SIEMENS

INSTALLATION AND INSTRUCTION MANUAL

PHASE SHIFT OVERLAY PLUS (PSO+)
(P/N 7A481 & 7A483)

JUNE 2012 AMENDED APRIL 2014

DOCUMENT NO. SIG-00-10-16
VERSION B.1

Siemens Industry, Inc., Rail Automation
9568 Archibald Ave., Suite 100,
Rancho Cucamonga, California 91730
1-800-793-SAFE

PRINTED IN U.S.A.

PROPRIETARY INFORMATION

TRANSLATIONS

The manuals and product information of Siemens are intended to be produced and read in English. Any translation of the manuals and product information are unofficial and can be imprecise and inaccurate in whole or in part. Siemens Industry, Inc., Rail Automation does not warrant the accuracy, reliability, or timeliness of any information contained in any translation of manual or product information from its original official released version in English and shall not be liable for any losses caused by such reliance on the accuracy, reliability, or timeliness of such information. Any person or entity who relies on translated information does so at his or her own risk.

WARRANTY INFORMATION

Siemens Industry, Inc., Rail Automation warranty policy is as stated in the current Terms and Conditions of Sale document. Warranty adjustments will not be allowed for products or components which have been subjected to abuse, alteration, improper handling or installation, or which have not been operated in accordance with Seller's instructions. Alteration or removal of any serial number or identification mark voids the warranty.

SALES AND SERVICE LOCATIONS

Technical assistance and sales information on **Siemens Industry, Inc., Rail Automation** products may be obtained at the following locations:

Siemens Industry, Inc., Rail Automation
2400 NELSON MILLER PARKWAY
LOUISVILLE, KENTUCKY 40223
TELEPHONE: (502) 618-8800
FAX: (502) 618-8810
SALES & SERVICE: (800) 626-2710
WEB SITE: http://www.rail-automation.com/

Siemens Industry, Inc., Rail Automation
939 S. MAIN STREET
MARION, KENTUCKY 42064
TELEPHONE: (270) 918-7800
CUSTOMER SERVICE: (800) 626-2710
TECHNICAL SUPPORT: (800) 793-7233
FAX: (270) 918-7830

DOCUMENT HISTORY

Version	Release Date	Sections Changed	Details of Change
A	09-10-10		Initial Release per P4-F115
A.1	11-29-10		Application drawings changed to reflect Transmit Enable (TX Enable) terminal connections and wire size distance data when units are more than 300 feet from the track.
A.2	12-06-10		Inserted Sections 6.4.1 – Program PSO+ Transmitter & 6.4.2 Program PSO+ Receiver
A.3	13-29-12		Updated Section 3.3.3.3.3 and Figures 7-6 & 7-7 to reflect correct wiring from 7A388 to 7A399, per email Nathan Edds, 3-22-12.
B	06-01-12		All images reformatted to display properly in Adobe PDF format
B.1	04-23-14		Siemens Corporate Rebranding

NOTES, CAUTIONS, AND WARNINGS

Throughout this manual, notes, cautions, and warnings are frequently used to direct the reader's attention to specific information. Use of the three terms is defined as follows:

WARNING

INDICATES A POTENTIALLY HAZARDOUS SITUATION WHICH, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY. WARNINGS ALWAYS TAKE PRECEDENCE OVER NOTES, CAUTIONS, AND ALL OTHER INFORMATION.

CAUTION

REFERS TO PROPER PROCEDURES OR PRACTICES WHICH IF NOT STRICTLY OBSERVED, COULD RESULT IN A POTENTIALLY HAZARDOUS SITUATION AND/OR POSSIBLE DAMAGE TO EQUIPMENT. CAUTIONS TAKE PRECEDENCE OVER NOTES AND ALL OTHER INFORMATION, EXCEPT WARNINGS.

NOTE

Generally used to highlight certain information relating to the topic under discussion.

If there are any questions, contact Siemens Industry Inc., Rail Automation Application Engineering.

ELECTROSTATIC DISCHARGE (ESD) PRECAUTIONS

Static electricity can damage electronic circuitry, particularly low voltage components such as the integrated circuits commonly used throughout the electronics industry. Therefore, procedures have been adopted industry-wide which make it possible to avoid the sometimes invisible damage caused by electrostatic discharge (ESD) during the handling, shipping, and storage of electronic modules and components. Siemens Industry, Inc., Rail Automation has instituted these practices at its manufacturing facility and encourages its customers to adopt them as well to lessen the likelihood of equipment damage in the field due to ESD. Some of the basic protective practices include the following:

- Ground yourself before touching card cages, assemblies, modules, or components.
- Remove power from card cages and assemblies before removing or installing modules.
- Remove circuit boards (modules) from card cages by the ejector lever only. If an ejector lever is not provided, grasp the edge of the circuit board but avoid touching circuit traces or components.
- Handle circuit boards by the edges only.
- Never physically touch circuit board or connector contact fingers or allow these fingers to come in contact with an insulator (e.g., plastic, rubber, etc.).
- When not in use, place circuit boards in approved static-shielding bags, contact fingers first. Remove circuit boards from static-shielding bags by grasping the ejector lever or the edge of the board only. Each bag should include a caution label on the outside indicating static-sensitive contents.
- Cover workbench surfaces used for repair of electronic equipment with static dissipative workbench matting.
- Use integrated circuit extractor/inserter tools designed to remove and install electrostatic-sensitive integrated circuit devices such as PROM's (OK Industries, Inc., Model EX-2 Extractor and Model MOS-40 Inserter (or equivalent) are highly recommended).
- Utilize only anti-static cushioning material in equipment shipping and storage containers.

For information concerning ESD material applications, please contact the Technical Support Staff at 1-800-793-7233. ESD Awareness Classes and additional ESD product information are also available through the Technical Support Staff.

TABLE OF CONTENTS

Section Title Page

TABLE OF CONTENTS

Section Title Page

TABLE OF CONTENTS

TABLE OF CONTENTS

Section Title Page

TABLE OF CONTENTS

Section Title Page

LIST OF FIGURES

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES

This page intentionally left blank

SECTION 1 –
SYSTEM OVERVIEW

1.1 GENERAL

The Phase Shift Overlay Plus (PSO+) Track Circuit is a modern, reliable, and secure processor based audio overlay system that is used to supply track occupancy information and is sufficiently versatile to permit use in a wide variety of applications.

The PSO+ has two configurations and each has a single printed circuit unit:

- PSO+ Transmitter, Part Number 7A481 (Code A or Code C)
- PSO+ Receiver, Part Number 7A483 (Code A or Code C)

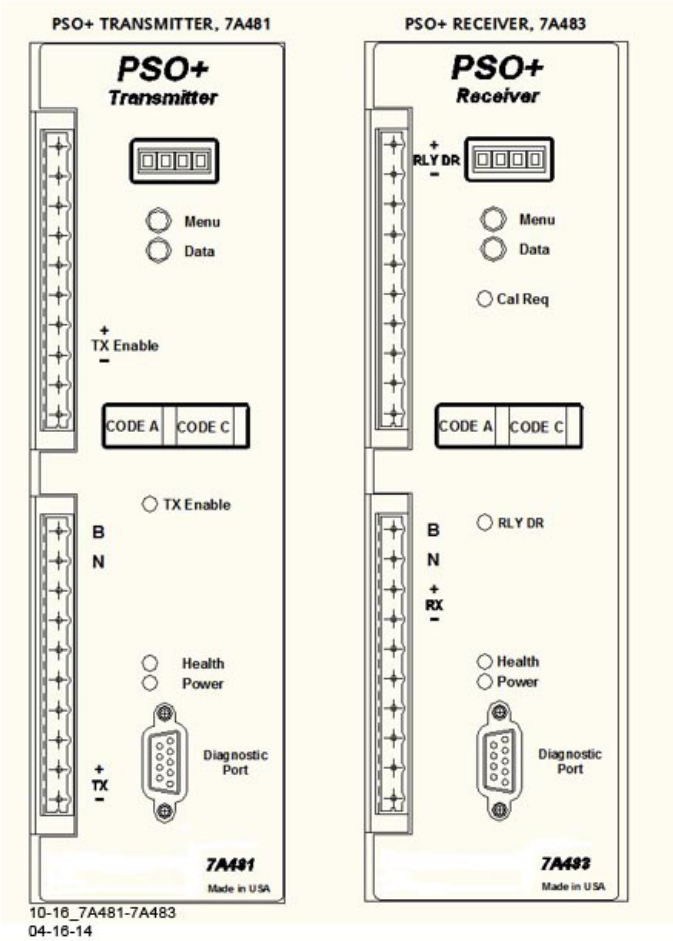


Figure 1-1:
PSO+ Transmitter & PSO+ Receiver

The PSO+ utilizes new features:

- Vital processor based
- Menu driven and uses a four character display

Menus provide field selectable options such as:

- PSO transmitter and receiver frequencies
- PSO transmit power

The PSO+ Transmitter and Receiver are functionally compatible with the PSO II, PSO III, and PSO 4000.

The Transmitter generates a modulated audio-frequency track signal. It sends a coded, 8-bit address code through the rails using an audio frequency signal as a carrier. The rail connections for the coupling unit delimit the other end of the track circuit. The modulated signal is detected by the receiver where it is decoded and processed. The Receiver responds only to signals of the proper frequency, address, and amplitude. The ability of PSO+ to differentiate between its operating signal and all other signals present on the track is due to the nonsymmetrical coded modulation and receiver decoding techniques which ensure that the system is immune to random or foreign AM, FM, and beat signals. The receiver decodes the signal and, if it qualifies the signal as valid, the receiver produces an output to energize a vital relay. The receiver is connected to the track via a Tuned Receiver Coupler, which is a separate piece of ancillary equipment.

No insulated joints are needed to confine the signal because the coupling units have low impedance at the operating frequency of the track circuit, and high impedance at all other frequencies. The PSO+ can also be used on the same track used for coded or non-coded DC or AC track circuits, Grade Crossing Predictors (GCPs), motion detectors, and other audio frequency track circuits.

The PSO+ is available with up to sixteen PSO+ carrier frequencies, ranging from 156 Hz to 4000 Hz, available for use in non-electrified territory. For electrified territory, ten standard PSO frequencies are available ranging from 645 Hz to 4000 Hz. For installations where multiple circuits are required on the same track, the PSO+ has two sets of eight frequencies (five for electrified territory) each that can be connected as required with negligible interference.

With specialized coupling units, the PSO+ units may also provide line overlay applications.

1.2 SPECIFICATIONS

1.2.1 Frequencies Available for Use with PSO+

The standard Siemens frequencies depicted in Table 1 – 1 are available for use with PSO+:

Table 1-1:
Standard Siemens Frequencies Available for Use with PSO+

156 Hz	211 Hz	285 Hz	348 Hz	430 Hz	525 Hz	**645 Hz**	**790 Hz**
970 Hz	**1180 Hz**	**1450 Hz**	**1770 Hz**	**2140 Hz**	**2630 Hz**	**3240 Hz**	**4000 Hz**

(Frequencies in **Bold** text are recommended for use in electrified territories)

1.2.2 PSO+ System Specifications

Table 1-2:
PSO+ System Specifications

PARAMETER	VALUES
Frequency Stability:	±0.01% (Hz) of the selected frequency
Modulation	Frequency Modulation with 8-bit serial address
Receiver Selectivity	Minimum 60 dB down on adjacent channels
Track Circuit Shunt	Typical values are between 0.06 ohm and 0.5 ohm sensitivity, other values are application dependent
Track Transmitter Load	25 Ohm
Track Receiver Load	250 Ohm
Relay Coil Resistance	400 to 1,000 Ohms
Input Power Supply	9.0 VDC to 16.5 VDC, 12.0 VDC nominal
Power Supply Ripple	1.0 VDC Peak to Peak maximum

Table 1-3:
PSO+ Current Draw Specifications

SUPPLY VOLTAGE	12.0V
PSO+ Transmitter, 7A481 Low Power	≈ 0.750A
PSO+ Transmitter, 7A481 High Power	≈ 0.750A
PSO+ Receiver, 7A483	≈ 0.360A

1.2.3 Maximum Operating Distances

The maximum operating distances shown in Table 1 – 4 are between transmitter and receiver track wire connections for end-fed track circuits. For center-fed track circuits, double the distances given to obtain the maximum receiver-to-receiver distance.

Table 1-4:
Maximum Operating Distances at 0.06-Ohm Shunting Sensitivity

APPLICATION	GROUP	FREQUENCY (HZ)	BALLAST	
			2 Ω/1,000 FT. OPERATING DISTANCE (FT.)	4 Ω/1,000 FT. OPERATING DISTANCE (FT.)
PSO MODULE FREQUENCIES	1	156	9,000/2,895.6	12,500/3,810.0
		285	6,900/2,103.1	9,800/2,987.0
		430	5,800/1,767.8	8,000/2,438.4
		645	4,700/1,432.6	6,600/2,011.7
		970	3,900/1,188.7	5,500/1,676.4
		1,450	3,300/1,005.8	4,600/1,402.1
		2,140	2,600/792.5	3,800/1,158.2
		3,240	2,100/640.1	3,000/914.4
	2	211	7,900/2,407.9	11,100/1,183.3
		348	6,300/1,920.2	9,000/2,743.2
		525	5,300/1,615.4	6,100/1,859.3
		790	4,300/1,310.6	5,500/1,676.4
		1,180	3,700/1,127.8	5,200/1,585.
		1,770	3,000/914.4	4,200/1,280.2
		2,630	2,400/731.5	3,300/1,005.8
		4,000	2,000/670.6	2,800/853.4

(Frequencies in **Bold** text are recommended for use in electrified territories)

NOTE

In electrified and/or light rail applications, frequencies less than 645 Hz and associated distances greater than 2000 ft. (609.6 m) are possible with certain limitations. An engineering review of usable frequencies below 645 Hz should be conducted to determine the proper operation and coverage.

1.2.4 Physical Data

Table 1-5:
Physical Dimensions and Environmental Ranges

PARAMETER	RANGE OF VALUES
Dimensions	9.54 inches high (24.23 centimeters) 3.65 inches wide (9.27 centimeters) 10.35 inches deep (26.29 centimeters)
Weight	6 pounds (2.7 kilograms)
Temperature Range	-40°F to +158°F (-40°C to +70°C)
Maximum Humidity	90% non-condensing

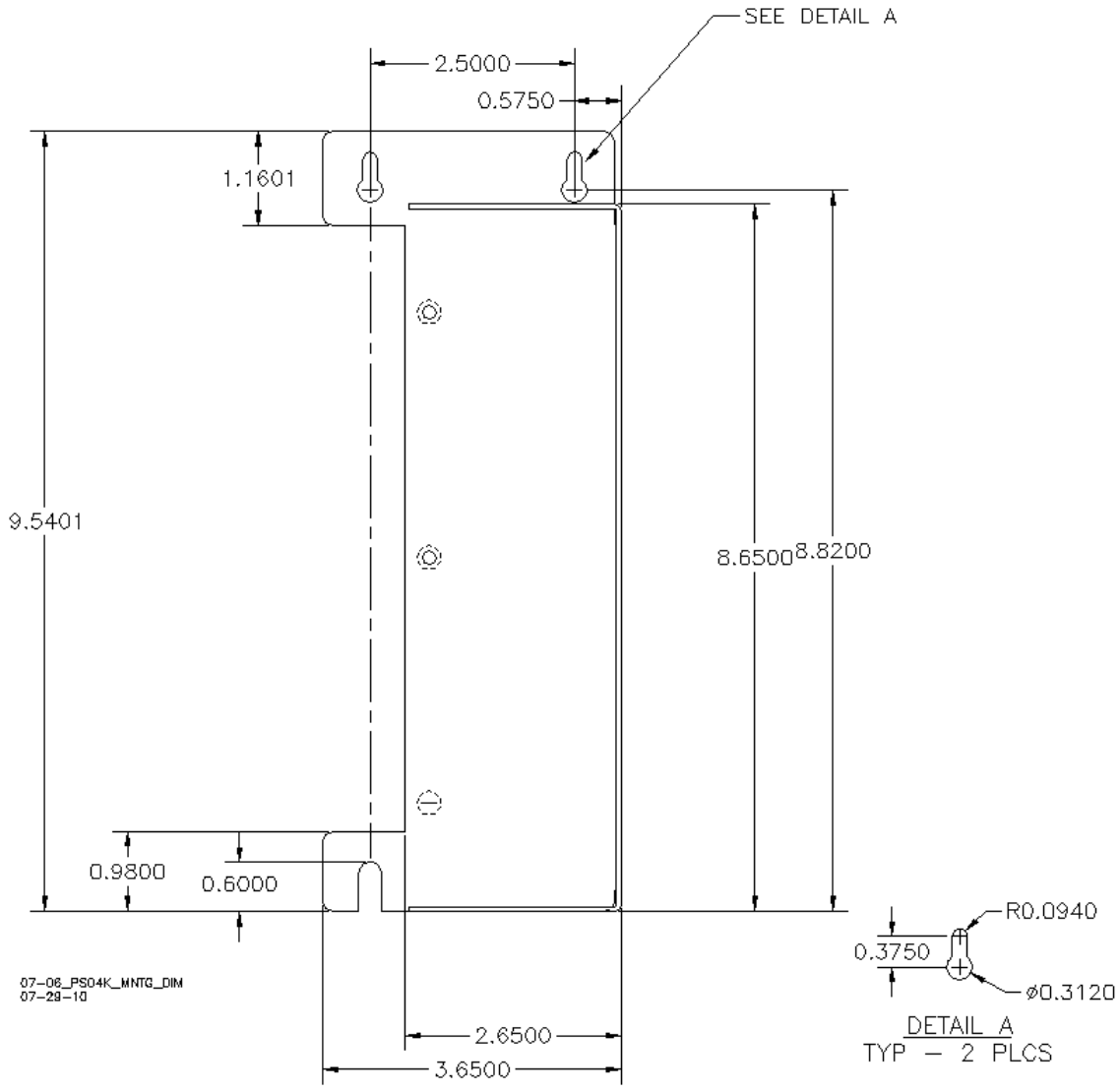


Figure 1-2:
PSO+ Mounting Dimensions

1.2.5 Maintenance Data

There is no periodic maintenance performed on the PSO+. There are no user maintainable parts within the PSO+. Defective units are replaced as a whole: if any portion of a transmitter fails, replace the 7A481 Transmitter; if any portion of receiver fails, replace the 7A483 Receiver.

SECTION 2 –
PSO+ DESCRIPTION

2.1 GENERAL DESCRIPTION

All PSO+ cases can be mounted either to a rack, a shelf or a backboard. See Figure 1 – 1 for general PSO+ case appearance and see Figure 1 – 2 and Table 1 – 8 for Case Physical Dimensions. Inside each case is a single printed circuit unit that plugs into a motherboard. All cases are powered by a power supply/battery that produces between 9.0 and 16.5 VDC (nominal 12 VDC). All connections made to the cases use 10-pin female connectors capable of accepting wire sizes from #14 – #28 AWG. All connections to track, battery or equipment outside the instrument house are made via the use of surge arrestors and equalizers. Further data common to all cases is presented in Sections 2.2 and 2.5.

2.2 COMMON CASE COMPONENTS

2.2.1.1 Four Character Alphanumeric Display

As depicted on the Transmitter in Figure 2-1, the Four Character Alphanumeric Display is located directly below the Unit Information written on the top of the faceplate. It displays letters, numbers, and limited symbols. Once the unit has completed the startup process, the top level display provides the model, frequency, unit type, and address (e.g., PSO+ 645 TX A).

2.2.1.2 MENU Button

The MENU Button is located immediately below the 4-Character Alphanumeric Display and is used in conjunction with the DATA Button to navigate the menus. Use the Menu Button to go down one level in the menu, to accept a parameter's value selection, or to begin unit calibration.

2.2.1.3 DATA Button

The DATA Button is located immediately below the MENU Button and has two uses. The first is to scroll (move from one menu item to the next) through parameter values, e.g., each time the DATA button is momentarily pressed, the next menu item is displayed. The second use is to go up one level in the menu, e.g., pressing and holding the DATA button moves up one menu level.

2.2.1.4 Power, Health, & I/O Status Indicators

These I/O, Health, and Power Status Indicator LEDs indicate:

- That power is on,
- The health status of the unit,
- Whether or not the output is energized,
- Whether or not the input is energized,
- Whether the receiver is calibrated,
- Whether or not the transmitter is sending, or

- Whether or not the track circuit is unoccupied.

The following LEDs depict the following:

- POWER – A steady green LED indicates that there is power to the case.
- HEALTH – A flashing yellow LED indicates system health,
- RLY DR – A steady red Relay Drive LED indicates track occupancy.
  - When the LED is lit, the track is unoccupied and the relay is energized,
  - When the LED is not lit the track is occupied and the relay is de-energized.
- TX Enable – A steady red Transmit Enable LED indicates that the transmitter is transmitting.
- CAL REQ – A steady red Calibration Required LED indicates that the receiver requires calibration; the lamp goes out when the receiver is calibrated.

2.2.1.5 Diagnostic Port

The diagnostic port is used by maintenance personnel to load new executive software using the standard Siemens Diagnostic Terminal (DT) program.

2.2.1.6 Power LED

The Power LED is lit green when power is applied to the unit.

2.3 PSO+ TRANSMITTER (P/N 7A481)

2.3.1 Transmitter Operation

The Transmitter, P/N 7A481 (Code A or Code C), generates a signal of the proper frequency, modulation rate, address, and signal amplitude. The transmitter utilizes either one of the 16 standard Siemens frequencies. The transmitter modulation frequency varies between ±1/64th of the chosen frequency (e.g. the Transmit Frequency selected is 2.14 kHz, and so the frequency ranges from 2.106 kHz to 2.173 kHz). The modulation is a Frequency Modulation providing a reoccurring eight bit non-symmetrical serial address. The transmit amplitude is determined by the Transmit Level (Low or High Power) selected during setup.

2.3.2 Transmitter Physical Layout

The Transmitter is mounted and connected as described earlier in paragraph 2.1 and Figure 7 – 2, and appears as illustrated in Figure 2-1.

Figure 2-1 depicts the face of the Transmitter, and Table 2-1 provides a description of each item. Each item is further described in the following sections. Figure 7 – 2 depicts a typical installation of a Transmitter / Receiver pair.

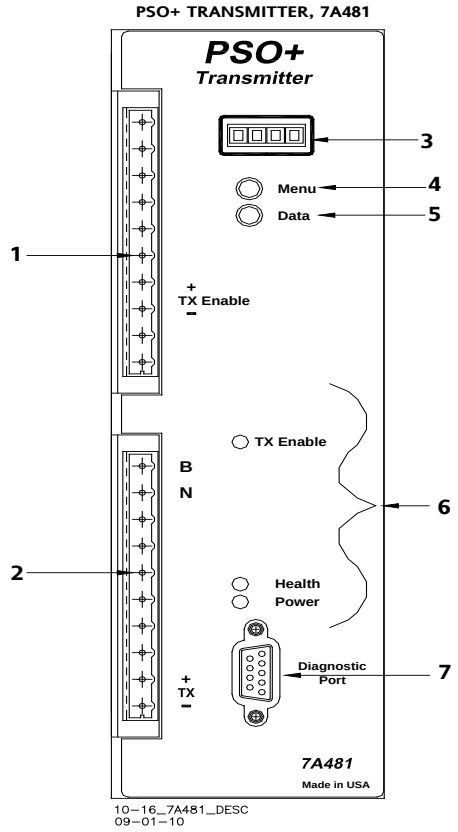


Figure 2-1:
PSO+ Transmitter, 7A481

Table 2-1:
TRANSMITTER, P/N 7A481 OPERATING CONTROLS

ITEM NO.	DESCRIPTION
1	Upper 10-pin Connector
2	Lower 10-pin Connector
3	Four Character Alphanumeric Display
4	MENU Button
5	DATA Button
6	I/O, Health, & Power Status Indicators
7	Diagnostic Port

Table 2-2 provides pin assignment information for Upper and Lower 10-pin WAGO-style Connectors. The Upper 10-pin Connector links the TX Enable input to the unit. The Lower 10-pin Connector links the power supply/battery power and the track connections to the Unit. The pins on both connectors are numbered sequentially from 1 – 10 from bottom to top.

TABLE 2-2:
TRANSMITTER 10-PIN CONNECTOR ASSIGNMENT CHART

PIN NUMBER	UPPER 10-PIN CONNECTOR	LOWER 10-PIN CONNECTOR
1	Not Used	Transmitter to Rail 2
2	Not Used	Transmitter to Rail 1
3	TX Enable Negative	Not Used
4	TX Enable Positive	Not Used
5	Not Used	Not Used
6	Not Used	Not Used
7	Not Used	Not Used
8	Not Used	Not Used
9	Not Used	Power Supply / Battery Negative Input
10	Not Used	Power Supply / Battery Positive Input

2.3.2.1 Upper 10-pin Connector

The Upper 10-pin Connector allows connection for the Transmit Enable inputs. The unit only transmits when an external input is energized.

2.3.2.2 Lower 10-pin Connector

The Lower 10-pin Connector provides power supply/battery positive and negative connections for devices contained within the Unit. In the Transmitter, the Pins 1, 2, 9, & 10 are active. Pins 1 & 2 are the Transmitter connections to Rails 1 and 2, respectively and Pins 9 & 10, which provide battery negative and positive power to the Unit, respectively.

2.3.2.3 Health LED

The unit is considered healthy when:

- Frequency is set and
- The power supply voltage is between 9.0 and 16.5 VDC and
- The unit is functional

The Health LED is lit and flashes yellow at 1 Hz when unit is healthy and at 6 Hz when unhealthy.

2.3.3 Transmitter Settings

The user can select from the list of 16 Siemens frequencies. The user can select to send the signal on either Low or High power.

2.3.4 Transmit Enable LED Indicator

The TX Enable LED indicates that the unit transmitter is functioning and sending a signal to the receiver. The TX Enable LED is lit whenever the unit:

- Has been configured to the proper frequency and
- The power supply voltage is greater than 9.0 VDC but less than 16.5 VDC and
- The TX Enable input is energized, and
- The transmitter is healthy

The TX Enable LED is not lit when:

- The transmitter frequency is not set, or
- If the transmit enable input is de-energized, or
- The transmitter is unhealthy.

2.4 PSO+ RECEIVER (P/N 7A483)

2.4.1 Receiver Operation

The Receiver, P/N 7A483 (Code A or Code C), detects the proper frequency, address, and signal amplitude sent by the transmitter. The receiver is connected to the track via a Tuned Receiver Coupler, which is a separate piece of equipment. No insulated joints are needed to confine the signal because the coupling units have low impedance at the operating frequency of the track circuit, and high impedance at all other frequencies. The receiver will detect any of the 16 standard Siemens frequencies. The modulation is a Frequency Modulation providing a reoccurring eight bit non-symmetrical serial address. The receiver must verify frequency, address, and signal amplitude prior to energizing any output functions.

2.4.2 Receiver Physical Layout

The Receiver is mounted and connected as described earlier in paragraph 2.1 and Figure 7 – 2, and appears as illustrated in Figure 2-2. Figure 2-2 depicts the face of the Receiver, and Table 2-3 provides a description of each item. Figure 7 – 2 depicts a typical installation of a Transmitter / Receiver pair. Each item is further described in the following sections.

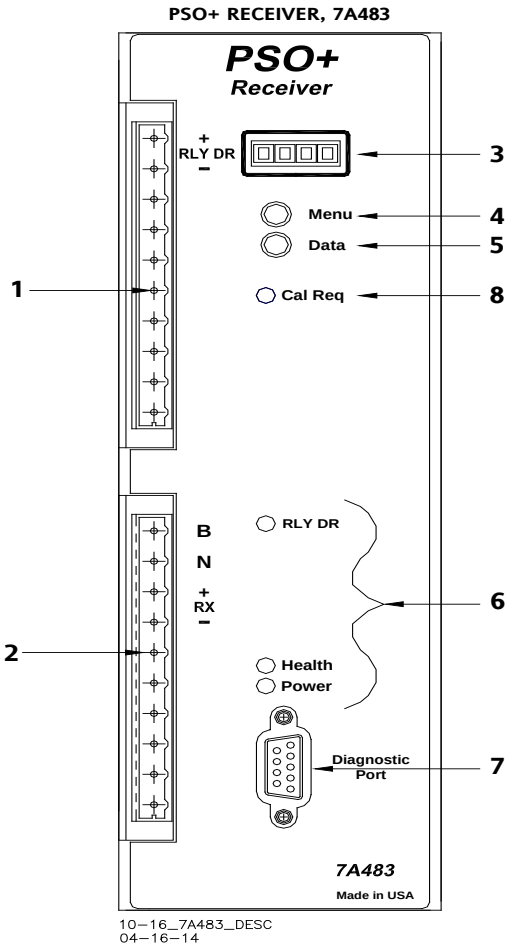


Figure 2-2:
PSO+ Receiver, 7A483

Table 2-3:
RECEIVER, P/N 7A473 OPERATING CONTROLS

ITEM NO.	DESCRIPTION
1	Upper 10-pin Connector
2	Lower 10-pin Connector
3	Four Character Alphanumeric Display
4	MENU Button
5	DATA Button
6	I/O, Health, & Power Status Indicators
7	Diagnostic Port
8	Calibration Required (CAL REQ) Indicator

Table 2-4 provides pin assignment information for Upper and Lower 10-pin WAGO-style Connectors. The Upper 10-pin Connector links the Relay Drive (RLY DR) output to the Unit. The

Lower 10-pin Connector links the power supply/battery power and the track connections to the Unit. For further information regarding couplers, see Section 3, Auxiliary Equipment and Section 7, Application Drawings. The pins on both connectors are numbered sequentially from 1 – 10 from bottom to top.

Table 2-4:
Receiver 10-pin Connector Assignment Chart

PIN NUMBER	UPPER 10-PIN CONNECTOR	LOWER 10-PIN CONNECTOR
1	Not Used	Not Used
2	Not Used	Not Used
3	Not Used	Not Used
4	Not Used	Not Used
5	Not Used	Not Used
6	Not Used	Not Used
7	Not Used	Receiver 2 to Applicable Coupler
8	Not Used	Receiver 1 to Applicable Coupler
9	Relay Drive (RLY DR) +	Power Supply / Battery Negative Input
10	Relay Drive (RLY DR) -	Power Supply / Battery Positive Input

2.4.2.1 Upper 10-pin Connector

The Upper 10-pin Connector Block allows connection for Relay Drive (RLY DR) output to pins 9 & 10, leads for RLY DR - & RLY DR +, respectively.

2.4.2.2 Lower 10-pin Connector

The Lower 10-pin Connector provides power supply/battery positive and negative connections for devices contained within the Unit. In the Receiver, the Pins 7, 8, 9, & 10 are active. Pins 7 & 8 are the Transmitter connections to Rails 2 and 1, respectively and Pins 9 & 10, which provide battery negative and positive power to the Unit, respectively.

2.4.2.3 Health LED

The unit is considered healthy when:

- The receiver frequency is set and
- The receiver is calibrated and
- The power supply voltage is between 9.0 and 16.5 VDC and
- The unit is functional.

The Health LED is lit and flashes yellow at 1 Hz when unit is healthy and at 6 Hz when unhealthy.

2.4.3 Receiver LED Indicators

When the unit is configured and receiving a signal from the transmitter following calibration, the Receiver LEDs are in the states shown:

2.4.3.1 Calibration Required (CAL REQ) LED

The calibration indicator is a red LED with “Cal Req” printed next to the LED. The red LED is lit when the receiver requires calibration. When the receiver is calibrated, the LED goes out.

2.4.3.2 Relay Drive (RLY DR) LED

The Relay Drive (RLY DR) LED is lit when the track is unoccupied and the RLY DR output is energized. When the track is occupied, the RLY DR output is de-energized and the RLY DR LED goes out.

2.4.4 Receiver Configuration Parameters

The Receiver menu allows the Receive Frequency Selection to be configured from the 16 standard Siemens frequency list.

2.4.5 Receiver Calibration

The Receiver requires user calibration in order to set the appropriate threshold for train detection. A shunt (e.g. 0.06Ω, 0.1 Ω, etc.) is placed at a specific location on the track and the calibration for the receiver is started. The Unit monitors the signal level and stores that signal level in Non-Volatile Memory (NVRAM). This stored signal level is then used as a base line to determine whether the track is occupied. See Section 6.5 for calibration procedures.

2.5 PSO+ SYSTEM WIDE COMMON DATA

2.5.1 Receiver Signal Level

This data is shown on the 4-Character Display. The receiver signal level for the receiver may be viewed via the VERS portion of the menu. The signal level data refreshes at least once per second.

2.5.2 System Diagnostic Data

This data is shown on the 4-Character Display with DIAG flashing on the display. Whenever an error occurs, the system provides diagnostic messages via the 4-Character Alphanumeric Display.

2.5.3 Diagnostic Messages

The system provides diagnostic messages that enable personnel to see if there are any problems in the system. The Unit Health LED indicates if the system is healthy (slow flash) or unhealthy (fast flash). The following messages scroll across the 4-Character Display:

- XMIT ERROR – Transmitter error
- TX FREQ NOT SET – Transmitter frequency not set
- TX RECOVERING – Transmitter is recovering from unhealthy state
- RCV ERROR – Receiver error
- CAL REQD – Receiver requires calibration
- CARRIER ONLY – Receiver receives a carrier signal but no code
- RCV FREQ NOT SET – Receiver frequency is not set
- RCV RECOVERING – Receiver is recovering from unhealthy state
- WRONG CODE RCVD – Receiver receives wrong address code

See Appendix B, Troubleshooting for further information regarding diagnostic messages.

2.5.4 Performance Data

The Vital Relay Output indicating PSO Occupancy will de-energize within 1.0 seconds from the application of a shunt (of the same value as used for calibration) for a properly adjusted track circuit.

The Vital Relay Output indicating PSO Occupancy will energize within the following number of seconds plus the two second pickup delay from the removal of a shunt.

Table 2-5:
Output Occupancy Energization Times

FREQUENCY	TIME
< 645	2s
>= 645	1s

The Transmitter stops generating the transmit signal within 1s of the transmit enable input de-energizing.

The Transmitter starts generating the transmit signal within 1s of the transmit enable input energizing.

2.5.5 System Data

LEDs on the unit depict:

- Relay Drive Activation
- Transmit Enable
- Receiver Calibration required
- Unit Health
- Power

2.5.6 LED Data

The Unit shows:

- Whether power is being applied to the unit using a green LED.
- The health of the unit using a yellow LED.
- Whether an input is energized using red LEDs.
- Whether an output is energized using red LEDs.

2.6 PSO+ SYSTEM FUNCTIONAL REQUIREMENTS

2.6.1 General

When executive software is changed, the systems sets the configuration parameters back to their default values.

Reprogramming is required whenever he Unit reboots and the configuration stored in NVRAM is invalid, and

- Receiver frequency has not been set, or,
- The Transmitter frequency has not been set

SECTION 3 –
ANCILLARY EQUIPMENT

3.1 GENERAL

The equipment described in the following paragraphs may be used with the PSO+. Refer to Section 7 for application diagrams illustrating use of these items.

CAUTION

THE DEVICES DESCRIBED HERE MUST BE MOUNTED IN WEATHERPROOF ENCLOSURES UNLESS STATED OTHERWISE.

Table 3-1:
Equipment-Paragraph Cross Reference Chart

Paragraph	Equipment Covered	Paragraph	Equipment Covered
3.6.1	AC Shunt, Wide Band, 8A076A	3.3.7	PSO Insulated Joint Bypass Coupler (Tuned), 7A422-f [1]
3.2.1	Battery Choke, 62648	3.3.6	PSO Line Coupler, Low Z, 7A403 with PSO Line Terminator, 7A345
3.2.1	Battery Choke, 8A065	3.3.4.1	Receiver Line to Rail Coupler, 7A377-1-f [1]
3.5.1	Battery Surge Protection	3.3.4.4	Receiver Line To Rail Coupler, 7A377-2-f [1]
3.4	Cab Signal Filter, 7A417-X [2]	3.5.2	Track Wire Surge Protection in Electrified Territory
3.3.3	Line to Receiver Coupler, 7A388	3.3.5	Transmitter Line to Rail Coupler, 7A399-f [1]
3.2.1	PSO Battery Choke, 7A360	3.3.1	Tuned Receiver Coupler, 7A355-f [1]
3.2.4	PSO Battery Line Filter, 7A418	3.3.2	Tuned Receiver Coupler, Hi Z, 7A366-f [1]

[1] **–f** following part number indicates unit is frequency specific – use appropriate PSO+ frequency

[2] **–X** following part number indicates dash number options are available

3.2 BATTERY CHOKES AND FILTERS

WARNING

WHERE GCP'S OR MOTION SENSORS ARE INSTALLED WITH THE PSO+, THE 7A360 CHOKE MUST NOT BE USED. INSTEAD, USE THE 8A065A OR 62648 CHOKES (8A065A MUST BE USED WITHIN MODEL 300 OR 400 GCP APPROACHES).

3.2.1 Equipment Description

PSO Battery Choke, 7A360, (see Figure 3-1) connects in series to the rail of any track battery within the track circuit. Suitable substitutions for the PSO Battery Choke, 7A360 are the Battery Choke, 62648 and Battery Choke, 8A065A (see Figure 3-2).

Each of the battery chokes consists of a large inductor and a set of AREMA binding posts on a mounting base (see Figure 3-1 and Figure 3-2 for mounting dimensions).

3.2.2 Mounting Dimensions

3.2.2.1 PSO Battery Choke, 7A360

Mounting Dimensions for the PSO Battery Choke, 7A360 are as follows:

- Dimensions:
  - 5.0 inches (12.70 centimeters) wide
  - 5.5 inches (13.97 centimeters) deep
  - 3.4 inches (8.64 centimeters) high
- Weight:
  - 6 pounds, 8 ounces (2.95 kilograms) (approximate)

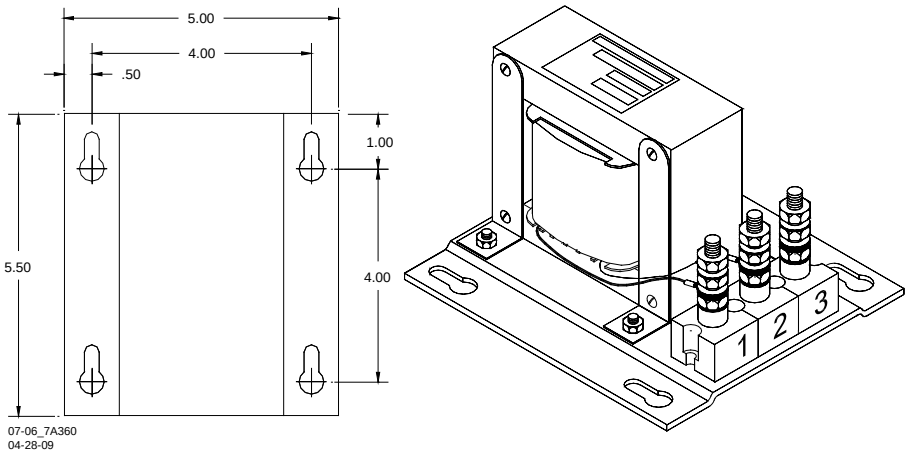


Figure 3-1:
PSO Battery Choke, 7A360 With Mounting Dimensions

3.2.2.2 Battery Choke 62648 and Battery Choke 8A065A

Mounting Dimensions for the Battery Choke, 62648 and Battery Choke, 8A065A are as follows:

- Dimensions:
  - 4.5 inches (11.43 centimeters) wide
  - 5.0 inches (12.70 centimeters) deep
  - 8.5 inches (21.59 centimeters) high (to top of terminal studs)
- Weight
  - 17 pounds (7.72 kilograms) (approximate)

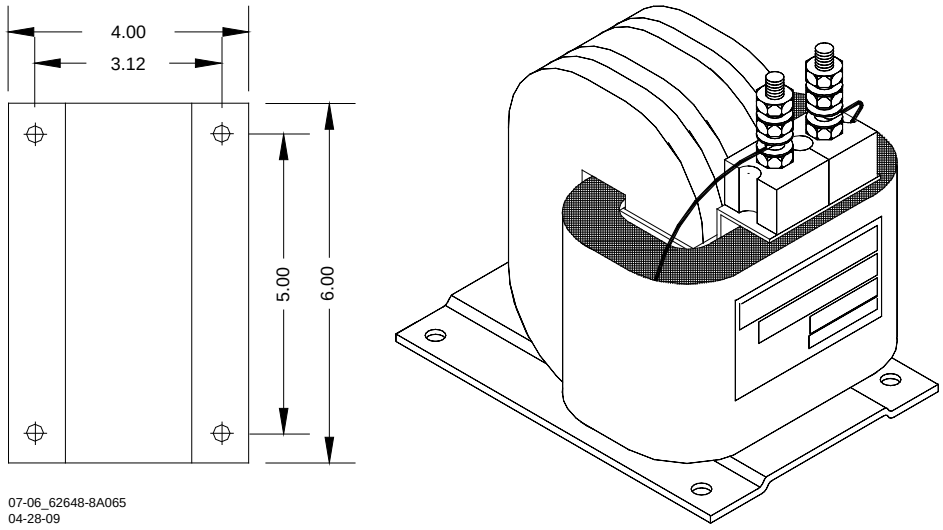


Figure 3-2:
Battery Choke, 62648 & Battery Choke, 8A065A with Mounting Dimensions

3.2.3 Application Installation, 7A360, 62648 & 8A065A

Application installation of a Battery Choke is as described in Section 4.5.5 and as depicted in Figure 3-3.

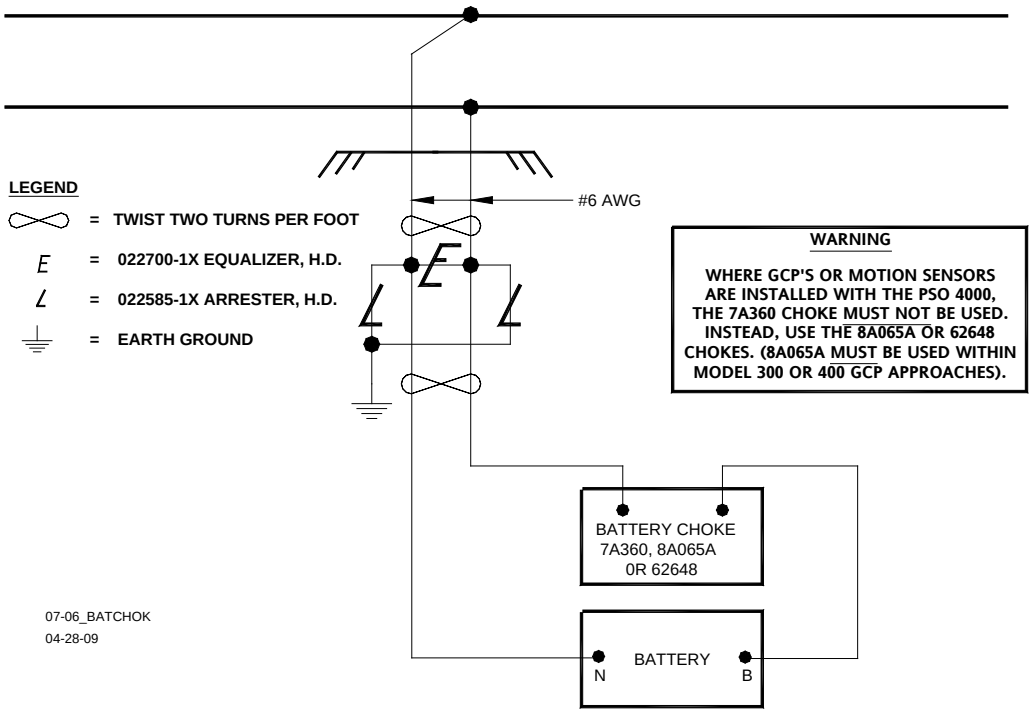


Figure 3-3:
Typical Battery Chokes 8A065A, 62648, or
PSO Battery Choke, 7A360 Application Installation

3.2.4 PSO Battery Line Filter, 7A418

3.2.4.1 Equipment Description, 7A418

The PSO Battery Line Filter, 7A418 assembly consists of a large choke coil, a capacitor, and a set of AREMA binding posts on a mounting base.

3.2.4.2 Mounting Dimensions, 7A418

Mounting Dimensions for the 7A418 Battery Line Filter assembly are as follows:

- Dimensions
  - 5.0 inches (12.70 centimeters) wide
  - 9.0 inches (22.86 centimeters) deep
  - 3.75 inches (9.53 centimeters) high

- Weight
  - 7 pounds, 2 ounces (3.23 kilograms) (approximate)

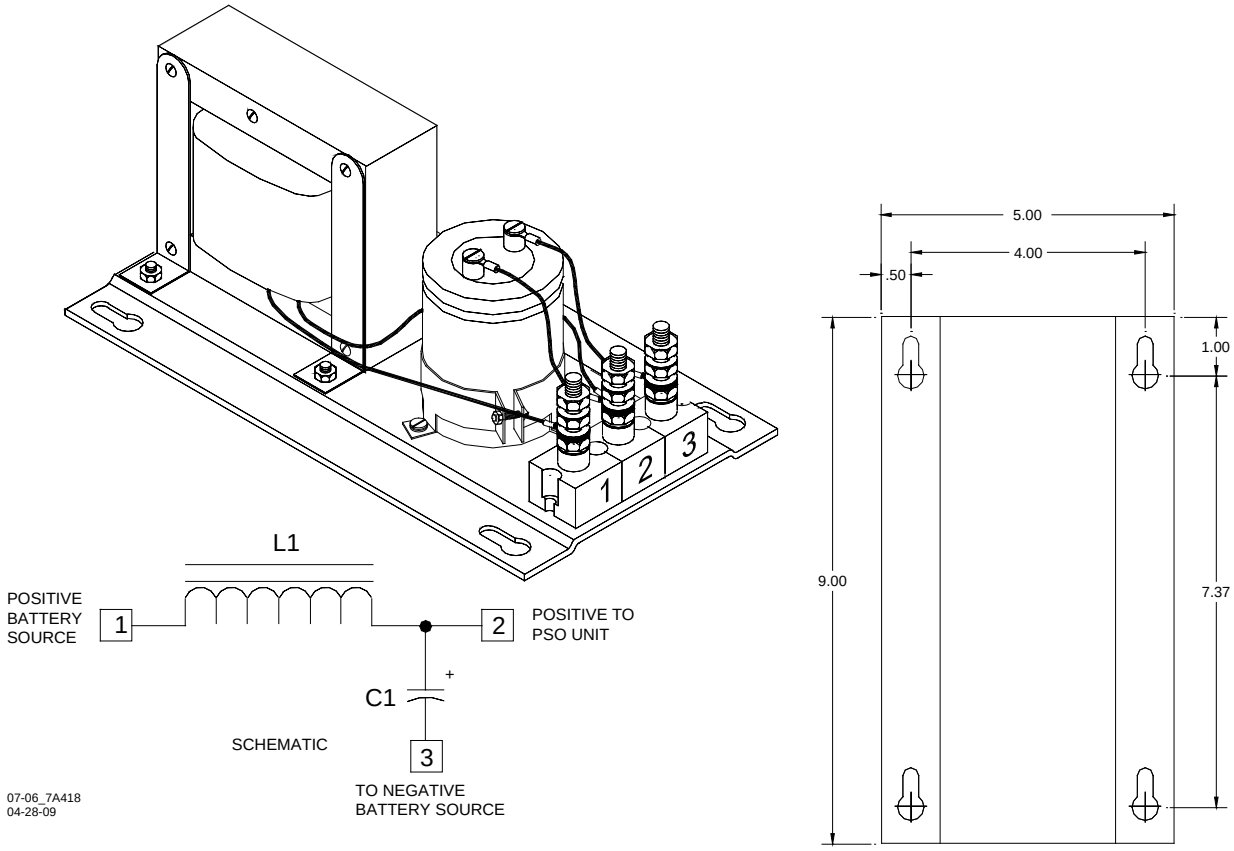


Figure 3-4:
PSO Battery Line Filter, 7A418, With Mounting Dimensions

3.2.4.3 Application Installation, 7A418

PSO Battery Line Filter, 7A418, is recommended for use in providing decoupling between the battery and those PSO+ Assemblies utilizing the same frequency.

In track circuits where the transmitters and receivers are powered from the same battery, install the filter between the battery and each transmitter and the battery and each receiver of the same frequency (see examples below).

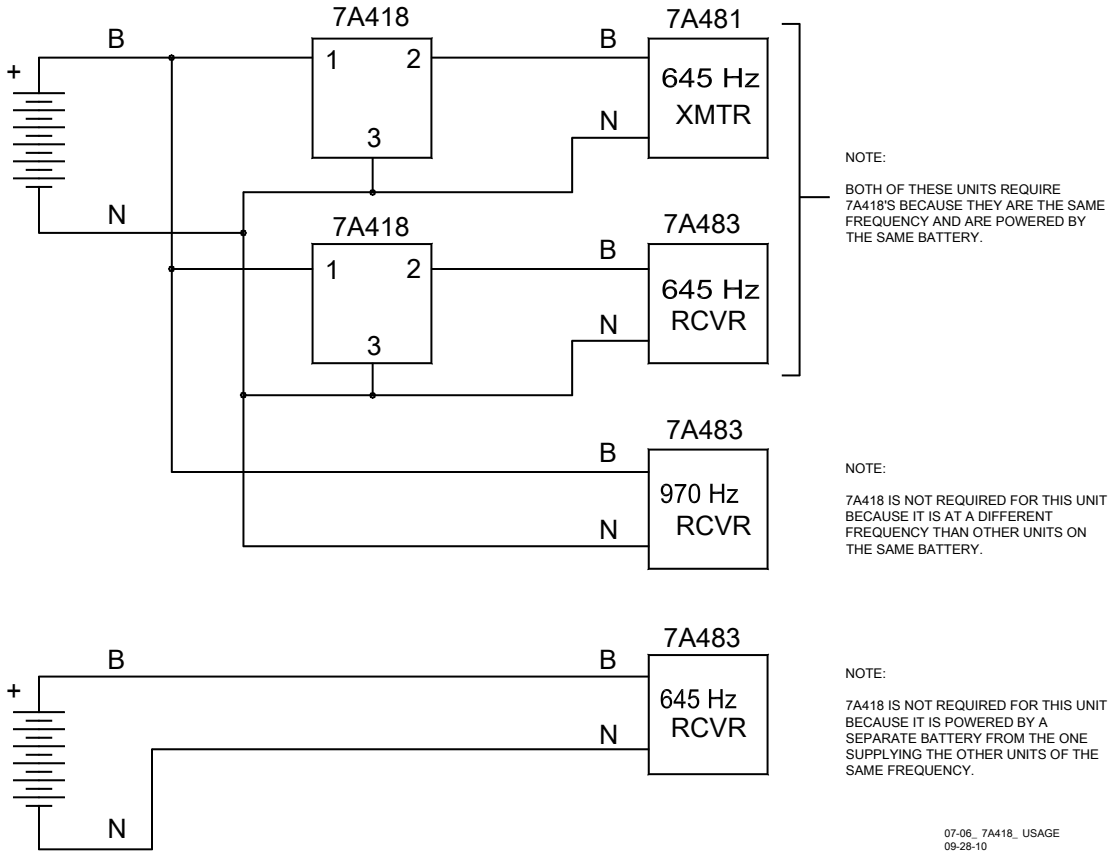


Figure 3-5:
Battery Line Filter Usage Guidelines

3.3 PSO COUPLERS

NOTE

PSO Couplers (7A355-f, 7A366-f, 7A377-X-f, & 7A399-f) are available for use for the 16 standard PSO+ carrier frequencies.

3.3.1 Tuned Receiver Coupler, 7A355-f

3.3.1.1 Equipment Description, 7A355-f

The Tuned Receiver Coupler, 7A355-f couples the phase shift overlay signal from the track to the receiver. The 7A355-f coupler provides a low (1 – 2 ohm) impedance to the receiver from the track. However, the coupler does not shunt other signals from the track since a low impedance is produced only at the specified frequency. The coupler must always be the same frequency as programmed on the PSO+ transmitter and receiver.

The coupler assembly consists of a tubular PVC plastic enclosure with mounting brackets at the base. There are four AREMA binding posts on the top of the assembly that provide connections to the circuits housed within the sealed unit (see Figure 3-6).

3.3.1.2 Mounting Dimensions, 7A355-f

Mounting Dimensions for the Tuned Receiver Coupler, 7A355:

- Dimensions:
  - 3.50 inches (8.89 centimeters) in diameter
  - 7.75 inches (19.69 centimeters) high (to top of AREMA binding posts)
- Weight
  - 3.5 pounds (1.59 kilograms) approximate

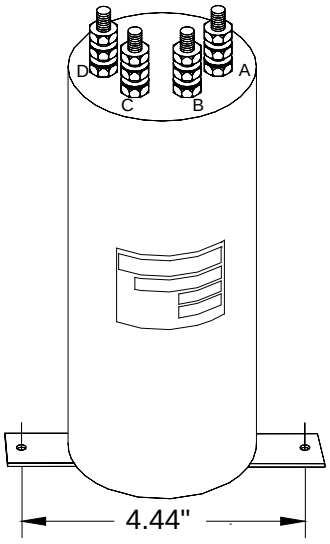


Figure 3-6:
Tuned Receiver Coupler, 7A355-f

3.3.1.3 Application Installation, 7A355-f

See Figure 7-2, 7-3, and Figure 7-6 for Tuned Receiver Coupler, 7A355-f application installation drawings. The coupler terminals are connected as follows:

- Terminals A & B connect to the wire leads that are connected to the Wayside Signal Station (WSS) surge equipment terminals which are in turn connected the appropriate gauge twisted pair track leads that connect to the rails.
- Terminals C & D connect to the wire leads connected to "RX –" and "RX +" on the PSO+ Lower 10-pin Connector

Twisted pair track wires running from the shelter surge equipment that is connected to the Tuned Receiver Coupler, 7A355-f to the rails via may be #9 AWG for distances of up to 100 ft. (30.5 m). For distances between 100 – 300 ft. (30.5 – 91.4 m) in length, track wires should be be #6 AWG.

For distances greater than 300 ft. (30.52 m) but less than 2000 ft. (609.6 m), the Tuned Receiver Coupler, 7A355-f should be replaced by the Line to Receiver Coupler, 7A388. The 7A388 should be used in conjunction with either the Receiver Line to Rail Coupler, 7A377-1-f or the Receiver Line to Rail Coupler, 7A377-2-f (see paragraphs 3.3.4.1 and 3.3.4.4, respectively).

3.3.2 Tuned Receiver Coupler, Hi Z, 7A366-f

3.3.2.1 Equipment Description, 7A366-f

NOTE

Maximum track distances will be reduced by at least 30% in applications using the Tuned Receiver Coupler, Hi Z, 7A366-f.

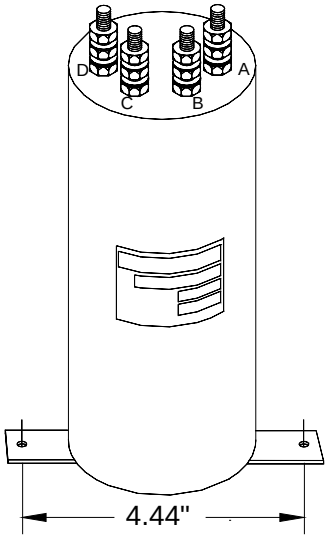


Figure 3-7:
Tuned Receiver Coupler, Hi Z, 7A366-f

The Tuned Receiver Coupler, Hi Z, 7A366-f couples the phase shift overlay signal from the track to the receiver. The 7A366-f coupler provides an input impedance of 5 ohms, enabling other receivers on the track to be operated from the same transmitter. The coupler must always be of

the same frequency as that set on the PSO+ transmitter and receivers. The coupler assembly consists of a tubular PVC plastic enclosure with mounting brackets at the base. There are four AREMA binding posts on the top of the assembly that provide connections to the circuits housed within the sealed unit (see Figure 3-7).

3.3.2.2 Mounting Dimensions, 7A366-f

Mounting Dimensions for the Tuned Receiver Coupler, Hi Z, 7A366:

- Dimensions:
  - 3.50 inches (8.89 centimeters) in diameter
  - 7.75 inches (19.69 centimeters) high (to top of AREMA binding posts)
- Weight
  - 3.5 pounds (1.59 kilograms) approximate

3.3.2.3 Application Installation, 7A366-f

See Figure 7-3 for Tuned Receiver Coupler, Hi Z, 7A366-f application installation drawings. The coupler terminals are connected as follows:

- Terminals A & B connect to the wire leads that are connected to the shelter surge equipment terminals which are in turn connected the appropriate gauge twisted pair track leads that connect to the rails.
- Terminals C & D connect to the wire leads connected to “RX –“ and “RX +” on the PSO+ Lower 10-pin Connector

There must be a minimum of 500 ft. (152.4 m) separating the track connections of the Tuned Receiver Coupler, Hi Z, 7A366-f from the track connections of the PSOOA Transmitter, 7A471.

Track wires connecting the Tuned Receiver Coupler, Hi Z, 7A366-f to the rails may be #9 AWG for distances between the coupler and the track of up to 100 ft. (30.5 m). When the distances are between 100 – 300 ft. (30.5 – 91.4 m) in length, track wires should be #6 AWG.

For distances greater than 300 ft. (30.52 m) but less than 2000 ft. (609.6 m), the Tuned Receiver Coupler, Hi Z, 7A366-f should be replaced by the Line to Receiver Coupler, 7A388. The 7A388 should be used in conjunction with either the Receiver Line to Rail Coupler, 7A377-1-f or the Receiver Line to Rail Coupler, 7A377-2-f (see paragraphs 3.3.4.1 and 3.3.4.4, respectively).

3.3.3 Line to Receiver Coupler, 7A388

3.3.3.1 Equipment Description, 7A388

The Line to Receiver Coupler, 7A388 is non-tuned and provides transmitter to line coupling or line to receiver impedance matching. The 7A388 coupler assembly consists of a tubular PVC plastic enclosure with mounting brackets at the base. There are four AREMA binding posts on the top of the assembly that provide connections to the circuits housed within the sealed units (see Figure 3-8).

3.3.3.2 Mounting Dimensions, 7A388

Mounting Dimensions for the Line to Receiver Coupler, 7A388 are as follows:

- Dimensions:
  - 3.5 inches (8.89 centimeters) in diameter
  - 10.75 inches (27.31 centimeters) high (to top of AREMA binding posts)
- Weight
  - 5.25 pounds (2.38 kilograms) (approximate)

3.3.3.3 Application Installation, 7A388

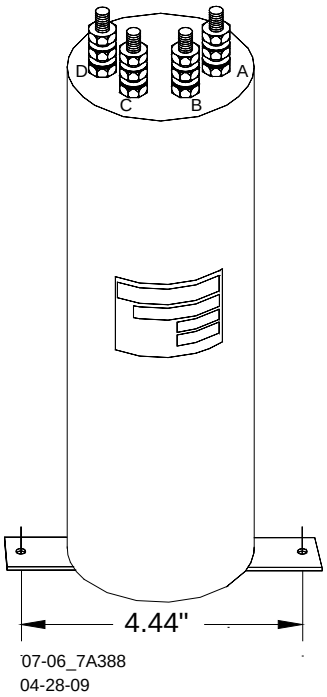


Figure 3-8:
Line to Receiver Coupler, 7A388

See Figure 7-4, Figure 7-5, Figure 7-6, and Figure 7-7 for Line to Receiver Coupler, 7A388 application installation drawings. The coupler terminals are connected as follows:

3.3.3.3.1 Connecting Line to Receiver Coupler 7A388 to Receiver Line to Coupler, 7A377-1-f

- Terminals A & B connect to the wire leads connected to the shelter surge equipment terminals that are connected to the #14 AWG twisted pair of line wires which are connected to the equalizer that is connected to the #10 AWG leads marked “LINE” on the 7A377-1-f, (See Figure 7-4 for exact wiring)
- Terminals C & D connect to the wire leads connected to “RX –“ and “RX +” on the PSO+ Lower 10-pin Connector

3.3.3.3.2 Connecting Line to Receiver Coupler 7A388 to Receiver Line to Coupler, 7A377-2-f

- Terminals A & B connect to the wire leads that are connected to the shelter surge equipment terminals which are connected to the #14 AWG twisted pair of line wires that are connected

to the equalizer which is connected to the wire leads connected to Terminals C & D on the 7A377-2-f, (See Figure 7-5 for exact wiring)

- Terminals C & D connect to the wire leads connected to “RX –“ and “RX +” on the PSO+ Lower 10-pin Connector

3.3.3.3.3 Connecting Line to Receiver Coupler 7A388 to Transmitter Line to Coupler, 7A399-f

- Terminals A & B connect to the wire leads that are connected to the shelter surge equipment terminals which are connected to the #14 AWG twisted pair of line wires that are connected to the equalizer that is connected to the wire leads connected to Terminals A & B on the 7A399-f (See Figure 7-6 or Figure 7-7 for exact wiring).
- Terminals C & D connect to the wire leads connected to “TX –“ and “TX +” on the PSO+ Lower 10-pin Connector

The Line to Receiver Coupler, 7A388 should be used when the distance from the rails to the transmitter or receiver to the track is between 300 ft. (30.52 m) but less than 2000 ft. (609.6 m) (based on using 14AWG; increasing the diameter of the wire will proportionally increase the potential distance from 2000 ft./609.6 m).. The Line to Receiver Coupler, 7A388 is used in conjunction with either the Receiver Line to Rail Coupler, 7A377-1-f for a pole mounted configuration or the Receiver Line to Rail Coupler,7A377-2-f for a shelf mounted configuration (see paragraphs 3.3.4.1 and 3.3.4.4 respectively) or the Transmitter Line to Rail Coupler, 7A399-f.

3.3.4 Receiver Line to Rail Coupler, 7A377-1-f and Receiver Line to Rail Coupler, 7A377-2-f

NOTE

The Receiver Line to Rail Couplers, 7A377-1-f or 7A377-2-f, are tuned couplers and should be mounted in a weatherproof shelter located within 100 ft. (30.5 m) of the track connection. The track wire which connects the Receiver Line to Rail Coupler, 7A377-1-f or 7A377-2-f to the rails should be #6 AWG.

The Receiver Line to Rail Coupler, 7A377-1-f (see Figure 3-9) and the Receiver Line to Rail Coupler, 7A377-2-f (see Figure 3-10), provide line to rail coupling when the receiver is remotely located from the rail connections as depicted in Figure 7-4 and Figure 7-5.

3.3.4.1 Equipment Description, 7A377-1-f

The 7A377-1-f coupler assembly consists of a tubular PVC plastic enclosure with mounting plates extending from each end suitable for pole mounting. There are two #6 AWG wires marked “Rail” and two #10 AWG wires marked "Line" (see Figure 3-9). When ordering, specify part number 7001-7A377-ffff (ffff = the assigned frequency for the coupler).

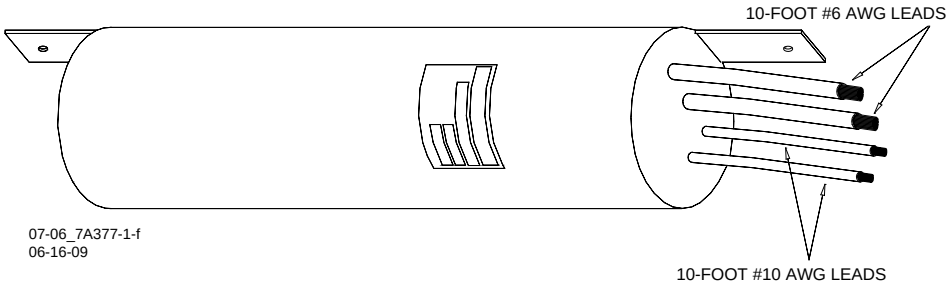


Figure 3-9:
Receiver Line to Rail Coupler, 7A377-1-f

3.3.4.2 Mounting Dimensions, 7A377-1-f

Mounting Dimensions for the Receiver Line to Rail Coupler, 7A377-1-f are as follows:

- Dimensions:
  - 3.50 inches (8.89 centimeters) O.D. in diameter
  - 9.50 inches (24.13 centimeters) in length (mounting brackets not included)
  - 13.00 inches (33.02 centimeters) in length (mounting brackets included)
- Weight
  - 8 pounds (3.63 kilograms) (approximate)
- Leads:
  - Stranded, black, 10 ft. (3.05 m) length; two #6 AWG (marked Rail) and two #10 AWG (marked Line)

3.3.4.3 Application Installation, 7A377-1-f

See Figure 7-5 for application installation drawings. The coupler wires are connected as follows:

- The two 10-foot (3.05 m) long, #6 AWG leads (marked “Rail”) are connected to the sealed equalizer that is connected to the appropriate gauge twisted pair track wires connected to the rails
- The two 10-foot (3.05 m) long, #10 AWG leads (marked “Line”) are connected to the sealed equalizer that is connected to the #14 AWG twisted pair of line wires that are connected to equipment shelter surge panel terminals that are in turn connected to Terminals A & B of the 7A388 (see Figure 7-4 for exact wiring)

The Receiver Line to Rail Coupler, 7A377-1-f should be used when the distance from the receiver to the track is between 300 ft. (30.52 m) but less than 2000 ft. (609.6 m) (based on using 14AWG; increasing the diameter of the wire will proportionally increase the potential distance from 2000 ft./609.6 m). The Receiver Line to Rail Coupler, 7A377-1-f is used in conjunction with the Line to Receiver Coupler, 7A388 (see paragraph 3.3.3).

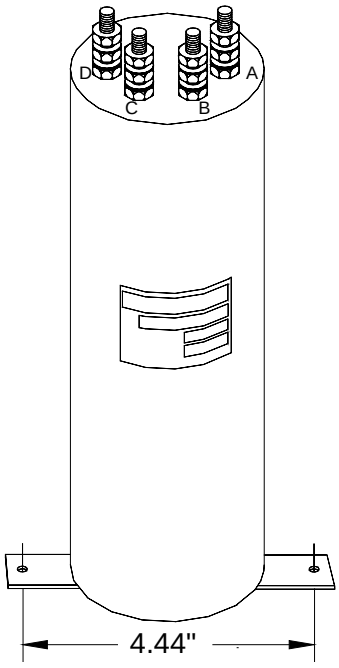


Figure 3-10:
Receiver Line to Rail Coupler, 7A377-2-f

3.3.4.4 Equipment Description, Receiver Line-to-Rail Coupler 7A377-2-f

The 7A377-2-f coupler assembly consists of a tubular PVC plastic enclosure with mounting plates extending across the base suitable for shelf mounting. It is similar to the 7A377-1-f, but rather than having four wires protrude from the top of the assembly, the top of the 7A377-2-f has four AREMA binding posts that provide terminal connections for interface wiring (see Figure 3-10). When ordering, specify part number 7002-7A377-ffff (ffff = the assigned frequency for the coupler).

3.3.4.5 Mounting Dimensions, 7A377-2-f

Mounting Dimensions for the 7A377-2-f Receiver Line to Rail Coupler are as follows:

- Dimensions
  - 3.5 inches (8.89 centimeters) O.D. in diameter
  - 10.75 inches (27.31 centimeters) in height (to top of binding posts)
- Weight:
  - 8 pounds (3.63 kilograms) (approximate)

3.3.4.6 Application Installation, 7A377-2-f

See Figure 7-5 or Figure 7-7 for application installation drawings. The coupler terminals are connected as follows:

- Terminals A & B are connected to the wire leads that are connected to the equalizer that is connected to the appropriate gauge twisted pair track wires, which are connected to the rails.
- Terminals C & D are connected to the wire leads that are connected to the sealed equalizer that is connected to the #14 AWG twisted pair of line wires that are connected to equipment shelter surge panel terminals that are in turn connected to Terminals A & B of the 7A388

The Receiver Line to Rail Coupler, 7A377-2-f should be used when the distance from the receiver to the track is between 300 ft. (30.52 m) but less than 2000 ft. (609.6 m) (based on using 14AWG, increasing the diameter of the wire will proportionally increase the potential distance from 2000 feet). The Receiver Line to Rail Coupler, 7A377-2-f is used in conjunction with the Line to Receiver Coupler, 7A388 (see paragraph 3.3.3).

3.3.5 Transmitter Line to Rail Coupler, 7A399-f

3.3.5.1 Equipment Description, 7A399-f

The Transmitter Line to Rail Coupler, 7A399-f couples the transmitter line to the track (see Figure 7-6 or Figure 7-7). The 7A399-f coupler assembly consists of a tubular PVC plastic enclosure with mounting brackets at the base. There are four AREMA binding posts on the top of the assembly that provide connections to the circuits housed within the sealed units (see Figure 3-11).

NOTE

The Transmitter Line to Rail Coupler, 7A399-f should be mounted in a weatherproof shelter located within 100 ft. (30.5 m) of the track connection. The track wire connecting the Transmitter Line to Rail Coupler, 7A399-f to the track should be #6 AWG.

3.3.5.2 Mounting Dimensions, 7A399-f

Mounting Dimensions for the Transmitter Line to Rail Coupler, 7A399-f are as follows:

- Dimensions:
  - 3.50 inches (8.89 centimeters) in diameter
  - 7.75 inches (19.69 centimeters) high (to top of AREMA binding posts)
- Weight:
  - 4.00 pounds. (1.81 kilograms) (approximate)

3.3.5.3 Application Installation, 7A399-f

See Figure 7-6 or Figure 7-7 for Transmitter Line to Rail Coupler, 7A399 application installation drawings. The coupler terminals are connected as follows:

- Terminals A & B are connected to the wire leads that are connected to the sealed equalizer that is connected to the #14 AWG twisted pair of line wires that are connected to equipment shelter surge panel terminals that are in turn connected to Terminals A & B of the 7A388

- Terminals C & D are connected to the wire leads that are connected to the equalizer that is connected to the appropriate gauge twisted pair track wires, which are connected to the rails.

The Transmitter Line to Rail Coupler, 7A399-f should be used when the distance from the receiver to the track is between 300 ft. (30.52 m) but less than 2000 ft. (609.6 m), (based on using 14AWG, increasing the diameter of the wire will proportionally increase the potential distance from 2000 feet).

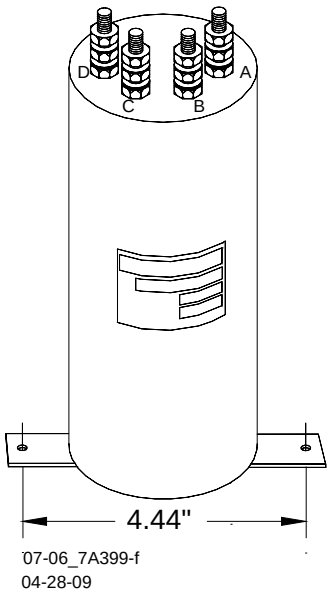


Figure 3-11:
Transmitter Line to Rail Coupler, 7A399-f

The Transmitter Line to Rail Coupler, 7A399-f is used in conjunction with the Line to Receiver Coupler, 7A388 (see paragraph 3.3.3).

3.3.6 PSO Line Coupler, Low Z, 7A403

3.3.6.1 Equipment Description, 7A403

Control for additional signal aspects can be provided by overlaying a PSO+ frequency on two-wire signal HD line circuits. PSO+ line circuits can also be used to provide block indications between CTC control points by overlaying a frequency on the two-wire signal control circuits. The PSO circuit may be continued by coupling between line circuits between intermediate signals.

The PSO Line Coupler, Low Z, 7A403, with PSO Line Terminator, 7A345 is used to couple the PSO+ transmitter and receiver to the line as shown in Figure 7-8. The same coupler is used to bridge between adjacent circuits at intermediate signals when the PSO+ line circuit extends farther than one signal block. Frequencies higher than 970 Hz are recommended for line circuit applications. A battery choke must be installed in series with the DC line battery. The PSO Battery Choke, 7A360 is recommended for this purpose.

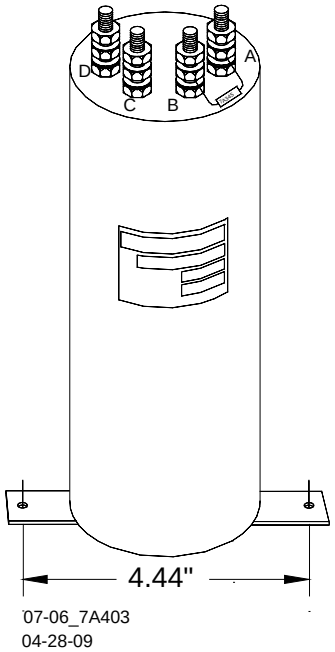


Figure 3-12:
PSO Line Coupler, Low Z, 7A403 with PSO Line Terminator, 7A345

The coupler assembly consists of a tubular PVC plastic enclosure with mounting brackets at the base. There are four AREMA binding posts on the top of the assembly that provide connections to the circuits housed within the sealed unit (see Figure 3-12).

3.3.6.2 Mounting Dimensions, 7A403

Mounting Dimensions for the PSO Line Coupler, Low Z, 7A403 are as follows:

- Dimensions:
  - 3.5 inches (8.89 centimeters) O.D. in diameter
  - 8.25 inches (20.96 centimeters) in height (to top of AREMA binding posts)
- Weight:
  - 5 pounds (2.27 kilograms) (approximate)

3.3.6.3 Application Installation, 7A403

WARNING

CONFIRM PROPER SIGNAL SYSTEM OPERATION FOLLOWING LINE OVERLAY INSTALLATION.

See Figure 7-8 for PSO Line Coupler, Low Z, 7A403 application installation drawings. The coupler terminals are connected as follows:

3.3.6.3.1 Signal West (Transmitter)

- Terminals A & B connect to the wire leads connected to "TX –" and "TX +" on the PSO+ Lower 10-pin
- Connector Terminal C to West positive wire
- Terminal D to West negative wire

3.3.6.3.2 Signal Junction (Intermediate)

- Terminal A to West positive wire
- Terminal B to West negative wire
- Terminal C to East positive wire
- Terminal D to East negative wire

3.3.6.3.3 Signal East (Receiver)

- Terminals A & B connect to the wire leads connected to "RX –" and "X +" on the PSO+ Lower 10-pin
- Terminal C to West positive wire
- Terminal D to West negative wire

Only those frequencies higher than 970 Hz are recommended for use with the PSO Line Coupler, 7A403. A PSO Battery Choke, 7A360 must be placed in series with each line battery.

3.3.7 PSO Insulated Joint Bypass Coupler (Tuned), 7A422-f

WARNING

WHEN ADDING OR REPLACING INSULATED JOINT COUPLERS, APPROPRIATE TESTS MUST BE MADE TO DETERMINE THAT THE INSULATED JOINT COUPLER DID NOT ADVERSELY AFFECT OTHER HIGHWAY CROSSING WARNING SYSTEMS OR WAYSIDE SIGNAL SYSTEM TRACK CIRCUITS.

THE 7A422-F MUST NOT BE USED TO PASS GCP OR MOTION SENSOR FREQUENCIES.

CAUTION

THE PSO INSULATED JOINT BYPASS COUPLER (TUNED), 7A422-F, SHOULD BE CONNECTED AS CLOSE AS PRACTICABLE TO THE INSULATED JOINTS, GENERALLY NO MORE THAN 25 FT. (7.62 M)FROM THE RAILS AND, TO AFFORD MAXIMUM PROTECTION FROM PHYSICAL DAMAGE, BE ENCASED IN A PROTECTIVE ENCLOSURE.

NOTE

The track wire connecting the PSO Insulated Joint Bypass Coupler (Tuned), 7A422-f, to the rails should be #6 AWG as a minimum.

3.3.7.1 Equipment Description, 7A422-f

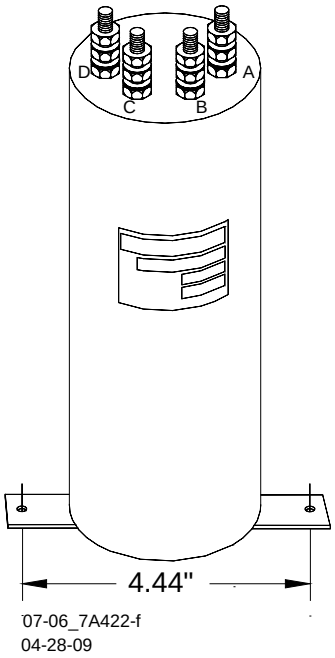


Figure 3-13:
PSO Insulated Joint Bypass Coupler (Tuned), 7A422-f

The PSO Insulated Joint Bypass Coupler (Tuned), 7A422-f, passes a specific PSO+ frequency around an insulated joint in non-electrified territory.

The coupler assembly consists of a tubular PVC plastic enclosure with mounting brackets at the base. There are four AREMA binding posts on the top of the assembly that provide connections to the circuits housed within the sealed unit (see Figure 3-13).

3.3.7.2 Mounting Dimensions, 7A422-f

Mounting Dimensions for the PSO Insulated Joint Bypass Coupler (Tuned), 7A422-f are as follows:

- Diameter:
  - 3.5 inches (8.89 centimeters) O.D. in diameter
  - 9.75 inches (24.77 centimeters) in height (to top of AREMA binding posts)
- Weight:
  - 7 pounds (3.18 kilograms) (approximate)

Generally, the distance from the weatherproof enclosure enclosing the Tuned Joint Coupler, 7A422-f to the rails should not exceed 25 feet.

The track wire connecting the Tuned Joint Coupler, 7A422-f to the rails should be #6 AWG.

3.3.7.3 Application Installation, 7A422-f

Application installation of the Tuned Joint Coupler 7A422-f is as described in Section 4.5.4 and as depicted in Figure 3-14. The coupler terminals are connected as follows:

- Terminal A connects to Rail 1 on the east side of the insulated joint
- Terminal B connects to Rail 2 on the east side of the insulated joint
- Terminal C connects to Rail 2 on the west side of the insulated joint
- Terminal D connects to Rail 1 on the west side of the insulated joint

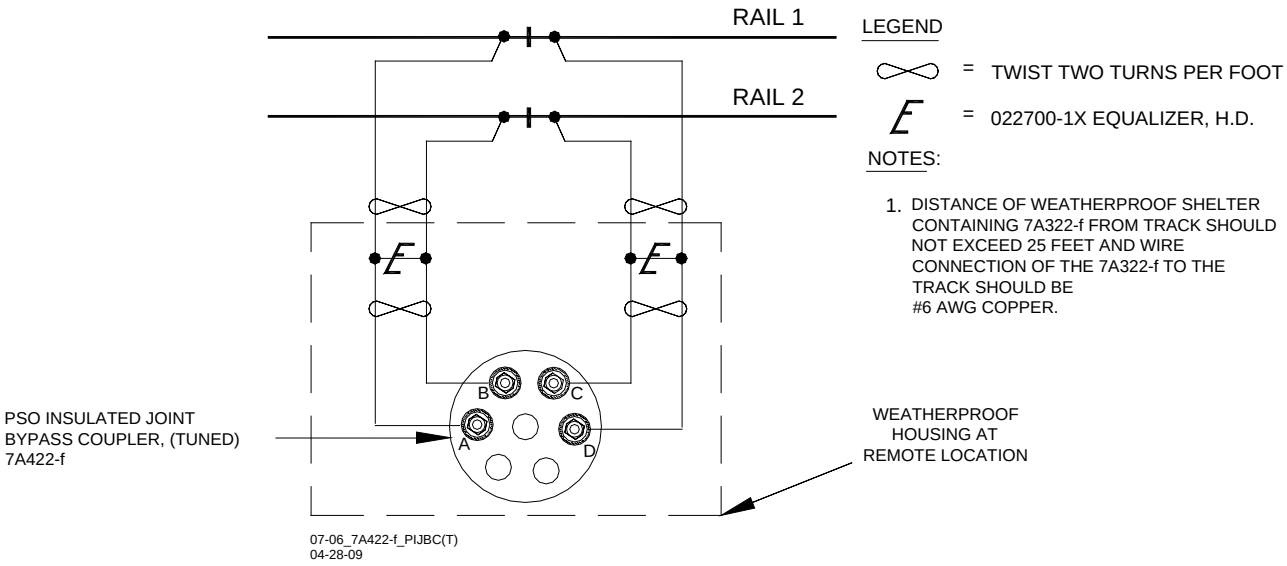


Figure 3-14:
Typical 7A422-f Tuned Joint Bypass Coupler Application

3.4 AC TRACK CIRCUIT/CAB SIGNAL FILTER, 7A417-X

3.4.1 Equipment Description, 7A417-X

The Cab Signal Filter, 7A417-X, is designed for use in territory where 60, 90, 100, or 200-Hz cab signal or AC Track Circuits are used.

3.4.2 Mounting Dimensions, 7A417-X

The 7A417-X filter assembly can be configured according to signal frequency and relay mounting base type as indicated in the tab chart below (see Table 3-2). See Table 3-3 and Figure 3-16 for mounting dimensions. Due to the multiplicity of configurations and dimensions, refer to Figure 3-16 for the different mounting dimensions.

- Weight:
  - 4 pounds, 8 ounces (2.04 kilograms) (average)

Table 3-2:
Cab Signal Filter Relay Base Manufacturer-Frequency Cross Reference

7A417-X DASH NUMBER TAB CHART				
RELAY BASE CONFIGURATION	**FREQUENCY**			
	100 HZ	**60 HZ**	**200 HZ**	**90 HZ**
Transcontrol	-01	-11	-21	-31
U. S. & S. (Ansaldo)	-02	-12	-22	-32
Safetran™	-03	-13	-23	-33

Mounting Dimensions for the Cab Signal Filter, 7A417-X assembly are delineated in Table 3-3:

Table 3-3:
Cab Signal Filter Dimensions

Dash Number	Dimensions
-01, -02, -03, -11, -12, -13, -31, -32, -33	7.75 inches (19.69 centimeters) high
-21, -22, -23	5.0 inches (12.70 centimeters) high
-01, -11, -21, -31	6.75 inches (17.15 centimeters) wide 9.0 inches (22.86 centimeters) deep
-02, -12, -22, -32	4.94 inches (12.55 centimeters) wide 8.00 inches (20.32 centimeters) deep
-03, -13, -23, -33	4.94 inches (12.55 centimeters) wide 9.4375 inches (23.97 centimeters) deep

3.4.3 Application Installation, 7A417-X

The filter should be installed on the primary side of the track transformer as described in Section 4.5.1 and as depicted in Figure 3-15.

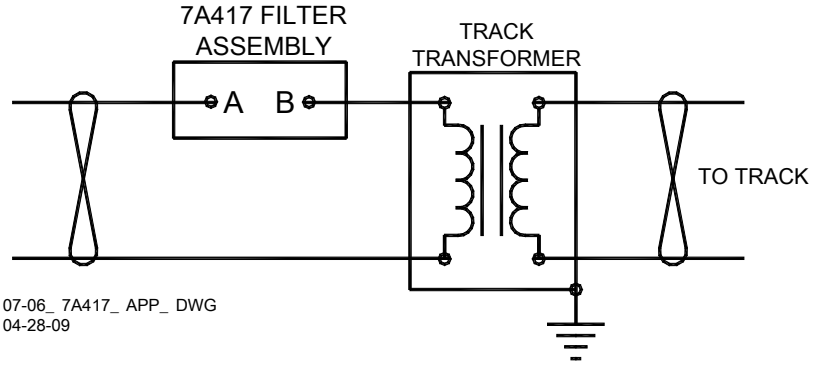


Figure 3-15:
Cab Signal Filter Installation

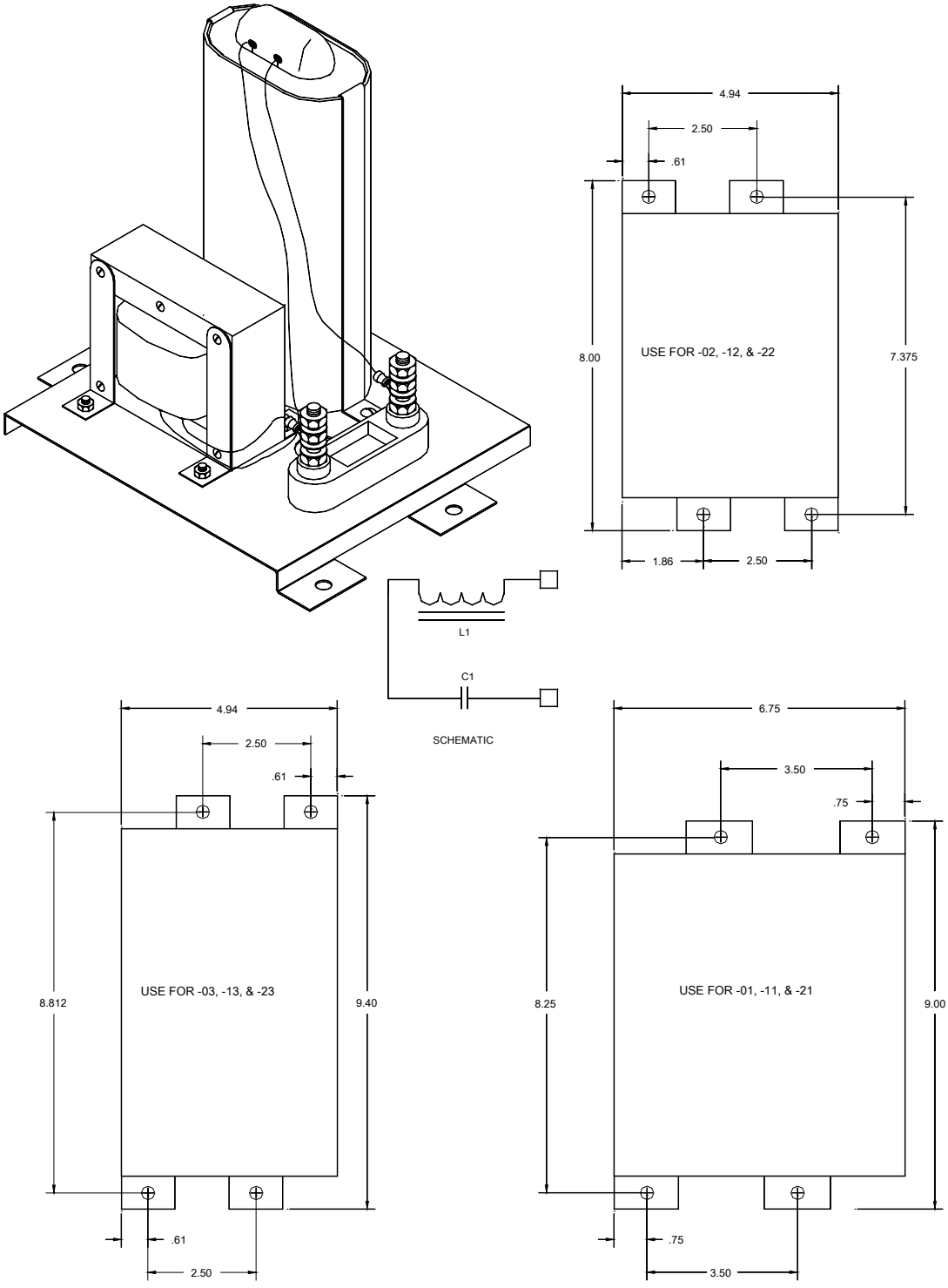


Figure 3-16:
Cab Signal Filter, 7A417-X, with Mounting Dimensions

3.5 SURGE PROTECTION REQUIREMENTS

3.5.1 Battery Surge Application Installation

The PSO+ incorporates built-in surge protection. However, primary surge protection must be installed on all power supply/battery as shown in Figure 3-17. Track wire surge protection is shown on application drawings in Section 7.

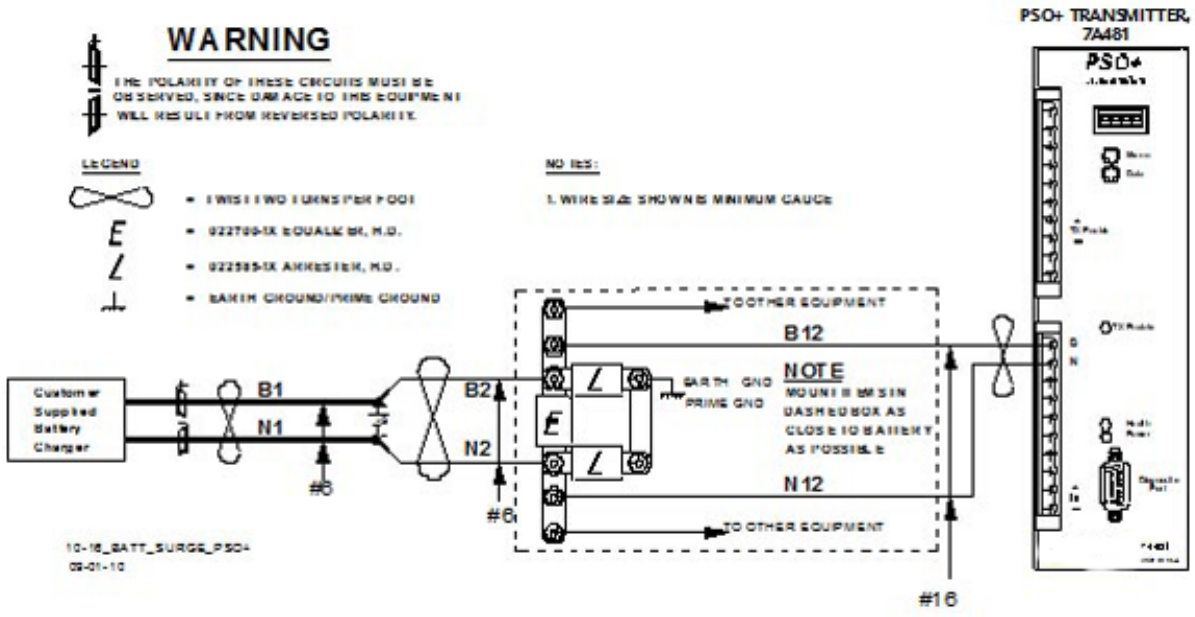


Figure 3-17:
Primary Battery Surge Protection

3.5.2 Surge and Track Wire Protection for Electrified Track

WARNING

IN ELECTRIFIED TERRITORY, ENSURE THAT THE EQUALIZER IN THE TRACK SURGE PANEL IS REPLACED BY A THIRD ARRESTOR.

In electrified territory, fuses and arresters must be installed on track leads as shown in Figure 3-18.

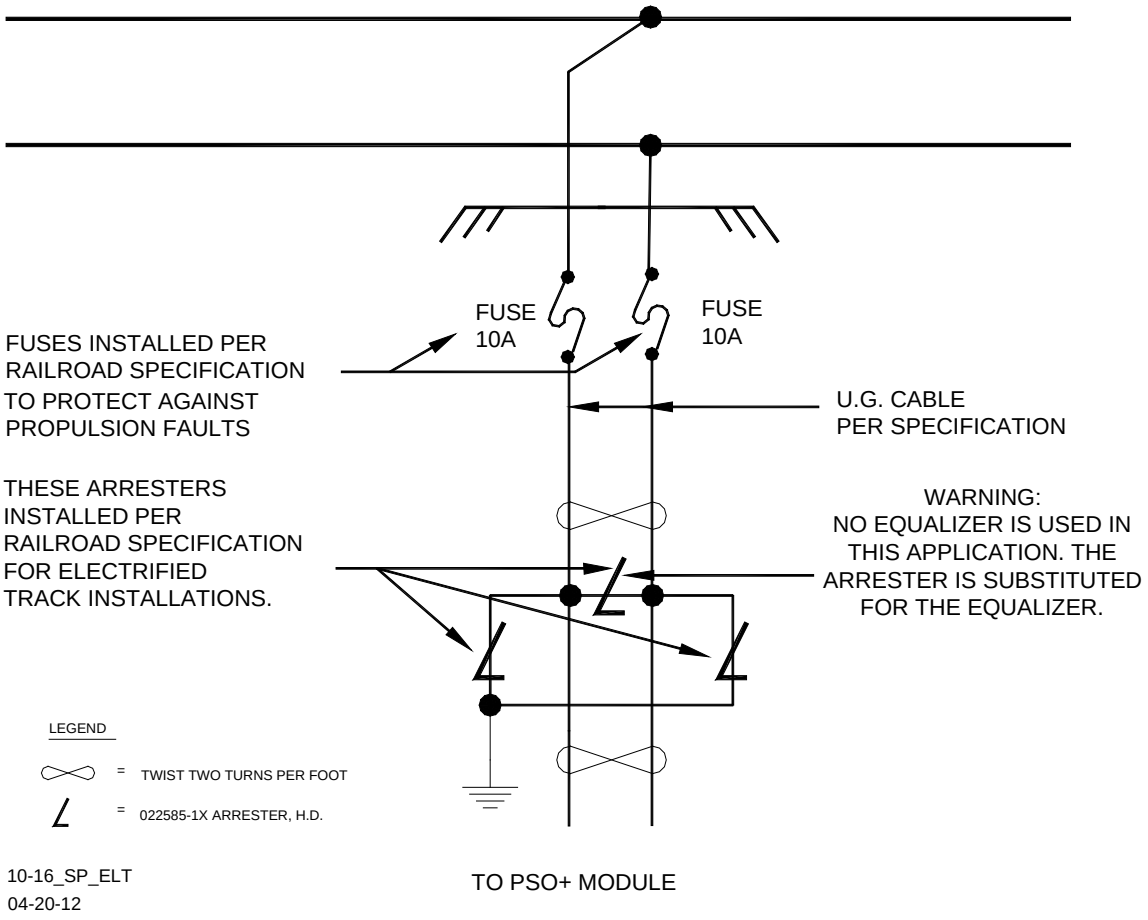


Figure 3-18:
Surge and Fused Track Wire Protection in Electrified Track

3.6 AC SHUNT, WIDE BAND, 8A076A

WARNING

THE 8A076A WIDEBAND SHUNT MUST NOT BE USED TO BYPASS INSULATED JOINTS IN DC CODED TRACK CIRCUITS, WHERE AC OR CODED AC CIRCUITS EXIST, OR AT FEED POINT JOINTS OF UNIDIRECTIONAL GCP APPROACHES.

WHEN ADDING OR REPLACING BYPASS SHUNTS, APPROPRIATE TESTS MUSTS BE MADE TO DETERMINE THAT THE BYPASS SHUNT DID NOT ADVERSELY AFFECT OTHER HIGHWAY CROSSING WARNING SYSTEM OR WAYSIDE SIGNAL SYSTEM TRACK CIRCUITS.

CAUTION

THE SHUNT SHOULD BE CONNECTED AS CLOSE AS PRACTICABLE TO THE RAILS (WITHIN THE #6 AWG WIRE LEAD LENGTH) AND, TO AFFORD MAXIMUM PROTECTION FROM PHYSICAL DAMAGE, BE ENCASED IN A PROTECTIVE ENCLOSURE OR BURIED (EITHER VERTICALLY OR HORIZONTALLY IN A TERMINAL SHUNT BURIAL KIT, 62776) AT AN APPROPRIATE DEPTH. IT IS NOT NECESSARY TO BURY THE SHUNT BELOW THE FROST LINE.

3.6.1 Equipment Description, 8A076A

The AC Shunt, Wide Band, 8A076A (see Figure 3-19), provides an effective short circuit to AC but presents an open circuit to DC. This shunt is used to bypass insulated joints in DC track circuits.

The AC Shunt, Wide Band, 8A076A, is housed in a hermetically sealed, cylindrical case with a pair of 10 ft. (3.05 m) leads extending from one end.

3.6.2 Mounting Dimensions, 8A076A

- Dimensions:
  - 3.35 inches (8.5 centimeters) in diameter
  - 7.5 inches (19.1 centimeters) in height
- Weight:
  - 7 pounds (3.18 kilograms) (approximate)
- Leads:
  - 10 ft. (3.05 m); #6 AWG, stranded, black PVC

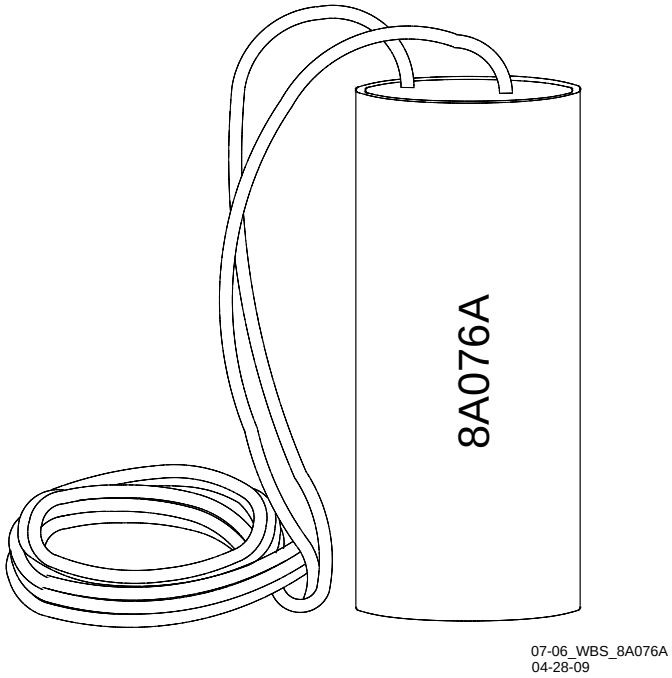


Figure 3-19:
AC Shunt, Wide Band, 8A076A

3.6.3 Application Instruction, 8A076A

The AC Shunt, Wide Band, 8A076 is placed as shown in Figure 3-20.

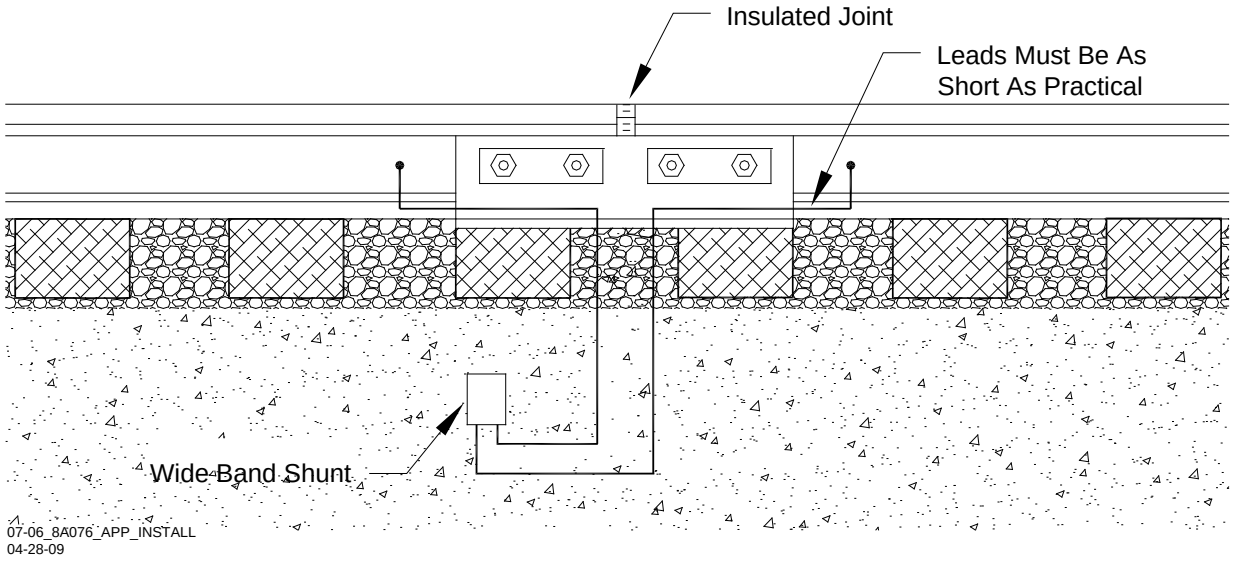


Figure 3-20:
Insulated Joint Coupler Installation

SECTION 4 –
APPLICATION GUIDELINES

4.1 GENERAL

PSO+ track circuit applications should conform to the guidelines found in this section to ensure proper operation and trouble free performance. The PSO+ system is capable of operation without insulated joints at either end or at both ends of the track circuit. Guidelines are provided for electrified and/or light rail operations as well as heavy rail applications. For special applications requiring additional information, contact Siemens Applications Engineering. Information describing the following functions is contained in this section:

- Frequency Grouping and Maximum Operating Distances
- Frequency Usage and Compatibility Guidelines
- Application Requirements
- Application Programming Guidelines

4.2 MAXIMUM OPERATING DISTANCES AND FREQUENCY GROUPING

NOTE

Avoid using adjacent channel frequencies on the same track. This is generally accomplished by separating the frequencies into two groups, as depicted in Table 4-1 and Table 4-2.

When mixing standard and alternate frequencies, several frequencies may not be compatible due to harmonic content.

4.2.1 PSO+ Frequency Groups

As a general rule, avoid using adjacent channel frequencies on the same track except as described in the NOTE below Table 4-2. This is generally accomplished by separating the frequencies into two groups with one channel separation between frequencies in each group as follows:

4.2.1.1 Non-Electrified Track Frequency Groups

One channel separation between frequencies is provided by dividing the 16 PSO+ frequencies into two groups of eight frequencies each as follows:

Table 4-1:
Non-Electrified Track Frequency Groups

Group 1 (Hz)	Group 2 (Hz)
156	211
285	348
430	525
645	790
970	1,180
1,450	1,770
2,140	2,630
3,240	4,000

NOTE

All frequencies within a group are compatible and may be intermixed without restriction on the same rails without insulated joint separation.

4.2.1.2 Electrified Track Frequency Groups

One channel separation between frequencies is provided by dividing the 10 PSO+ frequencies for electrified track into two groups of five frequencies each as follows:

Table 4-2:
Electrified Track Frequency Groups

GROUP 1 (HZ)	GROUP 2 (HZ)
645	790
970	1,180
1,450	1,770
2,140	2,630
3,240	4,000

NOTE

See Table 4-4 for AFTAC II unit frequency groupings (700 Hz and higher) and Table 4-5 for AFO unit frequency groupings (all frequencies are suitable for electrified territory).

4.2.2 PSO+ Module Standard Frequency Data

Table 4-3 provides maximum operating distance and frequency grouping data for Siemens PSO+ Modules.

The maximum operating distances shown in are between transmitter and receiver track wire connections for end-fed track circuits. For center-fed track circuits, double the distances given to obtain the maximum receiver-to-receiver distance.

Table 4-3:
Maximum Operating Distances at 0.06-Ohm Shunting Sensitivity for PSO+ Module Standard Frequencies

APPLICATION	GROUP	FREQUENCY (HZ)	BALLAST	
			2 Ω/1,000 FT. OPERATING DISTANCE (FT./M)	4 Ω/1,000 FT . OPERATING DISTANCE (FT./M)
PSO+ MODULE STANDARD FREQUENCIES	1	156	9000/2743	12000/3658
		285	6900/2103	9600/2926
		430	5800/1768	7400/2256
		645	4700/1433	6700/2042
		970	3900/1189	5600/1707
		1,450	3200/975	4700/1433
		2,140	2600/792	3400/1036
		3,240	2100/640	2900/884
	2	211	7900/2408	11000/3353
		348	6300/1920	8600/2621
		525	5200/1585	7200/2195
		790	4000/1219	6200/1890
		1,180	3700/1128	5100/1554
		1,770	3000/914	4100/1250
		2,630	2300/701	3200/975
		4,000	2000/610	2700/823

(Frequencies in **Bold** text are recommended for use in electrified territories)

4.2.2.1 PSO+ Module Alternate I (Harmon AFTAC II) Frequency Data

Table 4-4 provides maximum operating distance and frequency grouping data for frequencies used by Harmon AFTAC II units.

The maximum operating distances shown in are between transmitter and receiver track wire connections for end-fed track circuits. For center-fed track circuits, double the distances given to obtain the maximum receiver-to-receiver distance.

NOTE

The alternate frequencies depicted in Table 4-4 are those typically used by Harmon equipment and are available for use with PSO+. However, the alternate frequencies use Siemens modulation patterns and are not directly compatible with non- Siemens transmitters or receivers.

Table 4-4:
Maximum Operating Distances at 0.06-Ohm Shunting Sensitivity for PSO+ Module Alternate I (Harmon AFTAC II) Frequencies

APPLICATION	GROUP	FREQUENCY (HZ)	BALLAST	
			2 Ω/1,000 FT. OPERATING DISTANCE (FT./M)	4 Ω/1,000 FT. OPERATING DISTANCE (FT./M)
PSO+ MODULE ALTERNATE I (HARMON AFTAC II) FREQUENCIES	1	500	5100/1554	6900/2103
		900	4200/1280	5200/1585
		1300	3500/1067	4300/1311
		2300	2600/792	3300/1006
		3100	2100/640	2900/884
		4000	2000/610	2700/823
		5400	1700/518	2200/670
		6400	1600/488	1900/518
		7700	1500/457	1700/518
		8900	1400/427	1600/488
		10200	1300/396	1500/457
	2	**700**	4400/1341	5900/1798
		1100	3800/1158	4600/1402
		1600	3100/945	4000/1219
		2800	2400/732	3000/914
		3500	2000/610	2800/853
		4900	1800/549	2300/701
		5900	1700/518	2000/610
		7100	1500/457	1800/549
		8300	1400/427	1700/518
		9500	1300/396	1600/488

(Frequencies in **Bold** text are recommended for use in electrified territories)

4.2.2.2 PSO+ Module Alternate II (US&S AFO) Frequency Data

Table 4-5 provides maximum operating distance and frequency grouping data for frequencies used by US&S AFO units.

The maximum operating distances shown in are between transmitter and receiver track wire connections for end-fed track circuits. For center-fed track circuits, double the distances given to obtain the maximum receiver-to-receiver distance.

NOTE

The alternate frequencies depicted in Table 4-5 are those typically used by US&S equipment and are available for use with PSO+. However, the alternate frequencies use Siemens modulation patterns and are not directly compatible with non- Siemens transmitters or receivers.

Table 4-5:
Maximum Operating Distances at 0.06-Ohm Shunting Sensitivity for PSO+ Module Alternate II (US&S AFO) Frequencies

APPLICATION	GROUP	FREQUENCY (HZ)	BALLAST	
			2 Ω/1,000 FT. OPERATING DISTANCE (FT./M)	4 Ω/1,000 FT. OPERATING DISTANCE (FT./M)
PSO+ MODULE ALTERNATE II (US&S AFO) FREQUENCIES	1	**1000**	4000/1219	4600/1402
		1250	3500/1067	4400/1341
		1500	3300/1006	4100/1250
		1750	2900/884	3600/1097
		2300	2600/792	3300/1006
		2800	2400/732	3000/914
	2	**1125**	3.800/1158	4500/1372
		1375	3400/1036	4200/1280
		1640	3000/914	3600/1097
		1875	2800/853	3500/1067
		2175	2700/823	3400/1036
		2675	2500/762	3100/945

(Frequencies in **Bold** text are recommended for use in electrified territories)

NOTE

In electrified and/or light rail applications, frequencies less than 645 Hz and associated distances greater than 2000 ft. (609.6 m) are possible with certain limitations. An engineering review of usable frequencies below 645 Hz should be conducted to determine the proper operation and coverage.

The operating distance at any PSO+ operating frequency depends on the shunting sensitivity used, the ballast resistance encountered at the installation site and whether impedance bonds for electrified track are installed.

4.2.3 0.06-Ohm Shunting Sensitivity and No Impedance Bonds

Table 4-3, Table 4-4, and Table 4-5 indicate the recommended maximum PSO+ operating distances at each operating frequency under the following conditions:

- Ballast resistance values of 2 ohms per 1,000 ft (304.8 m) and 4 ohms per 1,000 ft (304.8 m)
- Shunting sensitivity of 0.06 ohm
- No impedance bonds in the circuit

Distances specified are between the transmitter and receiver for end-fed track circuits. Maximum receiver-to-receiver distances for center – fed track circuits are found by doubling listed distances.

4.2.4 0.2-Ohm Shunting Sensitivity and No Impendence Bonds

NOTE

In electrified and/or light rail applications, frequencies less than 645 Hz and associated distances greater than 2000 feet (609.6 m) are possible with certain limitations. An engineering review of usable frequencies below 645 Hz should be conducted to determine the proper operation and coverage.

Maximum PSO+ operating distance with 0.2-ohm shunting sensitivity and no impedance bonds in the circuit is 75% of the operating distance in Table 4-3, Table 4-4, and Table 4-5 for each frequency based on 2 ohms per 1000 ft. (304.8 m) of ballast resistance.

4.2.5 0.06-Ohm Shunting Sensitivity with Impedance Bonds

The maximum PSO+ operating distance with 0.06-ohm shunting sensitivity and with impedance bonds in the circuit is 3000 ft. (914.4 m) based on ballast resistance of 2 ohms per 1000 ft. (304.5m). Useable PSO+ frequencies are 645 through 4000 Hz. An engineering review of usable frequencies below 645 Hz must be performed to ensure proper operation and coverage.

4.2.6 0.2-Ohm Shunting Sensitivity with Impendence Bonds

Where there is a mixture of both electrified and non-electrified trains in operation, in general use 0.2 Ohm shunting sensitivity. The maximum PSO+ operating distance with 0.2-ohm shunting sensitivity, with impedance bonds in the circuit, is 2000 ft. (609.6 m) based on ballast resistance of 2 ohms per 1000 ft. (304.5 m). Usable PSO+ frequencies under these conditions are 645 through 4000 Hz. An engineering review of usable frequencies below 645 Hz must be performed to ensure proper operation and coverage.

4.3 FREQUENCY USAGE AND COMPATIBILITY GUIDELINES

4.3.1 AFO Frequency and 3000/4000 Family GCP Frequency Compatibility

Audio Frequency Overlay (AFO) equipment such as Siemens's PSO Module, Harmon's AFTAC II units, and United Switch and Signal's AFO units can be utilized within Model 3000/4000 GCP approaches. The tables below detail the compatibility of each manufacturer's equipment.

4.3.1.1 PSO+ Standard Frequency Compatibility

Table 4-6 depicts the frequency compatibility of the PSO+ and Model 3000/4000 GCPs.

Table 4-6:
PSO+ Standard Frequency and 3000/4000 Family GCP Frequency Compatibility

			Model 3000/4000 GCP Frequencies (Hz)										
			86	114	156	211	285	348	430	525	645	790	970
PSO+ Standard Frequencies	Group 1 Frequencies	156					▨	▨	▨	▨	▨	▨	▨
		285		▨	▨						▨	▨	▨
		430		▨	▨		▨				▨	▨	▨
		645	▨	▨	▨		▨					▨	▨
		970	▨	▨	▨	▨	▨	▨				▨	▨
		1450	▨	▨	▨	▨	▨	▨				▨	▨
		2140	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		3240	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	Group 2 Frequencies	211						▨		▨		▨	▨
		348										▨	
		525	▨	▨	▨	▨							
		790	▨	▨		▨	▨	▨					
		1180	▨	▨	▨	▨	▨	▨	▨				
		1770	▨	▨	▨	▨	▨	▨	▨	▨			▨
		2630	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		4000	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

▨ Compatible INCOMPATIBLE

NOTE

When emplacing a PSO+ transmitter in GCP territory, Siemens recommends that a Transmitter Line-to-Rail Coupler, 7A399-f be emplaced in series with the PSO+ Transmitter. In these applications, 7A399-f is connected directly to the PSO+ without the use of a

Line to Receiver Coupler, 7A388. Ensure that the coupler is connected in series as shown in the application diagrams. The connections in this application are reversed from those typically made when the 7A399-f is used with the 7A388.

4.3.1.2 Harmon AFTAC II Unit

Table 4-7 depicts the frequency compatibility of the PSO+ Alternate I (Harmon AFTAC II) frequencies with the frequencies used by Model 3000 or Model 4000 families of Grade Crossing Predictors.

Table 4-7: PSO+ Alternate I (Harmon AFTAC II) Frequency & 3000/4000 Family GCP Frequency Compatibility

			Model 3000/4000 GCP Frequencies (Hz)										
			86	114	156	211	285	348	430	525	645	790	970
PSO+ Alternate I (Harmon AFTAC II) Frequencies	Group 1 Frequencies	500	▨	▨	▨	▨	▨	▨			▨	▨	▨
		900	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
		1300	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		2300	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		3100	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		4000	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		5400	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		6400	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		7700	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		8900	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		10200	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	Group 2 Frequencies	700	▨	▨	▨	▨	▨	▨	▨	▨			▨
		100	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		1600	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		2800	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		3500	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		4900	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		5900	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		7100	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		8300	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		9500	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨

▨ Compatible INCOMPATIBLE

NOTE

In some cases, AFTAC II unit compatibility with Model 3000/4000 GCP frequencies can be affected by Island Frequency, when that frequency is too close to the selected AFTAC II frequency. Changing the Island Frequency can sometimes enable the use of a given AFTAC II unit frequency.

4.3.1.3 United Switch and Signal AFO Unit

Table 4-8 depicts the frequency compatibility of the PSO+ Alternate II (US&S AFO) frequencies with the frequencies used by Model 3000 or Model 4000 families of Grade Crossing Predictors.

Table 4-8:
PSO+ Alternate II (US&S AFO) Frequency and 3000/4000 Family GCP Frequency Compatibility

			Model 3000/4000 GCP Frequencies (Hz)										
			86	114	156	211	285	348	430	525	645	790	970
PSO+ Alternate II (US&S AFO) Frequencies	Group 1 Frequencies	1000	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	
		1250	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		1500	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		1750	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		2300	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		2800	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	Group 2 Frequencies	1125	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		1375	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		1640	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		1875	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		2175	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
		2675	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
▨ Compatible													
INCOMPATIBLE													

NOTE

In some cases, AFO unit compatibility with Model 3000/4000 GCP frequencies can be affected by Island Frequency, when that frequency is too close to the selected AFO unit frequency. Changing the Island Frequency can sometimes enable the use of a given AFOI unit frequency.

4.3.2 Non-Electrified Track

All PSO+ operating frequencies (156 through 4000 Hz) are available for use on non-electrified track.

4.3.3 Electrified Track

NOTE

In electrified and/or light rail applications, frequencies less than 645 Hz and associated distances greater than 2000 feet (609.6 m) are possible with certain limitations. An engineering review of usable frequencies below 645 Hz should be conducted to determine the proper operation and coverage.

The PSO+ system may be used in either AC or DC electrified track providing all other application requirements are met. PSO+ operating frequencies 645 through 4000 Hz should be used on electrified track.

4.3.4 Employment Guidelines

4.3.4.1 Like Address Code Frequency Repetition

For PSO+s with like addresses (A or C), frequencies can be repeated on the same track when separated by at least 10,000 ft (3048 m) and one set of non-bypassed insulated joints (no type of insulated joint couplers used around the insulated joints).

4.3.4.2 Different Address Code Frequency Repetition

Identical frequencies may be used on either side of non-bypassed insulated joints (end-to-end track circuits) provided different address codes are used.

4.3.4.3 Like Address Code Frequency Repetition Using Non-Bypassed Insulated Joints

For PSO+s with like addresses (A or C), frequencies can be repeated without restriction on the same track when separated by two sets of non-bypassed insulated joints providing each set of insulated joints is separated by a minimum of 3,000 ft. (914.4 m).

4.3.4.4 Frequency Assignments in Multiple Track Territories

Normal caution must be exercised in assigning and setting multiple track addresses and frequencies. In multiple track territory frequency assignments must follow a pattern that avoids using the same frequency on adjacent tracks. Since it is not possible to meet this requirement in three- and four-track territory with available PSO+ frequencies, the address coding scheme described in Section 4.3.4.2 can be employed here as well. Each track uses a separate frequency

with alternating track circuits assigned different address codes and separated by a set of non-bypassed insulated joints.

4.3.4.5 Multiple Track Highway Crossings

Multiple track highway crossing approaches can use group 1 frequencies on one track (track number 1) and group 2 frequencies on the other track (track number 2). Since two frequencies from each group are required at each crossing, when all frequencies have been used, the same frequencies may be repeated but this time using the group 2 frequencies on track number 1 and group 1 frequencies on track number 2. Continue to alternate this pattern as required. For further details, contact Siemens Application Engineering.

4.3.4.6 Impedance Bonds in Electrified Territory

CAUTION

USE OF INSULATED JOINT BYPASS COUPLERS ON ELECTRIFIED TRACK IS NOT RECOMMENDED DUE TO SURGE DAMAGE CONCERNS.

Impedance bonds used in electric propulsion territory should provide a minimum of 2 ohms of impedance at all PSO+ frequencies in operation.

4.4 REQUIREMENTS FOR OVER RAIL NON-SHUNTING APPLICATIONS

PSO+ systems are frequently used as a medium to transmit information from one location to another over rail. A common use is to indicate the position of a hand throw switch. When applied in this manner the PSO+ system is not required to shunt down when a train is present.

Even though the PSO+ is not required to shunt with a train, application rules are still necessary to avoid interference between transmitters and receivers, which are not of the same pair. "Separation Distance" refers to the distance between a receiver of one circuit and a transmitter of the same frequency and address that is intended for a different circuit. The rules for this non-shunting application are as follows:

- PSO+ frequencies maybe repeated with one set of unbypassed insulated joints and a separation distance of 10,000 ft. (3048 m). The essential point is that no coupling device can bypass the insulated joint.
- PSO+ frequencies may be repeated with two sets of unbypassed insulated joints and at least 3000 ft. (914.4 m) separation distance.
- When unbypassed joints are not available, identical frequencies can still be reused on the same track. When repeating frequencies of like addresses the following rules still apply:
    - For frequencies 156Hz through 525Hz, the separation must be at least 50,000 ft. (15240 m).
    - For frequencies 625Hz through 1450Hz, the separation must be at least 30,000 ft. (9144 m).
    - For frequencies 1770 and above, the separation must be at least 20,000 ft. (6401 m).

- If the separation distances for each frequency are not available, repeating is still possible but alternative addresses (A and C) must be used. When using this application both receivers should be between the transmitter locations. In any case, there should be at least 50000 feet (15, 240 m) between any transmitter and unassociated receiver.
- PSO+ circuit lengths can be 30% longer than the distances published for 0.06 Ohm Shunting. If shunt overrun (pre-shunting) is a concern, distances and calibration should revert to applications required for a shunting application.

4.5 ANCILIARY EQUIPMENT APPLICATION GUIDELINES

NOTE

In some AC/DC coded/CAB applications, additional filters may be required. Contact Siemens Applications Engineering.

4.5.1 AC Current/Cab Signal Filter, 7A417-X

Cab Signal Filter, 7A417-X is designed for use in track territory where 60, 90, 100, or 200-Hz cab signal is used. The filter should be installed on the primary side of the track transformer as shown in Figure 3 – 15.

For Cab Signal Filter, 7A417-X equipment description, see Section 3.4.1; for mounting dimensions, see Section 3.4.2 and Figure 3 – 16, and for application installation drawings, see Section 3.4.3 and Figure 3 – 15. Correct frequency and relay mounting base type must be specified in the railroad's written instructions and the couplers should be installed per the railroad's written instructions.

4.5.2 Transmitter Line Applications

When it is desirable to transmit signals over dedicated line wire or buried cable to the track, a Line to Receiver Coupler, 7A388 (See Section 3.3.3 and Figure 3-8), must be used to couple the transmitter to the line and a Transmitter Line to Rail Coupler, 7A399-f (See Section 3.3.5 and Figure 3-11), must be used to couple the line to the rail (for application drawing see Figure 7-6 or Figure 7-7). Correct frequency information must be specified in the railroad's or agency's written instructions and the couplers should be installed per those written instructions. A typical application is when the distance from the transmitter to the rail is between 300 – 2000 ft. (91.4 – 670.6 m) (based on using 14AWG, increasing the diameter of the wire will proportionally increase the potential distance from 2000 ft./609.6 m).See Section 6.2.3 for further information regarding maximum distances for track wiring).

4.5.3 Receiver Line Applications

When open line or cable carries the signal from the rail to a distant receiver, the pole mounted Receiver Line to Rail Coupler, 7A377-1-f (See Section 3.3.4.1 and Figure 3-9), or the shelf mounted Receiver Line to Rail Coupler, 7A377-2-f (See Section 3.3.4.4 and Figure 3-10) is required to couple the track to the line and a Line to Receiver Coupler, 7A388 (See Section 3.3.3 and Figure 3-8) is used to couple the line to the receiver. Total resistance of the line or cable pair must not exceed

100 ohms (see Figure 7 – 4 and Figure 7 – 5 for typical application drawings). Correct frequency information must be specified in the railroad's or agency's written instructions and the couplers should be installed per those written instructions A typical application is when the distance from the transmitter to the rail is between 300 – 2000 ft. (91.4 – 670.6 m) (based on using 14AWG, increasing the diameter of the wire will proportionally increase the potential distance from 2000 ft./609.6 m). See Section 6.2.3 for further information regarding maximum distances for track wiring).

4.5.4 Insulated Joint Bypass Couplers (Non-Electrified Rail Only)

WARNING

WHEN GRADE CROSSING PREDICTOR (GCP) OR MOTION SENSOR FREQUENCIES ARE ALSO BYPASSED AROUND INSULATED JOINTS, ALONG WITH PSO+ FREQUENCIES, ALWAYS FOLLOW THE INSTRUCTIONS GOVERNING THE GCP OR MOTION SENSOR INSTALLATION.

Two types of insulated joint bypass couplers are used with PSO+:

1. PSO+ Insulated Joint Bypass Coupler (Tuned), 7A422-f (See Figure 3-13), is used with PSO+ circuits only in DC track circuits where there are no predictors used (for description, see Section 3.3.7; for application installation drawing, see Figure 3-14).
2. AC Shunt, Wide Band, 8A076A (See Figure 3-19) is acceptable for PSO+ operation when GCP's are being bypassed around insulated joints with wideband shunts. For description, see Section 3.6.1; for application installation drawing, see Figure 3-20.

When using the 7A422-f coupler, insulated joint coupler connections should be made with #6 AWG. Track wire should not exceed 25 ft. (7.62 m) in length, since the shorter the wire lengths and the larger the wire diameters, the less PSO+ signal loss will occur at each insulated joint. Correct frequency information must be specified in the railroad's written instructions and the couplers should be installed per the railroad's written instructions.

4.5.5 Battery Choke

WARNING

IF A BATTERY CHOKE IS INSTALLED WITHIN A MODEL 300 OR 400 GCP APPROACH, THE 8A065A CHOKE MUST BE USED.

When the PSO+ track circuit includes a DC track circuit track battery, or a track battery is located within 500 ft. (152.4 m) of a PSO+ track circuit that is not isolated by insulated joints, PSO+ Battery Choke, 7A360 (See Figure 3-1), is connected in series with the track battery. When GCP's or motion sensors are installed within PSO+ track circuits, Battery Choke, 8A065A, or Battery

Choke, 62648 (See Figure 3-2), must be used in place of the 7A360 battery choke (for description, see Section 3.2.1). See Figure 3-3 for a typical application installation.

4.5.6 Surge Protection

The PSO+ incorporates built – in surge protection. However, primary surge protection must be installed on all AC power, battery, line, and track leads as described in Section 3.5.1. A typical battery surge protection application drawing is presented in Figure 3-17. In electrified territory, track wire surge protection must be installed as shown in Figure 3-18. All other track wire surge protection is shown in application drawings in Section 7.

4.5.7 Use of PSO+ with PSO+ II, PSO+ III, and PSO+ Equipment

The PSO+ receiver and transmitter units are compatible with the signal format and track levels of Siemens Rail's PSO+ II, PSO+ III, and PSO+ receiver and transmitter units using the same address format. This means that a PSO+ II, PSO+ III, and PSO+ transmitter is capable of driving a track circuit containing a PSO+ receiver, and that PSO+ II, PSO+ III, and PSO+ receivers are capable of receiving and decoding a signal emanating from a PSO+ transmitter (A or C address only).

NOTE

When PSO+ applications overlap with MS/GCP track circuits, additional filtering may be required.

SECTION 5 –
PSO+ SYSTEM MENU DESCRIPTION

5.1 GENERAL

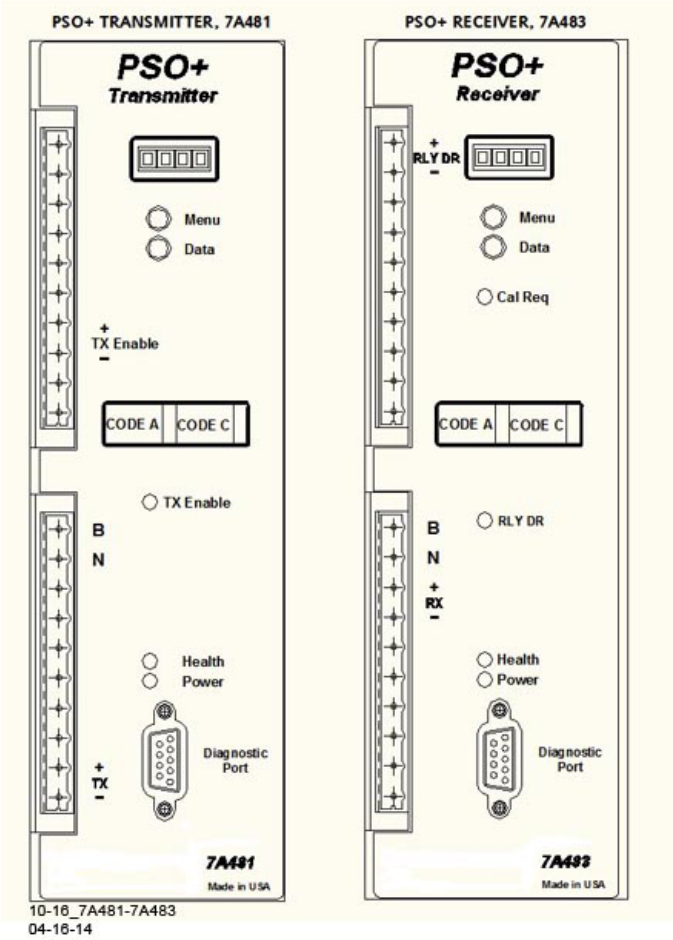


Figure 5-1:
PSO+ Transmitter & PSO+ Receiver

The PSO+ differs from earlier Phase Shift Overlay versions (PSO II & PSO III) in that its operation is completely software driven. There are no jumpers connected to the unit, nor are there any straps used to enable high power operation. The units come with the software pre-loaded, ready for field installation; requiring only individual unit software configuration following the railroad's approved wiring or installation instructions to place the unit into operation. This section addresses the PSO+ Menu System (see Section 5.2) and Menu Navigation (see Section 5.3).

5.2 MENU SYSTEM OVERVIEW

The menu system allows users to implement changes without having to rely upon laptop computers to interface with the Unit. Each Unit has its own specific menu system of main menus, sub-menus, parameters, and individual values.

5.2.1 Navigating the Menus

Each Unit has two buttons on the face of the Unit. The top button is the MENU Button and the bottom button is the DATA Button (See Figure 5-1).

In general, the pushbuttons are used to navigate the menus as shown in Table 5-1:

Table 5-1:
General Menu Navigation and Selection Using The Pushbuttons

OPTION DESIRED	ACTION TAKEN
Go down a MAIN Menu level (e.g., if at the TOP LEVEL MENU, select to navigate to the first PARAMETER item of the Menu)	Press MENU momentarily
Move to the next PARAMETER value	Press DATA momentarily
To modify a PARAMETER value	Hold MENU until the desired parameter appears, press DATA multiple times until desired value appears, then hold MENU until SET (PARAMETER NAME) = (DESiRED VALUE)? appears
To scroll down through PARAMETER items	Each time DATA is pressed a new PARAMETER item appears
To SAVE CHANGES to modified PARAMETER values	Hold MENU until desired value appears
Go up one level (e.g., if in the INFO MENU SUB-MENU such as RX SIGNAL LEVEL, select to return to INFO at MAIN Menu level)	Hold DATA until desired value appears

5.2.2 Setup Menu Processes

Users can perform all the tasks required in the menu using the buttons as described in Table 5-1 above. However, certain additional steps are required when performing Calibration.

5.2.3 Program Menu Processes

The purpose of the program menu is to allow users to quickly go to a specific parameter that requires editing.

The unit must be programmed in order to place the unit into operation.

- To program the unit, set the values desired as described in Table 5-1.
- After programming the Transmitter and Receiver, track calibration is required. See Section 6 for further installation, programming, and calibration procedures.

5.2.4 Calibration Menu Processes

Calibration is used to set signal threshold values (SIG LVL=100) for the Receiver. (See Section 6, Installation, Programming, and Calibration Procedures for step by step calibration instructions.

5.3 UNIT MAIN MENUS

Each of the Unit Menus differs from the others. While many values are common across the Units, care must be taken so that proper selections are made. Default entries are shown in **bold** type.

5.3.1 PSO+ Transmitter

NOTE

The following symbols are used in this table and have these associated meanings

- **+** = Non-editable Unit Information

The menu for the PSO+ Transmitter is as depicted in Table 5-2 below.

Table 5-2:
PSO II+ Transmitter Menu System

PARAMETER	VALUES
DIAG	Appears only when required. See Appendix B for further information
TFRQ=	**NONE**, 156, 211, 285, 348, 430, 525, 645, 790, 970, 1180, 1450, 1770, 2140, 2630, 3240, 4000
TX LVL=	**HIGH**, Low
VERS=	+MEF=PSO_XX.MEF, +ID=9V380A1.3, *BOOT=9V388A01.B, +XIL=80428.CO1.7, +PART=7000-7A481-0001, +SERIAL=2345, +BUILD DATE=09-01-10, +HW REV=B

5.3.2 PSO+ Receiver

NOTE

The following symbols are used in this table and have these associated meanings

- **+** = Non-editable Unit Information
- ***** = Command – Calibration process is running.

The menu for the PSO+ Receiver is as depicted in Table 5-3 below.

Table 5-3:
PSO II+ Receiver Menu System

PARAMETER	VALUES
DIAG	Appears only when required. See Appendix B for further information
RLVL	Range = 0 – 9999
RFRQ=	**NONE**, 156, 211, 285, 348, 430, 525, 645, 790, 970, 1180, 1450, 1770, 2140, 2630, 3240, 4000
CAL	***CAL**, CAL (See Section 6.5 for information pertaining to PSO+ calibration)
VERS=	+MEF=PSO_XX.MEF, +ID=9V380A1.3, +BOOT=9V388A01.B, +XIL=80428.CO1.7, +PART=7000-7A481-0001, +SERIAL=2345, +BUILD DATE=09-01-10, +HW REV=B

SECTION 6 –
INSTALLATION, PROGRAMMING, & CALIBRATION PROCEDURES

6.1 GENERAL REQUIREMENTS

It is recommended that the following wiring and installation requirements be read before the starting installation. Follow approved railroad wiring instructions and procedures for the installation. Once the installation is complete, program each PSO+ unit per approved railroad written instructions prior to calibration.

6.2 WIRING REQUIREMENTS

6.2.1 Battery Wiring

Battery wiring to the PSO+ equipment should be #16 AWG stranded minimum and twisted in pair. The wires are connected to at the shelter battery surge suppression panel. For proper battery surge protection, the battery surge suppression panel should be wired as shown in Figure 3 -17 and Figure 7 – 2.

6.2.2 Case Wiring

Case wiring to the PSO+ equipment should be #16 AWG stranded. See individual application drawings in Section 7 for additional information.

6.2.3 Track Wiring

Equipment connections to the rails should be as short as practical (preferably less than a 100 ft. {30.5 m} pair) and should be #9 AWG or #6 AWG. For lengths of 100 – 300 ft. (30.5 – 91.4 m), use #6 AWG. If the lengths exceed 300 ft. (91.4 m), Receiver Rail to Line Coupler, 7A377-1-f, Receiver Rail to Line Coupler, 7A377-2-f, or Transmitter Rail to Line Coupler, 7A399-f, should be used. The 7A377-1-f, 7A377-2-f, or 7A399-f couplers must be emplaced in a weatherproof shelter that is positioned as close as possible to the track, but no more than 100 ft. (30.5 m) from the track. Track wires should be plug connected or welded to the rails.

Typically, the maximum distance between the Line to Receiver Coupler, 7A388 and the Receiver Line-to-Rail Coupler, 7A377-1-f or 7A377-2-f, or the Line to Receiver Coupler, 7A388 and the Transmitter Line-to-Rail Coupler, 7A399-f is 2000 ft. (609.6 m), when using #14 AWG stranded wire Table 6-1 provides the maximum distance possible between the Couplers for 10 AWG through 14 AWG, inclusive.

Table 6-1:
Maximum Distance Between A Line to Receiver Coupler, 7A388 and A Line to Rail Coupler 7A377-X-f or A Line to Rail Coupler 7A399-f

WIRE SIZE	DIAMETER (INCH)	DIAMETER (MILLIMETER)	MAXIMUM DISTANCE (FT)
14 AWG	0.0641	1.628	2000
13 AWG	0.0720	1.828	2500
12 AWG	0.0808	2.053	3100
11 AWG	0.0907	2.305	4000
10 AWG	0.1019	2.588	5000

6.3 PSO+ INSTALLATION

Perform the following steps to install the PSO+ units:

1. Install and connect all PSO equipment in the wayside signaling location per the railroad's or agency's approved wiring or installation diagram.
2. Connect all required leads per the railroad's or agency's approved wiring or installation diagram.

6.4 PROGRAMMING

The PSO+ allows application functions to be configured in software, reducing the equipment and wiring needed by older generation track occupancy information systems. The following application programming guidelines are provided to assist in planning PSO+ usage. See Section 5.2 for information on navigating the programming menu.

6.4.1 Program PSO+ Transmitter

1. Observe the face of the Transmitter. Either DIAG is flashing or PSO+ XXXX TX (Code) (e.g., PSO+ 645 TX A) scrolls in the 4-Character Display.
2. If desired frequency appears in the window, proceed to step 7. If PSO+ XXXX TX (Code) (e.g., PSO+ 645 TX A) shows the wrong frequency in the 4-Character Display, proceed to step 4. If DIAG is flashing, proceed to step 3.
3. If DIAG is flashing, press and hold the MENU button for approximately two (2) seconds. DIAG stops flashing. Navigate to the TFRQ menu. Press and hold the MENU button for approximately two (2) seconds. NONE flashes in the 4-Character Display. Proceed to step 5.
4. If PSO+ XXXX TX (Code) (e.g., PSO+ 645 TX A) appears in the 4-Character Display and the frequency is not the desired frequency, press and hold the MENU button for approximately two (2) seconds. The currently selected frequency (e.g., 645) flashes in the 4-Character Display.

5. Press and release the DATA button until the desired frequency appears, then press and hold the MENU button for approximately two (2) seconds. SET TFRQ = XXXX? (e.g., SET TFRQ=4000?) appears in the 4-Character Display.
6. Press and hold the MENU Button for approximately two (2) seconds until TFRQ=XXXX (e.g., TFRQ=4000 HZ) appears. Shortly afterward, the Transmit Level (TLVL) setting appears.
7. If the written instructions state that currently depicted transmit level will be used, proceed to step 10; transmitter programming is complete. If the other setting will be used, press and hold the MENU button for approximately two (2) seconds. The current value (e.g., HIGH) flashes in the 4-Character Display.
8. Press the DATA button until the desired value (e.g., TLVL=LOW) appears. Press and hold the MENU button for approximately two (2) seconds. SET TLVL = XXXX? (e.g., SET TLVL=LOW?) appears in the 4-Character Display.
9. Press and hold the MENU Button for approximately two (2) seconds until TLVL=XXXX (e.g., TLVL=LOW) appears. Transmitter programming is complete.
10. Press and hold the MENU button for approximately two (2) seconds. The top level menus displays PSO+ XXXX TX (Code) (e.g., PSO+ 4000 TX A) appears in the 4-Character Display in four letter segments.

6.4.2 Program PSO+ Receiver

1. Observe the face of the Receiver. Either DIAG is flashing or PSO+ XXXX RX (Code) (e.g., PSO+ 645 RX C) scrolls in the 4-Character Display.
2. If desired frequency appears in the window, proceed to CALIBRATE PSO+ RECEIVER. If PSO+ XXXX RX (Code) (e.g., PSO+ 645 RX C) shows the wrong frequency in the 4-Character Display, proceed to step 4. If DIAG is flashing, proceed to step 3.
3. If DIAG is flashing, press and hold the MENU button for approximately two (2) seconds. DIAG stops flashing. Navigate to the RFRQ menu. Press and hold the MENU button for approximately two (2) seconds. NONE flashes in the 4-Character Display. Proceed to step 5.
4. If PSO+ XXXX RX (Code) (e.g., PSO+ 645 RX C) appears in the 4-Character Display and the frequency is not the desired frequency, press and hold the MENU button for approximately two (2) seconds. The currently selected frequency (e.g., 645) flashes in the 4-Character Display.
5. Press and hold the MENU button for approximately two (2) seconds. The currently programmed frequency or NONE appears. Press the DATA button until the desired frequency appears, then press and hold the MENU button for approximately two (2) seconds. SET RFRQ = XXXX? (e.g., SET RFRQ=156?) appears.
6. Press and hold the MENU Button for approximately two (2) seconds until RFRQ=XXXX (e.g., RFRQ=156 HZ) appears. Receiver programming is complete.

7. Press and hold the DATA button for approximately two (2) seconds. The top level menus displays PSO+ XXXX RX (Code) (e.g., PSO+ 156 RX C) appears in the 4-Character Display in four letter segments.

6.5 PSO+ CALIBRATION

WARNING

VERIFY THAT THE PSO+ TRANSMITTER AND THE PSO+ RECEIVER SOFTWARE, FREQUENCY, AND ADDRESS FORMATS ARE AS SPECIFIED BY THE RAILROAD'S OR AGENCY'S APPROVED WIRING OR INSTALLATION DIAGRAM. FAILURE TO DO SO MAY LEAD TO INCORRECT OR UNSAFE OPERATION OF THE TRACK CIRCUIT.

IF ANY RECEIVER IS CALIBRATED IN POOR BALLAST CONDITIONS, IT MUST BE RE-CALIBRATED WHEN BALLAST CONDITIONS IMPROVE.

FAILURE TO FOLLOW THE RAILROAD'S OR AGENCY'S APPROVED WIRING OR INSTALLATION GUIDELINES REGARDING RECEIVER SETTINGS AND CALIBRATION MAY LEAD TO POSSIBLE UNSAFE OPERATION OF THE TRACK CIRCUIT.

AFTER CALIBRATION, VERIFY THAT THE PSO CIRCUIT DE-ENERGIZES WHEN SHUNTED WITH THE APPROPRIATE CALIBRATION RESISTANCE (0.06, 0.2, 0.3, 0.4, OR 0.5 OHMS). FAILURE TO DO SO MAY LEAD TO INCORRECT OR UNSAFE OPERATION OF THE TRACK CIRCUIT.

FOLLOWING INSTALLATION OR AFTER ANY RECEIVER MENU CHANGES HAVE BEEN MADE, RECALIBRATE THE RECEIVER AND TEST FOR PROPER OPERATION PER THE REQUIREMENTS SPECIFIED IN TABLE 6-2 AND TABLE 6-3.

With the PSO+ Receiver, 7A483 properly installed and programmed per railroad instructions, calibrate the receiver (RX) as follows:

1. When the track ballast is good, connect a track test shunt (hardwire, 0.06-ohm, 0.2-ohm, or as required) across the track at the receiver track connections. When the ballast is poor, connect the shunt across the track at a point 30 feet beyond the receiver track connections. Verify solid connections of the shunt to each rail.

2. To Calibrate the Receiver
   - Press the MENU Button until *CAL appears.
   - *CAL and CAL alternately flash during the calibration process.
   - PASS or FAIL appears for twenty (20) seconds when calibration is complete. When PASS appears, continue to Step 3. If FAIL appears, the CALIBRATION REQUIRED LED remains lit.

WARNING

IF "FAIL" APPEARS ON THE DISPLAY, THE CALIBRATION REQUIRED (CAL REQ) REMAINS LIT, OR THE RELAY DRIVE (RLY DR) LED DOES NOT LIGHT, THE CALIBRATION PROCESS DID NOT COMPLETE. SHOULD THIS HAPPEN, CYCLE THE UNIT POWER AND THEN REPEAT STEP 2 ABOVE. IF "FAIL" APPEARS AGAIN, FURTHER TROUBLESHOOTING IS REQUIRED.

3. Remove the test shunt. The Cal Req LED should go out. If Cal Req LED does not go out, the calibration process has failed (refer to the WARNING above). Inspect all equipment and connections and repeat steps 1 & 2. If the calibration fails again, further troubleshooting is required.
4. The RLY DR LED should light once the test shunt has been removed. If not, proceed to Appendix B, Troubleshooting.

6.6 RECALIBRATION AND REPROGRAMMING

6.6.1 Recalibration/Reprogramming Requirements Due to Programming Changes

Table 6-2 indicates the receiver recalibration requirements that result from any of the indicated programming changes.

Table 6-2:
Recalibration/Reprogramming Requirements Due to Programming Changes

PROGRAMMING CHANGES REQUIRING RECALIBRATION	RECIEVER CALIBRATION REQUIRED?
PSO+ Frequency Changed	Yes
Transmit Level Changed From Low to High Or High to Low	Yes

6.6.2 Recalibration/Reprogramming Requirements Due to Track Equipment Changes

Table 6-3 indicates the recalibration required when any changes made to the existing track equipment.

Table 6-3:
Recalibration/Reprogramming Requirements Due to Track Equipment Changes

TRACK EQUIPMENT CHANGES REQUIRING RECALIBRATION	RECEIVER CALIBRATION REQUIRED?
Termination Shunts of Other Frequencies Added, Removed From, or Moved Within PSO+ Approach	Yes
Wideband Insulated Joint Coupler (8A076) Replaced in PSO+ Approach	Yes
Tuned Insulated Joint Couplers (7A422-f) Replaced in PSO+ Approach	Yes
PSO+ Track Wire(s) Replaced	Yes
PSO+ Transmitter or Receiver Moved to New Location	Yes

SECTION 7 –
APPLICATION DIAGRAMS

This section contains the following typical PSO+ installation diagrams. Connections are also shown for Ancillary Equipment.

Table 7-1:
PSO+ Application Drawings

DRAWING	TITLE
Figure 7-1	Surge and Fused Track Wire Protection in Electrified Track
Figure 7-2	Typical PSO+ NWP Application
Figure 7-3	PSO Application Using Tuned Receiver Coupler, Hi Z, 7A366-f
Figure 7-4	PSO+ Application Using Line to Receiver Coupler, 7A388 and Receiver Line to Rail Coupler, 7A377-1-f
Figure 7-5	PSO+ Application Using Line to Receiver Coupler, 7A388 and Receiver Line to Rail Coupler, 7A377-2-f
Figure 7-6	PSO+ Application Using Transmitter Line to Rail Coupler, 7A399-f, and Line to Receiver Coupler, 7A388
Figure 7-7	PSO+ Application Using Transmitter Line to Rail Coupler, 7A399-f with Line to Receiver Coupler, 7A388 and Line to Receiver Coupler, 7A388 with Receiver Line to Rail Coupler, 7A377-2-f
Figure 7-8	Typical PSO+ Line Overlay Application Using PSO Line Coupler, Low Z, 7A403 With PSO Line Terminator, 7A345

WARNING

IN ELECTRIFIED TERRITORY, ENSURE THAT THE NORMAL EQUALIZER PLACED ACROSS THE PSO TRACK LEADS IN THE TRACK SURGE PANEL IS REPLACED BY A THIRD ARRESTOR PER RAILROAD OR AGENCY SPECIFICATION AS SHOWN IN FIGURE 7-1.

ENSURE THAT THE PSO TRACK LEADS HAVE FUSES INSTALLED PER RAILROAD OR AGENCY SPECIFICATION AS SHOWN IN FIGURE 7-1.

NOTE

In the following application drawings, all wiring is #16 AWG stranded wire unless otherwise noted.

The Receiver Line to Rail Couplers, 7A377-1-f or 7A377-2-f and the Transmitter Line to Rail Coupler 7A399-f must be mounted in a weatherproof housing as near to the track as possible, but no further than 100 feet from the track.

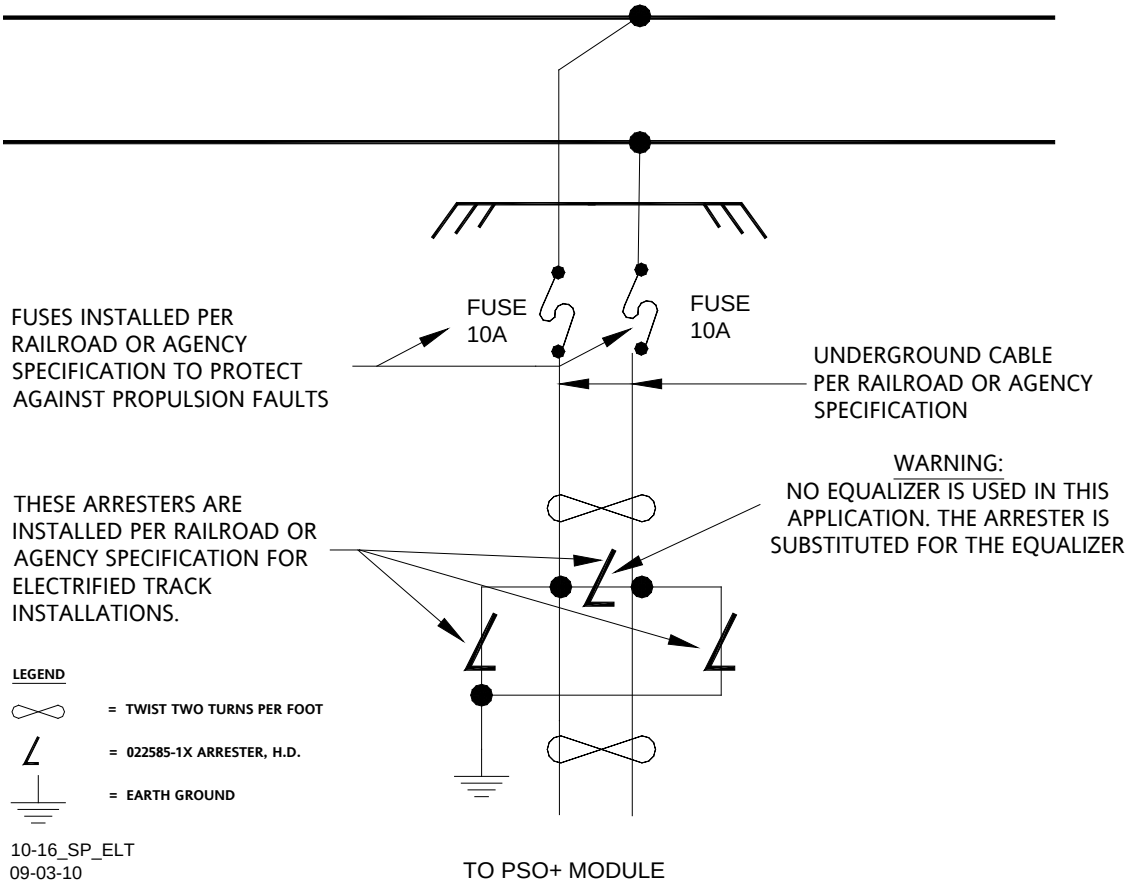
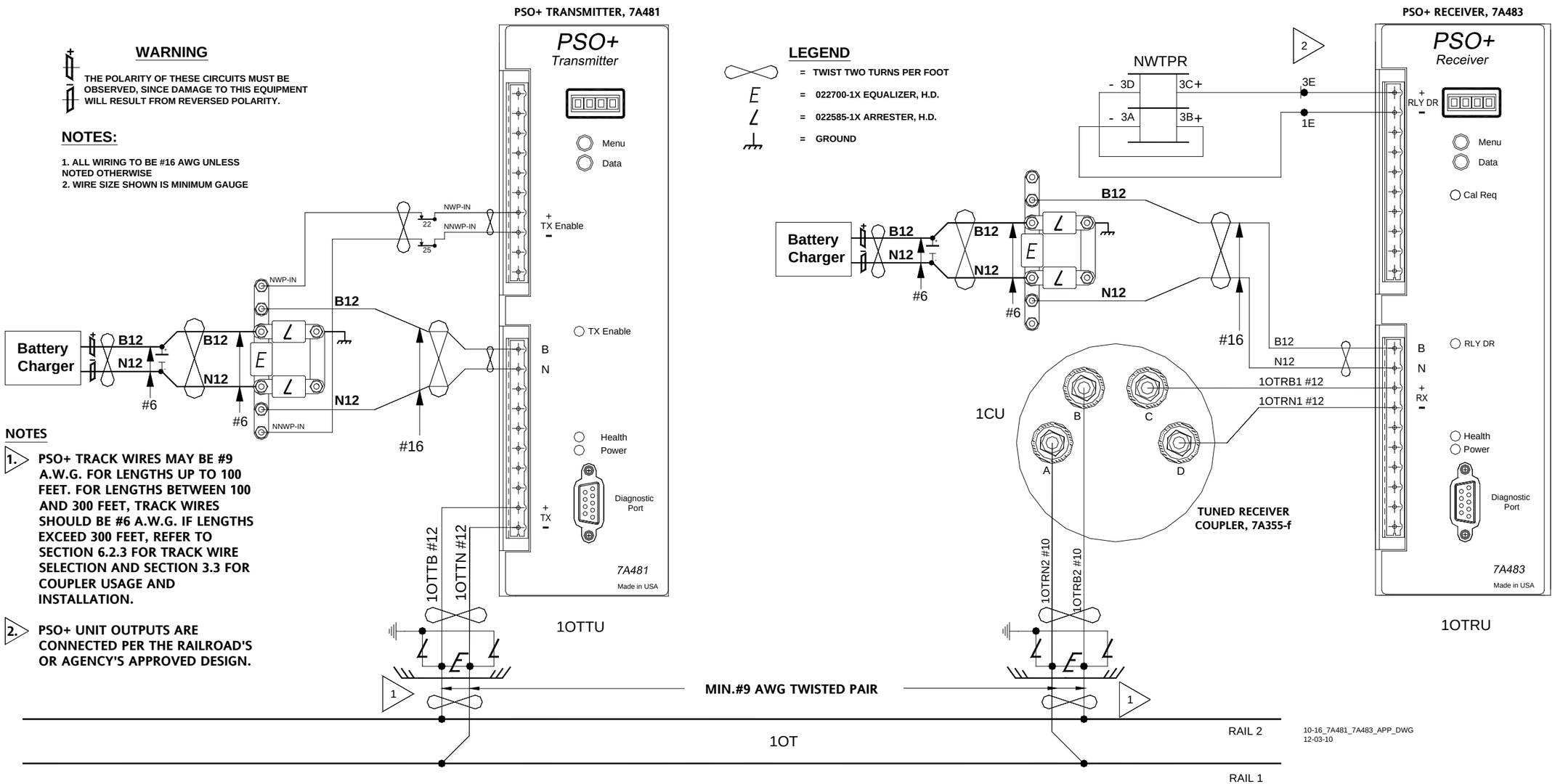


Figure 7-1:
Surge and Fused Track Wire Protection in Electrified Track



Typical PSO NWP Application

Figure 7-2:
Typical PSO+ NWP Application

NOTES

1. PSO+ TRACK WIRES MAY BE #9 A.W.G. FOR LENGTHS UP TO 100 FEET. FOR LENGTHS BETWEEN 100 AND 300 FEET, TRACK WIRES SHOULD BE #6 A.W.G. IF LENGTHS EXCEED 300 FEET, REFER TO SECTION 6.2.3 FOR TRACK WIRE SELECTION AND SECTION 3.3 FOR COUPLER USAGE AND INSTALLATION.

2. PSO+ UNIT INPUTS AND OUTPUTS ARE CONNECTED PER THE RAILROAD'S OR AGENCY'S WRITTEN INSTRUCTIONS.

3. THERE MUST BE A MINIMUM OF 500 FEET SEPARATING THE TRACK CONNECTIONS OF THE TUNED RECEIVER COUPLER, HI Z, 7A366 FROM THE TRACK CONNECTIONS OF THE PSO+ TRANSMITTER, 7A481.

4. MAXIMUM TRACK DISTANCES WILL BE REDUCED AT LEAST 30% IN THIS APPLICATION.

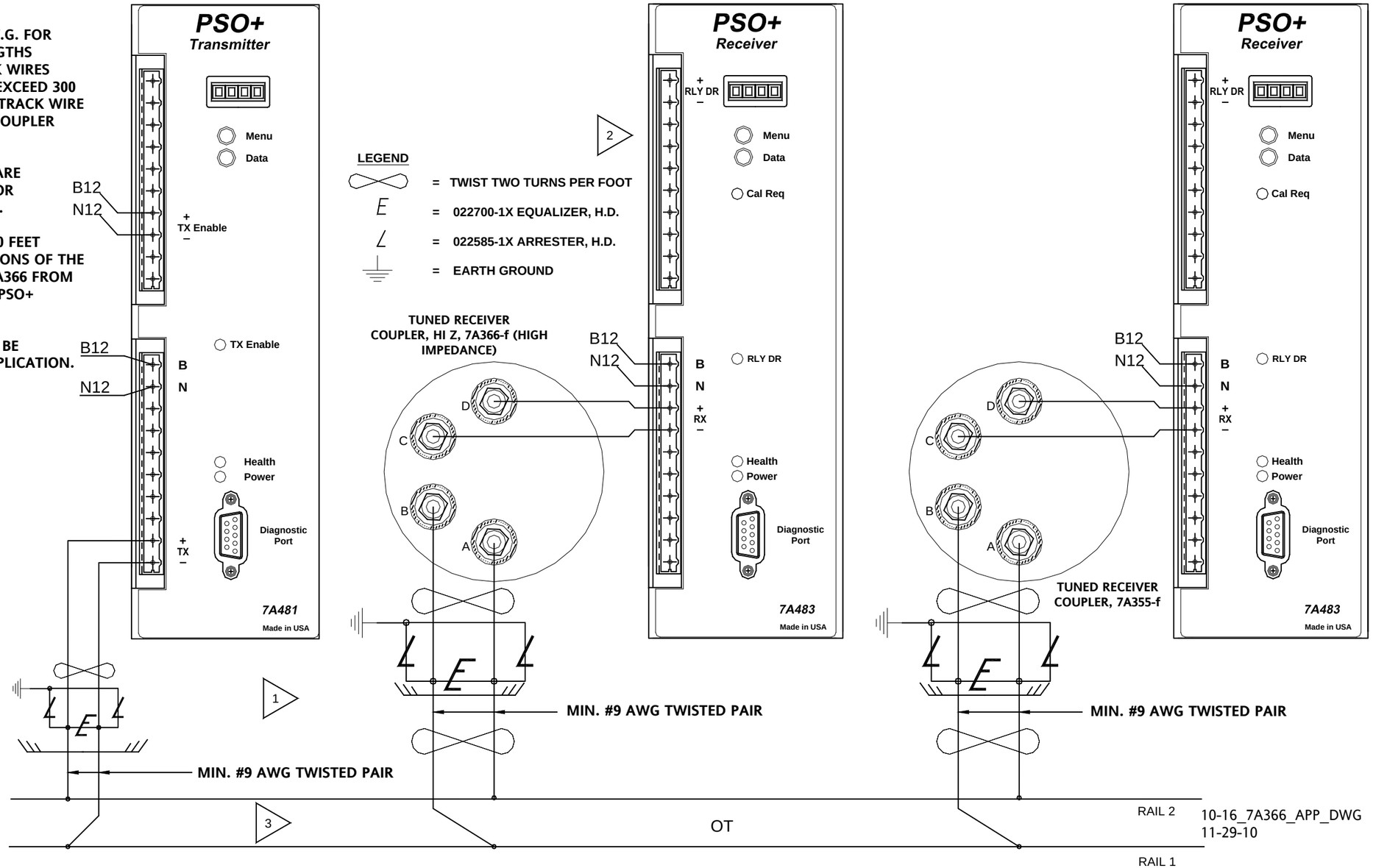


Figure 7-3:
PSO Application Using Tuned Receiver Coupler, Hi Z, 7A366-f

NOTES

1. **PSO+ TRACK WIRES MAY BE #9 A.W.G. FOR LENGTHS UP TO 100 FEET. FOR LENGTHS BETWEEN 100 AND 300 FEET, TRACK WIRES SHOULD BE #6 A.W.G. IF LENGTHS EXCEED 300 FEET, REFER TO SECTION 6.2.3 FOR TRACK WIRE SELECTION AND SECTION 3.3 FOR COUPLER USAGE AND INSTALLATION.**

2. **PSO+ UNIT INPUTS AND OUTPUTS ARE CONNECTED PER THE RAILROAD'S OR AGENCY'S WRITTEN INSTRUCTIONS.**

3. **THE WEATHERPROOF HOUSING CONTAINING THE RECEIVER LINE-TO-RAIL COUPLER, 7A377-1-f MUST BE PLACED AS CLOSE AS POSSIBLE TO THE TRACK, BUT NO FURTHER THAN 100 FEET FROM THE TRACK.**

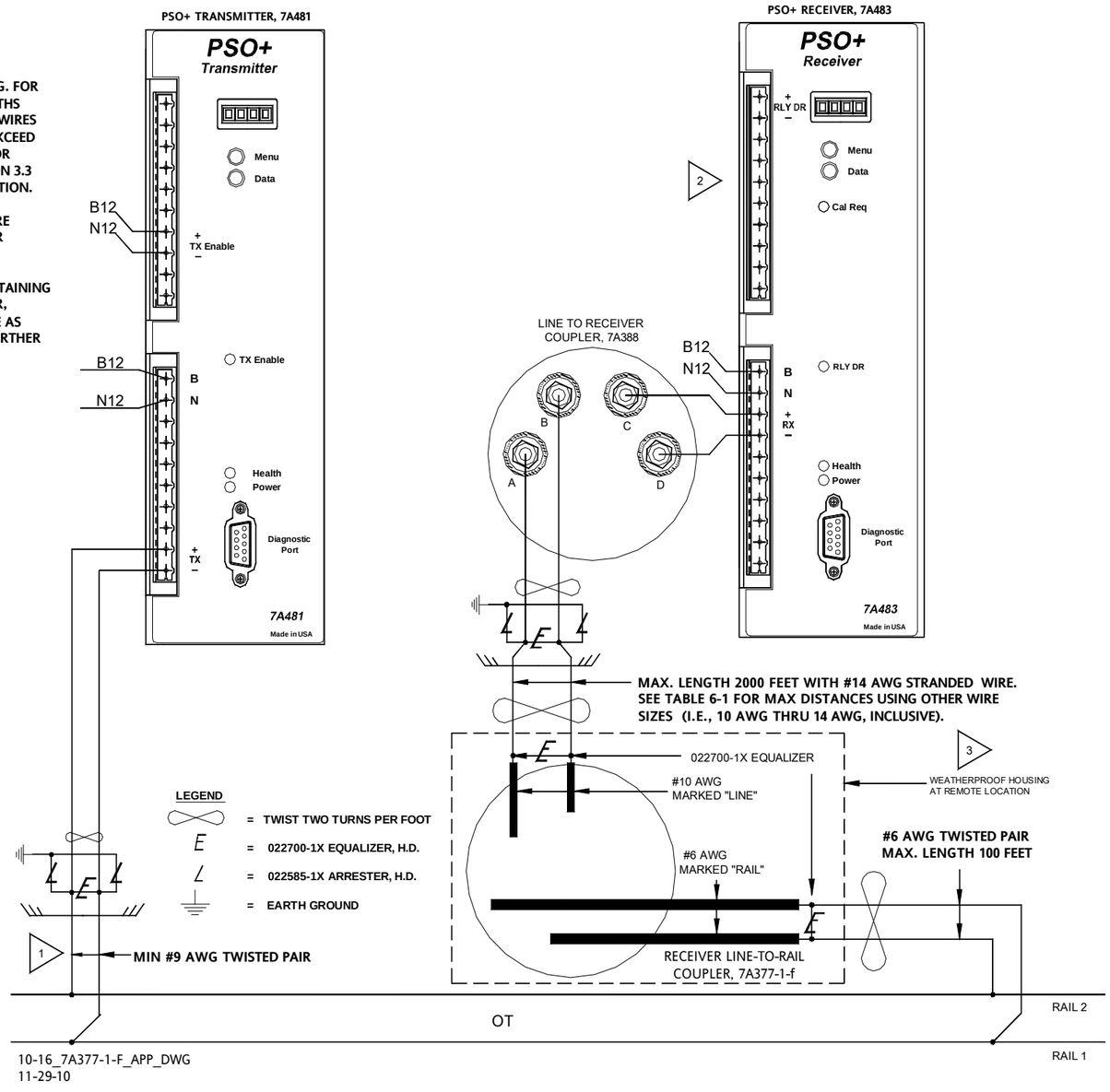


Figure 7-4:
PSO+ Application Using Line to Receiver Coupler, 7A388 and Receiver Line to Rail Coupler, 7A377-1-f

NOTES

1. **PSO+ TRACK WIRES MAY BE #9 A.W.G. FOR LENGTHS UP TO 100 FEET. FOR LENGTHS BETWEEN 100 AND 300 FEET, TRACK WIRES SHOULD BE #6 A.W.G. IF LENGTHS EXCEED 300 FEET, REFER TO SECTION 6.2.3 FOR TRACK WIRE SELECTION AND SECTION 3.3 FOR COUPLER USAGE AND INSTALLATION.**

2. **PSO+ UNIT INPUTS AND OUTPUTS ARE CONNECTED PER THE RAILROAD'S OR AGENCY'S WRITTEN INSTRUCTIONS.**

3. **THE WEATHERPROOF HOUSING CONTAINING THE RECEIVER LINE-TO-RAIL COUPLER, 7A377-2-f MUST BE PLACED AS CLOSE AS POSSIBLE TO THE TRACK, BUT NO FURTHER THAN 100 FEET FROM THE TRACK.**

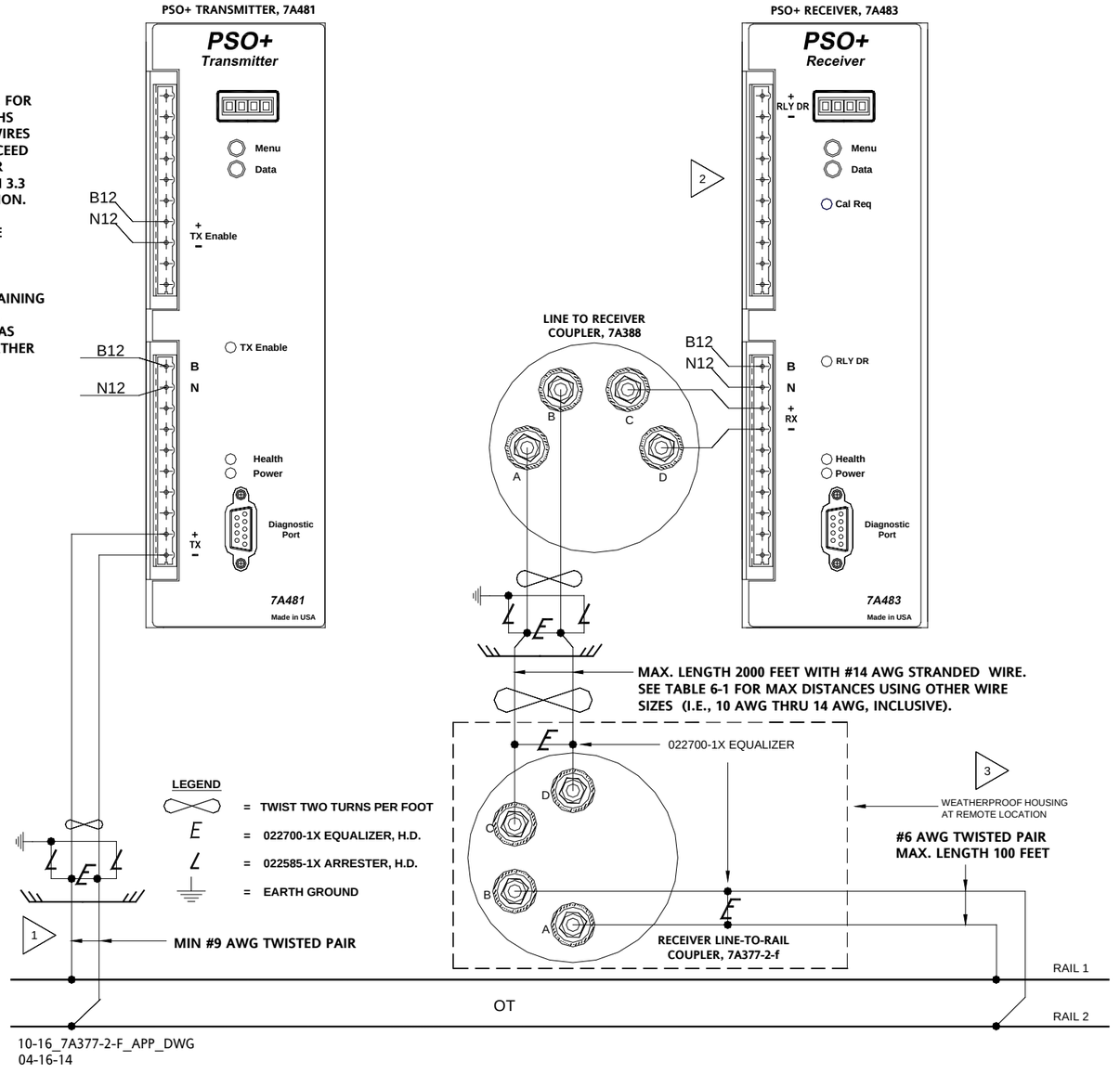
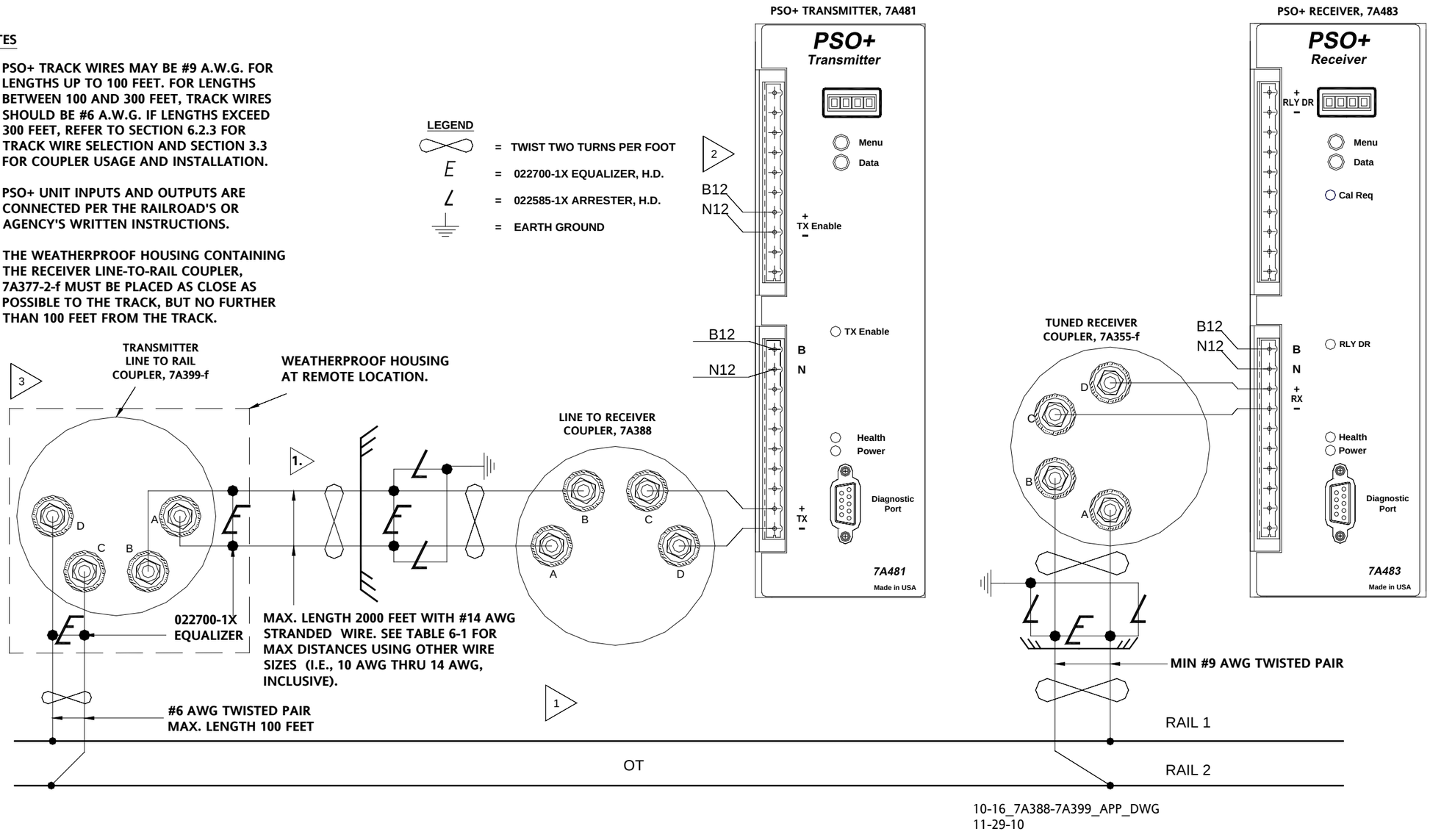


Figure 7-5:
PSO+ Application Using Line to Receiver Coupler, 7A388 and Receiver Line to Rail Coupler, 7A377-2-f

NOTES

1. PSO+ TRACK WIRES MAY BE #9 A.W.G. FOR LENGTHS UP TO 100 FEET. FOR LENGTHS BETWEEN 100 AND 300 FEET, TRACK WIRES SHOULD BE #6 A.W.G. IF LENGTHS EXCEED 300 FEET, REFER TO SECTION 6.2.3 FOR TRACK WIRE SELECTION AND SECTION 3.3 FOR COUPLER USAGE AND INSTALLATION.
2. PSO+ UNIT INPUTS AND OUTPUTS ARE CONNECTED PER THE RAILROAD'S OR AGENCY'S WRITTEN INSTRUCTIONS.
3. THE WEATHERPROOF HOUSING CONTAINING THE RECEIVER LINE-TO-RAIL COUPLER, 7A377-2-f MUST BE PLACED AS CLOSE AS POSSIBLE TO THE TRACK, BUT NO FURTHER THAN 100 FEET FROM THE TRACK.



10-16_7A388-7A399_APP_DWG
11-29-10

Figure 7-6:
PSO+ Application Using Transmitter Line to Rail Coupler, 7A399-f, and Line to Receiver Coupler, 7A388

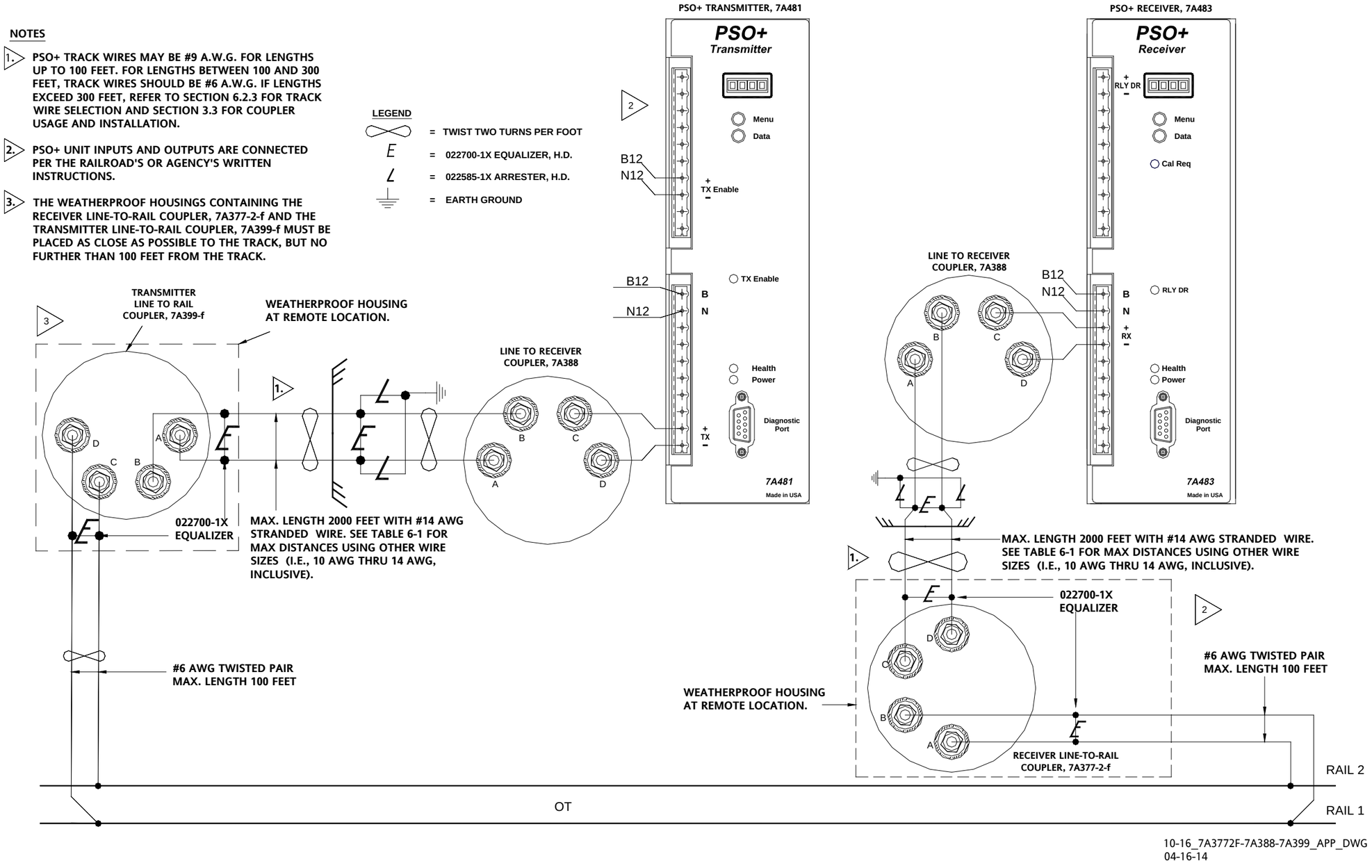


Figure 7-7:
PSO+ Application Using Transmitter Line to Rail Coupler, 7A399-f with Line to Receiver Coupler, 7A388 and Line to Receiver Coupler, 7A388 with Receiver Line to Rail Coupler, 7A377-2-f

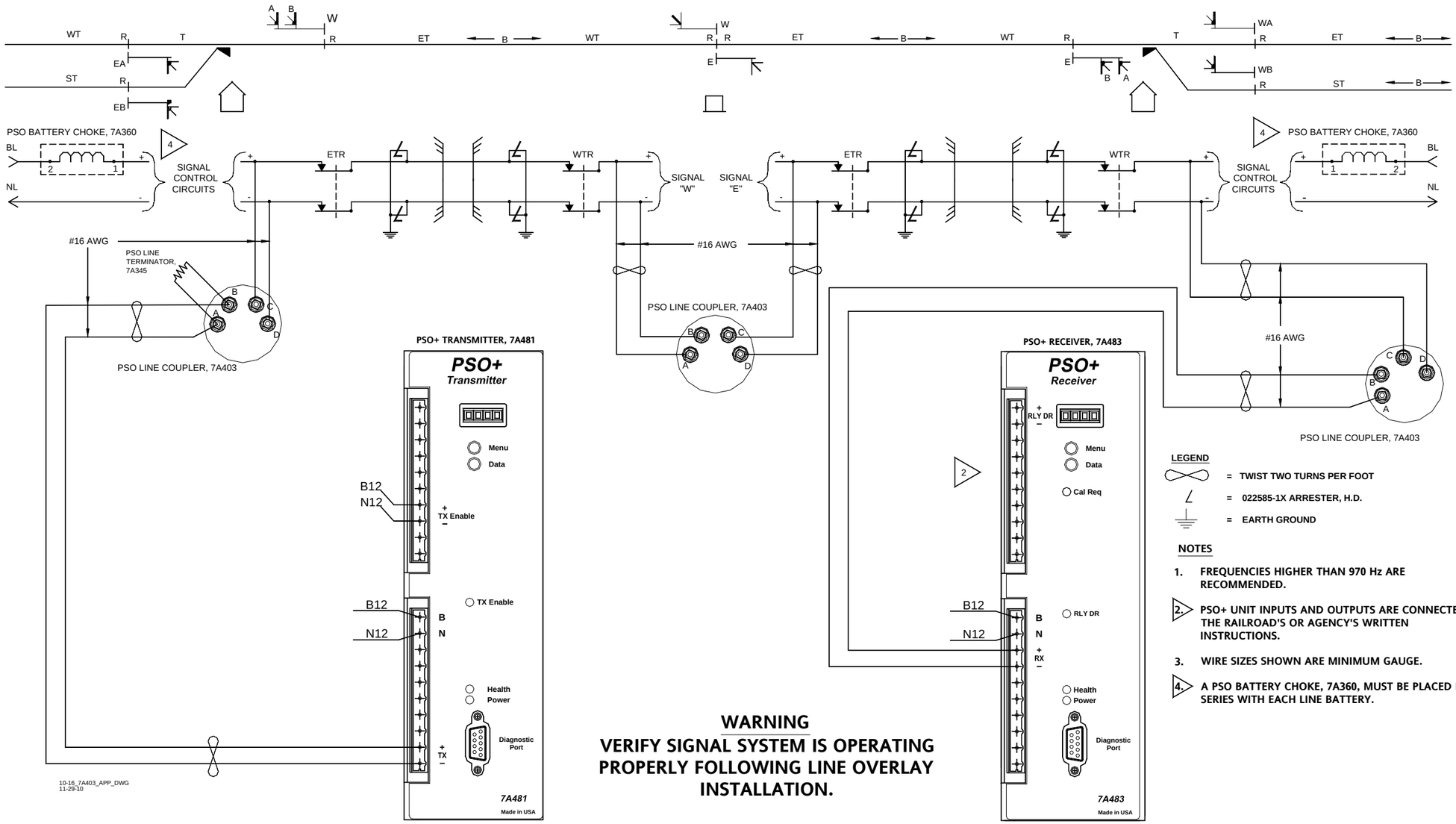


Figure 7-8:
Typical PSO+ Line Overlay Application
Using PSO Line Coupler, Low Z, 7A403
With PSO Line Terminator, 7A345

This page left intentionally blank

APPENDIX A –
MISCELLANEOUS INFORMATION

A.1 GLOSSARY

Table A-1:
Glossary

TERM	DEFINITION
AF	Audio Frequency
AFO	Audio Frequency Overlay
AREMA	American Railway Engineering And Maintenance-of-Way Association
CAL	Calibration Programming Submenu
CAL REQ LED	Calibration Required LED
dB	Decibels
DIAG	Diagnostics Programming Submenu
DT	Siemens Rail Systems Diagnostic Terminal Utility Diagnostic Terminal – The Diagnostic Terminal (DT) is an Siemens Rail developed Windows® based software that can run on a PC, which allows users install software.
-f	Frequency
GCP	Grade Crossing Predictor – A train detection device used as part of a highway-railroad grade crossing warning system to provide a relatively uniform warning time.
FLASH MEMORY	A type of non-volatile memory that can be reprogrammed in-circuit via software.
HIGHWAY-RAILROAD GRADE CROSSING ADVANCE WARNING SIGN	A traffic control sign (round yellow sign with RR and a black X) placed by the highway agency in advance of many highway-railroad grade crossings
HEALTHY	The PSO Unit itself and the VPI or the VRO are operating as intended. Health is generally indicated by a solid green light. Unhealthy conditions are indicated by a flashing yellow LED.
Hz	Hertz
kHz	Kilohertz
LED	Light Emitting Diode
LOS	Loss of Shunt – Commonly due to rust and/or rail contamination. LOS timers provide a pick up delay function.
NVRAM	Non-Volatile Random Access Memory
PCB	Printed Circuit Board
PICKUP DELAY	An internal delay time between when an input receives the signal to pickup and when it actually responds

Continued on next page

Table A-1 Concluded

TERM	DEFINITION
PSO	Phase Shift Overlay
PSO II	Phase Shift Overlay II
PSO III	Phase Shift Overlay III
PSO 4000	Phase Shift Overlay 4000 Track Circuit
PSO+	Phase Shift Overlay Plus Track Circuit
RLY DR LED	Relay Drive LED
RX	Receive or Receiver
RX CAL REQD	Receiver Calibration Required
TX	Transmit or Transmitter
TX ENABLE LED	Transmit Enable LED
TX UNHEALTHY	Transmitter Unit is unhealthy
UNIT	Physical package including PCBs and input/output terminals for connecting to external devices and equipment.
VERS	Version Data Submenu
VPI	Vital Parallel Input
VRO	Vital Relay Output
WSS	Wayside Signal Station

A.2 ORDERING INFORMATION

To order replacement components please call Customer Service at (800) 793-7233:

Table A-2:
PSO+ Replacement Parts and Part Numbers

ITEM DESCRIPTION	PART NUMBER
PSO+ UNITS	
Transmitter Code A	7000-7A481-0001
Transmitter Code C	7000-7A481-0002
Receiver Code A	7000-7A483-0001
Receiver Code C	7000-7A483-0002
PSO+ AUXILIARY EQUIPMENT	
AC Shunt, Wide Band, 8A076	8000-8A076-0001
Battery Choke, 62648	6000-62648-0001
Battery Choke, 8A065	8000-8A065-0001
Cab Signal Filter, 7A417-X	7000-7A417-00XX (see Note 2 below)
Line to Receiver Coupler, 7A388	7000-7A388-0001
PSO Battery Choke, 7A360	7000-7A360-0001
PSO Battery Line Filter, 7A418	7000-7A418-0001
PSO Insulated Joint Bypass Coupler (Tuned), 7A422-f	7000-7A422- ffff (see Note 1 below)
PSO Line Coupler, Low Z, 7A403	7000-7A403-0001
PSO Line Terminator, 7A345	7000-7A345-0001
Receiver Line to Rail Coupler (Pole Mounted)7A377-1-f	7001-7A377- ffff (see Note 1 below)
Receiver Line to Rail Coupler (Shelf Mounted)7A377-2-f	7002-7A377- ffff (see Note 1 below)
Transmitter to Line Rail Coupler, 7A399-f	7000-7A399- ffff (see Note 1 below)
Tuned Receiver Coupler, 7A355-f	7000-7A355- ffff (see Note 1 below)
Tuned Receiver Coupler, Hi Z, 7A366	7000-7A366- ffff (see Note 1 below)
PSO+ SUPPORTING EQUIPMENT	
Siemens Rail Diagnostic Terminal (DT)	Z224-9V234-A01E (see Note 3 below)

Note 1: Order the component by the frequency required as per the railroad's wiring or installation diagram (i.e. -0156 for 156 Hz frequency, 2630 for 2.63 kHz, 4000 for 4.0 kHz, etc.)

Note 2: See Section 6.1.7, Cab Signal Filter 7A417-X, and Table 6-3, Cab Signal Filter Manufacturer-Frequency Cross Reference for the final two digits of the required code specifying the manufacturer and the frequency required for the location.

Note 3: The Siemens Rail Diagnostic Terminal (DT) CD shipped will be the latest version available. The Z224-9V234-A01E version was current at the time of this document's publication.

This page intentionally left blank

APPENDIX B –
TROUBLESHOOTING

B.1 GENERAL

There is no periodic maintenance performed on the PSO+. There are no user maintainable parts within the PSO+. Defective units are replaced as a whole: if any portion of a transmitter fails, replace the 7A481 Transmitter; if any portion of receiver fails, replace the 7A483 Receiver.

Troubleshooting the PSO+ is very simple. Clear problems identified by DIAG errors per Table B-1. Clear other issues per the Troubleshooting Diagram in Figure B-1.

B.2 DIAGNOSTIC (DIAG) MESSAGES

Perform any actions directed by the unit in the Reason column. If the correction fails to bring the unit back into operation, replace the unit.

Table B-1:
PSO+ Diagnostic (DIAG) Messages

MESSAGE	REASON
XMIT ERR	Transmitter error
TX FREQ NOT SET	Transmitter frequency not set
TX RECOVERING	Transmitter recovering from unhealthy state such as freq not set/not supported, transmitter error.
RCV ERROR	Receiver not active (receiver time out). p/s buffer samples out of sync. p/s magnitude differ or p/s address code differ ADC channel failure
CAL REQD	Receiver requires calibration.
CARRIER ONLY	Receiver receives a carrier signal but no code.
RCV FRQ NOT SET	Receiver freq not set
RCV RECOVERING	Receiver recovering from unhealthy state such as freq not set, bad cal magnitude (cal magnitude = 0), ADC failure, p/s magnitude/code differs, receiver not active (receiver time out), p/s buffer samples out of sync.
WRONG CODE RCVD	Receiver receives wrong address code

B.3 TROUBLESHOOTING OTHER PSO+ ISSUES

WARNING

AFTER INSTALLATION OR AFTER ANY MENU CHANGES HAVE BEEN MADE, RECALIBRATE THE RECEIVER AND TEST FOR PROPER OPERATION. REQUIRED OPERATIONAL TEST SHOULD BE PERFORMED IN ACCORDANCE WITH RAILROAD OR AGENCY PROCEDURES.

IF ANY RECEIVER IS CALIBRATED IN POOR BALLAST CONDITIONS, IT MUST BE RE-CALIBRATED WHEN BALLAST CONDITIONS IMPROVE.

AFTER CALIBRATION, VERIFY THAT THE TRACK CIRCUIT DE-ENERGIZES WHEN THE TRACK CIRCUIT IS SHUNTED WITH THE APPROPRIATE CALIBRATION RESISTANCE. FAILURE TO DO SO MAY LEAD TO INCORRECT OR UNSAFE OPERATION OF THE TRACK CIRCUIT.

FAILURE TO FOLLOW THE RAILROAD'S OR AGENCY'S APPROVED WIRING OR INSTALLATION GUIDELINES REGARDING SETTINGS AND CALIBRATION MAY LEAD TO POSSIBLE UNSAFE OPERATION OF THE TRACK CIRCUIT.

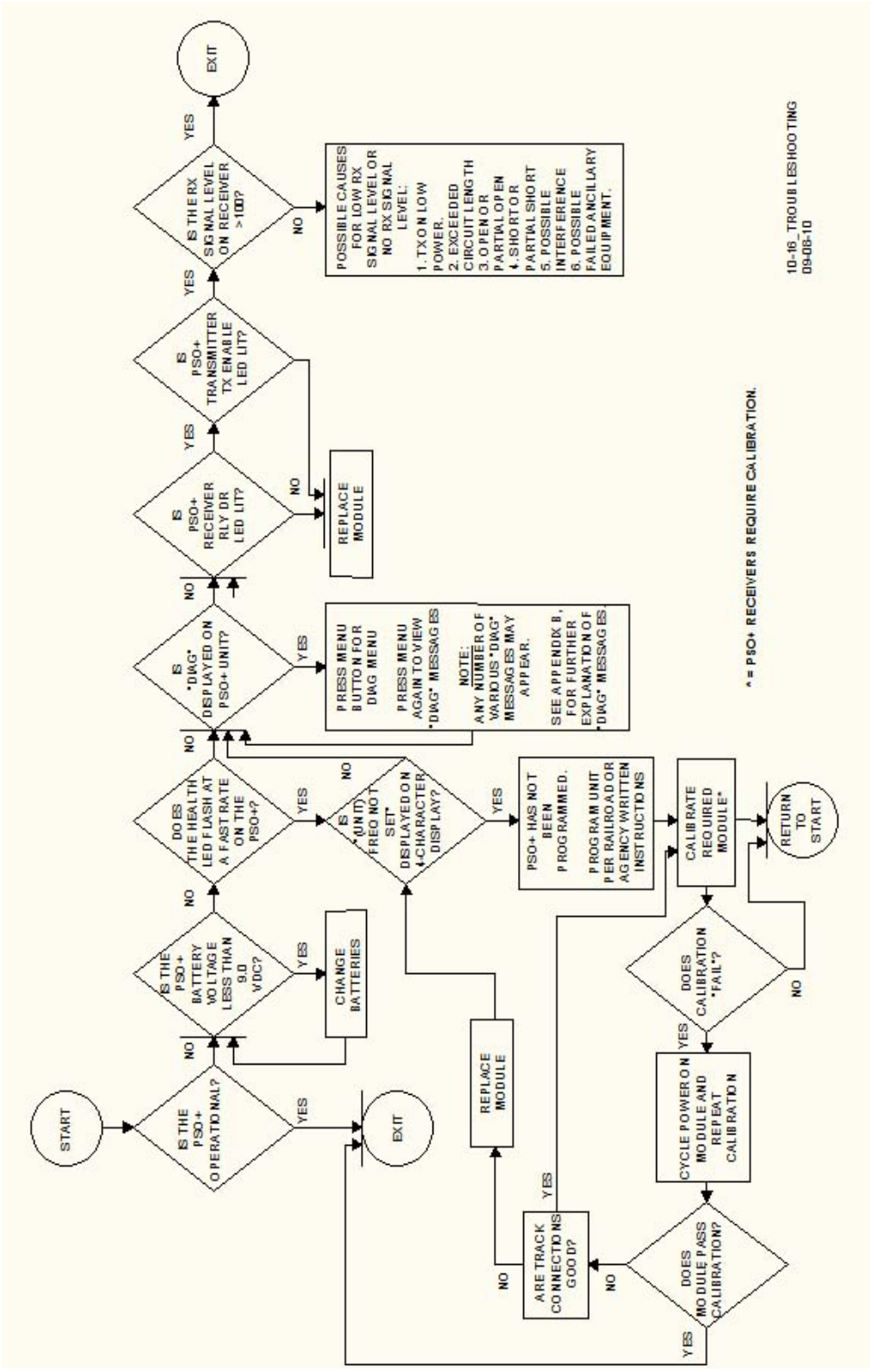


Figure B-1:
PSO+ Troubleshooting Diagram

This page intentionally left blank