer. Data will not be deleted from the CHMM until the memory is entirely full. Once memory is full the oldest piece of data will be removed as the newest data is stored. The CHMM is of a sufficient size to store 48 hours of data with 30% spare memory.

Recorded data is protected from modification. Sequential time stamping within the log files protect data from being tampered with. An md5 CRC is used in conjunction with the time stamp of the data. If data within a file has been modified in any way the data view tool will indicate that the file has been modified from its original state.

A configuration file is used to configure the data set that will be recorded. The present configuration file identifies the data that is listed in Table 2-1, that follows in Section 2.5.

2.5 Monitored Data

The monitored parameters that cause events to occur are specified by IEEE1482.1-1999, the technical specification and identified as parameters of interest unique to the P3010 LRV. The ER will monitor and record the LRV Operator's actions, the Automatic Train Protection (ATP) system indicators and commands, the resulting operating conditions, and the LRV responses. This data is discrete, pulse or analog signals. These signals are obtained from the MVB or Ethernet network by the ER processor. The monitored signals are listed in Table 2-1. A Data Viewer Manual with detailed instructions for use can be found by clicking on the help tab from the data viewer screen and is supplied as a PTU manual.

2.6 Data Transfer

The collected data on the CHMM can be extracted to guarantee long-term storage.

A Portable Test Unit (PTU) is typically used to retrieve the ER data. The PTU can connect to any open Ethernet PTU port to access the recorded ER data. The PTU can also be used to configure the desired signals to be monitored and recorded from a list of available signals. Upon power-up of the ER, a list of default signals will be recorded. Additionally, the ER is equipped with a USB port that allows for manual retrieval of data. A properly formatted USB memory stick (FAT-32) can be inserted into the ER USB port. Recorded ER data will automatically copy to the memory stick, leaving the original data intact on the CHMM. The USB flash drive can be removed and placed into a workstation to review the data. The USB LED indicators can be used to determine the functional state of the data transfer. Data transferred to the PTU will be EMM file type. This is mirrored memory of the Crash Hardened Memory Module which stores its files with an EPM or ECM file type.

Event Recorder data is downloaded automatically via Wi-Fi link when available in the yards.

Table 2-1. List of Event Recorder Signals

Input #	LRV Signal Equivalent
1	Active_CAB_A_Status
2	Active_CAB_B_Status
3	APS_Health_STATUS
4	APS Input Voltage
5	ato failed
6	Ato Rate Set Point
7	ATO Release Button A CAB Status
8	ATO Release Button B CAB Status
9	ato twc bad stop
10	ATP Bypass Switch Status
11	atp decal rate
12	atp_display_spd_limit
13	atp dwell expired
14	atp fail
15	atp MFB NVital In
16	atp MFB Vital Out
17	atp MIO Vital In
18	atp MIO Vital Out
19	atp_no_motion
20	atp oper mode
21	atp overspeed
22	atp_system_speed
23	atp train berth
24	atp twc bypass
25	atp valid cab signal
26	atp Vital In1 high byte
27	atp Vital In1 low byte
28	atp Vital In2 high byte
29	atp Vital In2 low byte
30	Audible_Alarm_Cutout_A_Status
31	Audible_Alarm_Cutout_B_Status
32	Brake_Inhibit_Bypass_Status
33	Bypass_Summary_Status
34	Cab A Propulsion Inhibit Status
35	Cab B Propulsion Inhibit Status
36	Car Number Center
37	Car Number Lead

Table 2-1. List of Event Recorder Signals (cont'd.)

Input #	LRV Signal Equivalent
38	Car Number Tail
39	Carwash TL
40	CM_TL Status
41	Deadman_A_Status
42	Deadman_B_Status
43	Direction_Control1_TL_Status
44	Direction_Control2_TL_Status
45	Door_CLOSE_LEFT_Status
46	Door_CLOSE_LEFT_Summary_Status
47	Door_CLOSE_RIGHT_Status
48	Door_CLOSE_RIGHT_Summary_Status
49	Door_Interlock_Bypass_Status
50	Door_OPEN_LEFT_Status
51	Door_OPEN_RIGHT_Status
52	Door_RELEASE_LEFT_Status
53	Door_RELEASE_RIGHT_Status
54	DoorEmergencyReleaseState
55	ECUA_BCPressure
56	ECUA_FBECU_Slide_Detect
57	ECUA_LoadWeight
58	ECUB_BCPressure
59	ECUB_FBECU_Slide_Detect
60	ECUB_LoadWeight
61	ECUC_BCPressure
62	ECUC_FBECU_Slide_Detect
63	ECUC_LoadWeight
64	Emergency_Brake_TL
65	Emergency Brake TL Status
66	FB_FAULT_and_CUTOUT_Summary_TL_Status
67	FBECU_PB_Apply_PS
68	FBECU_PB_Rel_PS
69	FBECUA_Major_Fault
70	FBECUA_SB_Apply
71	FBECUA_SB_Rel
72	FBECUB_Major_Fault
73	FBECUB_SB_Apply

Table 2-1. List of Event Recorder Signals (cont'd.)

Input #	LRV Signal Equivalent
74	FBECUB_SB_Rel
75	FBECUC_Major_Fault
76	FBECUC_SB_Apply
77	FBECUC_SB_Rel
78	Friction_Brake_A_TRUCK_Cutout_Status
79	Friction_Brake_B_TRUCK_Cutout_Status
80	Friction_Brake_C_TRUCK_Cutout _Status
81	Friction_Brake_ON_A_UNIT_Status
82	Friction_Brake_ON_B_UNIT_Status
83	Friction_Brake_Release_TL_Status
84	Head End A Unit Status
85	Head End B Unit Status
86	Headlight_HIGH_Beam_A_UNIT_Status
87	Headlight_HIGH_Beam_B_UNIT_Status
88	Headlight_LOW_Beam_A_UNIT_Status
89	Headlight_LOW_Beam_B_Unit_Status
90	HIGH_BELL_A_UNIT_Status
91	HIGH_BELL_B_UNIT_Status
92	HIGH_HORN_A_UNIT_Status
93	HIGH_HORN_B_UNIT_Status
94	HRSB_TL
95	HSCB_Status_PLUA
96	HSCB_Status_PLUB
97	HVACA Fresh Air Temp
98	HVACA Return Air Temp
99	HVACA Supply Air Temp
100	HVACA Temp Set Point
101	HVACB Fresh Air Temp
102	HVACB Return Air Temp
103	HVACB Supply Air Temp
104	LCU CarNumber
105	LCU Time Date
106	LIMPHOME_TL
107	LOW_BELL_A_UNIT_Status
108	LOW_BELL_B_UNIT_Status
109	LOW_HORN_A_UNIT_Status
110	LOW_HORN_B_UNIT_Status

Table 2-1. List of Event Recorder Signals (cont'd.)

Input #	LRV Signal Equivalent
111	M_TL_Status
112	MFB NVital In - Amp Pwr A BkCk
113	MFB NVital In – Amp Pwr B BkCk
114	MFB NVital In – TWC Cutout
115	MFB Vital Out – Depart Test Sel
116	MFB Vital Out – Forward
117	MFB Vital Out – Power Cut
118	MFB Vital Out – Reverse
119	MIO Vital In – Cab Sig A BkCk
120	MIO Vital In - Cab Sig B BkCk
121	MIO Vital In – Cab Test A BkCk
122	MIO Vital In – Cab Test B Bkck
123	MIO Vital In – Enable Doors L BkCk
124	MIO Vital In – Enable Doors R BkCk
125	MIO Vital In – FSB BkCk
126	MIO Vital Out – Cab Sig A Sel
127	MIO Vital Out – Cab Sig B Sel
128	MIO Vital Out – Cab Test A Sel
129	MIO Vital Out – Cab Test B Sel
130	MIO Vital Out – Emergency Brake
131	MIO Vital Out – Enable Doors Left
132	MIO Vital Out – Enable Doors Right
133	MIO Vital Out – FSB
134	MIO Vitral In – ATP Not Bypass
135	MRPressure
136	Network_Control_Bypass_Status
137	No_Motion_Bypass_Status
138	NO_MOTION_Relay_Status
139	Pantograph Down TL
140	Pantograph Up TL
141	PBEDSetPoint_TL
142	PIC Activated TL
143	PIC Answered
144	PLU_Fault_and_Cutout_TL_Status
145	PLUA_AC208_Status
146	PLUA_Cutout_Status

Table 2-1. List of Event Recorder Signals (cont'd.)

147	PLUA Direction of Actual Movement
148	PLUA_Distance_Counter
149	PLUA_Dynamic_Brake_Available
150	PLUA_Dynamic_Brake_Fault_Status
151	PLUA_Power_Cut_TL
152	PLUA_Power_Effort_Feedback
153	PLUA_ReferenceSpeed
154	PLUA_Rollback_Signal
155	PLUA Slip Detected
156	PLUA_Speed_Restriction_Limit
157	PLUA_Stopping_Brake
158	PLUB_AC208_Status
159	PLUB_Cutout_Status
160	PLUB Direction of Actual Movement
161	PLUB_Dynamic_Brake_Available
162	PLUB_Dynamic_Brake_Fault_Status
163	PLU_B_Power_Cut_TL
164	PLUB_Power_Effort_Feedback
165	PLUB_ReferenceSpeed
166	PLUB_Rollback_Signal
167	PLUB Slip Detected
168	PLUB_Speed_Restriction_Limit
169	PLUB_Stopping_Brake
170	Reset_TL (Propulsion_Reset_TL)
171	Sanding_Control_TL_Status
172	SCEB_TL
173	Silent Alarm
174	Tail End A Unit Status
175	Tail End B Unit Status
176	Towing_Mode_TL
177	Track_Brake_Control_CB_Status
178	Track_Brake_Control_TL_Status
179	Track_Brake_TBCB3A_Status
180	Track_Brake_TBCB3B_Status
181	Track_Brake_TBCB3C_Status
182	Track_Brake_TBCB4A_Status
183	Track_Brake_TBCB4B_Status
184	Track_Brake_TBCB4C_Status

Table 2-1. List of Event Recorder Signals (cont'd.)

185	Track_Brake_TL
186	TrainReferenceSpeed_TL
187	Vital In1 High – ATP ACK
188	Vital In1 High – ATP Bypass
189	Vital In1 High – Doors Closed A
190	Vital In1 High – Doors Closed B
191	Vital In1 High -Fric App A
192	Vital In1 High -Fric App B
193	Vital In1 High – No Fric Fault
194	Vital In1 High – No Prop Fault
195	Vital In1 Low – A End
196	Vital In1 Low – B End
197	Vital In1 Low -Coast A
198	Vital In1 Low – Coast B
199	Vital In1 Low – FSB A
200	Vital In1 Low -FSB B
201	Vital In1 Low -Type I
202	Vital In1 Low -Type II
203	Vital In2 High – Dept Test Sel BkCk
204	Vital In2 High -For BkCk
205	Vital In2 High – Power Cut BkCk
206	Vital In2 High -Rev BkCk
207	Vital In2 Low – ATO
208	Vital In2 Low -CM
209	Vital In2 Low -EB App
210	Vital In2 Low -Forward
211	Vital In2 Low -M
212	Vital In2 Low -Manual
213	Vital In2 Low -No Power Cut
214	Vital In2 Low - Reverse
215	WWAS Alarm

2.7 Diagnostics

The ER performs power up diagnostics, Power On Self Test (POST), to provide an integrity check of the event recorder system. A series of internal tests are executed every time the ER is powered up. If an error is discovered during the test that would affect the functionality of the ER, it will be annunciated to the Train Operators Display (TOD). The diagnostic tests are transparent to the operation of the Event Recorder and do not interfere with the regular operation or monitoring of the LRV.

2.8 Health Status

The ER has a “FAULT” LED indicator directly on the device that shows its health status. The health status includes passing the self-test. The indicator should only be activated if the system health is OK. If the ER fails a self-test the indicator should extinguish. The health status is reported to the MDS.

2.9 Event Review and Analysis

Data can be reviewed using software on designated PTU(s). The software provides raw data as well as a graphical interface. The data can be retrieved from the file location where it is stored or directly from a USB flash drive. The software is capable of a zoom function that allows a time resolution selection of six-hour, six-minute, and six-second screens. The software allows the operator to sort, search, and perform analysis on all data in the log files, including all snapshot data. The PTU manual contains detailed instructions on using the Event Review analysis software. Additionally, a detailed manual is available on the “Help” tab of the PTU interface.

2.9.1 Graphics Software

Graphics software is provided to allow viewing of downloaded data. The graphics software is able to display parameters with a resolution equal to the maximum number of data points in the log files. The software is capable of displaying up to 20 analog channels, 20 digital channels, or any combination of the two displayed on a single screen. It also allows the user to scroll chronologically through the data being displayed. The user is able to zoom in on points of interest on the graphical display. Information such as time, date, and signal status/value is available for accurate readouts. Values for each of the analog channels will be displayed, in engineering units, on the same screen. Print-out capability of all screens including calculations, tabulations, analysis results, etc. is available.

CHAPTER 3.0

SPECIAL TOOLS AND MATERIALS

3.1 Introduction

No special tools are required.

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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. Obvious malfunctions from damage observed during the visual inspection are to be corrected. Follow all warnings and cautions in Chapter 5.0 before performing any work on the Event Recorder equipment.

4.2 Scheduled Maintenance Index

Table 4-1 is a scheduled maintenance index, which lists maintenance intervals and each maintenance task for the Event Recorder equipment. The reference column indicates the section of this manual that details these maintenance procedures.

Table 4-1. Scheduled Maintenance

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 1600 Event Recorder Running Maintenance & Servicing Manual Section Reference
120,000 Miles	Event Recorder (RER-103)	Run ER Functional Tests: • Self Test • User Interface • System Error Verification	5.3.2
		1. Visually inspect Event Recorder mounting hardware for tightness.	5.3.2
		2. Visually check for loose wiring or connectors.	
		3. Ensure equipment enclosure and screens are clean to prevent dust entering the unit using a clean dry cloth.	
		4. Ensure there are no obstructions blocking ventilation of the Event Recorder unit.	
		5. Using USB stick, download event recorder data and review to confirm functionality	
840,000 Miles or when indicated by Fault Logging	Event Recorder (RER-103)	Replace battery for Real Time Clock (RTC)	5.3.3

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CHAPTER 5.0

CORRECTIVE MAINTENANCE

5.1 Introduction

This chapter provides inspection and adjustment procedures for the Event Recorder equipment.

5.2 Safety Precautions

WARNING

TO PREVENT ELECTRICAL SHOCK, DO NOT OPEN THE ENCLOSURE WHILE POWERED ON. ALWAYS DISCONNECT POWER PRIOR TO DISASSEMBLING THE UNIT.

WARNING

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

WARNING

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

WARNING

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.

5.3 Corrective Maintenance Procedures

5.3.1 Diagnostic Self-Test

On Start-Up, the Event Recorder automatically performs a diagnostic self-test to verify proper operation.

Faults are transmitted to the Monitoring and Diagnostic System (MDS) when they occur. Below is a table of faults that will be recorded on the vehicle fault log and their description(s).

Table 5-1. Faults Recorded on Vehicle Fault Log

Fault Name	Description of the Fault
ER_CONFIG_ERR	ER Configuration file missing or invalid
RTC_BATTERY_LOW	ER Real Time Clock battery low
PRG_MEM_CHK_FAIL	ER Program Memory Check Fail
DTA_MEM_CHK_FAIL	ER Data Memory Check Fail
UNCHANGE_IN_92_DAY	No ER inputs change in 92 day
HIGH_TEMPERATURE	High Temperature
ER_SUPPLY_FAILURE	Internal ER Power Supply Failure
USB_PRC_HALT	USB communication process halted
USB_PRC_ERR	USB communication process system error
MVB_BOARD_MISS	MVB board Missing
MVB_BRD_HW_FAIL	MVB board hardware failure
MVB_BRD_COM_ERR	MVB board communication error
MVB_BRD_CFG_ERR	MVB board Configuration error
MVB_LINEA_DISTURB	MVB Line A disturbed
MVB_LINEB_DISTURB	MVB Line B disturbed
CHM_MODULE_MISS	Crash Hardened Memory module missing
CHM_STEST_FAIL	Self test failed on Crash Hardened Memory
CHM_COM_ERR	Crash Hardened Memory module communication error
EMM_MODULE_MISS	Events Mirror Memory module missing
EMM_STEST_FAIL	Self test failed on Events Mirror Memory module
EMM_COM_ERR	Events Mirror Memory module communication error
ESM_MODULE_MISS	Events Spooler Memory device is missing
ESM_STEST_FAIL	Self test failed on Events Spooler Memory module
ESM_COM_ERR	Events Spooler Memory communication error
ESM_FULL_ERR	Events Spooler Memory is full
PTU_PRC_HALT	PTU communication process halted
PTU_PRC_ERR	PTU communication process system error
RIO_PRC_HALT	RIO board Management Process halted
RIO_PRC_ERR	RIO board Management Process System error
MVB_PRC_HALT	MVB communication process halted

Table 5-1. Faults Recorded on Vehicle Fault Log (cont'd.)

Fault Name	Description of the Fault
MVB_PRC_ERR	MVB communication process system error
CHM_PRC_HALT	Crash Hardened Memory management process halted
CHM_PRC_ERR	Crash Hardened Memory management process system error
EVE_PRC_HALT	Events scanning process halted
EVE_PRC_ERR	Events scanning process software system error
MDS_PRC_HALT	MDS process halted
MDS_PRC_ERR	MDS process system error
MDS_COM_ERR	MDS communication error

The Event Recorder, RER103, implements Alarms data logging function internally for diagnostic purposes. The Alarms Data Logger is able to store up to 2000 events in a retentive circular buffer (Alarm Log) plus the current Alarms status and Alarms counter for every alarm (Alarm Status). For every Alarm the following information are stored:

- *Log ID code*
- Log Timestamp
- Log Status (Set/Reset)
- Log Counter

The RER can be accessed using the PTU LOG function through the Ethernet interface. There are three Alarm Levels with different criticality, as defined in the following table:

Table 5-2. LOG Types and Definition

LOG Type	Terminology	Definition
FAULT	Fault	An internal or external condition that could affect the data recording or the proper operation of the device and requires immediate attention.
ALARM	*Warning*	A warning message that doesn't affects the functioning of the device but requires attention.
INFO	*Info*	An information message that doesn't affects the functioning of the device and doesn't requires attention.

If a Fault condition is present, FAULT led on the front panel is illuminated. If an Alarm condition is present, ALARM led on the front panel is illuminated. Current defined Fault ID are defined in the following table (Unassigned parameter ID are reserved for further developments):

Table 5-3. List of Event Recorder Internal Log IDs

LOG ID	LOG Number	LOG TYPE	Remark
ER_CONFIG_ERR	1	FAULT	ER Configuration file missing or invalid
RTC_BATTERY_LOW	2	ALARM	The Real Time Clock battery is low
PRG_MEM_CHK_FAIL	3	FAULT	ER Program Memory Check Fail
DTA_MEM_CHK_FAIL	4	FAULT	ER Data Memory Check Fail
reserved	5	FAULT	reserved
UNCHANGE_IN_92_DAY	6	ALARM	No ER inputs change in 92 day
HIGH_TEMPERATURE	7	ALARM	High Temperature
ER_SUPPLY_FAILURE	8	FAULT	Internal ER Power Supply Failure
reserved	10	FAULT	reserved
reserved	11	FAULT	reserved
reserved	12	FAULT	reserved
reserved	13	FAULT	reserved
reserved	14	FAULT	reserved
reserved	15	FAULT	reserved
reserved	16	FAULT	reserved
reserved	17	FAULT	reserved
reserved	18	FAULT	reserved
reserved	20	FAULT	reserved
reserved	21	FAULT	reserved
reserved	22	FAULT	reserved
reserved	23	FAULT	reserved
reserved	24	FAULT	reserved
reserved	30	FAULT	reserved
reserved	31	FAULT	reserved
reserved	32	FAULT	reserved
reserved	33	FAULT	reserved
reserved	34	FAULT	reserved
reserved	40	FAULT	reserved
reserved	41	FAULT	reserved
reserved	42	FAULT	reserved
reserved	43	FAULT	reserved
reserved	44	FAULT	reserved
USB_PRC_HALT	46	FAULT	USB communication process halted
USB_PRC_ERR	47	FAULT	USB communication process system error
MVB_BOARD_MISS	50	FAULT	MVB board Missing

Table 5-3. List of Event Recorder Internal Log IDs (cont'd.)

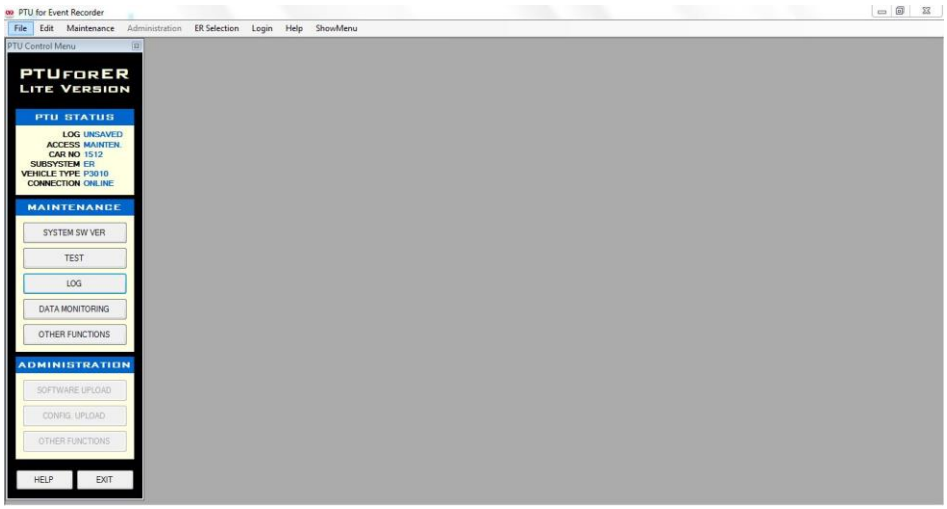
LOG ID	LOG Number	LOG TYPE	Remark
MVB_BRD_HW_FAIL	51	FAULT	MVB board hardware failure
MVB_BRD_COM_ERR	52	FAULT	MVB board communication error
MVB_BRD_CFG_ERR	53	FAULT	MVB board Configuration error
MVB_LINEA_DISTURB	54	ALARM	MVB Line A disturbed
MVB_LINEB_DISTURB	55	ALARM	MVB Line B disturbed
CHM_MODULE_MISS	60	FAULT	Crash Hardened Memory module missing
CHM_STEST_FAIL	61	FAULT	Self test failed on Crash Hardened Memory
CHM_COM_ERR	62	FAULT	Crash Hardened Memory module communication error
EMM_MODULE_MISS	65	FAULT	Events Mirror Memory module missing
EMM_STEST_FAIL	66	FAULT	Self test failed on Events Mirror Memory module
EMM_COM_ERR	67	FAULT	Events Mirror Memory module communication error
ESM_MODULE_MISS	70	FAULT	Events Spooler Memory device is missing
ESM_STEST_FAIL	71	FAULT	Self test failed on Events Spooler Memory module
ESM_COM_ERR	72	FAULT	Events Spooler Memory communication error
ESM_FULL_ERR	73	FAULT	Events Spooler Memory is full
PTU_PRC_HALT	76	FAULT	PTU communication process halted
PTU_PRC_ERR	77	FAULT	PTU communication process system error
RIO_PRC_HALT	80	FAULT	reserved
RIO_PRC_ERR	81	FAULT	reserved
MVB_PRC_HALT	84	FAULT	MVB communication process halted
MVB_PRC_ERR	85	FAULT	MVB communication process system error
CHM_PRC_HALT	88	FAULT	Crash Hardened Memory management process halted
CHM_PRC_ERR	89	FAULT	Crash Hardened Memory management process system
EVE_PRC_HALT	92	FAULT	Events scanning process halted
EVE_PRC_ERR	93	FAULT	Events scanning process software system error
MDS_PRC_HALT	96	FAULT	MDS process halted
MDS_PRC_ERR	97	FAULT	MDS process system error
MDS_COM_ERR	98	FAULT	MDS communication error
ER_SYSTEM_REBOOT	100	INFO	ER reboot (Set=START, Clear=DONE)
ER_TIMEDATE_ADJ	101	INFO	ER timedate adjust (Set=ERR, CLEAR=OK)
ER_FIRMWARE_UPDATE	110	INFO	ER firmware Update (Set=ERROR Clear=DONE)
ER_PRM_FILE_UPDATE	111	INFO	ER Parameterization file Update (Set=ERROR
ER_CFG_FILE_UPDATE	112	INFO	ER Configuration file Update (Set=ERROR Clear=DONE)
ER_SELF_TEST	120	INFO	ER Self Test (Set=FAIL Clear=PASS)
ER_CHMM_DOWNLOAD	130	INFO	CHMM download (Set=ERROR Clear=DONE)

5.3.2 120,000 Mile Maintenance Interval

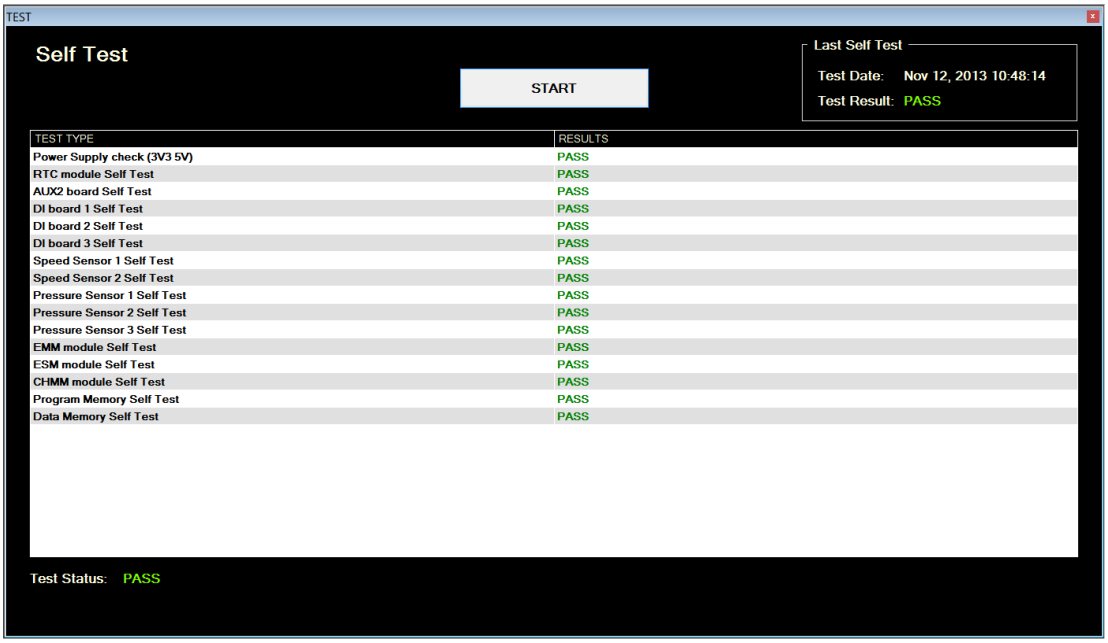
Functional Check with the PTU

Run the Event Recorder Function tests following the steps below:

1. With a PTU connected to the car Ethernet network, open the PTU for ER application.
2. From the main screen of the PTU software click the Test button under Maintenance.



3. The Self-Test screen will appear, click the start button of the self-test screen.



4. Confirm the test result is PASS.

Physical Inspection

1. Visually inspect the Event Recorder mounting hardware for tightness.
2. Visually check for loose wiring or connectors.
3. Ensure equipment enclosure and screens are clean using a clean dry cloth.

USB Port Function Confirmation

1. Download ER data to USB stick.
2. Read Data from USB stick using PTU to confirm functionality of USB port.
3. If USB is non-functional, replace ER.

5.3.3 840,000 Mile Maintenance Interval

Replace the battery for the Real Time Clock (RTC). The battery is a 3V Lithium CR2032 battery. Battery health is automatically checked through the ER diagnostics.

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CHAPTER 6.0

LUBRICATION

6.1 Introduction

No lubrication is needed for the Event Recorder.

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CHAPTER 7.0

COMPONENT REMOVAL AND INSTALLATION

7.1 Introduction

The following are the removal and installation procedures for the Event Recorder equipment.

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. A M12 connector tool is available that ensures proper tightness. This tool has a torque “click” when the proper tightness occurs.

Typical M12 Connector Tool

7.2 Removal

7.2.1 Event Recorder Rack

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. THE VOLTAGES IN ENERGIZED EQUIPMENT CAN CAUSE INJURY OR DEATH.

2. Turn off the Event Recorder Circuit Breaker in the Low Voltage Circuit Breaker found in the A-Unit Cab. Disconnect the electrical connectors (5) to the Event Recorder (1). See Figure 7-1.

3. Remove the four M6 x 16 screws (2), M6 lock washers (3), and M6 plain washers (4).

4. Carefully remove the Event Recorder (1).

7.2.2 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 7-2.

2. Gently pull the PWR module (6) straight out from the Event Recorder Rack (1) unit to release the PCB from the backplane.

3. Place the PWR module (6) in an electrostatic-free bag.

7.2.3 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 Figure 7-2.

2. Gently pull the CPU module (8) straight out from the Event Recorder Rack (1) to release the PCB from the backplane.

3. Place the CPU module (8) in an electrostatic-free bag.

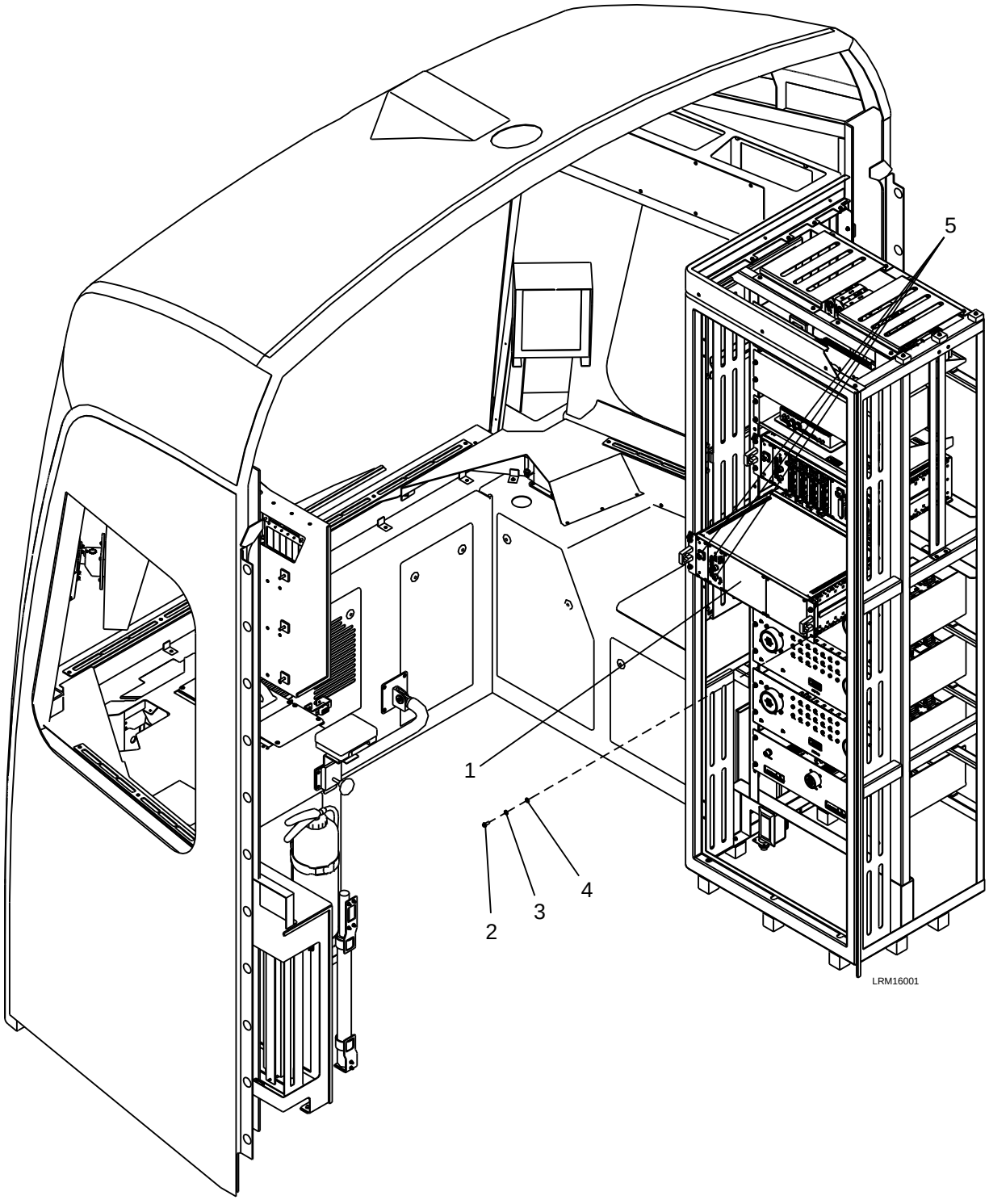

Figure 7-1: Event Recorder Rack

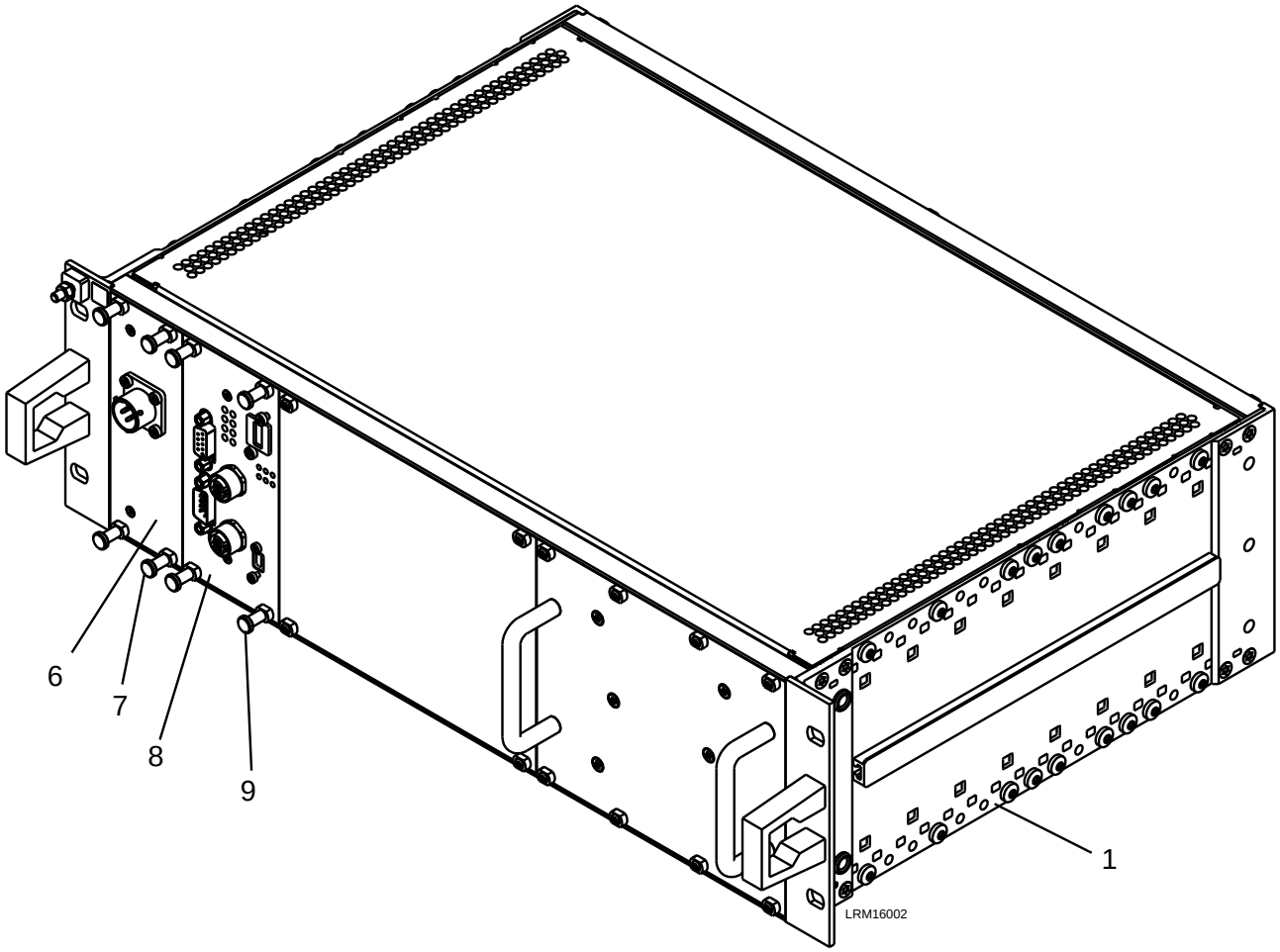

Figure 7-2: Event Recorder Equipment

7.2.4 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 7.2.3.
2. Gently remove the battery from the holder (10). See Figure 7-3.
3. Install new replacement battery by carefully placing it into the holder and pressing down to snap it into place. The battery is a CR 2032 Lithium 3 V battery.

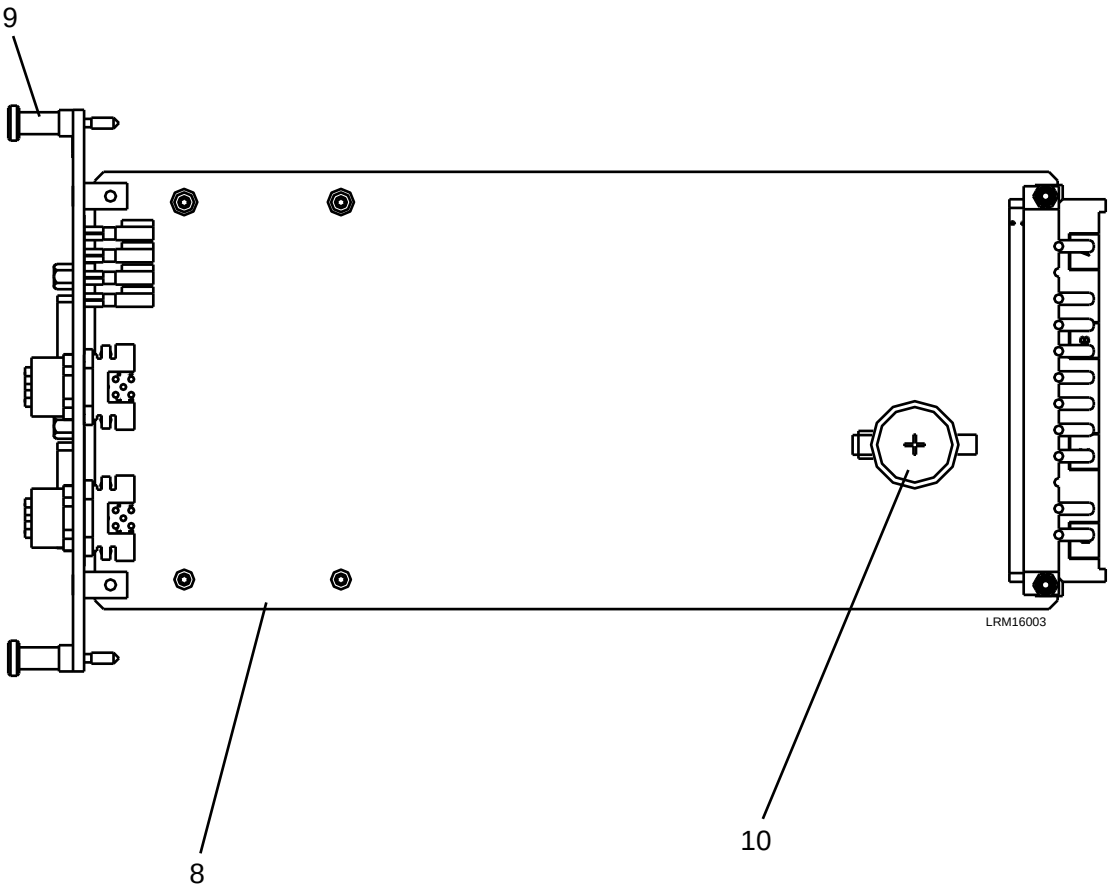

Figure 7-3: Real Time Clock (RTC) Battery

7.3 Installation

7.3.1 Event Recorder Rack

1. Open the right-side electric locker door located in the A-Unit. See Figure 7-1.
2. Carefully install the Event Recorder (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 electrical connectors (5) to the Event Recorder (1) and grounding strap.
6. Restore power by placing Event Recorder circuit breaker in the ON position.
7. Check LEDs for correct functioning of the device.
8. Close the right-side electric locker door located in the A-Unit.

7.3.2 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 Event Recorder Rack (1) unit to seat the PCB into the backplane.
3. Screw the four screws (7) to secure the PWR module (6). See Figure 7-2.

7.3.3 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 Event Recorder Rack (1) to seat the PCB into the backplane.
3. Screw four screws (9) to secure the CPU module (8). See Figure 7-2.

7.3.4 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 7-3. The battery is a CR 2032 Lithium 3 V battery.
2. Gently push the CPU module (8) straight into the Event Recorder Rack (1) to seat the PCB into the backplane. Use caution to ensure that the EMI seals on the sides of the card face plate are not distorted on insertion.
3. Screw four screws (9) to secure the CPU module (8). See Figure 7-2.

CHAPTER 8.0

SOFTWARE REPROGRAMMING

8.1 Reprogramming the Software

There are two pieces of software used by the ER for its functionality:

- Firmware, the base operating software of the unit (file ends in .sh). This is reprogrammed through the web interface.
- Configuration, the operating executable (file ends in .cfg). This is reprogrammed through the PTUforER software.

To reprogram the firmware you must access the web interface. See Figure 8-1.

In order to access the web interface, connect a PTU to the car Ethernet network and navigate to 10.0.X.90

You must log in as “SuperAdmin” in order to gain access to the software update functionality. See Figures 8-2 and 8-3.

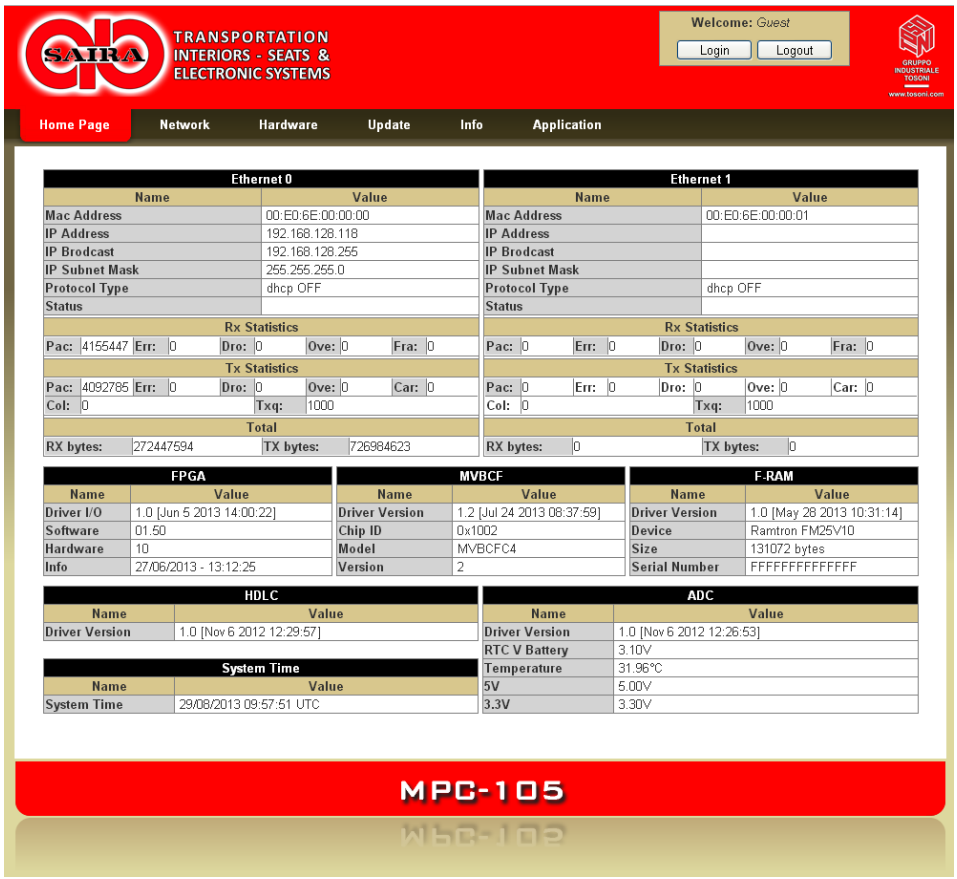

Figure 8-1: Web Interface

Figure 8-2: Login Screen

Figure 8-3: Software Update

8.2 Reprogramming the Configuration File

1. To reprogram the configuration file you must load PTUforER and connect a PTU to the car Ethernet network.

The configuration file must reside in the configuration file folder on the PTU located at:

/Program Files (x86)/Saira Electronics/PTUforER Lite LAP3010/Configurations

See Figures 8-4 through 8-8.

2. When the application is loaded, the home screen shown in Figure 8-4 appears.

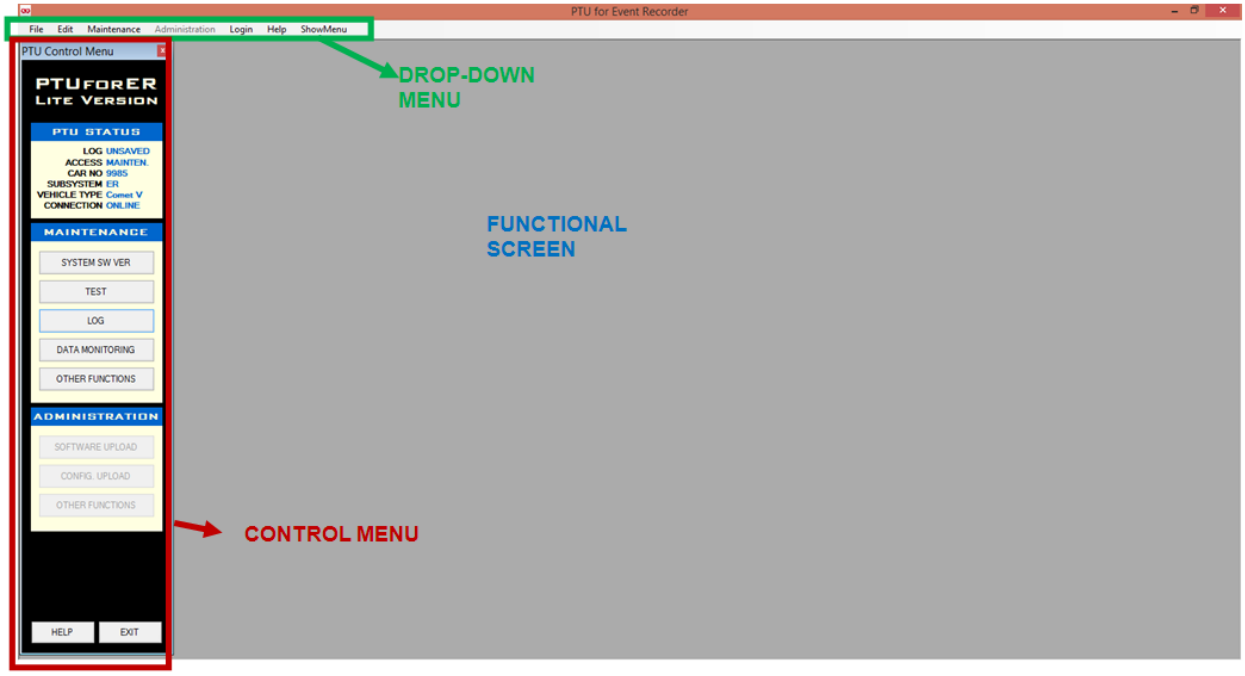

Figure 8-4: PTUforER-Lite Home Screen

3. You must log in as an administrator to upload the software. See Figure 8-5.

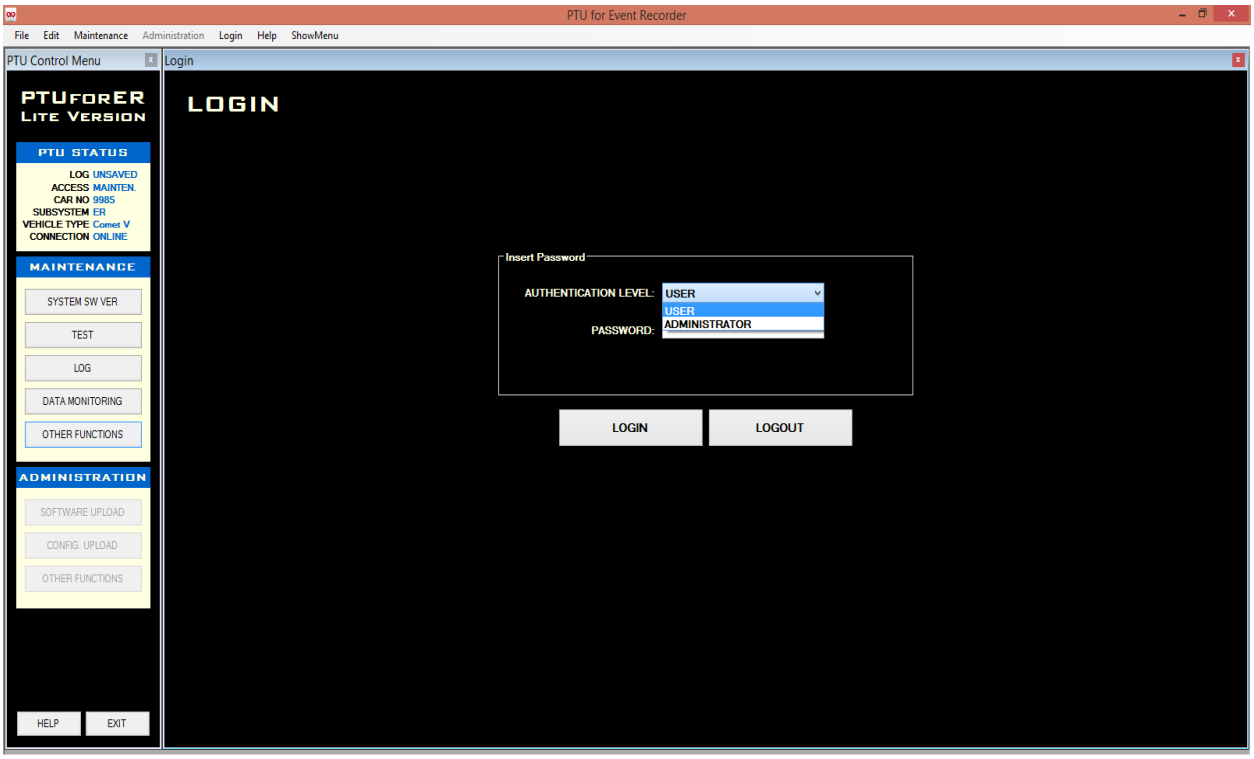

Figure 8-5: PTUforER-Lite Login Screen

4. File must be in the configurations file on local PTU:

   Program Files(x86)/SairaElectronics/PTUforER LITE LAP3010/Configurations

See Figure 8-6.

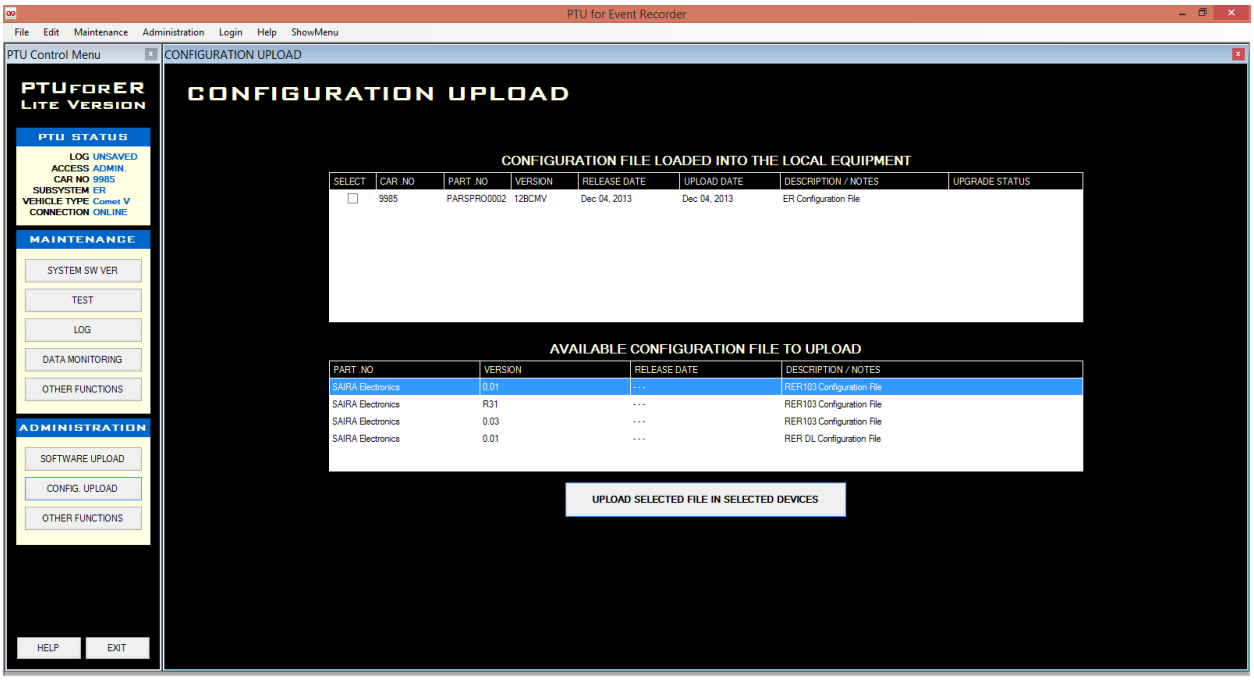

Figure 8-6: PTUforER-Lite Configuration Upload Screen

5. When you click on the test button it takes you to the self test screen. See Figure 8-7.

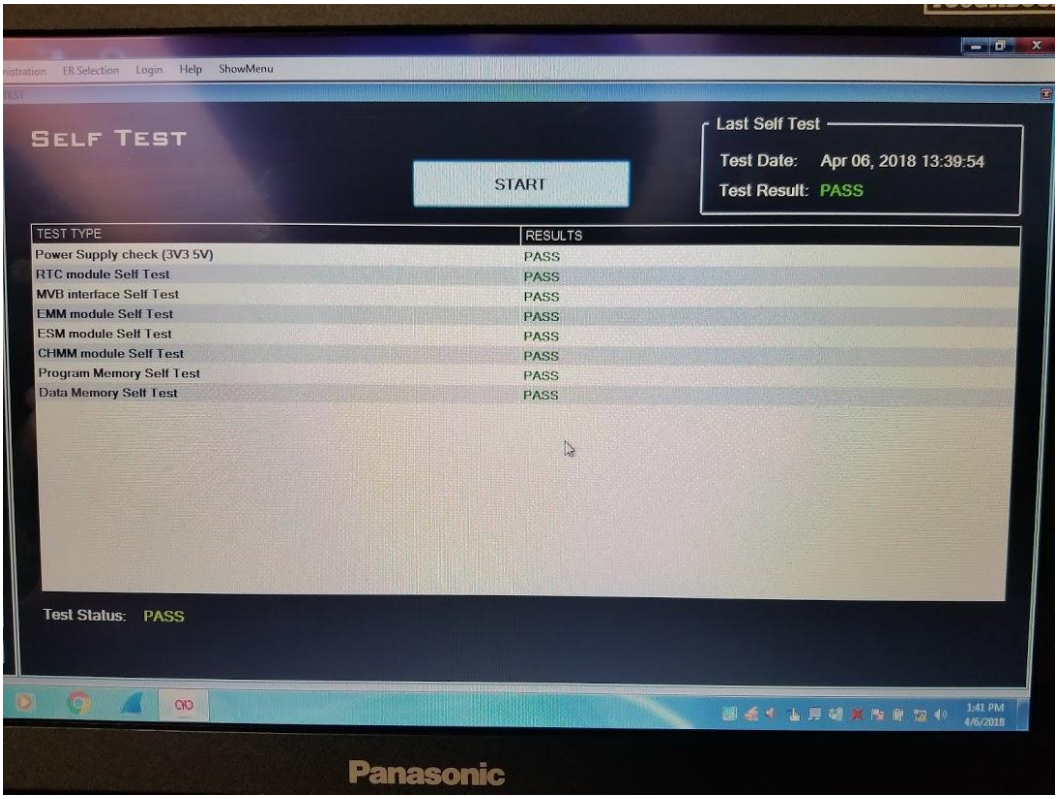

Figure 8-7: PTUforER-Lite Self Test Screen

6. When you click the Log function it takes you to the screen shown in Figure 8-8 below.

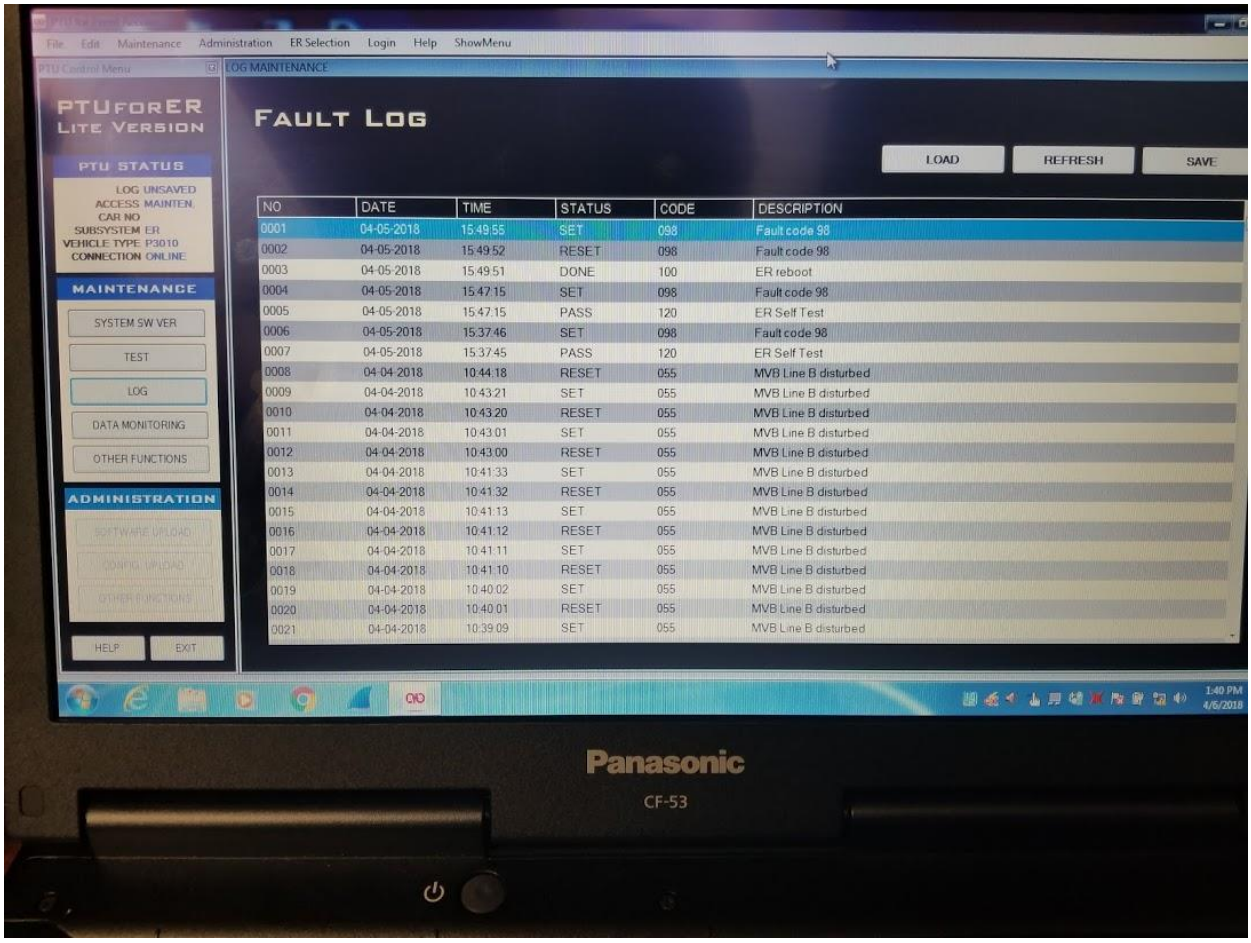

Figure 8-8: PTUforER-Lite Fault Log Screen

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CHAPTER 9.0

TROUBLESHOOTING

9.1 Introduction

This chapter provides troubleshooting procedures for the Event Recorder equipment.

9.2 Troubleshooting

Table 9-1. Troubleshooting Matrix

Symptom	Probable Cause(s)	Corrective Action(s)
Red FAULT LED remains ON (continuously illuminated)	A major fault has occurred	Check RER Fault Codes to identify the Fault cause. If necessary, substitute the device.
Red ALARM LED remains ON (continuously illuminated)	A minor fault has occurred	Check the RER Fault Codes to identify the Fault cause. If necessary, substitute the device.
Green RUN LED doesn't blink	RER application is not running	Check RER configuration against errors. Power off and Power on to retrigger POST and confirm. If necessary, substitute the device.
Yellow LEDs S1, S2 and S3 remains ON (continuously illuminated)	Error in POST phase	Check RER configuration against errors. Power off and Power on to retrigger POST and confirm. If necessary, substitute the device.
Green POWER LED fails to illuminate	No power being supplied to RER unit	Check "Event Recorder" circuit breaker and check power input cable connection and power module.
	LED is defective	Replace CPU module.

Table 9-2. USB LEDs Indications / Status

Function	L4	L5	L6	L3	Action
Invalid USB stick	OFF	OFF	ON	--	Replace USB stick
Insufficient memory space on USB stick	OFF	ON	ON	--	Replace USB stick
I/O error	ON	OFF	ON	--	Substitute device
Hardware malfunction of the USB interface of the Event Recorder	ON	ON	ON	--	Substitute device
Active Cab condition (no USB downloading allowed)	ON	OFF	OFF	ON	Ensure LRV is in "Local" without active cab
Event Recorder in Disable or Maintenance State (no USB downloading allowed)	OFF	ON	OFF	ON	Ensure LRV is in "Local" without active cab

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INDEX

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APPENDIX

DETAILED SIGNAL LIST

This Appendix presents the list of signals recorded by the Event Recorder as programmed as the car is delivered.

This signal list was refined through the car delivery cycle to record the required signals and unique signals to the LRV that were found to be most informative for troubleshooting various car conditions encountered during the acceptance cycle. These signals are continuously recorded and provide a means to troubleshoot vehicle conditions after the fact.

Signal listed below are interpreted as follows:

- Scaled signals units are showed in Signal Description.
- For 2-bit information, decimal values are displayed by the Event Recorder. Typically, 00 = not valid, 01 = 1, 10=2 and 11= not valid.
- For 8-bit information, the Event Recorder displays the decimal value, and that must be converted to binary to read the individual status. A calculator is included as a utility program with Windows. Use the programmer mode to translate from decimal to binary. An example of conversion from decimal 148 to Binary is shown below. B8 is the most significant bit.

ER value Decimal	Binary	B8	B7	B6	B5	B4	B3	B2	B1
148	10010100	1	0	0	1	0	1	0	0

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
1	Active_CAB_A_Status	00 = Not Valid 01 = A-CAB NOT active cab (MCKSR5A De-Energized) 10 = A-CAB ACTIVE cab (MCKSR5A Energized) 11 = Not Valid		257
2	Active_CAB_B_Status	00 = Not Valid 01 = B-CAB NOT active cab (MCKSR5B De-Energized) 10 = B-CAB ACTIVE cab (MCKSR5B Energized) 11 = Not Valid		257
3	APS_Health_STATUS	APS MVB Port 1537 0 = APS HEALTHY (No Faults) 1 = APS NOT Healthy (Fault Detected)		
4	APS Input Voltage	APS MVB Port 1537 Line Voltage VDC		
5	ato failed	ATC MVB Port 1409 0 = Normal 1 = Failed		
6	Ato Rate Set Point	ATC MVB Port 1408 ATO Generated PWM Signal	X	
7	ATO Release Button A CAB Status	00 = Not Valid 01 = ATO Release Button Not Pressed 10 = ATO Release Button Pressed 11 = Not Valid		838
8	ATO Release Button B CAB Status	00 = Not Valid 01 = ATO Release Button Not Pressed 10 = ATO Release Button Pressed 11 = Not Valid		840
9	ato twc bad stop	ATO Stop Out of Tolerance (ATC MVB Port 1409) 0 = ATO Stop Not Out of Tolerance 1 = ATO Stop Out of Tolerance	X	
10	ATP Bypass Switch Status	00 = Not Valid 01 = ATP Bypass NOT active (ATPBPR2 De-Energized) 10 = ATP Bypass ACTIVE (ATPBPR2 Energized) 11 = Not Valid	X	276

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
11	atp decal rate	ATC MVB Port 1409 ATP Deceleration Rate Scaled signal: mphps	X	
12	atp_display_spd_limit	ATC MVB Port 1409 ATP Display Speed Limit Scaled signal: mph	X	
13	atp dwell expired	ATP Dwell, indicates to the operator to get ready to go (ATC MVB Port 1409) 0 = ATP Dwell not Expired 1 = ATP Dwell Expired	X	
14	atp fail	ATC MVB Port 1409 0 = Normal 1 = Failed		
15	atp MFB NVital In	Multifunction Brd Non Vital Inputs (ATC MVB Port 1409) B1 – Track Brake Applied, 0 = not applied, 1 = applied B2 – TWC Cutout, 0 = not cutout, 1 = cutout B3 – Spare 1, B4 – Spare 2, B5 – Amp PwrA BkCk, 0 = powered, 1 = not powered B6 - Amp Pwrb BkCk, 0 = powered, 1 = not powered B7 – Battery OV, 0 = OK, 1 = above 30 VDC B8 – Battery UV 0 = OK, 1 = below 18 VDC	X	904
16	atp MFB Vital Out	Multifunction Brd Vital Outputs (ATC MVB Port 1409) B1 – Forward, 0 = Dir TL 1 de-energized, 1 = Dir TL 1 energized (ATO only) B2 – Reverse, 0 = Dir TL 2 de-energized, 1 = Dir TL 2 energized (ATO only) B3 – Power Cut, 0 = Power Cut, 1 = No Power Cut B4 – Not used B5 – Not used B6 – Vzero, Not Used B7 – Depart Test Select, 0 = Type II, 1 = Type I B8 – Not Used	X	904

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
17	atp MIO Vital In	Mixed I/O Vital Inputs (ATC MVB Port 1409) B1 – Enable Doors L BkCk, 1 = Relay de-energized, 0 = Relay energized B2 – Enable Doors R BkCk, 1 = Relay de-energized, 0 = Relay energized B3 – FSB BkCk, 1 = Relay de-energized, 0 = Relay energized B4 – CAB Signal A BkCk, 1 = Relay de-energized, 0 = Relay energized B5 – CAB Signal B BkCk, 1 = Relay de-energized, 0 = Relay energized B6 – CAB Test A BkCk, 1 = Relay de-energized, 0 = Relay energized B7 – CAB Test B BkCk, 1 = Relay de-energized, 0 = Relay energized B8 – ATP Not Bypass, 0 = ATP in Bypass, 1 = ATP Not in Bypass	X	904
18	atp MIO Vital Out	Mixed I/O Vital Outputs (ATC MVB Port 1409) B1 – Enable Doors Left, 0 = Not Enabled, 1 = Enabled (ATO only) B2 – Enable Doors Right, 0 = Not Enabled, 1 = Enabled (ATO only) B3 – FSB, 0 = FSB applied, 1 = FSB Not applied B4 – Emergency Brake, 0 = EB applied, 1 = EB Not applied B5 – CAB Signal A Select, 0 = A End Not selected, 1 = A End selected B6 – CAB Signal B Select, 0 = B End Not selected, 1 = B End selected B7 – CAB Test A Select, 0 = A End Not selected, 1 = A End selected B8 – CAB Test B Select, 0 = B End Not selected, 1 = B End selected	X	904
19	atp_no_motion	ATC MVB Port 1409 0 = Motion 1 = No Motion	X	
20	atp oper mode	ATP Modes of Operation (ATC MVB Port 1409) 0 = Off, 1 = Local, 2 = Manual, 3 = Manual with ATO, 4 = Street Running, 5 = Car Wash, 6 = Stop & Proceed 7 = ATP Bypass	X	
21	atp overspeed	ATC MVB Port 1409 0 = Under speed 1 = Over speed	X	
22	atp_system_speed	ATC MVB Port 1409 ATP System Speed Scaled signal: mph	X	

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
23	atp train berth	Train Berth in Station from ATP (ATC MVB Port 1409) 0 = Train is not Berthed 1 = Train is Berthed	X	
24	atp twc bypass	The Type II TWC has been Bypassed (ATC MVB Port 1409) 0 = TWC is not bypassed 1 = TWC is bypassed	X	904
25	atp valid cab signal	Valid Cab Signal (ATC MVB Port 1409) 0 = No Valid Cab Signal 1 = Valid Cab Signal	X	
26	atp Vital In1 high byte	Vital Input Brd 1 High Byte (ATC MVB Port 1409) B1 – ATP bypass, 0 = ATP Not in Bypass, 1 = ATP in Bypass B2 – Doors Closed A, 0 = Doors Not closed, 1 = Doors closed if A End keyed on B3 – Doors Closed B, 0 = Doors Not closed, 1 = Doors closed if B End keyed on B4 – Friction Applied A, 0 = Not applied, 1 = Applied if A End keyed on B5 – Friction Applied B, 0 = Not applied, 1 = Applied if B End keyed on B6 – No Friction Fault, 0 = Fault, 1 = No Fault B7 – No Prop Fault, 0 = Fault, 1 = No Fault B8 – ATP ACK 0 = ATP ACK Not pressed, 1 = ATP ACK pressed	X	904
27	atp Vital In1 low byte	Vital Input Brd 1 Low Byte (ATC MVB Port 1409) B1 – FSB A, 0 = Master Controller Not in FSB, 1 = MC in FSB B2 – Coast A, 0 = Master Controller in Power, 1 = MC in Coast or Brake B3 – FSB B, 0 = Master Controller Not in FSB, 1 = MC in FSB B4 – Coast B, 0 = Master Controller in Power, 1 = MC in Coast or Brake B5 – A End, 0 = A Cab keyed OFF, 1 = A Cab keyed ON B6 – B End, 0 = B Cab keyed OFF, 1 = B Cab keyed ON B7 – Type I, 0 = Not in Type I, 1 = in Type I B8 – Type II 0 = Not in Type II, 1 = in Type II	X	904
28	atp Vital In2 high byte	Vital Input Brd 2 High Byte (ATC MVB Port 1409) B1 – Forward BkCk, 1 = Relay de-energized, 0 = Relay energized B2 – Reverse BkCk, 1 = Relay de-energized, 0 = Relay energized B3 – Power Cut BkCk, 1 = Relay de-energized, 0 = Relay energized B4 – Vzero BkCk, Not Used B5 – Dept Test Sel BkCk, 0 = Type I, 1 = Type II B6 – Spare 1, B7 – Spare 2, B8 – Spare 3	X	904

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
29	atp Vital In2 low byte	Vital Input Brd 2 Low Byte (ATC MVB Port 1409) B1 – Manual, 0 = Not Manual 1 = Manual B2 – ATO, 0 = Not ATO 1 = ATO B3 – M, 0 = Brake or Coast Mode 1 = Power Mode ACTIVE B4 – CM, 0 = Brake Mode 1 = Power or Coast Mode ACTIVE B5 – No Power Cut, 0 = Power Cut 1 = No Power Cut B6 – Forward, 0 = Dir 2 TL de-energized 1 = Dir 2 TL energized B7 – Reverse, 0 = Dir 1 TL de-energized 1 = Dir 1 TL energized B8 – EB Applied 0 = No EB applied 1 = EB applied	X	904
30	Audible_Alarm_Cutout_A_ Status	00 = Not Valid 01 = Audible Alert Cutout is NOT Cutout (ABPRA Relay De-Energized) 10 = Audible Alert Cutout is Cutout (ABPRA Relay Energized) 11 = Not Valid		277
31	Audible_Alarm_Cutout_B_ Status	00 = Not Valid 01 = Audible Alert Cutout is NOT Cutout (ABPRB Relay De-Energized) 10 = Audible Alert Cutout is Cutout (ABPRB Relay Energized) 11 = Not Valid		277
32	Brake_Inhibit_Bypass_Status	00 = Not Valid 01 = Brake Inhibit is Not Bypassed (BIBPR Relay De-Energized) 10 = Brake Inhibit is Bypassed (BIBPR Relay Energized) 11 = Not Valid	X	276
33	Bypass_Summary_Status	00 = Not Valid 01 = No Bypasses are Active (BPIR Relay De-Energized) 10 = One or more Bypasses are Active (BPIR Relay Energized) 11 = Not Valid	X	276
34	Cab A Propulsion Inhibit Status	00 = Not Valid 01 = Cab Propulsion Inhibit NOT active (CPIRA Relay De-Energized) 10 = Cab Propulsion Inhibit ACTIVE (CPIRA Relay Energized) 11 = Not Valid		261
35	Cab B Propulsion Inhibit Status	00 = Not Valid 01 = Cab Propulsion Inhibit NOT active (CPIRB Relay De-Energized) 10 = Cab Propulsion Inhibit ACTIVE (CPIRB Relay Energized) 11 = Not Valid		261
36	Car Number Center	Middle car number in the train. (Value of 0 or 65535 = no center car. Single or two car train.)		
37	Car Number Lead	Lead car number in the train		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
38	Car Number Tail	End car number in train. (Value of 0 = no tail car. Single car train.)		
39	Carwash TL	Carwash Mode Trainline (summarized from PLUA and PLUB) (Port 100) 0 = No Carwash Mode 1 = Carwash Mode ACTIVE		
40	CM_TL Status	BRK (BRAKE) Mode Hardware Trainline 00 = Not Valid 01 = Brake Mode 10 = Power or Coast Mode ACTIVE 11 = Not Valid		259
41	Deadman_A_Status	00 = Not Valid 01 = Deadman NOT Active (DMRA Relay De-Energized) 10 = Deadman ACTIVATED (DMRA Relay Energized) 11 = Not Valid		262
42	Deadman_B_Status	00 = Not Valid 01 = Deadman NOT Active (DMRB Relay De-Energized) 10 = Deadman ACTIVATED (DMRB Relay Energized) 11 = Not Valid		262
43	Direction_Control1_TL_Status	00 = Not Valid 01 = Direction Control 1 TL NOT Active (DCFR2A Relay De-Energized) 10 =Direction Control 1 TL ACTIVATED (DCFR2A Relay Energized) 11 = Not Valid		254
44	Direction_Control2_TL_Status	00 = Not Valid 01 = Direction Control 2 TL NOT Active (DCFR2B Relay De-Energized) 10 =Direction Control 2 TL ACTIVATED (DCFR2B Relay Energized) 11 = Not Valid		254
45	Door_CLOSE_LEFT_Status	Command to close the left side doors 00 = Not Valid 01 = Door CLOSE LEFT NOT active (DLCR Relay De-Energized) 10 = Door CLOSE LEFT ACTIVE (DLCR Relay Energized) 11 = Not Valid		501
46	Door_CLOSE_LEFT_ Summary_Status	Local car door status 00 = Not Valid 01 = One or more doors on car are open (DLCSR Relay De-Energized) 10 = All doors on car are closed (DLCSR Relay Energized) 11 = Not Valid		528

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
47	Door_CLOSE_RIGHT_Status	Command to close the right side doors 00 = Not Valid 01 = Door CLOSE RIGHT NOT active (DRCR Relay De-Energized) 10 = Door CLOSE RIGHT ACTIVE (DRCR Relay Energized) 11 = Not Valid		502
48	Door_CLOSE_RIGHT_ Summary_Status	Local car door status 00 = Not Valid 01 = One or more doors on car are open (DRCSR Relay De-Energized) 10 = All doors on car are closed (DRCSR Relay Energized) 11 = Not Valid		528
49	Door_Interlock_Bypass_Status	00 = Not Valid 01 = Door Interlock Bypass NOT active (DIBPRA Relay De-Energized) 10 = Door Interlock Bypass ACTIVE (DIBPRA Relay Energized) 11 = Not Valid		276
50	Door_OPEN_LEFT_Status	Command to open the left side doors 00 = Not Valid 01 = Door OPEN LEFT NOT active (DLOR Relay De-Energized) 10 = Door OPEN LEFT ACTIVE (DLOR Relay Energized) 11 = Not Valid	X	501
51	Door_OPEN_RIGHT_Status	Command to open the right side doors 00 = Not Valid 01 = Door OPEN RIGHT NOT active (DROR Relay De-Energized) 10 = Door OPEN RIGHT ACTIVE (DROR Relay Energized) 11 = Not Valid	X	502
52	Door_RELEASE_LEFT_Status	Command to release the left side doors 00 = Not Valid 01 = Door RELEASE LEFT NOT active (DLER Relay De-Energized) 10 = Door RELEASE LEFT ACTIVE (DLER Relay Energized) 11 = Not Valid	X	501
53	Door_RELEASE_RIGHT_ Status	Command to release the right side doors 00 = Not Valid 01 = Door RELEASE RIGHT NOT active (DRER Relay De-Energized) 10 = Door RELEASE RIGHT ACTIVE (DRER Relay Energized) 11 = Not Valid	X	502

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
54	DoorEmergencyReleaseState	Emergency Door Release State (DCU MVB Port 2178) 00000000 = No Handles Activated 00000001 = Door A1/A2 Emergency Open Handle Activated 00000010 = Door A3/A4 Emergency Open Handle Activated 00000100 = Door A5/A6 Emergency Open Handle Activated 00001000 = Door A7/A8 Emergency Open Handle Activated 00010000 = Door B1/B2 Emergency Open Handle Activated 00100000 = Door B3/B4 Emergency Open Handle Activated 01000000 = Door B5/B6 Emergency Open Handle Activated 10000000 = Door B7/B8 Emergency Open Handle Activated		
55	ECUA_BCPressure	ECU A Brake Cylinder Pressure (ECUA MVB Port 768) Scaled signal: PSI		
56	ECUA_FBECU_Slide_Detect	ECUA Slide Indication (ECUA MVB Port 768) 0 = ECUA has detected no wheel slide 1 = ECUA has detected wheel slide		
57	ECUA_LoadWeight	Load Weight on the A truck (ECUA MVB Port 768) Scaled signal: PSI		
58	ECUB_BCPressure	ECUB Brake Cylinder Pressure (ECUB MVB Port 896) Scaled signal: PSI		
59	ECUB_FBECU_Slide_Detect	ECUB Slide Indication (ECUB MVB Port 896) 0 = ECUB has detected no wheel slide 1 = ECUB has detected wheel slide		
60	ECUB_LoadWeight	Load Weight on the B truck (ECUB MVB Port 896) Scaled signal: PSI		
61	ECUC_BCPressure	ECUC Brake Cylinder Pressure (ECUC MVB Port 800) Scaled signal: PSI		
62	ECUC_FBECU_Slide_Detect	ECUC Slide Indication (ECUC MVB Port 800) 0 = ECUC has detected no wheel slide 1 = ECUC has detected wheel slide		
63	ECUC_LoadWeight	Load Weight on the C truck (ECUC MVB Port 800) Scaled signal: PSI		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
64	Emergency_Brake_TL	Emergency Brake Trainline (Port 100) 0 = Emergency Brake Applied (One or more EBR2C Relay De-Energized in train) 1 = No Emergency BRAKE (All EBR2C Relays Energized in train)		256
65	Emergency Brake TL Status	Emergency Brake Trainline Activation STATUS (from RIO-B Input) 00 = Not Valid 01 = Emergency Brake Applied (EBR2C Relay De-Energized) 10 = No Emergency BRAKE (EBR2C Relay Energized) 11 = Not Valid		256
66	FB_FAULT_and_CUTOUT_ Summary_TL_Status	00 = Not Valid 01 = ECU FAULT & CUTOUT TL – Faulted or Cutout 10 = ECU FAULT & CUTOUT TL No Faults and Not Cutout (when FBCOR or FBFR is Energized) 11 = Not Valid	X	406
67	FBECU_PB_Apply_PS	ECUA Parking Brake Applied Pressure Switch (ECUA MVB Port 768) 0 = Park Brake Not Applied (≥ 20 psi) 1 = Park Brake Applied (≤ 23 psi)		
68	FBECU_PB_Rel_PS	ECUA Parking Brake Release Pressure Switch (ECUA MVB Port 768) 0 = Park Brake Not Released (≤ 35 psi) 1 = Park Brake Released (≥ 72.5 psi)		
69	FBECUA_Major_Fault	ECUA Fault Status (ECUA MVB Port 768) 0 = ECUA does not have a fault 1 = ECUA has an active fault that requires immediate attention		
70	FBECUA_SB_Apply	ECUA Service Brake Applied Pressure Switch (ECUA MVB Port 768) 0 = Service Brake Not Applied (≤ 30 psi) 1 = Service Brake Applied (≥ 57 psi)		
71	FBECUA_SB_Rel	ECUA Service Brake Released Pressure Switch (ECUA MVB Port 768) 0 = Service Brake Not Released (≥ 1 psi) 1 = Service Brake Released (≤ 5 psi)		
72	FBECUB_Major_Fault	ECUB Fault Status (ECUB MVB Port 896) 0 = ECUB does not have a fault 1 = ECUB has an active fault that requires immediate attention		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
73	FBECUB_SB_Apply	ECUB Service Brake Applied Pressure Switch (ECUB MVB Port 896) 0 = Service Brake Not Applied (≤ 30 psi) 1 = Service Brake Applied (≥ 57 psi)		
74	FBECUB_SB_Rel	ECUB Service Brake Released Pressure Switch (ECUB MVB Port 896) 0 = Service Brake Not Released (≥ 1 psi) 1 = Service Brake Released (≤ 5 psi)		
75	FBECUC_Major_Fault	ECUC Fault Status (ECUC MVB Port 800) 0 = ECUC does not have a fault 1 = ECUC has an active fault that requires immediate attention		
76	FBECUC_SB_Apply	ECUC Service Brake Applied Pressure Switch (ECUC MVB Port 800) 0 = Service Brake Not Applied (≤ 9 psi) 1 = Service Brake Applied (≥ 17 psi)		
77	FBECUC_SB_Rel	ECUC Service Brake Released Pressure Switch (ECUC MVB Port 800) 0 = Service Brake Not Released (≥ 1 psi) 1 = Service Brake Released (≤ 5 psi)		
78	Friction_Brake_A_TRUCK_ Cutout_Status	00 = Not Valid 01 = A-Truck Friction Brake NOT cutout (BCORA Relay De-Energized) 10 = A-Truck Friction Brake CUTOUT (BCORA Relay Energized) 11 = Not Valid		277
79	Friction_Brake_B_TRUCK_ Cutout_Status	00 = Not Valid 01 = B-Truck Friction Brake NOT cutout (BCORB Relay De-Energized) 10 = B-Truck Friction Brake CUTOUT (BCORB Relay Energized) 11 = Not Valid		277
80	Friction_Brake_C_TRUCK_ Cutout _Status	00 = Not Valid 01 = C-Truck Friction Brake NOT cutout (BCORC Relay De-Energized) 10 = C-Truck Friction Brake CUTOUT (BCORC Relay Energized) 11 = Not Valid		277
81	Friction_Brake_ON_A_UNIT_ Status	00 = Not Valid 01 = One or more Friction Brakes in the train are NOT Applied (FBORA Relay De-Energized) 10 = All Friction Brakes in the train are Applied (FBORA Relay Energized) 11 = Not Valid	X	404

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
82	Friction_Brake_ON_B_UNIT_ Status	00 = Not Valid 01 = One or more Friction Brakes in the train are NOT Applied (FBORB Relay De-Energized) 10 = All Friction Brakes in the train are Applied (FBORB Relay Energized) 11 = Not Valid	X	404
83	Friction_Brake_Release_TL_ Status	00 = Not Valid 01 = One or more Friction Brakes are NOT Released 10 = All Friction Brakes in the train are RELEASED 11 = Not Valid		403
84	Head End A Unit Status	HEAD END A-UNIT STATUS 00 = Not Valid 01 = A-CAB Head End NOT Active (HER1A Relay De-Energized) 10 = A-CAB Head End ACTIVE (HER1A Relay De-Energized) 11 = Not Valid		251
85	Head End B Unit Status	HEAD END B-UNIT STATUS 00 = Not Valid 01 = B-CAB Head End NOT Active (HER1B Relay De-Energized) 10 = B-CAB Head End ACTIVE (HER1B Relay De-Energized) 11 = Not Valid		251
86	Headlight_HIGH_Beam_ A_UNIT_Status	00 = Not Valid 01 = Headlight High Beam is NOT ON (HLHR Relay De-Energized) 10 = Headlight High Beam is ON (HLHR Relay Energized) 11 = Not Valid	X	601
87	Headlight_HIGH_Beam_ B_UNIT_Status	00 = Not Valid 01 = Headlight High Beam is NOT ON (HLHR Relay De-Energized) 10 = Headlight High Beam is ON (HLHR Relay Energized) 11 = Not Valid	X	601
88	Headlight_LOW_Beam_ A_UNIT_Status	00 = Not Valid 01 = Headlight LOW Beam is NOT ON (HLLR Relay De-Energized) 10 = Headlight LOW Beam is ON (HLLR Relay Energized) 11 = Not Valid	X	601
89	Headlight_LOW_Beam_ B_Unit_Status	00 = Not Valid 01 = Headlight LOW Beam is NOT ON (HLLR Relay De-Energized) 10 = Headlight LOW Beam is ON (HLLR Relay Energized) 11 = Not Valid	X	601

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
90	HIGH_BELL_A_UNIT_Status	00 = Not Valid 01 = High Bell is NOT ON 10 = High Bell is ON 11 = Not Valid	X Local Car	829
91	HIGH_BELL_B_UNIT_Status	00 = Not Valid 01 = High Bell is NOT ON 10 = High Bell is ON 11 = Not Valid	X Local Car	829
92	HIGH_HORN_A_UNIT_Status	00 = Not Valid 01 = High Horn is NOT ON 10 = High Horn is ON 11 = Not Valid	X Local Car	829
93	HIGH_HORN_B_UNIT_Status	00 = Not Valid 01 = High Horn is NOT ON 10 = High Horn is ON 11 = Not Valid	X Local Car	829
94	HRSB_TL	High Rate Service Brake Trainline (Port 100) 0 = HRSB is NOT Requested 1 = HRSB is Requested		259/260
95	HSCB_Status_PLUA	PLUA MVB Port 512 00 = Not Valid 01 = HSCB Opened 10 = HSCB Closed 11 = Not Valid		202
96	HSCB_Status_PLUB	PLUB MVB Port 640 00 = Not Valid 01 = HSCB Opened 10 = HSCB Closed 11 = Not Valid		202
97	HVACA Fresh Air Temp	HVAC A Fresh Air Temperature (HVACA MVB Port 1025) Scaled signal: Deg. F		
98	HVACA Return Air Temp	HVAC A Return Air Temperature (HVACA MVB Port 1025) Scaled signal: Deg. F		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
99	HVACA Supply Air Temp	HVAC A Supply Air Temperature (HVACA MVB Port 1025) Scaled signal: Deg. F		
100	HVACA Temp Set Point	HVAC A Temperature Set Point (HVACA MVB Port 1025) Scaled signal: Deg. F		
101	HVACB Fresh Air Temp	HVACB Fresh Air Temperature (HVACB MVB Port 1153) Scaled signal: Deg. F		
102	HVACB Return Air Temp	HVACB Return Air Temperature (HVACB MVB Port 1153) Scaled signal: Deg. F		
103	HVACB Supply Air Temp	HVACB Supply Air Temperature (HVACB MVB Port 1153) Scaled signal: Deg. F		
104	LCU CarNumber	Local car number		
105	LCU Time Date	Not applicable		
106	LIMPHOME_TL	LIMP HOME Trainline (LHRB State or Trainline State) (Port 100) 0 = Limp Home is NOT Requested 1 = Limp Home Mode is Requested		259/276
107	LOW_BELL_A_UNIT_Status	00 = Not Valid 01 = Low Bell is NOT ON 10 = Low Bell is ON 11 = Not Valid	X Local Car	829
108	LOW_BELL_B_UNIT_Status	00 = Not Valid 01 = Low Bell is NOT ON 10 = Low Bell is ON 11 = Not Valid	X Local Car	829
109	LOW_HORN_A_UNIT_Status	00 = Not Valid 01 = Low Horn is NOT ON 10 = Low Horn is ON 11 = Not Valid	X Local Car	829
110	LOW_HORN_B_UNIT_Status	00 = Not Valid 01 = Low Horn is NOT ON 10 = Low Horn is ON 11 = Not Valid	X Local Car	829

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
111	M_TL_Status	PWR (POWER) Mode Hardware Trainline 00 = Not Valid 01 = Brake or Coast Mode 10 = Power Mode ACTIVE 11 = Not Valid		259
112	MFB NVital In - Amp Pwr A BkCk	0 = Not powered 1 = Not powered	X	904
113	MFB NVital In – Amp Pwr B BkCk	0 = Powered 1 =Not Powered	X	904
114	MFB NVital In – TWC Cutout	0 = Not Cutout 1 = Cutout	X	904
115	MFB Vital Out – Depart Test Sel	0 = Type II 1 = Type I	X	904
116	MFB Vital Out – Forward	0 = Dir TL 1 de-energized 1 = Dir TL 1 energized	X	904
117	MFB Vital Out – Power Cut	0 = Power Cut 1 = No Power Cut	X	904
118	MFB Vital Out – Reverse	0 = Dir TL 2 de-energized 1 = Dir TL 1 energized	X	904
119	MIO Vital In – Cab Sig A BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
120	MIO Vital In - Cab Sig B BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
121	MIO Vital In – Cab Test A BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
122	MIO Vital In – Cab Test B Bkck	0 = Relay Energized 1 = Relay De-energized	X	904

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
123	MIO Vital In – Enable Doors L BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
124	MIO Vital In – Enable Doors R BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
125	MIO Vital In – FSB BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
126	MIO Vital Out – Cab Sig A Sel	0 = A End Not Selected 1 = A End Selected	X	904
127	MIO Vital Out – Cab Sig B Sel	0 = B End Not Selected 1 =B End Selected	X	904
128	MIO Vital Out – Cab Test A Sel	0 = A End Not Selected 1 = A End Selected	X	904
129	MIO Vital Out – Cab Test B Sel	0 = B End Not Selected 1 =B End selected	X	904
130	MIO Vital Out – Emergency Brake	0 = EB Applied 1 = EB Not Applied	X	904
131	MIO Vital Out – Enable Doors Left	0 = Not Enabled 1 =Enabled (ATO only)	X	904
132	MIO Vital Out – Enable Doors Right	0 =Not Enabled 1 =Enabled (ATO Only)	X	904
133	MIO Vital Out – FSB	0 = FSB Applied 1 =FSB Not Applied	X	904
134	MIO Vitral In – ATP Not Bypass	0 = ATP In Bypass 1 = ATp Not in Bypass	X	904

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
135	MRPressure	Main Reservoir Pressure (ECUC MVB Port 800) Scaled signal: PSI		415
136	Network_Control_Bypass_ Status	00 = Not Valid 01 = Network Control Bypass NOT active (NCBPRA Relay De-Energized) 10 = Network Control Bypass ACTIVE (NCBPRA Relay Energized) 11 = Not Valid		276
137	No_Motion_Bypass_Status	00 = Not Valid 01 = No Motion Bypass is NOT Bypassed (NMBPR1B Relay De-Energized) 10 = No Motion Bypass is Bypassed (NMBPR1B relay Energized) 11 = Not Valid		276
138	NO_MOTION_Relay_Status	No Motion on the car 00 = Not Valid 01 = VEHICLE MOVING (NMR1B Relay De-Energized) 10 = Vehicle NOT Moving (NMR1B Relay Energized) 11 = Not Valid		304
139	Pantograph Down TL	Pantograph DOWN STATUS (Trainline MVB Port 100) 0 = Pantograph DOWN Control NOT Active 1 = Pantograph DOWN Control ACTIVE		
140	Pantograph Up TL	Pantograph UP RELAY STATUS (Trainline MVB Port 100) 0 = Pantograph UP Control NOT Active 1 = Pantograph UPControl ACTIVE		
141	PBEDSetPoint_TL	Propulsion and Brake Control PWM Signal (Trainline) (Port 100)		259/260
142	PIC Activated TL	CCU PIC Activated Signal from the Lead CCU Only to the TL (Trainline MVB Port 104) 0 = ERROR 1 = No Action 2 = PIC Activated 3 = UNDEFINED		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
143	PIC Answered	CCU PIC Answered Signal from the Lead CCU Only to the TL (Trainline MVB Port 104) 0 = ERROR 1 = No Action 2 = PIC Answered 3 = UNDEFINED		
144	PLU_Fault_and_Cutout_TL_ Status	00 = Not Valid 01 = One or more Propulsion Fault or Cutout in the train 10 = No Propulsion Faults and No Cutout in the train 11 = Not Valid	X	306
145	PLUA_AC208_Status	PLUA 208 VAC Status (PLUA MVB Port 512) 00 = Not Valid 01 = PLUA 208 VAC NOT Available for cooling fans 10 = PLUA 208 VAC is Available for cooling fans 11 = Not Valid		323
146	PLUA_Cutout_Status	00 = Not Valid 01 = Propulsion A-Truck is NOT Cutout (PCORA Relay De-Energized) 10 = Propulsion A-Truck is Cutout (PCORA Relay Energized) 11 = Not Valid		277
147	PLUA Direction of Actual Movement	PLUA Direction Status (PLUA MVB Port 512) 00 = Not Valid 01 = Vehicle Movement Direction is Correct 10 = Vehicle Movement Direction is NOT Correct 11 = Not Valid		
148	PLUA_Distance_Counter	PLUA Distance to MDS (PLUA MVB Port 512) 1 Pulse count =1 meter		
149	PLUA_Dynamic_Brake_ Available	PLUA Dynamic Brake Availability (PLUA MVB Port 512) Sent to Friction Brakes 00 = Not Valid 01 = PLUA Dynamic Brake Active 10 = PLUA Dynamic Brake Off 11 = Not Valid		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
150	PLUA_Dynamic_Brake_Fault_ Status	00 = Not Valid 01 = PLUA is Faulted (PDFRA De-Energized) 10 = PLUA is Operational (PDFRA Energized) 11 = Not Valid		306
151	PLUA_Power_Cut_TL	PLUA Power Cut Status (PLUA MVB Port 512) 00 = Not Valid 01 = Power Cut 10 = No Power Cut 11 = Not Valid		308
152	PLUA_Power_Effort_ Feedback	PLUA Tractive Effort (PLUA MVB Port 512) Scaled signal: N Range: -51200 thru +51000 N		
153	PLUA_ReferenceSpeed	PLUA Speed (PLUA MVB Port 512) Scaled signal: mph		
154	PLUA_Rollback_Signal	PLUA Rollback Status (PLUA MVB Port 512) 00 = Not Valid 01 = PLUA Detected No Rollback 10 = PLUA Detected a Rollback 11 = Not Valid		
155	PLUA Slip Detected	PLUA Spin/Slide Status (PLUA MVB Port 512) 00 = Not Valid 01 = PLUA Detected No Spin or Slide 10 = PLUA Detected a Spin or Slide 11 = Not Valid		
156	PLUA_Speed_Restriction_ Limit	PLUA Speed Restriction (PLUA MVB Port 512) 35 mph = Speed Restriction 65 mph = Normal Operation	X	
157	PLUA_Stopping_Brake	PLUA Stopping Brake Status (PLUA MVB Port 512) 00 = Not Valid 01 = PLUA Stopping Brake NOT Active 10 = PLUA Stopping Brake Active 11 = Not Valid		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
158	PLUB_AC208_Status	PLUB 208 VAC Status (PLUB MVB Port 640) 00 = Not Valid 01 = PLUB 208 VAC NOT Available for cooling fans 10 = PLUB 208 VAC is Available for cooling fans 11 = Not Valid		323
159	PLUB_Cutout_Status	00 = Not Valid 01 = Propulsion B-Truck is NOT Cutout (PCORB Relay De-Energized) 10 = Propulsion B-Truck is Cutout (PCORB Relay Energized) 11 = Not Valid		277
160	PLUB Direction of Actual Movement	PLUB Direction Status (PLUB MVB Port 640) 00 = Not Valid 01 = Vehicle Movement Direction Correct 10 = Vehicle Movement Direction NOT Correct 11 = Not Valid		
161	PLUB_Dynamic_Brake_ Available	PLUB Dynamic Brake Availability (PLUA MVB Port 640) Sent to Friction Brakes 00 = Not Valid 01 = PLUB Dynamic Brake Active 10 = PLUB Dynamic Brake Off 11 = Not Valid		
162	PLUB_Dynamic_Brake_Fault_ Status	00 = Not Valid 01 = PLUB is Faulted (PDFRB De-Energized) 10 = PLUB is Operational (PDFRB Energized) 11 = Not Valid		306
163	PLU_B_Power_Cut_TL	PLUB Power Cut Status (PLUB MVB Port 640) 00 = Not Valid 01 = Power Cut 10 = No Power Cut 11 = Not Valid		308
164	PLUB_Power_Effort_ Feedback	PLUB Tractive Effort (PLUB MVB Port 640) Scaled signal: N Range: -51200 thru +51000 N		
165	PLUB_ReferenceSpeed	PLUB Speed (PLUB MVB Port 640) Scaled signal: mph		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
166	PLUB_Rollback_Signal	PLUB Rollback Status (PLUB MVB Port 640) 00 = Not Valid 01 = PLUB Detected No Rollback 10 = PLUB Detected a Rollback 11 = Not Valid		
167	PLUB Slip Detected	PLUB Rollback Status (PLUB MVB Port 640) 00 = Not Valid 01 = PLUB Detected No Spin or Slide 10 = PLUB Detected a Spin or a Slide 11 = Not Valid		
168	PLUB_Speed_Restriction_ Limit	PLUB Rollback Status (PLUB MVB Port 640) 35 mph = Speed Restriction 65 mph = Normal Operation		
169	PLUB_Stopping_Brake	PLUB Rollback Status (PLUB MVB Port 640) 00 = Not Valid 01 = PLUB Stopping Brake NOT Active 10 = PLUB Stopping Brake Active 11 = Not Valid		
170	Reset_TL (Propulsion_Reset_TL)	Propulsion Reset Trainline from the TOD (Port 100) 0 = Propulsion Reset NOT Active 1 = Propulsion Reset ACTIVE		
171	Sanding_Control_TL_Status	00 = Not Valid 01 = No Sanding Requested 10 = Sanding is Requested 11 = Not Valid		412
172	SCEB_TL	SLIDE CONTROLLED EMERGENCY BRAKE Trainline (Port 100) 0 = SCEB is Active 1 = No SCEB		259
173	Silent Alarm	CCU Silent Alarm Activated Signal from the Lead CCU Only to the TL (Trainline MVB Port 104) 0 = ERROR 1 = No Action 2 = Silent Alarm Activated 3 = UNDEFINED		

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
174	Tail End A Unit Status	TAIL END A-UNIT STATUS 00 = Not Valid 01 = A-CAB Tail End NOT Active (TER1A De-Energized) 10 = A-CAB Tail End ACTIVE (TER1A Energized) 11 = Not Valid		251
175	Tail End B Unit Status	TAIL END B-UNIT STATUS 00 = Not Valid 01 = B-CAB Tail End NOT Active (TER1B De-Energized) 10 = B-CAB Tail End ACTIVE (TER1B Energized) 11 = Not Valid		251
176	Towing_Mode_TL	Towing Mode (Command Generated from the TOD, this signal is activated when the lead PLU acknowledges to enter Tow Mode) (Port 100) 0=Towing Mode NOT Active, 1=Towing Mode ACTIVE		
177	Track_Brake_Control_CB_ Status	00 = Not Valid 01 = Track Brake Control Circuit Breaker (TBCCB) OFF 10 = Track Brake Control Circuit Breaker (TBCCB) ON 11 = Not Valid		408
178	Track_Brake_Control_TL_ Status	00 = Not Valid 01 = Track Brake is NOT Applied (TBRC Relay De-Energized) 10 = TRACK BRAKE is Applied (TBRC Relay Energized) 11 = Not Valid		408
179	Track_Brake_TBCB3A_Status	00 = Not Valid 01 = Track Brake A-TRUCK Circuit Breaker (TBCBA) OFF 10 = Track Brake A-TRUCK Circuit Breaker (TBCBA) ON 11 = Not Valid		407
180	Track_Brake_TBCB3B_Status	00 = Not Valid 01 = Track Brake B-TRUCK Circuit Breaker (TBCBB) OFF 10 = Track Brake B-TRUCK Circuit Breaker (TBCBB) ON 11 = Not Valid		407
181	Track_Brake_TBCB3C_Status	00 = Not Valid 01 = Track Brake C-TRUCK Circuit Breaker (TBCBC) OFF 10 = Track Brake C-TRUCK Circuit Breaker (TBCBC) ON 11 = Not Valid		407

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
182	Track_Brake_TBCB4A_Status	00 = Not Valid 01 = Track Brake A-TRUCK Circuit Breaker (TBCBA) OFF 10 = Track Brake A-TRUCK Circuit Breaker (TBCBA) ON 11 = Not Valid		407
183	Track_Brake_TBCB4B_Status	00 = Not Valid 01 = Track Brake B-TRUCK Circuit Breaker (TBCBB) OFF 10 = Track Brake B-TRUCK Circuit Breaker (TBCBB) ON 11 = Not Valid		407
184	Track_Brake_TBCB4C_Status	00 = Not Valid 01 = Track Brake C-TRUCK Circuit Breaker (TBCBC) OFF 10 = Track Brake C-TRUCK Circuit Breaker (TBCBC) ON 11 = Not Valid		407
185	Track_Brake_TL	Track Brake Trainline (Port 100) 0 = No Track Brakes 1 = Track Brake are Applied		
186	TrainReferenceSpeed_TL	(Port 100) Scaled signal: mph		
187	Vital In1 High – ATP ACK	0 = ATP ACK Not pressed 1 = ATP ACK pressed	X	904
188	Vital In1 High – ATP Bypass	0 = ATP Not in Bypass 1 = ATP in Bypass	X	904
189	Vital In1 High – Doors Closed A	0 = Doors Not Closed 1 = Doors Closed	X	904
190	Vital In1 High – Doors Closed B	0 = Doors Not Closed 1 = Doors Closed	X	904
191	Vital In1 High -Fric App A	0 = Applied if A End keyed on 1 = Not applied	X	904
192	Vital In1 High -Fric App B	0 = Applied if B end keyed on 1 = Not applied	X	904

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
193	Vital In1 High – No Fric Fault	0 = Fault 1 = No Fault	X	904
194	Vital In1 High – No Prop Fault	0 = Fault 1 = No Fault	X	904
195	Vital In1 Low – A End	0 = A Cab keyed OFF 1 = A Cab keyed ON	X	904
196	Vital In1 Low – B End	0 = B Cab keyed OFF 1 = B cab keyed ON	X	904
197	Vital In1 Low -Coast A	0 = Master Controller in Power 1 = MC in Coast or Brake	X	904
198	Vital In1 Low – Coast B	0 = Master Controller in Power 1 = MC in Coast or Brake	X	904
199	Vital In1 Low – FSB A	0 =Master Controller Not in FSB 1 = MC in FSB	X	904
200	Vital In1 Low -FSB B	0 = Master Controller Not in FSB 1 = MC in FSB	X	904
201	Vital In1 Low -Type I	0 = Not in Type I 1 = In Type I	X	904
202	Vital In1 Low -Type II	0 = Not in Type II 1 = In Type II	X	904
203	Vital In2 High – Dept Test Sel BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
204	Vital In2 High -For BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
205	Vital In2 High – Power Cut BkCk	0 = Relay Energized 1 = Relay De-energized	X	904

Input #	LRV Signal Equivalent	Description	Valid Lead Car Only	Circuit Diagram Page #
206	Vital In2 High -Rev BkCk	0 = Relay Energized 1 = Relay De-energized	X	904
207	Vital In2 Low – ATO	0 = Not in ATO 1 = In ATO	X	904
208	Vital In2 Low -CM	0 = Brake Mode 1 = Power of Coast Mode ACTIVE	X	904
209	Vital In2 Low -EB App	0 = No EB applied 1 = EB applied	X	904
210	Vital In2 Low -Forward	0 = Dir 2 TL de-energized 1 = Dir 2 TL energized	X	904
211	Vital In2 Low -M	0 = Brake or Coast Mode 1 = Power Mode ACTIVE	X	904
212	Vital In2 Low -Manual	0 = Not Manual 1 = Manual	X	904
213	Vital In2 Low -No Power Cut	0 = Power Cut 1 = No Power Cut	X	904
214	Vital In2 Low - Reverse	0 = Dir TL1 de-energized 1 = Dir TL2 energized	X	904
215	WWAS Alarm	Wayside Worker Alert Signal (Port 1792) 00 = Not Valid 01 = No Alert / Alert Cleared 10 = Alert Received 11 = Not Valid	X	