SIEMENS

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INSTALLATION & INSTRUCTION

PHASE SHIFT OVERLAY III (PSO III)

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DOCUMENT HISTORY

Version	Release Date	Sections Changed	Details of Change
A	1-23-01		Initial release (recalled because product not released. All manuals shipped following recall marked PRELIMINARY)
A	9-12-02		Re-release as version A with new date of September 2002 added WARNING to step 10 of para. 7.1 added CAUTION to para. 6.3 voltage changes in para. 7.1 added 90 Hz information for 7A417
A.1	9-4-14	Front matter only	Rebrand for Siemens

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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:

NOTE

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

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.

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.

If there are any questions, contact Safetran 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. Safetran 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 Safetran California Division Technical Support Staff in Rancho Cucamonga, California. ESD Awareness Classes and additional ESD product information are also available through the Technical Support Staff.

SECTION I

INTRODUCTION

1.0 SYSTEM OVERVIEW

The Phase Shift Overlay III (PSO III) track circuit manufactured by Safetran Systems Corporation™, Cucamonga, California, is used to supply track occupancy information for crossing warning devices, as well as other train or vehicle detection systems. The PSO III is a reliable and secure solid-state vital system that is sufficiently versatile to permit use in a wide variety of complex installations.

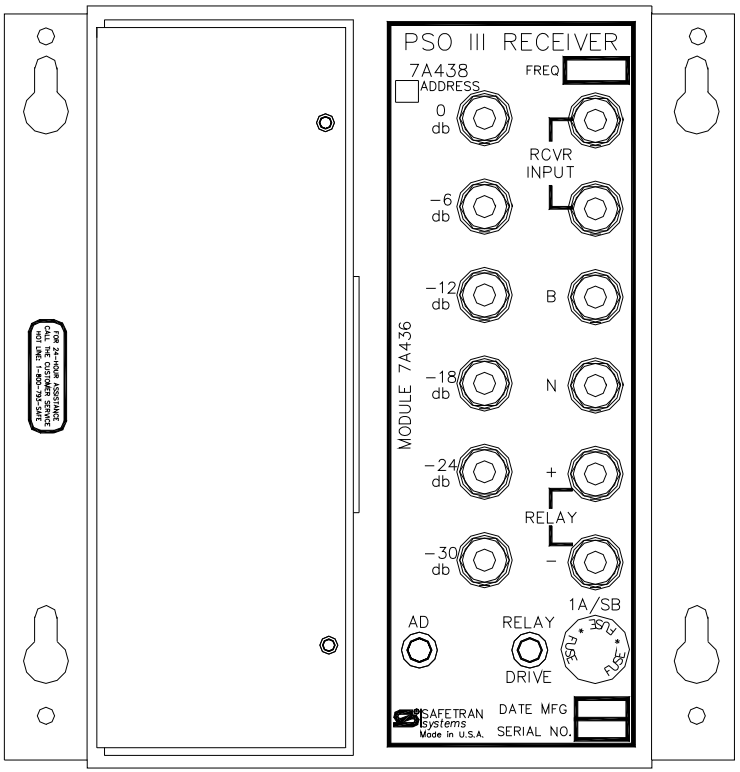
The PSO III is available in two configurations; ‘standard’ and Crossing Package. The 'standard' configuration (figure 1-1) consists of separate transmitter and receiver assemblies. Each of these assemblies contains a single printed circuit module. The transmitter assembly sends a coded, 8-bit address through the rails using an audio frequency signal as a carrier. The modulated signal is detected by the receiver assembly where it is decoded and processed. The receiver responds only to signals of the proper frequency, modulation rate, address, and amplitude. The ability of PSO III to differentiate between its operating signal and all other signals present on the track is due to the non-symmetrical coded modulation and receiver decoding techniques which ensure that the system is immune to random or foreign AM, FM, and beat signals.

The Crossing Package (figure 1-2) includes two receiver modules and a combination transmitter/ receiver island circuit module (62609) in a single case. The Crossing Package receiver modules are identical to those used in the 'standard' receiver assemblies. The island module used in the Crossing Package is Safetran’s Intelligent Processor Island (IPI) module. See Section IV for further information on the Crossing Package.

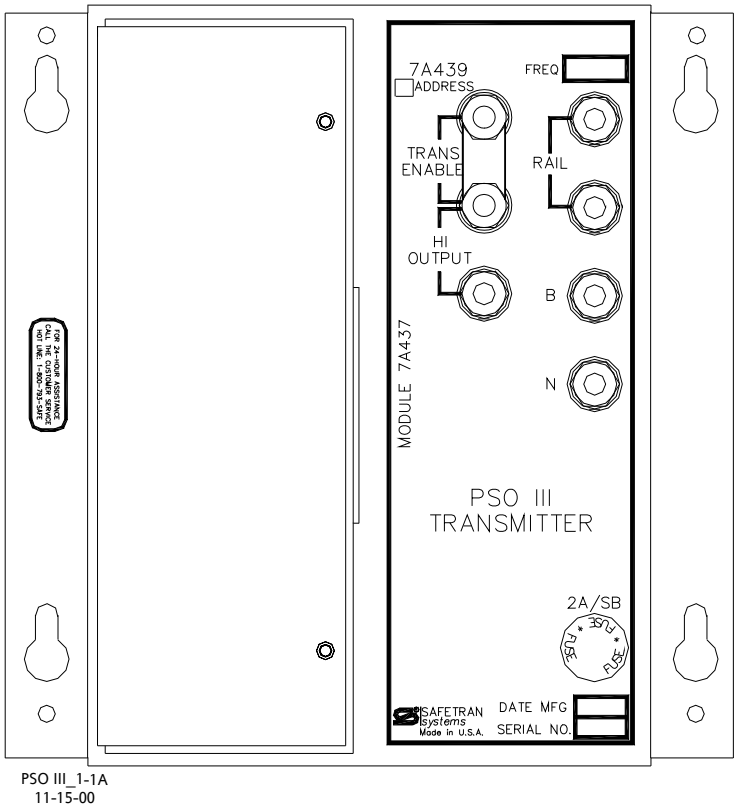
1.0.1 Address Formats

The PSO III is available in either of two address formats (“A” or “C”). The “A” address format is standard and is intended for most PSO III applications. Unless specified otherwise at the time an order is placed for the PSO III, the “A” address is provided. The “C” address format is intended for use in applications involving a high-density mix of frequencies and multiple tracks.

PSO III transmitter and receiver cases and modules are assigned specific part numbers according to the address format used. Refer to table 1-1 for part number assignments. Both cases and modules are also marked with decals that identify the address format used (e.g., “A ADDR” or “C ADDR”). The decals are located adjacent to the assembly part number on the cases and adjacent to the module part number on the component side of the transmitter and receiver printed circuit modules.

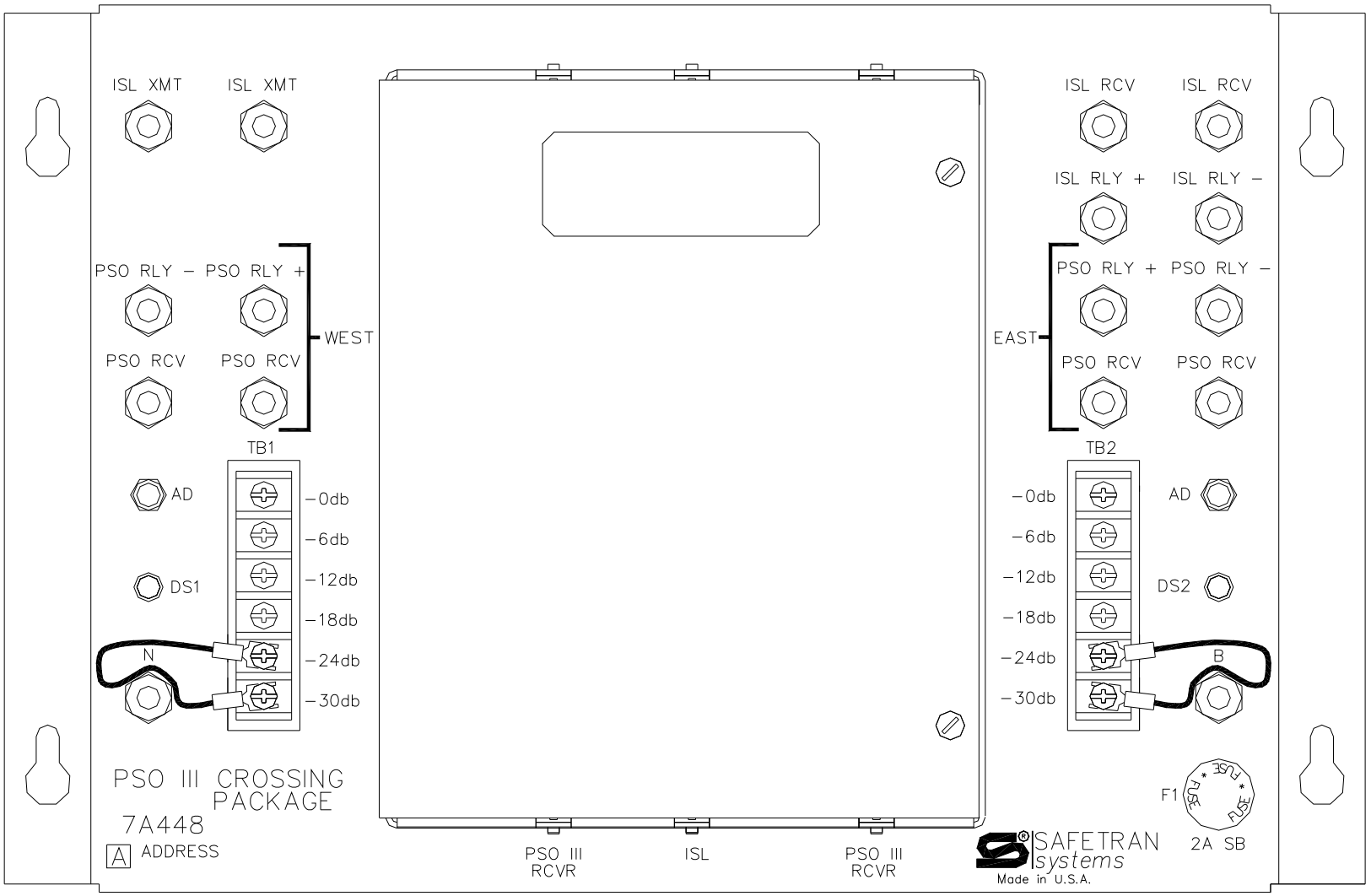


Receiver, 7A438



Transmitter, 7A439

Figure 1-1
Phase Shift Overlay III Transmitter And Receiver



PSOIII_XING
1-9-01

Figure 1-2
Phase Shift Overlay III Crossing Package, 7A448

The PSO III transmitter and receiver modules designed for "C" address operation only are electrically keyed to permit operation only in the "C" address cases. The same is true for the "A" address modules and cases. In addition, "C" address transmitter and receiver modules are further identified by blue ejector levers which are stamped with the assembly part number.

Table 1-1
PSO III Transmitter and Receiver Assembly Part Numbers

Assembly	Assembly (Case) Part Number	Module Installed	Module Installed
		A Address	C Address
Transmitter ("A" address)	7A439	7A437	
Transmitter ("C" address)	7A451		7A437-2
Receiver ("A" address)	7A438	7A436	
Receiver ("C" address)	7A453		7A436-2

Except for minor differences to provide specific address operation, the "C" address transmitter assembly is identical to the "A" address transmitter and the "C" address receiver assembly is identical to the "A" address receiver.

1.0.2 PSO III Frequencies

A wide variety of carrier frequencies are available for the PSO III. For use in non-electrified territory, 16 PSO III carrier frequencies, ranging from 156 Hz to 4,000 Hz, are available with the 'standard' PSO III and the Crossing Package. For electrified territory, 10 frequencies are available ranging from 645 Hz to 4000 Hz. Ten island frequencies are available for the Crossing Package and range from 4.9 kHz to 20.2 kHz. For installations where multiple circuits are required on the same track, the PSO III has two sets of eight frequencies (two sets of five for electrified territory) each that can be connected as required with negligible interference.

NOTE

The 62609 island module provides jumper positions for selecting the island frequencies 4.00, 3.24, 2.63 and 2.14 kHz. However, these frequencies are not used in PSO III applications

1.0.3 PSO III Transmitter And Receiver Front Panel Connectors And Indicators

Tables 1-2 and 1-3 describe the functions of each of the front panel mounted connectors and indicators on the PSO III Transmitter and Receiver cases. Refer to figure 1-1 for connector and indicator locations.

Table 1-2
PSO III Transmitter Case Front Panel Connector Functions

Front Panel Nomenclature	Description	Function
B	AREMA binding post	Positive battery connection
N	AREMA binding post	Negative battery connection
RAIL	AREMA binding posts	Track wire connections
TRANS ENABLE	AREMA binding posts	Strap these terminals to enable continuous transmitter operation
HI OUTPUT	AREMA binding posts	Strap these terminals to enable high power operation
2A/SB	Fuse holder	2-ampere slow blow fuse for positive battery input

Table 1-3
PSO III Receiver Case Front Panel Connector And Indicator Functions

Front Panel Nomenclature	Description	Function
B	AREMA binding post	Positive battery connection
N	AREMA binding post	Negative battery connection
RCVR INPUT	AREMA binding posts	Receiver input connections from track via an external coupling device such as a 7A355A Tuned Receiver Coupler
RELAY +/-	AREMA binding posts	Output to polar track relay
0dB, -6dB, -12dB, -18dB, -24dB, -30dB	AREMA binding posts	Receiver sensitivity strapping terminals --- one end of strap always connected to –30dB terminal.
AD	Test Jack	Amplitude detector test jack used during receiver adjustment procedure
RELAY DRIVE	LED	Relay drive indicator that lights when PSO Receiver RELAY output is energized
1A/SB	Fuse holder	1-ampere slow blow fuse for positive battery input

1.0.4 PSO III Accessories

A variety of accessory equipment is available for use with the PSO III. Where it is desirable to have the transmitter and receiver at the same location, rail-to-line and line-to-rail couplers are available to enable signals to be transmitted or received over lines. Accessory equipment is also available for specialized applications such as preventing the loading effects of track batteries and bypassing PSO III signals around insulated joints at selected locations.

WARNING

THE BYPASSING OF INSULATED JOINTS IN ELECTRIFIED TERRITORY IS NOT RECOMMENDED.

The PSO III is compatible with other Safetran equipment including motion sensors, grade crossing predictors, pulse-modulated track circuits, etc.

1.1 USE OF PSO III WITH PSO II EQUIPMENT

The PSO III receiver and transmitter units are compatible with the signal format and track levels of Safetran's PSO II receiver and transmitter units using the same address format. This means that a PSO III transmitter is capable of driving a track circuit containing a PSO II receiver, and that a PSO III receiver is capable of receiving and decoding a signal emanating from a PSO II transmitter. PSO III transmitter and receiver modules may also be used in the earlier PSO II cases with the same address format. However, the PSO III cases are electrically keyed to prevent the use of the PSO II modules in the newer PSO III cases. Table 1-4 indicates PSO III and PSO II interchangeability; that is, which modules will operate in each transmitter and receiver case. For example, the 7A400 PSO II transmitter case accepts either a PSO II (7A411) or PSO III (7A437) transmitter module.

Table 1-4
PSO II And PSO III Transmitter and Receiver Module/Case Interchangeability

System	Address Format	Module Type	Module Part Number	Assemblies (Cases)							
				PSO II				PSO III			
				A Address		C Address		A Address		C Address	
				7A400	7A405	7A420	7A425	7A438	7A439	7A451	7A453
PSO II	A Address	Receiver	7A416		X						
		Transmitter	7A411	X							
	C Address	Receiver	7A416-2				X				
		Transmitter	7A411-2			X					
PSO III	A Address	Receiver	7A436		X			X			
		Transmitter	7A437	X					X		
	C Address	Receiver	7A436-2				X				X
		Transmitter	7A437-2			X				X	

1.2 PSO III TRANSMITTER AND RECEIVER SPECIFICATIONS

PSO III Frequencies Available:

NOTE

Frequencies enclosed by dotted line are recommended for use in electrified territory

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

Frequency Stability: ±0.1% (Hz)

Modulation: Phase Modulation with 8-bit serial address

Transmitter Output Impedance: 2 Ω (nominal)

Receiver Sensitivity: 10 mV rms (minimum) at receiver input terminals

Receiver Selectivity: 60 dB down on adjacent channels

Specifications (Continued)

Receiver Input Impedance:	
With 7A355 Coupler –	Low impedance
With 7A366 Coupler -	High impedance
Surge Protection:	Secondary protection built-in, Primary protection required on all external lines
Relay Coil Resistance:	400 to 1,000 Ω
Environmental Range (Temperature):	-40 °F to +160 °F (-40 °C to +71 °C)
Input Voltage:	9.0 to 16.5 VDC (all units)
Input Current:	
Transmitter, 7A439/7A451 (low power)	350 mA nominal
Transmitter, 7A439/7A451 (high power)	600 mA nominal
Receiver, 7A438/7A453	400 mA nominal
Dimensions:	
Transmitter and Receiver	8.75 inches high (22.23 centimeters) 8.25 inches wide (20.96 centimeters) 9.50 inches deep (24.13 centimeters)
Shipping Weight:	
Transmitter and Receiver	5 pounds (each) (2.27 kilograms)

1.3 ORDERING INFORMATION

Unit Description	Address Format	Part Number
PSO III Transmitter	"A" address	7A439-f
PSO III Receiver	"A" address	7A438-f
PSO III Crossing Package with island	"A" address	7A448-f1-f2-IPI
PSO III Transmitter	"C" address	7A451-f
PSO III Receiver	"C" address	7A453-f
PSO III Crossing Package with island	"C" address	7A455-f1-f2-IPI

f = Selected from list of available frequencies
f1 = Frequency of receiver number 1
f2 = Frequency of receiver number 2
IPI = IPI Island Module included

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SECTION II

THEORY OF OPERATION

2.0 GENERAL

The PSO III System consists of a transmitter connected to the track at one location, and a receiver (which is coupled to the track through a tuned receiver coupling unit) at a remote location. The receiver operates the track relay which supplies track occupancy information. A separate island circuit is provided by the 62509 module in the Crossing Package which is described in Section IV.

2.1 TRANSMITTER ASSEMBLY (7A439, 7A451)

All major circuits of the transmitter assembly are contained on Transmitter Module, 7A437 (A address) or 7A437-2 (C address). External connections are accomplished via standard AREMA binding posts mounted on the transmitter case.

2.1.1 Circuit Description

Figure 2-1 is a simplified block diagram illustrating signal flow through the transmitter circuits. A high-frequency signal (between 1 and 2 MHz) is generated by a crystal-controlled oscillator. The signal is fed to circuits that comprise a divider and a digital frequency modulator. These circuits process the signal as follows: a counter stage produces an output that is 128 times that of the basic lower PSO III transmitted frequency. The signal is routed to a second counter stage which supplies an input to separate divide-by-62 and divide-by-64 counters. When the enable input from the code generator is applied to the modulator circuit, the divide-by-62 counter produces a corresponding output that is applied to one input of a two-input NAND gate. The other input to the NAND gate is the slightly lower frequency produced by the divide-by-64 counter. The resulting output from the NAND gate corresponds to the divide-by-64 counter output, unless the enable signal is present from the code generator.

A second counter stage continues to count the divided basic frequency until a reset pulse is received from the NAND gate, at which time the counter is reset and a count from zero is initiated. A toggle flip-flop changes state each time a reset pulse is applied to the second counter, resulting in an output signal which is one-half the reset frequency. Therefore, the output produced by the flip-flop is at the frequency produced by the first counter stage divided by 124 or 128, depending upon the state of the enable signal from the code generator.

The code generator produces a single bit of the address signal for every 32 cycles of the input signal. The enable signal is an 8-bit code which controls the divide-by-62 counter. Therefore, the enable signal modulates the transmitted output frequency with the proper address sequence.

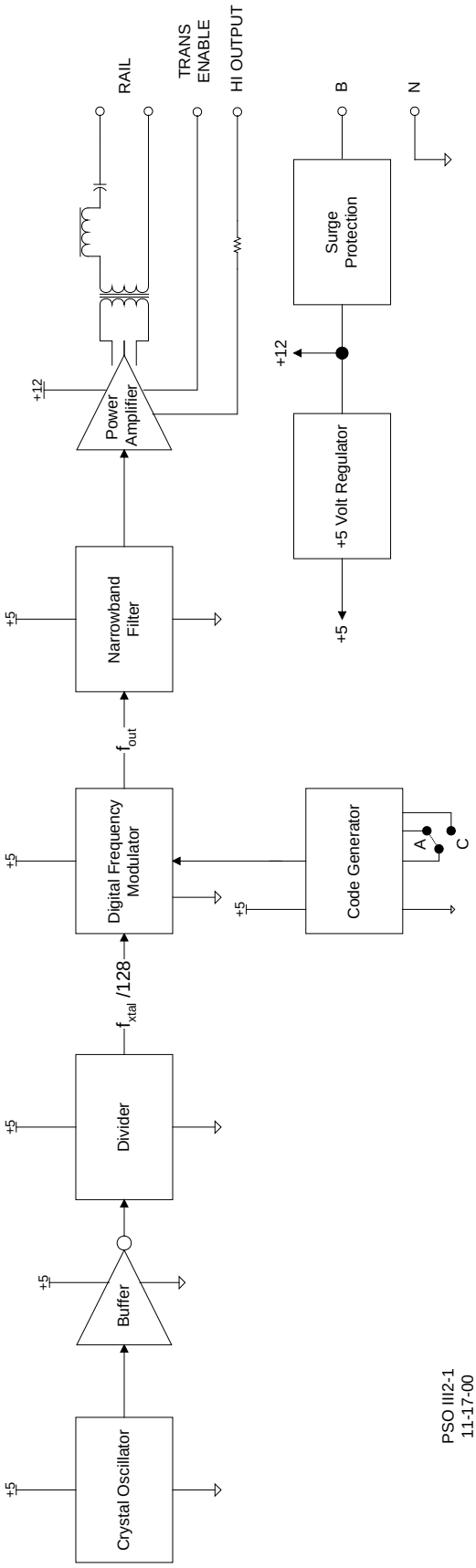


Figure 2-1
Transmitter Assembly, 7A439, Block Diagram

The output from the digital frequency modulator passes through a narrow-band filter on its way to the power amplifier. The narrow-band filter is a parallel resonant circuit with a Q of about 25 in the collector circuit of a gain-limited transistor amplifier. The inductive element is a pot core that is tuned with two parallel capacitors. The filtered signal is then applied through an opto-coupler to a flip-flop that provides square-wave drive to the power amplifier.

The power amplifier stage conditions and shapes the signal received from the narrow-band filter. The amplifier output is coupled through an impedance-matching transformer and output filters to the track. The filters remove the higher harmonics from the power amplifier output signal ensuring that a clean spectrum is applied to the track (see figure 2-2). The high filter impedance at frequencies other than the signal frequency serve to minimize loading of other circuits on the track.

2.1.2 Transmitter Harmonics

The harmonic content of the PSO III output waveform is minimized by the tuned output circuits used in the transmitter. The values shown below indicate the harmonic levels in a typical PSO III output waveform as it appears on the track. Any harmonics not listed are more than -60 dB below the fundamental PSO III transmitter signal.

Harmonic	Level
Second	-60 dB
Third	-30 dB
Fourth	-46 dB
Fifth	-60 dB

2.1.3 Transmitter Strapping Options

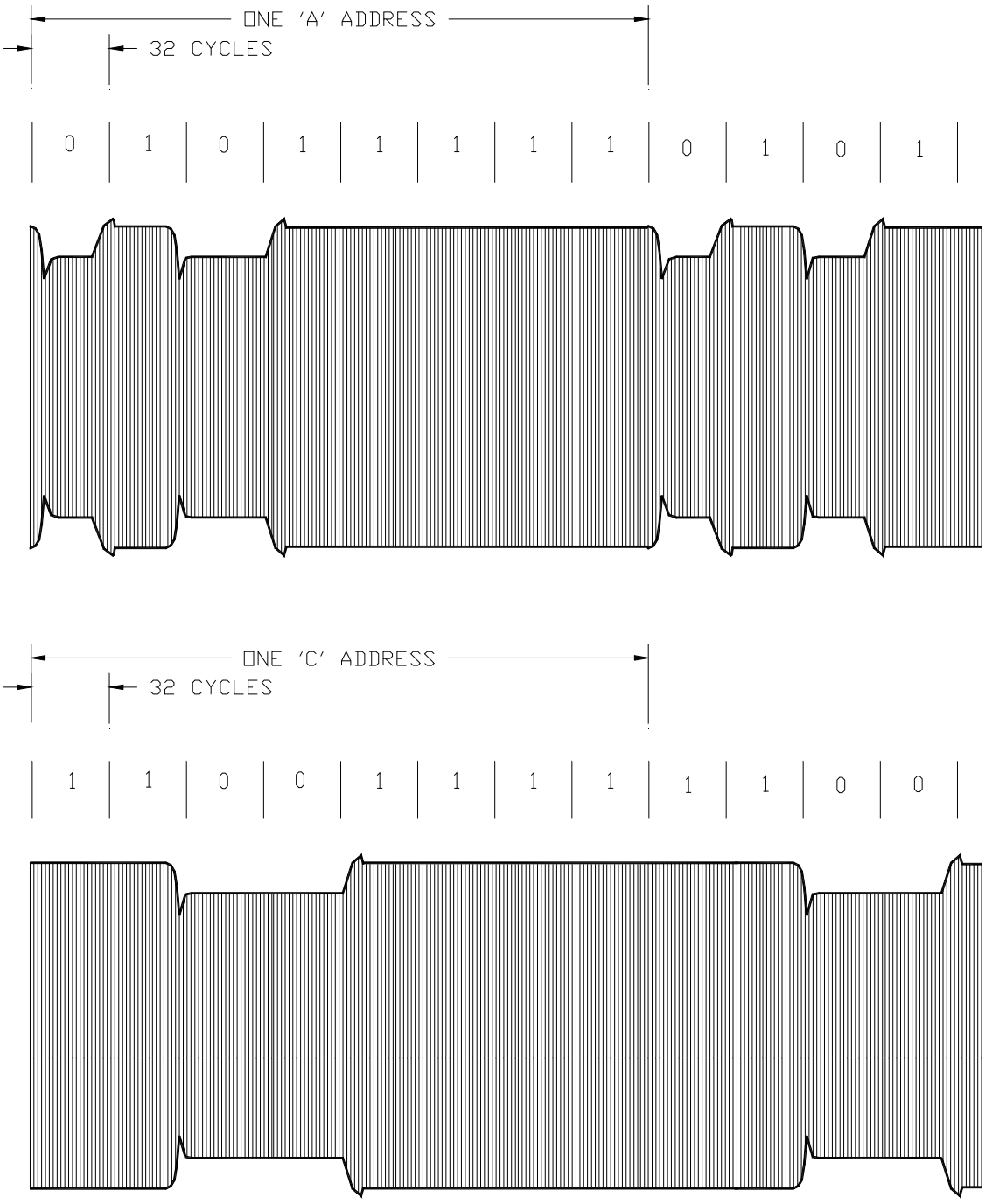
AREMA binding posts on the transmitter case front panel provide two strapping options. By strapping the TRANS ENABLE terminals, continuous low-power operation is enabled. Higher output power can be obtained by strapping both the HI OUTPUT and the TRANS ENABLE terminals. With either strapping option installed, the transmitter can be controlled remotely by switching the power off and on at the front panel B and N terminals via an external relay.

2.2 RECEIVER ASSEMBLY (7A438, 7A453, part of 7A448)

All major circuits of the receiver assembly are contained on Receiver Module, 7A436 (A address) or 7A436-2 (C address). External connections are accomplished via standard AREMA binding posts mounted on the receiver case.

2.2.1 Circuit Description

The block diagram for the receiver assembly is shown in figure 2-3. The following discription generally follows the signal flow from receiver input (**RCVR INPUT**) to relay output (**RELAY**).



NOTE: RELATIVE AMPLITUDE OF 0'S AND 1'S WILL VARY DEPENDING UPON TRACK CONDITIONS.

PSO III2-2
11-13-00

Figure 2-2
Typical Transmitter Frequency-Modulated Output Waveform (4,000 Hz)

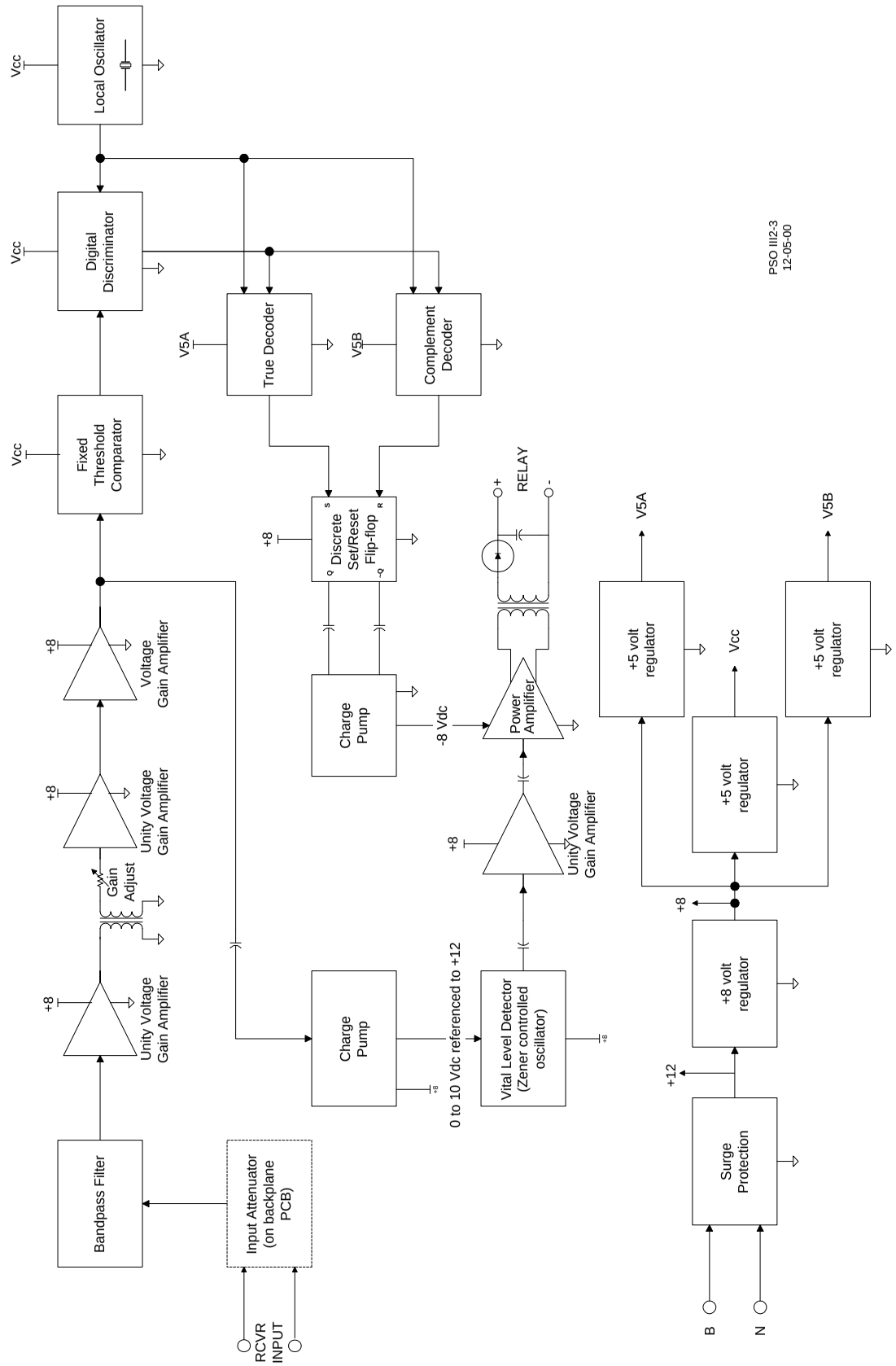


Figure 2-3
Receiver Assembly, 7A438, Block Diagram

An input attenuator on the backplane circuit board provides up to 30 dB of attenuation for the input signal in 6-dB steps. These steps provide a coarse adjustment for setting the track circuit shunting performance.

The input signal is then applied to a four-pole bandpass filter that provides at least 60 dB of attenuation at the nearest adjacent channel. The filter also provides a passive voltage gain by transforming its relatively low input impedance to a higher output impedance.

The filter output is applied to a unity voltage gain amplifier. Voltage gain is provided passively by a coupling transformer to the following unity gain amplifier. A 6 dB variable gain control is provided to allow fine adjustment of the track circuit. A discrete operational audio amplifier provides additional voltage gain.

The amplified signal is then applied to two different signal-processing channels. One channel verifies that the received signal amplitude is sufficient to allow the relay output to be energized. The second channel decodes the signal to vitally verify that it contains the correct code pattern. The outputs of these two channels are then vitally 'ANDed' to produce a DC relay-drive output.

In the first channel, a charge pump (voltage doubler) rectifies the audio frequency signal to obtain a DC voltage proportional to the signal amplitude. This DC voltage is referenced to the +12 volt DC power rail; therefore, when present, it must be higher than the highest DC power supply voltage. A vital level detector (also referenced to the +12 volt DC rail) checks the amplitude of the proportional DC voltage. It produces a 5 kHz sine wave output when the charge pump output exceeds about 5 volts. The 5 kHz sine wave is then buffered with a unity gain amplifier before being applied to the relay output power amplifier.

In the second channel, a fixed threshold comparator squares up the sine wave audio signal. The threshold of this comparator is at about the same level as that required to trigger the vital level detector in the first channel. Hence, both channels require about the same signal level to produce an output. The squared-up signal is applied to a digital discriminator that recovers the code pattern imposed on the signal by frequency modulation. A crystal clock at 16 times the nominal signal frequency is necessary for the discriminator to demodulate the signal. However, the comparator and discriminator are not vital. They merely produce a string of pulses that is applied to a vital decoding circuit. The decoding circuit checks whether the string of pulses has the correct timing and pattern.

The decoder is dual channel. One channel operates on a true representation of the pulse string while the second channel operates on an inverted or complemented representation. The code is an eight-bit word with a specific value. Both outputs must operate correctly in order to toggle the set/reset flip-flop that combines the decoder outputs. The flip-flop toggles at the frame rate of the modulated signal and produces a square wave output at half the frame rate.

Another charge pump rectifies the square wave and produces a DC voltage that is negative with respect to the power supply common rail. This is the only negative polarity DC voltage on the

circuit board. It supplies DC power to the relay output power amplifier. Recall that the input to the power amplifier is a 5 kHz sine wave generated by the vital level detector. Hence, the power amplifier cannot produce an output unless it has both a sine-wave input signal (from the channel that vitally verifies input signal amplitude) and a negative DC voltage (from the channel that vitally decodes the bit pattern imposed on the signal by frequency modulation). If either condition is not true, then no relay drive voltage is produced. The power amplifier output is transformer-coupled (for DC isolation) to a half-wave rectifier and capacitive filter. The filtered DC output is then available to drive a vital relay.

The +12 volt power input is surge protected and filtered. It is regulated to +8 volts DC to provide power for most of the receiver analog circuits. Separate +5 volt DC regulators are provided for the dual channel decoders.

2.2.2 Frequency Response

Typical PSO III receiver frequency response curves are shown in figure 2-4. The PSO III transmitter frequency varies less than 0.1 percent with temperature changes.

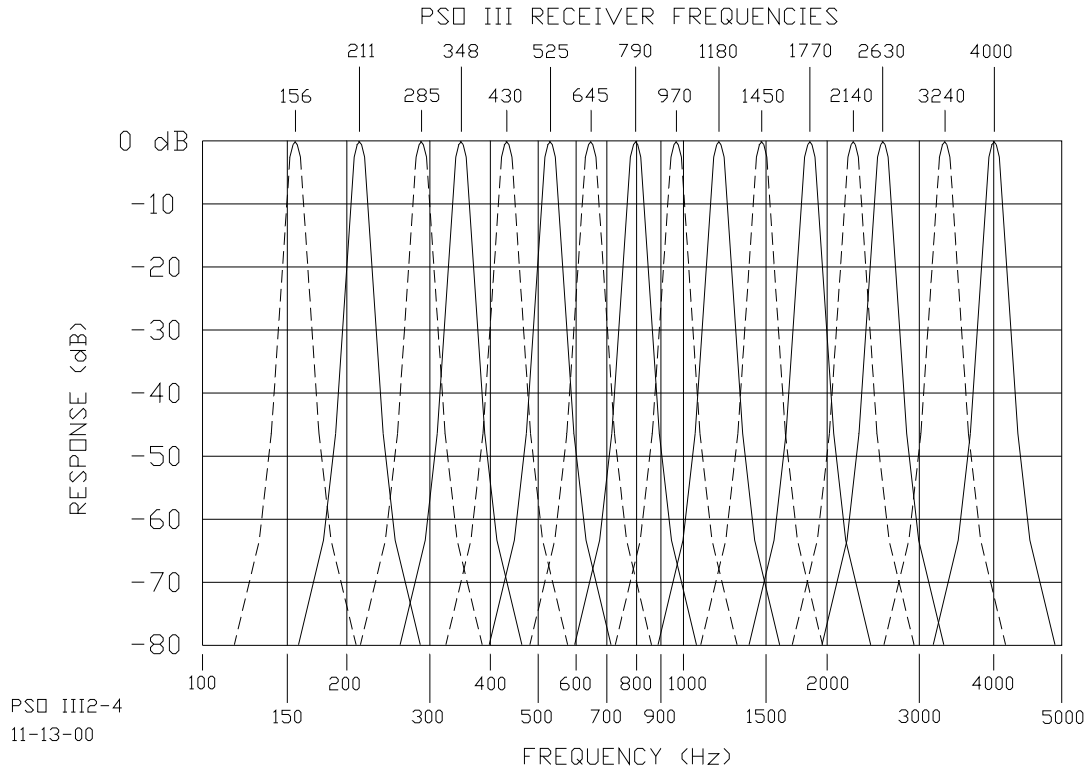


Figure 2-4
Typical Receiver Frequency Response Curves

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SECTION III

APPLICATION GUIDELINES

3.0 GENERAL

Application of PSO III track circuits should conform to the guidelines found in this section to ensure proper operation and trouble-free performance. Guidelines are provided for electrified and/or light rail operations as well as heavy rail applications. For special applications requiring additional information, contact Safetran™ Applications Engineering.

3.1 OPERATING DISTANCE

The operating distance at any PSO III 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. Various combinations of these factors are addressed in the following paragraphs.

3.1.1 0.06-Ohm Shunting Sensitivity And No Impedance Bonds

Table 3-1 indicates the recommended maximum PSO III operating distances at each operating frequency under the following conditions:

- Ballast resistance values of 2 ohms per 1,000 feet and 4 ohms per 1,000 feet
- 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.

3.1.2 0.2-Ohm Shunting Sensitivity And No Impedance Bonds

Maximum PSO III operating distance with 0.2-ohm shunting sensitivity and no impedance bonds in the circuit is 75% of the operating distance in table 3-1 for each frequency based on 2 ohms per 1000 feet of ballast resistance.

3.1.3 0.06-Ohm Shunting Sensitivity With Impedance Bonds

The maximum PSO III operating distance with 0.06-ohm shunting sensitivity and with impedance bonds in the circuit is 3000 feet based on ballast resistance of 2 ohms per 1000 feet. Useable PSO III frequencies are 645 through 4000 Hz.

Table 3-1
Maximum Operating Distances at Specific Ballast Resistances (0.06-ohm shunting sensitivity) – No Impedance Bonds In Circuit

Frequency (HZ)	Ballast Resistance 2 Ω/1,000 Ft. Operating Distance (Ft.)	Ballast Resistance 4 Ω/1,000 Ft. Operating Distance (Ft.)
156	9,000	12,500
211	7,900	11,100
285	6,900	9,800
348	6,300	9,000
430	5,800	8,000
525	5,300	7,400
645	4,700	6,600
790	4,300	6,100
970	3,900	5,500
1,180	3,700	5,200
1,450	3,300	4,600
1,770	3,000	4,200
2,140	2,600	3,800
2,630	2,400	3,300
3,240	2,100	3,000
4,000	2,000	2,800

3.1.4 0.2-Ohm Shunting Sensitivity With Impedance Bonds

The maximum PSO III operating distance with 0.2-ohm shunting sensitivity, with impedance bonds in the circuit, is 2000 feet based on ballast resistance of 2 ohms per 1000 feet. Usable PSO III frequencies under these conditions are 645 through 4000 Hz.

3.2 RECOMMENDED USE OF FREQUENCIES

3.2.1 Non-Electrified Track

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

3.2.2 Electrified Track

PSO III operating frequencies 645 through 4000 Hz should be used on electrified track.

3.3 FREQUENCY COMPATIBILITY GUIDELINES

1. Frequency Groups:

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

a) Non-Electrified Track Frequency Groups

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

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

b) Electrified Track Frequency Groups

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

Group 1 (Hz)	Group 2 (Hz)
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. Also, when all available frequencies have been used, adjacent frequencies can be intermixed provided the PSO III circuits are separated by a minimum of 1000 feet.

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

3. 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. 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 feet.

5. 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 III frequencies, the address coding scheme described in number 3 above (end-to-end track circuits) 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. The transmitter and receiver modules are stamped A ADD or C ADD (see paragraph 3.12).

NOTE

Unless otherwise specified, only "A" address transmitters and receivers are supplied.

6. 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 the group 1 frequencies on track number 2. Continue to alternate this pattern as required. For further details contact Safetran™ Application Engineering.

7. The IPI track circuit frequencies used in the Crossing Package and the PSO III frequencies are compatible with the exception of the four lowest IPI frequencies (4.00, 3.24, 2.63 and 2.14 kHz). These four IPI frequencies are generally not used in PSO III applications since they are duplicates of PSO III operating frequencies.

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

WARNING

USE OF INSULATED JOINT BYPASS COUPLERS ON ELECTRIFIED TRACK IS NOT RECOMMENDED

9. PSO III and 3000 MS/GCP frequency compatibility (see figure 3-1).

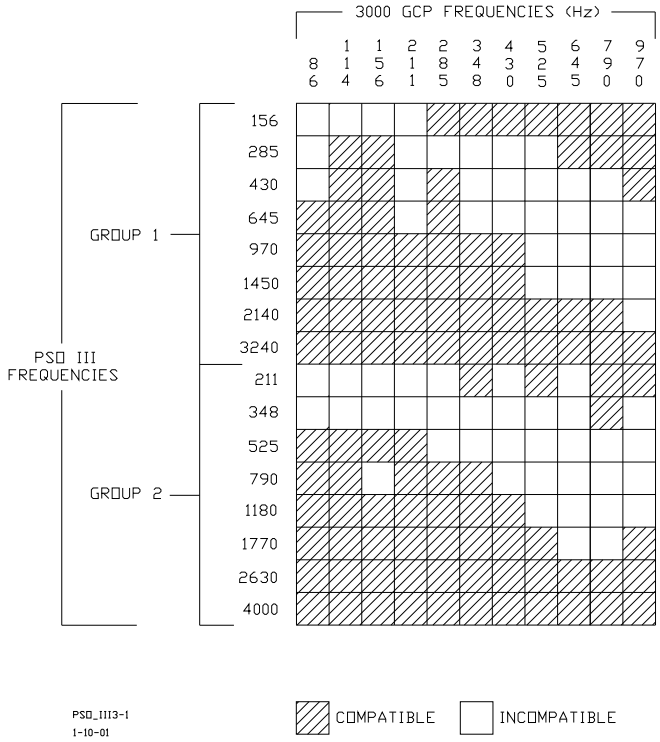
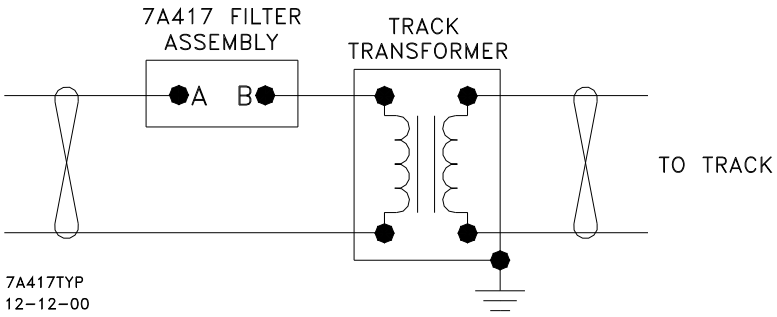


Figure 3-1
PSO III And 3000 MS/GCP Frequency Compatibility

3.4 PSO CAB SIGNAL FILTER, 7A417-X

PSO Cab Signal Filter, 7A417-X, is designed for use in 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 below. See Section V for further information.



3.5 MULTIPLE-RECEIVER APPLICATIONS (0.06-OHM SHUNTING SENSITIVITY ONLY)

A maximum of three receivers may be used on either side of a transmitter. When multiple receivers are used with a single transmitter, High Impedance Tuned Receiver Couplers, 7A366-f, must be used with the receiver(s) located nearest the transmitter. The receivers which are located farthest from the transmitter should use Tuned Receiver Couplers, 7A355A-f. When center-fed receivers are used, the receiver nearest the transmitter that is equipped with a 7A355A-f coupler must be no closer than 500 feet from the transmitter. See figure 8-2 for a typical application.

3.6 TRANSMITTER LINE APPLICATIONS

When it is desirable to transmit signals over dedicated line wire or buried cable to the track, a PSO Line Coupler, 7A388, must be used to couple the transmitter to the line and a Transmitter Line-to-Rail Coupler, 7A399-f, must be used to couple the line to the rail (see figure 8-4).

3.7 RECEIVER LINE APPLICATIONS

When open line or cable carries the signal from the rail to a distant receiver, Receiver Line-to-Rail Coupler, 7A377-f, is required to couple the track to the line and a PSO line coupler (7A388) is used to couple the line to the receiver. Total resistance of the line or cable pair must not exceed 100 ohms (see figure 8-3).

3.8 INSULATED JOINT BYPASS COUPLERS (NON-ELECTRIFIED RAIL ONLY)

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

1) Tuned Insulated Joint Bypass Coupler, 7A422-f, is used with PSO circuits (see figure 8-6).
2) Wideband Shunt, 8A076A, is acceptable for PSO operation when GCP's are being bypassed around insulated joints with wideband shunts.

WARNING

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

When using the 7A422-f coupler, insulated joint coupler connections should be made with number 9 AWG or larger copper wire and each wire should not exceed 100 feet in length. However, the shorter the wire length and the larger the wire size, the less PSO signal loss will occur at each insulated joint. For applications requiring coupler connections exceeding 100 feet in length, use number 6 AWG copper wire.

3.9 BATTERY CHOKE

When the PSO III track circuit includes a track battery, or a track battery is located within 500 feet of a PSO III track circuit that is not isolated by insulated joints, PSO Battery Choke, 7A360, is connected in series with the track battery. When GCP's or motion sensors are installed within PSO III circuits, Battery Choke, 8A065A, or Battery Choke, 62648, must be used in place of the 7A360 battery choke (see figure 8-7).

WARNING

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

3.10 SURGE PROTECTION

The PSO III incorporates built-in surge protection. However, primary surge protection must be installed on all AC power, battery, line, and track leads (see figure 8-9). In electrified territory, protection must be installed on track leads as shown in figure 8-10.

3.11 USE OF PSO III WITH PSO II EQUIPMENT

The PSO III receiver and transmitter units are compatible with the signal format and track levels of Safetran's PSO II receiver and transmitter units using the same address format. This means that a PSO III transmitter is capable of driving a track circuit containing a PSO II receiver, and that a PSO III receiver is capable of receiving and decoding a signal emanating from a PSO II transmitter. PSO III transmitter and receiver modules may also be used in the earlier PSO II cases with the same address format. However, the PSO III cases are electrically keyed to prevent the use of the PSO II modules in the newer PSO III cases. Table 3-2 indicates PSO III and PSO II interchangeability; that is, which modules will operate in each transmitter and receiver case. For example, the 7A400 PSO II transmitter case accepts either a PSO II (7A411) or PSO III (7A437) transmitter module.

3.12 PSO III MODULE FREQUENCY AND ADDRESS IDENTIFICATION

PSO III module operating frequencies are indicated on the bar code label affixed to the component side of each module. The frequency is identified by the last four digits of the 13-digit module EDP part number (e.g., 7000-7A436-0790 is a 790 Hz receiver module). The module address format is indicated on a label located adjacent to the module part number. See figure 3-2 for bar code (frequency) and address label locations.

Table 3-2
PSO II And PSO III Module/Case Interchangeability

System	Address Format	Module Type	Module Part Number	Assemblies (Cases)							
				PSO II				PSO III			
				A Address		C Address		A Address		C Address	
				7A400	7A405	7A420	7A425	7A438	7A439	7A451	7A453
PSO II	A Address	Receiver	7A416		X						
		Transmitter	7A411	X							
	C Address	Receiver	7A416-2				X				
		Transmitter	7A411-2			X					
PSO III	A Address	Receiver	7A436		X			X			
		Transmitter	7A437	X					X		
	C Address	Receiver	7A436-2				X				X
		Transmitter	7A437-2			X				X	

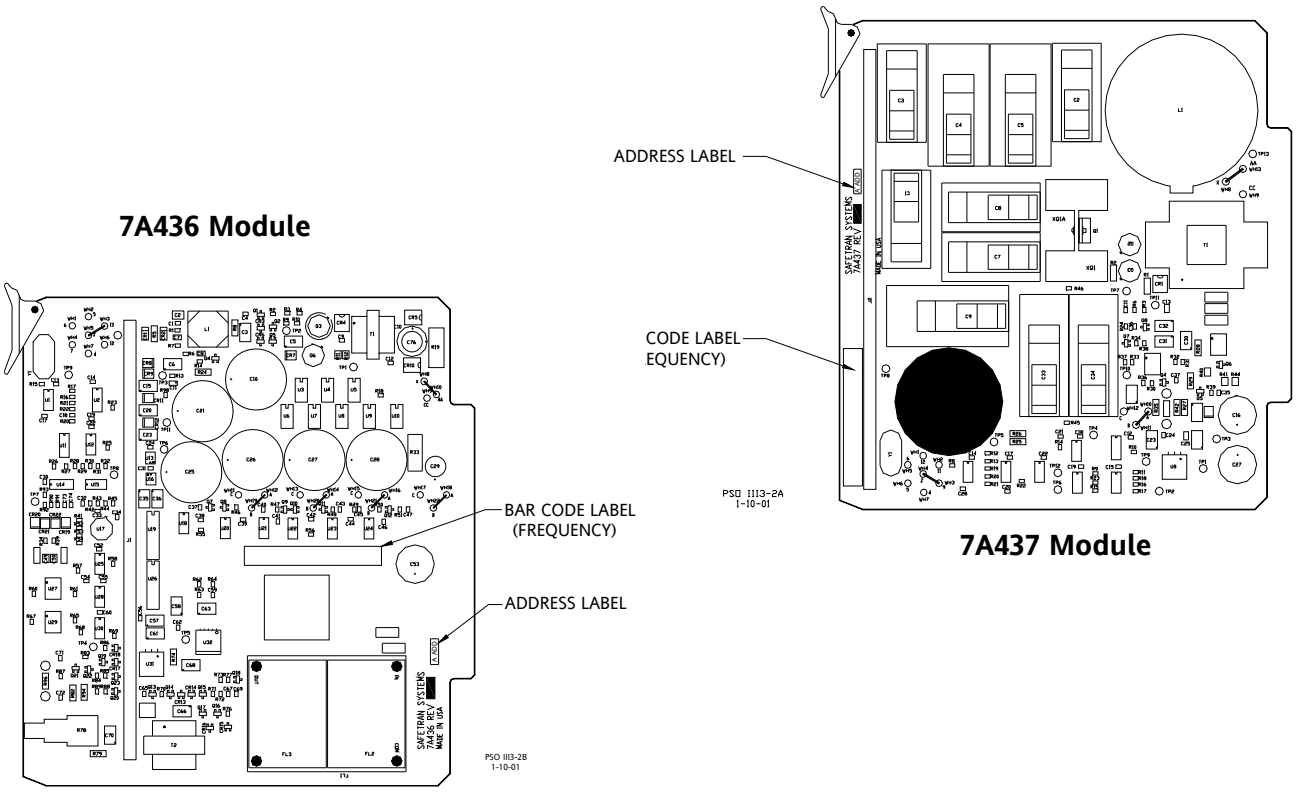


Figure 3-2
Address Code and Bar Code (Frequency) Label Locations, 7A436 And 7A437 Modules

SECTION IV

PSO III CROSSING PACKAGE

4.0 PSO III CROSSING PACKAGE OVERVIEW

The PSO III Crossing Package (figure 4-1) includes two receiver modules and a combination transmitter/ receiver island circuit module (62609) in a single case. The Crossing Package receiver modules are identical to those used in the 'standard' PSO III receiver assemblies and are described in Sections I and II. The island module used in the Crossing Package is Safetran's Intelligent Processor Island (IPI) module. The IPI module enables the system to supply a limited distance, frequency-shift-modulated, audio frequency track circuit with an effective range of up to 500 feet. While designated primarily for use as the island track circuit at highway crossings, the Crossing Package satisfies any application requiring a short, high-definition, audio frequency track circuit. See figure 8-5 for a typical PSO III Crossing Package installation.

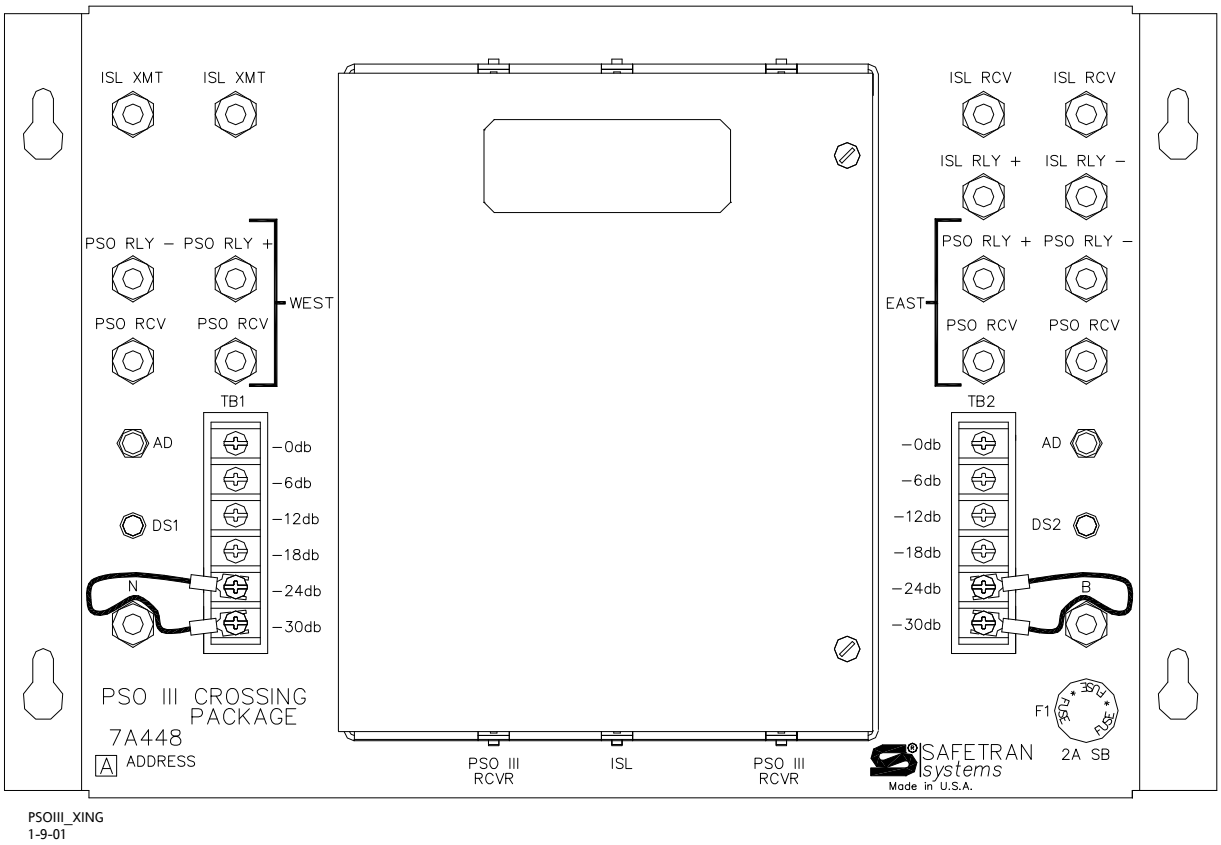


Figure 4-1
Phase Shift Overlay III Crossing Package, 7A448

4.0.1 Crossing Package Address Formats

The Crossing Package is available in either of two address formats ("A" or "C"). The "A" address format (part number 7A448) is standard and is intended for most PSO III Crossing Package applications. Unless specified otherwise at the time an order is placed for the Crossing Package, the "A" address is provided. The "C" address format (part number 7A455) is intended for use in applications involving a high-density mix of frequencies and multiple tracks. Except for minor differences to provide specific address operation, the "C" address units are identical to the "A" address units.

The Crossing Package cases and receiver modules are assigned specific part numbers according to the address format used. Refer to table 4-1 for part number assignments. Both cases and modules are also marked with decals that identify the address format used (e.g., "A ADDR" or "C ADDR"). The decals are located adjacent to the assembly part number on the cases and adjacent to the module part number on the component side of the receiver printed circuit modules.

Table 4-1
PSO III Assembly Part Numbers

Assembly	Assembly (Case) Part Number	"A" Address Receiver Modules Installed	"C" Address Receiver Modules Installed	Island Module
Crossing Package ("A" address)	7A448	7A436		62609
Crossing Package ("C" address)	7A455		7A436-2	62609

4.0.2 PSO III Crossing Package Front Panel Connectors And Indicators

Table 4-2 describes the functions of each of the front panel mounted connectors and indicators on the PSO III Crossing Package case. Refer to figure 4-1 for connector and indicator locations.

Table 4-2
PSO III Crossing Package Case Front Panel Connector And Indicator Functions

Front Panel Nomenclature	Description	Function
B	AREMA binding post	Positive battery connection
N	AREMA binding post	Negative battery connection
ISL XMT	AREMA binding posts	Island module transmitter output terminals
WEST PSO RLY +/-	AREMA binding posts	West receiver (receiver #1) output to West polar track relay
WEST PSO RCV	AREMA binding posts	West receiver (receiver #1) input connections from track via an external coupling device such as a 7A355A Tuned Receiver Coupler

Continued on next page

Table 4-2 (concluded)

TB1 (0dB, -6dB, -12dB, -18dB, -24dB, -30Db)	Terminal strip	West receiver (receiver #1) sensitivity strapping terminals -- one end of strap always connected to –30dB terminal
AD1	Test Jack	Amplitude detector test jack used during West receiver (receiver #1) adjustment procedure
DS1	LED	Relay drive indicator that lights when West receiver (receiver #1) PSO RLY output is energized
ISL RCV	AREMA binding posts	Island module receiver input terminals
ISL RLY +/-	AREMA binding posts	Output to polar island (crossing) relay
EAST PSO RLY +/-	AREMA binding posts	East receiver (receiver #2) output to East polar track relay
EAST PSO RCV	AREMA binding posts	East receiver (receiver #2) input connections from track via an external coupling device such as a 7A355A Tuned Receiver Coupler
TB2 (0dB, -6dB, -12dB, -18dB, -24dB, -30Db)	Terminal strip	East receiver (receiver #2) sensitivity strapping terminals -- one end of strap always connected to –30dB terminal
AD2	Test Jack	Amplitude detector test jack used during East receiver (receiver #2) adjustment procedure
DS2	LED	Relay drive indicator that lights when East receiver (receiver #2) PSO RLY output is energized
2A/SB	Fuse holder	2-ampere slow blow fuse for positive battery input

4.1 ISLAND CIRCUIT (INTELLIGENT PROCESSOR ISLAND (IPI), 62609)

The Intelligent Processor Island (IPI) is a single-board, microprocessor-based, multi-frequency, modulated, short-range track occupancy detector. It is frequency programmable via an on-board jumper and provides a simple automated process for calibration of the track circuit. An on-board four-character alphanumeric display indicates the selected operating frequency plus calibration process status and diagnostic troubleshooting codes.

The IPI is designed to detect poor shunting conditions in the IPI track circuit. If poor shunting is detected, the IPI initiates an internal loss-of-shunt timer that prevents relay drive from energizing during the poor-shunting episode.

4.1.1 Island Circuit Operating Modes

The IPI module operating modes are identified in table 4-3.

Table 4-3
IPI Module Operating Modes

Mode	Description	Comments
Initialization (includes Power Up & Soft Reset)	Boots the IPI to full operation, then transfers control to the next appropriate mode. During initialization, the IPI relay drive is held deenergized	This mode is selected automatically at power-up or after calibration occurs
Operating	Monitors the track and deenergizes relay drive when the circuit is occupied	IPI enters this mode automatically following successful initialization
Calibration	Used to establish shunting sensitivity level. Relay drive is held deenergized during calibration	User selectable via Calibration Select push button (figure 4-2)
Failure Processing	Determines health of the IPI. Processes error codes and transitions the IPI to the initialization mode or calibration mode as appropriate	Activates automatically if irregularity detected in either software or hardware

4.1.2 IPI Module Controls & Indicators

The IPI module is inserted in a card edge connector in the Crossing Package case. Located at or near the front edge of the module are various controls and indicators and an ejector lever which is attached to the top front corner. The controls and indicators are identified in figure 4-2 and described in the following paragraphs.

4.1.2.1 STATUS (Relay Drive) Indicator

The STATUS indicator is located immediately below the ejector lever and is identified by the label "STATUS" on the board surface adjacent to the indicator. During normal operation, the STATUS indicator is lit steady, but extinguishes to provide indication of track occupancy. If a module failure occurs, the STATUS indicator flashes at a fast rate (8 Hz) to indicate a failure.

4.1.2.2 ACTIVITY Indicator

The ACTIVITY indicator is located immediately below the STATUS indicator and is identified by the label "ACTIVITY" on the board surface adjacent to the indicator. It provides an indication of system operation and CPU activity. When the IPI is in the operate mode, the ACTIVITY indicator flashes at a slow rate (1 Hz). It does not flash during initialization, calibration, or if a module failure occurs.

4.1.2.3 Alphanumeric Display

A four-character alphanumeric display provides a variety of messages. These messages and the length of time they remain on the display are shown in table 4-4. The display also provides error codes (see table 4-5) which generally indicate an IPI module hardware failure.

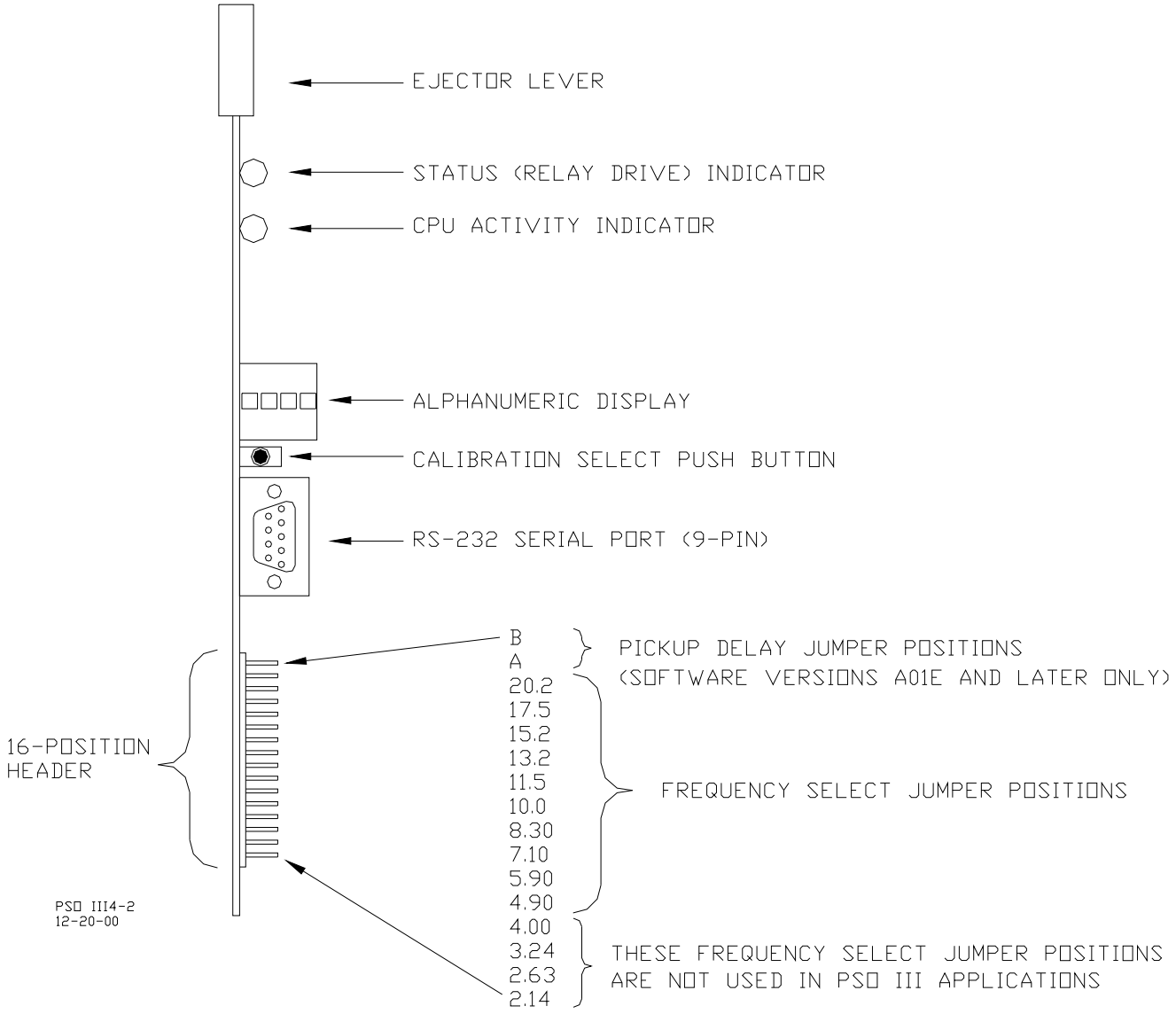


Figure 4-2
IPI Module Control And Indicator Locations

Table 4-4
IPI Display Messages

Message(s) Displayed	Length Of Time Message(s) Displayed	Comments
BOOT	9 seconds	Appears when IPI is powered up, at the end of the automated calibration process, and after any IPI errors are corrected
Software version display ... Example: **A01E**	5 seconds	Appears once the BOOT process is complete
REL (release)	2 seconds	Appears after calibration select push button is pressed and held for 2 seconds to initiate automated calibration
CAL*	4 seconds	Appears during automated calibration **NOTE** The asterisk symbol (*) in the CAL* message is actually a rotating bar that indicates calibration in progress.
DONE	Momentary	Appears momentarily at the end of the calibration process indicating that calibration is complete. The IPI then starts the BOOT process
ARMD (armed)	2 seconds	Appears while the IPI is initiating the calibration process. It appears following REL on the display once the calibration select push button is released, and indicates that the automated calibration process is armed or ready to be started
Actual operating frequency ..... example: **10.0** Pickup Delay Time Setting . example: **PU+4** (example indicates pickup delay of 4 seconds)	**For software level A01D and earlier:** Frequency only displayed indefinitely **For software level A01E and later:** Frequency alternates with pickup delay time. Frequency displayed for 8 seconds, then pickup delay setting for 2 seconds	Appears and remains on the display following successful completion of the IPI calibration, and indicates that the IPI is operational (no internal problems) and ready for in-service operation **WARNING** **THE IPI MUST ALWAYS BE RECALIBRATED FOR THE CROSSING IT CONTROLS PRIOR TO PLACING IT IN SERVICE.**

Continued on next page

Table 4-4 (concluded)

Message(s) Displayed	Length Of Time Message(s) Displayed	Comments
FAIL	Remains until calibration select push button is pressed and calibration tried again	Appears if automated calibration process does not run to completion. Calibration should be retried if FAIL appears.
CALR	Flashes intermittently	Appears if frequency jumper has been moved to a new frequency selection on 16-position header, but the IPI has not been recalibrated for the new frequency.
FRQ?	Flashes intermittently	This indicates that the frequency selection jumper has come off or that there is more than one frequency selected on the 16-position header.
SIG (signature)	Momentary	A status message that appears whenever on-frequency interference is sufficiently high to prevent the IPI modulation signature signal from being decoded on the IPI module.
LOS	Approximately 10 seconds	Appears whenever the IPI detects a loss of train shunting in the island.

Table 4-5
IPI Internal Failure Error Codes

Error Code	Error Description	Action Indicated
BATT	Battery voltage out of range	Check battery condition
CALC	Calibration parameters are corrupted.	Try recalibration. If the problem persists, replace the IPI module.
CRIT	Critical check failure	If the problem persists, replace the IPI module.
GB	Guard Band failure	If the problem persists, replace the IPI module.
HWSW	Hardware/Software incompatibility.	If the problem persists, replace the IPI module.
IRO	Island Relay Output failure	If the problem persists, replace the IPI module.
ISRX	Interrupt Service Routine failure	If the problem persists, replace the IPI module.
PHLT	Programmed Halt	If the problem persists, replace the IPI module.
PIRO	Primary Island Relay Output waveform failure	If the problem persists, replace the IPI module.

Continued on next page

Table 4-5 (concluded)

Error Code	Error Description	Action Indicated
PS_I	Intermediate power supply output incorrect	If the problem persists, replace the IPI module.
PS5A	5-volt analog supply output incorrect	If the problem persists, replace the IPI module.
PS5D	5-volt digital supply output incorrect	If the problem persists, replace the IPI module.
PS25	Internal reference supply voltage incorrect	If the problem persists, replace the IPI module.
RAM	RAM failure	If the problem persists, replace the IPI module.
ROM	ROM failure	If the problem persists, replace the IPI module.
SIRO	Secondary Island Relay Output waveform failure	If the problem persists, replace the IPI module.
STKG	Guardband error	If the problem persists, replace the IPI module.
STKP	Stack Pointer has exceeded its limits	If the problem persists, replace the IPI module.
TIME	Time comparisons failure	If the problem persists, replace the IPI module.
XCPT	Exception failure	If the problem persists, replace the IPI module.
PASS	All internal errors have been corrected	none

4.1.2.4 Calibration Select Push Button

The push-button switch located immediately below the alphanumeric display is used in conjunction with the display to initiate IPI calibration.

4.1.2.5 RS-232 Serial Port Connector

The 9-pin, female, D-type connector, located immediately below the calibration select push button, provides the RS-232 serial interface for downloading a new software revision from a PC to the IPI.

4.1.2.6 16-Position Header - Frequency Selection

The 16-position header located below the RS-232 serial port permits selection of the IPI frequency (see figure 4-3). Each of the lower 14 header positions corresponds to a different IPI operating frequency and consists of a pair of pins. Frequency selection is made by placing a jumper (shorting block) across the appropriate pair of pins. If the shorting block is moved to a new frequency select position, the operating frequency of the IPI does not change until the IPI is recalibrated (CALR appears on the display to indicate that calibration is required).

Each IPI module is furnished with one shorting block for frequency selection. Placement of the frequency select shorting block is generally done at the time of calibration. Header positions for frequency selection are labeled on the board surface adjacent to the header and are identified on figure 4-3. All indicated frequencies are in kilohertz (kHz).

NOTE

The lower four IPI frequencies (2.14, 2.63, 3.24 and 4.00 kHz) are not used for PSO III applications.

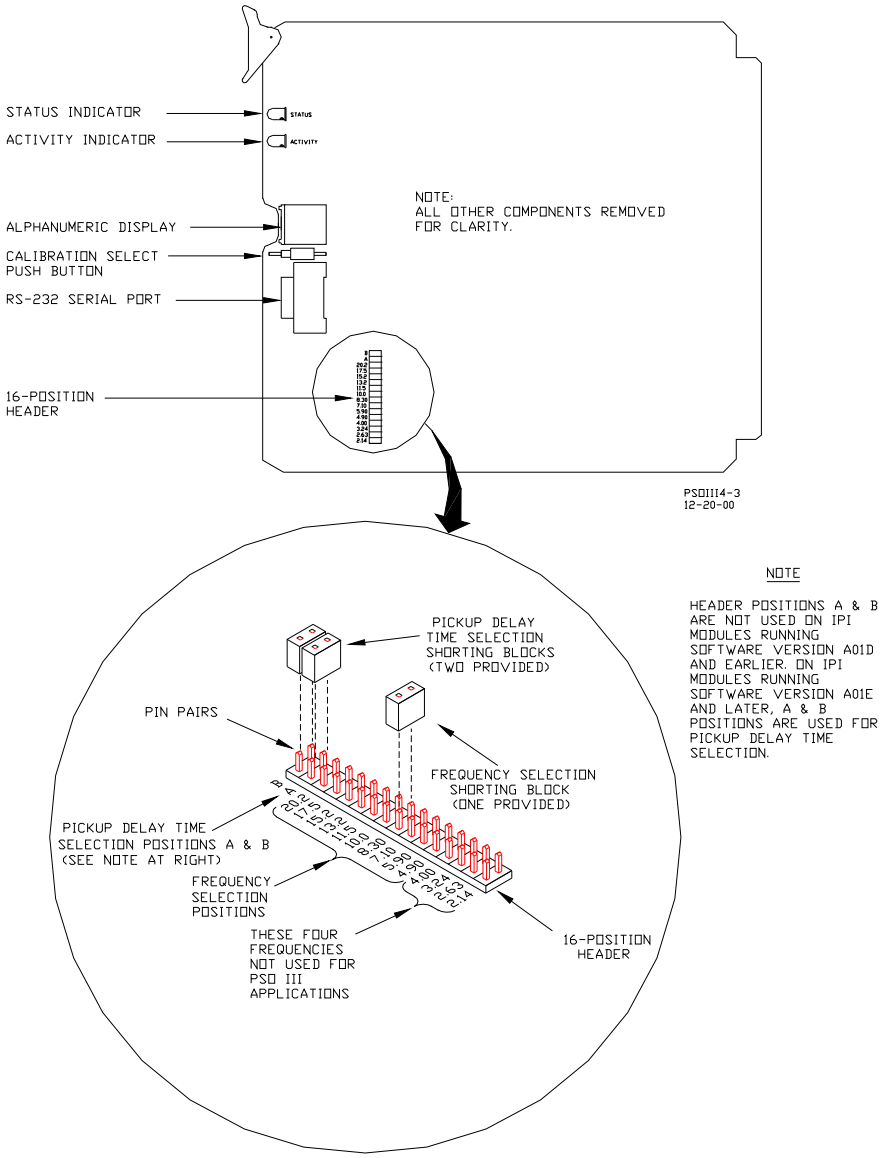


Figure 4-3
Jumper Positions On 16-Position Header

4.1.2.7 16-Position Header - Pickup Delay Time Selection (software level A01E and later only)

On IPI modules running software version A01E or later, positions A and B of the 16-position header permit selection of additional pickup delay time if required (see Section VII). Each IPI module is furnished with two shorting blocks for pickup delay selection (figure 4-3). Following any change of the pickup delay jumper(s), the IPI must be recalibrated in order to store the new pickup delay time value and make it active.

The pickup delay time setting appears on the IPI display alternating with the frequency display. The frequency is displayed for 8 seconds followed by the pickup delay time for 2 seconds. The format of the pickup delay time display is as follows:

Pickup Delay Time	IPI Display
No delay	PU+0
2-seconds	PU+2
4-seconds	PU+4
6-seconds	PU+6

The pickup delay feature is not available on IPI modules running software version A01D or earlier (software version identified on IPI display for approximately 5 seconds at power up). Therefore, positions A and B are not used with the earlier software.

NOTE

Only one frequency selection jumper is allowed. A missing frequency jumper, or two or more frequency jumpers, render an invalid selection.

NOTE

Modules running IPI software version A01E and later are supplied with two pickup delay time selection jumpers.

4.1.3 IPI Firmware Updates

The operating program for the IPI module is contained in a flash memory device located on the module. When revisions to the operating program are issued by Safetran Systems Corporation™, the flash device firmware is updated by simply downloading the new program from a PC to the IPI via the RS-232 serial port (see paragraph 4.1.2.5). Instructions for installing new software will be provided by Safetran™ when a new software revision level is issued.

4.2 USING PSO III CROSSING PACKAGE EQUIPMENT WITH PSO II CROSSING SYSTEM

The PSO III Crossing Package is compatible with the signal format and track levels of Safetran's PSO II crossing system using the same address format. This means that a PSO III transmitter is capable of driving a crossing system containing a PSO II receiver, and that a PSO III receiver in the Crossing Package is capable of receiving and decoding a signal emanating from a PSO II transmitter. PSO III receiver modules may also be used in the earlier PSO II crossing system cases with the same address format. However, the PSO III Crossing Package cases are electrically keyed to prevent the use of the PSO II modules in the newer PSO III cases.

Island modules used in the PSO II and PSO III units are interchangeable. However, the 62509 island module used in the PSO II crossing system is frequency specific.

Table 4-6 indicates PSO III Crossing Package and PSO II crossing system interchangeability.

Table 4-6
PSO II Crossing System And PSO III Crossing Package Module/Case Interchangeability

System	Address Format	Module Type	Module Part Number	Assemblies (Cases)			
				PSO II Crossing System		PSO III Crossing Package	
				A Address	C Address	A Address	C Address
				7A408	7A428	7A448	7A455
PSO II	A Address	Receiver	7A416	X			
	C Address	Receiver	7A416-2		X		
		Island	62509	X	X	X	X
PSO III	A Address	Receiver	7A436	X		X	
	C Address	Receiver	7A436-2		X		X
		Island	62609	X	X	X	X

4.3 CROSSING PACKAGE SPECIFICATIONS

Input Power:

Voltage	9-16.5 VDC
Current	1.3 A (nominal)

Transmitter Output Current: 0.2 ampere (maximum)

Microprocessor: Motorola 68332

Relay Drive Output: 400 to 1000-ohm load

Specifications continued

Island Frequencies:	4.9 kHz	10.0 kHz	17.5 kHz
	5.9 kHz	11.5 kHz	20.2 kHz
	7.1 kHz	13.2 kHz	
	8.3 kHz	15.2 kHz	

NOTE

The 62609 island module provides jumper positions for selecting the island frequencies 4.00, 3.24, 2.63 and 2.14 kHz. However, these frequencies are not used in PSO III applications.

Track Circuit Length: Determined by track wire connections (50 – 500 ft.)

Surge Protection: Secondary protection built-in, Primary protection required on all external lines

Environmental (Temperature): -40 °F to +160 °F (-40 °C to +71 °C)

Island Pickup Delay Time: Field programmable - 0, 2, 4, 6 seconds (IPI software version A01E and later only)

Dimensions: 11 inches high (27.94 centimeters)
14.38 inches wide (36.52 centimeters)
9.50 inches deep (24.13 centimeters)

Shipping Weight: 16 pounds (7.26 kilograms)

4.4 ORDERING INFORMATION

Unit Description	Address Format	Part Number
PSO III Crossing Package with island	"A" address	7A448-f1-f2-IPI
PSO III Crossing Package with island	"C" address	7A455-f1-f2-IPI

f1 = Frequency of receiver number 1
f2 = Frequency of receiver number 2
IPI = IPI Island Module included

SECTION V

AUXILIARY EQUIPMENT

5.0 GENERAL

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

CAUTION

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

Paragraph	Equipment Covered	Paragraph	Equipment Covered
5.1	62648, Battery Choke	5.3	7A399-f, PSO Transmitter Line-to-Rail Coupler (1)
5.2	7A355A-f, Tuned Receiver Coupler (1)	5.4	7A403, Line Overlay Coupler
5.1	7A360, PSO Battery Choke	5.8	7A417-X, PSO Cab Signal Filter (2)
5.2	7A366-f, High Impedance Tuned Receiver Coupler (1)	5.5	7A418, Battery Line Filter
5.3	7A377-1-f, PSO Receiver Line-to-Rail Coupler (1)	5.6	7A422-f, Tuned Insulated Joint Bypass Coupler (1)
5.3	7A388, PSO Line Coupler	5.1	8A065A, Battery Choke

(1) **-f** following part number indicates unit is frequency specific - use appropriate PSO III frequency

(2) **-X** following part number indicates dash number options are available

5.1 BATTERY CHOKES 62648, 7A360 AND 8A065A

PSO Battery Choke, 7A360, is used in series with connections to the rail of any track battery within the track circuit. Suitable substitutions for the 7A360 choke are the 8A065A and 62648 battery chokes (figure 8-7).

WARNING

WHERE GCP'S OR MOTION SENSORS ARE INSTALLED WITH THE PSO III, 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).

Each of the battery chokes consists of a large inductor and a set of AREMA binding posts on a mounting base (see figures 5-1 and 5-2 for mounting dimensions).

Specifications for the 7A360 PSO Battery Choke 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)

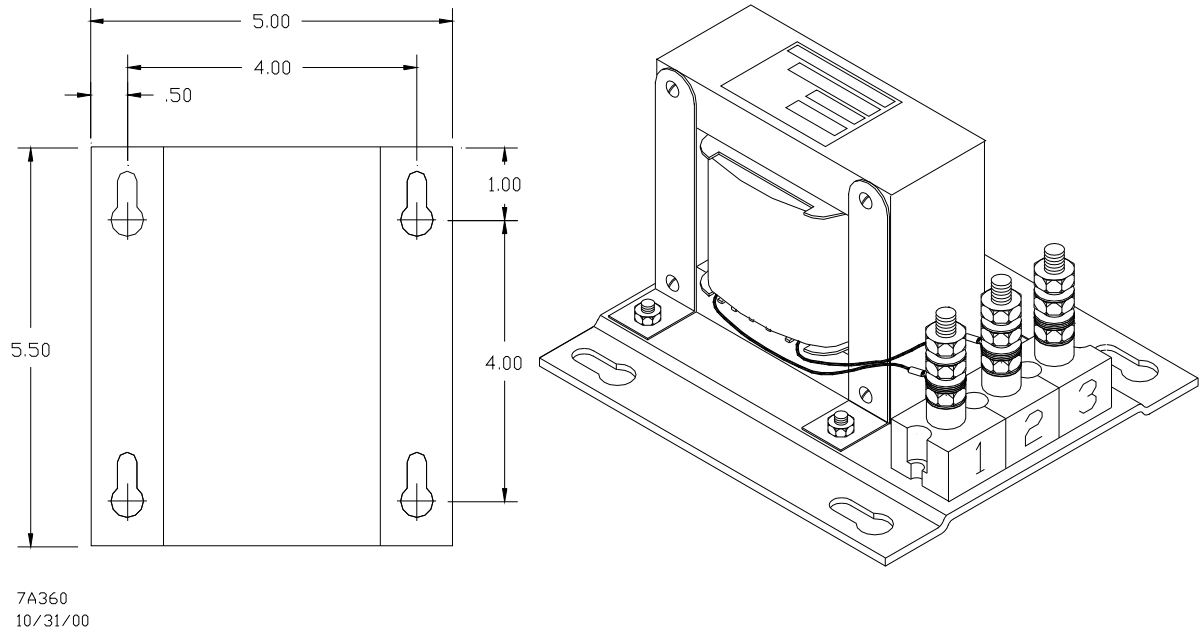


Figure 5-1
7A360 PSO Battery Choke With Mounting Dimensions

Specifications for the 62648 and 8A065A Battery Chokes 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)

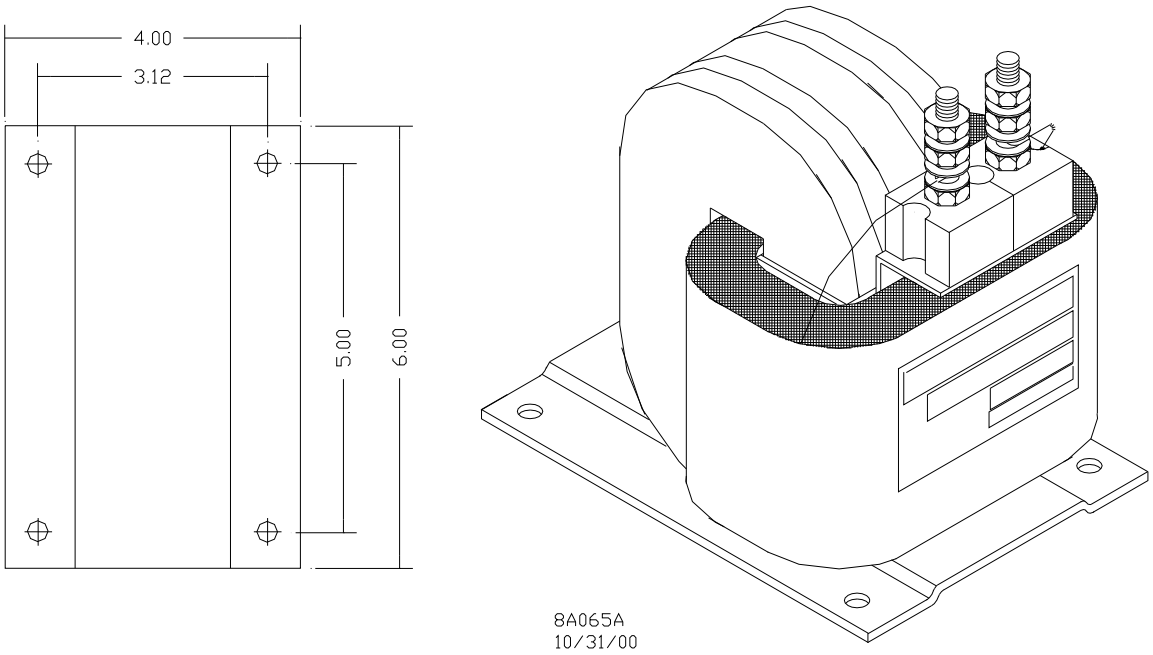


Figure 5-2
62648/8A065A Battery Choke With Mounting Dimensions

5.2 TUNED RECEIVER COUPLERS, 7A355A-F AND 7A366-F

Tuned Receiver Couplers, 7A355A-f and 7A366-f, couple the PSO III signal from the track to the receiver. The 7A355A-f coupler provides a low (0.6 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 7A366-f coupler provides an input impedance of 5 ohms, enabling other receivers on the track to be operated from the same transmitter. Either coupler must always be of the same frequency as the receiver (see figure 8-2).

Each coupler assembly consists of a tubular ABS plastic enclosure with mounting brackets at the base. Protruding from the top of each assembly are four AREMA binding posts that provide connections to the circuits housed within the sealed unit (see figure 5-3).

Specifications for the 7A355A-f and 7A366-f Tuned Receiver Couplers are as follows:

Diameter	3.5 inches (8.89 centimeters) O.D.
Height	7.75 inches (17.15 centimeters) (to top of AREMA binding posts)
Weight	3.5 pounds (1.59 kilograms) (approximate)

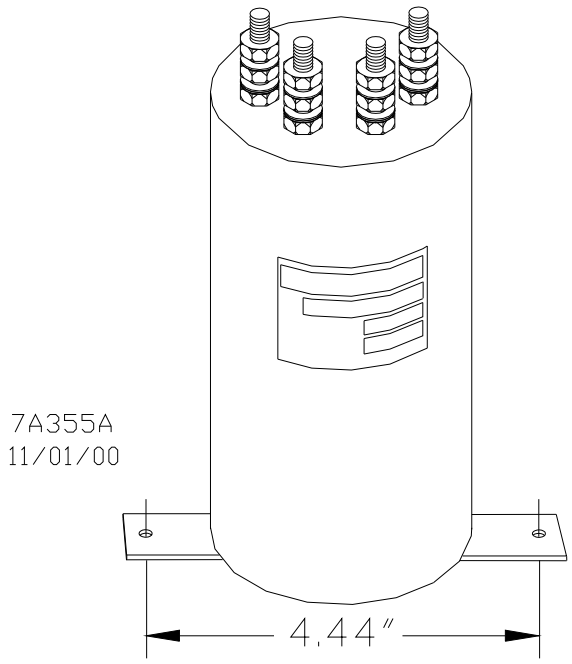


Figure 5-3
Tuned Receiver Couplers, 7A355A-f And 7A366-f

5.3 LINE-TO-RAIL/RAIL-TO-LINE COUPLERS, 7A377-1-F, 7A388, AND 7A399-F

Receiver Line-To-Rail Coupler, 7A377-1-f, provides line-to-rail coupling when the receiver is remotely located from the rail connections. The 7A388 Line-To-Receiver Coupler provides transmitter-to-line coupling or line-to-receiver impedance matching. The 7A399-f Transmitter Line-To-Rail Coupler is used to couple a transmitter line to the track (see figures 8-3 and 8-4).

The 7A377-1-f coupler assembly consists of a tubular ABS plastic enclosure with mounting plates extending from each end. Protruding from the top of the assembly are two #6 AWG wires marked "Rail" and two #10 AWG wires marked "Line" (see figure 5-4).

Specifications for the 7A377-1-f Receiver Line-To-Rail Coupler are as follows:

Diameter	3.5 inches (8.89 centimeters) O.D.
Height	9.5 inches (24.13 centimeters)
Weight	8 pounds (3.63 kilograms) (approximate)
Leads	10 feet (304.8 centimeters); two #6 AWG and two #10 AWG, stranded, black PVC

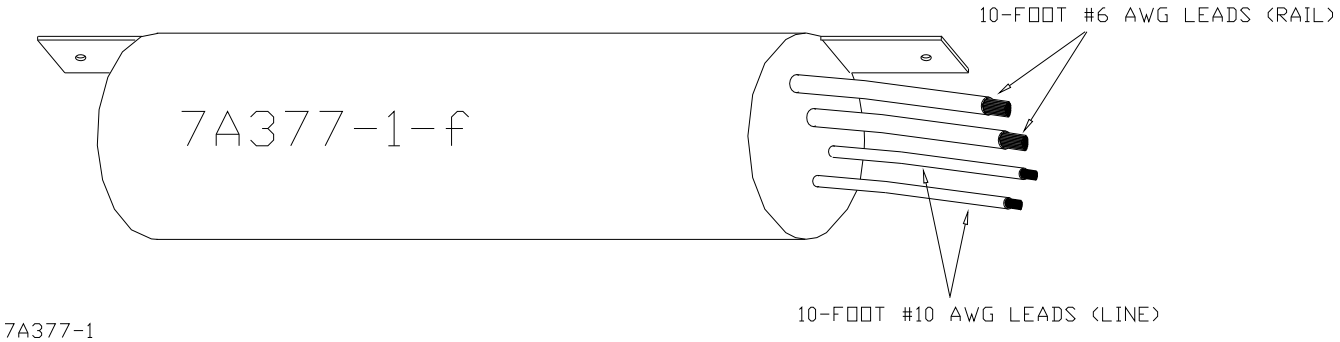


Figure 5-4
Receiver Line-To-Rail Coupler, 7A377-1-f

The 7A388 and 7A399-f coupler assemblies each consist of a tubular ABS plastic enclosure with mounting brackets at the base. Protruding from the top of each assembly are four AREMA binding posts that provide connections to the circuits housed within the sealed units (see figure 5-5).

Specifications for the 7A388 Line-To-Receiver Coupler and the 7A399-f Transmitter Line-To-Rail Coupler are as follows:

7A388		**7A399-f**	
Diameter:	3.5 inches (8.89 centimeters) O.D.	Diameter:	3.5 inches (8.89 centimeters) O.D.
Height:	10.75 inches (27.30 centimeters) (to top of AREMA binding posts)	Height:	8.75 inches (22.23 centimeters) (to top of AREMA binding posts)
Weight:	6 pounds (2.72 kilograms) (approximate)	Weight:	4 pounds, 12 ounces (2.16 kilograms) (approximate)

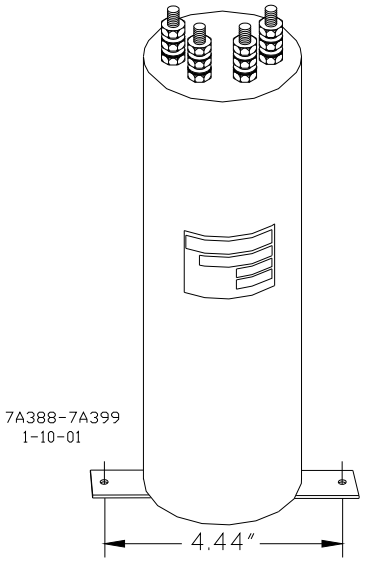


Figure 5-5
Typical of Line-To-Receiver Coupler, 7A388, and Transmitter Line-To-Rail Coupler, 7A399-f

5.4 LINE OVERLAY COUPLER, 7A403

Control for additional signal aspects can be provided by overlaying a PSO III frequency on two-wire signal HD line circuits. PSO III 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, coupling between line circuits at intermediate signals.

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

The coupler assembly consists of a tubular ABS plastic enclosure with mounting brackets at the base. Protruding from the top of the assembly are four AREMA binding posts that provide connections to the circuits housed within the sealed unit (see figure 5-6).

Specifications for the 7A403 PSO Line Overlay Coupler are as follows:

Diameter	3.5 inches (8.89 centimeters) O.D.
Height	8.25 inches (20.96 centimeters) (to top of AREMA binding posts)
Weight	5 pounds (2.27 kilograms) (approximate)

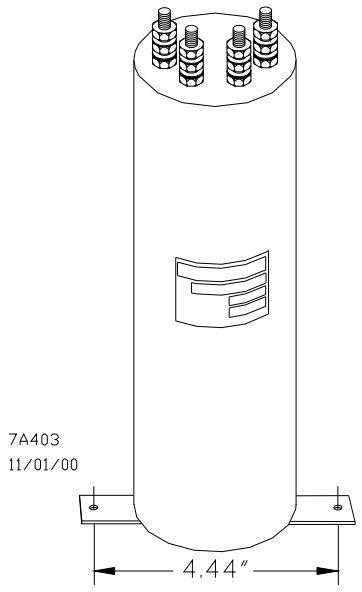
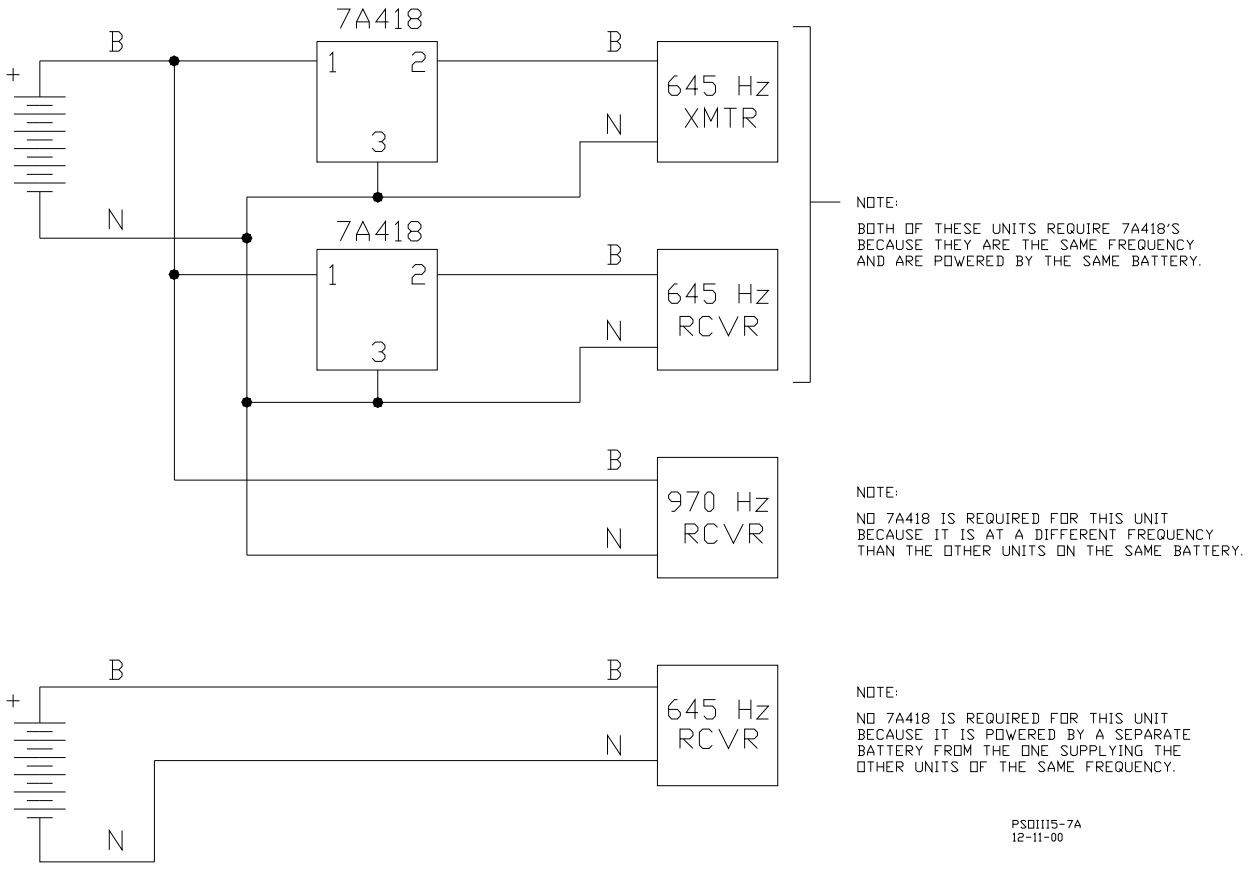


Figure 5-6
PSO Line Overlay Coupler, 7A403

5.5 BATTERY LINE FILTER, 7A418

Battery Line Filter, 7A418, provides decoupling between the battery and PSO III transmitter and receiver and is recommended in high noise/ripple environments. In track circuits where the transmitter and receiver 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).



The 7A418 filter assembly consists of a large choke coil, a capacitor, and a set of AREMA binding posts on a mounting base. See figure 5-7 for mounting dimensions.

Specifications 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)

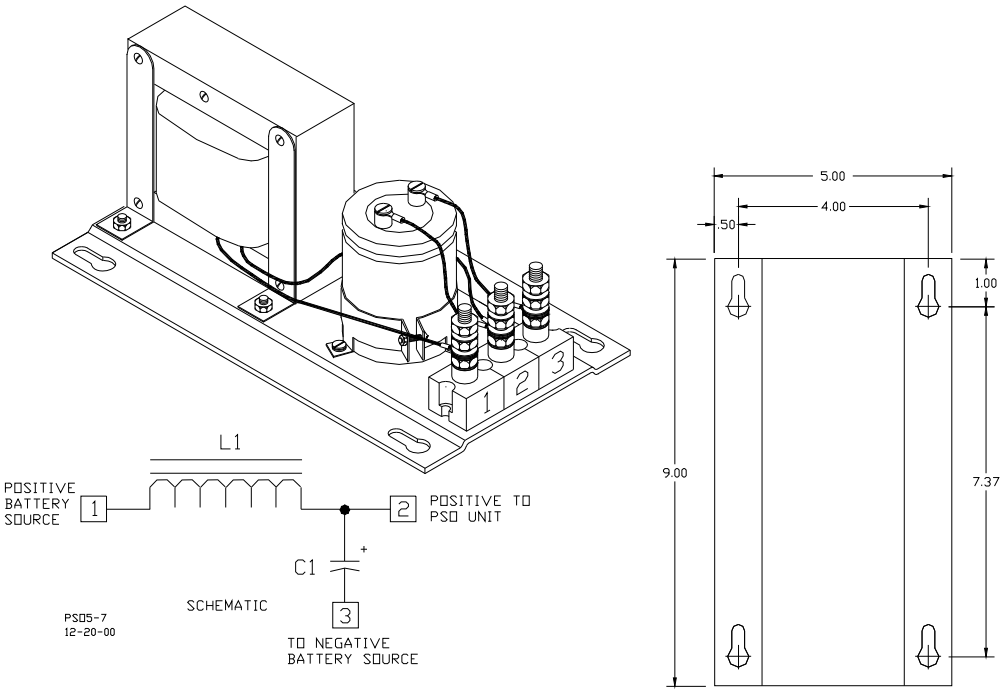


Figure 5-7
Battery Line Filter, 7A418, With Mounting Dimensions

5.6 TUNED INSULATED JOINT BYPASS COUPLER, 7A422-F

Tuned Insulated Joint Bypass Coupler, 7A422-f, is tuned to pass a specific PSO III frequency around an insulated joint in non-electrified territory.

WARNING

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

The coupler assembly consists of a tubular ABS plastic enclosure with mounting brackets at the base. Protruding from the top of the assembly are four AREMA binding posts that provide connections to the circuits housed within the sealed unit (see figure 5-8).

Specifications for the 7A422-f Tuned Insulated Joint Bypass Coupler are as follows:

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

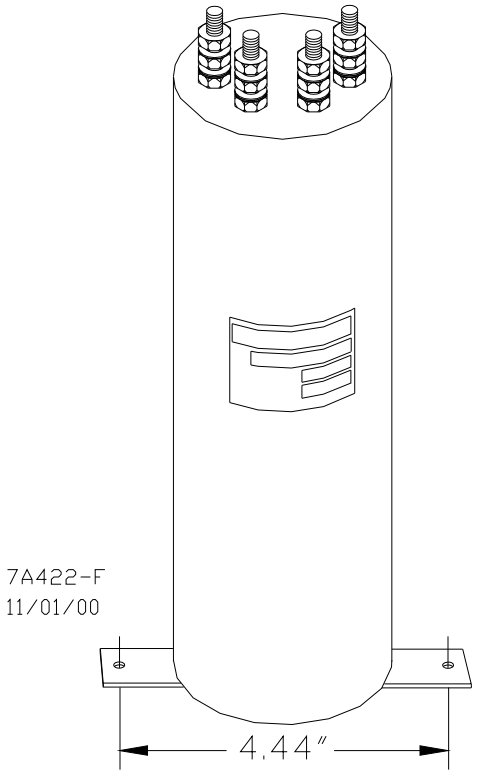
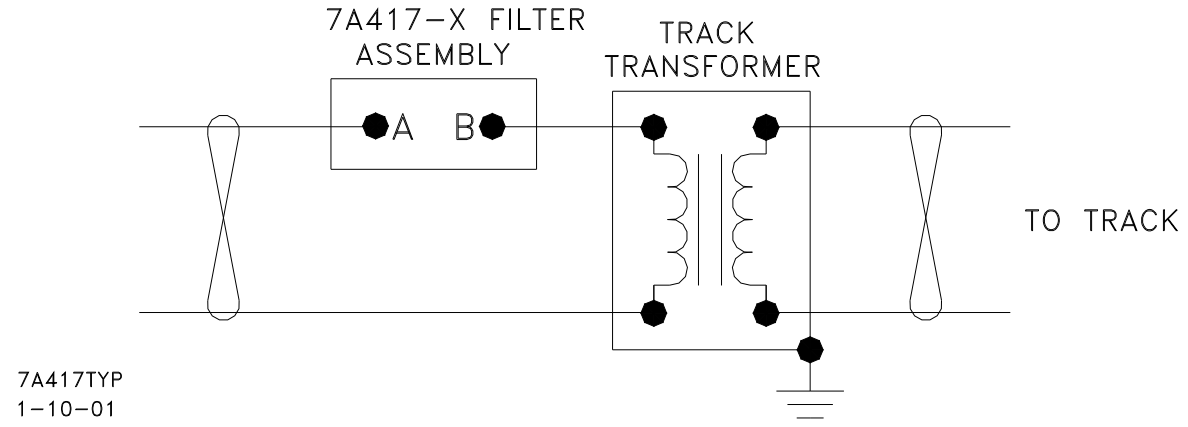


Figure 5-8
Tuned Insulated Joint Bypass Coupler, 7A422-f

5.7 PSO CAB SIGNAL FILTER, 7A417-X

PSO Cab Signal Filter, 7A417-X, is designed for use in 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 below.



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 figure 5-9 for mounting dimensions.

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.	-02	-12	-22	-32
Safetran™	-03	-13	-23	-33

Specifications for the 7A417-X PSO Cab Signal Filter assembly are as follows:

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

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

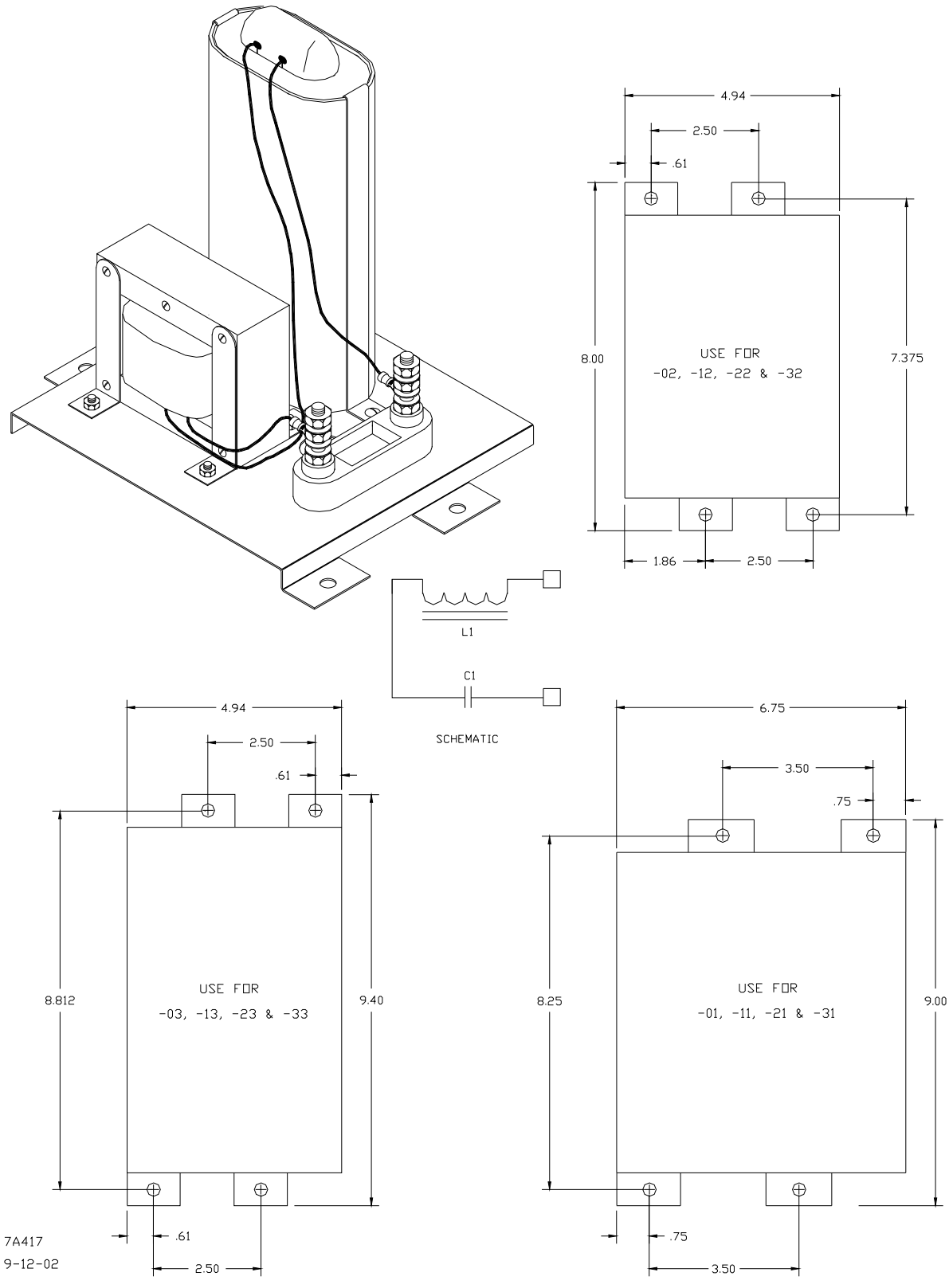


Figure 5-9
PSO Cab Signal Filter, 7A417-X, With Mounting Dimensions

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SECTION VI

INSTALLATION PROCEDURES

6.0 GENERAL REQUIREMENTS

It is recommended that this entire section be read before installation of the PSO III is started and then reference may be made to applicable paragraphs as required. Figure 6-1 depicts a typical PSO III installation.

6.1 WIRING

6.1.1 AC Power

To minimize interference, all AC power lines in the instrument case should be twisted pairs and separated from the PSO III signal wires as much as practical.

6.1.2 Battery Wiring

Battery wiring to the PSO III equipment should be number 10 AWG or larger and twisted in pair. When the transmitter and receiver(s) are operated from the same battery, the B and N wires must run directly to the battery bus terminals in the enclosure.

6.1.3 Case Wiring

Case wiring to the PSO III equipment should be number 16 AWG or larger, unless otherwise specified.

6.1.4 Track Wiring

Equipment connections to the rails should be as short as practical (preferably less than a 100-foot pair) and should be number 9 AWG or larger insulated copper wire. For lengths of 100 to 300 feet, use number 6 AWG. If lengths exceed 300 feet, Receiver Rail-To-Line Coupler, 7A377, or Transmitter Rail-To-Line Coupler, 7A399, should be used. Track wires may be plug connected or welded to the rails.

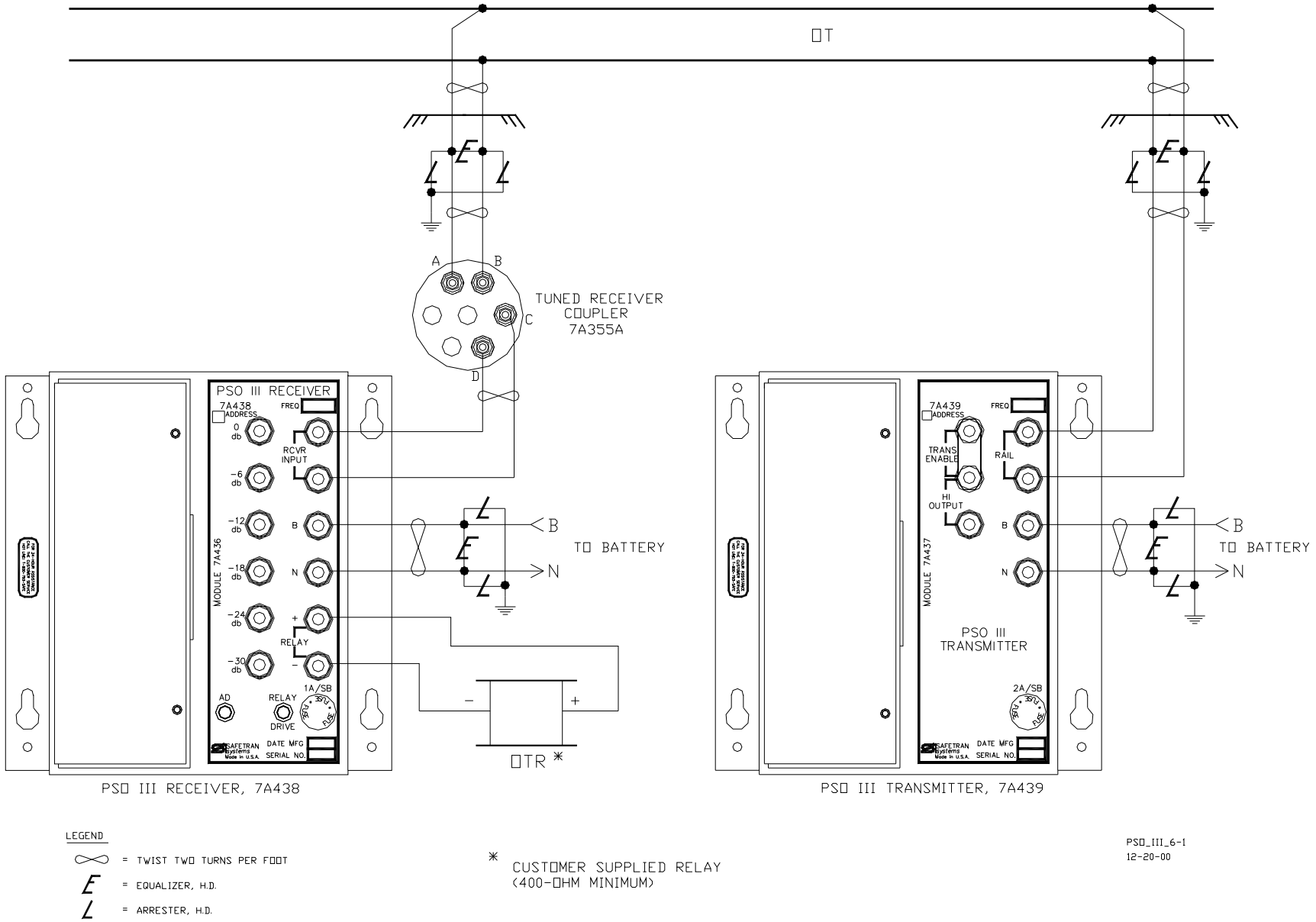

Figure 6-1
Typical PSO III Installation

6.2 TRANSMITTER INSTALLATION

WARNING

VERIFY THAT PSO III TRANSMITTER FREQUENCY AND ADDRESS FORMAT ARE AS SPECIFIED BY THE RAILROAD'S APPROVED WIRING OR INSTALLATION DIAGRAM. FAILURE TO DO SO MAY LEAD TO INCORRECT OR UNSAFE OPERATION OF THE TRACK CIRCUIT. REFER TO FIGURE 6-2 FOR LOCATION OF TRANSMITTER MODULE ADDRESS AND FREQUENCY LABELS.

Perform the following steps to install the transmitter:

(1) Remove the fuse from the transmitter.

(2) Connect the two track wires to the transmitter **RAIL** terminals.

(3) Connect the battery wires to the **B** and **N** terminals on the transmitter. Ensure correct polarity.

(4) **Continuous low-power transmitter operation:**

For continuous low-power operation, connect a terminal strap between the **TRANS ENABLE** terminals.

Continuous hi-power transmitter operation:

For continuous hi-power operation, connect a terminal strap between the **TRANS ENABLE** terminals and also a terminal strap between the **HI OUTPUT** terminals.

(5) If the transmitter is to be keyed through relay contacts, strap the transmitter terminals for either continuous low or hi power operation (step 4 above), and then route the leads to the **B** and **N** terminals through the contacts of an external keying relay as shown in figure 6-3.

(6) Apply power to the transmitter by inserting the fuse.

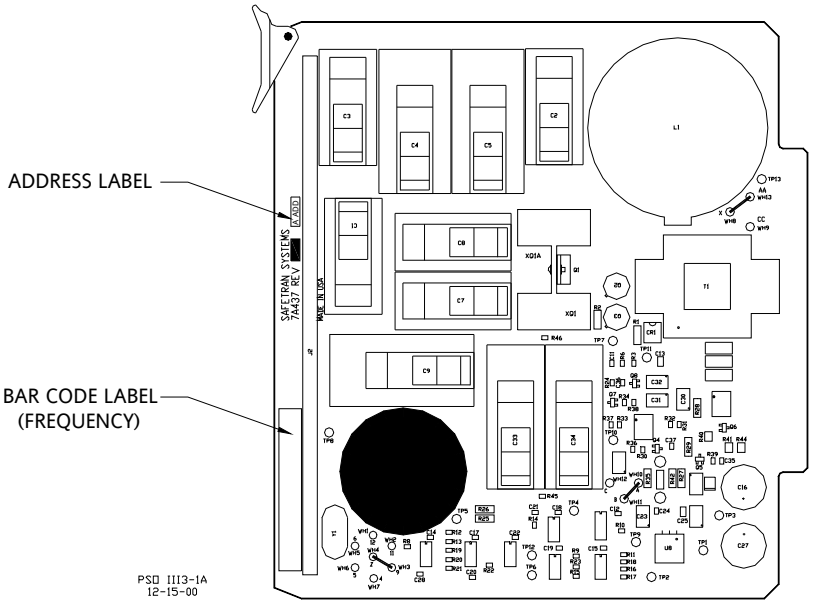

Figure 6-2
Location of Transmitter Module Address and Frequency Labels

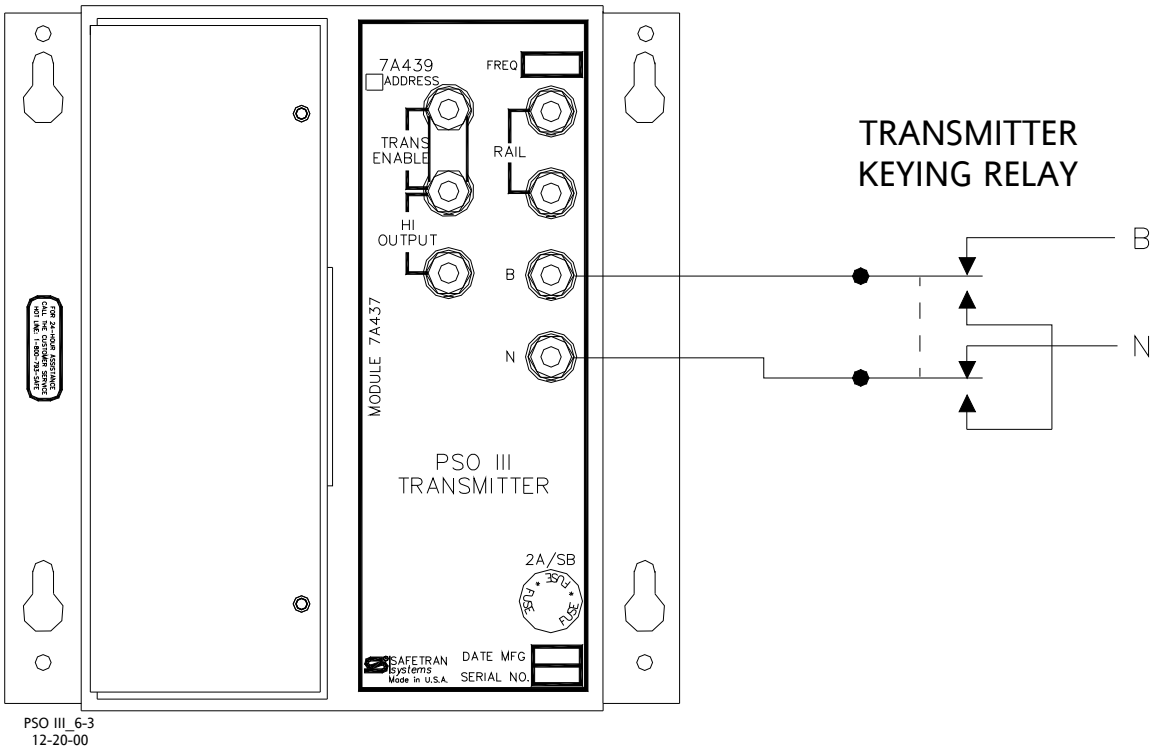

Figure 6-3
PSO III Transmitter Connections To Remote Keying Relay
(Transmitter Shown Strapped For Continuous Low-Power Operation)

6.3 RECEIVER INSTALLATION

CAUTION

BEFORE INSTALLING PSO III EQUIPMENT, ENSURE THAT NO OTHER EQUIPMENT IS CONNECTED TO THE TRACK THAT, EITHER BY ITSELF OR IN CONJUNCTION WITH THE PSO III TRANSMITTER, CAN CREATE AN ERRONEOUS SIGNAL TO WHICH THE PSO III RECEIVER MAY RESPOND.

WARNING

VERIFY THAT PSO III RECEIVER FREQUENCY, RECEIVER COUPLER FREQUENCY AND ADDRESS FORMAT ARE AS SPECIFIED BY THE RAILROAD'S APPROVED WIRING OR INSTALLATION DIAGRAM. FAILURE TO DO SO MAY LEAD TO INCORRECT OR UNSAFE OPERATION OF THE TRACK CIRCUIT. REFER TO FIGURE 6-4 FOR LOCATION OF RECEIVER MODULE ADDRESS AND FREQUENCY LABELS.

Perform the following steps to install the receiver:

(1) Remove the fuse from the receiver.

(2) Connect the track wires to terminals A and B on the receiver coupler.

(3) Connect wires from coupler terminals C and D to **RCVR INPUT** terminals of the receiver.

(4) Connect the battery wires to the **B** and **N** terminals on the receiver. Ensure correct polarity.

(5) Connect the relay coil to the **RELAY +** and **-** terminals on the receiver. Ensure correct polarity as required. The relay coil resistance must be between 400 and 1,000 ohms.

(6) Apply power to the receiver by inserting the fuse.

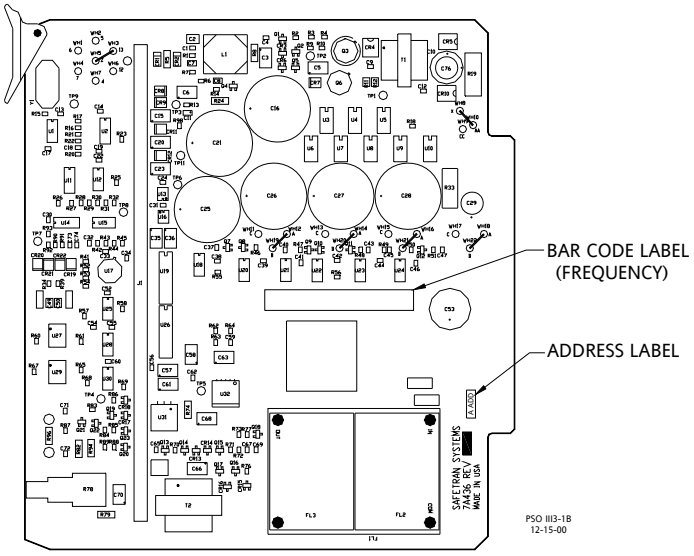

Figure 6-4
Location of Receiver Module Address and Frequency Labels

6.4 CROSSING PACKAGE INSTALLATION

WARNING

VERIFY THAT THE FREQUENCY AND ADDRESS FORMAT OF EACH PSO III RECEIVER IS AS SPECIFIED BY THE RAILROAD'S APPROVED WIRING OR INSTALLATION DIAGRAM. ALSO VERIFY THAT THE RECEIVER AND CORRESPONDING RECEIVER COUPLER FREQUENCIES ARE IDENTICAL. FAILURE TO DO SO MAY LEAD TO INCORRECT OR UNSAFE OPERATION OF THE TRACK CIRCUIT. REFER TO FIGURE 6-4 FOR LOCATION OF RECEIVER MODULE ADDRESS AND FREQUENCY LABELS.

Perform the following steps to install the Crossing Package:

(1) Remove the fuse from the Crossing Package.

(2) Connect track wires of the WEST receiver to terminals A and B on the tuned receiver coupler.

(3) Connect wires from coupler terminals C and D to **WEST PSO RCV** terminals on the Crossing Package.

(4) Connect WEST receiver relay coil wires to **WEST PSO RLY +** and **-** terminals on the Crossing Package. Ensure correct polarity.

(5) Repeat steps 2 through 4 for the EAST receiver.

(6) Connect battery wires to **B** (+) and **N** (-) terminals on the Crossing Package. Ensure correct polarity.

(7) Connect island circuit transmit track wires to **ISL XMT** terminals on the Crossing Package.

(8) Connect island circuit receive track wires to **ISL RCV** terminals on the Crossing Package.

(9) Connect island circuit relay coil to **ISL RLY +** and **-** terminals on the Crossing Package. Ensure correct polarity. The relay should be a standard railroad-type with a coil resistance of 400 ohms or higher.

(10) Apply power to the Crossing Package by inserting the fuse. Proceed to Section VII for applicable checkout and adjustment procedures.

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SECTION VII

CHECKOUT AND ADJUSTMENT

7.0 GENERAL

This section contains checkout and adjustment procedures for the PSO III receiver module (7A436 used in 7A438 and 7A448 configurations or 7A436-2 used in 7A453 and 7A455 configurations), and the IPI island module (62609) which is used in the Crossing Package (7A448 and 7A455).

WARNING

THE CHECKOUT AND ADJUSTMENT PROCEDURES PROVIDED HERE APPLY TO THE PSO III EQUIPMENT ONLY. DO NOT USE CHECKOUT AND ADJUSTMENT PROCEDURES INTENDED FOR THE PSO II EQUIPMENT.

7.1 PSO III RECEIVER ADJUSTMENT

Follow the steps listed below to adjust the PSO III receiver(s). When adjusting the Crossing Package, perform the procedures for receiver number 1 first, then repeat all applicable steps for receiver number 2.

A VOM (Simpson, Model 260, Series 3 or equivalent) is required to set the amplitude detector (AD) level to +11 volts. Since the AD voltage may fluctuate slightly at certain PSO III operating frequencies, the AD level is adjusted so that peak deflection is no greater than +11 volts.

1. Verify that the PSO III Receiver module and receiver coupler (7A355A-f or 7A366-f), when used, are the same frequency.

2. With the meter set to read +DC on the 10 VDC scale, connect the common (black) lead to terminal **B** on the receiver and the positive (red) lead to the **AD** test jack (figure 7-1).

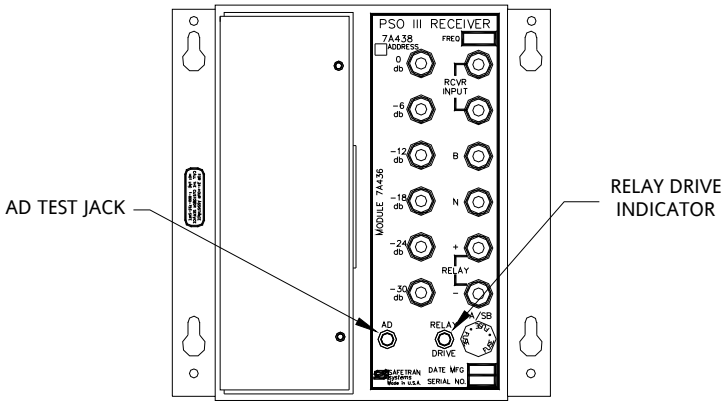
3. Connect a temporary jumper between the -30 dB and 0 dB terminals (maximum receiver sensitivity). Note that the **RELAY DRIVE** indicator (**DS1** and **DS2** on Crossing Package) lights when the receiver relay is energized and the meter indicates 6.5 volts or higher.

4. Remove the module cover and adjust the receiver module gain adjust potentiometer (figure 7-2) to the fully CW position.

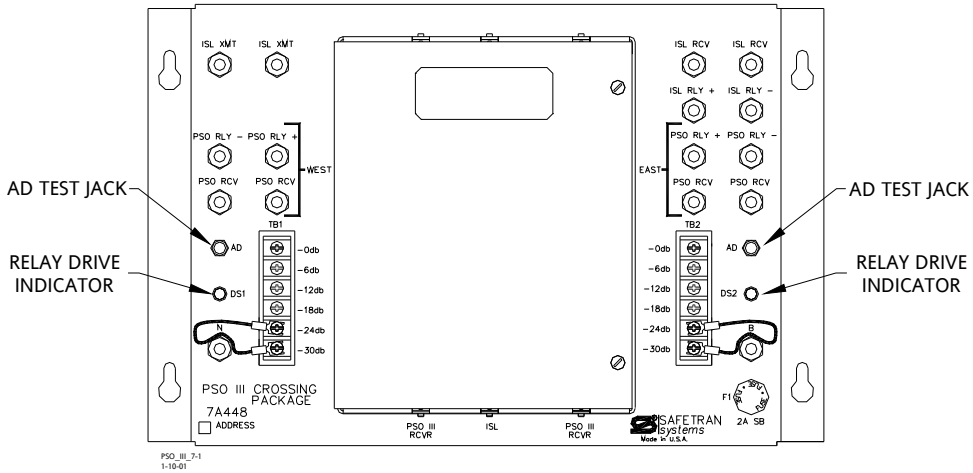
5. When the track ballast is dry, connect a shunt (0.06-ohm or 0.2-ohm) across the track at the receiver track connections. When the ballast is damp, connect the shunt across the track at a point 10 feet beyond the receiver track connections. Ensure that the shunt has solid connections to each rail. If the AD level is above 5 volts, disconnect the jumper from the 0 dB terminal and connect it to the -6 dB terminal. If necessary, continue to move this end of the jumper to the next lower numbered terminal until the 5-volt reading is produced (-6 dB to -12 dB, -12 dB to -18 dB, etc.).

NOTE

Except in erratic shunting or light rail applications, the 0.06-ohm shunt is normally used. PSO III receivers installed in light rail traction territories or rusty rail areas are normally adjusted using a 0.2-ohm shunt.



7A438 RECEIVER ASSEMBLY



7A448 CROSSING PACKAGE

Figure 7-1
AD Test Jack and Relay Drive Indicator Locations

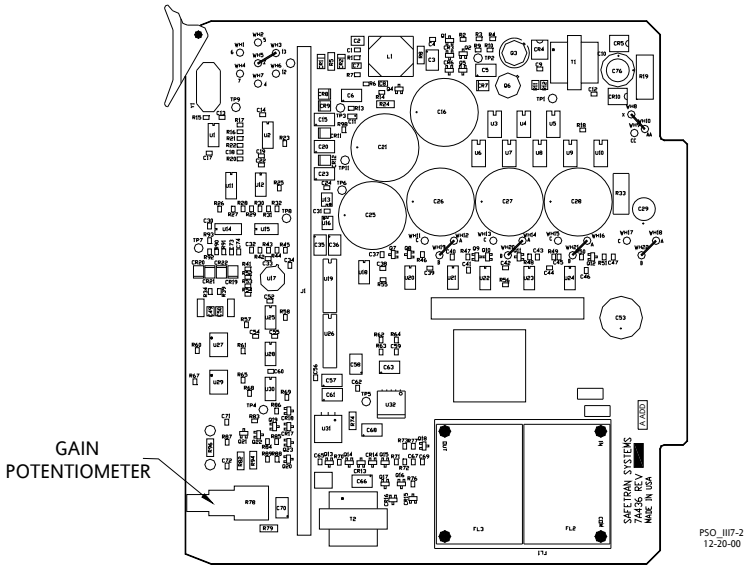


Figure 7-2
Gain Potentiometer Location On 7A436 Receiver Module

6. Adjust the receiver module gain adjust potentiometer CCW until the AD voltage is +4.0 volts. Verify that the receiver relay is de-energized and that the relay voltage is 0 VDC.

7. Remove the temporary jumper (step 4) and install a permanent jumper on the same terminals. Remove the meter test leads and the track shunt. The receiver relay should energize.

8. Remove the transmitter fuse. The receiver relay should de-energize. Return the fuse to the original position. When adjusting a Crossing Package (7A448 or 7A455), repeat steps 1 through 8 for the other receiver.

9. For the Crossing Package only (7A448 or 7A455), adjust the island receiver as described in paragraph 7.2.

10. The system is now ready for operation. Verify proper operation of the track circuit equipment before placing in service in accordance with railroad procedures and applicable FRA rules.

WARNING

VERIFY THAT THE TRACK RELAY DE-ENERGIZES WHEN THE TRACK CIRCUIT IS SHUNTED WITH THE APPROPRIATE RESISTANCE (EITHER 0.06 OR 0.2 OHMS). FAILURE TO DO SO MAY LEAD TO INCORRECT OR UNSAFE OPERATION OF THE TRACK CIRCUIT.

7.1.1 Receiver Adjustment For Line-To-Line Applications

1. With the meter set to read +DC on the 10 VDC scale, connect the common (black) lead to terminal **B** on the receiver and the positive (red) lead to the **AD** test jack (figure 7-1).

2. Connect a temporary jumper between the front panel -30 dB and 0 dB terminals (maximum receiver sensitivity).

3. With the gain potentiometer adjusted fully clockwise, move the 0-dB end of the front panel gain jumper to the –6 dB position. If necessary, continue to move this end of the jumper to the next lower numbered terminal until the meter reads just above +7 volts (-6 dB to -12 dB, -12 dB to -18 dB, etc.).

4. Adjust the gain potentiometer to drop the meter reading to 6.5 volts.

5. Now move the moveable end of the jumper up two terminals so that the gain is 12 dB higher.

NOTE

If the receiver does not drop out with no gain jumper installed, then install a jumper in the –24 dB position.

6. Remove the temporary jumper and install a permanent jumper in its place.

7. Verify that the receiver AD voltage is higher (more positive) than 6.5 volts DC.

8. Remove the transmitter fuse and verify that the AD voltage is between zero and +1.0 VDC.

9. Return the fuse to the original position. The system is now ready for operation.

7.2 IPI MODULE ISLAND CIRCUIT ADJUSTMENT

There are three simple procedures that must be performed before placing the IPI in service. The first is to select the operating frequency by installing a jumper on the IPI module. The second is to configure jumper(s) for pickup delay time if required (IPI modules running software version A01E and later only). And the third is to perform the automated calibration of the island circuit.

WARNING

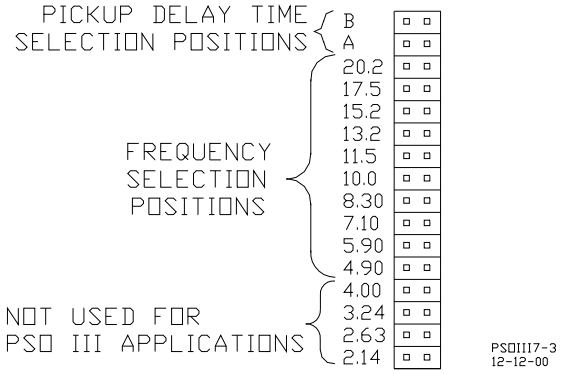
AFTER INSTALLATION OR AFTER ANY ISLAND CHANGES HAVE BEEN MADE, RECALIBRATE THE IPI AND TEST FOR PROPER OPERATION.

- ***IPI FREQUENCY SELECTION***

NOTE

If the IPI module is already installed in the case, remove power from the case and then remove the IPI module.

1. Select the desired IPI operating frequency by installing the provided shorting block across the appropriate pair of frequency selection pins on the 16-position header (see figure 2-5 or the following figure). **Only one frequency jumper is allowed.**



- ***IPI PICKUP DELAY TIME SELECTION (SOFTWARE VERSION A01E AND LATER ONLY)***

NOTE

The A and B positions on the 16-position header are not used on IPI modules running software version A01D or earlier. However, the A and B positions are used for pickup delay time selection on modules running software version A01E or later.

2. Additional pickup delay time may be added to the IPI module when needed using the A and B header positions. Refer to the chart below for proper jumper placement.

Install Jumper In these Header Positions	Pickup Delay Time Added (seconds)
A & B	0
A	2
B	4
no jumper on A or B	6

NOTE

Pickup delay time jumper(s) must be configured (if needed) prior to IPI track circuit calibration.

- ***IPI TRACK CIRCUIT CALIBRATION***

3. Install the IPI module in the case.

4. Make sure that power is applied to the IPI module for a minimum of 20 seconds before proceeding with calibration.

5. Temporarily install a **hardwire** shunt at the appropriate distance beyond the receiver rail connections as specified in the shunt distance chart below.

NOTE

Table 7-1 provides shunt distance values for shunting sensitivities of 0.12 and 0.3 ohm plus 0.4 and 0.5 ohm for areas where poor shunting is a problem.

Table 7-1
Hardwire Shunt Placement Distances For Various Shunting Sensitivities And IPI Island Frequencies

Island Frequency (kHz)	0.12 Σ Sensitivity Shunt Distance (Feet)	0.3 Σ Sensitivity Shunt Distance (Feet)	0.4 Σ Sensitivity Shunt Distance (Feet)	0.5 Σ Sensitivity Shunt Distance (Feet)
2.14	These four IPI frequencies are not used for PSO III applications			
2.63				
3.24				
4.0				
4.9	9.0	23	31	39
5.9	7.5	19	26	32
7.1	6.5	17	23	29
8.3	6.0	15	20	25
10.0	5.0	13	18	22
11.5	4.5	12	16	20
13.2	4.0	10	14	17
15.2	3.5	9	12	15
17.5	3.0	8	11	14
20.2	3.0	8	11	14

NOTE

For all installations where poor shunting has been experienced or is anticipated, a 4-second pickup delay jumper setting and 0.3 ohm shunting sensitivity calibration are recommended.

6. To calibrate the IPI, press and hold the IPI calibration select push button (figure 2-5) for 2 seconds until **REL** (release) appears on the display. Immediately release the push button and then momentarily press it again within 2 seconds. This starts the automated calibration process (**CAL*** appears on the display).

NOTE

The IPI module remains in the automatic Calibration mode for approximately 20 seconds. During this time, the display indicates **CAL*** for 6 seconds, **DONE** momentarily, **BOOT** for 9 seconds, and then the software revision level is displayed for 5 seconds. When the calibration process is complete, the IPI operating frequency is displayed (alternates with pickup delay setting when running A01E and later software versions).

NOTE

If **FAIL** appears on the display, the calibration process did not complete. Should this happen, cycle the IPI power and then repeat step 6. If **FAIL** appears again, replace the IPI module.

7. Once the calibration cycle is complete and the IPI operating frequency (and pickup delay setting if applicable) appears on the display, verify the following:

- That the frequency is correct
- That the pickup delay setting is correct (if applicable)
- That the IPI STATUS indicator is off
- That the IPI relay drive voltage is 0 VDC

8. Remove the hardwire shunt installed in step 5 and then verify the following:

- That the IPI STATUS indicator is lit
- That the IPI relay drive voltage is more than 10 VDC

9. Verify proper IPI operation by observing train moves.

7.2.1 IPI Module Troubleshooting

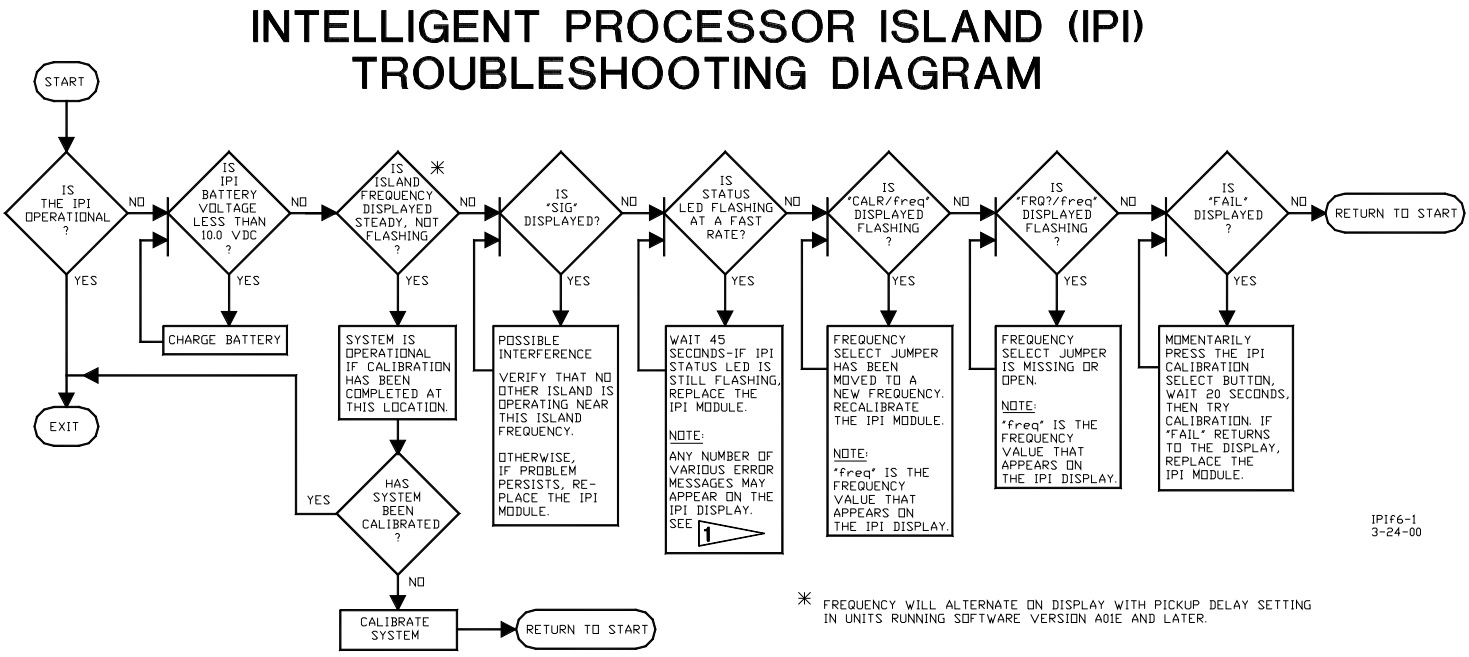


Figure 7-3
IPI Module Troubleshooting Chart

1

Internal error codes
(for reference only)

CALC
CRIT
GB
HWSW
IRO
ISRX
PHLT
PIRO
PS_I
PS5A
PS5D
PS25
RAM
ROM
SIRO
STKG
STKP
TIME
XCPT

NOTE

If any of the internal error codes listed to the left appear on the IPI display, typically the IPI module should be replaced if the problem persists. See Section II, table 2-2, for a description of these codes.

NOTE

If a loss-of-shunt is detected, the LOS indication flashes intermittently on the display for approximately 10 seconds.

SECTION VIII

DIAGRAMS

This section contains the following typical PSO III installation diagrams. Connections are also shown for PSO-related components.

Figure No.	Title
8-1	PSO III Installation With Tuned Receiver Coupler, 7A355A-f
8-2	PSO III Installation With Tuned Receiver Coupler, 7A366-f
8-3	PSO III Installation With Receiver Line-to-Rail Coupler, 7A377-1-f, And Line-To-Receiver Coupler, 7A388
8-4	PSO III Installation With Transmitter Line-to-Rail Coupler, 7A399-f
8-5	Typical Installation of PSO III Crossing Package With Island Circuit
8-6	Insulated Joint Bypass Device, 7A422-f
8-7	PSO Battery Choke, 7A360, 8A065A or 62648
8-8	Typical PSO III Line Overlay Application (includes 7A403 PSO Line Coupler)
8-9	Typical Battery Charger Surge Protection
8-10	Typical Track Wire Surge Protection For Use In Electrified Territory

NOTE

The application drawings provided here apply to both “A” and “C” address format PSO III transmitters, receivers and Crossing Packages.

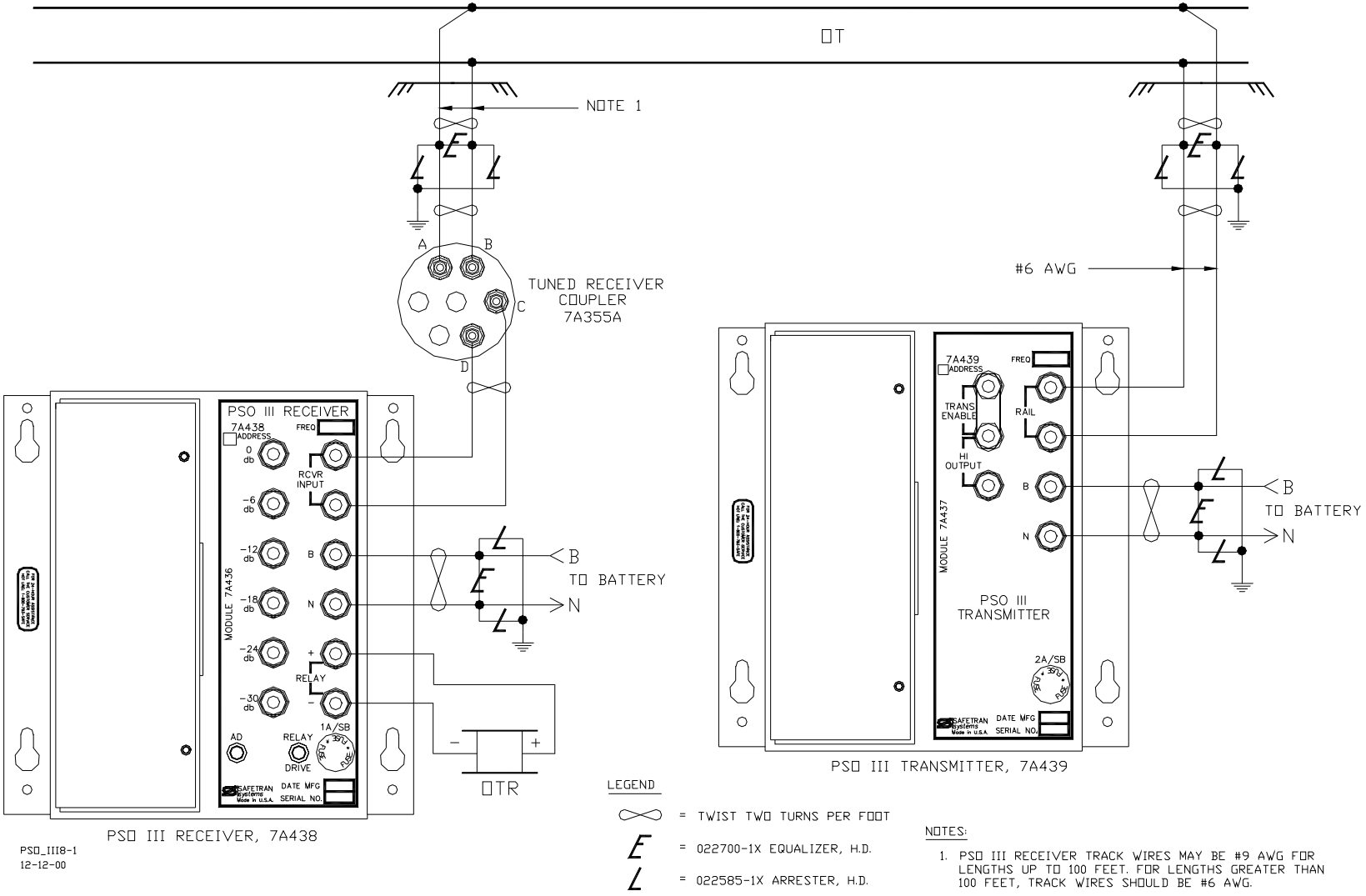


Figure 8-1
PSO III Installation With Tuned Receiver Coupler, 7A355A-f

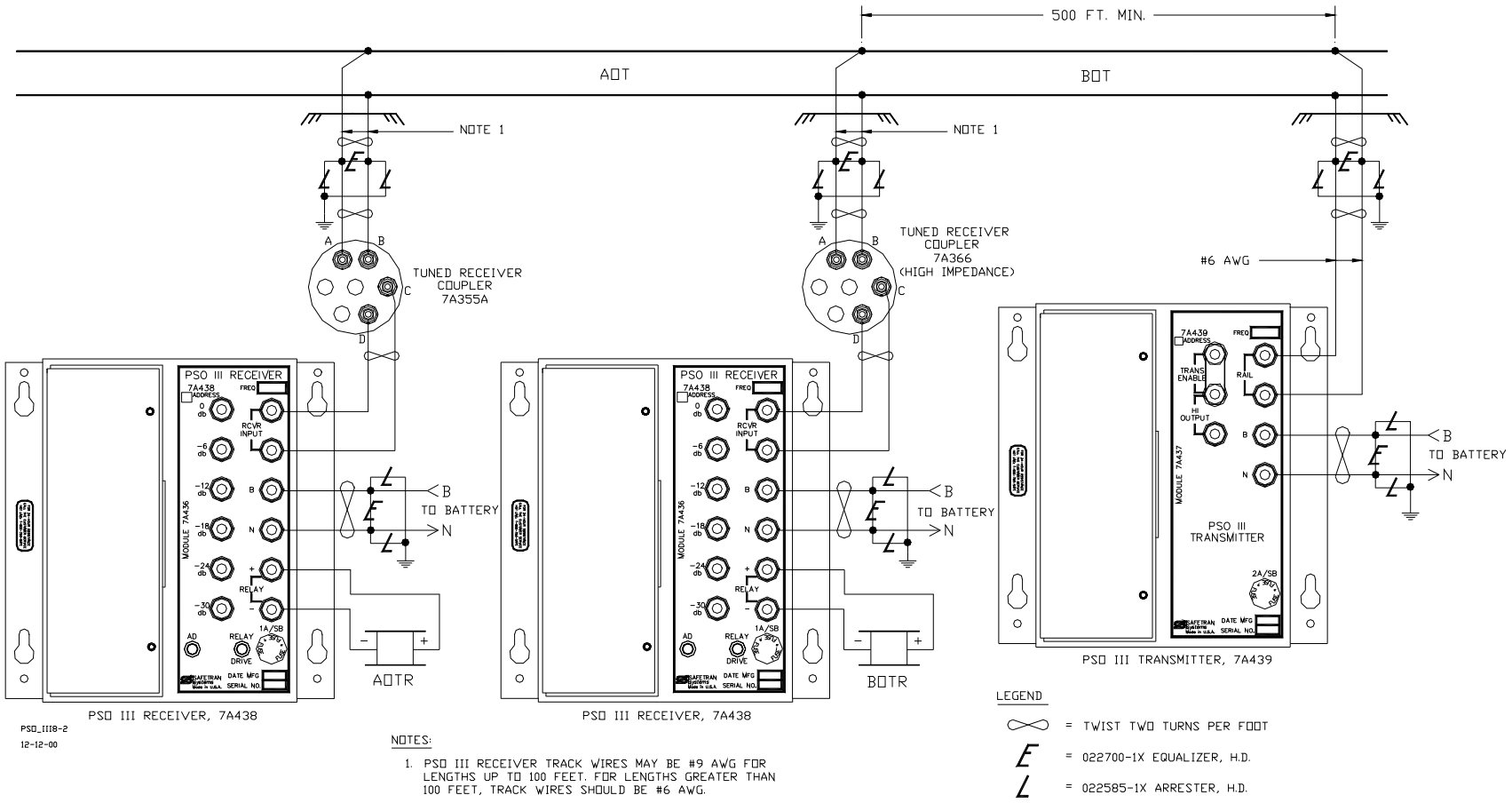


Figure 8-2
PSO III Installation With Tuned Receiver Coupler, 7A366-f

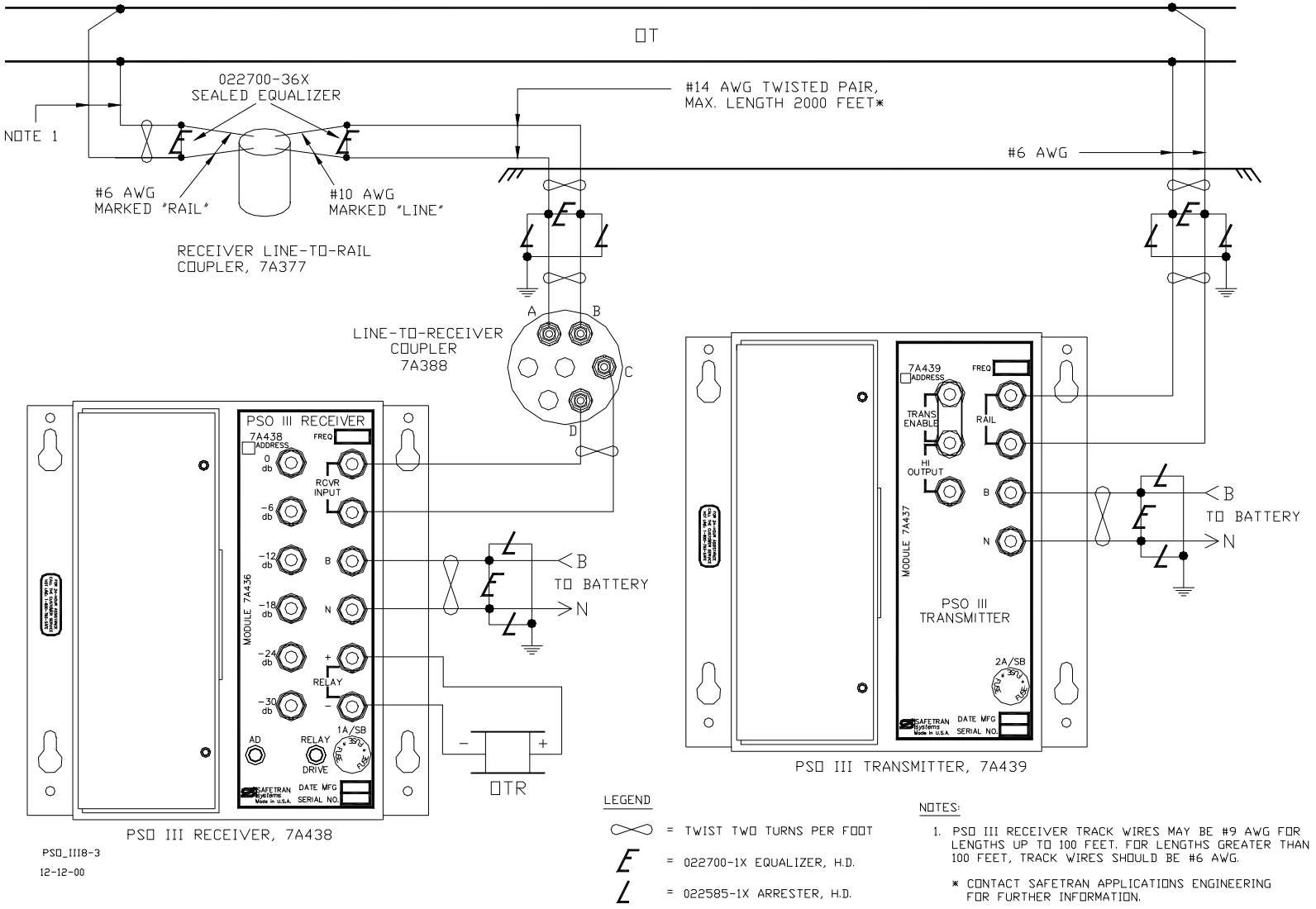


Figure 8-3
PSO III Installation With Receiver Line-To-Rail Coupler, 7A377-1-f, And Line-To-Receiver Coupler, 7A388

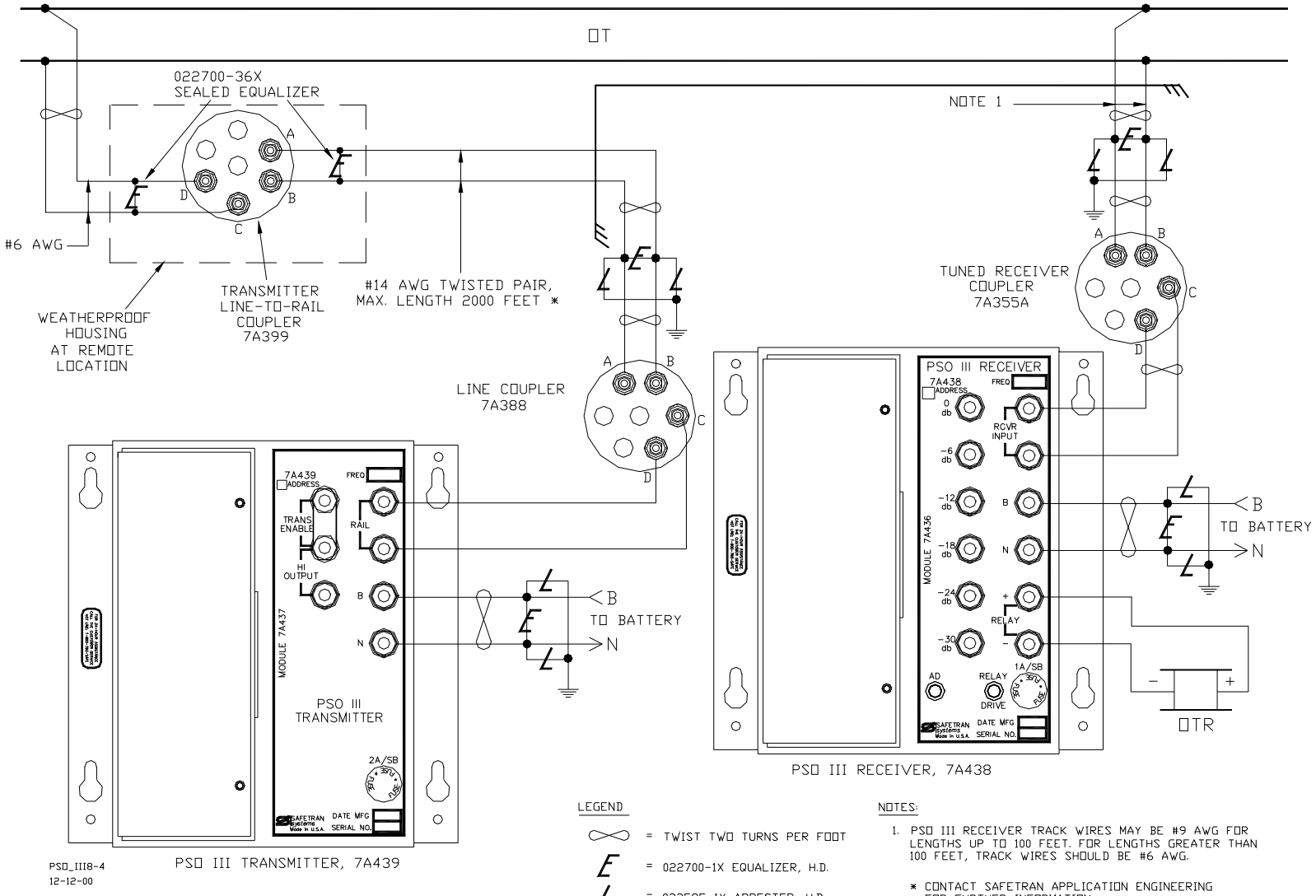


Figure 8-4
PSO III Installation With Transmitter Line-to-Rail Coupler, 7A399-f

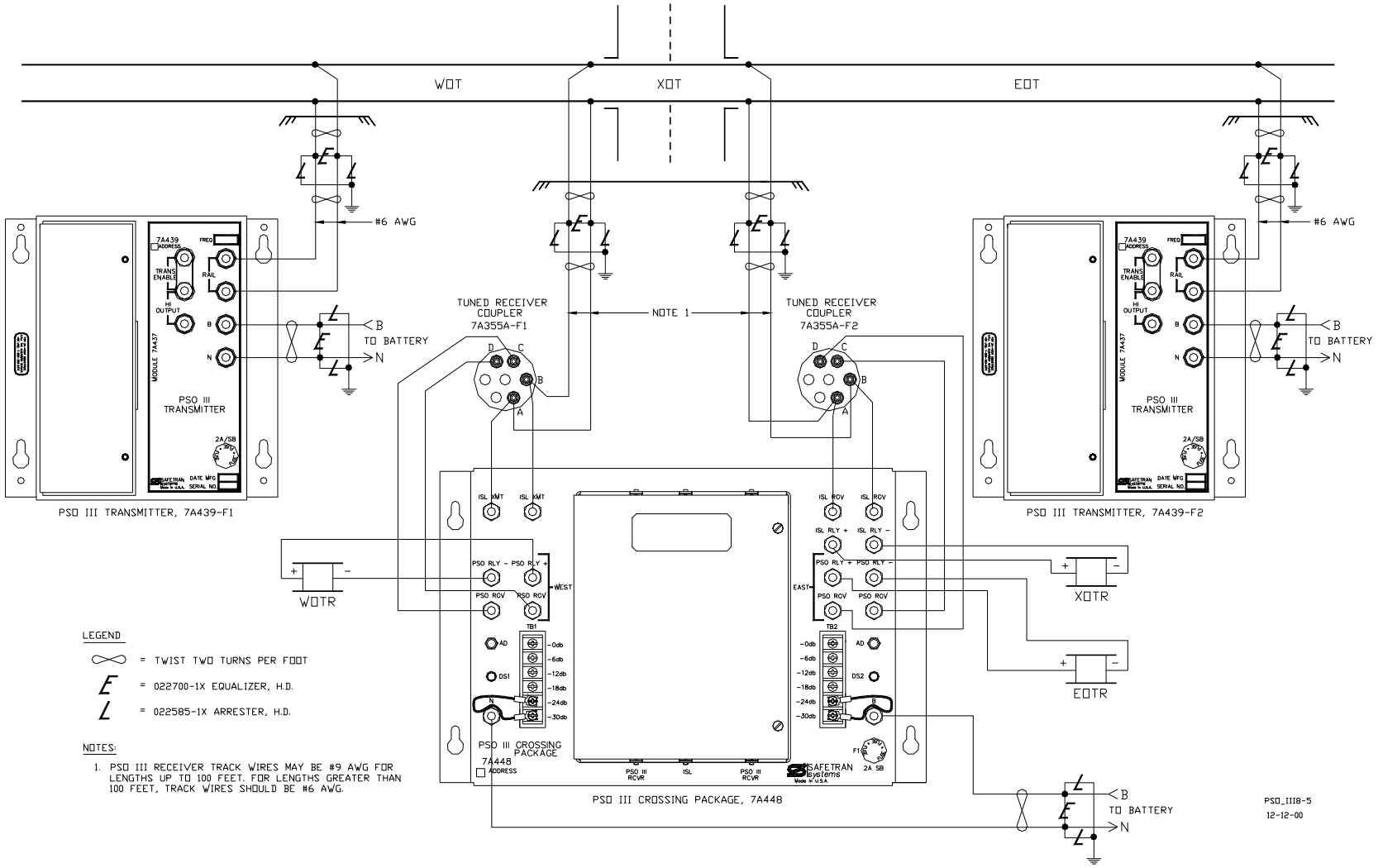
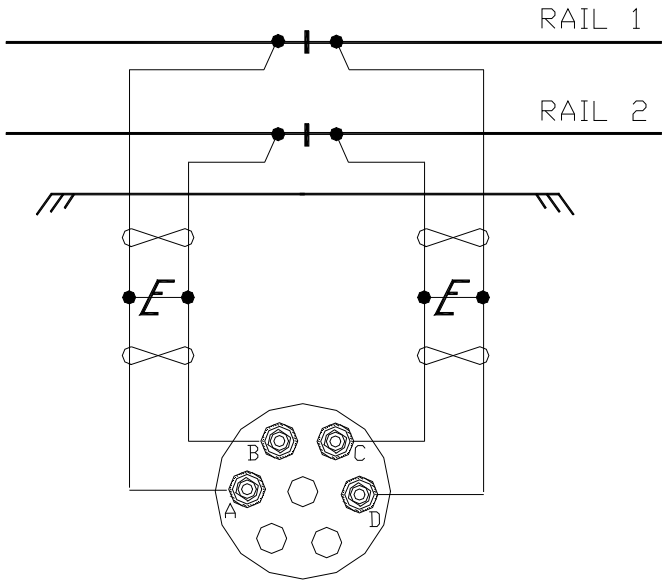


Figure 8-5
Typical Installation of PSO III Crossing Package With Island Circuit



7A422-F TUNED
INSULATED JOINT
BYPASS COUPLER

LEGEND

= TWIST TWO TURNS PER FOOT

= 022700-1X EQUALIZER, H.D.

NOTES:

1. DISTANCE OF 7A422-F BYPASS FROM TRACK SHOULD NOT EXCEED 100 FEET AND WIRE SHOULD BE #6 AWG COPPER.

PSO_III8-6

12-12-00

Figure 8-6
Insulated Joint Bypass Device, 7A422-f

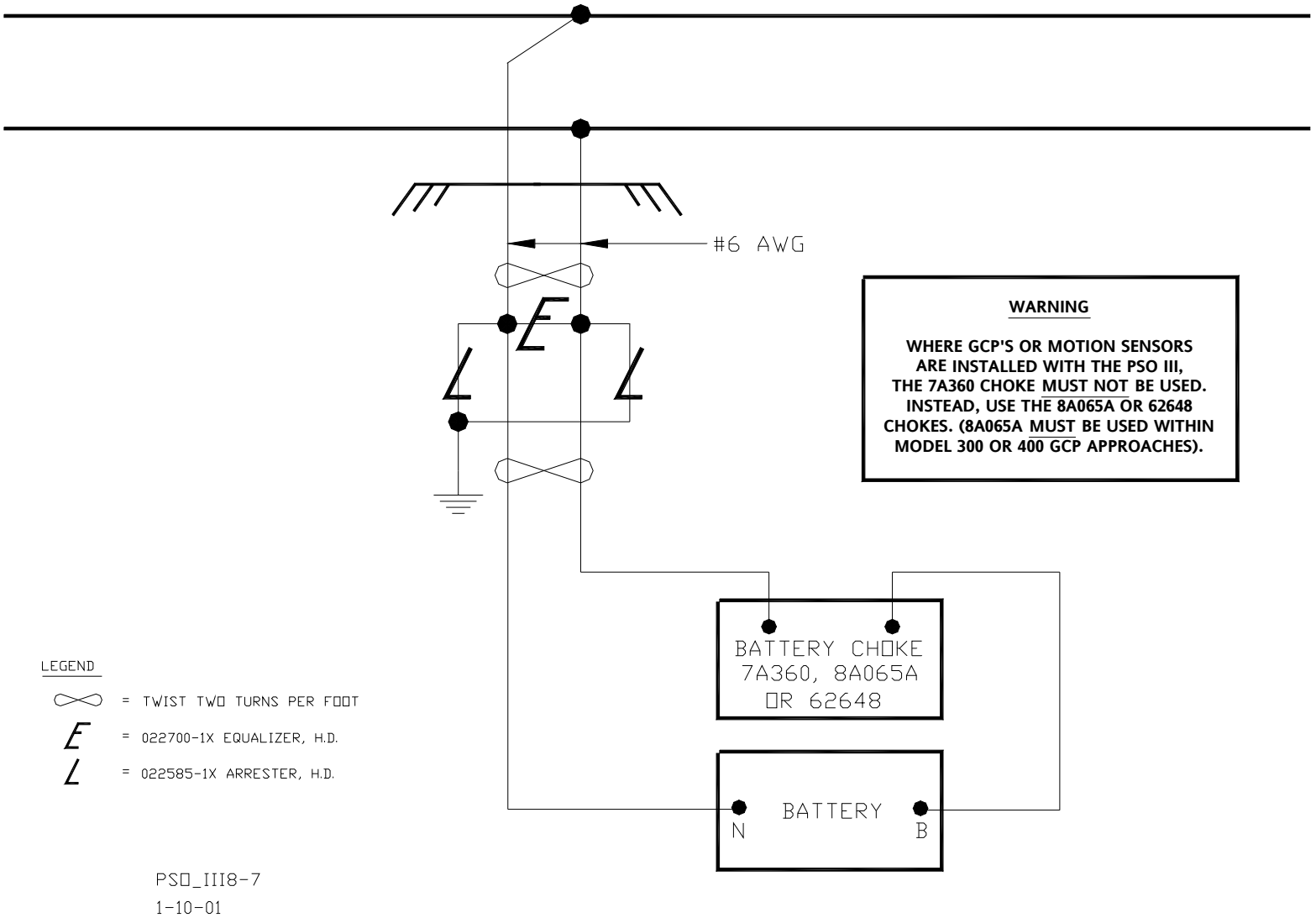
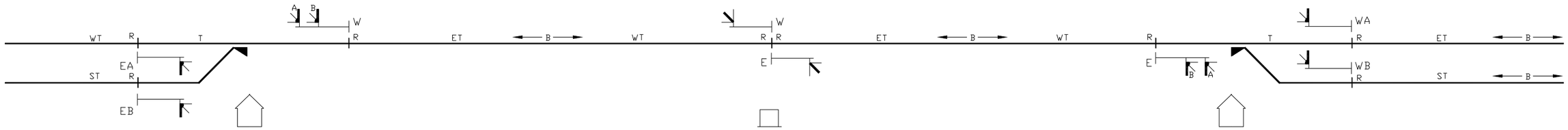
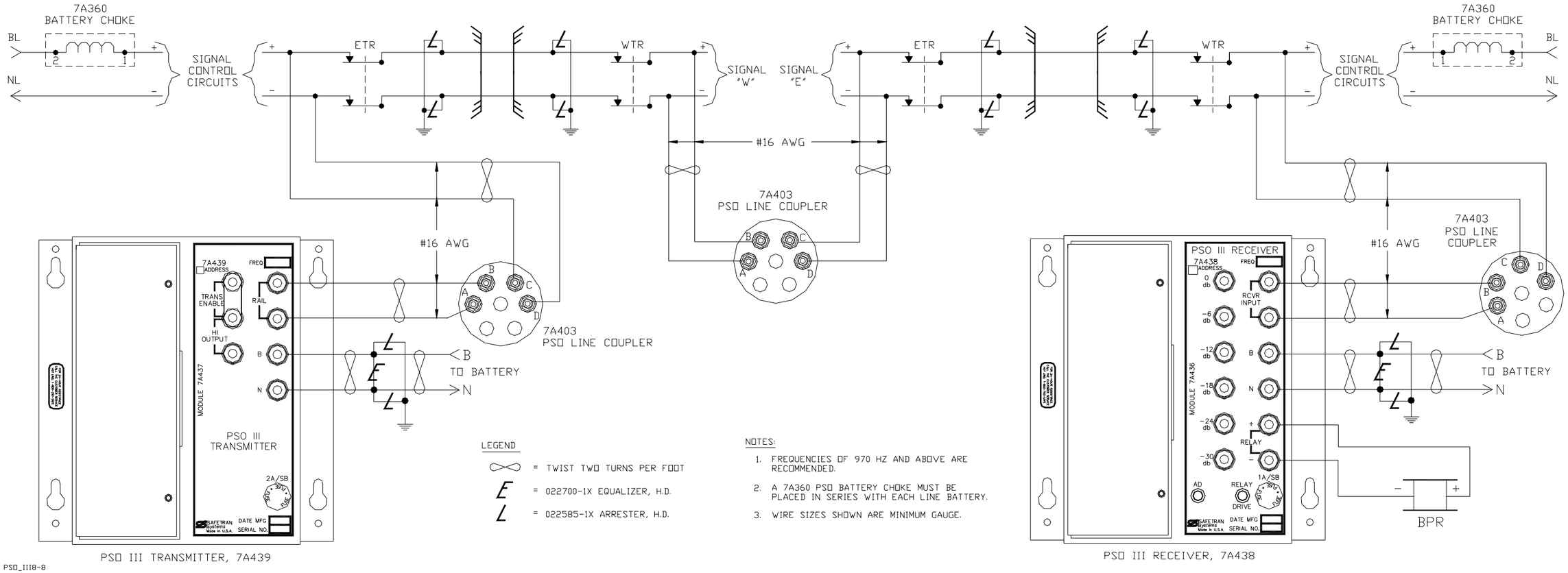


Figure 8-7
PSO Battery Choke, 7A360, 8A065A or 62648





LEGEND

= TWIST TWO TURNS PER FOOT

= 022700-1X EQUALIZER, H.D.

= 022585-1X ARRESTER, H.D.

NOTES:

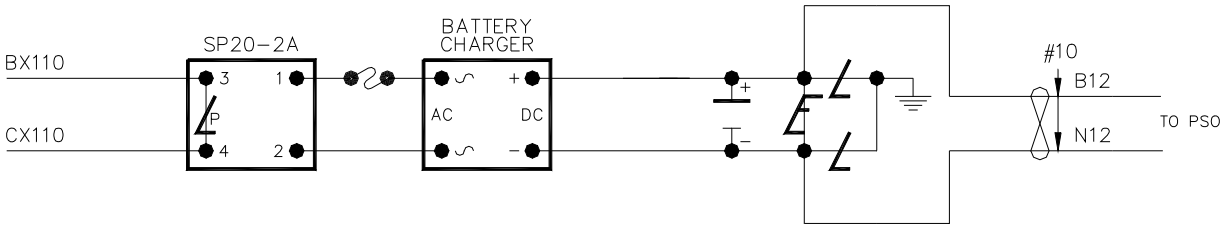
1. FREQUENCIES OF 970 HZ AND ABOVE ARE RECOMMENDED.
2. A 7A360 PSO BATTERY CHOKE MUST BE PLACED IN SERIES WITH EACH LINE BATTERY.
3. WIRE SIZES SHOWN ARE MINIMUM GAUGE.

PSO III TRANSMITTER, 7A439

PSO III RECEIVER, 7A438

PSO_III8-8
12-12-00

Figure 8-8
Typical PSO III Line Overlay Application



NOTES

1. WIRE SIZE SHOWN IS MINIMUM GAUGE.

LEGEND

= TWIST TWO TURNS PER FOOT

= 022700-1X EQUALIZER, H.D.

= 022701-1X ARRESTER, AC POWER LINE

= 022585-1X ARRESTER, H.D.

PSO_III8-9
12-12-00

Figure 8-9
Typical Battery Charger Surge Protection

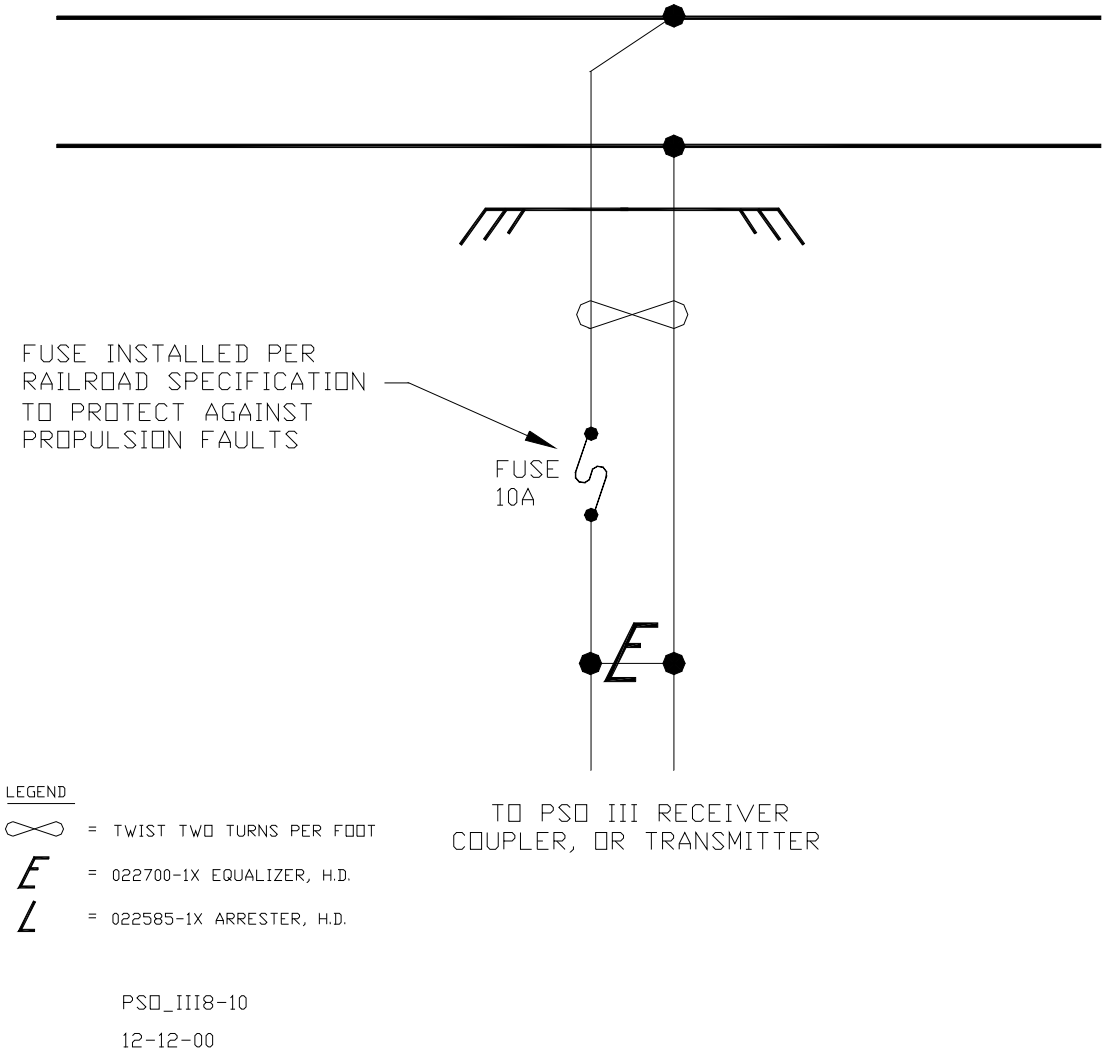


Figure 8-10
Typical Track Wire Surge Protection For Use In Electrified Territory

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7A377-1-f Receiver Line-To-Rail Coupler, 5-4, 6-1
7A388 Line-To-Receiver Coupler, 5-4
7A399-f Transmitter Line-To-Rail Coupler, 5-4, 6-1
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7A417-X Cab Signal Filter, 3-5, 5-9
7A418 Battery Line Filter, 5-7
7A422-f Tuned Insulated Joint Bypass Coupler, 5-8

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