P3010
Los Angeles LRV

AUTOMATIC TRAIN CONTROL and TRAIN-TO-WAYSIDE SYSTEM

Section 1500
RUNNING MAINTENANCE & SERVICING MANUAL

LIST OF EFFECTIVE PAGES

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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 Ansaldo STS (ASTS) Automatic Train Control (ATC) system is a microprocessor and electronic-based cab signaling system. The ATC enclosure and peripheral components provide the hardware and software necessary to implement the functional requirements of the LA P3010 specification for both Type I and Type II ATC systems. System components comprise the following interconnected and interdependent ATC subsystems:

- Automatic Train Protection (ATP),
- Automatic Train Operation (ATO),
- Train to Wayside Communications (TWC),
- Communications (COMM).

These subsystems share mounting space, power supplies, and interfaces with the vehicle. During vehicle operation, all the subsystems simultaneously perform their assigned functions to exchange data and ensure continuous operation.

The LACMTA P3010 ATC is designed for compatible functional operation on the metro lines listed below:

- Metro Blue Line (MBL) (Type I),
- Metro Green Line (MGL) (Type II),
- Pasadena Gold Line (PGL), including the Eastside Extension (Type I),
- Exposition (Type I),
- Crenshaw Line (Type II) (Future),
- Foothill Extension (Type I),
- Regional Connector (Type I) (Future).

A Line Selector Switch on the vehicle provides the method for properly configuring the ATC for operation on desired line and type of operation. In general Type I operation has ATP and TWC functional capabilities while Type II operation has ATP, TWC, and ATO functional capabilities.

1.2 Acronyms and Abbreviations

ADC	Analog to Digital Converter
ADU	Aspect Display Unit
AF	Audio Frequency
AMP	Amplifier
ASK	Amplitude Shift Keying
ASTS USA	Ansaldo STS USA
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
BA	Brake Assurance
BAFS	Brake Assured Full Service Stop
CCB	Communication Controller Board (PCB)
CCU	H&K TWC Communication/Control Unit
CM	Coast Motor trainline
COMM	Communication Subsystem
CPLD	Complex programmable Logic Device
CPM	Code Per Minute
CPS	Conditional Power Supply
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CSRD	Cab Signal Receiver-Demodulator
DDS	Direct Digital Signal
DPRAM	Dual Port Random Access Memory
DSP	Digital Signal Processing
DTG	Distance-To-Go
EB	Emergency Brake
EEPROM	Electrically Erasable Programmable Read Only Memory
ELD	Enable Left Doors
ERD	Enable Right Doors
ESL	Enforced Speed Limit
ESS	Emergency Station Stop
FPGA	Field programmable Gate Array
FSB	Full Service Brake
FSBR	Full Service Brake Relay
FSK	Frequency Shift Keying
H&K	Hanning & Kahl
Hz	Hertz
IC	Integrated Circuit

ID	Identification
IEB	Irrevocable Emergency Brake
IES	Irrevocable Emergency Stop
LACMTA	Los Angeles County Metropolitan Transportation Authority
LED	Light-Emitting Diode
LRV	Light Rail Vehicle
M	Motor (M) trainline
MAS	Maximum Authorized Speed
MBL	Metro Blue Line
MDS	Maintenance and Diagnostic System
MGL	Metro Green Line
MVB	Multifunction Vehicle Bus
ms	Milliseconds
NC	Normal Closed
NO	Normal Open
OCC	Operational Control Center
OSL	Operational Speed Limit
PCB	Printed Circuit Board
PDR	Preliminary Design Review
PGL	Pasadena Gold Line
PHW	Programmable Hardware
PSS	Precision Station Stop
PTU	Portable Test Unit
PWM	Pulse Width Modulation
PVID	Permanent Vehicle Identification
RES	Revocable Emergency Stop
RMS	Root Mean Square
RX	Receive Signal
SBD	Safe Braking Distance
SPI	Serial Peripheral Interface
SPO	Supervisory, Positioning, and Orientation
TOD	Train Operator Display
TS	Technical Specification
TWC	Train-to-Wayside Communication
TX	Transmit Signal
UEB	Unrecoverable Emergency Brake
UES	Unrecoverable Emergency Stop
VIA	Versatile Interface Adapter
Vdc	Voltage Direct Current

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CHAPTER 2.0

FUNCTIONAL DESCRIPTION

2.1 Introduction

The ATC system provides the operational functionality of ATP, ATO, and TWC subsystems in one integrated enclosure. ATP train control functionality is implemented vitally.

The LACMTA ATC system for the P3010 vehicle is comprised of several different subsystems that are integrated into a comprehensive train control system. Each subsystem provides different functions within the ATC system, and there are functional differences in the operation of the ATC system depending upon which line the ATC is operating. Refer to the LACMTA ATC System Operating Manual for a detailed discussion of these functional differences. This maintenance manual section provides an introductory overview of the following ATC subsystems to give the vehicle maintainer an understanding of the operational context of the ATC system components described in Section 2.2:

- Automatic Train Protection (ATP) subsystem; refer to Section 2.4
- Automatic Train Operation (ATO) subsystem; refer to Section 2.5
- Train-to-Wayside (TWC) subsystem; refer to Section 2.6
- Communications (COMM) subsystem; refer to Section 2.7

For ease in distinguishing ATC system operational differences between the Metro lines, ATC functionality on the Metro Blue Line (MBL), Expo Line (EXPO), and Pasadena Gold Line (PGL) and like lines are referred to as Type I operation and operation on the Metro Green Line (MGL) and like lines is referred to as Type II operation.

2.2 System Overview

The ATC provides the operational functionality of ATP, ATO, and TWC in one integrated enclosure. ATP train control functionality is implemented vitally.

The ATP functionality performs the following eight major functions across all Metro lines:

- Cab Signal Reception and Decoding
- Vehicle Speed Determination
- Over Speed Protection
- Braking and Propulsion Control
- Input / Output Processing
- Door Control
- ATP Operating Modes
- Departure Test
- Direction Control and Validation

ATO operation is Type II specific. The function of the ATO allows the LRV to automatically traverse the guide-way from one station to the next station. The vehicle performs speed regulation and station stopping in the Manual with ATO mode.

The berthed indication is provided from the wayside when operating on the Type II lines. The vehicle's onboard ATC system enables the doors on the correct side (left or right) according to the ATC stored track circuit ID table.

The ATO functionality is Non-Vital. The major functions of the ATO are as follows:

- Braking and Propulsion Control for Automatic Operations
- Speed Regulation
- Programmed Stopping
- Route Control

The TWC functionality is Non-Vital. The TWC subsystem is 100% compatible with H&K HSC-V TWC equipment and the ASTS TWC systems installed on Metro's existing alignments. The wayside transmits and receives non-vital information through the use of TWC loops situated between the rails and located at selected track locations. The vehicle TWC subsystem transmits and receives information through the use of TWC antennas mounted at each end of the vehicle. The selection of the active antenna is based upon which cab end is actively keyed. A Line Selector Switch on the vehicle provides the method for properly configuring the TWC for operation on the desired line.

The TWC performs the following major functions across all Metro lines:

- Route Control and Indication
- Overloop Detection & Indication
- Train Identification
- Results of Departure Test (Type II)
- Provides input to ATO subsystem (Type II)

2.3 System Functionality and Power Dependencies

Internally, the ATC Enclosure is separated into three subsystems:

- ATP
- TWC/ATO
- Communications/CSRD

In Type I Mode, the ATP is isolated from the TWC system physically and electrically. Powering off or removing a PCB from the ATC or the Type I TWC will not affect the other component. In Type II Mode, the subsystems are in layered dependence on the lower layered subsystems. The ATO subsystem is dependent on the TWC subsystem which is dependent on the ATP subsystem. For example, the TWC subsystem can remain active if the ATO subsystem is powered down or removed, but it cannot function if the ATP subsystem is powered down or removed. A failure of the TWC subsystem cannot cause a failure of the ATP subsystem. Additionally, there is a TWC Bypass Switch on the operator's console that will remove power from the TWC subsystem to add extra isolation through safety relays in the ATC. The ATC enclosure has one internal power switch located on the Battery Conditioner Board and is accessible from the front of the ATC enclosure. The switch is labeled "ATC".

When the ATC power switch is in the OFF position, power is removed from all components in the ATC enclosure beyond the Battery Conditioner Board. The ATC power switch must be in the OFF position to safely remove components from the ATC enclosure. Removal of a component under any other condition will result in failures of the ATC system. The exception to this is the Type I TWC that system external to the ATC enclosure. The Type I TWC system has a separate power supply and is not affected by the ATC system state.

2.4 ATP Subsystem

Refer to Figure 2-1. The ATP functionality performs the following major functions across all Metro lines:

- Wayside to detect the presence of vehicles and transmit control signals to vehicles. Each wayside track circuit continuously transmits vital data to the vehicle, generally referred to as Cab Signal. The Cab Signal data in each track circuit provides much of the information needed to determine the current safe speed of the vehicle in that particular track circuit.

  Different Cab Signal technologies are employed on Type I and Type II operation systems. As such, the ATP system is designed with two separate decoding subsystems to accommodate these methods. Depending on the position of the vehicle Line Selector switch, the ATP will select the appropriate decoding subsystem to use in determining the current speed limit.

  The Type I operational system is a non-profile-based step systems employing traditional ASK modulated coded carrier cab signal technology. When operating as a Type I operational system, the cab signal reception and decoding is the function of the CSRD subsystem.

  The Type II operational system is a profile-based system employing digital FSK cab signal technology. When operating as a Type II operational system, cab signal reception and decoding is the function of the CSRD subsystem.

- Vehicle Speed Determination - Determining vehicle speed is a critical and vital function of the ATP subsystem. The ATP subsystem will compare the speed pulses from the speed sensor that is installed on a non-powered, center truck axle 4 with that of another speed sensor installed on powered truck axle 6. The ATP vitally determines the vehicle speed using the received signals and user programmed wheel size values for each sensor.

  The “System Speed” value is used by the ATP subsystem as representation of the vehicle speed and is displayed on the ADU unless the ATC-ADU communication link is down, in which case the MVB speed will be displayed. System Speed is vitally determined using the two speed sensors described, and the decelerometer device. The output from each speed sensor is non – periodic square wave, whose frequency is based upon rotational velocity of a pole wheel connected to the axle. The ATP converts these pulses into linear distance using wheel diameter information. Speed for each sensor is then calculated as the linear distance per unit of time. The gear ratio on a motorized truck is 1:6.4264 and there are 60 teeth on pole wheel. For a new 28 inch wheel this translates to 77.0708 pulses/sec per mph, or 5394.9571 hz at 70 mph. For a worn 26 inch wheel this translates to 82.999 pulses/sec per mph, or 5809.96 hz at 70 mph. The gear ratio on the center, or trailer truck pole, is 1:1 and the pole wheel has 120 teeth.

For a new 28 inch wheel this translates to 24.0095 pulses/sec per mph, or 1680.6711 hz at 70 mph. For a worn 26 inch wheel this translates to 25.8564 pulses/sec per mph, or 1809.9538 hz at 70 mph.

The calculated speeds for each sensor are used to determine the value of “Tach Speed.” The vital parameter Tach Speed is determined using the greater of the two calculated sensor speed values; unless a Spin/Slide condition exists. During a declared Spin condition, the Tach Speed is determined based solely on the calculated speed from the speed sensor on the non-powered truck (the motor wheels are spinning), except when the non-powered truck speed is showing zero speed. In this situation the Tach speed from the powered truck will be used. When not in an active operating mode, or when in an active operating mode and the vehicle is not in a braking or declared Spin/Slide condition, the System Speed is set to the determined Tach Speed.

During both Type I and Type II operation, in the event of a declared Slide condition, or in situations where the speed sensors cannot be trusted, the ATP maintains an additional speed parameter that is calculated using the decelerometer device. When the vehicle is in a braking or declared slide condition, and the System Speed is greater than two (2) mph, the ATP determines a “Decel Speed” value for that cycle based upon the current cycle’s instantaneous brake rate value, and the previous cycle’s System Speed value. The ATP will grade compensate the brake rate when in Type II operation. System Speed is set to the greater of either the Tach Speed value, or the decelerometer adjusted speed value.

- Speed Sensors - The ATP subsystem utilizes three inputs from two active, zero-speed sensors. Two speed sensors are used to protect against singularly undetectable failures for speed signal acquisition. Two independent devices are used to reduce the possibility of single point failures. The devices are mounted on separate axles and powered by independent supplies. The probes reliably detect speeds to as low as approximately zero mph. One sensor provides two quadrature-phase inputs to the ATC system in order to assess direction.

  The sensors are used in determining vehicle motion parameters such as:

  - Vehicle Speed
  - Spin/Slide
  - V – zero State
  - No Motion State
  - Vehicle Position (Type II only)
  - Direction of Travel
  - Roll Back

- Wheel Wear Compensation - A wheel wear adjustment function is provided in the ATP for use in determining vehicle speed. The wheel wear will be entered using the TOD and the TOD will forward the wheel diameters to the ATC and Propulsion units. The ATP system allows for input of the correct wheel diameter to ensure accurate velocity measurements. This vital value may be adjusted between the nominal "new wheel diameter of 28.25 inch," to the minimum allowable wheel diameter of 26 inch, in 0.125 inch increments (values sent to ATC will be rounded up to nearest 0.125 increment). Both speed sensor equipped axles are required to have a wheel diameter value set and verified by a qualified maintainer. After measuring the wheel(s) associated with each speed sensor, the appropriate value(s) are entered into the ATP using the function keys on the TOD. The ATP will only permit entry of the wheel diameter values if the ATP is in Manual mode. If another mode is entered once the entry process has begun, the ATP will abort the entry session and revert back to using the current stored value. In addition, the ATP will require the train to be at V-zero and friction brakes to be applied. Once the input is made, the wheel diameter values are retained in the ATP subsystem EEPROM until authorized maintenance personnel adjust it.

  The ATP will use the largest wheel diameter setting upon start-up until the data is retrieved from the EEPROM to compute speed. The largest wheel diameter setting will also be used in the event that wheel diameter is determined to be corrupt (i.e. value out of range, EEPROM failure, etc.)

  The wheel wear calibration is necessary at the following times:

  - During each periodic inspection
  - After any wheel truing for which a speed sensor is associated
  - After replacement of a truck for which a speed sensor is associated

- Over Speed Protection – For Type II this function is the enforcement of the speed limit applied in this track circuit. It may range from 0 to 65 MPH in 5-MPH increments. The ROC may modify the current speed limit to adjust to operation requirements. Additional modification of the speed can be obtained when the ROC inserts performance level adjustments to allow optimum utilization of train separation. For Type I the current speed limit is determined by examining the combination of any code rate received from the CSRD subsystem or any operating modes that are in effect.

- Braking and Propulsion Control - This feature takes inputs from the various manual input devices available to the Operator, (key transfer switch, directional control, master controller) and applies these inputs to assure the vehicle is operated in direction, mode and in a safe manner based on the setting of these items. The application software uses the mode (from the key transfer switch) forward or reverse (from direction control), and M/CM for ATP Mode to permit vital movement.

- ATP Operating Modes - Manual, Manual with ATO, Local, and Bypass.

- ATP Departure Test - The on-board Departure Test exercises the following areas of the system in order to verify proper operation ADU interface, alarm activation, FSB application, EB application, door enable, ATP coil for valid cab signal detection, and ATC detection of ATP speed commands.

[redacted]

- Vehicle Orientation and Direction Control - This subset determines the proposed direction of travel from the wayside inputs and vehicle inputs assures operation in the correct direction and outputs this direction to other ATC functions and trainline logic.

- Door Control Enabling (Type II) - This function enables the correct side doors when stopping at a station based on track circuit number of the arrival track and direction of travel. An additional berth bit must be contained in the received FSK data to allow non-override operation. This function also provides assurance of the closed-door status prior to the ATP allowing movement of the vehicle.

- Permanent Vehicle Identification - This function uses vehicle obtained data from the Maintenance and Diagnostic System MDS to assign the vehicle ID in the ATC.

2.5 ATO Subsystem

Refer to Figure 2-2. The ATO functionality is non-Vital. The major functions performed by the ATO subsystem are:

- Braking and Propulsion Control - Provides the vehicle PBED input equivalent to the master controller for speed and braking controller and sets M and CM trainlines.

- Speed Regulation - Maintains the optimum vehicle speed with respect to the maximum speed allowed and performance level selected by the ROC.

- Programmed Stopping - This function decelerates the vehicle to a stop within the station boundaries.

- Route Control - When this feature is enabled, the ROC allows automatic routing of the vehicle (see Appendix B for specific codes) through the MGL trackage and future Type II alignments. This routing includes setting switch points and signals for first-come-first-served vehicle movement.

- Type II TWC communications - This is the feature responsible for communication with the wayside equipment allowing data transfers to and from the ROC.

- Train Identification - This function is assigned by ROC to track this vehicle along the travel of the MGL and future Type II alignments. The default train ID sent in TWC communication is the vehicle number contained in the PVID. This item can be changed by the ROC or Yard Controllers to reflect the train number while on the mainline. This item also affects automatic routing as messages are synchronized by this number. If the train ID is changed, auto routing treats this as a different vehicle and the previous vehicle is lost.

- Performance Modification - This feature allows the ROC to adjust the maximum speed of vehicle. PL1 allows maximum speed as defined in the control line information received from the FSK inputs; PL2 allows 90% of maximum, etc.

[redacted]

Figure 2-2: ATO Subsystem Block Diagram

2.5.1 Modifying the Train's Performance

The Controller can modify the performance of a train operating in ATO Mode. The Controller can accomplish this by changing the ATO subsystem's performance level, commanding the ATO subsystem to enter Coast mode, or changing the station stopping brake rate. These commands are sent to the train via TWC.

There are six performance levels. The ATO subsystem has tabled values of control speed limits, commanded accelerations, and programmed stop decelerations associated with each performance level. The performance levels are shown in Table 2-1.

Normally in ATO Mode the ATO subsystem will use PL1, sent by the ATP subsystem as the control speed. The Controller can use the performance levels to adjust to changes in the schedule or conditions along the track. For speed limits less than or equal to 8-MPH, the performance level control speed limit value less than maximum will be ignored, to keep low speed limit operations from being degraded, i.e., the control speed used by the ATO subsystem will be the value received from the ATP subsystem. All other characteristics of the PL will be observed, i.e., commanded acceleration, programmed stop deceleration.

Table 2-1. Performance Levels

Level	Control Speed Limit	Commanded Acceleration	Programmed Stop Deceleration
1	Maximum	Maximum	2.0 MPH/S
2	90%	Maximum	2.0 MPH/S
3	90%	75%	1.4 MPH/S
4	50%	Maximum	2.0 MPH/S
5	55 MPH	Maximum	2.0 MPH/S
6	25 MPH	Maximum	2.0 MPH/S

Coast mode is an additional performance level, requiring that PL1 through PL5 be in effect and that the speed limit be above 25 MPH when coast is requested. Coast mode commands the vehicle to coast between applications of power and allows the vehicle's actual speed to drop by 7-MPH before reapplying power.

In addition to the programmed stop deceleration specified by the performance level the Controller can also command the station stopping brake rate. The ATO would use the lower of the two rates commanded via TWC. The commanded station stopping brake rate would be used when stopping at the next station. These rates allow the Controller to adjust to poor rail friction at different times during the day and/or at different locations along the property.

Table 2-2. Station Stopping Brake Rate

Level	Station Stopping Brake Rate
0	No change, no action taken
1	2.0-MPH/SECOND
2	1.9-MPH/SECOND
3	1.8-MPH/SECOND
4	1.7-MPH/SECOND
5	1.6-MPH/SECOND
6	1.5-MPH/SECOND
7	1.4-MPH/SECOND
8	1.3-MPH/SECOND
9	1.2-MPH/SECOND

2.6 TWC Subsystem

The TWC performs the following major functions across all Metro lines:

- Route Control and Indication,
- Overloop Detection and Indication,
- Train Identification (Type II),
- Provides input to ATO subsystem (Type II).

The TWC functionality is non-vital. The TWC subsystem is 100% compatible with H&K HCS-V TWC equipment and the ASTS TWC systems installed on Metro’s existing alignments through the implementation of two separate Type I and Type II TWC carborne systems. The wayside transmits and receives non-vital information through the use of TWC loops situated between the rails and located at selected track locations. The vehicle TWC subsystem transmits and receives information through the use of TWC antennas mounted at each end of the vehicle. The selection of the active antenna is based upon which cab end is actively keyed. A Line Selector Switch on the vehicle provides the method for properly configuring the TWC for operation on the desired line.

For Type II data is transmitted to the vehicle at selected wayside locations via the Train / Wayside Communications (TWC) system. The TWC system provides for two-way communications. There is a master / slave relationship with the wayside. The vehicle's TWC has the master role and initiates communications with the wayside. The vehicle can send status / diagnostic information, or can be commanded to perform self-test functions. TWC messages can be exchanged with the vehicle while moving up to 45 mph.

The information transmitted to the train includes the following:

- 2-way/continuous mode status
- Link status between TWC PC and TWC wayside unit
- Change Tracking ID
- Change Route ID
- Change Performance Level -- ATO Mode only
- Enter Coast Mode -- ATO Mode only
- Cancel Coast Mode -- ATO Mode only
- Close Doors (The Close Doors command is used to control the Dwell Expire indicator on the ADU.)
- Set Station Stopping Brake Rate -- ATO Mode only
- Update Time (no longer used on P3010)

The information transmitted by the train includes the following:

- ETA Timer -- requests continuous mode
- Master Vehicle PVID
- Tracking ID
- Route ID
- Static Departure Test Status
- Doors Open
- Doors Closed
- Train Mode
- Performance Level
- Coast Mode Status
- Train Orientation
- Train Length
- Program Station Stopping Brake Rate Index
- Time Updated (no longer used on P3010)
- V_zero
- Spin/Slide Detected
- Train Berthed
- ATO Stop Out of Tolerance

For Type I Under normal circumstances, during power ON the Route ID will default to 0. However, the TWC system provides for manual route requests to be entered by the Operator, or other MTA personnel. Manual entry of a valid Route ID is accomplished through the use of the soft buttons located on the ADU/TWC Interface Panel. Valid route IDs range from 1-19.

With the lead cab keyed into an active mode and not in motion, the Operator can set the desired Route ID number using TWC Interface screen on the ADU.

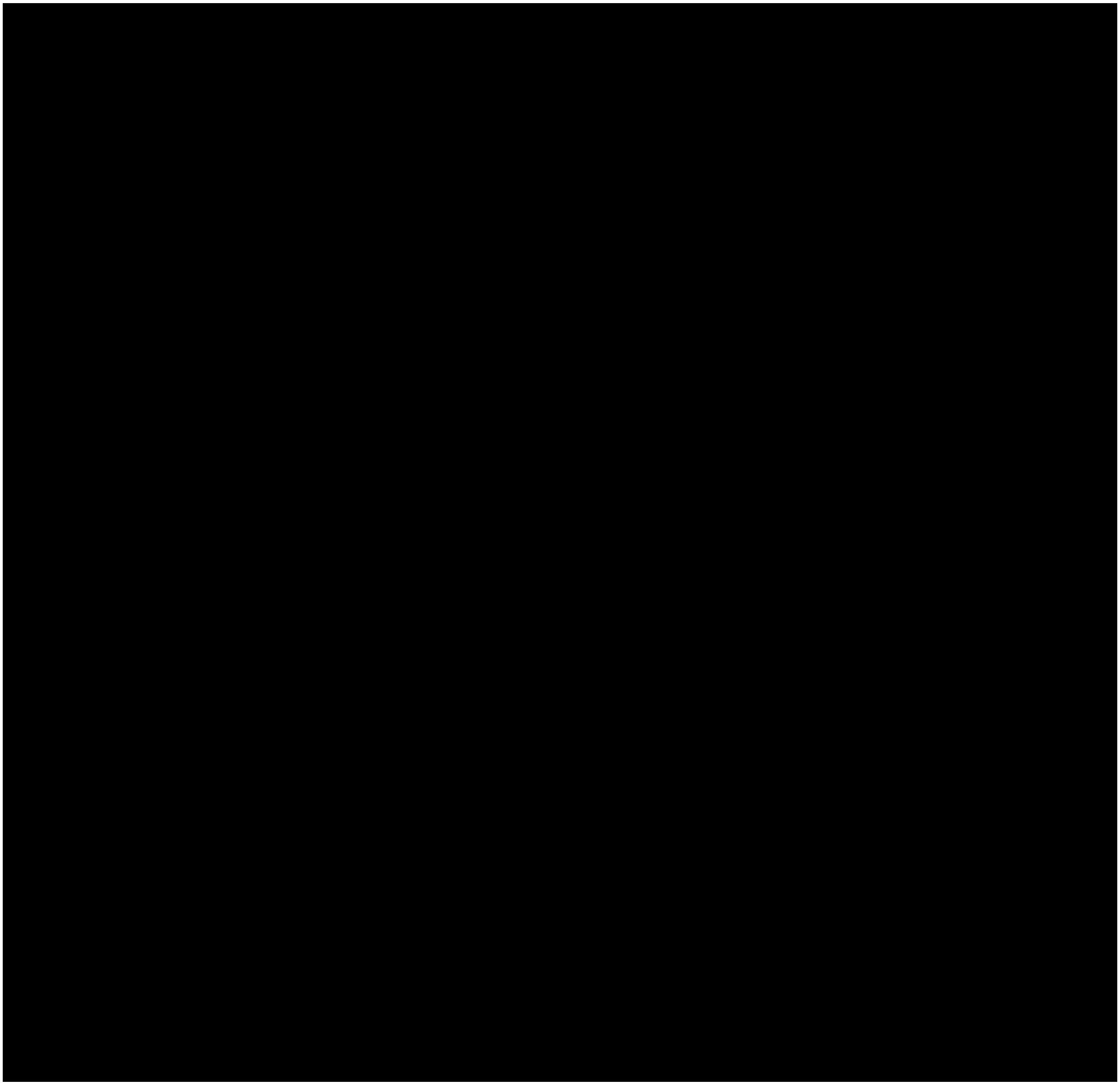
To initiate a route request, the Operator will press and release one, or a combination of four pushbuttons located on the ADU/TWC Interface Panel in order to select the desired route. Interaction with any pushbutton as defined will set data bits in the 19-bit response message corresponding to the selected request pushbutton(s). The possible valid request options are:

- Primary Route Request
- Secondary Route Request
- Non-Mainline Route Request
- Primary + Non-Mainline Route Request
- Secondary + Non-Mainline Route Request
- Cancel Route Request

The TWC Bypass Switch on the bypass panel disables the Type II TWC subsystem used on the MGL. This switch provides a non-vital TWC_Cutout input to the Multifunction PCB, which de-energizes the TWC Modem PCB. Removing power from the TWC Modem PCB effectively disables the input from the ASTS Type II TWC subsystem to the ATC system. The ATO subsystem is still operable with the TWC subsystem bypassed; however, operation on the MGL will proceed without information from the wayside. Type I TWC is cutout using the low voltage circuit breaker

2.7 COMM Subsystem

Refer to Figure 2-3 and Figure 2-4. The COMM subsystem provides the means to exchange data among the sub-systems and the external networks. The system data logging function is also contained within the COMM subsystem. The functionality of the COMM subsystem is the same for either the Type I or Type II ATC System. The system provides event logging, Type II TWC communication, MVB communication, train Ethernet communication, PTU connection, and ADU communication via the MVB.



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2.8 Equipment Description

There are no differences in the ATC package or in the installation of the ATC system on the P3010 LRV based upon Type I or Type II operation. Each P3010 LRV is equipped with one ATC system. This includes equipment mounted in an electronics cabinet in the vehicle cab and also external to the car-body.

The list below provides a brief description of the major hardware components associated with the ATC system. The ATC system for the LACMTA P3010 LRVs consists of the following:

- ATC MicroCab Enclosure – The enclosure incorporates the system’s vital logic and interfacing circuits, a decelerometer, and a vital relay for control of a vital output to the emergency brake system. One enclosure is installed in each P3010 vehicle and in the B cab.
- Aspect Display Unit (ADU) – The ADU / TWC Panel is incorporated into a single flat-panel display unit mounted in each cab of the LRV for the vehicle operator. Two ADUs are installed in each P3010 vehicle (one A-End and one B-End).
- Truck-mounted cab signal pick-up coils – Four pick-up coils are mounted on each P3010 vehicle (two on the lead A-End truck and two on the lead B-End truck). Each pair of coils is wired to a junction box. These devices incorporate two internal coils. One coil detects cab signals from the rails; the other coil is used for testing.
- Vehicle body-mounted TWC antennas – Four TWC antennas are mounted on each vehicle (two on the A-End and two on the B-End); one Type I TWC antenna and One Type II TWC Antenna is mounted at each end.
- Type I H&K TWC CCU antennas – mounted in each cab in the ceiling.
- Speed Sensor – (Supplied by KI) - The ATC will have three inputs from two active speed sensors to determine speed and direction of travel. One speed sensor will be mounted on axle 6 of the motorized truck and provide one output channel dedicated to the ATC. The other speed sensor will be mounted on axle 4 of the trailer truck and provide two quadrature phase output channels dedicated to the ATC. These two speed channels will provide speed and quadrature phase information to determine direction of travel information.

Refer to Figure 2-5 for an overview of ATC system equipment in the P3010 LRV.

Refer to Figure 2-6 for an overview diagram of the ATC system vehicle-level configuration. The ATC unit for the P3010 LRV is mounted in the B-End Cab and the speed sensor for the powered truck is mounted to the B-End truck.

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Figure 2-5: ATC System Equipment Overview [redacted]stem Overview Block Diagram

2.9 ATC System Power Distribution

The ATC enclosure has a master power switch located on the Battery Conditioner PCB, which is accessible from the front of the ATC enclosure: When in the OFF position, the ATC power switch removes power from all system components in the ATC enclosure beyond the Battery Conditioner PCB. In addition, the Battery Conditioner PCB has a resettable circuit breaker to protect the ATC circuits.

2.10 ATC Enclosure and Components

The MicroCab Enclosure consists of a welded steel enclosure designed for mounting in the P3010 vehicle equipment rack. The enclosure contains the following major components:

- One integrated cardfile with plug-in PCBs for the MicroCab vital logic and interfaces to other peripheral equipment and subsystems (e.g., speed sensors and pick-up coils),
- One Decelerometer for measuring vehicle braking rate,
- One Vital Relay (ASTS USA PN-159B) for controlling a vital output to the vehicle emergency brake system,
- One Battery Conditioner PCB for filtering input power from the vehicle battery and protecting the MicroCab® circuits from voltage transients,
- Two Relay PCBs that provide safety relays for controlling various system functions,
- Six mating connectors to interface with external circuits and equipment wiring (power and data) to the cardfile,
- Two Electrically Erasable Programmable Read-Only Memory (EEPROM) circuits that store vehicle-specific data for the ATP and ATO Logic CPU PCBs.

Refer to Figure 2-7. The ATC enclosure is installed in an electronics locker located behind the driver on the B-End of the LRV. The enclosure's dimensions are approximately 17-in. (H) x 20-in. (W) x 13.5-in. (D) and weighs approximately 63 pounds. The front of the enclosure is open and it does not have a front door. An external ground stud, mounted near the vehicle wiring connectors, allows grounding the enclosure to the vehicle chassis to provide EMI protection for the system. The enclosure operates with input power from 17VDC to 30VDC vehicle battery power.

The enclosure does not have special cooling or ventilation requirements, and does not incorporate an internal fan. Like all ASTS USA hardware, the enclosure is designed to operate over a temperature range of -40ºC to +70ºC.

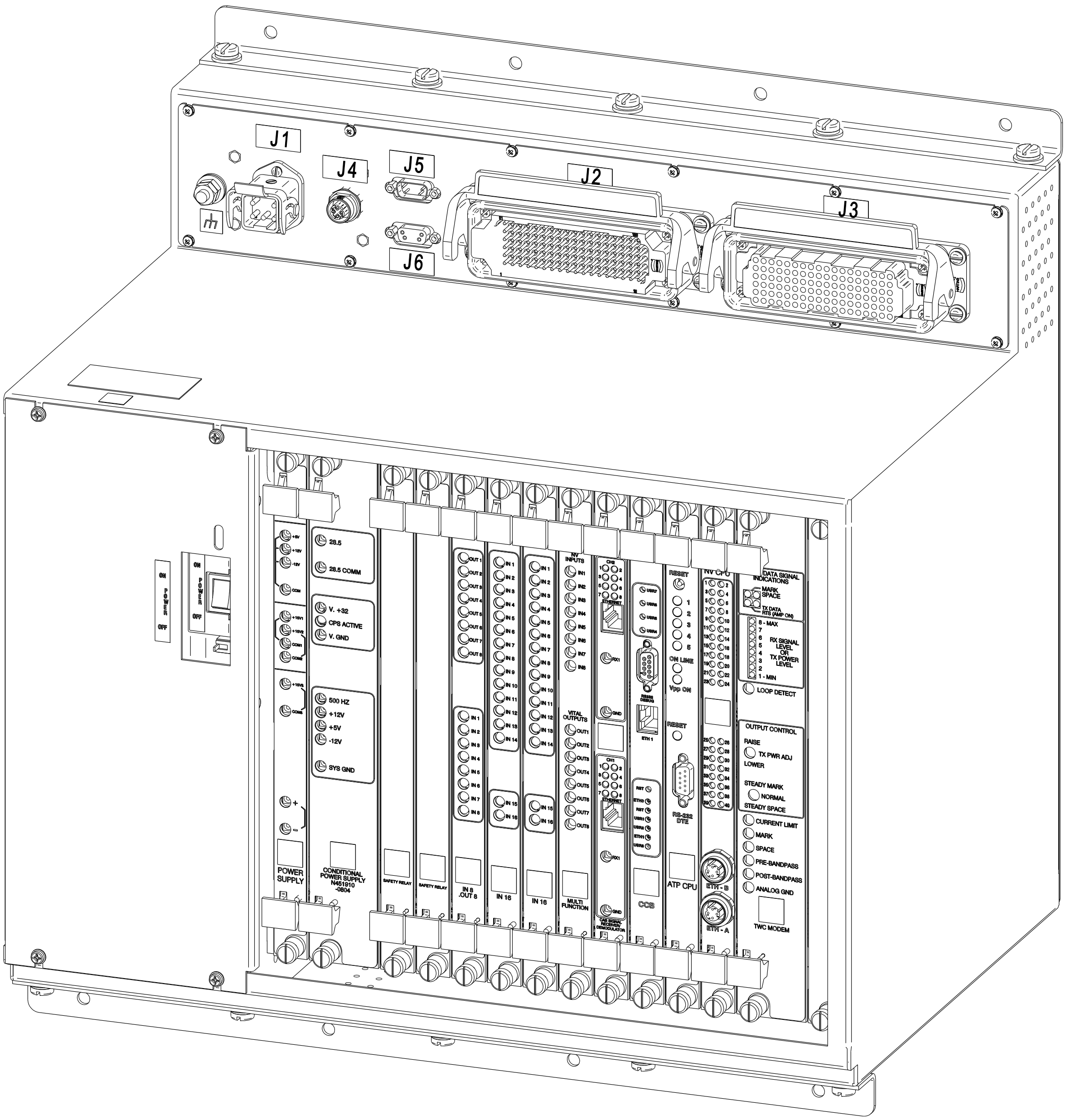

Figure 2-7: ATC System Enclosure

Refer to Figure 2-8. Connector jacks across the top of the ATC Enclosure provide the interface between the ATC System and external vehicle components and circuits.

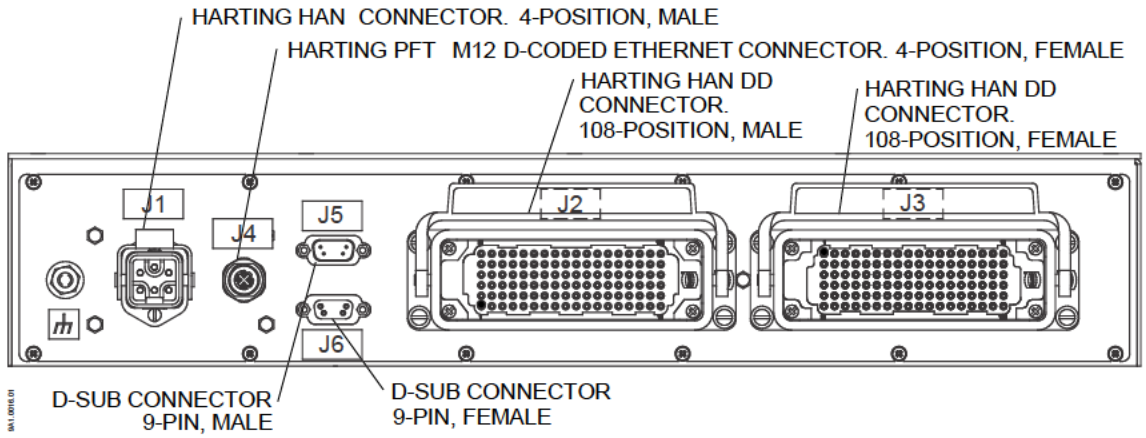

Figure 2-8: ATC Enclosure Connectors

Refer to Figure 2-9. The cardfile section of the enclosure contains the controlling logic (hardware and software), PCB power supply and interface circuits. ATP and TWC / ATO subsystem equipment is housed in the same enclosure. ATP subsystem components are separated from the TWC / ATO subsystem components. The ATC cardfile contains printed circuit board (PCB) assemblies, which include:

- Power Supply PCB Assembly,
- Conditional Power Supply (CPS) PCB Assembly,
- Safety Relay PCB Assemblies (2),
- Mixed Vital Input / Output (I/O) PCB Assembly,
- Vital Input PCB Assemblies (2),
- Multifunction PCB Assembly,
- Cab Signal Receiver Demodulator (CSRD) PCB Assembly,
- Vital ATP Logic CPU PCB Assembly,
- Communications Control Board (CCB) Assembly.
- ATO CPU (SPO) PCB Assembly,
- TWC Modem PCB Assembly

Refer to Figure 2-50. Each PCB includes front panel controls and/or displays as appropriate to the PCB's function within the ATC system. One unused slot is covered with a blanking panel.

A backplane motherboard in the enclosure contains connectors to enable PCB-to-PCB communications, data interface with external circuits and equipment, and distribution of PCB operating power.

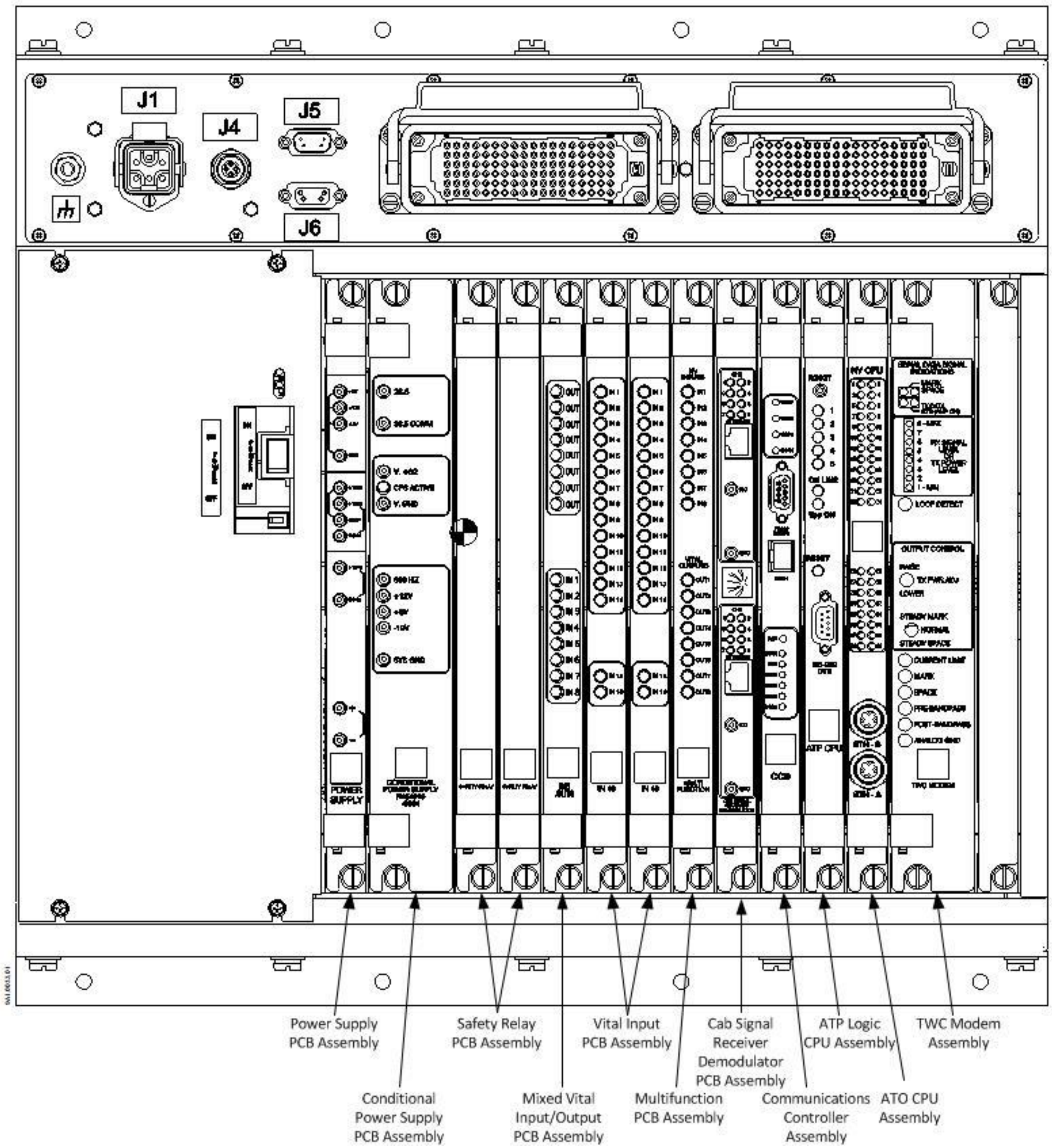

Figure 2-9: ATC System Cardfile Components

Refer to Figure 2-10. The ATC Enclosure also contains a covered compartment to the left of the PCB cardfile that contains the following components:

- Decelerometer Sensor and Mounting Assembly
- Vital Relay and mounting base
- Battery Conditioner PCB

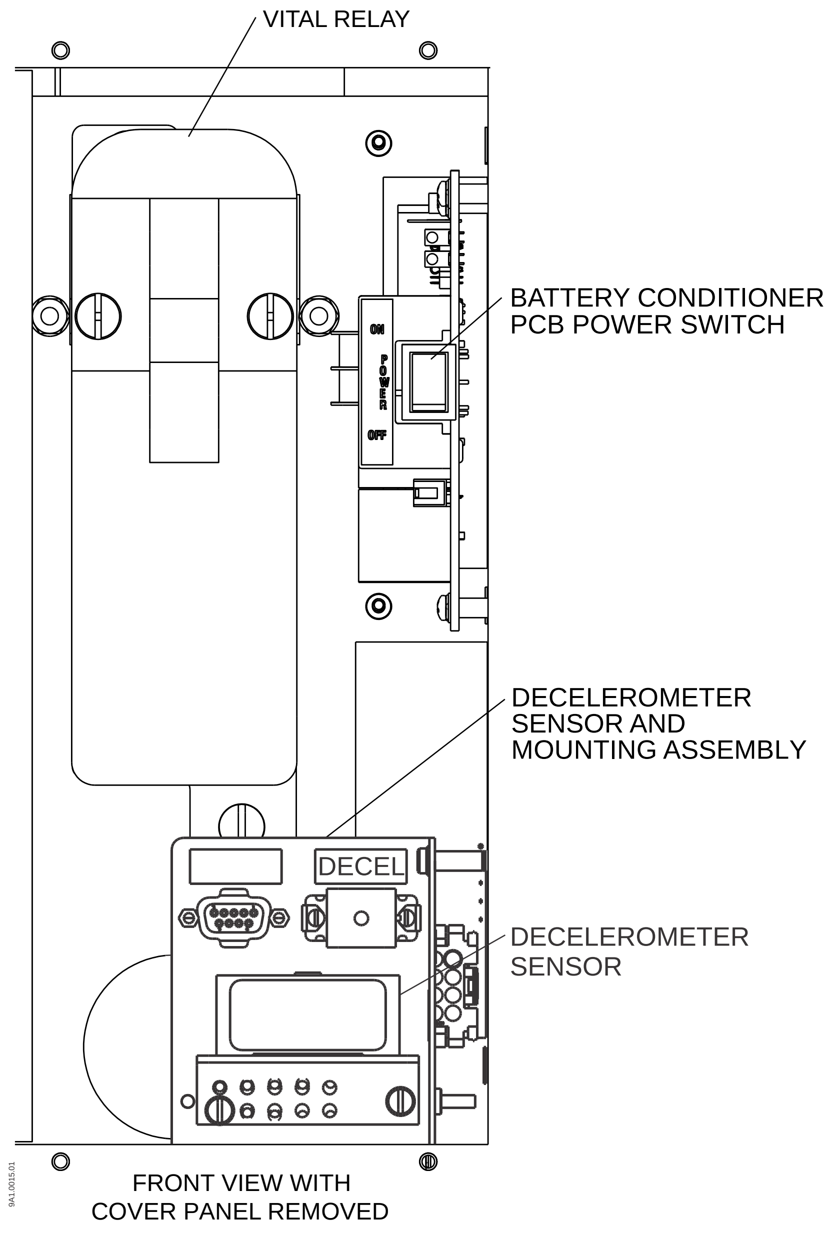

Figure 2-10: ATC Enclosure Compartment Components

2.10.1 Enclosure Backplane Motherboard PCB

The ATC Backplane PCB, also known as the "motherboard," is located in the rear of the ATC enclosure and functions to route signals among the enclosure PCBs and the interface connectors that carry signals to and from the vehicle, to distribute power to the ATC system components, and to provide data paths between the system PCBs. In addition to the external interface connections, the Battery Conditioner PCB, Decelerometer, and all cardfile PCB assemblies are mated to the backplane motherboard PCB through plug-in connectors. Refer to Figure 2-11 for an overview diagram of the Motherboard PCB.

[redacted]

The ATC backplane motherboard houses two Electrically-Erasable Programmable Read-Only memory (EEPROM) devices that store critical vehicle-specific configuration parameters such as wheel diameter settings, used by the ATP subsystem to calculate vehicle speed, and Permanent Vehicle Identification (PVID) that are read by the subsystem CPUs upon ATC system startup. In the event a subsystem CPU PCB is replaced, the EEPROMs retain the data that is retrieved by the new component. Refer to Figure 2-12 for an I/O block diagram of the Motherboard PCB.

[redacted]

Refer to Figure 2-13 for an illustration of the Motherboard PCB.

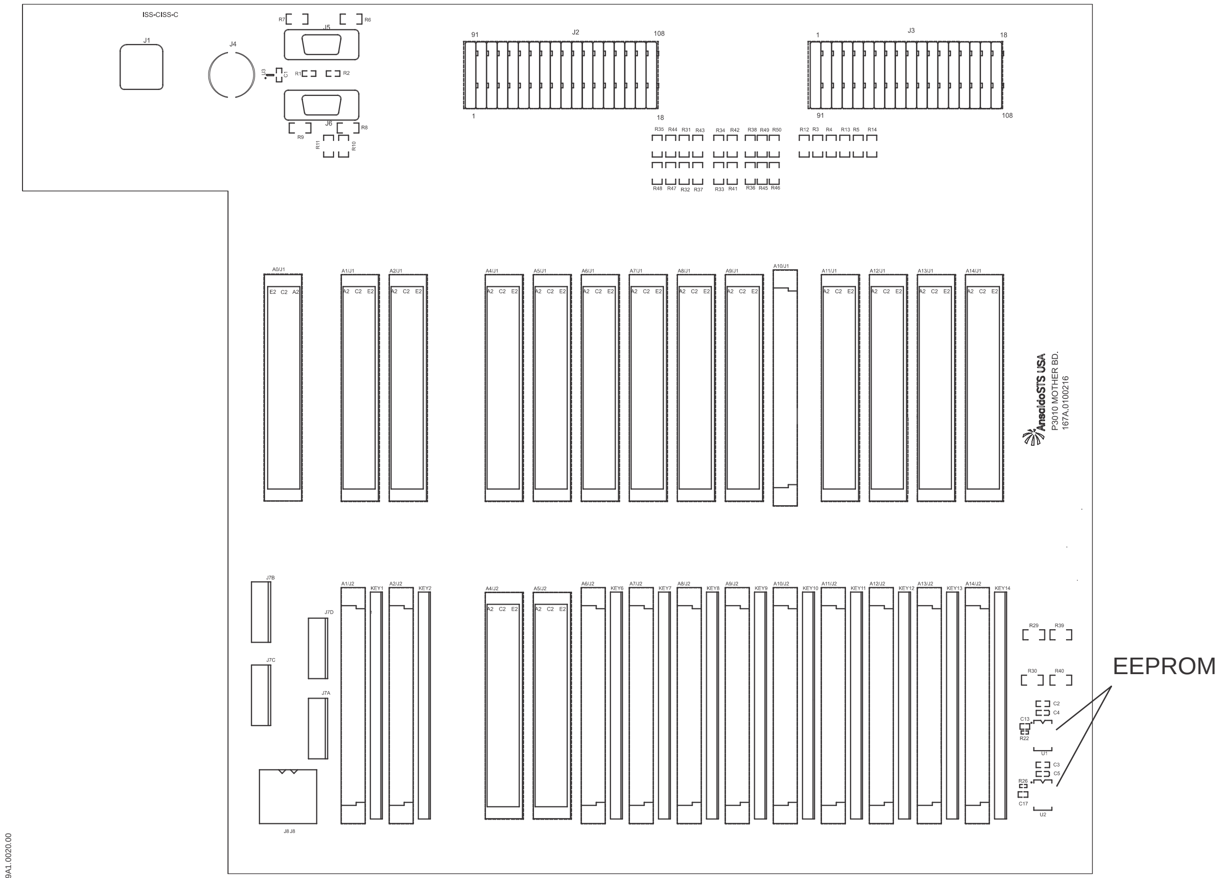

Figure 2-13: ATC Backplane Motherboard PCB

2.10.2 Battery Conditioner PCB

The Battery Conditioner PCB protects the ATC system components from a continuous over-current condition and provides protection against transient voltages that may be present on the vehicle battery input lines. The PCB filters battery voltages ranging from 17 Vdc to 30 Vdc. Refer to Figure 2-14 for an overview diagram of the Battery Conditioner PCB.

The PCB incorporates a power switch (SW1) on the front of the PCB that interrupts incoming battery power to the PCB and the rest of the ATC system. A resettable thermal circuit breaker (F1) in-line with the power switch, rated at 8A, guards against excessive current draw by the system. Front-end circuitry protects the rest of the PCB and the ATC system. A separate filtering circuit mitigates common mode and differential mode noise. Decoupling capacitors in the PCB output circuitry filter high frequency noise and accommodate spikes in current draw by the ATC system from the vehicle battery. Refer to Figure 2-15 for a functional block diagram of the Battery Conditioner PCB.

The Battery Conditioner PCB mounts on the upper-right sidewall of the partition that separates its compartment from the ATC cardfile, and mates with connectors on the ATC backplane Motherboard PCB to receive battery power and distribute conditioned DC power (COND BATT±) to the rest of the ATC system. The PCB includes a voltage monitor circuit that provides feedback signals to the system to indicate an out of tolerance high or low battery voltage. Two green, front-facing LEDs on the PCB edge above the power switch indicate an over-voltage or an under voltage condition.

Refer to Figure 2-16 for an illustration of the Battery Conditioner PCB.

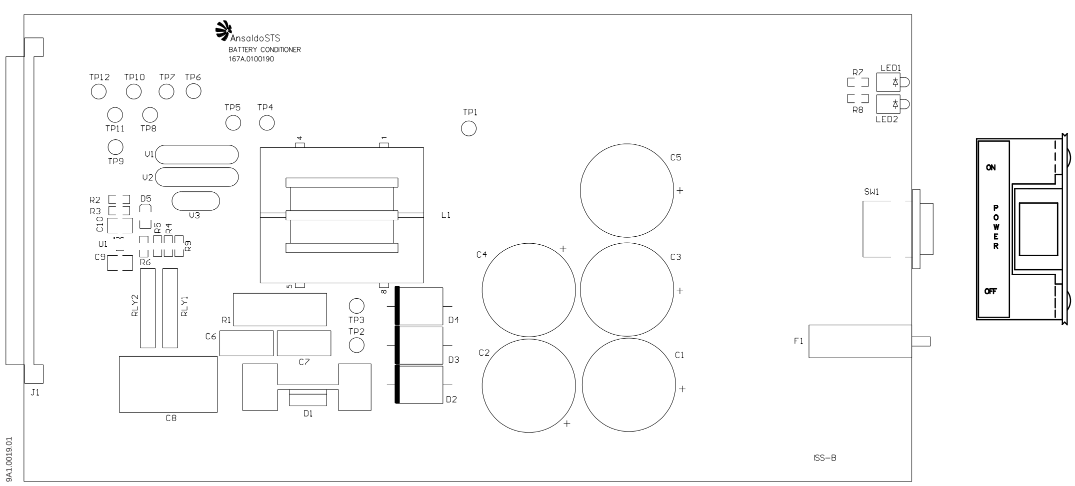

Figure 2-16: Battery Conformance PCB

2.10.3 Power Supply PCB Assembly

The Power Supply PCB converts the vehicle's conditioned battery supply input from the Battery Conditioner PCB to isolated, regulated output voltages that provide system-level power, power for the speed sensors (not supplied by ASTS USA), and operating power to the ASTS ATP Track Receiver Coil Antennas.. Refer to Figure 2-17 for an overview diagram of the Power Supply PCB.

[redacted]

The PCB converts conditioned battery power into regulated +5 Vdc and ±12 Vdc that is supplied to the backplane and distributed to the ATC subsystem components by the motherboard in the cardfile. These voltages are isolated from the battery supply. The Power Supply PCB also contains three isolated power supplies that convert conditioned battery voltage into individual +15 Vdc potentials that power the speed sensors and Receiver Coil Antennas. Refer to Figure 2-18 for a functional block diagram of the Power Supply PCB.

[redacted]

Refer to Figure 2-19. The front panel of the Power Supply PCB Assembly contains test jacks to measure the PCB's input voltage from the Battery Conditioner PCB and output voltages from the power supplies on the PCB.

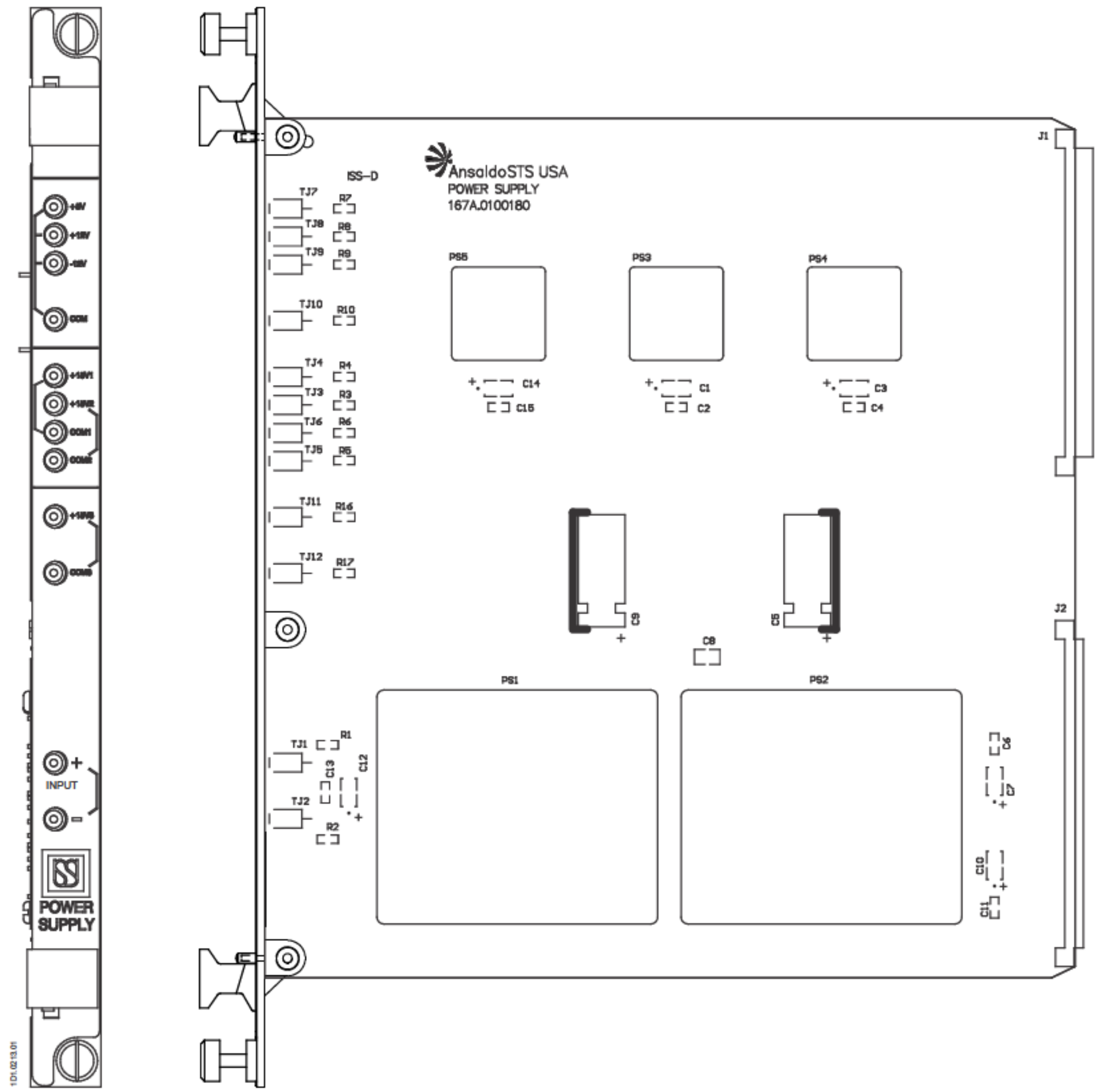

Figure 2-19: Power Supply PCB Assembly

2.10.4 Conditional Power Supply PCB Assembly

The Conditional Power Supply (CPS) PCB Assembly receives conditioned vehicle battery power and provides isolated 31.5 Vdc power for the vital circuits in the ATP subsystem. Refer to Figure 2-20 for an overview diagram of the Conditional Power Supply PCB.

[redacted]

Key circuits on the CPS PCB include a vital DC generator, vital battery chopper, and vital 31.5V output. During normal operation, the ATP CPU PCB provides a 500 Hz signal to the CPS PCB that enables the vital DC voltage output. In the event of an ATP CPU failure or detection of a safety-related fault, the ATP CPU disables its 500 Hz signal, which turns off the vital voltage output from the CPS PCB and de-energizes 31.5 Vdc power to all vital outputs. Removal of the vital 31.5V output de-energizes the Vital Relay, which results in an immediate system request for an Emergency Brake application. Refer to Figure 2-21 for a functional block diagram of the Conditional Power Supply PCB.

[redacted]

Refer to Figure 2-22. Front-panel devices on the CPS PCB Assembly include test jacks for field and shop testing of PCB circuitry and one discrete LED to indicate the presence of the 31.5 Vdc vital output.

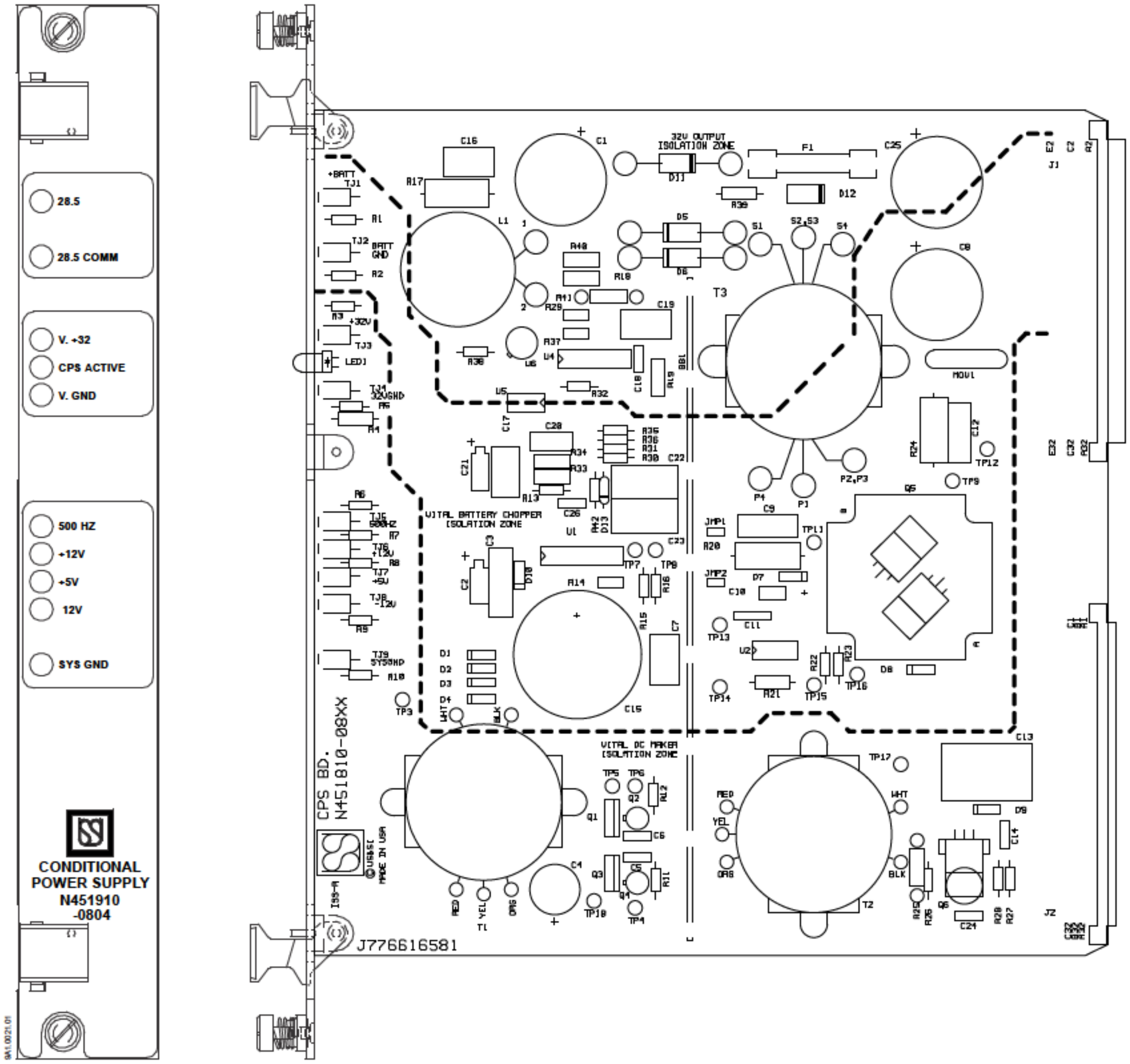

Figure 2-22: Conditional Power Supply PCB Assembly

2.10.5 Safety Relay PCB Assemblies

Two Safety Relay Assemblies are installed in the ATC enclosure. Each Safety Relay PCB contains 12 safety (double-break and back-checked) relays that provide the ATP output interface to external vehicle circuits and the steering logic for selecting Cab Signal and TWC antenna sources.

The safety relays are driven by optically isolated vital and non-vital outputs from the Multifunction PCB, the Mixed Vital Input / Output PCB, and the ATO CPU PCB. One safety relay provides the interface for the Full Service Brake signal. This relay is normally energized. When ATC system logic deenergizes the relay, its contacts open and the vehicle brake system receives a signal that requests a Full Service Brake application.

System functions that interface with the safety relays include:

- Forward, Reverse, and Power Cut trainlines
- M and CM trainlines
- A-end and B-end track receiver antenna selection
- A-end and B-end TWC antenna selection
- Door Enabling and FSB, trainlines

[redacted]

The safety relays on the Safety Relay PCB have additional contacts to provide vital inputs that are back-checked. The status of each relay's backcheck contacts provide a vital input to the Multifunction PCB, Mixed Vital Input / Output PCB, or a Vital Input PCB that are monitored by the ATP CPU. The ATP monitors the backcheck contacts every software cycle (250 ms) and during each commanded safety relay state change. Refer to Figure 2-24 for a diagram of a typical safety relay circuit.

[redacted]

Refer to Figure 2-25. The front panel of the Safety Relay PCB is blank and does not contain any indications or controls.

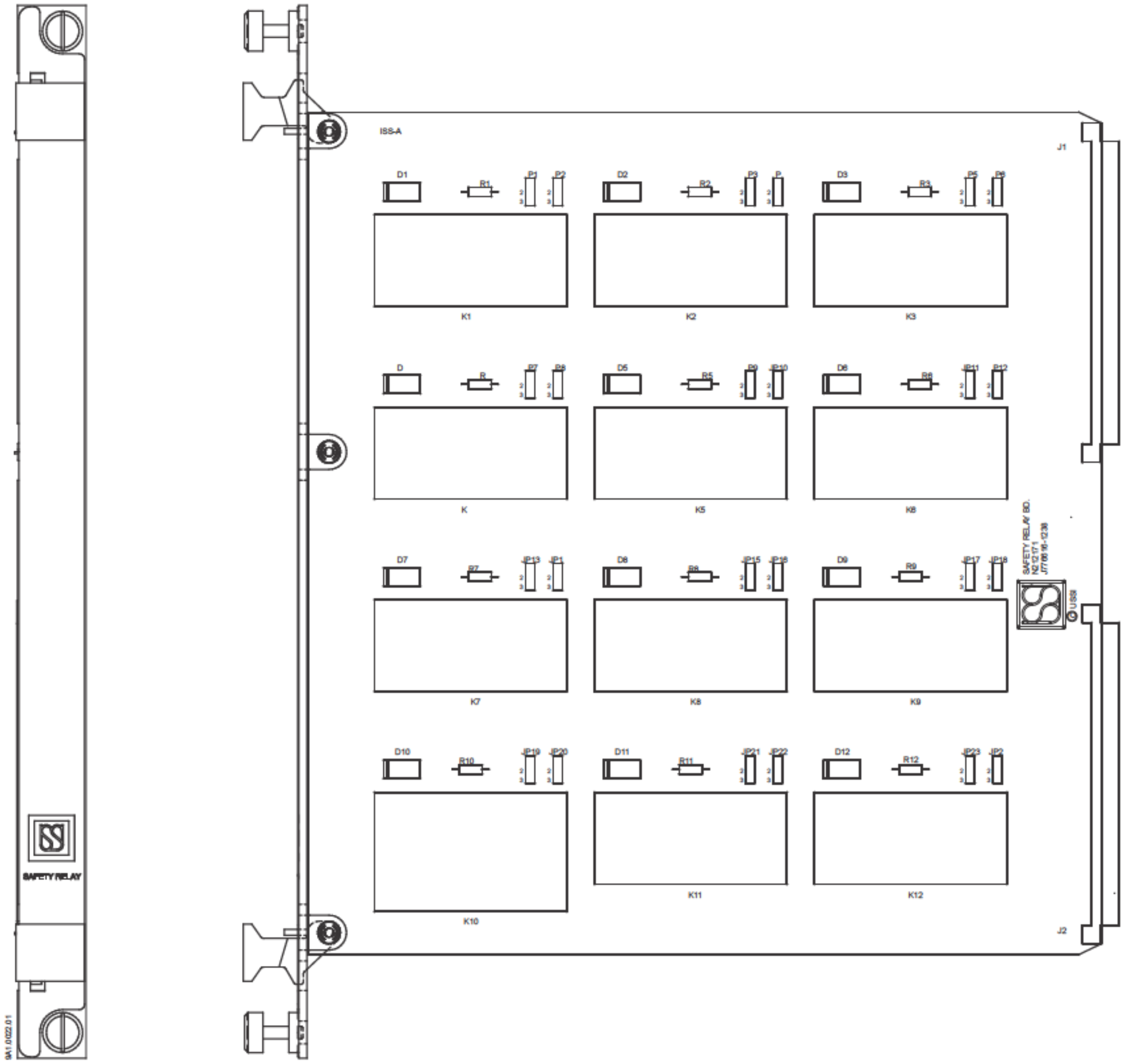

Figure 2-25: Safety Relay PCB Assembly

2.10.6 Mixed Vital Input / Output PCB Assembly

The Mixed Vital Input / Output Assembly (Vital 8 In 8 Out) contains eight (8) vital input channels and eight (8) vital output channels. Each output can drive a relay coil or an indicator lamp. Each input is capable of receiving a 24Vdc nominal voltage input from the vehicle trainlines. For the P3010 vehicle, the PN 159B Vital Relay, which is the ATC system interface with the Emergency Brake, is controlled by a vital output from this component. Refer to Figure 2-26 for an overview diagram of the Mixed Vital Input / Output PCB.

[redacted]

Refer to Figure 2-27. Discrete yellow and green LEDs on the assembly's front panel indicate the on/off states of the individual inputs and outputs.

2.10.7 Vital Input PCB Assemblies

Two (2) Vital Input PCBs are installed in the ATC enclosure. Each Vital Input PCB is a vital Class II circuit, and contains sixteen (16) input circuits that monitor cab control, vehicle status, and closed-loop inputs. Each input circuit can receive an isolated, differential signal. The PCBs are connected to the G96 Bus on the backplane motherboard to receive system power and to communicate with the ATP CPU PCB. The input assemblies share a common PCB hardware design that allows their use on both the Type I and the Type II systems. Refer to Figure 2-28 for an overview diagram of the Vital Input PCBs.

Each of the vital input circuits can read an isolated, differential signal. A transient protection circuit protects the input circuit from harmful transient voltages. A monitor circuit provides control over the input. The ATP CPU sets the monitor circuit to a known state and verifies that the input circuit registers the correct state. Each channel can be checked independently or in combinations with other inputs. A watchdog timer must be updated by the ATP CPU or the monitor circuit is reset. Following the monitor circuit, the input signal is conditioned and optically isolated to adjust the signal level to the system logic level. The signal can then be read by the input register and displayed by illuminating an LED on the front panel of the PCB. The Vital Input PCB contains a G96 I/O Bus Interface circuit to pass information to the ATP CPU via the motherboard backplane.

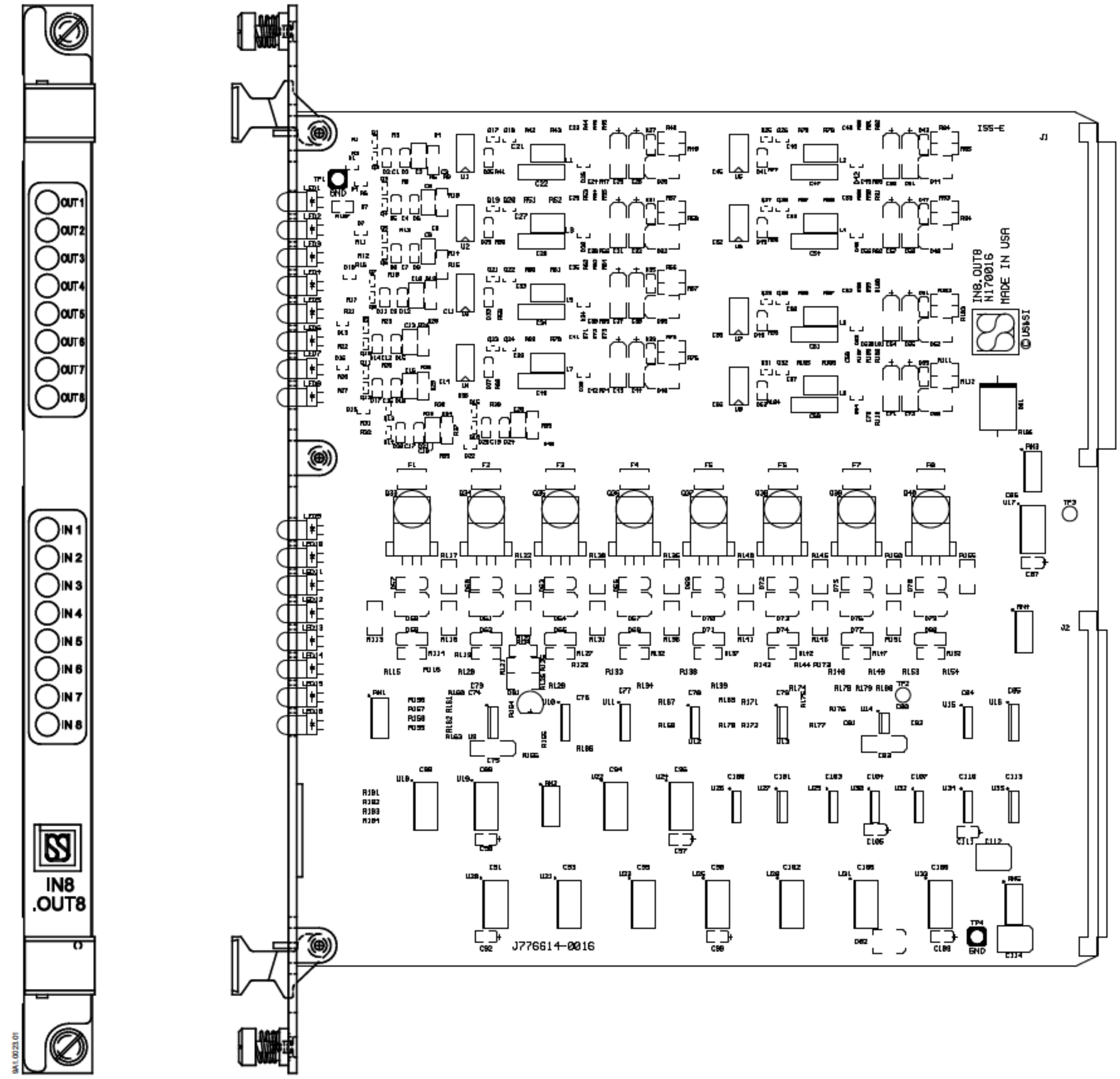

Figure 2-27: Mixed Vital Input / Output PCB Assembly

[redacted]

Refer to Figure 2-30. Sixteen (16) LEDs on the front panel of each Vital Input PCB Assembly indicate the on/off status of the individual input channels.

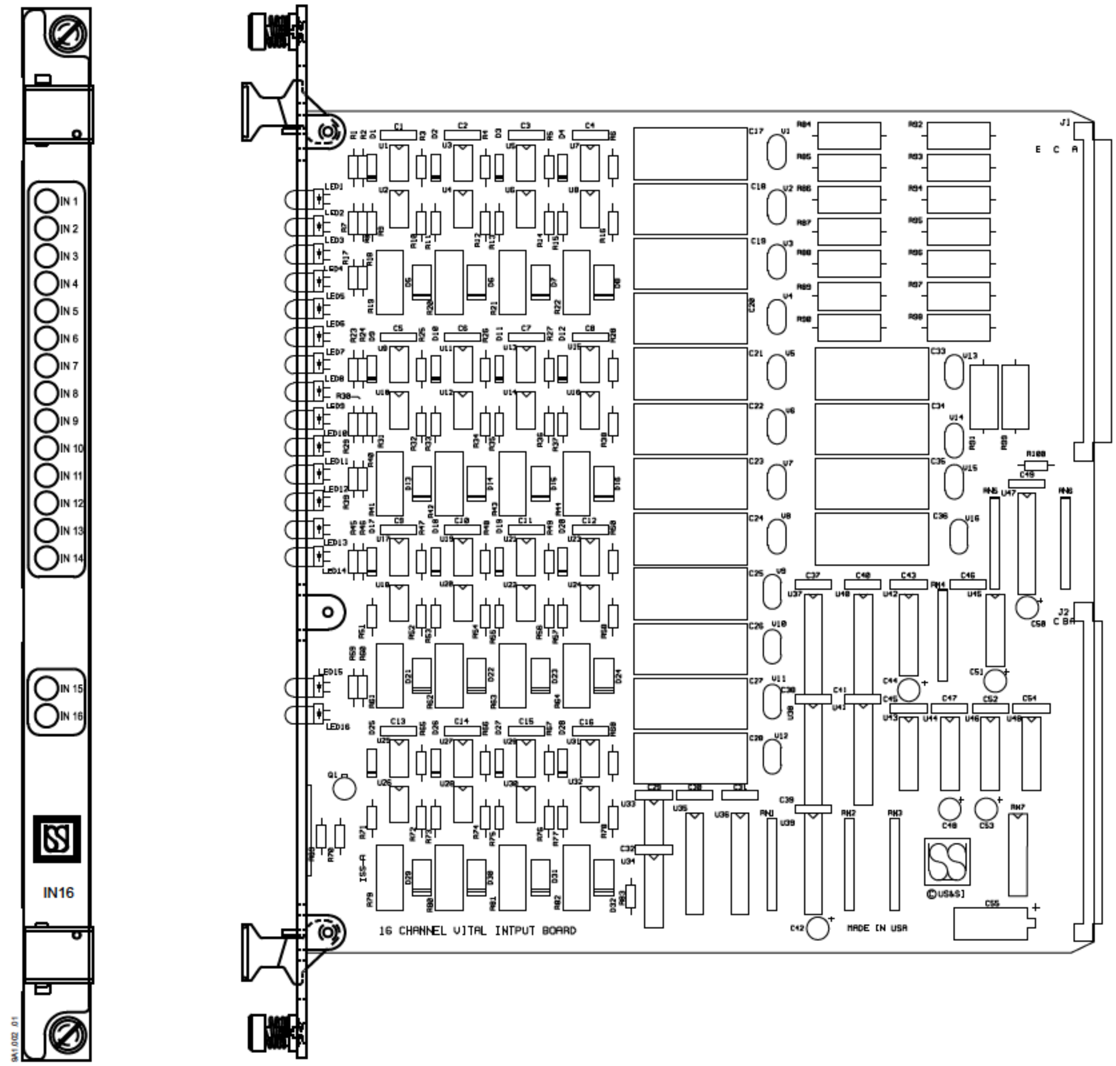

Figure 2-30: Vital Input PCB Assembly

2.10.8 Multifunction PCB Assembly

The Multi-Function PCB performs the following functions:

- Type I Departure Test: Generates modulated-carrier cab test signals for use during the MBL and PGL Departure Tests.
- Decelerometer Interface: Contains circuitry that accepts inputs from the decelerometer and reports vehicle acceleration/deceleration results to the ATP Logic CPU Assembly.
- Speed Sensor (Tachometer) Input: Decodes input signal pulses from the speed sensors into speed information that is transmitted to the ATP Logic CPU and ATO CPU.
- Vital Outputs – Provides eight (8) vital outputs for the ATP. Seven (7) output channels control safety relays; one channel is currently not used.
- Non-Vital Inputs – Provides eight (8) optically isolated non-vital inputs. Two of the inputs are used for ATC Bypass indication and Spin/Slide indication.

The ATP Logic CPU communicates with the Multifunction PCB Assembly via the cardfile backplane motherboard to control all the PCB's operations and interfaces. Refer to Figure 2-31 for an overview diagram of the Multifunction PCB.

[redacted]

The MFB design is decomposed into functional components. These high-level components designate either a hardware component or programmable hardware component (VHDL). The following figure illustrates the major top-level hardware functional components of the Multifunction PCB. These components may consist of a single IC, multiple ICs or passive devices, or several stages of circuitry. Refer to Figure 2-32 for a functional block diagram of the Multifunction PCB.

[redacted]

Refer to Figure 2-33. Front panel devices on the Multifunction PCB include eight (8) LEDs that indicate the state of the vital outputs, and eight (8) LEDs that indicate the states of the PCB's non-vital inputs.

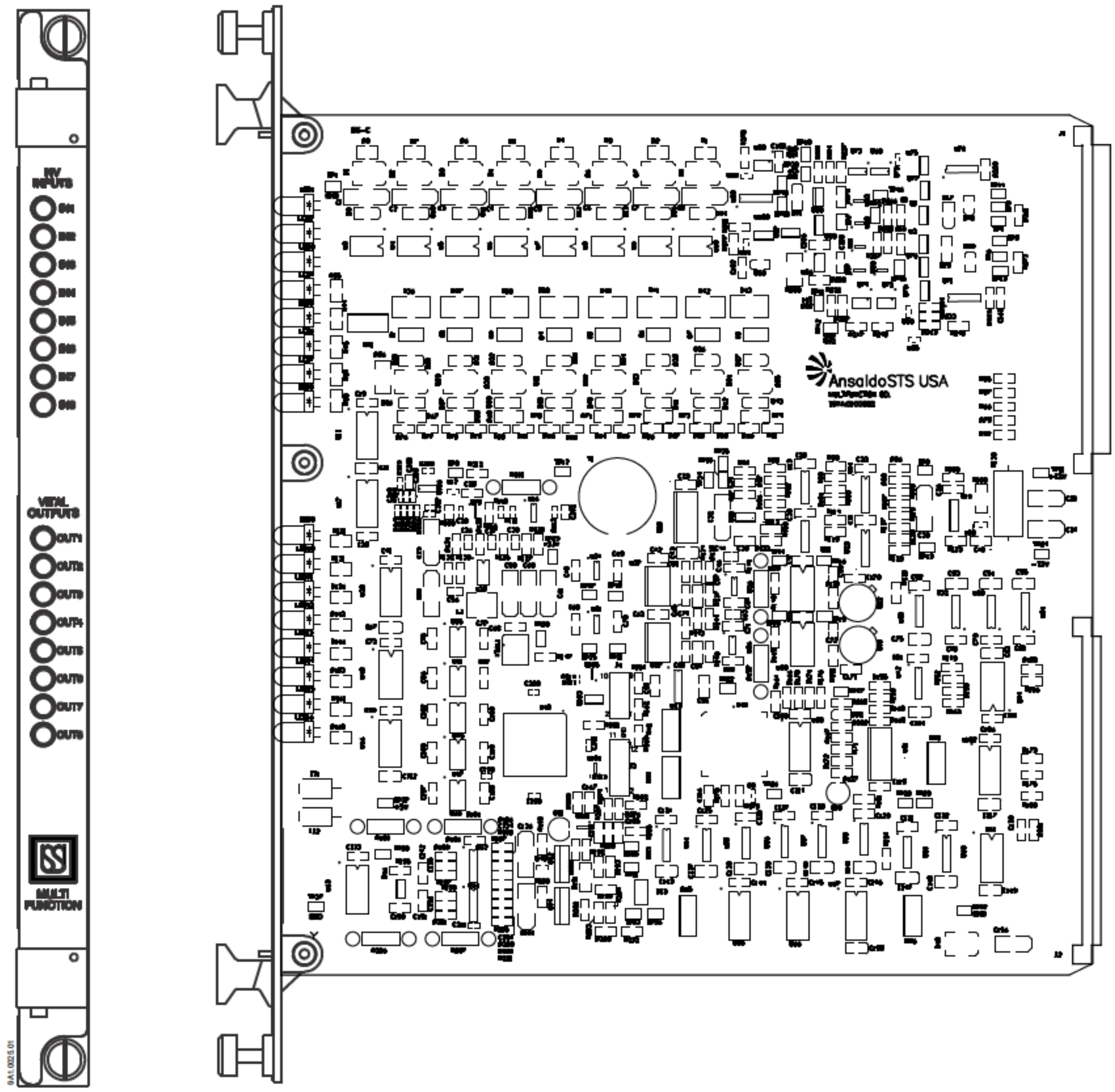

Figure 2-33: Multifunction PCB Assembly

2.10.9 Cab Signal Receiver Demodulator PCB Assembly

The Cab Signal Receiver Demodulator (CSRD) Assembly receives, filters, and processes all ATP-related wayside track circuit signals, including both 100 Hz and 250 Hz step speed signals and FSK profile speed signals. This component's advanced design replaces the 100 Hz Filter/Demodulator, 250 Hz Filter/Demodulator, Decoder CPU, FSK Receiver and FSK CPU assemblies in the earlier MicroCab system installed in LACMTA P2550 vehicles. Refer to Figure 2-34 for an overview diagram of the Cab Signal Receiver Demodulator PCB.

[redacted]

The CSRD PCB receives signals (ASK and FSK) from the track receivers and decodes the signals to determine the speed code for the current track circuit occupied by the vehicle. The CSRD operates on a 10 ms cycle time to process the signals, and uses redundant hardware architecture to develop vital outputs that are transmitted to the ATP Logic CPU Assembly over redundant serial peripheral interface (SPI) communication links on the backplane bus. The messages on these links are protected by using a protocol that places a CRC on the messages to validate the integrity of the data. Additionally, message sequence numbers are inserted in each message to guard against stale data. Once the data has been received and validated by the ATP CPU, it is processed and handled in the same manner as all other vital data.

The CSRD PCB incorporates Digital Signal Processing (DSP) hardware technology with configurable software, and communicates fail-safe vital decoded signaling information to the ATP Logic CPU. The fail-safe architecture is a composite; each safety-related function is performed by more than one item (redundancy). Two composite items together on the PCB form vital hardware architecture. This ensures system safety in the event of any type of single random recognized fault. The following figure illustrates the High Level Architecture of the CSRD PCB. Refer to Figure 2-35 for a functional block diagram of the Cab Signal receiver Demodulator PCB.

[redacted]

The circuit components on the CSRD PCB may be composed from a single IC, multiple ICs or passive devices, or several stages of circuitry. The diagram below represents one of the two composite items of the CSRD PCB. The second composite item (redundant item) is identical although it incorporates a diverse FPGA, synthesis, and place & route process. The following figure is a top-level diagram that decomposes one channel of CSRD PCB functions into circuit components. Refer to Figure 2-36 for a composite functional diagram of a single channel on the CSRD PCB.

[redacted]

Refer to Figure 2-37. The Ethernet ports on the front panel of the CSRD PCB are for ASTS factory use only.

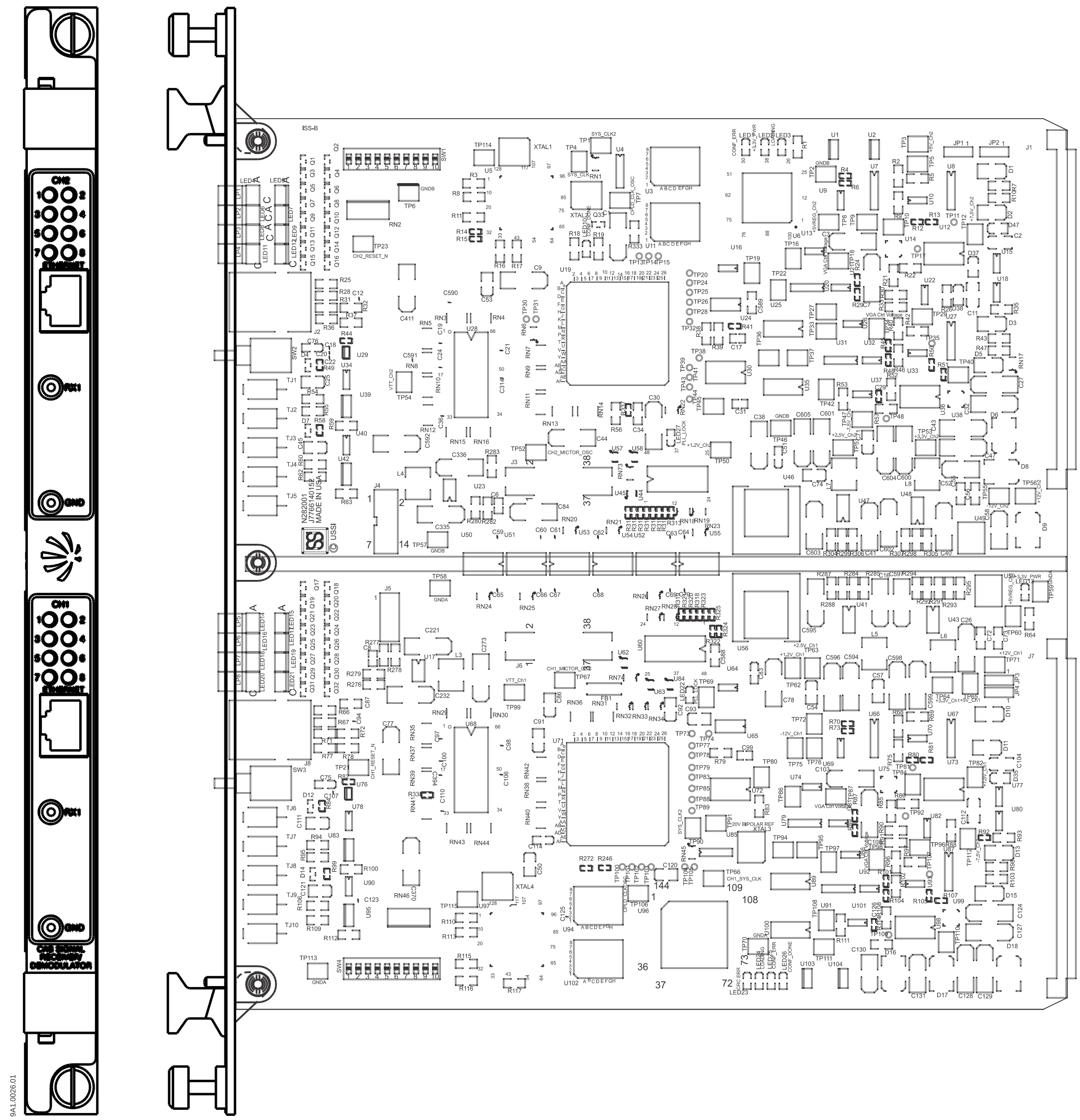

Figure 2-37: Cab Signal Receiver Demodulator PCB Assembly

2.10.10 ATP Logic CPU Assembly

The ATP Logic CPU Assembly contains the vital logic software that performs all of the ATC system's safety-related computations and actions. Its primary responsibility is to enforce cab signal overspeed limits and place the system in a safe state in the event of a failure.

Key functions of the ATP Logic CPU Assembly include:

- Processing code rate (cab signal aspect) information and monitoring vehicle speed,
- Controlling the indications on the ADU,
- Monitoring vital inputs and controlling vital outputs,
- Conducting and monitoring the automated Departure Test,
- Monitoring ATP, ATO, and TWC subsystem performance.

The ATP Logic CPU is a Motorola 68332 microprocessor and operates on a 250ms cycle time. The 332 performs all of the ATP safety-related calculations and executes ATP safety functions. The ATP CPU PCB interfaces with the G96 I/O Bus on the backplane motherboard PCB for system power, and to communicate with other ATC system PCBs connected to the backplane. The following figure shows and overview of the ATP CPU PCB. Refer to Figure 2-38 for an overview diagram of the ATP Logic CPU PCB.

[redacted]

In addition to the Motorola 68332 processor, the ATP CPU PCB contains a number of peripheral circuits. The PCB has volatile Random Access Memory (RAM) for use by the processor, non-volatile flash memory, and a real time clock circuit to set time stamps on system events. The 500 Hz Conditional Power Supply enable signal is generated by the processor and is conditioned on the PCB prior to going off board. The ATP CPU PCB also houses circuitry to interface with the G96 I/O Bus, handle serial communications, and a Serial Peripheral Interface (SPI) port. Two Versatile Interface Adapter (VIA) ICs on the PCB are configured to interface with other system devices. The following figure illustrates a block diagram of the ATP CPU processor circuitry and its I/O interfaces. Refer to Figure 2-39 for an interface diagram for the ATP CPU.

[redacted]

Refer to Figure 2-40. Discrete LEDs on the front panel of the CPU assembly indicate hardware status. The front panel also includes a master CPU reset pushbutton switch. A DB-9 serial port is for ASTS factory use only.

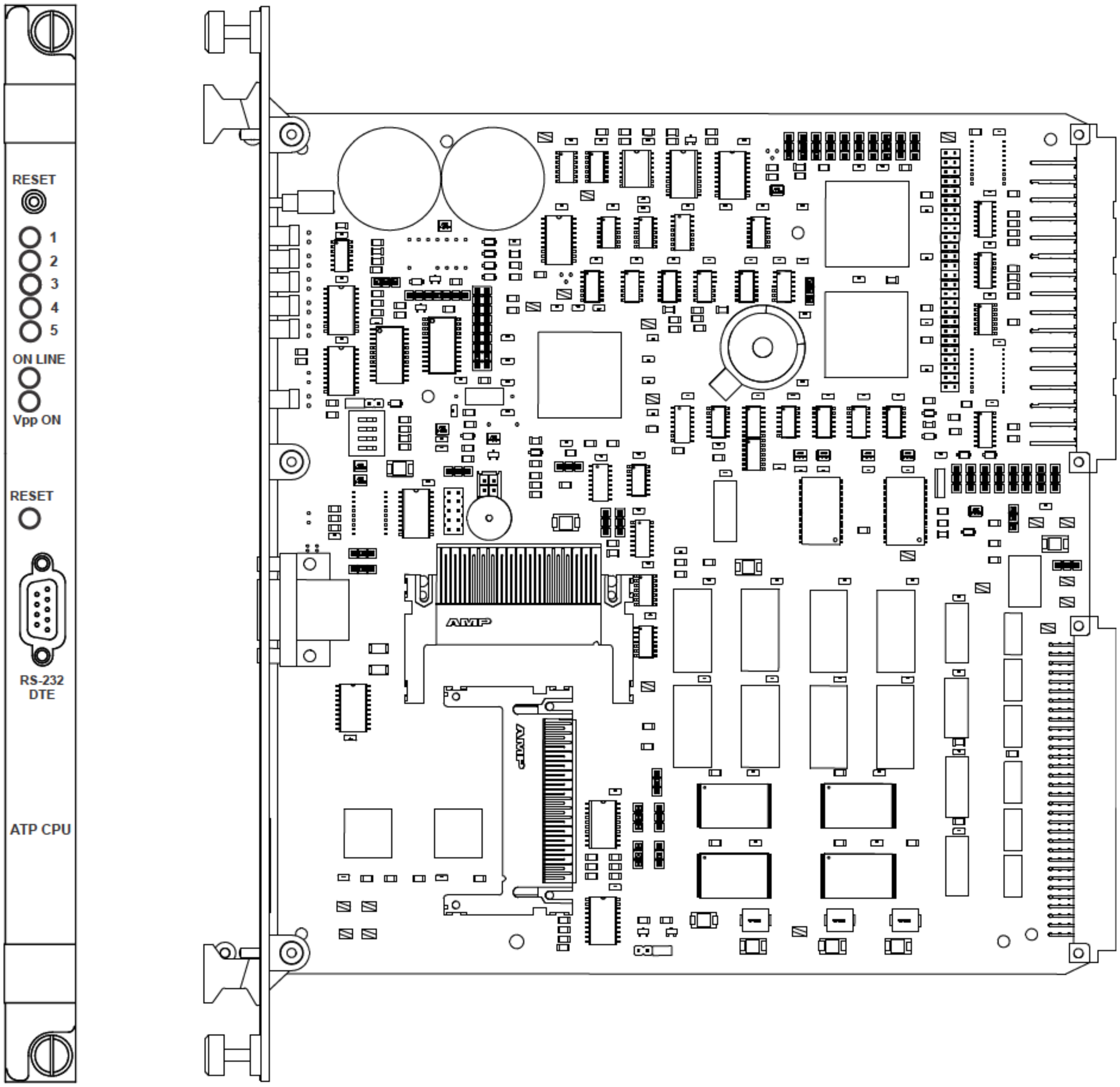

Figure 2-40: ATP Logic CPU Assembly

2.10.11 Communications Controller Assembly

The Communications Controller Assembly (Communications Control Board - CCB) provides the hub for communication among the ATC subsystems and the external networks. Specifically, it provides Multifunction Vehicle Bus (MVB) and redundant Ethernet-compatible interfaces for the ATC system. It interfaces data to and from the vehicle's on-board MVB and Ethernet networks with the ATP CPU and ATO CPU assemblies via the G96 I/O Bus on the ATC backplane motherboard. Refer to Figure 2-41 for an overview diagram of the Communications Controller PCB.

[redacted]

The CCB is a microprocessor-controlled component with permanent application software installed. The CCB assembly is a Class II device; i.e., it is field-configurable and can pre-process information, but the microprocessor's program is fixed.

The CCB assembly contains the necessary interfaces to conform to applicable MVB specifications as a slave device. It includes two dedicated and isolated links for a redundant MVB connection, four isolated RS-485 serial links, one isolated RS-232 serial link, and one Ethernet communication link.

For example, the CCB can provide a dedicated Ethernet interface to connect the ATP Logic CPU to the vehicle's MDS and simultaneously communicate with the ADU via the MVB. Overall, the CCB enables the ATP Logic CPU to route information to/from other vehicle systems and peripheral equipment. The CCB also provides an RS-232 serial link to the TWC Modem Assembly that allows it to interface with other ATC subsystems through the G96 I/O Bus or directly to the ATO CPU over an RS-485 link.

The Communication Controller PCB is divided into the following major circuitry modules:

- Power Supply Module
- G96 Interface Module
- MVB Interface Module
- RS-485/RS-232 Communication Interface Module

- Ethernet Interface Module
- Transposition Interface Module
- Programmable Hardware Module

The CCB does not have a processor of its own. It uses a daughterboard that contains the necessary processor and other interface components necessary for the ATC system. The daughterboard is a major component of the CCB, and is installed on the CCB PCB. It interfaces to the ATP subsystem CPU processors through a DPRAM interface in the G96 VMA / VPA address space. All the major components for MVB, RS-485, Ethernet, and RS-232 are present on the daughterboard. All connections to the daughterboard are routed through connectors on the CCB PCB. Refer to Figure 2-42 for a functional diagram of the Communications Controller PCB.

[redacted]

Refer to Figure 2-43 for views of the Communications Controller PCB Assembly.

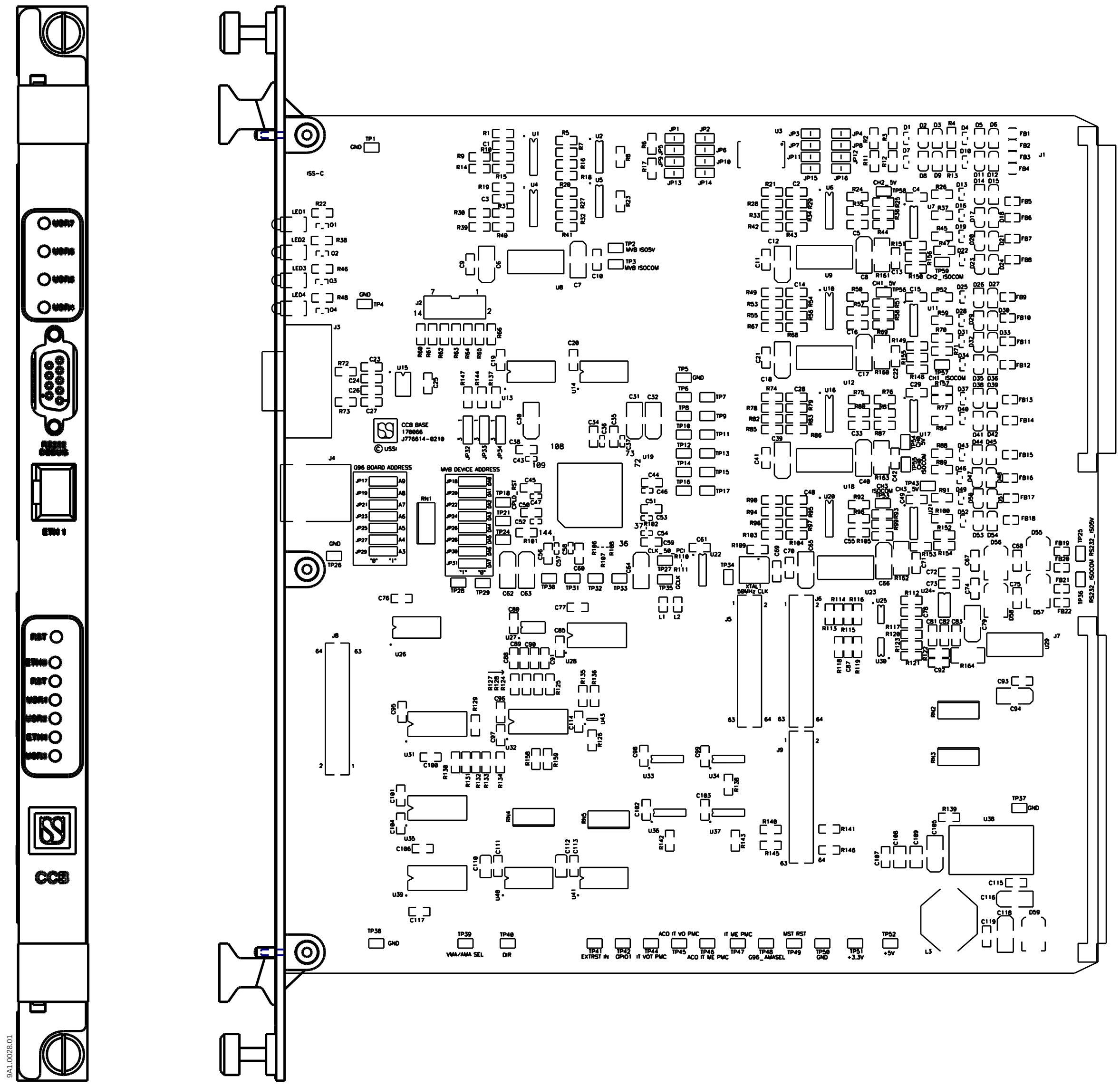

Figure 2-43: Communications Controller PCB Assembly

2.10.12 ATO CPU Assembly

The Automatic Train Operation (ATO) CPU Assembly is a non-vital component that supports overall ATC system operation by performing various ATO functions with its own software application. It features a Field-Programmable Gate Array (FPGA) to perform its programmed functions. The PCB's circuitry contains a communications transceiver and accommodates a speed sensor input and other discrete I/O. The ATO CPU PCB is also referred to as the Supervision, Positioning, and Operation (SPO) board, and it operates on a 100ms cycle time. Refer to Figure 2-44 for an overview diagram of the ATO PCB.

[redacted]

In conjunction with data from the ATP and TWC subsystems, the PCB performs ATO functions that include:

- Processing vehicle inputs to the ATO subsystem
- Communications with the ATP subsystem for exchange of diagnostic, status, and track position data

For Automatic Train Operation functionality, SPO PCB hardware is used when the vehicle is operating in automatic mode, and includes a dedicated tachometer input to detect vehicle speed and other discrete digital I/O interfaces that control traction effort and brake application. Consequently, the ATO SPO PCB performs functions required by Automatic Train Operation, including precision station stop (PSS).

ATO-specific events are transmitted to the Communication Controller Assembly for storage in the overall ATC event management system. Refer to Figure 2-45 for a functional diagram of the ATO PCB.

[redacted]

Refer to Figure 2-46. The front panel on the ATO CPU Assembly includes several subsystem monitoring LEDs and two M12 Ethernet ports.

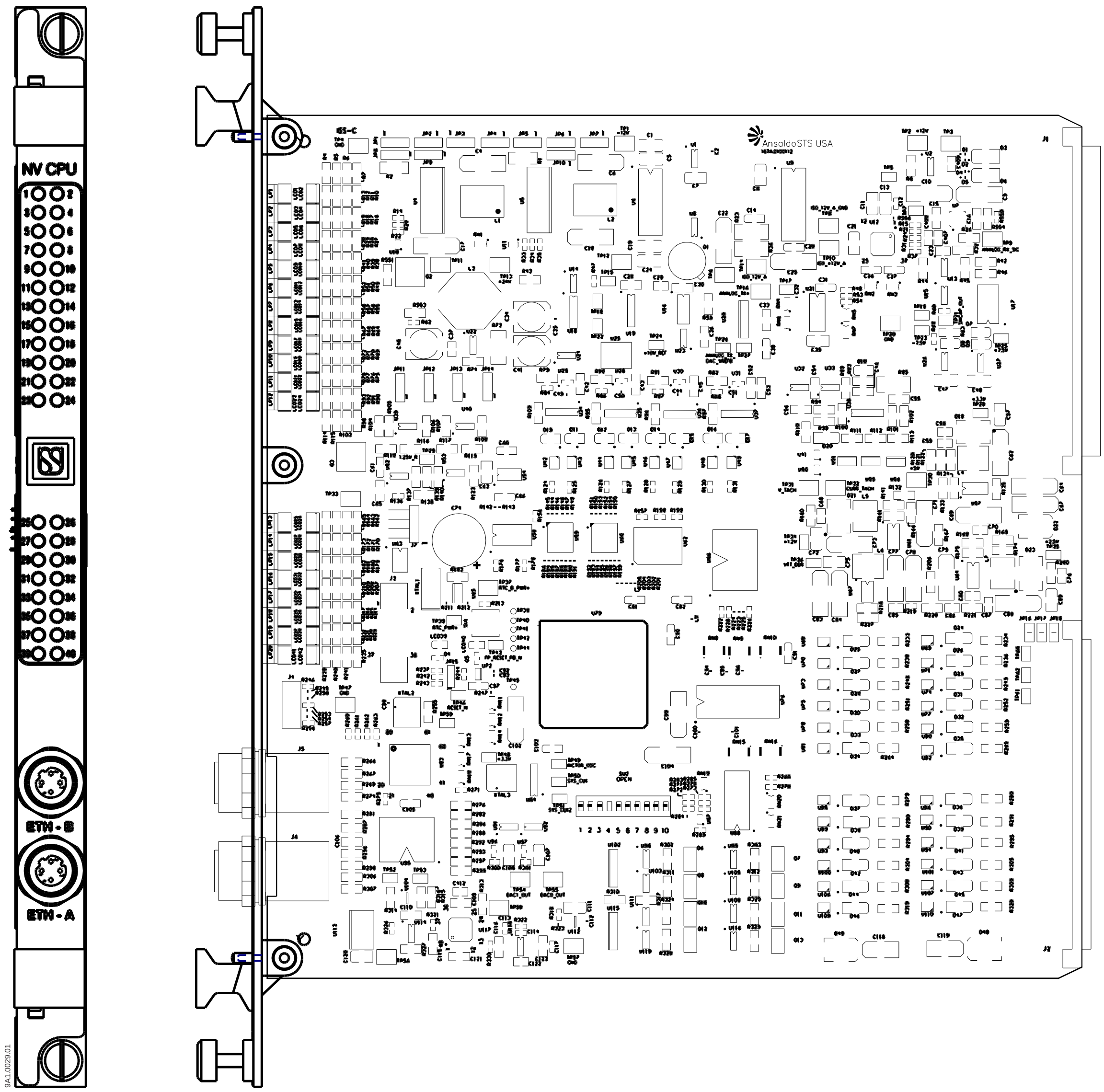

Figure 2-46: ATO CPU Assembly

2.10.13 TWC Modem Assembly

The non-vital TWC Modem PCB Assembly operates as a modem for the wireless transfer of serial data between the vehicle and wayside. The transmit section generates the modem carrier frequency, which is FSK-modulated to encode the digital message data. The carrier level is then raised sufficiently to drive an external loop antenna. The receive section filters and demodulates a FSK-modulated carrier to extract the digital message data. The digital input and output message data are processed over an RS-232 link to the Communication Controller PCB and then over RS-485 or G96 bus to the ATO CPU PCB.

The TWC Modem PCB is only used in conjunction with the Type II TWC Antenna.

Refer to Figure 2-47 for an overview diagram of the TWC Modem PCB.

[redacted]

Figure 2-47: TWC Modem PCB Overview

TWC Modem PCB receives and transmits Binary Frequency Shift Keying (BFSK) signals from and to the TWC Antenna input selected by the Safety Relay PCB and communicates through an RS-232 link with the Communication Controller PCB (CCB), which interfaces with the ATO CPU in the ATO subsystem. The TWC Modem Assembly performs the following major functions:

- Demodulates the TWC signal received from the wayside through the TWC Antenna and serially transmits the data over an RS-232 data link to the Communication Controller PCB,
- Serially receives the data to be transmitted to the wayside from the CCB via an RS-232 data link, modulates the data, and transmits the data via the TWC Antenna to the wayside,
- Detects transpositions and provides a serial output to the CCB for event logging and use by the ATP and ATO subsystems.

[redacted]

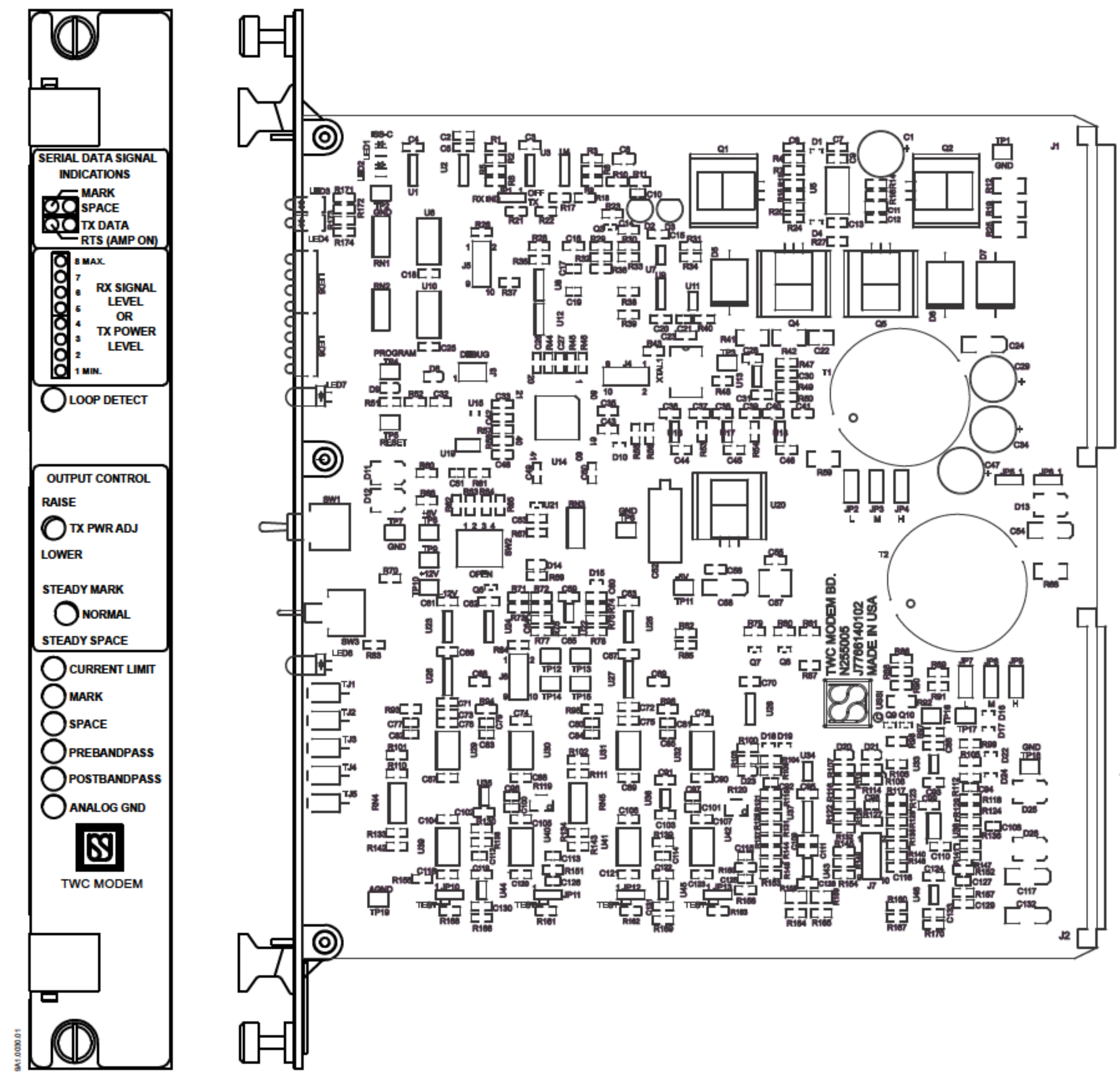

Figure 2-49: TWC Modem Assembly

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[redacted]

2.10.14 Vital Relay

Refer to Figure 2-51. The ASTS USA PN-159B Vital Relay provides a direct interface between the ATP subsystem and the vehicle Emergency Brake trainline. During normal operation, the relay is energized by an ATP vital output and its contacts are closed. When the ATP Logic CPU detects a condition requiring an Emergency Brake, the ATP de-energizes the Vital Relay and its contacts open to interrupt the Emergency Brake trainline to request an Emergency Brake application.

For the P3010 vehicle, the Vital Relay also contains contacts that interface with the Door Enable trainlines. When the ATP subsystem de-energizes the relay to request an Emergency Brake application, these contacts open and interrupt the Left Doors Enable (ELD) and Right Doors Enable (ERD) trainlines to ensure that door enabling is not possible during an Emergency Brake condition.

The PN-159B is a double-coiled, 24-volt relay with coil resistances of 400/400 ohms. Contacts are 6 front-back, low voltage with silver-to-silver impregnated fronts and silver-to-silver backs. The relay is mounted to a plug-in base located in the ATC enclosure in the same compartment as the Battery Conditioner PCB and the Decelerometer.

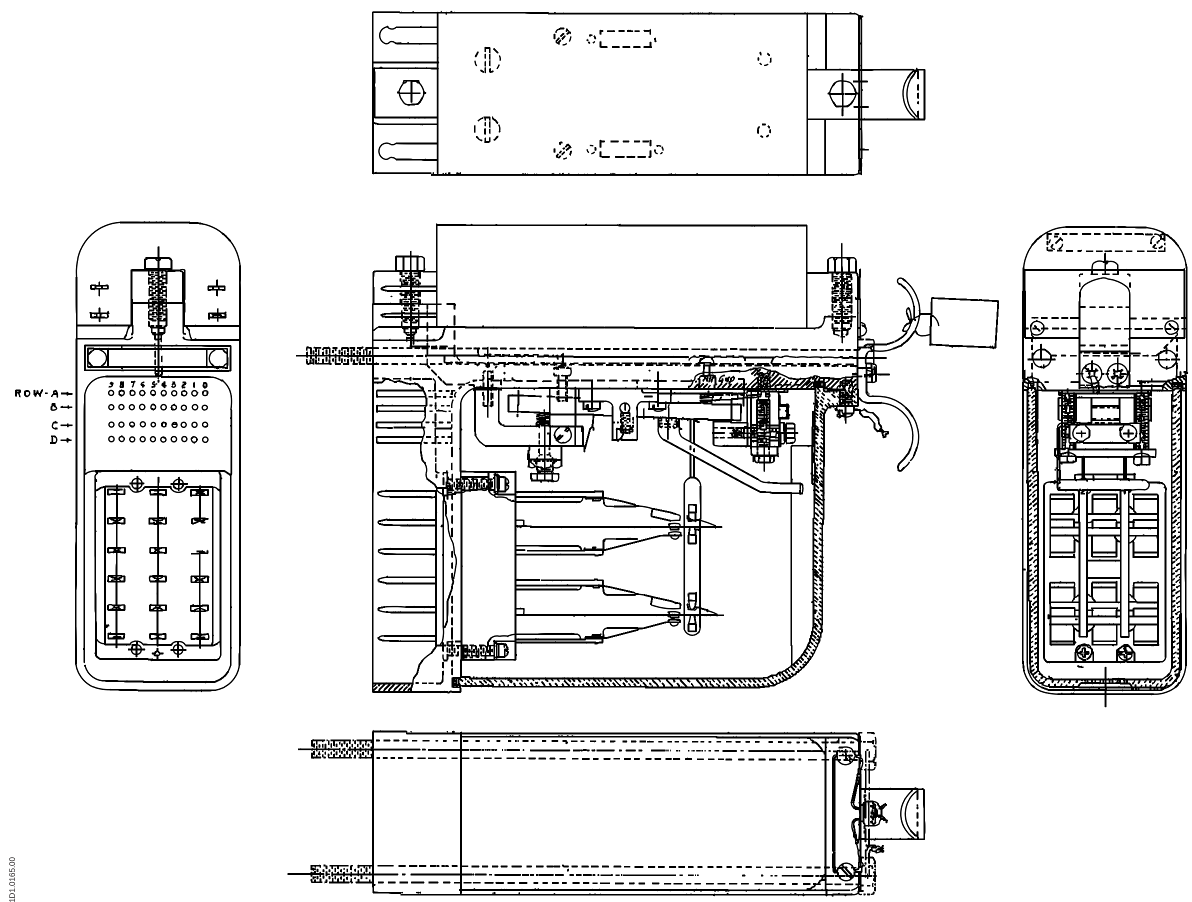

Figure 2-51: Vital Relay

2.10.15 Decelerometer Assembly

Refer to Figure 2-52. The Decelerometer is an electrolytic tilt sensor. The output polarity and amplitude of the sensor are proportional to the amount of acceleration or deceleration experienced by the vehicle. The Decelerometer signal is grade-compensated while measuring the true traction (acceleration) and braking (deceleration) efforts of the P3010 LRV.

The Decelerometer sensor is located in the compartment on the lower left of the ATC Enclosure below the Battery Conditioner PCB, and is mounted on an adjustable bracket assembly that facilitates sensor calibration. The Decelerometer interface with the ATC system is through a 12-position Tyco connector to the backplane motherboard PCB, and provides two channels. These two channels are monitored by the ATP Logic CPU through the Multifunction PCB. The mounting bracket is used to calibrate the Decelerometer to null its output when the vehicle is level and not moving.

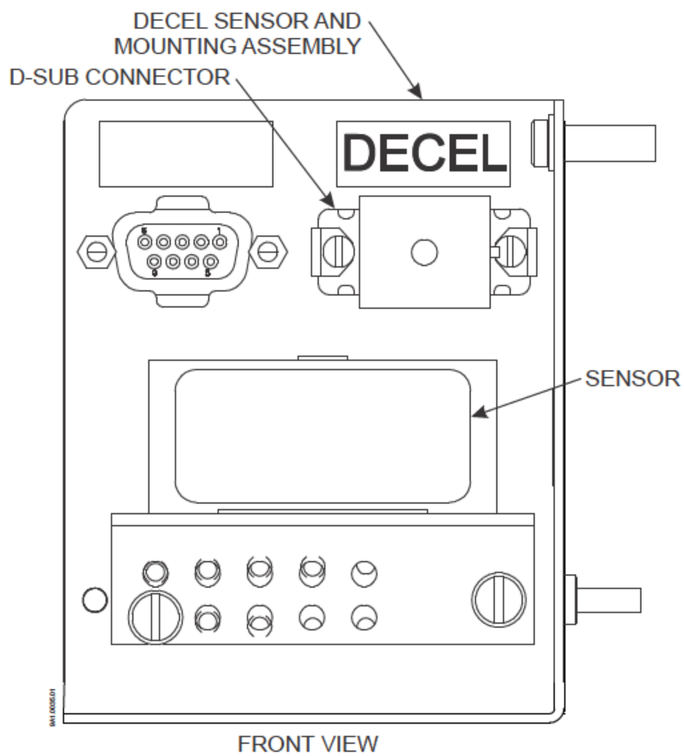

Figure 2-52: Decelerometer Sensor and Mounting Assembly

2.11 Antennas and TWC Equipment

Three different types of antennas used by the ATC system are installed externally on the P3010 LRV to receive signals from the rails and wayside: 1) ATP Track Receivers, 2) ASTS Type II TWC Antenna, and 3) Hanning & Kahl (H&K) Type I TWC Antenna, are mounted on the A-End and B-End of the car set. The ATC System monitors the position of the key switch in each vehicle cab for cab control information. When the ATC system determines that either the A-End or B-End cab is active ("keyed"), the corresponding set of ATP Track Receivers and TWC Antenna are electrically connected by relays to the ATC system via the Safety Relay PCB.

2.11.1 ATP Track Receivers

Refer to Figure 2-53. A pair of ATP Track Receivers is mounted above the rails on the lead truck at each cab end (4 total Track Receivers per vehicle). This antenna's design detects both 100/250 Hz cab signals and digital FSK cab signals. The Track Receivers incorporate separate coil elements that receive 100/250 Hz and FSK, and an additional element used exclusively to test the ATP cab signal detection circuitry. The differential cab signal outputs from each pair of Track Receivers (referenced to each other) are coupled to the CSRD PCB Assembly in the ATC enclosure through a junction box and vehicle wiring.

Each receiver antenna consists of a compact horizontal bar approximately one foot long, plus a central mounting bracket. For ease of identification, each left-hand Track Receiver is black; each right-hand Track Receiver is yellow. Only one pair of Track Receivers is active at a time; the ATP subsystem uses relays on the Safety Relay PCB Assembly to select the appropriate pair of antennas depending on which cab is active.

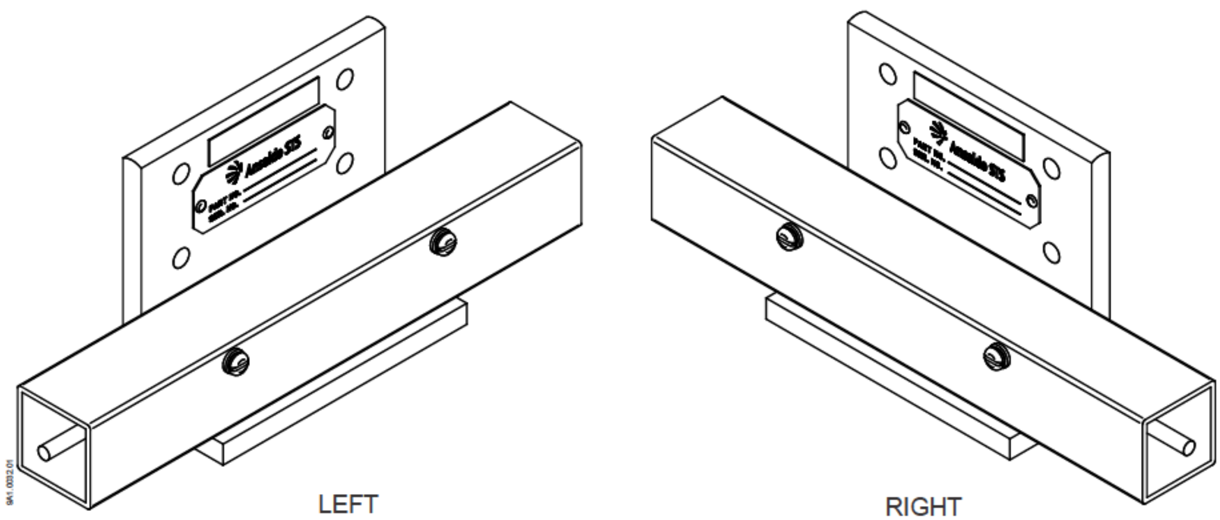

Figure 2-53: ATP Track Receiver Antennas

Each Track Receiver Antenna utilize a 4000 turn Main Coil mounted on a 2000µ ferrite bar that inductively receives signals modulated by current transmitted through the track by wayside transmission equipment. The coil leads are connected to an Amplifier PCB. The Amplifier PCB conditions the received signal from the Main Coil and allows the signal to be transmitted to the Automatic Train Protection (ATP) equipment without signal loss attributed to inter-connecting wire capacitance.

In addition to the main 4000 turn coil, a 100 turn coil is included and mounted on the ferrite bar. This coil couples test signals, generated by the ATP, into the ferrite while the ATP performs a Departure Test; a test that checks system peripheral and internal functionality before allowing the train to run in revenue service.

Each ATP Track Receiver contains an Amplifier PCB (1.5” x 1.5”) encapsulated in the receiver housing that is used to transmit a low level track signal, received by the receiver bar coil, undistorted and without voltage gain to the ATP system via shielded car wiring. Long cables are more susceptible to the introduction of propulsion electrical noise onto the cab signal being received. To reduce this possibility, shielded cables are used for interconnecting the electrical signal from the Receiver Antenna to the ATP subsystem. Shielded cables, in turn, inherently have larger values of cable capacitance that require consideration to keep signal degradation to a minimum. The Amplifier PCB is designed to maximize the output impedance of the Track Receiver Antenna, which negates the losses due to cable capacitance.

The Amplifier PCB is designed to directly connect a three twisted pair cable to: 1) input +15 VDC voltage to the PCB from the Power Supply PCB Assembly, 2) get connection to the Test Coil and 3) connect to the Main Coil via the Amplifier PCB conditioning circuitry.

2.11.2 TWC Antennas

Refer to Figure 2-54 and Figure 2-55. The TWC subsystem allows wireless transmission of data and commands between the vehicle and wayside equipment. The Type I TWC subsystem (MBL, PGL, and similar Metro lines) uses two (2) Hanning & Kahl (H&K) TWC antennas, one at each end of the vehicle. The Type II TWC subsystem (MGL and similar Metro lines) uses two (2) ASTS TWC antennas, also mounted at each end of the vehicle. Each ASTS antenna contains two coils; however, in the P3010 vehicles, only one coil is used to transmit and receive.

The TWC Antennas receive and transmit signals to and from the TWC subsystem and TWC loops mounted between the rails. Each Type II TWC Antenna connects to the ATC system through vehicle wiring. Only one Type I or Type II antenna at a vehicle end is active at a time. Depending upon which vehicle cab is active (keyed) and the position of the Line Selector Switch, the ATP subsystem selects the appropriate Type II antenna via relays on the Safety Relay PCB Assembly. The appropriate Type I TWC Antenna is selected depending upon which TWC Communications Control Unit (CCU; refer to Section 2.5.3) is energized by an active cab.

The Type I TWC subsystem also includes a vehicle-mounted TWC Communication/Control Unit (CCU) in each cab, and interconnecting cables with connectors from the CCU to a power supply, to the TWC antenna (HCS-V transponder), and to the ADU through an RS-485 interface. The CCU converts and transmits data received from the ADU to the Type I TWC antenna

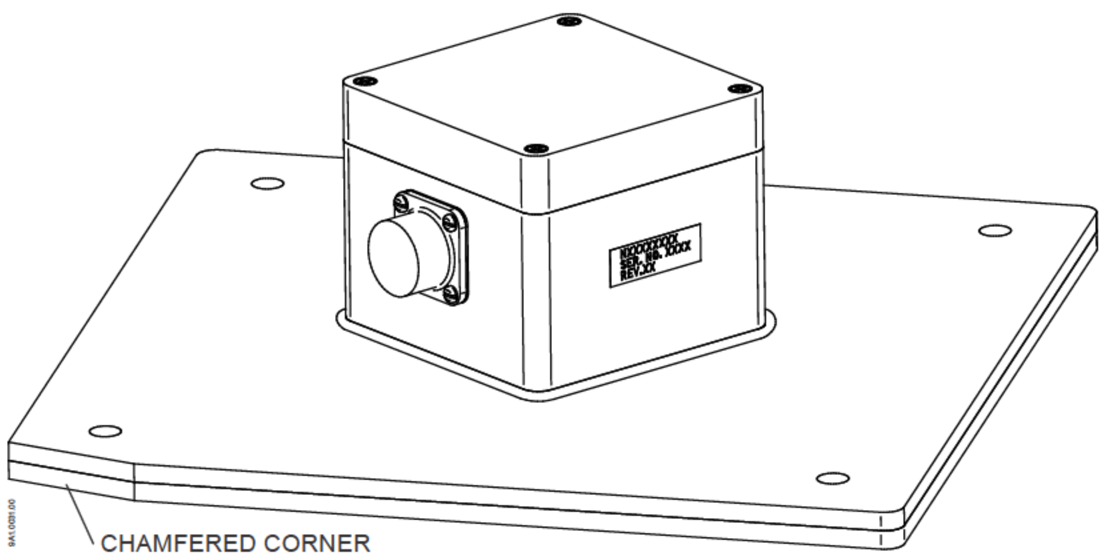

Figure 2-54: Type II TWC Antenna

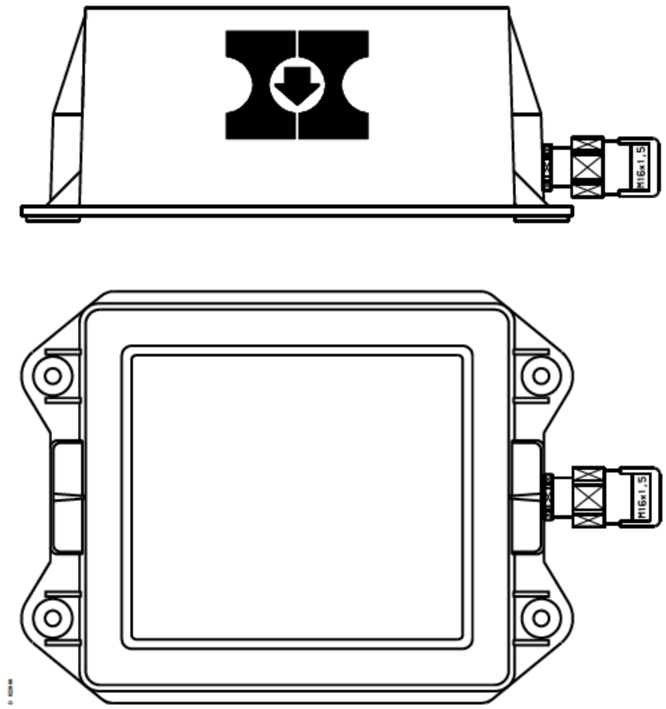

Figure 2-55: Type I TWC Antenna

2.11.3 Type I TWC Communications Control Unit

Refer to Figure 2-56. The Communications Control Unit (CCU) for the Type I TWC system is housed in an aluminium case. The CCU is mounted inside the P3010 vehicle in the ceiling of each cab and is accessible. The CCU receives vehicle power and the signals from the Type I antenna mounted under the vehicle (refer to Section 2.5.2) and processes the signals to determine the type of wayside communication system and set the proper protocol for the ATC system to process the wayside data for display and control.

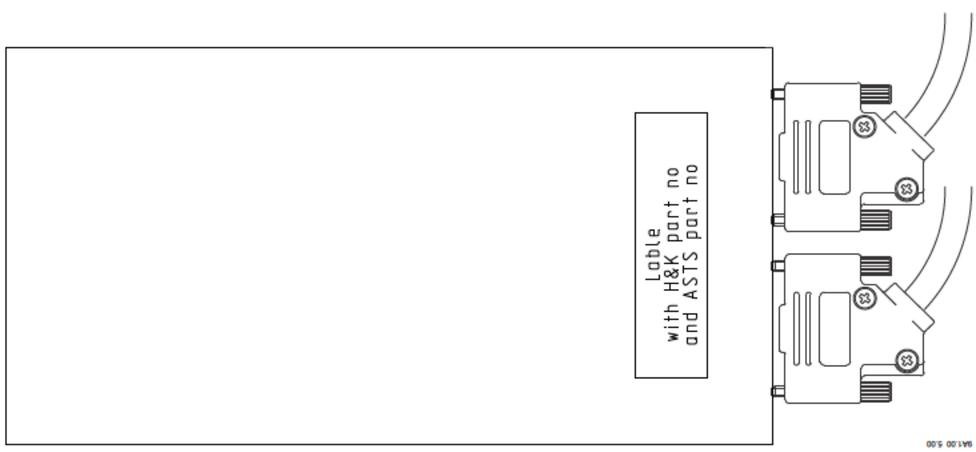

Figure 2-56: Type I TWC Communication Control Unit

Refer to Figure 2-57. One side of the CCU contains connectors for CCU power and the Type I TWC antenna (transponder). Other connectors provide RS-485 and RS-232 interfaces. Operating pushbuttons, an LED display, and LED indicators are also located with the connectors.

CCU connectors, controls, and indications:

1. 15-pin connector for the cable to the Type I TWC antenna (transponder)
2. 9-pin connector for an RS-485 interface to the Operator Interface Panel (ADU)
3. 15-pin connector for CCU power from the vehicle and I/O control signals
4. 9-pin connector for an RS-232 interface (not used in the P3010 vehicle)
5. 9-pin connector for a CAN interface (not used in the P3010 vehicle)
6. RESET pushbutton is used to restart the CCU; for example, after software update.
7. Seven-segment LED display:

a. Displays software version after pressing pushbutton S.

b. In normal operating mode, the external LED segments illuminate in succession.

c. Displays P in programming mode when the CCU is connected via an interface cable to a PC for programming.

d. Displays L when a message is received from the wayside and answered with no Acknowledgement received.

e. Displays U when a message is received from the wayside and answered with an Acknowledgement received.

f. Displays three horizontal segments when the CCU receives communication type HCS-R from the wayside.

8. Red (top) LED illuminates when communication with the ADU over the RS-485 interface is in progress.
9. Green (bottom) LED flashes when vehicle DC power is connected to the CCU.
10. Service pushbutton S displays the CCU software version in the seven-segment LED display when pressed.

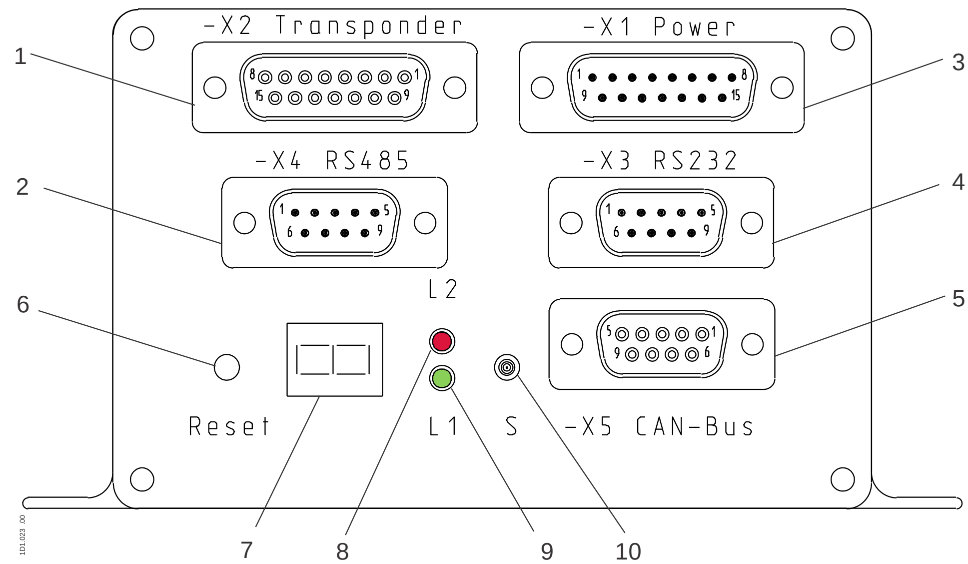

Figure 2-57: Type I TWC Communication Control Unit Interface

2.12 Speed Sensors

The ATC system receives inputs from two dual-channel tachometers (speed sensors) mounted on each P3010 vehicle. Both channels from one tachometer and one channel from the other tachometer are inputs to the ATC system. The speed sensors are within the scope of the vehicle-builder's supply. Both tachometers receive 15VDC isolated power from the Power Supply PCB Assembly in the ATC enclosure (refer to Section 2.10.3).

Refer to Figure 2-58. Signals from both channels of Speed Sensor 7 (axle 4) and one channel of Speed Sensor 9 (axle 6) are processed for speed determination by the Multifunction PCB in the ATP subsystem. The channel outputs from Speed Sensor 7 (axle 4) are 90 degrees out-of-phase with each other. The two channels from this speed sensor provide both speed and direction of travel information to the Multifunction PCB. One speed sensor channel from Speed Sensor 7 (axle 4) is also passed through the Multifunction PCB to the ATO (SPO) PCB in the ATO subsystem for speed information.

The signal from the second channel on Speed Sensor 9 (axle 6) is routed to the B Truck friction brake electronic control unit on the vehicle, and is not used by the ATC system.

[redacted]

2.13 Operator Interface (ADU/TWC) Panel

Refer to Figure 2-59 and Figure 2-60. A combined ATC and TWC display panel (Figure 2-61 and Figure 2-62) provides the vehicle operator with audible and visual controls and indications for the ATP, ATO and TWC subsystems. The Aspect Display Unit (ADU) also allows the operator to select ATC operating modes and system tests. The ADU panel incorporates a single Liquid Crystal Display (LCD) window for all ATC system indications. Pushbuttons around the LCD display area allow the operator or maintainer to interface with different ATC and TWC system functions. The ADU is equipped with an audible alarm for various conditions such as ATP overspeed.

The ADU also provides the functionality of a TWC Interface Panel. Because the P3010 vehicles will operate on Metro lines with different operational rules, the flat panel ADU, while being an integrated display to the operator, has two different main screens tailored for operation on Type I and Type II lines. Refer to Figure 2-63 and Figure 2-64.The Type I TWC Communications Control Unit in each cab connects to the ADU through an RS-485 interface.

One ADU/TWC Interface Panel is mounted in each operating cab. The interface between the ATC and the ADU is over the P3010 Multifunction Vehicle Bus (MVB) network. The ADUs for the P3010 vehicles are Non-Vital, and are not designed as fail-safe devices. The ADU is not serviceable and is replaced as a complete assembly.

The Event Codes that cause the ATP Failure, TWC Failure, and ATO Failure indicators on the ADU to display are shown in Table 2-3.

Table 2-3. ADU Display Event Triggers

	ADU Indicator		
	ATP Failure	ATO Failure	TWC Failure
Event Trigger	1-19	5033	5018
	32-34	5034	5019
	41 & 44	5035	5043
	1001-1039	5020	7030
	2503-2509		
	2601-2627		
	2700-2709		

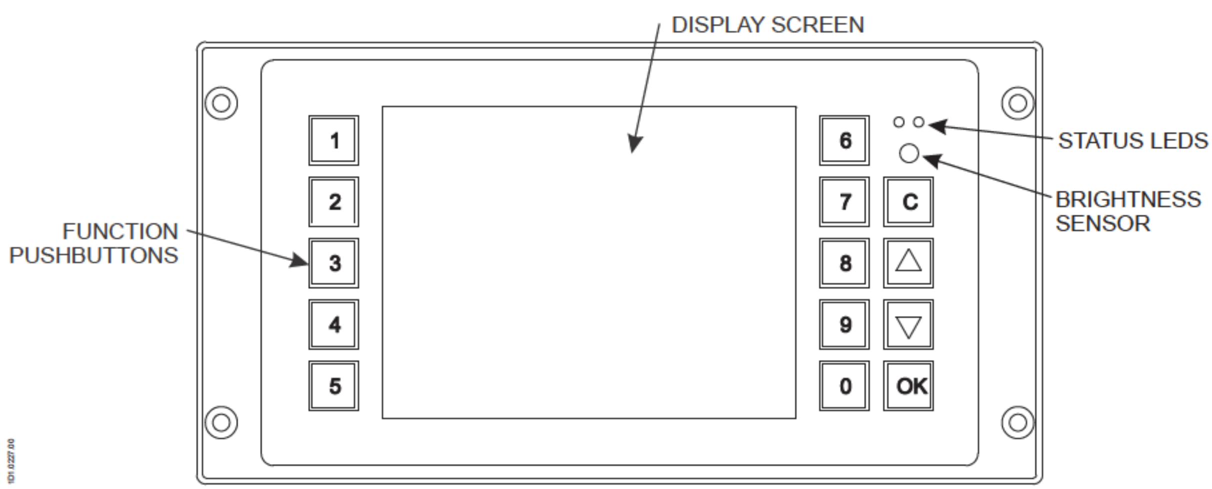

Figure 2-59: ADU / TWC Interface Panel

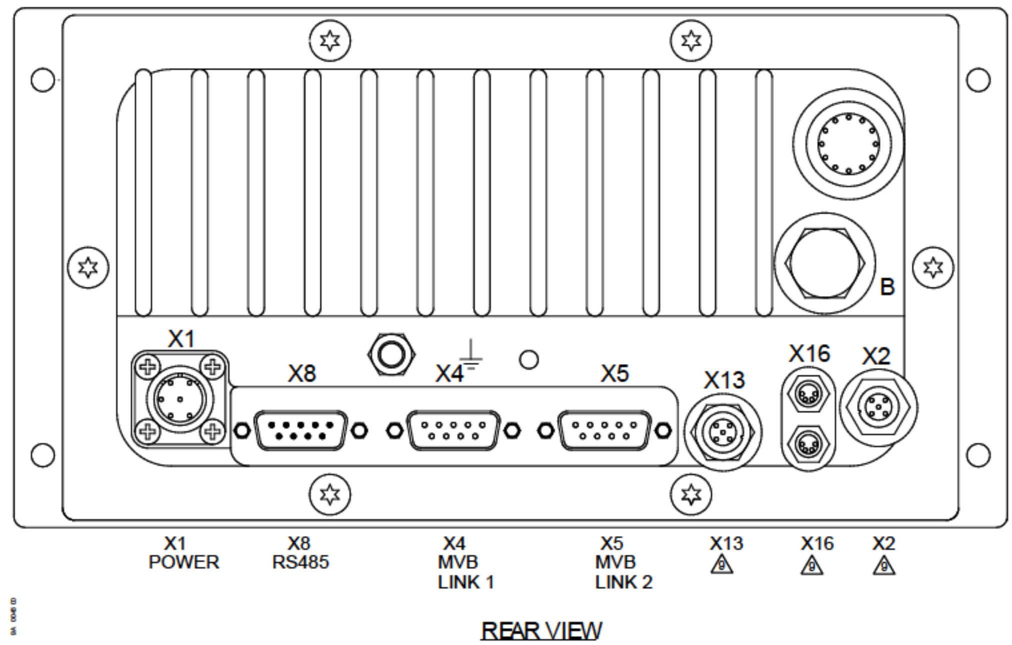

Figure 2-60: ADU / TWC Interface Panel (Rear View)

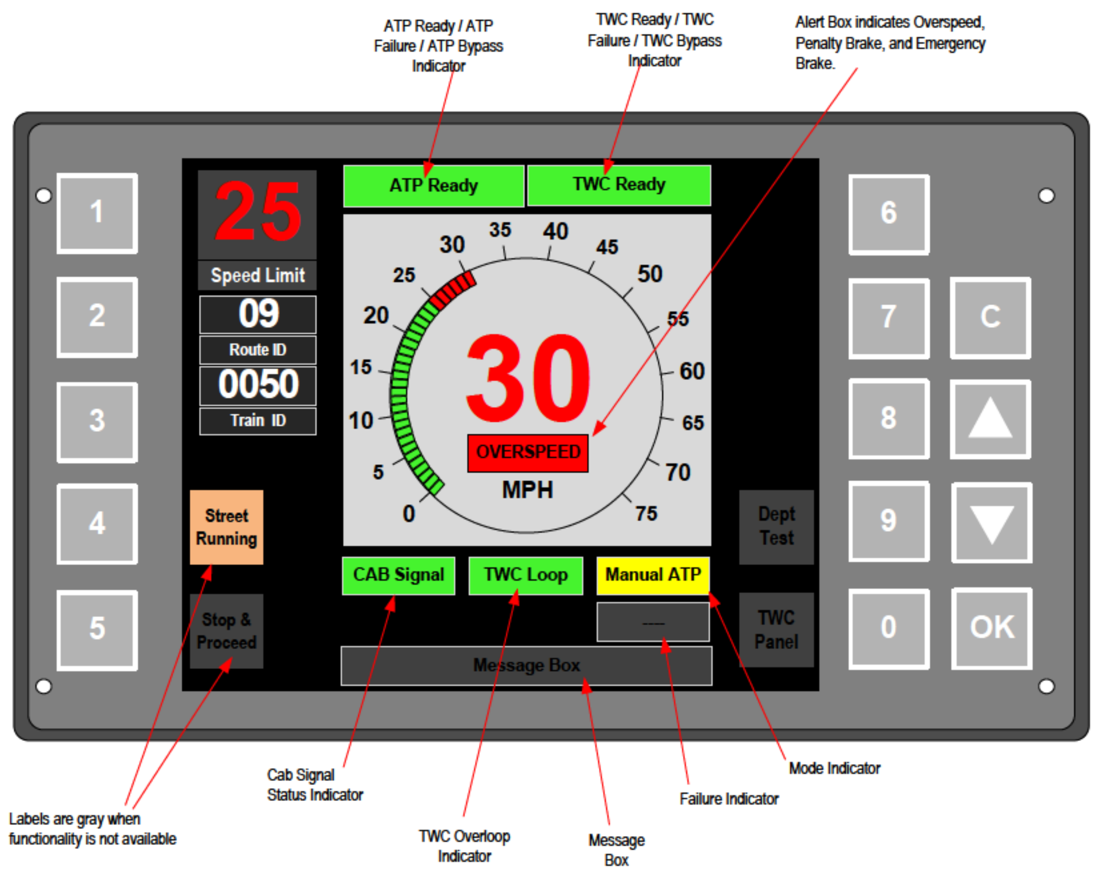

Figure 2-61: Type I ADU Main Screen

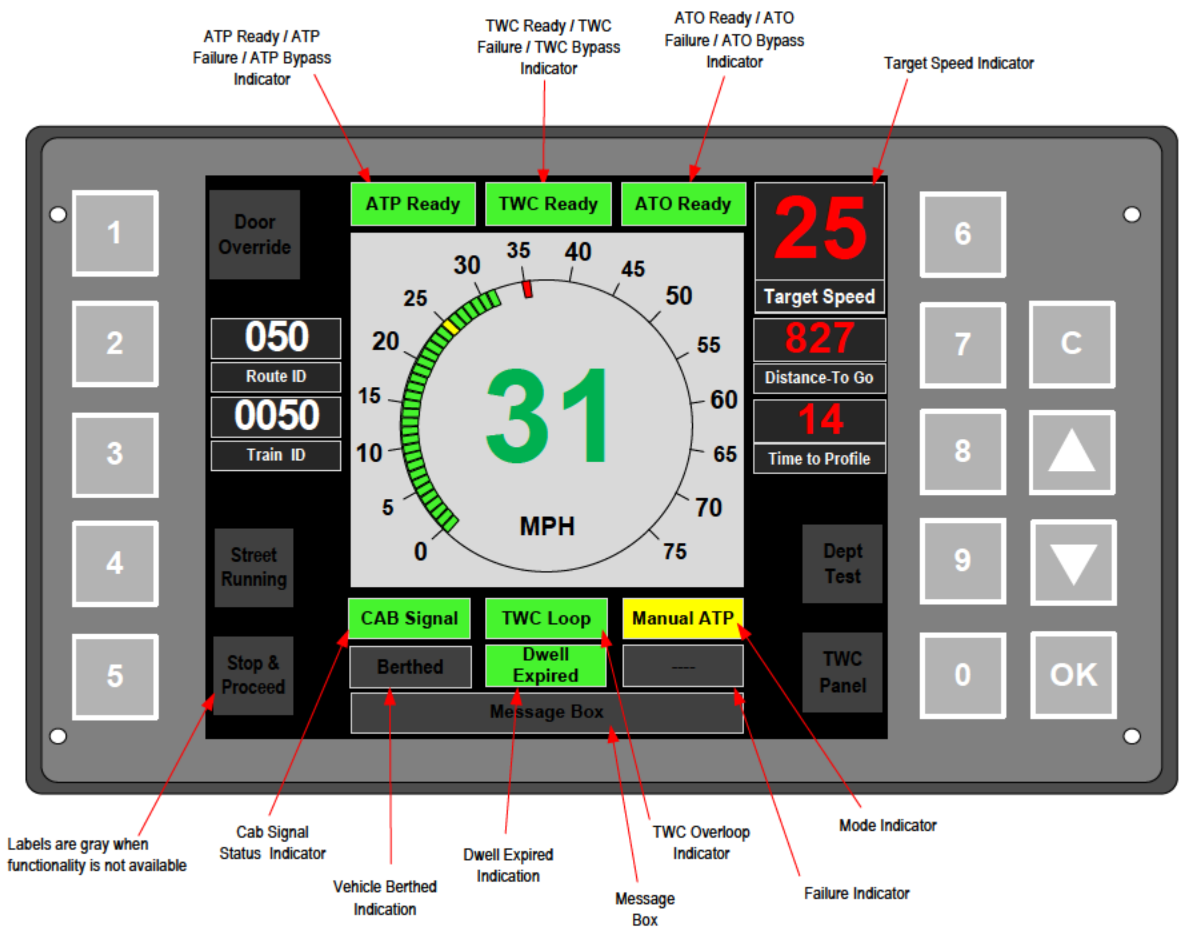

Figure 2-62: Type II ADU Main Screen

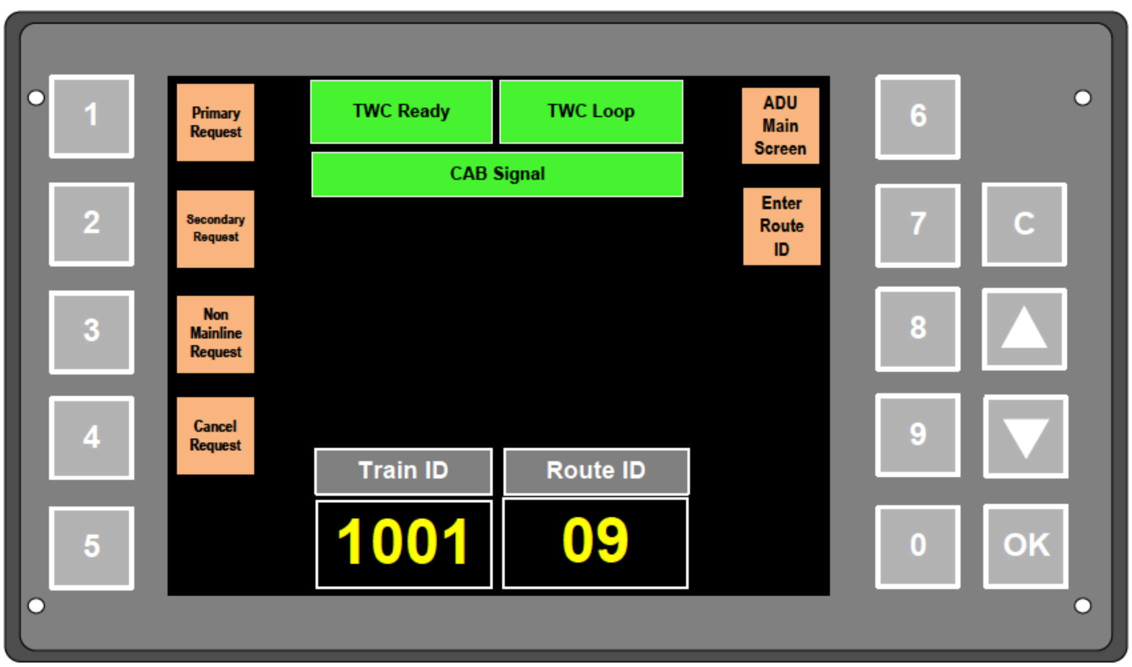

Figure 2-63: Type I TWC Main Screen

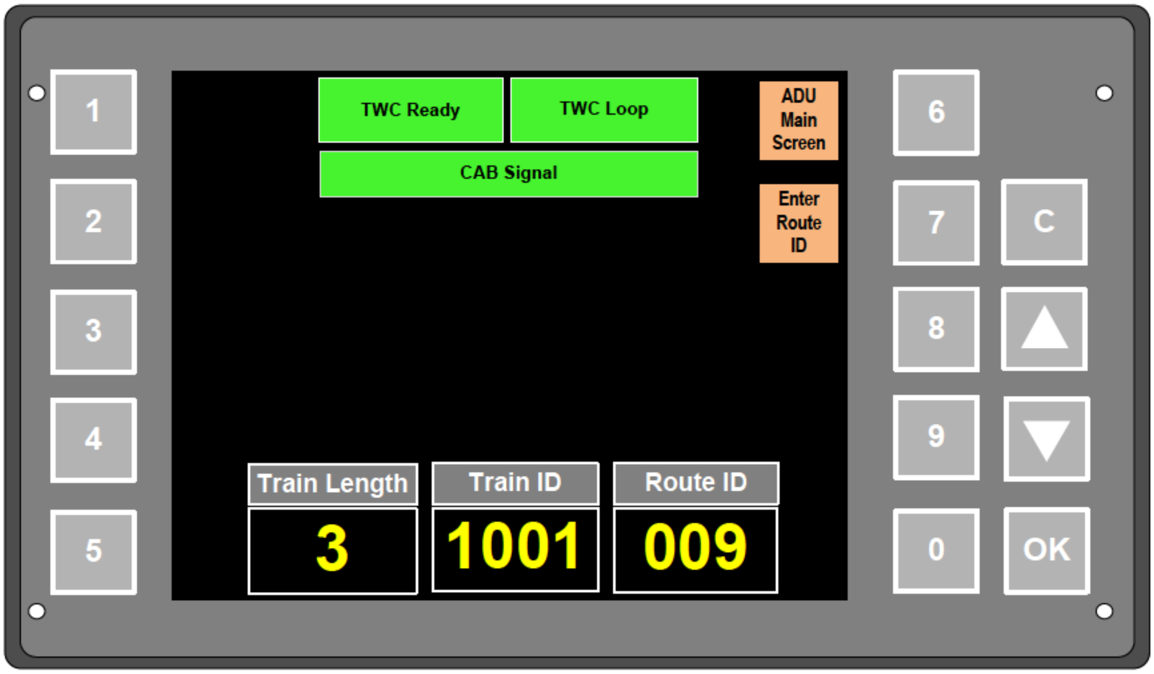

Figure 2-64: Type II TWC Main Screen

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CHAPTER 3.0

SPECIAL TOOLS AND MATERIALS

3.1 Introduction

Only common hand tools are required for the majority of preventive and corrective maintenance tasks associated with the ATC / TWC system.

System event (fault code) management, troubleshooting, and some calibration procedures require the use of a Portable Test Unit (PTU), which is a software application running on a laptop computer connected the ATC System. Refer to the ATC System Portable Test Unit Manual for detailed PTU operating instructions.

Refer to Table 3-1, which lists the cleaning agents and materials recommended by ASTS USA to clean ATC system equipment, and their uses.

Table 3-1. ATC System Cleaning Materials

Name	Manufacturer	Use
Household cleaner	Commercial (Pine Sol – Clorox Co. item no. 97326, or equivalent)	Clean exterior surfaces of system components in the vehicle interior
Lint-free and other cleaning cloths	Commercial	Clean and dry component exterior surfaces
Soft bristle brush	Commercial	Remove dust and foreign matter from electrical connections and equipment surfaces
Wire or stiff-bristle brush	Commercial	Remove excessive dirt and grime from exterior system components
Compressed air in aerosol can	Commercial (Enviro-Tech Duster - Techspray Co. item no. 1671-10S, or equivalent)	Remove foreign matter and dust from equipment and electrical component surfaces

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CHAPTER 4.0

SCHEDULED MAINTENANCE TASKS

4.1 Introduction

This section provides an overview of the ATC / TWC System maintenance tasks that are performed on a regular schedule to maximize equipment life and ensure continued operation of the system at peak functionality. This type of maintenance is considered preventive maintenance.

4.2 Scheduled Maintenance Index

The scheduled preventive maintenance intervals for the LACMTA P3010 ATC / TWC system and equipment vary with the maintenance task performed. These maintenance procedures primarily involve general inspection, cleaning, and adjustment of system components.

Table 4-1 is an index of schedules ATC / TWC system maintenance activities that lists each preventive maintenance task and its frequency. The reference column indicates the section for the procedure to perform each maintenance task.

Table 4-1. ATC / TWC Scheduled Maintenance Intervals

Maintenance Interval	Part Description	Scheduled Maintenance Task	Section 1500, ATC/TWC Running Maintenance Manual Section Reference
10,000 miles	ATC / TWC System	Inspect the ATC / TWC System	Section 4.3.1
30,000 miles	ATC / TWC System	Clean the ATC / TWC System	Section 4.3.2
60,000 miles	Wheel Size	Adjust Wheel Size Parameter	Section 4.3.3
60,000 miles	Decelerometer	Check that the Decelerometer is within Calibration	Section 4.3.4
Every 4 years	Vital Relay	Inspect and Test the Vital Relay	Section 4.3.5
Every 6 years	Vital Relay	Calibrate the Vital Relay	Section 4.3.6

4.3 Scheduled Maintenance Procedures

The following subsections provide the procedures to perform the scheduled preventive maintenance tasks associated with the ATC / TWC system.

4.3.1 Inspect the ATC / TWC System

WARNING

DANGER OF PERSONAL INJURY EXISTS WHEN INSPECTING SYSTEM EQUIPMENT EXTERNAL TO OR UNDER THE VEHICLE. ENSURE THAT PRECAUTIONS ARE TAKEN TO PREVENT VEHICLE MOVEMENT DURING THESE INSPECTIONS.

4.3.1.1 Routine System Inspections

A cursory inspection of the ATC / TWC equipment should be conducted on a routine basis. This routine inspection may be performed on a daily basis prior to placing a vehicle into revenue service. The following items should be observed for physical damage and checked on each trailer car during a routine inspection:

- ATC Enclosure locker door in B-End cab is closed and locked
- Track Receiver Antennas are intact and securely mounted
- TWC Antennas are intact and securely mounted
- No signs of damage to ATC / TWC system equipment mounted to vehicle exterior

4.3.1.2 Scheduled System Inspections

A thorough inspection of the ATC system equipment should be conducted on a regularly scheduled basis. The inspection consists of observing the appearance of each equipment item under inspection to verify the physical integrity of the system components and connections.

The ATC enclosure, Track Receiver Antennas and Junction Boxes, TWC Antennas, and interconnecting wiring and cables should be subjected to a thorough inspection to check for damage to these components. ATC system components mounted on the exterior of the vehicle may require cleaning before an adequate inspection can be performed.

This procedure should be performed every 10,000 miles (16,100 km).

<u>Equipment Required</u>

None

<u>Initial Conditions</u>

- ATC system power circuit breakers set to OFF,
- Master Controller in Brake position,
- Full Service Brake is applied,
- Vehicle wheels are chocked to prevent movement.

Procedure

Perform the following steps to inspect the ATC / TWC system components.

1. Set all ATC system power circuit breakers to OFF.

2. Set the ATC system power switch to OFF.

3. Ensure the vehicle brake is applied and the wheels are chocked to prevent movement.

4. Inspect the ATC enclosure.

a. Enclosure exterior is clean and free of damage and corrosion.

b. Enclosure external I/O connectors at the top of the enclosure are fully inserted and secure in their receptacles: P1, P2, and P3 connectors are latched; P4, P5, and P6 connectors are fully screwed in.

c. External enclosure cables are free from nicks, cuts, fraying, or other signs of damage.

d. All cardfile PCB assemblies are fully inserted in their cardfile slots; upper and lower mounting screws on each assembly are hand-tight; PCB assemblies show no signs of deterioration.

e. Decelerometer, Vital Relay, and Battery Conditioner compartment cover plate is securely fastened on the front of the enclosure with four (4) screws.

WARNING

DANGER OF PERSONAL INJURY EXISTS WHEN INSPECTING SYSTEM EQUIPMENT EXTERNAL TO OR UNDER THE VEHICLE. ENSURE THAT PRECAUTIONS ARE TAKEN TO PREVENT VEHICLE MOVEMENT DURING THESE INSPECTIONS.

NOTE: ATC system components on the vehicle's exterior may require cleaning to perform an adequate inspection. Wipe off excessive dirt and grime, if necessary, to expose components for a proper inspection.

5. Inspect the ATP Track Receiver Antennas.

a. Left and Right Track Receiver Antennas are securely mounted to the vehicle body.

b. Track Receiver Antennas are intact with no signs of physical damage that would impair their functionality.

c. Cables from left and right Track Receiver Antennas are securely mounted to the vehicle frame from the antennas to the junction box; cables are free from nicks, cuts, fraying, or other signs of damage.

6. Inspect the ATC system speed sensors.

a. ATC system speed sensors on Axles #4 and speed sensor on Axle #6 are securely mounted and show no signs of physical damage.

b. Speed sensor cables are securely mounted to the vehicle body and are free of nicks, cuts, fraying, or other signs of damage.

7. Inspect the Type I and Type II TWC Antennas.

a. TWC Antennas are securely mounted to the vehicle body.

b. TWC Antenna housings are intact with no cracks or signs of physical damage.

c. TWC Antenna cable connectors are secure and tight and intact.

d. TWC Antenna cables are securely mounted to the vehicle frame; cables are free of nicks, cuts, fraying, or other signs of damage.

8. Verify that the Type I TWC Communications Control Unit (CCU) is securely mounted in the ceiling of each cab and their plug and screw cable connections are secure and tight.

9. Restore ATC system power circuit breakers and power switch to normal position.

Report any indications of ATC system component degradation, damage, or other condition that could compromise ATC system integrity or performance to a maintenance supervisor.

4.3.2 Clean the ATC / TWC System

Cleaning ATC system equipment is necessary to remove accumulated dirt and other substances that, if allowed to accumulate, can cause corrosion and overheating due to poor ventilation. In some instances, if equipment surfaces are extremely dirty, cleaning permits routine inspections to be performed properly by exposing equipment surfaces.

This procedure should be performed every 30,000 miles of vehicle service.

Equipment Required

Refer to Table 3-1 for a list of the cleaning agents and materials recommended to perform this procedure.

Initial Conditions

- ATC system power circuit breakers and power switch set to OFF,
- Master Controller in Brake position,
- Full Service Brake is applied,
- Vehicle wheels are chocked to prevent movement.

Procedure

Perform the following steps to clean the ATC system components.

1. Set all ATC system power circuit breakers to OFF.
2. Set the ATC system power switch to OFF.
3. Ensure the vehicle brake is applied and the wheels are chocked to prevent movement.
4. At the ATC Enclosure, remove dust and dirt from accessible surfaces using a soft bristle brush.

CAUTION

WHEN USING COMPRESSED AIR TO BLOW OUT DIRT AND DUST PARTICLES FROM THE CARDFILE, DIRECT AIR AT A SHALLOW ANGLE RELATIVE TO THE PCB ASSEMBLIES; OTHERWISE, LOOSE OR DAMAGED COMPONENTS MAY OCCUR.

5. At the ATC Enclosure, blow out dust and dirt from inaccessible areas around the cardfile PCB assemblies and other enclosure components using low-pressure compressed air.
6. Wipe enclosure exterior surfaces (not electrical conductors) with a lint-free cloth dampened with a solution of water and an approved cleaning agent so that dirt and foreign matter are removed.
7. Dry component surfaces with a clean, lint-free cloth.
8. Wipe the front face of the Aspect Display Unit (ADU) with a lint-free cloth dampened with a solution of water and an approved cleaning agent so that surface dirt and foreign matter are removed.
9. Dry component surfaces with a clean, lint-free cloth.

WARNING

DANGER OF PERSONAL INJURY EXISTS WHEN CLEANING SYSTEM EQUIPMENT EXTERNAL TO OR UNDER THE VEHICLE. ENSURE THAT PRECAUTIONS ARE TAKEN TO PREVENT VEHICLE MOVEMENT DURING CLEANING.

NOTE: Large accumulations of dirt and grime on exterior system components may require the use of a wire or stiff-bristle brush for removal. Use care not to damage component connectors or cables when using a brush.

10. Using a clean cloth, remove accumulated dirt and grime from left and right Track Receiver Antennas, TWC Antennas, and associated cables.

11. Restore ATC system power circuit breakers to normal position.

Report any indications of ATC system component degradation, damage, or other condition that could compromise ATC system integrity or performance to a maintenance supervisor.

4.3.3 Adjust Wheel Diameter

The diameters of the wheels on Axle #4 and #6 adjacent (closest) to the speed sensors is a parameter in the ATP CPU calculation to determine vehicle speed. The diameter of this wheel is measured on a scheduled basis or as necessary, and entered into ATC system memory for accurate speed calculations.

The wheel size parameter is adjustable from a nominal new wheel value of 28.25 inches to a minimum value of 26 inches in 0.125-inch increments, and requires the use of the ATC system PTU. Wheel diameter values are saved to an EEPROM on the backplane motherboard PCB and read by the ATP CPU during system startup.

This procedure should be performed every 60,000 miles and also under the following conditions:

- MDS system message indicates a discrepancy between measured and known distance traveled,
- Wheel truing of the Axle #4 or #6 wheel adjacent to an ATC system speed sensor,
- Replacement of the Axle #4 or #6 wheel adjacent to an ATC system speed sensors,
- New logic is installed on the car.

Equipment Required

- Wheel Gauge, Pi Tape,, or other approved wheel diameter measuring device
- Portable Test Unit (laptop) with Ansaldo STS ATC System PTU software.

NOTE: This procedure is only for updating the wheel diameter through the PTU. Wheel diameter can also be updated through the TOD.

Initial Conditions

- ATP is in an inactive mode,
- Vzero is achieved (train is completely stopped),
- Friction Brakes are applied,
- Master controller is in Manual and not in ATO, Street Running or Stop & Proceed position.

Setup

NOTE: Refer to the Special Tools and Test Equipment Manual, Section 1500, ATC Portable Test Unit, for detailed PTU operating instructions.

Perform the following steps to prepare the PTU for this procedure.

1. Connect an Ethernet cable between the PTU laptop and an Ethernet connector in the B-cab area.

2. Energize the laptop, logon to the Windows™ operating system, and launch the ATC PTU application.

Procedure

1. Using a wheel gauge, Pi tape, or other approved measuring device, measure the diameters of the wheels adjacent (closest) to the two ATC system tachometers (speed sensors).

2. Access the Wheel Diameter calibration function in the PTU by navigating either of the following paths:

    - PTU Control Panel → ADMINISTRATION area → Calibration
    - PTU Main Window Toolbar → Administration → Calibration option

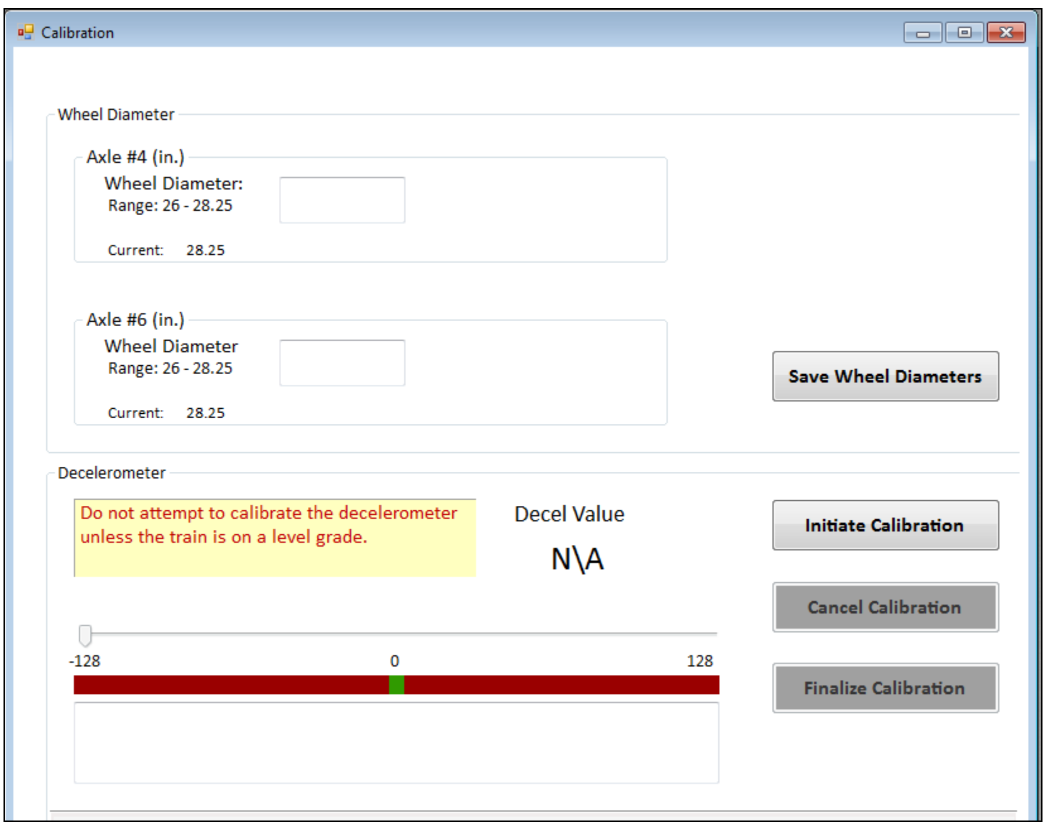

Figure 4-1: PTU Wheel Diameter Adjustment Window

NOTE: The wheel diameter adjustment algorithm in the PTU will accept any value between 28.25 and 26 inches. Only the numerals 0 - 9 are accepted as valid inputs; a decimal is optional. The PTU rejects any invalid inputs with an error message. Newly entered and existing value text appears in red in the boxes. The values displayed change to green after they are accepted and saved.

3. Copy the three tables below onto a separate sheet of paper and enter the wheel size information provided by Metro in the tables. **Do not write directly in this manual**.

Wheel B3 (inches)	
Wheel B4 (inches)	
Wheel C3 (inches)	
Wheel C4 (inches)	

4. Add the B3 wheel size and the B4 wheel size and divide by 2 and enter the result in the table. This is the Axle 6 Average wheel size.

5. Round the Axle 6 Average wheel size up to the nearest 1/8” and enter the result in the table. This is the Axle 6 ATC wheel size.

Axle 6 Average (inches)	
Axle 6 ATC (inches)	

6. Using the PTU, confirm that the value of atp_wheel_size2 is equal to the Axle 6 ATC wheel size above. If not, enter the correct Axle 6 ATC wheel size via the PTU or the TOD and use the PTU to confirm that the new value has been accepted.

7. In the Wheel Diameter area at the top of the window, enter the measured value for the diameters for the wheels in the text box.

8. Add the C3 wheel size and the C4 wheel size and divide by 2 and enter the result in the table. This is the Axle 4 Average wheel size.

9. Round the Axle 4 Average wheel size up to the nearest 1/8” and enter the result in the table. This is the Axle 4 ATC wheel size.

Axle 4 Average (inches)	
Axle 4 ATC (inches)	

10. Confirm that the value of **atp_wheel_size1** is equal to the Axle 4 ATC wheel size above. If not, enter the correct Axle 4 ATC wheel size via the PTU or the TOD and use the PTU to confirm that the new value has been accepted.

NOTE: Entered wheel diameter values are automatically rounded up or down to the nearest 1/8-inch (±0.125 in.) when saved.

11. In the bottom right of the Wheel Diameter area, select Save Wheel Diameters.

12. Exit the ATC PTU application, shutdown the PTU laptop computer, and disconnect the PTU cable from the Ethernet port.

4.3.4 Calibrate the Decelerometer

Decelerometer calibration is necessary to level the Decelerometer sensor with respect to level tangent track to ensure accurate vehicle acceleration and deceleration measurements. The calibration requires that the vehicle be in a level condition ± 0.1 degrees (approximately ±1½%) at the time of the calibration.

The maintainer performs the calibration by connecting the ATC Portable Test Unit (PTU) to an Ethernet port that accesses the ATC system. The maintainer adjusts the mounted angle of the Decelerometer sensor in the ATC Enclosure while monitoring the values of the sensor's electrical signal outputs with the PTU.

When a Decelerometer is successfully calibrated, a “valid calibration” data-bit flag is set and recorded in the EEPROMs on the ATC backplane motherboard in the ATC Enclosure. This flag is read by the ATC system during system startup. There is no indication in the cab of valid or invalid Decelerometer calibration status.

Once initiated, the calibration is conducted by positioning the Decelerometer to balance the forward and reverse sensor outputs. The maintainer performs a final interaction with the PTU to register the calibration within the ATC system memory on the EEPROMs. At any termination of the calibration process, the ATC system monitors the setting of the Decelerometer and accepts the calibration as valid only if the Decelerometer is level within 3 bits; otherwise, the ATC rejects the calibration setting as invalid. In the event that any of the initial conditions to perform the calibration are violated during the calibration process or the calibration session times out after 10 minutes, the ATC system will terminate the session and set an “invalid calibration” flag in system memory.

The decelerometer calibration should be checked on the PTU every 60,000 miles to make sure that it is within the calibration range. The Decel Cal Status on the ATP tab of the DATA MONITORING window should be GREEN. If the Decel Cal Status indication is RED then the decelerometer needs recalibrated.

This procedure should be performed under the following conditions:

- The ATP clears the decelerometer calibration,
- Initial installation, replacement, or movement of the ATC Enclosure,
- Replacement of the Decelerometer sensor.

Equipment Required

- Phillips-head screwdriver,
- Flat-head screwdriver,
- Portable Test Unit (laptop) with Ansaldo STS ATC System PTU software.

Initial Conditions

NOTE: Do not attempt to calibrate the decelerometer unless the train is on a level grade with no inclination.

- The vehicle is on level, tangent track,
- Zero speed is achieved,
- No other ATC system calibration or adjustment utility is in progress,
- No ATC system crosscheck failure is active.

WARNING

IF CALIBRATION IS INITIATED IT MUST BE COMPLETED SUCCESSFULLY. FAILURE TO CALIBRATE THE DECELEROMETER WILL RESULT IN THE DEPARTURE TEST FAILING AND EMERGENCY BRAKE APPLICATIONS DURING SERVICE.

Setup

NOTE: Refer to the Special Tools and Test Equipment Manual, Section 1500, ATC Portable Test Unit, for detailed PTU operating instructions.

Perform the following steps to prepare the PTU for this procedure.

1. Connect an Ethernet cable between the PTU laptop and an Ethernet connector in the B-cab area.

2. Energize the laptop, logon to the Windows™ operating system, and launch the ATC PTU application.

Procedure

1. Access the Decelerometer Calibration function in the PTU by navigating either of the following paths:

    - PTU Control Panel → ADMINISTRATION area → Calibration
    - PTU Main Window Toolbar → Administration → Calibration option

2. Refer to Figure 4-2. Remove the four (4) pan-head cover screws and remove the cover panel on the front left side of the ATC Enclosure.

3. Refer to Figure 4-3. Locate the Decelerometer and mounting assembly inside the bottom of the exposed compartment.

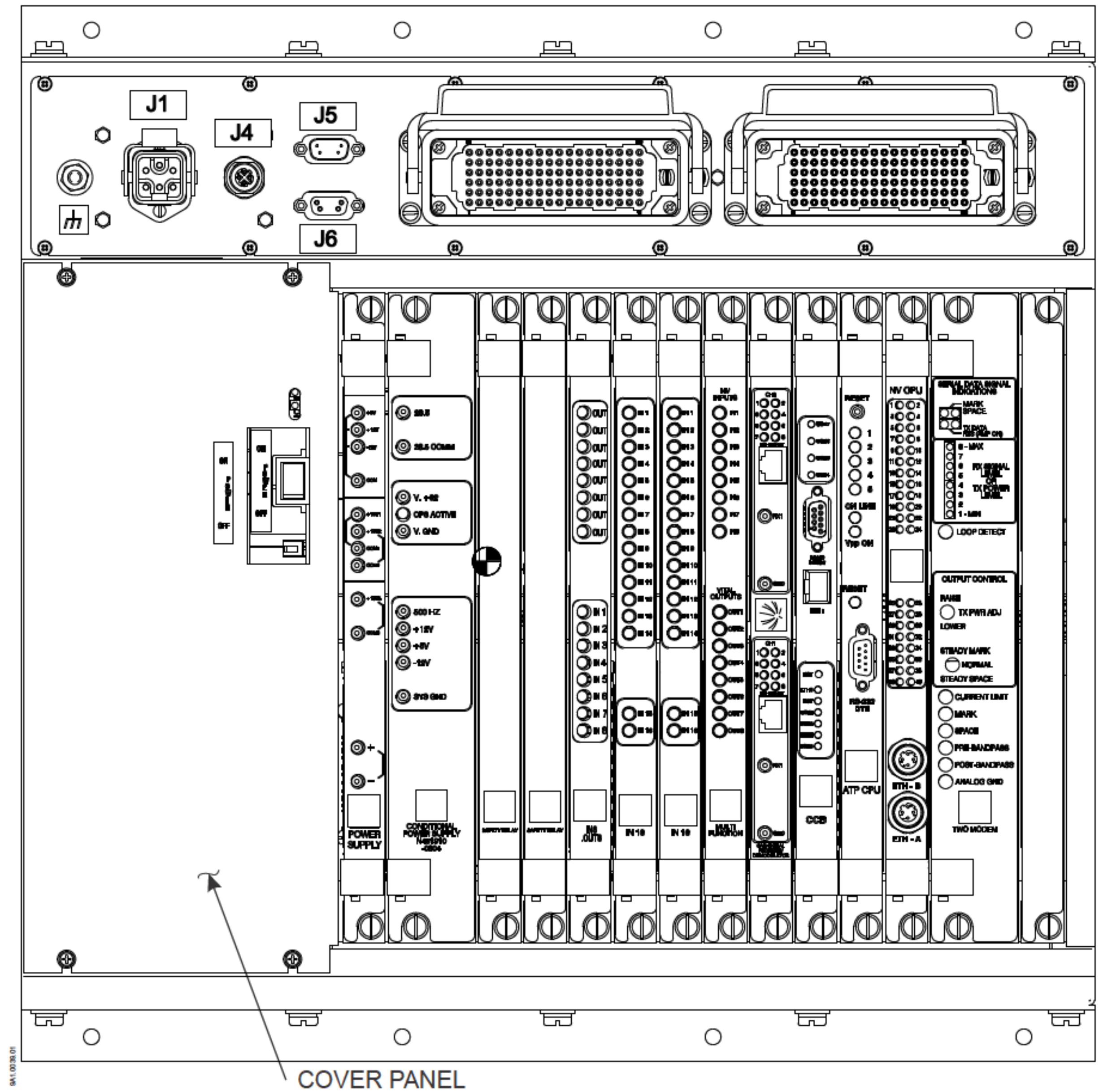

Figure 4-2: ATC Enclosure Cover Panel

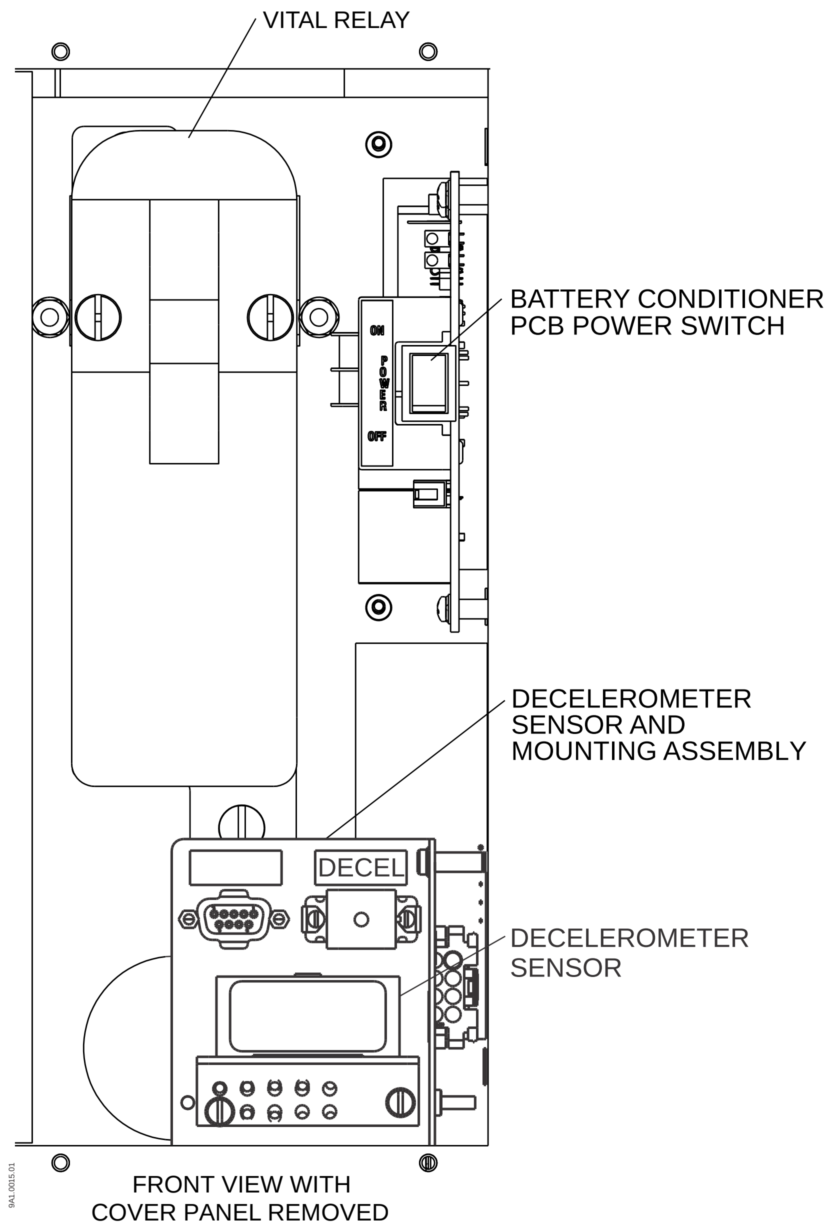

Figure 4-3: ATC Enclosure Compartment

4. Refer to Figure 4-4. Loosen the pivot screw at the front of the adjustment plate.

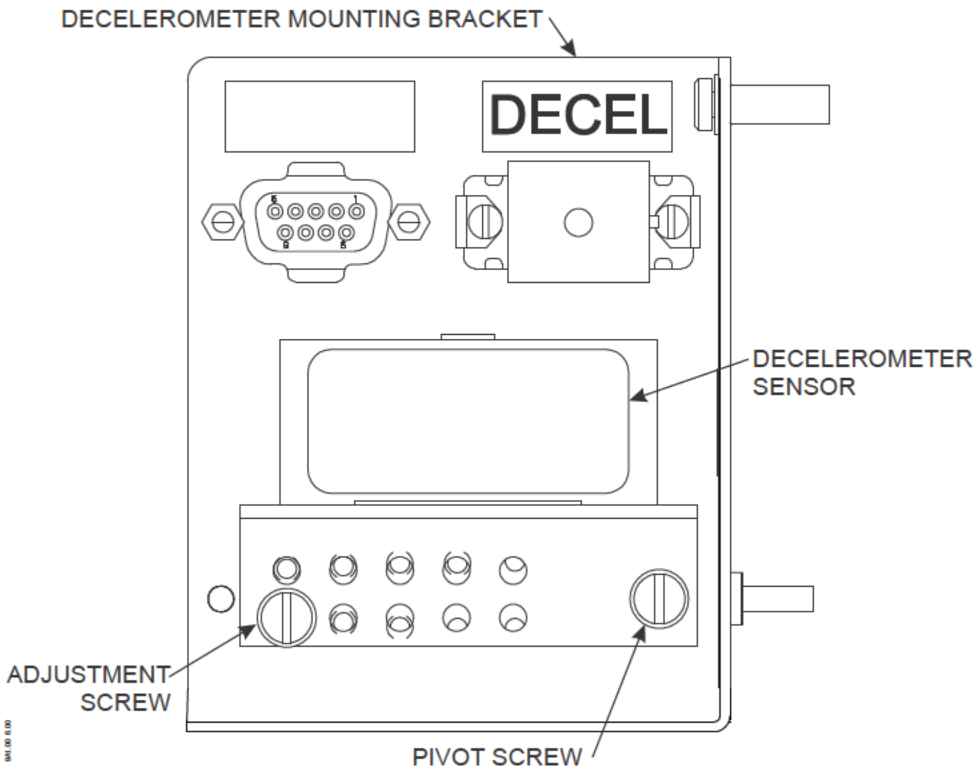

Figure 4-4: Decelerometer Mounting Assembly

5. Remove the adjustment screw, lock-washer, and washer securing the adjustment plate to the mounting bracket.

6. Refer to Figure 4-5. Select the Initiate Calibration button to begin the calibration process.

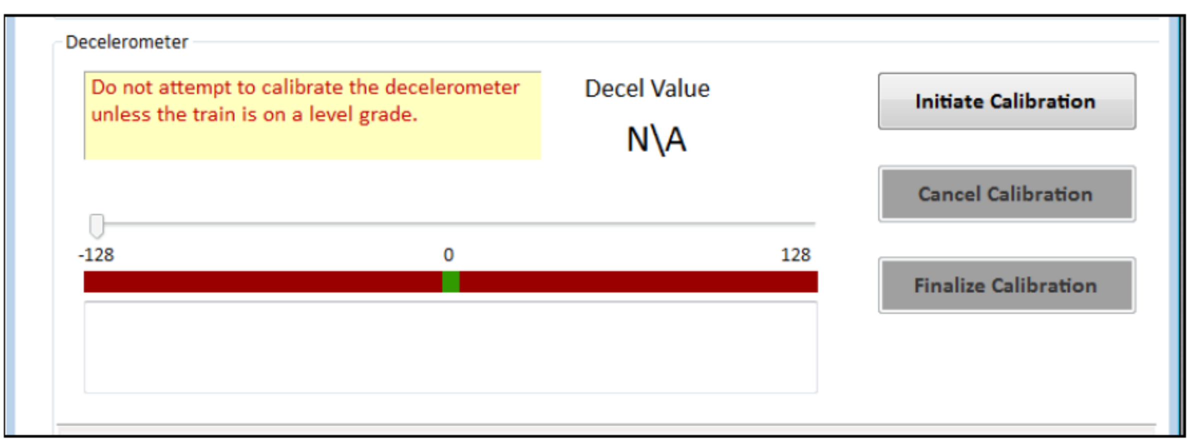

Figure 4-5: PTU Decelerometer Calibration Window

7. Adjust the tilt of the Decelerometer sensor up or down around the pivot point until the slider-pointer is within the green band displayed at the bottom of the form and the Decel Value in the digital display is within the range of 0±3.

8. Insert the adjustment screw (with lock-washer and washer) through the hole in the adjustment plate that aligns most closely to a hole in the mounting bracket.

9. Tighten the adjustment and pivot screws to secure the Decelerometer sensor in its calibrated position.

10. Monitor the calibration value displayed in the PTU window while tightening the screws to ensure the readings remains in calibration. The PTU Decel Value should still indicate 0±3 after tightening the adjustment and pivot screws. Readjust the position of the Decelerometer, if required, to maintain an acceptable calibration value.

11. Select the Finalize Calibration button to register the calibration in the ATC system and complete the calibration procedure.

12. Replace the cover onto the ATC Enclosure and secure it with four (4) pan-head screws.

13. Exit the ATC PTU application, shutdown the PTU laptop computer, and disconnect the PTU cable from the Ethernet connector.

4.3.5 Inspect and Test the Vital Relay

In addition to the inspection requirement during normally scheduled maintenance intervals, the Vital Relay must be inspected more thoroughly and tested at least once every four (4) years. Additional visual inspection items include checking relay contacts for damage or misalignment, corrosion or other contamination of parts, loose parts inside of the cover, a broken seal, and cracked or broken cover. The Vital Relay is tested by plugging the relay into a relay test stand and performing the test procedures. The test procedures are described in ASTS Service Manual SM-10242.

In addition to the requirement to perform a more detailed inspection of the Vital Relay, maintenance personnel must remove and test all vital carborne relays at least once every four (4) years. The tests should verify that the relay meets design specifications and operating characteristics for pick-up and drop-away current.

Relays that do not successfully pass the 4-year inspection and tests must not be returned to service. Relays that do not meet the specification requirements defined in ASTS Service Manual SM-10242, *PN-159B Relay Test Stand* after inspection and testing must be returned to Ansaldo STS USA for adjustment and repair. This maintenance can only be performed by Ansaldo STS.

Initial Conditions

ATC system power circuit breakers and power switch set to OFF,

Relay Inspection

1. Perform the steps to Remove the Vital Relay from the ATC enclosure per Section 7.2.4.1.

2. Record the relay serial number and bar code number, ATC enclosure serial number, and the P3010 LRV number from which the relay was removed on the appropriate maintenance form.

3. Visually inspect the relay for the following conditions. If any of these conditions is found, return the relay to Ansaldo STS for repair.

a. Damage to relay contacts or contact misalignment

b. Corrosion or other contamination of parts

c. Loose parts inside cover

d. Broken cover seal

e. Cracked or broken cover

4. Record the inspection results on the maintenance form.

5. Perform the steps to Install the Vital Relay from the ATC enclosure per Section 7.2.4.2.

4.3.6 Calibrate the Vital Relay

All vital relays installed in locomotive or carborne equipment must be removed from service every six (6) years and returned to Ansaldo STS USA for necessary calibration, adjustment, repair, and/or refurbishment. This maintenance can only be performed by ASTS.

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CHAPTER 5.0

CORRECTIVE MAINTENANCE TASKS

5.1 Introduction

Corrective maintenance activities for the P3010 ATC system primarily encompass the replacement of faulty or failed components and equipment that can be performed on the vehicle in the maintenance facility. For component replacement procedures, refer to Chapter 7, Component Removal and Installation.

5.2 Test ATC System Power Supplies

Testing the ATC system's power supplies may aid maintainers to isolate system problems.

Vehicle battery input power to the ATC system and ATC system-generated voltages can be measured at test jacks on the front of the Conditional Power Supply (CPS) PCB Assembly and the Power Supply PCB Assembly in the enclosure cardfile to ensure power supply integrity, and to detect component degradation that may cause system problems.

Equipment Required

Digital Multimeter with test leads

Initial Conditions

ATC system power circuit breakers set to ON

NOTE: Check the voltage input to the Power Supply PCB first per the following procedure.

1. If the Conditional Power Supply PCB output is out of tolerance, replace the Battery Conditioner PCB.
2. If the +5V, ±12V, or and +15V are out of tolerance, replace the Power Supply PCB Assembly.
3. If the CPS 31.5V supply is out of tolerance, replace the Conditional Power Supply Assembly.

Procedure

Perform the following steps to test the ATC system power supplies.

1. Refer to Figure 5-1. On the front panel of the Power Supply PCB Assembly, measure voltages at the following test points:

- **+** to **–** (bottom of front panel) measures Conditioned Battery Power from the Battery **Conditioner** PCB to the Power Supply PCB and should read 17 Vdc to 30 Vdc, 24 Vdc nominal
- **+5V** to **COM** should read +5.0 Vdc ± 0.05 Vdc
- **+12V** to **COM** should read +12.0 Vdc ± 0.12 Vdc
- **-12V** to **COM** should read –12.0 Vdc ± 0.12 Vdc
- **+15V1** to **COM1** should read +15.0 Vdc ± 0.15 Vdc
- **+15V2** to **COM2** should read +15.0 Vdc ± 0.15 Vdc
- **+15V3** to **COM3** should read +15.0 Vdc ± 0.15 Vdc

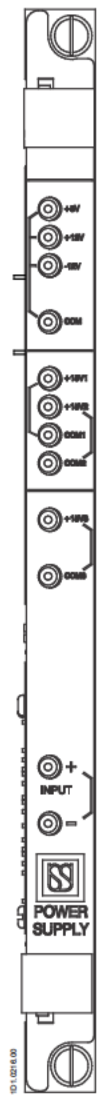

Figure 5-1: Power Supply PCB Assembly Front Panel

2. Refer to Figure 5-2. On the front panel of the Conditional Power Supply (CPS) PCB Assembly, measure voltages at the following test points:

    - **28.5.** to **28.5 COMM** should read Conditioned Battery Power voltage input from the Battery Conditioner PCB of 17 Vdc to 30 Vdc, 24Vdc nominal
    - **V. +32** to **V. GND** should read CPS vital voltage output of 31.5 Vdc ± 0.32 Vdc
    - **+12V** to **SYS GND** should read +12.0 Vdc ± 0.12 Vdc
    - **+5V** to **SYS GND** should read +5.0 Vdc ± 0.05 Vdc
    - **–12V** to **SYS GND** should read –12.0 Vdc ± 0.12 Vdc

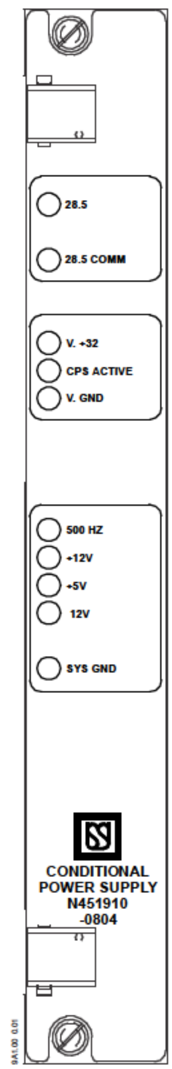

Figure 5-2: CPS PCB Assembly Front Panel

3. If the Conditional Power Supply PCB voltages are not within specified tolerances, replace the Conditional Power Supply PCB Assembly.

4. If the Power Supply PCB voltages are not within specified tolerances, replace the Power Supply PCB Assembly.

5.3 Calibrate the TWC Modem PCB

This section describes the procedure for setting the transmit level of the onboard TWC Modem PCB (ASTS USA part number P20B.0100078). The transmit level is set with the TWC Modem PCB driving the carborne Type II TWC Antenna (ASTS USA part number N21088501). This procedure should be performed when:

- The TWC Modem PCB is replaced,
- The A-end or B-end ASTS Type II TWC Antenna is replaced, or
- After the installation of a new ATC enclosure on a vehicle.

This procedure must be performed twice – once to calibrate the PCB with the A-end cab keyed and again to verify the calibration with the B-end cab keyed.

Equipment Required

A metric tape measure or ruler is required to perform this procedure.

Initial Setup

Before starting the setup, ensure the following conditions exist:

- The vehicle is stationary and positioned over a pit in the workshop,
- Full Service Brake is applied,
- The wheels are chocked,
- The vehicle has been properly leveled by an experienced technician,
- ATO operating mode selected.

Measure the distance between the bottom surface of the A-end and B-end vehicle-mounted Type II TWC Antenna plates and the top surface of the rail. The distance should be between 135 mm and 160 mm. If the distance is out of tolerance, the TWC Antenna's height must be adjusted before proceeding.

TWC Modem PCB Jumper Settings

Proceed as follows to setup the TWC Modem PCB:

1. De-energize power to the ATC enclosure.
2. Remove the TWC Modem PCB Assembly from the enclosure cardfile.
3. Refer to Section 7.3.13 and Figure 5-3. Verify that the jumpers and switches on the TWC PCB are set as indicated.
4. Reinstall the TWC Modem PCB Assembly into the enclosure cardfile.
5. Energize the ATC Enclosure.

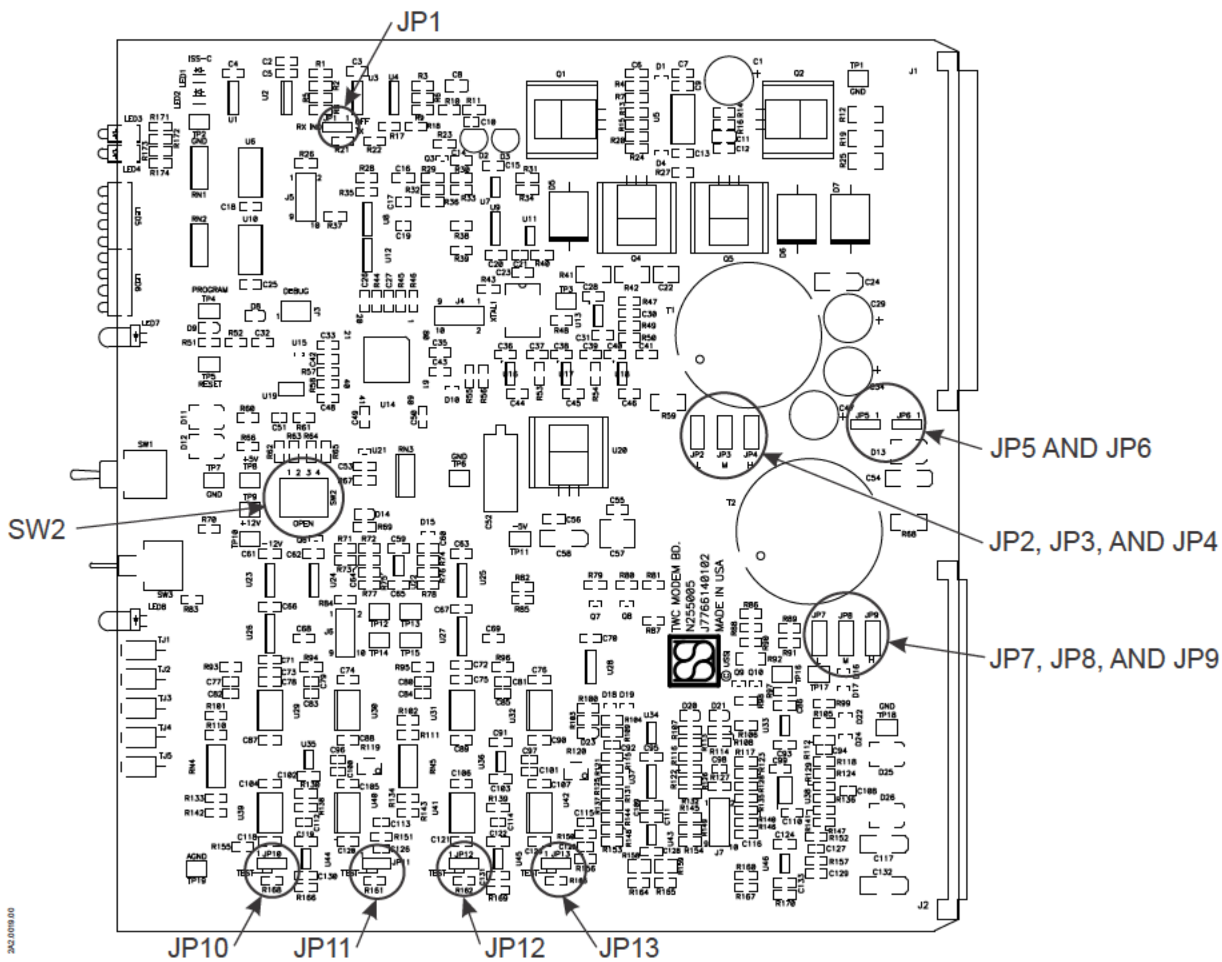

Figure 5-3: TWC Modem PCB Jumper and Switch Locations

Calibration Procedure

Perform the following steps to calibrate the transmit power level of the TWC Modem PCB.

1. Activate (key-up) the A-cab.

2. Refer to Figure 5-4. On the front panel of the TWC Modem PCB Assembly, use the OUTPUT CONTROL - TX PWR ADJ RAISE/LOWER switch and set the transmit power to Level 4. This is indicated by illuminating TX PWR LEVEL LEDs 1-4 on the front panel of the TWC Modem PCB Assembly. Toggling the switch once will allow you to display the current TX level. To adjust the level, you must toggle the switch a second time within one second.

3. Set the Output Control switch to the STEADY MARK position.

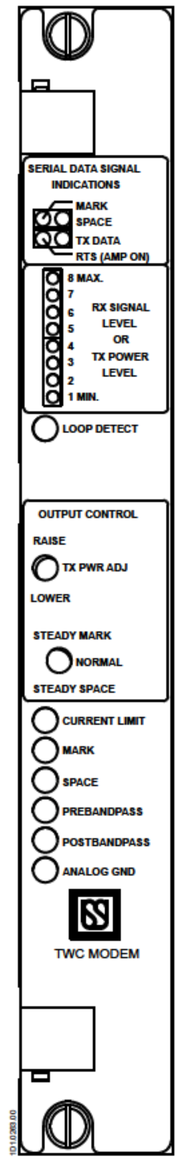

Figure 5-4: TWC Modem PCB Assembly Front Panel

4. De-activate the A-cab and activate (key-up) the B-cab.
5. Verify that the TX PWR LEVEL LEDs 1-4 on the front panel of the TWC Modem PCB Assembly are still illuminated.
6. Repeat the above steps as necessary until the TX PWR LEVEL LEDs 1-4 on the front panel of the TWC Modem PCB Assembly are illuminated when either cab is active (keyed).
7. Return the vehicle and ATC system to normal operating configuration, as desired.

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CHAPTER 6.0

LUBRICATION

6.1 Introduction

No lubrication tasks are associated with the ATC / TWC System.

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CHAPTER 7.0

COMPONENT REMOVAL AND INSTALLATION

7.1 Introduction

There is no scheduled maintenance interval for component replacement tasks. However, some replacement tasks may need to be performed (e.g., vital relay removal and installation) to support preventive maintenance activities.

Table 7-1 summarizes the ATC System Component Removal and Installation activities.

Table 7-1. ATC Component Replacement Maintenance Tasks

ATC System Component	Maintenance Task	Reference
Enclosure Cardfile PCB Assembly	Replace	Section 7.2.1
Battery Conditioner PCB	Replace	Section 7.2.2
Decelerometer Sensor and Mounting Assembly	Replace	Section 7.2.3
Vital Relay	Replace	Section 7.2.4

All Train Control component replacement procedures consist of two major tasks: Remove and Install. Component replacement tasks may exchange an existing part with a new part, or the same part may be removed and reinstalled into the system, depending upon the purpose of performing the replacement task.

7.2 ATC System Component Replacement Procedures

7.2.1 Replace Enclosure Cardfile PCB Assembly

This procedure is used to replace any of the PCB assemblies installed in the cardfile in the ATC enclosure.

Equipment Required

- Grounding wrist strap,
- Flat-head screwdriver,
- Replacement PCB assembly (if required),
- Anti-static bags.

Initial Conditions

ATC system power circuit breakers and power switch set to OFF

CAUTION

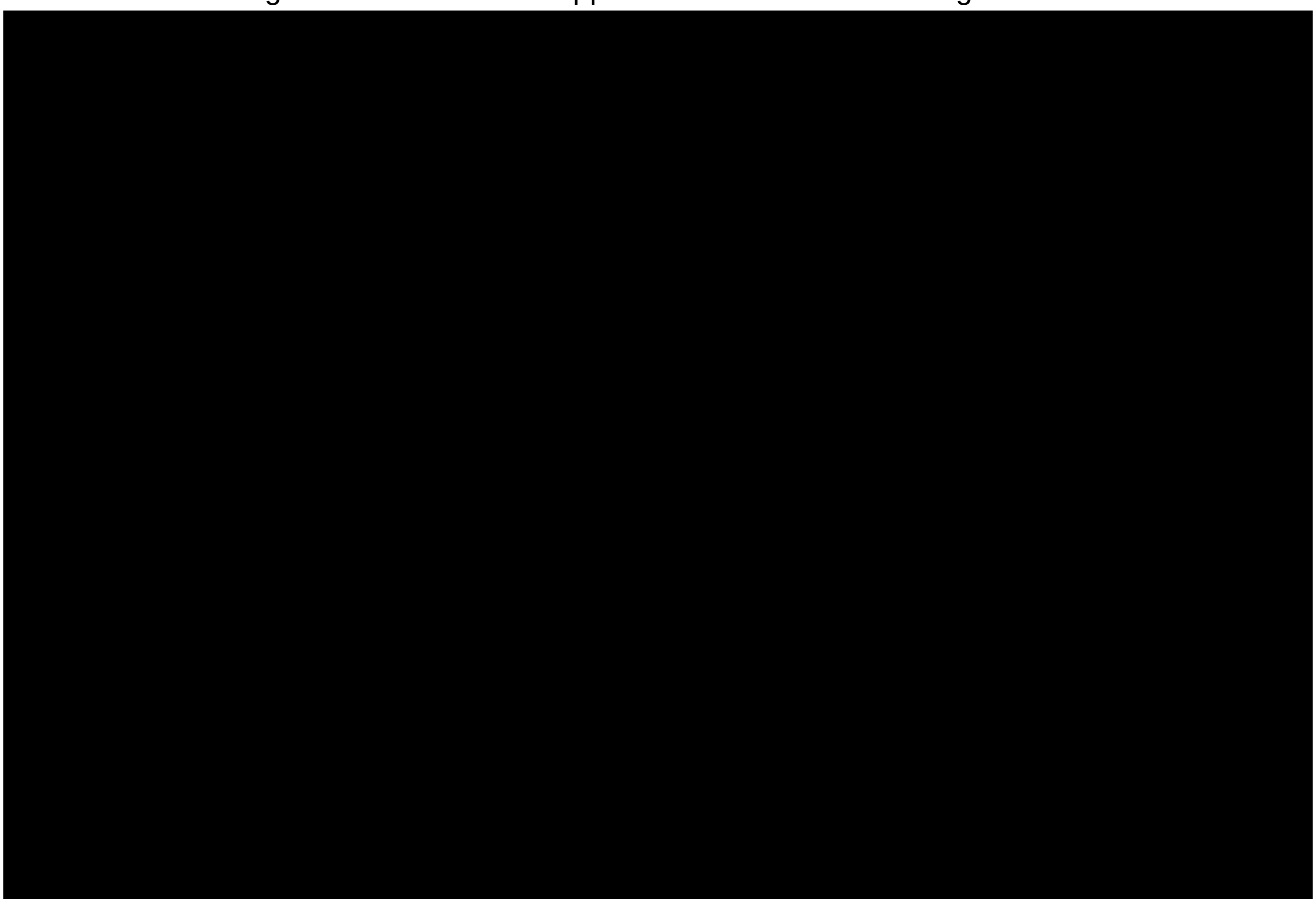
TO PREVENT PCB DAMAGE, USE A GROUNDING WRIST STRAP WHEN HANDLING PCB ASSEMBLIES TO AVOID ELECTROSTATIC DISCHARGE DAMAGE TO PCB COMPONENTS AND CIRCUITRY. ATTACH THE WRIST STRAP TO THE NEAREST BARE METAL ITEM GROUNDED TO THE VEHICLE BODY.

7.2.1.1 Remove Cardfile PCB Assembly

Perform the following steps to remove a PCB assembly from the cardfile in the ATC enclosure.

1. Locate the PCB to be removed within the ATC cardfile.

2. Refer to Figure 7-1. Loosen the upper and lower PCB retaining screws.



3. Place thumbs inside upper and lower PCB ejector tabs and rotate tabs outward to disengage the connectors on the rear of the PCB from the backplane motherboard PCB.

4. Refer to Figure 7-2. Withdraw the PCB assembly straight out from the upper and lower slotted guide rails and remove the assembly from the cardfile.

CAUTION

TO PREVENT PCB DAMAGE FROM ESD, DO NOT EXCESSIVELY HANDLE PCBS. PLACE THE PCB ASSEMBLY INTO AN ANTI-STATIC BAG IMMEDIATELY AFTER REMOVING THE ASSEMBLY FROM THE CARDFILE. TRANSPORT AND STORE PCB ASSEMBLIES ONLY IN ANTI-STATIC BAGS.

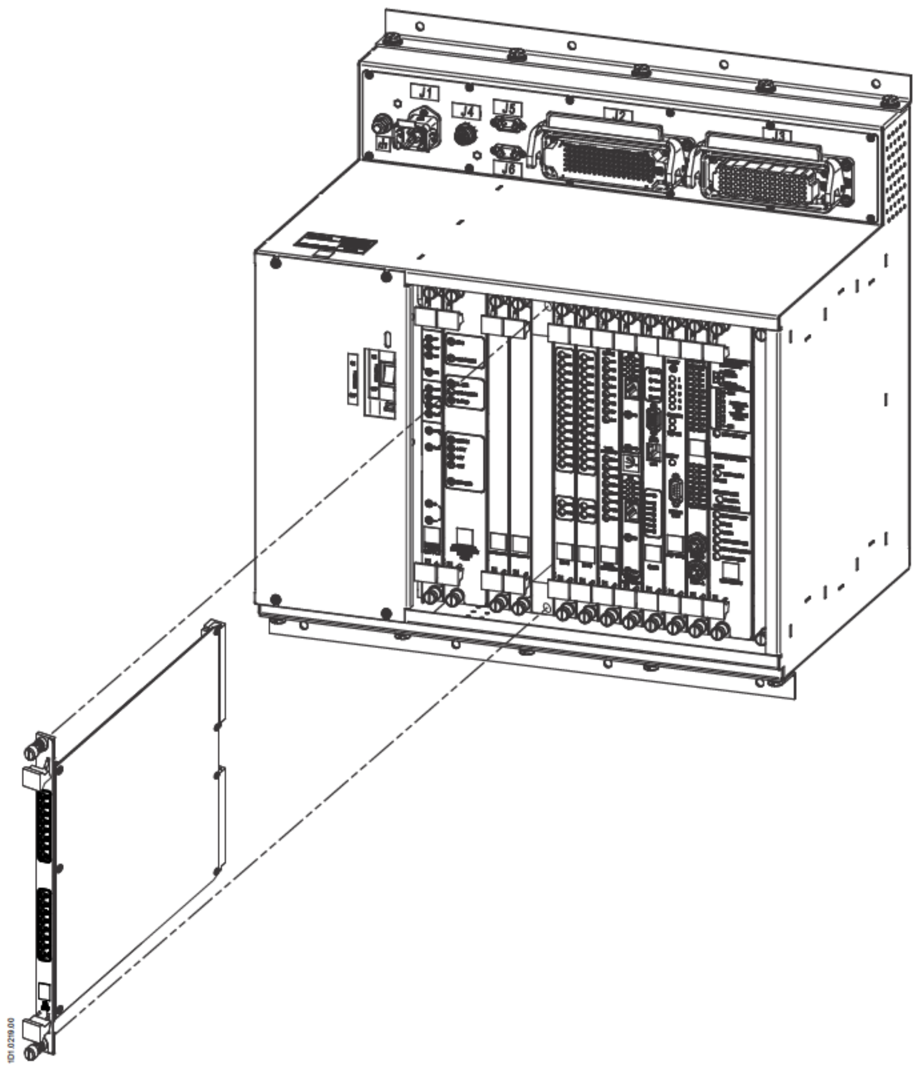


Figure 7-2: PCB Assembly Removal

5. Place the PCB assembly into an anti-static bag for transport and storage.

7.2.1.2 Install Cardfile PCB Assembly

Perform the following steps to install a PCB assembly from the cardfile in the ATC enclosure.

1. Refer to Section 7.3. If applicable, ensure the jumper and switch settings on the PCB are set correctly for the LACMTA P3010 operating application.

2. Place the PCB assembly in the correct cardfile location between the upper and lower PCB guide rails.

3. Slide the PCB assembly into the cardfile until the PCB connectors meet the connectors on the backplane motherboard PCB at the rear of the cardfile.

4. Firmly and evenly push on the front face of the PCB assembly to fully mate the PCB and backplane connectors.

5. Ensure the upper and lower assembly ejector tabs are seated in position towards the front face of the PCB.

6. Hand-tighten the upper and lower PCB retaining screws.

7. Restore ATC system power circuit breakers and power switch to normal position.

8. Refer to Section 8.4. Perform the ATC system Departure Test to verify system operability.

7.2.2 Replace Battery Conditioner PCB

Perform this procedure to replace the Battery Conditioner PCB in the ATC enclosure.

Equipment Required

- Phillips-head screw driver,
- Short (3") Phillips-head screwdriver or 90° offset Phillips-head screwdriver.

7.2.2.1 Remove Battery Conditioner PCB

1. Refer to Figure 7-3. Remove four (4) #6-32 X 5/16" Phillips-head screws with captive washers and remove compartment cover panel.

2. Refer to Section 7.2.4. Perform the procedure to remove the Vital Relay.

NOTE: The illustration above shows the Vital Relay already removed.

3. Remove four (4) #6-32 X 5/16" Phillips-head mounting screws with captive washers from the top and bottom front corners and side edges of the Battery Conditioner PCB.

4. Carefully pull the Battery Conditioner PCB towards the compartment opening and unplug the PCB rear connector from the backplane Motherboard PCB.

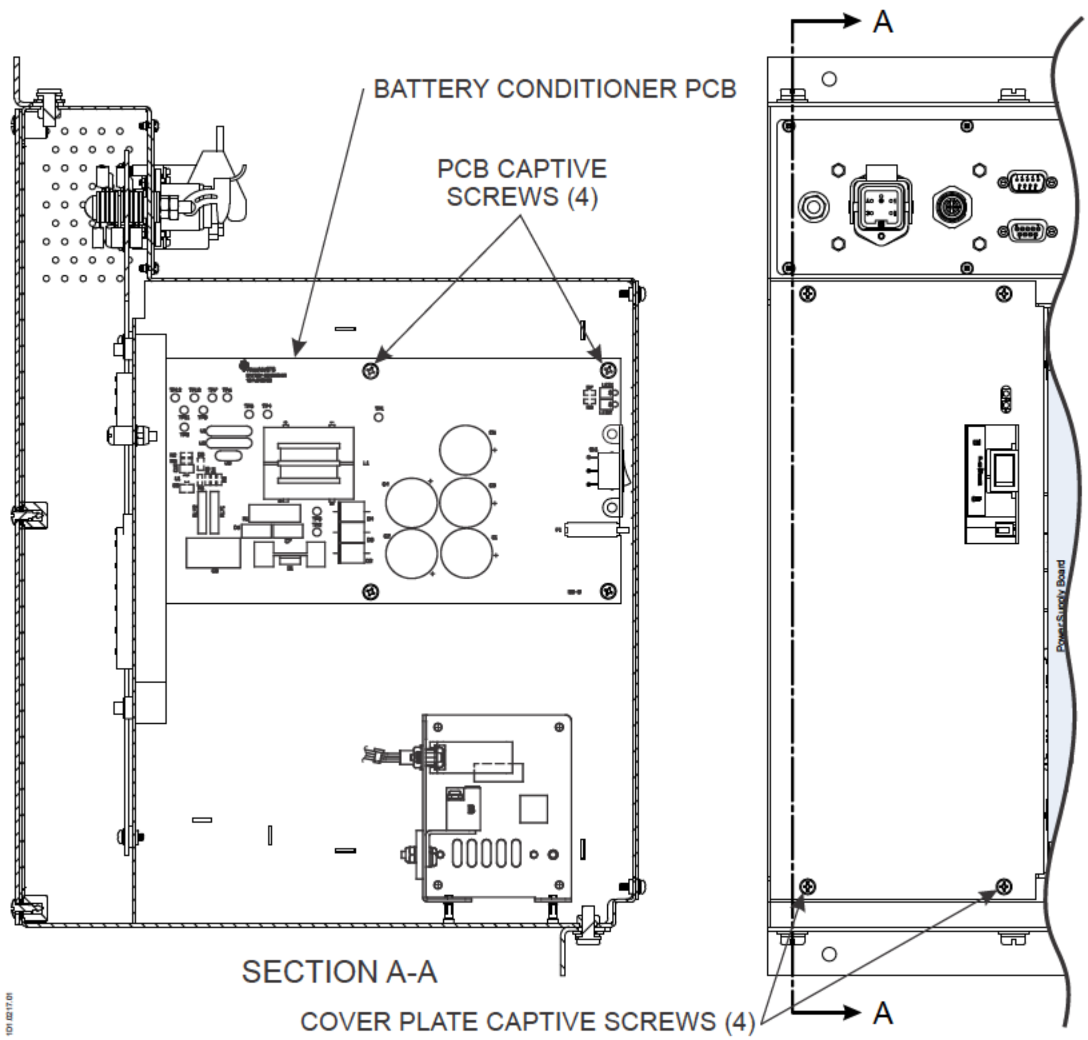


Figure 7-3: Battery Conditioner PCB Replacement Details

CAUTION

TO PREVENT PCB DAMAGE FROM ESD, DO NOT EXCESSIVELY HANDLE PCB. PLACE THE PCB INTO AN ANTI-STATIC BAG IMMEDIATELY AFTER REMOVING THE PCB FROM THE ENCLOSURE. TRANSPORT AND STORE PCB ONLY IN AN ANTI-STATIC BAG.

5. Remove the Battery Conditioner PCB from the enclosure compartment.

7.2.2.2 Install Battery Conditioner PCB

1. Position the Battery Conditioner PCB in the enclosure compartment. Align and firmly mate the PCB rear connector with the connector on the backplane Motherboard PCB at the rear of the enclosure.

2. Install four (4) #6-32 X 5/16" Phillips-head mounting screws with captive washers from the top and bottom front corners and side edges of the Battery Conditioner PCB.

3. Refer to Section 7.2.4. Perform the procedure to install the Vital Relay.

4. Install four (4) #6-32 X 5/16" Phillips-head screws with captive washers to secure the enclosure compartment cover panel.

5. Refer to Section 8.4. Perform the ATC system Departure Test to verify system operability.

7.2.3 Replace Decelerometer Sensor and Mounting Assembly

Perform this procedure to replace the Decelerometer Sensor and Mounting Assembly in the ATC enclosure.

Equipment Required

- Phillips-head screw driver,
- Short (3") Phillips-head screwdriver or 90° offset Phillips-head screwdriver.

7.2.3.1 Remove Decelerometer Sensor and Mounting Assembly

1. Remove the four (4) #6-32 X 5/16" Phillips-head screws with captive washers and remove the Decelerometer compartment cover panel.

2. Refer to Figure 7-4. Locate the Decelerometer Sensor and Mounting Assembly in the bottom center of the compartment below the Vital Relay and Battery Conditioner PCB.

3. Refer to Figure 7-5. Remove the four (4) #6-32 X 5/16" Phillips-head screws with captive washers in the corners of the bracket on the right side of the mounting assembly.

NOTE: The Decelerometer Sensor and Mounting Assembly rests unattached on three (3) keying pins at the bottom of the enclosure.

4. Lift the Decelerometer Sensor and Mounting Assembly off the keying pins and, with wiring harness attached, carefully remove the mounting assembly to the exterior of the enclosure compartment.

5. Disconnect the Decelerometer wiring harness connector plug from the backplane Motherboard PCB.

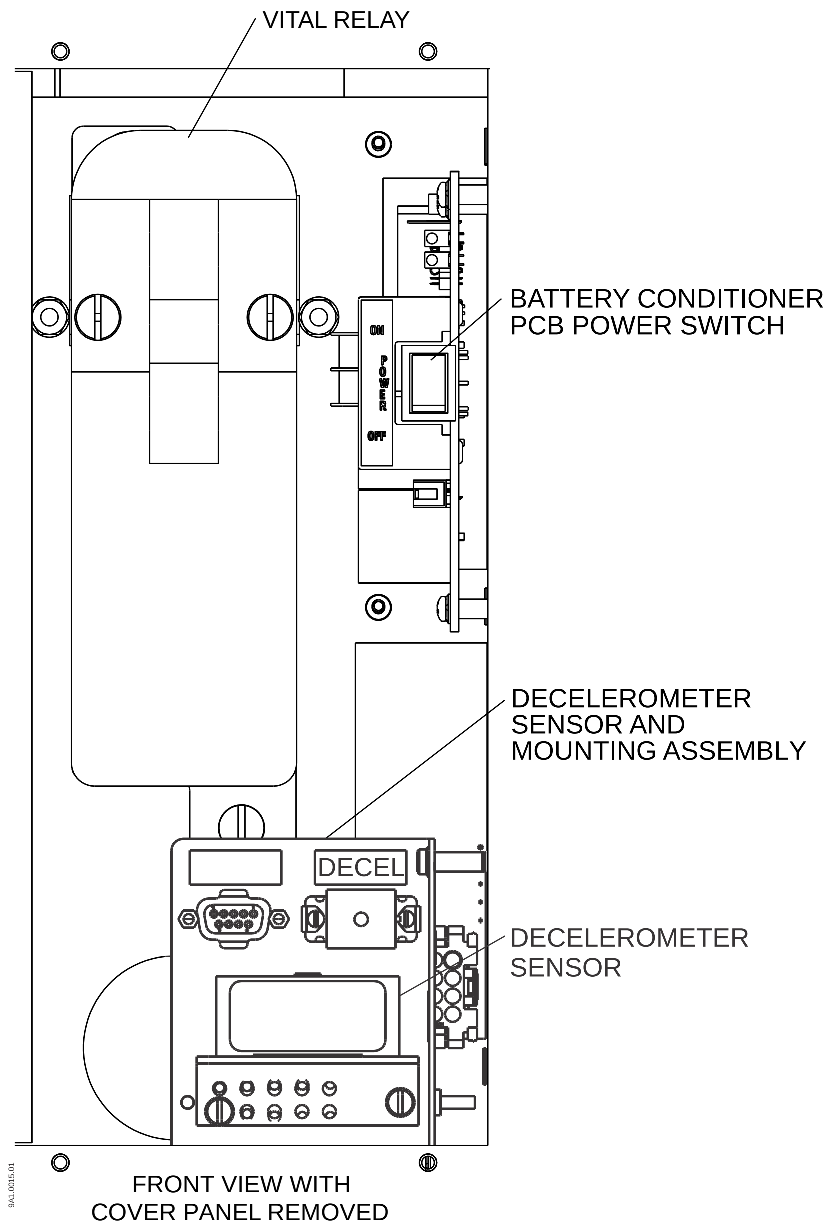


Figure 7-4: Decelerometer Sensor and Mounting Assembly

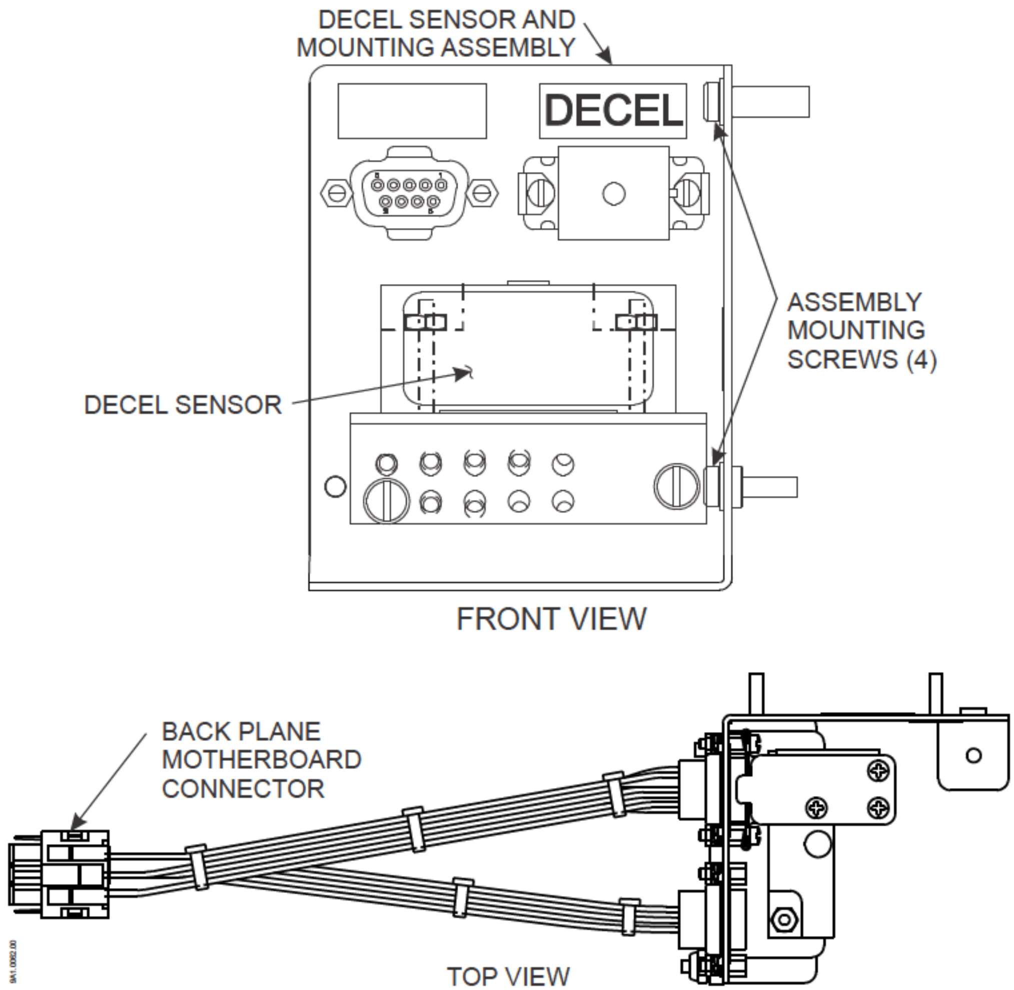


Figure 7-5: Decelerometer Sensor and Mounting Assembly Replacement Derails

7.2.3.2 Install Decelerometer Sensor and Mounting Assembly

1. Connect the Decelerometer wiring harness connector plug into the backplane Motherboard PCB inside the compartment at the rear of the enclosure.

2. Position the mounting assembly on the three (3) keying pins at the bottom of the enclosure compartment.

3. Install the four (4) #6-32 X 5/16" Phillips-head screws with captive washers in the corners of the bracket on the right side of the mounting assembly.

4. Restore ATC system power circuit breakers to normal position.

5. Refer to Section 4.3.3. Perform the procedure to Calibrate the Decelerometer.

6. Install four (4) #6-32 X 5/16" Phillips-head screws with captive washers to secure the Decelerometer compartment cover panel.

7. Refer to Section 8.4. Perform the ATC system Departure Test to verify system operability.

7.2.4 Replace the Vital Relay

Perform this procedure to remove and install the ASTS PN-159B Vital Relay.

Equipment Required

- Wire cutters,
- Flat-head screwdriver,
- Torque wrench, 0-50 in.-lb. range,
- Security wire (ASTS part number A043013) or equivalent,
- Security seal (ASTS part number J079351) or equivalent,
- Crimping tool for security wire seal.

Initial Conditions

ATC system power circuit breakers set to OFF

CAUTION

TO PREVENT DAMAGE TO THE RELAY, SET THE ATC SYSTEM CIRCUIT BREAKER(S) TO OFF BEFORE REMOVING OR INSTALLING THE RELAY.

7.2.4.1 Remove the Vital Relay

Perform the following steps to remove the Vital Relay from its mounting base in the ATC enclosure.

1. Remove the four (4) #6-32 X 5/16" Phillips-head mounting screws with captive washers and remove the Vital Relay compartment cover panel.

2. Refer to Figure 7-6. Locate the Vital Relay in the top left of the compartment above the Decelerometer Sensor and Mounting Assembly and to the left of the Battery Conditioner PCB.

3. Cut mounting bolt security wire with wire cutters. Remove the security wire from the two (2) relay mounting bolts.

4. Remove the relay mounting bolts (2) while holding the relay in place.

5. Using both hands, one under the relay for support, gently rock the relay from side to side and pull the relay outward to disconnect the relay contacts from the mounting base.

6. Remove the Vital Relay from the enclosure.

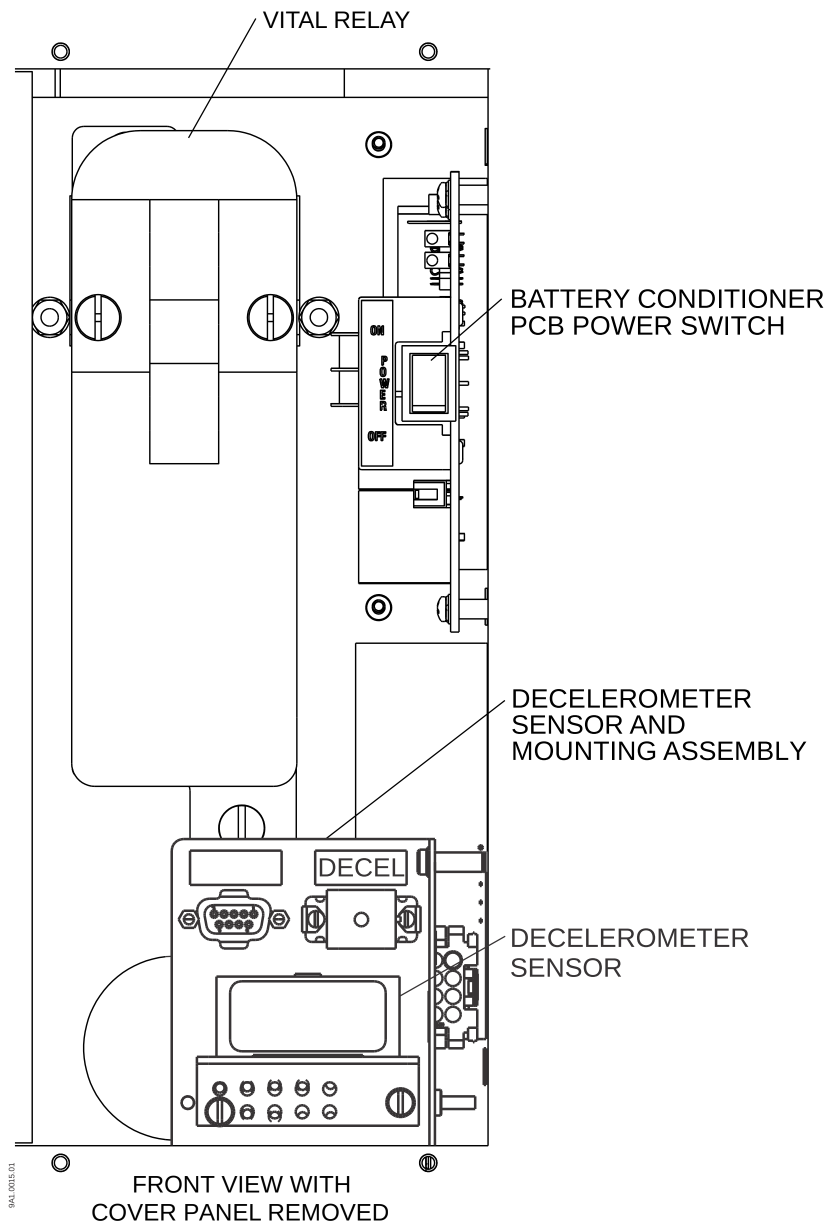


Figure 7-6: Vital Relay

7.2.4.2 Install the Vital Relay

Perform the following steps to install the Vital Relay into its mounting base in the ATC enclosure.

1. Align the relay male contacts to the female contacts on the mounting base, and plug the relay into the base.

2. Push the relay firmly against the mounting base.

3. Insert and hand-tighten the two (2) relay mounting bolts.

4. Torque the two (2) mounting bolts to 25 in.-lb ± 5 in.-lb. Do not over-tighten the bolts.

5. Push the security wire through the holes in the heads of the two (2) mounting bolts. Wrap the wire around the bolt heads in an approved method and direction to prevent rotation of the mounting bolts.

6. Use a crimping tool to secure the ends of the security wire with a lead seal (or similar).

7. Install four (4) #6-32 x 5/16" Phillips-head screws with captive washers to secure the Vital Relay compartment cover panel.

8. Restore ATC system power circuit breakers to normal position.

9. Refer to Section 8.4. Perform the ATC system Departure Test to verify system operability.

7.3 PCB Jumper and Switch Settings

When replacing a PCB assembly in the ATC enclosure cardfile, the maintainer should ensure that the jumper and switch settings on the PCB, if applicable, are set correctly for the LACMTA P3010 operating application. Refer to the following sections.

7.3.1 Power Supply PCB Assembly – Slot 1

Jumper/Switch Settings: There are no jumpers or switches on this PCB.

7.3.2 Conditional Power Supply PCB Assembly B – Slots 2-3

Jumper/Switch Settings: There are no jumpers or switches on this PCB.

7.3.3 Safety Relay PCB Assembly – Slot 4

Jumper/Switch Settings: There are no jumpers or switches on this PCB.

7.3.4 Safety Relay PCB Assembly – Slot 5

Jumper/Switch Settings: There are no jumpers or switches on this PCB.

7.3.5 Mixed Vital I/O PCB Assembly – Slot 6

Jumper/Switch Settings: There are no jumpers or switches on this PCB.

7.3.6 Vital Input PCB Assembly – Slot 7

Jumper/Switch Settings: There are no jumpers or switches on this PCB.

7.3.7 Vital Input PCB Assembly – Slot 8

Jumper/Switch Settings: There are no jumpers or switches on this PCB.

7.3.8 Multifunction PCB Assembly – Slot 9

Jumper/Switch Settings: There are no jumpers or switches on this PCB.

7.3.9 Cab Signal Receiver Demodulator (CSRD) PCB Assembly – Slot 10

Jumper Settings: There are no jumpers on this PCB.

Switch Settings:

Switch	Setting
SW1, switch 2	ON
SW1, All other switches	OFF
SW4, switch 2	ON
SW4, all other switches	OFF

7.3.10 Communication Controller PCB (CCB) Assembly – Slot 11

Jumper Settings:

Jumper	Setting
JP1	Not Installed
JP2	Installed
JP3	Installed
JP 4	Not Installed
JP 5	Not Installed
JP 6	Installed
JP 7	Installed
JP 8	Not Installed
JP 9	Not Installed
JP 10	Installed
JP 11	Installed
JP 12	Not Installed
JP 13	Not Installed
JP 14	Installed
JP 15	Installed
JP 16	Not Installed
JP 17	“0”
JP 18	“0”
JP 19	“0”
JP 20	“0”
JP 21	“0”
JP 22	“0”
JP 23	“0”
JP 24	“0”
JP 25	“0”
JP 26	“0”
JP 27	“0”
JP 28	“0”
JP 29	“0”
JP 30	“0”
JP 31	“0”
JP 32	1-2
JP 33	1-2
JP 34	1-2

Switch Settings: There are no switches on this PCB.

7.3.11 ATP CPU PCB Assembly – Slot 12

Jumper Settings

Jumper	Setting
JP1	2-3
JP2	Not Installed
JP3	2-3 (soldered)
JP 4	2-3
JP 5	Not Installed
JP 6	2-3 (soldered)
JP 7	1-2
JP 8	1-2
JP 9	1-2
JP 10	2-3
JP 11	1-2
JP 12	1-2
JP 13	2-3
JP 14	1-2
JP 15	1-2
JP 16	1-2
JP 17	1-2
JP 18	1-2
JP 20	2-3
JP 21	2-3
JP 22	2-3
JP 23	2-3
JP 24	1-2
JP 25	2-3
JP 26	2-4
JP 27	1-2 (soldered)
JP 28	2-3
JP 29	2-3
JP 30	2-3
JP 31	1-2
JP 32	2-3
JP 33	2-3
JP 34	1-2
JP 35	1-2
JP 36	1-2

Switch Settings

Switch	Setting
DIP Switches 1-3	Open
DIP Switch 4	Closed

7.3.12 ATO CPU PCB (SPO) Assembly – Slot 13

Jumper Settings

Jumper	Setting
JP 1	2-3
JP 2	2-3
JP 3	2-3
JP 4	2-3
JP 5	1-2
JP 6	2-3
JP 7	2-3
JP 8	1-2
JP 9	2-3
JP 10	2-3
JP 11	1-2
JP 12	1-2
JP 13	1-2
JP 14	1-2
JP 15	2-3
JP 16	Installed
JP 17	Installed
JP 18	Installed

Switch Settings

Switch	Setting
SW2	1on, 2-10 off

7.3.13 TWC Modem PCB Assembly – Slots 14-15

Jumper Settings

Jumper	Setting
JP 1	1-2
JP 2	Installed
JP 3	Not Installed
JP 4	Not Installed
JP 5	1-2
JP 6	1-2
JP 7	Installed
JP 8	Not Installed
JP 9	Not Installed
JP 10	2-3
JP 11	2-3
JP 12	2-3
JP 13	2-3

Switch Settings

Switch	Setting
SW2	1-3 OPEN, 4 CLOSED

Using the switches on the front panel of the TWC Modem, set the Tx Level to 4 LEDs.

CHAPTER 8.0

TROUBLESHOOTING

8.1 Introduction

This section presents general ATC system troubleshooting and fault isolation guidelines and procedures to assist maintainers in identifying and replacing faulty or failed system components.

8.2 Troubleshooting Safety

While troubleshooting the ATC system, take care to avoid personal injury. Avoid situations that present the danger of electrical shock or injury from moving equipment. Exercise extreme care when working around the ATC system with the wiring and electronics exposed. Notify others before leaving an open system unattended. Disconnect power if the system will be unattended.

While working on the system, the vehicle could unexpectedly move, possibly causing damage or injury. Warn others to stay clear of the vehicle since it could become activated without notice. Depending on the severity and type of problem, disconnecting the ATC system from external systems may prevent danger from other systems.

8.3 General Troubleshooting Guidelines

Consider the answers to these questions and guidelines before troubleshooting any problem. By following these guidelines, it may be possible to quickly resolve a problem.

1. Under what circumstances did the fault or failure occur?

   Was it during normal operation, during preventive maintenance, during a diagnostic procedure, or while changing a parameter setting? This information could help to repeat the failure and isolate the problem.

2. Did something change?

   Has this system worked previously or is this a startup problem? If the system worked properly in the past, has anything changed? Has there been hardware, software, or wiring changes?

   Ensure the problem is with the ATC system.

3. Could the problem be coming from something external that is interfering with ATC operation?

   Verify the problem.

   Check the major system functions to verify that there really is a problem.

   De-energize the system for 30 seconds and then reapply power to the system. Allow the system CPUs to reset completely. It could be an intermittent or single-occurrence problem. If the problem continues, proceed further with troubleshooting activities.

4. Try the simple things first.

   With system power off, remove and reseat each cardfile PCB assembly. As the PCBs are removed, observe each one for obvious problems such as hot spots and burn marks. Check all PCB connectors to ensure they are firmly attached and connector pins are straight. Check cables for damage and signs of wear.

5. Avoid complicating the problem.

   While troubleshooting the problem, avoid making the problem more difficult to isolate. Take care not to create more problems, in which case multiple symptoms and a much more difficult troubleshooting situation may result.

6. Could the problem be related to a noisy electrical environment?

   Some faults can be caused by electromagnetic interference (EMI). For example, CPU faults and memory errors can be caused by excessive electrical noise on the power lines or noise from external sources. These types of problems are difficult and time-consuming to trace, perhaps requiring special techniques and test equipment. This type of fault tracing is beyond the scope of this manual.

7. After completing troubleshooting corrective activities, and especially after replacing any ATC system components, perform the Departure Test.

   The Departure Test confirms proper operation of all major functional areas of the ATP system.

8.4 Departure Test

This test verifies the functionality of the ATP system for both Type I (MBL/PGL) or Type II (MGL and similar Metro lines) operation. These tests may be performed each day before entering revenue service in accordance with LACMTA administrative policies, and after corrective maintenance on the system to ensure its full operability.

Setup

- Vehicle is on level, tangent track to prevent rollaway,
- Bypass switches are set in position to prevent vehicle response to braking or propulsion requests,
- Line Select Key Switch is set to the correct mode for the line on which the vehicle is operating: Type I or Type II.

Initial Conditions

Ensure the following initial conditions are satisfied to perform the Departure Test:

- ATC is power ON,
- A-Cab is keyed,
- Mode Selector Switch is in the MANUAL position,
- Reverser is in the Forward position,
- Master Controller is in the minimum brake position,
- Emergency Brake is not applied,
- No penalty brake is applied,
- Not in Stop & Proceed, Street Running, or Car Wash Mode,
- No friction brake fault,
- No propulsion fault.

Procedure

Perform the following steps to perform the Departure Test:

1. Verify the following conditions on the ADU:

a. ATP Ready indicator is Green.

b. TWC Ready indicator is Green.

c. ATO Ready indicator is Green (Type II only).

d. Cab Signal indicator is Orange indicating No cab Signal (Type I only).

2. Hold the Master Controller in the minimum brake position during the entire departure test.

NOTE: The Departure Test will terminate and Fail if the Master Controller is released before the test is complete.

3. Press Key 9 (Dept Test) on the ADU and follow prompts displayed on the ADU. Monitor the ADU display for the performance and completion of the ADU Self Test.

NOTE: If the Departure Test does not start, verify that all the initial conditions to perform the test are satisfied.

4. Monitor the ADU to confirm the Departure Test is in progress.

5. Follow on-screen instructions to provide an acknowledge input during the Departure Test when prompted.

6. Monitor the ADU to verify the Departure Test PASS or FAIL status at the end of the test.

7. Place the Master Controller in the FSB position.

8. If the departure test fails, key off the active cab and key it back on

NOTE: If the Departure Test fails the ATC applies a penalty brake and will not let the train move. To clear the penalty brake the active cab must be keyed of and then back on. Check the ATC event log (either through the TOD or using the ATC PTU) and look for events 63-92 to determine why the departure test failed.

9. Key off the A-Cab and key up the B-Cab.

10. Verify the initial conditions to perform the Departure Test are still satisfied.

11. Perform steps 2 through 8 above to perform the Departure Test from the B-Cab.

8.5 Investigate Power Supplies

If there are no obvious faults, the first step in analyzing the problem is to measure the power supply voltages. These are some general guidelines for investigating power supply problems.

1. Check ATC system circuit breakers and the Battery Conditioner PCB circuit breaker.

2. Check power supplies.

Refer to Section 5.2. Perform the "Test ATC System Power Supplies" maintenance procedure. If the power supply voltages are not as specified, investigate. The system will not work properly if the supplied power is incorrect. A low battery supply voltage can be the cause of a failure in some other part of the system.

3. Measure voltages with the power supplies under load.

Measure the supplies with the system intact, with all PCB assemblies installed, and all cables connected. If there is no output voltage from the Power Supply PCB, check the obvious possibilities, such as a defective switch, tripped circuit breaker, or open connection.

4. Check the stability of input power.

While checking the power supplies, also check the stability of the incoming battery power. Some faults can be caused by a momentary power failure or drop in the voltage level. The ATC CPUs, memory chips, and other electronic circuits can be susceptible to voltage fluctuations.

8.6 General Diagnostic Routine

No single diagnostic routine guarantees quick success for every problem with the ATC system. What follows is a general course of action, a logical sequence to follow to trace almost any problem to its most likely cause.

1. Thoroughly analyze the symptoms.

Symptoms may be helpful for finding a fault, but be wary of another person's report of the symptoms. The most reliable analysis is gained by personally recreating and observing the symptoms. Log the time, date, and details associated with observed problems.

2. Observe the system indicators.

Perform the ATC system Departure Test. The Departure Test will identify ATC system problems within specific subsystems and functional areas.

Most system faults can be observed in the event log system accessible with the Portable Test Unit (PTU). Use the PTU to review the active and previously logged events for clues of the problem. A Maintenance Specialist uses the (PTU):

- To extract Snapshot Data that is logged by the ATC system

  NOTE: For more information on state data refer to the lists in Section 8.9.4 Snapshot Events.

- To extract event logs

  NOTE: For more information on events, refer to Section 9.0 ATC Event Descriptions.

The logged data is kept in the CCB PCB. The Maintenance Specialist connects the PTU to the PTU port to retrieve the data.

Details of operating the PTU are given in a separate document, refer to the Special Tools and Test Equipment Manual, Section 1500, ATC Portable Test Unit.

Data that is retrieved is saved in .db3 files (SQL Database) so that it can be opened using SQL Lite browser.

The Maintenance Specialist can also retrieve snapshot events from the ATC. This is data describing the state of the system immediately before a more or most critical event.

In general, it is a good idea to down load all of the events when a fault is suspected or declared. If the memory is full, snapshots can take several hours to download. To expedite the process select the snapshot that corresponds to the event in question. The event files should always be downloaded even when time is critical. All files are somewhat helpful in most cases, but some of the faults will require only one event to solve the cause. The following are some general guidelines as to which events to start examining, although, this is not inclusive or exclusive.

1. Read through Problem Report generated from MTA
2. If the ADU and ATC are both fully powered and the cardfile has no error codes displayed on the TOD: Download All Events
3. Save the log to a location that can be referred to in the future
4. Save your logs so that you can determine which car you received the information from, and when. In addition they are date/time stamped according to when they were downloaded.
5. If your Problem Report was generated with location specific information, such as " this happened in between Douglas and the Yard", then look at the ATO station stops to find out what happened around that time and between those locations. If location is not available use the time reference.
6. Then look at the events before, around and after that time period.
7. If there is any identifiable Event that might have a snapshot related to it, download the corresponding snapshot.
8. It is also best to look at any Events that happened before and after the reported incident to determine if another PCB might have caused the errors messages.
9. At this point reference the Tables included in Chapter 9.0 as well as snapshot Table in Section 8.9.3 to find recommended action to be taken for the Events found.
10. Additionally, if it is found that the individual LRUs are not the problem areas nor is the cardfile, utilizing the schematics and wiring diagrams it may be necessary to trace through the rack to determine if there is a connection problem.
11. Also, there may be cause to determine that a system outside of the rack is causing the reported problems.

3. Troubleshoot in a logical sequence.

Continue with the troubleshooting process only after becoming convinced that there really is a hardware problem. After accessing the system's Enclosure, measure the power supply voltages first. Then, based on an error message or symptom define which functional circuit seems to be causing the problem. From there, the problem can be narrowed to a PCB assembly or two, or to another major component (such as the Vital Relay or speed sensors).

4. Troubleshooting ATC input / output faults.

An apparent ATC system fault may actually be due to broken or damaged vehicle wiring or harness connectors. This may be especially important to remember if a fault first appears after work was performed on or near the vehicle wiring or ATC system harness connectors.

8.7 Other Troubleshooting Considerations

Before beginning troubleshooting the ATC system, here are a few more suggestions:

1. Have spares available.

Have available at least one spare PCB assembly for each unique PCB in the ATC Enclosure cardfile, plus one spare Vital Relay (ASTS model PN-l59B). This will permit quick substitution when a fault is localized to a specific PCB assembly or the relay.

2. Use the spare PCB Assemblies to speed repairs.

If an active failure is suspected to be caused by a certain PCB, swap it with a known good spare. Note whether the problem remains. If not, then the cause of the trouble is found.

3. Match the configuration of the original.

When substituting circuit board assemblies, ensure that the new PCB is the correct part. Verify that the replacement is a known good component, that installed software (if applicable) is the current version, and that its jumpers and switches (if applicable) are set to the proper configuration.

4. Install PCB Assemblies correctly.

Verify that PCBs are installed correctly in the cardfile. Each PCB is uniquely keyed to a specific slot in the cardfile. Do not force a PCB assembly into the wrong cardfile slot.

8.8 Troubleshooting from Symptoms

This section is a guide to isolate a problem when there is no reliable event log information that could help identify it. The symptoms listed below are representative of what might be observed. Troubleshooting procedures are listed which suggest courses of action for resolution of these problems.

8.8.1 Completely Dead System

Symptoms may include tripped system circuit breakers, no response, no indications, and no sign of life. This is probably due to loss of main power or a major defect in the power distribution circuitry. Loss of power for panel indicators could give the impression of a dead unit. Follow the Troubleshooting: Power procedure.

8.8.2 Partially Dead System

Symptoms include a complete or partial loss of LED indications or by a subsystem CPU cycling through reset. Perform the Troubleshooting: Power procedure.

8.8.3 Nonfunctioning System

In this condition, the system is not functioning correctly (as observed or as perceived). The system may be "locked up" or may simply not be responding to one or more inputs. Perform the Troubleshooting: General ATC System Malfunction procedure.

8.8.4 Improper Display, But Proper Function

The system functions correctly (as observed or as perceived), but the indications are not consistent with performance. (Example: Wrong or no speed displayed.) Perform the Troubleshooting: ADU Malfunction procedure.

If a failure indication is displayed on the ADU the event logs should be examined for the following event codes:

ATP Failure

- Event Codes 1-19
- Event Codes 32-34
- Event Codes 41 and 44
- Event Codes 1001-1039
- Event Codes 2503-2509
- Event Codes 2601-2627
- Event Codes 2700-2709

ATO Failure

- Event Code 5033
- Event Code 5034
- Event Code 5035
- Event Code 5020

TWC Failure

- Event Code 5018
- Event Code 5019
- Event Code 5043
- Event Code 7030

8.9 Troubleshooting from Event Logs

The ATC system incorporates an event-recording feature. This feature pre-defines conditions that trigger an event. Most events are defined as faults and failures in the ATC system. However, operating conditions that are not associated with faults or failures are also events. Therefore, the event-recording feature provides a means not only to diagnose a system or component fault, but also to record noteworthy operating conditions.

With communication established between the ATC system and the vehicle MDS, every event is uniquely identified with an identification code and a time and date stamp when the system records the event. The recording system also creates a snapshot file with each event. The snapshot file contains system data immediately prior to each event. The event snapshot data provides an additional method to analyze system abnormalities.

The triggering condition and reset condition for each event differ among all events. Some events latch or "set" and do not reset or "clear" until the condition(s) that created the event no longer exist. Both the set and reset transitions of an event are logged as they occur. Some events merely record the occurrence of an operating condition and do not latch. These events are active for just a brief period and are classified as an “Instantaneous Occurrence”. Additionally, certain events cause the ATC system to lock out into a fail-safe condition.

8.9.1 The ASTS Event Management System

Each of the microprocessors in the ATC system records the occurrence of noteworthy subsystem events. To simplify event viewing, all of these events are routed to the Communication Control PCB Assembly (CCB). All event logs and snapshot data files are stored in Flash memory on the CCB. A maintainer can access the events and snapshot files stored in the CCB with the ATC PTU through an Ethernet interface to the ATC system Common Faults ASTS Event Management System

8.9.2 Common Faults

This section contains troubleshooting guides for common faults.

8.9.2.1 Lost Cab Signal

If the MTA problem report indicates that the train lost cab signal, verify if the problem is occurring on multiple trains or if it is isolated to a single train. If it is occurring on multiple trains it is a wayside issue and Signals should verify the track circuit in that area is working correctly. Lost Cab events will always be logged with a mode change (e.g., manual/local). If it is an isolated issue, start by checking the following:

1. Download the events logs.
2. Look through the logs to see how frequent the event occurs. If it is consistently reoccurring, replace the CSRD PCB. If the event is intermittent or a one-time failure, follow the steps below.
3. Around the reported time of the event look for the following events:

a. ATP CSRD Failure Event Rcvd
   - i. The CSRD has detected a critical fault and shutdown. Reset the ATC and run the departure test.
   - ii. If the departure test passes, the train can be put back into service.
   - iii. If the departure test fails with event 77 (Dept Test: Code Rate for Cab A Failed) or 81 (Dept Test: Code Rate for Cab B Failed), test all pickup coils and replace the faulty coil. Test coils per P3010-KI-MAN-00096 Pick-Up Coil Test Equipment Manual.
   - iv. If the departure test fails with event 76 (CSRD self test failure), replace the CSRD PCB.

b. ATP CSRD Module Fail
   - i. The CSRD has detected a critical fault and shutdown. Reset the ATC and run the departure test.
   - ii. If the departure test passes, the train can be put back into service.
   - iii. If the departure test fails with event 77 (Dept Test: Code Rate for Cab A Failed) or 81 (Dept Test: Code Rate for Cab B Failed), test all pickup coils and replace the faulty coil. Test coils per P3010-KI-MAN-00096 Pick-Up Coil Test Equipment Manual.
   - iv. If the departure test fails with event 76 (CSRD self test failure), replace the CSRD PCB.

c. ATP CSRD Link Down

   i. The ATP has detected a communication fault to the CSRD PCB. Reset the ATC, wait 60 seconds for the system to initialize, and then verify that LED 2 on the ATP CPU is illuminated amber.

   ii. If LED 2 is illuminated amber, run the departure test.

   iii. If the departure test passes, the train can be put back into service.

   iv. If the departure test fails with event 77 (Dept Test: Code Rate for Cab A Failed) or 81 (Dept Test: Code Rate for Cab B Failed), test all pickup coils and replace the faulty coil.

   v. If the departure test fails with event 76 (CSRD self test failure), replace the CSRD PCB.

   vi. If LED 2 is off, replace the CSRD PCB.

   vii. If LED 2 is still off, replace the ATP CPU.

d. The ATP has reported the CSRD self test to have failed

   i. The internal self test timer has expired. Run the departure test to reset the timer.

e. ATP CSRD Data Mismatch Error

   i. The CSRD has decoded different cab signals on the two separate receivers. This can happen if the train stops over a track circuit bond.

   ii. Run the departure and verify that it passes. If the departure test fails, check for Departure Test Failure events 62-92 and follow the action column in Chapter 9.

f. CSRD Bad FSK CRC (Type II only)

   i. The CSRD decoded a track circuit message with a bad CRC.

   ii. Run the departure test.

   iii. If the departure test passes, the train can be put back into service.

   iv. If the departure test fails with event 77 (Dept Test: Code Rate for Cab A Failed) or 81 (Dept Test: Code Rate for Cab B Failed), test all pickup coils and replace the faulty coil. Test coils per P3010-KI-MAN-00096 Pick-Up Coil Test Equipment Manual.

   v. If the departure test fails with event 76 (CSRD self test failure), replace the CSRD PCB.

   vi. If the departure test passes and this issue is reported on multiple trains, inform wayside that there is a track circuit issue.

g. ATP FSK Message Bad CRC Error (Type II only)

  i. The CSRD decoded a track circuit message with a bad CRC.

  ii. Run the departure test.

  iii. If the departure test passes, the train can be put back into service.

  iv. If the departure test fails with event 77 (Dept Test: Code Rate for Cab A Failed) or 81 (Dept Test: Code Rate for Cab B Failed), test all pickup coils and replace the faulty coil. Test coils per P3010-KI-MAN-00096 Pick-Up Coil Test Equipment Manual.

  v. If the departure test fails with event 76 (CSRD self test failure), replace the CSRD PCB.

  vi. If the departure test passes and this issue is reported on multiple trains. inform wayside that there is a track circuit issue.

4. If none of the above events are shown in the event log, the cab signal loss was because the received wayside signal was outside of the acceptable tolerances.

a. Inform wayside of your findings for their investigation.

b. Run the departure test and verify that it passes. If the departure test fails, check for Departure Test Failure events 62-92 and follow the action column in Chapter 9.

8.9.2.2 Station Stopping Problems

If the MTA problem report indicates that the train overshot or undershot a station, verify if the problem is occurring on multiple trains or if it is isolated to a single train. If it is occurring on multiple trains it is a wayside issue and Signals should verify the track circuits and TWC in that area are working correctly. If it is an isolated issue, start by checking the following:

1. Download the events logs.

2. Around the reported time of the event look for the following events:

a. TWC Bypassed

  i. Restore the TWC Bypass switch to the Not Bypassed position.

b. No TWC Detected

  i. The ATO passed two consecutive TWC loops without establishing TWC communication.

  ii. Verify the jumper and switch settings per Chapter 7.3.13 and calibration settings per Chapter 5.3.

  iii. Verify the TWC operation using P3010-KI-MAN-00095 Type II TWC Test Equipment Manual.

  iv. If TWC operation is verified as correct please inform wayside of your findings for their investigation.

c. No Valid Transpositions
   i. The ATO did not validate any transpositions in the platform which results in position uncertainty.
   ii. Verify the jumper and switch settings per Chapter 7.3.13 and calibration settings per Chapter 5.3.
   iii. Verify the TWC operation using P3010-KI-MAN-00095 Type II TWC Test Equipment Manual.
   iv. If TWC operation is verified as correct please inform wayside of your findings for their investigation.
d. Track circuit detected without a bond detect
   i. The ATP detected a track circuit crossing without validating the bond. This results in position uncertainty.
   ii. Reset the ATC and run the departure test.
   iii. If the departure test passes the train can be put back into service.
   iv. If the departure test fails with event 77 (Dept Test: Code Rate for Cab A Failed) or 81 (Dept Test: Code Rate for Cab B Failed) test all pickup coils and replace the faulty coil.
   v. If the departure test fails with event 76 (CSRD Selftest failure) replace the CSRD PCB.
e. Bond Based Station Stop
   i. The ATO did not detect any TWC in the platform and used the bond detection only to stop in the station.
   ii. Verify the jumper and switch settings per Chapter 7.3.13 and calibration settings per Chapter 5.3.
   iii. Verify the TWC operation using P3010-KI-MAN-00095 Type II TWC Test Equipment Manual.
f. High Brake Rate Commanded
   i. The ATO had to request a brake rate greater than 2.0 mph/s for more than 10 seconds.
   ii. Check the Kinkisharyo MDS system for propulsion and braking system faults.
g. No CTM was detected in the platform
   i. The ATO did not detect any transpositions in the platform which results in position uncertainty.
   ii. Verify the jumper and switch settings per Chapter 7.3.13 and calibration settings per Chapter 5.3.
   iii. Verify the TWC operation using P3010-KI-MAN-00095 Type II TWC Test Equipment Manual.

h. ATO Detected Slide

   i. The ATO detected a slide during the station stop resulting in position uncertainty.

   ii. No action is required.

8.9.2.3 TWC Problems on Type I Lines

If the MTA problem report indicates that the train was not able to communicate with wayside TWC on the Type I Lines, verify if the problem is occurring on multiple trains or if it is isolated to a single train. If it is occurring on multiple trains it is a wayside issue and Signals should verify the TWC in that area are working correctly. If it is an isolated issue, perform P3010-KI-MAN-00097 Type I TWC Test Equipment Manual.

8.9.3 Event Hierarchy

The following information is associated with each event and displayed by the PTU:

Event Code – the unique identification number of the event. This field is used to populate the ‘Code’ entry in the PTU event log window.

NOTE: There are gaps in the sequence of Event Code numbers to accommodate future events, or events that are not applicable to the LACMTA P3010 ATC system.

Event Name – The name of the event. This field is used to populate the ‘Name’ entry in the PTU event log window.

Description – A brief description of the event. This field is used to populate the ‘Description’ entry in the PTU event log description display.

Severity – Identifies the severity classification of the event. The level of severity is classified into three groups:

1. Error
2. Warning
3. Information

Source – Identifies the ATC subsystem that detected the event. This field is used to populate the ‘Subsystem’ entry in the PTU event log description display.

Action – The appropriate action (if any) to take in order to clear the event.

LRU – The LACMTA apparatus tabulation number of the Lowest Replaceable Unit (LRU) associated with the event.

Snapshot Triggered – Denotes if a snapshot is generated for the event.

MDS Flag (0x0000 sent to MDS) – If the value is 0x0000, it is sent to the MDS.

For a complete listing of ATC system events, refer to CHAPTER 9.0. For operating instructions of the ATC PTU, refer to the Special Tools and Test Equipment Manual, Section 1500, ATC Portable Test Unit.

8.9.4 Snapshot Events

Snapshots are the data describing the state of the system immediately before a more or most critical event. The following table explains the data contained in a snapshot event log.

Table 8-1. Snapshot Data

Parameter	Units	Comments
adu_cab_a		The source of ADU message is cab A
adu_cab_b		The source of ADU message is cab B
atp_type_one		System is in Type I
atp_type_two		System is in Type II
atp_ready		ATP Operating Status
ato_ready		ATO Operating Status
ato_speed_setpoint	MPH x 10	ATO Adjusted Control Speed
ato_tach_speed	MPH x 10	ATO Tach Speed
ato_accel_cmd	MPH/s x 10	ATO Commanded Acceleration
ato_dist_to_go	Feet x 10	ATO Distance to Go for a Station Stop
ato_station_id		ATO Station ID
atp_failed		ATP Failure
ato_stop_in_progress		ATO Programmed Stop Complete
ato_bond_detect		ATO Bond Detection
ato_xposn_detect		ATO Transposition Detection
ato_failed		ATO Failure
atp_cab_a_active		Cab A Active
atp_cab_b_active		Cab B Active
atp_bypass		ATP has been bypassed
atp_twc_bypass		The TWC has been bypassed
atp_train_berthed		the train berthed
atp_dwell_expired		Dwell expired indication
ato_twc_bad_stop		ATO station stop is outside of +/- 36 inches
ato_xpos_valid		Number of valid transpositions detected
ato_xpos_invalid		Number of invalid transpositions detected
ato_xpos_idx		Transposition index applied to last detection
atp_valid_cab_signal		Valid cab signal is present
atp_no_motion		No Motion declared
atp_vzero_declared		Vzero declared
atp_rollaway		Rollaway condition Is declared
atp_overspeed		Overspeed condition exists
atp_spin_detect		Spin condition is declared
atp_slide_detect		Slide condition is declared
atp_active_events		Active events

Table 8-1. Snapshot Data (cont'd.)

Parameter	Units	Comments
atp_oper_mode		Operational Mode (0=Off, 1=Local,2=Manual, 3=Manual with ATO, 4=Street Running, 5=CarWash, 6=Stop & Proceed)
atp_dept_test_status		Departure Test Status (0=Not Run, 1=In Progress, 2=Waiting Ack, 3=Passed, 4=Failed, 5=Cancelled, 6=Shop Failure)
atp_emergency_brake		Emergency Brake Applied
atp_penalty_brake		Penalty Brake Applied
atp_full_service_brake		Full Service Brake Applied
atp_ues_brake		Unrecoverable EB (Type II Only)
atp_ato_profile_speed	MPH x 10	ATO profile speed calculated by ATP
atp_wayside_dir_east		The direction as designated by wayside - east
atp_wayside_dir_west		The direction as designated by wayside - west
atp_decel_status		Decel calibration status
atp_raw_dir_1		Decelerometer reading (dir 1 and 2 should always add to 255)
atp_raw_dir_2		Decelerometer reading (dir 1 and 2 should always add to 255)
atp_speed_powered_truck	MPH x 10	Tach speed - powered truck
atp_display_spd_limit	MPH x 10	Display speed limit
atp_speed_non_powered_truck	MPH x 10	Tach speed - non-powered truck
atp_system_speed	MPH x 10	ATP System Speed
atp_decel_rate	MPH/s	atp_decel_rate
atp_Vital_In1_low_byte		Vital Inputs Card 1 Low Byte Bit 0: MC_FSB_A Bit 1: MC_COAST_A Bit 2: MC_FSB_B Bit 3: MC_COAST_B Bit 4: A_END Bit 5: B_END Bit 6: TYPE1_LINE Bit 7: TYPE2_LINE
atp_Vital_In1_high_byte		Vital Inputs Card 1 High Byte Bit 0: ATP_BYPASS Bit 1: DOORS_CLOSED_A Bit 2: DOORS_CLOSED_B Bit 3: FRICTION_APPLIED_A Bit 4: FRICTION_APPLIED_B Bit 5: FRICTION_FAULT Bit 6: PROP_FAULT Bit 7: ATP_ACK
atp_Vital_In2_low_byte		Vital Inputs Card 2 Low Byte Bit 0: MANUAL Bit 1: ATO_MODE Bit 2: M_IN Bit 3: CM_IN Bit 4: POWER_CUT_IN Bit 5: FORWARD_IN Bit 6: REVERSE_IN Bit 7: EB_APPLIED

Table 8-1. Snapshot Data (cont'd.)

Parameter	Units	Comments
atp_Vital_In2_high_byte		Vital Inputs Card 2 High Byte Bit 0: BKCHK_FORWARD Bit 1: BKCHK_REVERSE Bit 2: BKCHK_POWER_CUT Bit 3: SPARE_1 Bit 4: BKCHK_DEPART_TEST_SEL Bit 5: SPARE_2 Bit 6: SPARE_3 Bit 7: SPARE_4
atp_MFB_NVital_In		Non Vital Inputs (Multifunction board) Bit 0: TB_APPLIED Bit 1: TWC_CUTOUT Bit 2: SPARE_1 Bit 3: SPARE_2 Bit 4: BKCHK_AMP_PWR_AEND Bit 5: BKCHK_AMP_PWR_BEND Bit 6: BATTERY_OverVoltage Bit 7: BATTERY_UnderVoltage
atp_MFB_Vital_Out		Vital Outputs (Multifunction board) Bit 0: FORWARD Bit 1: REVERSE Bit 2: POWER_CUT Bit 3: M Bit 4: CM Bit 5: SPARE_1 Bit 6: DEPART_TEST_SELECT Bit 7: SPARE_2
atp_MIO_Vital_In		Vital Inputs (Mixed I/O) Bit 0: BKCHK_ELD Bit 1: BKCHK_ERD Bit 2: BKCHK_FSB Bit 3: BKCHK_CABSIG_SEL_A Bit 4: BKCHK_CABSIG_SEL_B Bit 5: BKCHK_TEST_SEL_A Bit 6: BKCHK_TEST_SEL_B Bit 7: ATP_NOT_BYPASS
atp_MIO_Vital_Out		Vital Outputs (Mixed I/O) Bit 0: ELD Bit 1: ERD Bit 2: FSB Bit 3: EB Bit 4: CABSIG_SEL_A Bit 5: CABSIG_SEL_B Bit 6: TEST_SEL_A Bit 7: TEST_SEL_B
ato_route_id		ATO Route ID
atp_pvid		Permanent vehicle ID stored in EEProm
atp_aspect_track_id		Type I Aspect or Type II Track Circuit ID
csrd1_fsk_v_good_msg		Type II good message received from wayside track circuit
csrd1_fsk_v_consec_msg_match		Type II two good messages have been received from wayside

Table 8-1. Snapshot Data (cont'd.)

Parameter	Units	Comments
csrd1_fsk_v_active_msg		Type II the CSRD is currently receiving messages from wayside
csrd1_fsk_v_track_id		Type II wayside track circuit ID
csrd1_fsk_v_next_frequency		Type II wayside frequency for next track circuit
csrd1_fsk_active_channel_freq		Type II wayside frequency of current track circuit
csrd1_fsk_next_channel_freq		Type II wayside frequency for next track circuit
csrd1_fsk_active_channel_level		Type II wayside track ciruit received signal level for current track circuit
csrd1_fsk_next_channel_level		Type II wayside track ciruit received signal level for next track circuit
csrd1_fsk_falling_active_counter		Type II bond crossing event indicating that the current track circuit level dropped by 25%
csrd1_fsk_rising_next_counter		Type II bond crossing event indicating that the next track circuit level has risen to the detection level
csrd1_fsk_bond_ok_counter		Type II. The ATP has validated a bond crossing. Falling active and rising next occurred within 22 feet of one another.
csrd2_fsk_v_good_msg		Type II good message received from wayside track circuit
csrd2_fsk_v_consec_msg_match		Type II two good messages have been received from wayside
csrd2_fsk_v_active_msg		Type II the CSRD is currently receiving messages from wayside
csrd2_fsk_v_track_id		Type II wayside track circuit ID
csrd2_fsk_v_next_frequency		Type II wayside frequency for next track circuit
csrd2_fsk_active_channel_freq		Type II wayside frequency of current track circuit
csrd2_fsk_next_channel_freq		Type II wayside frequency for next track circuit
csrd2_fsk_active_channel_level		Type II wayside track ciruit received signal level for current track circuit
csrd2_fsk_next_channel_level		Type II wayside track ciruit received signal level for next track circuit
csrd2_fsk_falling_active_counter		Type II bond crossing event indicating that the current track circuit level dropped by 25%
csrd2_fsk_rising_next_counter		Type II bond crossing event indicating that the next track circuit level has risen to the detection level
csrd2_fsk_bond_ok_counter		Type II. The ATP has validated a bond crossing. Falling active and rising next occurred within 22 feet of one another.
atp_decel_accel_rate	MPH/s x 100	Decelerometer reported acceleration rate
atp_tach_accel_rate	MPH/s x 100	Tachometer reported acceleration rate
atp_low_fluid_test_status		Status of low fluid test
atp_bond_suppression		Type II indication on whether the ATP has turned off bond detection

Table 8-1 Snapshot Data (cont'd.)

Parameter	Units	Comments
atp_penalty_brake_request		Brake bits for penalty brake request Bit 0: LINE_SELECTOR_CROSSCHK Bit 1: FWD_REV_CROSSCHK Bit 2: KEYED_CAB_CROSSCHK Bit 3: FSB_CROSSCHK Bit 4: DPT_SRC_SIG_CROSSCHK Bit 5: VZ_DECEL_PB Bit 6: SPD_MISMATCH Bit 7: LOST_SPEED_SENSOR Bit 8: MOTION_MODE_CHANGE Bit 9: MOTION_LINE_CHANGE Bit 10: DECEL_FLUID_ERR Bit 11: BYPASS_SEL_CROSSCHK Bit 12: CAB_SIG_SEL_A_CROSSCHK Bit 13: PC_CROSSCHK Bit 14: FORWARD_CROSSCHK Bit 15: REVERSE_CROSSCHK Bit 16: MODE_SELECTOR_CROSSCHK Bit 17: DOORS_NOT_CLOSED Bit 18: INVALID_MODE Bit 19: MOTION_REV_CHANGE Bit 20: CAB_SIG_SEL_B_CROSSCHK Bit 21: DIRECTION_CROSSCHK Bit 22: TEST_SIG_SEL_A_CROSSCHK Bit 23: TEST_SIG_SEL_B_CROSSCHK Bit 24: TWC_ANTENNA_CROSSCHK Bit 25: M_CM_CROSSCHK Bit 26: VEHICLE_RELEASE_IN_ATO_IN_MOTION Bit 27: EB_CROSSCHK
atp_fsb_pc_request		Brake bits for PC request Bit 0: FULL_SERV_BRK Bit 1: OVERSPEED Bit 2: EMERG_BRK Bit 3: DEPT_TEST Brake bits for FSB request Bit 4: PENALTY_BRAKE Bit 5: OVERSPEED_PENALTY Bit 6: ILLEGAL_REVERSE Bit 7: ZERO_SP_LIMIT_STOP Bit 8: CPU_RESET_WITH_SPEED Bit 9: DOORS_ENABLED Bit 10: REVERSER_IN_NEUTRAL Bit 11: DOORS_NOT_CLOSED Bit 12: INVALID_ORIENTATION Bit 13: ATO_LINK_DOWN Bit 14: UES_BRAKE Bit 15: EB Bit 16: HOLDING_BRAK Bit 17: IES_BRAKE Bit 18: CSRD_SELF_TEST Bit 19: SW_UPLOAD Bit 20: CCB_VEH_HOLD_REQ

Table 8-1 Snapshot Data (cont'd.)

Parameter	Units	Comments
atp_ies_ues_eb_hb_request		Brake bits for IES Bit 0: TERMINAL_OVERRUN Bit 1: FSK_INVALID_DIR Bit 2: FRICTION_FAULT Bit 3: FSK_TRACK_OUT_OF_SEQ Brake bits for Holding Brake Bit 4: ATO_VEH_HOLD Brake bit for UES Bit 5: FSK_TRACK_ID_BAD Brake bits for EB Bit 6: SPEED_IN_DEPT_TEST Bit 7: PROPULSION_CUT Bit 8: OVERSPEED_BA_FAIL Bit 9: PROFILE_OSL_EXCEEDED Bi t10: ATP_BYPASS Bit 11: ROLLBACK Bit 12: BM_FAILED Bit 13: MARINE_BUMPER_DISTANCE Bit 14: MARINE_WEST_DISTANCE Bit 15: ELD_XCHK Bit 16: ERD_XCHK Bit 17: SLIDE_WITH_DECEL_FAILED Bit 18: ROLLAWAY Bit 20: TRAIN_GREATER_THREE Bit 21: FAULT_DOORS_NOT_CLOSED

8.10 Troubleshooting Procedures

NOTE: Prior to performing any of these procedures, perform the General Troubleshooting Guidelines in Section 8.3 to save time and effort, and to prevent an incorrect conclusion.

Beginning with Step 1 of the appropriate procedure, continue to the next step until the solution is found. If the final step does not fix the problem, then the cause is probably external to the ATC equipment.

8.10.1 Troubleshooting: General ATC System Malfunction

CAUTION

DO NOT REMOVE OR INSTALL ANY ATC PCB ASSEMBLY WITH POWER APPLIED. OPEN THE VEHICLE ATC SYSTEM CIRCUIT BREAKER BEFORE REPLACING SYSTEM COMPONENTS.

1. Verify that all cardfile PCB assemblies are properly installed.
2. Verify the jumper and switch settings of each PCB, if applicable.
3. Verify that all software versions are current.
4. Verify the ATC inputs and outputs.
5. Continue with Troubleshooting: Power.

8.10.2 Troubleshooting: Power

Determine the extent of the problem by determining if the problem is confined to the ADU, Type I TWC, or ATC Enclosure. Based on this determination, perform the following battery voltage checks to ATC system components. These tests verify voltage levels of the vehicle power supply to the ATC and Type I (H&K) TWC Communication Control Unit (CCU).

<u>Setup</u>

In the A-Car / B-Car married pair with the power problem:

a. Remove power from ATC components by turning off the “Aspect Display Unit” breakers (both A and B end), “Automatic Train Control” breaker (B end), and “Train to Wayside” breaker (B end).

b. Refer to Figure 8-1. Disconnect the J1 connector from the front panel of the ATC Unit.

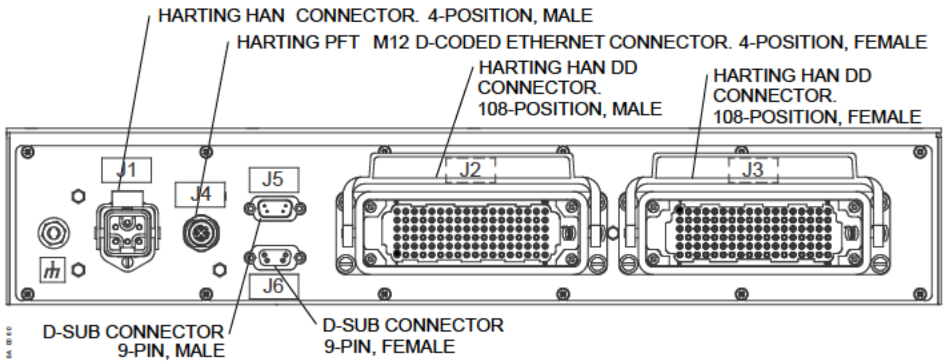


Figure 8-1: ATC Enclosure Interface Connectors

c. Refer to Figure 8-2. Disconnect the 15 pin D-SUB connectors to the H&K TWC CCUs.

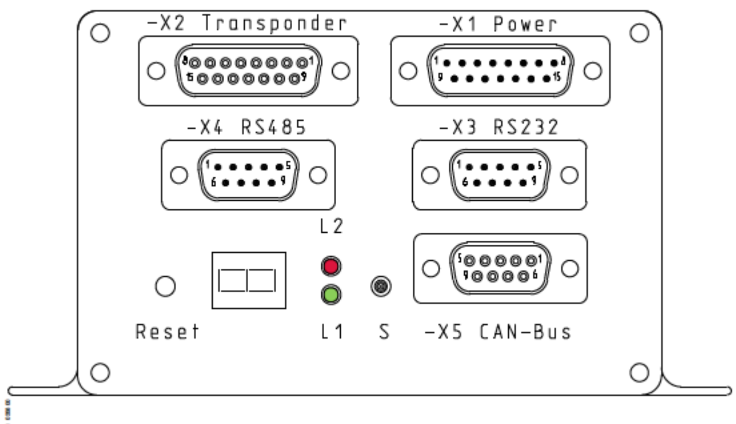


Figure 8-2: TWC CCU Interface Connectors

Procedure

1. Apply power to the ATC Unit so that the incoming power is present at the J1-Power connector, 15 pin D-SUB connectors for A-End and B-End H&K TWC CCU, and X1 Connectors for A-End and B-End ADU.

CAUTION

USE CAUTION TO PREVENT A SHORT CIRCUIT BETWEEN BATTERY + AND BATTERY – PINS WHILE THE ATC SYSTEM CIRCUIT BREAKER IS CLOSED.

2. Refer to Figure 8-3. Using a digital multimeter verify voltages levels at the pins of the J1 Power connector.

Description	Pin Number		Expected Value
	From (+)	To (-)	
Battery source 1	J1.1	J1.2	17 - 30 VDC (Nom 24VDC)
Battery source 2	J1.3	J1.5	17 - 30 VDC (Nom 24VDC)
Battery source 1	J1.3	J1.2	17 - 30 VDC (Nom 24VDC)
Battery source 2	J1.1	J1.5	17 - 30 VDC (Nom 24VDC)

Figure 8-3: Enclosure Connector J1 Pins

3. Ensure the vehicle is selected for Type I mode and the TWC Circuit Breaker is ON. Key up the A cab.

4. Refer to Figure 8-4. Using a digital multimeter verify voltages levels at the pins of the A end TWC CCU X1 Connector supplying power to the TWC CCU.

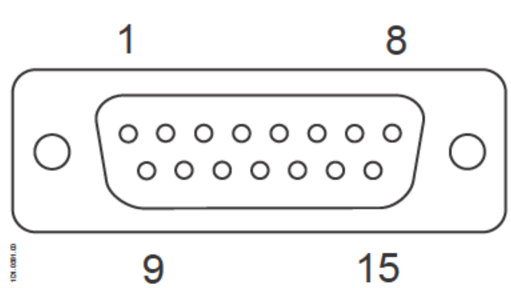


Figure 8-4: TWC CCU Connector X1 Pins

Description	Pin Number		Expected Value
	From (+)	To (-)	
Power	X1.8	X1.15	17 - 30 VDC (Nom 24VDC)
Active Cab Input	X1.1	X1.15	17 - 30 VDC (Nom 24VDC)

5. Refer to Figure 8-4. Repeat steps 3 and 4 but on the B end. Ensure that the B cab is keyed up and the A cab is not.

Description	Pin Number		Expected Value
	From (+)	To (-)	
Power	X1.8	X1.15	17 - 30 VDC (Nom 24VDC)
Active Cab Input	X1.1	X1.15	17 - 30 VDC (Nom 24VDC)

6. If the expected voltages are not present in any of the above steps, troubleshoot the wiring harnesses and fix the problem before continuing.

7. Remove power from ATC Unit, ADU, and H&K TWC equipment by opening their associated circuit breakers.

8. Reconnect Enclosure J1 Power connector and A-end and B-end Type I (H&K) TWC CCU connectors.

9. If acceptable incoming power is not detected to the system, the problem is external to the ATC system and is with the vehicle battery or power supply wiring. Continue troubleshooting activities accordingly.

10. Check the Battery Conditioner circuit breaker.

11. If the problem is suspected to be with the ATC Power Supply PCB, refer to Section 5.2 and perform the Test ATC System Power Supplies procedure to verify the input and output voltages at the front panel of the PCB assembly. Replace the ATC Power Supply PCB Assembly if Conditioned Battery input voltage is acceptable and any output voltage is not within acceptable tolerance.

12. If the problem is suspected to be with the Conditional Power Supply (CPS) PCB, refer to Section 5.2 and perform the Test ATC System Power Supplies procedure to verify the input and output voltages at the front panel of the PCB assembly. Replace the ATC Conditional Power Supply PCB Assembly if Conditioned Battery input voltage is acceptable and any output voltage is not within acceptable tolerance.

13. Unload the vehicle input power supply.

CAUTION

DO NOT REMOVE OR INSTALL ANY ATC PCB ASSEMBLY WITH POWER APPLIED. OPEN THE VEHICLE ATC SYSTEM CIRCUIT BREAKER BEFORE REPLACING SYSTEM COMPONENTS.

14. Remove all PCB assemblies from the ATC cardfile except for the ATC Power Supply PCB Assembly. Check the PCB's output voltages. If the power supplies on the PCB return to normal output values, replace the cardfile PCB assemblies one or two at a time until the PCB causing the power supply loading problem is identified and then replace that PCB assembly. Otherwise, continue with the next step.

15. Replace the Power Supply PCB Assembly and re-check its outputs. If the problem persists, there may be an excessive load in the system (for example, in the cardfile wiring).

16. Replace the ATC Enclosure.

8.10.3 Troubleshooting: ADU Malfunction

1. In the event of a black unresponsive ADU screen, perform the following troubleshooting steps :

a. Check the ATC to ADU wiring. Verify the connections at the rear of the ADU are securely fastened and cable connectors are fully inserted. Replace any damaged cables.

b. Check main power to the ADU coming from the X1 connector:

   i. Remove power from the A-End and B-End ADUs by opening their associated circuit breakers.

   ii. Refer to Figure 8-5. Disconnect the X1 connectors from the ADUs.

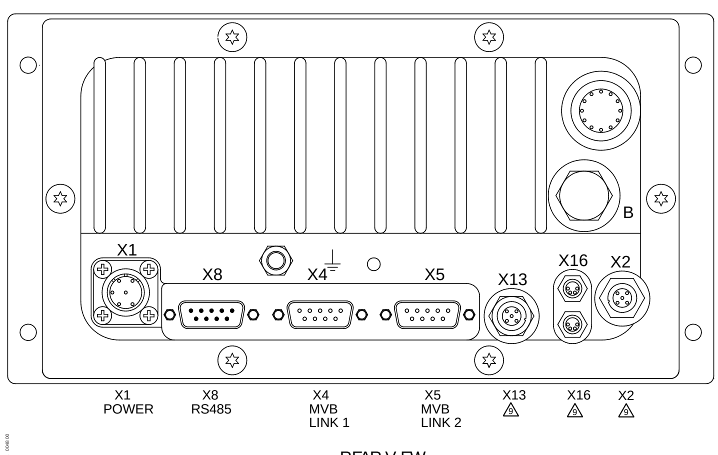


Figure 8-5: ADU Interface Connectors

iii. Refer to Figure 8-6. Using a digital multi-meter verify voltages levels at the pins of the A-cab ADU X1 Connector supplying power to the A-End ADU. Check for the presence of the A-End jumper by checking for continuity between the specified pins.

Description	Pin Number		Expected Value
	From (+)	To (-)	
Battery source 1	X1.1	X1.2	17 - 30 VDC (Nom 24VDC)
Battery source 2	X1.3	X1.2	17 - 30 VDC (Nom 24VDC)
ADU A-End Jumper	X1.4	X1.5	Short Circuit

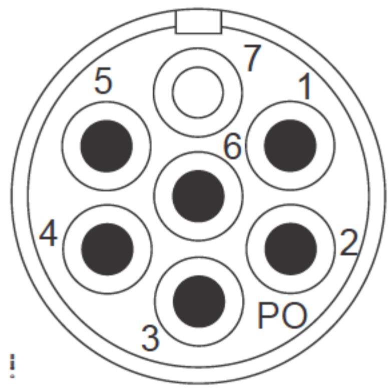


Figure 8-6: ADU Connector X1 Pins

iv. Key up the B cab.

v. Refer to Figure 8-6. Using a digital multimeter verify voltages levels at the pins of the B-cab ADU X1 Connector located in the B cab. Check to make sure the A-End jumper is not installed by checking the absence of continuity between the specified pins.

Description	Pin Number		Expected Value
	From (+)	To (-)	
Battery source 1	X1.1	X1.2	17 - 30 VDC (Nom 24VDC)
Battery source 2	X1.3	X1.2	17 - 30 VDC (Nom 24VDC)
ADU A-End Jumper	X1.4	X1.5	Open Circuit

vi. If the expected voltages are not present in any of the above steps, troubleshoot the wiring harnesses and fix the problem before continuing.

vii. If the voltages correspond with the tables above, replace the ADU.

2. In the event of the ADU showing a default loading screen, perform the following troubleshooting steps:

a. Verify the ATP cardfile LED's 1,2,3 are illuminated. If not, reload CCB Executive and Configuration software to the CCB cardfile and reset the ATC rack.

b. If problem persists, exchange the CCB cardfile with a known working board from a different LRV. If this resolves the issue, replace CCB cardfile with a new board.

8.10.4 Troubleshooting: ATC Cardfile PCB Assembly Malfunction

CAUTION

DO NOT REMOVE OR INSTALL ANY ATC PCB ASSEMBLY WITH POWER APPLIED. OPEN THE VEHICLE ATC SYSTEM CIRCUIT BREAKER BEFORE REPLACING SYSTEM COMPONENTS.

1. Verify the proper installation of the PCB assembly in the ATC cardfile.

Verify that the PCB is fully inserted into its cardfile slot and the connectors on the rear of the PCB are firmly mated with the connectors on the backplane Motherboard PCB. Check all jumper and switch settings and software versions, if applicable.

2. Query the ATC Event Management System with the PTU.

Investigate the cause, and clear any active PCB-related fault codes.

3. Replace the PCB assembly.

4. Replace the ATC Enclosure.

8.10.5 Troubleshooting: Decelerometer Malfunction

1. Verify the proper installation and calibration of the decelerometer.

a. Verify that the decelerometer is properly installed.

b. Calibrate the decelerometer.

2. Replace the Multifunction PCB Assembly.

3. Replace the Decelerometer Sensor.

8.10.6 Troubleshooting: Echo and Type Faults

CAUTION

DO NOT REMOVE OR INSTALL ANY ATC PCB ASSEMBLY WITH POWER APPLIED. OPEN THE VEHICLE ATC SYSTEM CIRCUIT BREAKER BEFORE REPLACING SYSTEM COMPONENTS.

1. Verify the proper installation of the affected PCB assembly with the echo or type fault.

2. Replace the affected PCB assembly.

3. Remove all other PCB assemblies from the cardfile except for the ATP CPU PCB Assembly.

This will cause other faults. Check to see if the original fault is still active. If not, check to see if one PCB assembly causes the fault to reappear when the PCB is reinstalled.

4. Replace the ATP CPU PCB Assembly.

5. Replace the ATC Enclosure.

8.10.7 Troubleshooting: CSRD Faults

CSRD module fail, CSRD link down, and other CSRD faults may occur at start up. This is normal and is due to one half of the CSRD receiving a reset command before the other. If these faults are seen at startup with CSRD Self Test passed event, no further investigation is necessary. If these faults occurred along with ATP CSRD Link Down event, further troubleshooting may be required.

CHAPTER 9.0

ATC EVENT DESCRIPTIONS

9.1 Introduction

This section provides the Event List for the ATC units on the LACMTA 3010 LRV ATC System.

The Event List table contains the following columns:

Event Code – the unique identification number of the event. This field is used to populate the ‘Code’ entry in the PTU event log window.

NOTE: There are gaps in the sequence of Event Code numbers to accommodate future events, or events that are not applicable to the LACMTA P3010 ATC system.

Event Name – The name of the event. This field is used to populate the ‘Name’ entry in the PTU event log window.

Description – A brief description of the event. This field is used to populate the ‘Description’ entry in the PTU event log description display.

Severity – Identifies the severity classification of the event. The level of severity is classified into three groups:

1. Error
2. Warning
3. Information

Source – Identifies the ATC subsystem that detected the event. This field is used to populate the ‘Subsystem’ entry in the PTU event log description display.

Action – The appropriate action (if any) to take in order to clear the event.

LRU – The LACMTA apparatus tabulation number of the Lowest Replaceable Unit (LRU) associated with the event. The LRU ID numbers shown in the **LRU** column of the Event Code List are defined in Table 9-1.

Snapshot Triggered – Denotes if a snapshot is generated for the event.

MDS Flag (0x0000 sent to MDS) – If the value is 0x0000, it is sent to the MDS.

Table 9-1. LRU ID Numbers

LRU ID	LRU
10	ATC enclosure
20	ADU
50	Tachometer
1001	Battery Conditioner
1002	Safety Relay 1
1003	Safety Relay 2
1004	CCB PCB
1005	TWC Modem PCB
1006	ATO PCB
1007	CSRD PCB
1008	ATP PCB
1009	Vital Input 1 PCB
1010	Vital Input 2 PCB
1011	Mixed I/O PCB
1012	Multifunction PCB
1013	Conditional Power Supply PCB
1014	Power Supply PCB
1016	Decelerometer

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1	Global Echo Register Event	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1008	No	0x0000
2	Generic Type Register Event	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1008	No	0x0000
3	Generic VPA Compare Event	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1008	No	0x0000
10	CPU Board SysErr ID	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
13	Multifunction Board SysErr ID	Triggered when either the Decel Not Near Zero or the ADC busy events are triggered.	1	ATP	Check the multifunction board is securely plugged into the correct slot inside the card file. Check the 5v reference voltages on the power supply. Check the + and - 12v reference voltages on the power supply to ensure they are within tolerance. Verify ground connections are installed and secure since this is typically an outside noise issue. If the problem persists, replace the decelerometer and multifunction board. If the problem still persists, the issue is outside the ATC enclosure	1012	No	0x0000
14	Mixed Output Board SysErr ID	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1013	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
19	ATP Vital Variable Event	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1008	No	0x0002
25	CSRD1 Driver Event	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1007	No	0x0000
26	CSRD2 Driver Event	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1007	No	0x0000
27	CSRD1 CPU Event	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1007	No	0x0000
28	CSRD2 CPU Event	No Trigger Conditions, this is a Parent ID	1	ATP	No Reset conditions. This is a parent ID	1007	No	0x0000
29	CSRD Proc Event	Parent ID for Events.	1	ATP	Parent ID. No Reset Conditions.	1007	No	0x0000
30	Tach Spin Detected	Triggered when the ATP system detects an abnormal acceleration from the tachometers that are outside the physical capabilities of the vehicle, 4mph/s.	2	ATP	Reset when the acceleration between the two tachometer sensors agree for one second and no speed mismatch is active.	50	Yes	0x0002
31	Tach Slide Detected	Triggered when the dv/dt of either tachometer is greater than 6mph/s	2	ATP	Reset when the difference between speed sensors is less than 5 mph and the calculated decelerometer speed is within 5 mph of both sensors. Also reset by the operator key off and key on the active cab.	50	Yes	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
32	Tach Speed Sensor Mismatch	Triggered when the tachometer inputs are reading a difference in speed greater than6 mph for 16 seconds.	1	ATP	Check the tachometers to verify continuity to the system. If the problem persists, replace the tachometers. If the problem still persists, replace the multifunction board. If the problem still persists, the issues is outside the ATC Rack.	50	Yes	0x0002
33	Tach Loss of Sensors Detected	Triggered when a sudden drop to 0 mph on both tachometers occurs that is unrealistic.	1	ATP	Key the cab out and then back in to clear the crosscheck condition. If the problem still persists, check the tachometer installation. Check wires from tachometers to ATC rack. If the problem still persists, replace the multifunction board. If the problem still persists, the issue is outside the ATC rack.	50	Yes	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
34	Tach Loss of Sensors Error	Triggered when a loss of sensors event is declared for more than 10 seconds.	1	ATP	Key the cab out and then back in to clear the crosscheck condition. If the problem still persists, check the tachometer installation. Check wires from tachometers to ATC rack. If the problem still persists, replace the multifunction board. If the problem still persists, the issue is outside the ATC rack.	50	Yes	0x0000
39	Decel Not Level	A decelerometer calibration was performed but the final values were outside the allowed level tolerance	3	ATP	Perform a decelerometer calibration and adjust the decelerometer to 128/128 +/- 2 bits.	1016	No	0x0002
40	Decel Calibration Started	Triggered when a decelerometer calibration is started by the operator.	3	ATP	Informational event. No reset conditions.	1016	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
41	Decel Calibration Failed	Triggered when a decelerometer calibration is started, but the calibration timed out or the values are outside the allowed tolerance.	3	ATP	Perform a decelerometer calibration and adjust the decelerometer to 128/128 +/- 2 bits.	1016	No	0x0000
42	Decel Calibration Passed	Triggered when a decelerometer calibration is started and the values are accepted by the operator within the allowed time limit.	3	ATP	Informational event. No reset conditions.	1016	No	0x0002
43	Decel Calibration Exited	Triggered when a decelerometer calibration was started, but rejected by the operator before accepted the new values.	3	ATP	informational event. No reset conditions.	1016	No	0x0002
44	Decel Calibration Invalid	Triggered when a hardware or software error occurs on the decelerometer and the ATP can no longer trust the validity of the calibration.	1	ATP	Perform a successful decelerometer calibration.	1016	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
45	ADU link data is not being received	Triggered when the ATP is not receiving valid responses from the ADU within a certain time period.	2	ATP	Check the connection to the ADU and verify no loose or frayed wires are present. Verify continuity between the ADU and ATC rack. If the problem persists, replace the ADU. If the problem still persists, replace the ATP processor board.	20	No	0x0002
46	Friction Brake Fault Active	Triggered when the friction brake fault input to the ATP system is low.	1	ATP	Reset when the friction brake fault input goes high. Verify what caused a fault on the friction brake system.	1008	No	0x0000
47	Line Type Change in Motion	Triggered when the line selector switch is moved while the vehicle is in motion	2	ATP	Reset when the vehicle is at Vzero.	1008	Yes	0x0000
48	Mode Change in Motion	Triggered when the mode selector switch is moved while the vehicle is in motion	2	ATP	Reset when the vehicle is at Vzero.	1008	Yes	0x0002
49	Reverser Change in Motion	Triggered when the reverser input changes direction while the vehicle is moving	2	ATP	Reset when the vehicle is at Vzero.	1008	Yes	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
50	Invalid Mode	Multiple mode inputs are on at the same time and the ATP cannot decide which mode the system should be in.	1	ATP	Ensure that only ATO or Manual mode is selected.	1008	No	0x0000
51	Speed Limit Control Mode Activated	Triggered when the propulsion fault input is active to the ATP system.	1	ATP	Reset when the propulsion fault input turns off. Verify what caused a fault on the propulsion system.	1008	No	0x0000
52	ATP Acknowledge Stuck Push Button	Triggered when the ATP acknowledge button input is on for 30 consecutive seconds or more	2	ATP	Reset by turning the ATP acknowledge button input off.	1008	No	0x0000
53	Manual Mode entered	Triggered when the ATP enters manual mode	3	ATP	Informational event. No reset conditions.	1008	No	0x0000
54	ATO Mode entered	Triggered when the ATC system enters ATO mode	3	ATP	Informational Event. No reset conditions.	1008	No	0x0000
55	Stop and Proceed Mode entered	Triggered when the ATC system enters stop and proceed mode.	3	ATP	Informational event. No reset conditions.	1008	No	0x0000
56	Car Wash Mode entered	Triggered when the ATC system enters car wash mode.	3	ATP	informational event. No reset conditions.	1008	No	0x0000
57	Street Mode entered manually	Triggered when the ATC system enters street mode	3	ATP	Informational event. No reset conditions.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
58	Local Mode entered	Triggered when the ATC system enters Local Mode	3	ATP	Informational event. No reset conditions.	1008	No	0x0000
59	Bypass Mode entered	Triggered when the ATC is placed in Bypass	3	ATP	Reset when the bypass input goes low and the ATC system enters normal operations.	1008	No	0x0000
60	Bypass Mode exited	Triggered when the ATC is placed in normal mode from bypass mode	3	ATP	informational event. No reset conditions.	1008	No	0x0000
62	Departure Test Start	Triggered when the operator requests a departure test	3	ATP	Informational event. No reset conditions.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
63	Departure Test Monitor Condition Failed	Triggered when one of the initial conditions for the departure test are lost and the departure test must abort	2	ATP	Re-establish the initial conditions required to run a departure test and ensure the conditions are satisfied for the duration of the departure test. Train is in Manual Mode (No sub mode are active, e.g. Street Running) Train is at Vzero Direction is Forward Friction brakes are applied EB is released Penalty brake is clear No propulsion faults No friction brake faults Doors are closed	1008	No	0x0000
64	Departure Test Passed	Triggered when the departure test is executed and passed	3	ATP	Informational event. No reset conditions.	1008	No	0x0000
65	Departure Test Failed	Triggered when the departure test is executed and failed.	2	ATP	Informational event. No reset conditions. Check events 68-81 for cause of failure.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
68	Departure Test FSB Crosscheck Failure	Triggered when the departure test detects a failure of the Full Service Brake backcheck. The commanded relay is in the same state as the backcheck input	1	ATP	Verify the circuit for the backcheck continuity. Verify the safety relay is operating normally. If the problem persists, replace the relay associated with the output. If the problem still persists, replace the Mixed IO board.	1008	No	0x0000
70	Departure Test Abort	Triggered when the operator cancels the departure test before the test is completed.	1	ATP	Informational event. No reset conditions.	1008	No	0x0000
71	Departure Test Overspeed Failure - EB	Triggered when the departure test detects an issue with the emergency brake backcheck. The emergency brake output is in the same state as the backcheck input	1	ATP	Verify the PN159 relay is wired correctly and the connection is secure. Verify the multifunction board and mixed IO boards are securely installed in the ATC rack. If the problem persists, replace the PN159. If the problem still persists, replace the Multifunction board and Mixed IO board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
72	Departure Test Mode Failure	Triggered when a departure test request is received but one or more of the initial conditions are not satisfied	1	ATP	Verify all initial conditions are satisfied and rerun the departure test. Train is in Manual Mode (No sub mode are active, e.g. Street Running) Train is at Vzero Direction is Forward Friction brakes are applied EB is released Penalty brake is clear No propulsion faults No friction brake faults Doors are closed	1008	No	0x0000
73	Departure Test Door Crosscheck Failure	Triggered when the door enable output is in the same state as the backcheck input	1	ATP	Verify the circuit for the backcheck continuity. Verify the safety relay is operating normally. If the problem persists, replace the relay associated with the output. If the problem still persists, replace the Mixed IO board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
75	No Acknowledge Pressed	Triggered when the operator fails to press the acknowledge button at the end of a departure test	1	ATP	Rerun the departure test and press the acknowledge button.	1008	No	0x0000
76	CSRD Self test failure	Triggered when the ATC is running a departure test and the CSRD reports back a self test failure	1	ATP	Rerun the departure test. If the problem persists, replace the CSRD board.	1007	No	0x0000
77	Dept Test: Code Rate for Cab A Failed	Triggered when the departure test is expecting a code rate to be received and validated by the CSRD but the CSRD never reports the expected code rate on the A end of the vehicle.	1	ATP	Verify the multifunction board is securely installed in the ATC Rack. Verify the CSRD is able to receive cab signal. If no cab signal is received by the CSRD, verify pickup coils are installed and functioning properly. If CSRD and coils are working properly, replace the multifunction board. If problem persists, replace the CSRD board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
78	Dept Test: EB Applied Test failed	Triggered when the departure test detects an issue with the emergency brake backcheck. The emergency brake output is in the same state as the backcheck input	1	ATP	Verify the PN159 relay is wired correctly and the connection is secure. Verify the multifunction board and mixed IO boards are securely installed in the ATC rack. If the problem persists, replace the PN159. If the problem still persists, replace the Multifunction board and Mixed IO board.	1008	No	0x0000
80	Slide with Bad Decel	Triggered when the ATP system detects a slide condition for over 2.75 seconds and the decelerometer is reporting an error and the values cannot be trusted	1	ATP	Recalibrate the decelerometer. If the problem persists, verify the 5v power supply line is within tolerance. If problem persists, replace decelerometer. If problem still persists, replace the multifunction board and power supply.	1008	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
81	Dept Test: Code Rate for Cab B Failed	Triggered when the departure test is expecting a code rate to be received and validated by the CSRD but the CSRD never reports the expected code rate on the B end of the vehicle.	1	ATP	Verify the multifunction board is securely installed in the ATC Rack. Verify the CSRD is able to receive cab signal. If no cab signal is received by the CSRD, verify pickup coils are installed and functioning properly. If CSRD and coils are working properly, replace the multifunction board. If problem persists, replace the CSRD board.	1008	No	0x0000
82	Rollback	Triggered when the tach direction is expected to go in the FORWARD direction, but the tachometers are showing reverse movement. Triggered when the speed is above Vzero or the train moves 20 inches.	2	ATP	Verify the installation of the tachometers is perpendicular to the gear teeth. Verify the wire and grounds are secure. If the problem persists, replace the tachometers. If the problem still persists, replace the multifunction board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
83	Rollaway	Triggered when the tachometer are showing speed in the forward direction, but the M and CM trainlines are not indicating propulsion. Triggered when the speed is above Vzero or the train moves 20 inches.	2	ATP	Verify the master control is in the propulsion position and the input is being received by the ATC rack. Verify the tachometers are installed correctly. If the problem persists, replace the multifunction board. If the problem still persists, replace the vital input board.	1008	No	0x0000
84	Decelerometer error during departure test	Triggered during a departure test when the decelerometer is not calibrated or reporting a hardware failure.	1	ATP	Recalibrate the decelerometer. If the problem persists, verify the 5v power supply line is within tolerance. If problem persists, replace decelerometer. If problem still persists, replace the multifunction board and power supply.	1008	No	0x0000
85	CSRD Self test Passed	Triggered when the CSRD self test reports a passed status to the ATP	3	ATP	Informational event. No reset conditions.	1008	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
86	The ATP has requested a CSRD self test	Triggered when the ATP system requests the CSRD to run a self test.	3	ATP	Informational event. No reset conditions.	1008	No	0x0002
87	Departure Test Overspeed Failure - Friction	Triggered when the departure test detects a failure of the ATC FSB relay.	1	ATP	Informational event. No reset conditions.	1008	No	0x0000
88	Invalid Wheel Size	Triggered when the ATP detects a wheel size outside the allowed range.	1	ATP	perform a valid wheel size calibration. If the problem persists, replace the EEPROM.	1008	No	0x0000
89	Invalid Wheel Size Complement	Triggered when the ATP reads the wheel size from the EEPROM but the complement of the wheel size does not match.	1	ATP	Perform a valid wheel size calibration. If the problem persists, replace the EEPROM.	1008	No	0x0002
90	Bad Track ID	A track circuit ID was detected that is not in the ATP track map.	1	ATP	This is a wayside track circuit problem. The track circuit has the wrong track ID programmed.	1008	No	0x0000
91	Departure Test 6840 speed test failed	Departure Test 6840 speed test failed	1	ATP	Key off and key back on the cab. Then run departure test again. If problem persists replace the Multifunction PCB.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
92	Departure Test VIA speed test failed	Departure Test VIA speed test failed	1	ATP	Key off and key back on the cab. Then run departure test again. If problem persists replace the Multifunction PCB.	1008	No	0x0000
93	Street Mode entered automatically	Street Mode was entered automatically	3	ATP	Informational event. No reset conditions.	1008	No	0x0000
101	Invalid Direction	Triggered when the CSRD is reporting a direction value outside the allowed range	1	ATP	Informational event. No reset conditions.	1008	Yes	0x0000
102	Track ID Out of Sequence	Triggered when the ATP detects a track circuit ID that is out of the expected order of track circuits	1	ATP	Check wayside equipment for proper functionality. If the problem persists, replace the CSRD board.	1008	Yes	0x0000
103	Lost Cab Signal	Triggered when the CSRD loses cab signal or the cab signal message cannot be validated	1	ATP	Run the departure test and verify that the test passes. If the test fails check for the following events: ATP CSRD Failure Event Rcvd, ATP_CSRD Module Fail, CSRD FSK Message Cleared Due to Mismatch.	1008	Yes	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
105	Invalid Orientation	Triggered when the orientation of the vehicle cannot be determined	1	ATP	Have the vehicle cross a wayside bond in either ATP or ATO mode to re-establish orientation.	1008	No	0x0000
106	Sudden Speed Limit Downgrade Occurred	Triggered when the ATP detects a sudden downgrade in the allowed speed limit.	2	ATP	Informational event. No reset conditions.	1008	No	0x0002
107	Enforced Speed Limit has been exceed	Triggered when the vehicle speed is above the allowed speed limit.	2	ATP	Bring the vehicle under the speed limit and acknowledge any alarms	1008	No	0x0002
108	Target track circuit not found	Triggered when the target track circuit ID is outside the tabled track circuits.	1	ATP	Verify wayside equipment is functioning properly. If problem persists, replace the CSRD board.	1008	No	0x0000
109	The ATO link is down	Triggered when communication from the ATP to the ATO is lost	1	ATP	Verify both the ATP and ATO boards are securely installed in the ATC rack. Verify the power supply voltages are within tolerance. If problem persists, replace the ATO board. If problem still persists, replace the ATP board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
110	The ATP has reported the CSRD self test to have failed.	Triggered when the ATP receives a failed self test status from the CSRD	1	ATP	Rerun a departure test. If the problem persists, replace the CSRD board.	1008	No	0x0000
111	The wheel size has been updated from the PTU	Triggered when the user updates the wheel size from the PTU	3	ATP	Informational event. No reset conditions.	1008	No	0x0000
112	The wheel size has been updated from the TOD	Triggered when the user updates the wheel size from the TOD	3	ATP	Informational event. No reset conditions.	1008	No	0x0000
113	The PVID has been updated	Triggered when the user updates the PVID	3	ATP	Informational event. No reset conditions.	1008	No	0x0002
114	The software upload had started	Triggered when a software upload has been requested and accepted by the ATP system	3	ATP	Informational Event. No reset conditions.	1008	No	0x0002
115	Doors are open while vehicle is moving	Triggered when the doors are open while the vehicle is moving above the No Motion limit of 0.5 mph.	1	ATP	Close the doors and bring the vehicle to a stop. Press acknowledge to clear any alarms. If problem persists, reset the ATC rack.	1008	No	0x0000
116	Vehicle release pressed while in ATO and moving	Triggered when the release pushbutton is pressed while in AUTO mode and the vehicle is in motion.	1	ATP	Depress the release pushbutton.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
118	Speed was detected while in the dept. test	Triggered when the ATP detects speed pulses while the departure test is running.	1	ATP	Informational Event. No reset conditions.	1008	No	0x0000
119	Brake assurance has failed	Triggered during an overspeed condition and the required brake assurance rate of 2.0 mph/s was not achieved	1	ATP	If the problem persists, check the braking system on the vehicle to ensure adequate brakes are being applied. Check the decelerometer calibration is valid.	1008	No	0x0000
120	The OSL profile has been exceeded	Triggered during ATO mode when the ATO has exceeded the OSL profile and the ATP applied brakes	1	ATP	Reset when the vehicle speed is below the speed limit	1008	No	0x0000
121	Brake monitoring has failed	Triggered when the brake monitoring function has determined the brakes are not achieving the required deceleration rate of 1.12 mph/s on a type II system.	1	ATP	Check the braking system to ensure adequate braking is being achieved	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
122	Fifteen ft. distance in Marine bumper track exceeded	If the ATP position is greater than 15 feet when the vehicle is travelling west and the track circuit ID is the Marine platform exit track the ATP will apply the EB.	1	ATP	There is no clearing this event. The operator has to change the train direction and position the train in the Marine platform track.	1008	No	0x0000
123	Too far into Marine bumper with a missed bond	If the ATP misses the exit bond of the Marine platform track and the vehicle is travelling west and the track circuit ID is the Marine platform exit track the ATP will apply the EB.	1	ATP	There is no clearing this event. The operator has to change the train direction and position the train in the Marine platform track.	1008	No	0x0000
124	Train length reported by MVB is out of range	The vehicle is reporting a train length greater than 3 or the MVB is down. When the MVB is down the train length sent to the ATC is 15.	1	ATP	Check that the vehicle TCMS is functioning correctly.	1008	No	0x0000
125	Friction fault while doors not closed	The vehicle has indicated there are no friction brakes applied while the doors are open. Per CPUC guidelines brakes must be applied while doors are open. EB is applied to insure brakes are applied.	1	ATP	Will clear once vehicle indicates friction brakes are applied.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
126	Illegal reverse	Vehicle put into reverse while in ATP or ATO mode. Reverse is only allowed in car wash mode.	1	ATP	Will clear once the reverser is Forward.	1008	No	0x0000
127	Speed detected during ATP reset	The multifunction PCB is reporting that the train is still moving while the system is starting up.	1	ATP	If train is at Vzero and event is triggered replace multifunction PCB.	1008	No	0x0000
128	Doors are enabled	Informational event that the FSB is applied because the doors are enabled.	3	ATP	N/A	1008	No	0x0000
130	Doors are not closed	Informational event that the FSB is applied because the doors are open.	3	ATP	N/A	1008	No	0x0003
131	Software upload brakes	Informational event that the FSB is applied because software is being loaded.	3	ATP	N/A	1008	No	0x0002
132	The doors have been overridden by the operator	The operator has used the door enable bypass function on the ADU.	2	ATP	N/A	1008	No	0x0000
133	FSK Cab Signal was detected at the start of Dept Test	The ATP detected FSK cab signal at Dept Test start and will use this signal to test cab antennas (Type II only)	3	ATP	N/A	1007	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
134	FSK Cab Signal was not detected at the start of Dept Test	The ATP did not detect FSK cab signal at Dept Test start and will use signal the ATO to generate a test signal (Type II only)	3	ATP	N/A	1007	No	0x0000
135	The emergency brake has been applied by an outside subsystem.	Informational event where the emergency brake has been applied by an outside subsystem.	3	ATP	The event will reset when the conditions are no longer met.	1008	No	0x0000
136	The ATP has inhibited the ATO from moving.	The ATP has detected a track that is not allowed while in ATO mode. A UES brake is applied.	1	ATP	The ATC will need to be bypassed. Reset the ATC once the vehicle is no longer in the non permitted track circuit.	1008	No	0x0000
137	Friction brake is not applied and the door are not closed.	The vehicle has indicated there are no friction brakes applied while the doors are open and the vehicle is stopped. Per CPUC guidelines brakes must be applied while doors are open. EB is applied to insure brakes are applied.	1	ATP	Will clear once vehicle indicates friction brakes are applied.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
900	Attempt to change EEPROM while not in manual mode	The EEPROM data tried to be updated in an invalid state.	3	ATP	Place vehicle into manual mode.	1008	No	0x0002
901	Attempt to change EEPROM while not at Vzero	The EEPROM data tried to be updated in an invalid state.	3	ATP	Make sure the vehicle is at Vzero.	1008	No	0x0002
902	Attempt to change EEPROM while propulsion request	The EEPROM data tried to be updated in an invalid state.	3	ATP	Make sure the master controller is in the FSB position.	1008	No	0x0000
903	The time to adjust EEPROM data has expired	The timeout has expired to update EEPROM data.	3	ATP	N/A	1008	No	0x0000
904	The decel calibration flag has been cleared	Triggered when the ATP clears the decelerometer calibration flag in EEPROM. This could occur during a failed calibration session, if the decelerometer becomes unstable, or if the EEPROM data becomes corrupted	2	ATP	Perform a successful decelerometer calibration.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
905	The EEPROM defaults have been restored	Triggered when the ATP tries to read the EEPROM but the data returned is corrupted or the complement of the data does not match the stored value.	2	ATP	informational event. No reset conditions.	1008	No	0x0000
906	EEPROM - brakes not set	The EEPROM data tried to be updated in an invalid state.	2	ATP	Make the sure the friction brakes applied input is on.	1008	No	0x0000
1001	Branch test failure	An internal CPU diagnostic has executed a branch command but returned to the incorrect address	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1002	Register Test Failure	An internal CPU diagnostic has found an error while testing the internal registers of the CPU. The CPU Tried to read/write to a CPU register but never received a response	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1003	Instruction Test Failure	An internal CPU diagnostic tested all assembly instructions and determined the improper response was received.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1004	Stack Test Failure	An internal CPU diagnostic determined that the stack pointer has become corrupted.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1005	ROM Test Failure	The Read only memory of the microprocessor has been corrupted and cannot be read	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1006	RAM Test Failure	The Random access memory of the microprocessor has been corrupted and cannot be used	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1007	Address Bus Test	The address lines of the microprocessor have become unstable or corrupted.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1008	Data Bus Test	The information on the data bus has become unstable or corrupted.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1009	Stack Boundaries Corrupted	The microprocessor stack pointer was tested and found to be outside the allocated range	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1010	Bad Return Address	The CPU has failed to function properly due to a microprocessor return address invalid	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1011	Time Source Failure	The CPU has failed to function properly due to a microprocessor failure of the primary or secondary time source interrupt falling outside the allowed range	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1012	Task Checksum Failure	The CPU got caught in an infinite loop or the processing time was longer than the allowed cycle time.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1013	Invalid Exception	The CPU has detected an undefined interrupt or unexpected interrupt.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1014	EEPROM Write Failure	The EEPROM never returned a write success or the write instruction timed out.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1015	Destructor was called	The CPU tried to execute code inside the class destructor which should never be executed. The failure caused the CPU to shut down.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1016	Bus Error	The Bus lines on the ATP are corrupted or unresponsive	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1017	Vital Input 1 Task Error	The vital input driver did not execute all expected functions within the driver	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1009	No	0x0000
1018	Vital Input 2 Task Error	The vital input driver did not execute all expected functions within the driver	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1009	No	0x0000
1019	Multifunction Board Task Error	the multifunction board driver did not execute all the expected functions within the driver	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1012	No	0x0000
1020	Mixed Vital I/O Board Task Error	The Mixed Vital I/O board driver did not execute all the expected functions within the driver	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1021	ATP Task Called Error	The ATP processor failed to execute all of the expected ATP logic.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1022	Pure Virtual Function Called	This error is received when the c++ has a run-time problem resolving a function address	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1023	Spurious Interrupt	The spurious interrupt handler was executed unexpectedly, which caused the ATP processor to fail.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0000
1024	Mine Field Encountered	The CPU processor has a corrupted program counter or memory that caused the program counter to jump to an undefined area in memory.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1025	Database Comparison Error	An internal comparison of the track map failed.	1	ATP	Reset the ATC CB. If the problem persists replace the ATP CPU.	1008	No	0x0002
1028	System Startup	Informational event of when the ATC startups.	3	ATP	N/A	1008	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1029	Vital Variable Compare Error	Both copies of the vital variable do not match at the end of the cycle. The double path function that sets the variable produced different results for each copy.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1030	Vital Variable Bounds Check	A vital variable was set to a value that is outside the allowed range for that variable.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1031	Vital Variable Invoke Instantiation	There are too many vital variables or the CPU memory has become corrupted.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1032	Vital Variable Vital Table Corrupted	The CPU detected a vital variable that was declared but never initialized or the vital index pointer is outside the allowable range.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1033	Vital Variable Bad Pointer	The internal vital diagnostics has determined a mismatch on a vital variable pointer.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1034	Vital Variable Checksum Error	The checksum of the vital variable's allowed values or the table of allowed values has become corrupted.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1035	Vital Variable Vital Timer Mismatch	one copy of the vital timer does not match the other copy and cannot be trusted. The failure caused the CPU to shut down.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1036	Vital Variable Table Echo Failure	The vital variable table has become corrupted.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1037	Vital Variable array index out of bounds	The vital variable index has been set to a value outside the allowable range.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1008	No	0x0002
1038	Mixed IO Board Task Error	The mixed I/0 board missed or failed to execute all expected functions.	1	ATP	Reset the ATP processor. If the problem persists, replace the ATP processor board.	1011	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1039	EEPROM Write Verify Failure	Triggered when a write to the EEPROM is executed but when reading back the data, the values do not match.	1	ATP	Reset the ATP processor. If the problem persists, replace the EEPROM board. If the problem still persists, replace the ATP processor board.	1008	No	0x0000
1040	ATP Application CRC mismatch	Triggered when the calculated CRC does not match the CRC stored in memory	1	ATP	Reprogram the ATP Application logic. If the problem persists, replace the ATP CPU Board.	1008	No	0x0000
1041	Track circuit detected without a bond detect	Triggered when the ATP detects a new track circuit ID without validating a bond crossing.	1	ATP	The event will reset automatically. If problem persists (event occurs more than 20 times on a single Type II round trip) verify the installation of the pickup coils. Verify that the height is 3-6 inches above top of rail. Also, run the departure test and verify departure test passes.	1008	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
1042	Unable to access bond data due to SPI being busy	Triggered when the ATP processor is too busy to process a bond crossing event.	1	ATP	Informational event. No reset condition.	1008	No	0x0002
2000	Vital Input 1 PCB Parent	N/A	1	ATP	N/A	1009	No	0x0000
2001	Vital Input 1 - Echo Register Error	An internal hardware check of the vital input board failed.	1	ATP	Reset the ATC CB. If the problem persists replace the vital input board.	1009	No	0x0000
2002	Vital Input 1 - Type Error	An internal hardware check of the vital input board failed.	1	ATP	Reset the ATC CB. If the problem persists replace the vital input board.	1009	No	0x0000
2003	Vital Input 1 - VPA Compare Error	An internal hardware check of the vital input board failed.	1	ATP	Reset the ATC CB. If the problem persists replace the vital input board.	1009	No	0x0000
2004	Vital Input 1 - Input 1 Unstable	Input 1 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Master Controller FSB A.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2005	Vital Input 1 - Input 2 Unstable	Input 2 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Master Controller Coast A.	1009	No	0x0000
2006	Vital Input 1 - Input 3 Unstable	Input 3 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Master Controller FSB B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2007	Vital Input 1 - Input 4 Unstable	Input 4 on the vital input board has toggled between states enough to reach the instability limit... 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Master Controller Coast B.	1009	No	0x0000
2008	Vital Input 1 - Input 5 Unstable	Input 5 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, A End.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2009	Vital Input 1 - Input 6 Unstable	Input 6 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, B End.	1009	No	0x0000
2010	Vital Input 1 - Input 7 Unstable	Input 7 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Type I.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2011	Vital Input 1 - Input 8 Unstable	Input 8 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Type II.	1009	No	0x0000
2012	Vital Input 1 - Input 9 Unstable	Input 9 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, ATP Bypass.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2013	Vital Input 1 - Input 10 Unstable	Input 10 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Doors Closed A.	1009	No	0x0000
2014	Vital Input 1 - Input 11Unstable	Input 11 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Doors Closed B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2015	Vital Input 1 - Input 12 Unstable	Input 12 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal Friction Brakes Applied A.	1009	No	0x0000
2016	Vital Input 1 - Input 13 Unstable	Input 13 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Friction Brakes Applied B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2017	Vital Input 1 - Input 14 Unstable	Input 14 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Friction Brake Fault.	1009	No	0x0000
2018	Vital Input 1 - Input 15 Unstable	Input 15 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Propulsion Fault.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2019	Vital Input 1 - Input 16 Unstable	Input 16 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, ATP Acknowledge.	1009	No	0x0000
2020	Vital Input 1 - Input 1 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Master Controller FSBA.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2021	Vital Input 1 - Input 2 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Master Controller Coast A.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2022	Vital Input 1 - Input 3 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Master Controller FSB B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2023	Vital Input 1 - Input 4 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Master Controller Coast B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2024	Vital Input 1 - Input 5 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, A End.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2025	Vital Input 1 - Input 6 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, B End.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2026	Vital Input 1 - Input 7 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Type I.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2027	Vital Input 1 - Input 8 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Type II.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2028	Vital Input 1 - Input 9 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, ATP Bypass.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2029	Vital Input 1 - Input 10 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Doors Closed A.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2030	Vital Input 1 - Input 11 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Doors Closed B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2031	Vital Input 1 - Input 12 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Friction Brakes Applied A.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2032	Vital Input 1 - Input 13 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Friction Brakes Applied B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2033	Vital Input 1 - Input 14 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Friction Brake Fault.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2034	Vital Input 1 - Input 15 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Propulsion Fault.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2035	Vital Input 1 - Input 16 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, ATP Acknowledge.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2036	Vital Input 1 - Input 1 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Master Controller FSB A.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2037	Vital Input 1 - Input 2 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Master Controller Coast A.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2038	Vital Input 1 - Input 3 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Master Controller FSB B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2039	Vital Input 1 - Input 4 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Master Controller Coast B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2040	Vital Input 1 - Input 5 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, A End.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2041	Vital Input 1 - Input 6 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, B End.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2042	Vital Input 1 - Input 7 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Type I.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2043	Vital Input 1 - Input 8 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Type II.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2044	Vital Input 1 - Input 9 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, ATP Bypass.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2045	Vital Input 1 - Input 10 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Doors Closed A.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2046	Vital Input 1 - Input 11 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Doors Closed B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2047	Vital Input 1 - Input 12 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Friction Brakes Applied A.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2048	Vital Input 1 - Input 13 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Friction Brakes Applied B.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2049	Vital Input 1 - Input 14 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Friction Brake Fault.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2050	Vital Input 1 - Input 15 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Propulsion Fault.	1009	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2051	Vital Input 1 - Input 16 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 1 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, ATP Acknowledge.	1009	No	0x0000
2100	Vital Input 2 PCB Parent	N/A	1	ATP	N/A	1010	No	0x0000
2101	Vital Input 2 - Echo Register Error	An internal hardware check of the vital input board failed.	1	ATP	Reset the ATC CB. If the problem persists replace the vital input board.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2102	Vital Input 2 - Type Error	An internal hardware check of the vital input board failed.	1	ATP	Reset the ATC CB. If the problem persists replace the vital input board.	1010	No	0x0000
2103	Vital Input 2 - VPA Compare Error	An internal hardware check of the vital input board failed.	1	ATP	Reset the ATC CB. If the problem persists replace the vital input board.	1010	No	0x0000
2104	Vital Input 2 - Input 1 Unstable	Input 1 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Manual Mode.	1010	No	0x0000
2105	Vital Input 2 - Input 2 Unstable	Input 2 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, ATO Mode.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2106	Vital Input 2 - Input 3 Unstable	Input 3 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, M Trainline.	1010	No	0x0000
2107	Vital Input 2 - Input 4 Unstable	Input 4 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, CM Trainline.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2108	Vital Input 2 - Input 5 Unstable	Input 5 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Power Cut.	1010	No	0x0000
2109	Vital Input 2 - Input 6 Unstable	Input 6 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Forward.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2110	Vital Input 2 - Input 7 Unstable	Input 7 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Reverse.	1010	No	0x0000
2111	Vital Input 2 - Input 8 Unstable	Input 8 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, EB Applied.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2112	Vital Input 2 - Input 9 Unstable	Input 9 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Safety Relay Backcheck Forward.	1010	No	0x0000
2113	Vital Input 2 - Input 10 Unstable	Input 10 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Safety Relay Backcheck Reverse.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2114	Vital Input 2 - Input 11 Unstable	Input 11 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Safety Relay Backcheck Power Cut.	1010	No	0x0000
2115	Vital Input 2 - Input 12 Unstable	Input 12 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Vzero Backcheck.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2116	Vital Input 2 - Input 13 Unstable	Input 13 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Safety Relay Back Check Departure Test Select.	1010	No	0x0000
2117	Vital Input 2 - Input 14 Unstable	Input 14 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2118	Vital Input 2 - Input 15 Unstable	Input 15 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Spare.	1010	No	0x0000
2119	Vital Input 2 - Input 16 Unstable	Input 16 on the vital input board has toggled between states enough to reach the instability limit. 3 of 20 samples during the 20 ms sampling period disagree with the other 17 reads. The input is considered off until the condition clears.	1	ATP	Ensure the vital input board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2120	Vital Input 2 - Input 1 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Manual Mode.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2121	Vital Input 2 - Input 2 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, ATO Mode.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2122	Vital Input 2 - Input 3 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, M Trainline.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2123	Vital Input 2 - Input 4 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, CM Trainline.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2124	Vital Input 2 - Input 5 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Power Cut.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2125	Vital Input 2 - Input 6 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Forward.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2126	Vital Input 2 - Input 7 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Reverse.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2127	Vital Input 2 - Input 8 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, EB Applied.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2128	Vital Input 2 - Input 9 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Safety Relay Backcheck Forward.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2129	Vital Input 2 - Input 10 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Safety Relay Backcheck Reverse.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2130	Vital Input 2 - Input 11 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Safety Relay Backcheck Power Cut.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2131	Vital Input 2 - Input 12 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2132	Vital Input 2 - Input 13 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Safety Relay Backcheck Departure Test Select.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2133	Vital Input 2 - Input 14 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2134	Vital Input 2 - Input 15 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2135	Vital Input 2 - Input 16 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2136	Vital Input 2 - Input 1 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital input board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure, Manual Mode.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2137	Vital Input 2 - Input 2 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, ATO Mode.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2138	Vital Input 2 - Input 3 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, M Trainline.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2139	Vital Input 2 - Input 4 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, CM Trainline.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2140	Vital Input 2 - Input 5 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, Power Cut.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2141	Vital Input 2 - Input 6 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, Forward.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2142	Vital Input 2 - Input 7 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, Reverse.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2143	Vital Input 2 - Input 8 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, EB Applied.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2144	Vital Input 2 - Input 9 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, Safety Relay Backcheck Forward.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2145	Vital Input 2 - Input 10 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, Safety Relay Backcheck Reverse.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2146	Vital Input 2 - Input 11 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, Safety Relay Backcheck Power Cut.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2147	Vital Input 2 - Input 12 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2148	Vital Input 2 - Input 13 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issue is outside of the ATC enclosure and is causing the input to remain in an active state, Safety Relay Backcheck Departure Test Select.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2149	Vital Input 2 - Input 14 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2150	Vital Input 2 - Input 15 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2151	Vital Input 2 - Input 16 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state.	1	ATP	Ensure the Vital Input board 2 is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the vital input board. If the problem still persists, the issues are outside of the ATC enclosure and are causing the input to remain in an active state, Spare.	1010	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2201	Multifunction Board Echo Register Error	The ATP processor tried to write a value to the multifunction board but did not receive a response.	1	ATP	Ensure the correct multifunction board is installed. Ensure the board is securely plugged into the correct slot inside the card file. Ensure no bent pins on the backplane and the board. If the problem persists, replace the multifunction board.	1012	No	0x0000
2202	Multifunction Board Type Register Error	The ATP processor was expecting a different multifunction board type than what was received.	1	ATP	Ensure the correct multifunction board is installed. Ensure the board is securely plugged into the correct slot inside the card file. Ensure no bent pins on the backplane and the board. If the problem persists, replace the multifunction board.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2203	Multifunction Board Write Compare Error	The echo and type checks passed on the multifunction board, but the read back returned a different value than what was written.	1	ATP	Ensure the correct multifunction board is installed. Ensure the board is securely plugged into the correct slot inside the card file. Ensure no bent pins on the backplane and the board. If the problem persists, replace the multifunction board.	1012	No	0x0000
2204	Decelerometer ADC busy	The multifunction board tried to read the decelerometer but the register reported a busy status.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. If the problem persists, replace the multifunction board.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2207	Decelerometer not near zero	The ADC circuit was briefly turned off to verify the ADC circuit was not stuck high. The test turned off the circuit, but was still reading values from the ADC.	2	ATP	If this event occurs during ATC System Startup and shortly after the Departure Test, then no maintenance event is necessary. If this event occurs after ATC is fully booted-up and not after a departure test, then perform the following below. Check the multifunction board is securely plugged into the correct slot inside the card file. Check the 5v reference voltages on the power supply. Check the + and -12v reference voltages on the power supply to ensure they are within tolerance. Verify ground connections are installed and secure since this is typically an outside noise issue.	1012	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2207 (cont'd.)	Decelerometer not near zero	The ADC circuit was briefly turned off to verify the ADC circuit was not stuck high. The test turned off the circuit, but was still reading values from the ADC.	2	ATP	If the problem persists, replace the decelerometer and multifunction board. If the problem still persists, the issue is outside the ATC enclosure	1012	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2208	Decelerometer not stable	This event is associated with the Decelerometer bad data and Decelerometer not near 0 events. If either of the above events is triggered long enough, a hardware error is declared and the unstable event is triggered.	1	ATP	Check the multifunction board is securely plugged into the correct slot inside the card file. Check the 5v reference voltages on the power supply. Check the + and -12v reference voltages on the power supply. Verify ground connections are installed and secure. Perform a static 10 turns test on the decelerometer to ensure the accuracy. If the problem persists, replace the decelerometer and multifunction board.	1012	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2209	Decelerometer is reporting bad values	The decelerometer readings from the analog to digital converters are reporting values outside of the allowed tolerance.	1	ATP	Check the multifunction board is securely plugged into the correct slot inside the card file. Check the 5v reference voltages on the power supply. Check the + and - 12v reference voltages on the power supply. Verify ground connections are installed and secure. If the problem persists, replace the multifunction board. If the problem still persists, replace the power supply.	1012	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2210	Decel Cal Invalid - Low Fluid	Triggered when the low fluid algorithm is reporting that the decelerometer acceleration rate is above the calculated tachometer rate for 4 out of the last 5 tests. The decelerometer calibration is invalidated and all brake rates are set to 0.	1	ATP	Perform a static 10 turns test on the decelerometer to ensure proper readings. Recalibrate the decelerometer. If the problem persists, replace the decelerometer. If the problem still persists, replace the multifunction board.	1012	Yes	0x0000
2211	Non-Vital Input 0 Unstable	Input 1 on the multifunction board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the multifunction board, Track Brake Applied.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2212	Non-Vital Input 1 Unstable	Input 2 on the multifunction board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the multifunction board, TWC Cutout.	1012	No	0x0000
2213	Non-Vital Input 2 Unstable	Input 3 on the multifunction board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the multifunction board, Spare.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2214	Non-Vital Input 3 Unstable	Input 4 on the multifunction board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the multifunction board, Spare.	1012	No	0x0000
2215	Non-Vital Input 4 Unstable	Input 5 on the multifunction board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the multifunction board, Safety Relay Backcheck Amp Power A End.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2216	Non-Vital Input 5 Unstable	Input 6 on the multifunction board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the multifunction board, Safety Relay Backcheck Amp Power B End.	1012	No	0x0000
2217	Non-Vital Input 6 Unstable	Input 7 on the multifunction board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the multifunction board, Battery Over Voltage.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2218	Non-Vital Input 7 Unstable	Input 8 on the multifunction board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the multifunction board, Battery Under Voltage.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2219	Vital Output 0 Fail	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the multifunction board. If the problem still persists, the issues are outside of the ATC enclosure, Forward.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2220	Vital Output 1 Fail	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the multifunction board. If the problem still persists, the issues are outside of the ATC enclosure, Reverse.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2221	Vital Output 2 Fail	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the multifunction board. If the problem still persists, the issues are outside of the ATC enclosure, Power Cut.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2222	Vital Output 3 Fail	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pits are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the multifunction board. If the problem still persists, the issues are outside of the ATC enclosure, Spare.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2223	Vital Output 4 Fail	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pits are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the multifunction board. If the problem still persists, the issues are outside of the ATC enclosure, Spare.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2224	Vital Output 5 Fail	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pits are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the multifunction board. If the problem still persists, the issues are outside of the ATC enclosure, Spare..	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2225	Vital Output 6 Fail	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the multifunction board. If the problem still persists, the issues are outside of the ATC enclosure, Departure Test Select.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2226	Vital Output 7 Fail	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the multifunction board. If the problem still persists, the issues are outside of the ATC enclosure, Spare.	1012	No	0x0000
2227	Monitor Fail	The monitor circuit that ensures the outputs are in the expected state has reported a critical error to the CPU board.	1	ATP	Ensure the multifunction board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. If the problem persists, replace the multifunction board.	1012	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2228	Decel test not run within maximum distance	Test not run within 100 miles and decel needs re-calibrated.	1	ATP	Calibrate decel.	1016	No	0x0000
2231	Decel low fluid test failed	informational event triggered when all criteria for the low fluid test have been satisfied and the test failed within the required distance	1	ATP	Perform a static 10 turns test on the decelerometer to ensure proper readings. Recalibrate the decelerometer. If the problem persists, replace the decelerometer. If the problem still persists, replace the multifunction board.	1016	Yes	0x0002
2232	Decel low fluid test passed	Triggered when all criteria for the low fluid test have been satisfied and the test passed within the required distance	3	ATP	no reset conditions. This is an informational event.	1016	No	0x0002
2400	CSRD PCB Parent	No trigger conditions, this is a parent ID	1	ATP	No reset conditions for Parent ID	1007	No	0x0000
2401	CSRD Ch1 Msg Bad CRC Error	Triggered when the CSRD channel 1 message to the ATP has a CRC error.	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2402	CSRD Ch2 Msg Bad CRC Error	Triggered when the CSRD channel 2 message to the ATP has a CRC error.	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002
2405	CSRD Ch1 Msg Seq Num Error	Triggered when the CSRD channel 1 sequence number is stale or corrupted	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002
2406	CSRD Ch2 Msg Seq Num Error	Triggered when the CSRD channel 2 sequence number is stale or corrupted	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002
2409	CSRD Imp Msg Bad CRC Error	Not used.	1	ATP	Not used.	1007	No	0x0002
2410	CSRD Imp Msg Seq Num Error	Not used.	1	ATP	Not used.	1007	No	0x0002
2411	ATP CSRD Sts Msg Bad CRC Error	Triggered when the CSRD status message has a CRC error.	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002
2412	ATP CSRD Sts Msg Seq Num Error	Triggered when the CSRD Status message sequence number is corrupted or stale.	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002
2413	CSRD Invalid	Corrupted message.	1	ATP	If issue persists reset the ATC rack.	1007	No	0x0002
2414	CSRD Undefined	The CSRD has triggered an event that is listed as a valid event, but undefined in the ATP system.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2415	CSRD Unknown	The CSRD has triggered an event that is listed as a valid event, but undefined in the ATP system.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2416	CSRD Data Bus Err	The internal diagnostic on the CSRD has determined the data bus on the CSRD is corrupted or failed	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2417	CSRD Address Bus Err	The internal diagnostic on the CSRD has determined the address bus on the CSRD is corrupted or failed	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2418	CSRD Power on Ram Err	The CSRD performed a memory check on the RAM boundaries and the check has failed	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2419	CSRD Periodic Ram Err	The CSRD performed a memory check on the RAM and the check has failed	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2420	CSRD Power on Code Err	The CSRD has shut down because it detected a code rate before completing the power up sequence	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2421	CSRD Periodic Code Err	The CSRD has shut down because it detected a code rate before completing the power up sequence	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2422	CSRD Reg Test Err	An internal CSRD diagnostic has detected an error with one of its registers and shut down.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2423	CSRD Instruct Test Err	The CSRD has failed an internal diagnostic on one of the assembly instruction tests.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2424	CSRD Stack Bounds Err	The CSRD has detected that the internal stack bounds are outside of the allowed tolerance	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2425	CSRD Spurious Interrupt	The CSRD has encountered an interrupt that is not defined in the vector table. The spurious interrupt handler has been called and caused a system error.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2426	CSRD Task Checksum Err	Not all the executive functions were called within the allowed cycle time which caused the checksum mismatch.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2427	CSRD Invalid Bool	The CSRD has detected that the boot program has failed to launch or does not exist	1	ATP	Power cycle the ATC rack. If the problem persists, reload the boot program. If the problem still persists, replace the CSRD.	1007	No	0x0002
2428	CSRD Invalid Int	The internal INT16 type has become corrupted	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD.	1007	No	0x0002
2429	CSRD Invalid Int16	The internal INT16 type has become corrupted	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD.	1007	No	0x0002
2430	CSRD Invalid U Byte	The internal U_BYTE type has become corrupted	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2431	CSRD Invalid U Int	the internal U_INT32 type has become corrupted	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2432	CSRD Invalid U Int16	the internal U_INT16 type has become corrupted	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2433	CSRD Invalid U Int32	the internal U_INT32 type has become corrupted	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2434	CSRD Inv Sys Cal Msg	The ATP has communicated to the CSRD an invalid system calibration message. The message was corrupted going to the CSRD	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2435	CSRD Inv Sys Command Msg	The ATP has communicated to the CSRD an invalid system command message. The message was corrupted going to the CSRD	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2436	CSRD Inv Test Sig Type	Triggered when an unknown test signal type is received by the CSRD	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2437	CSRD No New Msg Data	The CSRD expects periodic messages from the ATP and has not received a new message in the allocated time.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2438	CSRD Inv Ch Freq	The CSRD tested its hardware by using a known test signal, but the signal returned an unexpected value and caused the CSRD to shut down.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2439	CSRD Inv Imp Aspect Num	Triggered when the CSRD reports an aspect number outside of the allowed range	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2440	CSRD Inv Imp Cycle To Detect	Triggered when the CSRD has detected a cycle to detect outside the allowed range.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2441	CSRD Inv Imp Period	Triggered when the CSRD detects an impulse period outside the allowed range	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2442	CSRD Inv Mc Aspect Num	Triggered when the CSRD detects an modulated carrier aspect number outside the allowed range	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2443	CSRD Inv Mc Dual Carrier Mode	Triggered when the CSRD detects an invalid modulated dual carrier mode.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2444	CSRD Inv Mc Duty Cycle	Triggered when the CSRD detects a duty cycle outside the allowed range of the modulated carrier mode.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2445	CSRD Inv Mc Period	Triggered when the CSRD detects a period outside the allowed range while in modulated carrier mode	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2446	CSRD Inv Mc Trans To Detect	Triggered when the CSRD detects the transitions to detect has fallen outside the allowed range for modulated carriers	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board	1007	No	0x0002
2447	CSRD Cycle Timer Config	Triggered when the CSRD cycle timer configuration has fallen outside the allowed tolerance.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2448	CSRD Crit Comp Chk Failure	Triggered when one processor disagrees with the other processor and the CSRD goes into a system failure	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board	1007	No	0x0002
2449	CSRD Crit Demod Test Failure	Triggered when the demodulation test reports a failure	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2450	CSRD Demod Test Required	Triggered when the CSRD determines that a CSRD Self Test is required	3	ATP	Run a departure test. If the problem persists, replace the CSRD board.	1007	No	0x0000
2451	CSRD Test Def Freq Mismatch	Triggered when the test frequency's between processors have a mismatch	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2458	CSRD Board has been reset	Triggered by the CSRD on power up.	3	ATP	Informational Event. No reset conditions.	1007	No	0x0002
2459	CSRD UART 1 Framing Error	Triggered when the CSRD detects a UART 1 Framing Error	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2460	CSRD UART 1 Overrun Error	Triggered when the CSRD UART 1 Overrun Error is detected by the CSRD.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2461	CSRD UART 1 Rx Queue Full	Triggered when the UART 1 Rx Queue is full	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2462	CSRD Rx Wait Time Exceeded	Triggered when the RX wait timer has expired	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2463	CSRD Invalid System Calibration	Triggered when the CSRD detects a corrupted or missing System Calibration value.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2464	CSRD Invalid System Command	Triggered when the System Command message is corrupted	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2465	CSRD UART 1 Tx Queue Full	Triggered when the CSRD UART 1 transmit queue is full	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2466	CSRD UART 1 Tx Queue Overrun Error	Triggered when the Transmit queue on UART 1 has an overrun in its limits	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2467	CSRD Arbitration Wait Time Exceeded	Triggered when the CSRD Arbitration wait time exceeded its maximum value.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2475	CSRD LEDs Disabled	Triggered when the CSRD receives the disable LED command by the ATP.	3	ATP	Informational Event. Power cycle the ATC rack.	1007	No	0x0002
2476	CSRD Invalid Test Signal Type Received	Triggered when an unknown test signal type is received by the CSRD	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2477	CSRD Safe Aspect Message Data Used	Triggered when the safe aspect message data is being used by the CSRD	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002
2478	CSRD Safe Test Message Data Used	Triggered when the CSRD safe Test message data is being used.	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2479	CSRD Configuration CRC Error	Triggered when the CSRD configuration CRC error is received.	1	ATP	If the problem persists, Reload the System Configuration file on both the Xilinx and Altera processors. See SMI document (Attachment #2) If the problem persists, replace the CSRD board.	1007	No	0x0002
2480	CSRD Project Configuration CRC Error	The CSRD project configuration has a CRC error and cannot be trusted	1	ATP	If the problem persists, Reload the Project Configuration file on both the Xilinx and Altera processors. See SMI document (Attachment #2).If the problem persists, replace the CSRD board.	1007	No	0x0002
2481	CSRD Configuration Invalid	Triggered when the CSRD configuration file is invalid.	1	ATP	Reload the configuration files. If the problem persists, replace the CSRD board.	1007	No	0x0002
2484	CSRD Impulse Aspect Mismatch	Not used.	3	ATP	Not used.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2490	CSRD FSK Message Cleared Due to Mismatch	Triggered when a mismatch in the data between the two halves of the CSRD disagree.	3	ATP	Key down cab and restart. If problem persists move the train out of the current track circuit in ATC Bypass mode.	1007	No	0x0002
2496	CSRD Invalid Project Configuration	Triggered when the project configuration is detected to be invalid.	1	ATP	Reload the Project Configuration file on both processors. If the problem persists, replace the CSRD board.	1007	No	0x0002
2497	CSRD Bad FSK CRC	A track circuit message with a bad CRC was detected.	3	ATP	Informational event. If the problem persists verify that the receiver coils are 3-6 inches above the top of rail. Run departure test if departure test fails replace CSRD PCB.	1007	No	0x0003
2498	CSRD Arbitration Timed Out	CSRD Arbitration Timed Out	3	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	
2499	CSRD CRC Error	CSRD detected a CRC error	3	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2500	ATP FSK Message Bad CRC Error	The ATP received a track circuit message from the CSRD with a bad CRC.	1	ATP	Informational event. If the problem persists, replace CSRD PCB.	1007	No	0x0002
2501	ATP FSK Message Sequence Number Error	The ATP received a track circuit message from the CSRD with a bad sequence number.	1	ATP	Informational event. If the problem persists, replace CSRD PCB.	1007	No	0x0002
2503	ATP CSRD Link Down	Triggered when the ATP no longer receives responses from the CSRD	1	ATP	Power cycle the ATC rack. If the problem persists, ensure the CSRD is securely plugged into the system. If the problem persists, replace the CSRD board.	1007	No	0x0000
2504	ATP CSRD Failure Event Rcvd	Triggered when the ATP receives a failure event indication from the CSRD	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002
2506	ATP CSRD Unexpected Self test Req	Triggered when the CSRD starts a self test but was not told to do so by the ATP	1	ATP	Informational Event. No reset conditions.	1007	No	0x0002
2507	ATP_CSRD Data Mismatch Error	Triggered when there is a data mismatch between processors on the CSRD board.	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2508	ATP_CSRD Module Fail	Triggered when the CSRD module has a critical failure	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	Yes	0x0000
2509	CSRD Project Config Revision Mismatch	Triggered when the project configuration revision has a mismatch between processors.	1	ATP	Reload the Project Configuration file on both processors. If the problem persists, replace the CSRD board.	1007	Yes	0x0000
2510	CSRD System Config Revision Mismatch	Triggered when the system configuration revision has a mismatch between processors.	1	ATP	Reload the system configuration file on both processors. If the problem persists, replace the CSRD board.	1007	Yes	0x0000
2511	CSRD Software Application Revision Mismatch	Triggered when the CSRD detects an application software revision mismatch between processors.	1	ATP	Reload the application software on the CSRD. If the problem persists, replace the CSRD board.	1007	Yes	0x0000
2512	CSRD Self Test Unresponsive	Triggered when the self test timer in the CSRD has expired	1	ATP	Power cycle the ATC rack. If the problem persists, replace the CSRD board.	1007	Yes	0x0002
2600	Crosscheck Parent	N/A	1	ATP	N/A	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2601	Keyed Cab Crosscheck Error	Triggered when both cabs indicate they are keyed up.	1	ATP	Check that both cabs are not keyed up. If problem persists replace vital input board.	1008	No	0x0000
2602	Line Selector Crosscheck Error	Indicates both Type I and Type II modes are selected.	1	ATP	Check that the line selector switch is to either type I or type II. If problem persists replace vital input board.	1008	No	0x0000
2605	FSB Relay Backcheck Error	The FSB relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000
2606	L Door Enable Relay Backcheck Error	The left door enable relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000
2607	R Door Enable Relay Backcheck Error	The right door enable relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000
2608	Depart Cab Source Backcheck Error	The departure test cab source relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2609	Fwd-Rev Crosscheck Error	Triggered when both Forward and Reverse Trainlines are set.	1	ATP	Ensure that either the fwd or rev input is on at any given time.	1008	No	0x0000
2610	Vzero/Decel Crosscheck Error	Triggered when the ATP detects movement on the decelerometer without associated tachometer pulses. The movement threshold has been exceeded and the tachometers are no longer trusted	1	ATP	Ensure the tachometers are installed correctly and providing sufficient pulses. Recalibrate the decelerometer on level tangent track. If the problem persists, replace the tachometers.	1008	No	0x0000
2612	Direction Crosscheck Error	Triggered when direction from the tachometers does not match the Forward/Reverse trainlines.	1	ATP	Check that the vehicle is in either Forward or Reverse. Check that the wiring from the tachometers does not have any loose connections. If problem persists replace tachometer.	1008	No	0x0000
2616	Cab Signal A Backcheck Error	The A End Cab Signal Select relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2617	Cab Signal B Backcheck Error	The B End Cab Signal Select relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000
2618	Propulsion Cut Relay Backcheck Error	The Propulsion Cut relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000
2619	Forward Backcheck Error	The Forward relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000
2620	Reverse Backcheck Error	The Reverse relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000
2623	Mode Select Crosscheck Error	Triggered when both ATO and ATP mode are selected at the same time.	1	ATP	Verify that the mode selector switch is in the correct position.	1008	No	0x0000
2624	Test Signal Select A Backcheck error	The Test Signal Select A relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2625	Test Signal Select B Backcheck error	The Test Signal Select B relay back contact does not match the state of the front contact.	1	ATP	Reset ATC rack circuit breaker. If problem persists replace safety relay board.	1008	No	0x0000
2626	Bypass Selector Crosscheck Error	Triggered when input indicates ATP is bypassed and not bypassed.	1	ATP	Check that the ATP bypass switch is in either the bypass or not bypassed position. If the problem persists replace the vital input board.	1008	No	0x0000
2627	EB Crosscheck Error	Triggered when the ATC requests EB but the vehicle trainline indicates the EB is not applied.	1	ATP	N/A	1008	No	0x0000
2700	Emergency brake applied	Informational event triggered anytime the ATP requests an emergency brake.	1	ATP	Clear the condition that is causing the emergency brake. Make sure the vehicle is at Vzero and acknowledge any alarms. Key out and Key in the Cab. If problem persists, reset the ATP.	1008	Yes	0x0000
2701	Penalty brake applied	A condition to trigger the penalty brake is true.	1	ATP	Acknowledge the penalty brake. If the problem persists reset the ATC CB.	1008	Yes	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2702	Propulsion Cut Threshold Exceeded	The vehicle speed is above the OSL and power cut was applied.	1	ATP	N/A	1008	Yes	0x0000
2703	IES Brake applied	A condition to trigger the IES brake is true.	1	ATP	Acknowledge the IES brake. If the problem persists reset the ATC CB.	1008	Yes	0x0000
2707	UES Brake applied	A condition to trigger the UES brake is true.	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	Yes	0x0000
2708	Brake Monitoring Rate not achieved	Brake assurance in Type II has failed and the EB has been applied.	3	ATP	N/A	1008	Yes	0x0000
2709	Brake Assurance rate not achieved	Brake assurance in Type I has failed and the EB has been applied.	1	ATP	N/A	1008	Yes	0x0000
2801	Mixed IO Vital Register Error	The ATP processor tried to write a value to the mixed I/O board but did not receive a response.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors or backplane. If the problem persists, replace the Mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2802	Mixed IO Vital Type Error	The ATP processor was expecting a different mixed I/O board type than what was received.	1	ATP	Ensure the correct Mixed I/O board is installed. Ensure the board is securely plugged into the correct slot inside the card file. Ensure no bent pins on the backplane and the board. If the problem persists, replace the Mixed I/O board.	1008	No	0x0000
2803	Mixed IO Vital Write Compare Error	The echo and type checks passed on the mixed I/O board, but the read back returned a different value than what was written.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connectors or backplane. If the problem persists, replace the Mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2804	Mixed IO Input 0 Unstable	Input 1 on the Mixed I/O board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears. Note: Input 0 is the Safety Relay Checkback Enable Left Doors.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the mixed I/O board, Safety Relay Checkback Enable Left Doors.	1008	No	0x0000
2805	Mixed IO Input 1 Unstable	Input 2 on the Mixed I/O board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears. Note: Input 1 is the Safety Relay Checkback Enable Right Doors.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2806	Mixed IO Input 2 Unstable	Input 3 on the Mixed I/O board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears. Note: Input 2 is the Safety Relay Checkback Full Service Brake.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2807	Mixed IO Input 3 Unstable	Input 4 on the Mixed I/O board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears. Note: Input 3 is the Safety Relay Checkback Cab Signal Select A End.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2808	Mixed IO Input 4 Unstable	Input 5 on the Mixed I/O board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears. Note: Input 3 is the Safety Relay Checkback Cab Signal Select B End.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2809	Mixed IO Input 5 Unstable	Input 6 on the Mixed I/O board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears. Note: Input 5 is the Safety Relay Checkback Departure Test Coil Select A End	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2810	Mixed IO Input 6 Unstable	Input 7 on the Mixed I/O board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears. Note: Input 6 is the Safety Relay Checkback Departure Test Coil Select B End.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2811	Mixed IO Input 7 Unstable	Input 8 on the Mixed I/O board has toggled between states enough to reach the instability limit. The input is considered off until the condition clears. Note: Input 4 is the ATP Not Bypassed.	1	ATP	Ensure the Mixed I/O board is securely plugged into the correct slot inside the card file and no bent pins are present. Check the source of the input is providing a stable signal. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2820	Mixed IO Input 0 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time. Note: Input 0 is the Safety Relay Checkback Enable Left Doors.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2821	Mixed IO Input 1 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time. Note: Input 1 is the Safety Relay Checkback Enable Right Doors.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2822	Mixed IO Input 2 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time. Note: Input 2 is the Safety Relay Checkback Full Service Brake.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2823	Mixed IO Input 3 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time. Note: Input 3 is the Safety Relay Checkback Cab Signal Select A End.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2824	Mixed IO Input 4 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time. Note: Input 4 is the Safety Relay Checkback Cab Signal Select B End.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2825	Mixed IO Input 5 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time. Note: Input 5 is the Safety Relay Checkback Departure Test Coil Select A End.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2826	Mixed IO Input 6 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time. Note: Input 6 is the Safety Relay Checkback Departure Test Coil Select B End.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2827	Mixed IO Input 7 Shorted	The CPU tested the input while it was on by briefly turning the input off. The test fails when another input also changes state during this time. Note: Input 7 is the ATP Not Bypassed.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2836	Mixed IO Input 0 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state. Note: Input 0 is the Safety Relay Checkback Enable Left Doors.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2837	Mixed IO Input 1 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state. Note: Input 1 is the Safety Relay Checkback Enable Right Doors.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2838	Mixed IO Input 2 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state. Note: Input 2 is the Safety Relay Checkback Full Service Brake.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2839	Mixed IO Input 3 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state. Note: Input 3 is the Safety Relay Checkback Cab Signal Select A End.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2840	Mixed IO Input 4 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state. Note: Input 4 is the Safety Relay Checkback Cab Signal Select B End.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2841	Mixed IO Input 5 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state. Note: Input 5 is the Safety Relay Checkback Departure Test Coil Select A End.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2842	Mixed IO Input 6 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state. Note: Input 6 is the Safety Relay Checkback Departure Test Coil Select B End.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2843	Mixed IO Input 7 Monitor Failure	The CPU diagnostics turned the input's monitor circuit off to verify the input is not stuck in the ON position, but the input remained in the ON state. Note: Input 7 is the ATP Not Bypassed.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the input to the source and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2844	Mixed IO Output 1 Monitor Failure	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output. Note: Output 1 is the Enable Left Doors.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board. .	1008	No	0x0000
2845	Mixed IO Output 2 Monitor Failure	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output. Note: Output 2 is the Enable Right Doors.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2846	Mixed IO Output 3 Monitor Failure	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output. Note: Output 3 is the Full Service Brake.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2847	Mixed IO Output 4 Monitor Failure	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output. Note: Output 4 is the Emergency Brake.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2848	Mixed IO Output 5 Monitor Failure	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output. Note: Output 5 is the Cab Signal Select A.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000
2849	Mixed IO Output 6 Monitor Failure	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output. Note: Output 6 is the Cab Signal Select B.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2850	Mixed IO Output 7 Monitor Failure	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output. Note: Output 7 is the Test Coil Select A.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
2851	Mixed IO Output 8 Monitor Failure	The monitor circuit ensures the vital output is in the correct state by comparing the output state to a set of known voltages. If the output state does not match, the error is generated for the associated output. Note: Output 8 is the Test Coil Select B.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. Trace the output to the destination load and verify no loose or frayed wires are present. If the problem persists, replace the mixed I/O board. If the problem still persists, the issues are outside of the ATC enclosure, Test Coil Select B.	1008	No	0x0000
2852	Mixed IO Monitor Fail	The monitor circuit that ensures the outputs are in the expected state has reported a critical error to the CPU board.	1	ATP	Ensure the mixed I/O board is securely plugged into the correct slot inside the card file. Ensure no bent pins are on the connections. If the problem persists, replace the mixed I/O board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
3000	CCB Link Down	The CPU has failed to function properly due to a microprocessor internal error	2	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0000
3001	DPRAM Error No Data	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0000
3002	DPRAM Read Access Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0000
3003	DPRAM Bad Sector Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0000
3004	DPRAM Bad Size Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0000
3005	DPRAM No New Data Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
3006	DPRAM No Write Access Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0000
3007	No New CCB Data	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3008	CCB Link Up Parent	The CPU has failed to function properly due to a microprocessor internal error	3	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0002
3009	DPRAM No Error	The CPU has failed to function properly due to a microprocessor internal error	3	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0002
3010	CCB PCB Parent	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3011	Diagnostics complete	The CPU has failed to function properly due to a microprocessor internal error	3	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
3012	DPRAM Access Failure	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3013	Bad ROM	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3014	Bad RAM	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3015	Bad Stack	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3016	Skipped Cycle	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3017	Unexpected IRQ	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
3018	Logs Initialized	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3019	COMM Initialized	The CPU has failed to function properly due to a microprocessor internal error	3	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0002
3020	Invalid output message size	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3021	Invalid input message size	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3022	Link 1 - G96 Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3023	Link 2 - MVB Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
3024	Link 3 - Ethernet Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3025	Link 4 - Ethernet Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3026	Link 5 - RS232 Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3027	Link 6 - RS232 Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3028	Link 7 - RS232 Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3029	Link 8 - RS232 Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
3030	Link 9 - RS232 Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3031	Link 10 - RS232 Diagnostics Error	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1004	No	0x0000
3032	ATP CRC check failed	The CPU has failed to function properly due to a microprocessor internal error	1	ATP	Reset the ATC circuit breaker. If the problem persists, replace the CCB board.	1008	No	0x0000
5000	ATO Parent Event	NA	3	ATO	NA	1006	No	0x0000
5001	Event Queue Overflow	NA	2	ATO	NA	1006	No	0x0002
5002	Class Destructor Called	Software exception	1	ATO	Reload ATO software. If error persists replace ATO board.	1006	No	0x0002
5003	ATO Reset	ATO subsystem has reset	3	ATO	NA	1006	No	0x0002
5004	Emergency Brake Applied	Emergency brake was applied during vehicle motion	1	ATO	NA	1006	No	0x0000
5005	ATP/Vehicle Spin/Slide Detected	A spin or slide was indicated through MVB or from the ATP subsystem	2	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5006	Bypass ATC Mode	The vehicle has been keyed in Bypass mode	3	ATO	NA	1006	No	0x0002
5007	Local ATC Mode	The vehicle has been keyed in Local mode	3	ATO	NA	1006	No	0x0002
5008	Manual ATC Mode	The vehicle has been keyed in Manual mode	3	ATO	NA	1006	No	0x0002
5009	Manual with ATO ATC mode	The vehicle has been keyed in ATO mode	3	ATO	NA	1006	No	0x0002
5010	Undefined ATC mode	Software exception	1	ATO	Reload ATO software. If error persists replace ATO board.	1006	No	0x0000
5011	Track Plan Load Fail	Software exception	1	ATO	Reload ATO software. If error persists replace ATO board.	1006	No	0x0000
5012	Station Table Load Fail	Software exception	1	ATO	Reload ATO software. If error persists replace ATO board.	1006	No	0x0000
5013	M Relay Backcheck Error	The M output signal does not match the trainline	1	ATO	Check M trainline	1006	No	0x0000
5014	CM Relay Backcheck Error	The CM output signal does not match the trainline	1	ATO	Check CM trainline	1006	No	0x0000
5015	TWC Enable Relay Backcheck Error	The safety relay feedback does not match the output	1	ATO	Check the safety relay card	1006	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5016	TWC Coil A Select Relay Backcheck Error	The safety relay feedback does not match the output	1	ATO	Check the safety relay card	1006	No	0x0000
5017	TWC Coil B Select Relay Backcheck Error	The safety relay feedback does not match the output	1	ATO	Check the safety relay card	1006	No	0x0000
5018	TWC Link Failure	TWC communications have not been established while over a TWC loop	2	ATO	Event will reset automatically. Verify that the TWC modem switch settings match the maintenance manual. If problem continues replace TWC Modem PCB. If the problem persists, contact Wayside and request that they verify that the wayside TWC unit is functional.	1006	No	0x0000
5019	TWC Link to Central Failure	The central link bit in the TWC communication link is not asserted	3	ATO	Check communication link between wayside and central.	1006	No	0x0002
5020	ATP to ATO Communication Failure	ATC system data is no being received by the ATO subsystem.	2	ATO	Ensure CCB and ATO are properly seated in the cardfile.	1006	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5021	Bond Based Station Stop	No valid transpositions were detected in the station stop.	2	ATO	Event will reset automatically. Verify that the TWC modem switch settings match the maintenance manual. If the problem persists, contact Wayside and request that they verify that the wayside TWC unit is functional.	1006	No	0x0000
5022	Negative Distance To Go	ATO subsystem has detected that the distance to go has exceeded 20 feet past the target	1	ATO	Check for the following events: TWC Bypassed, No TWC Detected, No Valid Transpositions, Missed Bond, Bond Based Station Stop, High Brake Rate Commanded, No CTM was detected in the platform, Large Position Adjustment, Large XPOS Position Adjustment, or ATO Detected Slide.	1006	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5023	ATP/ATO Wheel Diameter Discrepancy	The ATP calibrated and ATO measured wheel sizes mismatch by more than 3 inches	2	ATO	Check wheel calibration	1006	No	0x0000
5024	Invalid TWC Data	Invalid TWC header	2	ATO	Check TWC communications.	1006	No	0x0000
5025	Incorrect TWC PVID	The TWC PVID does not match the vehicle PVID while berthed	2	ATO	NA	1006	No	0x0003
5026	Invalid ATP Data or ATP Comm Lost	The ATO has received train length or track circuit ID of 0 while not at Vzero	1	ATO	Check MVB and train Ethernet connections	1006	No	0x0000
5027	Missed Bond	ATO detected a new track circuit ID without getting a bond crossing event.	2	ATO	Event will reset automatically.	1006	No	0x0002
5028	Invalid ATP PVID	ATC is configured with a PVID of 0	1	ATO	NA	1006	No	0x0000
5029	Input 24V Battery Voltage Fault Detected	ATO detected 24V battery out of tolerance out of tolerance	1	ATO	Check the ATC vehicle battery feed.	1006	No	0x0000
5030	New Wheel Diameter Calculated	The ATO has calculated a new wheel diameter	2	ATO	The vehicle wheels should be measured and the new dimeters should be entered into the ATC.	1006	No	0x0000
5031	Station Stop Valid	The ATO determined that the vehicle stopped in the correct location with berth	3	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5032	Station Stop Berthed Received	The vehicle received the berth signal	3	ATO	NA	1006	No	0x0002
5033	Station Stop Undershoot	The ATO determined that the vehicle stopped a least 3 feet short of the target stopping location	1	ATO	Check for the following events: TWC Bypassed, No TWC Detected, No Valid Transpositions, Missed Bond, Bond Based Station Stop, High Brake Rate Commanded, No CTM was detected in the platform, Large Position Adjustment, Large XPOS Position Adjustment, or ATO Detected Slide.	1006	Yes	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5034	Station Stop Overshoot	The ATO determined that the vehicle stopped at least 3 feet past the target stopping location	1	ATO	Check for the following events: TWC Bypassed, No TWC Detected, No Valid Transpositions, Missed Bond, Bond Based Station Stop, High Brake Rate Commanded, No CTM was detected in the platform, Large Position Adjustment, Large XPOS Position Adjustment, or ATO Detected Slide.	1006	Yes	0x0000
5035	Station Stop without Berth	The wayside berth bit was received within 7 seconds of the train speed dropping below 0.5 mph.	2	ATO	Check for overshoot or undershoot. Check for Bond Based Station, Stop, No TWC detected, and No Valid Transpositions events. If this event is occurring on multiple trains there is a problem with the wayside track circuit.	1006	Yes	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5036	Programmed station stop aborted	The ATP aborted the PSS because wayside berth bit was not received within 7 seconds of the train speed dropping below 0.5 mph.	1	ATO	Check for overshoot or undershoot. Check for Bond Based Station, Stop, No TWC detected, and No Valid Transpositions events.	1006	No	0x0000
5037	ATO detected spin	The ATO has detected an acceleration greater than 10 mph/s	2	ATO	NA	1006	No	0x0002
5038	ATO detected slide	The ATO has detected an acceleration less than -10mph/s	2	ATO	NA	1006	No	0x0002
5039	Station Stop mode disabled	The vehicle has completed the PSS	3	ATO	NA	1006	No	0x0002
5040	Station Stop mode enabled	The vehicle has entered a beacon track and is preparing to perform a PSS	3	ATO	NA	1006	No	0x0002
5041	High Brake Rate Commanded	The ATO determined it was necessary to apply a higher brake rate than normal during a PSS to achieve the correct stopping profile.	2	ATO	Event will reset automatically.	1006	No	0x0000
5042	Large Bond Position Adjustment	The ATO has adjusted the PSS distance to go by a value greater than 10 feet in 100ms.	2	ATO	Event will reset automatically.	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5043	TWC bypass	The Type II TWC system has been bypassed.	2	ATO	NA	1006	No	0x0000
5044	No TWC detected	ATO passed 2 consecutive TWC loops with establishing TWC communication.	2	ATO	Event will reset automatically. Verify that the TWC modem switch settings match the maintenance manual. If problem continues replace TWC Modem PCB. If the problem persists, contact Wayside and request that they verify that the wayside TWC unit is functional.	1006	No	0x0000
5045	No Valid Transpositions	The vehicle stopped in a platform without detecting any valid transpositions.	2	ATO	Event will reset automatically. Verify that the TWC modem switch settings match the maintenance manual. If the problem persists, contact Wayside and request that they verify that the wayside TWC unit is functional.	1006	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5046	FSK Transmit Start	The FSK portion of the departure test has started	3	ATO	NA	1006	No	0x0002
5047	FSK Transmit Stop	The FSK portion of the departure test has completed	3	ATO	NA	1006	No	0x0002
5048	Coast	Coast mode is activated	3	ATO	Coast mode is cleared	1006	No	0x0002
5049	Station Stop Invalid	Not used	2	ATO	NA	1006	No	0x0000
5050	Station Stop Norwalk	Vehicle stopped at Norwalk	3	ATO	NA	1006	No	0x0002
5051	Station Stop Lakewood	Vehicle stopped at Lakewood	3	ATO	NA	1006	No	0x0002
5052	Station Stop Longbeach Freeway	Vehicle stopped at Longbeach Freeway	3	ATO	NA	1006	No	0x0002
5053	Station Stop Longbeach Blvd	Vehicle stopped at Longbeach Blvd	3	ATO	NA	1006	No	0x0002
5054	Station Stop Wilmington	Vehicle stopped at Wilmington	3	ATO	NA	1006	No	0x0002
5055	Station Stop Avalon	Vehicle stopped at Avalon	3	ATO	NA	1006	No	0x0002
5056	Station Stop Harbor	Vehicle stopped at Harbor	3	ATO	NA	1006	No	0x0002
5057	Station Stop Vermont	Vehicle stopped at Vermont	3	ATO	NA	1006	No	0x0002
5058	Station Stop Crenshaw	Vehicle stopped at Crenshaw	3	ATO	NA	1006	No	0x0002
5059	Station Stop Hawthorne	Vehicle stopped at Hawthorne	3	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5060	Station Stop Aviation	Vehicle stopped at Aviation	3	ATO	NA	1006	No	0x0002
5061	Station Stop Del Norte	Vehicle stopped at Del Norte	3	ATO	NA	1006	No	0x0002
5062	Station Stop Mariposa	Vehicle stopped at Mariposa	3	ATO	NA	1006	No	0x0002
5063	Station Stop El Segundo	Vehicle stopped at El Segundo	3	ATO	NA	1006	No	0x0002
5064	Station Stop Douglas	Vehicle stopped at Douglas	3	ATO	NA	1006	No	0x0002
5065	Station Stop Marine	Vehicle stopped at Marine	3	ATO	NA	1006	No	0x0002
5066	Brake Rate Index Invalid	NA	2	ATO	NA	1006	No	0x0002
5067	Brake Rate Index 1 Activated	ATO has set the PSS Brake Rate Index to 1	3	ATO	NA	1006	No	0x0002
5068	Brake Rate Index 2 Activated	ATO has set the PSS Brake Rate Index to 2	3	ATO	NA	1006	No	0x0002
5069	Brake Rate Index 3 Activated	ATO has set the PSS Brake Rate Index to 3	3	ATO	NA	1006	No	0x0002
5070	Brake Rate Index 4 Activated	ATO has set the PSS Brake Rate Index to 4	3	ATO	NA	1006	No	0x0002
5071	Brake Rate Index 5 Activated	ATO has set the PSS Brake Rate Index to 5	3	ATO	NA	1006	No	0x0002
5072	Brake Rate Index 6 Activated	ATO has set the PSS Brake Rate Index to 6	3	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5073	Brake Rate Index 7 Activated	ATO has set the PSS Brake Rate Index to 7	3	ATO	NA	1006	No	0x0002
5074	Brake Rate Index 8 Activated	ATO has set the PSS Brake Rate Index to 8	3	ATO	NA	1006	No	0x0002
5075	Brake Rate Index 9 Activated	ATO has set the PSS Brake Rate Index to 9	3	ATO	NA	1006	No	0x0002
5076	TWC PSS Brake Rate Index Invalid	NA	2	ATO	NA	1006	No	0x0000
5077	TWC Brake Rate 1 received	ATO received PSS Brake Rate Index 1 from TWC	3	ATO	NA	1006	No	0x0002
5078	TWC Brake Rate 2 received	ATO received PSS Brake Rate Index 2 from TWC	3	ATO	NA	1006	No	0x0002
5079	TWC Brake Rate 3 received	ATO received PSS Brake Rate Index 3 from TWC	3	ATO	NA	1006	No	0x0002
5080	TWC Brake Rate 4 received	ATO received PSS Brake Rate Index 4 from TWC	3	ATO	NA	1006	No	0x0002
5081	TWC Brake Rate 5 received	ATO received PSS Brake Rate Index 5 from TWC	3	ATO	NA	1006	No	0x0002
5082	TWC Brake Rate 6 received	ATO received PSS Brake Rate Index 6 from TWC	3	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5083	TWC Brake Rate 7 received	ATO received PSS Brake Rate Index 7 from TWC	3	ATO	NA	1006	No	0x0002
5084	TWC Brake Rate 8 received	ATO received PSS Brake Rate Index 8 from TWC	3	ATO	NA	1006	No	0x0002
5085	TWC Brake Rate 9 received	ATO received PSS Brake Rate Index 9 from TWC	3	ATO	NA	1006	No	0x0002
5086	TWC Performance Level Invalid	NA	2	ATO	NA	1006	No	0x0002
5087	Performance Level 1 activated	ATO has activated Performance Level 1	3	ATO	NA	1006	No	0x0002
5088	Performance Level 2 activated	ATO has activated Performance Level 2	3	ATO	NA	1006	No	0x0002
5089	Performance Level 3 activated	ATO has activated Performance Level 3	3	ATO	NA	1006	No	0x0002
5090	Performance Level 4 activated	ATO has activated Performance Level 4	3	ATO	NA	1006	No	0x0002
5091	Performance Level 5 activated	ATO has activated Performance Level 5	3	ATO	NA	1006	No	0x0002
5092	Performance Level 6 activated	ATO has activated Performance Level 6	3	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5093	TWC Performance Level Invalid	NA	2	ATO	NA	1006	No	0x0000
5094	Performance Level 1 received	ATO has received Performance Level 1	3	ATO	NA	1006	No	0x0002
5095	Performance Level 2 received	ATO has received Performance Level 2	3	ATO	NA	1006	No	0x0002
5096	Performance Level 3 received	ATO has received Performance Level 3	3	ATO	NA	1006	No	0x0002
5097	Performance Level 4 received	ATO has received Performance Level 4	3	ATO	NA	1006	No	0x0002
5098	Performance Level 5 received	ATO has received Performance Level 5	3	ATO	NA	1006	No	0x0002
5099	Performance Level 6 received	ATO has received Performance Level 6	3	ATO	NA	1006	No	0x0002
5100	Route ID Invalid	The ATC has revived an invalid route ID	2	ATO	NA	1006	No	0x0000
5101	Route 001 accepted	Route 001 accepted	3	ATO	NA	1006	No	0x0002
5102	Route 002 accepted	Route 002 accepted	3	ATO	NA	1006	No	0x0002
5103	Route 003 accepted	Route 003 accepted	3	ATO	NA	1006	No	0x0002
5104	Route 004 accepted	Route 004 accepted	3	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5105	Route 005 accepted	Route 005 accepted	3	ATO	NA	1006	No	0x0002
5106	Route 006 accepted	Route 006 accepted	3	ATO	NA	1006	No	0x0002
5107	Route 007 accepted	Route 007 accepted	3	ATO	NA	1006	No	0x0002
5108	Route 008 accepted	Route 008 accepted	3	ATO	NA	1006	No	0x0002
5109	Route 009 accepted	Route 009 accepted	3	ATO	NA	1006	No	0x0002
5110	Route 010 accepted	Route 010 accepted	3	ATO	NA	1006	No	0x0002
5111	Route 011 accepted	Route 011 accepted	3	ATO	NA	1006	No	0x0002
5112	Route 012 accepted	Route 012 accepted	3	ATO	NA	1006	No	0x0002
5113	Route 013 accepted	Route 013 accepted	3	ATO	NA	1006	No	0x0002
5114	Route 014 accepted	Route 014 accepted	3	ATO	NA	1006	No	0x0002
5115	Route 015 accepted	Route 015 accepted	3	ATO	NA	1006	No	0x0002
5116	Route 016 accepted	Route 016 accepted	3	ATO	NA	1006	No	0x0002
5117	Route 017 accepted	Route 017 accepted	3	ATO	NA	1006	No	0x0002
5118	Route 018 accepted	Route 018 accepted	3	ATO	NA	1006	No	0x0002
5119	Route 019 accepted	Route 019 accepted	3	ATO	NA	1006	No	0x0002
5120	Route 020 accepted	Route 020 accepted	3	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5121	Route 021 accepted	Route 021 accepted	3	ATO	NA	1006	No	0x0002
5122	Route 022 accepted	Route 022 accepted	3	ATO	NA	1006	No	0x0002
5123	Route 023 accepted	Route 023 accepted	3	ATO	NA	1006	No	0x0002
5124	Route 024 accepted	Route 024 accepted	3	ATO	NA	1006	No	0x0002
5125	Route 025 accepted	Route 025 accepted	3	ATO	NA	1006	No	0x0002
5126	Route 026 accepted	Route 026 accepted	3	ATO	NA	1006	No	0x0002
5127	Route 027 accepted	Route 027 accepted	3	ATO	NA	1006	No	0x0002
5128	Route 028 accepted	Route 028 accepted	3	ATO	NA	1006	No	0x0002
5129	Route 029 accepted	Route 029 accepted	3	ATO	NA	1006	No	0x0002
5130	Route 030 accepted	Route 030 accepted	3	ATO	NA	1006	No	0x0002
5131	Yard Route accepted	Route ID is a Yard Route	3	ATO	NA	1006	No	0x0002
5132	PowerUp/Init Route accepted	Route ID is power-up/Init	3	ATO	NA	1006	No	0x0002
5133	Train Length Invalid/Parent	The ATO has received an invalid train length.	1	ATO	NA	1006	No	0x0000
5134	Train Length 1 entered	The ATO has accepted a train length of 1	3	ATO	NA	1006	No	0x0002
5135	Train Length 2 entered	The ATO has accepted a train length of 2	3	ATO	NA	1006	No	0x0002
5136	Train Length 3 entered	The ATO has accepted a train length of 3	3	ATO	NA	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5137	No CTM was detected in the platform	No CTM was detected in the platform	2	ATO	Event will reset automatically. Verify that the TWC modem switch settings match the maintenance manual. If the problem persists, contact Wayside and request that they verify that the wayside TWC unit is functional.	1006	No	0x0002
5138	Large Xpos Position Adjustment	ATO has made a position adjustment greater than 20 feet based on the detection of a transposition.	2	ATO	Event will reset automatically. Verify that the TWC modem switch settings match the maintenance manual. If the problem persists, contact Wayside and request that they verify that the wayside TWC unit is functional.	1006	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
5139	ATO crawl mode entered	ATO has entered crawl mode due either to excessive spin, excessive slide, or passing the center xpos without detecting any xpos during PSS	2	ATO	Reset when either PSS has been complete, mode change, or active cab reset	1006	No	0x0000
7000	ADU Parent Event	The ADU has failed to function properly due to a microprocessor internal error	3	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0002
7001	Event Queue Overflow	The ADU has failed to function properly due to a microprocessor internal error	2	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0002
7002	Class Destructor Called	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0002
7003	ADU Reset	The ADU has failed to function properly due to a microprocessor internal error	3	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0002
7004	ADU Initialized	The ADU has been initialized.	3	ADU	Informational Event. No reset conditions.	20	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
7005	ADU HW Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	The operator pushed an ADU button multiple times in quick succession. Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7006	ADU Timing Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7007	ADU Stuck Keys	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7008	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7009	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
7010	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7011	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7012	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7013	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7014	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7015	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
7016	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7017	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7018	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7019	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7020	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7021	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
7022	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7023	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7024	ADU MVB API Error	The ADU has failed to function properly due to a microprocessor internal error	1	ADU	Reset the ADU circuit breaker. If the problem persists, replace the ADU.	20	No	0x0000
7025	ADU Bad Speed	The speed received over the MVB is above 75 mph.	1	ADU	Reset the ADU circuit breaker. If the problem persists, reference ADU troubleshooting in section 8.10.3.	20	No	0x0000
7026	ADU Bad Speed Limit	The speed limit received over the MVB is above 65 mph.	2	ADU	Reset the ADU circuit breaker. If the problem persists, reference ADU troubleshooting in section 8.10.3.	20	No	0x0002
7027	ADU Bad Dest ID	The destination ID entered is invalid for Type II.	2	ADU	Reset the ADU circuit breaker. If the problem persists, reference ADU troubleshooting in section 8.10.3.	20	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
7028	ADU ATC Comm Loss	The ADU lost communication with the ATC over the MVB.	1	ADU	Reset the ADU circuit breaker. If the problem persists, reference ADU troubleshooting in section 8.10.3.	20	No	0x0000
7029	ADU Vehicle Comm Loss	The ADU lost communication with the vehicle logic over the MVB.	1	ADU	Reset the ADU circuit breaker. If the problem persists, reference ADU troubleshooting in section 8.10.3.	20	No	0x0000
7030	ADU TWC Comm Loss	The ADU has lost communication with the Hanning and Kahl TWC CCU over the RS485 serial port.	3	ADU	Reset the ADU circuit breaker. If the problem persists, reference ADU troubleshooting in section 8.10.3.	20	No	0x0000
7031	ADU Crosscheck error	Both ADU's indicate they are active.	2	ADU	Check that only 1 cab is keyed up.	20	No	0x0002
7032	ADU TWC Bad Data received	The ADU has received a corrupted message from the Hanning and Kahl CCU.	1	ADU	Reset the ADU circuit breaker. If the problem persists, reference ADU troubleshooting in section 8.10.3.	20	No	0x0000
7033	ADU Display Window change	The active window on the ADU has changed.	3	ADU	N/A	20	No	0x0003
7034	ADU Route Entered	A new route has been entered.	3	ADU	N/A	20	No	0x0002

Event Code	Event Name	Description	Severity	Source	Action	LRU	Snapshot Available	MDS Flag (0x0000 sent to MDS)
7035	ADU Route Invalid	The route ID entered is invalid for Type I.	2	ADU	N/A	20	No	0x0000
7036	ADU Active Cab Change	The active cab as sent to the ADU has changed.	3	ADU	N/A	20	No	0x0002
7037	ADU TWC Send Pushbuttons	New data has been sent to the Hanning and Kahl CCU.	3	ADU	N/A	20	No	0x0002
7038	ADU TWC Send Route ID	New data has been sent to the Hanning and Kahl CCU.	3	ADU	N/A	20	No	0x0002
7039	ADU TWC Send Vehicle ID	New data has been sent to the Hanning and Kahl CCU.	3	ADU	N/A	20	No	0x0002
7040	ADU Operating Type Change	The operating mode has been change between Type I and Type II.	3	ADU	N/A	20	No	0x0000
7041	ADU Cab Address Change	The ADU address has changed.	3	ADU	N/A	20	No	0x0003
7099	ADU Misc Event	N/A	2	ADU	N/A	20	No	0x0002

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CHAPTER 10.0

REFERENCE DRAWINGS & DOCUMENTS

10.1 ATC System Functional Description – See Attachment #1

10.2 Software Modification Instructions – See Attachment #2

10.3 Vehicle Trainlines Interface Control Detailed Design – See Attachment #3

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ATTACHMENT #1

ATC System Functional Description

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Kinkisharyo International, L.L.C.
Los Angeles County Metropolitan Transportation Authority
New Light Rail Vehicles

Contract Number: P3010

ATC System Functional Description

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Abbreviation List

Abbreviation	
ADU	Aspect Display Unit
AF	Audio Frequency
ASK	Amplitude Shift Keying
ASTS USA	Ansaldo STS USA
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
BA	Brake Assurance
BAFS	Brake Assured Full Service Stop
CCB	Communication Controller Board
COMM	Communication Subsystem
CPM	Code Per Minute
CPS	Conditional Power Supply
CPU	Central Processing Unit
CRC	Cyclic Redundancy Check
CSRD	Cab Signal Receiver-Demodulator
DTG	Distance-To-Go
EB	Emergency Brake
EEPROM	Electrically Erasable Programmable Read Only Memory
ESL	Enforced Speed Limit
ESS	Emergency Station Stop
FSB	Full Service Brake
FSBR	Full Service Brake Relay
FSK	Frequency Shift Keying
Hz	Hertz
ID	Identification
IEB	Irrevocable Emergency Brake
IES	Irrevocable Emergency Stop
LACMTA	Los Angeles County Metropolitan Transportation Authority
LED	Light-Emitting Diode
LRV	Light Rail Vehicle
NC	Normal Closed
NO	Normal Open
MAS	Maximum Authorized Speed
MBL	Metro Blue Line
MDS	Monitoring and Diagnostic System
MGL	Metro Green Line
MVB	Multi-Function Vehicle Bus
OCC	Operational Control Center
OSL	Operational Speed Limit
PCB	Printed Circuit Board
PDR	Preliminary Design Review
PGL	Pasadena Gold Line
PTU	Portable Test Unit
PVID	Permanent Vehicle Identification
RES	Revocable Emergency Stop
RX	Receive Signal
SBD	Safe Braking Distance

Abbreviation	
SPO	Supervisory, Position, and Operational
STS	Hitachi Rail STS USA
TOD	Train Operator Display
TS	Technical Specification
TWC	Train-to-Wayside Communication
TX	Transmit Signal
UEB	Unrecoverable Emergency Brake
UES	Unrecoverable Emergency Stop

1 Introduction

The ATC enclosure and peripheral components provide the hardware and software necessary to implement the functional requirements of the LA P3010 specification for both Type I and Type II ATC systems.

The Ansaldo STS ATC enclosure is a microprocessor and electronic based cab signaling package designed and configured specifically for installation on the LACMTA P3010 Light Rail Vehicle or LRV.

The ATC system is functionally separated into five subsystems:

- ATP
- ATO
- TWC
- COMM
- ADU

There are functional differences in the operation of the ATC system depending upon which line the ATC is operating. Because of the operational differences between the various Metro lines, the ATC functional description provided in this document will be separated into subsections. One subsection describing MGL operation and one subsection describing MBL/PGL operation. For the ease of distinguishing between the two different types of functional operation, from this point forward in this document, the ATC functionality on the MBL/PGL (and like lines) will be defined as Type I operation and operation on the MGL (and like lines) will be defined as Type II operation.

The COMM subsystem provides the means to exchange data among the sub-systems and the external networks. The system data logging is also contained within the COMM subsystem. The functionality of the COMM subsystem will be primarily the same for either the Type I or Type II ATC System. The ATP, TWC, and ATO subsystems will have functional differences between Type I and Type II ATC systems. For this reason the functionality of the ATP, TWC, ATO and ADU will be described separately for Type I and Type II operation.

The LACMTA P3010 ATC is designed for compatible functional operation on the metro lines listed below:

- Metro Blue Line (MBL) (Type I)
- Metro Green Line (MGL) (Type II)
- Pasadena Gold Line (PGL), including the Eastside Extension (Type I)
- Exposition (Type I)
- Crenshaw Line (Type II)
- Foothill Extension (Type I)
- Regional Connector (Type I) (Future)

A Line Selector Switch on the vehicle provides the method for properly configuring the ATC for operation on desired line and type of operation. In general Type I operation has ATP and TWC functional capabilities while Type II operation has ATP, TWC, and ATO functional capabilities.

2 System Description

2.1 System Overview

The ATC will provide the operational functionality of ATP, ATO, and TWC in one integrated enclosure. ATP train control functionality is implemented vitally.

The ATP functionality will perform the following eight major functions across all Metro lines:

- Cab Signal Reception and Decoding
- Vehicle Speed Determination
- Over Speed Protection
- Braking and Propulsion Control
- Input / Output Processing
- Door Control
- ATP Operating Modes
- Departure Test
- Direction Control and Validation

ATO operation is Type II specific. The function of the ATO will allow the LRV to automatically traverse the guide-way from one station to the next station. The vehicle performs speed regulation and station stopping in the Manual with ATO mode.

The berthed indication is provided from the wayside when operating on the Type II line. The vehicle's onboard ATC system enables the doors on the correct side (left or right) according to the ATC stored track circuit ID table.

The ATO functionality is Non-Vital. The major functions of the ATO are as follows:

- Braking and Propulsion Control for Automatic Operations
- Speed Regulation
- Programmed Stopping
- Route Control

The TWC functionality is Non-Vital. The TWC subsystem is 100% compatible with H&K HSC-V TWC equipment and the ASTS TWC systems installed on Metro’s existing alignments. The wayside transmits and receives non-vital information through the use of TWC loops situated between the rails and located at selected track locations. The vehicle TWC subsystem transmits and receives information through the use of TWC antennas mounted at each end of the vehicle. The selection of the active antenna is based upon which cab end is actively keyed. A Line Selector Switch on the vehicle provides the method for properly configuring the TWC for operation on the desired line.

The TWC performs the following major functions across all Metro lines:

- Route Control and Indication
- Overloop Detection & Indication
- Train Identification
- Results of Departure Test (Type II)
- Provides input to ATO subsystem

2.2 System Hardware

There will be no differences in the ATC package or in the installation of the ATC System on the P3010 LRV based upon Type I or Type II operation. Each P3010 LRV is equipped with one ATC system. This includes equipment mounted in an electronics cabinet in the vehicle cab and external to the car-body.

The list below provides a brief description of the hardware being supplied as part of the ATC system. The ATC system for the LACMTA P3010 LRVs will consist of the following:

- An ATC MicroCab® Enclosure – The enclosure incorporates the system's vital logic and interfacing circuits, a decelerometer, and a vital relay for control of a vital output to the emergency brake system and door enables. One (1) enclosure is installed in each P3010 vehicle.
- Aspect Display Unit (ADU) – The ADU/TWC Panel will be incorporated into a single flat panel display unit mounted in each cab of the LRV for the vehicle operator. Two (2) ADUs are installed in each P3010 vehicle (one A-End and one B-End).
- Truck-mounted cab signal pick-up coils – These devices incorporate two internal coils. One of the internal coils detects FSK and 100/250 Hz signals. The second coil is used for testing. Four (4) pick-up coils are mounted on the vehicle (two on each A-End truck and B-End truck). Each pair of coils is wired to a junction box.
- Vehicle body-mounted TWC antennas – Two (2) ASTS TWC and two (2) Hanning & Kahl TWC antennas are mounted on the vehicle (one A-End and one B-End). Each ASTS TWC antenna is wired directly to the ATC enclosure whereas the Hanning & Kahl TWC antenna is wired to the Communications Control Unit external to the ATC Enclosure.

The ATC MicroCab® enclosure will contain various "plug – in" PCB's including:

- ATP CPU
- Vital Input and Output PCBs
- Multifunction PCB
- Conditional Power Supply (CPS)
- Cab Signal Receiver Decoder (CSRD)
- ATO CPU (SPO)
- TWC Modem PCB
- Communications Control Board (CCB)
- Power Supply PCBs
- Safety Relay PCBs

Additionally, the enclosure will contain a Decelerometer which is used to measure the vehicle braking rate, and one ASTS PN-159B Vital Relay for controlling a vital output to the vehicle brake system. The ATC Enclosure will interface to the external circuits/trainlines/equipment through two separate HARTING connectors, M12 Ethernet Connectors, and DB9 MVB connectors.

2.3 System Functionality and Power Distribution

Internally, the ATC Enclosure will be separated into three subsystems:

- ATP
- TWC/ATO
- Communications/CSRD

In Type I Mode, the ATP is isolated from the TWC system physically and electrically. Powering off or removing a PCB from the ATC or the Type I TWC will not affect the other component. In Type II Mode, the subsystems are in layered dependence on the lower layered subsystems. The ATO subsystem is dependent on the TWC subsystem is dependent on the ATP subsystem. For example, the TWC subsystem can remain active if the ATO subsystem is powered down or removed, but cannot function if the ATP subsystem is powered down or removed. This hierarchy defines that a failure of the TWC subsystem cannot cause a failure of the ATP subsystem. Additionally, there is a TWC Bypass Switch on the operator's console that will remove power from the TWC subsystem to add extra isolation through safety relays in the ATC. The ATC enclosure will have one internal power switch located on the Battery Conditioner Board and accessible from the front of the ATC enclosure. The switch will be labeled "ATC".

The ATC power switch, when in the OFF state, cuts power from all components in the ATC enclosure beyond the Battery Conditioner Board. It is only with the ATC power switch in the OFF state that components can safely be removed from the ATC. Removal of a component under any other condition will result in failures of the ATC. The exception to this is the Type I TWC system external to the ATC. The Type I TWC system has a separate power supply and is not affected by the ATC system state.

Figure 2 shows an overall ATC system vehicle-level configuration. The ATC unit for the P3010 LRV will be mounted in the B – End Cab and the speed sensor for the powered truck will be mounted to the B – End Truck.

2.4 Design Heritage and Correlation to P 2000 and P2550 Systems

The ATC equipment is a service-proven design and is based on the LA P2550 platform. The ATO subsystem functionality will be based on the P2000 LRV's. As with any product, Ansaldo has continued to improve and update its MicroCab® system since the P2550 system went into service. In addition, some customization will be required to accommodate P3010-specific requirements. For these reasons, several PCBs used in the P2000 and P2550 systems have been replaced with newer Ansaldo components. Among the improved or updated PCB's are:

PCB Description	Notes and Comments
Multifunction (MFB) PCB	The Multifunction PCB is used across multiple ASTS ATC projects. The PCB was updated for obsolescence, previous design defects, and additional tachometry circuitry for a third channel.
Supervisory Position & Operation (SPO) PCB	The SPO PCB was developed for ATC projects that require both an ATO and a TWC subsystem.
Cab Signal Receiver Decoder (CSRD)	The CSRD is a standard ASTS product developed to replace the design deficiencies, and obsolescence that were inherit with the previous filter PCB designs.

Table 1 – Updated or Improved Standard ASTS PCB's

There will also be newly developed PCB hardware to meet the P3010 specific requirements. This will include the following PCBs:

PCB Description	Notes and Comments
Power Supply PCB	A new PCB will be designed to meet the lower voltage requirement range of 17 VDC to 30 VDC as well as the higher power demand of improved or updated PCB's.
Battery Conditioner PCB	An existing design will be adapted to meet the lower voltage requirement range of 17 VDC to 30 VDC and the requirement to not utilize fuses for over current protection.
Motherboard	A newly designed motherboard is needed because of the unique design of the LACMTA enclosure with the self-contained Vital Relay, in addition to the particular suite of ASTS PCB's required for P3010 operation.

Table 2 – P3010 New PCB Development

Newly designed PCBs are required on many new transit projects to accommodate different car battery ranges, current draw for the number of PCBs per subsystems, and different number of relays depending on the complexity of the system requirements. The Power Supply PCB in this instance must be modified to meet Kinkisharyo requirements. The circuit designs on these PCBs are identical on ASTS USA systems, and have been proven in use, but the part number and board will be new.

ATP Receiver Coils will be redesigned for use on the P3010 vehicles. ATP pickup coils will contain coils to receive ASK and FSK cab signals as well as for testing the functionality of the pickup coils in a single assembly. Current ASTS USA truck-mounted receiver coils are not capable of the operating over the frequency range required for the cab reception on the various LACMTA lines. In addition, there will be an additional test coil to perform testing and to verify the track receiver coil integrity.

2.5 System External Interfaces

The ATC system exchanges information with peripheral equipment on the lead car, and also communicates on the MDS, MVB, and trainline networks.

[redacted]

Figure 1 – ATC System Diagram

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3 System Architecture

Figure 1 shows the ATC equipment layout and external interfaces as installed on an LA P3010 car set. The ATC is physically installed on the B-End of the P3010 car set. There are no installation differences for the ATC due to Type I or Type II functionality. The power on time for the ATC system is 60 seconds.

3.1 ATC Enclosure Components

The MicroCab Enclosure consists of a welded steel enclosure designed for mounting in the P3010 vehicle equipment rack. The enclosure contains the following major components:

- One (1) integrated cardfile with plug-in PCBs for the MicroCab vital logic and interfaces to other peripheral equipment and subsystems (e.g., speed sensors and pick-up coils)
- One (1) Decelerometer for measuring vehicle braking rate
- One (1) Vital relay (ASTS USA PN-159B) for controlling a vital output to the vehicle emergency brake system
- One (1) Battery Conditioner PCB for filtering input power from the vehicle battery and protecting the MicroCab® circuits from voltage transients
- Two (2) Safety Relay PCBs providing safety relays for controlling various functions
- Six (6) mating connectors for interfacing external circuit/equipment wiring (power and data) to the cardfile
- Two (2) EEPROMs to store vehicle-specific data for the ATO and ATP Logic CPU PCBs

The enclosure measures 18.7(H) x 19(W) x 12.8(D) inches and weighs about 60 pounds. The enclosure will not have a front door; however there is a panel protecting the Vital Relay, Decelerometer, and Battery Conditioner compartment. An external ground stud, mounted near the vehicle wiring connectors, allows grounding the enclosure to the vehicle chassis to provide EMI protection for the system. The enclosure operates from 17 to 30 VDC vehicle battery power. Figure 3 shows the general design of the enclosure.

The location of the ATC enclosure is inside a closet located behind the driver on the B End of the LRV. The enclosure does not have special cooling or ventilation requirements, and does not incorporate an internal fan. Like all ASTS USA hardware, the enclosure is designed for a temperature range of -40°C to +70°C.

MicroCab ATP and ATO, and Type II TWC subsystem equipment will be housed in the same enclosure. The Type II TWC subsystem can be isolated by using the TWC Bypass Switch external to the ATC Enclosure. This switch will remove power from the TWC Modem Board prohibiting transmission and reception of TWC Messages in Type II Mode. In Type I Mode TWC communication is provided by the Hanning & Kahl TWC Assembly that is electrically and physically separated from the ATC System. In Type II Mode it is not possible to remove the ATP subsystem and still have the Type II Mode TWC operational.

The cardfile section of the enclosure contains the controlling logic (hardware and software), PCB power supply and interface circuits. The backplane contains connectors to enable PCB-to-PCB communications, data interfaces with external circuits and equipment, and distribution of PCB operating power.

Each PCB includes front panel controls and/or displays as appropriate to the PCB's function within the system. Unused slots are covered with blanking panels (single or double-width).

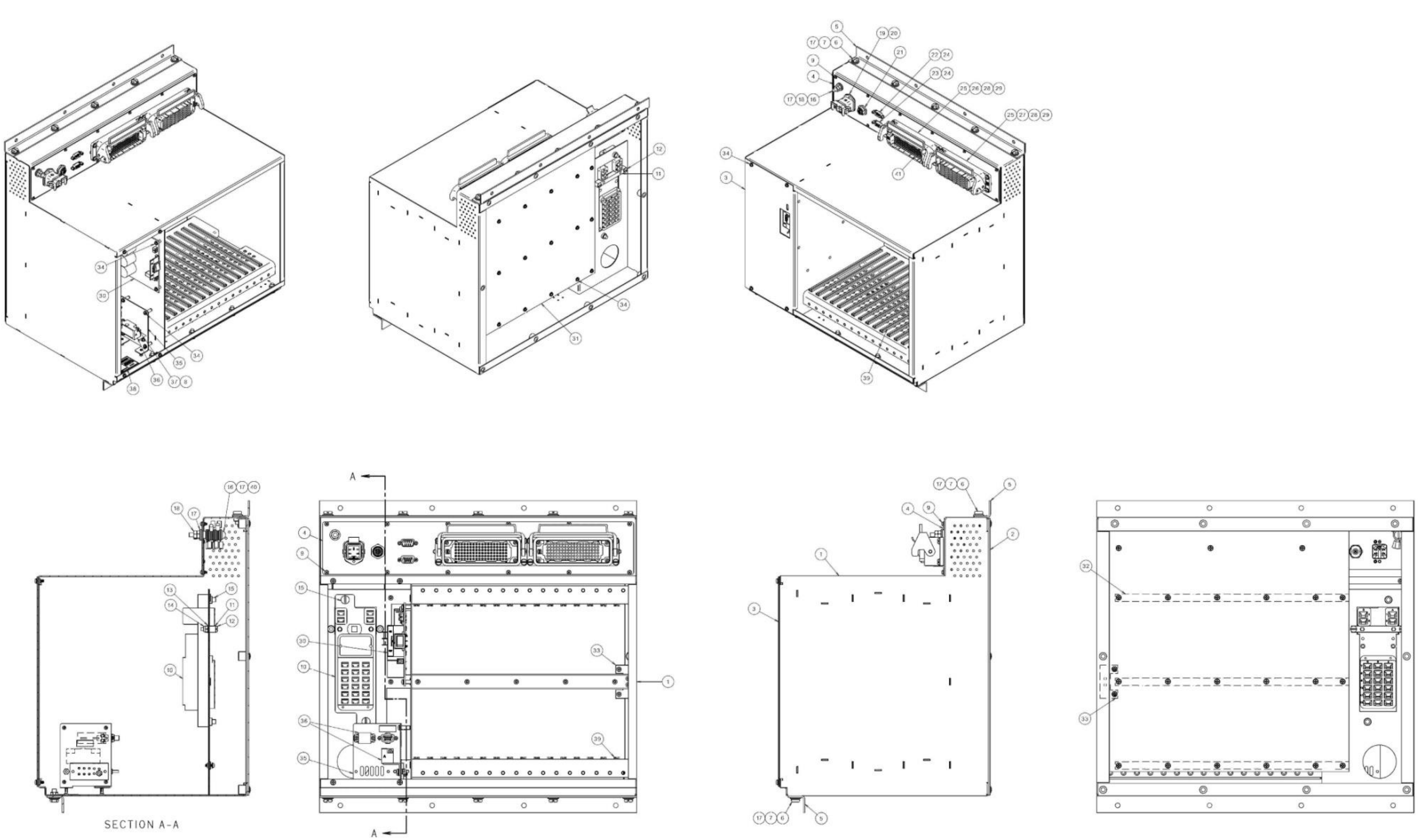


Figure 3 – ATC Enclosure - Mechanical

3.1.1 ATP Logic CPU

This PCB contains the ATP system's vital logic software and is primarily responsible for managing the system's vital overspeed protection function. The ATP Logic CPU will operate on a 250ms cycle time. Key functions of this board include:

- Cab signal detection and decoding
- Manage Vital Inputs/Outputs
- Train speed determination
- Over speed detection
- V-zero and No Motion determination
- Brake assurance
- Brake Monitoring
- Vital brake initiation
- Departure Testing
- Event management
- Door Enable Control
- Direction Assurance

3.1.2 Cab Signal Receiver-Demodulator PCB

The CSRD board is responsible for reception, filtering and processing of all cab signals received from the rails, including both 100 Hz and 250 Hz step speed signals and FSK profile speed signals. As such, it replaces the 100 Hz Filter/Demodulator, 250 Hz Filter/Demodulator, CSRD CPU, FSK Receiver and FSK CPU boards of the earlier MicroCab system installed in LACMTA's P2550 vehicles. The CSRD receives signals (ASK and FSK) from the track receivers and delivers the final processed cab signal speed commands to the ATP Logic CPU PCB via the cardfile backplane. The CSRD will operate on a 10 ms cycle time, and will utilize the leading and trailing edges of the ATP – related signal received from the rail for the step speed signals.

3.1.3 Vital Input PCBs

Two (2) Vital Input PCBs monitor the cab control, vehicle status and closed-loop inputs. They then send the received inputs to the ATP Logic CPU PCB via the cardfile backplane motherboard (G96).

The Vital Input PCBs will share a common PCB hardware design to allow use on the Type I, as well as the Type II systems. Stuck button checks must be performed externally on inputs which have a control signal defined as momentary.

3.1.4 Multi-Function PCB

The Multi-Function PCB performs the following functions:

- Type I Departure Test – Generates modulated-carrier cab test signals for use during the Type I Departure Tests.
- Decelerometer – Contains supporting decelerometer circuitry that reports acceleration/deceleration results to the ATP Logic CPU.
- Speed Sensor Input – Decodes the speed sensor input pulses into speed information for input to the ATP Logic CPU.
- Vital Outputs – Provides eight (8) vital output channels for the ATP.
- Non-Vital Inputs – Provides eight (8) optically isolated non-vital inputs.

All of the above operations and interfaces are controlled by the ATP Logic CPU board which communicates with the Multi-Function board via the cardfile backplane motherboard.

3.1.5 Communications Controller Board (CCB)

The CCB PCB is designed to provide MVB and redundant Ethernet-compatible interfaces for the LA P3010 project. It interfaces data to and from the vehicle's on-board MVB and Ethernet networks with the MicroCab ATP CPU and ATO CPU boards (via the ATC Control Unit's cardfile motherboard). The CCB is a microprocessor-controlled board with permanent application software that is loaded at the factory. It is designed as a "Class II" device, i.e. it is field-configurable and can pre-process information, but the microprocessor's program is fixed.

The CCB board contains all necessary interfaces to conform to the IEC-61375 MVB specification as a slave device. It includes two (2) dedicated and isolated RS-485 serial links for a redundant MVB connection, four (4) additional isolated RS-485 serial links, one (1) isolated RS-232 serial link and two (2) Ethernet communication links.

For example, the CCB board can provide a dedicated Ethernet interface to connect the ATP Logic CPU PCB to the vehicle's Monitoring and Diagnostic System (MDS) and at the same time, communicate with the ADU via the MVB. As such, the CCB enables the ATP Logic CPU board to route information to/from other train systems and peripheral equipment.

Another key function of the CCB is managing user diagnostic and event data downloading procedures and logging of ATP, ATO and TWC events.

The CCB also provides an RS-232 link to the TWC Modem Board to allow it to interface to the other ATC Subsystems through the G96 bus or over RS-485 to the ATO SPO Board.

3.1.6 Conditional Power Supply PCB

The Conditional Power Supply PCB (CPS) provides an isolated 31.5 VDC supply for the vital ATP circuits. The CPS receives 17-30 VDC power from the vehicle, and a 500 Hz life signal from the ATP Logic CPU. During normal operation, the life signal is ON and the CPS vital output supply is enabled. During an ATP Logic CPU or safety-related system fault, the life signal is turned OFF. This disables all vital outputs and results in an immediate Emergency Brake application request to stop the vehicle.

3.1.7 Power Supply PCB

The Power Supply PCB converts vehicle power into isolated supplies for the ATP circuits. The standard supplies are to provide +15VDC, ±12VDC, and +5VDC.

3.1.8 ATO SPO PCB

The ATO SPO PCB is a non-vital CPU board that will support overall ATC system operation by performing various ATO functions within its own software. It features a Field-Programmable Gate Array (FPGA) to perform software tasks. The ATO SPO PCB contains a communications transceiver as well as speed input, decelerometer input, and discrete I/O. The ATO CPU will operate on a 100ms cycle time. Key functions of this board include:

- Processing received wayside FSK message
- Transmitting FSK messages to the wayside
- Communications with the ADU for front panel indicators and displays
- Processing ADU inputs (example Route ID)
- Processing vehicle inputs to the ATO
- Communications with the ATP for exchange of diagnostic, status, and track position data

Note: ATO – specific events will be transmitted to the CCB PCB for storage in the overall ATC event logs (user-accessible).

3.1.9 TWC Modem Board

The non-vital TWC Modem Board operates as a modem for the wireless transfer of serial data between the vehicle and wayside. The transmit section generates the modem carrier frequency which is FSK modulated to encode the digital message data. The carrier level is then raised sufficiently to drive an external loop antenna. The receive section filters and demodulates a FSK-modulated carrier to extract the digital message data. The digital input and output message data are processed over an RS-232 link to the CCB and then over RS-485 or G96 bus to the ATO SPO PCB.

3.1.10 Battery Conditioner PCB (Enclosure-Mounted)

The Battery Conditioner Board PCB filters the vehicle battery input power and provides transient free voltage to the electronics powered by the output of the PCB. The Battery Conditioner PCB has a front-end circuit that protects the rest of the board as well as the system from a continuous over-current condition followed by protection against transient voltages that may be present on the input battery lines. After the transient protection, the filtering circuit is used to suppress common mode and differential mode noise. Decoupling capacitors are added to the conditioned voltage to filter any high frequency noise and to handle spikes in the current draw from battery. The PCB includes a voltage monitor that provides feedback signals to the system to indicate an out of tolerance battery voltage as well as driving front panel indicator LEDs.

3.1.11 EEPROM (Motherboard-Mounted)

Two Electrically-Erasable Programmable Read Only Memory (EEPROM) devices store critical vehicle-specific parameters, such as wheel diameter settings and Permanent Vehicle Identification (PVID). Each device is populated on the motherboard. Storing vehicle-specific parameters in EEPROM devices allows changing out the associated controller boards without reprogramming the vehicle-specific parameters.

3.1.12 Vital 8 In 8 Out Board

The Vital 8 In 8 Out PCB contains eight (8) Vital Input channels and eight (8) Vital Output channels. Each output can drive a relay coil or an indicator lamp. Each input is capable of receiving a 24VDC nominal voltage input from the vehicle trainlines. For the P3010, the PN 159 (Vital Relay) is controlled by the 8 In 8 Out Vital Output Board which communicates on the G96 bus.

Discrete LEDs are provided on the board’s front panel to show the on/off states of the individual inputs and outputs.

3.1.13 PN-159B Vital Relay (Enclosure-Mounted)

The ASTS USA PN-159B vital relay provides a direct interface between the ATP and the vehicle emergency brake trainline. When the ATP detects an emergency brake condition, the vital relay is de-energized, and its contacts open to interrupt the vehicle Emergency Brake trainline and put the vehicle into Emergency Brake. The PN-159B is a double coiled, 24 volt relay with coil resistances of 400/400 ohms. Contacts are 6 front-back, low voltage with silver-to-silver impregnated fronts and silver-to-silver backs. Mounting in the vehicle equipment rack base is accomplished with two bolts. Figure 4 shows the PN-159B relay.

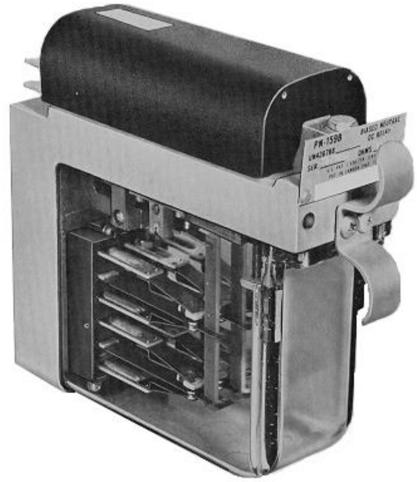


Figure 4 – ASTS PN –159B Vital Carborne Relay

For the P3010 application, the PN – 159 will provide contacts for the Emergency Brake application. The additional contacts of the PN – 159 will be provided for the Door Enable Left and Door Enable Right Trainlines that will be opened during an emergency brake application:

[redacted]

3.1.14 Safety Relay PCB

For the P3010 LRV, ASTS will use Safety Relays in which the additional relay contacts are used as an input which are back-checked as was provided on the P2550 vehicles.

The Safety Relay PCB contains 12 “safety” (double – break and back – checked) relays that provide the ATP output interface to the vehicle and the steering logic for selecting Cab Signal and TWC antenna sources.

Safety Relays (for various functions) are contained on the Safety Relay PCB and are each driven by optically isolated vital outputs on either the Multifunction PCB or the Vital 8 In 8 Out Board. One of several Safety Relays handles the Full Service Brake Relay (FSBR) signal. When the relay is energized, the contact is closed to allow for normal operation. When the relay is de-energized, contact is open and the vehicle will see the FSBR signal. This relay also contains a back-check contact, which is connected to the Vital Input PCBs or the Vital 8 In 8 Out PCB and monitored by the ATP system.

[redacted]

The operation of a Safety Relay depends on the forced operation of the relay’s inner contacts. If either of the inner contacts becomes welded, the normally-closed outer contacts remain open. Using the outer contacts as a feedback provides a check that inner contacts have not welded. The Safety Relay differs from a vital relay in that the possibility still exists for the inner relay contacts to weld. However, unlike the non-vital relay, a failure due to welded contacts is detectable.

Back-checking is accomplished once every software cycle (250 ms). Normal operation is shown in Figure 7. In Figure 8 illustrates response to a failed Safety Relay.

[redacted]

Safety Relay design and operation is governed by the EN-50205 standard:

- Contacts are mechanically interlocked in such a way that the NC contacts and the NO contacts can never be closed at the same time.
- This applies over the entire life span for contacts under both load and no-load conditions.
- 0.5 mm is the guaranteed contact opening for the contacts opposite to the contacts that are failed as welded, or closed for any other reason, under failure conditions.

Standard EN-50124-1 governs Safety Relay reinforced insulation:

- Reinforced (i.e. double) insulation between all circuits.
- Between NO Contact and Coil.
- Between NC Contact and Coil.
- Between NO Contact and NC Contact.
- Dimensioning of Normally Open (NO) Contact Gap (Compliant: EN – 50124-1 Table C.1).
- NO Contact Spacing ≥ 1.0 mm for Pollution Degree 2.

The CPS (Conditional Power Supply) feeds the vital relay which enables safety relay feeds for Left and Right Door Enables to be terminated. Therefore, the activation of the EB function will remove power from the Enable Left Doors and Enable Right Doors safety relay contacts.

3.1.14.1 Relay Signal Backchecks and Crosschecks

The following crosschecks and backchecks are performed on relay signals. In response to all crosscheck and backcheck errors, ATC will request a Penalty Brake (EB for Door Enables) in the same cycle as when the error has been declared.

Crosscheck		Description
Keyed Cab Crosscheck	✓	A and B cab are keyed up crosschecked
Line Selector Switch Crosscheck	✓	Both lines are selected or neither line is selected crosscheck
Manage Mode Selector Crosscheck	✓	Both modes (MANUAL and MANUAL with ATO) are selected or neither mode is selected
Manage Direction Crosscheck	✓	Crosscheck between vehicle direction and tach direction at speeds above 10 mph
V-zero Decelerometer Cross check	✓	V-zero status vs Decelerometer Crosscheck
Manage Fwd Rev Crosscheck	✓	Both Forward and Reverse inputs are On Crosscheck. If they are both off they are considered neutral
Bypass Crosscheck	✓	Bypass and Not In Bypass are in the same state
Emergency Brake Crosscheck	✓	When EB is requested, EB applied input is Off.
Backchecks		
FSB Backcheck	✓	Relay back contact crosscheck for FSB
DepartTestSrcSignal Backcheck	✓	Relay back contact crosscheck for Departure Test
Cab Signal Select A Backcheck	✓	Relay back contact crosscheck for A CAB signal select Relay
Cab Signal Select B Backcheck	✓	Relay back contact crosscheck for B CAB signal select Relay
Forward Backcheck	✓	Relay back contact crosscheck for Forward signal from Forward/Reverse Switch
Reverse Backcheck	✓	Relay back contact crosscheck for Reverse signal from ATO request of Fwd/Rev
Left Door Enable Backcheck	✓	Relay back contact crosscheck for Left Door Enable
Right Door Enable Backcheck	✓	Relay back contact crosscheck for Right Door Enable
Propulsion Cut Backcheck	✓	Relay back contact crosscheck for Propulsion Cut
A Cab TWC Select Backcheck	✓	A Cab TWC Select relay backcheck
B Cab TWC Select Backcheck	✓	B Cab TWC Select relay backcheck
M feed from the Master Controller Backcheck	✓	Master Controller M feed relay backcheck
CM feed Backcheck	✓	CM feed relay backcheck

3.2 External Components

3.2.1 Antennas

A set of ATP track receivers and two TWC antennas (1 Type I and 1 Type II) are installed on both the A-End and B-end of the car set. Fundamentally, the ATC System monitors the key switch located within each cab for cab control information. If neither transfer switch is active (keyed), the system is declared to be in Local mode. When either the A-End or B-End cab is determined to be In Control (Keyed Up) by the

ATC, the corresponding set of ATP track receivers and TWC antenna are electrically connected to the ATC.

3.2.1.1 ATP Track Receivers

ASTS USA will supply a single design of track receiver to detect 100/250 Hz cab signals as well as digital FSK cab signals. Internally, these receivers will incorporate coil elements to receive 100/250 Hz and FSK, plus an element used exclusively for testing the ATC systems cab signal detection function. Each receiver will couple the cab signals to the CSRD PCB in the ATP/TWC enclosure through a junction box and vehicle wiring. These receivers will be mounted in pairs on the vehicle's trucks, at both ends of the vehicle (4 total coils per vehicle). Each receiver will consist of a compact horizontal bar approximately one foot long, plus a central mounting bracket. Receivers will be tested to meet or exceed vibration requirements for truck mounted equipment. The ATP Track Receivers need to span the frequency range between 0 to 20 KHz, and will incorporate an Emitter/Follower amplifier design technique incorporated into the antenna.

Because only one pair of receivers is active at a time, the ATP electronics use relays to select the appropriate pair of receivers.

3.2.1.2 TWC Subsystems

The Type I TWC subsystem uses two (2) Hanning & Kahl TWC antennas, one at each end of the vehicle. The Type II TWC subsystem uses two (2) ASTS TWC antennas, one at each end of the vehicle. Each ASTS antenna includes one set of transmit and receive coils. Power on time for Type I TWC is 5 seconds.

The TWC antenna receives and transmits signals to and from the TWC loops mounted between the rails. Each TWC antenna connects to the ATP/TWC enclosure through the vehicle wiring.

For ASTS TWC antennas a Transformer "Step – Up/Step – Down" design will be incorporated in to the TWC modem board internal to the ASTS Enclosure and TWC Antenna. Because only one antenna is active at a time, the ATP and Type II TWC electronics use relays to select the appropriate antenna, as well as the appropriate set of transmit and receive coils.

3.2.2 Speed Sensors

The ATC will have three inputs from two active speed sensors to determine speed and direction of travel. One speed sensor will be mounted on axle 6 of the motorized truck and provide one output channel dedicated to the ATC. The other speed sensor will be mounted on axle 4 of a trailer truck and provide two quadrature phase output channels dedicated to the ATC. These two speed channels will provide speed and quadrature phase information to determine direction of travel information.

3.2.3 ADU and TWC Interface Panel

The Aspect Display Unit (ADU) provides the train operator with ATP, ATO and TWC related controls and indications. This unit incorporates a single Liquid Crystal Display (LCD) window for showing all ATC system indications. Pushbuttons are provided around the LCD display area to allow the operator to interface the ATC system.

The ADU is also equipped with an audible alarm for various conditions such as ATP overspeed. The ATP utilizes the audible alarm to alert the Operator to any significant change or condition in the ATP system. The ATP produces several types of audible indications. These include:

- Chirp – short on/off cycling of the alarm
- Beep – Single cycle of the alarm; ON for 0.5 seconds, then OFF
- Continuous – Continuous sounding of the alarm

Following table shows the conditions for which the alarm is sounded and released as well as the type of alarm that is used.

Alarm Condition	**Alarm Type**	**Release**
Speed Code Change (Type I) (Note: the code change can be upward or downward)	Beep	0.5 Seconds (Single beep)
Over Speed	Continuous	Rate achieved or under-speed, and Operator Acknowledgement Or EB Applied, and Operator Acknowledgement
Time to Profile less than 5 seconds (Type II only)	Beep	3 seconds (Three beeps)
Speed greater than BSL (Type II only)	Chirp	Speed less than or equal to the BSL
Target Speed Change (Type II only) (Note: the speed change can be upward or downward)	Beep	0.5 Seconds (Single beep)

No audible alarms will be provided for TWC events such as overloop, Route ID change or Train ID change.

Display brightness is automatically adjusted via a built-in light sensor. The operator can also manually adjust the brightness. However, there is a lower limit to the brightness adjustment.

The ADU is not serviceable and is replaced as a complete assembly.

The ADU power on time is 45 seconds.

The MicroCab ADUs for the LACMTA P3010 trains are not designed to be fail-safe devices, that is to say they are Non - Vital.

The MicroCab ADU provides visual and audible ATC indications to the vehicle operator. The ADU also allows the operator to select ATC operating modes and system tests. One ADU mounts in each operating cab. The interface between the ATC and the ADU will over the LRV's MVB network.

Because the P3010 vehicles will operate on Metro lines with different operational rules, the flat panel ADU, while being an integrated display to the operator, will have two different main screens tailored to operation on Type I or Type II lines.

The ADU will also provide the functionality of a TWC Interface Panel for the Hanning & Kahl TWC System utilized in Type I Mode via a flat panel display screen.

The various display screens will be described in more detail in Section 3.2.5.

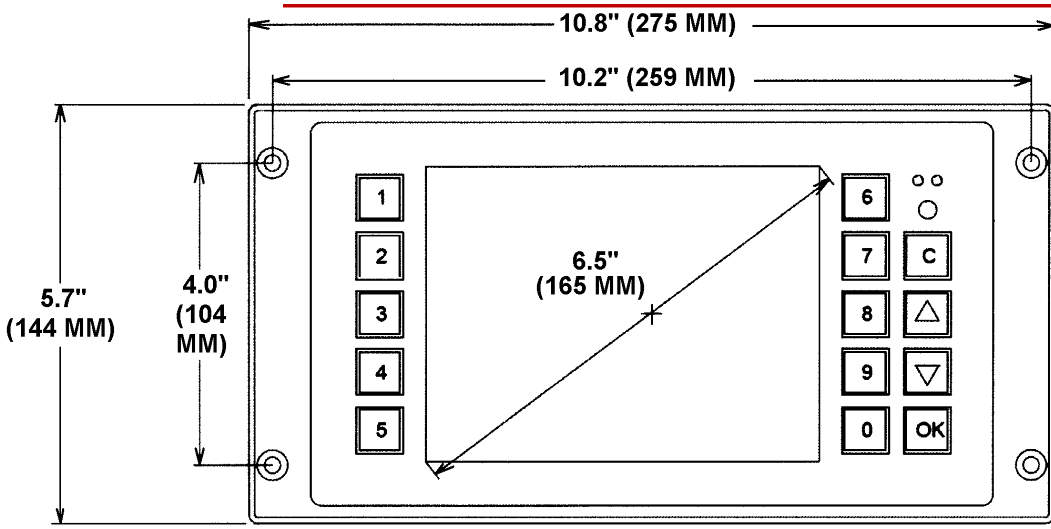


Figure 9 – ADU/TWC Interface Dimensions, Front

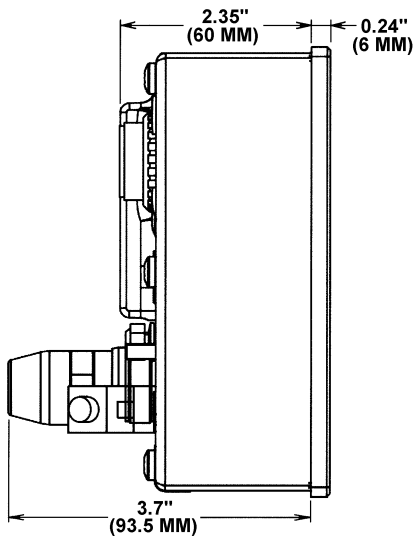


Figure 10 – ADU/TWC Interface Dimensions, Side with Connectors

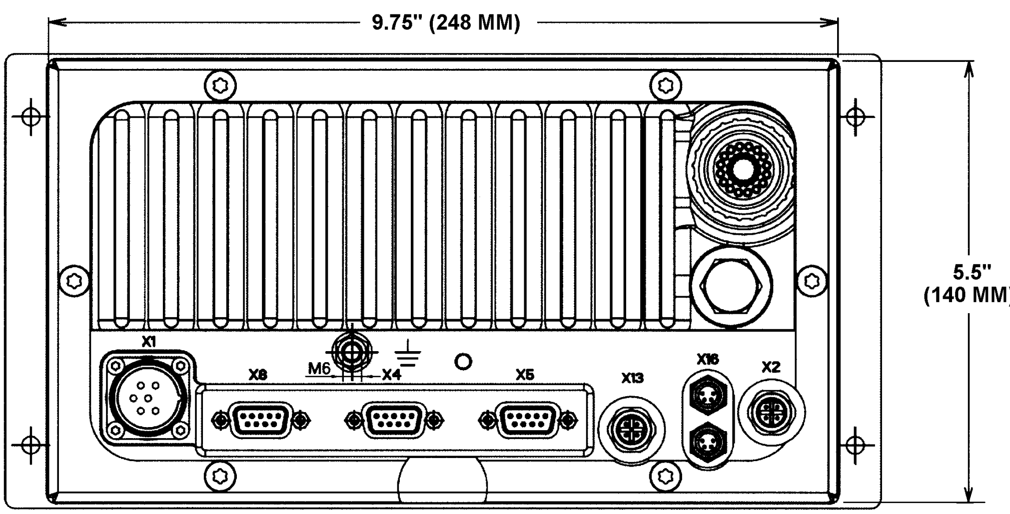


Figure 11 – ADU/TWC Interface Dimensions, Rear without Connector(s)

3.2.4 ADU and TWC Interface

The ADU is a microprocessor based flat panel display unit. The ADU will incorporate the functionality of both an ATP ADU and a TWC Interface panel. The ADU has a set of soft keys to allow user input to the ATC system as well as to change between the ADU main screen and the TWC Interface screen. Stuck button checks will be performed on the ADU soft keys. The ADU also has an audible alarm to alert the driver on certain events. Only the ADU in the active cab is powered on. The ADU softkeys have a service life of 10^6 operations (MFT5_EN_059109600E, Deuta-Werke). The life expectancy for a button pressed 100 times per day, 365 days per year is 27.4 years.

Figure 12 and Figure 13 show sample ADU screens for Type I and Type II operation. Figure 14 and Figure 15 – Type II TWC Interface Screen show an example TWC Interface screen. These screen shots are included for base discussion purposes to show some of the display options and possible screen layouts.

The ADU will provide the following inputs to the ATP system:

- Street Running Mode Switch
- Stop & Proceed Mode Switch
- Departure Test Start Button
- Door Enable Override

The ADU Main screen will display the following information to the user:

- Vehicle Speed (Digital and Speed Ring)
- Speed Limit (Digital and Speed Ring)
- Target Speed (Type II Only)
- Overspeed Indication
- Penalty Brake Applied Indication
- Emergency Brake Applied Indication
- Distance To Go (Type II Only)
- Time To Profile (Type II Only)
- ATP Failure
- TWC Failure
- ATO Failure (Type II Only)
- Route ID
- Train ID
- Cab Signal Status
- TWC Overloop Indication
- Dwell Expired Indication (Type II Only)
- Berthed Indication (Type II Only)
- Operating Mode
- ATP Bypassed Indication
- Friction Brake Fault Indication

The ADU will also provide the TWC Interface screen functionality. The ADU Main screen will have a button "TWC Panel" to switch to the TWC Interface screen as will the TWC Interface screen have a button "ADU Main Screen" to switch back to the ADU Main screen.

The TWC Interface screen is accessed by pressing the TWC Panel key on the ADU. This button will only be functional when the train is at V-zero speed. If the user is viewing the TWC Interface screen and V-zero is lost, the ADU will revert back to the ADU main screen. The ADU display will revert back to the ADU Main screen from any other screen if there has been no user input for a period of 5 seconds.

The TWC Interface screen will provide the following inputs to the TWC subsystem:

- Primary Request (Type I Only)
- Secondary Request (Type I Only)
- Non Mainline Request (Type I Only)
- Cancel Request (Type I Only)
- Enter Route ID
- Gate Call (Type II Only)
- Gate Cancel (Type II Only)
- Signal Cancel (Type II Only)

The TWC Interface screen will display the following information to the user:

- Train ID
- Route ID
- TWC Ready/TWC Fault
- TWC Overloop Indication
- Cab Signal status
- Train Length (Type II Only)
- Gate Call (Type II Only)

3.2.5 ADU and TWC Interface Sample Screens

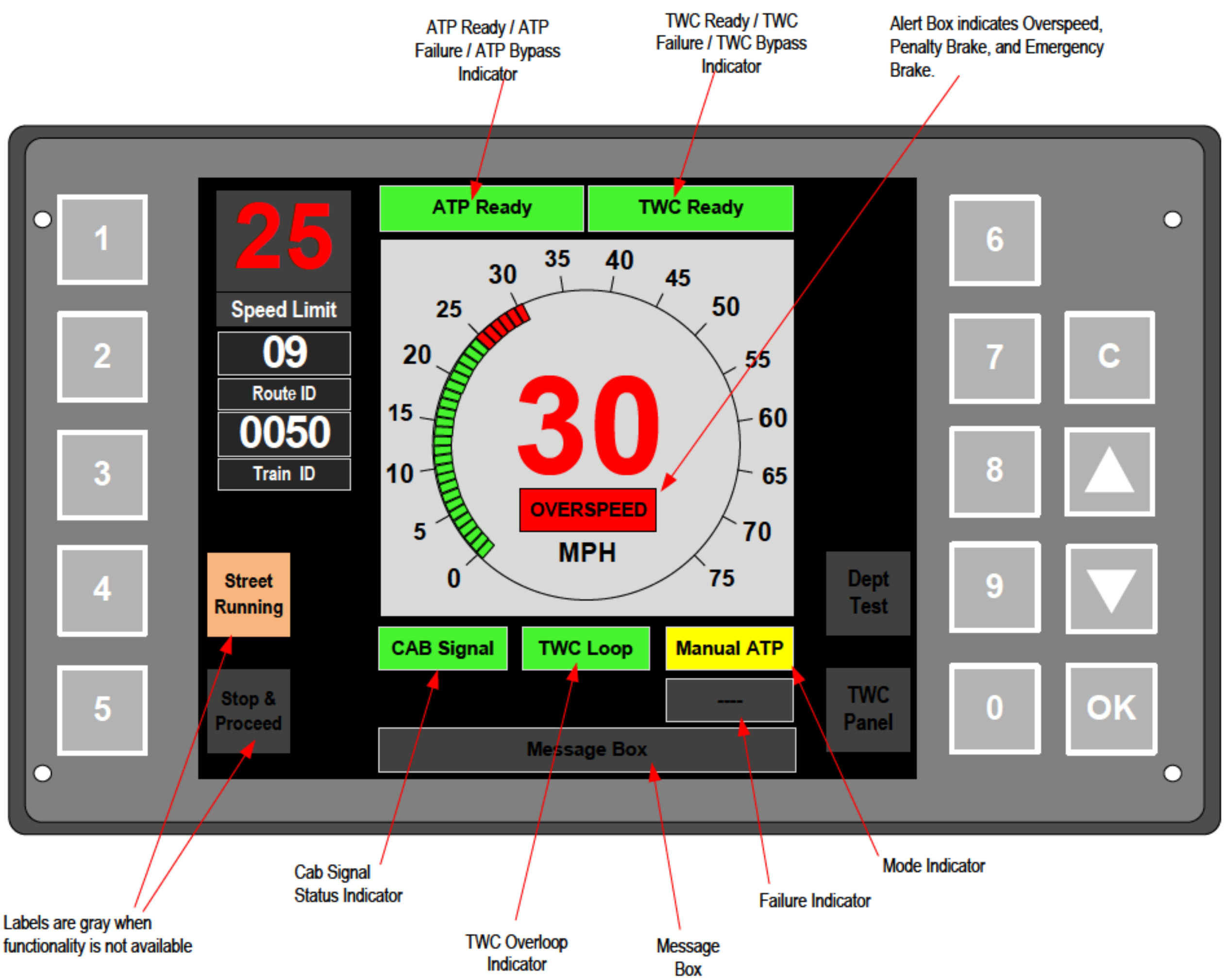


Figure 12 – Type I ADU Main Screen

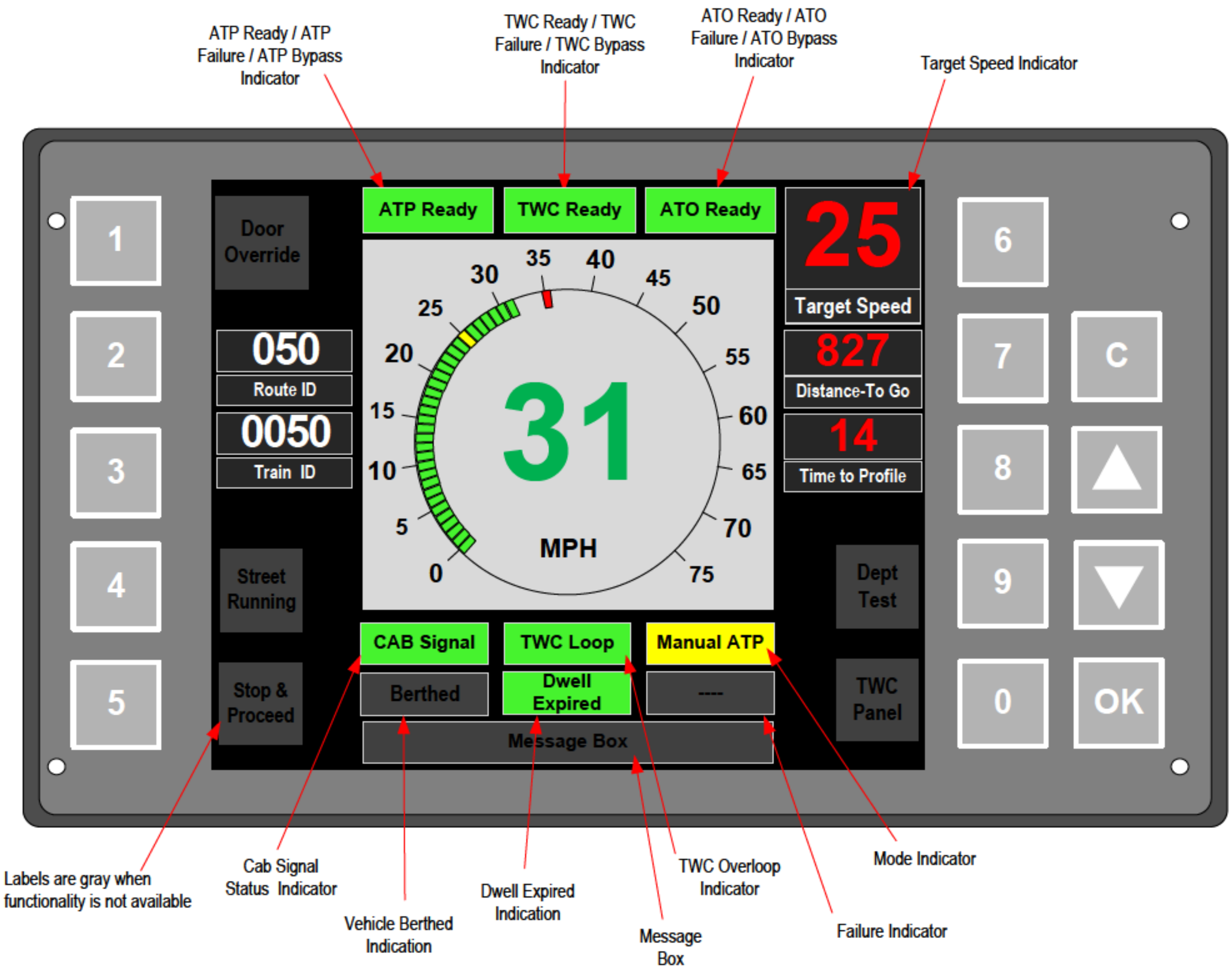


Figure 13 – Type II ADU Main Screen

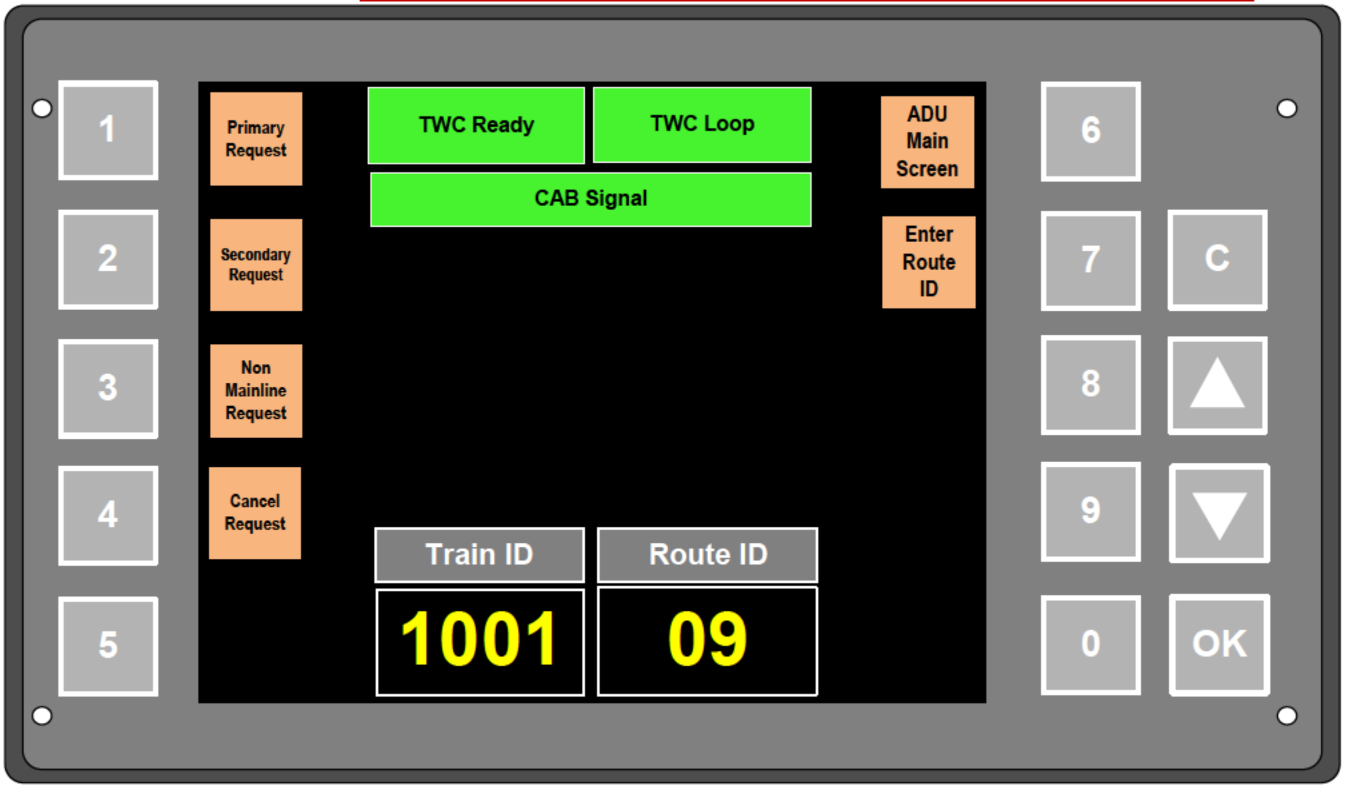


Figure 14 – Type I TWC Interface Screen

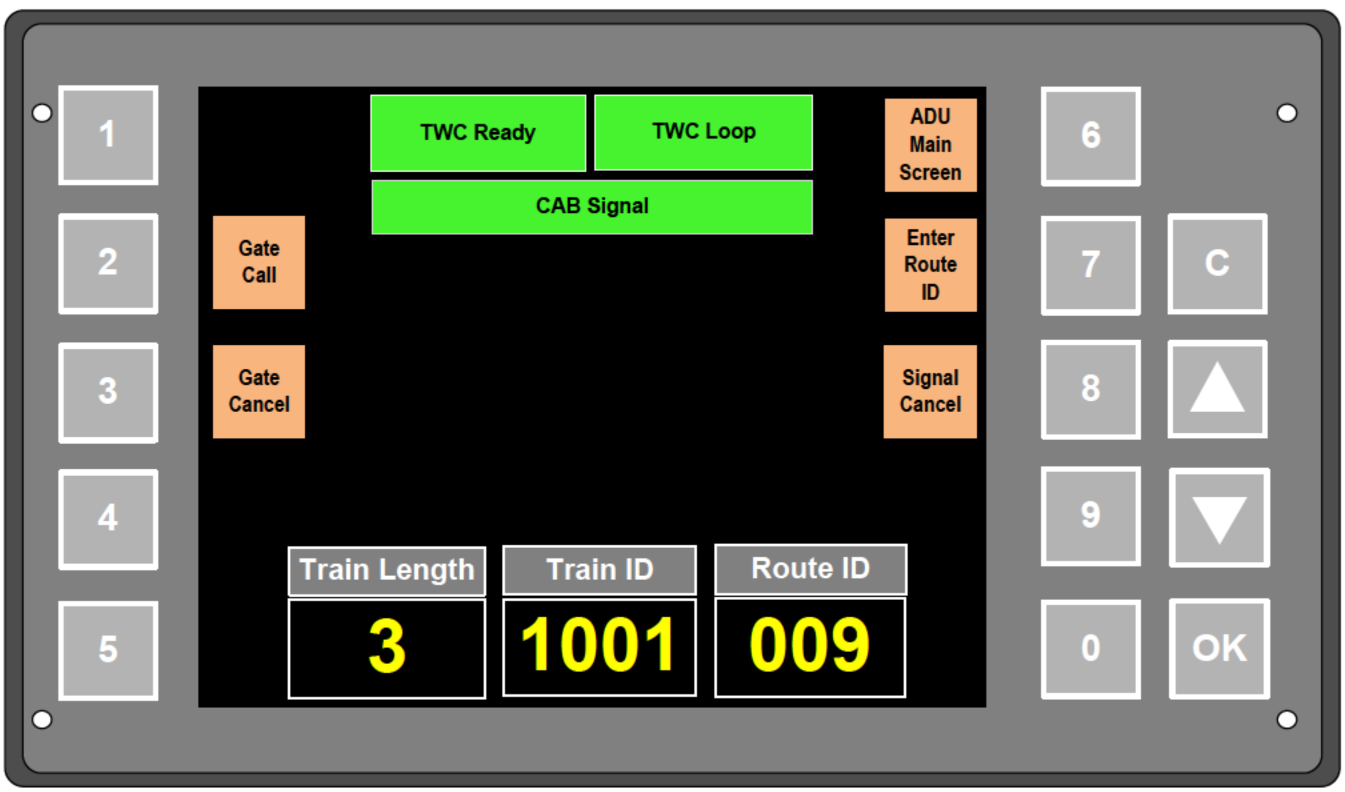


Figure 15 – Type II TWC Interface Screen

3.2.6 Vehicle Console Inputs to the ATC

In addition to the ADU, the ATC accepts inputs from the user through several controls located on the vehicle console over MVB only.

These vehicle console inputs include:

- Car Wash Mode button (MVB)
- ATO Release button (MVB)

4 ATC Functional Description

4.1 ATP Subsystem

4.1.1 Cab Signal Reception and Decoding

Track Circuits provide a mechanism for the wayside to detect the presence of vehicles and transmit control signals to vehicles. Each wayside track circuit continuously transmits vital data to the vehicle, generally referred to as Cab Signal. The Cab Signal data in each track circuit provides much of the information needed to determine the current safe speed of the vehicle in that particular track circuit.

Different Cab Signal technologies are employed on Type I and Type II operation systems. As such, the ATP system is designed with two separate decoding subsystems to accommodate these methods. Depending on the position of the vehicle Line Selector switch, the ATP will select the appropriate decoding subsystem to use in determining the current speed limit.

The Type I operational system is a non-profile-based step systems employing traditional ASK modulated coded carrier cab signal technology. When operating as a Type I operational system, the cab signal reception and decoding is the function of the CSRD subsystem. The detailed functionality of ASK Cab Signal Reception and Decoding will be described in Section 5.1.1.

The Type II operational system is a profile-based system employing digital FSK cab signal technology. When operating as a Type II operational system, cab signal reception and decoding is the function of the CSRD subsystem. The detailed functionality of FSK Cab Signal Reception and Decoding will be described in Section 6.1.1.

4.1.2 Vehicle Speed and Direction Determination

Determining vehicle speed is a critical and vital function of the ATP subsystem. The ATP subsystem will compare the speed pulses from the speed sensor that is installed on a non-powered, center truck axle 4 with that of another speed sensor installed on powered truck axle 6. The ATP vitally determines the vehicle speed using the received signals and user programmed wheel size values for each sensor.

4.1.2.1 Speed Sensors

The ATP subsystem utilizes three inputs from two active, zero-speed sensors. Two speed sensors are used to protect against singularly undetectable failures for speed signal acquisition. Two independent devices are used to reduce the possibility of single point failures. The devices are mounted on separate axles and powered by independent supplies. The probes reliably detect speeds to as low as approximately zero mph. One sensor provides two quadrature-phase inputs to the ATC system in order to assess direction.

The sensors are used in determining vehicle motion parameters such as:

- Vehicle Speed
- Spin/Slide
- V – zero State
- No Motion State
- Vehicle Position (Type II only)
- Direction of Travel
- Roll Back

4.1.2.2 Vehicle Speed Determination

The “System Speed” value is used by the ATP subsystem as representation of the vehicle speed and is displayed on the ADU unless the ATC-ADU communication link is down, in which case the MVB speed will be displayed. System Speed is vitally determined using the two speed sensors described, and the decelerometer device. The output from each speed sensor is non – periodic square wave, whose frequency is based upon rotational velocity of a pole wheel connected to the axle. The ATP converts these pulses into linear distance using wheel diameter information. Speed for each sensor is then calculated as the linear distance per unit of time. The gear ratio on a motorized truck is 1:6.4264 and there are 60 teeth on pole wheel. For a new 28 inch wheel this translates to 77.0708 pulses/sec per mph, or 5394.9571 hz at 70 mph. For a worn 26 inch wheel this translates to 82.999 pulses/sec per mph, or 5809.96 hz at 70 mph. The gear ratio on the center, or trailer truck pole, is 1:1 and the pole wheel has 120 teeth. For a new 28 inch wheel this translates to 24.0095 pulses/sec per mph, or 1680.6711 hz at 70 mph. For a worn 26 inch wheel this translates to 25.8564 pulses/sec per mph, or 1809.9538 hz at 70 mph.

The calculated speeds for each sensor are used to determine the value of “Tach Speed.” The vital parameter Tach Speed is determined using the greater of the two calculated sensor speed values; unless a Spin/Slide condition exists. During a declared Spin condition, the Tach Speed is determined based solely on the calculated speed from the speed sensor on the non-powered truck (the motor wheels are spinning), except when the non-powered truck speed is showing zero speed. In this situation the Tach speed from the powered truck will be used. When not in an active operating mode, or when in an active operating mode and the vehicle is not in a braking or declared Spin/Slide condition, the System Speed is set to the determined Tach Speed.

During both Type I and Type II operation, in the event of a declared Slide condition, or in situations where the speed sensors cannot be trusted, the ATP maintains an additional speed parameter that is calculated using the decelerometer device. When the vehicle is in a braking or declared slide condition, and the System Speed is greater than two (2) mph, the ATP determines a “Decel Speed” value for that cycle based upon the current cycle’s instantaneous brake rate value, and the previous cycle’s System Speed value. The ATP will grade compensate the brake rate when in Type II operation. System Speed is set to the greater of either the Tach Speed value, or the decelerometer adjusted speed value.

4.1.2.3 Wheel Wear Compensation

A wheel wear adjustment function is provided in the ATP for use in determining vehicle speed. The wheel wear will be entered using the TOD and the TOD will forward the wheel diameters to the ATC and Propulsion units. The ATP system allows for input of the correct wheel diameter to ensure accurate velocity measurements. This vital value may be adjusted between the nominal “new wheel diameter of 28.25 inch,” to the minimum allowable wheel diameter of 26 inch, in 0.125 inch increments (values sent to ATC will be rounded up to nearest 0.125 increment). Both speed sensor equipped axles are required to have a wheel diameter value set and verified by a qualified maintainer. After measuring the wheel(s) associated with each speed sensor, the appropriate value(s) are entered into the ATP using the function keys on the TOD. The ATP will only permit entry of the wheel diameter values if the ATP is in Manual mode. If another mode is entered once the entry process has begun, the ATP will abort the entry session and revert back to using the current stored value. In addition, the ATP will require the train to be at V-zero and friction brakes to be applied. Once the input is made, the wheel diameter values are retained in the ATP subsystem EEPROM until authorized maintenance personnel adjust it.

The ATP will use the largest wheel diameter setting upon start-up until the data is retrieved from the EEPROM to compute speed. The largest wheel diameter setting will also be used in the event that wheel diameter is determined to be corrupt (i.e. value out of range, EEPROM failure, etc.)

The wheel wear calibration is necessary at the following times:

- During each periodic inspection
- After any wheel truing for which a speed sensor is associated
- After replacement of a truck for which a speed sensor is associated

4.1.2.4 V-zero Speed Determination

A V-zero state is determined as a stopped and stable condition that is used as a latch for various ATP utilities. A V-zero state is declared when all of the following conditions are met:

- “System Speed” equates to a velocity of 0 mph for three (3) seconds continuous
- A V-zero/Decelerometer Crosscheck error is not declared

The ATP system is no longer in a V-zero state when the “System Speed” is greater than zero (0) mph for one (1) second continuous.

During the condition of a slide to a stop, V-zero state is not declared until Tach1, Tach2 and the DecelSpeed all equal 0 for 3 seconds.

4.1.2.5 No Motion Determination

A No Motion state is determined so that the ATP system can berth and enable doors only during Type II operation. A No Motion state is declared when all of the following conditions are met:

- System Speed is less than a velocity of 0.5 mph for two cycles (500msec)
- The ATP detects No Power (M/CM lines are low) being requested from the vehicle
- A V-zero/Decelerometer Crosscheck error is not declared

The ATP system is no longer in a No Motion state when the “System Speed” is greater than one (1) mph.

4.1.2.6 Loss of Speed Sensor Signal

The ATP system performs three types of vital crosschecks on the speed sensing circuitry: loss of sensors before moving, loss of sensors while moving, and speed mismatch between sensors.

4.1.2.6.1 Loss of Speed Sensors Crosscheck

The loss of speed sensors crosscheck is performed while the vehicle is moving (not in a V-zero state) and the ATP sub-system is in any operating mode. The loss of sensors crosscheck is used to determine the loss of both sensors while the train is in motion. If the speed from both speed sensors has transitioned to zero (0) mph from a value of six (6) mph or higher and it remains there for ten (10) seconds continuous, a loss of sensors error is declared. A loss of sensors error is cleared whenever ATP System transitions operating modes.

When a loss of sensors error is active a Penalty Brake application is requested if the ATP subsystem is in an active operating mode.

4.1.2.6.2 V-zero/Decelerometer Crosscheck

The V-zero / Decelerometer crosscheck is performed during a static V-zero state, while the ATP subsystem is in any operating mode except for Local (neither cab keyed in). V-zero is checked against acceleration / deceleration to verify that both speed sensors are electrically present before vehicle motion begins. Eight (8) seconds after V-zero is declared, a snapshot of the decelerometer is initiated with the expectation that the decelerometer will not deviate from the snapshot value (within ± 10 bits or 0.33333 mph/s) during a stable static condition such as V-zero. The crosscheck is effectively disabled until the snapshot values have been obtained. Once the snapshot values have been obtained, acceleration or deceleration observed on a cycle by cycle basis equaling or exceeding the threshold is accumulated during a V-zero state. In the event that acceleration or deceleration is accumulated to a value equivalent to a ten (10) mph velocity or greater in the absence of a speed signal, a V-zero / Decelerometer error is declared. The V – zero / Decelerometer error is cleared whenever pulses are detected from either sensor or the ATP System transitions operating modes by keying out and then keying in.

Upon declaration of a V – zero / Decelerometer error, a Penalty Brake application is requested, if the ATP subsystem is in an active operating mode. The Penalty Brake request is cleared when the V-zero / Decelerometer error is cleared. Additionally, the ATP will declare motion (i.e. V – zero and No Motion are cleared) and illuminate the ATP FAIL indicator on the ADU when a V-zero / Decelerometer error is declared.

In the event that the decelerometer is in a failed state, the V – zero / Decelerometer crosscheck is disabled, as the ATP will be requesting a Penalty Brake application in order to prevent further vehicle motion.

4.1.2.6.3 Speed Mismatch Crosscheck

A Speed Mismatch crosscheck is performed while the ATP subsystem is in any operating mode. The Speed Mismatch crosscheck is used to detect a problem with or the loss of a single speed sensor. The two speed sensors are checked against each other to detect abnormal speed deviations. If the speed measurement difference is greater than six (6) mph, a Speed Mismatch event is declared. If a Speed Mismatch event exists for sixteen (16) seconds, a Speed Mismatch error is declared. The Speed Mismatch error is cleared when the difference between the two speed indications is less than or equal to six (6) mph for one (1) second.

When a Speed Mismatch error is active, a Penalty Brake application is requested if the ATP subsystem is in an active operating mode. The Penalty Brake request is cleared when the Speed Mismatch error becomes inactive, or when the ATP transitions into an inactive operating mode.

4.1.2.7 Spin Detection

Spin detection is performed at all times. Spin detection is independent of all other speed sensor input checks. Spin detection is used to determine when the velocity from the speed sensor connected to the powered truck is invalid due to wheel slip. While a Spin condition is active, “System Speed” is determined utilizing only the output of the non-powered truck speed sensor, except in the instance that the non-powered truck is showing a speed of zero. In that case, the speed sensor on the powered truck will still be used for “System Speed” since the speed sensor on the non-powered truck may be missing or defective.

Acceleration mode is determined when both the CM and M trainlines are high. Acceleration mode is used to determine when the ATP monitors for a spin condition. While the vehicle is indicating that it is in power, the ATP monitors the acceleration (on a cycle by cycle basis) of the speed sensor on the powered truck and compares it to the acceleration of the speed sensor on the non-powered truck. If the acceleration of the powered truck speed sensor is four (4) mph/s greater than the non-powered truck speed sensor and the non-powered truck is not reporting 0 speed, a Spin condition is declared.

Once declared, a Spin condition is cleared when the acceleration of the powered truck speed sensor is two (2) mph/s less than, or equal to the acceleration of the non-powered truck speed sensor, for one (1) second continuous and no speed mismatch condition exists.

During a Vehicle declared Spin/Slide condition the ATO subsystem will maintain its propulsion request under a spin condition in order to allow the vehicle spin/slide control system to correct the spin/slide condition.

4.1.2.8 Slide Detection

Slide detection is performed at all times. The detection of slide is independent of all other speed sensor input checks. Slide detection is used to determine when the speed calculated from the speed sensors is invalid due to the wheels sliding and/or locked while braking. The ATP will declare a Slide condition when either tachometer reports a deceleration greater than the tolerance level of 6 mph/s. The system speed is set to the decelerometer based speed and a 3 second timer is started. To recover from a slide, there must be 3 consecutive seconds of good tachometer readings and the tachometer readings must be within 5 mph of the decelerometer speed. If at any time during the 3 seconds the tachometers report a mismatch or slide condition, the timer is reset. Once the timer expires, the slide condition is cleared. If the vehicle slides to a stop before the tachometers recover, the slide condition is cleared once both of the tachometers and the decelerometer speed report 0 mph for 3 seconds. If the slide condition persists for more than 2.75 seconds and the decelerometer is in error, the vehicle will initiate request an emergency brake.

4.1.2.9 Direction Determination

The ATP will monitor the two quadrature phase output channels from the speed sensor mounted on the non-powered truck to determine the direction of travel of the vehicle. In one direction of travel, Channel “A” non – periodic square wave will “lag” the Channel “B” non – periodic square wave. When operating the LRV in the opposite direction, Channel “A” non – periodic square wave will “lead” the Channel “B” non – periodic square wave.

4.1.2.10 Rollaway

The ATP subsystem will also monitor the speed sensors inputs in order to detect movement close to 0 mph. This will be used to monitor possible drift or slight motion (e.g. roll-away) that could occur when a train should be at a stop. The ATP shall initiate emergency braking in the event a train is detected to be rolling away. The emergency braking shall be applied before roll-away speed exceeds 1.0 mph, or before roll-back distance exceeds 20 inches.

4.1.2.11 Overspeed Protection

When operating as a Type II system, speed limits are mainly derived from the interpretation of the speed codes received from the CSRD subsystem. These speed limits are enforced by the ATP subsystem through the use of speed-vs-distance profiles. The profiles are constructed based on the Safe Braking Distance (SBD) model established for the Metro Green Line.

When operating as a Type I system, speed limits are mainly derived from the interpretation of the code rates received from the CSRD subsystem.

In addition to the information received from Cab Signal data, other factors can also affect which speed limit is currently in effect. These factors include special operational modes, such as Stop & Proceed, Street Running, Car Wash, Friction Brake Fault, or a Propulsion Fault, which would impose speed restrictions on vehicle operation.

Once the speed limit has been established, the ATP constantly monitors the current speed of the vehicle and compares it to the speed limit. Should the vehicle speed exceed the over speed set points of the effective speed limit, the ATP will take appropriate action to bring the vehicle back into compliance should the Operator fail to take the proper actions to bring the vehicle back to a safe operating speed.

For all Line Types, the ATP will default to a zero (0) speed limit when in an inactive operating mode.

4.1.2.12 Special Speed Limits

4.1.2.12.1 Speed Limit Control

The ATP interfaces to the vehicle No_Propulsion_Fault trainline. During normal operation, the ATP monitors the No_Propulsion_Fault input from the vehicle. The ATP buffers the input so as to prevent the cycling of Speed Limit Control for short periods of time in response to momentary propulsion faults. The ATP will not establish Speed Limit Control until the No_Propulsion_Fault input is seen to be active (de-energized) for six (6) seconds continuous.

When Speed Limit Control is active, the ATP will continue to enforce any speed limit that is more restrictive than the Speed Limit Control speed limit; the ADU will appear as normal. If a speed limit is in effect that is the same as Speed Limit Control speed limit, the ATP will always enforce the speed limit with the more restrictive value. If a speed limit is in effect that is less restrictive than the Speed Limit Control speed limit, the ATP shall enforce the Speed Limit Control speed limit. In this case, the ATP will display and the ATP will enforce a speed limit of thirty-five (35) mph on the ADU.

The ATP will perform normal over speed logic in response to an Over Speed condition, and enforce the normal FSB and EB times with Speed Limit Control active.

4.1.2.12.2 Stop and Proceed

When the system is in Manual (ON) mode, the ADU can enable Stop and Proceed operation. When this operation is manually requested in the absence of a valid speed command, the ATP will enforce the corresponding Stop & Proceed ESL for the currently configured line.

While in Stop & Proceed banking will not be used neither will the remaining drop time be used to delay the application of the Penalty Brake. If the Full Service Brake is active then the Emergency Brake will be applied after the Brake Assurance Timer has expired and the vehicle is not making brake rate. The vehicle will be brought to a stop as result, at which point the ATP will release Stop & Proceed mode once the vehicle reaches a stopped condition.

The request for Stop and Proceed is a non-vital function; however, the speed limit is vitally enforced.

4.1.2.12.3 Car Wash

The ATP receives activation and deactivation commands from the network in a conditioned response to a press of the Car Wash button on the Operator Console. Once the ATP has established Car Wash mode a car wash speed limit is displayed on the ADU, and a fixed speed limit will be enforced. A Departure Test cannot be running when trying to enter Car Wash mode.

The ATP will perform normal over speed logic in response to an Over Speed condition when Car Wash mode is active.

4.1.2.12.4 No Friction Brake Fault

The ATP receives input from the vehicle as to when a friction brake fault is detected, or when the friction brakes have been cutout. This indication is provided through the No Friction Brake Fault input from the vehicle. The ATC will take appropriate response depending if on Type I or Type II operation.

4.1.3 Decelerometer

The Decelerometer unit provides continuous readings of train deceleration. This device is grade-compensated with respect to measuring the true brake rate of the train. It is mounted near the front of the ATC Control Unit and incorporates an adjustable bracket so that it can be leveled relative to the train's longitudinal axis. Deceleration is measured with an electrolytic tilt sensor that translates motions into electrical signals. The Decelerometer interfaces to the ATP subsystem through a front 9-pin connector and provides two channels. These channels are monitored by the ATP CPU board through the Multi-Function PCB. Figure 16 shows the basic design the decelerometer.

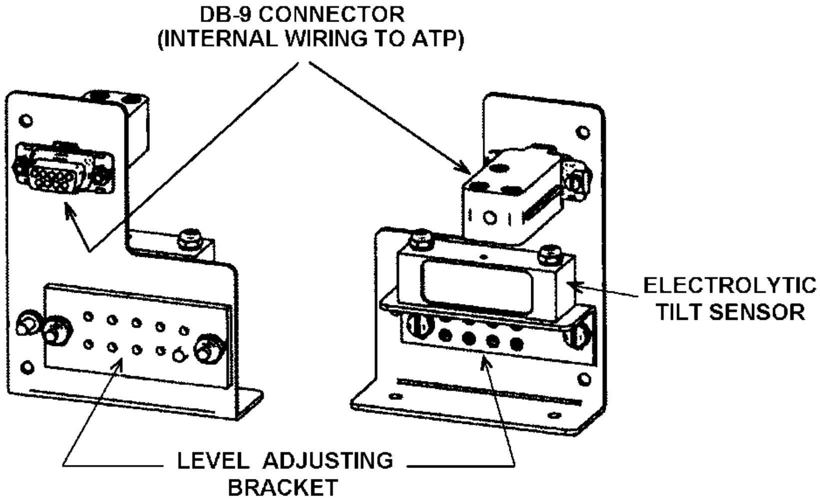


Figure 16 – Decelerometer Assembly

4.1.3.1 Decelerometer Calibration

The decelerometer calibration functions require that the car be on a level tangent track at the time of the calibration and that air bag levelers, if applicable, be leveled. The calibration is necessary to level the decelerometer after installation of the equipment rack.

The calibration is invoked by the maintainer, when in Manual mode, using the PTU. The Master Controller will need to be in a non-powered position and the friction brake must be applied. Once initiated, the calibration is conducted by removing the mounting screw holding the decelerometer device to the mounting plate, moving the device up or down to balance the displayed decelerometer outputs. Once the outputs are balanced, the mounting screw is placed into the closest mounting hole that maintains the calibration values. A final interaction is required by the maintainer to register the calibration within the ATP System memory.

4.1.3.2 Decelerometer Diagnostics

The ATP performs three vital diagnostic checks on the Decelerometer and its interface circuitry every processing cycle to ensure proper operation. The ATP checks the acceleration and deceleration values to determine if they sum to the appropriate value (255 ± 5 bits). If the value does not fall within the tolerance, an error is recorded. The ATP removes power from the Decelerometer and checks the reading while the power is off to ensure that the circuitry has not malfunctioned. If the reading does not fall within the appropriate values (0 ± 4 bits), an error is recorded. Finally, the state of the A/D converters is monitored**.** If the A/D converter reports a failure, an error is recorded. If any of these three diagnostic checks fail in any given cycle, a failure condition is declared, the failure condition reported to the MDS, and all Brake Rate calculations for that cycle are forced to zero (0) mph/s. If the failure condition persists for a period exceeding three (3) processing cycles, the decelerometer is declared to be in a failed state. Once declared to be in a failed state, the ATP will solidly illuminate the ATP FAIL indicator on the ADU, and no brake rate is reported by the Decelerometer.

An additional diagnostic check is performed that is intended to detect catastrophic failure (low fluid levels) of the decelerometer and is non-recoverable. This diagnostic monitors both outputs of the decelerometer and expects opposite but uniform variance when train forces are acting on it. In the event that the decelerometer has experienced catastrophic failure, the decelerometer is declared "unstable" and reported to the MDS. In addition, all Brake Rate calculations are forced to zero (0) mph/s and a Penalty Brake application is requested. The Penalty Brake application persists even after the vehicle has come to a complete stop and the ATP System must be bypassed to remove the brakes. To ensure that a system reset will not override this condition, a “valid decelerometer calibration” flag is cleared in EEPROM and is not re-set until a decelerometer calibration is completed (the decelerometer calibration assumes that the defective decelerometer has been replaced).

4.1.3.3 Deceleration Rate Determination

The decelerometer has a safety buffer applied to it. The ATP subtracts an error rate of 0.3 mph/s from the deceleration rate measured by the decelerometer. This is based on manufacturer tolerances and is used to make sure our calculations are vital. Therefore a 2.0 mph/s vehicle deceleration rate, as measured by the decelerometer, would correspond to a 1.70 mph/s rate reported by the ATP.

The decelerometer is an inertial motion unit and is not dv/dt based. This allows us to measure effort. For example if the train was rolling downhill from gravity the decel would register an acceleration rate of “0”.

4.2 Comm Subsystem

The Comm provides a means for the ATC internal sub-systems to exchange data. The Comm Subsystem also provides an interface between the ATC sub-systems and the external train interfaces (ADU, Propulsion, Event Recorder, PTU). The ATC event logging system and snapshot data is also managed and stored in the Comm Subsystem. The figure below is the preliminary communications of the ATC for the P3010 LRV:

[redacted]

4.2.1 Comm Functions

The following functions are performed by the Comm sub-system:

- Log Events
- Communicate on MVB
- Communicate on Train Ethernet
- Communicate with PTU
- Communicate with ADU

4.3 ATP Acknowledge Switch

For Type I and II system the ATP Acknowledge Switch is pressed by the operator under the following circumstances:

- To acknowledge a penalty brake application (or IES for a Type II system) after the penalty brake condition has cleared.
- To acknowledge an Emergency Brake application (or IEB for Type II system) after the Emergency Brake condition has cleared.
- To manually enter Street Running mode.
- To be used in combination with the Door Override button to override the door disable.

5 Type I Specific ATC Functional Description

The LA P3010 Type I ATC System is a microprocessor- based system that provides Automatic Train Protection (ATP) and Train-to-Wayside Communication (TWC) functionality.

5.1 ATP Subsystem

The LA P3010 Type I Automatic Train Protection (ATP) Sub-System is a microprocessor-based ASK cab signaling system.

5.1.1 Cab Signal Reception and Decoding

The vital data transmitted by the wayside track circuits is in the form of a 100 Hz, or alternating 100/250 Hz coded carrier.

The ATP receives the wayside signals via the Track Receivers mounted on the leading truck. The ATP selects the appropriate receiver pair according to the current active cab end. The coils inductively couple to the rail current and provide a signal to the ATP CSRD PCB. The CSRD digital filters remove any out-of-band noise, then demodulates the coded carrier. For reliable operations, the signal detection level is fixed calibrated for each line to detect signals greater than the specified minimum rail current. The received signal is subjected to validation checks on signal amplitude, proper period, and duty cycle measurements. From the demodulated code rate data, a dominant code rate is determined and validated. Once validated, the determined code rate is then forwarded to the vital ATP Logic CPU for proper interpretation.

The 3 dB cutoff frequencies for the 100 Hz digital filter will be 93 Hz and 107 Hz. The 3 dB cutoff frequencies for the 250 Hz digital filter will be 243 Hz and 257 Hz.

The in-rail cab signals for the Type I range from 2.0 to 20 Amps for normal operation (refer to tables Table 7, Table 4, and Table 3). The CSRD will be initially fixed calibrated for the minimum vehicle current detection thresholds of 2.0 Amps for the 100 Hz Carrier and 0.75 Amps for the 250 Hz Carrier for each line. These values may be adjusted during field testing to improve reliable operations on each line.

5.1.1.1 New Code Detection

The actual detection or recognition of a defined code rate is based on meeting two conditions. In order for a code rate to be declared, its drop timer must be running and its period detect counter must have reached the minimum cycles-to-detect value before the associated drop timer expires.

A code rate's drop timer is started when the first valid period corresponding to the code rate is detected. A period detect counter is used for each code rate to tally the number of valid code periods that have been detected for the associated code rate. This counter is incremented each time that the corresponding valid code rate is detected.

A new code rate is declared after the minimum number of cycles is detected within the drop time and it is the most restrictive code rate present.

5.1.1.2 Maintaining Established Code Rate

The continued detection or recognition of an existing code rate is based on meeting one condition. In order for a code rate to be maintained its drop timer must not be expired. If this condition is satisfied when a valid cycle is detected, the associated drop timer is reset. The drop timer is not affected if the detected cycle is invalid, and continues to count down towards expiration. Once the drop timer has expired, the code is discontinued.

5.1.1.3 Dominant Code Rate Determination

By design, multiple code rates may be simultaneously present on any given logical channel. A coded carrier channel may have multiple code rates defined. Only the most dominant code rate on a channel, which is typically the most restrictive, is communicated to the ATP Logic CPU as signal aspect information.

The 100 Hz channel is used to determine the dominant code rate. The dominant code rate is obtained by taking a bit mask of the present 100 Hz channel code rates and sequentially comparing them against a dominant code list. A dominant code list contains a series of individual bit masks arranged from most dominant to least dominant. The most dominant code rate present on the channel is chosen to set the dominant code mask for the 100 Hz channel.

The dominant code mask chosen for the 100 Hz channel is then logically ANDED with the bit mask of the present 250 Hz channel code rates. The result of this operation becomes the code mask for the 250 Hz channel. If the same code rate is not present on the 250 Hz channel, the 250 Hz channel code mask is set to “No Code” by this operation. If the same code rate is present on the 250 Hz channel, the 250 Hz channel code mask will be set to the bit mask for that code rate by this operation.

By using this method the 100 Hz channel determines the dominant code rate and the 250 Hz channel is only used as a qualifier in order to determine whether or not the code rate is present as a single or dual carrier code. A 250 Hz code rate will not be sent to the ATP Logic CPU without an equivalent 100 Hz code rate being present.

Valid cab signal characteristics for the Metro Blue Line and Pasadena Gold Line are defined in Table 6, Table 3 and Table 4.

The ATP cab signal acceptance parameters for the Metro Blue Line and the Pasadena Gold Line are defined in Table 5.

If at any time after a cab signal is established, the cab signal changes to a more permissive aspect, the cab signal drop timer will hold up the previously existing (more restrictive) rate until its drop timer is expired. Additionally, under a No Code condition or a more restrictive aspect is received, the new code will be displayed and enforced after the required cycles-to-detect have been satisfied. The cycles-to-detect and associated time-to-detect are shown in Table 6.

Code Rate (CPM)			Carrier Freq. (Hz.)			Level (Amps)		Duty Cycle (%)	
Nom.	Min (-5%)	Max (+5%)	Nom.	Min (-2%)	Max (+2%)	Min	Max	Min	Max
50	48	52	100	98	102	3.0	20.0	40	60
Dual-50	48	52	100/250	98/245	102/255	0.75	10.0	40	60
75	72	78	100	98	102	3.0	20.0	40	60
120	117	123	100	98	102	3.0	20.0	40	60

Code Rate (CPM)			Carrier Freq. (Hz.)			Level (Amps)		Duty Cycle (%)	
Nom.	Min (-5%)	Max (+5%)	Nom.	Min (-2%)	Max (+2%)	Min	Max	Min	Max
180	176	184	100	98	102	3.0	20.0	40	60
270	266	274	100	98	102	3.0	20.0	40	60
410	416	424	100	98	102	3.0	20.0	40	60

Table 3 – MBL Cab Signal Characteristics

Note: For Blue Line, the code transmitter relay used for the 410 code rate is actually a 420 code relay.

Code Rate (CPM)			Carrier Freq. (Hz.)			Level (Amps)		Duty Cycle (%)	
Nom.	**Min (+1 ms)**	**Max (-1 ms)**	**Nom.**	**Min (-1%)**	**Max (+1%)**	**Min**	**Max**	**Min**	**Max**
50.0	47.5	52.6	100	99	101	2-3	20.0	45	55
Dual-50.0	47.5	52.6	100/250	99/247.5	101/252.5	0.75	10.0	45	55
72.12	72.1	72.2	100	99	101	2-3	20.0	45	55
125.0	124.7	125.3	100	99	101	2-3	20.0	45	55
187.5	186.9	188.1	100	99	101	2-3	20.0	45	55
267.86	266.7	269.1	100	99	101	2-3	20.0	45	55
416.67	413.8	419.6	100	99	101	2-3	20.0	45	55

Table 4 – PGL Cab Signal Characteristics

Code Rate (CPM)			Carrier Freq. (Hz.)			Level (Amps)		Duty Cycle (%)	
Nom.	**Min**	**Max**	**Nom.**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
50	46	54	100	96	104	2.0	20.0	30	70
Dual-50	46	54	100	96/245	104/255	0.75	10.0	30	70
75	69	81	100	96	104	2.0	20.0	30	70
120	114	130	100	96	104	2.0	20.0	30	70
180	174	190	100	96	104	2.0	20.0	30	70
270	258	282	100	96	104	2.0	20.0	30	70
410	406	434	100	96	104	2.0	20.0	30	70

Table 5 – MBL & PGL Cab Signal Acceptance Characteristics (ATP Parameters)

Code Rate (CPM)	Cycles-to-Detect 100,250	CSRD Time-to-Detect (Max)	ATP Time-to-Detect (Max)
No Code	Drop Timer	4.10 seconds	4.45 seconds
Constant Carrier	N/A	4.10 seconds	4.45 seconds
50	2,1	2.60 seconds	2.95 seconds
75	2	1.71 seconds	2.06 seconds
120	2	1.07 seconds	1.42 seconds
180	3	1.035 seconds	1.385 seconds
270	4	0.94 seconds	1.29 seconds
410	6	0.90 seconds	1.25 seconds

Table 6 – Code Detection Times

Code Rate (CPM)	Drop Timer
50	5.1
Dual 50	7.6
75	4.1
120	4.1
180	4.1
270	4.1
410	4.1

Table 7 – Code Drop Times

5.1.2 Overspeed Determination and Protection

The current speed limit is determined by examining the combination of any code rate received from the CSRD subsystem, any operating modes that are in effect, and the status of the No_Propulsion_Fault and No_Friction_Brake Fault inputs. The only exception is if Car Wash mode is in effect. When Car Wash mode is in effect, the Car Wash speed limit will supersede all other speed limit indications (including any received Cab Signal indications). If Car Wash Mode is not in effect, then the ATP will determine speed limit based on whether Street Running or Stop and Proceed mode is in effect. If neither of these two modes is in effect, speed limit is determined based on the Code Rate received from the CSRD subsystem. In the case where the No_Propulsion_Fault input is deenergized, the ATP will enforce the more restrictive speed limit (ESL) of 35mph.

When the No_Friction_Brake_Fault input is de-activated (de-energized), the ATP will respond by displaying and flashing a 10 mph speed limit on the ADU, and enforcing a 12 mph Over Speed Limit if all of the following conditions exist:

- The ATP is not in Street Running mode,
- A more permissive speed limit is being received or is in effect.

No restriction is imposed if Street Running mode has been established. In all situations, the ATP will log an internal event when the No_Friction_Brake_Fault input becomes active.

The ATP will perform normal over speed logic in response to an Over Speed condition.

Table 8 defines the speed limits and tolerances for the Code Rates and Operating Modes. Any Code Rate other than what is listed in Table 8 is considered by the ATP to be an invalid code. The ATP interprets any invalid code as a "No Code."

Code Rate / Mode	Displayed Speed Limit (DSL)	Enforced Speed Limit (ESL)	Under Speed Set Point
No Code	0 mph	0 mph	0 mph
Constant Carrier	0 mph	0 mph	0 mph
50 CPM @ 100 Hz	10 mph	12 mph	DSL – 1.0 mph
50 CPM @ 100/250 Hz	15 mph	17 mph	DSL – 1.0 mph
75 CPM @ 100 Hz	25 mph	27 mph	DSL – 1.0 mph
120 CPM @ 100 Hz	35 mph	37 mph	DSL – 1.0 mph
180 CPM @ 100 Hz	45 mph	47 mph	DSL – 1.0 mph
270 CPM @ 100 Hz	55 mph	57 mph	DSL – 1.0 mph
410 CPM @ 100 Hz / Street Running	35 mph	37 mph	DSL – 1.0 mph
Car Wash	5 mph	5 mph	0 mph
Stop and Proceed	10 mph	13 mph	0 mph
Speed Limit Control	35 mph (max)	35 mph (max)	DSL – 1.0 mph
Friction Brake Fault	10 mph (max)	12 mph (max)	DSL – 1.0 mph

Table 8 – Type I Speed Limits and Tolerances

Over Speed detection is enabled only when operating in an active operating mode. The ATP will declare an Over Speed condition when the "System Speed" is greater than the ESL (see Table 8). Upon declaring an Over Speed condition, the ATP will request a propulsion cut, activate the ADU alarm, turn on the Over Speed ADU indicator, and initiate a brake assurance session.

Under normal circumstances (i.e. no speed sensor errors are present, and no slide condition has been declared), the ATP will remove the over speed condition once the "System Speed" is less than or equal to the under-speed set point, and the operator moves the Master Controller into a coast or any braking position. If a slide condition is active, the ATP replaces the use of the System Speed with the use of the Decelerometer Speed to recognize and/or properly terminate an over speed condition.

Once the over speed condition is removed, the ATP will remove any Over Speed Penalty Brake and propulsion cut requests, terminate all brake assurance sessions, deactivate the Over Speed indicator on the ADU, and silence the ADU alarm (if still activated).

For Over Speed conditions that are declared when the under speed set point is not zero (0) (i.e. Code-to-Code change), the ATP will request an Over Speed Penalty Brake should the brake assurance session fail before the LRV reaches the under-speed set point. For Over Speed conditions that are declared when the under set point is zero (0) (i.e. Code-to-No Code change), the ATP will forego the initial brake assurance session, and immediately request an Over Speed Penalty Brake.

Upon the request of an Over Speed Penalty Brake, the ATP will initiate an additional brake assurance session. If this brake assurance session fails, an Emergency Brake application is requested.

5.1.3 Brake Assurance and Propulsion Control

The ATP provides the following propulsion and braking control interfaces to the vehicle: Propulsion Cut, Full Service Brake, and Emergency Brake. Brake assurance is accomplished through the use of a Decelerometer. Under normal circumstances, the ATP does not use any of its braking or propulsion controls unless to assure a stopped condition, or unless to respond to the existence of an over speed, penalty brake, or emergency brake condition.

The ATP will request a Full Service Brake request when the vehicle has declared V-zero, the current speed limit is zero (0), and a Departure Test is not currently in progress.

5.1.3.1 Propulsion Cut

The ATP restricts the LRV from excessive acceleration through the use of its Propulsion Cut interface with the vehicle. The ATP requests a propulsion cut in response to an overspeed, penalty brake application, or emergency brake application. The request to cut propulsion is removed when the vehicle is under speed and no active penalty or emergency brake exists.

To protect against a possible runaway condition the ATP will enforce a secondary speed threshold set to four (4) mph above the speed at the instant of a request for a cut in propulsion. If speed increases above the secondary speed threshold, the ATP System initiates a request for Emergency Brake application. The Emergency Brake request is removed when V-zero is declared.

5.1.3.2 Brake Assurance (Type I)

Brake assurance is performed anytime the ATP system detects an Overspeed condition in order to verify safe braking of the vehicle within the constraints of the block design. The ATP uses the brake rate measured with the decelerometer device to assure the safe braking of the vehicle. When the brake assurance timer is expired and the bank is depleted the overspeed penalty brake is applied immediately, the same cycle the bank is depleted. Once initiated, Brake Assurance is terminated when the vehicle is under speed, the ATP has initiated an Emergency Brake request, or V-Zero has been achieved.

Table 9 And Table 10 define the reaction times for the various ATP system Brake Assurance conditions. The Brake Assurance rate used for both the Type I is 2.0 mph/s.

5.1.3.3 Code-To-Code Transition

When a train enters into a block that contains a more restrictive cab signal that is not a continuous carrier, the CSRD demodulates and decodes the new cab signal in 5.1 seconds or less and delivers the aspect and remaining detection time to the ATP within an additional 350 msec (any remaining drop time is available when the CSRD decodes and recognizes the new aspect in less than 4.1 seconds or 5.1 seconds). Upon detection of an Over Speed condition, the ATP initiates a free-run timer of 2.75 seconds for 75, 120, 270, 180, and 420 code rates.

If the code rate is Dual 50, or 50, then the free-run timer is initiated at 1.75 seconds. The remaining drop time is used when transitioning from a non-street running code rate. For brake assurance sessions that use an initial value of 1.75 seconds, when the timer expires (7.2 seconds from the insulated joint), the ATP initializes a FSB suppression bank with deceleration associated with the difference between the maximum allowable entry speed and the average grade compensated speed during the free-run period, and begins rate banking. The FSB suppression bank can forestall a penalty brake for a period of up to but not exceeding 1 second. For brake assurance sessions that use an initial value of 2.75 seconds for the free run timer, there is no banking but only a direct comparison between the rate required and rate achieved. If the rate achieved is not greater than or equal to the rate required, a penalty brake is requested by the ATP. If the free run timer is initialized to 1.75 seconds, then the FSB suppression bank is updated as follows:

- If the instantaneous brake rate measurement is above 2.0 mph/s, the difference is added to the FSB suppression bank thereby extending the suppression time up to a maximum of 1 second.
- If the instantaneous brake rate measurement is below 2.0 mph/s, the difference is deducted from the FSB suppression bank thereby reducing the suppression time. If during any cycle, the amount extracted from the FSB suppression bank needed to account for the brake assurance rate is not available, a service brake application is initiated by the ATP system.
- If the instantaneous brake rate measurement is equal to 2.0 mph/s, the FSB suppression bank is not affected.

In the event that the ATP System initiates a service brake application, a second brake assurance session is initiated with the EB suppression bank initialized to zero. For the first 2.5 seconds of the second BA session, all rate measured is banked in the EB suppression bank each ATP System software cycle. After the 2.5 seconds has expired, the rate banking begins. For each subsequent cycle of the ATP system software (every 250 ms), the instantaneous brake rate is measured. For any difference between the measured rate and the required brake assurance rate, the EB suppression bank will be adjusted as follows:

- If the instantaneous brake rate measurement is above 2.0 mph/s, the difference is added to the EB suppression bank thereby extending the suppression time.
- If the instantaneous brake rate measurement is below 2.0 mph/s, the difference is deducted from the EB suppression bank thereby reducing the suppression time. If during any cycle, the amount extracted from the suppression bank needed to account for the brake assurance rate is not available, an emergency brake application is initiated by the ATP system.
- If the instantaneous brake rate measurement is equal to the 2.0 mph/s, the EB suppression bank is not affected.

Note: A 50 code is currently the most restrictive code rate and therefore can't currently transition to a more restrictive code rate.

5.1.3.4 Code-To-No Code Transition

When a train enters into a block that contains a more restrictive cab signal that is a continuous carrier or no carrier, the CSRD will declare a No Code in 5.1 seconds or less, and delivers the aspect to the ATP within an additional 350 mSecdetection of an Over Speed condition, the ATP requests an immediate Overspeed Penalty Brake application, initiates a free-run timer to 1.75 seconds. When the timer expires the ATP initializes an EB suppression bank with deceleration associated with the difference between the maximum allowable entry speed and the average grade compensated speed during the free-run period, and begins rate banking. For each subsequent cycle of the ATP system software (every 250 ms), the instantaneous brake rate is measured. For any difference between the measured rate and the required brake assurance rate, the EB suppression bank will be adjusted as follows:

- If the instantaneous brake rate measurement is above 2.0 mph/s, the difference is added to the EB suppression bank thereby extending the suppression time.
- If the instantaneous brake rate measurement is below 2.0 mph/s, the difference is deducted from the EB suppression bank thereby reducing the suppression time. If during any cycle, the amount extracted from the EB suppression bank needed to account for the brake assurance rate is not available, an emergency brake application is initiated by the ATP system.
- If the instantaneous brake rate measurement is equal to 2.0 mph/s, the EB suppression bank is not affected

5.1.3.5 Pure Overspeed

Once the ATP detects that the train speed is above the overspeed limit the ATP applies a propulsion cut and activates the overspeed alarm. If a pure overspeed is detected by the ATP while in Stop and Proceed mode, the brake assurance timer is set to 2.5 seconds. For all other modes of operation, the pure overspeed BA timer is set to 2.0 seconds. Rate banking is enabled and any brake rate built up by the train is loaded in the bank. After the brake assurance timer expires the ATP checks that the deceleration rate and takes the following actions:

- If the rate is above 2.0mph/s any rate above 2.0mph/s is added to the bank
- If the rate is below 2.0mph/s the deficit from 2.0mph/s is subtracted from the bank
- If the bank reaches 0 and the rate is below 2.0mph/s an FSB is applied.

If the FSB is applied, the ATP starts a 2.5 second brake assurance timer. Rate banking is enabled and any brake rate built up by the train is loaded in the bank. After the second brake assurance timer expires the ATP checks the deceleration rate and takes the following actions:

- If the rate is above 2.0mph/s any rate above 2.0mph/s is added to the bank
- If the rate is below 2.0mph/s the deficit from 2.0mph/s is subtracted from the bank
- If the bank reaches 0 and the rate is below 2.0mph/s an EB is applied.

Note: The use of a 2.0s BA timer for pure overspeed in all modes except for S&P is to prevent a runaway train from tripping the EB.

[redacted]

[redacted]

[redacted]

Event	Description	4.1 Drop Time	5.1 Drop Time
Code to No-Code Detection Time	Constant or no carrier determined.	4.1	5.1
Over Speed Detection Time	1 ATP SW cycle + latency (350 ms max.)	0.350	0.350
Automatic Brake Application	Power cut and Full Service Brake initiated with secondary speed threshold for runaway @ v + 4 mph	**4.45 seconds**	**5.45 seconds**
Operator Reaction Time	Code to No Code - Automatic brake application only	N/A	N/A
Brake Assurance Delay Time	Time before ATP request for EB application, if brake rate is not achieved.	2.75	1.75
Time To Meet Brake Assurance Rate	ATP initializes bank with rate based on delta between Vmax and current V, and begins Brake Assurance (rate averaging with banking) to forestall EB application.	**7.2 seconds**	**7.2 seconds**
Total time to EB		**7.2 seconds**	**7.2 seconds**

Table 9 – Code to No Code Brake Assurance Times for Blue and Gold Lines

NOTE: If a down code occurs due to a Friction Brake Fault or a Speed Limit Control, there is no rate or speed banking associated with the brake assurance and the remaining drop time is not used. Also, during a transition in or out of street running mode, there is no rate or speed banking associated with the brake assurance.

Event	Description	4.1 Drop Time	5.1 Drop Time
Code to Code Detection Time	New code rate detected.	4.1s (max)	7.6 s (max)
Over Speed Detection Time	1 ATP SW cycle + latency (350 ms max.)	0.350 ms	0.350ms
Automatic Propulsion Cut	Power cut initiated with secondary speed threshold for runaway @ v + 4 mph. ATP initializes bank with rate based on delta between Vmax and current V, and begins Brake Assurance #1. Rate averaging with banking to forestall FSB application is only used for the 5.1 Drop Time rates with a maximum cap to FSB application of 4 seconds.	**4.45 seconds**	**5.45 seconds**
Operator Reaction Time	Code to code operator reaction time (+ indicates additional time based on code detection time remainder ie. remaining drop time)	2.75+	1.75+
Apply Speed Bank	ATP initializes a FSB suppression bank with deceleration associated with the difference between the maximum allowable entry speed and the average speed during the free-run period, then begins rate banking.	N/A	1.00
Time to Meet Brake Assurance Rate	On failure of Brake Assurance session #1, ATP requests Full Service Brake and begins Brake Assurance session #2 (rate banking).	**7.20 seconds**	**8.20 seconds**
Total Time to FSB		**7.2 seconds**	**8.2 seconds**
Brake Assurance Delay Time	Time before ATP request for EB application if brake rate is not achieved. Brake Assurance is checked and EB command is delivered.	2.5	2.5
Total time to EB		**9.7 seconds**	**10.7 seconds**

Table 10 – Code to Code Brake Assurance Times

CSRD Code Transition Times	No Code	Constant Carrier	50 CPM @ 100 Hz	50 CPM @ 100/250 Hz	75 CPM @ 100 Hz	120 CPM @ 100 Hz	180 CPM @ 100 Hz	270 CPM @ 100 Hz	410 CPM @ 100 Hz Street Running
No Code	X	4.1	3.91	3.91	2.57	1.61	1.38	N/A	1.05
Constant Carrier	4.1	X	3.91	3.91	2.57	1.61	1.38	N/A	1.05
50 CPM @ 100 Hz	5.1	4.1	X	2.6	2.57	1.61	1.38	N/A	1.05
50 CPM @ 100/250 Hz	5.1	4.1	7.6	X	2.57	1.61	1.38	N/A	1.05
75 CPM @ 100 Hz	4.1	4.1	3.9	3.91	X	1.61	1.38	N/A	1.05
120 CPM @ 100 Hz	4.1	4.1	3.9	3.91	2.57	X	1.38	N/A	1.05
180 CPM @ 100 Hz	4.1	4.1	3.9	3.91	2.57	1.61	X	N/A	1.05
270 CPM @ 100 Hz	4.1	4.1	3.9	3.91	2.57	1.61	1.38	N/A	1.05
410 CPM @ 100 Hz / Street Running	4.1	4.1	3.9	3.91	2.57	1.61	1.38	N/A	X

Table 11 – CSRD Maximum Code Transition Times

5.1.3.6 Over Speed Penalty Brake

The Full Service Brake is requested and a request for Propulsion Cut is made for all Over Speed Penalty Brake requests. The Full Service Brake is released and Propulsion enabled when the Over Speed Penalty Brake Request has cleared.

5.1.3.7 Penalty Brake

For all Penalty Brake requests, the ATP subsystem performs the following actions:

- The Full Service Brake is requested,
- A Propulsion cut is requested,
- The ADU ATP Fail lamp is flashed, when the vehicle reaches V-zero.

The Full Service Brake is released, propulsion is restored, and the ADU ATP Fail lamp is turned off when the Penalty Brake condition has cleared, the vehicle reaches V-zero, and the operator has acknowledged the penalty by pressing and releasing the ATP Acknowledge switch.

5.1.3.8 Emergency Brake

For all Emergency Brake requests, the ATP subsystem performs the following actions:

- The Emergency Brake is applied,
- A Propulsion cut is requested,
- The ADU ATP Fail lamp is flashed, when the vehicle reaches V-zero.

The Emergency Brake is released, propulsion is restored, and the ADU ATP Fail lamp is turned off when the Emergency Brake Request has cleared, the vehicle reaches V-zero, and the operator acknowledges by pressing and releasing the ATP Acknowledge switch.

5.1.4 ATP Modes of Operation

The ATP unit on each vehicle has several basic modes of operation:

- Manual (On) (active)
- Local (inactive)
- Bypass (inactive)

A mode change to any mode, other than Bypass, can only happen from a V-zero condition. If the vehicle is moving when the mode change is requested, a Penalty Brake is applied to bring the LRV to a stop, and then the mode change is implemented. The ATP will log an internal event any time a mode change is attempted while in motion. Additionally, the ATP will log internal events for mode change transitions to indicate the current active mode.

5.1.4.1 Manual (On) Mode

This is the normal operating mode for the ATP system. It is considered to be an active mode. All specified functions are available in this operating mode. Initially, entry in this mode occurs after either the A-End or B-End Transfer Switch has been placed into the Keyed position, the ATP Bypass switch is in a non-bypass position, and the ATO/Manual switch is in the Manual position.

In Manual (On) mode, the Operator is given the maximum allowable speed along with the ATP determined speed of the LRV on the ADU. Speed limits are determined from code rates received from the CSRD subsystem. The ATP then actively participates in supervising the safe operation of the LRV by performing over speed and brake assurance functions. While operating in this mode, Stop & Proceed, Street Running, and Car Wash special operations are available.

5.1.4.1.1 Stop and Proceed

Stop and Proceed operation is only permitted to avoid stranding the vehicle due to a loss of valid speed code data, or zero speed code from a track circuit. This function is considered to be a fully Operator-responsible action under strict operating rules. During Stop and Proceed operation, the ATP vitally limits the vehicle's speed in the absence of a valid speed command to 13 mph. If an Over Speed condition is detected, the vehicle is brought to a stop via a penalty brake application and Stop & Proceed mode is released.

Stop & Proceed operation can be requested by pressing & releasing the Stop & Proceed pushbutton on the ADU front panel. The ATP will permit Stop & Proceed operation if all of the following conditions exist:

- V-zero has been declared,
- The Master Controller is in a Coast or Braking position,
- The vehicle is indicating that no propulsion is being requested, and the Friction Brakes are applied,
- A loss of Cab Signal is declared, or valid Cab Signal is being received with a speed limit less than, or equal to 4 mph in Type II or constant carrier in Type I,
- Not in Street Running Mode,
- Not in Car Wash Mode,
- A Departure Test is not currently running,
- The Reverser Switch is in the Forward or Reverse position.

Once Stop & Proceed has been established, the ATP will limit the vehicle speed to the appropriate Stop & Proceed speed limit and indicate this mode by illuminating the Stop & Proceed ADU Indicator.

Once established, Stop & Proceed will be released when any of the following conditions are encountered:

- Valid Cab Signal is received with a valid speed code greater than 2 mph.
- V-zero is obtained after application of a Penalty Brake due to the detection of an Over Speed condition.
- Street Running Mode is activated.
- Car Wash Mode is activated.
- The Stop & Proceed pushbutton is pressed and released on the ADU front panel (at V-zero or in motion).
- The ATP is placed into an inactive operating mode (i.e. Local, or Bypass).
- The configured line changes.
- The Reverser is placed into a different position from the one used to enter Stop & Proceed.

5.1.4.1.2 Street Running

Street Running mode is automatically activated whenever the ATP receives a 410 Code from the CSRD subsystem. If the system fails to automatically enter Street Running Mode, the operator can manually enter this mode by the following steps:

- Press the Street Running button
- Press the ATP Acknowledge button
- Release the Street Running button.

The ATP will not permit entry into Street Running under the following conditions:

- A CSRD communications failure is detected.
- In Carwash
- In ATO
- A Departure Test is running.
- The Reverser is not in Forward.

Once Street Running operation has been established, the ATP will limit the vehicle speed to the Street Running speed limit of 37 mph and indicate this mode by illuminating the Street Running indicator on the ADU.

The ATP will terminate an active Street Running Mode upon the occurrence of any of the following:

- The ATP receives a valid non – 410 code rate (including Constant Carrier).
- A CSRD communications failure is detected.
- Line change

- The Reverser is not in Forward.
- Pressing the Street Running Push Button when there is no 410 code rate available.

When transitioning to or from Street Running the remaining drop time and rate banking is not used, so that the brakes can be applied faster if necessary.

5.1.4.1.3 Car Wash

During normal car wash, the vehicle propulsion system will regulate the vehicle speed at 2 mph. The ATP will supervise a fixed speed limit of 5 mph and provide over speed protection against a failure of the propulsion system to properly regulate the vehicle speed.

Activation and deactivation of Car Wash mode is accomplished via the Car Wash button on the Upper Control Panel. The vehicle activates Car Wash mode when the Car Wash button is pressed while the vehicle is at V-zero, Departure Test is not active, and the Master Controller is in the FSB position.

Upon receipt of the activation command over the MVB, the ATP will establish Car Wash mode when the following conditions are true:

- ATP has declared V-zero
- The Friction Brakes are applied
- The Master Controller is in a Coast or Brake position
- Departure Test is not running.
- MVB is valid

Car Wash mode will also prevent the Departure Test from starting. Once Car Wash mode has been established, the ATP will display and limit the vehicle speed to the Car Wash speed limit.

The ATP will implement Car Wash mode regardless of cab signal status (i.e. valid cab signal received, or lost cab signal). While in Car Wash mode, the ATP will indicate that valid Cab Signal is being received by flashing the Cab Signal indicator on the ADU.

If Car Wash mode is established when the Operator places the Reverser Switch into the Reverse position, the ATP will continue to provide over speed protection in the reverse direction by supervising the Car Wash speed limit.

5.1.4.2 Reverse Operation

During Type I operation, Reverse operation is permitted only when operating in Car Wash Mode. The ATP monitors the state of the Reverser Switch located on the Operator's Console. When the Operator places the Reverser Switch into the Reverse position, the ATP will request both a propulsion cut and a Full Service Brake application if Car Wash Mode is not established. If Car Wash mode is established when the Operator places the Reverser Switch into the Reverse position, the ATP will continue to provide over speed protection in the reverse direction by supervising the Car Wash speed limit.

5.1.4.3 Bypass Mode

If the Operator selects Bypass Mode (by breaking the seal and activating the ATP Bypass switch), the Operator has full responsibility for the proper and safe operation of the vehicle. In Bypass Mode, the Operator will be able to operate the vehicle from the local cab, under LACMTA operating rules. With the ATP equipment in Bypass, there is no over speed protection as vehicle logic bypasses any ATP propulsion and braking controls. As a result, the ATP will immediately de-energize all propulsion and braking relays upon entering Bypass.

When in Bypass Mode, the ADU will revert to basic speedometer operation displaying vehicle speed received from the ATP if able, otherwise from the speed provided via MVB.

In the event of an ATP system failure, the Operator is required to use the ATP Bypass switch to operate the LRV.

5.1.4.3.1 Door Operation During ATP Bypass

When the ATP is bypassed all door enable relays are de-energized. The ATP plays no role in overseeing or assuring safe door operation when it is bypassed. When the ATP is placed into bypass mode by activating a sealed ATP Bypass switch, the doors will be overridden by the vehicle wiring. When the ATP is bypassed, total control of the doors reverts back to the operator.

5.1.4.4 Local Mode

When the ATP is powered but neither A-End nor B-End is selected. While in local mode the ATP will apply an FSB.

5.2 TWC Subsystem Type I Operation

The primary function of the Type I TWC subsystem is to provide compatible communication with TWC systems currently installed on the Type I. The wayside transmits and receives non-vital information through the use of TWC loops situated between the rails and located at selected track locations. The vehicle TWC subsystem transmits information through the use of TWC antennas mounted at each end of the vehicle. The selection of the active antenna is based upon which cab end is actively keyed. A Line Selector Switch on the vehicle provides the method for properly enabling the appropriate TWC system for operation on the desired line.

ASTS ATC is compatible with all three; HCS-R, HCS-V and HCS-R+V wayside systems.

In Type I operation the TWC performs the following major functions:

- Route Control and Indication
- Overloop Indication

The P3010 Type I TWC subsystem communicates with the existing Exposition Line, Blue Line (MBL) and Gold Line (PGL) TWC wayside equipment and provides a single integrated interface for the operator to select and cancel route requests. The TWC subsystem is responsible for detecting when the vehicle is over a TWC loop and illuminates an overloop indicator to inform the operator.

5.2.1 TWC Operator Interfaces

The ADU/TWC Interface Panel will be incorporated on the Aspect Display Unit.

5.2.1.1 Route/Train ID Display

When operating in Type I Mode, the ROUTE and TRAIN ID display is utilized to display both the current Route ID and the current Train ID.

For operation on all lines, the ROUTE and TRAIN ID display will indicate "––" when communications between the Interface Panel and the TWC CCU is interrupted.

5.2.2 TWC Modes of Operation

The TWC system communicates with the wayside in a master/slave type relationship. The following TWC related features are supported by the TWC system:

- Route ID Entry/Validation
- Train ID Display
- Communications with the ADU

Additional functionality provided by the TWC system includes Overloop detection and indication.

The TWC system communicates with the Wayside using FSK-modulated digital serial messages. The messages are transmitted and received using FSK frequencies.

Transmission is dependent upon the integrity of the communications link between the TWC and ATP (via ADU). If the TWC has lost communications with ATP (i.e. TWC-ATP link error, ATP system failure, ATP power removed, etc.), the TWC will default the data missing from the ATP in messages to the wayside.

5.2.2.1 Off Mode

In this mode, the TWC is considered inactive. Off mode is entered when no cab end is activated.

5.2.2.2 On Mode

This is the normal operating mode for the TWC system. It is considered to be an active mode. All specified functions for the current selected line are available in this operating mode. Entry into this mode occurs after the Transfer Switch in one of the cab ends has been placed into the ON position. If no errors are detected with the system, the TWC will inform the operator that it is ready for operation by steady illumination of the TWC READY indicator on the ADU/TWC Interface Panel. If errors or faults are detected with the system, the ADU will illuminate the TWC FAULT indicator.

5.2.3 TWC Configuration

For Type I operation, the ATP will disable Type II TWC Modem and Type II TWC Antenna and the vehicle will power the H+K TWC based upon the Active Cab selection input.

5.2.3.1 Antenna Selection

Type I TWC system is selected based on the Active Cab selection input provided directly to H+K CCU.

5.2.4 TWC Operational Description

In Type I Operation the TWC transmits a 19-bit message to the wayside in response to a query pulse. When configured for operation on the Type I, the TWC subsystem operation involves the following line specific functions:

- Overloop Detection
- Operator Route Request
- Pushbutton Activation/Detection

5.2.4.1 Overloop Detection

The HCS-R wayside signal generator transmits a 2 ms – 100 kHz query pulse at regular intervals. After each query transmission is complete, the wayside generator suspends transmission and waits approximately 6 ms per loop for a response from the vehicle. This wait time can vary between 4 and 40 ms depending on the number of wayside loops. This process repeats indefinitely.

The HCS-V wayside signal generator transmits a 2 ms combination of 50 kHz and 100 kHz query pulse every 24 ms. After each query transmission is complete, the wayside generator suspends transmission and waits approximately 6 ms per loop for a response from the vehicle. This wait time can vary between 4 and 40 ms depending on the number of wayside loops. This process repeats indefinitely.

Upon receiving the wayside query pulse, the TWC system will initiate a single 90 kHz / 100 kHz, 19-bit response message. The OVER TWC LOOP indication is received over H&K CCU to ASTS ADU RS485 link.

The trailing cab shall not detect the overloop and will not communicate to the wayside even though the trailing end is on TWC loop and receives the valid query pulse.

5.2.4.2 Route Entry

5.2.4.2.1 Manual Route ID Entry

Under normal circumstances, during power ON the Route ID will default to “00”. However, the TWC system provides for manual route requests to be entered by the Operator, or other MTA personnel. Manual entry of a valid Route ID is accomplished through the use of the soft buttons located on the ADU/TWC Interface Panel.

With the lead cab keyed into an active mode and not in motion, the Operator can set the desired Route ID number using TWC Interface screen on the ADU.

The TWC will default to a Route ID of “0 0” upon power-up, until a Route ID other than “0 0“is entered as a reminder to complete the Route ID entry operation.

5.2.4.3 Operator Route Request

To initiate a route request, the Operator will press and release one, or a combination of four pushbuttons located on the ADU/TWC Interface Panel in order to select the desired route. Interaction with any pushbutton as defined will set data bits in the 19-bit response message corresponding to the selected request pushbutton(s). The possible valid request options are:

- Primary Route Request
- Secondary Route Request
- Non-Mainline Route Request
- Primary + Non-Mainline Route Request
- Secondary + Non-Mainline Route Request
- Cancel Route Request

5.2.4.4 Pushbutton Activation/Detection

The TWC system will evaluate the ADU/TWC Interface Panel soft buttons only when detected to be over a TWC loop. When a soft button is activated while over a TWC loop, the TWC subsystem will in latch the selected soft button, or valid soft button combination. Once activated and recognized by the TWC system, the soft button or soft button combination will be displayed on the TWC screen on the ADU/TWC Interface Panel.

Activating a soft button, or a combination of soft buttons, when the antenna is not over a loop will not result in the transmission of any data or indication of any activated soft buttons on the Route/Train ID display.

After the soft buttons have been activated, the TWC system will provide a 500 ms delay before setting and transmitting the data corresponding to the latched soft button(s) to the CCU. The data bits will be latched and set in the response message for two (2) seconds. Once the data bits have been latched in the response message, the TWC system will cease evaluation of any of the soft buttons. The TWC will continue to display the activated soft buttons on the Route/Train ID display until the data latch time has expired. Once the data latched time has expired, the TWC will clear the soft button indications on the Route/Train display. Additionally, the TWC system will ignore any further soft button activation within three (3) seconds following the expiration of the data latched time.

5.3 Type I Departure Tests

The on-board Departure Test exercises the following areas of the system in order to verify proper operation.

- Functional ADU Interface
- ATC detection of ATP ASK speed commands
- Downward Code Change Recognition & ATP Alarm Activation
- Over Speed Detection
- Alarm activation
- Full Service Brake application
- Emergency Brake application
- Decelerometer is properly calibrated
- Tachometer circuitry with 0.5 mph tolerance

A Departure Test status will be marked as "not run" when the ATC mode of operation is changed as follows:

- From power off to any Active mode
- From BYPASS to any Active mode
- Between Type I and Type II Operation

Note: There is NO Type I TWC Departure Test, however ADU is always communicating with the H&K CCU when in Type I and sends STS command and receives ACK response when it has no other data to send.

6 Type II Specific Functional Description

6.1 ATP Subsystem

The LA P3010 Type II Automatic Train Protection (ATP) subsystem is a microprocessor-based cab signaling system.

6.1.1 Cab Signal Reception and Decoding

The vital data transmitted by the wayside AF track circuits and decoded by the CSRD subsystem is a digitally formatted data message using FSK modulated signals. Eight carrier frequencies are used from 9.5 kHz to 16.5 kHz, spaced at 1 kHz intervals. The Mark and Space (high and low state) frequency separation is 400 Hz (base carrier ± 200 Hz). The CSRD selects a carrier by tuning one of the digitally tuned filters to the appropriate frequency. A second filter is tuned to the frequency of the next track circuit. Each message contains speed commands, track circuit ID, and next track circuit frequency.

The ATP receives the wayside messages via the pick-up coils mounted on the forward truck of each end of the LRV. The ATP selects the appropriate coil pair according to the current active cab end. The coils inductively couple to the rail current and provide a signal to the CSRD. The CSRD performs carrier frequency selection and FSK demodulation. Signal level thresholds are used to determine when a vehicle crosses into the next track circuit. The signal detection level is calibrated to detect signals above a predefined level based on the nominal rail current. Once the CSRD decodes and validates an FSK message, the data is then forwarded to the vital ATP Logic CPU.

The vital information, transmitted to the train and decoded by the CSRD subsystem, is a digital message of 72 bits. The information includes:

- **Track Circuit ID** tells the vehicle which track circuit the vehicle is traversing
- **Line Speed** is the maximum entrance speed permitted by the train within the control line. (65 to 0 in 5 mph steps plus 8, & 1 mph)
- **Target Speed** is the desired speed of the train at the end of the control line. (65 to 0 in 5 mph steps plus 8 & 1 mph)
- **Distance-to-go** represents the distance to the target speed
- **Next Carrier Frequency** tells the vehicle the next track circuit cab signaling frequency
- **Direction Control** sets the direction of travel
- **Berthed Indication** tells the vehicle it is within the usable limits of the station platform or a yard cleaning platform or departure track

Control lines exist on the Type II line where the target speed is greater than the line speed. The ATP will override the received line speed with the received target speed any time this condition exists.

In manual mode, a 6.5 mph speed limit is enforced with Emergency Brakes when the vehicle is within 60 ft. of the end of the station. In ATO mode, a 6.5 mph speed limit is enforced with Emergency Brakes when the vehicle is within 30 ft. of the end of the station. It is important to point out that in either mode the ATP will immediately command Emergency Brakes if the 6.5 mph speed limit is exceeded.

6.1.1.1 Cab Signal Message

The vital information transmitted to the vehicle and decoded by the vehicle's CSRD is a digital message of 72 bits. The message contains a total of 61 bits of information plus 11 bits used for rounding the message to the 72-bit total. The first 8 bits – the header bits – have a fixed pattern (01111110), and are used for synchronizing the onboard decoding function. The next 37 bits contain data to be used by the ATP. The final 16 bits of the message frame are the Cyclic Redundancy Check (CRC) bits for error detection. Table 12 shows the bit structure of the data message. The data is transmitted at 200 bits per second. A complete FSK message takes 360 milliseconds to transmit.

The number of rounding bits is variable. The variable number is a result of the AF-900 track circuits inserting a “0” bit into the message whenever there are five consecutive “1” bits of data. The FSK format used is a non-return to zero, meaning that the output of the AF-900 will stay at the “1” level (high,) unless a transition to zero (low) is forced. Inserting a false zero allows the receiver on the vehicle, controlled by a Phase Locked Loop, to keep in synchronization with the transmitted message. The receiver strips the inserted zeros when the data is decoded. The number of bits needed to round the message to the fixed 72-bit length depends on the number of zeros inserted in the message, and will vary from message to message.

Data Description	Bits
Track Circuit ID (Binary)	12
Line Speed	4
Target Speed	4
Distance-to-go	6
Direction Control	2
Next Carrier Frequency	3
Berthed Indication	1
Coupling/Uncoupling (not used)	2 (Ignored)
Out of Correspondence between direction and active coil (used only by Wayside Controller)	1 (Ignored)
Primary/Backup (used only by Wayside Controller)	1 (Ignored)
Spare	1(Ignore)
Total	**37**

Table 12 – Type II Cab Signal Message Data Bits

- ***Track Circuit ID*** – tells the vehicle which track circuit the vehicle is traversing. Using 12 bits allows 4096 unique track circuit ID numbers.
- Three parameters are involved in controlling train speed: Line Speed, Target Speed, and Distance-to-Go.
- ***Line Speed*** – is the maximum speed permitted by the vehicle while the current message is applicable.
- ***Target Speed*** – is the desired speed of the vehicle when it reaches the target.
- ***Distance-To-Go*** – represents the distance from the beginning of the current track circuit to the target. This defines the position of the target.
- These three parameters use encoded values to represent actual values. The 16 encoded Line and Target speed values represent 0, 1, 5, 8, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, and 65 mph. Distance-to-go has 64 encoded distances. They represent from 0 to 9000 feet. The increments vary from 25 to 1000 feet, depending on the length of the current track circuit. For conservatism, the actual physical distance is converted to the next lowest (or equal) of the available distance values.
- ***Direction Control*** – tells the vehicle in which direction it is allowed to move. If both or neither of the bits are set, the vehicle may not move at all. The two bits are never both set (both bits are 1) simultaneously.
- ***Next Carrier Frequency*** – these three bits indicate which of the eight possible track circuit frequencies is used in the next track circuit the vehicle will enter.

- ***Berthed Indication*** – The Berthed bit is sent in platform track circuits, some adjacent exit track circuits if the exit track is unoccupied, and in yard cleaning and platform track circuits. Setting the Berth bit in the exit track circuits allows the train to receive berthing information in “short” platform track circuits due to the close proximity of the pickup coils to the exit track when the vehicle is properly stopped. The bit tells the vehicle if it has cleared the entrance track and is used to permit door opening while in these tracks.

A valid FSK cab signal message contains:

- A valid Track circuit ID
- The direction bits set (neither both set nor both clear)

A non-zero cab signal message is one that contains either a non-zero line speed or non-zero target speed.

6.1.1.2 Loss of FSK Cab Signal

Two consecutive, identical new messages must be received before the ATP can use the decoded data as valid new cab signaling data. The worst-case time for the decoding of changed cab signal data received is three (3) worst-case message periods; less than 1.2 seconds for three 72-bit messages. Cab signaling data is continually sent to the ATP process, at least once each ATP process cycle, as long as consecutive messages of identical valid content are continuously and consecutively received by the CSRD.

In the event a message in the sequence is invalid (CRC check, and/or non-identical content), the last decoded message is retained for 2.8 seconds, or until it can update the cab signaling data (at the current frequency or the decoded “next frequency”). If valid cab signal data is decoded within the timed interval, the new data is passed to the ATP process, and the train continues as indicated.

In the event the vital timer times-out, a “Loss of Cab Signal” is declared and all zero data is sent to the ATP processor. The ATP will react by displaying a zero speed limit and turning off the Cab Signal indicator on the ADU. This will create an Over Speed condition if the vehicle is in motion. The ATP will react by bringing the vehicle to a stop. Once stopped, the ATP will continue to wait for cab signaling on the same frequency for which the signal was lost, and also the next frequency indicated in the last valid cab signal data. If cab signal is received before the vehicle is brought to a complete stop, the ATP will display the received speed code. The Over Speed condition is removed once the vehicle is below the MAS and the Operator moves the Master Controller to a Coast or Brake position, allowing continued movement of the vehicle.

With a loss of cab signal, the operator may select the option of entering Stop and Proceed mode as defined in Section 6.1.16.1.1 in order to move the vehicle. When the system is in Stop and Proceed mode and a loss of cab signal has been declared, the ATP will scan all valid track frequencies searching for a valid cab signal message.

Additionally, the ATP will scan all valid track frequencies under the following situations:

- Upon system power-up or reset;
- Upon a line selection change to Type II;
- Upon an operating mode change from any inactive to an active mode;
- When no valid cab signal is present while in Bypass mode.
- When no valid cab signal is present while at V-zero.

The ATP will remove any scan requests if any of the following occurs:

- Receiving valid cab signal with a line speed greater than zero when in an active mode (This latch condition, LS=0 helps attain proper speed limits at station turn-backs)
- Receiving valid cab signal when in Bypass mode

6.1.2 Current Speed Limits

The ATP constantly monitors the current speed of the vehicle and compares it to speed limits derived from several different sources. Speed limits are enforced by the ATP subsystem through the use of speed-vs.-distance profiles for the vehicle to follow. The profiles are constructed based on a Safe Braking Distance (SBD) model.

These profile speeds are enforced to vitally assure that the vehicle can safely meet the upcoming target speed within the allotted distance.

The ATP receives Line Speed (LS), Target Speed (TS) and Distance-To-Go (DTG) information in the cab signal messages sent from the wayside to the vehicle through the track circuit. Line Speed is the maximum authorized speed (MAS) permitted by the train within the control line. Target Speed is the desired speed at the end of the control line. Distance-To-Go is the distance to the target speed, referenced to the origin of the current track circuit. The ATP then uses this information to calculate an overspeed limit, or enforced speed limit, a control speed limit and a control speed. These calculated speed limits are further corrected for grade based on topographical information tabled in the ATP memory to vitally assure that the vehicle can safely meet the upcoming target speed. The position information is updated continuously to the vehicle anywhere along the track circuit.

When the system is in Manual (ATP) mode, the ADU can enable Stop and Proceed operation. When this operation is manually requested, the vehicle speed will be limited in the absence of a valid speed command. The presence of a valid non-zero speed command will supersede this speed limit. The request for Close In (Stop and Proceed) is a non-vital function; however, the speed limit is vitally enforced.

6.1.2.1 Special Override Conditions

6.1.2.1.1 Marine Station and Crossover

Speed limits are too low entering the Marine station platform adversely effecting revenue operations. As a result, the ATP will apply a special Target Speed override when traveling westbound into the Marine station, its approach and the bumper track. The ATP will override a zero (0) mph Target Speed when approaching the Marine platform and when receiving a line speed greater than 10 mph, a target speed of 0 mph, a wayside direction of west, valid orientation. The override will not go into effect, if it does not get the override in track 268 or 269 (the approach track). When the override is in effect, the ATP will set the Target Speed to eight (8) mph in Manual Mode or 6.5 mph in ATO mode and will subtract 100 ft. from the Distance-To-Go value. The ATP will drop the Target Speed back to zero (0) mph if the control lines go to zero. The override is removed if the vehicle is no longer in one of the appropriate track circuits where the override is permitted.

Logic was added to stop the train for an overshoot of Marine when traveling west (towards bumper) based on the entrance bond in addition to the exit bond. Basing an overshoot on the position within the Marine platform will apply the brakes sooner than waiting for cab signal change based on shunting of bumper track circuit (especially if rusted rail prevents shunting and bond detection).

An IEB will occur if the speed is greater than 5 mph in either of the Marine tail tracks (Bumper tracks) and not in Stop and Proceed mode.The speed limit through the Marine crossover is 15 mph. The ATP will ramp down the control speed over the approach to each crossover to avoid excessive braking and rough ride.

The west approaches to the Marine crossover will also include the Marine platform. There is no unique way of determining a crossover move from the Marine platform tracks so their portion of the reduction would always be applied.

6.1.2.1.2 Norwalk #1 Crossover

The east and west track 2 approaches to the Norwalk #1 crossover will include an additional track circuit east and west (TC1074 and TC1076) of the normal track 2 approach (TC1080) of the crossover. The speed limit through the Norwalk #1 crossover is 25 mph. This is to provide adequate distance to ramp down the control speed without excessive braking. There is no unique way of determining a crossover move from TC1074 or TC1076 so their portion of the reduction would always be applied.

6.1.2.1.3 Expo/Crenshaw Station and Crossover

The ATP will apply a special Target Speed override when traveling northbound into the Expo/Crenshaw station, its approach and the bumper track. The ATP will override a zero (0) mph Target Speed when approaching the Expo/Crenshaw platform and when receiving a line speed greater than 10 mph, a target speed of 0 mph, a wayside direction of north, valid orientation. The override will not go into effect, if it does not get the override in TC440T or TC441T (the approach track). When the override is in effect, the ATP will set the Target Speed to eight (8) mph in Manual Mode or 6.5 mph in ATO mode and will subtract 100 ft. from the Distance-To-Go value. The ATP will drop the Target Speed back to zero (0) mph if the control lines go to zero. The override is removed if the vehicle is no longer in one of the appropriate track circuits where the override is permitted.

An IEB will occur if the speed is greater than 5 mph in either of the Expo/Crenshaw tail tracks (Bumper tracks) and not in Stop and Proceed mode.The speed limit through the Expo/Crenshaw crossover is 15 mph. The ATP will ramp down the control speed over the approach to each crossover to avoid excessive braking and rough ride.
The north approaches to the Expo/Crenshaw crossover will also include the Expo/Crenshaw platform. There is no unique way of determining a crossover move from the Expo/Crenshaw platform tracks so their portion of the reduction would always be applied.

6.1.2.1.4 Aviation/Century Pocket Track

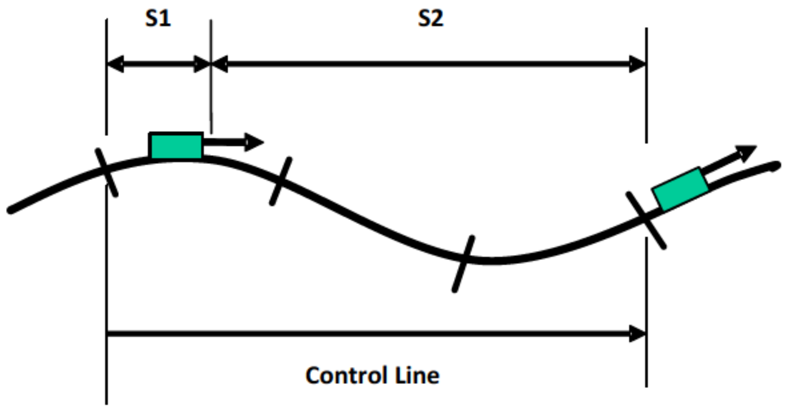
The ATP will apply a special Target Speed override when traveling northbound into the Aviation/Century pocket track, its approach and the bumper track. The ATP will override a zero (0) mph Target Speed when approaching the Aviation/Century pocket track and when receiving a line speed greater than 10 mph, a target speed of 0 mph, a wayside direction of north, valid orientation. The override will not go into effect, if it does not get the override in TC78T (the approach track). When the override is in effect, the ATP will set the Target Speed to eight (8) mph in Manual Mode or 6.5 mph in ATO mode and will subtract 100 ft. from the Distance-To-Go value. The ATP will drop the Target Speed back to zero (0) mph if the control lines go to zero. The override is removed if the vehicle is no longer in one of the appropriate track circuits where the override is permitted.

The speed limit through the Aviation/Century pocket track is 15 mph. The ATP will ramp down the control speed over the approach to each crossover to avoid excessive braking and rough ride.

6.1.3 Speed Distance Profile Algorithm

6.1.3.1 Safe Braking Distance (SBD) Envelope

The Safe Braking Distance Envelope (**SBD Envelope**) is a defined curve of velocity versus distance to go which is not to be exceeded by the train even in worst-case scenarios where emergency brake (EB) has to be applied. The worst-case braking rate for the EB is application specific and is adjusted by grade. This curve is not directly used by the ATP at all. It is only used as the beginning point to define the braking profile portion of all the other profile curves. When braking, especially to a zero speed target, the ATP must ensure that the vehicle never exceeds the speed defined by this curve.



S1 = Distance Traveled

S2 = Distance to go

Figure 21 – Distance To Go

The SBD Envelope is calculated using only the worst case brake rate (including the effects of grade), the target speed, and the distance from the vehicle to the target.

It does not include other vehicle parameters such as reaction time. At the given distance to the target (Distance-to-go minus the distance already traveled in the current track circuit) the SBD Envelope is the speed at which the vehicle when decelerating at the worst case brake rate will reach the target speed at the target. The SBD Envelope applies only to the braking portion of the profiling curves and is not applicable during the flat segments of the complete profile curves.

6.1.3.2 Safe Braking Distance Profile

The SBD profile is a calculated curve of velocity versus distance to go which is used to initiate the application of emergency brake (EB). The way in which the emergency brake (EB) is applied imposes additional constraints on the vehicle more restrictive than the SBD envelope. This profile assures that the EB will be able to achieve deceleration in time to stop the train, accounting for all of the specified conservative-side assumptions. When the vehicle ATP detects the SBD Profile has been exceeded it applies the EB.

The SBD Profile brings additional vehicle-specific and ATP-specific factors into the speed limit calculation. This curve defines the vital speed limit of the vehicle to maintain safe separation of trains, and honor civil or other speed limits commanded by the wayside.

In order to calculate the braking profile, the effect of gravity *(based upon height above a reference point)* and a constant vehicle braking deceleration *(braking rate over a distance)* are combined as a total acceleration function. The final velocity is the initial velocity adjusted by this acceleration function times its respective height to the target and distance-to-go. Therefore, various braking profiles can be generated by using different braking rates. Figure 22 show the speed vs. distance-to-go profile used in the Type II for a constant grade over the entire Distance-to-Target.

Using the Safe Brake Distance (SBD) model as the basis for determining speed limits for over speed enforcement, an over speed limit or Enforced Speed Limit (ESL), a Maximum Authorized Speed limit (MAS), and an Operational Speed Limit (OSL) are calculated. Also, shown Figure 22 is a Manual Operation profile identified as MO profile that is based on the Operational Speed Limit.

The SBD Profile is comprised of three segments. The first is a constant speed limit equal to the Line Speed plus a constant value. The last is also a constant speed limit but this time based on the Target

Speed plus a constant value. In between those two is the braking curve where it slows from the Line Speed segment to the Target Speed segment. The center segment is the SBD Braking Profile.

The SBD Braking Profile is used to assure that the vehicle will not exceed the SBD Envelope under any circumstances. When the Vehicle ATP detects the SBD Braking Profile is exceeded, the ATP asserts the EB. Due to various delays in the ATP, the propulsion, and the braking systems, the vehicle may continue to increase its speed for a time. The SBD Braking profile takes these delays into account so that the SBD Envelope is not exceeded.

When the train exceeds the SBD Profile curve the ATP system requests emergency brake. To apply the EB, first the ATP must determine that the train has exceeded the SBD Profile and react by de-energizing the train's EB circuit, which takes less than 2 ATP process cycles from the time the overspeed event occurs. During this time, plus the 0.5 seconds that the vehicle is specified to cut propulsion, the full acceleration capacity of the vehicle is assumed to take place. This is referred to as HyperAcceleration (A_{HYP}). When the EB is applied, it does not apply full braking force for 1.0 seconds. For this time, the braking effort used is one-half of the full SBD Braking Rate (1.12 mph/s). This is called Brake Build-Up. Over the distance traversed during both the HyperAcceleration and Brake Build-Up times, the grade is assumed to be the worst-case change in grade on the system for that distance (using the current position's grade as a baseline). The combined delay for the SBD Profile is shown on the velocity vs. time graph as a time-displaced curve under the SBD envelope (see Figure 24). HyperAcceleration and Brake Build-Up time combined will be 2 seconds or less.

For target speeds other than zero (0), the EB limit is the overspeed limit (i.e. 1.5 mph above the Line Speed limit, except for Car Wash – when the Line Speed is <= 2 mph, the overspeed limit is 3.5 mph above the control Line Speed limit). The SBD envelope speed target for a non-zero target location can safely be placed at the overspeed level; the SBD Profile then, being more restrictive by the hyper-acceleration and brake build-up time displacement, will be adjusted to meet the Line Speed limit when the target location is reached.

For a target speed of zero (0), the overspeed band of 1.5 mph does not apply, so the SBD envelope must target zero (0) speed. Of course, the speed limit at and beyond the target point is zero (0), as well as any time the Line Speed is zero (0). The stopping point will be defined as the Distance-to-Go point, minus possible vehicle overhang track circuit ahead, minus possible speed sensor position error, and minus the positioning uncertainty of the last track circuit bond crossed. The Overspeed Limit is defined as the SBD Profile, which targets a zero (0) speed limit at the target location as long as the vehicle is in motion. Once the vehicle comes to a stop where the Speed Limit is zero (0), the Overspeed Limit becomes 0.75 mph (to avoid nuisance EB applications for limited vehicle vibration or speed sensor noise), but the sensed motion of the vehicle is limited by Roll/Creep assurance when stopped.

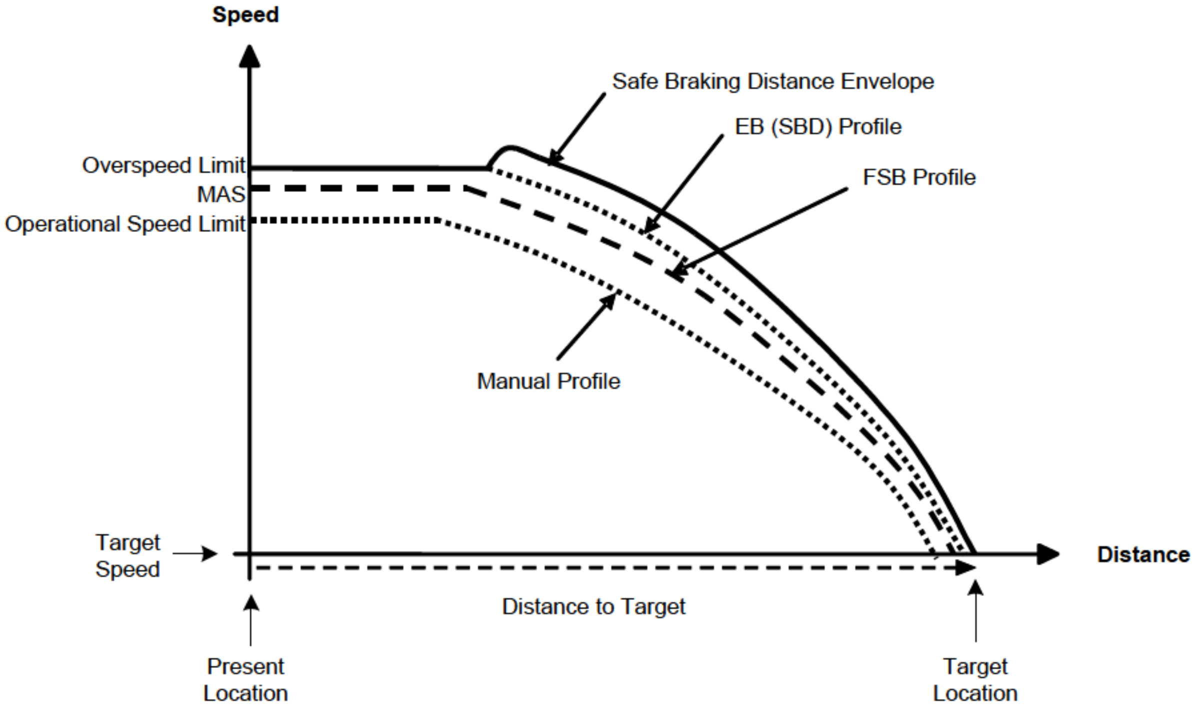


Figure 22 – Speed vs. Distance Profiles

Received Line Speed (MAS)	FSB Profile Speed Limit	EB Profile Speed Limit
0 mph	0 mph	0 mph
> 2 mph	MAS	MAS + 1.5 mph
≤ 2 mph	MAS + 1.5 mph	MAS + 3.5 mph

Table 13 – Profile Constant State Speed Limit

The ESL is set to the EB Profile speed limit unless overridden by a special condition. Fixed speed limit values are used for special operating modes.

The FSB profile is time displaced from the EB profile by the Full Service Brake (FSB) Assurance and Operator Reaction time. Table 14 shows the FSB speed limit determined for the constant part of the profile. The MAS is set to the FSB Profile speed limit unless overridden by a special condition.

The ATP calculates a "Time to Profile" with respect to the current vehicle speed and the FSB profile. Specifically, this is the time until the ATP system expects to cut propulsion and apply the FSB if no action is taken to slow down the train. The purpose of this time is to give the Operator a visual indication that he has a certain amount of fixed time to slow the train down before action is taken by the ATP.

Speed Limit / Mode	Beep Speed Limit (BSL)	Displayed Speed Limit (DSL)	Enforced Speed Limit (ESL)	Over Speed Limit (OSL)	Under Speed Set Point
0 mph	0 mph	0 mph	0 mph	0 mph	0 mph
All other Speed Limits	ESL – 2.0 mph	ESL – 2.0 mph	FSB Profile	EB Profile	ESL – 2.0 mph
Car Wash	5 mph	5 mph	5 mph	6.5 mph	0 mph

Speed Limit / Mode	Beep Speed Limit (BSL)	Displayed Speed Limit (DSL)	Enforced Speed Limit (ESL)	Over Speed Limit (OSL)	Under Speed Set Point
Stop and Proceed	8 mph	8 mph	9.5 mph	13 mph	0 mph
Speed Limit Control	35 mph	35 mph	35 mph	EB Profile	DSL – 1 mph
Friction Brake Fault	ESL – 2.0 mph	ESL – 2.0 mph	FSB Profile	EB Profile	DSL – 1 mph

Table 14 – Type II Speed Limit and Tolerances

[redacted]

6.1.3.3 Full Service Brake

If the train exceeds the line speed (in constant speed profiles) at the indicated fixed time (3 seconds) displacement from the SBD Profile, a request for FSB will be initiated by the ATP (see Figure 24). This compound curve is referred to as the FSB Profile. When the train's true speed-vs.-distance reaches the FSB Profile, a request for FSB (full-service braking) is initiated. The grade used to convert time to distance is that of the current train position. The patterned band right of the FSB profile in Figure 24 describes the typical motion of a vehicle that exceeds the FSB Profile (in this case, some control fault makes the vehicle suddenly accelerate just as it exceeds the ATO control band). In this way, unless a drastic propulsion/brake control fault occurs (e.g. only 70% of service braking is available, on a steep downhill grade, even though the FSB is commanded); the ATP will prevent the EB from being commanded by application of FSB. The curve displacement used should give sufficient time for the FSB to act to avoid commanding the EB. The vehicle is presumed to only require transitioning through part of the propulsion band, since either the ATO or the operator will have been commanding brakes for more than 2.0 sec. prior, to keep the vehicle under the speed limit.

At line speeds <= two (2) mph, the FSB upper limit is moved up to 1.5 mph above the line speed to allow the ATO a reasonable control band for 1.0 and 2.0 mph control speeds. The control speed values sent to the ATO for these cases are the 1.0 and 2.0 speed limit values. The ATP will command FSB at 1.5 mph above the control speed, and the EB will be applied at 3.5 mph above the control speed.

When the calculated FSB Profile speed limit is within 1.5 mph of the calculated EB Profile speed limit, it is reduced to 1.5 mph below the EB Profile speed limit, with the value limited to zero (0) mph.

When the calculated ATO Profile speed limit is within 1.5 mph of the calculated FSB Profile speed limit, it

[redacted]

6.1.3.4 ATO Control Envelope

The ATO Control Envelope is a speed/distance vehicle regulation control band bounded at its upper limit by the FSB Profile. The constant speed portion of the ATO Control Envelope is bounded by the line speed and the line speed minus 3.0 mph. The center of the ATO control envelope is a slowdown curve displaced in time by the ATO control reaction time allowance, from the FSB Profile. The ATO will regulate the train's speed typically 1.5 mph below the upper limit of the envelope. Note that in Figure 24, the ATO Control Speed Envelope describes the typical vehicle motion as the slow-down profile is reached. The ATO has enough time to bring the vehicle under control and avoid exceeding FSB Profile. The ATO to FSB Profile reaction time is 3.5 seconds.

For line speeds <= 2.0 mph, the ATO will regulate nominally at the line speed, in a band between 0.0 mph and the line speed plus 1.5 mph. Overspeed is always defined by the SBD profile.

6.1.3.5 Manual Operating Profile

Manual Operating Profile is used in the Manual ATP Mode of Operation, where the vehicle is under manual control of a driver using the Master Controller. For the constant speed portion of this profile, an audible beep is given to the operator at LS minus 2.0 mph.

The "Time to Profile" indicator on the ADU refers to this profile, with the purpose of giving the driver an estimate of how soon he should receive a warning beep at the train’s current velocity. For the braking portion of the profile, the operator is given an audible beep every time the speed gets within 5 seconds of the FSB Profile.

6.1.4 Reaction Time for Applying the EB

An overspeed condition can be produced when there is a failure of the vehicle ATO/braking/propulsion system, or if the ATC suddenly finds the cab signaling speed limit lower than its current speed. Providing the Overspeed Limit is exceeded, the ATC system commands the Emergency Brake, Full Service Brake, and the cutting the propulsion power. The actual worst-case timing from the point that the train’s speed exceeds the Overspeed Limit to application of full EB braking effort is summarized in Figure 25 as "Total HyperAcceleration + Brake Build-Up". If the overspeed is due to a sudden downgrade in the cab signal, a Sudden Speed Downgrade is declared instead. In this case, the overspeed limit remains as it was, and the FSB is applied (with brake monitoring). This is to avoid spurious EB applications when insufficient reaction buffer is available.

6.1.5 Reaction Buffer Needed to Avoid FSB and SBD Profiles

The following scenarios cover the range of cab signaling and control line related conditions that require the Vehicle ATC to react in an appropriate manner to keep the vehicle under control, and avoid achieving an overspeed condition that would result in applying the Emergency brake. This control reaction time buffer is associated with the "ATC/Train Control Reaction Time allowance", of the original block design. The train has at least the "ATC/Train Control Reaction Time Allowance" time to keep the vehicle under control. Figure 25 shows how the minimum reaction buffer is calculated. The typical speed envelope of the vehicle is expected to be within or below the gray band in the diagram. This value is the minimum to be applied to the control lines of the transit system for smooth (no FSB application) control of the train.

Figure 25 portrays the same speed distance profile, but in terms of speed vs. time. The ATP system actually generates the profiles as a set of fixed-time displaced profiles, where the speed vs. distance relationship is dependent on grade of the terrain ahead. This representation is simplistic, but helps in understanding how the ATP Profile algorithm actually works. The Vehicle ATC keeps track of its nose position on the transit system (within the unique track circuit it occupies).

The ATO receives new cab signaling data at the same time it is transferred into the ATP application process. The ATO is **“proactive”** to new more-restrictive cab signaling target speeds (TS). If the ATO receives a new TS that is lower in value than the last one, it temporarily (for ~1 second) either transitions its torque requests from its current value to coast (limiting jerk) if in propulsion, or it holds to the current value if in braking/coast. After 1 sec., the ATO resumes as prior to the TS down-grade, since the ATP prepares and transmits an updated command speed based on the new data to the ATO by that time. After 1 sec. the ATP will be giving lower command speeds, if the control line requires.

[redacted]

6.1.6 Overspeed Determination and Protection

An overspeed is declared when the train exceeds the Line Speed (ESL) limit. As soon as the train exceeds the line speed, the ATP commands full service brake in an attempt to bring the train under control before it exceeds the Emergency Brake Limit (EBL). When the train exceeds the EBL, the emergency brake is irrevocably applied by de-energizing the vital emergency brake circuit and opening the train's emergency brake loop. When reducing the vehicle speed to conform to a lower speed limit, the ATP system provides for a smooth down speed transition and also will minimize undershooting the lower speed limit.

Over Speed detection is enabled when operating in an active operating mode. When operating on the Type II system and the "System Speed" exceeds the Beep Speed Limit, the ATP will "chirp" the ADU alarm. The ATP will clear the "chirp" alarm when the "System Speed" is below the Beep Speed Limit or the "System Speed" is 0 mph and the Beep Speed Limit is 0 mph. The ATP will declare an overspeed condition when the "System Speed" exceeds the ESL. The ATP will perform the following actions upon declaration of an overspeed condition:

- Request an RES application (includes propulsion cut),
- Request a continuous ADU alarm,
- Turn on the OVER SPEED indicator on the ADU,

When the train speed is greater than the EBL (unless a sudden speed downgrade occurs), the ATP will request an EB application.

When a sudden speed limit downgrade occurs that results in an over speed condition (defined by the ESL dropping by more than 0.75 mph between processing cycles), the ATP will react the same as a non-sudden-speed-downgrade over speed, with the following exceptions:

- If the vehicle speed is greater than the ESL, the EB application is not requested unless the brake monitoring session fails.
- The sudden speed downgrade condition is cleared when the “System Speed” is less than the ESL.

An over speed condition is cleared once the “System Speed” reaches the under-speed set point, and the operator moves the Master Controller into a coast or any braking position. If a slide condition is active, the ATP replaces the use of the System Speed with the use of the Decelerometer Speed to recognize and/or properly terminate an over speed condition.

When the over speed condition is removed, the ATP removes the propulsion cut request, removes the Over Speed Penalty Brake request, removes any EB application request and turns off the OVER SPEED indicator on the ADU.

The ATP will turn off the continuous ADU alarm for any of the following conditions:

- The over speed condition is removed.
- An EB application has been requested, and the operator acknowledges by moving the master controller into a Coast or Brake position.

In order to avoid over speed EB applications due to erratic manual driving at low speed limits, an adjustment is made to the OSL only for the flat portion of the profile, for line speeds of between 5 and 10 mph (all inclusive). The OSL is raised an additional 2 mph (resulting in an OSL value of ESL + 3.5 mph). This value is overridden by the EB profile speed on the slowdown portion of the profile.

~~In order to avoid over speed EB applications due to erratic manual driving at high speed limits, an adjustment is made to the FSB Profile speed limit, for line speeds greater than 10 mph. The FSB Profile speed limit is reduced by 3 mph.~~

Any received Target Speed equal to one (1) mph is set to an override value of zero (0) and perform an SBD stop, unless the vehicle is in one of the following track circuits:

- Car Wash approach
- Car Wash
- Car Wash exit

At this point, the driver can enter Stop and Proceed and move ahead, according to the operation rules. If the vehicle is in one of the above track circuits when the received target speed is equal to one (1) mph, then the target speed value used remains the target speed value that is received.

Note: Type II Car Wash operations will be allowed in Manual Mode only.

6.1.7 Braking and Propulsion Control

Under normal (non-emergency) circumstances the only reason the ATP uses any of the braking or propulsion controls is to assure a stopped condition in the Type II. As part of berthing for passenger entry and exit, the ATP determines that No Motion condition is detected using the vital speed sensors. It checks the Friction Brake Applied indication for assurance. After waiting the specified length of time, the stop is vitally confirmed and doors are permitted to open. The ATP then sets the FSB and Propulsion Cut. The friction brake continues to be monitored to assure that it is both applied and has not failed during the vital stop. If either assurance fails, an Irrevocable Emergency Braking (IEB) occurs. When conditions are met that allow the ATP to end the vital stop, it deactivates its FSB output to release the friction brake.

The vehicle must be inhibited from moving during any hold-releasable or non-releasable. Full Service Brake (FSB) is applied by the ATP during all releasable and non-releasable holds.

If an emergency stop is required, the ATP activates the FSB. It assures the FSB rate using the vital speed sensors. If the FSB rate assurance fails, the ATP cuts the propulsion and activates the EB.

It should be noted that although the ATP is a vital device, the train's propulsion and service braking system are not. Although the command of the full service function is made by the ATP, it should not be considered a vital function for this reason. The ATP control of the Emergency Brake (EB) and the EB systems itself are vital, therefore the ATP assures the safe control of the train by EB application only when necessary.

6.1.7.1 Brake Monitoring

Brake Monitoring on a type II system is performed when full service brake is applied in case of sudden speed downgrade. Brake monitoring implies application of full service brake and verifying the braking effort measured by the decelerometer meets or exceeds the expected brake rate. Brake Monitoring is designed to avoid unnecessary application of the EB. The free run time will be 3.5 seconds. The Brake Assurance expected braking effort is 1.12 mph/s, however in some instances when there is no cab signal or cab signal is lost a 2 mph/s braking rate is used due to loss of or lack of position and topographical information.

6.1.7.2 Emergency Stopping

The profile-based control system is designed to minimize the possibility of having the vehicle ATP request an emergency brake application. If for some reason the current train speed is greater than the Enforced speed limit, the ATP requests a Brake Assured Full Service stop. In Type II operation brake assurance is accomplished by verifying that braking profile is being met. The events that could cause a Brake Assured Full Service stop to occur include:

- Loss of cab signaling (RES)
- Line and target speeds both go to zero (ESS indication, brakes applied immediately) (RES)
- Sudden speed limit downgrade (brakes applied immediately) (RES)
- Failure of the ATO system (in Automatic Mode only) (RES)
- Wrong direction detection between wayside and ATP determined direction (RES)

The ATP commands a Full Service Brake and cuts propulsion. The ATP subsystem generates a FSB Profile based on a brake rate of 1.12 mph/s. If the 1.12 mph/s rate is not maintained and the emergency brake profile is exceeded, the vehicle's emergency brakes are applied.

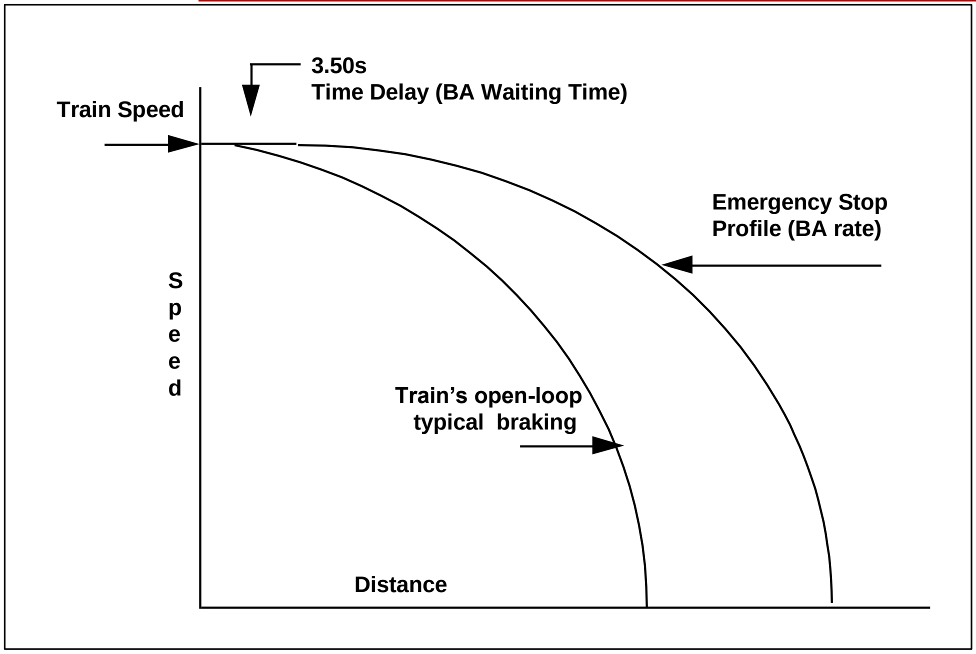


Figure 26 – Emergency Stop Deceleration Profile

The vehicle's ATC system must wait a specific time before it assures the FSB application. This wait time is based on the normal behavior of the vehicle's parameters and not the worst-case vehicle's parameters. The time the ATC waits before forcing the vehicle into a FSB profile is FSB-To-SBD profile reaction time allowance (3.50 seconds). Figure 26 shows the Emergency Stop Deceleration Profile. The profile is grade compensating and assures a braking effort of at least the Brake Assurance (BA) rate of 1.12 mph/s.

Depending upon the event, there are several types of emergency stops that can occur:

- **Unrecoverable Emergency Brake (UEB**) - Emergency brake is applied until the vehicle reaches a stop. ATP equipment prohibits movement of the vehicle by isolating its control outputs (only overridden by ATC Bypass) until the ATC is reset.
- **Unrecoverable Emergency Stop (UES)** - FSB is applied, with Emergency Brake being applied if the expected BA rate is not achieved, until the vehicle reaches a stop. ATP equipment prohibits movement of the train by isolating its control outputs (only overridden by ATC Bypass) until the ATC is reset.
- **Irrevocable Emergency Brake (IEB)** - Emergency brake is applied until vehicle reaches a stop. The ATP allows the train to move if the emergency condition clears after stopping.
- **Irrevocable Emergency Stop (IES)** - FSB is applied, with IEB being entered if the expected BA rate is not achieved, until the vehicle reaches a stop. ATP equipment allows train to move if the emergency condition clears after stopping.
- **Revocable Emergency Stop (RES)** - FSB is applied, with IEB being entered if the expected BA deceleration rate is not achieved. If the emergency condition clears, the FSB can be removed while the vehicle is still in motion. When this occurs, the train resumes operation at the current profile speed.

6.1.8 Reaction to Sudden Speed Downgrade

Normally, emergency brake is applied when the train's current speed exceeds the SBD profile speed. There are cases where the profile speed drops suddenly (> 0.75 mph between processing cycles). In these cases, an emergency stop (rather than EB) is performed. The following are sudden speed downgrade cases:

- An event occurs that forces the control lines to zero.
- A wayside failure presents an unachievable distance-to-go at 2.0 mph/s brake effort (for example, a track circuit fails).

When this condition exists, the ATP declares an emergency stop application (RES).

6.1.9 Reaction Friction Brake Fault

When the No Friction Brake Fault input is de-activated (de-energized), the ATP will respond by declaring an emergency stop application (IES) and the ATP will log an internal event when the No Friction Brake Fault input becomes active.

6.1.10 Route ID Operations

The OCC is capable of commanding vehicle movement from one track circuit to another track circuit and from one station to another station. This movement is defined as a route. A route can be assigned to the vehicle via a Route ID. The Route ID train operation is described as following:

- For all modes of operation, the Route ID can be set by central. The operator can also set the route via the TWC interface screen on the ADU. If the driver and Central both change the Route ID, the last route set is used.
- The Route tables on board the vehicle include attribute combinations, which have the route ID, trip type, destination station or destination track circuit, station to be bypassed, doors to be opened or closed, and revenue or non-revenue trip.
- There are three trip types: round trip, one-way trip, and yard/storage trip, one for each route.
- In a round trip, the destination station is a pair of turnback stations. The destination ID is alternated each time the vehicle reaches a turnback station. All revenue routes are round trips. The vehicle stops at every station in the round trip.
- In a one-way trip, the destination station is a unique station. Once the vehicle has reached the destination station, the ATO will declare the route to be completed and hold the vehicle until the route ID is changed. All express routes are one-way routes. The vehicle bypasses all stations except the destination station in the one-way trip.
- In a yard/storage trip, the destination location is either on a tail track / pocket track or a yard storage track. When the vehicle reaches a track circuit on those destination tracks by the designated route, the ATO will declare the route to be completed and hold the vehicle until the route ID is changed (this rule is not applied to route 500). All storage routes are yard/storage trips. The vehicle bypasses all track circuits except the destination track circuit.
- In a storage trip, the destination track circuit in the tail or pocket storage tracks is dynamic. The vehicle is required to stop at the last unoccupied track circuit in those storage tracks. As long as the vehicle has reached and stopped at the last unoccupied track circuit, the ATO will declare the route to be completed.
- Route 500 is set manually in the yard. The vehicle will follow the manual routing to the farthest storage location, yard platform or wash track. The ATO will declare the route complete once the vehicle stops in any of these valid locations.
- Norwalk station and Marine station are two must-stop stations. The vehicle should stop at those stations no matter what the route ID is.
- The route cannot be changed when the vehicle is moving through the beacon track circuits for a station. However, the route can be changed if the vehicle has stopped in a beacon track circuit. If a new route ID is received while the vehicle bypasses the station platform, the vehicle changes the route when the vehicle is out of the platform.
- The route ID 998 shall be asserted upon ATO initialization and every time the vehicle switches mode to LOCAL or BYPASS. Route ID 999 can be input when the vehicle is in No-motion State.

- If the train receives a Route ID of 000, from the TWC or the TWC Interface Panel, it is considered as NO CHANGE and uses/transmits to TWC/displays the last Route ID.

In the event that the TWC is incapable of communicating at a station, the NO TWC event will be logged and the train will proceed with its route. If the train has completed its route, it will follow the cab signaling. In ATO and Manual mode, the driver can manually modify the route by using the TWC Interface Screen on the ADU, under Central Operator interaction.

If the train receives an invalid Route ID (not in its EPROM table) from TWC or TWC Interface Panel, it will reject the ID and continue to move following the cab signal. The train will stop at all stations if in revenue service. The last valid route is displayed on the ADU.

6.1.11 Vehicle Holds

A vehicle hold is a state where the vehicle is held at zero velocity after a stop. Holds provide a way to inhibit the vehicle from going into motion.

The holds can be generated by the ATO itself, or initiated by the ATP.

The ATO generates the holds when:

a. Vehicle stops a station without berthing at the station platform (Miss-stop Hold)
b. Vehicle stops in a destination station or destination track circuit that is designated by a route (Route Hold).
c. Vehicle has the Route ID 998 or 999 (Init Hold).
d. TWC link failure (Releasable Hold)
e. New Route ID takes vehicle out of service (Releasable Hold)

The ATO Miss-stop hold shall be cleared by itself when the vehicle has berthed at the platform, or the vehicle stops in the exit track circuit and abort-stop is initiated, or the vehicle has been switched to Manual mode and back to ATO mode.

The ATO Route hold shall be cleared by itself when the vehicle receives a different route ID and the current station or track circuit is no longer designated as the destination location by the new route.

The ATO Init hold shall be cleared by itself when the vehicle receives a route ID that is neither 999 nor 998.

Releasable Hold - Not an emergency stop, it is the zero velocity enforcement state following a stop determined by the ATO, typically for reasons concerning routing. It can be released by TWC command, or by pressing the ATO Release push-button once when the hold condition no longer exists.

An ATP hold inhibits the train from going into motion. Brakes are applied by the ATP during all Vehicle Holds by cutting propulsion and commanding FSB. Other functions, such as dwell and door open/close, are not affected by a hold.

6.1.12 Vehicle Orientation Determination

In each cab signal message received, the ATP receives commands from the wayside regarding the direction that the vehicle should be traveling. The term “orientation” refers to the direction a designated end of the vehicle is facing.

The ATP will attempt to determine its orientation when in an active operating mode if orientation is not already established, and while receiving a valid cab signal with a non-zero line speed (traffic direction is inconclusive for a zero line speed). Only when the train is berthed at a station, or in the yard transfer track, can the orientation of a stationary train be automatically determined. If orientation is unable to be automatically determined, it can only be determined when the train crosses into the next track circuit. For example, orientation is East if the A-end is the head of the train, traffic is East, and the train crosses into a track circuit that is East of the previous valid track circuit. The ATP retains its orientation unless it is completely powered down, cab signal is lost, any inactive operating mode is entered, or Car Wash mode is entered.

The ATP determines its orientation according to Table 15 – Vehicle Orientation Determination.

Vehicle Orientation	Active Cab	Direction of travel
East	A-Cab	East
	B-Cab	West
West	A-Cab	West
	B-Cab	East
Unknown	A-Cab	Unknown
Unknown	B-Cab	Unknown

Table 15 – Vehicle Orientation Determination

The vehicle's keyed-up end is used as the reference point for general vehicle orientation.

However, the ATP uses orientation referenced to the A-cab end for enabling of the proper doors and for reporting purposes to the vehicle Operator and to central office. Because the ATP only selects the pickup coils from the keyed-up end of the vehicle, the Operator must always key down the current cab end and key up the opposite end's cab when traffic is turned by the wayside. The ATP will communicate its orientation status to the central office via the TWC subsystem.

Upon activation into an active operating mode, the ATP system will enforce a maximum Stop and Proceed speed limit until orientation is established. Orientation is not needed as part of the normal operations of the vehicle. However, the ATP will not be able to enable the doors until orientation has been established. Since the vehicle can be moved without having an established orientation, the Operator must always know the proper direction of traffic when moving the vehicle.

The ATP issues a Revocable Emergency Stop when a train is moving from the transfer track to dark territory on the way into the shop. This is caused by the established orientation not agreeing with the traffic direction. An Operator will enter Stop and Proceed Mode when cab signal is lost. Because the ATP is scanning in this mode the cab signal of TC 1517 is picked up but the orientation and traffic direction don't agree because the train is switched into the shop and not to the Y2AT tail track.

6.1.12.1 Direction Control

There are three types of direction which the ATP determines: traffic direction which is the direction with respect to the wayside (East or West), direction with respect to the vehicle orientation (active lead-cab car), and propulsion system direction (forward or reverse). While in ATO mode, the ATP will set the propulsion system so that the vehicle is always heading in a forward direction (lead end forward).Direction Assurance

The wayside gives the direction command to the vehicle as part of the Cab Signal message. The vehicle ATP interprets the command continuously, and performs a vital check to confirm it is traveling in the correct direction. The vehicle ATP expects to receive track circuit IDs in a particular order when it is traveling West, and in reverse order when traveling East. If there is a conflict between the expected track circuit ID order and the direction command, the ATP will request a Penalty Brake application (IES). The ATP will also request a Penalty Brake (IES) application in the event that a valid cab code is received without a valid direction (both East and West bits are the same value) except when the LRV is in a cab loop (neither direction bit is set). The ATP will request an RES if it determinates the orientation to be invalid.

6.1.12.2 Loop and Wye Turnback Orientation Change

There is only one wye turnback connecting the yard and the westbound track. This wye turnback involves two tracks, the yard entrance track and the yard throat track. The direction of traffic will change from west to east when entering the yard, passing from the yard entrance (west) to the yard throat track (east). If cab signal is maintained so that this transition is detected the orientation of the train will be inverted to adjust for the orientation change in the property it is traversing. Similarly, the direction of traffic will change from west to east when exiting the yard, passing from the yard throat track (west) to the yard entrance (east). If cab signal is maintained so that this transition is detected the orientation of the train will again be inverted to adjust for the orientation change in the property it is traversing. If a train loses cab signal and then picks it back up after entering or loses and picks up cab signal within this track, its orientation is no longer valid because the transition is lost. The orientation will be reset. The train will have to re-establish its orientation just as if it had powered up in this track.

6.1.13 Vehicle Position Determination

6.1.13.1 Track Circuit Tables

The vehicle's ATP system contains topographic data for the mapping of Track Circuit ID to specific track circuit parameters stored as tables in the ATP Logic PCB. Table 18 –Track Circuit Topographic Data shows the data stored in the track circuit tables. The key to the table is the current track Circuit ID. Track Circuit ID numbers for Metro Green Line (MGL) are currently assigned according to the following scheme:

Track Type	Track ID Range
Normal	0 - 1499
Yard	1500 - 1999
Crossovers	2000 - 2999
Spare	3000 - 4095

Table 16 – MGL Track ID Key

Track Circuit ID numbers for Crenshaw Line are currently assigned according to the following scheme:

Track Type	Track ID Range
Normal	3100 - 3899
Crossovers	3000 - 3099
Spare	3900 - 4095

Table 17 – Crenshaw Track ID Key

For additions or changes to track circuits, any unused track circuit ID number may be assigned.

Data	Description
Track Circuit ID	Unique integer number 1-4095 (KEY)
Length	Length of track circuit in feet (0-1100)
Elevation Profile	Velocity Head Slope & Offset
Track Circuit Type	Storage, Crossover, Platform.
Special Length	TC's that have intermediate entrance/exit points
Positive Normal Next TC	Next track circuit eastbound
Positive Reverse Next TC	Switch track circuit eastbound (0 = none)

Data	Description
Negative Normal Next TC	Next track circuit westbound
Negative Reverse Next TC	Switch track circuit westbound (0 = none)
Auxiliary Yard TC	Additional next track circuits in yard

Table 18 –Track Circuit Topographic Data

6.1.13.2 Bond Crossing Detection and Vehicle Position Determination

The vehicle must determine its position in a vital fashion with respect to the track circuit currently occupied along with its position within the Metro system during Type II operation. The vehicle ATP identifies which track circuit it currently occupies using Track Circuit ID and Direction Control data received in the cab signal messages sent from the wayside to the vehicle. It checks that the sequence of track circuit IDs is consistent with its direction of travel. It also vitally determines its position within the current track circuit using the track circuit boundaries as reference points. Safe separation between vehicles, speed limit protection, and station platform door control all require the train to accurately and vitally account for its position and direction of travel.

Crossing from one track circuit to the next provides the point of reference for position determination. Bonds are used to mark the boundaries of each track circuit. The CSRD subsystem continually monitors the amplitude of the signal in the current track circuit. As the vehicle reaches the end of a track circuit, the signal amplitude of the current received frequency begins to fall. The CSRD subsystem provides a “Bond Detect” indication to the ATP when the amplitude of the next frequency is greater than the Next Frequency Threshold (THnxt) and:

- The amplitude of the current signal falls below 75% of its peak, or
- The amplitude of the current signal falls below the Must Not Detect Threshold (THmnd).

Upon detecting the track circuit ID, the ATP resets its position to zero. Zero position is taken at the West end of each track circuit regardless of the direction of travel. This convention is consistent with the Elevation Profile data stored in the Track Circuit Tables for each Track Circuit. As the train proceeds into the track circuit, the speed sensor pulses accumulated since the boundary detection event are converted to distance and used to determine the current position in the track circuit. If any of the following events occur, the position is set to the end of the current track circuit (this is the most restrictive case):

- The bonds at consecutive track circuit boundaries have been missed.
- Initial detection of a track circuit upon vehicle power up.
- Cab signal is regained after a loss.
- A Track Circuit is out of sequence.
- Vehicle direction is changed (by the cab signal Direction Control bits).
- The bond at a track circuit boundary is missed and the track circuit exited is a special length track circuit.

Figure 27 shows signal amplitude received by a train throughout an “S” bond crossing, coming from an F1 signal area into an F3 signal area. Due to individual S bond characteristics, F3 can fall below the next threshold. In this case, the CSRD holds “up” the F3 signal for 2.8 seconds before declaring signal loss. Once data is received, the CSRD tunes the filter that was tuned to F1 to the next frequency decoded from the cab signal (F5).

[redacted]

Figure 27 – Signal Amplitude Received By Train through S – Bond

The CSRD will detect when the F1 signal drops 75% below its high-water mark. This event is recorded by the ATP in a timely manner so the vehicle can update its position in the next track circuit. Tables in the ATP will adjust for the approx. 11 foot offset between this event and the actual bond boundary. The ATP can verify this event by checking a table of track circuit lengths. If two consecutive bonds cannot be verified, the ATP will position the vehicle at the end of the current track circuit.

Figure 28 shows signal amplitude received by a train throughout an “O” bond crossing, coming from an F1 signal area into an F3 signal area. Due to bond characteristics F1 does fall below the minimum detect threshold before F3 rises above the next detect threshold. The CSRD holds “up” the F1 signal for 2.8 seconds before declaring signal loss.

The CSRD will detect when the F1 signal drops 75% below its high-water mark. This occurrence is reported to the ATP in a timely manner so the vehicle can update its position in the next track circuit. Tables in the ATP will adjust for the 3 foot offset between this event and the actual bond boundary. The ATP can verify this event by checking a table of track circuit lengths. If two consecutive bonds cannot be verified, the ATP will position the vehicle at the end of the current track circuit.

[redacted]

Figure 29 shows signal amplitude received by a train throughout a back-to-back Direct Inject bond crossing, coming from an F1 signal area into an F3 signal area. As a result of the bond modification characteristics, F1 does not fall below the minimum detect threshold before F3 rises above the next detect threshold.

The CSRD will detect when the F1 signal drops 75% below its high-water mark. This event is recorded by the ATP in a timely manner so the vehicle can update its position in the next track circuit. Tables in the ATP will adjust for the 4 foot offset between this event and the actual bond boundary. The ATP can verify this event by checking a table of track circuit lengths. If two consecutive bonds cannot be verified, the ATP will position the vehicle at the end of the current track circuit.

[redacted]

When crossing from Direct Inject to “O” bonds or “O” bonds to Direct Inject, the current signal amplitude can fall below the must not detect threshold before the next frequency signal rises above the next detect threshold. The ATP holds “up” the F1 signal for 2.8 seconds before declaring signal loss.   These “mixed” bonds are also tabled in the ATP and a 3 foot offset is applied between the bond crossing event and the actual bond boundary.

Figure 30 shows Direct Inject / O – Bond signal amplitudes crossing from an F1 signal area to an F3 signal area. Figure 31 shows O – Bond / Direct Inject signal amplitudes crossing from an F1 signal area to an F3 signal area.

[redacted]

[redacted]

[redacted]

[redacted]

6.1.13.3 Bond Crossing

The bond crossing event is determined (in the CSRD by a flag) to be set when the current frequency signal drops 75% below its high-water mark. This flag is checked by the ATP CPU within 5 milliseconds of the event. The ATP then starts a second distance counter recording the distance traveled. This becomes the new offset into the next track circuit. Also, a digital output is sent to the ATO indicating a new track circuit.

Bond Type	Distance in Feet
S bond	9
Direct Inject Bond & Direct Inject to Cab Loop Bond	4
Direct Inject to O Bond	3
O Bond to Direct Inject Bond	11
Double O Bond & O to Cab Loop Bond	13.5
Cab Loop to O Bond	0

Table 19 – Bond Type and Distance Offset

The corrected distance is then saved as a second position (with respect to a non – validated new track circuit). When a new track circuit ID is received by the ATP the second position becomes the current position in the new track circuit. If the new track circuit ID is not received, the ATP uses the distance from the last bond as its position until a loss of cab signal event stops the train. If a bond is detected in error, the track circuit ID will remain the same and the old position will still be used. The second position will be discarded in 20 feet.

6.1.13.4 Track Circuit Bond Detection Accuracy

It is estimated that the repeatable accuracy for bond boundary detection is within ± 1.0 Foot of the actual location of the boundary. Inaccuracy due to latency of detection by the CPU is very small and included in the expected accuracy stated (the distance the train could move at 66.5 mph or 100 ft/s for +1.0 ms is 0.1 Ft). The following bond detection adjustments will be used for calculations in programming the Vehicle ATC position-related functions; the most restrictive side of the range will be used as is appropriate for each particular ATP function associated with position:

S, O, DI Bond Detection Accuracy Adjustment = ± 1.0 Ft.

The parameters and functions that relate to this accuracy data will be adjusted as better estimates are determined.

In order to increase reliability on the Type II system, a single missed bond is not considered sufficient cause to set the vehicle position to the end of the track circuit. If a bond is missed and no previous bonds have been missed, the ATP will estimate its position in the current track circuit by adding 9% of the current track circuit length, plus an additional 10 feet, to the distance traveled since the expected TC boundary.

6.1.13.5 Track Circuit Crosschecking

The ATP crosschecks the track circuit information received with its locally stored track circuit tables. The following functional checks are performed:

- **Track Circuit Validity –** The received (cab signal) Track Circuit IDs must exist in the locally stored track circuit tables; otherwise, a emergency stop (UES) is requested and a loss of cab signal is declared.
- **Track Circuit Sequence –** The received (cab signal) Track Circuit IDs must follow the expected sequence, allowing for any cross-over circuits at switches; otherwise, a Penalty Brake application (IES) is requested.
- **Traffic Direction Check –** Check of ATP authorized direction of movement vs. the wayside message authorized direction of movement..
- **Vital Berthing Positions –** Station stopping vital berthing positions must be recognized and be utilized in safe berthing and door control. The ATP only enables the correct side doors and does not open them.

In Figure 35, assume that the vehicle is in Track Circuit 1550 and receiving an East Direction Bit. From Table 20, the ATP knows what Track ID to look for using the Track ID currently being decoded in Track 1550. If the vehicle is taking the crossover, the next Track ID is 2020. If the vehicle was not taking the crossover, the next Track ID is 1551. If the vehicle was receiving the West Direction Bit, the next Track ID to expect is 1549 (not shown in diagram).

When traveling on a universal crossover track circuit, the ATP will reduce the Distance-To-Go by a special length offset for the previous track circuit. This offset value is stored in the on-board track tables.

Note : For Figure 35 and Table 20, fictional track circuit ID numbers are used.

[redacted]

Track ID	East Direction Bit		West Direction Bit	
	Normal Next ID	Crossover Next ID	Normal Next ID	Crossover Next ID
1550	1551	2020	1549	-
1551	1552	-	1550	-
1920	1762	-	1550	-
1760	1761	-	1759	-
1761	1762	-	1760	-
1762	1763	-	1761	1920

Table 20 – Track Circuit ID

6.1.13.6 Adding New Track Circuits

The Track Circuit ID generated by each AF-900 track circuit is determined from its front panel controls on the wayside. When the wayside is extended, the applicable Track Circuit IDs are programmed into each new AF-900 track circuit. However, each carborne ATP unit will require a newly programmed onboard track circuit table. If a vehicle's ATP system does not have an updated track circuit table when it enters the new territory, a Penalty Brake (IES) application will be requested because the Track Circuit IDs decoded would not match the stored data onboard.

6.1.13.7 Initial Distance-to-Go

The initial Distance-to-Go value is 31 feet and is derived as the sum of the original worst-case late bond detection analysis (22 feet), the distance between ATP coil and 1st axle center (2 feet), and the distance between the 1st and 2nd axle counter (7 feet).

6.1.14 Vehicle Berthing For Station Stop

6.1.14.1 General

At a station stop, the vehicle must be properly aligned with the platform before it can open its doors for passenger loading and unloading. A berthed indication is provided by the wayside in the Cab Signal message, which informs the ATP that the train is completely in the platform area of the station. Berthed indication is vitally assured in order to safely open the vehicle doors and must be accomplished before the ATP enables the appropriate doors.

6.1.14.2 Platform Overshoot Recovery

A platform overshoot occurs if the vehicle overruns the platform track circuit and the vehicle is no longer aligned with the wayside TWC loop or it enters the exit track circuit. In either case, the vehicle is not berthed. The ATO will be aware of the overshoot, based on its calculated distance-to-go, and inform the wayside of the condition.

The ATP will not enable the door opening; instead it sends a message indicating it is not berthed to the ATO. Even if the ATO is aware of the platform overshoot, its corrective actions are restricted because a vehicle is not permitted to back up in ATO mode; if it does, it is moving against the direction of traffic

If the driver elects to do nothing, the train will pause for a 10 seconds then illuminate the DWELL EXPIRED indicator on the ADU. The driver must clear the missed stop hold by switching to MTO then back to ATO before pushing the ATO Release switch to allow the train to proceed.

6.1.14.3 Platform Undershoot Recovery

A platform undershoot occurs when the vehicle has stopped short of the platform during a programmed station stop. To reposition the train, a driver is required to switch the ATO mode to Manual mode, and manually drive the train to stop at the target position.

6.1.15 Door Control and Protection

6.1.15.1 General Door Control

The ATP controls only the enabling or disabling of the doors. In all operating modes, the safe opening or release for opening, of the doors is always a manual operation for which the Operator – under strict operating rule – must depress the appropriate Doors Right/Left Release, Doors Right/Left Open and Doors Right/Left Close buttons provided as part of the vehicle Operator's Console. Safe door opening is a vital assurance function of the vehicle, but <u>not</u> of the ATP.

When in an active mode, the ATP will enable the correct doors to open upon stopping at a station once assuring No-Motion, brakes applied, and berthed indication from wayside. The berthed bit from the platform Track Circuit informs the ATP that the train is completely in the platform area of the station.

Under normal circumstances, the ATP will not enable any doors for opening in any location other than while properly berthed at a station platform, yard transfer track, or cleaning track.

Whether the right or left side doors are enabled is based on vehicle A-cab orientation and the locally stored, tabled station and track data. With the doors enabled, the Operator has the ability to open and close the doors as desired.

6.1.15.2 Train Berthed And Door Enable Logic

The Berthed bit is generated from the wayside to the vehicle's ATC when the approach track circuit becomes unoccupied, the platform track circuit is occupied, and the exit track circuit is unoccupied. The Berthed bit is set on the platform track circuit after the rear of the train clears the approach track and a 5-second (loss of shunt) timer expires.

The Berthed bit remains high until the leading axle of the train shunts the exit track circuit or another train enters the entrance track. If the train in the platform track drifts back into the approach track, it will lose the Berth bit. If a second train enters the approach track while the first train is fully within the platform track, the berth bit will remain "on" for 10 seconds to allow time for the first train to berth.

Trains (in all modes) that start up in a platform track must wait 14 seconds (worst case) for the berth bit to be valid.

The berth bit is also asserted in the exit track for 180' platforms due to the close proximity of the pickup coils to the exit track.

An important timing detail is how fast the berthed command can be generated, in order for the train to start its open door sequence. This time is calculated by determining the time for the Track MicroLok to detect that the approach track circuit is unoccupied and then generate the berthed command. This time is calculated to be 2.0 seconds, as follows:

a. 1.0 seconds for the Track MicroLok to send the berthed command to the AF-900

b. 1.0 seconds for the vehicle to decode three messages.

As the train stops, the wayside generates the berthed command once the approach track circuit becomes unoccupied. For trains that are nominally the same size as the station, this time latency will pass as the train comes to a stop in the last few feet of its stop.

After stopping, if the train cannot vitally assure its position within the extent of the platform, it must wait seven (7) seconds before the berth bit is removed by wayside logic.

The vehicle ATC will not enable the doors to be opened if the berthed bit is not asserted in the valid cab signal data. This is important, because the doors of a train that is longer than the platform being stopped at must not open.

The ATP only enables the doors to open on the correct side when the following conditions apply:

a. ATP is in Manual or ATO Mode

b. Orientation is known

c. Track Circuit ID is a valid berthing track

d. Berthed bit is asserted

e. Station Rollback Protection is in effect

f. No Motion state is declared

g. Friction Brakes are applied

The Enable continues to be asserted until the doors are closed, and either the operator indicates departure by Master Controller moved to a non-braking position in Manual Mode, or departure is cued in ATO Mode via the ATO Release button.

6.1.15.3 Door Override

When the train is not berthed, the ATP will not enable doors to be opened. However, when the vehicle is at V-zero and not berthed, the Operator can override ATP's door enable function by pressing and holding the Door Override push button, pressing and releasing the ATP ACK button, and releasing the Door Override push button.

Once the Operator overrides the door disable, the doors will be enabled even if conditions to enable doors are not met.

6.1.15.4 Right/Left Door Selection

The ATC determines which doors (right/left) to enable at each station by reading its platform North/South table and by its orientation. The ATP only enables the correct side doors. The actual opening of the doors is done by the operator and not by the ATP. The relationship between the vehicle's "A" end and the vehicle orientation is shown in Figure 36 and Figure 37.

[redacted]

A platform track circuit entry in the topographical table includes information about the doors to be opened by the vehicle, i.e., North or South. "North" or "South" at a station is relative to the guideway. Figure 37 illustrates this situation.

a. Train 1 (see [a] in Figure 37), approaches the station in the A-end EAST direction. Once in track circuit 01T1, the data held in the track table indicates that the doors to be opened are NORTH. The vehicle opens its LEFT DOORS when proper berthing is verified and when No-Motion is detected.

b. Train 2 (see [b] in Figure 37) also approaches the station in the same direction. However, train 2 is traveling with B-end EAST. Once in track circuit 01T1, the data held in the track table indicates that the doors to be opened are NORTH. The vehicle opens its RIGHT DOORS when proper berthing and No-Motion is verified.

A-Cab Orientation	Platform Location	Door Enable
East	North	Left
East	South	Right
West	North	Right
West	South	Left
East or West	North & South	Left & Right

Table 21 – Type II Door Enable Determination

Once the ATP removes the Door Enable command, all doors that are closed will remain closed, unless the Operator overrides the enable function.

Upon termination of the dwell the ATP will provide a “Dwell Expire” indication on the ADU to cue the operator to close the doors and prepare for station departure. Station departure can also be done prior to expiration of the dwell.

In ATO mode, once the doors are closed, the operator must press the ATO Release button in order to release the vehicle for departure. Once the ATO Release button is pressed the ATP will also disable the doors.

6.1.15.5 Unplanned Door Openings

The ATP continually monitors the vital Doors Closed TL to assure that if the doors are opened abnormally, the appropriate action is taken. In the event that the doors are forced open while the vehicle is moving, the ATC will react to the situation by bringing the train to a stop, using FSB for both Automatic (ATO) and Manual (ATP) Modes.

6.1.16 ATP Modes of Operation

The ATP unit on each vehicle has several basic modes of operation:

- Manual (On) (active)
- Manual with ATO
- LOCAL (inactive)
- Bypass (inactive)

A mode change to any basic mode, other than Bypass, can only happen from a V-zero condition. If the vehicle is moving when the mode is changed, a Penalty Brake (IES) is applied to bring the LRV to a stop, and then the mode change is implemented. The ATP will log an internal event any time a mode change is attempted while in motion. Additionally, the ATP will log internal events for mode change transitions to indicate the current active mode.

6.1.16.1 Manual (On) Mode

This is the normal operating mode for the ATP system. It is considered to be an active mode. All specified functions are available in this operating mode. Initially, entry in this mode occurs after the Transfer Switch has been placed into the ON position, the ATP Bypass switch is in a non-bypass position, and the ATO/Manual switch is in the Manual position.

In Manual (On) mode, the Operator is given the maximum allowable speed along with the ATP determined speed of the LRV on the ADU. Speed limits are determined from speed codes received from the CSRD. The ATP then actively participates in supervising the safe operation of the LRV by performing over speed and brake assurance functions. While operating in this mode, Stop & Proceed, Street Running, and Car Wash special operations are available.

6.1.16.1.1 Stop and Proceed

Stop and Proceed operation is only permitted to avoid stranding the vehicle due to a loss of valid speed code data, or zero speed code from a track circuit. This function is considered to be a fully Operator-responsible action under strict operating rules. During Stop and Proceed operation, the ATP will enforce an EBL of 13 mph, in the absence of a valid speed command. If an Over Speed condition is detected, the vehicle is brought to a stop via a penalty brake application and Stop & Proceed mode is released.

Stop & Proceed operation can be requested by pressing & releasing the Stop & Proceed button on the ADU front panel. The ATP will permit entry into Stop & Proceed operation if all of the following conditions exist:

- V – zero has been declared,

- The Master Controller is in a Coast or Braking position,
- The vehicle is indicating that no propulsion is being requested and the Friction Brakes are applied,
- A loss of Cab Signal is declared, or valid Cab Signal is being received with a display speed limit of 1.5 mph,
- Not in Street Running Mode,
- Not in Car Wash Mode,
- A Departure Test is not currently running,
- The Reverser Switch is in the Forward or Reverse position (Note: for Reverse the MAS must be 0 mph).

Once Stop & Proceed has been established, the ATP will limit the vehicle speed to the appropriate Stop & Proceed speed limit and indicate this mode by illuminating the Stop & Proceed ADU Indicator. When operating in Stop & Proceed mode on the Type II, the ATP will scan for a valid FSK message on all assigned Track Frequencies while a loss of cab signal is declared.

Once established, Stop & Proceed will be released when any of the following conditions are encountered:

- Valid Cab Signal is received with a valid speed limit greater than 2 mph.
- V-zero is obtained after application of a Penalty Brake due to the detection of an Over Speed condition.
- Street Running Mode is activated.
- Car Wash Mode is activated.
- The Stop & Proceed pushbutton is pressed and released on the ADU front panel (at V-zero or in motion).
- The ATP is placed into an inactive operating mode.
- The configured line changes (Type I, Type II).
- The Reverser is placed into a different position from the one used to enter Stop & Proceed.

The presence of a valid speed limit greater than 2 mph will release Stop & Proceed mode. The ATP will maintain a maximum Stop & Proceed speed restriction until orientation is established (i.e. bond crossing, or berthed). This is done to ensure that the vehicle is not falsely receiving permissive control line data due to current dividing of the cab signal between two trains in the same track circuit.

In order to prevent the possibility of a vehicle being keyed up or exiting Bypass mode while occupying a track circuit with another train, the ATP will additionally impose a maximum Stop & Proceed speed restriction upon entry into an active operating mode when operating on the Type II system. The maximum Stop & Proceed speed restriction remains in effect upon reception of a valid speed code until orientation is established.

6.1.16.1.2 Car Wash

The ATP provides a special function for car wash operations. During car wash operation the vehicle propulsion system will regulate the vehicle speed to 2 mph. The Profile Speed Limits for Car Wash operations will be adjusted as follows: The EB Profile Speed Limit is 6.5 mph, the FSB Profile Speed Limit, Display Speed Limit and Beep Speed Limit are 5.0 mph.

Activation and deactivation of Car Wash mode is accomplished via the Car Wash button. Upon receipt of the activation command over the MVB, the ATP will establish Car Wash mode when the ATP has declared V-zero, the Friction Brakes are applied, and the Master Controller is in a Coast or Brake position and no Departure Test is running. Car Wash mode will also prevent the Departure Test from starting. Once Car Wash mode has been established, the ATP will display and limit the vehicle speed to the Car Wash speed limit. After completion of the wash cycle, the “Car Wash” mode is cancelled by pressing the Car Wash button, vehicle at V-zero, and the Master Controller is in a brake or coast position.

The ATP will implement Car Wash mode regardless of cab signal status (i.e. valid cab signal received, or lost cab signal). While in Car Wash mode, the ATP will indicate that valid Cab Signal is being received by flashing the Cab Signal indicator on the ADU.

If Car Wash mode is established when the Operator places the Reverser Switch into the Reverse position, the ATP will continue to provide over speed protection in the reverse direction by supervising the Car Wash speed limit.

Reverse operation is available only in Car Wash mode.

6.1.16.2 Manual with ATO Mode

In Manual ATO/ATP Operation, the vehicle automatically traverses the guide way from one station to the next station. Initially, entry in this mode occurs after the Transfer Switch has been placed into the ON position, the ATP Bypass switch is in a non-bypass position, and the ATO/Manual switch is in the ATO position.

The vehicle performs speed regulation and station stopping. Although not used for door control, CLOSE DOORS commands can be received via the TWC system. The vehicle's onboard ATC system enables the doors on the correct side (North or South) according to the track circuit ID table. The driver has the responsibility of initiating the control, a pushbutton, for the correct doors to open and close. Wayside provides an indication when dwell time has been completed, and the driver must push the ATO Release pushbutton to depart the station. In the event of doors failing to open, the driver is also provided with the capability to override the door open command.

Manual ATO mode is not available east of Arbor Vitae signals 2 or 8. The ATP will apply an IES if the Track Circuit ID is greater than 3300 to inhibit Manual ATO operation.

6.1.16.3 Bypass Mode

If the Operator selects Bypass Mode (by breaking the seal and activating the ATP Bypass switch), the Operator has full responsibility for the proper and safe operation of the vehicle. In Bypass Mode, the Operator will be able to operate the vehicle from the local cab, under LACMTA operating rules. With the ATP equipment in Bypass, there is no over speed protection as vehicle logic bypasses any ATP propulsion and braking controls. As a result, the ATP will immediately de-energize all propulsion and braking relays upon entering Bypass. When in Bypass Mode, the ADU will revert to basic speedometer operation displaying vehicle speed provided via MVB.

In the event of an ATP system failure, the Operator is required to use the ATP Bypass switch to operate the LRV.

6.1.16.3.1 Door Operation During ATP Bypass

When the ATP is bypassed all door enable relays are de-energized. The ATP plays no role in overseeing or assuring safe door operation when it is bypassed. When the ATP is placed into bypass mode by activating a sealed ATP Bypass switch, the doors will be overridden by the vehicle wiring. When the ATP is bypassed, total control of the doors reverts back to the operator.

6.1.16.4 Local Mode

When the ATP is powered but neither A-End nor B-End is selected.

6.1.17 Runaway Logic

For ATO mode: If vehicle acceleration is greater than 2/3 of the maximum acceleration on a 4% grade, within ~1 mph of the speed limit, the ATP will respond as if the vehicle speed exceeds the FSB profile, anticipating the occurrence of vehicle speed exceeding FSB speed (speed limit) on the next processor cycle, 250 milliseconds.

For On mode: The check is against operator control and avoiding EB application if the operator is not maintaining proper control of the train. The speed limit would be dropped an additional 3 mph and runaway would be reduced to a 2 mph window with no coast position requirement. The reaction time and allowed acceleration are tapered down as the speed approaches the speed limit. The speed limit buffer is divided by the reaction time to produce the allowed acceleration as shown in Table 22 below:

Table 22 – Allowed Acceleration for Runaway Logic

Speed Limit Buffer	Reaction Time	Acceleration
5 mph	7 cycles	2.04 mph/s (used for alarm only)
4 mph	6 cycles	1.90 mph/s (used for alarm only)
3 mph	5 cycles	1.71 mph/s (used for alarm only)
2 mph	4 cycles	1.43 mph/s
1 mph	3 cycles	0.95 mph/s

6.2 ATO Subsystem

The ATO is a microprocessor-based system that controls train speed via train propulsion and braking interface and performs automatic station stop using inputs from strategically placed wayside transitions and is only available in Type II operation. The ATO receives the control speed from the ATP and controls the train speed within the ATO control envelope.

A channel from one of the ATP speed sensors is used by the ATO sub-system to determine the vehicle speed. The propulsion and braking commands are made utilizing the MVB and the M and CM trainlines. As the train approaches a station platform, the ATO utilizes the FSK and the TWC information to enforce the stopping profile within the station. The ATO calculates a stopping profile and regulates train speed to this profile to gradually slow the train to a full stop in the station platform. While the ATO is performing speed regulation or station stopping, the number of changes in acceleration rates or changes resulting in a decrease in either positive or negative tractive effort is kept to a minimum. A decelerometer is monitored by the ATO to maintain accurate distance-to-go calculations.

The ATO sub-system does not perform any vital functions.

6.2.1 ATO Position Determination

The programmed station stop is initiated as the vehicle enters the beacon track circuit. The beacon track circuit is located some distance away from an approaching station. In order to stop the vehicle within the allowed station stop tolerance (±36 in.), the ATO has to estimate the current position as the vehicle is traveling in the beacon track circuit and the platform track circuit.

The ATO will utilize the track circuit boundary crossing interrupt signal, TWC transposition signal, vehicle direction and track circuit ID from the ATP to determine vehicle position and direction of travel.

A fixed distance from the beginning of each beacon track circuit to the end of platform is tabled in the beacon table. As the vehicle crosses a beacon track circuit boundary, the ATO uses bond detection as a baseline to calculate the distance traveled in the beacon track circuit. The ATO also uses the track circuit ID and the travel direction received from the ATP to determine which data in the beacon table should be used to calculate the vehicle current position.

As the vehicle enters the platform track circuit, the ATO uses the transposition interrupt signal as the baseline and the known location of each transposition tabled in station table to adjust the distance-to-go to the platform stopping position.

ATO will use ATP System Speed, which is based on the decelerometer, during spin/slide conditions. If a slide accumulates enough positional error, the ATO will transition to Crawl mode and disable transposition detection.

ATO shall disable transposition detection when Distance-to-Go is less than 15 feet and when leaving a station.

6.2.2 Speed Regulation

6.2.2.1 Speed Regulation via the MVB

Train speed is regulated through the M, CM trainlines and its associated non-vital MVB Link Rate Request values.

The ATO will request only brake application when the LRV is east of Arbor Vitae signals 2 or 8.

6.2.2.2 Speed Regulation during ATP Stops and Slow – downs

During normal ATP stopping and slow – downs, that is, when the target speed is less than line speed, the train is slowed following the safe braking distance curve. The speed control function receives new target speed and speed limit values from the ATP profile.

6.2.2.3 Performance Levels

The Performance Level is part of the TWC message and can be modified by Central. The vehicle receives performance levels, determined by central. The performance level consists of Speed Limit, Commanded Acceleration, and Programmed Deceleration. To minimize the amount of data transferred, a table of six performance levels is stored onboard the vehicle. To modify the current performance level, the central sends a 1-digit command.

Level	Speed Limit	Commanded Acceleration	Programmed Deceleration
1 (normal)	Maximum	Maximum	2.0 mph/s
2	90%	Maximum	2.0 mph/s
3	90%	75%	1.4 mph/s
4	50%	Maximum	2.0 mph/s
5	55 mph	Maximum	2.0 mph/s
6	25 mph	Maximum	2.0 mph/s

Table 23 – Performance Levels

6.2.2.4 Coast Mode

Coast Mode is an additional performance level, requiring that level 1 through 5 be in effect and that control speed be above 25 mph when coast is requested by the central. Coast mode instructs the vehicle to coast in the current propulsion unit, and allows the vehicle's actual speed to drop by 7 mph before reapplying power.

6.2.3 Programmed Stopping

6.2.3.1 Station Stopping

Trains will stop at station platforms when requested by the route assigned to that train. Platforms that are three car lengths (or longer) will require the one-car trains to stop in the center of the platform, the two-car trains and the three-car trains to stop at the end of the platform.

Platforms that are two car lengths will require all the trains to stop with the lead vehicle at the end of the platform. To aid in the accuracy attained during programmed station stopping, the TWC communication loop within the platform bounds is crossed at fixed distances, providing a null indication to the TWC receiver. Platforms normally have five such crossings (transpositions) with the exception of 180' platforms which have three transpositions. Transpositions are located at the platform and at known distances from either end of the platform. The number of transpositions that a train picks up may vary and is dependent on the length of the train, the length of the platform, and the stop position.

Single-car trains can expect to receive two to three transpositions in a station stop. Longer trains may get up to seven transpositions during a stop in the longer stations. The ATO has tabled information on each station that includes the Station ID, name, transposition locations, the north / south platform track circuit IDs, elevation and other data.

The ATO will prioritize stopping in the platform boundaries to trying to meet its ± 36 inch requirement and risk overshooting the platform when no TWC transpositions are validated. If the ATO has established TWC communication and the vehicle has passed the window of the center transposition without validating a transposition, the vehicle will go into Crawl mode. Crawl mode will set vehicle speed to 4 mph and fade down to 2.5 mph while monitoring for the stop conditions. The vehicle will stop as soon as it receives the ATP Berthed indication, when the ATO believes that it is near the stopping point, or when the exit bond is detected.

A programmed station stop is initiated when the train enters a pre-defined/tabled “beacon” track circuit located some distance away from an approaching station. The ATO, which is receiving track circuit/direction messages from the ATP every quarter-second, references a “beacon” table for a track circuit/direction match. As the train enters the beacon track circuit, a match occurs and the table returns the approaching station ID and the distance-to-go for the train to reach a pre-determined stopping point within the platform. The ATO further determines if a programmed stop is to occur at this station by its Route ID. A separate Route ID table contains a list of station IDs that the train is to stop at. It also contains information on the type of trip (round-trip/one-way etc.), the destination station(s) and door control on stopping.

In order to compensate for overshoot during station stop, when vehicles are close, the commanded acceleration is limited and the ATO accounts for the stopping time delay due to current vehicle acceleration when calculating point to initiate stopping profile.

The ATO will enable the station stop no matter if the beacon track bond is detected, and update the distance-to-go based on the distance traveled from the last bond, the previous track information, and the expected stop position if the beacon track circuit bonds are missed.

The table below defines the station stopping strategy for Westbound routes:

Westbound Station Stopping Strategy						
WESTBOUND ROUTE			1-Car Consist		2-Car Consist	
Station	Station Type	Direction	West End of Platform	Center of Platform	West End of Platform	Center of Platform
Lakewood	Long Three - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Long Beach Blvd.	Long Three - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Willowbrook	Three - Car	Westbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Avalon	Three - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Harbor	Three - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Vermont	Long Three - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Crenshaw	Three - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Hawthorne	Three - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Aviation	Two - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Mariposa	Two - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
El Segundo	Three - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Douglas	Two - Car	Westbound	Lead Vehicle	N/A	Lead Vehicle	N/A
Redondo	Two - Car	Westbound	N/A	Lead Vehicle	Lead Vehicle	N/A

The table below defines the station stopping strategy for Eastbound routes:

Eastbound Station Stopping Strategy						
EASTBOUND ROUTE			1-Car Consist		2-Car Consist	
Station	Station Type	Direction	Center of Platform	East End of Platform	Center of Platform	East End of Platform
Douglas	Two - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
El Segundo	Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Mariposa	Two - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Aviation	Two - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Hawthorne	Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Crenshaw	Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Vermont	Long Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Harbor	Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Avalon	Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Willowbrook	Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Long Beach Blvd.	Long Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Lakewood	Long Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle
Norwalk	Three - Car	Eastbound	N/A	Lead Vehicle	N/A	Lead Vehicle

6.2.3.2 Station Stop Profile

The programmed station stop, once initiated, is performed in three stages:

Constant Speed: The vehicle continues at the ATO control speed until reaching a distance from the station where deceleration occurs. The equation:

$$D = V^2/2a$$

Is solved to determine this distance (D), where (V) is the current speed and (a) is the braking rate. The normal (and default) station stopping braking rate is 2.0 mph/s. The Wayside TWC can set the rate from the previous station by adjusting the station stop brake rate or performance level. This target distance is further adjusted for grade using a tabled elevation for the stop location and reception of current elevation from the ATP every cycle. It is also adjusted for transport or processing delays and delays experienced in application of the full required braking power.

Constant Deceleration: The vehicle gets into the constant deceleration stopping profile and computes the required instantaneous brake rate (a). This is calculated from the latest estimated value of distance-to-go (d) using the equation:

$$a = V^2/2d$$

As the vehicle crosses track circuit boundaries, actual (tabled) distances replace the estimated distance-to-go. This helps to correct and minimize any distance measurement errors that may have been accumulated while computing the distance-to-go. The constant deceleration will continue and as the train enters the platform track circuit, it further refines its position determination by indications of TWC transposition crossings. A table of the expected crossing distances resides in the ATO to window expected TWC crossings. This will assist in filtering out superfluous or missing TWC crossing indications. The train continues in this constant deceleration mode until the train velocity goes below a threshold value or the distance-to-go becomes less than a pre-stopping level.

Stop: For a short distance ahead of the final stopping point, the train moves at a “crawl” speed until it is within a calculated distance very close from the stopping point, where a final application of the brakes is made to bring it to a smooth and accurate stop.

6.2.3.3 Station Stop Evaluation

Once the train is stopped, the ATO evaluates the precision of the stop with reference to the distance-to-go at that point. If the distance-to-go has a value within ± 3 feet and safe berthing is communicated by the ATP, the ATO declares the stop to be successful and activates its internal default dwell timer.

If the train had for some reason stopped short, e.g., the distance-to-go is greater than 3 feet, the ATO will check to see if the train has berthed. If the train is berthed, the ATO will log the vehicle berthed event, inform Central that the vehicle has stopped short but berthed, and activate its dwell timer. If the train is not berthed, the ATO will log the bad stop event, set a Miss-Stop hold, and inform Central the vehicle has a bad stop. In this case the ATO indicator on the ADU panel will be flashing. To reposition the train, a driver is required to switch the ATO mode to Manual mode, and manually drive the train to stop at the target position.

If the train overshoots the stop, the ATO will check to see if the train has berthed. If the train stops beyond the usable limits of the platform (not berthed) and the ATC is in the ATO mode, it logs the bad stop and departs following cab signal. If the train is berthed, the ATO will log the vehicle berthed event, inform Central the vehicle has stopped with overshoot but berthed, and activate its internal dwell timer. If the train is not berthed, the ATO will log the bad stop event, inform Central the vehicle has a bad stop, and complete the station stop. If the train overshoots the platform in ATO mode, it runs a 10 second timer. The train can also be released to the next station by pushing the ATO Release button on the vehicle.

Once the station stop is completed, the ATO logs the station stop event to indicate at which station the vehicle has stopped. The ATO will reset all the parameters that were related to the station stop and get ready for the next station stop.

6.2.3.4 Station Stop Brake Rate

The need for a different brake rate would be apparent from Spin/Slide Detected indications received from vehicles stopping at the affected station. The vehicle will transmit this indication when either the vehicle ATC or the vehicle systems detect a spin/slide condition. .Weather-related spin/slide indications will typically be more momentary in nature. When the vehicle has met the spin/slide condition, the ATO is commanded to set the station stop brake rate to 1.4 mph/s in order to stop vehicle safely. The ATO will latch the spin/slide indication and transmit it to Central at the next TWC loop. During a slide condition the ATO shall use the ATP calculated System Speed which factors in decelerometer based speed during a slide condition. If the spin/slide occurred as the vehicle approached the station platform, the ATO will transmit the spin/slide indication to Central in the current TWC loop. If the current TWC loop is not working, the ATO will carry the spin/slide indication and transmit at the next available TWC loop.

Consistent spin/slide indications from vehicles passing through the station indicate a need for a change in the station stopping brake rate or a performance level. The station stop brake rate and the performance level can be set at the previous station from Central through TWC communication.

Each station will have a predefined range for an allowable station stop brake rate. Predefined brake rate ranges already exist, but may change based on the performance of the rate request interface between the ATO and the Propulsion systems on the P3010 vehicle.

There are nine different station stop brake rates, as shown in Table 24. The Central Office will determine which performance level and the station stop brake rate should be applied to the vehicle.

Station Stop Brake Index	Station Stop Brake Rate
1	2.0 mph/s
2	1.9 mph/s
3	1.8 mph/s
4	1.7 mph/s
5	1.6 mph/s

Station Stop Brake Index	Station Stop Brake Rate
6	1.5 mph/s
7	1.4 mph/s
8	1.3 mph/s
9	1.2 mph/s

Table 24 – Station Stop Brake Rate

Each station will have a predefined range for an allowable station stop brake rate. If the station stop brake rate commanded by Central is greater than the maximum station stop brake rate allowed by the station, the ATO will apply the maximum brake rate to the station stop. This rule is also applied to the spin/slide station stop brake rate (1.4 mph/s). If the minimum brake rate allowed by station is less than the 1.4 mph/s, the ATO will use the allowed minimum brake rate in station stop deceleration.

6.2.4 Yard and Storage Track Stopping

The vehicle is required to stop in the center of the yard and storage track at its programmed stop. The storage track includes the pocket track and the tail track. All of the yard and storage track circuits equipped with TWC loop are tabled to assist the programmed stop. The yard and storage track circuit lengths are tabled also to assist the vehicle to stop at the proper position.

The destination track circuit is pre-defined in the route data. The ATO initiates the programmed yard or storage track stop as the vehicle crosses the destination track circuit boundary. The ATO performs the same speed control algorithm as the station stop to bring the vehicle to a stop in the center of the destination track circuit. Once the vehicle stops in the destination track circuit, the ATO declares the stop to be completed.

If the destination track circuit is occupied, the vehicle is required to stop at the last unoccupied storage track circuit. The vehicle stops in this track circuit by the ATP braking profile (target speed is zero) and usually it is not centered in the storage track circuit. In this case, the ATO will declare the stop to be completed and assign the current track circuit to be the destination track circuit.

The vehicle will be able to accept a new route from Central through the TWC communication or from the driver to set the route through the ADU. Once a new route is received, the ATO will clear the hold if any and be ready to depart.

For Mainline and Yard Storage Tracks, the TWC is used to center the vehicle accurately in preparation for uncoupling/coupling sequences. The TWC loop boundaries at either end of these tracks are used as an initial wayside landmark for the stopping algorithm. The center-track transposition gives an accurate re-calibration point before the stop, and the TWC antenna at both ends of the vehicle should be able to communicate with the wayside loop if centered in the track circuit (90 ft. vehicle. TWC center in from each end 6 ft; TWC-TWC distance = 78 ft.; TWC wayside loop 80 ft. with center transposition; therefore, 2 ft. stopping window). The same table used to assist station stops will provide the data to stop the vehicle in the proper position in the various storage tracks. Once the vehicle is stopped and centered within ± 3 feet, it reports vehicle centered to central via TWC.

There are scenarios where a vehicle will be parked in a storage track but not centered (end vehicle). A vehicle cannot re-center if it receives a Route ID whose destination is the current TC. The vehicle will respond to this route request with a 999, indicating it will not move. The vehicle will have to move to another TC and back in order to center in the original TC.

6.2.5 Station Departure

Certain conditions must exist in order for a train in ATO mode to depart a station or a non-platform track circuit. From the perspective of the ATO, these conditions are:

- Valid communication with the ATP (i.e., no link failure)

- Valid Route ID
- Valid Track Circuit ID (received from the ATP)
- Non-zero speed set-point (received from the ATP)
- Valid Train Length (over MVB)
- Valid Train Direction (received from the ATP)
- Valid wheel size (initially received from the ATP and then re-checked by the ATO during station stops)
- No releasable or non-releasable holds active
- Route ID is not 999 or 998
- No Destination Route Hold active
- No Missed Stop Hold active
- Valid "Release" signal from the ATP (which is dependent on the fulfillment of various safety checks undertaken by the ATP)
- Dwell expired
- Doors Closed

6.3 TWC Subsystem

The TWC system, a subset of the ATO Subsystem, makes possible bi-directional digital data transmissions between the wayside and vehicle. TWC communication is supported ***only*** in the ATO and Manual operational modes of the vehicle. The TWC-related features supported in each of the four major vehicle modes are summarized in Table 25. Note that trains operating in Bypass mode will not attempt TWC communication.

TWC-related Feature	Vehicle Mode			
	ATO	**Manual**	**Local**	**Bypass**
TWC powered and sending indication data?	X	X	NO	NO
TWC departure control	NO	NO	NO	NO
Assign Tracking ID	X	X	NO	NO
Assign Route ID	X	X	NO	NO
Assign Performance Level	X	NO	NO	NO
Set Coast Mode	X	NO	NO	NO
Change Station Stopping Brake Rate	X	NO	NO	NO
Set Master Clock	NO	NO	NO	NO

Table 25 – TWC Related Features Supported in Various Vehicle Modes

Data transfer is achieved by magnetic coupling between the antenna under the train and a loop of cable positioned in all stations, storage track circuits and transfer tracks of the yard/mainline interface. The vehicle portion of the TWC system receives and transmits information through TWC antenna mounted beneath each end of the vehicle. The digital, serial data transmission uses FSK modulation for transmit and receive functions. The vehicle TWC is the *master* unit and the wayside TWC unit is the *slave* unit. The slave unit transmits only after being interrogated by the master unit. The vehicle TWC message contains full identification, along with data messages. The following is a breakdown of the two-way communication variables between the vehicle and the wayside:

Transmitted to the wayside from the vehicle:

- ETA
- Master PVID
- Tracking ID
- Route ID
- Static Departure Test Status

- Door Open/Closed Status
- ATC mode (ATO, Manual, etc.)
- Current Performance Level
- Coast Mode
- A-End East/West
- Train Length
- Current Station Stopping Brake Rate
- Master Time Updated
- V-zero
- Spin/Slide Detected
- Train Berthed
- ATO Stop Out of Tolerance
- Gate Call
- Gate Cancel
- Signal Cancel

Transmitted to the vehicle from the wayside:

- Master PVID
- Set Tracking ID
- Set Route ID
- Set Performance Level
- Set/Cancel Coast Mode
- Close Doors
- Set Station Stopping Brake Rate
- Set Date (Month, Day, Year)
- Set Time (Hour, Minute, Second)
- Gate Call

The primary function of the Type II TWC subsystem is to provide compatible two-way communication with TWC systems currently installed on the Type II line. The wayside transmits and receives non-vital information through the use of TWC loops situated between the rails and located at selected track locations. The vehicle TWC subsystem transmits and receives information through the use of TWC antennas mounted at each end of the vehicle. The selection of the active antenna is based upon which cab end is actively keyed.

The TWC performs the following major functions in Type II operation:

- Route Control and Indication
- Overloop Indication
- Train Identification
- Departure Test

The P3010 TWC subsystem communicates with the existing TWC wayside equipment and provides a single integrated interface for the operator to select and cancel route requests. The TWC system receives and decodes FSK modulated signals propagated from the TWC loops mounted between the rails. The TWC system also transmits FSK modulated signals to the TWC loops. The TWC subsystem is also responsible for detecting when the vehicle is over a TWC loop and illuminates an overloop indicator to inform the operator.

TWC Transmit Logic will be as follows:

- The TWC will transmit when keyed to ATO or Manual (ON) mode from another mode and the track circuit ID the ATO receives from the ATP is 0.
- Platform Entrance tracks, Platform Exit tracks and all TWC locations: Transmit if not in Continuous mode.
- All other locations: Never Transmit.

ATO will continue to send TWC message for one second when the vehicle is out of the Exit TC to prevent the alarm bit being carried over to next station.
ATO will resume the TWC message transmission right after the vehicle stops in platform instead of waiting for wayside finishing the continuous mode then starting the transmission.

6.3.1 TWC Operator Interfaces

The ADU/TWC Interface Panel will be incorporated on the Aspect Display Unit.

6.3.1.1 Route/Train ID Display

When configured for Type II operation, the ROUTE/TRAIN ID display is utilized to display both the current Route ID and the current Train ID. For operation on all lines, the ROUTE/TRAIN ID display will indicate "−−−" when communications between the Interface Panel and the TWC Controller PCB is interrupted.

6.3.2 Train Length Determination

Train length is received in a non-vital manner via the MVB link. Train length will be displayed on the ADU TWC Interface screen.

This setting is used by the ATO and TWC functions to determine if the train is too long to be routed to 2-vehicle stations. Legal consists are 1, 2, or 3 vehicle trains. For trains indicated to be longer than 3 via the MVB message, the ATP will apply an IEB and will not be permitted to be moved. Trains longer than 3 vehicles must be operated in ATC BYPASS.

6.3.3 Permanent Vehicle Identification (PVID)

The MDS will supply the LRV number to the ATC system. The communication interface PCB internal to the ATC unit will supply the vehicle ID information to the ATP/ATO and the TWC subsystems. The TWC Subsystem provides for the input and storage of a Permanent Vehicle Identification (PVID) value. The range of the PVID is 0000 to 9999. This value identifies the vehicle in which the ATP/TWC system resides. Vehicle identity is independent of the PCBs of the TWC system. The PVID for each vehicle is stored on an EEPROM, which is installed as a separate component of the ATC Enclosure.

The TWC will utilize a default PVID value of "0000" if communications with the EEPROM cannot be established. If a failure to communicate to the EEPROM is detected, the TWC will indicate a fault to the Operator by illuminating the TWC FAULT indicator on the ADU/TWC Interface Panel. In addition, the TWC will log an internal event, and report the fault to the vehicle MDS.

The PTU will use the PVID as the default value when any files are being saved.

6.3.4 TWC Modes of Operation

The TWC unit on each vehicle has only two basic modes of operation:

- ON (active)
- OFF (inactive)

The vehicle provides a TWC Bypass switch that is located in each cab to bypass the TWC system should a problem arise with the unit's operation. However, a specific Bypass mode is not supported by the TWC as placing the TWC Bypass switch into the Bypass position removes power from the TWC system. The status of the TWC Bypass switch is monitored by the ATP and reported to the vehicle MDS for display on the vehicle TOD.

6.3.4.1 Off Mode

In this mode, the TWC is considered inactive. Off mode is entered when no cab end is activated and the TWC is not in bypass

6.3.4.2 On Mode

This is the normal operating mode for the TWC system. It is considered to be an active mode. All specified functions for the current selected line are available in this operating mode. Entry into this mode occurs after the Transfer Switch in one of the cab ends has been placed into the ON position, and the TWC Bypass switch is in a non-bypass position. If no errors are detected with the system, the TWC will inform the operator that it is ready for operation by steady illumination of the TWC READY indicator on the ADU/TWC Interface Panel. The TWC will begin to transmit when the ATC is keyed to an Active Mode mode from an Inactive mode and the track circuit ID is 0. If errors or faults are detected with the system, the TWC will illuminate the TWC FAULT indicator.

6.3.5 TWC Configuration

Upon power-up, the TWC system defaults with no line selected. If no Line Selector Crosscheck error is active, the TWC will set its internal operation for the indicated line. The Vehicle will remove power to the Type I H+K TWC system.

6.3.5.1 Antenna Selection

Antenna selection is determined based upon the Cab In Control inputs to the ATO. Upon power-up, the ATO internally defaults with no antenna selected. If no Keyed Cab Crosscheck error is active, the ATO will select the appropriate A-end or B-end antenna based upon the corresponding Cab In Control indication.

6.3.5.2 TWC Coil Selection

The Coil Selection Logic will be as follows:

- For 2-car and short 3-car platforms (those under 300 feet) select trailing coil whenever the train is stopped and berthed in the platform or stopped in the exit track. Continue to select trailing coil as train departs until the train detects the track following the exit track.
- All other locations: Select the leading coil.

6.3.6 TWC Operational Description

The TWC system communicates with the wayside in a master/slave type relationship. The vehicle's TWC has the master role and initiates communication with the wayside. The following TWC related features are supported by the TWC system:

- Departure Control
- Route ID Entry/Validation
- Train ID Assignment
- Serial Communications with ATO
- Grade Crossing functions: Gate Call, Gate Cancel and Signal Cancel

Additional functionality provided by the TWC system includes Overloop Detection and Indication and Departure Test.

The TWC system communicates with the Wayside using FSK-modulated digital serial messages. The messages are transmitted and received using FSK frequencies of 54 kHz and 64 kHz. The existing Wayside TWC units have two modes of communication: continuous and two-way. The TWC utilizes two-way communication with the Wayside during normal operation. Continuous communication mode is used. Transmission of messages by the TWC occurs in all modes other than Bypass, Cutout, and Local.

6.3.6.1 Overloop Detection

The vehicle TWC system has a master/slave relationship with the Wayside TWC unit. The vehicle TWC is the link Master and will initiate communications with each Wayside TWC unit (link slave). The Master will transmit poll messages at a periodic rate whether a valid response is received or not. Slaves transmit responses only after receiving a valid message containing the Master's PVID or a general PVID. Invalid messages/responses or messages containing incorrect PVIDs are ignored.

Type II TWC only transmits at certain times (e.g. power-up or key-up) and in specific locations based upon Track Circuit ID (Refer to Item 3 in Appendix A). When the antenna is not positioned over a TWC loop, the vehicle TWC will not receive any response to the transmitted poll message. When the antenna becomes positioned over a TWC loop, the Wayside will respond to the poll message by sending the most current data from the wayside systems. Upon seeing a valid wayside response to the poll message, the CCB TWC link active status will indicate that TWC is now over a TWC loop.

Once the TWC system has determined that it is over a loop, it provides an indication to the Operator. The indication to the Operator is accomplished via illumination of the OVER TWC LOOP indicator on the ADU/TWC Interface Panel. The TWC system will continue to indicate that it is over the wayside loop as long as it continues to receive a valid response to the poll messages.

If the TWC system does not receive a valid response to any transmitted poll messages within four (4) seconds of receiving the last valid response, the TWC system will assume that it is no longer over a loop. The TWC system will indicate this by turning off the OVER TWC LOOP indicator.

6.3.6.2 Antenna Swapping

In order to extend the amount of time that the vehicle can transmit and receive messages when pulling out of a station, or to accommodate a station stop where the selected antenna is no longer positioned over a loop, the ATO system provides a TWC antenna swapping function. Once the TWC system has detected that it is over a wayside loop in a station platform track circuit, the system will switch to the opposite end antenna if it does not receive a valid response to any transmitted poll messages within 2.0 seconds of receiving the last valid response. Once the TWC has switched once to the opposite end, the TWC will return the antenna selection back to the original selection after not receiving a valid response to any transmitted poll messages within 2.0 seconds of receiving the last valid response. The ATO will not permit any further TWC swapping until the ATO has determined that it is no longer over a TWC loop and then it has determined to be overloop once again.

The ATO utilizes information contained in the on-board track tables located on the ATP to determine whether it is within a station platform track circuit. The ATO will suspend the TWC antenna swapping function if the ATP is reporting that it is not currently in a platform or platform exit track circuit, or if the TWC has suspended the transmission of all messages to the wayside.

6.3.6.3 Train Identification

On the Type II line, Central is able to track the movement and supervise the routing of trains. Train identification on the Type II line consists of a fixed portion and a variable portion. The fixed portion is the permanent, four-digit vehicle number unique to each LRV. The variable portion includes a four-digit Tracking ID number which is issued by Central. The entire PVID of the leading car is transmitted in each TWC message transmitted to the wayside. NOTE: Even though the Tracking ID provides for four digits, the existing MGL only utilizes three digits. The Tracking ID number is displayed on the TWC screen located on the ADU/TWC Interface Panel.

The TWC will set (default) the Tracking ID to the PVID upon power-up, and every time that the TWC enters an inactive mode.

6.3.6.4 Route Entry / Validation

6.3.6.4.1 Route ID Tables

On the existing MGL TWC system, route selection by the wayside is performed strictly on the Route ID received from the vehicle. Therefore, the ATO will validate any received or manually entered Route ID. If an invalid Route ID is received or entered, the vehicle will maintain the previous Route ID. In this way, any route that the vehicle does not accept will not affect previous wayside routing decisions.

In order for the ATO to validate all received or manually entered Route IDs, all valid Route IDs are stored in tables located in non-volatile memory.

6.3.6.4.2 Manual Route ID Entry

Under normal circumstances, the Route ID will be set by Central and sent to the vehicle via the TWC. However, the ADU/TWC system provides for manual route requests to be entered by the Operator, or other MTA personnel, under Central Operator interaction. Manual entry of a valid Route ID is accomplished through the use of soft buttons on the ADU/TWC Interface Control Panel. If the Operator and Central both change the Route ID, the TWC will use the last route set.

With the lead cab keyed into an active mode, the Operator enters in the desired Route ID number using the ADU/TWC Interface Panel soft buttons. If the number entered represents a valid Route ID, the ADU will display the entered number. If the entered number does not represent a valid ID, the ADU will continue to display the previous valid Route ID.

While the vehicle is not moving, the TWC will toggle its Route ID display between the newly entered number and zero as a reminder to complete the operation. The reminder is suspended while the vehicle is in motion.

6.3.6.5 Departure Control

When a train makes a station stop, the ATP/ATO system will provide an indication to the Operator when it is time to depart the station. The ATP/ATO system maintains a 20 second default dwell timer which is activated upon overloop detection, No Motion determination from ATP, and berthed indication from the ATP. If valid messages are being received, the ATP/ATO will not indicate that it is time to depart until a Close Doors command is received from the Wayside. If valid response messages are not being received, the ATP/ATO will indicate that it is time to depart when the on-board dwell timer expires. The ATP/ATO will disable the default dwell timer, as well as any departure indication upon detection of motion.

6.3.6.6 Grade Crossing

Grade crossings only apply to platforms of northbound routes to West Chester and Fairview Height stations. When the vehicle is stopped at either of these stations northbound, the Operator is able to request the crossing warning to be deactivated. The grade crossing will activate automatically when the LRV is berthed at the station (i.e. gate call by the wayside). If the dwell is to be extended beyond the standard 20 second dwell time, the Operator can request the warning to be cancelled by pressing the Gate Cancel button on the ADU/TWC Interface Panel. If the conditions are safe, the wayside will deactivate the crossing. When the dwell is to be terminated, the Operator can either manually request the crossing warning to be activated by pressing the Gate Call button on the ADU/TWC Interface Panel or proceed into the next track circuit for the gate call to be automatically activated by the wayside.

6.3.6.7 Signal Cancel

Typically, the signal protecting the interlocking will be cleared before the LRV reaches the signal protecting the interlocking. However, in an abnormal case (due to either failures or other problems), the Operator might want to request a different route. In these cases, the Operator needs the ability to cancel the current route. The Operator can request to clear the signal by pressing the Signal Cancel button on the ADU/TWC Interface Panel. A new Route ID number must then be entered on the ATU/TWC Interface Panel.

6.4 Type II Departure Test

For operation on the Type II line, the on-board Departure Test exercises the following areas of the system in order to verify proper operation:

- Functional ADU Interface
- Alarm activation
- Full Service Brake application
- Emergency Brake application
- Door Enable function
- ATC detection of ATP FSK speed commands through actual cab signals or injected test signals
- Decelerometer is properly calibrated
- Tachometer circuitry with 0.5 mph tolerance

A Departure Test status will be marked as “not run” when the ATC mode of operation is changed as follows:

- From power off to any Active mode
- From BYPASS to any Active mode
- Between Type I and Type II Operation

The status of the Departure Test reported to Central and displayed to the operator will permit the distinction between actual ATC failures and what are termed “Shop Failures”.

7 Event System

The ATC system will have a consolidated event management system. The events for all of the ATC subsystems will be stored in the COMM subsystem. The events will be retrievable from the COMM subsystem using the PTU connected to the ATC via an Ethernet interface. The COMM subsystem shall store state data of 10 seconds previous and of 5 seconds after ATC system event generation. The COMM Subsystem has 250 MB of memory dedicated for state data and 200 KB of memory dedicated to store events.

All events shall have the PVID appended when logged by the ATC system.

8 Software Uploads and Maintenance

The COMM subsystem is also responsible for routing software upgrade requests and data to other ATC subsystems from the PTU. Using the PTU, in a password protected mode, the user can upload new software to the processors of the various subsystems included as part of the ATC package. Before beginning a software upgrade for any subsystem, the COMM subsystem checks the No-Motion status of the train. If the train is not currently at zero speed, the COMM will reject the software upgrade request from the PTU. The upgradable software items include:

- ATP Application
- CSRD Project Configuration File
- CSRD System Configuration File
- TWC/ATO Application
- TWC/ATO Configuration File
- ADU Application
- CCB Application

9 PTU Functionality

9.1.1 User Interface

The PTU provides a graphical user interface, adhering to the requirements referenced in the following subsections. The GUI is the user's sole means of performing data analysis, troubleshooting, and testing of the carborne systems.

9.1.2 Connectivity

The PTU connects to the ATC system through a connection to the Train Ethernet network. The current operating mode of the ATC has no bearing upon the PTU-ATC interactions.

9.1.3 Event Log Functionality

The PTU provides a means for the user to analyze ATC system events on the train, download those events, and play back a precise recall of the conditions on the train before, during, and after the event transpired.

9.1.4 Data Playback

The user is able to play back data by way of event files, or by recording real-time data while on the train to a playback file. The same functionality available during real-time data viewing, e.g. charting of process variables, is available while playing back recorded data.

9.1.5 Data Charting

While playing a recorded playback file, or playing an event file, or streaming real-time data, the PTU is capable of charting user-selected individual data points.

9.1.6 Software Maintenance

The PTU is responsible for maintaining the ATC subsystem software. It is the sole means of updating subsystem software for all of the following subsystems:

- TWC/ATO
- ATP
- CSRD
- CCB
- ADU

9.1.7 PTU Access Control

The PTU has two tiers of user access. The base tier requires the user to authenticate to the Windows laptop at logon time, this is general access. The upper tier is password-protected.

The PTU restricts access to Administrator-level modules by way of making the buttons inactive unless a password is supplied.

ATTACHMENT #2

Software Modification Instructions

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Kinkisharyo International, L.L.C.
Los Angeles County Metropolitan Transportation Authority
New Light Rail Vehicles

Contract Number: P3010

ATC Software Modification Instructions

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Approved : ____________________
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HSTS Document Number	CDRL Number	Revision	3.0
USASSO24-CEPH4-601	N/A	Date	April 25, 2023

Document Revision History

REVISION	DATE	AUTHOR	REASON FOR REVISION
1.00	7/31/2014	M.Hill	First Submission
1.01	2/26/2016	M.Hill	Updated for ATC 1.00 Release
2.0	4/27/2017	M.Hill	Updated for ATC 2.00 Release and MAKI 3594 comments
2.2	3/20/2018	D. Dixon	
2.3	11/3/2021	E. Rosswog	Added notes for CCB software update for handling the event logs and snapshots.
3.0	4/25/2023	V. Lokam	• Changed IO_DELAY_COUNT from 15 to 10 in Step 7e of Section 2.9.3.1. • Added Section 2.10

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1 INTRODUCTION

1.1 PURPOSE

This document defines the steps necessary to load and verify the installation of updated software for the LA P3010 Automatic Train Control System.

1.2 SCOPE

This document covers installation instructions for the following software configuration items: ATP Boot Software, ATP Application Software, CSRD Application Software, CSRD System and Project Configuration Software, CCB Application Software, CCB Configuration File, ATO SPO Board Software, ADU Software, Multi-Function Board Software, Type II TWC Modem Software and Type I H&K TWC CCU Software.

1.3 ACRONYMS

Acronym	Term
ADU	Aspect Display Unit – Operator Display
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
CCB	Communications Controller Board
CCU	Communications Control Unit
CPU	Central Processing Unit
CSRD	Cab Signal Receiver Demodulator
HSTS	Hitachi Rail STS
LED	Light Emitting Diode
LRU	Line Replaceable Unit
PCB	Printed Circuit Board
PTE	Portable Test Equipment
PTU	Portable Test Unit
SCI	Software Configuration Item
SPO	Supervisory, Position and Operational Board (ATO PCB)
TWC	Train Wayside Communications
USB	Universal Serial Bus

1.4 REFERENCE DOCUMENTS

N/A

1.5 SOFTWARE CONFIGURATION INFORMATION

The table below lists each SCI in the ATC system.

SCI	Software Part Number	Device	Format
ATP Boot Software	P43N.0100384_00	Flash EEPROM	Flash file
ATP Application Software	P43N.0100371_00	Flash EEPROM	Motorola S-Record
CSRD Application Software	Standard Product	Flash EEPROM	Flash file
CSRD System Configuration Data	P44N.0100003_00	Flash EEPROM	Flash file
CSRD Project Configuration	P44N.0100002_00	Flash EEPROM	Flash file
CCB Application Software	P43N.0100374_00	NAND Flash	Tar file
CCB Configuration File	P43N.0100559_00	NAND Flash	Tar file
ATO SPO Board Software	P43N.0100372_00	Flash EEPROM	Flash file
ADU Software	P43N.0100375_00	Flash	Executable

Table 1: Software Configuration Item Information

2 SOFTWARE UPDATE PROCEDURE

2.1 ATP BOOT SOFTWARE

The following instructions pertain to uploading ATP Boot Software

2.1.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

A computer with Windows 7/XP/2000 installed.

A male/female null modem serial cable with DB-9 connector.

OPTIONAL: A USB to serial converter if computer has no built in serial port.

Hitachi Rail STS USA MicroCab 332 Flash Programmer software part number N4512322517.

ATP Boot software that needs to be loaded (which will be named atp_boot.abs). Part Number P43N.0100384_00

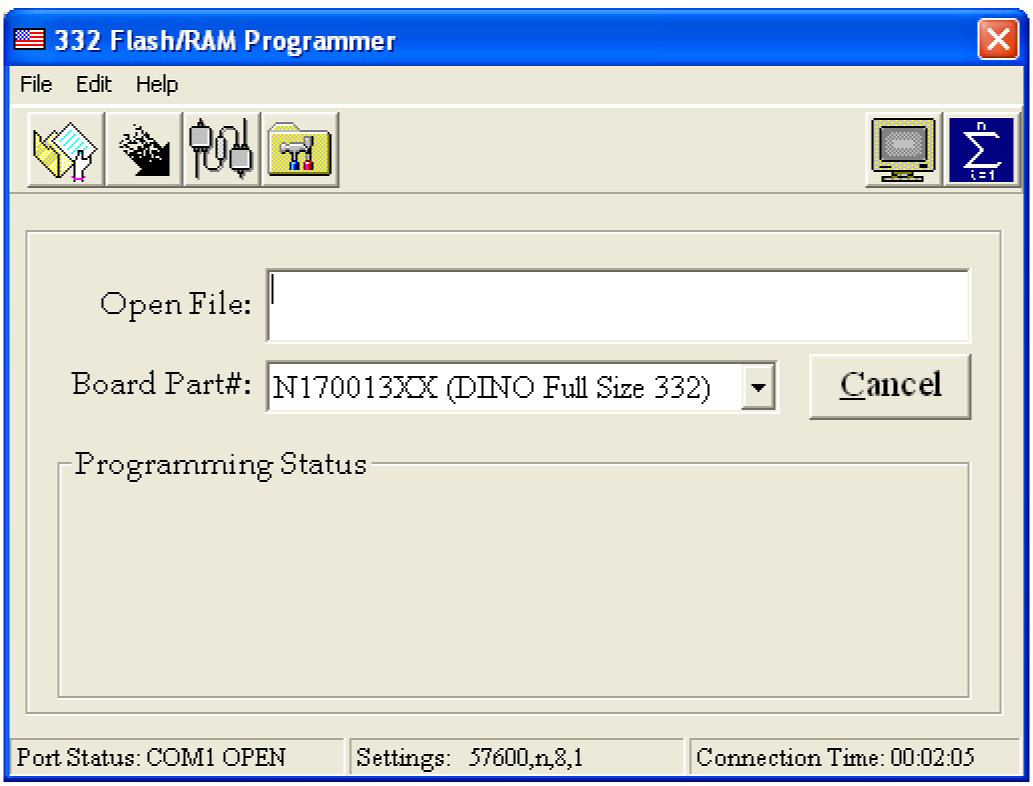

Figure 1: MicroCab 332 Flash Programmer

2.1.2 SETUP

If updating software to a subsystem, boot the computer and start the MicroCab 332 Flash Programmer software. Connect the serial cable to the computer and the sub-system to be re-programmed. The

MicroCab 332 Flash Programmer has a help file integrated in it; a copy of the help file is located in Appendix A.

2.1.3 INSTRUCTIONS

1. Turn off the ATC enclosure.
2. Unscrew and remove the board labeled ATP CPU.
3. Locate Jumper 30 (JMP 30). It is on the bottom printed circuit board, on the bottom center of the board.
4. **NOTE: This step may not be necessary due to current jumper state.** Remove the jumper from the 1-2 position and reinsert it in the 2-3 position.
5. **Locate Jumper 24 (JMP 24) and move to 2-**3 position to allow programming of boot loader (only required for boot loader updates not ATP application/executive).
6. Reinsert the ATP CPU board into the rack and tighten the screws.
7. Connect the DB9 female to male null modem cable from the computer to the front panel of the ATP CPU. **Note: Use of a USB to serial converter might be necessary**.
8. Run the 332 Flash programmer.
9. Set the board type to N170013XX DINO full sized 332 from Board Part # selection.
10. Press the Open SREC File to Download button. (*Hover over buttons for help descriptions*)
11. Select the ATP Boot software path and file that you wish to load.
12. To configure the 332 flash programmer to use the identified COMM port select “COMM Port Properties” button. The identified COMM port is the port allocated to either the male/female null modem serial cable with DB-9 connector or USB to serial converter. This can be confirmed using the Device Manager function of Windows.
13. Select the correct COMM port from the drop down menu as shown below and press the “OK” button.

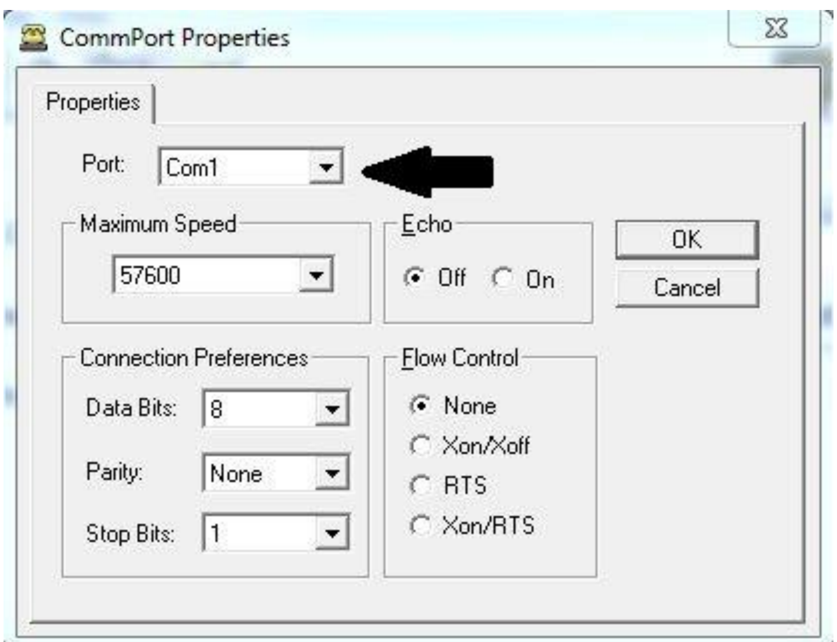

Figure 2: MicroCab 332 Flash Programmer CommPort Properties

14. Select the “Advanced Load / Erase Options” button (*Hover over buttons for help descriptions*) and

configure the menu to the options shown below:

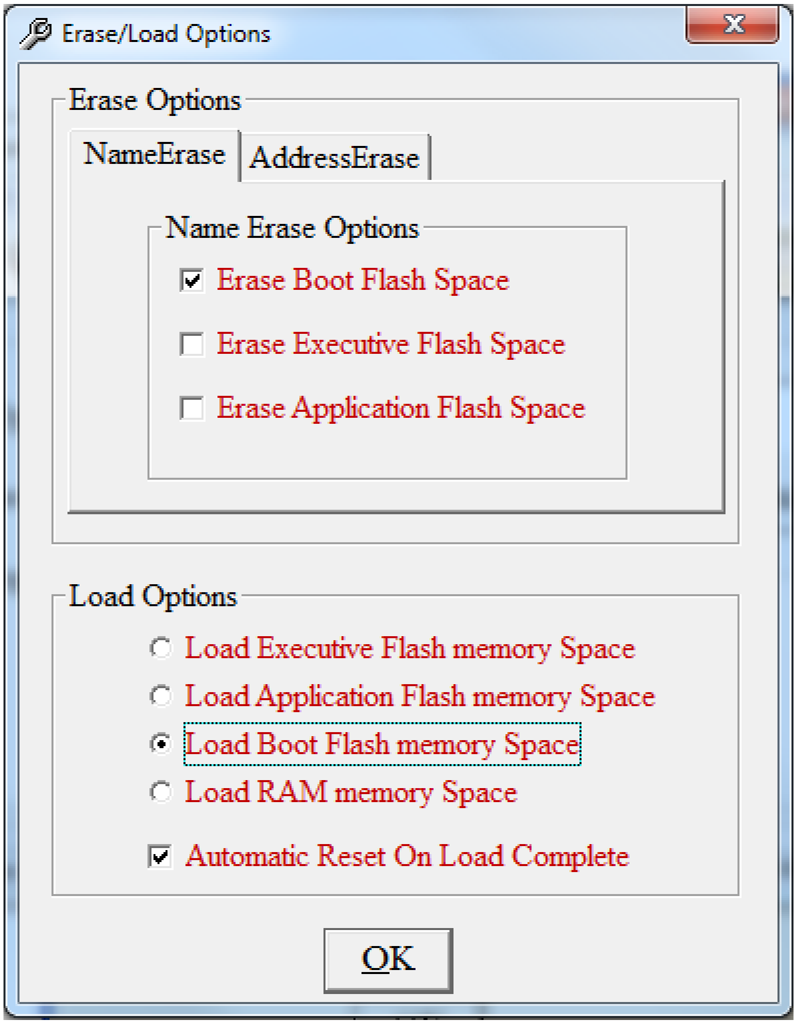

Figure 3: MicroCab 332 Flash Programmer Load Screen

15. Press the "Load Open SREC" button. (*Hover over buttons for help descriptions*)
16. Turn on the ATC enclosure.
17. Follow the directions that the 332 flash programmer produces.
18. Once loading begins, do not use computer for other uses.
19. After the loading is complete, disconnect the serial connection and close all windows.
20. Turn off the ATC enclosure.
21. Unscrew and remove the board labeled ATP CPU.
22. Locate Jumper 30 (JMP 30). It is on the bottom printed circuit board, on the bottom center of the board.
23. Remove the jumper from the 2-3 position and reinsert it in the 1-2 position.
24. Locate Jumper 24 (JMP 24) and move to 1-2 position to prevent boot loader updates.
25. Reinsert the ATP CPU board into the rack and tighten the screws.

2.2 ATP APPLICATION SOFTWARE

The following instructions pertain to ATP sub-system utilizing a Flash EEPROM device to store application software.

2.2.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

A computer with Windows 7/XP/2000 installed.

A male/female null modem serial cable with DB-9 connector.

OPTIONAL: A USB to serial converter if computer has no built in serial port

Hitachi Rail STS USA MicroCab 332 Flash Programmer software part number N4512322517.

ATP software that needs to be loaded (which will be named flash.abs). Part Number P43N.0100371_00

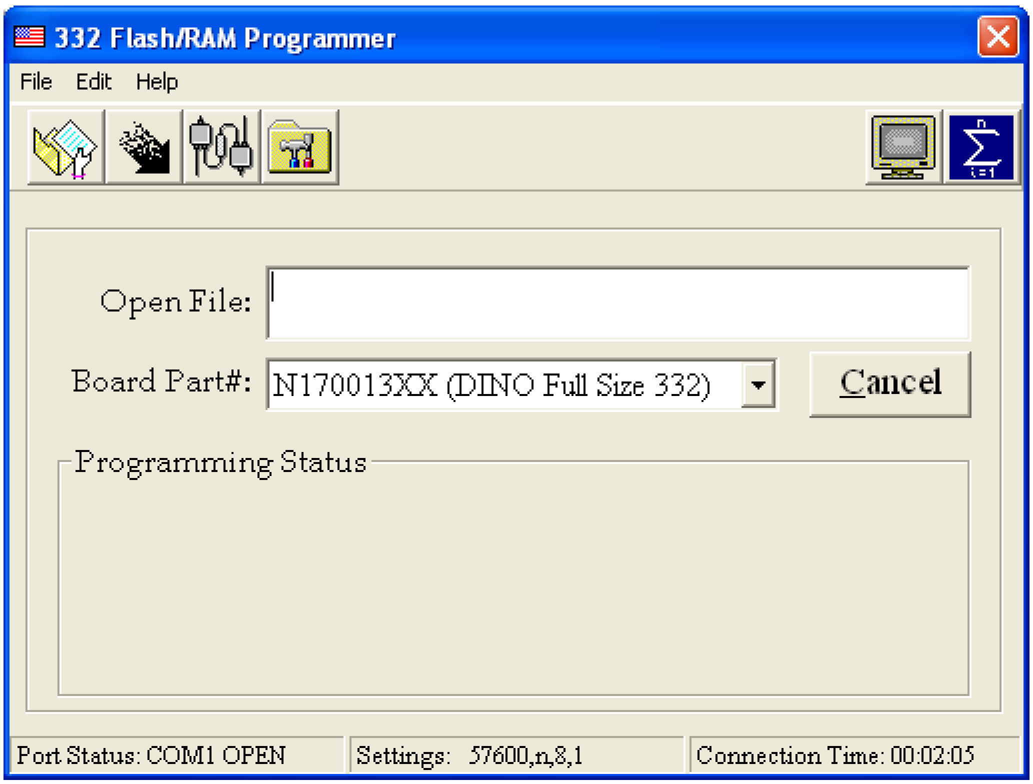

Figure 4: MicroCab 332 Flash Programmer

2.2.2 SETUP

If updating software to a subsystem, boot the computer and start the MicroCab 332 Flash Programmer software. Connect the serial cable to the computer and the ATP sub-system to be re-programmed. The MicroCab 332 Flash Programmer has a help file integrated in it; a copy of the help file is located in Appendix A.

2.2.3 INSTRUCTIONS

1. Follow the instructions 1-10 in section 2.1.3
2. Select the ATP software path and file that you wish to load.
3. Select the “Advanced Load / Erase Options” button and configure the menu to the options shown below:

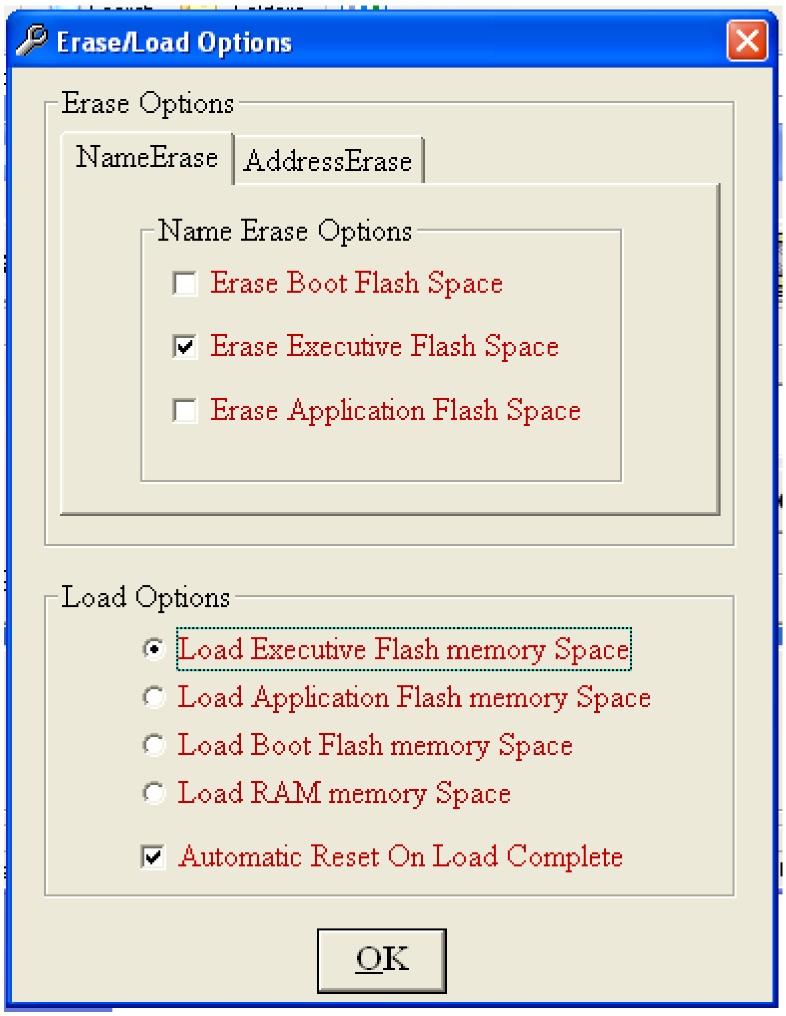

Figure 5: MicroCab 332 Flash Programmer Load Screen

4. To configure the 332 flash programmer to use the identified COMM port select “COMM Port Properties” button. The identified COMM port is the port allocated to either the male/female null modem serial cable with DB-9 connector or USB to serial converter. This can be confirmed using the Device Manager function

of Windows.

5. Select the correct COMM port from the drop down menu as shown below and press the “OK” button.

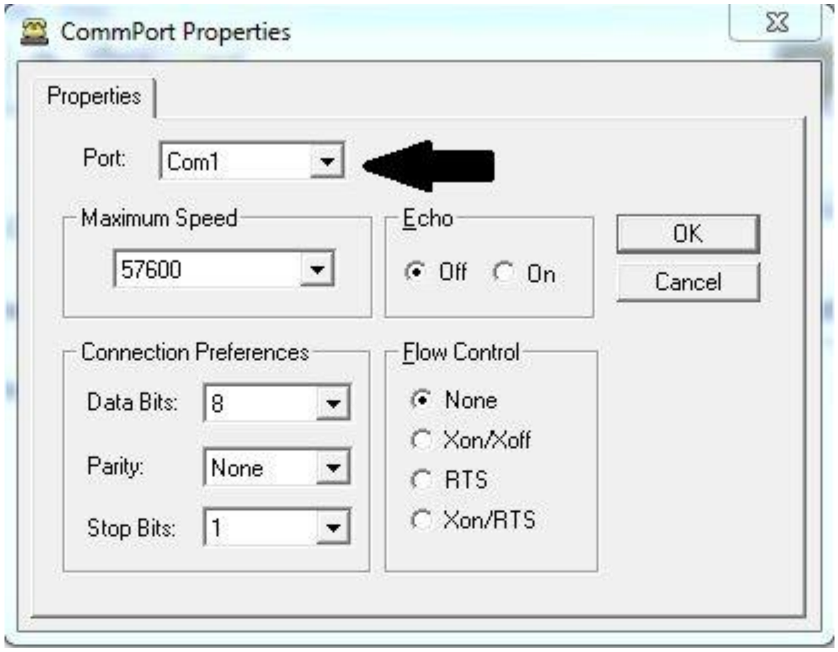

Figure 6: MicroCab 332 Flash Programmer CommPort Properties

6. Follow the instructions 15 in section 2.1.3

When Loading the ATP Application/Executive wait until LEDs 1-4 on ATP CPU are lit solid before cycling power to allow completion of transfer to flash.

LED 4 will blink during the S-record transfer process via. PTU / 332 utility and stay on solid when step is complete.
LED 3 will be ON during the flash erase process.
LED 2 will blink during the during the EXEC Copy
LED 1 will be ON along with the LED2, LED 3 and LED 4, indicating the ATP SW upload is completed.

2.3 CSRD APPLICATION SOFTWARE

The following instructions pertain to how to load the CSRD application software.

2.3.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

- A computer with Windows 7/XP/2000 installed.
- An Ethernet cable.
- Hitachi Rail STS USA CSRD Boot loader version P1.02 software part number P43N.0100711.
- CSRD files:
  FPGA

CSRD_FPGA.flash
Download.bit
Boot
CSRD_Altera_Boot.flashCSRD_Xilinx_Boot.srecCSRD_Xilinx_BRAM_Bootloader.bin Application
CSRD_Altera_Build .flash
CSRD_Altera_Build_CRC_Table .srec
CSRD_Xilinx_App .srec
CSRD_Xilinx_App_CRC_Table .srec

- **OPTIONAL: The csrd_ip ip configuration script (see CSRD Software Loader Batch File Example)**

2.3.2 SETUP

If updating software to a subsystem, boot the computer to be used to load software

2.3.3 INSTRUCTIONS

2.3.3.1 *Configuring the computer*

1. If the csrd_ip ip config script is available then run that script as administrator and skip to step 8. If the script is not available then follow step 2 through 7.
2. Select Start -> Control Panel -> Network Connections.
3. Select the properties of the Local Area Connection icon.
4. Select Internet Protocol (TCP/IP) and select the Properties button.
5. In the Internet Protocol (TCP/IP) Properties window, select the “Use the following IP address:” radio button.
6. Enter the IP address, Subnet mask and Default gateway as shown below.

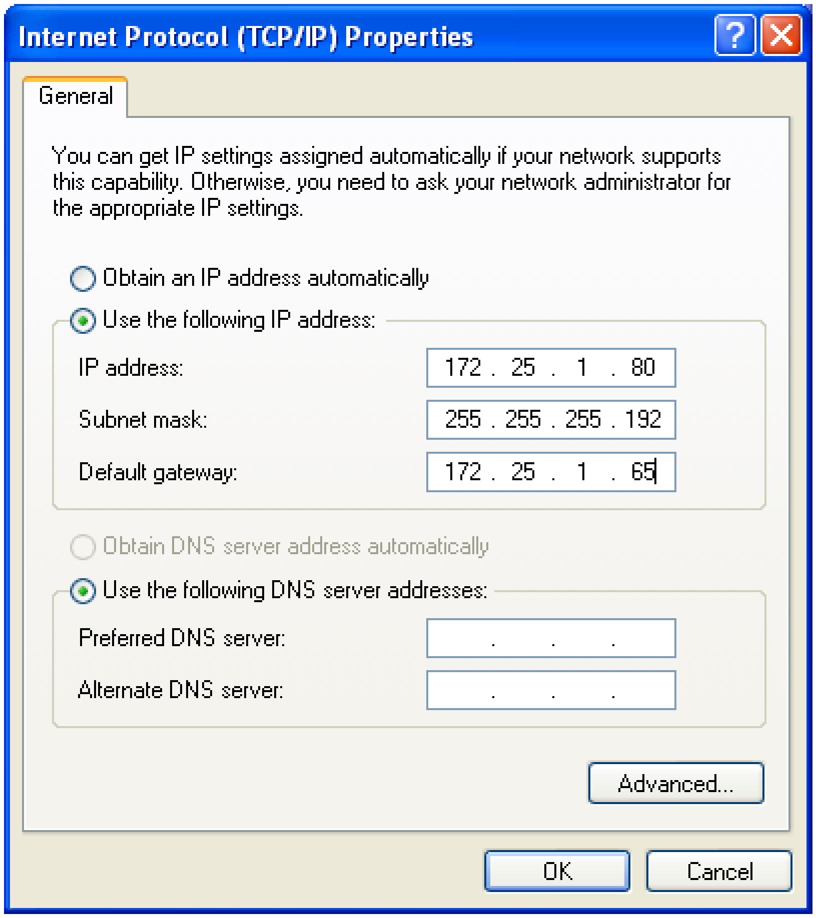

Figure 7: Internet Protocol Properties Window

7. Select “OK” button to exit and apply changes.

2.3.3.2 ***Setting Up the CSRD board***

8. Turn OFF the ATC enclosure.
9. Unscrew and remove the board labeled Cab Signal Receiver/Demodulator.
10. Locate SW4 on the Cab Signal Receiver/Demodulator (CSRD) board. SW4 is located on the Altera side or lower portion of the board.
11. Put switch #1 (Disable Watchdog) on SW4 in the On position (switch #1 up).
12. Put switch #2 (Enable Bootloader) on SW4 in the Off position (switch #2 down).
13. Put switch #3 (Debug Enabled) on SW4 in the Off position (switch #3 down).
14. Locate SW1 on the CSRD board. SW1 is located on the Xilinx side or upper portion of the board.
15. Put switch #1 (Disable Watchdog) on SW1 in the On position (switch #1 up).
16. Put switch #2 (Enable Bootloader) on SW1 in the Off position (switch #2 down).
17. Put switch #3 (Debug Enabled) on SW1 in the Off position (switch #3 down).
18. Reinsert the CSRD board into the rack.
19. Turn ON the ATC enclosure.

20. Verify that the boot program started by LEDs 1-3 being solid RED on both portions of the CSRD board.

2.3.3.3 *Loading the CSRD Boot file*

Skip to step 33) if boot software loading is not needed

21. Connect an Ethernet cable from the LAN port on the computer to the bottom port labeled ETHERNET on the CSRD board.
22. Open CSRD Boot loader program.
23. Type **CTRL+SHIFT+b** to enable the BOOT function

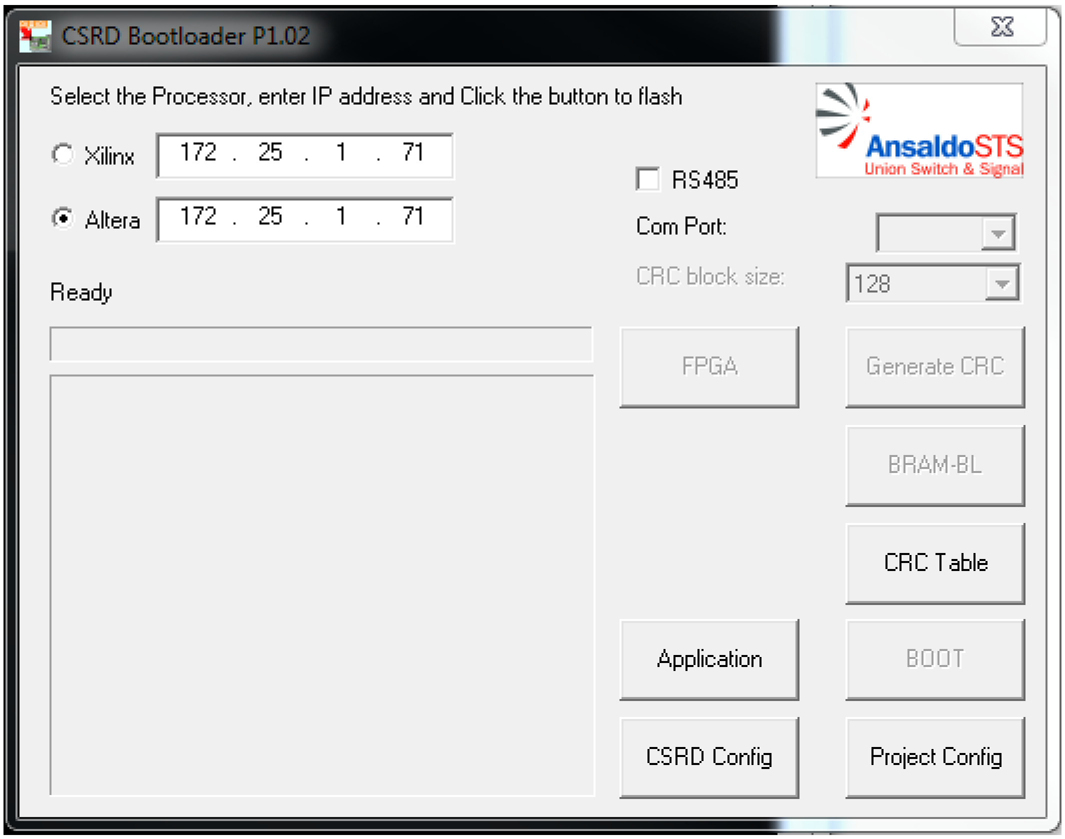

Figure 8: CSRD Bootloader

24. On the CSRD bootloader, select the Altera radio button.
25. Press the BOOT button, and select the CSRD_Altera_Boot .flash file.

26. When loading is complete, connect an Ethernet cable from the LAN port on the computer to the top port labeled ETHERNET on the CSRD board.
27. On the CSRD bootloader, select the Xilinx radio button.
28. Press the BOOT button, and select the CSRD_Xilinx_Boot .srec file.
29. Press the BRAM-BL button, and select the CSRD_Xilinx_BRAM_Bootloader .bin file.

30. When loading is complete, close the CSRD bootloader by pressing the Cancel (X on right top corner of window) button.
31. Turn OFF the ATC enclosure.
32. Turn ON the ATC enclosure.

2.3.3.4 *Loading the CSRD PHW*

Skip to step 44) if FPGA loading is not needed

33. Connect an Ethernet cable from the LAN port on the computer to the bottom port labeled ETHERNET on the CSRD board.
34. Open CSRD Boot loader program.
35. Type **CTRL+SHIFT+b** to enable the FPGA function

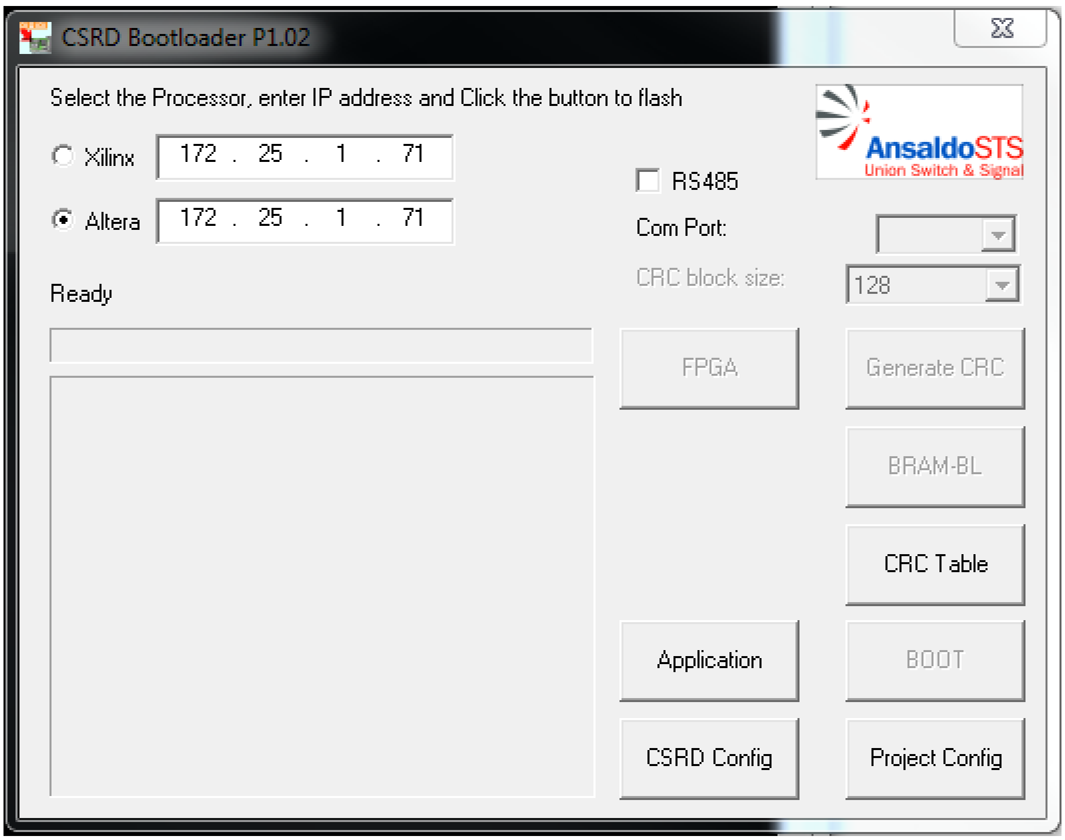

Figure 9: CSRD Bootloader

36. On the CSRD bootloader, select the Altera radio button.
37. Press the FPGA button, and select the CSRD_FPGA.flash file.

38. When loading is complete, connect an Ethernet cable from the LAN port on the computer to the top port labeled ETHERNET on the CSRD board.
39. On the CSRD bootloader, select the Xilinx radio button.
40. Press the FPGA button, and select the Download.bit file.
41. When loading is complete, close the CSRD bootloader by pressing the Cancel (X on right top corner of window) button.

42. Turn OFF the ATC enclosure.
43. Turn ON the ATC enclosure.

2.3.3.5 *Loading the CSRD Application file*

44. Connect an Ethernet cable from the LAN port on the computer to the bottom port labeled ETHERNET on the CSRD board.
45. Open CSRD Boot loader program.

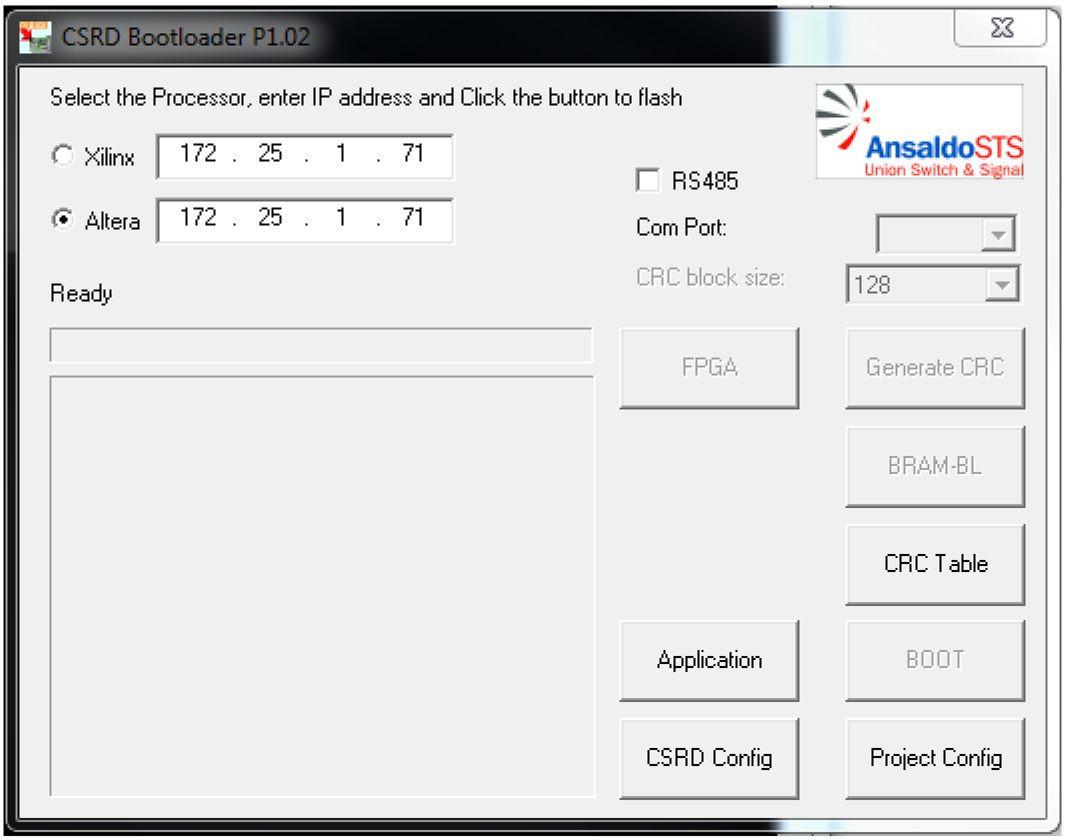

Figure 10: CSRD Bootloader

46. On the CSRD bootloader, select the Altera radio button.
47. Press the Application button, and select the CSRD_Altera_Build .flash file.
48. Press the CRC Table button, and select the CSRD_Altera_Build_CRC Table .srec file.
49. When loading is complete, connect an Ethernet cable from the LAN port on the computer to the top port labeled ETHERNET on the CSRD board.
50. On the CSRD bootloader, select the Xilinx radio button.
51. Press the Application button, and select the CSRD_Xilinx_App .srec file.
52. Press the CRC Table button, and select the CSRD_Xilinx_App_CRC Table .srec file.
53. When loading is complete, close the CSRD bootloader by pressing the Cancel button.
54. Turn OFF the ATC enclosure.
55. Unscrew and remove the board labeled Cab Signal Receiver/Demodulator.

56. Locate SW4 on the Cab Signal Receiver/Demodulator (CSRD) board. SW4 is located on the Altera side or lower portion of the board.
57. Put switch #1 (Enable Watchdog) on SW4 in the Off position (switch #1 down).
58. Put switch #2 (Disable Bootloader) on SW4 in the On position (switch #2 up).
59. Leave switch #3 (Debug Enabled) on SW4 in the Off position (switch #3 down).
60. Locate SW1 on the CSRD board. SW1 is located on the Xilinx side or upper portion of the board.
61. Put switch #1 (Enable Watchdog) on SW1 in the Off position (switch #1 down).
62. Put switch #2 (Disable Bootloader) on SW1 in the On position (switch #2 up).
63. Leave switch #3 (Debug Enabled) on SW1 in the Off position (switch #3 down).
64. Reinsert the CSRD board into the rack and tighten the screws.
65. Turn ON the ATC enclosure.

2.4 CSRD SYSTEM AND PROJECT CONFIGURATION SOFTWARE

The following instructions pertain to how to load the CSRD system and project configuration files.

2.4.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

- A computer with Windows 7/XP/2000 installed.
- An Ethernet cable.
- Hitachi Rail STS USA CSRD Boot loader software part number P43N.0100711.
- CSRD System and Project Configuration files that need to be loaded (which will be named LA_P3010_CSRD_Configuration_XXX.srec and LA_P3010_CSRD_Project_Config_XXX.srec
- **OPTIONAL: The csrd_ip ip configuration script**

2.4.2 SETUP

If updating software to a subsystem, boot the computer to be used to load software

2.4.3 INSTRUCTIONS

2.4.3.1 *Configuring the computer*

1. If the csrd_ip ip config script is available then run that script as administrator and skip to step 8. If the script is not available then follow step 2 through 7.
2. Select Start -> Control Panel -> Network Connections.
3. Select the properties of the Local Area Connection icon.
4. Select Internet Protocol (TCP/IP) and select the Properties button.
5. In the Internet Protocol (TCP/IP) Properties window, select the “Use the following IP address:” radio button.
6. Enter the IP address, Subnet mask and Default gateway as shown below.

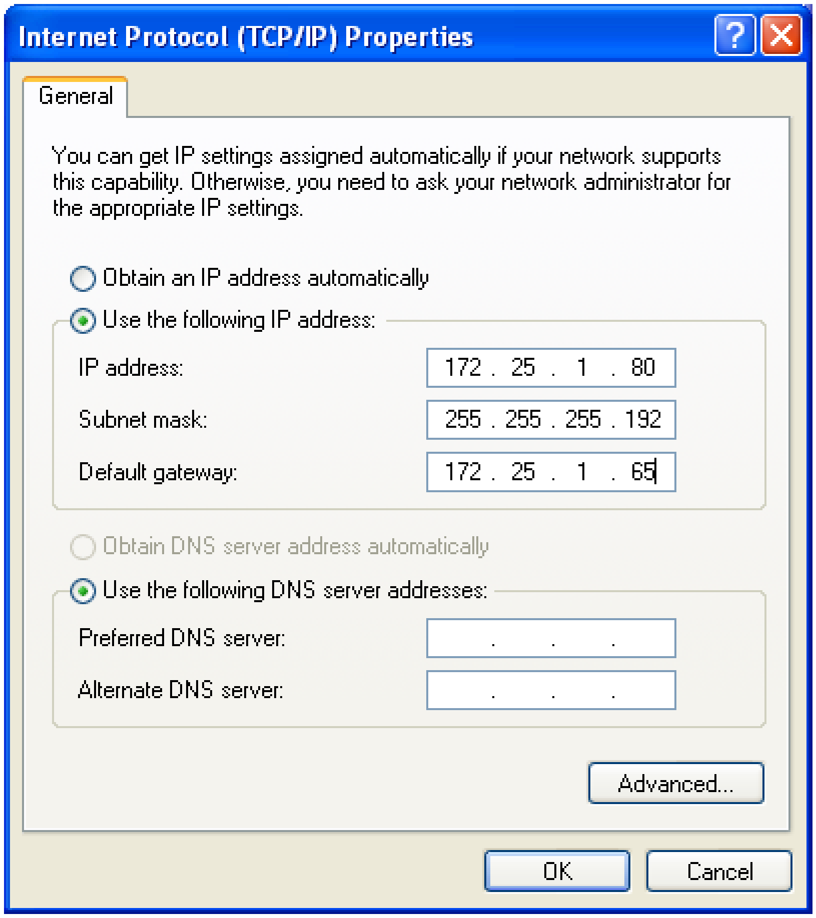

Figure 11: Internet Protocol Properties Window

7. Select “OK” button to exit and apply changes.

2.4.3.2 *Setting Up the CSRD board*

8. Turn OFF the ATC enclosure.
9. Unscrew and remove the board labeled Cab Signal Receiver/Demodulator.
10. Locate SW4 on the Cab Signal Receiver/Demodulator (CSRD) board. SW4 is located on the Altera side or lower portion of the board.
11. Put switch #1 (Disable Watchdog) on SW4 in the On position (switch #1 up).
12. Put switch #2 (Enable Bootloader) on SW4 in the Off position (switch #2 down).
13. Put switch #3 (Debug Enabled) on SW4 in the Off position (switch #3 down).
14. Locate SW1 on the CSRD board. SW1 is located on the Xilinx side or upper portion of the board.
15. Put switch #1 (Disable Watchdog) on SW1 in the On position (switch #1 up).
16. Put switch #2 (Enable Bootloader) on SW1 in the Off position (switch #2 down).
17. Put switch #3 (Debug Enabled) on SW1 in the Off position (switch #3 down).
18. Reinsert the CSRD board into the rack and tighten the screws.
19. Turn ON the ATC enclosure.

20. Verify that the boot program started LEDs 1-3 being solid RED on both portions of the CSRD board.

2.4.3.3 *Loading the CSRD System and Project configuration file:*

21. Connect an Ethernet cable from the LAN port on the computer to the bottom port labeled ETHERNET on the CSRD board.
22. Open CSRD Boot loader program.

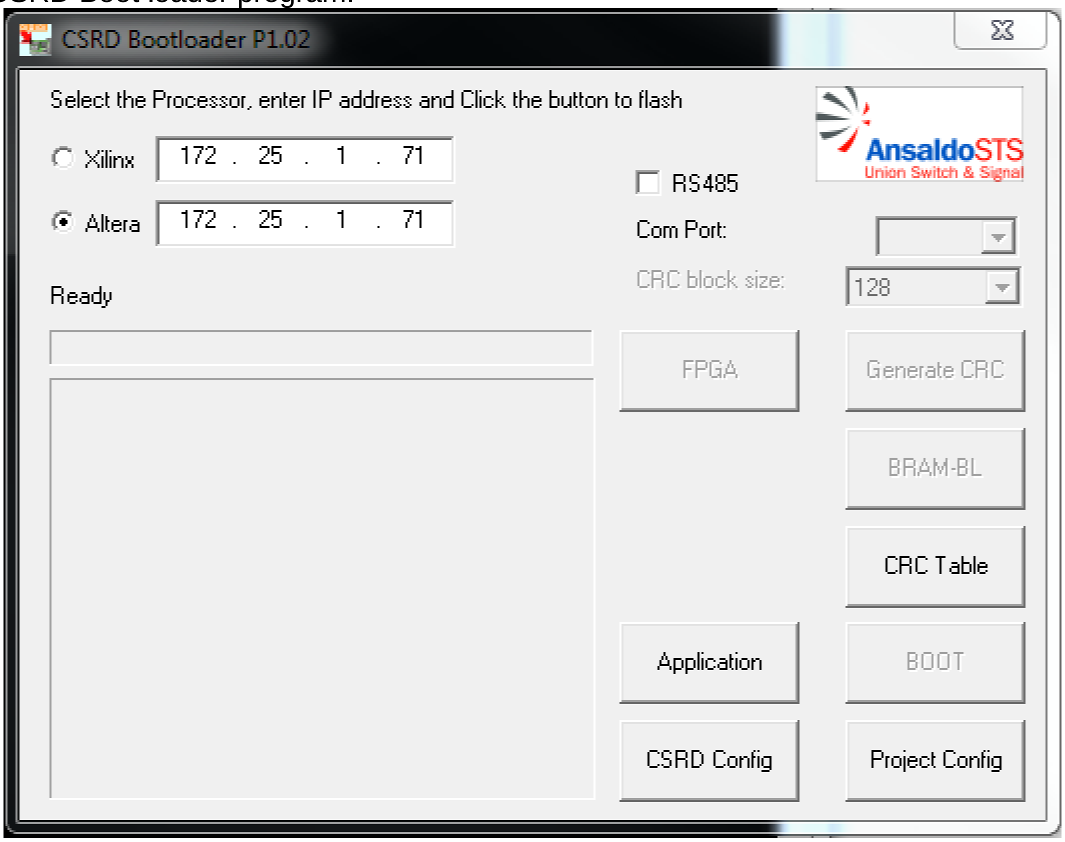

Figure 12: CSRD Bootloader

23. On the CSRD bootloader, select the Altera radio button.
24. Press the Project Config button for loading Project configuration and/or CSRD Config button for loading System Configuration, and select appropriate configuration file.
25. When loading is complete, connect an Ethernet cable from the LAN port on the computer to the top port labeled ETHERNET on the CSRD board.
26. On the CSRD bootloader, select the Xilinx radio button.
27. Press the Project Config button for loading Project configuration and/or CSRD Config button for loading System Configuration, and select appropriate configuration file.
28. When loading is complete, close the CSRD bootloader by pressing the Cancel button.
29. Turn OFF the ATC enclosure.
30. Unscrew and remove the board labeled Cab Signal Receiver/Demodulator.
31. Locate SW4 on the Cab Signal Receiver/Demodulator (CSRD) board. SW4 is located on the Altera side or lower portion of the board.
32. Put switch #1 (Enable Watchdog) on SW4 in the Off position (switch #1 down).

33. Put switch #2 (Disable Bootloader) on SW4 in the On position (switch #2 up).
34. Leave switch #3 (Debug Enabled) on SW4 in the Off position (switch #3 down).
35. Locate SW1 on the CSRD board. SW1 is located on the Xilinx side or upper portion of the board.
36. Put switch #1 (Enable Watchdog) on SW1 in the Off position (switch #1 down).
37. Put switch #2 (Disable Bootloader) on SW1 in the On position (switch #2 up).
38. Leave switch #3 (Debug Enabled) on SW1 in the Off position (switch #3 down).
39. Reinsert the CSRD board into the rack and tighten the screws.
40. Turn ON the ATC enclosure.

2.5 CCB APPLICATION AND CONFIGURATION SOFTWARE

The following instructions pertain to how to load the CCB application software.

2.5.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

- A computer with Windows 7/XP/2000 installed.
- An Ethernet cable.
- Internet Explorer, Google Chrome, Mozilla Firefox.
- CCB Application Software that needs to be loaded (which will be named ccb.tar).
- **OPTIONAL: The ccb_ip ip configuration script (see ccb_ip ip Configuration script Example)**

2.5.2 SETUP

If updating software to a subsystem, boot the computer to be used to load software.

NOTE: This method is only for upgrading a working board that has some previous version of the CCB software loaded. It cannot be used for programming a blank or corrupted board. If board fails to program please contact HSTS support.

2.5.3 INSTRUCTIONS

2.5.3.1 *Downloading Event Log and Snapshot Files*

The event log and snapshot files that are stored on the CCB should be downloaded and saved with the PTU prior to performing a CCB software update. After loading the updated CCB software, the event log and snapshots will be cleared.

1. Connect the PTU laptop to the ATC system and launch the PTU application.
2. Once connected, click on the “Log” button from the menu bar.
3. The event log will automatically be loaded from the CCB. Once the Event Log is displayed on the screen, save the event log. This can be done in two different ways.

a. Click the “Save All” button. This operation will download the event log and will download all of the snapshot files from the CCB. NOTE: if there are many snapshots in the event log, this operation could take a long time.
b. Click the “Save Selected” button. This operation will only download the snapshots associated with events that are selected in the Event Log List view. Multiple events can be selected by pressing CTRL while clicking the events. If no events are selected, this operation will only download the event log and will not download any snapshot files.

2.5.3.2 *Configuring the computer*

1. Run as administrator the ccb_ip ip configuration script. If not available then go to step 2. If able to run script then go to step 3.
2. Configure the IP Address of the computer to be in the same subnet as the CCB Board. (For example, use an IP Address 169.254.2.21 & netmask of 255.255.255.0 if the CCB IP Address is 169.254.2.20 & netmask is 255.255.255.0).
3. Run the Ethernet cable from the computer to the Ethernet Connector on the front-panel of the CCB.
4. Power the rack that contains the CCB Board to be upgraded. Wait for about 90 seconds.
5. Open the browser and type in the IP address of the CCB Board in the "Address Bar". Hit the Enter" key.
   a. Note: (The default IP Address for the front panel Ethernet port of the CCB is either 169.254.2.10 or 169.254.2.20, but may have been changed. You can confirm the IP address by running the “ping” command).
6. In the page that is loaded in the browser, click on the “Setup” button at the top right corner.
7. A login window appears - use the password “USS” (without the quotes) to login.
8. In the page that is loaded in the browser, click on the “Upload” button.

2.5.3.3 *Loading the CCB Application Software*

1. A page is loaded in the browser. In the field that says “Please select an Upload Type:” select “System Executive (TAR file)".
2. In the same page, press the “Browse button to select the CCB software path and file to load.
3. In the same page, press the “Upload” button that appears below the “Browse” button.
4. Wait for the upload to complete – A progress bar is displayed which indicates the progress of the operation. When the operation completes, a message is displayed indicating that the upload was successful. This usually takes about 5 minutes.
5. Power down and power up the rack.

2.5.3.4 *Loading the CCB Configuration File*

1. A page is loaded in the browser. In the field that says “Please select an Upload Type:”, select “Configuration File (TAR File)”
2. In the same page, press the “Browse button to select the CCB software path and file to load.
3. In the same page, press the “Upload” button that appears below the “Browse” button.
4. Wait for the upload to complete – A progress bar is displayed which indicates the progress of the operation. When the operation completes, a message is displayed indicating that the upload was successful. This usually takes about 5 minutes.

5. The exit setup mode.
6. A window will appear asking to accept changes.
7. Power down and power up the rack.

2.5.3.5 *Clearing the Event Log and Snapshot Files*

1. After completing the software update on the CCB, connect the PTU laptop to the ATC rack.
2. Launch the PTU application that is associated with the version of the CCB software that was installed in the previous steps.
3. Once connected, click on the “Log” button from the PTU’s menu bar. Upon launching, the event log will be loaded automatically and will be displayed on the screen.
4. Once the event log is displayed, click on the “Erase” button.
   Note: The erase button is only available for PTU users with administrator privileges. In order to access the button, log into the PTU as an administrator.
5. On the resulting screen, click the “Erase Logs” button. Wait until the LED icon next to “Erase Complete” is green.

2.6 ATO SPO BOARD SOFTWARE

The following instructions pertain to how to load the ATO application and FPGA software.

2.6.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

- A computer with Windows 7/XP/2000 installed.
- USB Blaster programmer (as available from Altera or Terasic or distributors)
- ATO Flash Utility File (_Flash_ATO batch file) (see ATO Flash Utility File Example)

2.6.2 SETUP

If updating software to a subsystem, boot the computer to be used to load software.

Install device driver for USB Blaster if necessary.

2.6.3 INSTRUCTIONS

2.6.3.1 *Setting up the ATO SPO Board*

1. Power down the ATO SPO board.
2. Connect the USB Blaster to the JTAG located on the ATO SPO board as shown below. Ensure that Pin 1 of the JTAG is connected to Pin 1 of the USB Blaster.

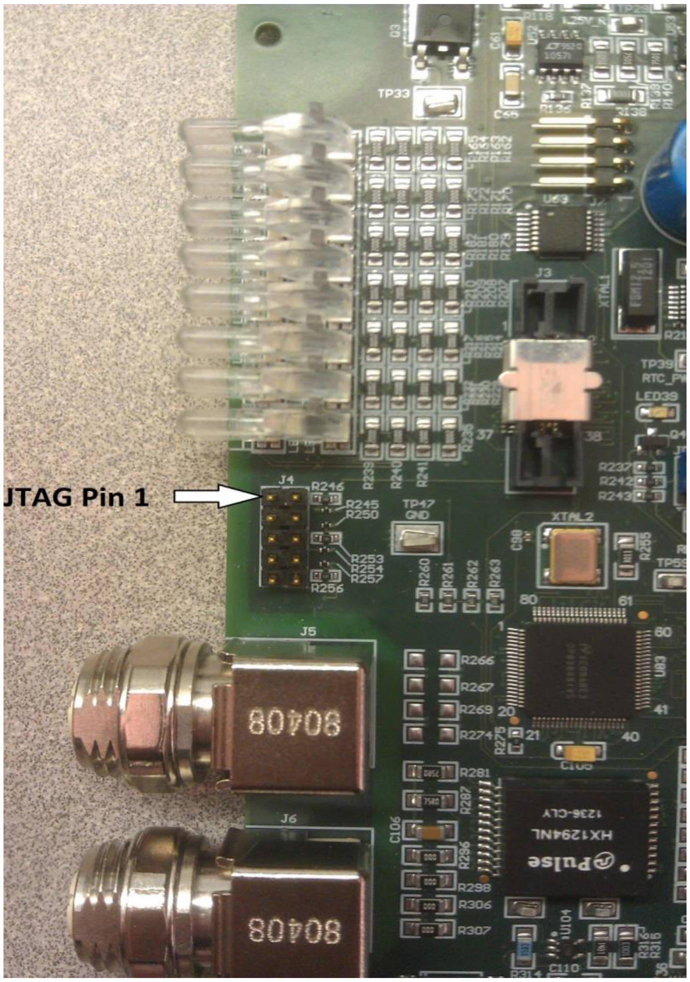

Figure 13: SPO JTAG Pin 1

3. Ensure that jumper 1 on SW2 (shown below) is in the “ON” position.

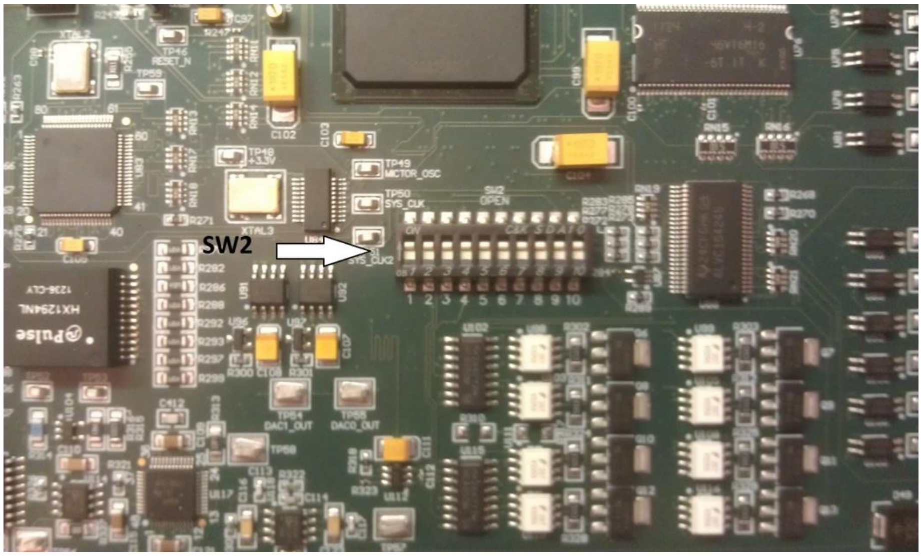

Figure 14: SPO SW2

4. Ensure that jumper 15 (JP15) on ISS-B board or jumper 19 (JP19) on ISS-A board is in the 2-3 position as shown below:

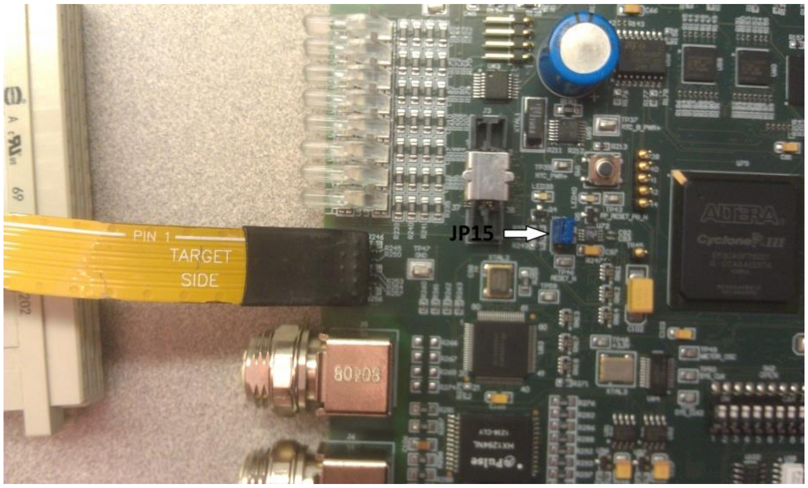

Figure 15: SPO – JP15

NOTE: JP19 or JP15 is to stay in this position. Putting the jumper in position 1-2 will put the board in continual reset.

5. Power up the SPO board.

2.6.3.2 *Loading the SPO FPGA, Bootloader and Application Software*

6. Run the _Flash_ATO batch file.
7. Press enter when application to be loaded is shown at the prompt.

8. When loading is complete, remove power to the SPO board.
9. Ensure that jumper 1 on SW2 is in the “OFF” position.
10. Apply power to the SPO board

2.7 ADU SOFTWARE

The following instructions pertain to how to load the ADU software

2.7.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

- A computer with Windows 7/XP/2000 installed.
- USB Cable compatible with USB drive.
- ADU executable (ADU file)

2.7.2 SETUP

Plug in USB cable for USB drive into ADU. Part number P20I.0100021.
Power on the ADU

2.7.3 INSTRUCTIONS

- Insert USB drive. The existing application will be killed
- A beep is asserted prior to software is being loaded
- Application Software will be updated automatically
- A beep will be asserted when finished update and the ADU screen will display that system is halted..
- Remove the USB Drive and Cable, and then cycle the power of ADU to start the updated application.

2.8 MULTIFUNCTION BOARD SOFTWARE

The following instructions pertain to how to load the Multifunction Board software

2.8.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

- A computer with Windows 7/XP/2000 installed.
- USB Blaster
- 10.1_programmer_windows

2.8.2 SETUP

If updating software to a subsystem, boot the computer to be used to load software.

Install device driver for USB Blaster if necessary.

2.8.3 INSTRUCTIONS

2.8.3.1 *Setting up the Multifunction Board*

1. Power down the Multifunction board.
2. Connect the USB Blaster to the JTAG located on the Multifunction board as shown below. Ensure that Pin 1 of the JTAG is connected to Pin 1 of the USB Blaster.

Figure 16: Multifunction JTAG pin 1

3. Power up the Multifunction Board.

2.8.3.2 *Loading the Multifunction Board Software*

4. Run application quartus_pgmw.
5. On the top left side of the Quartus II Programmer click Hardware setup.
6. Click on USB-Blaster and then close to set the USB-Blaster as your Hardware.
7. On the left hand side of the Quartus II Programmer click “Add File”, and then navigate to the file directory location containing the Multifunction board software file. This file will be named PTM.pof click open.

NOTE: do not click on “Auto Detect”

8. After you have opened your PTM.pof file a device with option boxes will appear in the upper dialog box. Check all Program/Configure boxes and all Verify boxes.
9. Click the start tab and wait until the top right progress bar states that %100 of the software is uploaded.

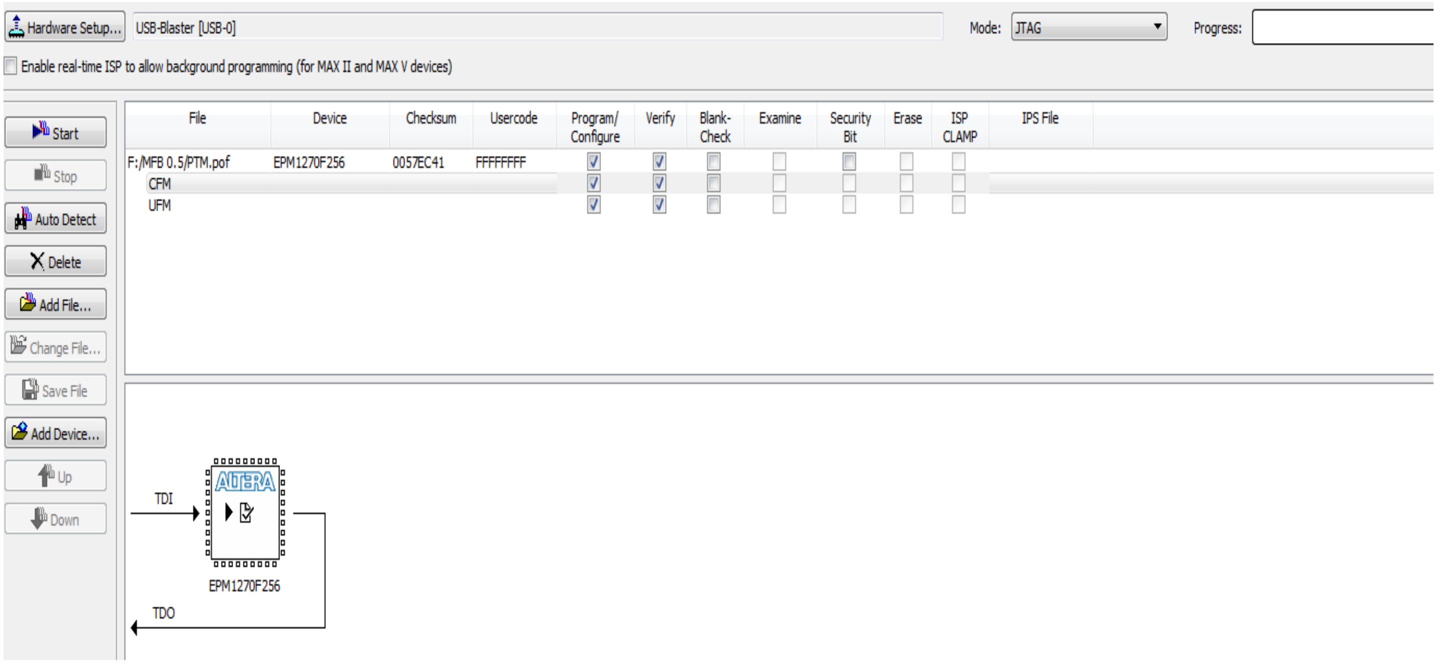

Figure 17: Quartus II Programmer

10. Turn power off to the board and remove the USB Blaster.

2.9 TYPE II TWC MODEM BOARD SOFTWARE

The following instructions pertain to how to load the TWC Modem Board software

2.9.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

- A computer with Windows 7/XP/2000 installed.
- PE Micro Multilink Universal FX Debugger and Install CD

2.9.2 SETUP

If updating software to a subsystem, boot the computer to be used to load software.

2.9.3 INSTRUCTIONS

2.9.3.1 *Programming the TWC Modem Board*

1. Make sure all necessary drivers are installed for the PE Micro Multilink Universal FX debugger. The Drivers can be installed by running multilink_universal_install.exe found on the CD.
2. Install the prog12z program, version 2.00.00.01 or later and follow the on screen activation instructions.
3. Plug the Multilink Universal FX into a USB cable and connect to a computer.
4. Plug the 6 pin ribbon cable to the debug pins located on the TWC modem board. Make sure the Red wire on the ribbon cable is on the left hand side
5. Connect a jumper from TP9 to TP4.
6. Start the PROG12Z - Flash Programmer application. This can be located by going to Start - All Programs - PEMicro - P&E HCS12 Flash Programmer - PROG12Z - Flash Programmer
7. The PEMICRO Connection Manager should pop up on the Screen. Verify that the interface says USB Multilink, USB Multilink FX
   a) Verify the Port is USB1 : Multilink Universal FX Rev A (PE5750507)
   b) If the port does not say USB1, verify the programmer is connected to the computer and the blue LED is on.
   c) If the port still does not say USB1, click the Refresh List button at the top of the Connection Manager.
   d) Verify the Target CPU is "MC12/MCS12 - Autodetect Device Type"
   e) In the BDM Communications Speed Section, set "Use IO_DELAY_CNT = 10"
   f) MCU Internal Bus Frequency (for programming) should be set to Auto-Detect
   g) Reset Options. Delay after Reset and Before communicating to target for 0 ms should NOT be selected.
   h) Power Control for Cyclone / Multilink Universal FX should have Provide Power to Target selected only
   i) Power Down Delay should be 250 mS and Power Up Delay should be 1000 mS
8. Click “Connect (Reset)” at the bottom of the Connection Manager

9. Specify Programming Algorithm to Use should pop up. - Select 912B32_32K.12P and Click Open (if the specific file cannot be found, it can be located in the release folder containing the new software)
10. The Base address should pop on the screen - Type 8000 for the Base Address and Click Ok
11. Under the Choose Programming Functions on the Left hand side of the program double click "SS Specify Object File"
12. The Specify Object File to Load box will pop on the screen. Navigate to the ABS file that is going to be loaded then click open.
13. Under the Choose Programming Functions, double click "EM Erase Module". Verify in the status Window that "Erasing. Module has been erased." has been written.
14. Under the Choose Programming Functions, double click "PM Program Module". Verify the Programming Address $00FFFE. Programmed. has been written.
15. Under the Choose Programming Functions, double click "VM Verify Module (All Bytes)". Verify the Verifying Address $00FFFF. Verified. has been Written in the status Window.
16. Under the choose Programming function, double click “SC Show Module CRC”. The Device CRC is displayed on the right hand side under Configuration window (It is also displayed in the Status Window).
17. Disconnect the BDM from the TWC Modem Board.
18. Remove the Jumper from TP4 and TP9
19. Cycle Power on the TWC Modem Board.

2.9.3.2 *Configuring the TWC Modem Board*

When programming the TWC Modem you also need to configure the following for proper TWC operation on LACMTA Green Line:

1. Set the Jumpers on the TWC Modem such that JP2 and JP7 are connected.
2. Set DIP switch SW2-3 on the TWC Modem to the Open position.
3. Set DIP switch SW2-4 on the TWC Modem to the Closed position.
4. Using the switches on the front panel of the TWC Modem, set the Tx Level to 4 LEDs.

2.10 TYPE I H&K TWC CCU FIRMWARE

The following instructions pertain to how to load the H&K TWC firmware

2.10.1 EQUIPMENT

The equipment necessary to complete this operation is as follows:

- Null modem serial cable or Null Adapter
- USB to RS232 adapter
- 24VDC Power Supply @ 1A
- DB-15 Power Supply adapter
- Piece of jumper wire (or paper clip)
- Turbo Flasher software

2.10.2 FIRST TIME SETUP

Execute "_englishTurboFlasher.cmd" as Admin user, and setupTurboFlasher.exe as admin user. Wait for the software to install.

2.10.3 INSTRUCTIONS

1. Power OFF the CCU by disconnecting the X1 Power cable from the CCU.
2. Disconnect the X2 Transponder cable from the CCU.
3. Install a jumper between pins 14 and 15 of the X2 Transponder 15 pin connector on the CCU.

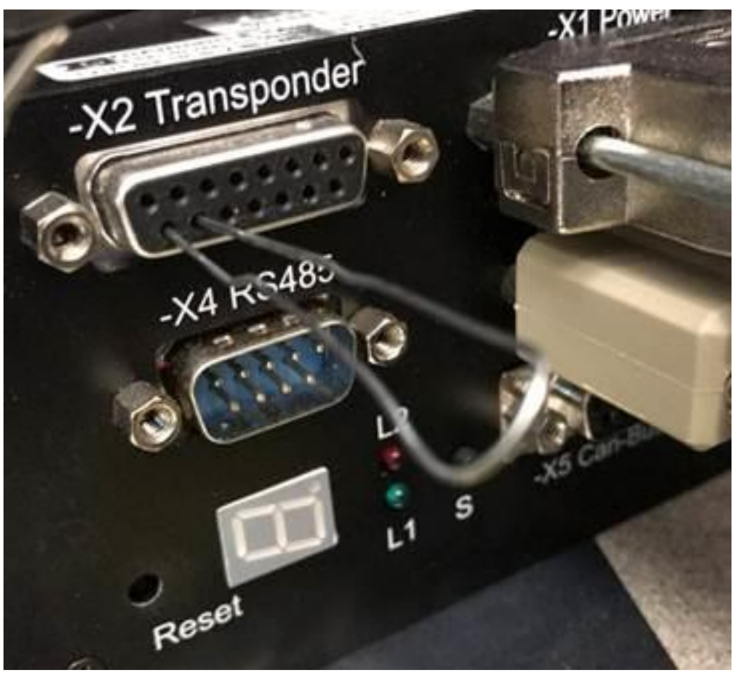

Figure 18: Transponder Jumper Pin 14 – 15

4. Connect a RS232 **Null Modem cable** to the CCU RS232 port and laptop.
5. Power ON the CCU by re-connecting the X1 Power cable.
6. Find the COM PORT Windows assigned the USB Serial Adapter, and select it:

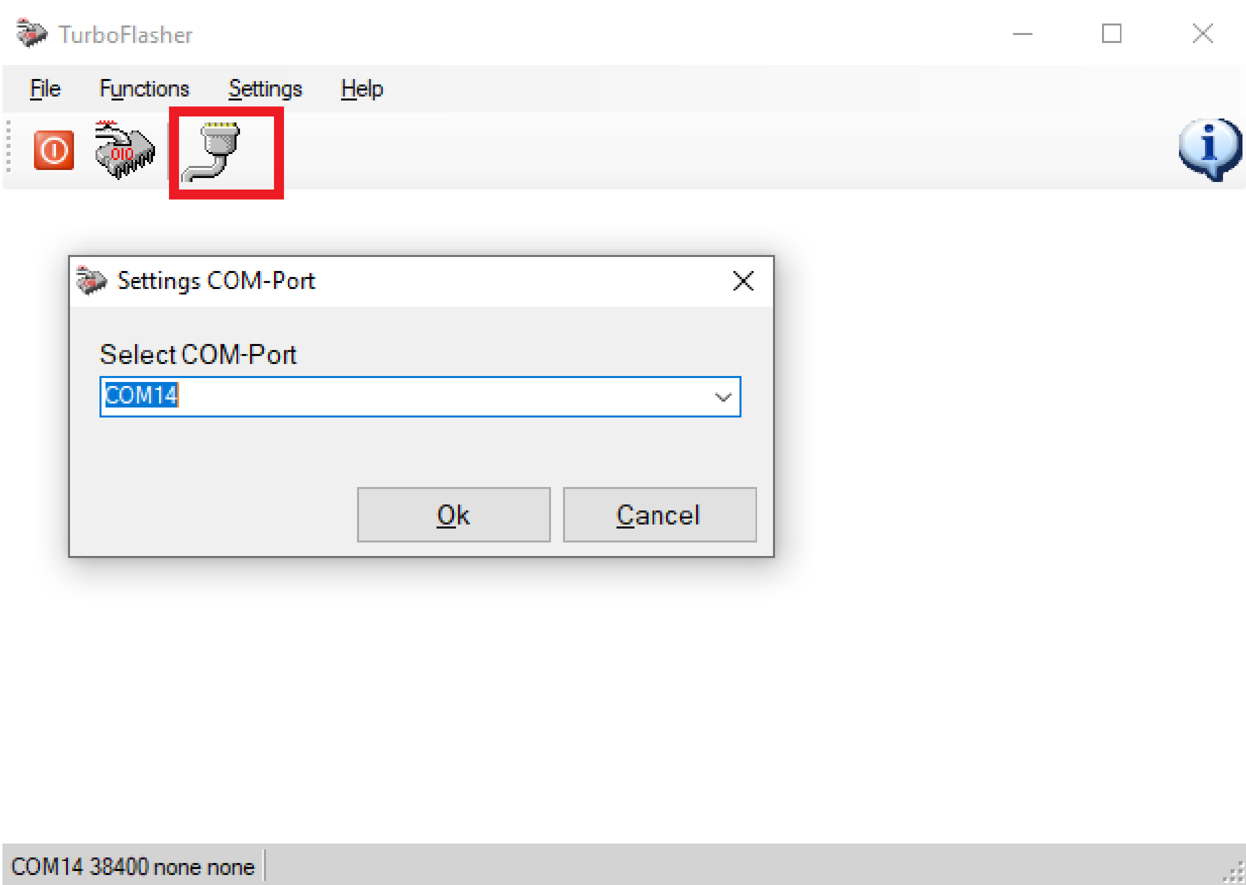

Figure 19: COM PORT Window

7. Launch the TurboFlasher program and click Load Program:

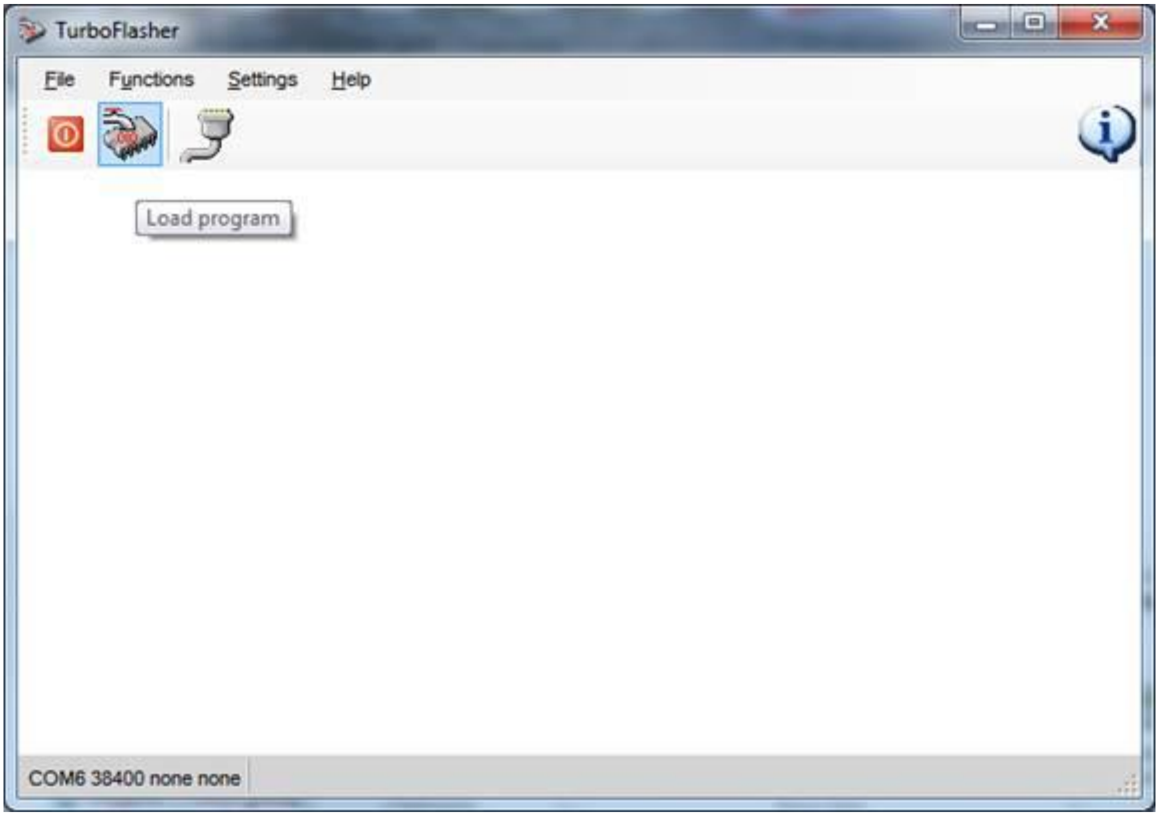

Figure 20: TurboFlasher Program

8. Select universal mode, and select IFC2/HID/HIOD/HCP/HCSV for the Read out Software and save option.

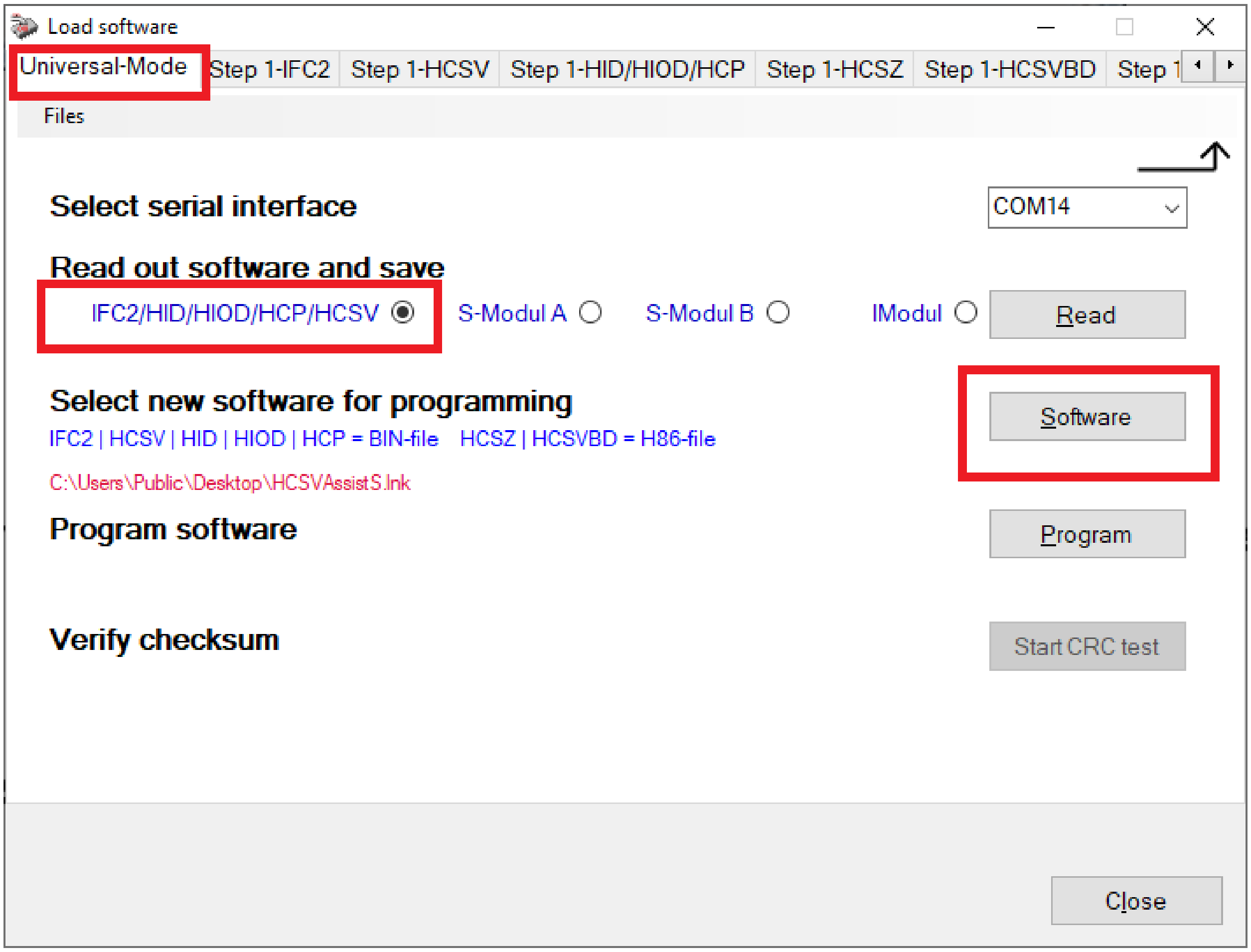

Figure 21: TurboFlasher Program

9. Click on the Software Button, and in the bottom right hand corner, change the file type to H86 Files:

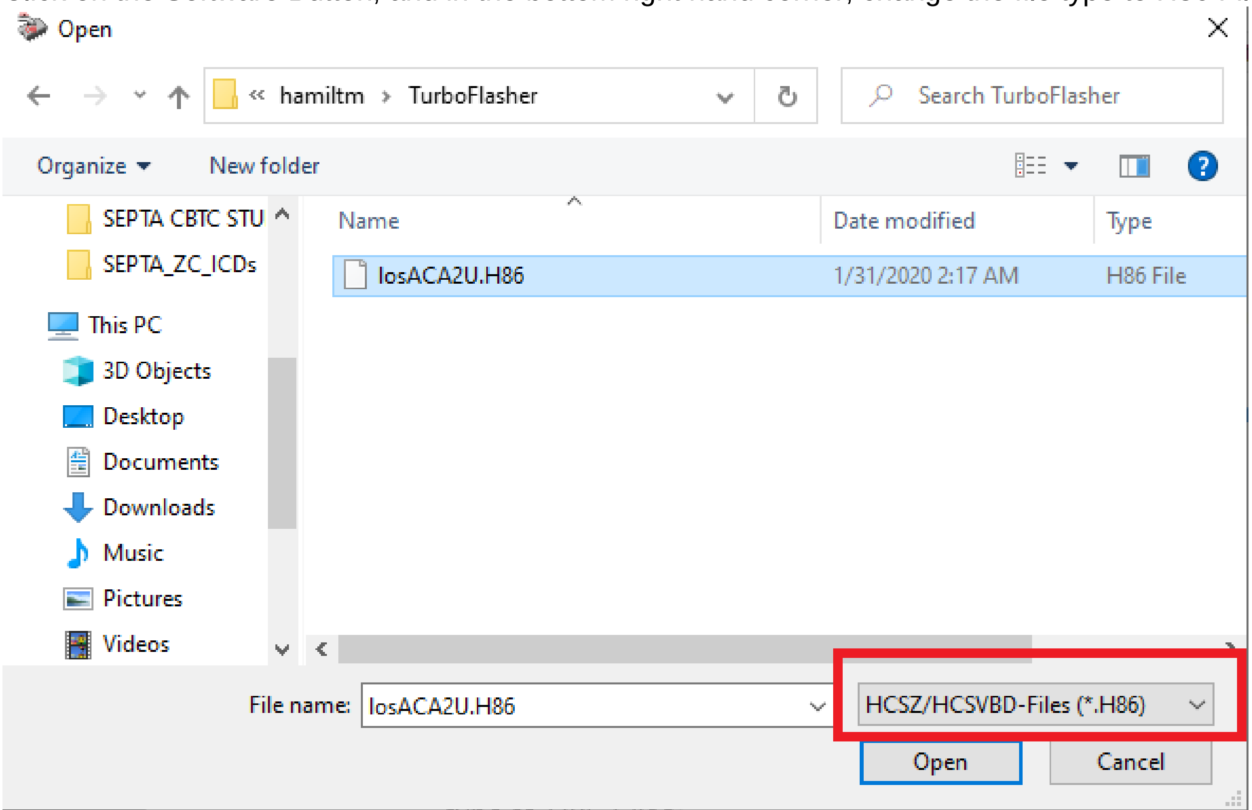

Figure 22: Software Folder

10. Browse for the losABA8U.H86 firmware file (or the latest version).

11. Press the Program Button.

12. A dialog box will display stating to switch connection on and off again. Just click ok.

13. The CCU will be programmed and the seven-segment display and LEDS L1 and L2 will be illuminated.

14. Wait for the RED L2 LED to turn off from the initial ON state.

15. Power OFF the CCU by disconnecting the X1 Power cable from the CCU.

16. Remove the jumper between pins 14 and 15 of the X2 Transponder connector.

17. Re-connect the X2 Transponder cable to the CCU and secure.

18. Re-connect the X1 Power cable to the CCU and secure.

19. To verify correct programming, press the “S” button on the CCU. It will flash out “L.b8” (or whatever version that was loaded) on the seven segment display for the version number.

20. Verify that the TWC READY indicator is illuminated Green on the active cab ADU.

21. On the active cab ADU, press Key 2, Key 7 in sequential order to access the ADU Diagnostic screen.

22. Verify that the correct version of CCU software is displayed on the ADU Diagnostic screen.

APPENDIX A

GENERAL INFORMATION

MicroCab 332 Flash Programmer provides a simple user interface to erase and load a new Motorola S-record file into the Flash EEPROM of the 332 Controller.

HARDWARE SETUP

The computer serial COM port selected on the display panel must be connected via a Null modem cable to the RS232 port of the 332.

The 332 Controller must have a power supply capable of providing its programming voltage. The normal +5V, +12V and Common that is provided on the motherboard connector should be all that is necessary.

HOW TO USE THE PROGRAMMER

Set up the hardware as described in the "Hardware Setup" section of the Appendix.

Select the S-record file to download into the 332 Flash memory. This can done by typing the correct drive, path and file name in the S-record display on the programmer window. Clicking on the "Change File" button on the programmer to get a file selection window will is another alternative.

Select which type of board is being loaded, a Mini 332 or a Full-size 332. This selection only varies the baud rate in which the board is programmed.

Click on the "Load" button on the programmer window to download the file into Flash. If an existing file has not been chosen, it will prompt for one.

The program will instruct the user to reset or restart the 332 Controller in order to invoke the Boot Program. The instruction message window must be acknowledged before resetting or restarting the board.

Indicators will show which tasks are occurring as they happen. The green indicators show that a task has completed correctly. Red indicators show that a task has failed or cancelled by the user.

Programming often takes 5-10 minutes to complete. The longest task by far to complete is the actual programming, so a pop-up window with a %complete indicator will pop-up as this task is performed to give the user feedback.

If all tasks are performed correctly and completely, a final pop-up message will indicate that the programming is complete.

BOOT INVOKE FAILURE

The "Boot Invoke" task should complete within a couple of seconds from the time the 332 is reset or restarted. Make sure that you acknowledge the window that instructs you to reset the 332 by clicking "Ok" before resetting the processor.

Check that the proper board type is set on the Programmer window.

Check that the COM port selected is the correct one.

Check that you have a good null-modem cable connected to the 332 diagnostic port.

If all these conditions are satisfied and the task still fails, the 332 board does not have a compatible version of the Boot Monitor or the Boot Monitor has become corrupted. This programmer cannot be used.

FLASH ERASE FAILURE

The "Flash Erase" task should complete within five minutes (usually much faster) from the start of the procedure. When this type of failure occurs the following generally causes it:

Jumper settings on the board are not correct. Check that the jumpers on the 332 board are configured so that the flash can be programmed (consult the board's schematics).

If these conditions are met, it may be possible that there is a failure with the Flash devices.

FLASH PROGRAMMING FAILURE

The "Flash Programming" task will take several minutes to complete, however, a pop-up window indicates a continuous scrolling progress bar while it is programming.

Check that the file selected to load into Flash is a valid file compiled for Flash. This program will only load a Motorola S-record format file. It is recommended that the file be copied to the PC's hard drive to increase performance rather than used off a network drive or a floppy disk.

If the file format is confirmed as valid and the Programming Failure occurs then there may be a problem with the Flash devices on the board.

CSRD SOFTWARE LOADER BATCH FILE EXAMPLE

```
@ECHO OFF

ECHO Script to run CSRD Loader - Developed by HSTS
ECHO May need to run this as administrator privilege and adjust for specific Firewalls/Permissions
ECHO Actions: adjust TCP/IP Settings, Run CSRD Loader and Revert IP settings when complete
pause

REM ***** Use the IP address and subnet mask below ******
set varip=172.25.1.80
set varsm=255.255.255.192
set vargw=172.25.1.65

ECHO Setting IP Address[%varip%], Subnet Mask [%varsm%] and Gateway [%vargw%] for CSRD Loader
netsh int ipv4 set address name= "Local Area Connection" source = static addr = %varip% mask = %varsm%
gateway=%vargw%
REM ECHO Here are the new settings for %computername% "Local Area Connection":
REM netsh int ip show config
pause

ECHO starting CSRD Loader tool
C:
REM Locate the CSRDBootloader.exe file path and change the directory accordingly.
CD C:\Program Files\CSRD\CSRD Bootloader
start CSRDBootloader.exe
ECHO Do not continue until CSRD Loader session has been exited
pause

ECHO Resetting IP Address and Subnet Mask For DHCP
netsh int ip set address name = "Local Area Connection" source = dhcp
ECHO Resetting DNS For DHCP
netsh int ip set dns name = "Local Area Connection" source = dhcp
ECHO Resetting Windows Internet Name Service (WINS) For DHCP
netsh int ip set wins name = "Local Area Connection" source = dhcp

ECHO End of Script to run CSRD Loader - Developed by HSTS
pause
```

CCB_IP IP CONFIGURATION SCRIPT EXAMPLE

```
@ECHO OFF

ECHO Script to run CCB IP Configuration - Developed by HSTS
ECHO May need to run this as administrator privilege and adjust for specific Firewalls/Permissions
ECHO Actions: adjust TCP/IP Settings, Run ccb_ip
pause

REM ***** Use the IP address and subnet mask below ******
set varip=169.254.2.10
set varsm=255.255.255.0
set vargw=169.254.2.1

ECHO Setting IP Address[%varip%], Subnet Mask [%varsm%] and Gateway [%vargw%] for CCB IP configuration
netsh int ipv4 set address name= "Local Area Connection" source = static addr = %varip% mask = %varsm% gateway=%vargw%
REM ECHO Here are the new settings for %computername% "Local Area Connection":
REM netsh int ip show config
pause

ECHO Resetting IP Address and Subnet Mask For DHCP
netsh int ip set address name = "Local Area Connection" source = dhcp
ECHO Resetting DNS For DHCP
netsh int ip set dns name = "Local Area Connection" source = dhcp
ECHO Resetting Windows Internet Name Service (WINS) For DHCP
netsh int ip set wins name = "Local Area Connection" source = dhcp

ECHO End of Script to run CSRD Loader - Developed by HSTS
pause
```

ATO FLASH UTILITY FILE EXAMPLE

```
:: Flashes the software for the ATO release to a SPO board.
:: __Dependencies__:
:: Release files.
:: Altera Nios II v10.1 development tools.

::==============================================================::
:: COPYRIGHT 2013, REVISED 2021, Hitachi Rail STS.              ::
::==============================================================::

:: Set up environment.
@set TITLE=%~n0
@cd /d %~dp0 && title %TITLE% && echo off

if not exist "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" (
   title [ERROR] %TITLE%
   echo ERROR: This machine does not have the required Altera tools installed!
   echo --------
   echo Please install the Altera Nios II v10.1 development tools.
   echo Once installed, confirm that the SOPC_KIT_NIOS2 environment variable is properly configured.
   echo The path "%%SOPC_KIT_NIOS2%%\Nios II Command Shell.bat" must be valid.
   echo --------
   pause
   exit /b 1
)

echo About to flash the following:
echo   - FPGA firmware
echo   - SPO bootloader
echo   - LACMTA-3010 ATO application
::echo   - LACMTA-3010 ATO config settings
::echo   - LACMTA-3010 ATO filter settings
::echo   - LACMTA-3010 Green Line Track Plan
::echo   - LACMTA-3010 Green Line Station Table
echo Please connect USB Blaster to the target SPO board.
echo This process may take a few minutes.
pause
echo --------

:: Flash the files to the board.
call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-configure-sof spo_fpga.sof
call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-flash-programmer --base=0 --epcs --accept-bad-sysid --program --verify spo_fpga.flash
call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-flash-programmer --base=0x8000000 bootloader.flash
call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-flash-programmer --base=0x8000000 lacmta3010_ato.flash
::call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-flash-programmer --base=0x8000000 AtoConfig.flash
```

```
::call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-flash-programmer --base=0x8000000
AtoFilters.flash
::call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-flash-programmer --base=0x8000000
track_data.flash
::call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-flash-programmer --base=0x8000000
station_table.flash
call "%SOPC_KIT_NIOS2%\Nios II Command Shell.bat" nios2-download -r -g

title [DONE] %TITLE%
echo --------
echo Flashing complete, SPO processor has been reset and should currently be running.
pause
exit /b 0
```

ATTACHMENT #3

Vehicle Trainlines Interface Control Detailed Design

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Kinkisharyo International, L.L.C.
Los Angeles County Metropolitan Transportation Authority
New Light Rail Vehicles

Contract Number: P3010

Vehicle Trainlines Interface Control Detailed Design

Ansaldo STS A Hitachi Group Company
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Approved:	Hari Aithal – Project Manager	6/7/2017 Signature / Date

ASTS Document Number	CDRL Number	Revision	6.2
USASS024–CEPH2–106	USASSO24–118	Date	June 06, 2017

Document Revision History

Revision	Date	Author	Reason For Revision	Review & Approval Date
0.0	3/15/13	Seth Ammer	Initial Release to Customer	
1.0	4/22/13	Seth Ammer	Response to P3010_KI_USS_LTR_00021	
2.0	6/20/13	Seth Ammer	Response to P3010_KI_USS_LTR_00021 and document changes approved by Jeff Fennig per email correspondence	
3.0	7/12/13	Seth Ammer	Response to P3010–KI–USS–LTR–00037	
4.0	7/23/13	John Best	Response to MAKI–0815	12/20/2013
4.1	1/10/14	Brian Adams	Response to P3010_KI_USS_LTR_00073	2/3/2014
5.0	3/21/14	Seth Ammer	Response to MAKI-1156	3/28/2014
5.1	3/31/14	Seth Ammer	Updates to new pin out information	
6.0	7/18/14	Mike Romanucci	J2 Pinout updated, Corrections to Mating Conn Kits, Figure B-8:1 and Figure B-8:2. Update H&K Part Numbers. Response to MAKI-1506, Add Appendix F	
6.1	10/9/14	Mike Romanucci	Update H&K Part Numbers. Response to MAKI-1905. Updated Appendix D and F message layouts	
6.2	6/6/17	Ryan McCarty	Update Type II TWC message for 4 digit PVID. Updated 3.2.1 TWC Connector	

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The purpose of this document is to provide and identify the Vehicle Trainlines that will be used by the Automatic Train Control supplier, Ansaldo STS USA (ASTS), for the Los Angeles County Metropolitan Transportation Authority (LACMTA) and P3010 New Light Rail Vehicle builder Kinkisharyo (KI).

In general, the Vehicle Train lines are the signals and connections from the Automatic Train Control (ATC) System and the vehicle.

2. SCOPE

This document will apply to all product/supplier development within the scope of the Vehicle Train Lines design. This document will be used as a guideline to define the ASTS expectations of the interface from the ATC to vehicle and peripherals.

2.1. Terminology

2.1.1. Acronyms

The following acronyms are used in this document:

ADU	Aspect Display Unit
ATC	Automatic Train Control
ATO	Automatic Train Operation
ATP	Automatic Train Protection
AWG	American Wire Gauge
FSB	Full Service Brake
I/O	Input/Output
LACMTA	Los Angeles County Metropolitan Transportation Authority
LRV	Light Rail Vehicle
MVB	Multifunction Vehicle Bus
TWC	Train to Wayside Communication
VDC	Volts Direct Current

2.1.2. Definitions

The following items are used as indicated throughout this document:

- **Automatic Train Control (ATC):** ATC is the complete system of Train Control utilizing ATO, ATP, TWC, and other technologies.
- **Automatic Train Operation (ATO):** ATO systems include door enabling, speed regulation in Type II Mode.
- **Automatic Train Protection (ATP):** ATP systems include train detection, train separation, interlocking control, and speed limit enforcement.

- **Component:** (IEEE Std. 610.12–1993) One of the parts that make up a system. A component may be hardware or software and may be subdivided into other components.
  NOTE: The terms module, component, and unit are often used interchangeably or defined as sub–elements of one another in different ways depending on the context.
- **PN–159 Vital Relay:** The Vital Relay is used in circuit applications where safety is a critical factor. Such an example is ATP application of the vehicle's Emergency Brake. The Vital Relay relies on gravity for contact break, and utilizes special materials to prevent the relay contacts from welding.
- **Safety Relay:** The operation of the Safety Relay depends on the forced operation of the relays inner contacts. If either of the inner contacts become welded, the normally closed outer contacts remain open. Using the back contacts as a feedback provides a check that the inner contacts have not welded. The Safety Relay differs from the Vital Relay in that the possibility still exists for the inner relay contacts to weld. But, unlike the Non–Vital Relay, a failure due to welded contacts is detectable.
- **Train to Wayside Communication (TWC):** TWC systems provide a communication means to transmit and receive information between the train and the wayside.

2.1.3. Referenced Documents

	Document Number	Document Title (Name)
[1]	ICDD_TWC_P3010	TWC Los Angeles, 275083 ICDD TWC P3010 (ICDD_TWC_P3010_V4.docx)
[2]	D00015038-x	Hanning & Kahl – HCS-V Interface set HVF0-5K07 Circuit Diagram (D00015038-x.pdf, where x is the version number)

Table 1 - Referenced Documents

2.2. Cable Categories

The vehicle wiring should be segregated into classes (e.g. power, signal and communication). Each of the signals discussed in this document will possess a class identification to aid the Vehicle Contractor in wiring the ATC Rack and Peripherals. Table 2 below lists the cable categories. To the extent possible, physical separation should be maintained between classes.

Cable Category	Category Description
A	Data transmission bus (bit–stream, antenna leads, microphone circuits)
B	Sensors (speed, temperature, pressure, etc.)
C	Battery level control and indications
D	Auxiliary equipment
E	Propulsion motor voltage circuits
F	Line conductor

Table 2 – Cable Categories

3. PHYSICAL CONNECTIONS

3.1. ATC Connections

See Appendix A for all of the ATC Pinout Tables

3.1.1. Power

All power to the ATC equipment will pass through the J1 connector on the ATC enclosure. This connector is a HARTING Han Q 3A connector.

J1	Battery Input to ATP Equipment:
Definition:	Power input to the ATP equipment located in the ATP Rack from the vehicle battery, with Circuit Breaker over current protection.
Level:	24.0 VDC (nominal battery)
Operating Range:	17 – 30 VDC
Current:	7.5 A NOTE: This value is a placeholder. Exact values for the current consumption of the ATC Rack will be updated in future releases of this document.
Breaker:	7.5 A minimum
Wire:	16 AWG, 2 sets (cable category C)

Table 3 – Battery Input to ATP Equipment

LACMTA P3010 Vehicle Power Connector P1:

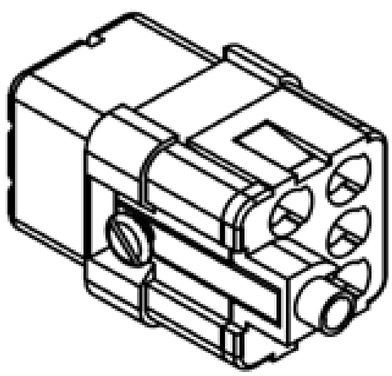


Figure 3:1 Vehicle – Side P1 Connector

Connector Side	Description	ASTS P/N	Manufacturer P/N:
J1 – ATC	Housing/Bulkhead:	4349.0100141	HARTING 09 62 003 0304
	Male Insert:	J7091461868	HARTING 09 12 005 3001
	Contact, Male:	4349.0100144	HARTING 09 33 000 6195
P1 - Vehicle Kit: P20I.0100040	Housing/Bulkhead:	4349.0100163	HARTING 19 20 003 1421
	Female Insert:	J7091461869	HARTING 09 12 005 3101
	Contact, Female, Crimp, #16 AWG:	J7091461870	HARTING 09 33 000 6216

Table 4 – ATC Enclosure P1 / J1 Connector Information

3.1.2. Input /Output

All of the LRV's Input / Output interface to the ATC equipment will pass through the J2 and J3 connectors on the ATC enclosure. The J2 and J3 connectors are HARTING Han 24DD (Size 24B) connectors, differently gendered to avoid cross connection.

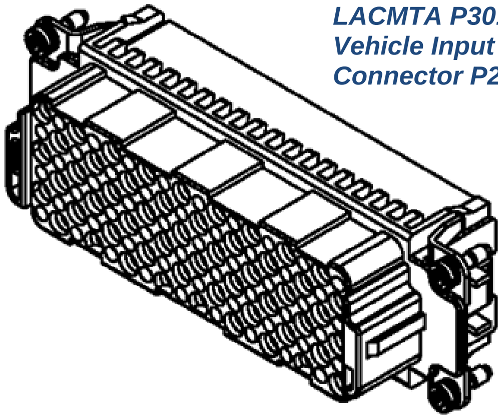


Figure 3:2 Vehicle – Side P2 Connector

Connector Side	Description	ASTS P/N	Manufacturer P/N
J2 – ATC	Housing/Bulkhead:	4349.0100114	HARTING 09 30 024 0307
	Male Insert:	J7091461858	HARTING 09 16 108 3001
	Contact, Male PCB Pin:	JR112600000125	HARTING 09 15 000 6191
P2 – Vehicle Kit: P20I.0100041	Housing/Bulkhead:	4349.0100164	HARTING 19 30 024 0448
	Cable Entry:	6007433	HARTING 19 00 000 5098
	Female Insert:	J7091461859	HARTING 09 16 108 3101
	Contact, Female, Crimp, #16 AWG:	J7091461864	HARTING 09 15 000 6221

Table 5 – ATC Enclosure P2 / J2 Connector Information

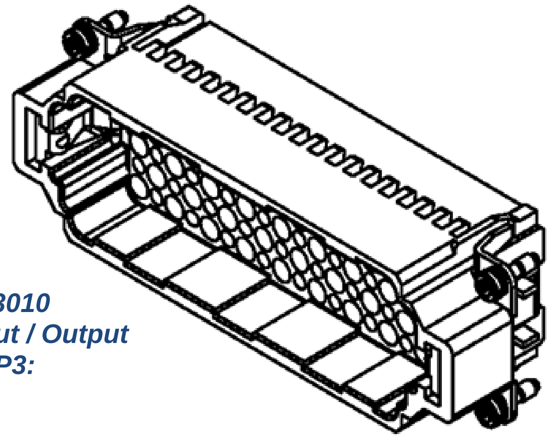


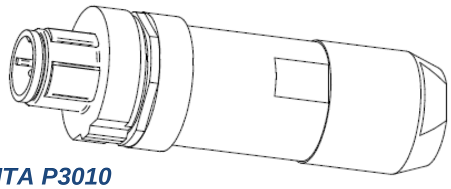
Figure 3:3 Vehicle – Side P3 Connector

Connector Side	Description	ASTS P/N	Manufacturer P/N
J3 – ATC	Housing/Bulkhead:	4349.0100114	HARTING 09 30 024 0307
	Female Insert:	J7091461859	HARTING 09 16 108 3101
	Contact, Female PCB Pin:	JR112600000126	HARTING 09 15 000 6291
P3 – Vehicle Kit: P20I.0100042	Housing/Bulkhead:	4349.0100164	HARTING 19 30 024 0448
	Male Insert:	J7091461858	HARTING 09 16 108 3001
	Contact, Male, Crimp, #18 AWG:	J7091461866	HARTING 09 15 000 6122

Table 6 – ATC Enclosure P3 /J3 Connector Information

3.1.3. Ethernet

The ATC has an Ethernet connection that passes through the J4 connector on the ATC enclosure. This connector is an M12, D–code connector.



LACMTA P3010 Vehicle Ethernet Connector P4:

Figure 3:4 Vehicle – Side P4 Connector

Connector Side	Description	ASTS P/N	Manufacturer P/N
J4 – ATC	One-piece Connector, PCB Mount	4346.0100365	HARTING 21 03 381 6410
P4 – Vehicle Kit: P20I.0100043	One-piece Connector, 4-8mm Cable Jacket OD, #20-26 AWG Wires	4346.0100416	Phoenix Contact 1436738

Table 7 – ATC Enclosure P4 /J4 Ethernet Connector Information

3.1.4. MVB

The ATC has two MVB connections that pass through the J5 and J6 connectors on the ATC enclosure. These connectors are DB–9 Serial connectors

The ATC Connector for J5 is a DB–9 Serial Male.

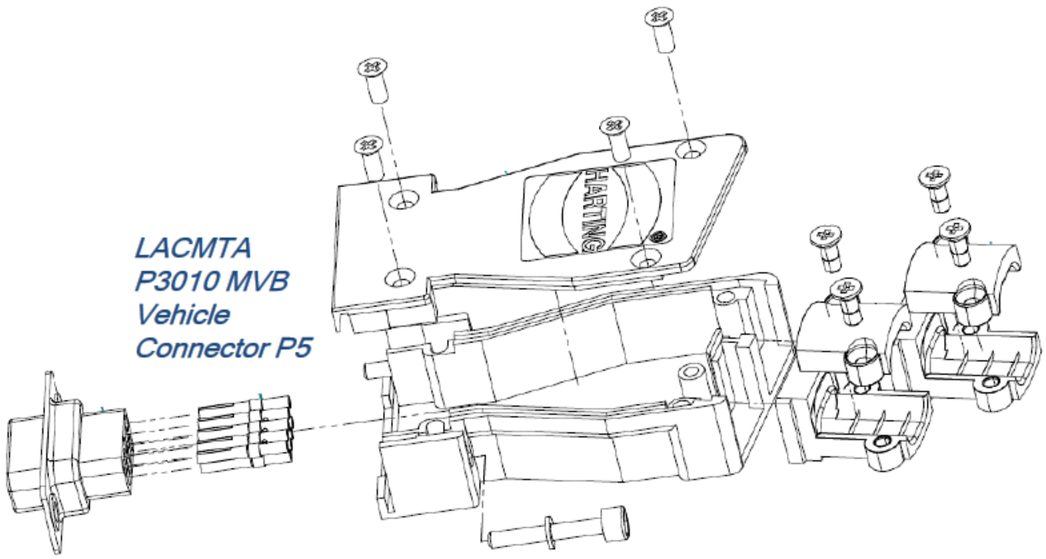


Figure 3:5 Vehicle –Side P5 Connector

Connector Side	Description	ASTS P/N	Manufacturer P/N
J5 – ATC	D-sub Male	4346.0100423	HARTING 09 65 161 6712
	Screwlocks, Female, #4-40	4349.0100179	TYCO 828102-1
P5 – Vehicle Kit: P20I.0100044	Hood, #4-40 Jackscrews	6006877	HARTING 66 67 009 0346
	Cable Clamp, 7-10mm	6006878	HARTING 61 03 000 0044
	D-sub Female Terminal	6001520V00	HARTING 09 67 009 4701
	Contact, Female, Crimp, #18-22 AWG	4350.0100019	HARTING 09 67 000 3476

Table 8 – ATC Enclosure P5 / J5 Connector DB – 9 Serial Female

ATC Connector J6 is a DB–9 Serial Female.

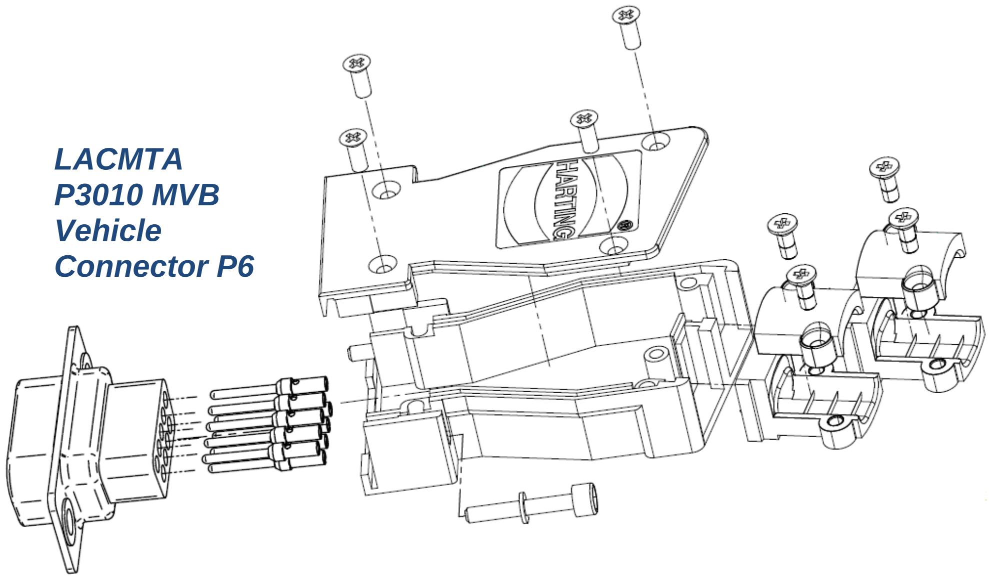


Figure 3:6 Vehicle –Side P6 Connector

Connector Side	Description	ASTS P/N	Manufacturer P/N
J6 – ATC	D-sub Female	4346.0100424	HARTING 09 66 151 6512
	Screwlocks, Female, #4-40	4349.0100179	TYCO 828102-1
P6 – Vehicle Kit: P20I.0100045	Hood, #4-40 Jackscrews	6006877	HARTING 66 67 009 0346
	Cable Clamp, 7-10mm	6006878	HARTING 61 03 000 0044
	D-sub Male Terminal	6001693M00	HARTING 09 67 009 5601
	Contact, Male, Crimp, #18-22 AWG	4350.0100017	HARTING 09 67 000 3576

Table 9 – ATC Enclosure P6 / J6 Connector DB – 9 Serial Male

3.2. Peripheral Connections

3.2.1. TWC Antenna

The Type II TWC Antenna is a communication system for the vehicle ATC. The antenna is connected through wired contacts on the ATC side and an Amphenol connector on the antenna side.

Connector Side	Description	ASTS P/N	Manufacturer P/N
TWC Antenna	Connector	J706167	ITT/CANNON MS3102R16S-1P
Vehicle Kit: P20I.0100048	Connector	4346.0100515	ACC05E16S-1S(025)LC
	Contact, 16-20AWG	4349.0100100	Amphenol 10-597109-161
	Endbell	4349.0100243	Amphenol 10-564867-16Y
	Sealing Washer	4349.0100244	Amphenol 10-597109-161

Table 10 – TWC Antenna Connector

3.2.2. ATP Track Receiver

The ATP Track Receiver is linked to the system through wire leads and as such does not have a connector.

3.2.3. Aspect Display Unit

The Aspect Display Unit (ADU)

P1	Battery Input to ADU Equipment:
Definition:	Power input to the Aspect Display Units (ADU) in each cab, from the vehicle battery , with Circuit Breaker over current protection
Level:	24.0 VDC (nominal battery)
Operating Range:	16.8 – 31.2 VDC
Current:	5.0 A NOTE: this value is a placeholder. Exact values for the current consumption of the ADU Equipment will be updated in future releases of this document.
Breaker:	5.0 A minimum
Wire:	16 AWG, (cable category C)

Table 11 – Battery Input to ADU

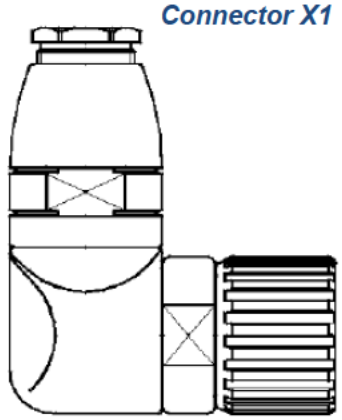


Figure 3:7 Vehicle –Side ADU / TWC Interface Panel P1 Connector

Coninvers M23 CIR 6 pos

Connector Side	Description	ASTS P/N	Manufacturer P/N
ADU X1 – Vehicle Kit: P20I.0100047	90° Male Crimp Shell/Housing:	4346.0100120	Coninvers RC-06S1N8A-ZH-00
	Contact, Crimp or Solder, #14-16 AWG:	4350.000040	Coninvers RC-5AS2000

Table 12 – ADU / TWC Interface Panel ADU X1 / ADU P1

RS-485 Link between ADU and Hanning & Kahl (Type I) TWC

Connector Side	Description	ASTS P/N	Manufacturer P/N
ADU X8 – Vehicle Kit: P20I.0100046	Hood, #4-40 Jackscrews	6006877	HARTING 66 67 009 0346
	Cable Clamp, 7-10mm	6006878	HARTING 61 03 000 0044
	D-sub Male Terminal	6001693M00	HARTING 09 67 009 5601
	Contact, Male, Crimp, #18-22 AWG, for RS485 Cable	4350.0100017	HARTING 09 67 000 3576
	Terminating Resistor	J7355001210	121Ω, 1/4W, 1%, 50ppm, Axial
	Contact, Male, Crimp, #22-26 AWG, for Terminating Resistor	6007789	HARTING 09 67 000 5576
	Wire, #22 AWG, ETFE, for Loopback Wires	A0457790004	
	Contact, Male, Crimp, #20-24 AWG, for Loopback Wires	4350.0100024	HARTING 09 67 000 8576

Table 13 – ADU / TWC Interface Panel ADU X8 / ADU P8

4. ATC TO VEHICLE I/O INTERFACES

4.1. Summary of ATC to Vehicle I/O Interfaces

Signal	Direction Input / Output	Functional Description	High State	Conditions for Transition to Low	Vitality V = Vital NV = Non - Vital	Circuit Type DB = Double - Break SB = Single - Break	Cable Category	Voltage Reference / Output	Current Absorption / Output
MANUAL	Input	ATO Mode Switch set to Manual Mode from the Active Cab	Manual	ATO Mode Switch in active cab is set to ATO	V	SB	C	Battery	50 mA
ATO	Input	ATO Mode Switch set to ATO Mode from the Active Cab	ATO	ATO Mode Switch in active cab is set to Manual	V	SB	C	Battery	50 mA
AEND	Input	A–end Transfer Switch State	A–End Active	A – End Keyed OFF	V	SB	C	Battery	50 mA
BEND	Input	B–end Transfer Switch State	B–End Active	B – End Keyed OFF	V	SB	C	Battery	50 mA
TWC_BYPASS	Input	TWC is cutout by TWC Cutout Switch	The TWC is Cutout	TWC Cutout Switch moved to CutIn position	NV	SB	C	Battery	50 mA
ATP_BYPASS	Input	Indicates the ATP is Bypassed	The ATP is Bypassed	ATP_Bypass switch moved to Normal position	V	SB	C	Battery	50 mA
ATP_NO_BYPASS	Input	Indicates the ATP is Not Bypassed	The ATP is Not Bypassed	ATP_Bypass switch moved from Normal position	V	SB	C	Battery	50 mA
ATC_ACK	Input	Indicates the ATC Ack button has been pressed (Not a hardware / Power Reset) on the Driver's Console	ATC_ Ack Input ON. This will cause an Penalty Brake Reset.	Pressing and release of ATC_ Ack button	V	SB	C	Battery	50 mA
TYPE_I	Input	Indicates the Line Selector Switch (LSS) is in the Type I position (ASK, or non – Green Line Mode)	ATC is in Type I Mode	LSS is moved to Type II position	V	SB	C	Battery	50 mA
TYPE_II	Input	Indicates the Line Selector Switch (LSS) is in the Type II position (FSK, or Green Line Mode)	ATC is in Type II Mode	LSS is moved to Type I position	V	SB	C	Battery	50 mA
MC_FSB_A	Input	Indicates the A – End Master Controller is in the Full Service Brake (FSB) Position	A – End Master Controller is in the Full Service Brake Position	A – End Master Controller is moved out of the Full Service Brake Position	V	SB	C	Battery	50 mA
MC_FSB_B	Input	Indicates the B – End Master Controller is in the Full Service Brake (FSB) Position	B – End Master Controller is in the Full Service Brake Position	B – End Master Controller is moved out of the Full Service Brake Position	V	SB	C	Battery	50 mA

<table>
<tr><th>Signal</th><th>Direction Input / Output</th><th>Functional Description</th><th colspan="3">High State</th><th>Conditions for Transition to Low</th><th>Vitality
V = Vital
NV = Non‐Vital</th><th>Circuit Type
DB = Double‐Break
SB = Single‐Break</th><th>Cable Category</th><th>Voltage Reference / Output</th><th>Current Absorption / Output</th></tr>
<tr><td>MC_COAST_A</td><td>Input</td><td>Indicates the A–end Master Controller is in an unpowered position (braking included)</td><td colspan="3">A – End Master Controller is in Coast or a Brake position</td><td>A – End Master Controller is moved to a Power position</td><td>V</td><td>SB</td><td>C</td><td>Battery</td><td>50 mA</td></tr>
<tr><td>MC_COAST_B</td><td>Input</td><td>Indicates the B–end Master Controller is in an unpowered position (braking included)</td><td colspan="3">B – End Master Controller is in Coast or a Brake position</td><td>B – End Master Controller is moved to a Power position</td><td>V</td><td>SB</td><td>C</td><td>Battery</td><td>50 mA</td></tr>
<tr><td>CM</td><td>Input</td><td>Indicates status of the CM trainline</td><td colspan="3">CM Trainline is in a Power or Coast position</td><td>CM Trainline moved to a Brake position</td><td>V</td><td>SB</td><td>C</td><td>Battery</td><td>50 mA</td></tr>
<tr><td>M</td><td>Input</td><td>Indicates status of the M trainline</td><td colspan="3">M Trainline is in a Power position</td><td>M Trainline moved to a Brake or Coast position</td><td>V</td><td>SB</td><td>C</td><td>Battery</td><td>50 mA</td></tr>
<tr><td rowspan="3">REVERSE_INPUT</td><td rowspan="3">Input</td><td rowspan="3">Indicates status of the Direction 1 Trainline</td><td>A – End Active</td><td>AND</td><td>Direction / Reverser placed in “Forward” Direction</td><td>1) De – Activate A – End Active Cab.
2) Move A – End Direction / Reverser to” Reverse” position</td><td rowspan="3">V</td><td rowspan="3">SB</td><td rowspan="3">C</td><td rowspan="3">Battery</td><td rowspan="3">50 mA</td></tr>
<tr><td colspan="4">OR</td></tr>
<tr><td>B – End Active</td><td>AND</td><td>Direction / Reverser placed in “Reverse” Direction</td><td>1) De – Activate B – End Active Cab.
2) Move B – End Reverser to Forward position</td></tr>
<tr><td rowspan="3">FORWARD_INPUT</td><td rowspan="3">Input</td><td rowspan="3">Indicates status of the Direction 2 Trainline</td><td>B – End Active</td><td>AND</td><td>Direction / Reverser placed in “Forward” Direction</td><td>1) De – Activate B – End Active Cab.
2) Move B – End Direction / Reverser to” Reverse” position</td><td rowspan="3">V</td><td rowspan="3">SB</td><td rowspan="3">C</td><td rowspan="3">Battery</td><td rowspan="3">50 mA</td></tr>
<tr><td colspan="4">OR</td></tr>
<tr><td>A – End Active</td><td>AND</td><td>Direction / Reverser placed in “Reverse” Direction</td><td>1) De – Activate A – End Active Cab.
2) Move A – End Reverser to Forward position</td></tr>
<tr><td>NO_POWER_CUT</td><td>Input</td><td>Indicates the vehicle propulsion has been cut</td><td colspan="3">Propulsion cut not in effect</td><td>Propulsion has been cut</td><td>V</td><td>SB</td><td>C</td><td>Battery</td><td>50 mA</td></tr>
<tr><td>TB_APPLIED</td><td>Input</td><td>Indicates the Track Brakes are Applied</td><td colspan="3">Track Brake is applied</td><td>Track Brake is not applied</td><td>NV</td><td>SB</td><td>C</td><td>Battery</td><td>50 mA</td></tr>
</table>

Signal	Direction Input / Output	Functional Description	High State	Conditions for Transition to Low	Vitality V = Vital NV = Non‐Vital	Circuit Type DB = Double‐Break SB = Single‐Break	Cable Category	Voltage Reference / Output	Current Absorption / Output
EB_APPLIED	Input	Indicates the Emergency Brake is applied	Emergency Brake is applied	Emergency Brake is not applied	V	SB	C	Battery	50 mA
FRICTION_APPLIED_A	Input	Indicates all of the Friction Brakes are Applied when the A – End Cab is activated	If A – End active = Friction Brakes are all applied	Friction Brakes are not all applied.	V	SB	C	Battery	50 mA
FRICTION_APPLIED_B	Input	Indicates all of the Friction Brakes are Applied when the B – End Cab is activated	If B – End active = Friction Brakes are all applied	Friction Brakes are not all applied.	V	SB	C	Battery	50 mA
NO_FRICTION_FAULT	Input	Indicates there is a FAULT or CUTOUT condition on one or more friction brakes	No Friction Brake fault present	Friction Brake Fault occurs	V	SB	C	Battery	50 mA
DOORS_CLOSED_A	Input	Indicates doors closed and locked if A – End cab is selected	If A – End active = Doors are closed	If A – End active = Doors are open	V	SB	C	Battery	50 mA
DOORS_CLOSED_B	Input	Indicates doors closed and locked if B – End cab is selected	If B – End active = Doors are closed	If B – End active = Doors are open	V	SB	C	Battery	50 mA
NO_PROP_FAULT	Input	Indicates a Fault or Cutout in any vehicle Propulsion Control System	No Propulsion fault present	Propulsion Fault occurs	V	SB	C	Battery	50 mA
SPARE_NVI_1	Input	Spare Non–Vital Input	NA	NA	NV	SB	C	Battery	50 mA
SPARE_NVI_2	Input	Spare Non–Vital Input	NA	NA	NV	SB	C	Battery	50 mA
SPARE_VI_1	Input	Spare Vital Input	NA	NA	V	SB	C	Battery	50 mA
SPARE_VI_2	Input	Spare Vital Input	NA	NA	V	SB	C	Battery	50 mA
SPARE_VI_3	Input	Spare Vital Input	NA	NA	V	SB	C	Battery	50 mA
CM_FEED **CM_RETURN**	Output	Control of the CM trainline used in Type II ATO mode only.	The ATO is requesting Coast or Power	The ATO requesting Brake	V	SB	C	Battery	TBD
M_FEED **M_RETURN**	Output	Control of the M trainline used in Type II ATO mode only.	The ATO is requesting Power	The ATO requesting Brake or Coast	V	SB	C	Battery	TBD
REVERSE_FEED **REVERSE_RETURN**	Output	ATC direction request used in TYPE II ATO Mode only. No function in other modes	ATO is requesting the vehicle be configured for movement in the Reverse direction A – End Active | AND | Direction / Reverser placed in “Reverse” Direction OR	ATO removes Reverse request	V	SB	C	Battery	TBD

Signal	Direction Input / Output	Functional Description	High State	Conditions for Transition to Low	Vitality V = Vital NV = Non - Vital	Circuit Type DB = Double - Break SB = Single - Break	Cable Category	Voltage Reference / Output	Current Absorption / Output
			B – End Active AND Direction / Reverser placed in "Forward" Direction						
FORWARD_FEED **FORWARD_RETURN**	Output	ATC direction request used in TYPE II ATO Mode only. No function in other modes	ATO is requesting the vehicle be configured for movement in the Forward direction. A – End Active AND Direction / Reverser placed in "Forward" Direction OR B – End Active AND Direction / Reverser placed in "Reverse" Direction	ATO removes Forward request	V	SB	C	Battery	TBD
POWER_CUT_FEED **POWER_CUT_RETURN**	Output	ATC propulsion cutout	The ATP is requesting a Propulsion Cut	No ATP Propulsion Cut request	V	SB	C	Battery	TBD
EB_FEED+ **EB_FEED–** **EB_RETURN+** **EB_RETURN–**	Output	ATC request to apply EB	The ATP is not requesting an Emergency Brake Application	ATP Emergency Brake request	V	DB	C	Battery	TBD
ELD_FEED_A **ELD_FEED_B** **ELD_RETURN_A** **ELD_RETURN_B**	Output	ATC request to enable Left Side Doors (with respect to "A – Cab") ELD_FEED_A is used when A – Cab is Active. ELD_FEED_B is used when B – Cab is Active.	ATP is enabling the Left Side Doors	ATP removes Left Side Door Enable	V	DB	C	Battery	TBD
ERD_FEED_A **ERD_FEED_B**	Output	ATC request to enable Right Side Doors (with respect to "A – Cab") ERD_FEED_A is used when A –	ATP is enabling the Right Side Doors	ATP removes Right Side Door Enable	V	DB	C	Battery	TBD

Signal	Direction Input / Output	Functional Description	High State	Conditions for Transition to Low	Vitality V = Vital NV = Non ‑ Vital	Circuit Type DB = Double ‑ Break SB = Single ‑ Break	Cable Category	Voltage Reference / Output	Current Absorption / Output
ERD_RETURN_A **ERD_RETURN_B**		Cab is Active. ERD_FEED_B is used when B – Cab is Active.							
FSB_FEED_A **FSB_FEED_B** **FSB_RETURN_A** **FSB_RETURN_B**	Output	ATP request to apply Full Service Brake	The ATP is not requesting a Full Service Brake Application	ATP Full Service Brake request	V	DB	C	Battery	TBD
SPARE_VO1_FEED+ **SPARE_VO1_FEED–** **SPARE_VO1_RETURN+** **SPARE _VO1_RETURN–**	Output	Spare Vital Output	[Undefined]	[Undefined]	V	DB	C	Battery	TBD

Table 14 – Summary of ATC to Vehicle I/O Interfaces

4.2. Detailed Signal Descriptions

Discrete Inputs

MANUAL: Operating Mode set to Manual Mode. This is a vital input signal indicating that the operator has placed the vehicle into Manual Mode. This signal is active HIGH, and is normally generated from the active cab only. This signal will only be valid if ATO input signal is LOW.

ATO: Operating Mode set to ATO Mode. This is a vital input signal that the operator has placed the vehicle into ATO Mode. This signal is active HIGH, and is normally generated from the active cab only. This signal will only be valid if Manual input signal is LOW.

AEND: A–End Cab Keyed ON. This is a vital input signal that the operator has keyed ON the A–End Cab. This signal is active HIGH. This signal will only be valid if BEND is LOW.

BEND: B–End Cab Keyed ON. This is a vital input signal that the operator has keyed ON the B–End Cab. This signal is active HIGH. This signal will only be valid if AEND is LOW.

TWC_CUTOUT: This is a non–vital input signal that the operator has cutout the TWC. This signal is active HIGH.

ATP_BYPASS: This is a vital input signal that the operator has bypassed the ATP. This signal is active HIGH.

ATP_NOT_BYPASS: This is a vital input signal that the operator has NOT bypassed the ATP. This signal is active HIGH.

ATP_BYPASS and ATP_NOT_BYPASS must be in agreement. If ATP_BYPASS is HIGH to indicate the ATP has been bypassed, ATP_NOT_BYPASS must be LOW to be in agreement. The opposite is true when the ATP is not bypassed. Any other combination of signals will be regarded as invalid.

ATP_ACK: This is a vital input signal that the operator has pressed the ATC Acknowledge button from the drive console. This signal is active HIGH. The ATC will only act upon this signal if the vehicle is not moving (VZERO). If the vehicle is in motion when this signal is asserted, the ATP will apply the vehicle brakes and will reset when no motion is detected.

TYPE_I: Type I Mode. This is a vital input signal that the operator has placed the vehicle into Type I operation. Type I operation applies to all non–Green Line compatible lines. This signal is active HIGH. This signal will only be valid if TYPE_II is LOW.

TYPE_II: Type II Mode. This is a vital input signal that the operator has placed the vehicle into Type II operation. Type II operation applies to all Green Line compatible lines. This signal is active HIGH. This signal will only be valid if TYPE_I is LOW.

MC_FSB_A, MC_FSB_B: Master Controller Full Service Brake. This is a vital input signal that the Master Controller has been set in the Full Service Brake Position from each end respectively. This signal is active HIGH.

MC_COAST_A, MC_COAST_B: Coast/Brake. This is a vital input signal that the Master Controller has been set in any unpowered position including Coast and any Braking position from each end respectively. This signal is active HIGH.

M and CM: Indicates status of M and CM trainlines.

FORWARD_IN: Indicates status of Forward Trainline.

REVERSE_IN: Indicates status of Reverse Trainline.

NO_POWER_CUT: Propulsion Power Cutout Input. This is a vital input signal that indicates the vehicle has received the POWER_CUT trainline output from the ATC. This signal is active Low.

TB_APPLIED: Track Brakes Applied. This is a non–vital input signal that indicates the Track Brakes have been applied. This signal is active HIGH.

EB_APPLIED: Emergency Brake Applied. This is a vital input signal that indicates the Emergency Brake has been applied. This signal is active HIGH.

FRICTION_APPLIED_A: Friction Brakes Applied. This is a vital input signal. When the A-End cab is selected, this indicates the status of when all friction brakes are applied. This signal is active HIGH.

FRICTION_APPLIED_B: Friction Brakes Applied. This is a vital input signal. When the B-End cab is selected, this indicates the status of when all friction brakes are applied. This signal is active HIGH.

NO_FRICTION_FAULT: Friction Brake Fault. This is a vital input signal that indicates there is a Fault or Cutout condition on one or more of the vehicle Friction Brakes. This signal is active LOW.

DOORS_CLOSED_A: All Doors closed and locked when the A–End is selected. This is a vital input signal that indicates all doors, left side doors and right side doors, have been closed and locked on the train. This signal is active HIGH.

DOORS_CLOSED_B: All Doors closed and locked when the B–End is selected. This is a vital input signal that indicates all doors, left side doors and right side doors, have been closed and locked on the train. This signal is active HIGH.

NO_PROP_FAULT: This is a vital input signal that indicates one or more of the Propulsion Control Systems has a Fault condition or is cutout. This signal is active LOW.

SPARE_NVI_1: Spare Non–Vital Input 1. This is a non–vital input signal that has no function at this time. In future revisions this input may be repurposed and renamed.

SPARE_NVI_2: Spare Non–Vital Input 2. This is a non–vital input signal that has no function at this time. In future revisions this input may be repurposed and renamed.

SPARE_VI_1: Spare Vital Input 1. This is a vital input signal that has no function at this time. In future revisions this input may be repurposed and renamed.

SPARE_VI_2: Spare Vital Input 2. This is a vital input signal that has no function at this time. In future revisions this input may be repurposed and renamed.

SPARE_VI_3: Spare Vital Input 3. This is a vital input signal that has no function at this time. In future revisions this input may be repurposed and renamed.

Discrete Outputs

CM_FEED, CM_RETURN, M_FEED, M_RETURN: In Type II ATO Mode only, this is a vital output signal that applies the following logic to Coast, Brake, and Power.

CM = 0 and M = 0 is BRAKE,

CM = 1 and M = 0 is COAST,

CM = 1 and M = 1 is POWER,

All other states will be considered invalid.

FORWARD_FEED, FORWARD_RETURN: Forward Trainline. In Type II ATO Mode only, this is a vital output signal that indicates the ATC has requested vehicle forward motion in relation to the A–End Cab. In all other modes this signal has no function.

REVERSE_FEED, REVERSE_RETURN: Reverse Trainline. In Type II ATO Mode only, this is a vital output signal that indicates the ATC has requested vehicle reverse motion in relation to the A–End Cab. In all other modes this signal has no function.

POWER_CUT_FEED, POWER_CUT_RETURN: Power Cut. This is a vital output signal that will remove any tractive effort from the propulsion system. This signal does not affect vehicle braking.

EB_FEED, EB_RETURN: Emergency Brake Release. This is a vital output signal that indicates the ATC has requested to release the Emergency Brake. This trainline is controlled by a PN–159 Vital Relay with a double–break, feed/return architecture. This signal is active HIGH.

ELD_FEED_A, ELD_RETURN_A: Enable Left Doors with respect to A-End when A-Cab is enabled. This is a vital output signal that indicates the ATC has requested to enable the Left Side Doors.

ELD_FEED_B, ELD_RETURN_B: Enable Left Doors with respect to A-End when B–Cab is enabled. This is a vital output signal that indicates the ATC has requested to enable the Left Side Doors.

ERD_FEED_A, ERD_RETURN_A: Enable Right Doors with respect to A-End when A–Cab is enabled. This is a vital output signal that indicates the ATC has requested to enable the Right Side Doors.

ERD_FEED_B, ERD_RETURN_B: Enable Right Doors with respect to A-End when B–Cab is enabled. This is a vital output signal that indicates the ATC has requested to enable the Right Side Doors.

FSB_FEED_A, FSB_RETURN_A: Full Service Brake. This is a vital output signal that indicates the ATP has requested application of the Full Service Brake on the A-End. This signal is operational in Type I and Type II modes.

FSB_FEED_B, FSB_RETURN_B: Full Service Brake. This is a vital output signal that indicates the ATP has requested application of the Full Service Brake on the B-End. This signal is operational in Type I and Type II modes.

SPARE_VO1_FEED, SPARE_VO1_RETURN: Spare Vital Output 1. This is a vital output signal that has no defined function at this time. In future revisions this input may be repurposed and renamed. This signal has double–break, feed/return architecture.

5. ATC TO PERIPHERAL INTERFACES

5.1. Summary of ATC to Peripheral Interfaces

Signal	Direction Input / Output / Bi - Directional	Function	Vitality V=Vital NV=Non-Vital	Circuit Type **DB = Double - Break** SB = Single - Break	Cable Category	Destination/Source	Voltage Reference / Output	Current Absorption / Output
TACH_1_SIG+ **TACH_1_SHIELD**	Input	Active Tachometer 1 Signal	NV		B	ATC Tachometer Channel 1. Vehicle Tachometer 7 on Axle 4 (trailer).	0–15 V	50 mA
TACH_1_PWR **TACH_1_GND**	Output	Power Supply for Tachometer 1	NV			ATC Tachometer Channel 1. Vehicle Tachometer 7 on Axle 4 (trailer).	15 VDC	1 A
TACH_2_SIG+ **TACH_2_SHIELD**	Input	Active Tachometer 2 Signal	NV		B	ATC Tachometer Channel 2. Vehicle Tachometer 7 on Axle 4 (trailer).	0–15 V	50 mA
TACH_2_PWR **TACH_2_GND**	Output	Power Supply for Tachometer 2	NV			ATC Tachometer Channel 2. Vehicle Tachometer 7 on Axle 4 (trailer).	15 VDC	1 A
TACH_3_SIG+ **TACH_3_SHIELD**	Input	Active Tachometer 3 Signal	NV		B	ATC Tachometer Channel 3. Vehicle Tachometer 9 on Axle 6 (motorized).	0–15 V	50 mA
TACH_3_PWR **TACH_3_GND**	Output	Power Supply for Tachometer 3	NV			ATC Tachometer Channel 3. Vehicle Tachometer 9 on Axle 6 (motorized).	15 VDC	1 A
MVB1_A.DATA.P **MVB1_A.DATA.N** **MVB1_B.DATA.P** **MVB1_B.DATA.N**	Bi – Directional	ATC MVB Link 1	NV		A	ATC to MVB	MVB	TBD
MVB2_A.DATA.P **MVB2_A.DATA.N** **MVB2_B.DATA.P** **MVB2_B.DATA.N**	Bi – Directional	ATC MVB Link 2	NV		A	MVB to ATC	MVB	TBD
BEND_TWC_TXRX+ **BEND_TWC_TXRX–** **BEND_TWC_SHIELD1**	Bi – Directional	B – End TWC Signal Coil (Type II) B – End TWC Test Coil (Type II)	NV		A	Local End TWC Antenna, Type II		TBD

Signal	Direction Input / Output / Bi -Directional	Function	Vitality V=Vital NV=Non-Vital	Circuit Type **DB = Double - Break** SB = Single - Break	Cable Category	Destination/Source	Voltage Reference / Output	Current Absorption / Output
BEND_TWC_TEST+ **BEND_TWC_TEST–** **BEND_TWC_SHIELD2** **BEND_TWC_SHIELD3**								
AEND_TWC_TXRX+ **AEND_TWC_TXRX–** **AEND_TWC_SHIELD1** **AEND_TWC_TEST+** **AEND_TWC_TEST–** **AEND_TWC_SHIELD2** **AEND_TWC_SHIELD3**	Bi – Directional	A – End TWC Signal Coil (Type II) A – End TWC Test Coil (Type II)	NV		A	Remote End TWC Antenna, Type II		TBD
BEND_CABSIG_RX+ **BEND_CABSIG_RX–** **BEND_CABSIG_SHIELD1** **BEND_CABSIG_TEST+** **BEND_CABSIG_TEST–** **BEND_CABSIG_SHIELD2** **BEND_CABSIG_SHIELD3**	Bi – Directional	B – End Cab Signal Coil B – End Cab Signal Test Coil	V		A	Local End Track Receivers	15 VDC	TBD
BEND_CABSIG_PWR+ **BEND_CABSIG_PWR–** **BEND_CABSIG_SHIELD4**	Output	B – End Cab Signal Power	V			B–End Cab Signal Antennas	15 VDC	TBD
AEND_CABSIG_RX+ **AEND_CABSIG_RX–** **AEND_CABSIG_SHIELD1** **AEND_CABSIG_TEST+**	Bi – Directional	A – End Cab Signal Coil A – End Cab Signal Test Coil	V		A	Remote End Track Receivers	15 VDC	TBD

Signal	Direction Input / Output / Bi‑Directional	Function	Vitality V=Vital NV=Non‑Vital	Circuit Type **DB = Double ‑ Break** SB = Single ‑ Break	Cable Category	Destination/Source	Voltage Reference / Output	Current Absorption / Output
AEND_CABSIG_TEST– **AEND_CABSIG_SHIELD2** **AEND_CABSIG_SHIELD3**								
AEND_CABSIG_PWR+ **AEND_CABSIG_PWR–** **AEND_CABSIG_SHIELD4**	Output	A – End Cab Signal Power	V		A	ATC to A – End Cab Signal junction box	15 VDC	TBD
ETHERNET_TX+ **ETHERNET_TX–** **ETHERNET_RX+** **ETHERNET_RX–**	Bi–Directional	ATC Ethernet	NV		A	Vehicle Ethernet	Ethernet	TBD

Table 15 – Summary of ATC to Peripheral Interfaces

5.2. Detailed Signal Descriptions

TACH1: Tachometer 1 Power and Signal. Power to Tachometer 1 is supplied and regulated by the ATC and is transmitted over a twisted shielded triad. The third conductor in the cable is the tachometer signal return to the ATC. This is Vehicle Tachometer 7 on Axle 4 (trailer). TACH_1_SIG- is provided, however it is configured on the ATC motherboard to be tied to ISO_1_COM if left unconnected.

TACH2: Tachometer 2 Power and Signal. Power to Tachometer 2 is supplied and regulated by the ATC and is transmitted over a twisted shielded triad. The third conductor in the cable is the tachometer signal return to the ATC. This is Vehicle Tachometer 7 on Axle 4 (trailer). TACH_2_SIG- is provided, however it is configured on the ATC motherboard to be tied to ISO_1_COM if left unconnected.

TACH3: Tachometer 3 Power and Signal. Power to Tachometer 3 is supplied and regulated by the ATC and is transmitted over a twisted shielded triad. The third conductor in the cable is the tachometer signal return to the ATC. This is Vehicle Tachometer 9 on Axle 6 (motorized). TACH_3_SIG- is provided, however it is configured on the ATC motherboard to be tied to ISO_2_COM if left unconnected.

ATC_MVB1_A.DATA, ATC_MVB1_B.DATA: ATC MVB Link 1. MVB bus connection to the ATC equipment.

ATC_MVB2_A.DATA, ATC_MVB2_B.DATA: ATC MVB Link 2. MVB bus connection to the ATC equipment.

BEND_TWC_TXRX: Local–End TWC Transmit/Receive. This is a non–vital signal that carries non–vital information between the local-end Type II TWC antenna and the ATC rack. The ATC will use the antenna on the lead–end of the vehicle as determined by the vehicle direction.

BEND_TWC_TEST: Local–End TWC Test Coil. This is a non–vital signal that carries non–vital information for testing the local-end Type II TWC antenna.

AEND_TWC_TXRX: Remote–End TWC Transmit/Receive. This is a non–vital signal that carries non–vital information between the remote-end Type II TWC antenna and the ATC rack. The ATC will use the antenna on the lead–end of the vehicle as determined by the vehicle direction.

AEND_TWC_TEST: Remote–End TWC Test Coil. This is a non–vital signal that carries non–vital information for testing the remote-end Type II TWC antenna.

BEND_CABSIG_RX: Local–End Cabsignal Track Receiver. This is a vital input signal that carries information from the rails into the ATP subsystem of the ATC. The ATC will use the Track Receivers on the lead–end of the vehicle as determined by the vehicle direction

BEND_CABSIG_TEST: Local–End Cabsignal Track Receiver Test Coil. This is a non-vital signal that carries non–vital information for testing the local end Track Receivers.

BEND_CABSIG_PWR: Local–End Cabsignal Track Receiver Power. This signal provides power to the active circuitry housed inside the ATP Receiver Bar. Power is provided by Power Supplies internal to the ATC.

AEND_CABSIG_RX: Remote–End Cabsignal Track Receiver. This is a vital input signal that carries information from the rails into the ATP subsystem of the ATC. The ATC will use the Track Receivers on the lead–end of the vehicle as determined by the vehicle direction.

AEND_CABSIG_TEST: Remote–End Cabsignal Track Receiver Test Coil. This is a non-vital signal that carries non-vital information for testing the remote end Track Receivers.

AEND_CABSIG_PWR: Remote–End Cabisgnal Track Receiver Power. This signal provides power to the active circuitry housed inside the ATP Receiver Bar. Power is provided by Power Supplies internal to the ATC.

ETHERNET_TX, ETHERNET_RX: ATC 4–wire Ethernet Link. This link allows the ATC to communicate with the vehicle Ethernet and the subsystems connected to it.

6. VEHICLE TO PERIPHERALS INTERFACES

6.1. Summary of Vehicle to Peripherals Interfaces

Signal	Direction Input / Output / Bi - **D**irectional	Function	Vitality V = Vital NV = Non -Vital	Circuit Type D**B** = Double - **B**reak S**B** = Single -**B**reak	Cable Category	Destination/Source	Voltage Reference/ Output	Current Absorption/ Output
ADU_MVB1_A.DATA.P **ADU_MVB1_A.DATA.N** **ADU_MVB1_B.DATA.P** **ADU_MVB1_B.DATA.N**	Bi–Directional	ADU MVB Link 1	NV		A	ADU to MVB	MVB	MVB
ADU_MVB2_A.DATA.P **ADU_MVB2_A.DATA.N** **ADU_MVB2_B.DATA.P** **ADU_MVB2_B.DATA.N**	Bi–Directional	ADU MVB Link 2	NV		A	MVB to ADU	MVB	MVB
AEND_ADU_JUMPER	N/A	A – End ADU designation (wire jumper only on A – End ADU)	NV	Wire Jumper	D	Wire jumper on A – End ADU connector X1	Wire Jumper	Wire Jumper
ADU_BATTERY+ **ADU_BATTERY–**	N/A	Vehicle Battery Supply to ADU	NV		D	ADU	Battery	1.8 Amps max

Table 16 – Summary of Vehicle to Peripherals Interfaces

6.2. Detailed Signal Descriptions

ADU_MVB1_A.DATA, ADU_MVB1_B.DATA: ADU MVB Link 1. MVB bus connection to the ADU.

ADU_MVB2 _A.DATA, ADU_MVB2_B.DATA: ADU MVB Link 2. MVB bus connection to the ADU.

AEND_ADU_JUMPER: The ADU is designated as the A–End ADU when pins 4 and 5 of ADU connector X1 are tied together. This connection is only made on the A–End ADU.

ADU_BATTERY: ADU Battery Supply. Battery Supply (17 – 30 VDC) from vehicle battery to the ADU.

7. PERIPHERAL TO PERIPHERAL INTERFACES

7.1. Summary of Peripheral to Peripheral Interfaces

Signal	Direction Input / Output / Bi-Directional	Function	Vitality V = Vital NV = Non - Vital	Circuit Type DB = Double - Break SB = Single - Break	Cable Category	Destination / Source	Voltage Reference / Output	Current Absorption / Output
ADU_TxD_A **ADU_RxD_A**	Bi – Directional	RS – 485 Link to Hanning & Kahl TWC CCU	NV		A	A-end ADU to A-end Hanning & Kahl TWC CCU	RS485	TBD
ADU_TxD_B **ADU_RxD_B**	Bi – Directional	RS – 485 Link to Hanning & Kahl TWC CCU	NV		A	B-end ADU to B-end Hanning & Kahl TWC CCU	RS485	TBD

Table 17 – Summary of Peripheral to Peripheral Interfaces

7.2. Detailed Signal Descriptions

ADU_TxD_A, ADU_RxD_A: ADU to Hanning & Kahl TWC CCU RS–485 Link. This is an RS–485 Serial Communications Link between the Aspect Display Unit and the Hanning & Kahl TWC CCU that allows the ADU to function as a display for the TWC information in Type I Mode. This link will stay active regardless of ATC status.

ADU_TxD_B, ADU_RxD_B: ADU to Hanning & Kahl TWC CCU RS–485 Link. This is an RS–485 Serial Communications Link between the Aspect Display Unit and the Hanning & Kahl TWC CCU that allows the ADU to function as a display for the TWC information in Type I Mode. This link will stay active regardless of ATC status.

8. MVB TRAINLINES

8.1. Summary of MVB Trainlines

All MVB Input and Output Trainlines Signals are located in the Gateway Register (Port 100(dec), 64(hex).

Signal	Direction Input / Output / Bi-Directional	Byte Bit	Function	Vitality V = Vital NV = Non - Vital	Circuit Type DB = Double - Break SB = Single - Break	Cable Category	Destination / Source	Voltage Reference / Output	Current Absorption / Output
Spin_Slide_Indication_TL	Input	Byte 5 Bit 4	Summary of ECU and PLU Spin Slide indications 0 = Spin/Slide NOT Active 1 = Spin/Slide ACTIVE	NV		A	MVB to ATC	MVB	MVB
ATO_RELEASE_Indication_TL	Input	Byte 6 Bit 2	ATO Release Signal 0 = ATO Release Signal NOT Active 1 = ATO Release Signal ACTIVE (ATO Release Cab A or Cab B Push Button (ATORPB) Activated)	NV		A	MVB to ATC	MVB	MVB
Carwash_TL	Input	Byte 10 Bit 6	Carwash Mode Trainline 0 = No Carwash Mode 1 = Carwash Mode ACTIVE	NV		A	MVB to ATC	MVB	MVB
Wheel Diameter	Input	TBD	TBD	NV		A	MVB to ATC	MVB	MVB

Table 18 – Summary of Peripheral to Peripheral Interfaces

8.2. Detailed Signal Descriptions

Spin_Slide_Indication_TL: Summary of ECU and PLU Spin Slide indications. This is a non-vital, over MVB signal that indicates the summary of several Spin and Slide detection systems. When active, the ATC will adjust braking procedures to allow the vehicle to provide spin/slide control. This signal is active HIGH.

ATO_RELEASE_Indication_TL: ATO Release Signal. This is a non-vital, over MVB signal that indicates the state of the ADU Release/Depart pushbutton, A or B end. There are no separate signals for A-End and B-End. This signal is active HIGH.

Carwash_TL: Carwash Mode Trainline. This is a non-vital, over MVB signal that indicates the state of the Carwash Trainline. This signal is active HIGH.

Wheel Diameter: Wheel Diameter. This is a non-vital, over MVB signal that indicates the current wheel diameter.

APPENDIX A. ATC PINOUT

I. J1 – Power

Pin	Label	Signal
1	BATT+	Battery Input Positive
2	BATT–	Battery Input Negative
3	BATT+	Battery Input Positive
4	N/C	No Connection
5	BATT–	Battery Input Negative

Table 19 – ATC Pinout J1 (Power)

II. J2 – Input / Output 1

Pin	Label	Pin	Label	Pin	Label	Pin	Label	Pin	Label	Pin	Label
1	EB_FEED+	19	EB_RETURN+	37		55	EB_RETURN-	73	ELD_FEED_A	91	ERD_FEED_A
2	EB_FEED-	20		38		56		74		92	
3	ELD_FEED_B	21		39		57	ELD_RETURN_A	75		93	
4	ERD_FEED_B	22	FORWARD_FEED	40		58	ELD_RETURN_B	76		94	
5	CM	23		41	FSB_RETURN_A	59		77		95	FSB_FEED_A
6	M	24		42		60	FSB_RETURN_B	78		96	FSB_FEED_B
7	SPARE_VO1_FEED+	25		43	REVERSE_FEED	61		79	SPARE_VO1_RETURN+	97	CM_FEED
8	SPARE_VO1_FEED-	26		44	REVERSE_RETURN	62	FORWARD_RETURN	80	SPARE_VO1_RETURN-	98	CM_RETURN
9		27		45		63		81		99	M_FEED
10		28		46		64		82	ERD_RETURN_A	100	M_RETURN
11		29	POWER_CUT_FEED	47	POWER_CUT_RETURN	65		83	ERD_RETURN_B	101	
12	ATP_NOT_BYPASS	30	ATP_ACK	48	NO_PROP_FAULT	66	TYPE_I	84	MC_COAST_A	102	
13		31		49	TYPE_II	67	NO_FRICTION_FAULT	85	MC_COAST_B	103	
14		32		50	MC_FSB_B	68	DOORS_CLOSED_A	86		104	FORWARD_IN
15	AEND	33	MANUAL	51		69	DOORS_CLOSED_B	87	FRICTION_APPLIED_A	105	REVERSE_IN
16	BEND	34	ATO	52		70	SPARE_NVI_2	88	FRICTION_APPLIED_B	106	NO_POWER_CUT
17	TWC_CUTOUT	35		53	MC_FSB_A	71		89	TB_APPLIED	107	SPARE_NVI_1
18	ATP_BYPASS	36	SPARE_VI_3	54	SPARE_VI_2	72		90	EB_APPLIED	108	SPARE_VI_1

Table 20 – ATC Pinout J2 (Input / Output 1)

III. J3 – Input / Output 2

Pin	Label	Pin	Label	Pin	Label	Pin	Label	Pin	Label	Pin	Label
1	AEND_CABSIG_PWR+	19	AEND_CABSIG_PWR-	37	AEND_CABSIG_RX+	55	AEND_CABSIG_RX-	73	BEND_CABSIG_PWR+	91	BEND_CABSIG_PWR-
2	TACH_1_PWR	20	TACH_1_GND	38	TACH_1_SIG+	56		74	TACH_1_SIG-	92	
3	TACH_2_PWR	21	TACH_2_GND	39	TACH_2_SIG+	57		75	TACH_2_SIG-	93	BEND_CABSIG_RX+
4	TACH_3_PWR	22	TACH_3_GND	40	TACH_3_SIG+	58		76	TACH_3_SIG-	94	BEND_CABSIG_RX-
5		23		41		59		77		95	
6		24		42		60		78		96	
7	AEND_TWC_TEST+	25	AEND_TWC_TEST-	43		61	AEND_CABSIG_TEST+	79	AEND_CABSIG_TEST–	97	
8	BEND_TWC_TEST+	26	BEND_TWC_TEST-	44		62		80		98	BEND_TWC_TXRX+
9		27		45		63		81		99	
10		28		46		64	BEND_CABSIG_TEST+	82	BEND_CABSIG_TEST–	100	AEND_TWC_TXRX+
11		29		47		65		83		101	
12		30		48		66		84		102	BEND_TWC_TXRX-
13		31		49		67		85		103	
14		32		50		68		86		104	AEND_TWC_TXRX-
15		33		51		69		87		105	
16	AEND_TWC_SHIELD1	34	BEND_TWC_SHIELD1	52	AEND_TWC_SHIELD3	70	BEND_TWC_SHIELD3	88	AEND_CABSIG_SHIELD2	106	AEND_TWC_SHIELD2
17	BEND_CABSIG_SHIELD4	35	AEND_CABSIG_SHIELD4	53	TACH_1_SHIELD	71	TACH_3_SHIELD	89	BEND_CABSIG_SHIELD2	107	BEND_TWC_SHIELD2
18	BEND_CABSIG_SHIELD1	36	AEND_CABSIG_SHIELD1	54	TACH_2_SHIELD	72	AEND_CABSIG_SHIELD3	90	BEND_CABSIG_SHIELD3	108	RESERVED (CHASSIS GND)

Table 21 – ATC Pinout J3 (Input / Output 2)

IV. J4 – Ethernet

Pin	Label	Signal
1	ETHERNET_TX+	Data TX/RX+
2	ETHERNET_RX+	
3	ETHERNET_TX-	Data TX/RX-
4	ETHERNET_RX–	

Table 22 – ATC Pinout J4 (Ethernet)

V. J5 – MVB 1

Pin	Label	Signal
1	MVB1_A.DATA_P	
2	MVB1_A.DATA_N	
3		
4	MVB1_B.DATA_P	
5	MVB1_B.DATA_N	
6		
7		
8		
9		

Table 23 – ATC Pinout J5 (MVB 1)

VI. J6 – MVB 2

Pin	Label	Signal
1	MVB2_A.DATA_P	
2	MVB2_A.DATA_N	
3		
4	MVB2_B.DATA_P	
5	MVB2_B.DATA_N	
6		
7		
8		
9		

Table 24 – ATC Pinout J6 (MVB 2)

APPENDIX B. ADU PINOUT

I. X1 – Power

Pin	Label	Signal
1	ADU_BATTERY+	
2	ADU_BATTERY–	
3	ADU_BATTERY+	
4	GND_CODING	AEND_ADU_JUMPER (Wiring on the A–End ONLY)
5	ID0	

Table 25 – ADU Pinout X1 (Power)

II. X – MVB Link 1

Pin	Label	Signal
1	ADU_MVB1_A.DATA.P	
2	ADU_MVB1_A.DATA.N	
3	NC	
4	ADU_MVB1_B.DATA.P	
5	ADU_MVB1_B.DATA.N	
6	NC	
7	NC	
8	NC	
9	NC	

Table 26 – ADU Pinout X4 (MVB Link 1)

III. X5 – MVB Link 2

Pin	Label	Signal
1	ADU_MVB2_A.DATA.P	
2	ADU_MVB2_A.DATA.N	
3	NC	
4	ADU_MVB2_B.DATA.P	
5	ADU_MVB2_B.DATA.N	
6	NC	
7	NC	
8	NC	
9	NC	

Table 27 – ADU Pinout X5 (MVB Link2)

IV. X8 – RS – 485 Link

Pin	Label	Signal
1	ADU_TxD_A	
2	ADU_RxD_A	
3	ADU_TxD_A	
4	ADU_RxD_A	
5	GND	
6	ADU_TxD_B	
7	ADU_RxD_B	
8	ADU_TxD_B	
9	ADU_RxD_B	

Table 28 – ADU Pinout X8 (RS – 485 Link)

[redacted]

[redacted]

APPENDIX D. MVB INTERFACE

ATC Output Register 0x580

MVB_Out_580h_Msg (ver 1)	
Producer/Source	ATC
ver	1
name	MVB_Out_580h_Msg
Period	32 msec
Description	Traction Signal and Speed from ATC to Vehicle
Size	8 bytes
Port	1408(dec)/580(hex)
desc	MVB Output Message - Port 1408/580h

Data Layout

Byte num	**Bit number**							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	ato_prop_effort, byte 0 (MSB)							
1	ato_prop_effort, byte 1							
2	atp_system_speed, byte 0 (MSB)							
3	atp_system_speed, byte 1							
4	mvb580h_spare_4							
5	mvb580h_spare_5							
6	mvb580h_spare_6							
7	mvb580h_spare_7						ato_prop_effort_status	

ATC Output Register 0x581

MVB_Out_581h_Msg (ver 1)	
Producer/Source	ATC
ver	1
name	MVB_Out_581h_Msg
Period	64 msec
Description	ATC Data, mainly for the Event Recorder
Size	32 bytes
Port	1409(dec)/581(hex)
desc	MVB Output Message - Port 1409/581h

Data Layout

Byte num	**Bit number** 7	6	5	4	3	2	1	0
0	ato_twc_typeII failed	ato_failed	atp_failed	ato_twc_typeII ready	ato_ready	atp_ready	atp_type_two	atp_type_one
1	atp_valid_cab_signal	ato_twc_bad_stop	atp_dwell_expired	atp_train_berthed	atp_twc_bypass	atp_bypass	atp_cab_b_active	atp_cab_a_active
2	mvb581h_spare1	atp_active_events	atp_slide_detect	atp_spin_detect	atp_overspeed	atp_rollaway	atp_vzero_declared	atp_no_motion
3	mvb581h_spare2	atp_dept_test_status			atp_oper_mode			
4	atp_display_spd_limit, byte 0 (MSB)							
5	atp_display_spd_limit, byte 1							
6	atp_speed_non_powered_truck, byte 0 (MSB)							
7	atp_speed_non_powered_truck, byte 1							
8	atp_system_speed, byte 0 (MSB)							
9	atp_system_speed, byte 1							
10	atp_decel_rate, byte 0 (MSB)							
11	atp_decel_rate, byte 1							
12	ato_route_id, byte 0 (MSB)							
13	ato_route_id, byte 1							
14	atp_pvid, byte 0 (MSB)							
15	atp_pvid, byte 1							
16	ato_station_id							
17	atp_aspect_track_id, byte 0 (MSB)							
18	atp_aspect_track_id, byte 1							
19	atp_Vital_In1_low_byte							
20	atp_Vital_In1_high_byte							
21	atp_Vital_In2_low_byte							
22	atp_Vital_In2_high_byte							
23	atp_MFB_NVital_In							
24	atp_MFB_Vital_Out							
25	atp_MIO_Vital_In							
26	atp_MIO_Vital_Out							
27	mvb_581_spare, entry 0							
28	mvb_581_spare, entry 1							
29	mvb_581_spare, entry 2							
30	mvb_581_spare, entry 3							
31	mvb_581_spare, entry 4							

ATC Output Register 0x582

MVB_Out_582h_Msg (ver 1)	
Producer/Source	ATC
ver	1
name	MVB_Out_582h_Msg
Period	128 msec
Description	ATC Data for ADU Displays
Size	32 bytes
Port	1410(dec)/582(hex)
desc	MVB Output Message - Port 1410/582h

Data Layout

Byte num	**Bit number 7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	ato_twc_typeII failed	ato_failed	atp_failed	ato_twc_typeII ready	ato_ready	atp_ready	atp_type_two	atp_type_one
1	atp_valid_cab_signal	ato_twc_bad_stop	atp_dwell_expired	atp_train_berthed	atp_twc_bypass	atp_bypass	atp_cab_b_active	atp_cab_a_active
2	mvb582h_spare1	atp_active_events	atp_slide_detect	atp_spin_detect	atp_overspeed	atp_rollaway	atp_vzero_declared	atp_no_motion
3	mvb582h_spare2	atp_dept_test_status			atp_oper_mode			
4	atp_a_end_west	atp_a_end_east	atp_friction_brake_fault	atp_speed_limit_control	atp_ues_brake	atp_full_service_brake	atp_penalty_brake	atp_emergency_brake
5	mvb582h_spare3			atp_aud_req_beep1	atp_aud_req_beep3	atp_aud_req_alert	atp_aud_req_chirp	atp_aud_req_cont
6	mvb582h_spare4							ato_twc_overloop
7	atp display spd limit, byte 0 (MSB)							
8	atp_display_spd_limit, byte 1							
9	atp_speed_non_powered_truck, byte 0 (MSB)							
10	atp speed non powered truck, byte 1							
11	atp system speed, byte 0 (MSB)							
12	atp_system_speed, byte 1							
13	atp_decel_rate, byte 0 (MSB)							
14	atp_decel_rate, byte 1							
15	ato route id, byte 0 (MSB)							
16	ato_route_id, byte 1							
17	atp_pvid, byte 0 (MSB)							
18	atp_pvid, byte 1							
19	atp train len							
20	atp_aspect_track_id, byte 0 (MSB)							
21	atp_aspect_track_id, byte 1							
22	atp_target_speed							
23	atp distance to go, byte 0 (MSB)							
24	atp distance to go, byte 1							
25	atp_time_to_profile							
26	atp_event1, byte 0 (MSB)							
27	atp event1, byte 1							
28	atp event2, byte 0 (MSB)							
29	atp_event2, byte 1							
30	mvb582h_spare5, entry 0							
31	mvb582h_spare5, entry 1							

ADU Registers 0x500 and 0x5A0

MVB_adu_500h_5A0h_Msg (ver 1)	
Producer/Source	ADU
ver	1
name	MVB_adu_500h_5A0h_Msg
Period	128 msec
Description	Aspect Display Unit Data for the ATC Controller Only
Size	32 bytes
Port	1280(dec)/500(hex) and 1440(dec)/5A0(hex)
desc	MVB Output Message - Port 1280/500h and 1440/5A0h

Data Layout								
Byte num	**Bit number**							
	7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
0	adu_display_screen				adu_auto_bright	adu_error	adu_cab_b	adu_cab_a
1	adu_twc_typel_failure	adu_twc_typel_ready	adu_st_fail	adu_st_pass	adu_st_in_progress	adu_dept_test_request	adu_stop_proceed_request	adu_street_run_request
2	adu_bf2_spare				adu_door_override	adu_twc_cancel_request	adu_twc_non_main_request	adu_twc_sec_request
3	adu_route_id_request, byte 0 (MSB)							
4	adu_route_id_request, byte 1							
5	adu_events, entry 0, byte 0 (MSB)							
6	adu_events, entry 0, byte 1							
7	adu_events, entry 1, byte 0 (MSB)							
8	adu_events, entry 1, byte 1							
9	adu_rev, entry 0							
10	adu_rev, entry 1							
11	adu_rev, entry 2							
12	adu_rev, entry 3							
13	adu_rev, entry 4							
14	adu_rev, entry 5							
15	adu_crc, byte 0 (MSB)							
16	adu_crc, byte 1							
17	adu_crc, byte 2							
18	adu_crc, byte 3							
19	adu_spare, entry 0							
20	adu_spare, entry 1							
21	adu_spare, entry 2							
22	adu_spare, entry 3							
23	adu_spare, entry 4							
24	adu_spare, entry 5							
25	adu_spare, entry 6							
26	adu_spare, entry 7							

APPENDIX E. TYPE I TWC INTERFACE PROVIDED BY HANNING & KAHL

The Type I TWC Subsystem is provided by a Hanning & Kahl HCS-V system, with two complete systems per vehicle; one on the A-end and one on the B-end. For additional information refer to the Hanning & Kahl TWC ICDD [1]. This subsystem is made of the following components:

Component		Hanning & Kahl P/N	ASTS P/N
Hanning & Kahl On-board solution 420.075.002 (ASTS: 3238.0100012)	TWC Communication / Control Unit	44.605.008	3238.0100015
	Transponder, type HCS-V-T	44.645.140	3238.0100017
	Mating Connector, for CCU to Power Supply Cable	43.170.013	4346.0100437
	Cable, CCU to Transponder	44.627.601	7503.0100186
	Mating Connector, for CCU to ADU Cable	43.170.020	3238.0100029

The Type I TWC system connects only to the Aspect Display unit on each cab end over an RS-485 communication link. There is no direct connection between the Type I TWC system and the ATC, and both systems are fully independent. Reference Hanning & Kahl drawing D00015038-x [2].

APPENDIX F. TYPE II TWC INTERFACE PROVIDED BY ASTS

Type II TWC Message Formats

TWC Communication between the ATC and the Wayside uses a Genisys encoded message. A two-byte CRC checksum provides data security for all communications. The generator polynomial is the standard CRC-16 polynomial $x^{16} + x^{15} + x^{2} + 1$. The CRC bytes are calculated on the message header, address and data bytes of the message.

Special “Fx” control characters are used in the message header and message end bytes to identify the message type and message end. In order to distinguish these characters from regular characters in the address, data, and CRC bytes in the range of “F0” through “FE” are sent as a sequence of two bytes (Note that character FF is illegal since it is commonly created on noisy lines). This sequence consists of the data escape character “F0” followed by the low order nibble (right hex digit) of the original character. Therefore, once a message has been constructed, any occurrences of control characters in the address, data, and CRC bytes are replaced with two-byte sequences. Once a complete message frame has been received, the two-byte sequences must be replaced with the corresponding control character before further processing

twc_in_msg (ver 0)	
ver	0
name	twc_in_msg – Transmitted to Wayside from ATC
desc	The TWC Input Message

Data Layout

Byte num	Bit number 7	6	5	4	3	2	1	0
0	ato_twc_header							
1	ato_twc_node_addr							
2	ato_twc_eta, byte 0 (MSB)							
3	ato_twc_eta, byte 1							
4	ato_twc_pvid1_hundreds				ato_twc_pvid1_tens			
5	ato_twc_pvid1_units				ato_twc_pvid1_thousands			
6	ato_twc_tracking_id, byte 0 (MSB)							
7	ato_twc_tracking_id, byte 1							
8	ato_twc_route_id_hundreds				ato_twc_route_id_tens			
9	ato_twc_route_id_units				ato_twc_dept_test_status		ato_twc_spare2	
10	ato_twc_spare4	ato_twc_doors_open	ato_twc_doors_closed	ato_twc_spare3	ato_twc_mode			
11	ato_twc_perf_lvl				ato_twc_coast	ato_twc_spare5	ato_twc_travel_east	ato_twc_travel_west
12	ato_twc_spare6, byte 0 (MSB)							
13	ato_twc_spare6, byte 1							
14	ato_twc_pvid2_hundreds				ato_twc_pvid2_tens			
15	ato_twc_pvid2_units				ato_twc_spare7			
16	ato_twc_spare8, byte 0 (MSB)							
17	ato_twc_spare8, byte 1							
18	ato_twc_spare9				ato_twc_train_length			
19	ato_twc_pss_brake_rate				ato_twc_spare11	ato_twc_master_time_updated	ato_twc_vzero	ato_twc_spare10
20	ato_twc_spin_slide	ato_twc_berthed	ato_twc_bad_stop	ato_twc_spare12				
21	ato_twc_spare13, entry 0							
22	ato_twc_spare13, entry 1							
23	ato_twc_spare13, entry 2							
24	ato_twc_spare13, entry 3							
25	ato_twc_spare13, entry 4							

<table>
<tr><th colspan="9">twc_out_msg (ver 0)</th></tr>
<tr><td>ver</td><td colspan="8">0</td></tr>
<tr><td>name</td><td colspan="8">twc_out_msg – Transmitted to ATC from Wayside</td></tr>
<tr><td>desc</td><td colspan="8">The TWC Output Message</td></tr>
<tr><th colspan="9">Data Layout</th></tr>
<tr><th rowspan="2">Byte num</th><th colspan="8">Bit number</th></tr>
<tr><th>7</th><th>6</th><th>5</th><th>4</th><th>3</th><th>2</th><th>1</th><th>0</th></tr>
<tr><td>0</td><td colspan="8">twc_loop_address</td></tr>
<tr><td>1</td><td colspan="4">twc_pvid_hundreds</td><td colspan="4">twc_pvid_tens</td></tr>
<tr><td>2</td><td colspan="4">twc_pvid_units</td><td colspan="4">twc_pvid_thousands*</td></tr>
<tr><td>3</td><td colspan="8">twc_tracking_id, byte 0 (MSB) (4 Digit BCD)</td></tr>
<tr><td>4</td><td colspan="8">twc_tracking_id, byte 1</td></tr>
<tr><td>5</td><td colspan="4">twc_route_id_hundreds</td><td colspan="4">twc_route_id_tens</td></tr>
<tr><td>6</td><td colspan="4">twc_route_id_units</td><td colspan="4">twc_spare2</td></tr>
<tr><td>7</td><td colspan="4">twc_perf_lvl</td><td>twc_coast_set</td><td>twc_coast_cancel</td><td>twc_spare3</td><td>twc_close_doors</td></tr>
<tr><td>8</td><td colspan="8">twc_spare4</td></tr>
<tr><td>9</td><td colspan="4">twc_spare5</td><td colspan="4">twc_pss_brk_rate</td></tr>
<tr><td>10</td><td colspan="8">twc_month</td></tr>
<tr><td>11</td><td colspan="8">twc_day</td></tr>
<tr><td>12</td><td colspan="8">twc_year</td></tr>
<tr><td>13</td><td colspan="8">twc_hour</td></tr>
<tr><td>14</td><td colspan="8">twc_minute</td></tr>
<tr><td>15</td><td colspan="8">twc_second</td></tr>
</table>

*Note: Health indication for link between TWC PC and Wayside TWC SCC (twc_way_pc_link_status) removed per P3010-MA-KI-LTR-02146_1.

INDEX

T

V

APPENDIX A

HANNING & KAHL HCS-V RADIO COMMUNICATION SYSTEM EQUIPMENT MANUALS

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Operating Manual

HCS-V Radio Communication System

Carborne Equipment

Project: Los Angeles

EDP no.: 420 075 002

Title: Operating Manual
HCS-V Radio Communication System
Carborne Equipment

Version: 1.0
Date: 04.03.2014

Contents

1 General

This manual describes the carborne equipment of the HANNING & KAHL HCS-V communication system with HCS-V control panel W1 and transponder HCS-V-T designed for deployment in **Los Angeles, USA**.
The technical data enclosed describes the individual components.

The author of these operating instructions intends this manual to be read by the management of mass transit authorities, in particular, however, by the authorities' skilled workers who have had appropriate professional training as electricians or electronics specialists.

To guarantee safe and correct commissioning, maintenance and repair, it is imperative that these operating instructions are read and thoroughly understood before commencing work.

Assembly sequences and modes of operation other than those described in these operating instructions are not permissible and may lead to system failure.

1.1 Address of manufacturer and customer service

If you have any questions concerning these operating instructions, please contact:

HANNING & KAHL GmbH & Co KG
Rudolf-Diesel-Str. 6
33813 Oerlinghausen

Telephone: **+49 (0) 52 02 - 70 76 00**
Fax: **+49 (0) 52 02 - 70 76 29**
E-Mail: info@hanning-kahl.com

Internet: http://www.hanning-kahl.com/

HANNING & KAHL’s **Service Division** can be reached on:

Telephone: **+49 (0) 52 02 - 70 76 04**

In urgent cases, please contact the **on-call service**:
+49 171 3360360.

HANNING & KAHL's address in North America is:

HANNING & KAHL L.P.
114 DeKalb Street
Unit "C"
Bridgeport, PA 19405, USA

Phone: **+1 610 239 1620**
Fax: **+1 610 239 1615**
E-Mail: info@hukus-hanning.com

Please quote the number and the date indicated in the footer of this documentation.

1.2 EC conformity

The HCS-V communications system is EC conform. The certificate of EC conformity is available on request from the manufacturer’s address.

The identification plate of the HCS-V communications system bears the CE sign.

The HCS-V communication system fulfils the following international standards:

EN 50121-3-2: 2007-07 (EMC)

EN 60950-1: 2006+A11:2009+A1:2010+A12:2011 (Safety)

ETS 300 330: 2010 (Radio)

1.3 Symbols and conventions

The following symbols and conventions apply to the documentation:

Any procedural instruction is introduced with the sentence: ”Proceed as follows:“. Subsequent steps are numbered.

✓ A tick mark indicates certain conditions that must be satisfied before you start the actual procedure.

⇨ An arrow indicates that previously completed steps must be repeated.

➢ A triangle indicates several different operations that must be completed in sequence.

◈ A diamond indicates a number of different options. Please select.

● A dot indicates a first level bullet.

- A dash indicates a second level bullet.

ⓘ An information character designates a specific feature.


A book points to additional information in other documents.

2 Safety instructions

Observe the safety precautions in this chapter and all the other safety precautions throughout this manual

2.1 intended usage

The HCS-V carborne equipment described in this manual was developed for rail vehicles in **Los Angeles, USA**.

Observe all the information in this manual, in particular the safety warnings and the maintenance instructions.

If in doubt, or if operating circumstances change compared with the status which was made known to HANNING & KAHL when the order was placed, seek clarification with HANNING & KAHL.

2.2 unauthorized usage

The operational safety of communication system HCS-V can only be guaranteed when the device is installed and deployed as described in accordance with the previous chapters.

The limit values indicated in the chapter entitled “Technical Data“ must not be exceeded.

2.3 Personnel qualification and training

Personnel engaged with the operation, maintenance, inspection and assembly of the equipment must have the necessary qualifications. It is the responsibility of operators to determine areas of responsibility, competence and staff supervision. HANNING & KAHL can provide training if requested to do so by the operator of the communications system.

2.4 Dangers of non-observance of safety instructions

Non-observance of safety instructions can result in danger to persons, the environment and the device itself. Non-observance of safety instructions can also lead to a loss of rights to claim under warranty.

2.5 Safety instructions for assembly, maintenance and inspection work

The operator of the HANNING & KAHL equipment is expected to employ qualified personnel trained in the application of these instructions for all assembly and maintenance work.

The manufacturer/supplier assumes that general safety requirements (e.g. national directives for electrical installations, regulations for the prevention of accidents, in-house safety instructions) are known to the operator and his specialist staff and are observed.

All safety and protective devices must be re-installed/put back into operation immediately after completion of work.

2.6 Unauthorized modification and manufacture of spare parts

Modifications or changes are only permitted after consultation with the manufacturer.

Original spare parts and accessories authorized by the manufacturer contribute to safety. The use of any other parts may result in denial of all rights to claim for subsequent damage by HANNING & KAHL.

2.7 Designation of instructions and warnings in this manual

Special warnings and instructions in this manual are marked by the following symbols:

DANGER	**DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury**
WARNING	**WARNING indicates a potential hazardous situation which, if not avoided, could result in death or serious injury.**
CAUTION	**CAUTION indicates a potential hazardous situation which, if not avoided, may result in minor or moderate injury.**
NOTICE	**NOTICE indicates a potential hazardous situation which, if not avoided, may result in property damage.**

Safety instructions directly attached to the equipment must be completely legible and strictly followed at all times.

2.8 Important Notice

NOTICE

Material damage due to destruction of internal components!

Pulling and inserting components in the rack and connecting and separating cable connections while the operating voltage is switched on may damage internal components.

➢ Always switch off the operating voltage first.

3 Function

The HCS-V control panel W1 is connected to the HCS-V-T transponder via a cable set supplied.

The HCS-V-T transponder is mounted underneath the vehicle. It is activated by driving onto the receiver loop which is installed between the rails. It then transmits a data set according to its coding.

The receiver loop is connected to the HCS-V communication system (interrogator) in the wayside equipment. The HCS-V interrogator receives the data, decodes it and passes it on to a higher-ranking controller.

The HANNING & KAHL carborne equipment in Los Angeles includes:

- HCS-V-T transponder, EDP No.: 044.645.140
- HCS-V control panel W1, EDP No.: 044.605.008
- transponder connecting cable, (permanently connected to transponder HCS-V-T)
- cable for connecting the transponder to the HCS-V control panel W1, EDP No.: 44.627.601
- connecting cable, power supply, EDP No.: 044.608.901

4 Components

In the following chapters the individual components are explained in more detail. Apart from the transponder, whose description is project-independent, the technical information refers to component versions for **Los Angeles**.

4.1 Transponder HCS-V-T

Transponder HCS-V-T is mounted underneath both ends of a double-ended light rail vehicle. It functions as a transmitter/antenna which transfers information from the encoding device to the wayside equipment.

The attached manual **40805104_AE** on transponder HCS-V-T contains all technical information necessary for installation, programming, commissioning and maintenance.

4.2 HCS-V Control Panel W1

The HCS-V control panel W1 is connected to the HCS-V-T transponder. As an encoding device, it encodes the HCS-V-T transponder. HCS-V control panel W1 receives the logical information for encoding from the vehicle ADU system.

The enclosed description of HCS-V control panel W1 number 44605 008_AE contains all technical data and information on set-up, function, installation, commissioning.

The HCS-V control panel W1 for Los Angeles takes the form of an aluminum housing and is mounted on a rack on the vehicle.

4.3 Cable kit

Ready-for-use cables are supplied to connect the individual HANNING & KAHL carborne components in Los Angeles.

The cable connections are as follows:

Please refer to drawing D00015038 for cable lengths and position numbers.

Pos.: 2.1

6-pole shielded cable with a length of 4 m (13.12 ft) from the distribution voltage to the HCS-V control panel W1.

Pos.: 3.1

6-pole shielded cable with a length of 13 m (42.65 ft) between HCS-V control panel W1 and the connector (3.3 / 4.0),

Pos.: 4.2

The 6-pole shielded cable is permanently connected to the HCS-V-T transponder, and 4 m (13.12 ft) long.

Description of the cable connections:

The **6-pole shielded cable (Pos. 2.1)** connects transponder HCS-V-T and HCS-V control panel W1 to the corresponding power supply. The operating voltage DC +24 volt battery voltage must be fed in protected manner.
The vehicle signals AC (active cab), nvPD (non-vital vehicle detection), EOT (end of train) are transferred to HCS-V control panel W1.

The **6-pole shielded cable (Pos. 3.1)** makes the connection between HCS-V control panel W1 and transponder HCS-V-T. However, it does not end at the transponder, but in a plugged connector base outside the car body.

The **6-pole shielded cable (Pos. 5.1)** on transponder HCS-V-T is permanently wired to it and encapsulated. It has a plug connector at the end which fits into the heavy plug connector base.

4.4 Interface software

The user software for the HANNING & KAHL HCS-V control panel W1 was created specially for the project in **Los Angeles.**

Please refer to manual **44605008_AE** for a description.

5 Assembly

Assembly work includes:

- installation of transponder HCS-V-T,
- installation of the HCS-V control panel W1,
- laying of connecting cables.

Refer to operating instructions **40805104_AE** on how to install transponder HCS-V-T. The manual contains precise details of the mounting location and the clearances which have to be kept to adjacent metal parts.

When laying the connecting cables, ensure that they are laid tightly without contact to each other or other objects. Observe the smallest permissible bending radii.

For the type of cable deployed, the following bending radii minimum value applies:

a Cable 2.1 - 6x0.5 mm² (20AWG)

r = 40 mm (1.57 inch) (1)

r = 25 mm (1 inch), (2)

b Cable 3.1 - 6x0.5 mm² (20AWG)

r = 40 mm (1.57 inch) (1)

r = 25 mm (1 inch), (2)

c Cable 4.1 - 6x0.5 mm² (20AWG)

r = 40 mm (1.57 inch) (1)

r = 25 mm (1 inch), (2)

(1) - free type of installation

(2) - fixed type of installation

6 Commissioning

NOTICE

Damage to device as a result of destruction of internal components.

Pulling and inserting components in the rack and connecting and separating cable connections while the operating voltage is switched on may damage internal components.

➢ Always switch off the operating voltage first.

Commissioning cannot begin until:

✓ transponder HCS-V-T is mounted properly,

✓ HCS-V control panel W1 has been firmly mounted on the designated frame,

✓ all electric connections between HCS-V-T transponder, HCS-V control panel W1 and the power supply have been made in accordance with the drawing.

Proceed as follows:

1. Measure the operating voltage before you switch on for the first time.
   The operating voltage must be within the tolerances.
2. Measure the voltage of the vehicle signals (AC, EoT).
   The operating voltage must be within the tolerances.
3. Switch the car battery on.
4. Start the vehicle.
   HCS-V control panel W1 and transponder HCS-V-T are now switched on.

ⓘ To commission HCS-V control panel W1 and transponder HCS-V-T, please refer to the corresponding manual.

The following functions must be tested when performing the final acceptance test:

- Operating pushbuttons
- Car numbers

- Route numbers
- Inputs (AC, nvPD, EOT)

The steps involved in the final acceptance test are described in the following chapter.

7 Final acceptance based on commissioning protocol

The system and its components can be tested/accepted with the HANNING & KAHL HCS-V-PF testing device for carborne equipment or with HANNING & KAHL HCS-V wayside equipment which has already been commissioned.

When using the HCS-V-PF testing device, a test loop is deployed for reception of the data transmitted by the transponder. The testing device must be connected to a PC which has software HCS-V AssistS installed.

When using functionally-efficient HANNING & KAHL wayside equipment, a corresponding PC must also be connected.

For the test points described in the following chapters, the vehicle must be driven onto the receiver loop of the wayside equipment. Alternatively the test loop of the testing device can be pushed underneath the vehicle transponder. Then test the data transferred with the help of the menu item "Display loop data“ of the Software HCS-V AssistS and confirm the results in the commissioning protocol.

A **commissioning protocol** for the final acceptance test is also attached.

7.1 Testing 'Route numbers'

Proceed as follows:

1. Set the routes used by the transit authority on the ADU system.
2. Drive the rail vehicle with the HCS-V-T transponder onto the receiver loop of the wayside equipment, or push the test loop of the HCS-V-PF testing device underneath the transponder.
3. Check the data transmitted with the help of the menu item "Display loop data“ of the HCS-V AssistS software.
   Route information is displayed in clear text.
4. Confirm the test in the commissioning protocol.

7.2 Testing 'Pushbuttons'

Proceed as follows:

1. Drive the rail vehicle with the HCS-V-T transponder onto the receiver loop of the wayside equipment, or push the test loop of the HCS-V-PF testing device underneath the transponder.
2. Press the pushbuttons for the manual setting commands on the ADU system.
3. With the help of menu item "Display loop data" of HCS-V AssistS software, check the information on the respective manual setting command transmitted.
4. Confirm the test in the commissioning protocol.

7.3 Testing 'Car numbers'

Proceed as follows:

1. Set the car numbers used in your transit authority on the ADU system.
2. Drive the rail vehicle with the HCS-V-T transponder onto the receiver loop of the wayside equipment, or push the test loop of the HCS-V-PF testing device underneath the transponder.
3. Check the data transmitted with the help of the menu item "Display loop data“ of the HCS-V AssistS software.
   The information on the car numbers is displayed in clear text.
4. Confirm the test in the commissioning protocol.

8 Service

The system is generally maintenance free. HANNING & KAHL recommends the following checks.

Every **6 months**:

- Check that all plug and screw connections are tight.
- Check that all cable connections are tight and intact. Replace if necessary.
- Check that the transponder is attached securely.

9 Trouble shooting

Error	Possible cause	Indication	Corrective action
No data transmission from the vehicle	HCS-V control panel W1 defective	LEDs and seven-segment display on the control panel are off	Test power supply and cable to the control panel.
	Transponder defective	No proper data reception is displayed in the point controller / HCS-V-PF testing equipment.	Test the transponder with HCS-V-PF system testing equipment, and replace transponder if necessary
	Incorrect cabling		Test with the HCS-V-PF system testing equipment, correct errors in cabling

Table 1: Trouble shooting

For the following reasons, the HCS-V carborne equipment can only be repaired by HANNING & KAHL:

1 Assembly is mixed on the electronic board, i.e. SMD and conventional assembly have been selected.
Special knowledge and equipment are necessary for repair.

2 The components used work in an extended temperature range, i.e. only special-purpose components may be used for repair.

10 Appendix

Technical information:

- 44605008_AE
- 40805104_AE

Drawing:

- D00015038-x

HANNING & KAHL GmbH & Co KG	**Retour-Begleitschein** Return accompanying note **Bitte zu jedem Gerät ausfüllen!** Please fill in for each single unit!

Geräte-Typ Type		
Geräte-Nr. Serial number		
Artikel-Nr. item number		
Verkehrsbetrieb Transport Authority		
Ausfalldatum und Ausfallzeit Date of failure and downtime		
Fehlerart Type of error		
Permanent Permanent	**Ja** Yes	**Nein** No
Sporadisch Sporadic	**Ja** Yes	**Nein** No
Fehlerbeschreibung Error description		
Bemerkung Comment		
Datum / Unterschrift Date / name		
Ansprechpartner/Tel.-Nr. Contact person/Phone-no.		
Relevant für Steuerungen mit Mikroprozessor und EPROM Relevant for controller with microprocessor and EPROM		
Anzeige der CPU Display of CPU		
Version CPU und IFC Version of CPU and IFC		
Auszug Fehlerspeicher beifügen Include error memory of CPU and IFC		

HANNING & KAHL

Technical Information

HCS-V Radio Communication System

HCS-V-Control Panel W1

Project: Los Angeles

EDP no.: 44 605 008

Title: Technical Information
HCS-V Radio Communication System
HCS-V-Control Panel W1

Version: 1.0
Date: 04.03.2014

Contents

1 General

The HANNING & KAHL communication system HCS-V facilitates two-way wireless data transmission between rail vehicles and the stationary parts of the communication system in a controller.

The information to be transmitted can be setting commands, train numbers, etc, depending on the application.

The HCS-V control panel W1 described here is intended for installation in rail vehicles in **Los Angeles**.

The illustrations below show the front view with operating, display, and plug-in elements for Los Angeles.

Fig. 1: Front view of HCS-V control panel W1

The HCS-V control panel is tasked with configuring the connected HCS-V-T transponder in accordance with the data provided to it from the ADU system or via the vehicle signals.

The author intends this manual to be read by transit authority/vehicle-manufacture staff who have completed training as electricians or electronic engineers.

Work may only be performed by skilled and instructed staff.

1.1 Address of manufacturer and customer service

If you have any questions concerning these operating instructions, please contact:

HANNING & KAHL GmbH & Co KG
Rudolf-Diesel-Str. 6
33813 Oerlinghausen

Telephone: **+49 (0) 52 02 - 70 76 00**
Fax: **+49 (0) 52 02 - 70 76 29**
E-Mail: info@hanning-kahl.com

Internet: http://www.hanning-kahl.com/

HANNING & KAHL's **Service Division** can be reached on:

Telephone: **+49 (0) 52 02 - 70 76 04**

In urgent cases, please contact the **on-call service**:
+49 171 3360360.

HANNING & KAHL's address in North America is:

HANNING & KAHL L.P.
114 DeKalb Street
Unit "C"
Bridgeport, PA 19405, USA

Phone: **+1 610 239 1620**
Fax: **+1 610 239 1615**
E-Mail: info@hukus-hanning.com

Please quote the number and the date indicated in the footer of this documentation.

2 Safety instuctions

Observe the safety instructions in this chapter and all the other safety instructions throughout this manual.

2.1 Intended usuage

HCS-V control panel W1 encodes a HCS-V-T transponder within the framework of the HCS-V communication system.

It was developed for installation in a rail vehicle in **Los Angeles** and works with a project-specific user program.

Observe the assembly, commissioning and operating instructions in this manual.

2.2 Unauthorized usage

The operating safety of the HCS-V cab control panel is only guaranteed if the device is used for the purpose described in the chapter “Intended usage” above.

The limit values indicated in the chapter entitled “Technical Data“ must not be exceeded.

2.3 Personnel qualification and training

Personnel engaged with the operation, maintenance, inspection and assembly of the equipment must have the necessary qualifications. It is the responsibility of the operator to determine areas of responsibility, competence and staff supervision. HANNING & KAHL can provide training if requested to do so by the operator of the HANNING & KAHL equipment.

2.4 Dangers of non-observance of safety instructions

Non-observance of safety instructions can result in danger to persons, the environment and the device itself. Non-observance of safety instructions can also lead to a loss of rights to claim under warranty.

2.5 Safety instructions for assembly, maintenance and inspection work

The operator of the HANNING & KAHL equipment is expected to employ qualified personnel trained in the application of these instructions for all assembly and maintenance work.

The manufacturer/supplier assumes that general safety requirements (e.g. national directives for electrical installations, regulations for the prevention of accidents, in-house safety instructions) are known to the operator and his specialist staff and are observed.

All safety and protective devices must be re-installed/put back into operation immediately after completion of work.

2.6 Unauthorized modification and manufacture of spare parts

Modifications or changes are only permitted after consultation with the manufacturer.

Original spare parts and accessories authorized by the manufacturer contribute to safety. The use of any other parts may result in denial of all rights to claim for subsequent damage by HANNING & KAHL.

2.7 Designation of instructions and warnings in this manual

Special warnings and instructions in this manual are marked by the following symbols:

⚠ DANGER	**DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury**
⚠ WARNING	**WARNING indicates a potential hazardous situation which, if not avoided, could result in death or serious injury.**
⚠ CAUTION	**CAUTION indicates a potential hazardous situation which, if not avoided, may result in minor or moderate injury.**
NOTICE	**NOTICE indicates a potential hazardous situation which, if not avoided, may result in property damage.**

Safety instructions directly attached to the equipment must be completely legible and strictly followed at all times.

2.8 Important Notice

NOTICE

Material damage due to destruction of internal components!

Pulling and inserting components in the rack and connecting and separating cable connections while the operating voltage is switched on may damage internal components.

➤ Always switch off the operating voltage first.

3 Technical data

Data		Values
Operating voltage		DC 24 V (-30% - +20%)
Current consumption		max. 500 mA incl. connected HCS-V-T transponder
Dimensions Front panel	 Height Width	 69 mm (2.71 inch) 105 mm (4.13 inch)
Housing	Height Width Depth	69 mm (2.71 inch) 130 mm (5.11 inch) 205 mm (8.07 inch)
Connector, rear side	Depth	42 mm (1.65 inch)
Weight		1,550 g (3.42 pound)
Operating temperature range		-25°C …+70°C (-13°F … 158°F)
Storage temperature range		-25°C … +85°C (-13°F … 185°F)
Rel. humidity		95% non-condensing

Table 1: Technical data, HCS-V control panel W1

4 Function and construction

The following chapters contain more information on

- Operating mode
- Arrangement in the rail vehicle
- Operating elements
- Display elements
- Electric connections

4.1 Functional features

Communication system HCS-V consists of carborne and wayside equipment.

The carborne equipment includes the HCS-V control panel W1 and the HCS-V-T transponder. The HCS-V-T transponder is installed in the sub-structure of the rail vehicle and communicates with the wayside equipment via the receiver loop installed in the route.

The wayside equipment is installed in a control cabinet and electrically connected to the receiver loop. The data transmitted by the carborne equipment includes route number, manual setting commands, car number, etc. The wayside equipment decodes this data and converts it into setting commands for the higher-ranking controller, for example.

Via the polling pulse transmitted by the receiver loop, the HCS-V carborne equipment recognises whether the wayside equipment is a HCS-V or a HCS-R communication system. The HCS-V carborne equipment then transmits the data either as a 19-bit HCS-R telegram or as a HCS-V data protocol.

Depending on the route number entered, a switch (point) may be set, for example. In this operating mode, the train driver can concentrate more intensively on the traffic. The use of HANNING & KAHL carborne equipment thus helps increase traffic safety.

The functions of HCS-V control panel W1 presuppose that a separate unit is installed in each control desk of a bidirectional vehicle. The vehicle can drive alone or in traction with up to 3 vehicles. This traction then consists of the Lead Cab, a middle vehicle - the Trailing Cab and a Rear Cab.

Each vehicle generates signals which inform the control panel about its position in a traction. These signals are designated **AC** (active cab) and **EoT** (end of train). AC refers to the front of the train and EoT to the end of the train.

Possible train consists:

Car	first	
Transponder	front	rear
Information	AC = 1	EoT = 1

Table 2: The train consists of one car

Car	first		second	
Transponder	front	rear	front	rear
Information	AC = 1	EoT = 0	switched off	EoT = 1

Table 3: The train consists of two cars

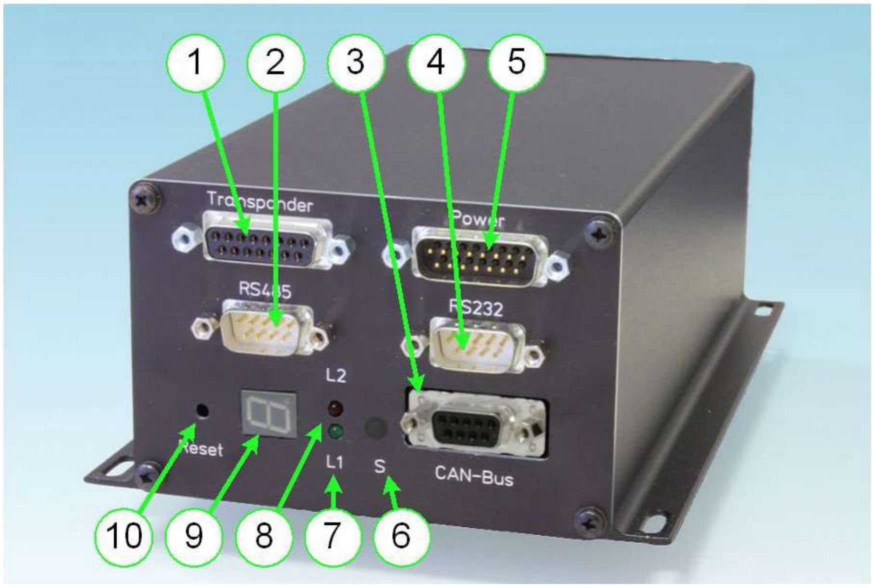
Car	first		second		third	
Transponder	front	rear	front	rear	front	rear
Information	AC = 1	EoT = 0	switched off	EoT = 0	switched off	EoT = 1

Table 4: The train consists of three cars

4.2 HCS-V control panel W1 design

The HANNING & KAHL HCS-V control panel is installed in an aluminum housing.

There are boreholes on the base plate for attachment of the aluminum housing inside the rail vehicle.



1 Connector for transponder
2 Connector for RS485 interface
3 Connector for CAN Bus
4 Connector for RS232 interface
5 Connector for power supply and vehicle signals
6 Service button S
7 LED green, flashes when the control panel is connected to DC 24 V
8 LED red, lights up when there is communication on the RS485 interface
9 Seven-segment display
10 Reset button

Fig. 2: Front view of HCS-V control panel W1

On a front side of HCS-V control panel W1 there are connectors for electric connection to the power supply and to the HCS-V-T transponder underneath the rail vehicle as well as RS485 / RS232 interfaces.

On the same side there are pushbuttons and a seven-segment display.

4.2.1 Operating elements

The following operating elements are on one end:

- Reset button.
  To re-start HCS-V control panel W1, e.g. after a software update.
- Service pushbutton (S).
  For display of software version with the help of the seven-segment display (display when first supplied: L.b.1)

4.2.2 Display

The following display elements are on one end:

- red LED – changes status when a correct telegram is received on the RS485 interface,

  green LED – flashes when the control panel is connected to DC 24 V operating voltage.

- seven-segment display
  - display of the software version after activation of pushbutton (S).
  - normal operating mode,
    The external segments light up after each other in succession.
  - display P – programming mode,
    the HCS-V control panel W1 is connected via an interface cable to a PC for programming
  - display L – message received from the wayside equipment and answered – **no** Acknowledge received.
  - display U – message received from the wayside equipment and answered – **an** Acknowledge received.
  - display of three horizontal bars - HCS-R communication is taking place

4.2.3 Electric connections

The following electric connections are on one end:

- 15-pin connector (POWER)
  for connection of the power supply and of control inputs and outputs.
- 15-pin connector (transponder)
  for connection of the transponder.
- three 9-pin connectors for RS232, RS485 and CAN interface.

  The CAN interface is not supported in this project.

4.2.4 HCS-V bit pattern table

HCS-V - DATA CODE TABLE P3010 Los Angeles (HCS-V Data) Version 2

LEAD CAB, LEAD VEHICLE						Control Inputs
Value	0 ... 19	32,48	1 ... 6	1	0 ... 1023	Extern 1 = AC (high)
Logic State	x	value	value	value	z	Extern 2 = EoT
Function	**R**	**nvPD**	**Push Buttons**	**AC/EOT**	**Car No**	Extern 3 = nvPD
						Extern 4 = spare
TRAILING CABs						
Value	32,48	0	0 ... 1023			Extern 1 = AC (low)
Logic State	value	value	z			Extern 2 = EoT (low)
Function	**nvPD**	**AC/EOT**	**Car No**			Extern 3 = nvPD
						Extern 4 = spare
REAR CAB, REAR VEHICLE						
Value	32,48	2	0 ... 1023			Extern 1 = AC (low)
Logic State	value	value	z			Extern 2 = EoT (high)
Function	**nvPD**	**AC/EOT**	**Car No**			Extern 3 = nvPD
						Extern 4 = spare

LEGEND		Notes
nvPD	Non-vital vehicle detection; Input Extern 3	All front transponder of trailing cars are unpowered
	32 - nvPD=1	Control Inputs
	48 - nvPD=0	The control inputs are controlled by the car electronic
Push Buttons	Value 1 = Primery Request	"Extern 1' is for function Active Cab
	Value 2 = Secondary Request	"Extern 2' is for function End of Train (EoT)
	Value 3 = Non Mainline Request	"Extern 3' is for function Non-vital vehicle detection (nvPD)
	Value 4 = Cancel	"Extern 4' is for spare
	Value 5 = Primary Request + Non Mainline Request	Input High (+24 V or +37V)
	Value 6 = Secondary Request + Non Mainline Request	
y	Value Depends Upon Push Buttuon Status	The Information about the Push Buttons, Route Number and the Vehicle Number were transmitted over the RS485 serial link by the ADU.
R	Route Number 2-digit	
x	Value Depends Upon Route Setting	
Car No	Car Number (bin coded)	
z	Value Depends Unit Setting	
AC/EOT	Value 0 (AC=0+Eot=0)	Softwareversion losAAB1U
	Value 1 (AC=1)	P/N No 44.605.008
	Value 2 (AC=0+Eot=1)	City Los Angeles

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Fig. 3: Bit pattern table, HCS-V control panel W1, EDP No.: 44605008

4.2.5 Bit pattern table

DATA CODE TABLE <Passadena Blue Line> Version 3.2

LEAD CAB, LEAD VEHICLE																				Control Inputs
Data Bit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Extern 1 = High
BCD/Binary	1		1	1	1	1					80	40	20	10	8	4	2	1	1	Extern 2 = nvPD (high)
Logic State	y	0	1/0	1/0	1/0	1/0	0	0	0	0	x	x	x	x	x	x	x	x	1	Extern 3 = LT/CT (*)
Function	nvPD	SP	PbP	PbS	PbNM	PbC	SP	SP	SP	SP	R	R	R	R	R	R	R	R	AC	Extern 4 = End of Train

TRAILING CABs																				
Data Bit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Extern 1 = Low
BCD/Binary	1	1	1	2	4	8	16	32	64	128	256	512							1	Extern 2 = nvPD (low)
Logic State	y	0	z	z	z	z	z	z	z	z	z	z	0	0	0	0	0	0	0	Extern 3 = LT/CT (*)
Function	nvPD	EoT	C	C	C	C	C	C	C	C	C	C	SP	SP	SP	SP	SP	SP	AC	Extern 4 = EoT (low)

REAR CAB, REAR VEHICLE																				
Data Bit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Extern 1 = Low
BCD/Binary	1	1	1	2	4	8	16	32	64	128	256	512							1	Extern 2 = nvPD (low)
Logic State	y	1	z	z	z	z	z	z	z	z	z	z	0	0	0	0	0	0	0	Extern 3 = LT/CT (*)
Function	nvPD	EoT	C	C	C	C	C	C	C	C	C	C	SP	SP	SP	SP	SP	SP	AC	Extern 4 = EoT (high)

LEGEND	
nvPD	Non-vital vehicle detection
PbP	Push Button Primary Request
PbS	Push Button Secondary Request
PbNM	Push Button Non-Mainline Request
PbC	Push Button Cancel
SP	Spare
x	Value Depends Upon Route Setting
y	Value Depends Upon "nvPD" Input
z	Value Depends Upon DIP Switch Setting
C	Car Number (bin coded)
R	Route Number 2-digit
AC/NL	AC= Active Cab / NL = Non Lead
EoT	End of Train

Notes

All front transponder of trailing cars are unpowered

Control Inputs
The control inputs are controlled by the car electronic
"Extern 1' is for function Active Cab
"Extern 2' is for function Non-vital vehicle detection (nvPD)
"Extern 3' is for function LT / CT (*)
"Extern 4' is for function End of Train (EoT)
Input High (+24 V or +37V)
(*) Lamp test/Commissioning Test
(Feature must be discussed to fulfil MTA maintenance requirements)

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Fig. 4: Bit pattern table, HCS-R control panel X1, EDP no.: 44605070

5 Assembly and commissioning instructions

The following chapters contain information on:

- Assembly of the HCS-V cab control panel
- Programming of vehicle data

5.1 Assembly of the HCS-V cab control panel

Install the HCS-V cab control panel in an appropriate and designated place on the assembly frame inside the driver's cab using the mounting plate provided.

The attachment material necessary is not part of the scope of supply.

Use lock washers / self-locking nuts to prevent the screwed connections from loosening.

5.2 Commissioning

Commissioning cannot begin until:

✓ the HCS-V-T transponder is mounted properly,

✓ the HCS-V control panel in the aluminum housing has been mounted properly in a safe place,

✓ all electric connections between HCS-V-T transponder, HCS-V control panel, ADU system and vehicle wiring (input signals, power supply) have been made.

NOTICE

Damage to device as a result of destruction of internal components.

Pulling and inserting components in the rack and connecting and separating cable connections while the operating voltage is switched on may damage internal components.

➢ Always switch off the operating

voltage first.

Proceed as follows:

1. Switch the battery on
2. Start the rail vehicle.
3. Look at the LED displays and the seven-segment display on the HCS-V control panel

- The green LED flashes constantly.
- The outer segments of the seven-segment display light up after each other in succession.

4. Should one of the above-mentioned displays not light up properly, consult the Chapter on "Trouble shooting“ to locate the error.

5.3 Connection to the ADU system

To make a proper connection with HCS-V control panel W1 via the RS485 interface, the ADU system must be configured as follows:

Baud rate: 57600
Data bits: 8
Parity: none
Stop bits: 1

The table below shows the possible commands of the ADU protocol.

ID	Command	Data length	Value range	Direction	Comment
01	NvPD	1 byte	0 or 1	ADU → CCU	Command for future extensions
02	Route number	1 byte	0 to 19	ADU → CCU	
03	Pushbutton	1 byte	0 = No pushbutton activated 1 = Pushbutton “Primary Request” activated 2 = Pushbutton “Secondary Request” activated 3 = Pushbutton “Non Mainline Request” activated 4 = Pushbutton “Cancel” activated	ADU → CCU	

			5 = Pushbutton "Primary Request + Non Mainline Request" activated 6 = Pushbutton "Secondary Request + Non Mainline Request" activated		
04	Car number	2 byte	1-1023	ADU → CCU	
05	Status	0 byte	Can be used as an operating signal	ADU → CCU	
80	Feedback	1 byte	0 = vehicle is not above the receiver loop 1 = vehicle is above the receiver loop	CCU → ADU	

When a correct command is received, the status of the red LED changes on the control panel.

5.4 Programming the vehicle data

Vehicle data is programmed via the built-in serial RS232 interface. The interface is on the front panel of the HCS-V control panel.

Equipment and materials required:

- PC with a terminal program installed
- Null modem interface cable (EDP no.: 110 225)

Proceed as follows:

1. Connect the null modem interface cable to the serial interface RS232 of HCS-V control panel.
2. Connect the null modem interface cable to PC serial interface RS232.
3. Switch the battery on.
4. Start the rail vehicle.

ⓘ Ensure that the PC has been configured for use of the terminal program as follows:
Baud rate: 57600
Data bits: 8
Parity: none
Stop bits: 1

5. Start the terminal program on the PC.

6. Enter "P" on the PC keyboard.
   A menu appears.
   A "P" lights up on the seven-segment display.

The following functions can be called up:

- Changing the CCU address (Default: 0x01),
- Entry of HCS-V data :

  Wagennummer (car number),
- Entry date/clock time,
- Read-out of data set,
- Read-out of logbook.

The two figures below show the setting of the CCU address and of the car number:

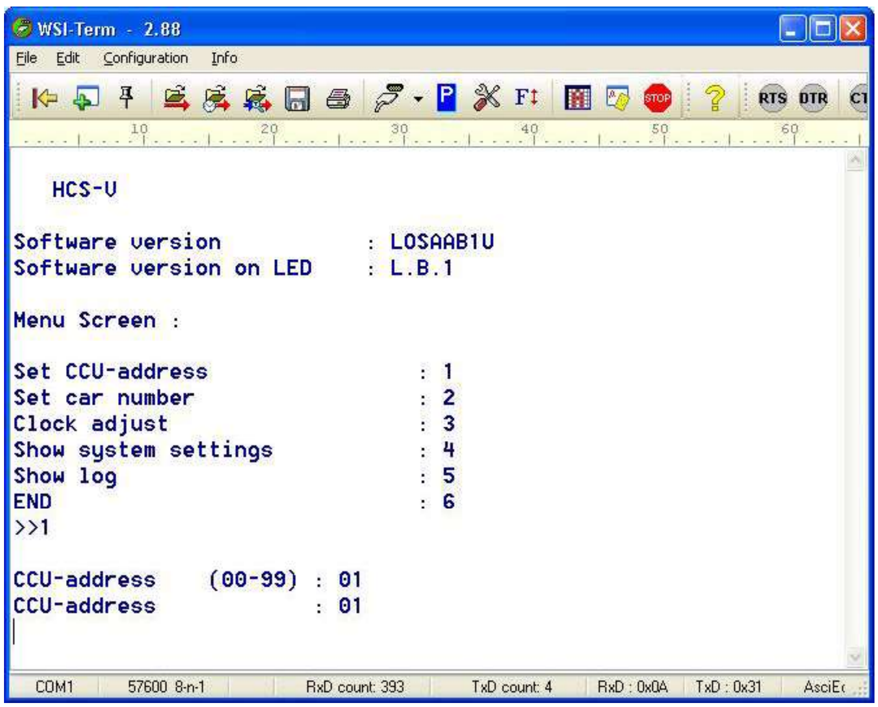


Fig. 5: Setting of the CCU address

CCU address:

The CCU address can be changed after entry of "1" for the selection "Set CCU address".
Entry is always in two-digit form "01".

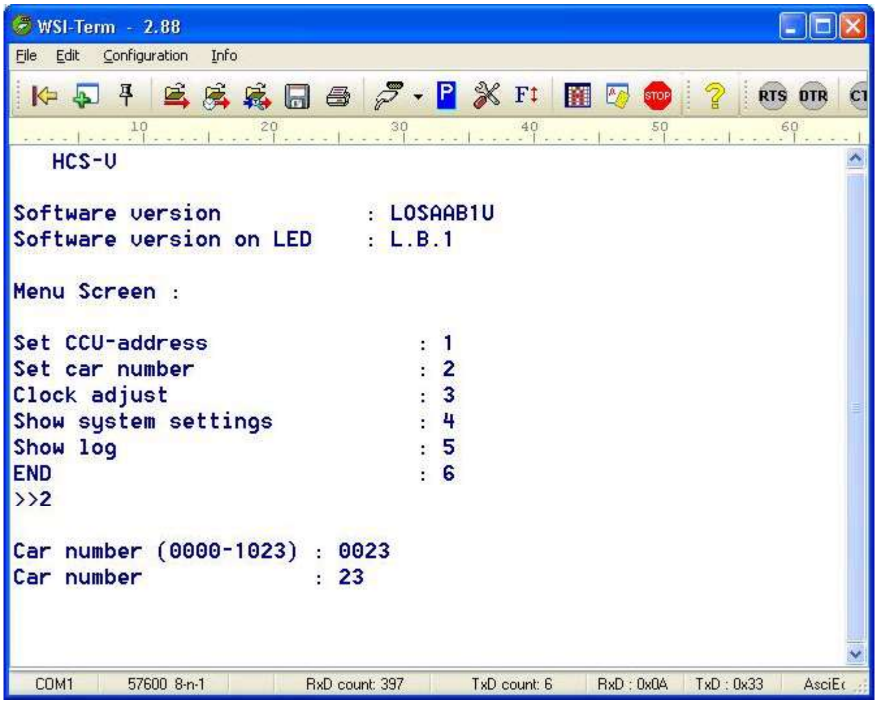


Fig. 6: Setting the car number

CCU address:

The car number can be changed after entry of "2“ for the selection "Set car number“.
Entry is always in four-digit form "0023“.

Data entry is always menu-led.

ⓘ Please note that in fields where values have to be entered, these values cannot be corrected if entered incorrectly. These values must be entered anew / overwritten under the same menu item.

The external segments light up on the seven-segment display when the entries have been completed as guided by the menu, and the operating state has been reached again.

5.5 Display of vehicle data

The status of the vehicle signals (AC, EoT, nvPD) and the settings made via the RS485 interface can be displayed with the help of a terminal program via the built-in serial RS232 interface. The interface is on the front panel of the HCS-V control panel.

Please consult the Chapter on 'Programming the vehicle data' for information on the devices and materials required, and the prerequisites.

Proceed as follows:

1. Start the terminal program on the PC.
2. Click the 'SPACE' key on the PC keyboard.
   In this case, the data is displayed and not a menu.

The following information is displayed:

- CCU address,
- Signal status AC (active cab),
- Signal status EoT (End of Train),
- Signal status nvPd,
- Car number,
- Route number,
- Pushbutton function.

The figure below is an example of the information displayed:

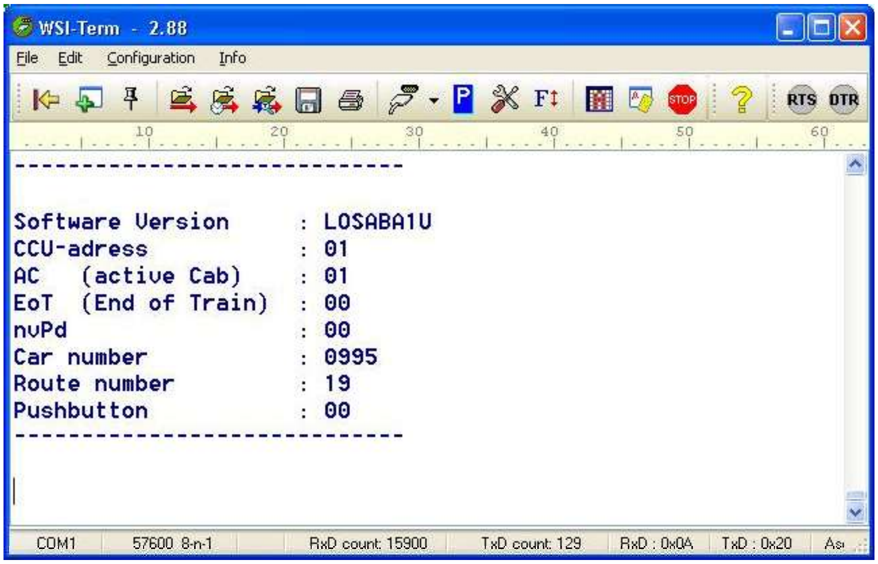


Fig. 7: Display of vehicle data

6 Trouble shooting

Fault	Possible cause	Indication	Fault clearance
HCS-V cab control panel is not functioning	Fuse defective	The displays do not light up	Replace fuse
	Hardware or software error	Communication does not function properly while the HCS-V-T transponder is above the receiver loop. No displays on the seven-segment display.	Check cable connections and correct errors if necessary. Send HCS-V cab control panel to HANNING & KAHL for inspection.

Table 5: Trouble-shooting

For the following reasons, the HCS-R cab control panel can only be repaired by HANNING & KAHL:

1 Mounting is mixed on the electronic board, i.e. SMD and normal mounting have been selected.
Special knowlegde and devices are necessary for repair.

2 The component used work in an extended temperature range, i.e. only special-purpose components may be used for repair.

7 Service

The HANNING & KAHL HCS-V cab control panel is generally maintenance free. HANNING & KAHL recommends the following checks.

7.1 Inspection intervals

Every 6 months:

- Check that all plug and screw connections are tight.
- Check that all cable connections are tight and intact.
  Replace if necessary.

7.2 Software update

The following devices and materials are necessary to perform software update:

- a PC which has the new software version saved.
- null modem interface cable (EDP No.: 110 225),
- HANNING & KAHL 'TurboFlasher' software
  (see Manual 40902805_en).

Proceed as follows:

1. Switch the operating voltage off.
2. Remove the transponder connector from the HCS-V control panel.
3. Bridge connectors 14 and 15 of the HCS-V-T transponder connection.
4. Connect the null modem interface cable to the serial interface RS232 of HCS-V control panel.
5. Connect the null modem interface cable to PC serial interface RS232.
6. Switch the operating voltage on.
7. Start the boot loader program on the PC.
8. Select the new software version.

9. Start the boot loading procedure.
   The new software version is transmitted.
10. Switch the operating voltage off when transmission is completed.
11. Remove the bridge on the HCS-V-T transponder connection.
12. Re-insert the transponder connector in the corresponding plug-in connection on the HCS-V control panel.
13. Switch the operating voltage on.

Commissioning protocol

for Hanning Communication System, HCS-V

Carborne equipment, **HCS-V control panel W1**

Version:	Customer	: Los Angeles
EDP No.:		: 044.605.008
Software No.		: 004.323.613
Documentation,		: 44605008_en.pdf
Documentation HCS-V wayside equipment		: 40805101_en.pdf
Documentation HCSVAssistS diagnosis		: 40805801_en.pdf
Software designation		: losABA1U

Test preparations:

For this test, use the HANNING & KAHL testing equipment HCS-V-PF (Art. No. 44.340.071) or installed and functioning wayside equipment.

To assess the data transmitted, a PC which has HCS-V AssistS software installed must be connected to the wayside equipment. The menu item "Display loop data“ displays the respective data transmitted.

Drive the rail vehicle onto the receiver loop so that the HCS-V-T transponder is directly above the front or rear part of the test loop.

To test HCS-R manual setting command transmission, the HCS-V wayside equipment must be configured temporarily for function as HCS-R interrogator. Restore to normal function after test.

Consult the corresponding manual for configuration of the HCS-V AssistS software.

Also consult manual 420 075 002_en for performance of the final acceptance test “

Commissioning protocol

for Hanning Communication System, HCS-V

Carborne equipment, **HCS-V control panel W1, Los Angeles**

Performance of final acceptance:

No.	Test	OK	Error
1	Programming the car number (ICD_RLS_01000) Check that the correct car number has been stored in HCS-V control panel W1, Los Angeles.		
2	Programming the CCU address (ICD_RLS_01005) Check that the correct CCU address has been stored in HCS-V control panel W1, (Default: 0x01).		
3	RS485 communication (ICD_RLS_01006) Check that communication via the RS485 interface is working properly.		
4	Operating voltage (ICD_RLS_01010) Check the operating voltage, Nominal value: DC 24 V, -30% - +20%		
5	Vehicle signal AC (ICD_RLS_01012) Check the input signal AC (Active Cab) from the vehicle controller Nominal value: Driver's cab started up: AC = DC 24 V Driver's cab not started up: AC = 0 V		
6	Vehicle signal EoT (ICD_RLS_01013) Check the input signal EoT (End of Train) from the vehicle controller Nominal value: Driver's cab is the end of the train: EoT = DC 24 V		
7	Electric connection (ICD_RLS_01014) Were the vehicle signals AC and EoT connected in compliance with wiring diagram D00015038-x ?		
8	Visual check (ICD_RLS_01020) The HCS-V-T transponder is installed underneath the driver's cab in the front part of the vehicle body.		
9	Visual check (ICD_RLS_01021) The HCS-V-T transponder was not installed directly on the bogie in order to avoid severe v brations when acceleration speeds are high.		
10	Visual check (ICD_RLS_01030) When mounting the HCS-V-T transponder, the clearances to metals and energy-carrying lines were observed (Document 40805104_en, Chapter "Assembly".		
11	Route number test (wayside equipment in **HCS-V / HCS-R mode**) Set about 5 different routes on the ADU system and drive across the receiver loop: The menu item "Display loop data" of HCS-V AssistS software displays the route set.		

Commissioning protocol

for Hanning Communication System, HCS-V

Carborne equipment, **HCS-V control panel W1, Los Angeles**

No.	Test	OK	Error
12	Pushbutton test (wayside equipment in **HCS-V / HCS-R mode**) Press the pushbuttons on the ADU system and drive across the receiver loop: The menu item "Display loop data“ of HCS-V AssistS software displays the setting commands.		
13	Route number test (wayside equipment in **HCS-R mode**) Set about 5 different routes on the ADU system and drive across the receiver loop: The menu item "Display loop data“ of HCS-V AssistS software displays the route set.		
14	Pushbutton test (wayside equipment in **HCS-R mode**) Press the pushbuttons on the ADU system SOP and drive across the receiver loop while doing so: The menu item "Display loop data“ of HCS-V AssistS software displays the setting commands.		

Table 6: Final acceptance

Vehicle identification number:_______________

Date: _______________

Signature:_______________

HANNING & KAHL

Operating Manual

HCS-V Communication System

Transponder HCS-V-T

Title: Operating Manual
HCS-V Communication System
Transponder HCS-V-T

Version: 2.3
Date: 30.09.2013

Contents

1 General

These operating instructions refer to

Transponder HCS-V-T

which forms part of the HANNING & KAHL communication system HCS-V.

Paragraphs 4.0 to 7.0 describe **Structure** and **Function** of Transponder HCS-V-T as well as **Commissioning** and **Maintenance** in a general manner.

Before starting work on the HANNING & KAHL Transponder HCS-V-T, the user or technician must read these operating instructions thoroughly.

The author of these operating instructions intends this manual to be read by the management of public transport authorities, in particular, however, by the authorities' skilled workers who have had appropriate professional training as electricians or electronics specialists.

1.1 Address of manufacturer and customer service

If you have any questions concerning these operating instructions, please contact:

HANNING & KAHL GmbH & Co KG
Rudolf-Diesel-Str. 6
33813 Oerlinghausen

Telephone: **+49 (0) 52 02 - 70 76 00**
Fax: **+49 (0) 52 02 - 70 76 29**
E-Mail: info@hanning-kahl.com

Internet: http://www.hanning-kahl.com/

HANNING & KAHL’s **Service Division** can be reached on:

Telephone: **+49 (0) 52 02 - 70 76 04**

In urgent cases, please contact the **on-call service**:
+49 171 3360360.

HANNING & KAHL's address in North America is:

HANNING & KAHL L.P.
114 DeKalb Street
Unit "C"
Bridgeport, PA 19405, USA

Phone: **+1 610 239 1620**
Fax: **+1 610 239 1615**
E-Mail: info@hukus-hanning.com

Please quote the number and the date indicated in the footer of this documentation.

1.2 Notes on the operating instructions

If you have any questions concerning these operating instructions, please quote the number indicated in the footer.

The date indicated in the footer refers to the respective status of the documentation.

1.3 EC conformity

A certificate of conformity is available. Transponder HCS-V-T bears the CE mark on its type plate. A copy of the certificate of conformity can be obtained from HANNING & KAHL on request.

Transponder HCS-V-T fulfils all the requirements of the following international standards:

EN 50155 (Suitability for rail operations),

EN 50121-3-2 (EMC test),

DIN 61373 (Vibration/Shock/Impact test),

DIN 5510 (Fire proof).

2 Safety instructions

Observe the safety precautions in this chapter and all the other safety precautions throughout this manual

2.1 Intended usage

The operating safety of the communication system described in this manual, the HCS-V, was developed for two-way data transmission from vehicles to permanently installed controllers. It forms a non-safety relevant data route for transmission of setting commands, run and line numbers and vehicle identification numbers for rail transport, for example.

2.2 Unauthorized usage

The operating safety of the HCS-V communications system described in this manual is only guaranteed when the device is used for the purpose intended, as described in the Chapter above.

The limit values indicated in the chapter entitled “Technical Data“ must not be exceeded.

2.3 Personnel qualification and training

Personnel engaged with the operation, maintenance, inspection and assembly of the equipment must have the necessary qualifications. It is the responsibility of operators to determine areas of responsibility, competence and staff supervision. HANNING & KAHL can provide training if requested to do so by the operator of the communications system.

2.4 Dangers of non-observance of safety instructions

Non-observance of safety instructions can result in danger to persons, the environment and the device itself. Non-observance of safety instructions can also lead to a loss of rights to claim under warranty.

2.5 Safety instructions for assembly, maintenance and inspection work

The operator of the HANNING & KAHL equipment is expected to employ qualified personnel trained in the application of these instructions for all assembly and maintenance work.

The manufacturer/supplier assumes that general safety requirements (e.g. national directives for electrical installations, regulations for the prevention of accidents, in-house safety instructions) are known to the operator and his specialist staff and are observed.

All safety and protective devices must be re-installed/put back into operation immediately after completion of work.

2.6 Unauthorized modification and manufacture of spare parts

Modifications or changes are only permitted after consultation with the manufacturer.

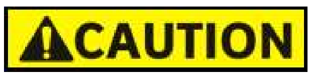
Original spare parts and accessories authorized by the manufacturer contribute to safety. The use of any other parts may result in denial of all rights to claim for subsequent damage by HANNING & KAHL.

2.7 Warning signs in the operating instructions

Special warnings and instructions are marked in this manual with the following pictograms:

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury

WARNING indicates a potential hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a potential hazardous situation which, if not avoided, may result in minor or moderate injury.

NOTICE indicates a potential hazardous situation which, if not avoided, may result in property damage.

Please also pay attention to instructions which are mounted directly on the product and ensure that they are always legible.

2.8 Important Notice

NOTICE

Material damage due to destruction of internal components!

Pulling and inserting components in the rack and connecting and separating cable connections while the operating voltage is switched on may damage internal components.

➢ Always switch off the operating voltage first.

3 Technical data

Transponder HCS-V-T

Data	Values
Temperature range:	
Operation:	-40°C...+70°C (-40 … 158°F)
Storage_	-40°C...+85°C (-40 … 185°F)
Relative humidity:	
Operation	0 ... 95 % rel.
Storage	max. 95 % rel. without condensation
Power supply	DC 18 … 27 V
Current consumption incl. HCS-V operating panel	max. 500 mA
Receiving frequency	50 - 100 kHz
Mounting position	Underneath the driver's cab
Electrical connection	Customer-specific: with connector
Certification	EN 50155 EN 50121-3/-2 DIN 61373

Table 1: Technical data, HCS-V-T

4 Transport and storage

The HANNING & KAHL HCS-V-T transponder is usually supplied in a sturdy cardboard box.

Leave the device in the box during storage and do not expose to an aggressive atmosphere.

The electrical contacts in the connectors on the cable must be protected against rain and high humidity.

5 Structure and function

The HANNING & KAHL communication system HCS-V facilitates wireless transmission of commands and information via receiver loops in the route between the vehicle and the stationary parts of the communication system on the route.

It is a two-way communication system, i.e. data can be transmitted from the vehicle to the wayside and from the wayside to the vehicle.

Data is transmitted in HCS-V procedure (two-way) or HCS-R procedure (one-way) .

The following figure illustrates the operating principles of the HANNING & KAHL HCS-V communication system.

Fig. 1: HCS-V Operating principle

As soon as Transponder HCS-V-T is located above the receiver loop, data is exchanged between the car borne and the wayside equipment.

Transponder HCS-V-T in the vehicle is in direct electrical connection with operating panel HCS-V-BG or IBIS/HCS-V interface.

- Transponder HCS-V-T facilitates one-way or two-way data transmission between car borne and wayside equipment.
- Electrical connection is made between transponder HCS-V-T and operating panel HCS-V-BG / IBIS/HCS-V interface with a shielded 10-conductor cable. The operating panel is in the driver's cab control panel. Control and indicating elements are installed in the front panel according to customer requirements.

5.1 Application area of Transponder HCS-V-T

Transponder HCS-V-T is normally mounted underneath the rail vehicle and is thus within the range of the receiver loops in the route while the vehicle is crossing.

Depending on the application, there are one or two transponders HCS-V-T underneath a vehicle.

Transponder HCS-V-T is connected in the vehicle via a shielded 10-conductor cable to a HCS-V system.

The electronic components of the transponder are firmly installed and cast in a plastic housing for protection against penetrating humidity.

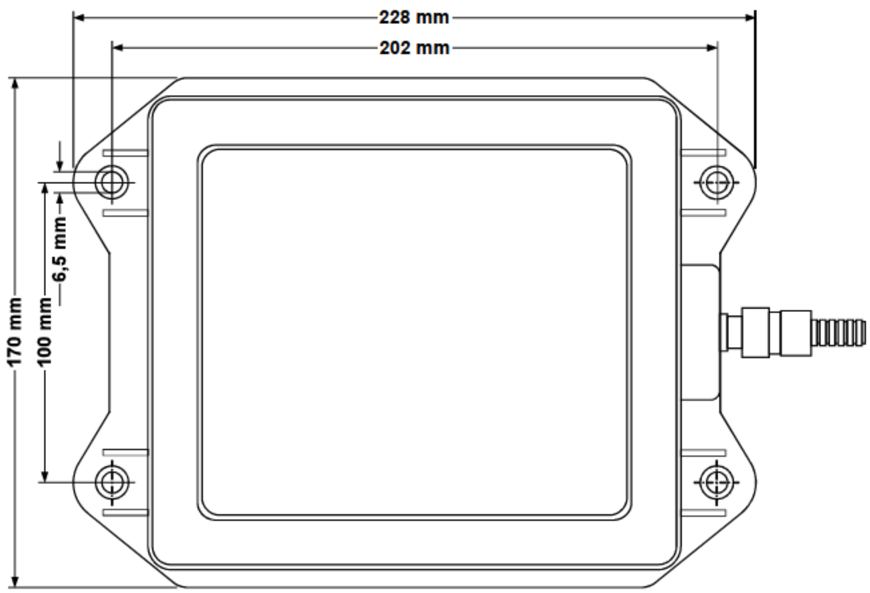


Fig. 2: Scale diagram of the transponder housing (top view)

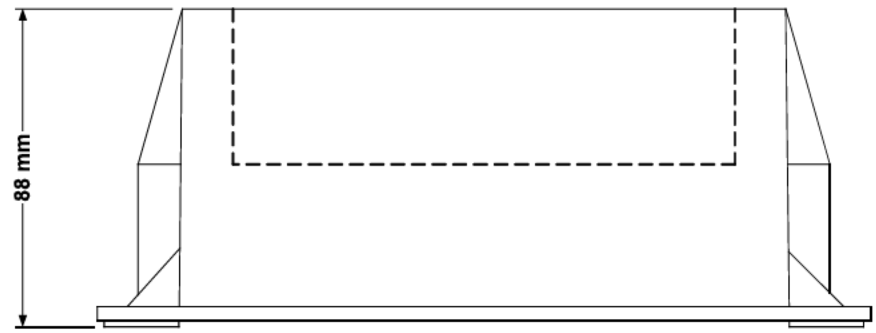


Fig. 3: Scale diagram of the transponder housing (side view)

The transponder housing has 4 bores to install the transponder with M6 screws underneath the floor panel.

A cable gland leads the cable out of the housing and provides strain relief.

5.2 Electrical connections

Depending on customer wishes and application, a connector can be mounted to the cable of Transponder HCS-V-T.

Cable supplied with connector mounted on request!

The cable is led through a cable gland and locked.

The connecting cable is protected by a hose.

NOTICE	**Danger of material damage!** **Pulling and inserting components in the rack and connecting and separating cable connections while the operating voltage is switched on may damage internal components.** **Always switch off the operating voltage first.**

Consult the documentation on vehicle wiring where applicable.

6 Installation

To ensure proper data transmission between Transponder HCS-V-T and the wayside equipment, the following must be observed when positioning the transponder underneath the vehicle:

ⓘ The transponder can be mounted directly underneath the driver's cab (A), in front of the bogie (truck) (B) or in the centre of the vehicle (C).
The transponder must not be installed directly on the bogie because it can be subject to severe vibrations at high acceleration rates.

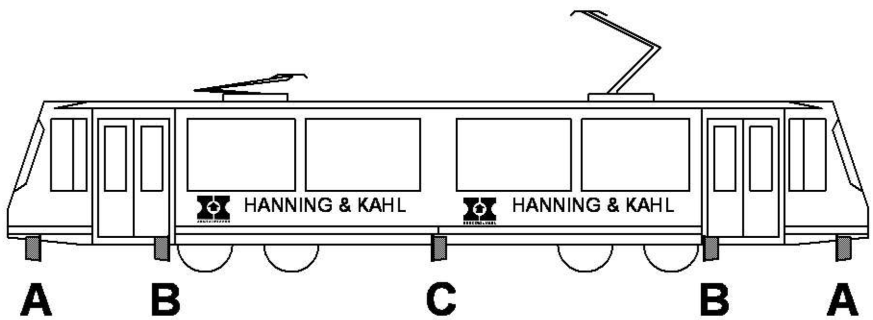


Fig. 4: Transponder mounting position

Mounting position A has greater clearance to possible sources of interference. Transmission errors may occur on receiver loops which are installed in tight bends.

The positioning of receiver loops requires special attention.

In **mounting position C** there is also a possibility of transmission errors due to sources of interference in or on the vehicle as well as while driving through tight bends.

Considering all the pre-requisites explained in this document, HANNING & KAHL recommends **mounting position (B)**. Data transmission in tight bends will not cause a problem. To minimize errors caused by interference, all pre-requisites should be met.

ⓘ Clearances have to be kept between the antenna in the transponder housing and metals and electrically conductive materials.
Within a radius of 40 cm (15.7 inch) around the transponder there must be no electrically conductive materials which could produce an electric circuit.

There must be no current-carrying cables in an area of 40 cm (15.7 inch) around the transponder housing.

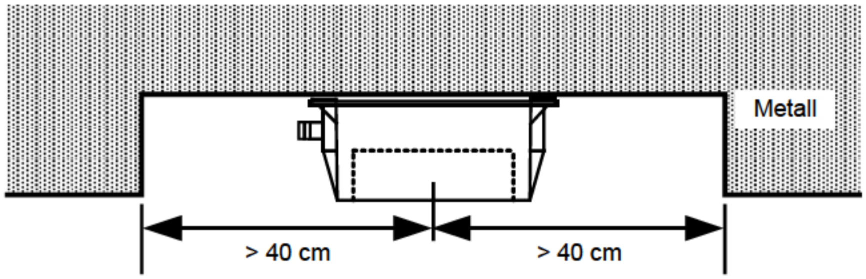


Fig. 5: Mounting clearances

Vehicle drive mechanisms may impair data transmission. When the transponder and the drive mechanism are both above the receiver loop at the same time, the drive mechanism can interfere with transmission.

Therefore the clearance between the vehicle drive mechanism and transponder installation location should be greater than the length of the receiver loop.

ⓘ These clearances must be observed as signals transmitted by the transponder may be weakened by metal vehicle parts in the immediate vicinity.
Clearance between the top of the rail and lower edge of the transponder must be in the range 150 ... 300 mm (5.9 ... 11.8 in).

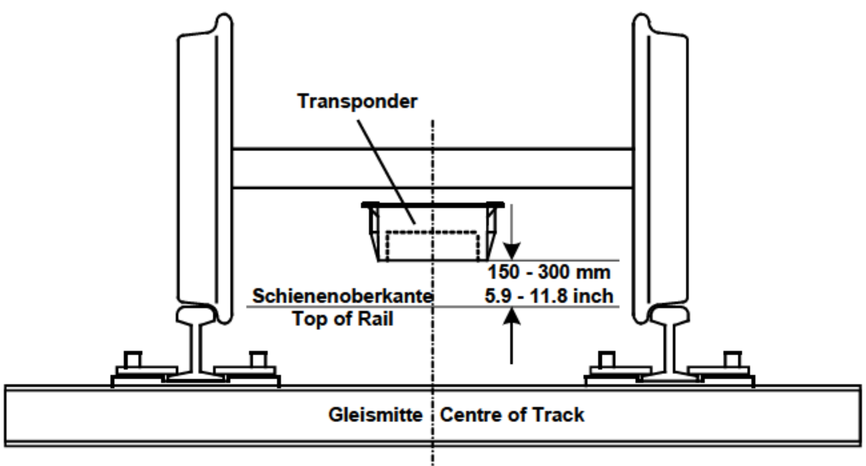


Abb. 6: Mounting height

- The transponder should be mounted as centrally as possible in the middle of the vehicle.
- Secure the connecting cable at a clearance of less than 100 mm (4 inch) to the transponder. The cable attachment must not damage the cable.
- Ensure a minimum bending radius of 50 mm (2 inch) of the transponder cable with protective hose!

  ⓘ The best position for the transponder must be established anew for new types of vehicles by carrying out measurements and trial runs taking the above-mentioned dimensions into consideration. Measurements and trial runs must be carried out/accompanied by HANNING & KAHL personnel.

7 Commissioning

NOTICE

Danger of material damage!

Pulling and inserting components in the rack and connecting and separating cable connections while the operating voltage is switched on may damage internal components.

Always switch off the operating voltage first.

Transponder HCS-V-T can be commissioned as soon as it is mounted and connected to operating panel HCS-V-BG / IBIS/HCS-V interface. The transponder can be tested with HANNING & KAHL testing equipment for communication systems or with a HCS-V system (wayside equipment) which has already been commissioned.

For testing the data records a portable PC on which the HCS-V AssistS diagnosis software is installed must be connected with the serial interface of the HCS-V wayside equipment (HCS-V test equipment). The data records received are indicated with the terminal function of the software.

For further information about the HCS-V AssistS diagnosis software please refer to the documentation 40805801_en.

Proceed as follows:

1. Start the vehicle.
   The transponder is now switched on.
2. Place the test receiver loop underneath the transponder of the rail vehicle.

   OR
3. Drive the rail vehicle so far until the transponder is above the test receiver loop.

ⓘ Ensure that the transponder is not directly above the middle strap of the test receiver loop, but directly above one of the two segments.

Commissioning must be confirmed by a commissioning report.

8 Maintenance

Generally speaking, the transponder is maintenance-free.
However, HANNING & KAHL recommends the following work be carried out:

Every 6 months:

- Check tightness of all plug-in and screw connections.
- Check that cable connections are tight and intact.
  - Replace if necessary.

Every 12 months:

- Function test

Every 5 years (acc. to BOStrab):

- General overhaul (function test) by HANNING & KAHL.

9 Appendices

Consult the following technical documentation:

Operating instruction, Communication system HCS-V – 40805101_AE

Operating manual, Diagnosis software HCS-V AssistS – 40805801_en

APPENDIX B

ROUTE IDENTIFICATIONS

This appendix lists and defines the route identifications that MGL may use while performing train operations. These route identifications are used by the ATO subsystem of the ATC system in ATO mode. The ATO subsystem will traverse the MGL property stopping at stations as specified by the last received route identification. This route identification can be received from TWC or entered by the Operator using the pushbuttons on the ADU.

NOTE: In ATO mode, the train will always stop at the Marine and Norwalk stations regardless of the route ID. This prevents accidental non-revenue route ID entry from carrying passengers into the Marine bumper or Norwalk tail track circuits.

Route ID	Description
No Destination Route IDs	
998	No route has been entered. This is the route displayed when the ATO subsystem is first initialized into mode. No motion in ATO mode will be possible until a valid route is entered.
999	Cancel previous route. No motion in ATO mode will be possible until a valid route is entered.
Round Trip Revenue Route IDs	
001	Marine to Norwalk
002	Norwalk to Marine
008	Douglas/Rosecrans
020	Willowbrook/Rosa Parks
021	Expo/Crenshaw
022	Westchester/Veterans
023	96th Street
024	Century/Aviation

Route ID	Description
Storage Route IDs	
027	Norwalk Tail Track 1091E (track 1 east end)
028	Norwalk Tail Track 1092A (track 2 west end)
029	Wilmington East Tail Track
030	Wilmington West Pocket Track
101	Inglewood Siding
102	Division 16 North
103	96th St Trail Track
104	Division 16 South
Yard Route IDs, Express	
500	Any Yard Storage / Platform / Wash Track