

Section 6: Harmon WCO-32 with Harmon WCO-33 Scanners

(Work Procedure 3)

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Train Control Engineering Defect Detector Work Procedure Number 3

Equipment: Harmon WCO-32 with Harmon WCO-33 Scanners

Purpose: Weekly, Monthly, Quarterly Tests as per Rule 27.0

WEEKLY

Test Equipment Needed: Simpson 260
(See Figure 6-1) Fluke 27, 87, or equivalent
Soldering iron

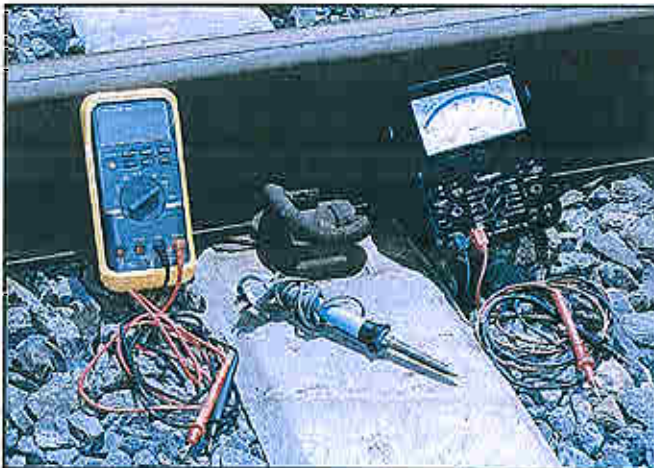


Figure 6-1: Fluke meter, soldering iron, and Simpson 260

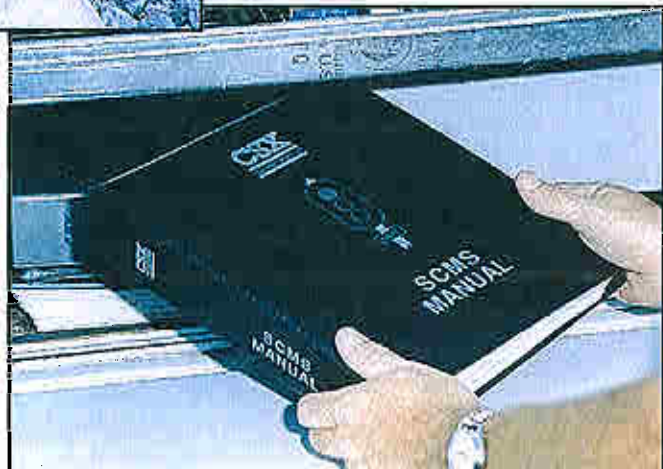


Figure 6-2: Signal Construction and Maintenance Standards manual

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1. Give the entire detector location a good visual inspection. Check, tighten, and/or replace any loose bolts and broken parts on the transducers, scanner bases, deflector blocks, and dragger. Inspect the ground rods and connections and replace or repair them to the CSX standard. (Refer to the *Signal Construction and Maintenance Standards* manual shown in Figure 6-2. Replace any badly damaged paddles on the dragger. Remove any debris or obstructions from the dragger. Check the dragger switch gasket to ensure water is not getting into the switch contact.



Figure 6-3: Inspecting the ground rods and connections

2. Remove the scanner covers and clean out the inside of each scanner base using a soft brush. Clean the scanner lenses and mirrors by carefully washing off any dirt and grime using a spray bottle with clean water or alcohol. Then finish cleaning them with a soft cloth. Do NOT clean with an ammonia-based product because it will damage the lenses. Check the proper operation of the scanner cover heaters and the shutter mechanisms by placing the Mode Select switch in CHOP mode. Moving parts within the scanner can be oiled with a light machine oil as necessary. Replace the scanner covers and clean them with a cleaning solution. If the scanner covers are still dingy or dull, paint them aluminum to help reflect heat away from the scanner.

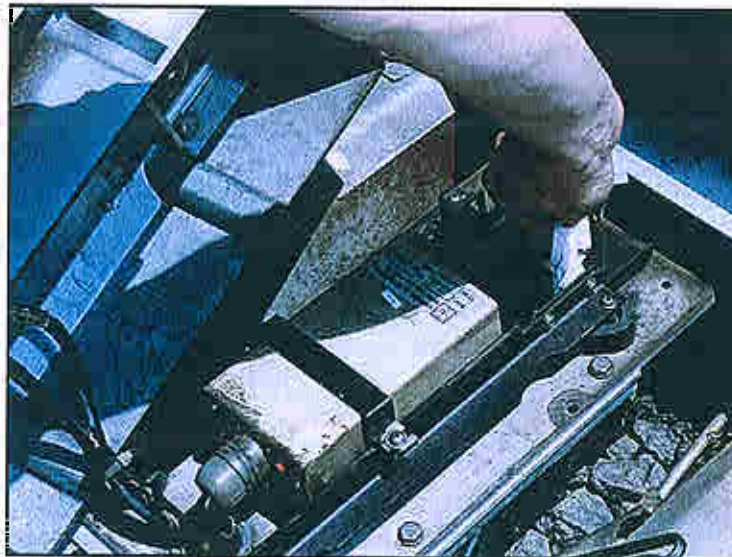


Figure 6-4: Cleaning the scanner lenses

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3. Check the chart recorder for proper operation to see if the desired information (such as train direction, train profile, proper gating, wheels missing, reverse gating, error information and/or codes) and normal heat levels of 4mm to 6mm are recorded. Be sure that the chart recorder has enough paper to last until the next inspection. Adjust the stylus pens, if necessary, to make a clear readable graph. Date and initial the graphs when you remove them from the recorder and keep them for 30 days.

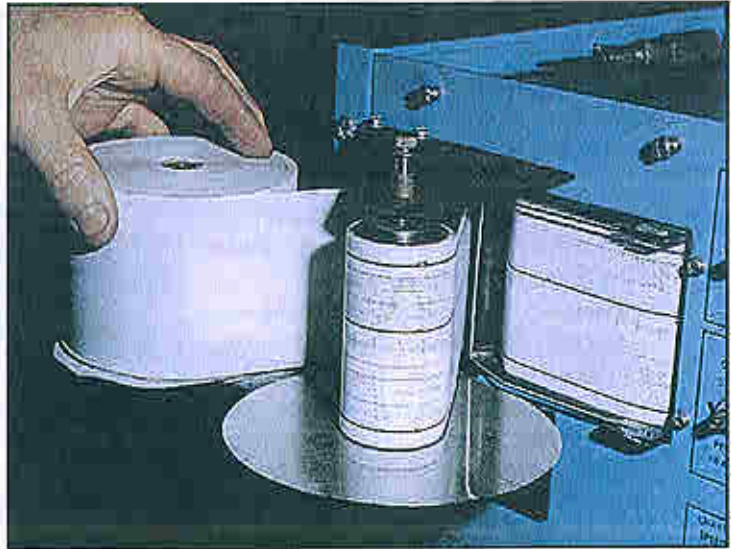


Figure 6-5: Checking the chart paper

4. With the Simpson 260, Fluke 27/87, or the equivalent, check and record in the log book the following voltages:

Rear of WCO-34 Processor	Voltage	Allowable range
+5VDC	+5VDC	+5.2VDC to + 4.9VDC
+12VDC	+12VDC	+12.4VDC to + 11.6VDC
-12VDC	-12VDC	-12.6VDC to -11.4VDC

NOTE: The above voltages are measured in reference to the common pin.

Rear of WCO-35 Power Supply	Voltage	Allowable range
TB1-5 to TB1-8	62.0VDC	62.0VDC \pm 6.0VDC
TB1-7 to TB1-8	47.0VDC	47.0VDC \pm 1.5VDC
TB1-2 to TB1-3 at 115VAC line voltage	24.0VDC	24.0VDC \pm 2.5VDC
TB2-1 to TB2-4	120VAC	120VAC (same as line input voltage)

NOTE: If the 62V is correct and the 47V is off slightly, reset the 47V to specification using the 47V adjustment that is accessible on the lower right corner of the rear panel.

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5. Run the functional self test. This mode tests the system by generating signals that simulate a train passing. Check that all alarms, time and date, and diagnostic messages are printed in accordance with CSX software documentation.
6. Switch the Data Display Mode switch to the continuous Test Train Mode "E." Heat pulses can be seen by the system if a heat source is held in front of the scanner in this mode. Wave a heated soldering iron in front of each scanner and verify that the detector fires on both sides. Activate the dragging equipment device. Be sure that the correct side fires for each channel and that all alarms are properly announced.
7. Open the Motion Detector Test switch and, with a metal object, strike a transducer one time to activate the system and create a greeting message. Verify with the vehicle radio or handheld radio that the audible message is clear (not distorted) and has proper amplitude. Close the Motion Detector Test switch.
8. Be sure that the radio is on, sweep the floor, and lock the location.



Figure 6-6: Train Control Safety sticker

MONTHLY

Additional Test Equipment Needed: Harmon WCO-41 calibrated heat source

1. Perform the weekly tests.
2. Attach the ambient reference block to the scanner mounting base out of direct sunlight. Plug the heat source target into the calibrated heat source. Turn on the calibrated heat source, set it to 70 degrees C, and allow it to heat for 15 minutes. The meter will first fully deflect. The test can be continued when the meter stabilizes at half scale deflection. Place the heat source target on the scanner view hole and put the system in CHOP mode. The chart recorder should indicate $15\text{mm} \pm 1\text{mm}$ chart deflection on that channel. Repeat the same test for the other channel.

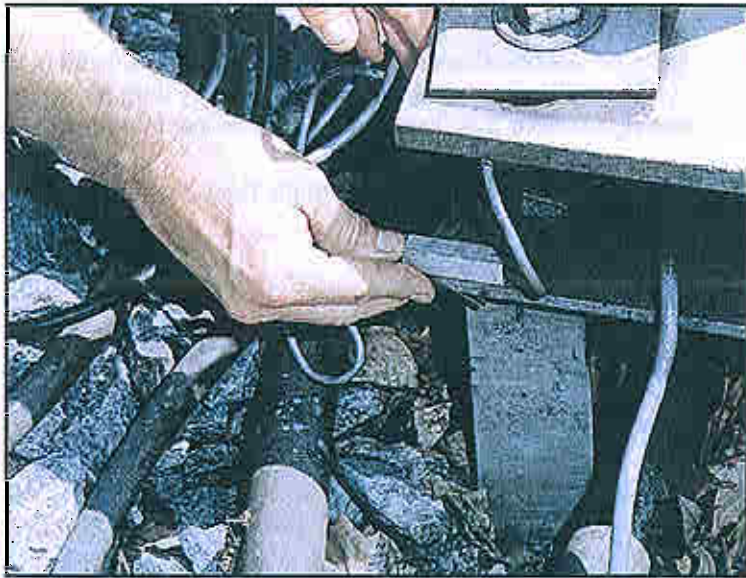


Figure 6-7: Placing the reference block out of direct sunlight

NOTE: If a new pre-amplifier is installed for any reason, allow the pre-amplifier to assume ambient temperature before doing a heat verification test on it. A newly installed pre-amplifier assumes ambient temperature in about two hours.

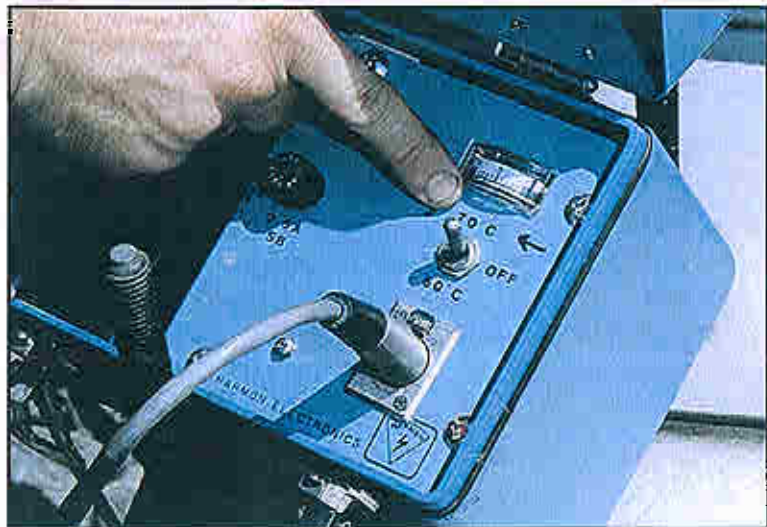


Figure 6-8: Calibrated heat source set to 70 degrees C

QUARTERLY

Additional Tools Needed:
(See Figure 6-9)

Metal tape line
24-inch level
Harmon scanner alignment fixture
Harmon Laser Alignment device
Appropriate hand tools

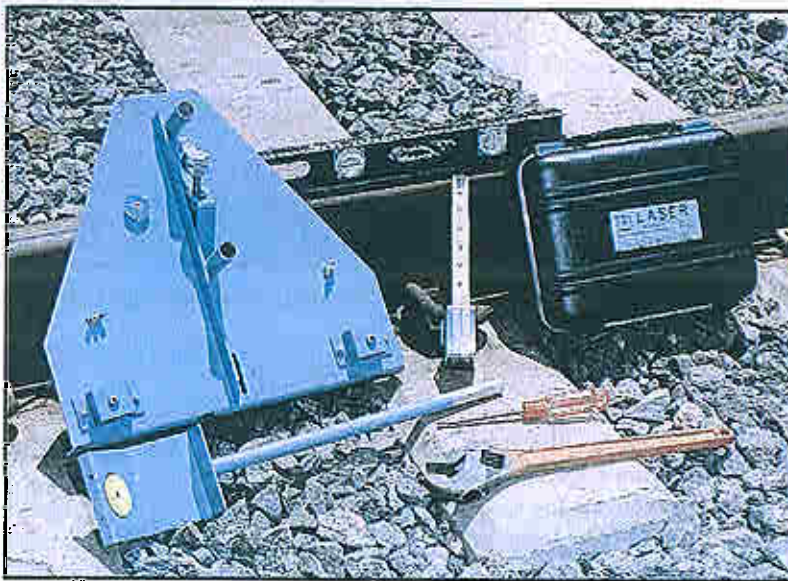


Figure 6-9: Additional tools needed for quarterly test

1. Perform the weekly and monthly tests.
2. The following measurements must be maintained for “inside scan” Harmon scanners. On the same rail as the transducers, the centerline of the transducers, which is the centerline of the gate, must be 24-1/2 inches from the centerline of the optical system. The centerline of the optical system is identified by the scribe mark that is perpendicular to the rail on the Universal Scanner.

The transducers must be spaced so that there is 17 inches from the center of the A transducers to the center of the B transducer. Each transducer must be 1-3/4 inches plus 1/8 inch minus zero from the top of the rail. The scanner view hole must be at 1 inch plus or minus 1/8 of an inch below the top of the rail. Maintain 6-3/4 inches distance from the gauge of the rail to the scribe mark that is parallel to the rail on the Universal Scanner view hole. Make sure that the scanner protective shutter assembly is level.



Figure 6-10: Measuring 24-1/2 from the gate to the optical system

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Using a triangulation method, check to be sure the scanners are located squarely across from each other. Place a small nail in a tie or measure and mark a concrete tie at the exact center of the track approximately 10 to 15 feet from the scanners.



Figure 6-11: Maintainer using triangulation procedure

Using a metal tape line, measure the distance from the nail or mark to the front edge of the scanner view hole that is installed on the same rail as the transducers. Note the distance. Now measure the distance from the nail or mark to the front edge of the other scanner view hole to be sure that it is the same. If it's not within 1/2 inch, move the second scanner boiler plate or foundation until it is. Make sure that the scanner protective shutter assembly is level.

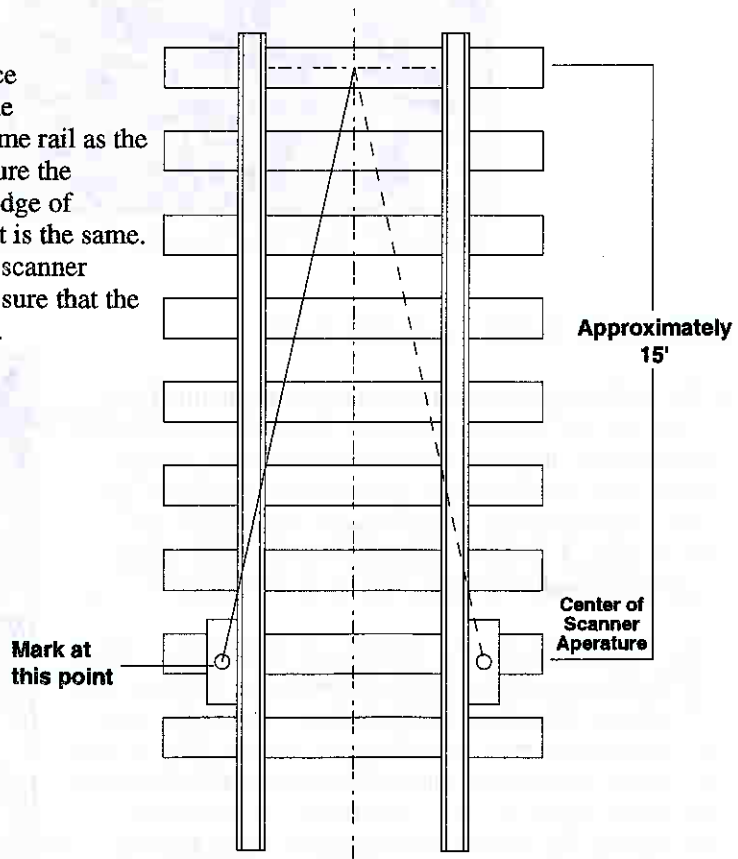


Figure 6-12: Diagram of triangulation

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3. Place the scanner alignment fixture on the rail between the wheel gate transducers 26 inches from the centerline of the Universal Scanner (the perpendicular scribe mark). Make sure that the fixture is stable and level by using the leveling bubble built into the fixture. Place the target paddle in the hole closest to the rail of the scanner alignment fixture (inside scan). Turn the system OFF and replace the scanner pre-amp with the laser device. Turn the system back ON and turn on the laser device. The laser beam should be visible in the center of the target paddle plastic nut (provided with the laser box). Adjust the mirror mounting, if necessary, to accomplish this. Repeat for the other side.



Figure 6-13: Alignment fixture attached to a rail



Figure 6-14: Laser device and mirror adjustment

4. Check the Harmon 1140B motion detector by doing the following:
 - a. Using the Simpson 260, Fluke 27/87, or the equivalent, insert the positive lead into the red test jack on the motion detector module.
 - b. Insert the black lead into the black test jack on the power amplifier card. The meter should read $200\text{VDC} \pm 5\text{VDC}$. Adjust the potentiometer on the transmitter board, if necessary, to obtain this reading.
 - c. Set the island adjustment by placing a .06 ohm shunt 3 feet outside the receive track leads.
 - d. Monitor the voltage across the island relay and adjust the receiver sensitivity potentiometer full clockwise. Voltage across the relay should read $\pm 1\text{VDC}$ of the battery supply voltage.
 - e. Reduce the potentiometer slowly counterclockwise until the relay voltage drops to 0 volts.
 - f. Tighten the lock nut.
 - g. Remove the shunt and the relay should energize $\pm 1\text{VDC}$ of the battery supply voltage.

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5. Measure the track gauge and check the surface of the track by observing the passing of a train. Notify proper authorities if the track conditions do not meet CSX standards.



Figure 6-15: Maintainer watching train by site

Harmon WCO-32 General Description

The Model 32 Hot Box Detector is designed to operate with Model 33 Ballast or Tie Mounted Scanners and the Model 3300 Rail Mounted Scanners. It provides all normal hot box detector functionality and has the capability to provide several types of alarm analysis:

- Simple Ratio
- Differential
- Absolute
- Carside Slope

The Model 32 Hot Box Detector broadcasts information via radio transmission to the train that was scanned most recently. The message broadcast conveys all faults detected by the system. Information passed to the crew and printed on a local printer includes the:

- Length of train in feet
- Train speed
- Axle number
- Side of the train
- Direction of travel
- Site location
- Type(s) of alarms detected

If one or more hot boxes have occurred, a summary of all heat levels for all journals on any car having a defect is printed. If dragging equipment (D.E.) is detected, then the D.E. number and the corresponding nearest axle number are printed. Otherwise "No Alarms" is printed.

NOTE: If a hot box is detected, the defective axle number is given as a count from the head of the train. If a hot box is detected with a high or wide load (assuming the high or wide load option was selected), a *nearest* axle count is included.

Model WCO-2 or WCO-27 Data Recorder

The Model WCO-2 or WCO-27 chart data recorder is a dual channel, thermal writing strip chart recorder. A significant feature of this recorder is its ability to use analog pens to reproduce digital data.

The channel one pen records the train direction, time, and date immediately after train passage. The channel two pen provides a printout of the total axle count, total cars, train speed, train length and type, and number of alarms. If the Model 34 signal processing unit is equipped with a Data Communications Processor (DCP), the channel two pen prints train direction, time, and date and time of train passage.

This microprocessor-based recorder has its logic circuitry, pen motor amplifiers, and power supplies all on a single plug-in Printed Wiring Board (PWB).

The front panel of the recorder includes test points, attenuator switches, and chart drive controls that allow the recorder to be used as a troubleshooting device.

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Model 34 Signal Processing Unit

The signal processing unit consists of a rack mounted enclosure containing a plug-in power supply card, built-in card extender, display/control panel, and a set of system cards.

All control, self-testing, and readouts are available at the control panel. The main power switch controls all power supplies for the system cards. The LED above the power switch indicates that the 5 volt power supply is operative. Individual circuit breakers are provided for the +5 VDC, +12VDC, and -12VDC supplies. The main power switch is also a circuit breaker that aids in protecting the primary side of the circuitry.

Inside the front panel door is a label outlining the system configuration and basic control usage. The built-in card extender is located on the right side behind the front panel door, and any system function card can be tested and adjusted while plugged into the extender card. The system function cards operate in any card slot and in any order. It is recommended that all cards be placed in consistent order to maintain uniformity among WCO-32 sites.

System Setup

The software documentation contains switch settings that are specific to each railroad since the software is customized to meet operating rules. Refer to the software documentation and the railroad operating rules before attempting to set up the system.

Analog Board Potentiometer Settings

Alarm levels can be set by using one of two methods. The first method is through potentiometers (pots) on the analog boards. The other method is to set them through a Data Communications Processor (DCP). If a DCP is installed, it is advisable to set and verify the alarm levels on the analog boards with the DCP turned off.

pot 1 (R28 on Analog II, R116A on Analog I)
Low Limit for simple (single) alarm analysis

pot 2 (R29 on Analog II, R116B on Analog I)
High Limit for absolute alarm analysis

pot 3 (R30 on Analog II, R122C on Analog I)
Carside Slope for carside alarm analysis

pot 4 (R31 on Analog II, R122D on Analog I)
Carside Low Limit for carside alarm analysis

pot 5 (R32 on Analog II, R123E on Analog I)
Gate Transducer Spacing

pot 6 (R33 on Analog II, R123F on Analog I)
Hot Wheel Limit (if installed)

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Pot	Parameter	Mimimum	Maximum	CSX values
1	Low Limit	5mm	15mm	8
2	High Limit	5mm	24mm	16
3	Carside Slope	.68	2.36	1.31
4	Carside Low Limit	5mm	15mm	7
5	Transducer Spacing	15 inches	30 inches	17
6	Hot Wheel Limit	15mm	24mm	N/A

Universal Processor Board

This board contains four DIP switches that are used for many different purposes, but are mainly for the selection of the type of scanners that are installed. Because the hot box detector software performs different integrity tests depending on the scanner type, it is necessary to select the type of scanners installed. (Refer to the software documentation for specific switch settings.)

Speech Board

The system milepost location is set on the speech board. DIP switches S1 and S2, located at the upper rear corner of the speech board, are used to set the milepost location.

The maximum number of alarms can also be set on the speech board. DIP switch S3 controls the maximum number of alarms that a system processes before an integrity failure condition exists.

DCP-3 Board & Parameters

The DCP-3 is an add-on product that adds data storage and data communications capabilities. For operating parameters and physical parameters, see the CSX DCP-3 software documentation.

Display Board

There are 16 DIP switches located on the front panel of the display board. These switches are used for many different purposes, for example, multi-track selection, data logging feature selection, safety messages, etc. (Refer to the software documentation for specific switch settings.)

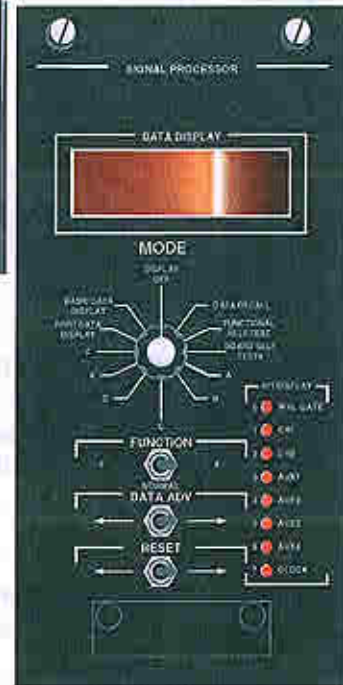
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Mode Switch Options:

- Display Off
- Data Recall
- Functional Self Test
- Board Self Test
- A-Display pot Settings
- B-CHOP
- C-Set Time and Date
- D-Recorder Calibration
- E-Continuous Test Train
- F-Tone Test/Display Temp
- Port Data Display
- Basic Data Display



Figure 6-16: Display board



NOTE: Refer to the owner's manual for descriptions of all tasks that can be accessed through the mode positions and proper operation of any positions used.

Model 35 Power Supply Description

The Model 35 power supply provides regulated +47VDC preamp power and DC reference shutter supply. The supply also provides unregulated +24VDC for protective shutter and integrity drive.

Physical Layout

The basic system is configured on a standard 84-inch relay rack containing the following system units:

Model WCO-2/WCO-27 Data Recorder

- Recorder Module
- Recorder Control Module

Model 34 Signal Processor

- | | |
|------------------------------------|--------------------|
| • Digital I/O Board | HPN 225809-000 |
| • Display & Test Board | HPN 226046-000 |
| • Analog II I/O Board | HPN 226348-000/007 |
| • Universal Processor Board | HPN 225807-000 |
| • Memory Board | HPN 225814-000 |
| • Speech Board | HPN 225815-000 |
| • DCP-3 Board | HPN 226459-000 |
| • Serial I/O - Time and Date Board | HPN 226264-000 |
| • Main Power Supply | HPN 225850-000 |

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Model 35 Power Supply

Wilmore Model 1403-12--500 Watt Inverter

Specifications

Power Requirements

Model 34 Universal Signal Processor
120 VAC, 60 Hz., less than 200 watts

Model 35 Power Supply
120 VAC, 60 Hz., less than 60 watts

Environmental Temperature

-40 degrees C to + 60 degrees C (-40 degrees F to + 140 degrees F)

Train Speed

8 MPH to 150 MPH

Tie/Ballast Mount Scanner

Power Requirements

Input Voltage +24VDC at 1 amp
110VAC
Heater Rating 200 watts at 110VAC
Approximately 54.5 degrees C

Operating Temperature

-40 degrees C to 60 degrees C

Harmon 32 with 33 Ballast Mount Scanner Parts Identification

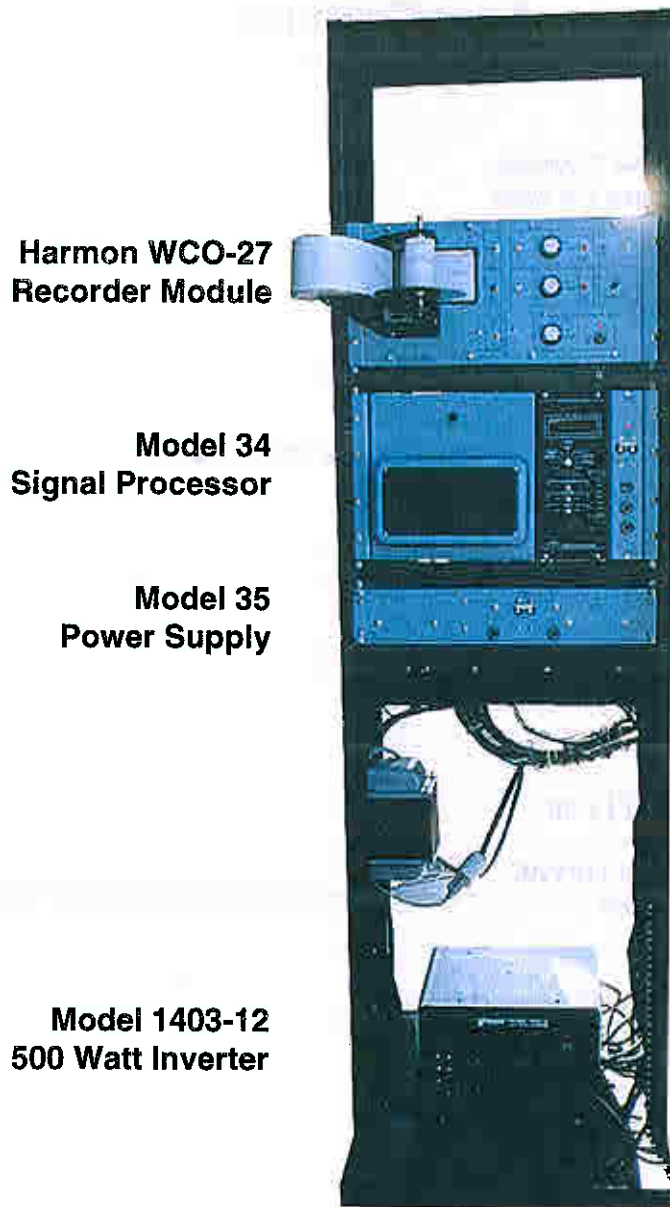


Figure 6-17: System layout

Harmon 32 with 33 Ballast Mount Scanner Parts Identification

**Harmon WCO-27
Recorder Module**

**Model 34
Signal Processor**

**Model 35
Power Supply**

**Model 1403-12
500 Watt Inverter**

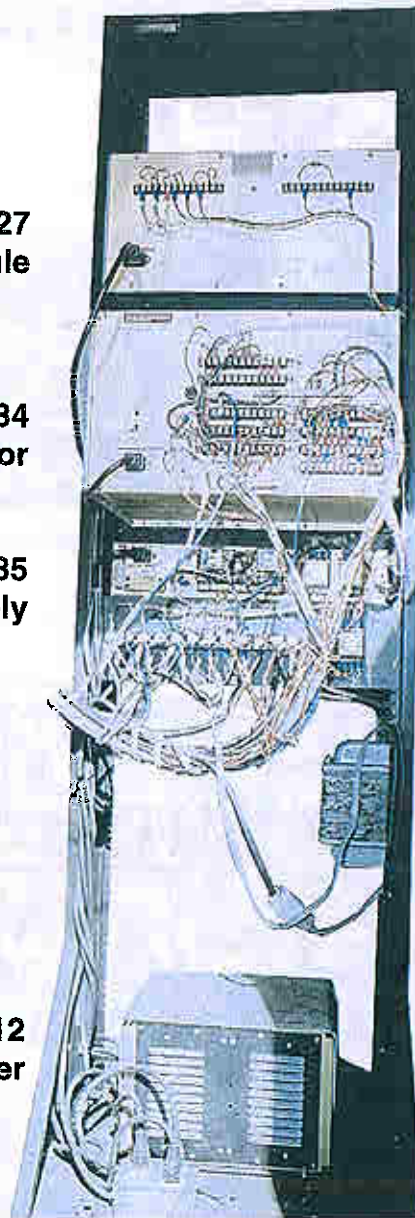


Figure 6-18: Rear view

Harmon 32 with 33 Ballast Mount Scanner Parts Identification



Figure 6-19: Scanner plate with pre-amp and reflector mirror

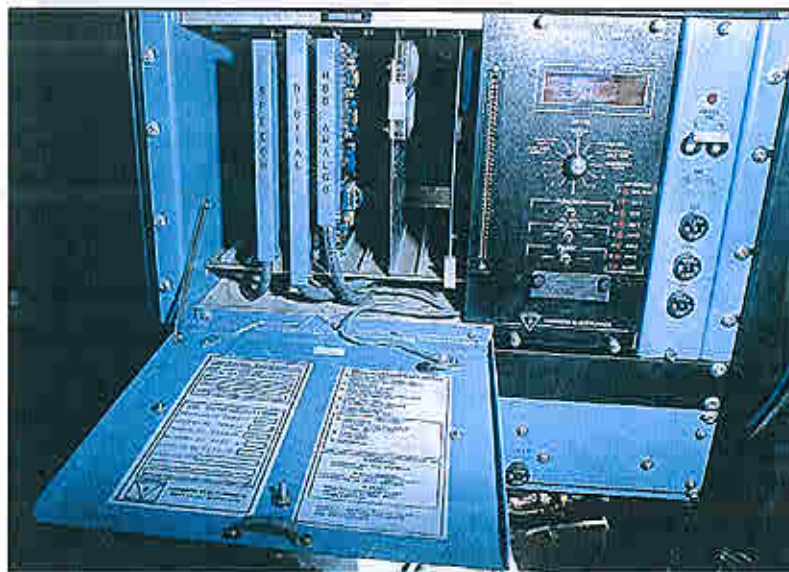


Figure 6-20: Signal processor panel lowered

Harmon 32 with 33 Ballast Mount Scanner Parts Identification

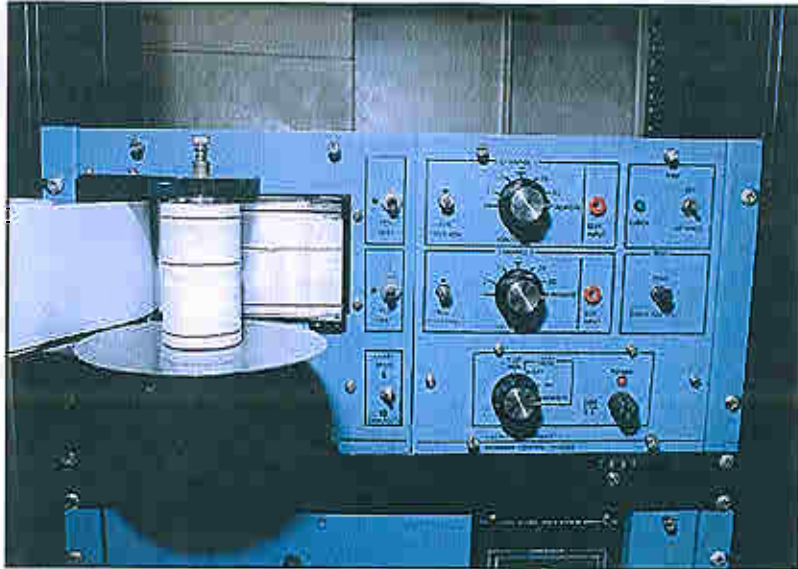


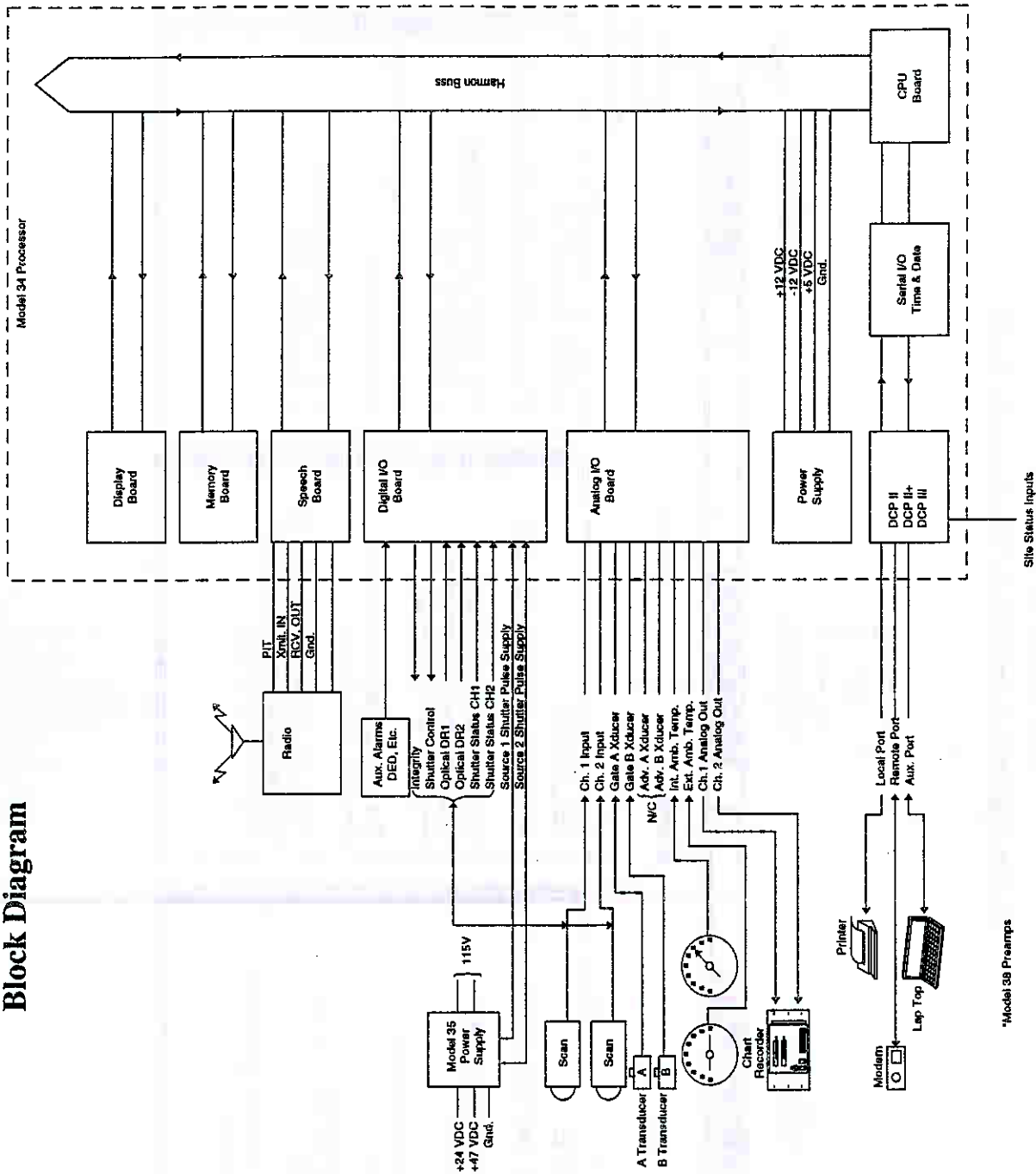
Figure 6-21: Recorder



Figure 6-22: Laser device

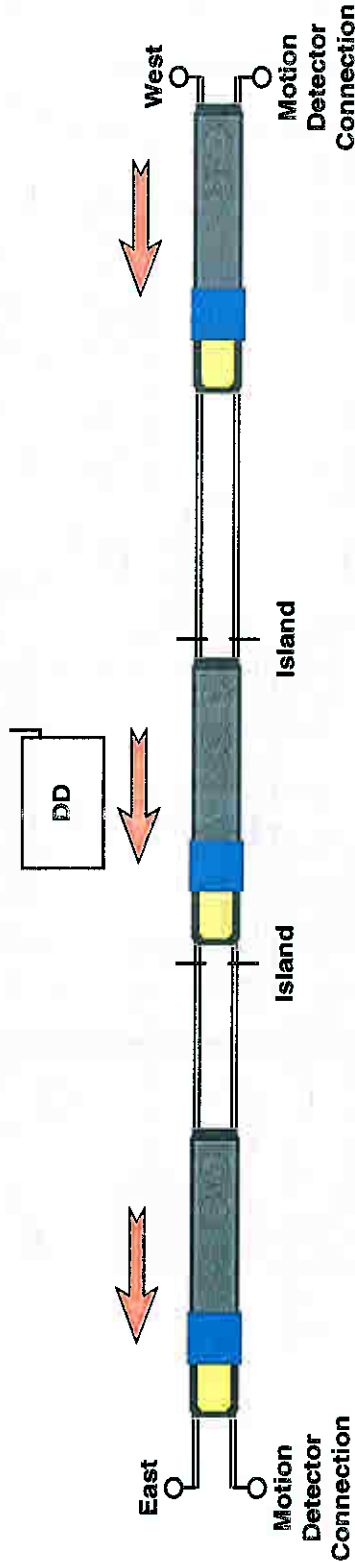
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Harmon 32 with 33 Ballast Mount Scanner Block Diagram



Harmon WCO-32

Basic Operation and Train Movement Chart



OFFSITE

- The island circuit is deactivated.
- The system performs the post-train test.
- The motion detector is deactivated.
- The departing message is transmitted.
- The chart recorder prints the train information.

ISLAND

- The island circuit is activated.
- The chart recorder starts recording and the greeting message is transmitted.
- The system establishes the direction of the train.
- The system checks all axes and stores/charts the data, issuing alarms if necessary.

APPROACH

- The motion detector is activated.
- The system performs the pre-integrity test.
- The case heaters turn off and the shutters open.
- The system passes the pre-integrity test.

Harmon WCO-3 Basic Operation

Expanded Train Movement Description

The sequence of events for the following three train-processing categories are described in detail:

- Train approach
- Train on the island circuit
- Train off site

Train approach

- The motion detector is activated. The motion detector relay (MDR) drops or de-energizes.
- The hot box detector performs a pre-integrity test. An internal heater is activated causing the pre-amplifier to read an absolute alarm on each channel.
- The shutters open and remove power from the scanner cover heaters.
- The system either passes or fails the pre-integrity test.

Train on the island circuit

- The train enters the island circuit of the motion detector. The island circuit relay (ISR) drops or de-energizes.
- The chart recorder starts recording the activity.
- The greeting message is transmitted.
- After more than 3 wheelgates have occurred, the system establishes the direction of the train.
- The system checks all axles and stores/charts all data. Alarms are broadcast as they occur via a 3-second tone.

Train off site

- The island circuit energizes the ISR.
- The system performs the post-train test (the same as the pre-test, except only on one channel).
- The system passes or fails the post-train test.
- Once the the train leaves the motion detector circuit or 8 seconds elapse since the last wheelgate, the hot box detector transmits the departing message with appropriate alarms and locations given from the head of the train. The chart recorder prints the information.

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Arrival Messages

The following chart identifies the arrival messages and alarms that occur:

Condition	Message Spoken	
<p>Passes system integrity tests.</p>	<p>1/4 second 1000Hz tone "CSX Equipment Defect Detector" "Milepost zzx Point x" (Leading zeros not spoken.) (If all digits are zero, the milepost phrase is not spoken.) "Track Number x" - or - "North/South/East/West Track" (Select the number or direction of the track if double track installation.) "Dragging Equipment Malfunction" (Announced if dragging equipment test failed.) "High Load Malfunction" (Announced if high load equipment test failed.) "Wide Load Malfunction" (Announced if wide load equipment test failed.)</p>	<p>3 second 1kHz tone (Sounds for each alarm upon detection.)</p>
<p>Fails system integrity tests.</p>	<p>1/4 second 1000Hz tone "CSX Equipment Defect Detector" "Milepost zzx Point x" (Leading zeros not spoken.) (If all digits are zero, the milepost phrase is not spoken.) "Track Number x" - or - "North/South/East/West Track" (Select the number or direction of the track if double track installation.) "Dragging Equipment Malfunction" (Announced if dragging equipment test failed.) "High Load Malfunction" (Announced if high load equipment test failed.) "Wide Load Malfunction" (Announced if wide load equipment test failed.) "Hot Box Detector Malfunction" "End of Transmission"</p>	<p>No real time alarm tones are transmitted.</p>

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Post-Train Messages

The following chart identifies the post-train messages that occur:

Condition	Message Spoken
<p>Passes system integrity tests with no alarms.</p> <p>Passes or fails end-of-train integrity tests.</p>	<p>"CSX Equipment Defect Detector"</p> <p>"Milepost zzx Point x" (Leading zeros not spoken.) (If all digits are zero, the milepost phrase is not spoken.)</p> <p>"Track Number x" - or - "North/South/East/West Track" (Select the number or direction of track if double track installation.)</p> <p>"No Defects" (Announced if there are no hot box defector malfunction conditions.)</p> <p>"Hot Box Defector Malfunction" (Announced if the end-of-train integrity tests failed.)</p> <p>"Axle Count Malfunction" (Announced if the train is too slow, stopped, or reversed its direction.)</p> <p>"Dragging Equipment Malfunction" (Announced if dragging equipment test failed.)</p> <p>"High Load Malfunction" (Announced if high load equipment test failed.)</p> <p>"Wide Load Malfunction" (Announced if wide load equipment test failed.)</p> <p>"Train Length zzzx Feet" (Announced if the front panel switch is selected.)</p> <p>"Train Speed zzx Miles Per Hour" (Announced if the front panel switch is selected.)</p> <p>"Total Axles zzx" (Announced if there is not an axle count malfunction condition and if the front panel switch is selected.)</p> <p>"Total Cars zzx" (Announced if the front panel switch is selected.)</p> <p>"Temperature zzx Degrees" (Announced if the front panel switch is selected.)</p> <p>Message announced 1-3 times. ***Safety Message Switch Selectable***</p> <p>"End of Transmission"</p>
<p>Passes system integrity tests with alarms.</p>	<p>"CSX Equipment Defect Detector"</p> <p>"Milepost zzx Point x" (Leading zeros not spoken.) (If all digits are zero, the milepost phrase is not spoken.)</p> <p>"Track Number x" - or - "North/South/East/West Track" (Select the number or direction of track if double track installation.)</p>

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Condition	Message Spoken
Passes system integrity tests with alarms. (continued)	"Count from Head of Train" (Announced if there is not an axle count malfunction condition.) "First Hot Box - N/S/E/W Rail - Axle zzx" (If there is an axle count malfunction, the axle phrase is not spoken.) "Second Hot Box - N/S/E/W Rail - Axle zzx" (If there is an axle count malfunction, the axle phrase is not spoken.) "First Dragging Equipment - Near Axle zzx" (If there is an axle count malfunction, the axle phrase is not spoken.) "First High Load Near Axle zzx" (If there is an axle count malfunction, the axle phrase is not spoken.) "First Wide Load - N/S/E/W Rail -Near Axle zzx" (If there is an axle count malfunction, the axle phrase is not spoken.) "Second Wide Load - N/S/E/W Rail - Near Axle zzx" (If there is an axle count malfunction, the axle phrase is not spoken.) "Hot Box Defector Malfunction" (Announced if the end-of-train train integrity tests failed.) "Axle Count Malfunction" (Announced if the train is too slow, stopped, or reversed its direction.) "More Defects" (Announced if the maximum number of defects is exceeded.) "Dragging Equipment Malfunction" (Announced if dragging equipment test failed.) "High Load Malfunction" (Announced if high load equipment test failed.) "Wide Load Malfunction" (Announced if wide load equipment test failed.) "Train Length zzzx Feet" (Announced if the front panel switch is selected.) "Train Speed zzx Miles Per Hour" (Announced if the front panel switch is selected.) "Total Axles zzx" (Announced if there is not an axle count malfunction condition and if the front panel switch is selected.) "Total Cars zzx" (Announced if the front panel switch is selected.) "Temperature zzx Degrees" (Announced if the front panel switch is selected.) Message announced 1-3 times. ***Safety Message Switch Selectable*** "End of Transmission"
Fails system integrity tests.	No post train message transmits.

Harmon Model 1140B/1141B Motion Detectors

General Description

1. The Harmon Model 1140B and 1141B Motion Detectors are designed for use as restart circuits in conjunction with Harmon Audio Frequency Train Activated Circuit (AFTAC) or existing track circuit systems in grade crossing protection applications. The device detects the decreasing level of its transmitted signal in the rail caused by the circuit-shortening effect of the approaching train. The motion detector is sensitive enough to provide detection when the rate of signal level decrease reaches .1 db per second. Therefore, the detection distance of the motion detector is a function of train speed.

Detection distance is relatively stable over a wide range of varying ballast conditions, but it is reduced in instances of very poor ballast resistance and other heavy track load conditions. Under nominal conditions, the motion detector should provide 25 seconds or more warning time at train speeds to 35 m.p.h.

Channels are provided in the frequency spectrum from .5 KHz to 10.2KHz. Detection distances under good track conditions may be expected to 2,500 feet up to 4 KHz for fast-moving trains. Slow-moving trains are provided about 25 seconds warning time, but an appropriately shorter detection distance results. Channels above 3.5 KHz are attenuated more and provide shorter detection distances. The higher frequencies can be employed when it is desired to limit the "look" distance of the unit. Since track conditions affect the distance capability, the chart in the specification section may be used only as a rough guide.

Since the motion detector does not sense a slow-moving train until it is relatively close for 25 seconds warning time, time-out circuits should be planned for track circuits in which slow-moving trains might stop prior to initial detection. If the train continues to approach the motion detector at the reduced speed (or after a stop and subsequent acceleration), it is "reacquired" by the motion detector when its speed is such that the decreasing signal level rate reaches the pre-set sensitivity level.

2. The motion detector contains an island circuit that is adjustable from a point about 10 feet from the points of coupling to the rail to its maximum distance. The "ring-by" of the island circuit is about 5 feet. The motion detector also contains a positive island circuit, which, when employed, provides a failsafe island section. If the positive island circuit is used, two 1,000 ohm neutral relays must also be used.
3. The motion sensing circuit relay output is redundant and is fed in series through two mercury-wetted relay contacts.
4. The motion detector, beyond the established island circuit, does not have built-in protection against either an open rail or a shorted rail situation. To provide this safety feature, an AFTAC or other wrap around circuit is recommended. The circuit should be set up to withhold control of the crossing protection relays until the motion detector has acquired the train. (See the schematic drawing section in the *Harmon Model 1140B/1141B Motion Detector* manual for sample relay logic.)
5. The unit operates on any stable nominal 12VDC (10.5 to 14VDC) externally provided power source and contains internal regulation, a rectifier surge protection panel, and 230VDC gas gap discharge devices across connections to the rail for protection against external overvoltages to a front steepness of up to

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5 KV per microsecond (5,000 amps over 20 microseconds). The unit draws approximately 1 amp (2 ohm load).

6. The relay output power provides about 12VDC to a 500-ohm relay if the battery source is 12VDC. If the battery source is less than 12VDC and the relay is less than 500 ohm (or two 1,000 ohm relays if the positive island circuit is used), then the relay output is proportionately lower than 12 volts.
7. Both the transmitter section and receiver section connections to the rail must be made through railroad provided external lightning protection devices (an equalizer and two heavy-duty arrestors for both sets of leads).

CAUTION: Polystyrene capacitors are used in the motion detector for frequency stability; therefore, it should not be subjected to temperatures over 160 degrees F.

8. When insulated joints exist within the desired track circuit, series-tuned coupling units are available for by-passing the insulated joints.
9. If the motion detector is connected to the rail employing the same leads as the battery of a DC track circuit, a reactor must be placed in series with one of the battery leads and rail (not between the motion detector and the rail). The reactor reluctance should be 10 ohms or higher at the motion detector frequency.
10. Typical circuit block diagrams appear in the schematic section of the *Harmon Model 1140B/1141B Motion Detector* manual.
11. When the motion detector is employed on a rusty rail, a time constant prevents the premature release of crossing protection that would be created by a train moving from shiny to rusty rail within the motion detector limits. It should be noted that this time constant also provides some false activation of crossing protection if transient shorts are experienced. The time constant is by-passed within the island circuit limits so that excessive "ring-by" does not occur. Unless otherwise specified, the time constant is approximately 15 ± 5 seconds. If it is desired to reduce the loss of shunt pickup delay, replace the 2mfd capacitor C8 on the motion detector (124B-1) module. Note that .68mfd provides about 8 seconds and .33mfd provides about 3 seconds. Due to inherent circuitry delays, a lower pickup delay cannot be obtained.

NOTE: The motion detector contains mercury-wetted relays mounted on the surge panel; therefore, the cabinet should be mounted in a horizontal position.

12. Since the motion detector senses decreases in its own signal level strength in the rail, it is also sensitive to power source fluctuations and inductively induced spikes. Momentary power source drops exceeding .5VDC cause the motion detector to "drop out." For this reason, surge suppressors should be provided in any circuit that draws any appreciable load, and a suitable reactor/capacitor should be provided in DC power leads to the motion detector. (Choke with .01H or more inductance and a 15VDC electrolytic capacitor of 25,000mfd or higher.) (Harmon 1182A)

The 1141A Motion Detector has a frequency modulated transmitter module (121A-7) for use as a transmitter with an FM AFTAC Receiver. The lowest modulating rate (Subtone A - 10Hz) cannot be used in the 1141A motion detector. Subtones B through F (16-84 Hz) can be utilized without detrimental effects.

Installation

1. Mount the cabinet in the physical location.
2. Attach the physical ground to the GND terminal.
3. Make rail connections (after lightning protection) to four rail terminals. (Two for the transmitter and two for the receiver). To effectively define the center of the crossing, connect the transmitter and receiver on opposite sides of the crossing.

NOTE: If the same leads are used for the DC track circuit connections, a reactor unit must be in one of the battery leads so that the battery will not present a "short" to the motion detector. Connect the motion detector leads between the reactor and rail.

4. If the motion detector is to be used beyond the limits of existing insulating joints, by-pass coupling units must be installed between the insulated joint connections.
5. Observing polarity, connect the (-) and (+) terminals to the 12VDC power source. Internal regulating is provided in the motion detector, and proper operation can be obtained from any stable 10 to 14VDC external power. Power below 12VDC, of necessity, results in reduced transmitter output and/or receiver relay output.
6. To adjust the motion detector transmitter output power, insert a voltmeter (250V scale) positive lead in the red test jack on the motion detector module, and insert the negative lead in the black test jack on the power amplifier. Turn on the transmitter potentiometer and adjust for 200VDC. This setting is the optimum transmitter output power and motion detecting sensing level. Lower levels can be used with slightly reduced sensitivity when the circuit is artificially shortened by a hardwire shunt. Tighten the lock nut. This should provide voltage on the test point of $200V \pm 5V$, and the voltage level on the rail will be $0db \pm 5db$.
7. Check the island circuit "ring-by" with a .06 ohm shunt. Under favorable ballast conditions, it should be 3 to 5 feet beyond the point of shunt connection during adjustment.
8. When the motion detector transmitter is used to activate a receiver at an adjacent location and additional power to the rails is required due to low ballast conditions, the following procedure can be used:
 - a. Increase the transmitter output by turning the potentiometer R5 clockwise to the desired output level.
 - b. Record this level for future adjustments. If a frequency selective voltmeter is not available, remove the track leads from the transmitter output, terminate the output with a 2 ohm load, and record the output level.
 - c. Place a DC voltmeter across the 200V test point and ground on the motion detector module. Reduce the input by turning the potentiometer R1 counterclockwise until the meter reads 200VDC.

NOTE: This procedure is applicable only on the Model 124B-1 Motion Detector module. The earlier versions do not have the input adjustment available.

Island Circuit Adjustment

1. Connect the voltmeter across the "relay" terminals, with the relay connected.
2. Connect an .06 ohm shunt across the rails at a point 3 feet beyond the desired island distance (for example, for a 100 foot island circuit, 53 feet from the center of the crossing). Only a C clamp type rail connection should be used on the shunt. A poor shunt means a long island during train passage.

NOTE: The island circuit should extend at least 3 feet beyond the motion detector rail connections.

If the ballast conditions are low or questionable, connect the shunt across the rails 10 feet beyond the desired island circuit distance. (This will result in somewhat longer "ring-by," that is, 25 to 30 feet from the island limit.) If the rails are rusty, it would be best to use an engine to set the island and monitor the rail with AC VTVM.

3. Observing the relay voltage on the meter, adjust the receiver sensitivity potentiometer (lower front section on the receiver printed circuit board) full clockwise (full turn of the pot to the right). The voltage across the relay should read battery supply voltage. Reduce the potentiometer slowly counterclockwise until the relay voltage drops to 0 volts. Tighten the lock nut.
4. Remove the shunt. The relay should energize ± 1 VDC of the battery supply voltage.

Harmon 1140B/1141B Motion Detector Parts Identification



Figure 6-23: Model 1140B Motion Detector

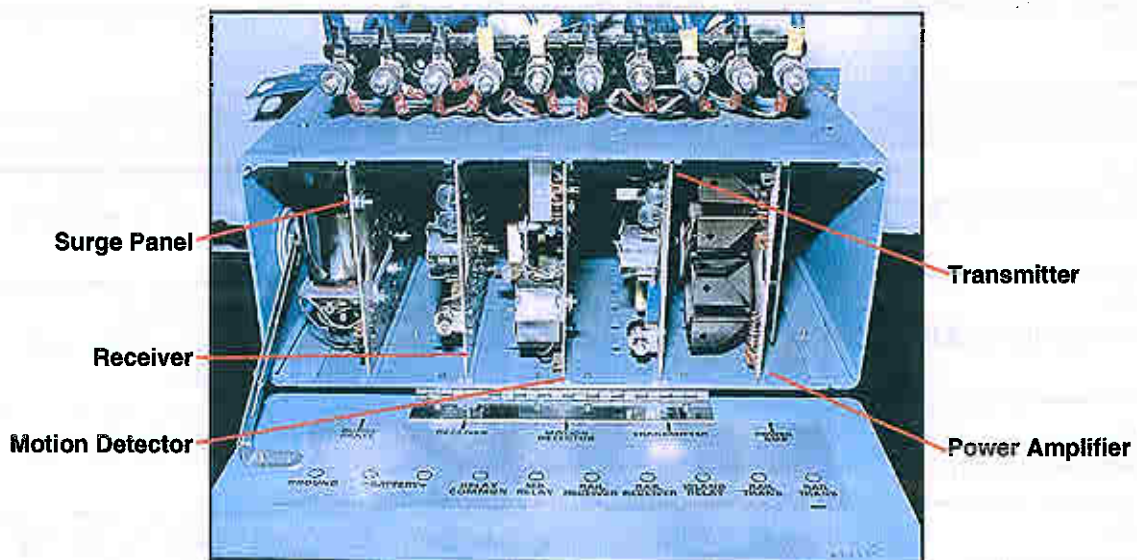


Figure 6-24: Model 1140B Motion Detector panel lowered

Standard Troubleshooting Procedure

System troubleshooting consists primarily of observing the system performance for the purpose of isolating trouble to a major assembly and then further isolating the trouble to a specific component or components within the major assembly.

As with any troubleshooting procedure, first determine whether the problem is inside or outside the processor unit. Consider first the internal steps to troubleshooting the hot box detector and then move to the external scanners, rack wiring, radio, cables, transducers, pre-amp, etc.

In order to effectively troubleshoot a defect detector system, the maintenance personnel should be familiar with how the system operates and be able to read and understand the block diagrams and circuit plans.

A defect system can be broken down into two basic sections:

- Rail or trackside equipment related to signal input
 - A. Transducers (provide approach or gating inputs)
 - B. Sensors (provide heat input)
 - C. Junction boxes, cabling, scanners (enable inputs to be sent to the house)
- Wayside equipment related to signal output:
 - A. Model 34 electronic chassis (amplifies heat signal and output for processing)
 - B. Recorder (charts heat profile of passing trains)
 - C. Power supplies (provide voltages for Harmon)

The Standard Troubleshooting Procedure is a general approach that can be applied to repairing defect detector equipment.

STANDARD TROUBLESHOOTING PROCEDURE	
Step 1: Identify the trouble symptom.	The trouble system lets the maintainer know that something is wrong with the equipment and will provide clues as to where the trouble can be found.
Step 2: Sectionalize the problem.	Each system or piece of equipment is divided into basic sections. Careful analysis of the trouble symptom (step 1) will direct the maintainer to the section that is in trouble.
Step 3: Localize the problem.	Each section of the equipment or system is further divided into circuits or components.
Step 4: Isolate the problem.	After localizing the faulty unit, circuit, or component, the trouble can be found by multimeter readings or a thorough visual inspection. Any voltage reading out of tolerance is a good indication of a problem in that circuit, or one feeding that circuit.

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STANDARD TROUBLESHOOTING PROCEDURE	
Step 5: Repair the problem.	Correct the circuit fault, or replace the defective unit or component.
Step 6: Perform an operational check.	Always check for proper equipment operation. Do not assume that the equipment is repaired by finding one fault.

A simplified example of applying the Standard Troubleshooting Procedures to the repair of defect detectors follows:

Upon arrival, take several minutes to analyze the visual evidence. Check the recorder graph and printout, if equipped with a printer. Check the AC power source and all power supplies in the system, making sure that all readings are normal. A careful examination of these sources, along with the trouble report information conveyed by the train crew and dispatcher, should enable the maintainer to analyze and determine what section the trouble is in. Refer to the systems block diagram and proceed in sectionalizing the problem area.

Now that the area of the equipment in trouble has been determined, further localize the problem to a specific card or module. Substitute a known good card or module for the suspected bad unit. If this clears up the trouble, perform an operational check and return the equipment to normal operation. If the trouble still exists, further isolate the problem to the faulty unit by checking the voltages in the area you have localized. The problem area frequently can be identified by finding an incorrect voltage level. If the voltage readings are not within specifications, repair or replace the faulty unit or component, and then perform the required operational checks to ensure that the problem is corrected. After successfully completing operational checks, restore the site to normal operation.

Normal voltage readings of all power supplies and gains that were previously logged should be referred to when proceeding through the troubleshooting procedure. Note that the block diagrams and/or truth tables supplied in the system manual are useful in helping to logically troubleshoot the defect detector system.

During train passage, both self-diagnostics and external system integrity checks are invoked. If a system error (malfunction) has occurred, then a detector malfunction message is sent to the train crew.

When a WCO-2 or WCO-27 chart recorder is used with the system, information regarding the trains passing the site is recorded and can be retrieved from memory for up to 4 trains. Other information and error codes can be printed after a train's heat profile and alarm messages (if any) are printed. These refer to program (software) and/or hardware deviations that might or might not have cleared up. Refer to the Harmon manual *Information and Error Codes* for an explanation of these error codes and possible action. This information can be very helpful in identifying and isolating trouble.

Troubleshooting the Harmon WCO-32 Detector

System malfunction problems and corrective actions are shown in the following table:

PROBLEM	ACTION
<p>Equipment defect detector malfunction</p>	<ol style="list-style-type: none"> 1. Run a functional self test to determine whether the problem is within the signal processor or external to it (for example, the scanners or other sensors, rack wiring, cable, radio, etc.) 2. Check the power supply voltages. Refer to "Work Procedure Number 3, Weekly." <p>NOTE: If voltages do not exist or are not within the allowable range or if the circuit breakers on the signal processor are tripped, refer to the chassis troubleshooting manual.</p> <ol style="list-style-type: none"> 3. Check to see if the Micro-monitor LED is flashing (at the lower edge of the processor board). If it is, the main program is not running correctly. Replace the processor board.
<p>Error codes BD0 through BD7 and XBD0 through XBD7</p>	<ol style="list-style-type: none"> 1. Run a board self test. <ol style="list-style-type: none"> a. If the boards are OK, go to step 2. b. If any boards fail: <ol style="list-style-type: none"> 1. TURN OFF THE POWER. 2. Replace the boards identified. c. If boards (analog, speech, or digital) still fail, then: <ol style="list-style-type: none"> 1. Disconnect the front connector. 2. Re-run the board self test. (If it passes with the connector disconnected, the problem is external, for example, dragger, radio malfunction, car clearance detector, etc.) 2. If there is no display present, replace the display board. <p>NOTE: Refer to the detector owner's manual for the display board removal procedures.</p> <ol style="list-style-type: none"> 3. If the problem appears to be external to the signal processor, check the voltages for the WCO-35 power supply. (Voltages should comply with the weekly work procedure requirements.)

Troubleshooting the WCO-38 Scanners and Pre-Amplifier

Scanner and pre-amplifier problems and corrective actions are shown in the following table:

PROBLEM	ACTION
<p>Hot box detector does not see enough heat (NO_MIN_LEVELS)</p>	<ol style="list-style-type: none"> 1. Place the HBD system in CHOP mode or perform a system self test train to verify that the protective shutter opens. 2. Clean the mirror. 3. Place the calibrated heat source on the top of the scanner with the heat block covering the scan hole. With the HBD system in CHOP mode, the data display should show $15\text{mm}\pm 1\text{mm}$. If a reading of $15\text{mm}\pm 1\text{mm}$ is not obtained, replace the pre-amplifier. 4. If the mirror is clean and the pre-amplifier sees enough heat from the calibrated heat source, verify that the scanner is in proper alignment. If all of the trackside equipment is working correctly, the problem might be in the Model 34 wayside electronics or cabling.
<p>Protective shutter stuck closed (error codes SHW-2 or SHW-3)</p>	<ol style="list-style-type: none"> 1. Perform a self test train on the hot box detector to verify that the protective shutter opens correctly. 2. Check the protective shutter for foreign material that could be keeping it in the closed position. 3. Remove the scanner cover and check for binding or worn parts. Replace the parts if they appear to be faulty. 4. Holding the protective shutter in the open position, verify approximately 0VDC on TB14-11/12. 5. Check the solenoid motor and replace if defective.

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PROBLEM	ACTION
Protective shutter stuck open (error codes SHW-1 or SHW-0)	<ol style="list-style-type: none"> 1. Verify visually that the protective shutter is closed. 2. Check the protective shutter for foreign material that could be keeping it in the open position. 3. Remove the scanner cover and check for binding or worn parts. Replace the parts if they appear to be faulty. 4. Holding the protective shutter in the closed position, verify approximately 12VDC on TB14-11/12. 5. Holding the protective shutter in the open position, verify approximately 0VDC on TB14-11/12. 6. Check the solenoid motor and replace if defective.
HBD, side 2 operation is marginal	Replace the pre-amplifier.
No integrity (error code SHX-4) - reference shutter HBD, side 1 operation is marginal	Replace the pre-amplifier.
No integrity (error code SHX-5) - reference shutter HBD, side 2 operation is marginal	Replace the pre-amplifier.
Sensor failed pre-train integrity test (error code CH-1 or CH-2 sensors)	<ol style="list-style-type: none"> 1. Check the output signal gain of the pre-amplifier by doing the following: <ol style="list-style-type: none"> a. Mount a calibrated heat source on the scanner. The heat source must cover the scanner opening. b. Place the system in CHOP mode. 2. Verify on the WCO2/WCO27 chart recorder that the applied heat produces approximately 14-15mm reading at 70 degrees above ambient. 3. Replace the pre-amplifier if the operation is marginal.

Troubleshooting the WCO-36 Transducers

Transducer problems and corrective actions are shown in the following table:

PROBLEM	ACTION
<p>Axle count malfunctions</p>	<ol style="list-style-type: none"> 1. Disconnect the cable for the suspected transducer or isolate the cable inside the wayside junction box. 2. Verify the wire polarity by doing the following: <ol style="list-style-type: none"> a. Be sure that the unit is disconnected from the HBD. b. Connect a DC voltmeter with the positive lead to the white wire and the negative lead to the black wire. c. Insert a metal object into the field of wheel pickup (top). A positive meter movement should be seen. If a positive deflection occurs, then the white wire is positive. If a negative deflection occurs, then the black wire is positive. d. Check the voltage and resistance with a Simpson TS-111. It should read either a minimum of 1 volt or have a resistance of 400-600 ohms between transducer leads. If no deflection is seen or if the resistance is not within the allowable range, replace the transducer. 3. Be sure that all cable connections are tight. <p>NOTE: Due to the strength of the magnets, it might be necessary to periodically clean metal filings from the top of the wheel transducers.</p>
<p>Gating transducer signals incorrect (error code W_4)</p>	<ol style="list-style-type: none"> 1. Be sure that the transducer is mounted securely at 35 foot-pounds. 2. Check the gate transducer output amplitude and polarity by doing the following: <ol style="list-style-type: none"> a. Be sure that the transducer is disconnected from the HBD. b. Connect a DC voltmeter with the positive lead to the white wire and the negative lead to the black wire. c. Simulate a wheel rolling into the positive and out of the negative transducer magnetic field. d. Observe the polarity of the output on the DC voltmeter. A positive meter movement should be seen. If a positive deflection occurs, then the white wire is positive. If a negative deflection occurs, then the black wire is positive.

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PROBLEM	ACTION
<p>Gating transducer axle counts not equal (error codes XA=HH, XB=HH, WHL GATE=TT)</p> <p>NOTE: HH is count of wheels crossing the transducer; TT is wheel gate count.</p>	<ol style="list-style-type: none"> 1. Check the gate transducers for defects (open or grounded). 2. Check the gate transducer wiring for defects (open, grounded, or polarity).
<p>Gate transducer wiring is incorrect; polarity is reversed (error codes XA REV or XB REV)</p>	<ol style="list-style-type: none"> 1. Check the gate transducer wiring for reversed polarity. 2. Check the gate transducer output amplitude and polarity by doing the following: <ol style="list-style-type: none"> a. Be sure that the transducer is disconnected from the HBD. b. Connect a DC voltmeter with the positive lead to the white wire and the negative lead to the black wire c. Simulate a wheel rolling into the positive and out of the negative transducer magnetic field. d. Observe the polarity of the output on the DC voltmeter. A positive meter movement should be seen. If a positive deflection occurs, then the white wire is positive. If a negative deflection occurs, then the black wire is positive.

Troubleshooting the WCO-2 or WCO-27 Data Recorder

Before checking the internal workings of the unit, a few preliminary checks should be made:

1. Be sure that all input connections, including power, HBD inputs, train passage and direction inputs (if any), proper interface option resistors used and proper interface jumpers are used as shown on CSX drawings.
2. Check that all controls are set up for the desired response from the recorder.
3. Check that the fuse is good.

If the problem still appears to be internal, the modules can be slid out together or independently (as required) to gain access to the recorder module, circuit board, etc. The recorder module contains only the recorder mechanism, pen heating transformers and controls, and the recorder drive relay. The remainder of the circuitry is in the recorder control module, mostly on the single circuit card.

CAUTION: The system can be run with the modules slid out, but line voltage is present at various points on the chassis.

Data recorder problems and corrective actions are shown in the following table:

PROBLEM	ACTION
Event pens not properly positioned.	Adjust the pen position potentiometer on the front panel for base line or zero millimeters on the chart paper.
Incorrect pen deflection (either high or low)	While holding in the print switch, adjust the gain potentiometers R84 (for channel 1) and R85 (for channel 2) for 15mm deflection. These potentiometers are located on the circuit board inside the recorder control module.
Excessive pen overshoot or undershoot	<ol style="list-style-type: none"> 1. While holding in the print switch, adjust the damping potentiometers R82 (for channel 1) and R83 (for channel 2) for pulses that are as flat as possible. These potentiometers are located on the circuit board inside the recorder control module. 2. Check the gain for 15mm deflection.
Recorder take-up reel slipping.	Replace the take-up reel drive belt.

Troubleshooting the 1140B and 1141B Motion Detectors

The motion detector problems and corrective actions are shown in the following table:

PROBLEM	ACTION
<p>No output relay voltage when no train present or no short exist between rails in island circuit</p>	<ol style="list-style-type: none"> 1. Check all wiring connections, fuses, and external power. Trouble can be traceable to dirty module tail plugs. 2. Check for broken track leads. 3. Check termination (WBS, NBS, hardwire). 4. Check the fuse. 5. Check for signs of severe lightning damage to printed circuit boards. 6. Check for 200VDC in the motion detector module (124B-1) test point. Level on the rail should be 1.4 to 3.2VAC. If this cannot be achieved, trouble may be in the transmitter or power amp. 7. Connect ACVTVM across terminals A and B of 121A board and check voltage for .5 to 1.5VAC. 8. If present, check the DC voltages from negative common to collectors of Q1, Q2, and Q3 for 8 to 12VDC in the 121A board. 9. Check the voltage across R8 for .1VDC \pm .02VDC on 121B board contacts 1 and 7. 10. Check the DC voltage negative common to collectors Q1 and Q2 for 8 to 12VDC on the 122A power amplifier 11. Check the DC resistance across terminals A and C on the power amplifier with the unit unplugged. (Continuity indicates a shorted capacitor.) 12. If the level on the rail is okay but it is still not possible to obtain 200VDC, check the voltage present at the collector of Q1 on the motion detector board (should be 10-12VDC). Check the bias on the emitter of Q1 (should be .15VDC across R7 - 1 ohm 1W resistor). Check for shorts on T1, T2, C1 through C6, and D1 through 7.

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PROBLEM	ACTION
No output relay voltage when no train present or no short exist between rails in island circuit (continued)	<p>13. If 200VDC is present but there is no relay voltage, use a Simpson VOM to check for the minimum range between 3 and +12V on pins R and S on the tail plug of the motion detector board. If either of these points is below 3V, the trouble may be due to a faulty Q2 or Q3 on the motion detector board.</p> <p>CAUTION: These are field effect transistors and must be handled with care. They are also matched units and whenever possible, replacement should be done by factory.</p> <p>14. If proper voltages appear on pins R and S, trouble could be a faulty relay 1 or 2 but would more likely be in the receiver. To determine this, check pins A and B of the receiver board for relay voltage. If no voltage appears, trouble is in the receiver. On the 131A receiver board, check the DC voltage from the negative common to collectors of Q1, Q2, and Q3 for 8 to 12VDC.</p>