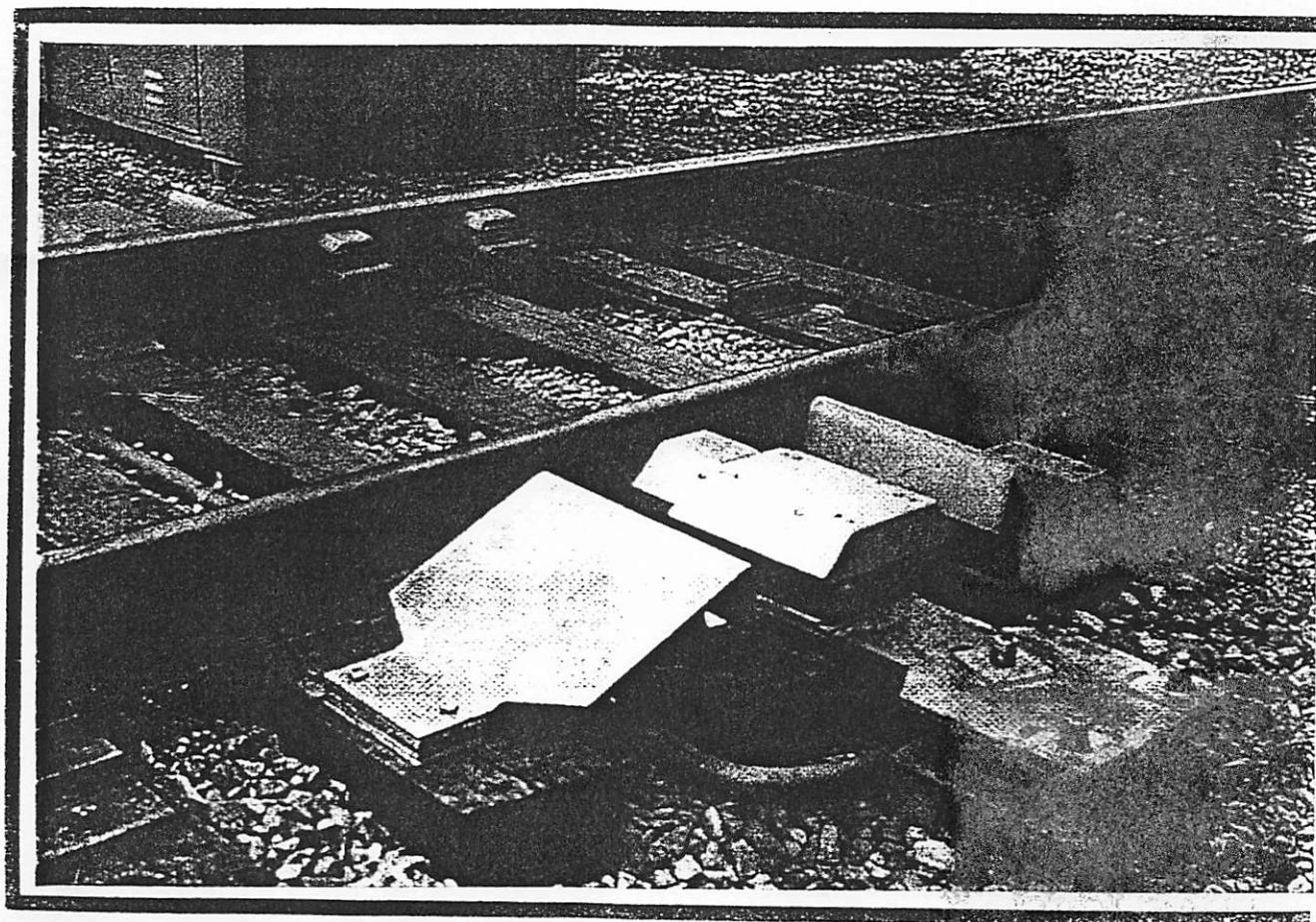
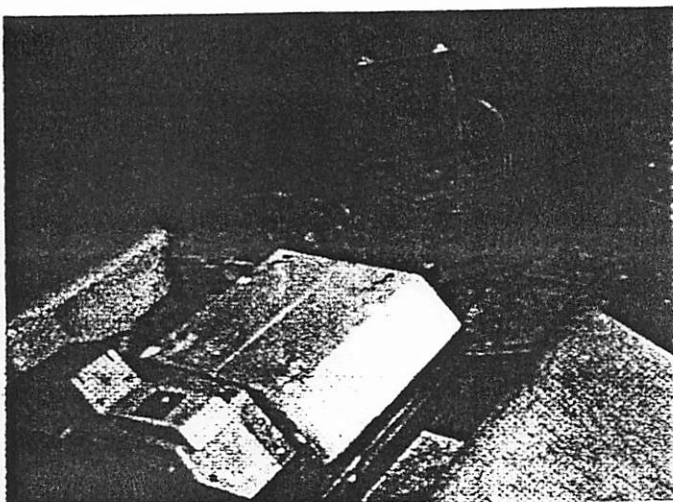

HARMON ELECTRONICS, INC.

HOT BOX DETECTOR SYSTEMS

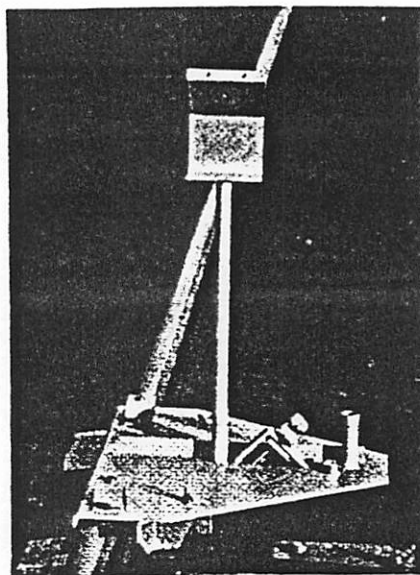


HOT BOX DETECTOR ALIGNMENT KIT



**CALIBRATED HEAT SOURCE
MODEL WCO-41A**

- Compact Size
- Ambient Temperature Probe



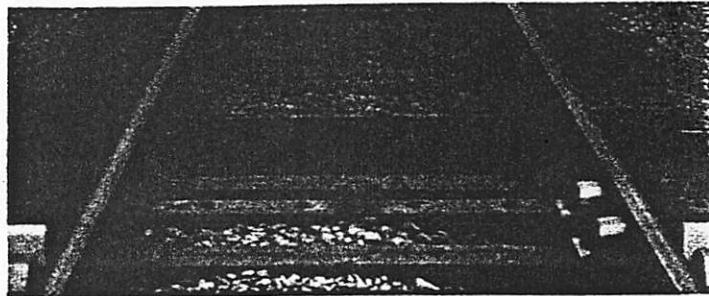
**TRACK ALIGNMENT FIXTURE
MODEL WCO-42A**

- Hot Box and Hub Wheel Alignment
- Magnetic Mount To Rail
- Easy Adjustment

COMPLETE TRAIN INSPECTION STATIONS



**HIGH WIDE LOAD
DETECTOR**



DRAGGING EQUIPMENT DETECTOR

The Harmon Advance Signal Processor for Hot Box Detector Systems was designed to be a Universal Microcomputer-Based System with the capabilities of essentially unlimited expansion. Through the use of interface cards the system has the capability to perform most functions that might be required in the complete train inspection station. Modular designs used in both the hardware and software of the system provide for ease of expansion and/or custom equipment configuration to meet the particular needs of the railroad.

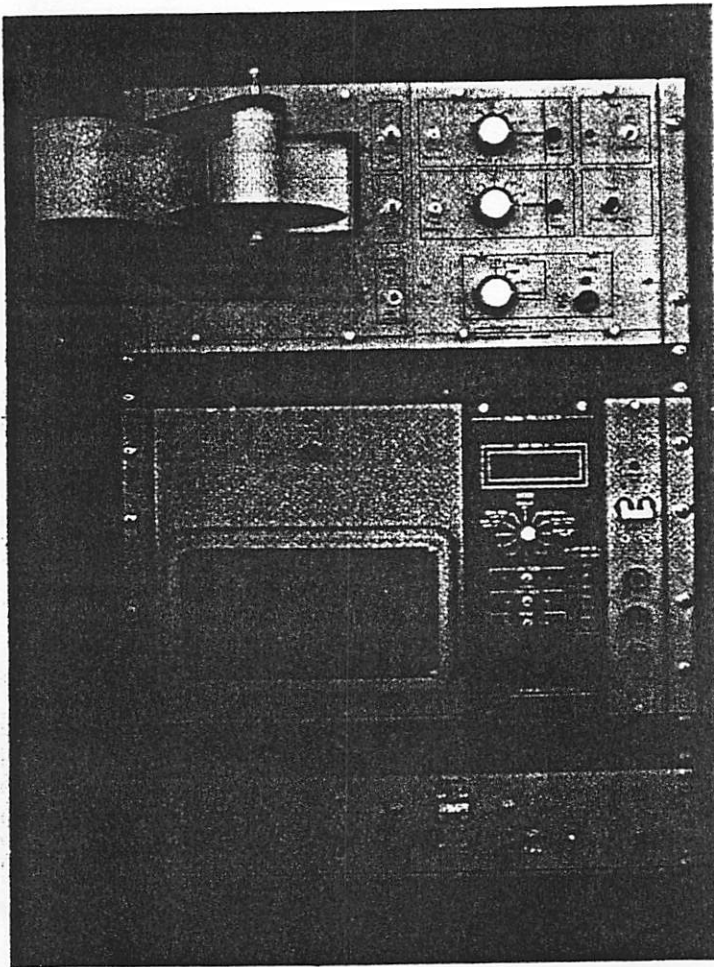
For further information, contact:

HARMON ELECTRONICS, INC.

P.O. Box 600 • Grain Valley, Missouri 64029 • (816) 249-3112 • Telex 42-6398



SYSTEM COMPONENTS



ANALOG RECORDER MODEL WCO-27

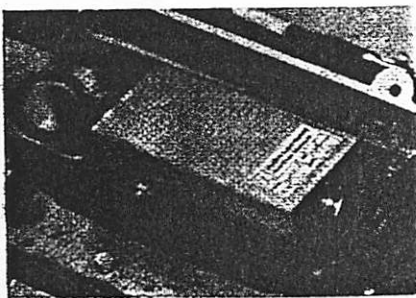
- Microprocessor Controlled Data Recorder
- Thermal Writing Pens
- Two Analog Channels, One Event Channel
- 500 Foot Paper Capacity and Take-Up Reel
- Built-In Time/Date and Train Direction Functions
- Test and Calibration Built-In
- Chart Speed — 5 or 10mm Per Second

ADVANCED SIGNAL PROCESSOR MODEL WCO-34

- Microprocessor Controlled Hot Box Detector/Talker
- Custom Programming Available
- Memory Data Logging
- Self Testing for System Integrity and Functional Test
- Additional Alarm Options: Dragging Equipment, Hot Wheel, Loose Wheel, High Wide Load, Flat Wheel
- Expandable for Future Alarm Requirements
- Hot Box Alarm — Absolute, Car Side or Train Side
- Mile Post Select Switch

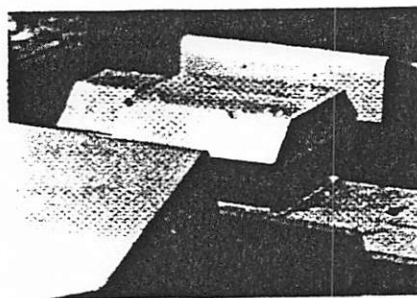
POWER SUPPLY MODEL WCO-35

- Rack Mounted
- Main Circuit Breaker
- Individual Power Supply Protection
- Interface Relay Sockets Available for Options



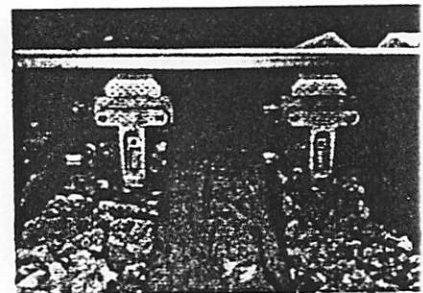
PREAMPLIFIER MODEL WCO-38

- Pyroelectric Sensor
- Germanium Lens
- High Speed Optical Reference Shutter
- Temperature Compensated



UNIVERSAL SCANNER MODEL WCO-33

- Target Area Flexibility
- Inside/Outside Scan or Wheel Hub Scan
- Hot Wheel Scan
- Cantilever Mounted Foundation
- Solenoid Controlled Protective Shutter
- External Sun Shield
- Two Plane Adjustable Mirror for Scan Angle
- Mounted Between Ties (No Cutting)
- Built-In Ice and Snow Heater



WHEEL TRANSDUCERS MODEL WCO-36

- Bolt or Clamp Mounting
- Plug Connector
- Optional Unit for Electrified Territory

OVERVIEW

The purpose of the Defect Detector System is to prevent derailments caused by malfunctioning equipment. Over heated bearings, wheels, dragging equipment and high or wide loads are examples.

The malfunctioning equipment is detected and its type and location is announced to the train crew by radio and stored in memory.

A typical system consists of wayside and trackside equipment. The wayside equipment housed in a bungalow near the track includes the Signal Processor /Talker, power supplies, radio and modem.

The trackside equipment includes infrared scanners, wheel transducers, junction boxes and dragging equipment detector.

Detection of hot bearings is accomplished by measuring the infrared energy emitted by them. A bearing that is 200 degrees F above the ambient temperature is dangerously hot.

Scanners are used to sense the infrared energy by scanning the bearing journal housing as it passes the location.

The journal housing is scanned at a 45 degree angle, approximately 25 inches above the top of the rail and 7 inches from the inside gauge.

Scanning takes place when the wheel is between the gate transducers.

The heat and wheel gate information are transferred to the processor by cables. The processor interprets the information, makes alarm decisions and sends a message to the train crew.

servo

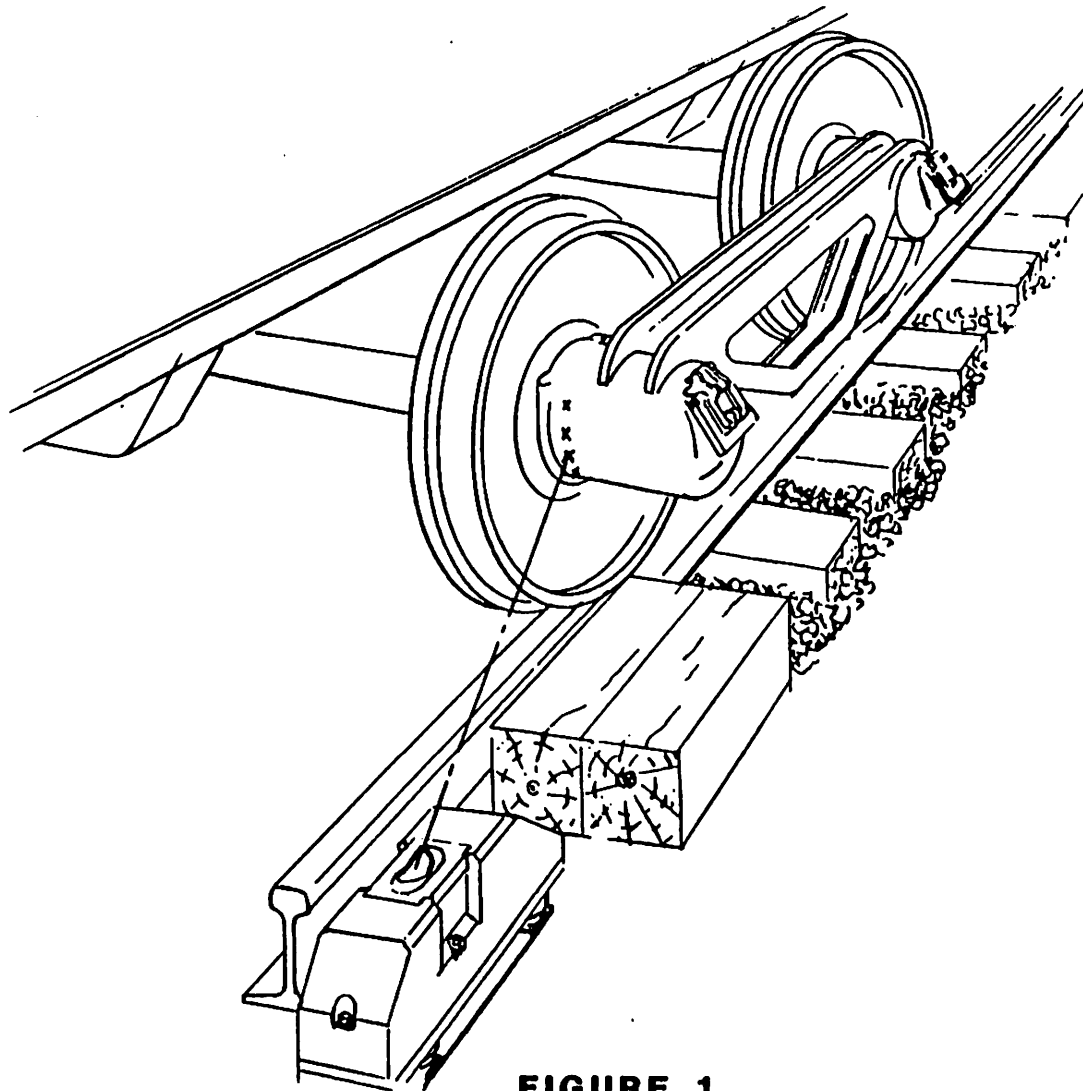


FIGURE 1

PICTORIAL VIEW, BEHIND-THE-FRAME SCAN

DRILL RAIL FOR 3/8" DIA.
BOLTS. (HARDWARE SUPPLIED WITH
WHEEL PICK-UP)

HOT BOX DETECTOR
TRACK ALIGNMENT FIXTURE
HPN 250443-000

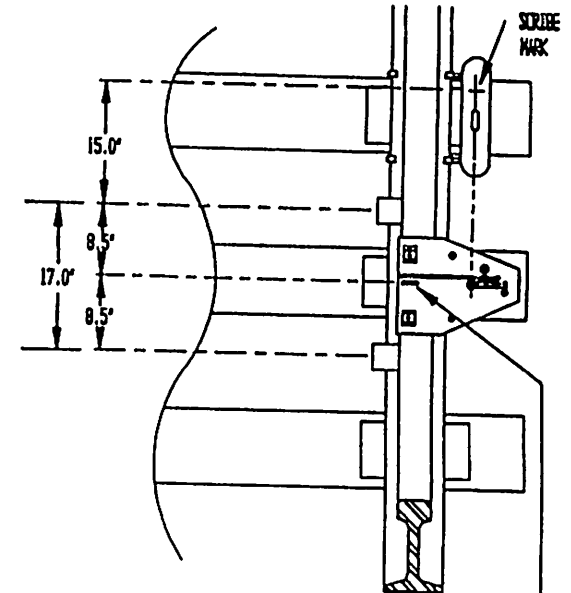
8.5' 8.5' 15.0'
FROM SCRIBE MARK ON SCANNER TO
CENTER OF FIRST TRANSDUCER

45 DEGREES REFERENCE

NOTE: TOP OF SCANNER SHOULD BE
EVEN WITH THE TOP OF
THE RAIL

WHEEL TRANSDUCERS

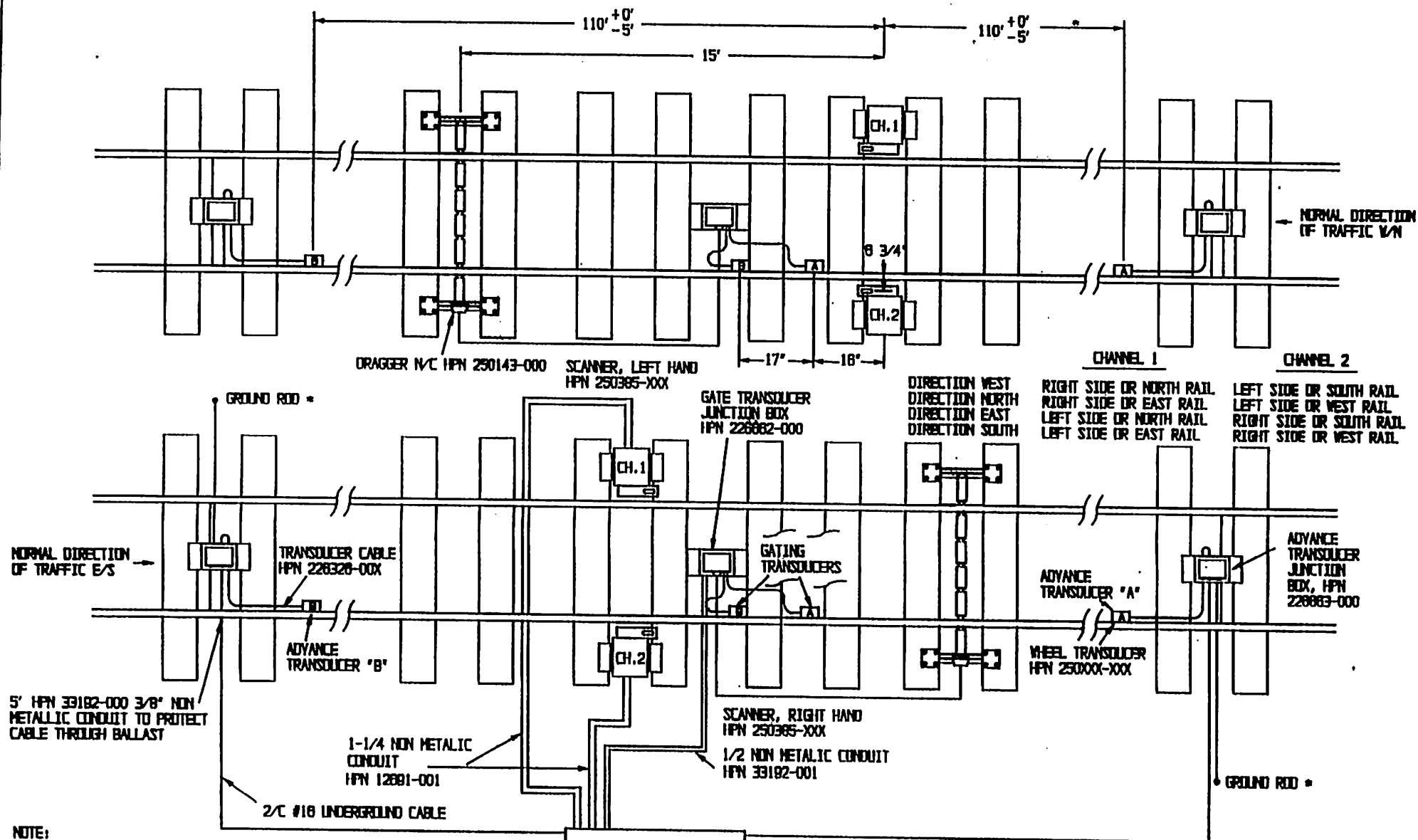
1 5/8" ± 1/4" - 0"



NOTE: A SCRIBE MARK MUST BE MADE ON THE RAIL 23.5"
FROM THE SCRIBE MARK ON THE SCANNER.

WHEN THE ALIGNMENT FIXTURE IS PLACED ON THE RAIL
THE SCRIBE MARK SHOULD BE SEEN INSIDE THE SLOT.

H.P.N.										DESCRIPTION		ITEM	
APPROVED		DATE				HARMON ELECTRONICS GRAIN VALLEY, MO. 64029		TITLE: RAILMOUNT SCANNER TRACKSIDE LAYOUT WITH ALIGNMENT FIXTURE (TYPICAL)		FILE NO. DRAWING NO. 4524-000		SHEET 2 OF 5 SIZE C	
DRAWN BY H. SCHOLMEYER		DATE 08/91											
MATERIAL		FINISH		TOLERANCE UNLESS NOTED									



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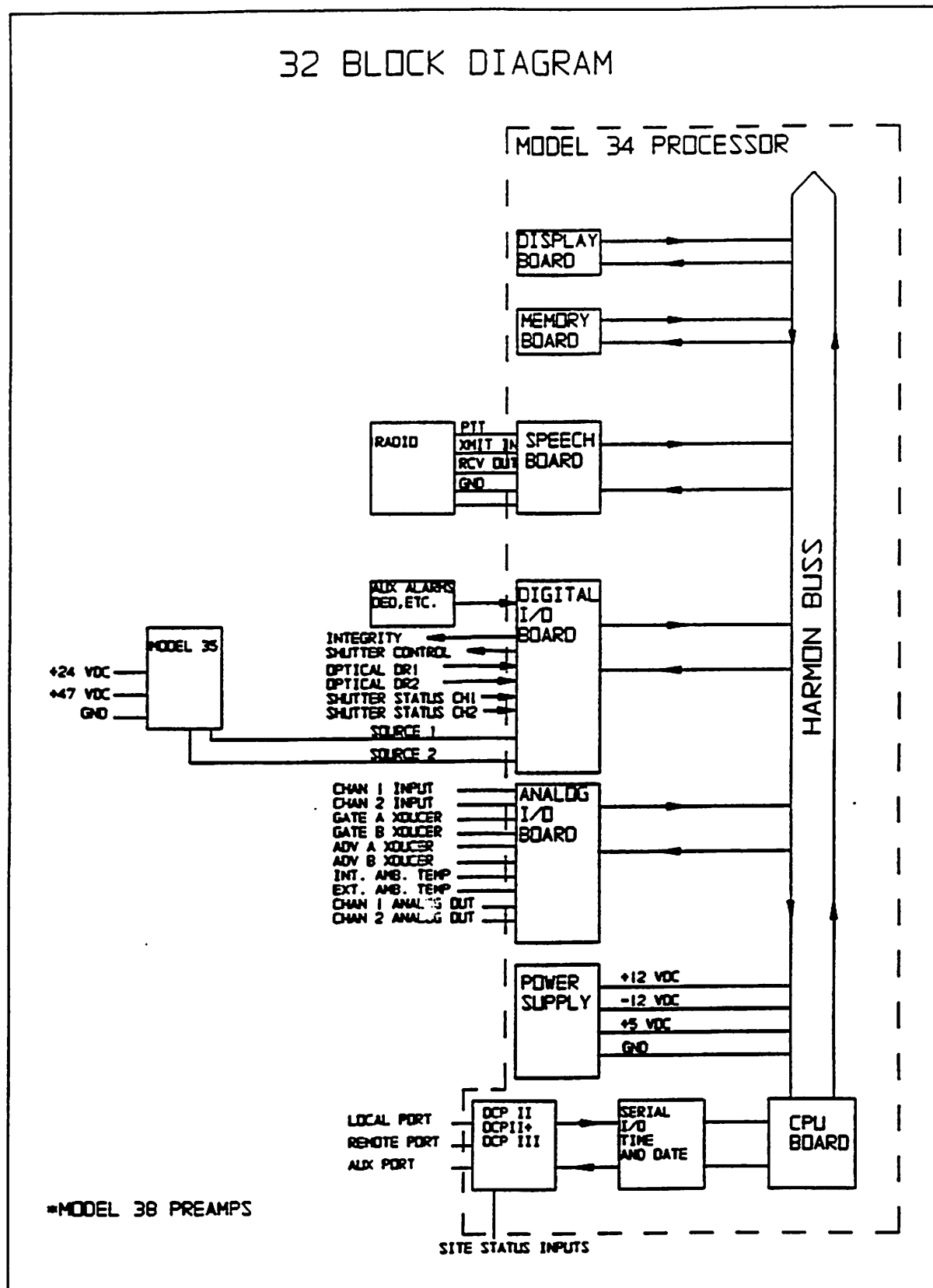


Figure 2 Model 32 Block Diagram

1. ALARM DECISIONS HIERARCHY.

Absolute alarm decisions (all axles)

Differential alarm decisions (all axles)

Carside slope alarm decisions (axles of recognized car)

2. ABSOLUTE ALARM DECISION:

Made on every axle after roller/friction bearing recognition. If the journal heat exceeds the High Limit pot setting there is an absolute alarm.

The alarm indicators will NOT appear until it has been determined that the axle with the absolute alarm is or is not contained within a recognized car.

3. DIFFERENTIAL ALARM DECISION:

Made on every axle after roller/friction bearing recognition.

To determine if a differential alarm exist the heat on both ends of the axle are compared. If one journal is three times hotter than the other and is above the Low Limit pot setting a differential alarm exist. The alarm indicators will NOT appear until it has been determined that the axle with the differential alarm is or is not contained within a recognized car.

4. CAR SIDE ANALYSIS ALGORITHM:

The axles contained within a recognized car are subjected to the CARSIDE ANALYSIS ALGORITHM. The following method is used for determining car-side alarm levels. The average heat is computed for one side of the car.

The carside alarm level is computed for the car. The heat level of each axel is compared to the computed carside alarm level. The above steps are repeated for the other side of the car.

Possible alarms are verified by checking that the possible alarm journal heat is fifty percent greater than the non alarm side

Analog I/O Pot Settings

Pot 1 (R28 on Analog II, R116A on Analog 1)

Low Limit for simple (single) alarm analysis. 5mm to 15mm

Pot 2 (R29 on Analog II, R116B on Analog 1)

High Limit for absolute alarm analysis. 15mm to 24mm

Pot 3 (R30 on Analog II, R122C on Analog 1)

Carside Slope for carside alarm analysis. 0.68 to 2.36

Pot 4 (R31 on Analog II, R122D on Analog I)

Carside Low Limit for carside alarm analysis. 5 mm to 15 mm

Pot 5 (R32 on Analog II, R123E on Analog 1)

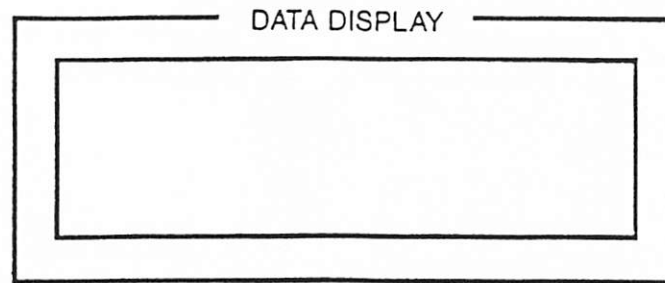
Gate Transducer Spacing for speed calculation. 15 to 30 inches

Pot 6 (R33 on Analog II, R123F on Analog I)

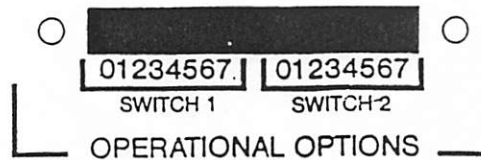
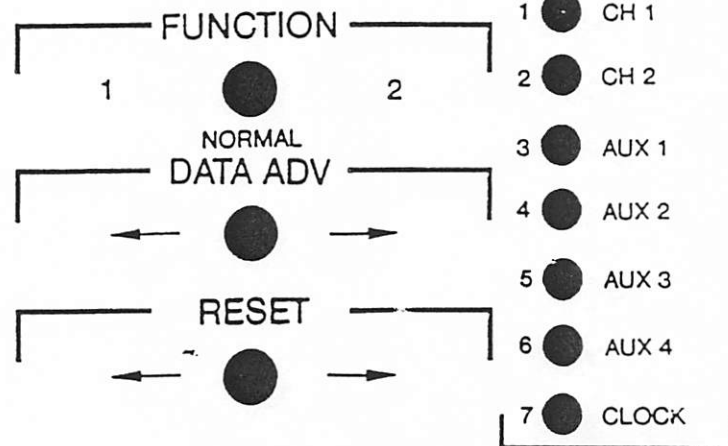
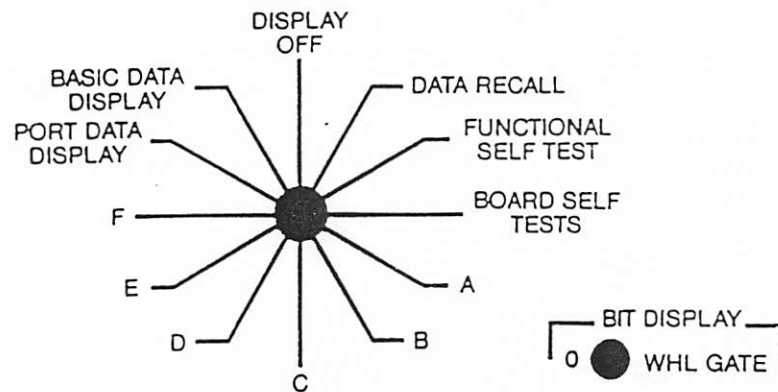
Hot Wheel Limit hot wheel analysis. 8mm to 24mm

SIGNAL PROCESSOR

25720-000



MODE



HARMON ELECTRONICS

DATA RECALL

Mode switch to **Data Recall** position.

Press **Data Advance** switch to retrieve last four trains with defects.

An integrity failure or warning will not be stored as a defect .

End of train message for stored trains are replayed and transmitted to local speaker only.

Loss of power to the unit erases stored trains.

FUNCTIONAL SELF TEST

Mode switch to **Functional Self Test** position.

Press **Data Advance** switch to initiate test train.

Test train consist of 172 axels divided into 42 four axel cars and 2 two axel cars.

Hot journal and auxiliary alarms are simulated internally.

Scanner protective shutters open.

Alarm messages are transmitted to local speaker only.

BOARD SELF TEST

Mode switch in **Board Self Test** position.

Press **Data Advance** switch once for first level tests.

Pass or fail will be displayed.

Press **Data Advance** switch twice for second level tests.

The name of the failed circuit will be displayed.

Boards tested.

1. Processor
2. Analog
3. Speech
4. Digital I/O
5. Rom

DISPLAY POT SETTINGS

Mode switch in position **A**.

View current alarm settings.

View potentiometer resistance.

Set alarm settings used in analysis.

1. Low limit

2. High limit

3. Carside low limit

4. Carside slope

5. Gate transducer spacing

6. Hot wheel limit

CHOP

Mode switch to position **B**.

Press **Data Advance** switch.

Opens scanner protective shutter assembly.

Initiates continious simuleted wheel gates.

Heat values can be verified for both channels.

SET TIME AND DATE

Mode switch to position **C**.

View current date and time.

Set year,month,day,hour,minuet.

RECORDER CALIBRATION

Mode switch in position **D**.

Produces calibration pulses at five, ten, fifteen and twenty millimeters.

CONTINUOUS TEST TRAIN

Mode switch in position **E**.

Simulates real train consisting of one thousand axels divided into four axel cars.

Three different speed trains may be selected.

Messages are broadcast over local speaker only.

Auxiliary alarms and train direction may be verified.

Scanner integrity tests are performed.

Heat can be seen by scanners.

TONE TEST / DISPLAY TEMPRATURE

Mode switch to position F.

Generates test tone to local radio.

View the current ambient temperature.

PORT DATA DISPLAY

Mode switch is in the **PORT DATA DISPLAY** position.

The **DATA DISPLAY** window the port number.

The **BIT DISPLAY** LEDs indicate the status of the digital ports.

The LED will be illuminated if the input is grounded, off if twelve volts is present.

BASIC DATA DISPLAY

MODE switch in the **BASIC DATA DISPLAY** position.

STANDBY.

If the hot box detector is currently not scanning a train and no other activity is currently being processed this message is displayed.

APPROACH

If a train has been detected by either the advance transducers or the track circuit this message is displayed.

SPD=XXX

If a train is passing the HBD the train speed is displayed.

TIMEOUT

If a train has just left the hot box detector, the end-of-train processing is being performed.



Model 32/75 Hot Box Detector

Harmon Electronics, Inc.

User's Manual

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Model 32 and 75 Hot Box Detector

Users Manual

October 4, 1993

This manual covers installation, operation, and troubleshooting for Harmon Electronics, Inc. Model 32 and 75 Hot Box Detectors. The Model 32/75 Technical Reference is available for in depth circuit and software analysis. This manual is divided into fourteen separate sections with each section covering a different topic of hot box detector operation and/or installation. A particular section may intentionally be left blank if that section does not apply to current installations.

Terms used in this manual.....	Section I
Hot Box Detector Operation.....	Section II
Model 3300RailMountScanners.....	Section III
Model 33 Tie/Ballast Mount Scanners.....	Section IV
Model 75 Servo Overlay.....	Section V
Model 75 GE Overlay.....	Section VI
Hot Box Detector Error Codes.....	Section VII
Hot Box Detector Software Documentation.....	Section VIII
Data Communications Processor.....	Section IX
Model 3300 Rail Mount Scanner Drawings and Parts List.....	Section X
Hot Box Detector Circuit Board Layout and Parts List.....	Section XI
Model 33 Tie/Ballast Mount Scanner Drawings and Parts List.....	Section XII
Model 3800 (IRIS)Preamplifier Users Guide.....	Section XIII
Site Layout Drawings.....	Section XIV

Terms Used In This Document

Following is a list and definitions of terms used throughout this document:

AC - Alternating Current

ACS - *™ Advanced Concept Scanner* - Advanced Concept Scanner is manufactured by Servo Corporation of America. The ACS is a type of scanner that can be installed on a Model 75 Overlay hot box detector.

ADC - Analog to Digital Convertor

Auxiliary - Digital inputs provided to the system for alarm determination.

Carside Average - Average heat for all journals on one side of the car. Used in *Carside Slope* alarm analysis.

Chart Recorder - *Model 2 (27) Data Recorder or Servo equivalent* - Any analog chart recorder connected to the hot box detector that is used to record train data.

Clearance Detector - A device used to detect high or wide loads.

CPU - Central Processing Unit.

DAC - Digital to Analog Convertor.

DC - Direct Current.

DCP - *Data Communication Processor* - Device used for storing and transmitting digital information acquired from the HBD. Used as a replacement for analog chart recorders.

DIP - Dual inline package.

EPROM - Electrically Programmable Read Only Memory. Used for program storage.

GND - Ground.

HBD - *Hot Box Detector* - A Model 32, 32R, 75 electronics chassis connected with trackside equipment manufactured by Harmon Electronics, Inc., General Electric, Servo Corporation of America.

Interface Panel - A rack mounted panel used to provide an interface/electrical protection from trackside equipment to the Model 34/75 electronics chassis.

IRIS - *InfraRed Imaging Sensor* - Actual device that scans the railcar journal for infrared heat. Can be placed in any scanner manufactured by Harmon Electronics, Inc.

LED - Light Emitting Diode.

Millimeter - Unit of measure commonly used for heat measured from a rail car journal.

Overlay - Term used to refer to Model 75 electronics manufactured by Harmon Electronics, Inc. connected to trackside equipment manufactured by another supplier.

Parameter - Any value set on an analog board or through the DCP that is used in alarm determination.

Pre-Amp - *Pre-amplifier* - Actual device that scans the railcar journal for infrared heat. Sometimes used synonymously with IRIS or Model 38 pre-amp.

RAM - Random Access Memory.

RMS - Rail Mount Scanner.

ROM - Read Only Memory.

Scanner - A device connected to the rail, attached to the ties, or attached to a cantilever buried in the ballast that scans passing railcar bearing for infrared heat.

Servo - © *Servo Corporation of America* - Servo Corporation of America, Hicksville, New York ("SERVO") manufactures trackside equipment for use on Model 75 Overlay Hot Box Detectors. Harmon Electronics, Inc. does not warranty equipment, specify installation or maintenance procedures, or repair equipment manufactured by Servo Corporation of America. All documentation and manuals provided by Servo Corporation of America are copyrighted and Harmon Electronics, Inc. honors those copyrights.

Trackside - Any equipment physically located along the rail or ballast.

Track Circuit - A portion of the track that contains electrical signals that provides presence indication or movement. Used to turn on the HBD.

Transducer - A magnetic device that provides a sine wave signal to the HBD to signal the presence of a wheel. Used for advance turn on or wheel gate processing.

Wayside - Any equipment located inside or on the bungalow.

Wheel Gate - Two transducers used to provide a signal to start scanning the journal and a signal to stop scanning the journal.

+5 VDC - Positive 5 volts DC.

-6 VDC - Negative 6 volts DC.

+12 VDC - Positive 12 volts DC.

-12 VDC - Negative 12 volts DC.

+200 VDC - Positive 200 volts DC.

-200 VDC - Negative 200 volts DC.

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Hot Box Detector Configuration

1. Introduction

This section contains information covering system descriptions and theory of operations for hot box detectors manufactured by Harmon Electronics, Inc. For precise information pertaining to a specific installation please refer to the installation drawings supplied with each system as custom configurations are available.

2. System Description

Hot box detectors manufactured by Harmon Electronics, Inc. come in two varieties. The Model 32/32R (Model 34 electronics chassis) is designed to operate with Model 33 ballast/tie mount scanners and the Model 3300 Rail Mount Scanners (RMS). The Model 75 is designed to operate with scanners supplied from other manufacturers and is referred to as an Overly hot box detector. Signals are sent from wheel detectors and infrared scanners trackside to the Model 34/75 electronics chassis for analysis.

The Model 34/75 electronics chassis consists of a rack mounted enclosure containing a plug in power supply for the system cards, a built-in card extender, a Display/Control Panel for service and troubleshooting, and a set of system cards configured to provide specific functionality required by the customer.

The system has been designed to operate under extreme noise conditions through the use of extensive shielding in the enclosure, multiple layer boards incorporating ground planes, and closely regulated power supplies. Only industrial and military qualified components are used throughout, and virtually all processor unit connectors have gold plated contacts for maximum stability and integrity.

After the initial setup, all control, self-testing and readouts are available through the Data Display Panel or through the Data Communication Processor (DCP). The main power switch controls all of the power supplies for the system cards. The LED above the power switch indicates that the 5 volt power supply is on. Individual circuit breakers are provided for the +5 VDC, +12 VDC, and -12 VDC supplies and the main power switch is also a circuit breaker which aids in protecting the primary side of the circuitry.

CAUTION: The hot box detector scanners has an additional power supply with its own circuit breaker. This power supply is usually mounted on a separate power supply panel located on the equipment rack.

Inside the front door is a label describing the configuration of the system plus a basic description of the **MODE** switch operation. The card extender to the right side, inside the door, is fixed in position and all of the function cards may be installed for troubleshooting or adjustment. The function cards will operate in any position inside the chassis but it is recommended that they remain in the position that they came from the factory in.

The Model 32/75 hot box detector has been designed to provide all normal hot box detector functionality plus several new provisions to improve operation, maintainability and greatly enhance system expandability. It has the capability to perform many alarm criteria modes including Simple Ratio, Differential, Absolute, Carside Slope, Three-Slope, etc. The specific alarm determination modes are custom configured and must be specified before the system is shipped from the factory. For specific alarm analysis contact Harmon Electronics, Inc.

The Model 34/75 electronics chassis is designed to operate with scanners made by various manufacturers. Integrity tests are performed on the different scanners providing the status of the scanner. These tests vary depending on the scanner type and is field configurable.

The Model 32/75 hot box detector is designed to provide information via radio transmission to the train crew of the train that was scanned most recently. The message broadcast, in any language, faults detected by the train inspection system. This information usually consists the axle number and side of the train, the direction of travel, site location information, and type(s) of alarm information. The milepost is set locally on the speech board and is included in every transmission. Site names can be included in the message if specified by the customer before the system is shipped from the factory.

The system provides all necessary interfacing for connection to transceivers, carrier systems, data modems, etc. Inputs are provided for additional alarm inputs such as dragging equipment detectors, clearance detectors, etc. Many of these auxiliary input devices are available from Harmon Electronics, Inc.

Checkout, service, and troubleshooting is made easier by internal self-test routines that display the test results on the Model 27 chart recorder or DCP. All connections are made to terminal strips, connectors, or optionally provided power supply, interconnect panels.

3. System Configuration

A typical hot box detector or overlay hot box detector consists of two groups of equipment - trackside equipment and wayside equipment. The trackside equipment consists of all hardware used to turn the system on and off, extract infrared heat readings from passing railcar journals, and provide integrity status of scanners. The wayside equipment consists all hardware and software used to process information obtained from the trackside equipment into digital data, alert the train crew, send digital data to a central point, etc.

4. Trackside Equipment

Trackside equipment consists of several components. Those components together provide the necessary signals to the wayside equipment. The trackside equipment can be broken down into two sub-systems - the wheel detectors and the scanners.

Scanners consist of the infrared detector and the scanner which houses the infrared detector. Scanners can be one of many types depending upon the specific configuration. Scanners can be

manufactured by Harmon Electronics, Inc. or a different manufacturer. For more information on trackside equipment refer to the sections on "Trackside Equipment".

Wheel detectors are used to turn the system on and off. Advance transducers are used to give the hot box detector system an advance turn on signal. Wheel detectors supply a signal to start scanning a journal and a signal to stop scanning the journal. A short range track circuit can also be used to supply the hot box detector system with an advance turn on signal.

The signals obtained from the wheel detectors along with the heat readings obtained from the scanners are processed by the wayside equipment. The processed data is then passed on to the train crew and dispatcher.

5. Wayside Equipment

Wayside equipment consists of all equipment located inside the bungalow. The wayside equipment processes the data obtained from the trackside equipment into usable information. This information is then passed onto the train crew via radio transmission and to the dispatcher or maintenance personnel via digital transmission. Figure 1 through figure 4 show block diagrams representing various configurations of wayside electronics.

Information obtained from the trackside equipment is also stored for future use or printed on a local chart recorder. The information that is printed on the chart recorder or stored for future use is the train length, number of axles, heat obtained from each journal bearing, number of cars, type of car, integrity status at the time of train passage, etc. Additional data can be stored if desired. Contact Harmon Electronics, Inc. for information concerning customization of software.

6. Alarm Analysis

Alarm analysis is performed on every axle of every car. The journal is first tested to see if the heat level has exceeded the "absolute" alarm level or "Hi Limit" parameter setting. The next test performed is after a group of axles has been recognized as a car. If a car has been recognized "Carside Analysis" is performed on that car. Refer to the section on Alarm Analysis for detailed information concerning Carside Analysis(p.34).

If a car has not been recognized, the journal that is being tested is compared to the journal on the other end of the axle. If the journal is three times as hot as the journal on the other end of the axle an alarm is given. Other types of alarm analysis are available and can be included into the software. For more information on types of alarm analysis or for a custom program contact Harmon Electronics, Inc.

Alarms can also be obtained from dragging equipment detectors, clearance detectors, hot wheel detectors (analog and digital), etc. Refer to the software documentation for specific message formats when alarms are detected.

32R BLOCK DIAGRAM

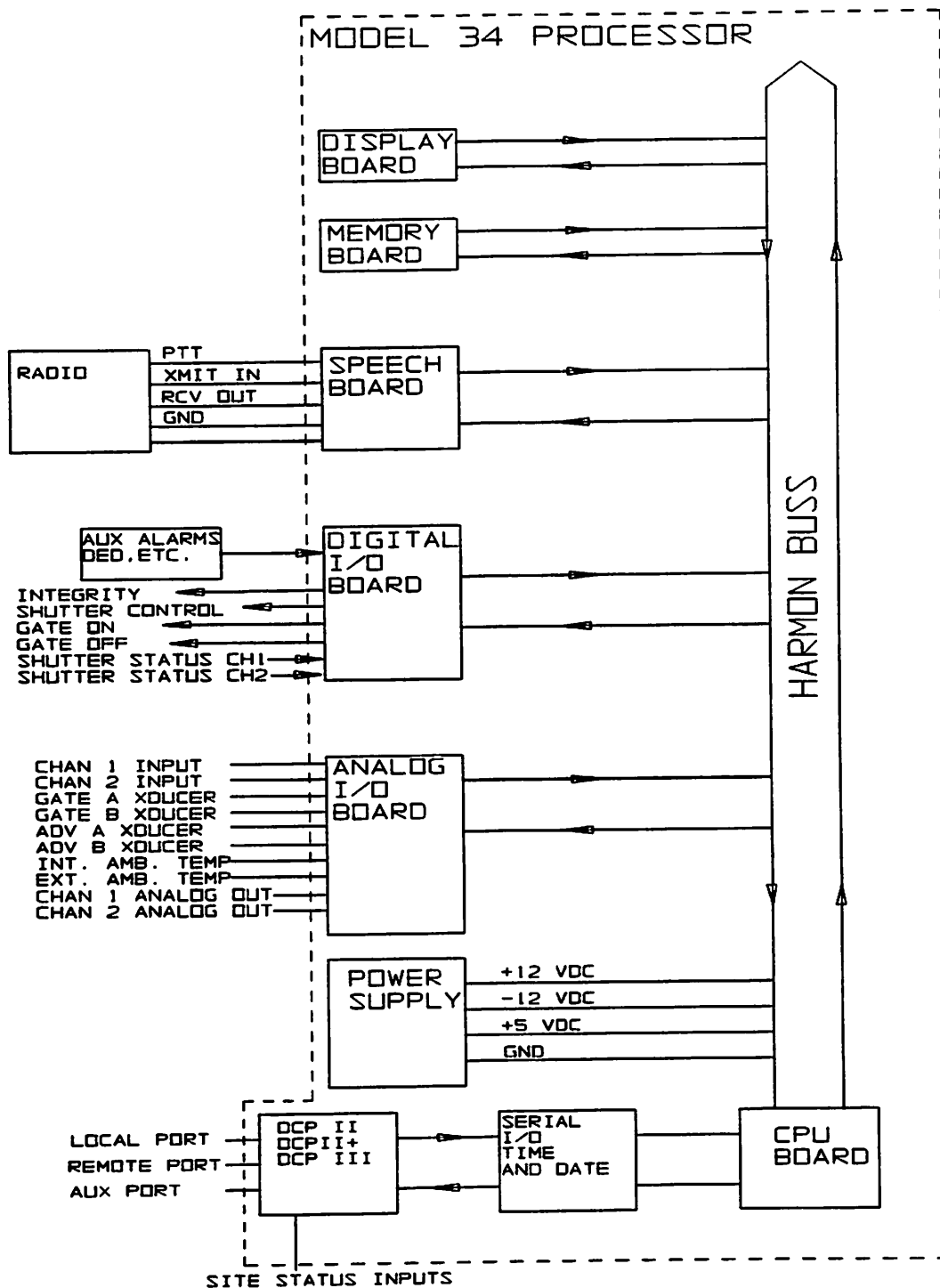


Figure 1 Model 32R Block Diagram

32 BLOCK DIAGRAM

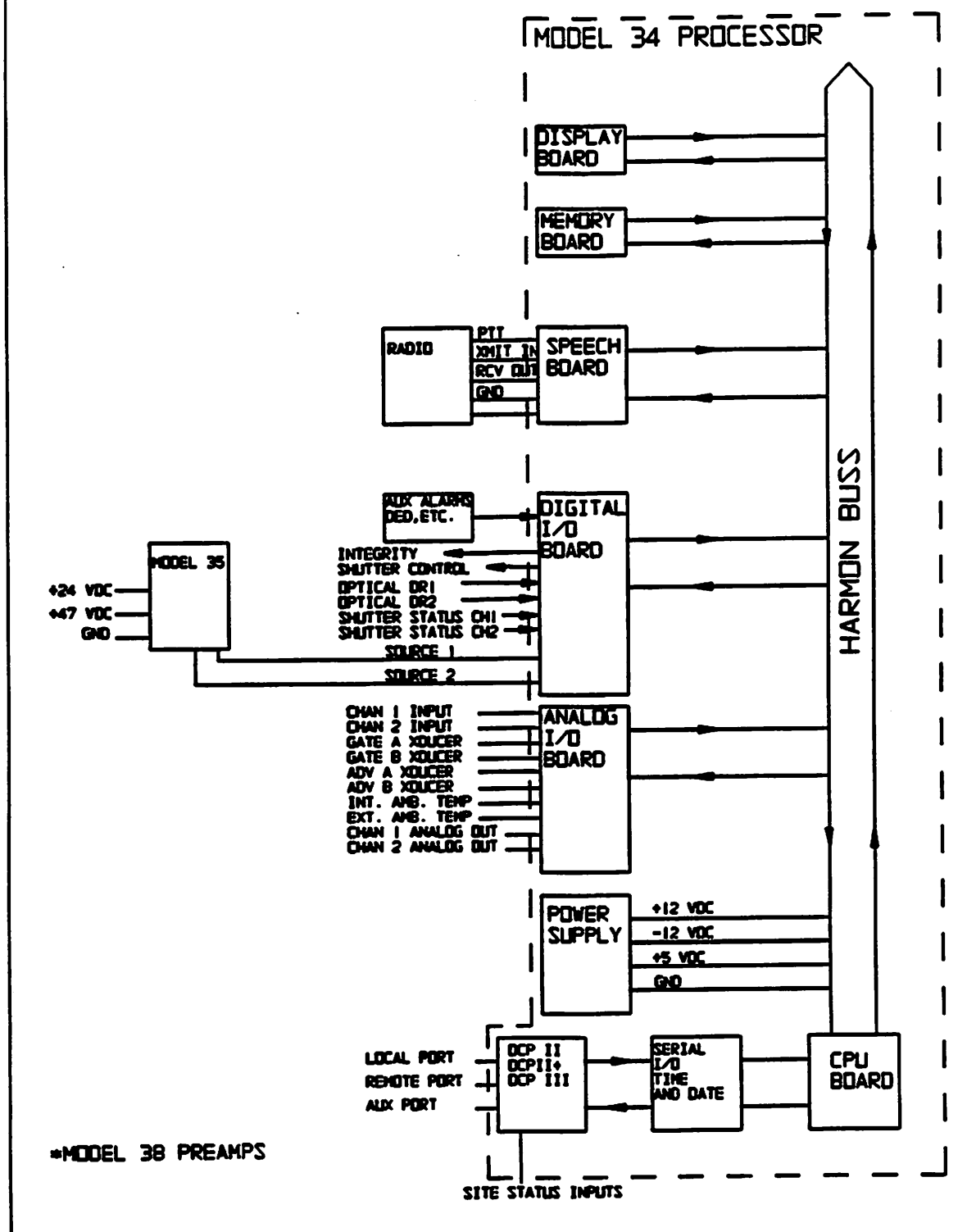


Figure 2 Model 32 Block Diagram

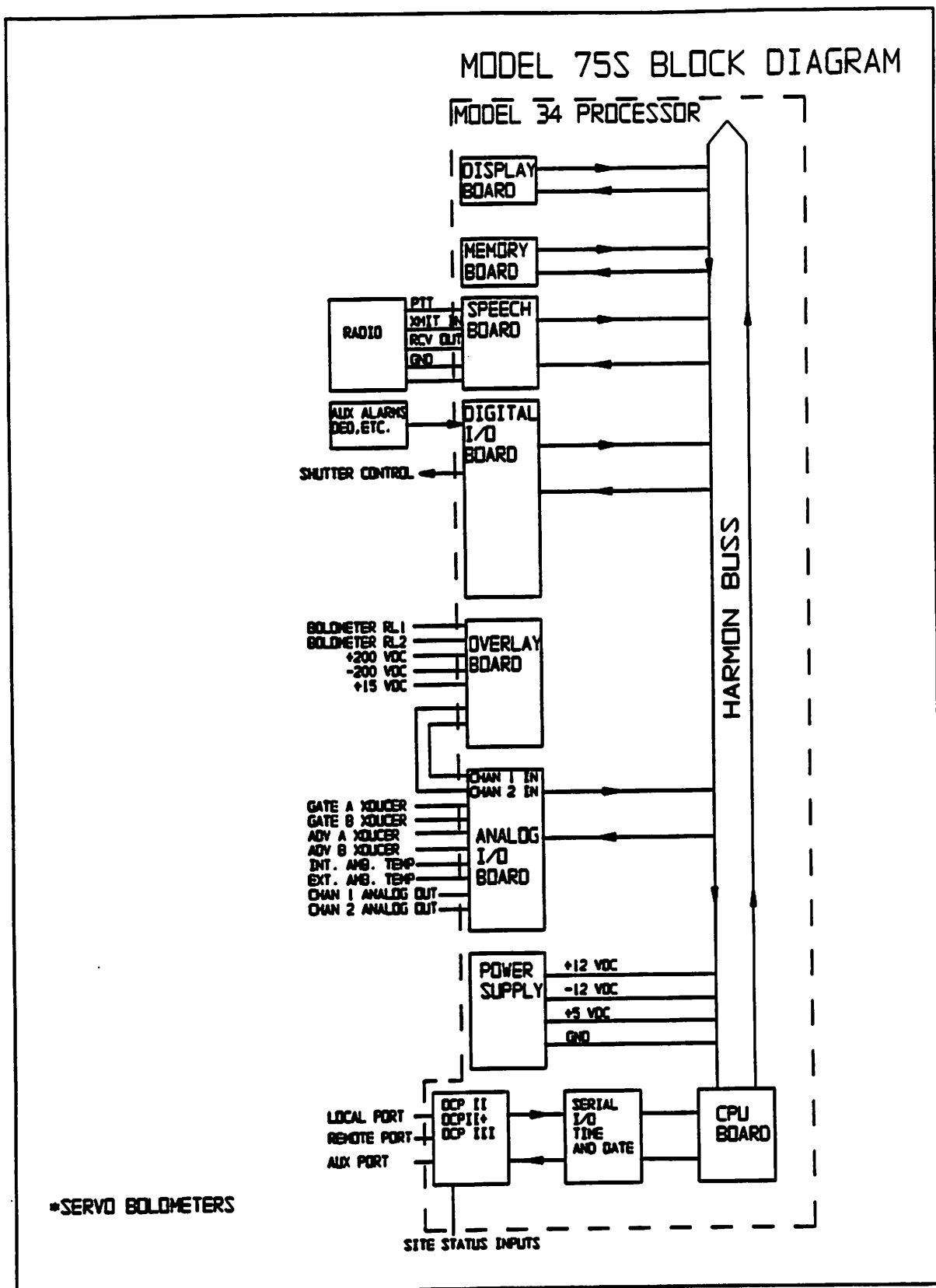


Figure 3 Model 75 - Servo - Electronics Block Diagram

MODEL 75G BLOCK DIAGRAM

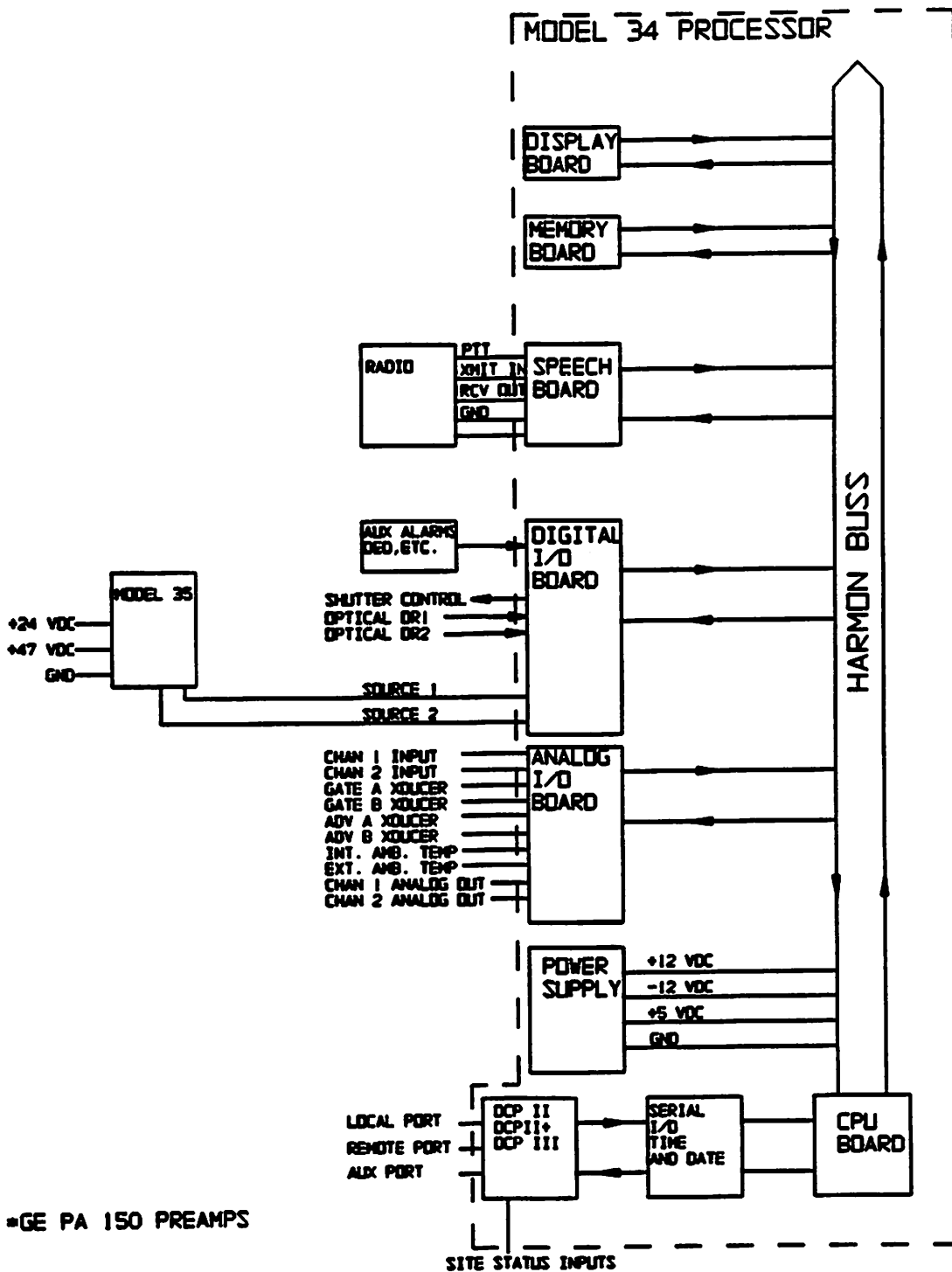


Figure 4 Model 75 - GE - Electronics Block Diagram

7. Specifications

7.1 POWER REQUIREMENTS

Model 34/75 Universal Signal Processor

120 VAC, 60 HZ., less than 200 watts.

Model 35 Power Supply

120 VAC, 60 HZ., less than 60 watts.

Interface Panel

120 VAC, 60 HZ., less than 300 watts.

7.2 ENVIRONMENTAL TEMPERATURE

-40°C to +60°C (-40°F to +140°F)

7.3 TRAIN SPEED

8 MPH to 150 MPH

7.4 FUNCTION CARD RATINGS (INPUTS AND OUTPUTS)

Relays (One on Speech Board and one on Digital I.O. Board)

Coil 12 VDC

Contacts 10 VA max.

Opto Isolator Circuits (One on Speech Board and two on Digital I.O. Board)

Input Typical: Logic 0 $\leq$ 1.5 VDC

Logic 1 $\geq$ 8 VDC, Max. 24 VDC

Output: Max, sink = 1 ma.

Logic Input/Output (Up to 8 on Speech Board and up to 24 on Digital I.O. Board)

Input Typical: Logic 0 $\leq$ 1.5 VDC

Logic 1 $\geq$ 6 VDC, Max. 30 VDC (Continuous)

Duration: Minimum Input Logic state for recognition = 2 msec.

Note: Each input is transient protected with a discrete suppressor.

Output Typical: (Depending on external connection.)

Logic 0 = approximately 1.5 V when sinking 200 ma.

Logic 1 = approximately 12 V via a 2 k Ω internal pull up resistor.

7.5 RAIL MOUNT SCANNER

Power Requirements

Input Voltage

+12 VDC at 1.5 Amps

110 VAC at 4.0 Amps

Heater Rating

400 Watts at 110 VAC

Approximately 54.5° C

Operating Temperature

-40° C to 71.1° C

Dimensions

Width

6 1/8 inches

Height

5 inches

Length

21 inches

Weight with clamps

45.0 pounds

7.6 UNIVERSAL WHEEL TRANSDUCER

Electrical

Power

Passive

Isolation

3000 VAC

Connection

16 gauge copper

Operational

Average Train Speed

5 to 150 MPH

Signal Output

Sinusoidal

Physical

Rail Types

90 lb to 150 lb

Mounting

3/8" grade 5 stainless steel bolts

Operating Temperature

-40° C to +71° C

Storage Temperature

-40° C to +85° C

Relative Temperature

0 to 100 % condensing

Shock

500 g along any axis

Vibration

20 g from 1 to 60 Hz along any

axis

8. Site Selection

8.1 To provide efficient and reliable performance the hot box detector should be located on tangent track at least $\frac{1}{4}$ mile from any curves.

8.2 Rail gage must be kept as tight as possible ($\frac{1}{4}$ inch or less) to reduce truck lateral movement. It is highly recommended that rail gage plates be installed, one on each side of the scanners.

8.3 The hot box detector should be installed far enough from a yard, terminal, or sidings to insure that the bearings being scanned have obtained the normal operating temperature.

8.4 To avoid false indications the hot box detector should be installed in an area where normal braking does not occur.

8.5 The hot box detector should be installed far enough from a tunnel so that any message being broadcast over the radio has enough time for complete transmission before the train is out of normal radio range.

8.6 Scanners should not be located near a rail joint. If it is at all possible the scanners should be located in the middle of a rail section in territory where welded rail is not installed.

9. Installation

9.1 Before installing the hot box detector system read the remaining contents of this manual.

10. System Interconnect

10.1 SCANNER CONNECTION

Since the Model 34 and Model 75 electronics can interface to all types of scanners please refer to the section covering the exact type of scanner used for the specific application. Currently the Model 34 and Model 75 Overlay can be interfaced with the Model 33, Model 3300 scanners, GE PA100, GE PA 150, and GE KF106 scanners, and Servo¹ scanners of all types.

Several types of interface/interconnect panels are available for installation and are not covered in this manual. Refer to the site specific procedures supplied with each system

¹Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

for more information concerning the installation of the specific panels. For more information concerning the types of interconnect/interface panels or for information concerning a customized panel contact Harmon Electronics, Inc.

10.2 AMBIENT TEMPERATURE

An external and internal ambient temperature monitor can be optionally installed (required for Model 3800 preamplifiers) to provide the hot box detector system with the current ambient temperature. Connect the external ambient temperature monitor using the following connections:

Green wire	to	Ground Buss
White wire	to	TB7-5
Black wire	to	AUX +12 VDC (TB 13-1)

10.3 MULTI TRACK CONNECTION/RADIO CONNECTION

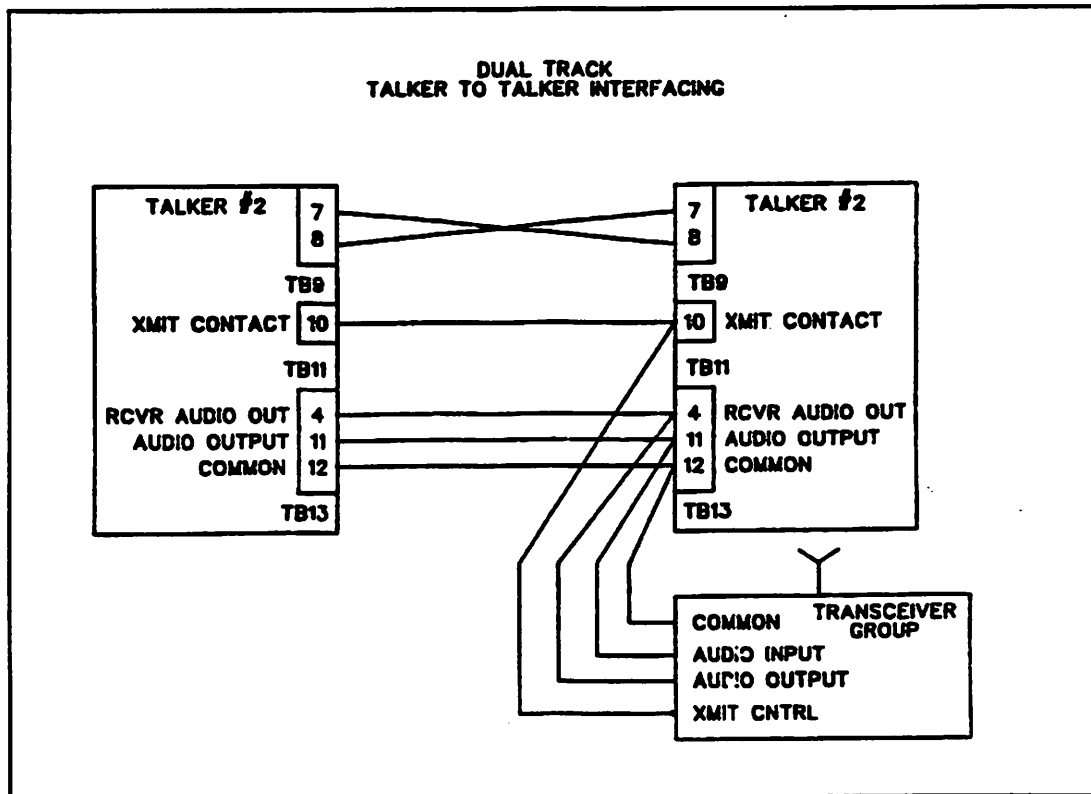


Figure 5 Diagram of multitrack interconnection.

The Model 34/75 electronics chassis has the ability to determine if the other hot box detector is transmitting if it is installed in a multi-track configuration in the same bungalow. If the hot box detector has a message to transmit to the train crew it first checks to see if the other hot box detector is transmitting. If it is not it then checks to

see if the radio channel is clear. Refer to figure 5 for specific interconnect information.

If the other hot box detector is transmitting and the radio channel is clear a timer is started. This timer will expire after three minutes. At this time the second hot box detector starts transmission regardless of the state of the first hot box detector. If more than two hot box detectors are installed in one location contact Harmon Electronics, Inc. for additional installation assistance.

If the other hot box detector is not transmitting but the radio channel is not clear a timer is initiated. This timer will expire after twenty seconds. At this time hot box detector will transmit regardless of who is using the radio channel. The message that is being transmitted to the train crew is the highest priority and must be transmitted before the train has gone too far to receive the message.

Note: If one chassis is turned off at a multiple track site, it is advised to remove wires from TB9-7 and TB9-8 of one chassis. This will prevent turned off unit from affecting transmission of electronics chassis in operation.

On multi track radio connections R1, R2, and C1 should be removed on one of the talkers.

11. System Setup

After the system has been completely installed site configuration is required. Site configuration consists of setting the milepost, setting the alarm level parameters, etc. The software documentation contains specific switch settings for each railroad since the software is customized to meet operating rules. Refer to the software documentation and railroad operating rules before attempting to setup the system.

11.1 WHEEL GATE SPACING

The wheel gate spacing must be entered into the system since constant measurements are not always possible or desirable. Exact spacing is required for the system to provide accurate train speed and axle spacings. Train speed is critical for the car recognition algorithm.

To adjust the wheel gate spacing pot 5 (R32 on the analog II board or R123E on the analog I board) must be adjusted. If an analog II board is used pot 5 is directly accessible, but if an analog I board is used it must be removed from the electronics chassis and installed in the extender card position before adjustment can be made.

11.2 ANALOG POT SETTINGS

Alarm levels can be set one of two ways. One of those ways is through pots on the analog boards. The other way is by setting them through a 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.

To adjust the alarm levels on the analog board, pots 1 - 4 (6 if a hot wheel detector is installed) must be adjusted. If an analog II board is used the pots are directly accessible, but if an analog I board is used it must be removed from the electronics chassis and installed in the extender card position before adjustment can be made.

Below is the pot number and designator for each style of analog board. Also is a table indicating the maximum and minimum values. These values may change depending upon the specific railroad requirements.

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.

Pot	Parameter	Minimum	Maximum
1	Low Limit	5mm	15mm
2	High Limit	5mm	24mm
3	Carside Slope	.68	2.36
4	Carside Low Limit	5mm	15mm
5	Transducer Spacing	15"	30"
6	Hot Wheel Limit	15mm	24mm

11.3 CPU BOARD SETTINGS

There are four DIP switches located on the Universal Processor Board (CPU board). These four switches may be used for many different purposes but are mainly for 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.

The software documentation contains specific switch settings for each railroad since the software is customized to meet operating rules. Refer to the software documentation and railroad operating rules before attempting to setup the system.

11.4 DIP SWITCHES

There are sixteen DIP switches located on the front panel of the Display Board. These sixteen switches may be used for many different purposes such as multi-track selection, selecting data logging features, etc. It is important to become familiar with the specific switch selections available since the software is customized for each railroad.

The software documentation contains specific switch settings for each railroad since the software is customized to meet operating rules. Refer to the software documentation and railroad operating rules before attempting to setup the system.

11.5 DATA COMMUNICATION PROCESSOR (DCP) SETTINGS

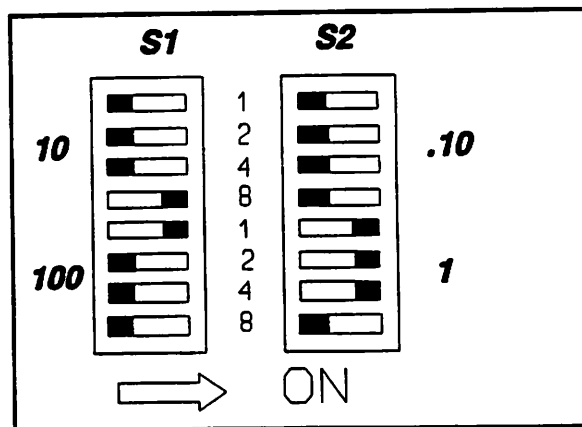
The DCP board has four DIP switches. These four switches determine the baud rate of the local port and the auxiliary port. They can also be customized for dedicated usage, such as a polling address.

The software documentation contains specific switch settings for each railroad since the software is customized to meet operating rules. The DCP also has many menu options that are used in site configuration. The site name should be set, the alarm levels should be set, etc. Refer to the software documentation and railroad operating rules before attempting to setup the system.

11.6 MILEPOST SETTING

11.6.1 The system milepost is set on the speech board. There are two, eight position DIP switches located on the speech board, S1 and S2. To set the milepost switches S1 and S2 must be positioned as follows:

The switch settings produce a hexadecimal number (0 - A). The hexadecimal number is then used as the milepost digit. The switch settings displayed produces the milepost 187.0. If the switch is set to the right it is on, or 1



and if the switch is set to the left it is off or 0. Each digit uses four switches. See figure 6 for an example. The following table can be used to assist in setting the milepost number.

SWITCH SETTING	MILEPOST DIGIT
1 2 4 8	
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
0 0 1 1	3
0 1 0 0	4
0 1 0 1	5
0 1 1 0	6
0 1 1 1	7
1 0 0 0	8
1 0 0 1	9

11.6.2 If the milepost requires a fourth digit it can be set using the Display board DIP switches. See the software documentation for details.

11.7 MAXIMUM NUMBER OF ALARMS

11.7.1 The maximum number of alarms can be set on the speech board. DIP switch S3 controls the maximum number of alarms that a system will process before an integrity failure condition exists. This number is also represented as a hexadecimal number with the following settings used to represent the maximum number of alarms.

SWITCH SETTING	MAXIMUM NUMBER OF ALARMS
1 2 3 4	
0 0 0 0	0
0 0 0 1	1
0 0 1 0	2
0 0 1 1	3
0 1 0 0	4
0 1 0 1	5
0 1 1 0	6
0 1 1 1	7
1 0 0 0	8
1 0 0 1	9
1 0 1 0	10
1 0 1 1	11

1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

12. System Time and Date

System time and date can be set either through the data display panel or through the DCP. To set the time and date through the data display panel the **MODE** switch must be placed in position "C". The **FUNCTION** switch is used to either increment or decrement the current selection. The **DATA ADVANCE** switch is used to increment to the next function.

If the system displays the initial time of 1984-01-01, this indicates that the battery had at some time lost power. The battery can be recharged by simply leaving the system installed with power applied. The valid range for the year display is from 1984 to 2082. If this range is exceeded the **DATA DISPLAY** will show "OBSOLETE". Upon initial installation it is very important to set the system time and date. If the time and date is incorrect the printing on the chart recorder will be invalid.

When the **MODE** switch is initially placed in position "C" the year will be displayed in the **DATA DISPLAY**. To change the year in a positive direction place the **FUNCTION** switch in position 2 and to change the year in a negative direction place the **FUNCTION** switch in position 1. To display the current year place the **FUNCTION** switch in the middle switch. The **FUNCTION** switch should be placed in the middle position when no changes are being made to the system time and date to avoid an errant time change.

To change the month, day, hour, minute, and second the procedure is exactly the same as described for the year. Setting the system time and date can be interrupted at any time by either pressing the **RESET** switch or by the approach of a train.

13. System Power-Up

When power is applied to the hot box detector the **DATA DISPLAY** shows important information about the system configuration. The first display will be the railroad name. The railroad name or abbreviation usually consists of the first letter of each name in the railroad name or customary abbreviation.

The software version number is displayed next. It is important to have the correct version of software installed or operation may not be as described in the software documentation. The software version number should match the software version number found in the software documentation. If a problem is found in the system and it requires assistance from customer service at Harmon Electronics, Inc. the software version number provides needed information.

The next information displayed will be the type of scanners installed trackside. If this display does not match the type of scanners installed check the DIP switch settings on the universal processor board against those found in the software documentation.

After all of the diagnostic headers have been displayed the system will perform an integrity test. After the integrity test has been completed the clock LED will begin to flash every second. If the LED located on the universal processor board flashes replace the software and/or the universal processor board.

14. System Check-Out

14.1 SCANNER HEAT VERIFICATION

Allow the preamplifier to assume ambient temperature. This will take at least two hours.

Place the calibrated heat source (HPN 250472-001) on the top of the channel 1 scanner. The heat block must cover the opening in the scanner cover.

Place the hot box detector system in the "CHOP" mode (position B of the mode switch). Press the **DATA ADVANCE** switch to initiate the "CHOP" mode. To change to channel 2 press the **DATA ADVANCE** switch a second time.

The **DATA DISPLAY** should show 15 ± 1 millimeter. If this heat reading is not obtained perform the alignment procedure one more time. If a satisfactory reading is not obtained return the IRIS preamplifier to the factory for calibration.

Perform the above steps for channel 2.

Scanner verification will be different if the scanners installed are not manufactured by Harmon Electronics, Inc. Refer to the section of this manual that covers the specific scanner type that is being installed.

14.2 SYSTEM VERIFICATION

After all of the equipment has been installed the system should be tested for correctness. Trains should be simulated using the site installation drawings 102147-000 for direction and alarm side verification. Alarms should be verified for proper side annunciation, axle count, alarm type, etc. After the train has been verified per the installation drawings the data should be compared to the data stored in the DCP for correctness. If there are any discrepancies the system wiring should be compared to the drawings provided with the system.

15. Model 34 and Model 75 Description

The Model 34 and Model 75 electronics chassis contain the same circuit boards with one

exception. The Model 75 electronics chassis contains one additional board. An interface board is supplied to provide the required power for the different types of scanners. The analog boards also have a different resistor installed depending upon which types of scanners are installed. Figures 7 shows a typical front view of a Model 34 electronics chassis while figure 8 show a typical rear view of a Model 34 electronics chassis.

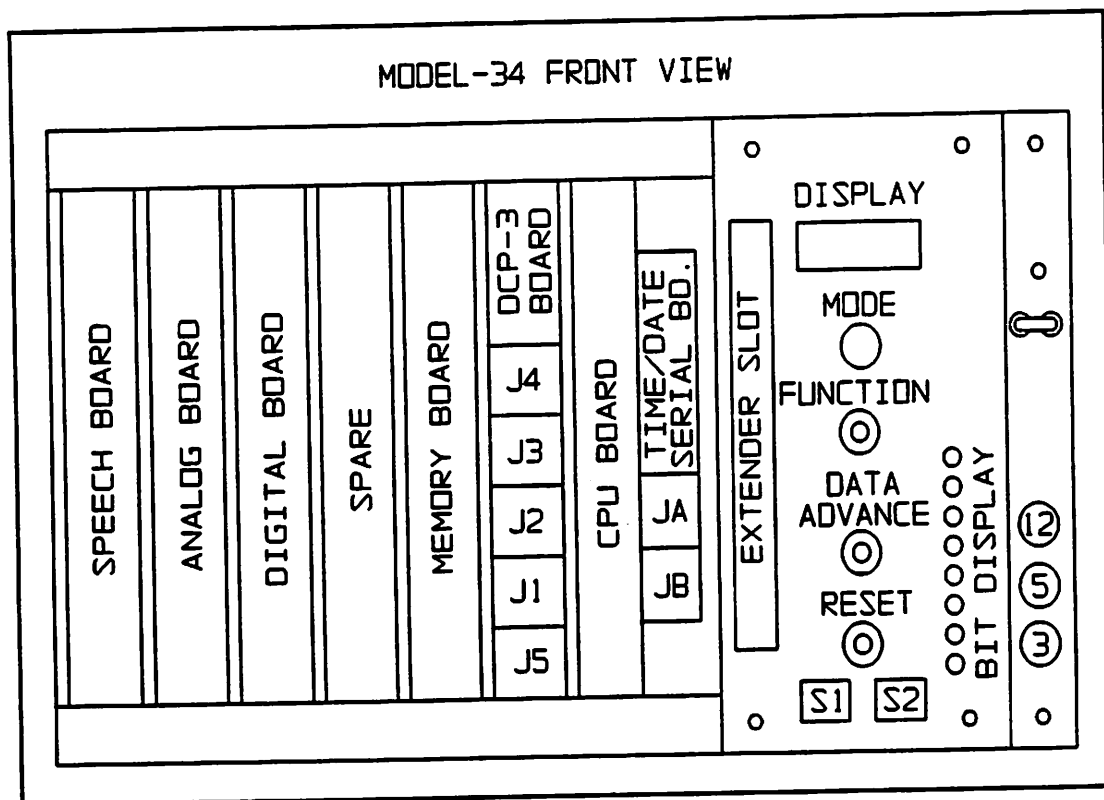


Figure 7 Front View of Model 34 Electronics Chassis.

A typical Model 34 electronics, chassis is made up of the following boards:

- | | |
|------------------------------------|--------------------|
| • 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 |

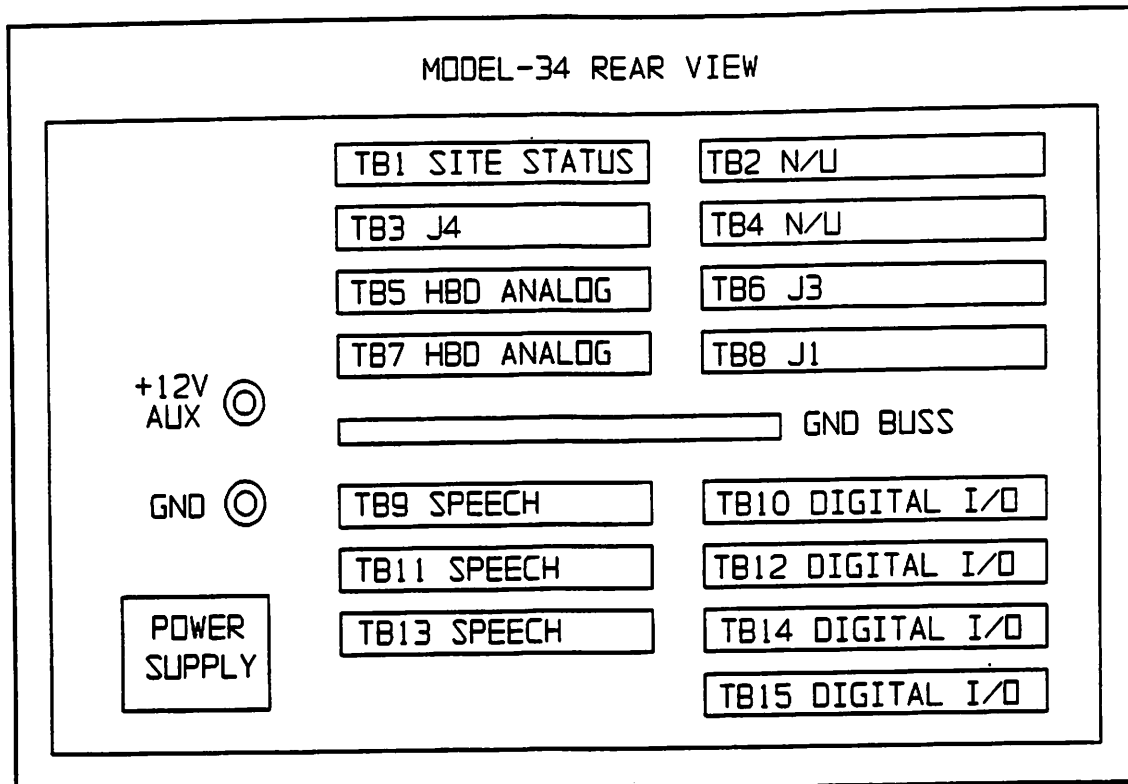


Figure 8 Rear View of Model 34 Electronics Chassis.

15.1 DIGITAL I/O BOARD

HPN 225809-000

The Digital Input/Output (I/O) board has the capacity to interface 24 bits of parallel I/O. Each input has a protection circuit capable of passing up to 30 volts DC. The outputs are capable of sinking 200 Ma with a maximum drop of 1.5 volts. In addition, two ports are capable of sourcing current through an RC network. This board also contains two Opto-Couplers that can be used to isolate any input or output circuit and an optional DPST or SPDT relay, also for isolating purposes.

The Digital I/O accepts inputs from the scanner protective shutter switch, the pre-amplifier optical shutter switch, track circuit, etc. It also controls external devices such as driving the analog chart recorder, opening the protective shutters, etc.

15.2 DISPLAY BOARD

HPN 226046-000

The Display board is the primary method by which the hot box detector system is controlled and information about the system is retrieved. The LED character displays are used to display system parameters and system setup configurations. The Rotary switch, toggle switches and dip switches are used to select modes of operation, reset the system, and provide on-site system configuration.

Detailed information concerning the operation of the Display board can be found in the section entitled "Mode Switch".

15.3 ANALOG I/O BOARD

HPN 226348-000/007

The Analog board can be used on a hot box detector or on a hot wheel detector, depending on jumper settings and software configuration. A hot box detector can have one hot bearing detector analog board and one hot wheel detector analog board with each board being capable of connecting to two scanners.

The Analog board interfaces either the IRIS or Model 38 pre-amp to the Universal Processor Board directly. If a scanner manufactured by another supplier is used, it is interfaced through the Overlay Interface board to the Analog board.

The Analog board converts the single sine wave from both wheel gate and advance wheel pickup transducers into interrupts and bit values. The bit values are then fed to the Universal Processor board. Depending upon the current bit pattern, the Analog board, scales and takes a peak heat reading. This peak heat reading is then used for alarm analysis for each bearing.

The Analog board also interfaces an ambient temperature sensor to the Universal Processor board. The input from the temperature sensor is scaled and digitized. The alarm parameters can for the hot box detector can also be set on this board.

15.4 UNIVERSAL PROCESSOR BOARD

HPN 225807-000

The Universal Processor board is the control center of the hot box detector system. The program memory (ROMs) on this board are custom programmed to meet each customer's specific requirements. The Universal Processor board controls all I/O communications, controls interrupts, makes alarm decisions, performs car recognition, and handles speech.

15.5 MEMORY BOARD

HPN 225814-000

The memory board contains the vocabulary of the HBD talker. The words and phrases are stored in Read Only Memory (ROM). The number of ROM's that are used is dependent upon the specific requirements of the railroad.

15.6 SPEECH BOARD

HPN 225815-000

The Speech board provides a means for the HBD to communicate directly with the train crew. The board produces computer generated speech from a predefined vocabulary. The board can also activate a radio and broadcast a verbal message to the train crew. The speech board also has external I/O lines, a relay, and an optical coupler.

15.7 DCP-3 BOARD

HPN 226459-000

The Data Communications Processor-3 (DCP-3) is an optional card that provides data storage of trains and data communication capability to the HBD. The DCP-3 can communicate digitally through the use of a data modem, RF modem, etc. It is also capable of communicating directly to a remote computer system if the software is programmed appropriately.

Data storage is performed in two ways. The DCP-3 stores the last twenty thousand axles worth of data. The DCP-3 also stores the last five trains with defects. For more information concerning the operation of the DCP-3 refer to the section IX on the DCP-3.

The DCP3 can accept eight separate programmable inputs, or site status inputs. The site status inputs can be connected to a set of dry relay contacts and can generate a message if the contacts make or break.

15.8 SERIAL I/O - TIME AND DATE BOARD

HPN 226264-000

The Time Date board interfaces to the Universal Processor board to provide a real time clock. This board also provides a serial link from the real time clock to the DCP3 board.

15.9 MAIN POWER SUPPLY

HPN 250850-000

The Main Power supply provides regulated ± 12 VDC and + 5V DC to the HBD processor and unregulated AUX 12 vdc for external uses(e.g. relay drive and opto-couplers etc.).

15.10 MODEL 75 OVERLAY ELECTRONICS

A Model 75 electronics for use on an overlay hot box detector system consists of the same boards with the addition of an overlay interface board. Figure 9 shows a typical front view of a Model 75 electronics chassis while figure 10 shows a typical rear view of a Model 75 electronics chassis.

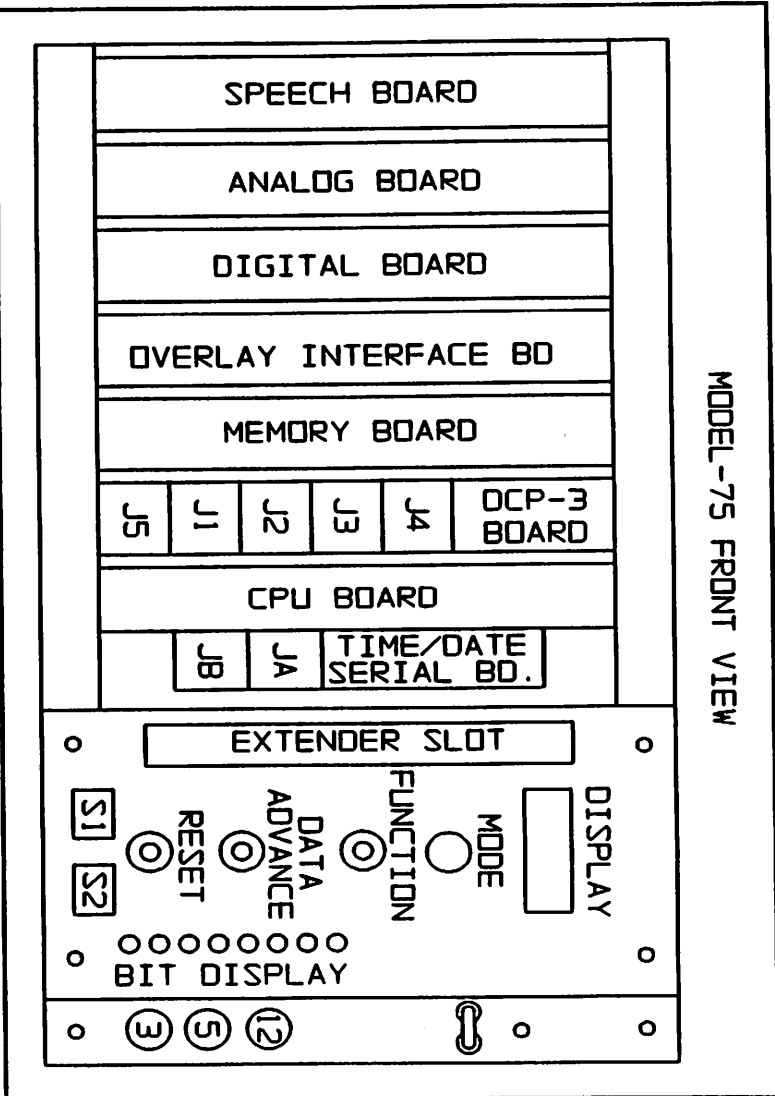


Figure 9 Front View of Model 75 Electronics Chassis.

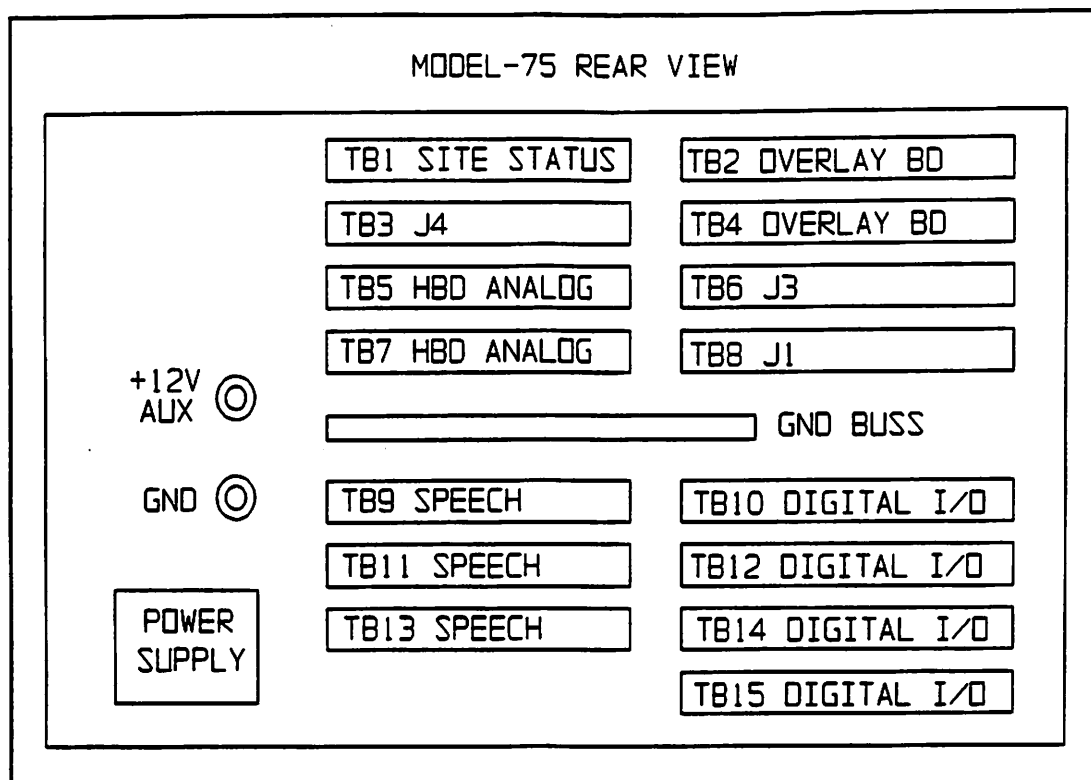


Figure 10 Rear View of Model 75 Electronics Chassis.

15.11 SERVO² OVERLAY INTERFACE BOARD

HPN 226171-000/003

The Servo Overlay Interface provides an interface between the Servo scanner and the Harmon Hot Box Detector. The Overlay board provides ± 200 volts to the scanner to power the bolometer. It also provides 160 VDC for model 7621 and 7707 sensors, and 24 VDC for 8808 and 8909 sensors.

The Servo Overlay board also provides an interface to the Servo ServoGraph chart recorder by providing a +180 Volt pen power supply and pen drive circuitry.

The output from the sensors is conditioned by the Servo overlay board before entering the Analog board on the HBD. Depending on the model of Servo sensor, different gain settings are used on the board. An adjustment pot is provided to adjust the gain. Refer to the Model 34/75 Technical Reference for information concerning the proper jumper setting.

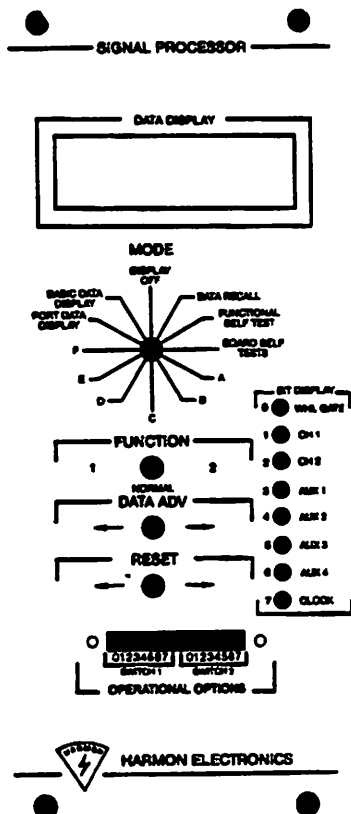
²Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

16. Model 35 Power Supply Description

The Model 35 power supply provides regulated +47VDC preamp power and +39VDC reference shutter supply. The supply also provides unregulated +24VDC for protective shutter and integrity drive.

17. MODE SWITCH

The front panel **MODE** switch selects tasks that are executed during the main loop of program execution. When a particular task is selected it may be necessary to use one or more of the three front panel switches. Following is a description of all of the tasks that can be accessed through the **MODE** switch and proper operation of any other switch that may be used.



- **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**

17.1 DISPLAY OFF

The **DISPLAY OFF** deactivates the front panel window. None of the front panel LEDs in the **BIT DISPLAY** column or in the **DATA DISPLAY** are illuminated for either a real train or a test train.

17.2 DATA RECALL

The last four trains with defects are stored in RAM for future use. **DATA RECALL** allows the end-of-train information for the last four trains with defects to be "replayed". The "replay" includes a reprint of all data (integrity, alarm, etc.) on the chart recorder if a recorder is installed and a complete retransmission of the voice message over the local speaker. The "replayed" voice messages is not transmitted over the radio.

Data recall trains are stored in a FIFO queue with the oldest train being deleted when a new train with a defect is obtained. Test trains are not stored in "Data Recall". Since train data is not stored in any type of non-volatile memory, all train data is deleted if power is removed for any reason. A system reset however, will not affect "Data Recall" memory.

To obtain the data for a desired train the **MODE** switch must be placed in the **DATA RECALL** position. "RECALL ?" will be displayed in the **DATA DISPLAY**. Press the **DATA ADVANCE** x times where 'x' is the number of the train that the retransmission is required for. If no data is available for that train, "NO DATA" is displayed in the **DATA DISPLAY**. If train data is available for the desired train, after a three second delay the chart recorder will begin printing and the message will begin to be retransmitted over the local speaker. The replayed data is not sent to the DCP again.

"Data Recall" is interrupted by the arrival of a real train at the detector site, or by pressing the **RESET** switch.

17.3 FUNCTIONAL SELF TEST

A test train is built into the hot box detector software. The test train contains one hundred seventy-two (172) axles divided into forty-two (42), four (4) axle cars and two (2), two (2) axle cars. The first two cars are six (6) axle locomotives and the third car is a four (4) axle locomotive. The remainder of the train is made up of typical rail cars.

A test train exercises every aspect of the hot box detector system, including the system integrity tests, exactly the same way that a real train does with one exception. A test train will not transmit any of the messages that are typically broadcast to a train crew over a radio. These verbal messages are present on the local speaker only. All train data processing is performed the same as a real train both on the local chart recorder and the DCP.

The self test train generates heat for every hot journal scanner and, if installed, every hot wheel scanner. The heat generated is injected into the system and causes alarms if the alarm levels are set at the appropriate levels. Auxiliary alarms are also generated at predefined axles. Following is a list of defects and where they are located on the train:

1. Channel 1 at axle 21. Absolute alarm.
2. Hot Wheel from axle 21 to axle 24.
3. Channel 2 at axle 32. Absolute alarm.
4. Auxiliary 1 at axle 84.
5. Auxiliary 2 at axle 87.
6. Channel 1 at axle 88. Ratio alarm.
7. Auxiliary 3 at axle 91.
8. Auxiliary 4 at axle 95.
9. Channel 2 at axle 172. Carside alarm.

For the test train to produce alarms as described above the alarm parameters should be set to the following levels:

Lo Limit:
 Hi Limit:
 Carside Lo Limit:
 Carside Slope:

Test trains can be produced at three different speeds - 33 miles per hour, 63 miles per hour and 133 miles per hour and can be initiated through the use of a Data Communication Processor (DCP) or through the front panel switches.

To initiate a test train through the DCP the **DISPLAY MODE** must be selected. Enter **<T1>** for a slow speed test train, **<T2>** for a medium speed test train and **<T3>** for a fast test train. There will be no indication to the user that a test train has been requested if connected to the **REMOTE** or **LOCAL** port of the DCP. A test train will be processed the same as a real train in the DCP. The only indication of a test train in the DCP will be a "T" in the train list. Test trains are not stored in defect train memory.

To initiate a test train through the Display Panel the **MODE** switch must be in the **FUNCTIONAL SELF TEST** position. The **DATA DISPLAY** window should show the phrase **"STANDBY"**. If the **DATA DISPLAY** window shows the phrase **"INTEGRITY"** the hot box detector is performing a two minute integrity test. The test train cannot be initiated until the integrity test is finished.

The **FUNCTION** switch determines the speed of the test train. Position "1" produces a slow speed test train, the middle position produces a medium speed test train and position "3" produces a fast test train. The train speed can be changed at any time during the test train by moving the **FUNCTION** switch from one position to another. A test train can be halted at any time by pressing the **RESET** switch.

When the hot box detector has finished "scanning" the test train all end of train data processing is performed. Data is sent to the DCP, the end-of-train message is broadcast through the local speaker, and the chart recorder records the train data. When the end-of-train processing is being performed the message "TIMEOUT" will be displayed on the **DATA DISPLAY**.

17.4 BOARD SELF TEST

The hot box detector is capable of performing a self test of internal circuit boards. There are two types of board self test performed by the hot box detector. This description specifically addresses the board self test performed from the window panel.

The board self test is used to test the performance of the individual circuit boards located within the hot box detector electronics chassis. The board self test is a detailed testing procedure which is performed at the board level by executing a sequence of tests on individual circuits of each board. The board self test is set up for two levels of examination. The first level tests the individual boards sequentially, showing the results in the **DATA DISPLAY** window "PASS" or "FAIL". The second mode also examines the boards sequentially, but upon reaching a specific sub-test that fails the **DATA DISPLAY** window will window the name of the circuit that caused the failure. This sub-test is repeated until the test passes or the maintainer advances the test to its next stage.

The board self test is performed in five states (six if a hot wheel detector is installed, one per HBD board). Each state consists of several sub-tests which exercise a specific circuit on the board. To perform a board self test the **MODE** switch must be in the **BOARD SELF TEST** position. The **DATA DISPLAY** window should show the phrase "TEST?". If the **DATA DISPLAY** window shows the phrase "INTEGRITY" the hot box detector is performing a two minute integrity test. The board self test cannot be initiated until the integrity test is finished.

The **FUNCTION** switch is not used in the board self test. The **RESET** switch, if pressed, will cancel the board self test, and the phrase "TEST?" will be displayed again. If a train is detected during a board self test, the test is immediately canceled.

The **DATA ADVANCE** switch is used to start and control the board self test. By pressing the **DATA ADVANCE** switch once the HBD will perform the first level of testing giving the "PASSED"/"FAILED" message for each board. By pressing the **DATA ADVANCE** switch a second time the HBD will execute the second level of testing. While the board self test is being executed the **DATA ADVANCE** switch is constantly monitored. If the **DATA ADVANCE** switch is pressed for the second time the remaining sub-tests will be performed using the second level of testing.

First level test

When a board self test is initiated the **DATA DISPLAY** shows the name of the board under test (CPU, ROM, SPEECH, DIGITAL, ANALOG). Once the test has been completed the **DATA DISPLAY** shows the "PASSED" phrase if the board passes all the sub-tests, and "FAILED" if any of the sub-tests fails. The HBD then tests the next board, windowing the results in the same fashion. After all the boards have been tested, the HBD windows "FAILED" if any of the boards failed their test, and "PASSED" otherwise.

Second level test

To initiate a second level board self test, the **DATA ADVANCE** switch must be pressed twice. At the second level of testing the **DATA DISPLAY** shows the name of the board under test. Sub-tests are performed to test the operation of each board (circuits). If the board passes all of the sub-tests, the **DATA DISPLAY** shows the phrase "PASSED", and begins testing the next board. If a sub-tests fails the **DATA DISPLAY** shows a message describing the failure. The test that caused the failure is repeated until the cause of failure disappears or the maintainer advances the test to the next state. By pressing the **DATA ADVANCE** switch, the next test is started.

When all of the boards have been tested, the **DATA DISPLAY** shows the phrase "FAILED" if any of the individual tests have failed. Otherwise the **DATA DISPLAY** shows the phrase "PASSED".

17.5 DISPLAY POT SETTINGS - "A"

The pot setting position (position "A") is used to adjust or window the system alarm levels. The alarm levels are located as adjustable pots on the analog board or in Non-Volatile memory located on the serial\time and date board if a DCP is installed.

Note: If an analog-II board is not installed it is necessary to remove the analog board from the electronics chassis and place it in the extender location on the front of the window and test panel before any actual adjustment can be made.

To adjust the alarm levels the **MODE** switch must be placed in the Pot Setting Position - "A". The **FUNCTION** switch can be in any position, but different information is displayed dependant upon the switch position. If the **FUNCTION** switch is in position "1" the raw value of the pot selected will be displayed in the **DATA DISPLAY** if no DCP is installed and "DCP ON" will be displayed if a DCP is installed. If the **FUNCTION** switch is in the middle position the actual name of the current value being set will be displayed in the **DATA DISPLAY**. If the **FUNCTION** switch is in position "2" the parameter value, in millimeters, of alarm level will be displayed in the **DATA DISPLAY**.

By pressing the **DATA ADVANCE** switch the next pot setting is displayed in the **DATA DISPLAY**. When the last pot setting has been made the first pot setting is again

displayed. There are six 10K Ω pots on each analog board which are used to set the hot box detector alarm levels. Following shows parameters assigned to each pot and the range of each.

- * pot 1 (R28 on Analog II, R116A on Analog I)
Lo limit for simple (single axle) alarm analysis.
Range: 5 mm - 15 mm
- * pot 2 (R29 on Analog II, R116B on Analog I)
Hi limit for absolute alarm analysis.
Range: 5 mm - 24 mm
- * pot 3 (R30 on Analog II, R122C on Analog I)
Carside Slope for carside alarm analysis.
Range: 0.68 - 2.36
- * pot 4 (R31 on Analog II, R122D on Analog I)
Carside Lo limit for carside alarm analysis.
Range: 5 mm - 15 mm
- * pot 5 (R32 on Analog II, R123E on Analog I)
Gate transducer spacing.
Range: 15 " - 30"
- * pot 6 (R33 on Analog II, R123F on Analog I)
Not Used unless a hot wheel detector is installed.
Range: 15 mm - 24 mm

The hot box detector stores the value of each pot in non-volatile memory located on the serial\time and date board. If the hot box detector detects presence of the time and date board, it will use alarm parameters from the non-volatile memory located on the board, and not the analog board voltage dividers(pots). Changing the pots on the analog board will not effect the values stored in the non-volatile memory. The only exception is pot 5, wheel gate spacing. The wheel gate spacing can only be changed through the analog board even if a time and date board is present. The only way to set the pot values when the serial\time and date board is present is through DCP commands. These commands are discussed in the DCP section of this manual.

17.6 CHOP - "B"

"Chop" is used during the installation, calibration, alignment, and maintenance of the hot box detector scanners and associated circuitry. The main function is to verify that scanners are reading an appropriate amount of heat.

For proper system calibration, a calibrated heat source is required for scanners manufactured by Harmon Electronics, Inc. and a function simulator/generator is required for scanners manufactured by Servo³ Corporation of America.

The **CHOP** mode is started by placing the **MODE** switch in position "B". The **DATA DISPLAY** will show "***CHOP***" if scanners manufactured by Harmon Electronics, Inc. are installed or "**-CHOP-**" if scanners manufactured by Servo Corporation of America are installed. Pressing the **DATA ADVANCE** switch initiates a series of continuous simulated wheel gates. Heat values read at the scanners are displayed on the **DATA DISPLAY** in the form of "**CHn xx.x**", where 'n' is a channel number and 'x' is a decimal digit. The heat displayed on the **DATA DISPLAY** is in millimeters. If a chart recorder is installed, the heat displayed is a graphical representation in millimeters. Pressing the **DATA ADVANCE** switch again steps through the attached scanners. The **CHOP** mode can be reset in one of three ways. Those are by pressing the **RESET** switch, the presence of a real train, and the **MODE** switch being placed in another position.

17.7 SET TIME AND DATE - "C"

System time and date can be set either through the data display panel or through the DCP. To set the time and date through the data display panel the **MODE** switch must be placed in position "C". The **FUNCTION** switch is used to either increment or decrement the current selection. The **DATA ADVANCE** switch is used to increment to the next function.

If the system displays the initial time of 1984-01-01, this indicates that the battery had at some time lost power. The battery can be recharged by simply leaving the system installed with power applied. The valid range for the year display is from 1984 to 2082. If this range is exceeded the **DATA DISPLAY** will show "**OBSOLETE**". Upon initial installation it is very important to set the system time and date. If the time and date is incorrect the printing on the chart recorder will be invalid.

When the **MODE** switch is initially placed in position "C" the year will be displayed in the **DATA DISPLAY**. To change the year in a positive direction place the **FUNCTION** switch in position 2 and to change the year in a negative direction place the **FUNCTION** switch in position 1. To display the current year place the **FUNCTION** switch in the middle switch. The **FUNCTION** switch should be placed in the middle position when no changes are being made to the system time and date to avoid an errant time change.

To change the month, day, hour, minute, and second the procedure is exactly the same as described for the year. Setting the system time and date can be interrupted at any time by either pressing the **RESET** switch or by the approach of a train.

³Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

17.8 RECORDER CALIBRATION - "D"

After a heat signal has been extracted from the scanner it is converted to a digital value on the analog board. This digital value is then routed through a DAC and sent to the analog chart recorder. This heat signal is represented as a pulse on the chart recorder and is measured in millimeters of deflection. To accurately measure the amount of deflection a method must be available to calibrate the chart recorder. The Recorder Calibration mode is used to insure that the analog chart recorder is functioning correctly and is properly aligned.

To enter the Recorder Calibration mode the **MODE** switch must be in position 'D'. The **DATA DISPLAY** will window "RCDR CAL". Pressing the **DATA ADVANCE** switch initiates a series of five, ten, fifteen, and twenty millimeter pulses on the analog chart recorder on both channels. The Recorder Calibration mode is terminated when the **RESET** is pressed, by positioning the **MODE** in any other position, or by the arrival of a real train.

If it is necessary to adjust the chart recorder, refer to the equipment manual for Model Model-2 Data Recorder.

17.9 CONTINUOUS TEST TRAIN - "E"

A continuous test train is built into the hot box detector software for maintenance procedures. The continuous test train contains one thousand axles divided into four axle cars.

A continuous test train exercises every aspect of the hot box detector system, including the system integrity tests, exactly the same way as a real train, with one exception. A continuous test train will not transmit any of the messages that are typically broadcast via radio to a train crew. These verbal messages are transmitted on the local speaker only. All train data processing is performed the same as a real train both on the local chart recorder and the DCP.

Continuous test trains can be produced at three different speeds - 33 miles per hour, 63 miles per hour and 133 miles per hour and can be initiated only through the front panel switches. A test train is processed the same as a real train in the DCP. The only indication of a test train in the DCP will be a "T" in the train list. Continuous test trains are not stored in the defect train list.

To initiate a test train through the Display Panel the **MODE** switch must be in the position **E**. The **DATA DISPLAY** window should show the phrase "STANDBY". If the **DATA DISPLAY** window shows the phrase "INTEGRITY" the hot box detector is performing a two minute integrity test. The continuous test train cannot be initiated until the integrity test is finished.

Signed by Israel Jones, texasrails.org 7/16/2026

The **FUNCTION** switch determines the speed of the continuous test train. Position "1" produces a slow speed test train, the middle position produces a medium speed test train and position "2" produces a fast test train. The train speed can be changed at any time during the test train by moving the **FUNCTION** switch from one position to another. A continuous test train can be halted at any time by pressing the **DATA ADVANCE** switch. At this time the hot box detector will go into the end-of-train processing the same as it would for a regular test train or a real train. When the end-of-train processing is being performed the message "TIMEOUT" will be displayed on the **DATA DISPLAY**. If the **RESET** switch is pressed the hot box detector will not process the train data.

The continuous test train has been designed so that the entire hot box detector system can be tested under controlled conditions. Heat signals can be injected into the scanners by placing a heat source in front of the scanners. All of the auxiliary inputs are active and alarms can be simulated by activating any of the alarm devices or inputs. All simulated alarms are treated as if a real train was being scanned.

17.10 TONE TEST/DISPLAY TEMPERATURE - "F"

With the **MODE** switch in position "F" (**TONE TEST AND TEMPERATURE DISPLAY**) the ambient temperature can be displayed on the **DATA DISPLAY** and a 1000 Hz tone can be generated to test the audio circuitry. The specific mode is dependent upon the position of the **FUNCTION** switch.

With the **FUNCTION** switch placed to position '1' the ambient temperature is displayed on the **DATA DISPLAY** window. The ambient temperature will be either the internal ambient temperature or the external ambient temperature. The temperature window can be toggled between the internal ambient temperature and external ambient temperatures by pressing the **DATA ADVANCE** switch.

The **DATA DISPLAY** window the phrase "EXT =xxx" or "INT=xxx" if the ambient temperature window is selected. "xxx" is the actual temperature reading and can be either positive or negative degrees Fahrenheit.

With the **FUNCTION** switch in the center position the **DATA DISPLAY** window will show "TONE TST". When the **DATA ADVANCE** switch is pressed a continuous 1000Hz tone will be transmitted over the radio and through the local speaker. This allows for complete testing of the audio circuitry, including the radio alignment.

17.11 PORT DATA DISPLAY

With the **MODE** switch in the **PORT DATA DISPLAY** position, the data present on the digital ports of the Model 32/75 electronics chassis can be displayed on the **BIT DISPLAY** on the window panel LEDs. The **BIT DISPLAY** has 8 vertically positioned LEDs which represent the 8 data bits of a particular port. In the **PORT DATA DISPLAY** mode the headings on the left of the LEDs which mark the top LED as bit 0 and the bottom LED as the bit 7 are used. An LED will be illuminated if the corresponding bit is grounded

(active), and off if a potential of 12 VDC exists across the input. The **PORT DATA DISPLAY** is a very helpful method in troubleshooting the hot box detector digital ports.

The **DATA DISPLAY** windows the port number (zero to two hundred fifty-five) in hexadecimal format (00H to 0FFH). A two digit hexadecimal value is used to represent the port number. The **FUNCTION** switch determines how the port number is incremented or decremented when the **DATA ADVANCE** switch is pressed. If the **FUNCTION** switch is set to position "1", the left digit of the port number is incremented. If the **FUNCTION** switch is set to position "2", the right digit of the port number is incremented. If the **FUNCTION** switch is in the center position, the port number is decremented by one.

A map of the ports and associated circuitry can be found in the Model 32/75 Technical Reference.

17.12 BASIC DATA DISPLAY

With the **MODE** switch in the **BASIC DATA DISPLAY** position the **DATA DISPLAY** windows several messages dependant upon the current activity of the hot box detector. Following is a list of possible messages that can be displayed on the **DATA DISPLAY** and the cause of each message:

STANDBY If the hot box detector is currently not scanning a train and no other activity is currently being processed this message is displayed.

INTEGRITY If a two-minute integrity test is being performed, this message is displayed.

APPROACH If a train has been detected by either the advance transducers or the track circuit this message is displayed.

SPD=xxx If a train is passing the hot box detector the train speed is displayed.

TIMEOUT If a train has just left the hot box detector, the end-of-train processing is being performed. This message is present as long as the chart recorder or the speech processor is active.

The **BIT DISPLAY** is also active and windows different messages with the **MODE** switch in the **BASIC DATA DISPLAY** position. Following is a list of possible messages that can be displayed in the **BIT DISPLAY** column:

WHL GATE The "WHL GATE" LED is illuminated when a wheel is detected by the wheel gate transducers. It is on as long as a journal is in the path of the scanner.

CH1 The "CH1" LED is illuminated when a hot journal has been detected on channel 1.

CH2 The "CH2" LED is illuminated when a hot journal has been detected on channel 2.

AUX1 The "AUX1" LED is illuminated when dragging equipment has been detected.

AUX2 The "AUX2" LED is illuminated when the auxiliary 2 input has activated.

AUX3 The "AUX3" LED is illuminated when the auxiliary 3 input has activated.

AUX4 The "AUX4" LED is illuminated when the auxiliary 4 input has activated.

CLOCK The "CLOCK" LED flashes once every second.

18. HBD Disable/Radio Mute

HBD DISABLE and **RADIO MUTE** are two features controlled by the HBD software. The HBD Disable function prevents the HBD from processing train data. The Radio Mute function disables the radio - the HBD will still process and record trains, but the train crew is not notified over the radio of any defects or integrity failures.

Both functions are controlled through commands from the DCP. The commands to disable/enable the HBD and mute/unmute the radio are found in the DCP documentation under the "Maintenance Mode". In systems where a DCP is not installed, it is not possible to use these two functions - the HBD is always enabled and the radio will always be active.

18.1 HBD DISABLE

The HBD uses two bytes of non-volatile memory to store the status of this function. During the first power-up after installing HBD software the HBD might be disabled. This is due to the fact that the software tries to retrieve the status of these functions from a part of memory which was never used by the previous versions. As a result, it might be necessary to enable the HBD using the DCP maintenance mode commands.

HBD tasks which are controlled by the HBD Disable command are: processing train data, simulating trains, and communication with the DCP.

Upon arrival of a train, the HBD checks the flag which represents the status of "HBD disable". If the flag is set (HBD is disabled), functions which perform pre-train activities are not called. The pre-train integrity test is not performed, the scanner protective shutters are not opened, the chart recorder remains off, and the front panel display does not change (it remains at "STANDBY"). The front panel clock LED, however, flashes. The clock LED indicates that the HBD software is running even if no activity is seen by the HBD.

HBD Disable is a software based command. This means that the software functions which process train data, store train data, and transmit train data are not called. The hardware interrupts, however, remain enabled. This means that transducer interrupts will still be processed and can be traced on the HBD boards.

Test trains are also controlled by the HBD Disable command. If the HBD is disabled, with the MODE switch in the FUNCTIONAL SELF TEST position or in the "E" position, test trains will not be generated. Test train commands from the DCP are also rejected by the HBD. The DCP displays a message informing the user that the HBD is currently disabled. Before requesting a self test train of either type the HBD should be reenabled.

Communication with the DCP is also affected by the HBD Disable command. After receiving a data packet (command) from the DCP, the HBD checks the HBD Disable status. If the HBD is currently disabled, the data packet from the DCP is rejected. The only exception is a request to reenable the HBD from the DCP.

TB9.4 of the speech board is used to show the status of the HBD Disable command. During the period that the HBD is disabled, TB9.4 is grounded so that an external device can be connected to give a visual indication of the current status.

Although the HBD Disable function is implemented in the HBD software, a DCP must be present to utilize these features. If no there is no DCP (either the DCP Present DIP switch is off, or the time date board is malfunctioning), the HBD is always enabled and the radio will be activated for real trains.

The HBD still performs other tasks such as the two minute integrity test, chop, display/modify time and date (front panel only), display pots, etc., while disabled. Note: these functions can only be performed from the HBD front panel.

18.2 RADIO MUTE

When the HBD has been set to mute the radio, it functions normally in all aspects of operation with one exception. The HBD does not transmit any verbal message either over the radio or over the external speaker.

TB9.3 of the speech board is used to show the status of the Radio Mute command. During the period that the HBD Radio is muted, TB9.3 is grounded so that an external device can be connected to give a visual indication of the current status.

19. Alarm Analysis

The hot box detector performs three types of alarm analysis on bearings that are being scanned. Absolute or High Limit checking is performed on every axle. Carside Analysis is performed on all axles belonging to a group of axles that the software has grouped as a recognized car. Differential testing (three to one) is performed on every axle that does not belong to a car.

Following is a detailed description of the steps taken in alarm analysis as well as alarm level adjustments:

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)
Not Used.

If the HBD is configured as a Hot Wheel Detector, a second analog board adds another set of six pots. Currently, only the first pot on the second analog board is used to set/adjust the low limit for Hot Wheel alarms.

Pot	Parameter	Minimum	Maximum
1	Simple alarm low limit	5mm	15mm
2	High Limit	5mm	24mm
3	Carside Slope	.68	2.36
4	Carside Low Limit	5mm	15mm
5	Transducer Spacing	15"	30"
6	not used		
7	Hot Wheel High Limit	15mm	24mm

19.1 FIRST POT:

The first pot is used to set the *Low Limit* level for the simple alarm analysis. The simple alarm analysis is performed on axles which have not been identified as a car. The following shows how the simple alarm analysis is performed, and how the first pot value is used in the procedure.

- For each out of sync axle (not recognized as belonging to a car):
- If the left side heat value is greater than the pot 1 value and the left side heat is greater than 3 times the right side heat then this axle has a differential alarm on the left side.
- If the right side heat value is greater than the pot 1 value and the right side heat is greater than 3 times the left side heat then this axle has a differential alarm on the right side.

19.2 SECOND POT:

The second pot is used to set/adjust the *High Limit* for the absolute alarm analysis. The absolute alarm analysis is performed for every axle of the train regardless of the car recognition process. The following procedure shows how the value of the second pot is used during absolute alarm analysis.

- For the current axle:
- If the left side heat value is greater than the pot 2 value then this axle has an absolute alarm on the left side.
- If the right side heat value is greater than the pot 2 value then this axle has an absolute alarm on the right side.

19.3 THIRD POT: CARSIDE SLOPE

19.4 FOURTH POT: CARSIDE LOW LIMIT

The third pot is used to set/adjust the *Carside Slope* alarm analysis, while the fourth pot sets/adjusts the *Carside Low Limit* for carside analysis. The carside alarm analysis is performed on a group of axles (4, or 6 axles) which have been identified as a car/locomotive. The following shows how the HBD performs its carside alarm analysis, and how the pot values are used.

- The average heat value is computed for the first side of the current car:
- add all the heat values for side 1
- subtract the largest and smallest heat value from total heat value
- divide the result by (number of axles -2)

$$\text{average heat} = \frac{\text{total heat} - \text{largest heat} - \text{smallest heat}}{\text{number of axles} - 2}$$

- Compute the carside alarm level for this car:
- alarm level = CS slope (pot 3) * average heat + CS limit (pot 4) - CS slope (pot 3)
- Compare each axle heat value(side 1) against the computed CS alarm level. If any axle heat is greater than the computed CS alarm level, there is the possibility of an alarm.

- Perform the validation alarm test as follows:
- If the heat value of side 2 (non-alarm side) is less than 50% of the heat value of the side 1 (possible alarm side) then mark the axle having a CS alarm. Note that the 50% is a predefined software constant.

- The above procedure is repeated again for the same car using the side 2 heat values.

19.5 FIFTH POT:

The fifth pot is used to set/adjust the gate transducer spacing. The gate transducer spacing is stored in inches and can range from 15" to 30".

20. Train Position Cases

The hotbox detector software operates in five cases, or states, depending upon the position of any trains. These five states are:

- Train Approach
- Train in Passage
- Train Stopped
- End of Train Timeout
- No Train Around

The software can also be interrupted by external events such as track circuits, wheel detectors, etc. The interrupts are discussed in the Model 34/75 Technical Reference and can be found in the Microcontroller handbook. Following is a brief description of each train processing states:

20.1 TRAIN APPROACH

This condition is set by either of the following conditions:

- Track circuit closure.
- Advance transducer detecting a wheel.

The Train Approach state is canceled if no wheels are detected within 20 seconds of track circuit closure or the advance transducer.

While in the Train Approach state the hot box detector software performs a number of tasks. These are:

- Open the protective shutters over the scanners.
- Activate the analog recorder.(if used)
- Notify the DCP that a train is coming.
- Start the scanner integrity test.

20.2 TRAIN IN PASSAGE

This condition is set when a wheel gate transducer detects at least three wheels.

While this condition is set the following tasks occur:

- Axle data is checked to calculate speed of both the train and the car. An integrity failure is set if the train speed drops below five miles per hour.
- The heat values are sampled for each axle.
- A 4 second 1000 Hz tone is sounded for each alarm.
- If too many alarms are detected an integrity failure is given.

This condition ends when either the track circuit opens or no axles are detected for an interval of eight seconds.

20.3 TRAIN STOPPED

This condition is set if no axles are detected for eight seconds and the track circuit is still closed.

When a train is stopped, the hot box detector software enters the end-of-train timeout condition. Before the end-of-train timeout state is entered several tasks are performed. Those are:

- The transducer counts are compared against each other.
- Car count is computed.
- The data is printed on the chart recorder.
- End of train message is sent to the DCP.

20.4 END OF TRAIN TIMEOUT

This condition sets after Train In Passage ends - when no axles are detected for eight seconds and/or the track circuit opens.

When the End-of-Train Timeout state is entered the following actions occur:

- Protective shutters are closed.
- Analog recorder is shut off after all data is printed.
- End of train message is spoken and radio turns off when it is finished speaking.
- The end-of-train integrity test is performed.
- The calibration pulses are printed on the chart recorder.
- The train data is sent to the DCP.
- Data is moved to **DATA RECALL** if an alarm was detected.
- Internal memory is prepared for the next train.

20.5 NO TRAIN AROUND

The No Train Around state is the normal state of the hot box detector software that is not currently processing a train.

In the No Train Around state the system performs the following:

- The **DATA DISPLAY** is updated using the front panel controls.
- Communication with the DCP is maintained.
- Run test trains initiated by either the front panel or the DCP.
- Monitor all external devices such as track circuit, wheel gates, other HBD, etc. for activity.
- Monitor the front panel switches and update as required.
- Monitor the tunnel circuit for activity and respond accordingly.
- Update the internal timers.

The HBD continuously updates the internal and external temperature and the time/date. If selected with the **MODE** switch, the **DATA DISPLAY** is also updated.

The parameter settings are continuously updated either through the front panel switches and analog board or through the DCP. The **DATA DISPLAY** is also updated if selected by the **MODE** switch.

The arrival of a real train at the detector cancel all of the front panel manual mode selections. This includes Data Recall, Test Trains, Chop Mode, etc. For more information on the operation of the **MODE** switch refer to the **MODE SWITCH** section of this manual.

Interrupts that occur are processed according to the position of the front panel switches or DCP selection.

For more detailed information concerning the software and how the software interfaces with the hardware please refer to the Model 34/75 Technical Reference.

Model 3300 Rail Mount Scanner

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1. Introduction

1.1 This section contains information pertaining to installation, operation, and maintenance of trackside equipment required for a Mode 34 Hot Box Detector.

2. Description

2.1 MODEL 3300 RAIL MOUNT SCANNER (HPN 250577-000/001)

2.1.1 The Model 3300 Rail Mount Scanner (RMS) has been designed to be mounted on the rail base either straddling a tie or between ties. A locking solenoid has been incorporated to prevent the shutter from being opened from the outside. The protective shutter is normally in the closed position when the system is not scanning a train or a maintenance procedure is not being performed.

2.1.2 The preamplifier used in the Model 3300 rail mount scanner is the Model 3800 (IRIS) (HPN 250875-100).

2.1.3 Thermostatically controlled scanner heaters are incorporated in the scanner to prevent ice and snow from blocking the view of the scanner and jamming the protective shutter.

2.2 UNIVERSAL WHEEL TRANSDUCER DESCRIPTION (HPN 250730-000)

2.2.1 The Universal Wheel Transducer (UWT) is a passive device that synchronizes passing rail car wheel flanges with wayside electronics to perform heat analysis. The output of the universal wheel transducer is a single sine wave whose period and amplitude are a function of train speed. The UWT functions at train speeds between 3 and 150 miles per hour.

2.2.2 The universal wheel transducer can be mounted on any rail size between 90 pounds and 150 pounds. The rail can be electrified or non-electrified.

2.3 A typical arrangement of trackside equipment is shown in drawing 102147-000.

3. Specifications

3.1 RAIL MOUNT SCANNER

Power Requirements

Input Voltage

+12 VDC at 1.5 Amps

110 VAC at 4.0 Amps

Heater Rating

400 Watts at 110 VAC

Approximately 54.5° C

Operating Temperature

-40° C to 71.1° C

Dimensions

Width

6½ inches

Height

5 inches

Length

21 inches

Weight with clamps

45.0 pounds

3.2 UNIVERSAL WHEEL TRANSDUCER

Electrical

Power

Passive

Isolation

2400 VAC

Connection

16 gauge copper

Operational

Average Train Speed

3 to 150 MPH

Signal Output

Sinusoidal

Physical

Rail Types

110 lb to 150 lb

Mounting

¾ grade 5 stainless steel bolts

Operating Temperature

-40° C to +71° C

Storage Temperature

-40° C to +85° C

Relative Temperature

0 to 100 % condensing

Shock

500 g along any axis

Vibration

20 g from 1 to 60 Hz along any axis

3.3 ACCESSORIES

	HPN
Laser Alignment Fixture	250874-000
IRIS Preamplifier	250875-100
Ambient Temperature Probe	250835-002/003
Calibrated Heat Source	250472-001
Scanner Guard (4)	250705-000
Track Alignment Fixture	250443-000
Rail Mount Scanner Cable (2)	226712-XXX, where XXX is the specific part number for the length of cable required from 35 feet to 135 feet, in 10 feet intervals
RMS Installation Tool Kit	180260-001

Parts included in the tool kit (HPN 180260-001):

- 1 each $\frac{3}{4}$ inch X $\frac{1}{2}$ inch 12 point drive socket wrench
- 1 each 15/16 inch X $\frac{3}{8}$ inch 12 point drive socket wrench
- 1 each 15/16 inch open end wrench
- 1 each $\frac{1}{2}$ inch open end wrench
- 1 each 5/16 inch allen wrench
- 1 each $\frac{1}{4}$ inch allen wrench

4. General Installation Information

4.1 Two Model 3300 Rail Mount Scanners are required for detection of hot journals, one on each side of the track. Two additional hot wheel scanners can be added if hot wheel detection is incorporated into the system.

4.2 Two universal wheel transducers are fastened to the rail to provide the HBD system with signals for the wheel gating function. Optionally, two additional universal wheel transducers can be used to provide advance start signals. Location and dimensions of the wheel transducers are shown on the installation drawings (see drawing 102147-000, sheet 1 of 3).

5. Installation of Model 3300 Rail Mount Scanners

5.1 Carefully unpack the equipment and inspect for shipping damage. If any damage is evident or if any of the items on the packing slip is missing please notify Harmon Electronics, Inc. immediately. Before proceeding with the trackside equipment installation read the entire installation procedure.

***** NOTE *****

The following tools are required for scanner installation:

- 1 each $\frac{3}{4}$ inch X $\frac{1}{2}$ inch 12 point drive socket wrench
- 1 each 15/16 inch X $\frac{5}{8}$ inch 12 point drive socket wrench
- 1 each 15/16 inch open end wrench
- 1 each $\frac{1}{2}$ inch open end wrench
- 1 each 5/16 inch allen wrench
- 1 each $\frac{1}{4}$ inch allen wrench

All of the above listed tools should be included in the scanner installation tool kit (HPN 180260-001). If any of the tools is missing please contact Harmon Electronics, Inc. for a replacement kit.

5.2 Locate the point where the scanners are to be placed on the rail. A scanner can straddle a tie or it can be placed between ties. Clear an area beneath the rail where the scanners are to be installed.

5.3 Remove rail creepers and spikes from the tie that the scanner is to be mounted over.

5.4 Locate the left and right scanner by standing facing the prevalent train direction. The right scanner will have the cable connection coming out of the right side with the scanner setting in its normal operating position.

5.5 Mount the right scanner to the outside of the right rail. Proper rail determination can be

obtained from drawing 102147-000, sheet 1 of 3.

5.6 Mount the scanners using the rail clamps provided. Spacers located in the middle of the clamp (see drawing 201620-000, item 18) may be moved to the outside to provide for proper engagement of the rail base depending on the weight of the rail. When installing scanner clamps on the rail, if the screw (see drawing 201620-000, item 3) bottoms out before tightening, add a spacer beneath the ramp washers (see drawing 201620-000, item 1). If the screw still bottoms out before tightening, add the second spacer. The clamp bolts should be tightened to at least 160 foot pounds of torque.

5.7 Loosen the two $\frac{3}{4}$ inch bolts (see drawing 201620-000, item 2) under the scanner to allow the scanner to be level. The scanner should be adjusted so that the top of the scanner is lower than the top of the rail. These bolts must then be tightened to 160 foot pounds of torque.

5.8 Installation should be made in accordance with drawing 102147-000. Using a tape measure, measure from the inside of the rail to the scribe mark that runs lengthwise along the top of the scanner cover. This measurement should be $6\frac{3}{4}$ inches. Using the $\frac{5}{16}$ inch socket provided loosen the four bolts on the bottom of the scanner. This will allow the scanner to slide either closer to or farther away from the rail so that the proper distance can be obtained. Measure both ends of the scanner so as to insure that the scanner is parallel to the rail. When the $6\frac{3}{4}$ inches has been obtained tighten the four $\frac{5}{16}$ inch bolts holding the scanner to the clamps.

5.9 Repeat steps 6.5 through 6.8 above on the opposite rail, insuring that the scanner is exactly opposite the first one installed. The scribe mark as shown on drawing 102147-000 sheet 2, of 3, must be in exact alignment with the scribe mark on the first scanner installed.

5.9.1 To insure proper scanner placement the following procedure should be used (see drawing 102147-000, sheet 3 of 3).

5.9.1.1 Select a tie ten to fifteen feet in front of the tie directly under the scanners. See figure 1 illustrating the triangulation method of scanner placement.

5.9.1.2 Measure from the inside edge of both rails to find the center of the tie selected to be used as the alignment tie.

5.9.1.3 Anchor a piece of wire long enough to reach from the center of the alignment tie to the scanners.

5.9.1.4 Keep the wire taut and move it to the scribe mark on the left scanner and mark the wire at that point.

5.9.1.5 Keep the wire taut and move it to the right rail and position the right scanner so that the scribe mark is in line with the mark on the wire.

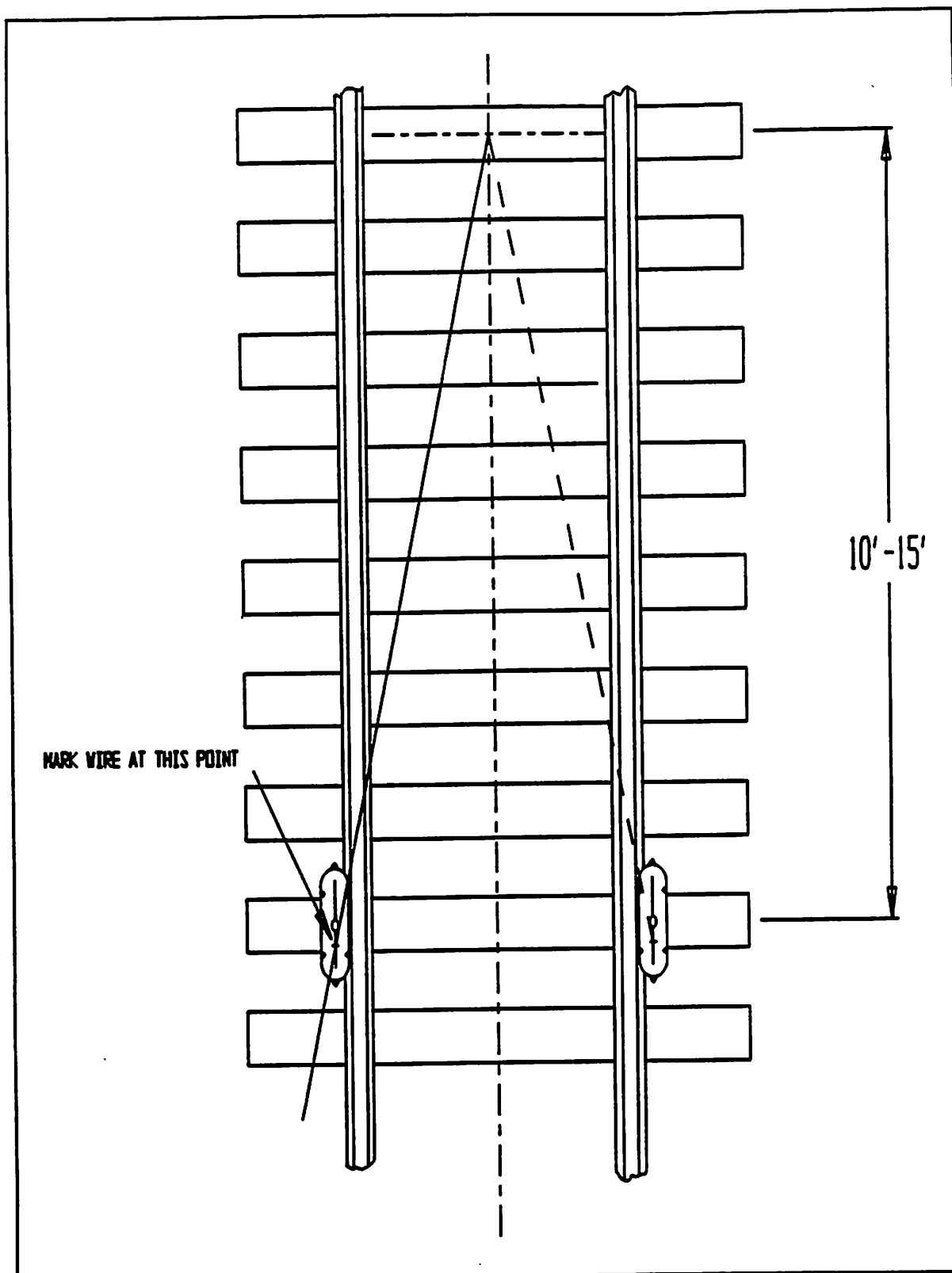


Figure 1 Scanner placement using the triangulation method.

5.10 Install the scanner cables at the cabin end in accordance with the installation drawings (see drawing 102046-000).

5.11 Connect the scanner cable to the scanner using the plug connector located on the bottom of the scanner base (see drawing 201615-000, item 11) to secure the connector against unauthorized removal.

6. Installation of Universal Wheel Transducers

6.1 Universal Wheel Transducers can be attached to the rail by using bolts that are supplied with the universal wheel transducer or by the use of transducer clamps. The installation dimensions are the same for both clamp and bolt mounting. If universal wheel transducer used for gating the system on and off, they are referred to as wheel gate transducers; if a universal wheel transducer is used for system turn on it is referred to as the advance transducer. The installation procedure for the wheel gate transducers and advance transducers are exactly the same.

6.2 Before attaching the universal wheel transducers to the rail correct positioning is required. Universal wheel transducers should be installed in accordance with drawing 102147-000, sheets 1 and 2 of 3.

6.3 Wheel gate transducers should be installed by performing the following steps:

6.3.1 Wheel gate transducers are referred to as wheel gate transducer A and wheel gate transducer B. Wheel gate transducer A is always the wheel gate transducer that is placed to the east or south of wheel gate B. The wheel gate transducer closest to the scanner should be attached to the rail 15 inches from the scribe mark on the top of the scanner cover. The other wheel gate transducer should be attached to the rail 17 inches from the first wheel gate transducer. These dimensions may change depending upon how far down from the top of the rail the top of the scanner is placed (see drawing 102147-000, sheet 3 of 3). For example, if the scanner is $\frac{1}{2}$ inch below the top of the rail, the distance from the scribe line on the top of the scanner cover to the center of the wheel gate transducers should be $23\frac{1}{2}$ inches. If the scanner is below the top of the rail it should be moved farther from the center of the wheel gate transducers the same distance as the scanner is from the top of the rail.

6.3.2 Insure that the "keeper bar" or alignment device is removed when the universal wheel transducer is installed.

6.3.3 After the exact placement of the universal wheel transducer has been determined the top of the universal wheel transducer should be placed with the top of the alignment device resting on the top of the rail and the bottom of the alignment device resting on the top of the transducer. The magnet inside the transducer will hold the alignment device in place.

6.3.4 Using the universal wheel transducer as a template mark the rail for bolt locations. After

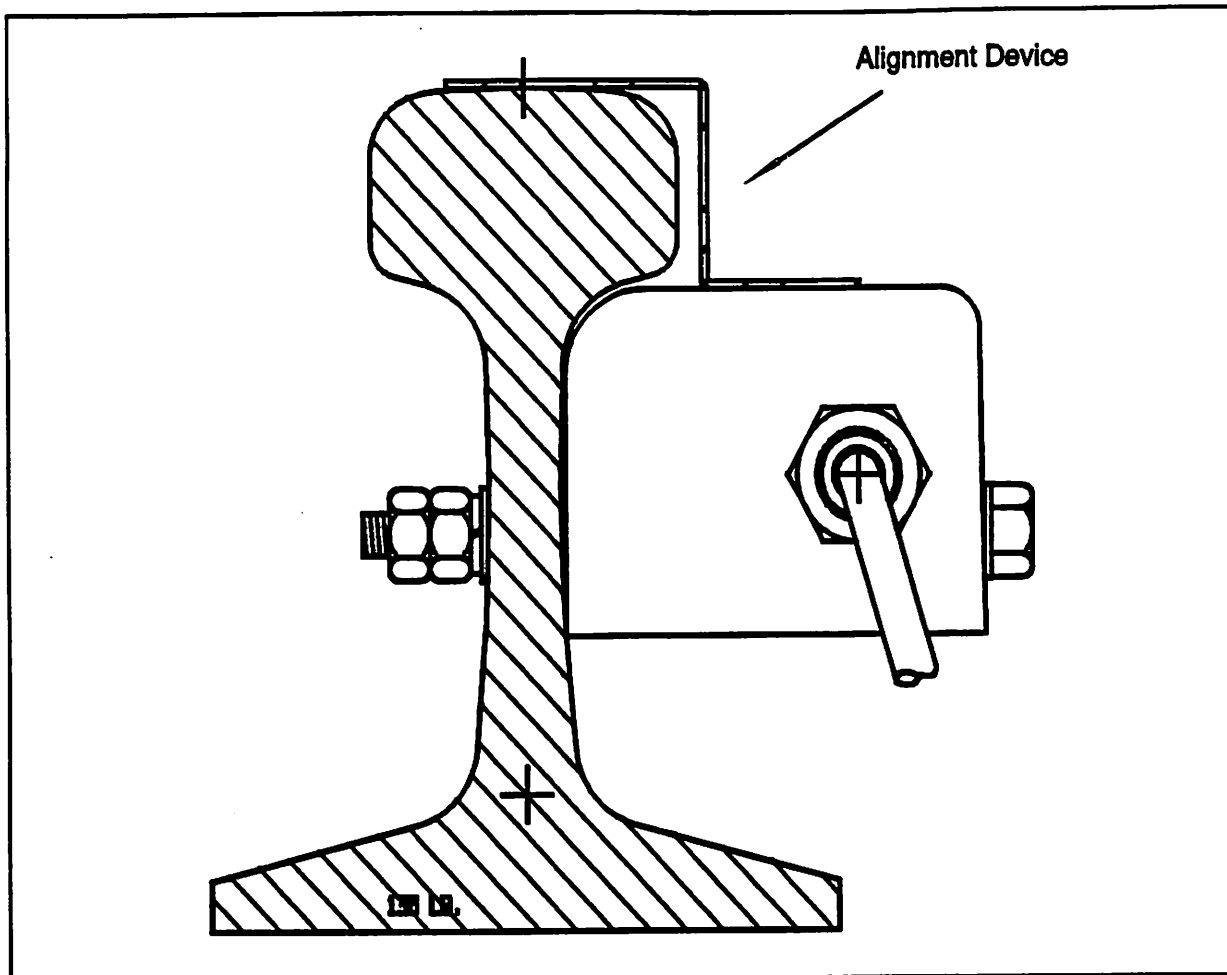


Figure 2 Placement of Universal Wheel Transducer on rail.

the rail has been marked for proper hole location, drill two $\frac{3}{8}$ inch holes. Place the bolt through the universal wheel transducer with the head of the bolt on the inside of the rail and the nuts on the outside of the rail. When tightening the bolts the torque placed on the bolts should not exceed 35 foot/pounds. **NOTE: Check bolts for tightness after several days of traffic.**

6.3.5 A rubber hose (not supplied) may be used to protect the universal wheel transducer cable from damage. If a rubber cable is going to be installed it should be connected over the stainless steel "nipple" that protrudes from the side of the universal wheel transducer. The cable should then be secured with a common hose fitting (not supplied). A standard conduit fitting can be accessed by removing the conduit cap and stainless steel "nipple".

6.4 Install the transducer cables for both the wheel gate transducers and the advance transducer (if used) in accordance with the installation drawings (see drawing 102147-000, sheet 1 of 3).

6.5 It is recommended that lightning protection devices be connected across each transducer lead pair.

6.6 It is also recommended that for maximum lightning protection, protective devices be connected between each rail and earth ground in the vicinity of the advance transducers.

7. Installation of Scanner Guards

7.1 Scanner guards are installed on either side of a rail mount scanner to prevent damage from dragging equipment. A typical installation is shown in figure 3.

7.2 The scanner guards must be placed on the outside of the rail. The end of the scanner guard and guard clamp must be at least 1 inch from the rail mount scanner and clamp.

7.3 Place one scanner guard so that it fits over the tie located between wheel gate transducers A and B.

7.4 Place the other scanner guard on the opposite end of the scanner.

8. Installation of Model 34 Electronics

8.1 To install the Model 34 electronics chassis make connections as outlined in the following pages. Due to custom configuration it may be necessary to refer to the specific site application drawings provided with the system.

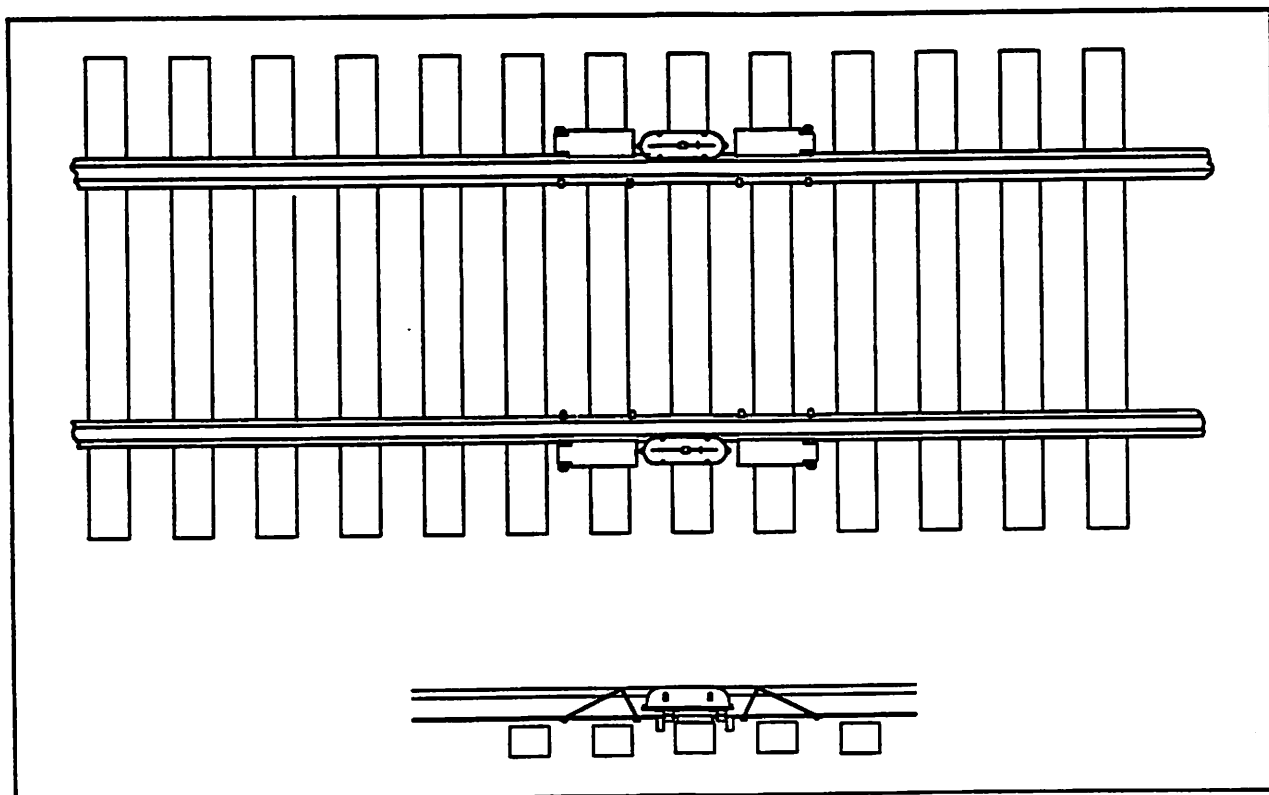


Figure 3 Placement of Rail Mount Scanner Guards

Model 34 Electronics Installation

Universal Wheel Transducers

Gate A +	Model-34	TB5-5	Black
Gate A -	Model-34	TB5-4	White
A Shield	Gnd		
Gate B +	Model-34	TB5-7	Black
Gate B -	Model-34	TB5-6	White
B Shield	Gnd		
Adv A +	Model-34	TB5-9	Black
Adv A -	Model-34	TB5-8	White
A Shield	Gnd		
Gate B +	Model-34	TB5-11	Black
Gate B -	Model-34	TB5-10	White
B Shield	Gnd		

Note: All transducer shields may be tied together and terminated at the Model 34 Overlay Ground Buss.

Ambient Temperature Monitor

HPN 250835-000

Gnd	Model 34	Gnd Buss	Green
Output	Model 34	TB7-5	White
+12VDC	Model 34	AUX +12V	Black

Note: Install the ambient temperature input network (HPN 225185-000) into position IN3 on the analog board.

Model 27 Data Recorder

HPN 250534-000

TB1-1	Model 34	TB5-1	Channel 1 input
TB1-3	Model 34	TB5-2	Channel 2 input
TB1-5	Model 34	Gnd Buss	Ground
TB1-3	Model 34	TB12-5	Event Pen
TB1-12	Model 34	TB15-9	Recorder Drive

Model 3300 Scanner

A	Interface Panel	TB1-4	Gate Off	Blk
B	Interface Panel	TB3-9	Gnd	Blk
C	Interface Panel	TB1-1	Channel 1 Signal	Red
*	Interface Panel	TB1-2	Channel 2 Signal	Red
D	Interface Panel	TB2-9	Channel 1 Receive	Blk
*	Interface Panel	TB2-11	Channel 2 Receive	Blk
E	Interface Panel	TB1-9	External Temp	Grn
F	Interface Panel	TB1-6	Integrity	Blk
G	Not Used			
H	Not Used			
J	Interface Panel	TB1-3	Gate On	Wht
K	Interface Panel	TB1-10	Aux +12 VDC	Blk
L	Interface Panel	TB2-10	Channel 1 Transmit	Yel
*	Interface Panel	TB2-12	Channel 2 Transmit	Yel
M			115 VAC (BX)	Blk
N			115 VAC (NX)	Wht
P			115 VAC Gnd	Grn
R	Interface Panel	TB1-11	Channel 1 Shutter	Brn
*	Interface Panel	TB1-12	Channel 2 Shutter	Brn
U	Interface Panel	TB1-7	Solenoid +12 VDC	Blu
V	Interface Panel	TB3-9	Gnd	Blk
W	Not Used			
X	Not Used			

* All preamplifier connections are parallel for channel 1 and channel 2 sensors except for the signal outputs, serial data outputs, and shutter status outputs.

Note: If Model 3300 scanners are installed with a Model 34 electronics chassis the IN3 networks that must be installed on the analog board are either a HPN 225983-001 or HPN 226580-001.

Radio Connections

Model 34	TB11-10	Key
Model 34	TB13-4	Transmit Output
Model 34	TB13-11	Transmit Receive
Model 34	TB11-11	Common

Multi Track Talker

Talker 1		To	Talker 2		To	Transceiver
Model 34	TB9-7		Model 34	TB9-8		
Model 34	TB9-8		Model 34	TB9-7		
Model 34	TB11-10		Model 34	TB11-10		Key
Model 34	TB13-4		Model 34	TB13-4		Transmit Output
Model 34	TB13-11		Model 34	TB13-11		Transmit Receive
Model 34	TB11-12		Model 34	TB11-12		Common

Dragging Equipment Detector Connections

Gate J-box	TB1-7 To	Model 34	Gnd Buss
Gate J-box	TB2-7 To	Model 34	TB14-7

Track Circuit Connection

Track Circuit Input	To	Model 34	TB12-3
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Note: See application drawings for specific configuration.

9. Scanner Alignment

**** CAUTION ****

Scanner temperature can reach 130 degrees Fahrenheit.
To avoid discomfort while handling the scanner cover,
power must be removed from the scanner.
The appropriate circuit breaker is located on the
hot box detector.

**** CAUTION ****

9.1 For the heat sensor in the IRIS preamplifier to see hot journals, the scan angle must be adjusted for the correct "look point". This is accomplished by mounting the scanner to the proper dimensions and making minor corrections by adjusting three positioning screws (see drawing 102147-000, sheet 3 of 3).

9.2 Place the scanner alignment fixture (HPN 250443-000) on the rail outside of gage between the wheel gate transducers and the "target point" location as shown on the installation drawings (see drawing 102147-000, sheet 3 of 3). Attach the alignment fixture securely to the top of the rail to provide a stable reference point for the optical target located on the top of the fixture. Make sure the optical target is in correct location.

9.3 Level the top surface of the alignment fixture using the bubble level incorporated in the fixture.

9.4 The yellow circle on the optical target must face toward the scanner protective shutter opening.

9.5 Remove the scanner cover and IRIS hold down bracket.

9.6 Place the laser alignment fixture (HPN 226587-001) in the preamplifier cradle so that the pins in the front of the laser are engaged in the front mounting block.

9.7 Connect the preamplifier cable to the laser and turn the laser on.

9.8 Place the hot box detector system in the "CHOP" mode (position 'B' on the MODE switch). Press the DATA ADVANCE switch to start the "CHOP" function. This is done to keep the protective shutters open when performing the following tests:

9.8.1 Note the position of the laser light on the target. Use the positioning screws to bring the laser light into the center of the target. Loosen the three allen screw heads that hold the scanner to the base plate (see drawing 102147-000, sheet 3 of 3). One is located on the end of the scanner next to the shutter motor and the other two are on either side of the cradle that holds

the IRIS preamplifier. By loosening the 15/16 inch nut and using a ½ inch wrench on the flattened portion of the threaded sleeve, adjustment of the scanner can be accomplished. Repeat this step for each of the three adjusting sleeves as required to bring the laser light into the center of the target. Do not adjust the sleeve down more than ¼ inch. If more adjustment is required use the coarse adjustment (see drawing 102147-000, sheet 3 of 3).

9.8.2 When the laser light is in the center of the target, tighten the 15/16 inch nut while holding the sleeve with the ½ inch wrench. With the allen wrench, tighten the three screws that go down the middle of the sleeves.

9.9 Remove the laser and replace the IRIS preamplifier. Fasten the IRIS preamplifier securely with the hold-down bracket.

9.10 Replace the scanner cover.

9.11 Repeat steps 9.2 through 9.10 for the opposite rail.

9.12 Reset the circuit breaker located on the hot box detector.

10. Scanner Heat Verification

10.1 Allow the IRIS preamplifier to assume ambient temperature. This will take at least two hours.

10.2 Place the calibrated heat source (HPN 250472-001) on the top of the channel 1 scanner. The heat block must cover the opening in the scanner cover.

10.3 Place the hot box detector system in the "CHOP" mode (position B of the MODE switch). Press the DATA ADVANCE switch to initiate the "CHOP" mode. To change to channel 2 press the a DATA ADVANCE switch a second time.

10.4 The DATA DISPLAY should show $15 \pm$ millimeter. If this heat reading is not obtained perform the alignment procedure one more time. If a satisfactory reading is not obtained return the IRIS preamplifier to the factory for calibration.

10.5 Perform steps 10.1 through 10.4 for channel 2.

11. Scanner Maintenance

****** CAUTION ******

**Scanner temperature can reach 130 degrees Fahrenheit.
To avoid discomfort while handling the scanner cover,
power must be removed from the scanner.
The appropriate circuit breaker is located on the
hot box detector.**

****** CAUTION ******

11.1 The mirror should be cleaned at least every four weeks. This is done by removing the protective shutter assembly and removing the shutter stop assembly (shown as item 42 on drawing 201615-000). The shutter stop assembly can be removed by removing the allen screw located in the top of the assembly. The mirror is now accessible and should be cleaned with a soft cotton cloth and alcohol.

11.2 Scanner alignment should be performed at least once every three months and after track work of any kind has been performed. This should be performed by following the guidelines in the Scanner Alignment section of this manual.

11.3 Moving parts within the scanner should not be oiled. Parts are self lubricating. If trouble persists replace the bushings.

11.4 When all maintenance procedures have been completed reset the circuit breaker located on the hot box detector.

11.5 Scanners can be configured to be used on either rail. If it is required to replace a scanner the connector orientation can be changed by removing three screws (see drawing 201615-000, item 14). Rotate the connector block (item 43) 180° and replace the screws. The scanner can now be placed on the scanner clamp.

11.6 If it becomes necessary to replace an IRIS preamplifier verify that the black shock absorbers (see drawing 201616-000, item 10) are not torn. If they are torn they should be replaced.

12. Wheel Transducer Maintenance

12.1 Due to the strength of the magnets it may be necessary to periodically clean metal filings from the top of the wheel transducers.

13. Troubleshooting Procedures

13.1 This section is designed to aid in troubleshooting problems with the rail mount scanner. Each section will contain a potential problem and a recommended solution. If the problem persists after using the troubleshooting procedures contact Harmon Electronics, Inc. for assistance.

13.1.1 Hot box detector reports protective shutter stuck closed.

Solution: Perform a self test train on the hot box detector and verify that the protective shutter opens correctly.

Solution: Check the protective shutter for foreign material that could be keeping it in the closed position.

Solution: Remove the scanner cover and check for binding or worn bushings. Replace the bushings if they appear to be faulty. **DO NOT OIL BUSHINGS.**

Solution: Holding the protective shutter in the open position, using a DC voltmeter check for 0 volts between terminal 1 and 3 of the Shutter Stop Assembly (see drawing 201615-000, item 42). Adjust the proximity sensor closer to the protective shutter until 0 volts appears or replace the sensor if 0 volts cannot be obtained. The adjustment procedure is described on drawing 226427-000.

Solution: The solenoid motor may be defective (see drawing 226427-000).

13.1.2 Hot box detector reports protective shutter stuck open.

Solution: Verify visually that the protective shutter is closed with the hot box detector in the "STANDBY" mode. If the hot box detector is in the "STANDBY" Mode the word 'STANDBY' will be displayed in the **DATA DISPLAY** with the **MODE** switch in the **BASIC DATA DISPLAY** position.

Solution: Check the protective shutter for foreign material that could be keeping it in the open position.

Solution: Remove the scanner cover and check for binding or worn bushings. Replace the bushings if they appear to be faulty. **DO NOT OIL BUSHINGS.**

Solution: With the protective shutter in the closed position, using a DC voltmeter check for 12 volts between terminal 2 and 3 of the Shutter Stop Assembly (see drawing 201615-000, item 42). If 12 volts is not present check the power supply on the Model 34 electronics chassis.

Solution: With the protective shutter in the closed position, using a DC voltmeter check for 12 volts between terminal 1 and 3 of the Shutter Stop Assembly (see drawing 201615-000, item 42). If 12 volts is not present replace the sensor using the procedure as described on drawing 226427-000

Solution: The solenoid motor may be defective (see drawing 226427-000).

13.1.3 Scanner cover gets too hot.

Solution: Remove the scanner cover. Using an AC voltmeter check for 110 VAC on pins A and B of the connector. If this voltage is too high check the AC power coming into the hot box detector bungalow.

Solution: The scanner cover can reach temperatures of 130°. Before replacing the scanner cover, verify that the cover is indeed exceeding the specified heat level.

13.1.4 Scanner cover gets too hot.

Solution: Remove the scanner cover. Using an AC voltmeter check for 110 VAC on pins A and B of the connector. If this voltage is not present or it too low check the AC cutoff relay located on the Model 34 electronics located in the equipment bungalow.

13.1.5 Hot Box Detector does not see enough heat.

Solution: Place the HBD system in the "CHOP" mode or else perform a system self test train and verify that the protective shutters open. If the protective shutters do not open perform the troubleshooting steps as outlined in under section 11.1.

Solution: Clean the mirror as described in the Scanner Maintenance section of this manual.

Solution: Place the calibrated heat source on the top of the scanner cover with the heat block covering the scan hole. With the HBD system in the "CHOP" mode the **DATA DISPLAY** should show 15 ± 1 MM. If a reading of 15 ± 1 MM is not obtained replace the IRIS preamplifier and perform the Scanner Heat Verification procedure as described in section 10.

Solution: If the mirror is clean and the IRIS preamplifier 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 may be in the Model 34 wayside electronics or cabling.

13.1.6 Scanner sees too much heat.

Solution: Place the calibrated heat source on the top of the scanner cover with the heat block covering the scan hole. With the HBD system in the "CHOP" mode the **DATA DISPLAY** should show 15 ± 1 MM. If a reading of 15 ± 1 MM is not obtained replace the IRIS preamplifier and perform the Scanner Heat Verification procedure as described in section 10.

Solution: If the mirror is clean and the IRIS preamplifier 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 may be in the Model 34 wayside electronics or cabling.

13.1.7 HBD reports transducer errors.

Solution: Verify wire polarity by connecting a DC voltmeter with the positive lead connected to the black wire and the negative wire to the white wire. With a metal bar (keeper bar) at rest on both magnets, quickly remove the bar while watching the DC voltmeter. If a positive deflection is seen the black wire is positive and the white wire is negative.

Solution: Using an oscilloscope with the transducer not connected to the wayside electronics swing a ferrous metal object across the top of the transducer. The output should appear as a sine wave with the oscilloscope connected across the black wire and the cable shield and the output will appear as a cosine wave with the oscilloscope connected across the white wire and the cable shield. Since the amplitude is a function of speed and distance, the amplitude will vary greatly. If these conditions are not present, replace the transducer.

Model 33 Tie/Ballast Mount Scanner

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1. Introduction

1.1 This section contains information pertaining to installation, operation, and maintenance of trackside equipment required for a Model 32 Hot Box Detector.

2. Description

2.1 MODEL 33 SCANNER (HPN)

2.1.1 The Model 33 Tie/Ballast Mount Scanner (RMS) has been designed to be mounted between two ties. A locking solenoid has been incorporated to prevent the shutter from being opened from the outside. The protective shutter is normally in the closed position when the system is not scanning a train or a maintenance procedure is not being performed.

2.1.2 The preamplifier used in the Model 33 scanner can be either the Model 3800 (IRIS) (HPN 250875-100) or the Model 38 (HPN 250430-000).

2.1.3 Thermostatically controlled scanner heaters are incorporated in the scanner to prevent ice and snow from blocking the view of the scanner and jamming the protective shutter.

2.2 UNIVERSAL WHEEL TRANSDUCER DESCRIPTION (HPN 250730-000)

2.2.1 The Universal Wheel Transducer (UWT) is a passive device that synchronizes passing rail car wheel flanges with wayside electronics to perform heat analysis. The output of the universal wheel transducer is a single sine wave whose period and amplitude are a function of train speed. The UWT functions at train speeds between 3 and 150 miles per hour.

2.2.2 The universal wheel transducer can be mounted on any rail size between 110 pounds and 150 pounds. The rail can be electrified or non-electrified.

2.3 A typical arrangement of trackside equipment is shown in drawing 102037-???

3. Specifications

3.1 TIE/BALLAST MOUNT SCANNER

Power Requirements

Input Voltage

+24 VDC at 1 Amp
110 VAC

Heater Rating

200 Watts at 110 VAC
Approximately 54.5° C

Operating Temperature

-40° C to 60° C

3.2 UNIVERSAL WHEEL TRANSDUCER

Electrical

Power

Passive

Isolation

2400 VAC

Connection

16 gauge copper

Operational

Average Train Speed

5 to 150 MPH

Signal Output

Sinusoidal

Physical

Rail Types

90 lb to 150 lb

Mounting

3/8 grade 5 stainless steel bolts

Operating Temperature

-40° C to +71° C

Storage Temperature

-40° C to +85° C

Relative Temperature

0 to 100 % condensing

Shock

500 g along any axis

Vibration

20 g from 1 to 60 Hz along any axis

3.3 ACCESSORIES

	HPN
Laser Alignment Fixture	250874-000
Model 38 Preamplifier	250430-000
IRIS Preamplifier	250875-100
Ambient Temperature Probe	250835-002
Calibrated Heat Source	250472-001
Scanner Guard (4)	250705-000
Track Alignment Fixture	250443-000
Shutter Cable (2)	226063-xxx
Heater Cable (2)	226066-xxx
Preamplifier Cable (2)	226064-xxx, where XXX is the specific part number for the length of cable required from 35 feet to 135 feet, in 10 foot intervals

4. General Installation Information

4.1 Two Model 33 tie mount scanners are required for detection of hot journals, one on each side of the track. Two additional hot wheel scanners can be added if hot wheel detection is incorporated into the system.

4.2 Two universal wheel transducers are fastened to the rail to provide the HBD system with signals for the wheel gating function. Optionally, two additional universal wheel transducers can be used to provide advance start signals. Location and dimensions of the wheel transducers are shown on the installation drawings (see drawing 102037-000).

5. Installation of Model 33 Tie/Ballast Mount Scanners

5.1 Carefully unpack the equipment and inspect for shipping damage. If any damage is evident or if any of the items on the packing slip is missing please notify Harmon Electronics, Inc. immediately. Before proceeding with the trackside equipment installation read the entire installation procedure.

5.2 Locate the point where the scanners are to be placed on the rail. A scanner must be placed between two ties. Clear an area beneath the rail where the scanners are to be installed.

5.3 Remove rail creepers from around the tie that the scanner is to be mounted over.

5.4 Locate the left and right scanner by standing facing the prevalent train direction. The left hand scanner is determined by point the scanner in the same direction.

5.5 Mount the right scanner to the outside of the right rail. Proper rail determination can be obtained from drawing 102037-000.

5.6 Refer to drawing 102026-000 for tie mount scanner dimensions and 102028-000 for ballast mount dimensions.

5.7 Using a tape measure, measure from the inside of the rail to the scribe mark that runs lengthwise along the top of the protective shutter assembly. This measurement should be 6 $\frac{3}{4}$ inches. By loosening the three bolts located on the cantilever arm the scanner can slide either closer to or farther away from the rail so that the proper distance can be obtained. Measure both ends of the protective shutter assembly to insure that the protective shutter assembly is parallel to the rail. When the 6 $\frac{3}{4}$ inches has been obtained tighten the three bolts.

5.8 Repeat steps 5.5 through 5.7 above on the opposite rail, insuring that the scanner is exactly opposite the first one installed. The scribe mark as shown on drawing 102028-000 or 102026-000 must be in exact alignment with the scribe mark on the first scanner installed.

5.8.1 To insure proper scanner placement the following procedure should be used (see drawing 102028-000 or 102026-000)

5.8.1.1 Select a tie ten to fifteen feet in front of the tie directly under the scanners. See figure 1 for the triangulation method of scanner placement.

5.8.1.2 Measure from the inside edge of both rails to find the center of the tie selected to be used as the alignment tie.

5.8.1.3 Anchor a piece of wire long enough to reach from the center of the alignment tie to the scanners.

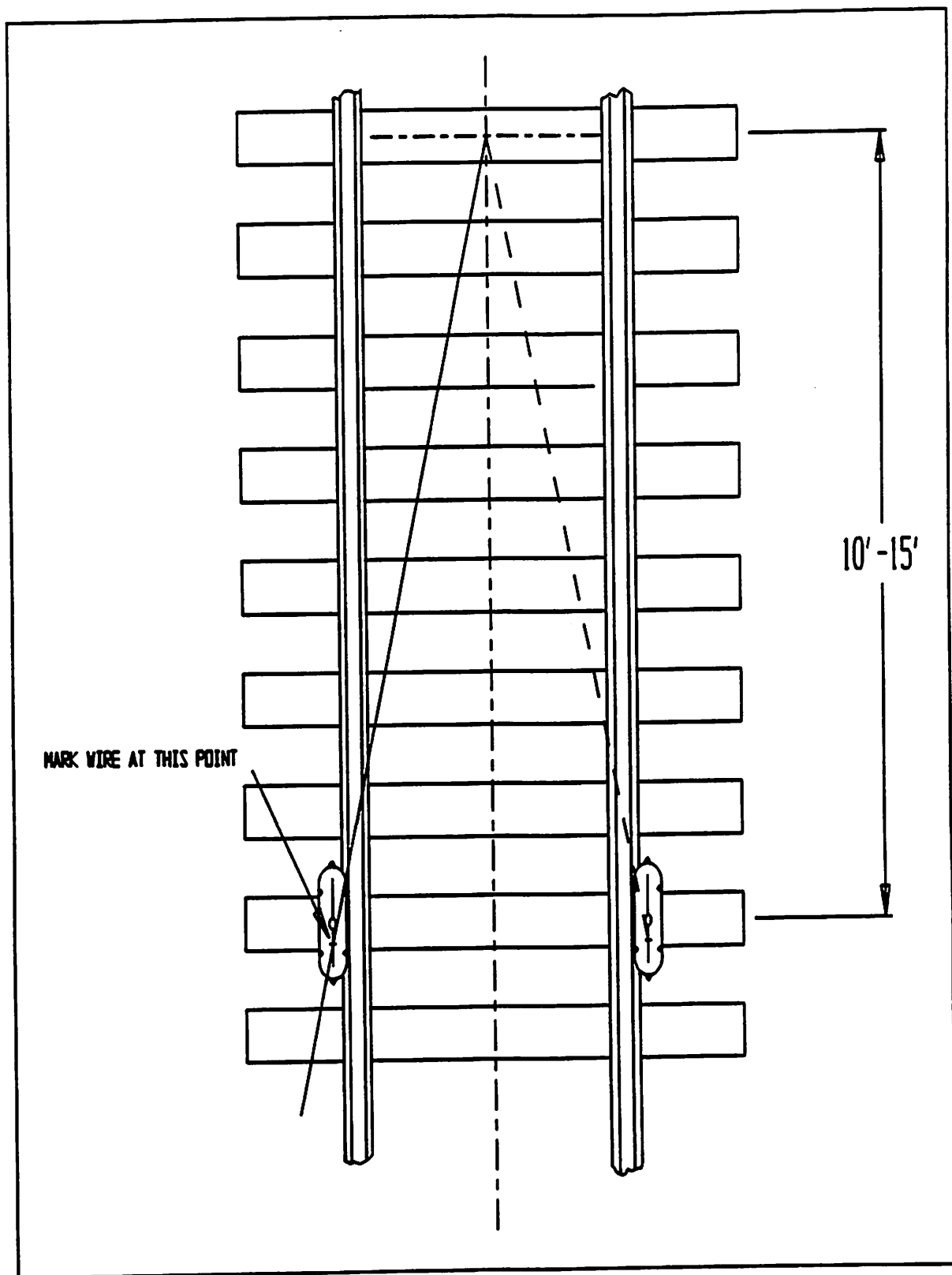


Figure 1 Scanner placement using the triangulation method.

5.8.1.4 Keep the wire taut and move it to the scribe mark on the left scanner and mark the wire at that point.

5.8.1.5 Keep the wire taut and move it to the right rail and position the right scanner so that the scribe mark is in line with the mark on the wire.

5.9 Install the scanner cables at the cabin end in accordance with the installation drawings (see drawing 102046-000).

6. Installation of Universal Wheel Transducers

6.1 Universal Wheel Transducers can be attached to the rail by using bolts that are supplied with the universal wheel transducer or by the use of transducer clamps. The installation dimensions are the same for both clamp and bolt mounting. If universal wheel transducer used for gating the system on and off, they are referred to as wheel gate transducers; if a universal wheel transducer is used for system turn on it is referred to as the advance transducer. The installation procedure for the wheel gate transducers and advance transducers are exactly the same.

6.2 Before attaching the universal wheel transducers to the rail correct positioning is required. Universal wheel transducers should be installed in accordance with drawing 102147-000, sheets 1 and 2 of 3.

6.3 Wheel gate transducers should be installed by performing the following steps:

6.3.1 Wheel gate transducers are referred to as wheel gate transducer A and wheel gate transducer B. Wheel gate transducer A is always the wheel gate transducer that is placed to the east or south of wheel gate B. The wheel gate transducer closest to the scanner should be attached to the rail 16 inches from the scribe mark on the top of the scanner cover. The other wheel gate transducer should be attached to the rail 17 inches from the first wheel gate transducer.

6.3.2 Insure that the "keeper bar" or alignment device is removed when the universal wheel transducer is installed.

6.3.3 After the exact placement of the universal wheel transducer has been determined the top of the universal wheel transducer should be placed with the top of the alignment device resting on the top of the rail and the bottom of the alignment device resting on the top of the transducer. The magnet inside the transducer will hold the alignment device in place.

6.3.4 Using the universal wheel transducer as a template mark the rail for bolt locations. After the rail has been marked for proper hole location, drill two $\frac{3}{8}$ inch holes. Place the bolt through the universal wheel transducer with the head of the bolt on the inside of the rail and the nuts on the outside of the rail. When tightening the bolts the torque placed on the bolts should not

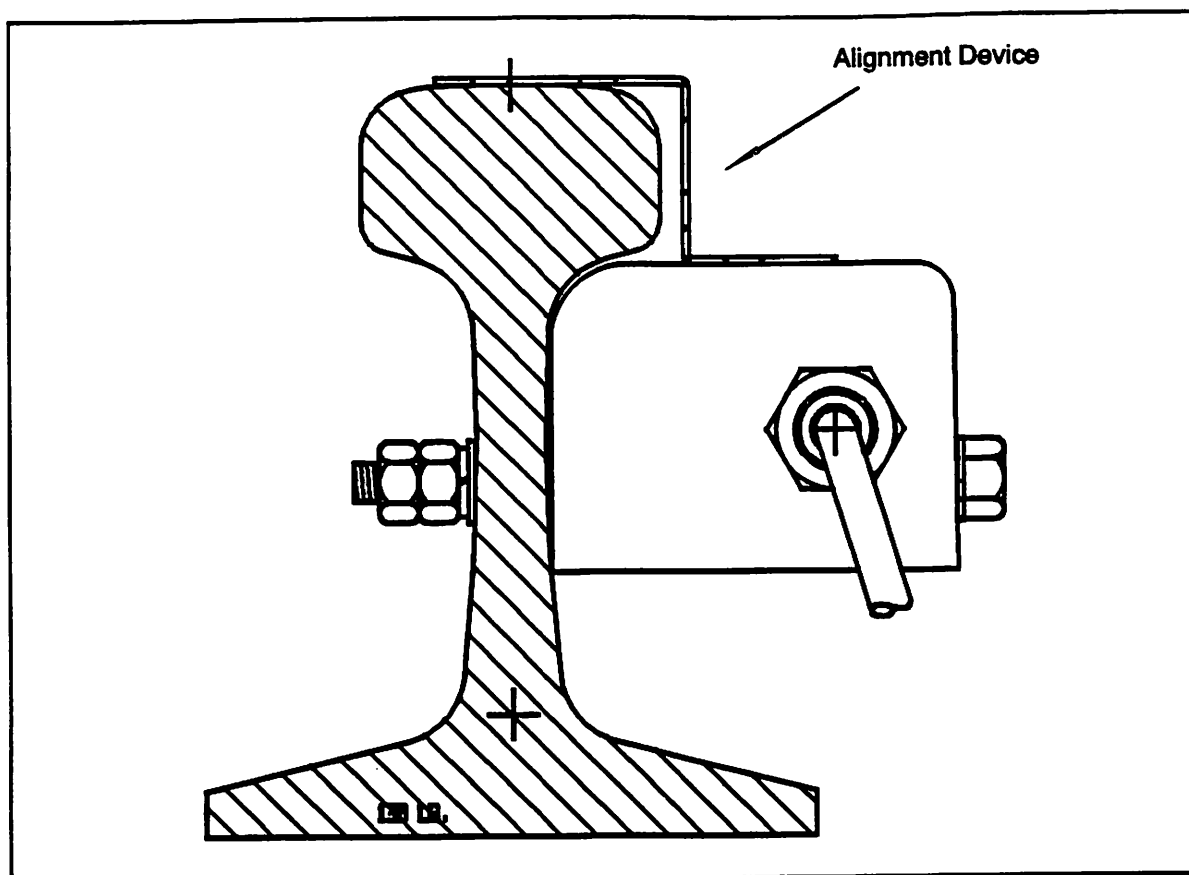


Figure 2 Placement of Universal Wheel Transducer on rail.

exceed 35 foot/pounds. **NOTE:** Check bolts for tightness after several days of traffic.

6.3.5 A rubber hose (not supplied) may be used to protect the universal wheel transducer cable from damage. If a rubber cable is going to be installed it should be connected over the stainless steel "nipple" that protrudes from the side of the universal wheel transducer. The cable should then be secured with a common hose fitting (not supplied). A standard conduit fitting can be accessed by removing the conduit cap and stainless steel "nipple".

6.4 Install the transducer cables for both the wheel gate transducers and the advance transducer (if used) in accordance with the installation drawings (see drawing 102147-000, sheet 1 of 3).

6.5 It is recommended that lightning protection devices be connected across each transducer lead pair.

6.6 It is also recommended that for maximum lightning protection, protective devices be connected between each rail and earth ground in the vicinity of the advance transducers.

7. Installation of Scanner Guards

7.1 Scanner guards are installed on either side of a rail mount scanner to prevent damage from dragging equipment. A typical installation is shown in figure 3.

7.2 The scanner guards must be placed on the outside of the rail.

7.3 Place one scanner guard so one end is laying on the tie next to the scanner. The other end should rest on the next tie. Using the lag screws that come with the scanner guards, attach them to the ties.

7.4 Place the other scanner guard on the opposite end of the scanner.

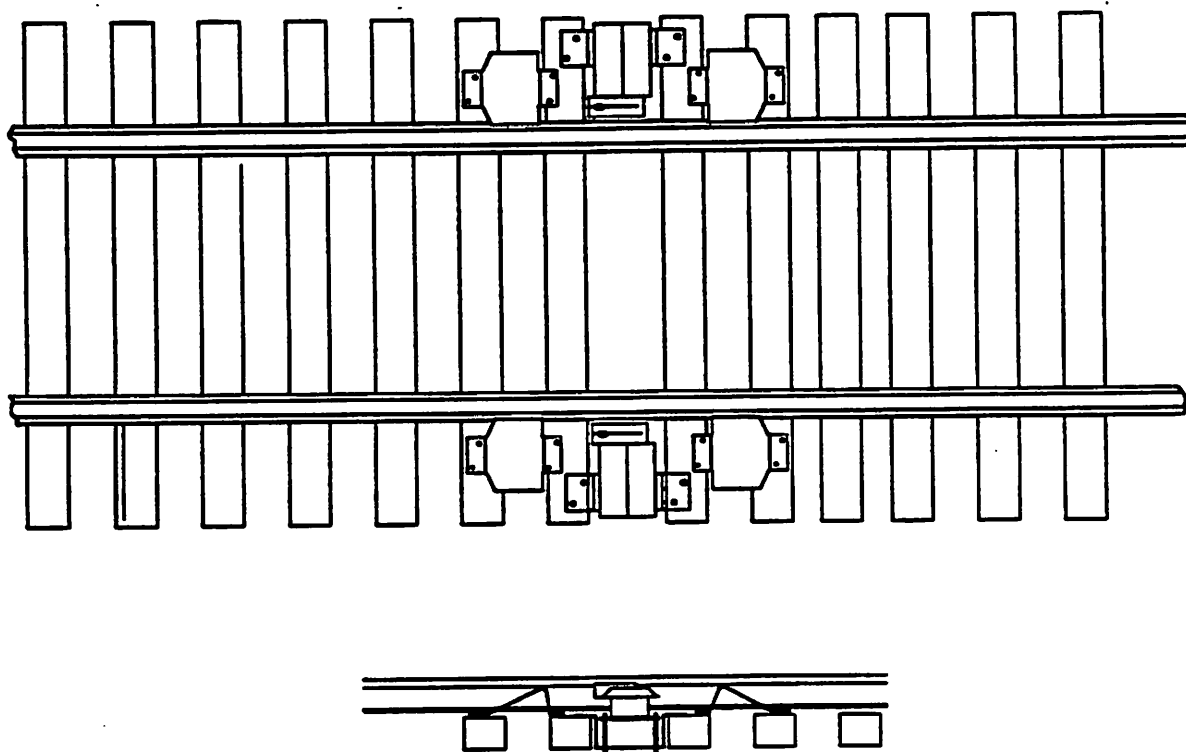


Figure 3 Placement of Tie/Ballast Mount Scanner Guards

8. Installation of Model 34 Electronics

8.1 To install the Model 34 electronics chassis make connections as outlined in the following pages. Due to custom configuration it may be necessary to refer to the specific site application drawings provided with the system.

Model 34 Electronics Installation

Universal Wheel Transducers

Gate A +	Model-34	TB5-5	Black
Gate A -	Model-34	TB5-4	White
A Shield	Gnd		
Gate B +	Model-34	TB5-7	Black
Gate B -	Model-34	TB5-6	White
B Shield	Gnd		
Adv A +	Model-34	TB5-9	Black
Adv A -	Model-34	TB5-8	White
A Shield	Gnd		
Gate B +	Model-34	TB5-11	Black
Gate B -	Model-34	TB5-10	White
B Shield	Gnd		

Note: All transducer shields may be tied together and terminated at the Model 34 Overlay Ground Buss.

Ambient Temperature Monitor HPN 250835-000

Gnd	Model 34	Gnd Buss	Green
Output	Model 34	TB7-5	White
+12VDC	Model 34	AUX +12V	Black

Note: Install the ambient temperature input network (HPN 225185-000) into position IN3 on the analog board.

Model 27 Data Recorder HPN 250435-000

TB1-1	Model 34	TB5-1	Channel 1 input
TB1-3	Model 34	TB5-2	Channel 2 input
TB1-5	Model 34	Gnd Buss	Ground
TB1-3	Model 34	TB12-5	Event Pen
TB1-12	Model 34	TB15-9	Recorder Drive

Model 38 Preamplifier Cable

A	Model 34	TB15-2	Opt. Shutter 1	Blk
B	Model 34	Gnd Buss	Gnd	Blk
C Channel 1	Model 34	TB7-10	Channel 1 Signal	Red
C Channel 2	Model 34	TB7-9	Channel 2 Signal	Red
E	Model 35	TB1-6	+47 VDC	Grn
F Channel 1	Model 34	TB15-12	Tie Point	Blk
F Channel 2	Model 35	SO3-6	Integrity Relay	Blk
G Channel 1	Model 35	TB1-4	+24 VDC	Blu
G Channel 2	Model 34	TB15-12	Tie Point	Blu
J	Model 34	TB15-3	Opt. Shutter 2	Wht
K	Model 34	TB1-10	Aux +12 VDC	Blk

Heater Cable

TB1-5	115 VAC Gnd	Grn
TB1-6	115 VAC (BX)	Blk
TB1-9	115 VAC (NX)	Wht

Model 33 Shutter Cable**Channel 1**

TB1-1	Model 34	TB15-11	Tie Point	Blk
TB1-2	Model 35	TB1-3	+24 VDC	Red
TB1-3	Model 34	Gnd Buss	Ground	Blk
TB1-4	Model 34	TB14-12	Channel 1 Shutter	Red

Channel 2

TB1-1	Model 35	SO4-6	Shutter Relay	Blk
TB1-2	Model 34	TB15-11	Tie Point	Red
TB1-3	Model 34	Gnd Buss	Ground	Blk
TB1-4	Model 34	TB14-11	Channel 2 Shutter	Red

Note: If Model 33 scanners are installed with a Model 38 preamplifier the IN5 networks that must be installed on the analog board are either a HPN 225983-000, HPN 226579-000 or HPN 226580-000. If Model 33 scanners are installed with a Model 3800 IRIS preamplifier the IN5 networks that must be installed on the analog board are either a HPN 225983-001 or HPN 226580-001.

Radio Connections

Model 34	TB11-10	Key
Model 34	TB13-4	Transmit Output
Model 34	TB13-11	Transmit Receive
Model 34	TB11-11	Common

Multi Track Talker

Talker 1	To	Talker 2	To	Transceiver
Model 34	TB9-7	Model 34	TB9-8	
Model 34	TB9-8	Model 34	TB9-7	
Model 34	TB11-10	Model 34	TB11-10	Key
Model 34	TB13-4	Model 34	TB13-4	Transmit Output
Model 34	TB13-11	Model 34	TB13-11	Transmit Receive
Model 34	TB11-12	Model 34	TB11-12	Common

Dragging Equipment Detector Connections

Gate J-box	TB1-7 To	Model 34	Gnd Buss
Gate J-box	TB2-7 To	Model 34	TB14-7

Track Circuit Connection

Track Circuit Input	To	Model 34	TB12-3
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Note: See application drawings for specific configuration.

9. Scanner Alignment

9.1 For the heat sensor in the preamplifier to see hot journals, the scan angle must be adjusted for the correct "look point". This is accomplished by mounting the scanner to the proper dimensions and making minor corrections by adjusting the mirror.

9.2 Place the scanner alignment fixture (HPN 250443-000) on the rail outside of gage between the wheel gate transducers and the "target point" location as shown on the installation drawings (see drawing 102028-000 or 102026-000). Attach the alignment fixture securely to the top of the rail to provide a stable reference point for the optical target located on the top of the fixture. Make sure the optical target is in correct location.

9.3 Level the top surface of the alignment fixture using the bubble level incorporated in the fixture.

9.4 The yellow circle on the optical target must face toward the scanner protective shutter opening.

9.5 Remove the scanner cover and preamplifier hold down bracket and loosen the mirror locking screws slightly.

9.6 Place the laser alignment fixture (HPN 226587-001) in the preamplifier cradle so that the pins in the front of the laser are engaged in the front mounting block.

9.7 Connect the preamplifier cable to the laser and turn the laser on.

9.8 Place the hot box detector system in the "CHOP" mode (position 'B' on the MODE switch). Press the DATA ADVANCE switch to start the "CHOP" function. This is done to keep the protective shutters open when performing the following tests:

9.8.1 Note the position of the laser light on the target. The mirror can be adjusted horizontally and vertically. The mirror should not move so freely that it slides out of place with nobody touching it. Adjust the mirror in both directions until the red laser light is in the center of the target point.

9.8.2 When the mirror has been centered, slowly tighten the mirror locking screws making sure that the light does not leave the center position.

9.9 Remove the laser and replace the preamplifier. Fasten the preamplifier securely with the hold-down bracket.

9.10 Replace the scanner cover.

9.11 Repeat steps 9.2 through 9.10 for the opposite rail.

9.12 Reset the circuit breaker located on the hot box detector.

10. Scanner Heat Verification

10.1 Allow the preamplifier to assume ambient temperature. This will take at least two hours.

10.2 Place the calibrated heat source (HPN 250472-001) on the top of the channel 1 scanner. The heat block must cover the opening in the scanner cover.

10.3 Place the hot box detector system in the "CHOP" mode (position B of the mode switch). Press the **DATA ADVANCE** switch to initiate the "CHOP" mode. To change to channel 2 press the **DATA ADVANCE** switch a second time.

10.4 The **DATA DISPLAY** should show $15 \pm$ millimeter. If this heat reading is not obtained perform the alignment procedure one more time. If a satisfactory reading is not obtained return the preamplifier to the factory for calibration.

10.5 Perform steps 10.1 through 10.4 for channel 2.

11. Scanner Maintenance

11.1 The mirror should be cleaned at least every four weeks. This is done by removing the scanner housing to expose the mirror. The mirror is now accessible and should be cleaned with a soft cotton cloth and alcohol.

11.2 Scanner alignment should be performed at least once every three months and after track work of any kind has been performed. This should be performed by following the guidelines in the Scanner Alignment section of this manual.

11.3 Moving parts within the scanner may be oiled with a light machine oil.

11.4 When all maintenance procedures have been completed reset the circuit breaker located on the hot box detector.

12. Wheel Transducer Maintenance

12.1 Due to the strength of the magnets it may be necessary to periodically clean metal filings from the top of the wheel transducers.

13. Troubleshooting Procedures

13.1 This section is designed to aid in troubleshooting problems with the rail mount scanner. Each section will contain a potential problem and a recommended solution. If the problem persists after using the troubleshooting procedures contact Harmon Electronics, Inc. for assistance.

13.1.1 Hot box detector reports protective shutter stuck closed.

Solution: Perform a self test train on the hot box detector and verify that the protective shutter opens correctly.

Solution: Check the protective shutter for foreign material that could be keeping it in the closed position.

Solution: Remove the scanner cover and check for binding or worn bushings. Replace the bushings if they appear to be faulty. **DO NOT OIL BUSHINGS.**

Solution: Holding the protective shutter in the open position, verify approximately 0 VDC on TB14-11/12.

Solution: The solenoid motor may be defective and need to be replaced.

13.1.2 Hot box detector reports protective shutter stuck open.

Solution: Verify visually that the protective shutter is closed with the hot box detector in the "STANDBY" mode. If the hot box detector is in the "STANDBY" Mode the word 'STANDBY' will be displayed in the DATA DISPLAY with the MODE switch in the BASIC DATA DISPLAY position.

Solution: Check the protective shutter for foreign material that could be keeping it in the open position.

Solution: Remove the scanner cover and check for binding or worn bushings. Replace the bushings if they appear to be faulty.

Solution: With the protective shutter in the closed position, verify approximately +12 VDC on TB14-11/12.

Solution: With the protective shutter in the closed position, verify approximately 0 VDC on TB14-11/12.

Solution: The solenoid motor may be defective and need to be replaced.

13.1.3 Hot Box Detector does not see enough heat.

Solution: Place the HBD system in the "CHOP" mode or else perform a system self test train and verify that the protective shutters open. If the protective shutters do not open perform the troubleshooting steps as outlined in under section 11.1.

Solution: Clean the mirror as described in the Scanner Maintenance section of this manual.

Solution: Place the calibrated heat source on the top of the scanner cover with the heat block covering the scan hole. With the HBD system in the "CHOP" mode the DATA DISPLAY should show 15 ± 1 MM. If a reading of 15 ± 1 MM is not obtained replace the preamplifier and perform the Scanner Heat Verification procedure as described in section 10.

Solution: If the mirror is clean and the preamplifier 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 may be in the Model 34 wayside electronics or cabling.

13.1.4 Scanner sees too much heat.

Solution: Place the calibrated heat source on the top of the scanner cover with the heat block covering the scan hole. With the HBD system in the "CHOP"

mode the **DATA DISPLAY** should show 15 ± 1 MM. If a reading of 15 ± 1 MM is not obtained replace the preamplifier and perform the Scanner Heat Verification procedure as described in section 10.

Solution: If the mirror is clean and the preamplifier 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 may be in the Model 34 wayside electronics or cabling.

13.1.5 HBD reports transducer errors.

Solution: Verify wire polarity by connecting a DC voltmeter with the positive lead connected to the black wire and the negative wire to the white wire. With a metal bar (keeper bar) at rest on both magnets, quickly remove the bar while watching the DC voltmeter. If a positive deflection is seen the black wire is positive and the white wire is negative.

Solution: Using an oscilloscope with the transducer not connected to the wayside electronics swing a ferrous metal object across the top of the transducer. The output should appear as a sine wave with the oscilloscope connected across the black wire and the cable shield and the output will appear as a cosine wave with the oscilloscope connected across the white wire and the cable shield. Since the amplitude is a function of speed and distance, the amplitude will vary greatly. If these conditions are not present, replace the transducer.

Model 75-S Overlay

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1. Introduction

1.1. This section contains information pertaining to interface, operation, and maintenance of trackside equipment manufactured by Servo¹ Corporation of America for installation with Model 75 Hot Box Detectors Overlays (HBD).

2. Description

2.1 SCANNER DESCRIPTION

2.1.1 The Model 75 overlay system can be interfaced to all scanners and bolometer types manufactured by Servo Corporation of America.

2.2 ACCESSORIES

Function Simulator/Generator

¹Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

3. General Installation Information

3.1 Two scanners are required for detection of hot journals, one on each side of the track. Hot wheel scanners can be added if hot wheel detection is incorporated into the system.

3.2 Two wheel transducers are fastened to the rail to provide the HBD system with signals for the wheel gating function. Optionally, two additional universal wheel transducers can be used to provide advance start signals. Wheel transducers and advance transducers should be installed per the manufacturers recommendations.

4. Installation of Scanners

4.1 If the Model 75 overlay is to be installed using existing scanners a thorough inspection of the trackside equipment must be made. This inspection will verify that the scanners, cables and junction boxes are in good mechanical and electrical condition. If new scanners are being used they should be installed in accordance with manufacturers guidelines.

5. Installation of Wheel Transducers

5.1 Wheel transducers should be installed using the manufacturers guidelines. Location and placement of wheel transducers for both wheel gate and advance system startup should also be determined by manufacturers guidelines.

5.2 It is recommended that lightning protection devices be connected across each transducer lead pair.

5.3 It is also recommended that for maximum lightning protection, protective devices be connected between each rail and earth ground in the vicinity of the advance transducers.

6. Trackside Equipment Modification

6.1 If the scanners being used are 7707/7621 perform the following steps to modify the scanner junction box. Refer to figure 1. If the scanners being used are Advanced Concept Scanners (ACS) all cables terminate directly on the Model 75 electronics rack located inside the bungalow.

6.1.1 To minimize noise remove capacitors C104 and C105 and any excessive wire.

6.1.2 Remove R103 and R104.

6.1.3 Move the wire terminated on TB103-B to TB102-1 and the wire terminated on TB103-0 to TB102-2.

6.2 If the scanners being used are 8808/8909/ACS no modifications are required.

6.3 If the scanners being used are 8808/8909 perform the following steps to modify the regulator junction box. Refer to figure 1 for the junction box cable diagram.

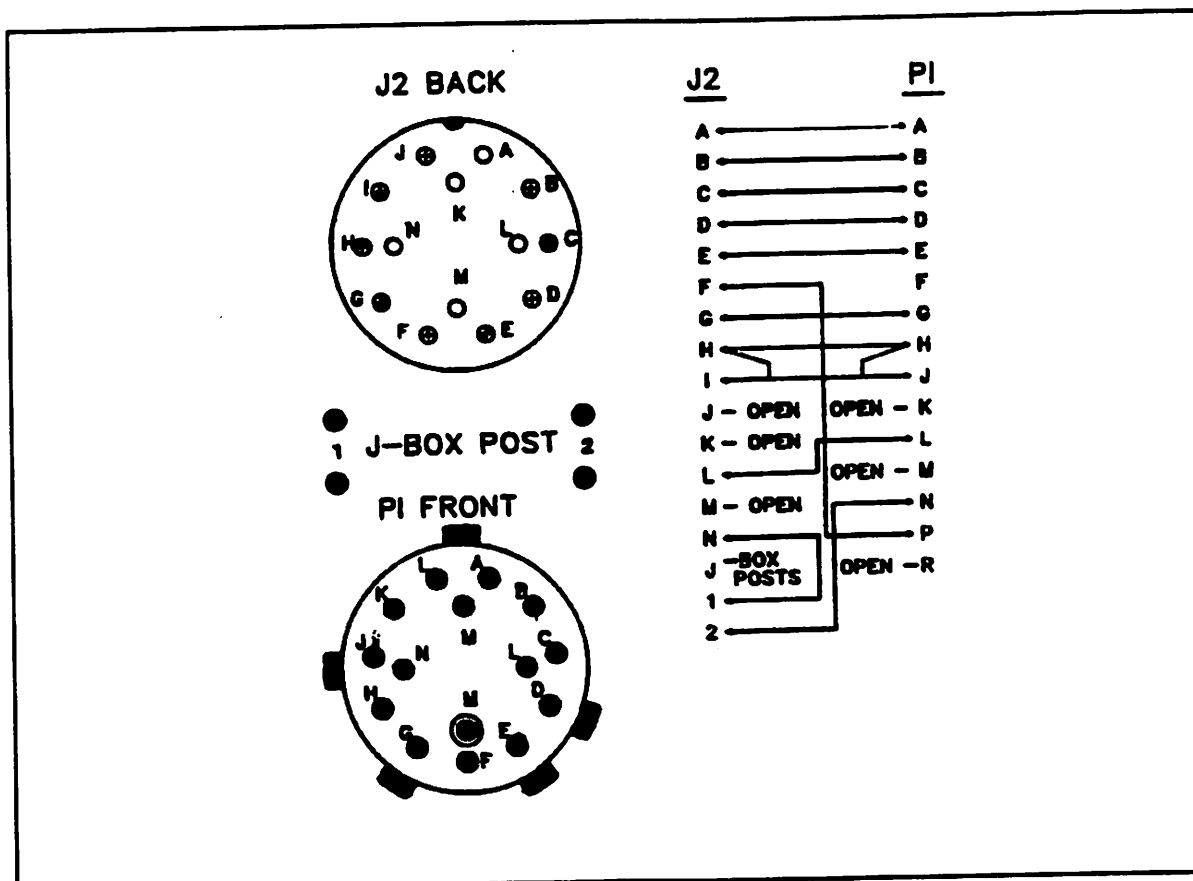


Figure 1 Junction box cable diagram.

6.3.1 Modify the regulator junction box as shown in figure 1 or remove the junction box amplifier and voltage regulator assembly and install interface cable HPN 200601-000

6.4 If the scanners being used are 7707/7621 no modifications to the regulator junction box are required.

7. Model 75 Overlay Equipment Installation

7.1 Before the Model 75 Overlay electronics can be installed the existing equipment must be removed. Disconnect and mark all cable wiring from the Servo² data processing equipment and remove the equipment from the rack. Unless an alternate 12 VDC power supply for protective shutter operation is being supplied, leave the existing 12 VDC power supply in the rack.

7.2 Install the Model 75 Overlay electronics chassis the following instructions and the site installation drawings provided with the system.

²Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

Servo³ Overlay Installation

Transducers

Gate A +	To	Model-75	TB5-5
Gate A -	To	Model-75	TB5-4
A Shield	To	Gnd	
Gate B +	To	Model-75	TB5-7
Gate B -	To	Model-75	TB5-6
B Shield	To	Gnd	
Adv A +	To	Model-75	TB5-9
Adv A -	To	Model-75	TB5-8
A Shield	To	Gnd	
Gate B +	To	Model-75	TB5-11
Gate B -	To	Model-75	TB5-10
B Shield	To	Gnd	

Note: All transducer shields may be tied together and terminated at the Model 75 Overlay Ground Buss.

Ambient Temperature Monitor HPN 250835-000

Gnd	To	Model 75	Gnd Buss	Green
Output	To	Model 75	TB7-5	White
+12VDC	To	Model 75	AUX +12VDC	Black

Note: Install the ambient temperature input network (HPN 225185-000) into position IN3 on the analog board.

Model 27 Data Recorder HPN 250435-000

TB1-1	To	Model 75	TB5-1	Channel 1 input
TB1-3	To	Model 75	TB5-2	Channel 2 input
TB1-5	To	Model 75	Gnd Buss	Ground
TB1-3	To	Model 75	TB12-5	Event Pen
TB1-12	To	Model 75	TB15-9	Recorder Drive

³Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

Advanced Concept Scanner Connections

A	To	Shutter Relay S11-8	Heater 115 VAC (BX)	Blu
B	To	Model 75 TB4-9	+15 VDC	Wht/Yel
C	To	Model 75 TB2-10	+200 VDC	Grn
D	To	Integrity Relay S10-5	-200 VDC	Wht/Grn
E	To	House AC	Heater 115 VAC (NX)	Yel
F	To	Shutter PS Common	Shutter Common	Wht
G	To	Model 75 TB2-2	Signal Out	Grn/Yel
*	To	Model 75 TB2-6	Signal Out	Grn/Yel
H			Gnd	Grn/Wht
I			Gnd	Wht
J	Not Used		N/C	
K	Not Used		N/C	
L	To	Shutter Relay S11-7	Shutter Control	Blk
M	Not Used		Spare	Red
N	Not Used		Integrity Heater	Grn

* All preamplifier connections are parallel for channel 1 and channel 2 sensors except for the signal outputs.

Integrity Relay

S10-10	To	Model 75 +12 VDC Stud	Blu
S10-2	To	Model 75 TB14-9 Integrity Drive	Brn
S10-1	To	Model 75 TB2-12 -200 VDC	Vio

Shutter Relay

S11-10	To	Model 75 +12 VDC Stud	Blu
S11-2	To	Model 75 TB14-10 Shutter Drive	Yel
S11-6	To	+12 VDC Power Supply	Red
S11-11	To	House 115 VAC (BX)	

Ambient Temperature Sensor

GND	To	Model 75 GND BUSS	Grn
R1	To	Model 75 TB2-3 Thermistor	Blk
R2	To	Model 75 TB2-7 Thermistor	Wht

Radio Connections

Model 75	TB11-10	Key
Model 75	TB13-4	Transmit Output
Model 75	TB13-11	Transmit Receive
Model 75	TB11-11	Common

Multi Track Talker

Talker 1	To	Talker 2	To	Transceiver
Model 75	TB9-7	Model 75	TB9-8	
Model 75	TB9-8	Model 75	TB9-7	
Model 75	TB11-10	Model 75	TB11-10	Key
Model 75	TB13-4	Model 75	TB13-4	Transmit Output
Model 75	TB13-11	Model 75	TB13-11	Transmit Receive
Model 75	TB11-12	Model 75	TB11-12	Common

Dragging Equipment Detector Connections

Gate J-box	TB1-7	To	Model 75	Gnd Buss
Gate J-box	TB2-7	To	Model 75	TB14-7

Track Circuit Connection

Track Circuit Input	To	Model 75	TB12-3
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8. Bolometer and Preamplifier Voltage Heat Verification

8.1 Verify the bolometer bias voltage is set to ± 200 VDC. If ± 200 VDC is not present on the test points or on the back of the Model 75 overlay chassis adjust R44 til ± 200 VDC is present.

8.2 Verify the Preamplifier voltage is set to +15 VDC . If +15 VDC is not present on the test points or on the back of the Model 75 overlay chassis adjust R9 for +15 VDC.

9. Scanner Alignment and Heat Verification

9.1 Scanner alignment should be performed using the manufacturers guidelines.

9.2 Place the function simulator/generator on the top of the channel 1 scanner. This should be done using the manufacturers recommended guidelines.

9.3 Place the hot box detector system in the "CHOP" mode (position B of the mode switch). Actuate the DATA ADVANCE switch to initiate the "CHOP" mode. To change to channel 2 actuate the DATA ADVANCE a second time.

9.4 With the function simulator/generator setup to produce 130 degrees Fahrenheit the display should read 15 ± 1 MM or 10 ± 1 MM depending upon railroad specification.

9.5 If the expected heat levels are not displayed perform the following steps:

9.5.1 Remove power from the Model 75 overlay chassis.

9.5.2 Carefully remove the interface board (HPN 226171-000) from the Model 75 overlay chassis and place it on the extender card socket located on the Display and Test Panel.

9.5.3 Plug in power to the function simulator/generator and place it in position as described for scanner alignment.

9.5.4 Place the hot box detector system in the "CHOP" mode (position B of the mode switch). Actuate the DATA ADVANCE switch to initiate the "CHOP" mode. To change to channel 2 actuate the DATA ADVANCE a second time.

9.5.5 With the function simulator/generator setup to produce 130 degrees Fahrenheit the display should read 15 ± 1 MM or 10 ± 1 MM depending upon railroad specification. To adjust channel 1 to obtain 15 MM rotate R68 on the Servo⁴ Interface Board and to adjust channel 2 rotate R85. If 15 MM cannot be obtained change jumper positions E2, E3, E4, or E5 on the Servo Interface Board. Drawing 35757-000 sheet 2 of 2 contains a table showing the appropriate jumper settings.

⁴Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

9.5.6 Carefully remove the Servo Interface Board from the extender card socket and replace it in the Model 75 overlay chassis.

9.5.7 Reapply power to the Model 75 overlay chassis.

10. Scanner Maintenance

10.1 Scanner maintenance should be in accordance with the manufacturers recommended guidelines.

11. Wheel Transducer Maintenance

11.1 Due to the strength of the magnets it may be necessary to periodically clean metal filings from the top of the wheel transducers.

12. Troubleshooting Procedures

12.1 This section is designed to aid in troubleshooting problems with the rail mount scanner. Each section will contain a potential problem and a recommended solution. If the problem persists after using the troubleshooting procedures contact Harmon Electronics, Inc. for assistance.

12.1.1 Hot Box Detector does not see enough heat.

Solution: Place the HBD system in the "CHOP" mode or else perform a system self test train and verify that the protective shutters open. If the protective shutters do not open perform the troubleshooting steps as outlined in the manufacturers guidelines.

Solution: Clean the mirror as described by the manufacturer.

Solution: Place the function simulator/generator on the top of the scanner cover in accordance with the manufacturers guidelines. With the HBD system in the "CHOP" mode the front panel display should be 15 ± 1 MM. If a reading of 15 ± 1 MM is not obtained adjust the Servo⁵ Interface Board as outlined in and perform the Scanner Heat Verification procedure as described in section 9.

Solution: If the mirror is clean and the bolometer sees enough heat off of the function simulator/generator, verify that the scanner is in proper alignment. If all of the trackside equipment is working correctly the problem may be in the Model 75 wayside electronics or cabling.

12.1.2 Scanner sees too much heat.

⁵Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

Solution: Place the function simulator/generator on the top of the scanner cover in accordance with the manufacturers guidelines. With the HBD system in the "CHOP" mode the front panel display should be 15 ± 1 MM. If a reading of 15 ± 1 MM is not obtained adjust the Servo⁶ Interface Board as outlined in and perform the Scanner Heat Verification procedure as described in section 9.

Solution: If the mirror is clean and the bolometer sees enough heat off of the function simulator/generator, verify that the scanner is in proper alignment. If all of the trackside equipment is working correctly the problem may be in the Model 75 wayside electronics or in the cabling.

12.1.3 HBD reports transducer errors.

Solution: Verify wire polarity by connecting a DC voltmeter with the positive lead connected to the black wire and the negative wire to the white wire. With a metal bar (keeper bar) at rest on both magnets, quickly remove the bar while watching the DC voltmeter. If a positive deflection is seen the black wire is positive and the white wire is negative.

Solution: Using an oscilloscope with the transducer not connected to the wayside electronics swing a ferrous metal object across the top of the transducer. The output should appear as a sine wave with the oscilloscope connected across the black wire and the cable shield and the output will appear as a cosine wave with the oscilloscope connected across the white wire and the cable shield. Since the amplitude is a function of speed and distance, the amplitude will vary greatly. If these conditions are not present, replace the transducer.

⁶Servo and ACS are registered trademarks of Servo Corporation of America, Hicksville, New York.

Model 75-G Overlay

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1. Introduction

1.1 This section contains information pertaining to interface, operation, and maintenance of trackside equipment manufactured by General Electric for installation with Model 75 Hot Box Detectors Overlays (HBD).

2. Description

2.1 SCANNER DESCRIPTION

2.1.1 The Model 75 overlay system can be interfaced to all scanners and preamplifier types manufactured by General Electric.

2.2 ACCESSORIES

Calibrated Heat Source

3 General Installation Information

3.1 Two scanners are required for detection of hot journals, one on each side of the track.

3.2 Two wheel transducers are fastened to the rail to provide the HBD system with signals for the wheel gating function. Optionally, two additional universal wheel transducers can be used to provide advance start signals.

4. Installation of Scanners

4.1 If the Model 75 overlay is to be installed using existing scanners a thorough inspection of the trackside equipment must be made. This inspection will verify that the scanners, cables and junction boxes are in good mechanical and electrical condition. If new scanners are being used they should be installed in accordance with manufacturers guidelines.

5. Installation of Wheel Transducers

5.1 Wheel transducers should be installed using the manufacturers guidelines. Location and placement of wheel transducers for both wheel gate and advance system startup should also be determined by manufacturers guidelines.

5.2 It is recommended that lightning protection devices be connected across each transducer lead pair.

5.3 It is also recommended that for maximum lightning protection, protective devices be connected between each rail and earth ground in the vicinity of the advance transducers.

6. Model 75 Overlay Equipment Installation

6.1 Before the Model 75 overlay electronics can be installed the existing equipment must be removed. Disconnect and mark all cable wiring from the current data processing equipment and remove the equipment from the rack.

6.2 Install the Model 75 Overlay electronics chassis per the following wiring information. The Model 75 overlay electronics can operate with PA100, PA150, and KF106 scanners. Use the pages that relate to the proper scanner type.

GE PA100 Overlay Installation

Transducers HPN 250831-000 J-Box Connection (if used)

Gate A +	TB2-1 Blue	Model-75	TB5-5	Black
Gate A -	TB2-2 Red	Model-75	TB5-4	White
A Shield	TB2-3	Gnd		
Gate B +	TB2-4 Blue	Model-75	TB5-7	Black
Gate B -	TB2-5 Red	Model-75	TB5-6	White
B Shield	TB2-6	Gnd		
Adv A +	TB4-3 Blue	Model-75	TB5-9	Black
Adv A -	TB2-3 Red	Model-75	TB5-8	White
A Shield	TB2-3	Gnd		
Gate B +	TB4-3 Blue	Model-75	TB5-11	Black
Gate B -	TB2-3 Red	Model-75	TB5-10	White
B Shield	TB2-3	Gnd		

Note: All transducer shields may be tied together and terminated at the Model 75 Overlay Ground Buss.

Ambient Temperature Monitor HPN 250835-002

Gnd	To	Model 75	Gnd Buss	Green
Output	To	Model 75	TB7-5	White
+12VDC	To	Model 75	AUX +12V	Black

Note: Install the ambient temperature input network (HPN 225185-000) into position IN3 on the analog board.

Model 35A Power Supply HPN 250431-000

TB1-1	To	Model 75	SO2-8	Protective Shutter
TB1-11	To	Model 75	TB15-4	Open Shutter
TB1-12	To	Model 75	TB15-5	Close Shutter

Model (2)27 Data Recorder**HPN 250435-000**

TB1-1	To	Model 75	TB5-1	Channel 1 input
TB1-3	To	Model 75	TB5-2	Channel 2 input
TB1-5	To	Model 75	Gnd Buss	Ground
TB1-3	To	Model 75	TB12-5	Event Pen
TB1-12	To	Model 75	TB15-9	Recorder Drive

Preamplifiers

A	To	Model 75	TB15-2	Optical Shutter Drive 1	Violet
B	To	Model 75	GND BUSS	Sensor Common	Wht/Blk
C	To	Model 75	TB7-10	Channel 1 Signal Output	Blk/Wht
*	To	Model 75	TB7-9	Channel 2 Signal Output	Blk/Wht
D	Not Used				
E	To	Model 35	TB1-6/7	+47VDC	Yellow
F	To	Model 75	TB2-10	Bolometer +270 VDC	Om/Blk
G	To	Model 75	TB2-12	Bolometer -270 VDC	Blu/Blk
H	To	OPS	TB1-3/4	-24VDC Heater Circuit	Brown
J	To	Model 75	TB15-3	Optical Shutter Drive 2	Grey
K	Not Used				
L	Not Used				

* All preamplifier connections are parallel for channel 1 and channel 2 sensors except for the signal outputs.

-24VDC Overlay Power Supply (OPS)**HPN 250871-001**

TB1-3/4	To	Preamp Pin H	-24VDC
TB1-2	To	Gnd Stud	

Radio Connections

Model 75	TB11-10	Key
Model 75	TB13-4	Transmit Output
Model 75	TB13-11	Transmit Receive
Model 75	TB11-11	Common

Multi Track Talker

Talker 1		To	Talker 2		To	Transceiver
Model 75	TB9-7		Model 75	TB9-8		
Model 75	TB9-8		Model 75	TB9-7		
Model 75	TB11-10		Model 75	TB11-10		Key
Model 75	TB13-4		Model 75	TB13-4		Transmit Output
Model 75	TB13-11		Model 75	TB13-11		Transmit Receive
Model 75	TB11-12		Model 75	TB11-12		Common

Scanner Connections

Heater Line 120VAC	Model 35	TB2-1	Black
Heater Neutral	Model 35	TB2-4	Red
Protective Shutter Channel 1	Model 75	TB15-12	White
Protective Shutter Channel 2	Model 75	SO2-6	Green
Protective Shutter Channel 1	Model 75	TB15-12	Green
Protective Shutter Channel 2	Model 35	TB1-4	White

Dragging Equipment Detector Connections

Gate J-box	TB1-7 To	Model 75	Gnd Buss
Gate J-box	TB2-7 To	Model 75	TB14-7

GE PA150 Overlay Installation

Transducers HPN 250831-000 J-Box Connection (if used)

Gate A +	TB2-1 Blue	Model-75	TB5-5	Black
Gate A -	TB2-2 Red	Model-75	TB5-4	White
A Shield	TB2-3	Gnd		
Gate B +	TB2-4 Blue	Model-75	TB5-7	Black
Gate B -	TB2-5 Red	Model-75	TB5-6	White
B Shield	TB2-6	Gnd		
Adv A +	TB4-3 Blue	Model-75	TB5-9	Black
Adv A -	TB2-3 Red	Model-75	TB5-8	White
A Shield	TB2-3	Gnd		
Gate B +	TB4-3 Blue	Model-75	TB5-11	Black
Gate B -	TB2-3 Red	Model-75	TB5-10	White
B Shield	TB2-3	Gnd		

Note: All transducer shields may be tied together and terminated at the Model 75 Overlay Ground Buss.

Ambient Temperature Monitor HPN 250835-002

Gnd	To	Model 75	Gnd Buss	Green
Output	To	Model 75	TB7-5	White
+12VDC	To	Model 75	AUX +12V	Black

Note: Install the ambient temperature input network (HPN 225185-000) into position IN3 on the analog board.

Model 35A Power Supply HPN 250431-000

TB1-11	To	Model 75	TB15-4	Open Shutter
TB1-12	To	Model 75	TB15-5	Close Shutter

Model (2)27 Data Recorder**HPN 250435-000**

TB1-1	To	Model 75	TB5-1	Channel 1 input
TB1-3	To	Model 75	TB5-2	Channel 2 input
TB1-5	To	Model 75	Gnd Buss	Ground
TB1-3	To	Model 75	TB12-5	Event Pen
TB1-12	To	Model 75	TB15-9	Recorder Drive

Preamplifiers

A	To	Model 75	TB15-2	Optical Shutter Drive 1	Violet
B	To	Model 75	Gnd Buss	Sensor Common	Wht/Blk
C	To	Model 75	TB7-10	Channel 1 Signal Output	Blk/Wht
*	To	Model 75	TB7-9	Channel 2 Signal Output	Blk/Wht
D	Not Used				
E	To	Model 35	TB1-6	+47 VDC	Yellow
F	Not Used				
G	Not Used				
H	Not Used				
J	To	Model 75	TB15-3	Optical Shutter Drive 2	Grey
K	Not Used				
L	Not Used				

Note: All preamplifier connections are parallel for channel 1 and channel 2 sensors except for the signal outputs.

Radio Connections

Model 75	TB11-10	Key
Model 75	TB13-4	Transmit Output
Model 75	TB13-11	Transmit Receive
Model 75	TB11-11	Common

Multi Track Talker

Talker 1		To	Talker 2		To	Transceiver
Model 75	TB9-7		Model 75	TB9-8		
Model 75	TB9-8		Model 75	TB9-7		
Model 75	TB11-10		Model 75	TB11-10		Key
Model 75	TB13-4		Model 75	TB13-4		Transmit Output
Model 75	TB13-11		Model 75	TB13-11		Transmit Receive
Model 75	TB11-12		Model 75	TB11-12		Common

Scanner Connections

Heater Line 120VAC	Model 35	TB2-1	Black
Heater Neutral	Model 35	TB2-4	Red
Protective Shutter Channel 1	Model 75	TB15-12	White
Protective Shutter Channel 2	Model 75	SO2-6	Green
Protective Shutter Channel 1	Model 75	TB15-12	Green
Protective Shutter Channel 2	Model 35	TB1-4	White

Dragging Equipment Detector Connections

Gate J-box	TB1-7	To	Model 75	Gnd Buss
Gate J-box	TB2-7	To	Model 75	TB14-7

GE KF106 Overlay Installation

Transducers HPN 250831-000 J-Box Connection (if used)

Gate A +	TB2-1 Blue	Model-75	TB5-5	Black
Gate A -	TB2-2 Red	Model-75	TB5-4	White
A Shield	TB2-3	Gnd		
Gate B +	TB2-4 Blue	Model-75	TB5-7	Black
Gate B -	TB2-5 Red	Model-75	TB5-6	White
B Shield	TB2-6	Gnd		
Adv A +	TB4-3 Blue	Model-75	TB5-9	Black
Adv A -	TB2-3 Red	Model-75	TB5-8	White
A Shield	TB2-3	Gnd		
Gate B +	TB4-3 Blue	Model-75	TB5-11	Black
Gate B -	TB2-3 Red	Model-75	TB5-10	White
B Shield	TB2-3	Gnd		

Note: All transducer shields may be tied together and terminated at the Model 75 Overlay Ground Buss.

Ambient Temperature Monitor HPN 250835-002

Gnd	To	Model 75	Gnd Buss	Green
Output	To	Model 75	TB7-5	White
+12VDC	To	Model 75	AUX +12V	Black

Note: Install the ambient temperature input network (HPN 225185-000) into position IN3 on the analog board.

Model 35A Power Supply HPN 250431-000

TB1-11	To	Model 75	TB15-4	Open Shutter
TB1-12	To	Model 75	TB15-5	Close Shutter

Model (2)27 Data Recorder HPN 250435-000

TB1-1	To	Model 75	TB5-1	Channel 1 input
TB1-3	To	Model 75	TB5-2	Channel 2 input
TB1-5	To	Model 75	Gnd Buss	Ground
TB1-3	To	Model 75	TB12-5	Event Pen
TB1-12	To	Model 75	TB15-9	Recorder Drive

Preamplifiers

A	To	Model 75	TB4-6	+6 VDC	Brown
B	To	Model 75	Gnd Buss	Sensor Common	White
C	To	OPS	TB1-3	-24 VDC Bolometer Heater	
D	To	OPS	TB1-2	Return Bolometer Heater	
E	To	Model 75	TB7-10	Channel 1 Signal Output	Green
*	To	Model 75	TB7-9	Channel 2 Signal Output	Green
F	To	Model 75	TB4-9	+28 VDC	Yellow
G	Not Used				
H	To	Model 75	TB15-3	Optical Shutter Drive 2	Grey
J	To	Model 75	TB15-2	Optical Shutter Drive 1	Violet
K	To	Model 75	TB2-10	Bolometer +120 VDC	Blu/Blk
L	To	Model 75	TB2-12	Bolometer -120 VDC	Om Blk

* All preamplifier connections are parallel for channel 1 and channel 2 sensors except for the signal outputs.

-24VDC Overlay Power Supply (OPS) HPN 250871-001

TB1-3	To	Preamp Pin C	-24VDC
TB1-2	To	Preamp Pin D	24V Return

Radio Connections

Model 75	TB11-10	Key
Model 75	TB13-4	Transmit Output
Model 75	TB13-11	Transmit Receive
Model 75	TB11-11	Common

Multi Track Talker

Talker 1		To	Talker 2		To	Transceiver
Model 75	TB9-7		Model 75	TB9-8		
Model 75	TB9-8		Model 75	TB9-7		
Model 75	TB11-10		Model 75	TB11-10		Key
Model 75	TB13-4		Model 75	TB13-4		Transmit Output
Model 75	TB13-11		Model 75	TB13-11		Transmit Receive
Model 75	TB11-12		Model 75	TB11-12		Common

Scanner Connections

Heater Line 120VAC	Model 35	TB2-1	Black
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Heater Neutral	Model 35	TB2-4	Red
Protective Shutter Channel 1	Model 75	TB15-12	White
Protective Shutter Channel 2	Model 75	SO2-6	Green
Protective Shutter Channel 1	Model 75	TB15-12	Green
Protective Shutter Channel 2	Model 35	TB1-4	White

Dragging Equipment Detector Connections

Gate J-box	TB1-7	To	Model 75	Gnd Buss
Gate J-box	TB2-7	To	Model 75	TB14-7

7. Scanner Bolometer Voltage Verification

The KF106 and PA100 Pre amps incorporate a bolometer for infrared detection. This bolometer requires a high voltage DC supply. This high voltage power supply is located on the Overlay Interface board. Power requirement for the KF106 is ± 120 VDC and ± 270 for the PA100. To adjust this Voltage use R44 on the Overlay Interface board.

8. Scanner Alignment

8.1 Scanner alignment should be performed using the manufacturers guidelines.

9. Scanner Heat Verification

9.1 Allow the preamplifier to assume ambient temperature. this will take at least two hours.

9.2 Place the calibrated heat source on the top of the channel 1 scanner. The heat block must cover the opening in the scanner.

9.3 Place the hot box detector system in the "CHOP" mode (position B of the mode switch). Actuate the DATA ADVANCE switch to initiate the "CHOP" mode. To change to channel 2 actuate the DATA ADVANCE a second time.

9.4 With the calibrated heat source set to the 50° Celsius position the display should read 10 ± 1 MM.

9.5 If this heat reading is not obtained perform the alignment procedure one more time. If a satisfactory reading is not obtained return the preamplifier to the factory for calibration.

10. Scanner Maintenance

10.1 Scanner maintenance should be in accordance with the manufacturers recommended guidelines.

11. Wheel Transducer Maintenance

11.1. Due to the strength of the magnets it may be necessary to periodically clean metal filings from the top of the wheel transducers.

12. Troubleshooting Procedures

12.1 This section is designed to aid in troubleshooting problems with the rail mount scanner. Each section will contain a potential problem and a recommended solution. If the problem persists after using the troubleshooting procedures contact Harmon Electronics, Inc. for assistance.

12.1.1 Hot Box Detector does not see enough heat.

Solution: Place the HBD system in the "CHOP" mode or else perform a system self test train and verify that the protective shutters open. If the protective shutters do not open remove the scanner cover and check the shutter solenoid..

Solution: Clean the lens as described by the manufacturer.

Solution: Place the calibrated heat source on the top of the scanner cover with the heat block covering the scan hole. With the HBD system in the "CHOP" mode the front panel display should be 10 ± 1 MM. If a reading of 10 ± 1 MM is not obtained perform the Scanner Heat verification procedure as described in section 9.

Solution: If the lens is clean and the preamplifier sees enough heat off of the calibrated heat source, verify that the scanner is in proper alignment. If all of the trackside equipment is working correctly the problem may be in the Model 75 wayside electronics or cabling.

12.1.2 Scanner sees too much heat.

Solution: Place the calibrated heat source on the top of the scanner cover with the heat block covering the scan hole. With the HBD system in the "CHOP" mode the front panel display should be 10 ± 1 MM. If a reading of 10 ± 1 MM is not obtained perform the Scanner Heat Verification procedure as described in section 9.

Solution: If the lens is clean and the bolometer sees enough heat off of the calibrated heat source, verify that the scanner is in proper alignment. If all of the trackside equipment is working correctly the problem may be in the Model 75 wayside electronics or in the cabling.

12.1.3 HBD reports transducer errors.

Solution: Verify wire polarity by connecting a DC voltmeter with the positive lead connected to the black wire and the negative wire to the white wire. With a metal bar (keeper bar) at rest on both magnets, quickly remove the bar while watching the DC voltmeter. If a positive deflection is seen the black wire is positive and the white wire is negative.

Solution: Using an oscilloscope with the transducer not connected to the wayside electronics swing a ferrous metal object across the top of the transducer. The output should appear as a sine wave with the oscilloscope connected across the black wire and the cable shield and the output will appear as a cosine wave with

the oscilloscope connected across the white wire and the cable shield. Since the amplitude is a function of speed and distance, the amplitude will vary greatly. If these conditions are not present, replace the transducer.

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Hot Box Detector Error Codes

HBD	ADV_X_A_XXX, ADV_X_B_XXX
DCP	
Definition	Advance transducer counts are not equal.
HBD Integ	Not effected.

When the train leaves the HBD the advance transducer counts are compared. If the difference between the counts is 5 or more, the HBD issues the "ADV_X_" warning, indicating that the signals received from advance transducers are not equal.

The "ADV_X_A_XXX" warning message is followed by the first advance transducer count. The HBD then prints the second advance transducer count in the form of "ADV_X_B_XXX", where "XXX" is the second advance transducer count. Note: Advance transducer A (first transducer) is the one on the south/east side of the advance transducer B.

The advance transducer counts should be equal to the number of axles. Compare both counts with the number of axles, to determine which transducer is at fault.

Solution: Check the advance transducer wiring for opens/grounds. Make sure they are fastened solidly, and the wiring polarity is correct.

HBD	ALARM_CKSUM_ERR
DCP	
Definition	Alarm buffer was damaged.
HBD Integ	HBD announce integrity failure.

The HBD sets aside enough memory to store up to 16 alarms per train. Upon train departure the HBD tests the memory buffer which stores the alarm information. This test consists of a checksum on data stored in the buffer and is performed before announcing the End Of Train message.

"ALARM_CKSUM_ERR" error message appears if the checksum test fails. In this case HBD announces an integrity failure, because the alarms announced may be corrupt.

Solution: Perform the second level of "HBD board self test" and examine the CPU board status. There are two static RAMs on the CPU board that provide the memory space used for

the alarm buffer. If the CPU fails the test, replace the CPU board, otherwise notify Harmon Electronics.

HBD	BD_0
DCP	
Definition	CPU Board Failure.
HBD Integ	HBD announces integrity failure.

The HBD performs an integrity test once every two minutes. This test consists of examining the integrity of critical components of all the system boards and the I/O ports that interface to the trackside equipment. The result of the pre-train integrity test and the two minute integrity test are then combined (ORed) to determine the integrity of HBD system.

The "BD_0" indicates that the CPU board has failed the pre-train integrity test (two minute integrity failure is printed as "XBD_0"). The error message is followed by one of the following names, indicating which component failed the test.

FAULT	General failure
CPU CHIP	8031 micro-controller
ROM0	First program EPROM
ROM1	Second program EPROM
ROM2	Third program EPROM
ROM3	Fourth program EPROM
RAM SEL	RAM select lines
RAM ADDR	RAM address lines
UPB RAM	RAM chips on CPU board

Solution: If the failure is due to one of the program EPROMs (ROM0, ROM1, ROM2, ROM3), the HBD program has been damaged. In this case replace the EPROM which has been damaged. For other failures, you have to replace the CPU board.

For more information on how the HBD boards are examined, and more detail on each component, refer to the "Board Self Test" section of the Model 34/75 Technical Reference.

HBD	BD_1
DCP	
Definition	ROM Board Failure (Speech data has been damaged).
HBD Integ	HBD announces integrity failure.

The HBD performs an integrity test once every two minutes. This test consists of examining the integrity of critical components of all the system boards and the I/O ports that interface to the trackside equipment. The result of the pre-train integrity test and the two minute integrity test are then combined (ORed) to determine the integrity of HBD system.

"BD_1" indicates that the ROM board, which holds all the speech EPROMs, has failed the pre-train integrity test (two minute integrity failure is printed as "XBD_1"). The error message is followed by the EPROM which failed the test (numbers start from zero).

<u>Solution:</u>	ROM0:	Replace first speech EPROM
	ROM1:	Replace second speech EPROM
	...	
	...	
	ROM15:	Replace 16th speech EPROM.

For more information on how the HBD boards are examined, and more detail on each component, refer to the "Board Self Test" section of the Model 34/75 Technical Reference.

HBD	BD_2
DCP	
Definition	Speech Board Failure.
HBD Integ	HBD announces integrity failure.

The HBD performs an integrity test once every two minutes. This test consists of examining the integrity of critical components of all the system boards and the I/O ports that interface to the trackside equipment. The result of the pre-train integrity test and the two minute integrity test are then combined (ORed) to determine the integrity of HBD system.

"BD_2" indicates that the speech board has failed the pre-train integrity test (two minute integrity failure is printed as "XBD_2"). The error message is followed by one of the following names, indicating which component on speech board failed the test.

IO PORT: Port 2 of speech board.
RST CAP: Reset capacitors of port 2.

In case of "RST_CAP" failure, replace the speech board.

If the IO port has failed the test, examine the external devices which are connected to the port 2 of speech board. The following table shows the external devices which control port 2.

SPEECH BOARD PORT 2

Bit	function	HBD back panel	Dir
0	Transmitter on/off control	TB9.1	Out
1	Tunnel circuit	TB9.2	In
2	Radio Mute	TB9.3	Out
3	HBD disable	TB9.4	Out
4	Protective shutter 3 switch	TB9.5	In
5	Protective shutter 5 switch	TB9.6	In
6	Transmitter request	TB9.7	Out
7	Other HBD transmitter request	TB9.8	In

In case of port failure, perform the second level of the "HBD board self test". Study the HBD front panel LEDs to determine which bit is failing the test. Refer to board self test section of the Model 34/75 Technical Reference for more information on the board self test.

If one of the output bits is failing (P2.0, P2.2, P2.3, P2.6), reset the HBD. Wait until the HBD performs its power-up house-keeping (front panel shows "STANDBY"). Perform the "HBD board self test" again, if the failure re-appears, replace the digital board.

If the failure is due to one of the input bits (P2.1, P2.4, P2.5, P2.7) examine the external device which controls the bit. For example if P2.4 is the cause of failure, the third scanner is reporting a stuck open protective shutter. Refer to "DIGITAL AND SPEECH I/O PORTS" section of the Model 34/75 Technical Reference for more information on the input bits (the proper potential across these bits). The input bits should show 12 VDC during their ideal state.

Solution: Measure the input at the back of the electronics chassis to determine if the external device is grounding the input, or the port electronics have been damaged.

For more information on how the HBD boards are examined, and more detail on each component, refer to the "Board Self Test" section of the Model 34/75 Technical Reference.

HBD	BD_3
DCP	
Definition	Digital Board Failure.
HBD Integ	HBD announces integrity failure.

The HBD performs an integrity test once every two minutes. This test consists of examining the integrity of critical components of all the system boards and the I/O ports that interface to the trackside equipment. The result of the pre-train integrity test and the two minute integrity test are then combined (ORed) to determine the integrity of HBD system.

"BD_3" error message indicates that the digital board has failed the pre-train integrity test (two minute integrity failure is printed as "XBD_3"). The error message is followed by one of the following names, indicating which component failed the test.

INTERRUPT:	Interrupt lines
PORT0:	Port 0 of digital board
PORT1:	Port 1 of digital board
PORT2:	Port 2 of digital board
RST CAP:	Reset capacitors of ports

If the failure is caused by "RST_CAP" or "INTERRUPT", replace the digital board. Otherwise examine the external circuits connected to the specified port.

The following table shows the external devices connected to each digital port.

DIGITAL BOARD PORT 1			
Bit	function	HBD back panel	Dir
0	Not Used	TB10-1	--
1	Not Used	TB10-2	--
2	Aux 1, Dragging Equip.	TB10-3	In
3	Aux 2, High Load	TB10-4	In
4	Aux 3, Wide Load 1	TB10-5	In
5	Aux 4, Wide Load 2	TB10-6	In
6	Not Used	TB10-7	--
7	Wheel gate intr.	TB10-8	Out

DIGITAL BOARD PORT 1			
Bit	function	HBD back panel	Dir
0	Direction 1	TB12-1	Out
1	Direction 2	TB12-2	Out
2	Track Circuit	TB12-3	In
3	Aux Recorder Drive	TB12-4	Out
4	Recorder Event Pen Drive	TB12-5	Out
5	System Integ Drive	TB12-6	Out
6	Main Alarm Drive	TB12-7	Out
7	Not Used	TB12-8	--

Digital Board Port 2			
Bit	function	HBD back panel	Dir
0	Not Used	TB14-8	--
1	Integ Test Lamp Drive	TB14-9	Out
2	Prot Shutter Drive	TB14-10	Out
3	Prot Shutter Switch 1	TB14-11	In
4	Prot Shutter Switch 2	TB14-12	In
5	Real Train Passing	TB15-1	Out
6	Open Optical Shutter	TB15-2	Out
7	Close Optical Shutter	TB15-3	Out

In case of port failure perform the second level of the "HBD board self test". Study the HBD front panel LCDs to find out which bit is failing the test (refer to board self test section for more information on LCDs).

Solution: If one the output bits fails, reset the HBD. Wait until the HBD performs its power-up house-keeping (front panel shows "STANDBY"). Run "HBD board self test" again, if the failure re-appears, replace the digital board.

If the failure is due to an "input" bit, examine the external device which controls that bit. For example, port zero is controlled by the auxiliary alarm detectors. If P0.2 is the failure, then the dragger is open. All the inputs must be at 12 VDC during their ideal state. Examine the HBD back panel connection, to see if the failed input is grounded (by the external device), or the port electronics have been damaged. Please refer to "DIGITAL AND SPEECH I/O PORT", for more information on I/O ports, and how to examine individual bits.

For more information on how the HBD boards are examined, and more detail on each component, refer to the "Board Self Test" section of the Model 34/75 Technical Reference.

HBD	BD_4
DCP	
Definition	Analog Board Failure.
HBD Integ	HBD announces integrity failure.

The HBD performs an integrity test once every two minutes. This test consists of examining the integrity of critical components of all the system boards and the I/O ports that interface to the trackside equipment. The result of the pre-train integrity test and the two minute integrity test are then combined (ORed) to determine the integrity of HBD system.

"BD_4" error message indicates that the analog board (or the first analog board if system is a Hot Wheel Detector) has failed the integrity test (two minute integrity failure is printed as "XBD_4"). The error message is followed by one of the following names, indicating which component has failed the integrity test:

FAULT	General failure
DAC1	DA Converter 1
DAC2	DA Converter 2
ADC	AD converter
+5V	5 VDC power supply
-6V	-6 VDC power supply
+12V	12 VDC power supply
-12V	-12 VDC power supply
PKHLD1 0	first peak hold (zero test)
PKHLD1 P	first peak hold (positive test)
CAP 1 SAG	first peak hold (cap sag test)
PKHLD2 0	second peak hold (zero test)
PKHLD2 P	second peak hold (positive test)
CAP 2 SAG	second peak hold (cap sag test)

The analog board (or the first analog board in case of a Hot Wheel Detector) needs to be replaced.

For more information on how the HBD boards are examined, and more detail on each component, refer to the "Board Self Test" section of the Model 34/75 Technical Reference.

HBD	BD_5, BD_6
DCP	
Definition	Second digital board/memory board failure
HBD Integ	Read the following.

BD_5 refers to the second digital board, while BD_6 refers to the second memory board. The current version of HBD does not use either of the boards. Thus these error messages should never appear (HBD integrity will not be effected).

HBD	BD_7
DCP	
Definition	Second Analog Board Failure
HBD Integ	HBD announces integrity failure.

This error message only appears if the system has been configured as a Hot Wheel Detector, where the system uses two analog boards. In this case the second analog board has failed the integrity test, and needs to be replaced.

Refer to "BD_4" (first analog board failure), for more information.

HBD	CH_1_SENSOR, CH_2_SENSOR, CH_3_SENSOR, CH_4_SENSOR
DCP	
Definition	Sensors failed pre-train integrity test.
HBD Integ	HBD announce integrity failure.

Upon arrival of train (real or test train), HBD performs its pre-train integrity test. The pre-train integrity test examines all the scanners and trackside equipment.

A part of this test is to open the optical shutters and turn the lamp inside the scanners on (for a few moments). The HBD then closes the optical shutters and processes heat signals from the lamp. The heat must be greater than the "absolute alarm limit" for the sensors to pass (the heat

from the channel 3 and 4, if the detector is configured as a Hot Wheel Detector, must be greater than "Hot Wheel alarm limit"). Note: This test is performed for all the scanners in use at trackside. "Absolute alarm limit" is set/adjusted using pot 2 on the first analog board. "Hot Wheel limit" is set/adjusted using pot 6, on the first analog board.

"CH_x_SENSOR", where x is the sensor number which failed, indicates that the sensor was not able to generate the proper signal from the scanner lamp.

Solution: Perform the second level of "HBD board self test" to examine port 2 of the digital board. Bit P2.1 (TB14-9) controls the lamp inside the scanner (it should be grounded to turn the lamp on).

Run a "HBD test train", and measure TB14-9 potential. Make sure TB14-9 is grounded for a few moments. If port 2 of the digital board fails, or TB14-9 is not grounded, replace the digital board.

When performing the "HBD board self test", examine the analog board components (peak hold, AD converter,...).

Note: The error message "CH_1_2_SENSOR" indicates that both channel one and two sensors are bad.

HBD	ERR_1
DCP	
Definition	Error in speech processing routines.
HBD Integ	Not effected.

This error can be caused by several factors:

- a - The correct speech EPROMs are not installed.
- b - One or more of speech EPROMs have been damaged.
- c - An internal error in the speech processing routines.

"ERR_1" warning message is issued, if the HBD could not announce its "train passing" and/or "End Of Train" messages in the proper format.

Solution: Perform the second level of "HBD board self test" to examine the speech EPROMs on the ROM board (press the data advance switch twice). If any of the speech EPROMs have been damaged, the DATA DISPLAY will indicate its number (starting from 0). In this case replace the speech EPROM.

If all the speech EPROMs are in good condition, run the "HBD test train", to determine if the word "UHH" is spoken. If the "UHH" is spoken, one of the needed speech EPROMs is not installed or is faulty. Check the Speech ROM vocabulary for a complete list of speech EPROMs.

If the "board self test" and "test trains" do not reveal anything, notify Harmon Electronics. The HBD sets aside enough memory for 600 words. "ERR_1" is also issued, if during train passage or train departure, the speech buffer overflows.

HBD	ERR_3
DCP	
Definition	HBD could not determine train direction.
HBD Integ	Not effected.

Upon arrival of train, the advance transducers perform the following tasks:

- a - start up the system.
- b - determine train direction.

If the advance transducers are dead or faulty, the HBD uses the gating transducers to determine train direction.

"ERR_3" indicates that the HBD did not receive any direction information from the advance transducers/gate transducers.

The HBD determines train direction, it grounds TB12-1 (P1.0 of digital board) for direction 1, meaning first transducer was traversed first, or ground TB12-2 (P1.1 of digital board) for direction 2, meaning the second transducer was traversed first. First transducer is always to the south/east of the second transducer (refer to the Model 34/75 Technical Reference for more information, on how the HBD processes the signals from transducers).

Solution: Perform the second level of "HBD board self test", by pressing the DATA ADV switch twice. Examine port 1 of digital board (port 1 indicates train direction to the outside world). Replace the digital board in case of port failure.

Check for defective (open/grounded) or dead advance transducers. Make sure they are fastened solidly, and the wiring polarity is correct.

If the wiring is correct, run "HBD test train", and observe if the error message appears. Signals from the advance transducers are converted to digital form by IC24(U7) and IC27(U8) of analog

board. Port zero of analog board provides the HBD, with the digital signals, while port 4 of analog board controls the transducer interrupts. Port zero, port four, IC24(U7), and IC27(U8) are not examined during the analog board test. Test trains, however, can reveal if the components are in proper working condition. If the same error appears during a test train, replace the analog board.

HBD	ERR_4
DCP	
Definition	The other HBD did not release the Radio on time.
HBD Integ	Not effected.

In a double track installation, two HBDs can be connected to use the same radio. In this case the first HBD checks the status of transmitter, before transmitting its message. If the other HBD has control of radio, the first HBD will wait up to 5 minutes. If the other HBD does not release the transmitter within the 5 minute wait period, the first HBD will transmit its message regardless of the status of transmitter.

Port 2 of speech board provides one input and one output, for the two HBDs to manage the radio.



Bit P2.7 (TB9-8) is an input. It is grounded if the other HBD has control of radio. Bit P2.6 (TB9-7) is an output, which is grounded by the HBD which has control of transmitter.

Solution: Perform the second level of "HBD board self test" to examine the integrity of speech board port 2. If port 2 fails the test, replace the speech board.

If the port passes the test, check the handshake lines for proper installation and operation. TB9-8 should be at 12 VDC, if no one has control of transmitter.

Note: A backup routine monitors how long the HBD has control of the transmitter. If the HBD does not release the transmitter in 3 minutes, the backup routine will truncate the message, and release the transmitter. In other words, the HBD should never have control of transmitter for more than three minutes.

HBD	ERR_5
DCP	
Definition	Pre-train integrity test was not completed.
HBD Integ	HBD announces bad integrity.

Advance transducers (or track circuit) inform the HBD of arrival of a train. The HBD starts its pre-train integrity test upon receiving a signal from the advance transducers. The pre-train integrity test examines all the HBD boards, the scanners, and the auxiliary input status. This test requires approximately two seconds to perform all its sub-tests.

"ERR_5" indicates that the pre-train integrity test did not have enough time to perform its duties. In other words, first axle of train arrived at the gating transducers before the test was completed. In this case, the HBD announces integrity failure. Note: Integrity failure in this case does not necessarily mean that the has system failed.

Solution: If high speed trains pass this track, the advance transducers have to be moved further away from the detector.

HBD	ERR_SP_xx
DCP	
Definition	Stack failure, (internal software error).
HBD Integ	Not effected.

The stack is a virtual part of the HBD software. The HBD examines its stack status once every 50 milliseconds. If any errors are detected, the HBD takes the proper steps to correct the problem. In this case, the HBD will issue a warning message. The warning message is used for software debugging purposes. Please notify Harmon Electronics, Inc. if the warning message "ERR_SP_xx" appears (xx is a two digit hex value used for debugging).

HBD	FAIL_AUX_x
DCP	
Definition	Auxiliary input port failed integrity test.
HBD Integ	HBD announce integrity failure.

Upon arrival of a train (signals from advance transducer/track circuit) the HBD examines port 0 of digital board as part of its pre-train integrity test. This port is used for auxiliary alarm inputs. If any of the alarm inputs are grounded, HBD will announce integrity failure, and prints the "FAIL_AUX_x" error message. Following the "FAIL_AUX_", is a digit, specifying which input was stuck.

Alarm inputs are as follow:

TB10-3	Dragger	FAIL_AUX_1
TB10-4	High Load	FAIL_AUX_2
TB10-5	Wide Load 1	FAIL_AUX_3
TB10-6	Wide Load 2	FAIL_AUX_4

Note: It is possible to have an error message such as "FAIL_AUX_123", indicating dragger, high load, and wide load 1 are stuck.

Solution: Perform the second level of "HBD board self test", and examine the status of digital board I/O port zero. If the port is at fault, replace the digital board. Otherwise examine the external device which controls the input at fault. These inputs should be at 12 VDC during their ideal state.

HBD	NO_MIN_LEVELS
DCP	
Definition	Cold Train Passing.
HBD Integ	Read the followings.

At the end of train passage (real trains only), the HBD performs the minimum heat level test. This test is made of two parts. First every axle of train is checked for a minimum heat level of 2.6 mm (note that the 2.6mm is a constant value). If none of the axles have a heat value above 2.6mm, then the second part of test may be performed. Refer to railroad specific operation for information concerning the cold train test. If any axle (one on both sides) has a heat signal over the 2.6 mm, train is considered warm, and the second part of test is bypassed.

If minimum heat level test fails on first part (all axles below 2.6 mm), then the second test (deviation test) is performed. For this test to pass, the difference between the highest and lowest heat values for each side must be greater than 0.4mm (4 F). In another word, if the

highest heat for side 1 - lowest heat for side 1 or
highest heat for side 2 - lowest heat for side 2

is greater than .4 mm, train is considered warm. A cold train on the other hand, has failed both tests. In this case, the HBD increments the cold train counter and compares it to the "maximum allowable cold trains" which is set/adjusted by the front panel DIP switches S2.0 and S2.1.

If HBD detects a cold train, it will issue a warning. If number of consecutive cold trains exceed the "maximum allowable cold trains", HBD reports an integrity failure. Note: Every time HBD detects a warm train, the cold train counter is reset to zero.

Solution: A cold train is an indication that the scanners may not be working properly. Use the HBD chop mode (and a calibrated heat source) to examine system response to heat signals. Also inspect the scanner protective shutters, to verify that they are not stuck closed.

If the scanners are in proper condition, use second level of "HBD board self test" to examine integrity of analog board circuits (peak hold, AD converter,...). Replace the analog board, if any of its components fail the test.

HBD	RADIO_AUDIO, RADIO_RF
DCP	
Definition	Radio test failed.
HBD Integ	HBD announce integrity failure.

The HBD checks the operation of the radio transmitter, using an external RF detector, and checks that the RF is actually modulated using an external receiver.

These error messages should never appear, because the radio test has been disabled for most versions of software.

HBD	SHX_0, SHX_1, SHX_2, SHX_3
DCP	
Definition	Scanner protective shutters are stuck opened/closed
HBD Integ	Read the followings

Upon arrival of train (real or test train), HBD performs a pre-train integrity test. The pre-train integrity test examines all I/O ports controlled by external devices and the scanners. Part of this test is to examine the Hot Wheel scanner protective shutters.

First the hbd examines the protective shutters, they must be closed (TB9-5 and TB9-6 must be at 12 VDC). Then the HBD opens the protective shutters and re-examines their status. At this point they must be open (TB9-5 and TB9-6 must be grounded). Note: TB9-5 and TB9-6 are controlled by the switch mechanism of protective shutters.

The following warning/error messages are issued if the protective shutters fail the test.

SHX_0	channel three protective shutter is stuck open.
SHX_1	channel four protective shutter is stuck open.
SHX_2	channel three protective shutter is stuck closed.
SHX_3	channel four protective shutter is stuck closed.

If the protective shutters are stuck opened, HBD issues a warning. On the other hand, if the protective shutters are stuck closed, HBD will announce an integrity failure.

Solution: Use "HBD chop" mode, or "HBD test trains" to verify visually that the protective shutters open/close properly.

Check protective shutter for foreign material that could be keeping the shutter in open/closed position.

The micro switch solenoid motor may be defective.

If the scanner micro_switch passes the test, run second level of "HBD board self test" to examine status of port 2 on speech board and port 2 of digital board. Bit P2.2 (TB14-10) of digital board controls the protective shutters, while P2.4 and P2.5 of speech board return status of micro switch. Replace any board which fails the test.

HBD	SHW_0, SHW_1, SHW_2, SHW_3
DCP	
Definition	Scanner protective shutters are stuck opened/closed
HBD Integ	Read the followings

Upon arrival of train (real or test train), HBD performs a pre-train integrity test. The pre-train integrity test examines all the I/O ports controlled by external devices, and the scanners. Part of this test is to examine the scanner protective shutters.

First the hbd examines the protective shutters, they must be closed (TB14-11 and TB14-12 must be at 12 VDC). Then the HBD opens the protective shutters and re-examines their status. At this point they must be open (TB14-11 and TB14-12 must be grounded). Note: TB14-11 and TB14-12 are controlled by the switch mechanism of protective shutter.

The following warning/error messages are issued if the protective shutter fails.

SHW_0	channel one protective shutter is stuck open.
SHW_1	channel two protective shutter is stuck open.
SHW_2	channel one protective shutter is stuck closed.
SHW_3	channel two protective shutter is stuck closed.

If the protective shutters are stuck opened, HBD issues a warning. If the protective shutters are stuck closed, however, the HBD will announce an integrity failure.

Solution: Use "HBD chop" mode, or "HBD test trains" to verify visually that the protective shutters open/close properly.

Check protective shutter for foreign material that could be keeping the shutter in open/closed position.

The micro switch solenoid motor may be defective.

If the scanner micro_switch passes the test, run second level of "HBD board self test" to examine status of port 2 on digital board. Bit P2.2 (TB14-10) controls the protective shutters, while P2.3 and P2.4 return status of micro switch. If port 2 fails the test, replace the digital board.

HBD	TOO_MANY_ALRMS
DCP	
Definition	Passing train had too many alarms.
HBD Integ	Not effected.

Maximum number of alarms per train is set/adjusted by switch S3 on the speech board (from a minimum of 3 to a maximum of 10 alarms).

The HBD issues this warning message when total number of alarms for the passing train exceeds the maximum number of alarms set by switch S3. In this case the HBD announces the alarms (refer to software documentation), up to the count set by switch S3. It then announces "excessive alarms" (refer to software documentation for specific messages).

Front panel DIP switch S2.7 can be used to over ride issuing "too many alarms" warning for test trains. In this case the test train can have more alarms than set by S3. Note: The maximum number of alarms allowed for any train is 16.

HBD	W_0
DCP	
Definition	Both directions were set during train passage.
HBD Integ	Not effected.

Upon arrival of train, the advance transducers perform the following tasks:

- a - start up the system.
- b - determine train direction.

If the advance transducers are dead or faulty, the HBD uses the gating transducers to determine train direction.

"W_0" indicates that the HBD either received direction information from both advance transducers, or the information from the gating transducers were not correct.

Once HBD determines train direction, it will ground TB12-1 (P1.0 of digital board) for direction 1, meaning first transducer was traversed first, or ground TB12-2 (P1.1 of digital board) for

direction 2, meaning the second transducer was traversed first. First transducer is always to the south/east of the second transducer. In this case both outputs were grounded by the HBD (refer to "transducers input" for more information, on how the HBD processes the signals from transducers, and proper order of interrupts from the transducers).

Solution: Run second level of "HBD board self test", by pressing the data advance switch twice. Examine port 1 of digital board. Replace the digital board in case of port failure.

Check for defective (open/grounded) or dead advance transducers. Make sure they are fastened solidly, and the wiring polarity is correct.

If the wiring is correct, run "HBD test train", and observe if the error message appears. Signals from the advance transducers are converted to digital form by IC24(U7) and IC27(U8) of analog board. Port zero of analog board provides the HBD, with the digital signals, while port 4 of analog board controls the transducer interrupts. Port zero, port four, IC??(U7), and IC??(U8) are not examined during the analog board test. Test trains, however, can reveal if the components are in proper working condition. If the same error appears during a test train, replace the analog board.

HBD	W_1
DCP	
Definition	Random Access Memory (RAM) is almost full.
HBD Integ	Not effected.

HBD checks its own integrity in so many different ways. "W_1" is another (debugging) warning message, which is issued if the software predicts a failure.

Solution: Notify Harmon Electronics, if this warning appears.

HBD	W_3
DCP	
Definition	Maximum radio transmit time was exceeded.
HBD Integ	Not effected.

When the HBD takes control of the transmitter to announce its messages (real trains only), it initiates a 3 minute timer. A backup routine will truncate the message, and release the radio, if the 3 minute timer expires.

This warning message indicates that the speech transmitted may have taken too long (more than 3 minutes).

Notify Harmon Electronics, Inc. if this message appears frequently. The maximum allowable time can be increased to prevent the warning message.

HBD	W_4
DCP	
Definition	Gating transducer signals were not correct.
HBD Integ	Not effected.

The gating transducers generate a sine wave which is converted

to digital form via analog board circuit; IC??(U6). The converted digital signals provide the HBD with information regarding the movement of axles. The proper signals for each axle should be as follows:

- Positive pulse of first transducer.
- Negative pulse of first transducer.
- Positive pulse of second transducer.

"W_4" indicates that the transducer interrupts (polarity of pulses) were not received in order, and at some point the HBD, had to re-initialize its gating interrupt structure.

The axle count may not be correct when the "W_4" message appears.

Solution: Check gate transducer output amplitude and polarity. Simulate a wheel rolling into (+) and out of (-) transducer magnetic field and observe polarity of output on DC voltmeter.

If the wiring is correct, run "HBD test train", and observe if the error message appears. Signals from the gating transducers are converted to digital form by IC23(U6) and IC22B,IC25B(U3) and IC22A,IC25A(U4) of analog board. Port zero of analog board provides the HBD, with the digital signals, while port 3 of analog board controls the transducer interrupts. Port zero, port three, IC24(U7), IC22B,IC25B(U3), and IC22A,IC25A(U4) are not examined during the analog board test. Test trains, however, can reveal if the components are in proper working condition. If the same error appears during a test train, replace the analog board.

HBD	W_2, W_5, W_6
DCP	
Definition	Removed from new version of HBD.
HBD Integ	NA

HBD	W_7
DCP	
Definition	Train changed its direction.
HBD Integ	Not effected.

Upon arrival of train, the advance transducers perform the following tasks:

- a - start up the system.
- b - determine train direction.

If the advance transducers are dead or faulty, the HBD uses the gating transducers to determine train direction.

"W_7" indicates that the HBD received change of direction information from the advance transducers/gating transducers (direction information was reversed during train passage). In this case, the chart recorder shows change of direction by a negative (down ward) vertical bar on channel one and two.

Determine if train stopped and/or reversed direction while passing the detector (this error might also appear if train speed was less than 8 MPH).

Solution: Examine the advance transducers. Make sure they are fastened solidly, and the wiring polarity is correct.

If the wiring is correct, run "HBD test train", and observe if the error message appears. Signals from the advance transducers are converted to digital form by IC24(U7) and IC27(U8) of analog board. Port zero of analog board provides the HBD, with the digital signals. Port zero, port 3, port 4, IC24(U7), and IC27(U8) are not examined during the analog board test. Test trains, however, can reveal if the components are in proper working condition. If the same error appears during a test train, replace the analog board.

HBD	X_A_XXX, X_B_XXX, WHL_GATE_XXX
DCP	
Definition	Gate transducer counts are not equal.
HBD Integ	Read the following

Upon train departure, the HBD compares the signals received from gating transducers. This warning/error message indicates that the gating transducer counts are not equal.

The HBD issues a warning, if the difference between the transducer counts is 5, or 6. It issues an error message if the count is 7 or more. Note: If the difference is 4 or less, the HBD does not issue any warnings. In case of error message (a difference of 7 or more), the HBD announces integrity failure.

The "X_A_XXX" warning/error message will be followed by the first gating transducer count. The HBD then prints the second gating transducer count in the form of "X_B_XXX", where "xxx" is the second transducer count. Finally HBD will print the number of axles for this train in the form of "WHL_GATE_XXX", where "xxx" is number of axles.

Solution: Check the gating transducer wiring for opens/grounds and polarity.

If the wiring is correct, run "HBD test train", and observe if the error message appears. Signals from the gating transducers are converted to digital form by IC23(U6) and IC24(U7) of analog board. Port zero of analog board provides the HBD, with the digital signals, while port 3 is used by the HBD to control the transducer interrupts. Port zero, port 3, IC23(U6), and IC24(U7) are not examined during the analog board test. Test trains, however, can reveal if the components are in proper working condition. If the same error appears during a test train, replace the analog board.

HBD	X_A_REV?, X_B_REV?
DCP	
Definition	5 millisecond interrupt warning.
HBD Integ	

The gating transducers generate a sine wave which is converted to digital form via analog board circuit; IC23(U6). The converted digital signals provide the HBD with information regarding the movement of axles. The proper signals for each axle should be as follows:

- Positive pulse of first transducer.
- Negative pulse of first transducer.
- Positive pulse of second transducer.

The "X_A_REV?" and "X_B_REV?", however, indicate that the transducer interrupts/signals were not received in order. At some point of train passage, the polarity of signals were reversed.

The HBD issues this warning if, the number of reversed signals for each gating transducer is more than 8 (noise can create the reverse polarity).

These warning messages indicate that the gating transducer wiring is not correct (polarity is reversed).

Solution: Run "HBD test train", and observe if the error message appears. Signals from the gating transducers are converted to digital form by IC23(U6) and IC24(U7) of analog board. Port zero of analog board provides the HBD, with the digital signals, while port 3 is used by the HBD to control the transducer interrupts. Port zero, port 3, IC23(U6), and IC24(U7) are not examined during the analog board test. Test trains, however, can reveal if the components are in proper working condition. If the same error appears during a test train, replace the analog board.

To verify polarity (if necessary) make sure that the transducer is disconnected from the HBD. Connect a DC voltmeter with the positive lead to the white wire and the negative lead to the black wire. Insert a metal object the field of the wheel pickup (top). A positive meter movement should be seen. If a positive deflection is seen then the white wire is positive. If a negative movement is seen then the black wire is positive.

Using an oscilloscope with the wheel transducer not connected to the HBD, swing a ferrous object accross the magnet. The output will appear as a sine wave when monitoring the oscilloscope with the positive side connected to the white lead and the oscilloscope common connected to the the black lead. The amplitude is a function of the speed of the object and the distance of the object from the transducer. Amplitude may vary.

HBD	XBD_0, XBD_1, XBD_2, XBD_3, XBD_4, XBD_5, XBD_6,...
DCP	
Definition	HBD board failure.
HBD Integ	HBD announces integrity failure.

The HBD performs an integrity test once every two minutes. This test consists of examining the integrity of critical components of all the system boards and the I/O ports that interface to the trackside equipment. The result of the pre-train integrity test and the two minute integrity test are then combined (ORed) to determine the integrity of HBD system.

"XBD_x", where x indicates the board number which failed the test, indicates that the specified board failed the two minute integrity test (when there was no train around). "BD_x" error message, on the other hand, indicate that the specified board failed the pre-train integrity test.

XBD_0	CPU Board.
XBD_1	ROM Board.
XBD_2	Speech Board.
XBD_3	Digital Board.
XBD_4	Analog Board.
XBD_5	Second Digital Board (Not Used).
XBD_6	Second ROM Board (Not Used).
XBD_7	Second Analog Board (Hot Wheel Detectors only).

The "BD_x" error messages are followed by the name of component which failed the pre-train integrity test. In case of "XBD_x" error messages, the second level of "HBD board self test" must be executed, to determine which component failed the two minute integrity test. Please refer to similar "BD_x" section for more information on how to test the specified board.

HBD	5MS_xx
DCP	
Definition	5 millisecond interrupt warning.
HBD Integ	Not effected.

The 8031 microcontroller provides two 16 bit counters/timers. These timers are used by the HBD, to manage the operation of its tasks. The HBD core operates on a 2.5 mili-second timer. There are also some tasks which are executed once every 5 milliseconds. When the 5 millisecond timer expires, HBD examines the status of its tasks, making sure all were performed.

The "5MS_xx" error message indicates, that the HBD tasks combined together require more than 5 milliseconds to execute. The "xx" is a two digit number which indicates the lag time.

The "5MS_xx" is simply a debugging tool. The presence of this warning does not mean that some of the HBD tasks were not perform. If the "5MS_xx" warning message appears too often, notify Harmon Electronics, Inc.

Miscellaneous Messages:

PWR_ON

HBD has lost electrical power since the last train passage. Determine if electrical power was interrupted for any reason.

MON_RT

Micro-computer Monitor has reset the Micro-computer, since the last train passage.

TRN_SLW

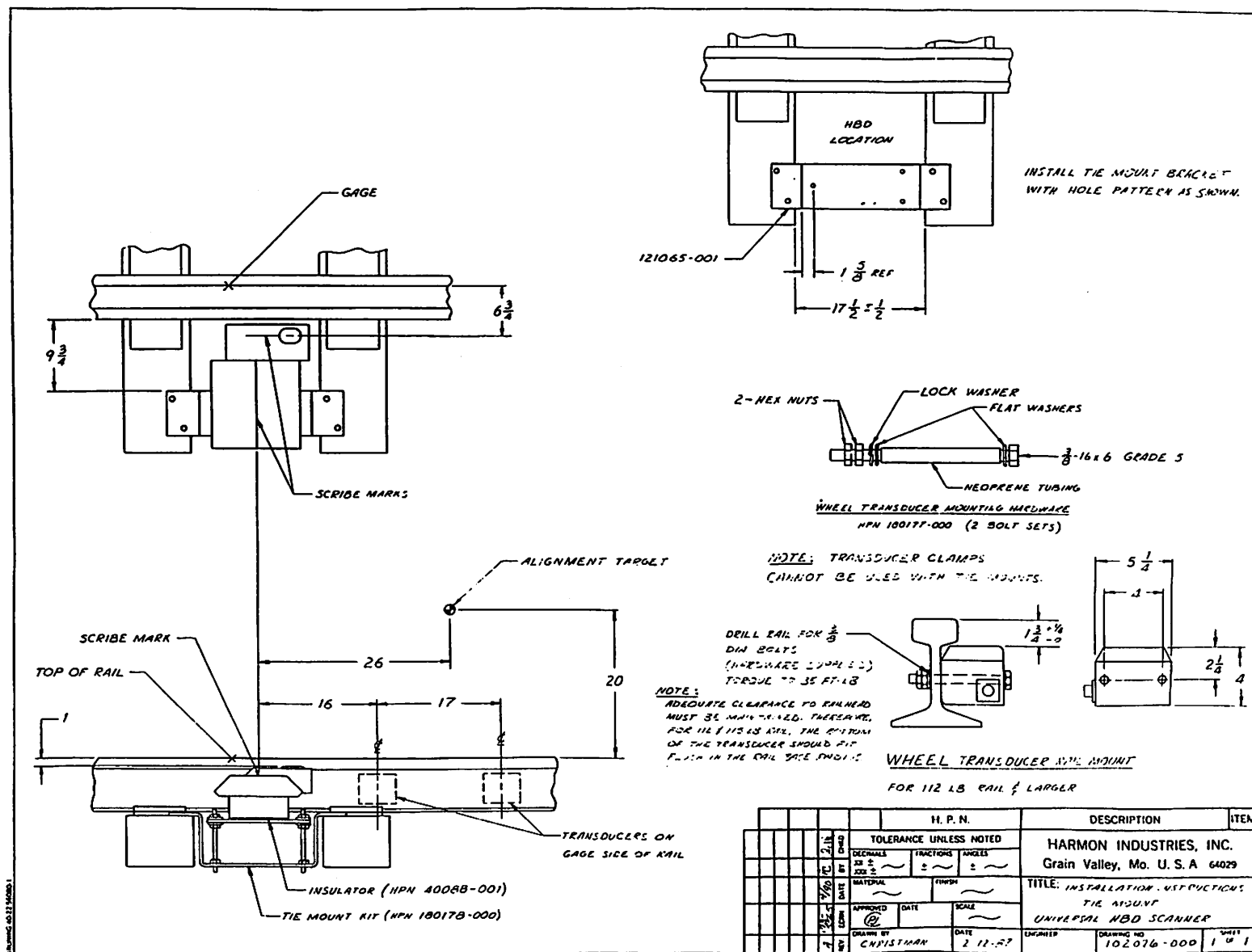
If the train speed goes below 5 miles per hour the system integrity may be affected. Refer to railroad specific documentation for details concerning this message.

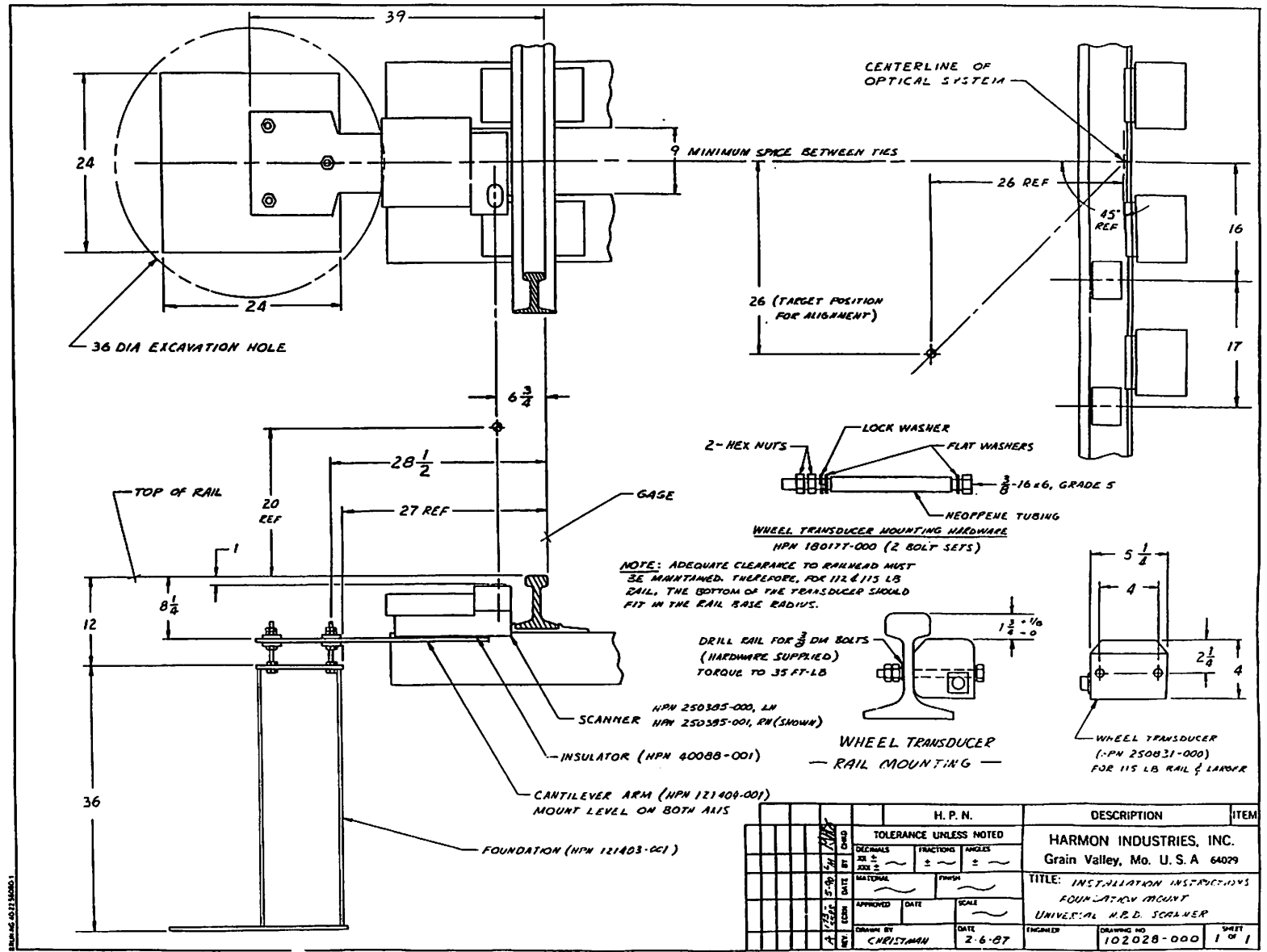
NO_INTEG

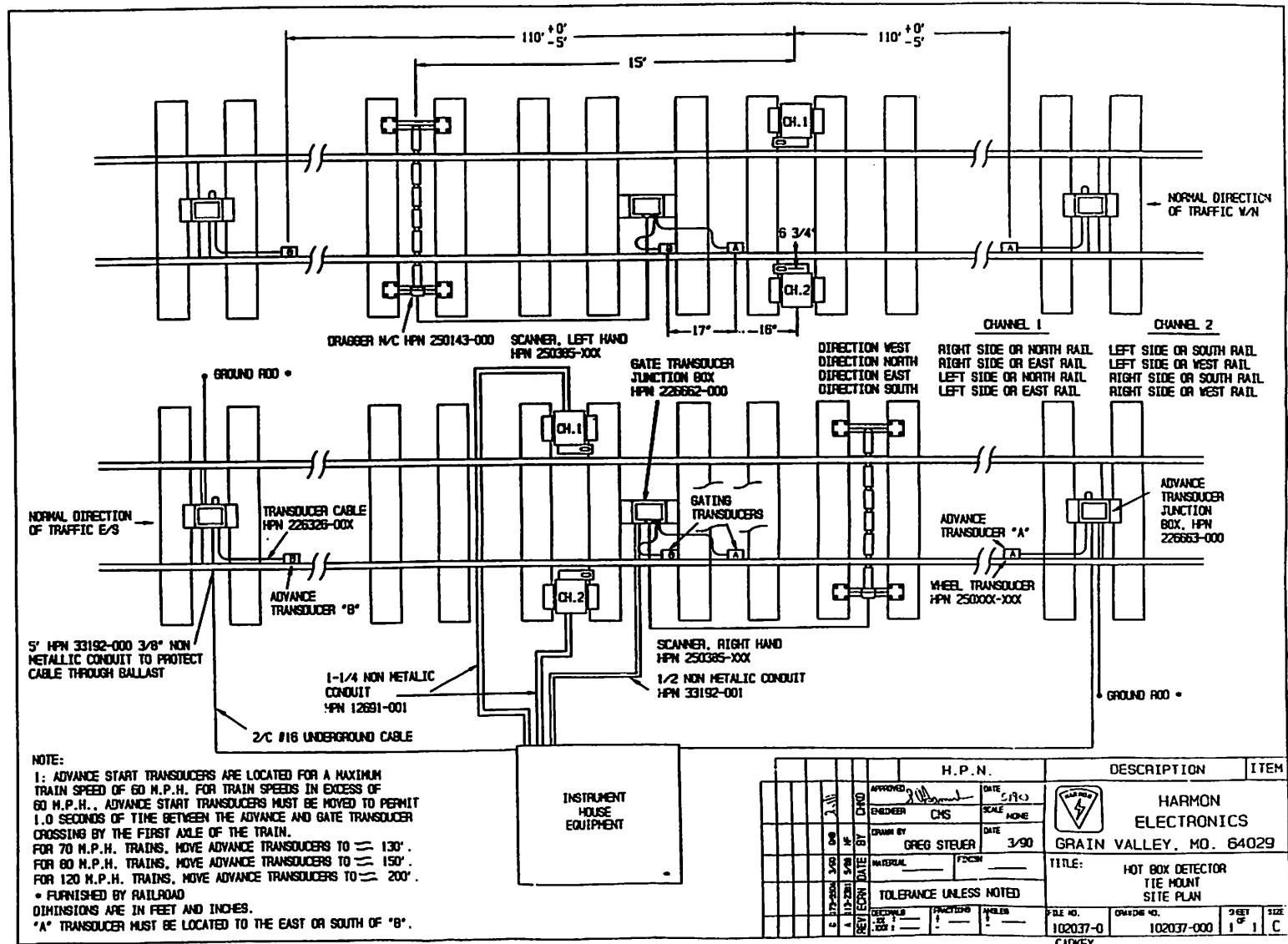
One of the integrity tests failed (board test, scanner test, aux inputs). HBD performs an integrity test upon arrival of a train. This test includes HBD boards, scanners, and stuck auxiliary inputs. "NO_INTEG" indicates that the integrity test has failed. The "NO_INTEG" will also appear if the passing train had too many alarms (refer to speech board switch 3, for maximum number of alarms).

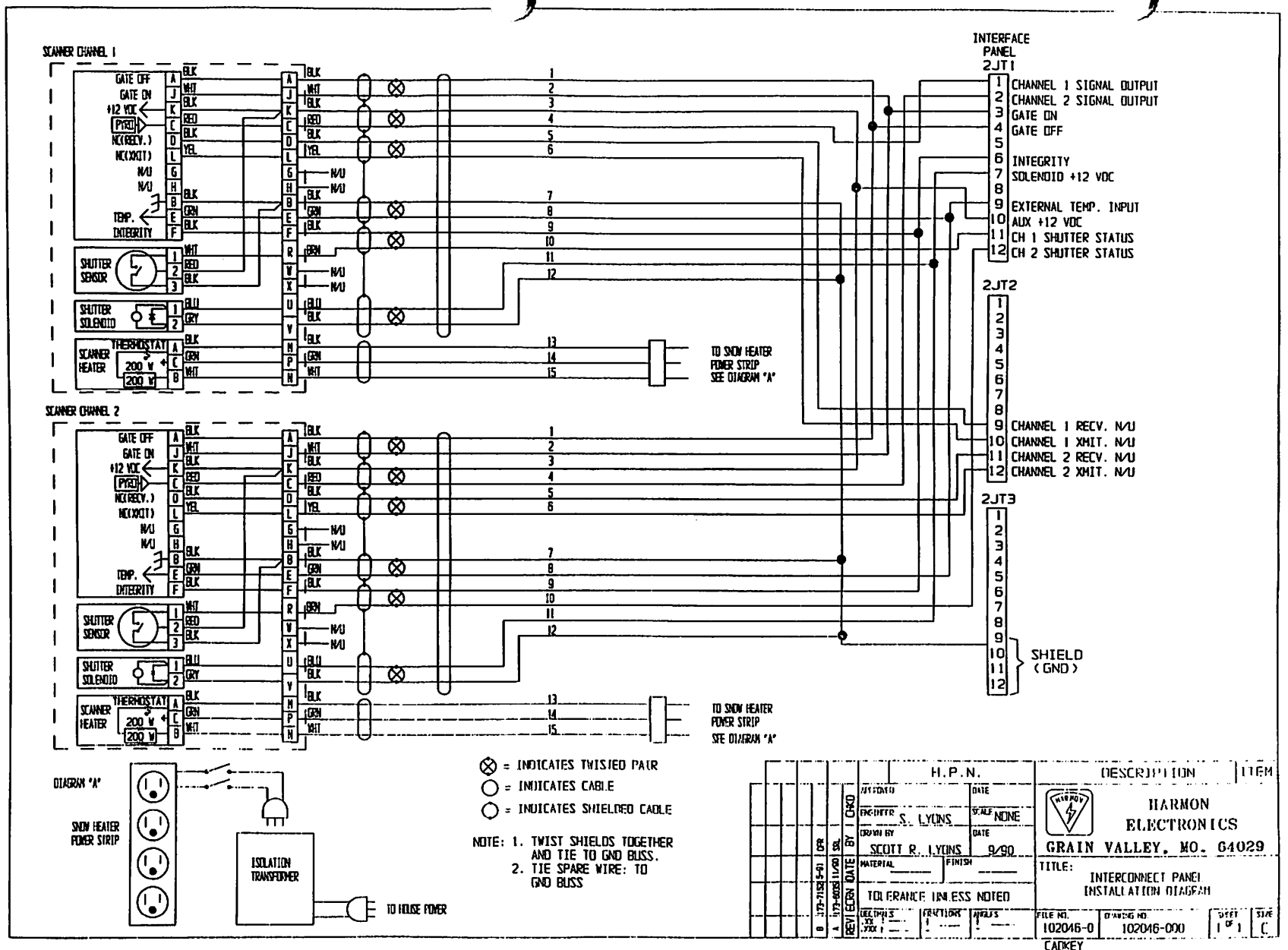
REPLACE THIS PAGE WITH HOT BOX DETECTOR SOFTWARE DOCUMENTATION

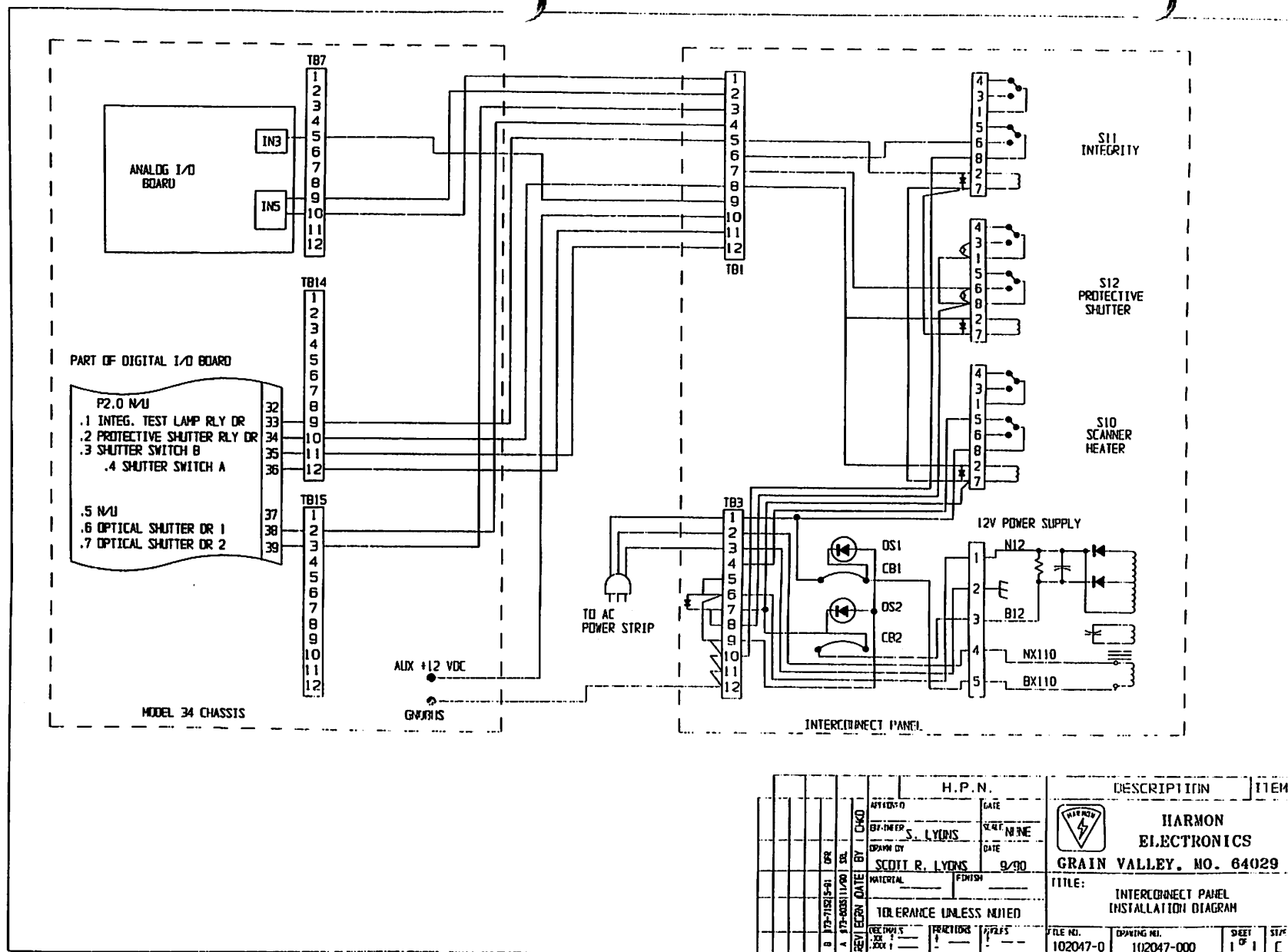
REPLACE THIS PAGE WITH DATA COMMUNICATIONS PROCESSOR SOFTWARE
DOCUMENTATION



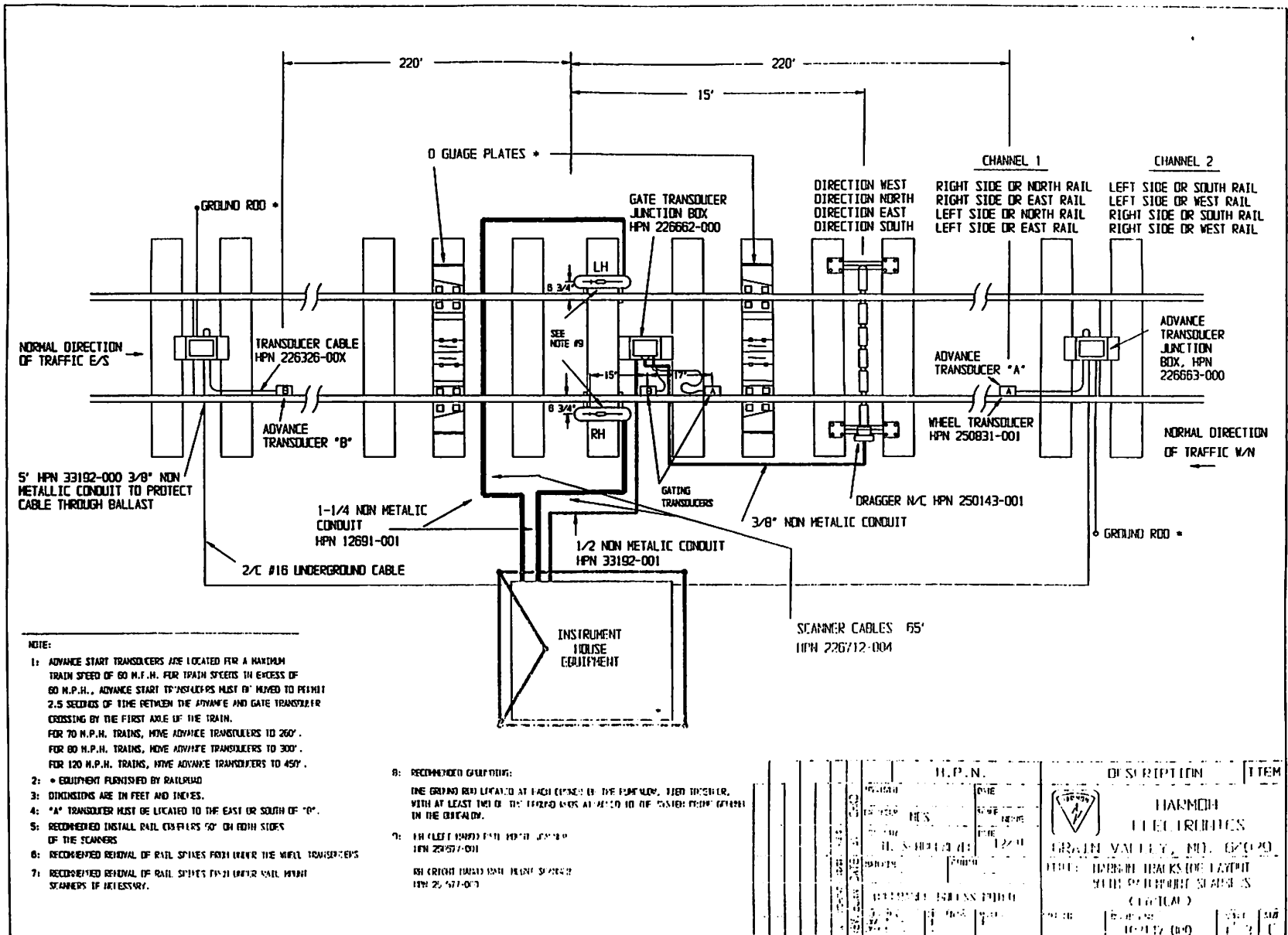








H.P.N.				DESCRIPTION		ITEM
REV	BY	DATE	DATE	 HARMON ELECTRONICS GRAIN VALLEY, NO. 64029		TITLE: INTERCONNECT PANEL INSTALLATION DIAGRAM
1	SCOTT R. LYONS	9/90				
2	SCOTT R. LYONS	9/90		FILE NO. 102047-0		PRINTING NO. 102047-000
3	SCOTT R. LYONS	9/90		TOLERANCE UNLESS NOTED		SEET 1 OF 1
4	SCOTT R. LYONS	9/90		CARTKEY		STA C



(NOTE): FOR EVERY 1/2" BELOW THE RAIL THAT THE TOP OF THE SCANNER IS LOCATED, MOVE THE SCANNER BACK 1/2" SO THAT THE ANGLE FROM THE ALIGNMENT FIXTURE TO THE SCANNER REMAIN AT A 45 DEGREE ANGLE.

HOT BOX DETECTOR
TRACK ALIGNMENT FIXTURE
HPN 250443-000

FROM SCRIBE MARK ON SCANNER TO
CENTER OF FIRST TRANSDUCER

45 DEGREES REFERENCE

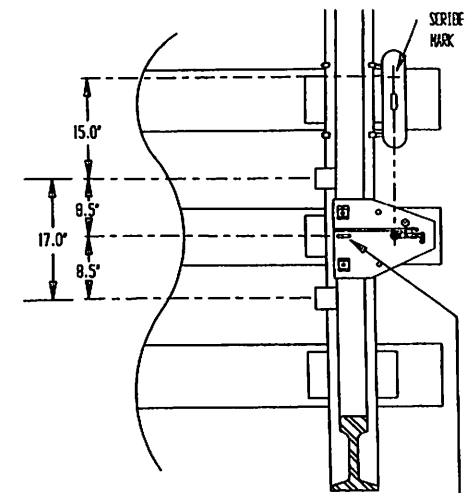
NOTE: TOP OF SCANNER SHOULD BE
EVEN WITH THE TOP OF
THE RAIL

NOTE: A SCRIBE MARK MUST BE MADE ON THE RAIL 23.5"
FROM THE SCRIBE MARK ON THE SCANNER.
WHEN THE ALIGNMENT FIXTURE IS PLACED ON THE RAIL
THE SCRIBE MARK SHOULD BE SEEN INSIDE THE SLOT.

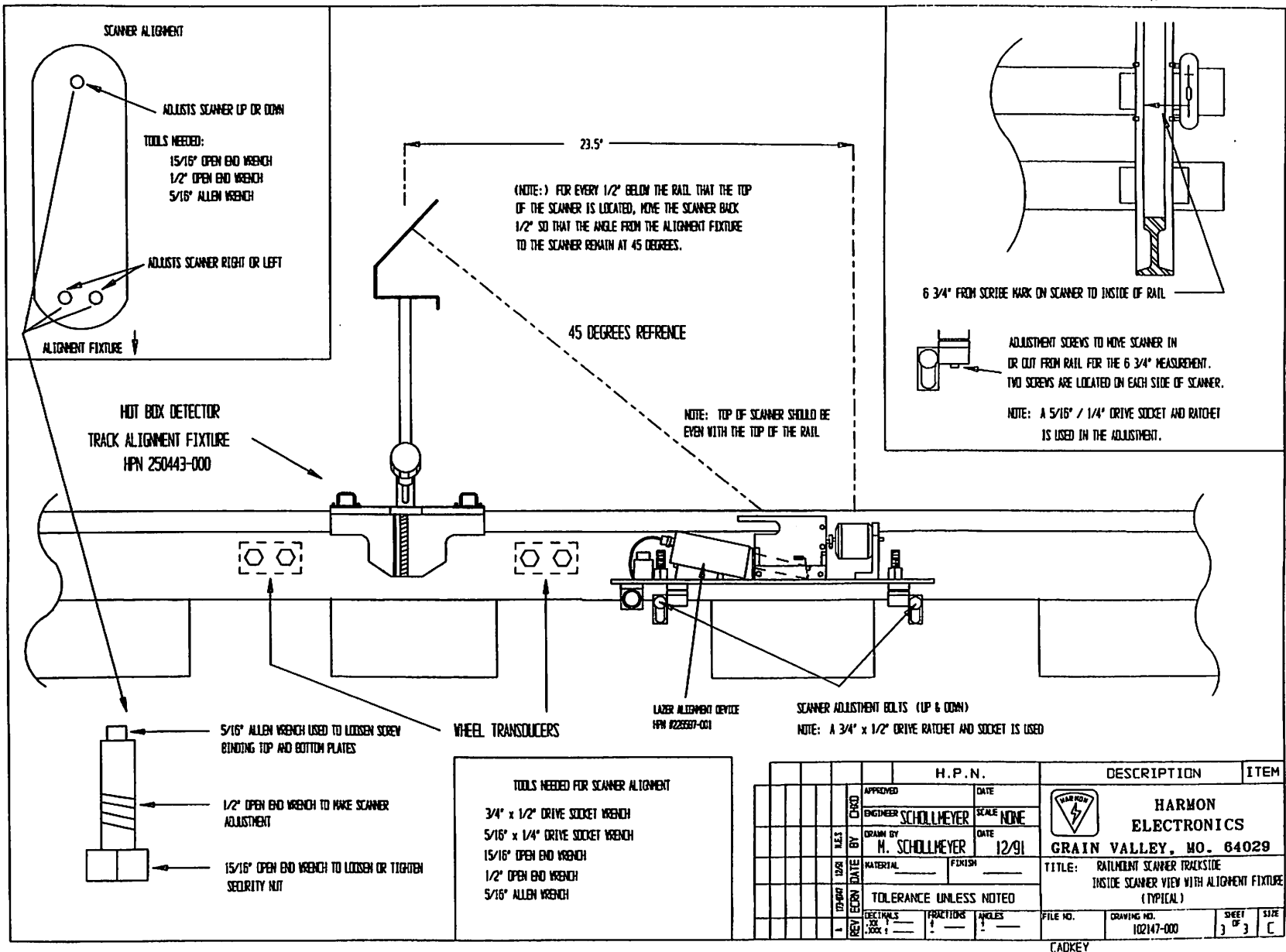
WHEEL TRANSDUCERS

DRILL RAIL FOR 3/8" DIA.
BOLTS. (HARDWARE SUPPLIED WITH
WHEEL PICK-UP)

1 5/8" ± 1/4" - 0"



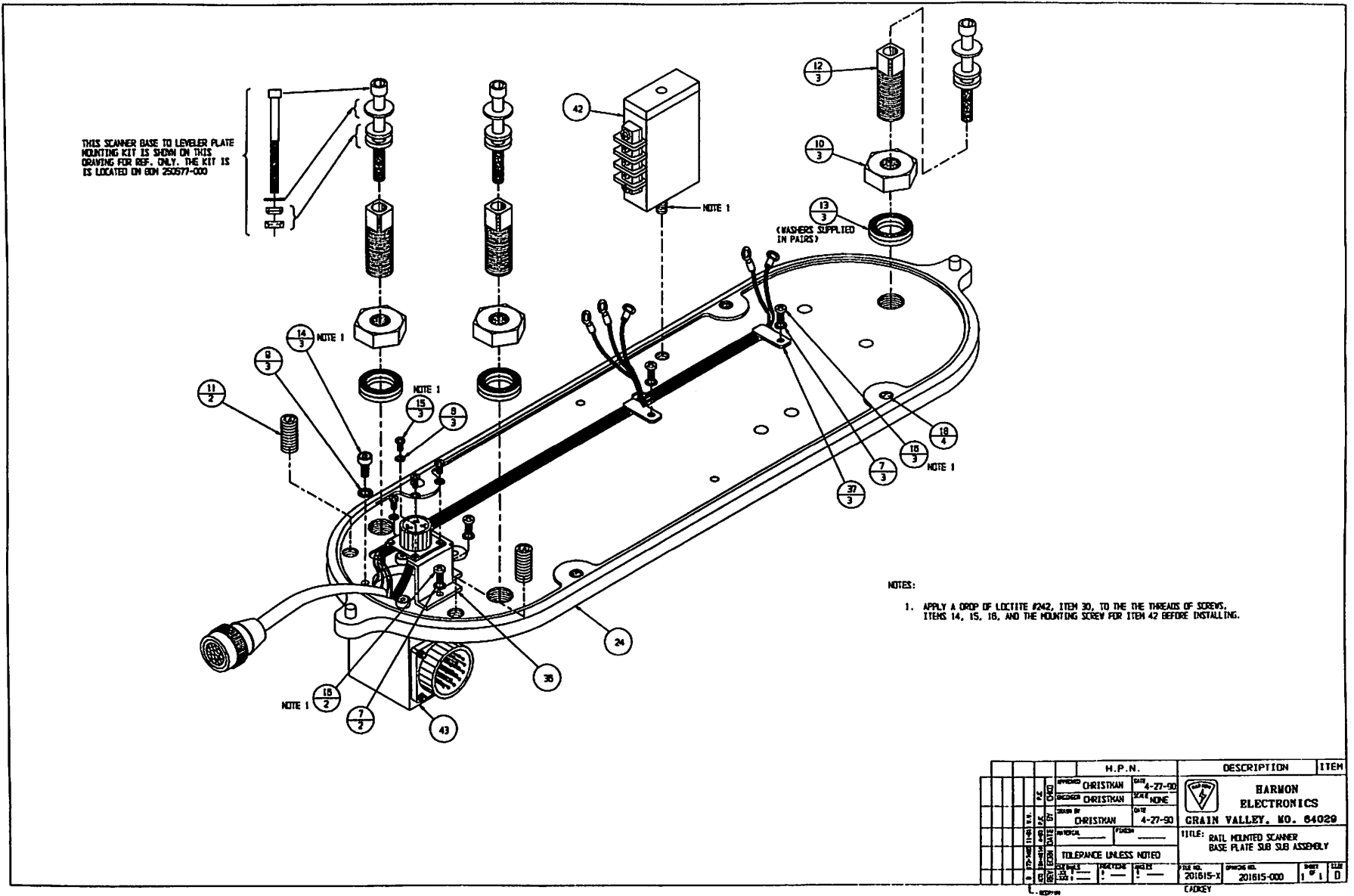
H. P. N.										DESCRIPTION		ITEM



PARENT: 201615-000

DESC: ASSY BASE PLATE SUB

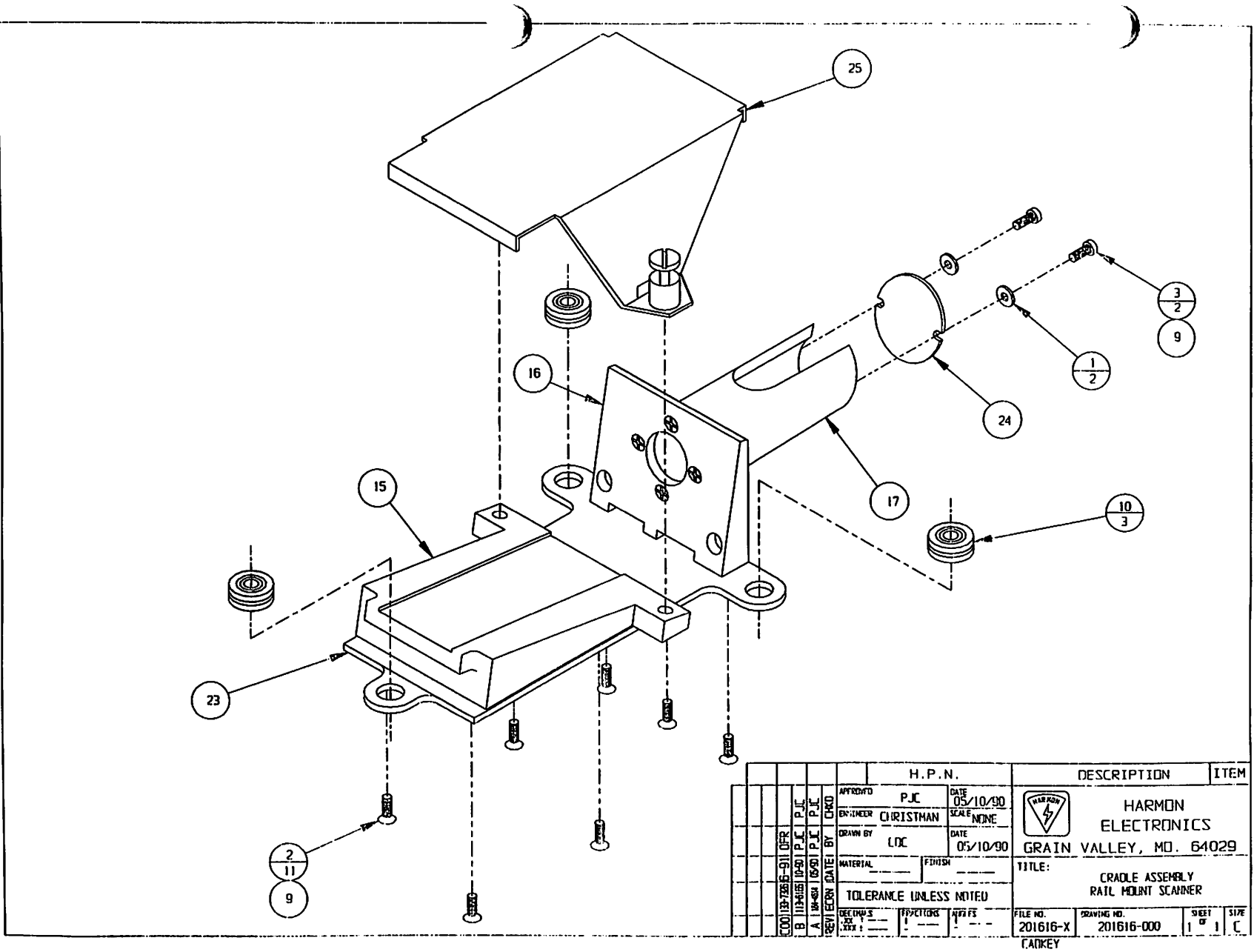
DIN	USAGE	COMP_PART	COMP_DESC
007	5.0000	013002-011	WASHER 6 INTL SS
008	3.0000	013002-012	WASHER 4 INTL SS
009	3.0000	013002-014	WASHER 8 INTL SS
010	3.0000	013039-005	NUT 5/8-18 X 17/32 HEX SS
012	3.0000	013350-000	SCREW 5/8-18 LEVEL
013	3.0000	013351-017	WASHERS 5/8 LOCK PERM TIGHT SS
014	3.0000	013427-3724	SCREW 8-32 X 3/4 SHC SS
001	2.0000	013437-1340	SCREW 3/8-16 X 1-1/4 SET ZPS
015	3.0000	013492-3408	SCREW 4-40 X 1/4 PPH SS
016	5.0000	013492-3614	SCREW 6-32 X 7/16 PPH SS
018	4.0000	013880-009	SCREW 5/16-18 X .312 HELICOIL
024	1.0000	022539-004	BASE PLATE W/HELICOIL/PINS
030	0.0000	029003-000	ADHESIVE LOCTITE #242
036	1.0000	122550-003	BRKT HEATER CONN PAINTED
037	3.0000	122584-001	CLAMP RAIL MNT SCANNER CABLE
042	1.0000	201623-000	ASSY SHUTTER STOP
043	1.0000	201645-000	ASSY CONNECTOR



PARENT: 201616-000

DESC: ASSY CRADLE SUB

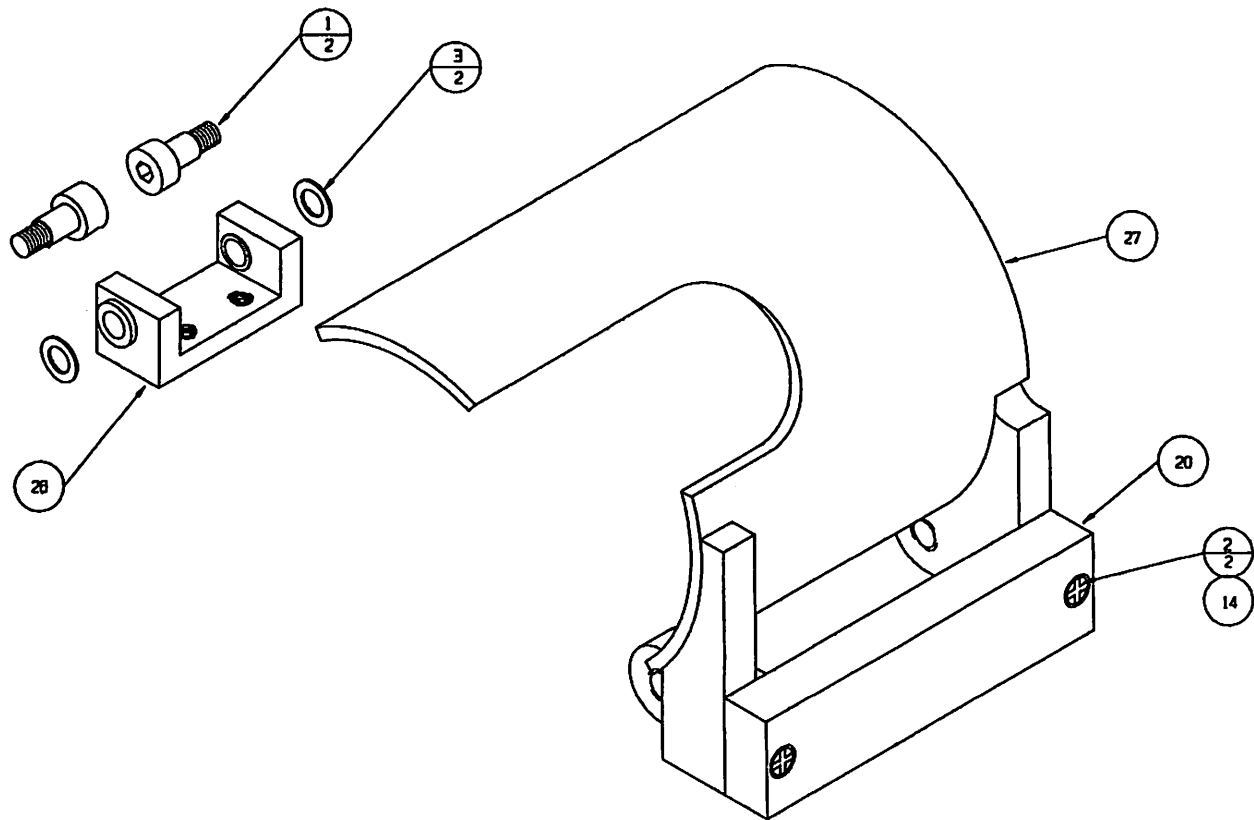
DIN	USAGE	COMP_PART	COMP_DESC
001	2.0000	013002-011	WASHER 6 INTL SS
002	11.0000	013491-3612	SCREW 6-32 X 3/8 PFH SS
003	2.0000	013492-3612	SCREW 6-32 X 3/8 PPH SS
009	0.0000	029003-000	ADHESIVE LOCTITE #242
010	3.0000	031187-000	GROMMET SHEAR
015	1.0000	065158-005	WEDGE RAIL MNT SCAN W/PNT W/HE
016	1.0000	065159-003	STANCHION RAIL MNT SCAN W/FIN
017	1.0000	065231-001	MOUNT MIRROR ANODIZED
023	1.0000	122506-001	CRADLE IRIS ANODIZED
024	1.0000	122507-001	MIRROR PAINTED
025	1.0000	122508-009	BRKT HOLD DOWN IRIS W/PADS



PARENT: D201617-000

DESC: ASSY SHUTTER SUB

DIN	USAGE	COMP_PART	COMP_DESC
001	2.0000	013327-135	SCREW 1/4-20 X 3/8D X 1/2 SHDR
002	2.0000	013491-3624	SCREW 6-32 X 3/4 PFH SS
003	1.0000	013924-010	WASHER WAVE SPRING .44ID
014	0.0000	029003-000	ADHESIVE LOCTITE #242
020	1.0000	065242-001	COUNTERWEIGHT PAINTED
026	1.0000	201651-000	ASSY HINGE
027	1.0000	201653-000	ASSY SHUTTER



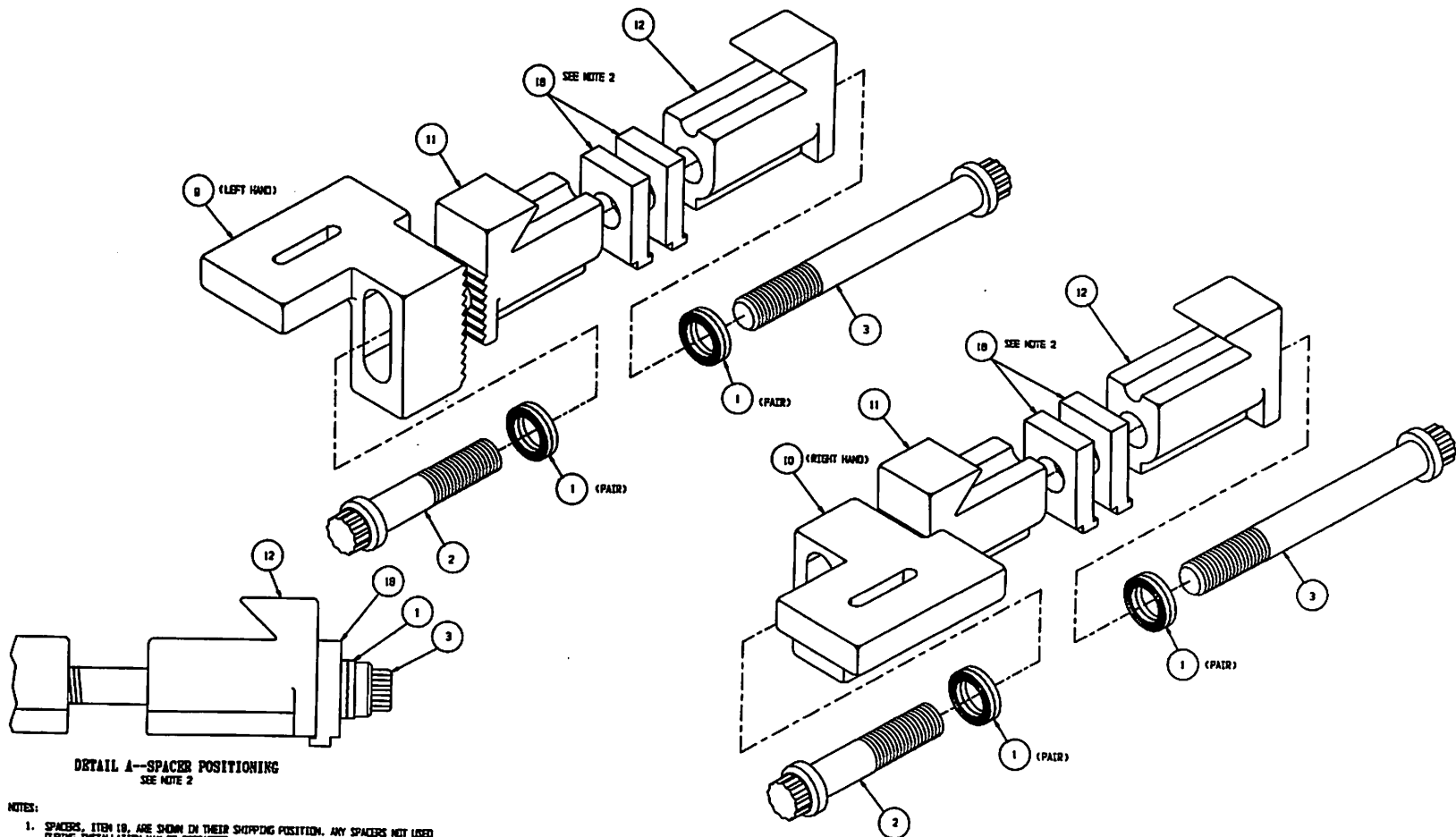
H.P.N.										DESCRIPTION		ITEM	
		APPROVED		DATE				HARMON ELECTRONICS					
		ENGINEER CHRISTMAN		SCALE NONE									
		DRAWN BY CDC		DATE 04/11/90		TITLE: SHUTTER ASSEMBLY RAIL MOUNT SCANNER		FILE NO. 201617-X CADDY		DRAWING NO. 201617-000	SHEET OF 1	SIZE C	
		MATERIAL		FINISH									
		TOLERANCE UNLESS NOTED											
B		220-003	A	18-000	4/00	PLT	MTK	REV	ECN	DATE	BY	CHKD	

PARENT: 201618-000

DESC: ASSY SOLENOID

DIN	USAGE	COMP_PART	COMP_DESC
001	1.0000	007124-001	SOLENOID ROTARY MACNHINED
007	2.0000	013002-011	WASHER 6 INTL SS
008	2.0000	013002-015	WASHER 1/4 INTL SS
009	1.0000	013367-000	SCREW 1/4-20 X 3/4 SQH CUP SS
010	2.0000	013492-3620	SCREW 6-32 X 5/8 PPH SS
016	0.0000	029003-000	ADHESIVE LOCTITE #242
023	2.0000	032368-1018	TERM RNG #6 22-16 AWG RED
024	1.0000	032891-901	TERM STRIP 2 POS
030	1.0000	065152-001	BRKT SOLENOID ANODIZED
031	1.0000	065153-002	DRIVE ARM W/INSERT
037	1.0000	122502-001	SOLENOID SPRING COVER PAINTED
043	1.0000	225930-016	ASSY TERMINAL STRIP COMPONENTS

1. TRIM SOLENOID LEADS TO 4".



DETAIL A--SPACER POSITIONING
SEE NOTE 2

NOTES:

1. SPACERS, ITEM 18, ARE SHOWN IN THEIR SHIPPING POSITION. ANY SPACERS NOT USED DURING INSTALLATION MAY BE DISCARDED.
2. WHEN INSTALLING CLAMPS ON RAIL, IF SCREW, ITEM 3, BOTTOMS OUT BEFORE TIGHTENING, ADD A SPACER, ITEM 18, BENEATH RAMP WASHERS, ITEM 1. IF IT STILL BOTTOMS OUT BEFORE TIGHTENING, ADD SECOND SPACER. SEE DETAIL "A".

H.P.N.										DESCRIPTION		ITEM
					OFFICER	CHRISTIAN	7-29-69		HARNON ELECTRONICS			
					SUBJECT	CHRISTIAN	SOLO					
					DATE OF INFO	WMOAC	11-11-91					
					RECEIVED FROM							
					TOLERANCE UNLESS NOTED					GRAIN VALLEY, MO. 64020		
										RAIL MOUNTED SCANNER, TRACK CLAMP SLB S/B ASSY.		
										FILE NO. 20180-X CADDY		
										SHOOT # 20180-000		
										PAGE # 1		

PARENT: 201623-000

DESC: ASSY SHUTTER STOP

DIN	USAGE	COMP_PART	COMP_DESC
003	1.0000	005683-000	CABLE TIE HOLDER
001	1.0000	006159-000	FOAM 1/4 X 5/8 X 1-3/4 W/PSA
000	2.0000	013002-011	WASHER 6 INTL SS
007	1.0000	013030-002	WASHER 5/16 SPL SS
009	1.0000	013355-000	SCREW 5/16-18 X 2-1/4 CAPTIVE
008	2.0000	013492-3620	SCREW 6-32 X 5/8 PPH SS
014	0.0000	029003-000	ADHESIVE LOCTITE #242
021	1.0000	032891-902	TERM STRIP 3 POS
021	1.0000	065157-001	SHUTTER STOP ANODIZED
009	1.0000	013491-3612	SCREW 6-32 X 3/8 PFH SS

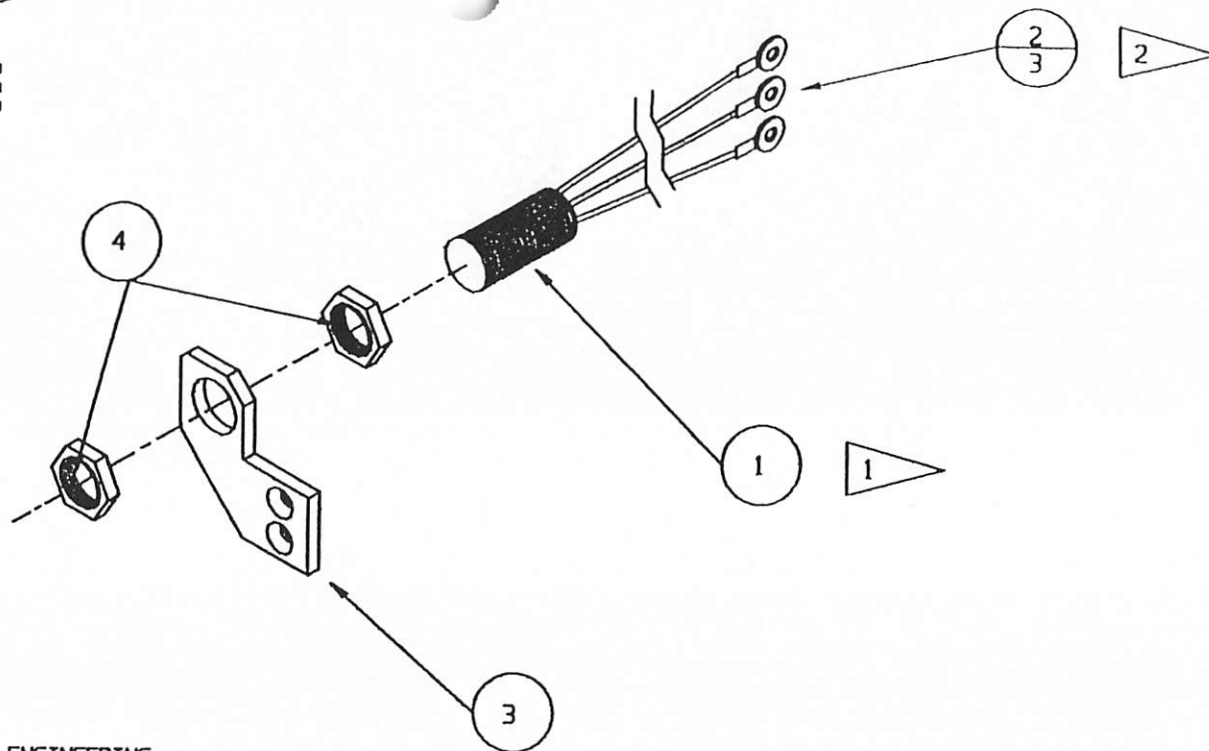
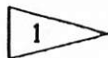
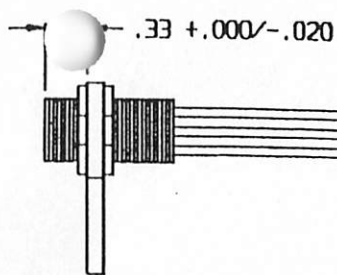


- | | | | | | | | | | | | | | | | | | | | |
|-----|--|-----|--|------------------------|--|---|--|--|--|----------------------|--|----------------------|--|---------------------------|--|---------------|--|-----------|--|
| | | | | H. P. N. | | | | DESCRIPTION | | | | ITEM | | | | | | | |
| | | | | APPROVED | | DATE | |  <p>HARMON
ELECTRONICS
GRAIN VALLEY, MD. 64029</p> | | | | | | | | | | | |
| | | | | ENGINEER CHRISTMAN | | SCALE NONE | | | | | | | | | | | | | |
| | | | | DRAWN BY CDC | | DATE 06/06/90 | | | | | | | | | | | | | |
| | | | | MATERIAL _____ | | FINISH _____ | | <p>TITLE:</p> <p>SHUTTER STOP ASSEMBLY
RAIL MOUNT SCANNER</p> | | | | | | | | | | | |
| | | | | TOLERANCE UNLESS NOTED | | | | | | | | | | | | | | | |
| AOC | | REV | | DATE | | DECIMALS
1/XX : _____
1/XXX : _____ | | FRACTIONS
1/ : _____ | | ANGLES
1/ : _____ | | FILE NO.
201623-X | | DRAWING NO.
201623-000 | | SHEET
OF 1 | | SIZE
B | |
| | | | | P.J.C. BY CHO | | | | CADKEY | | | | | | | | | | | |

PARENT: 201644-000

DESC: ASSY SENSOR

DIN	USAGE	COMP_PART	COMP_DESC
001	1.0000	009275-000	SWITCH PROXIMITY
004	0.0001	029003-000	ADHESIVE LOCTITE #242
002	3.0000	032368-1018	TERM RNG #6 22-16 AWG RED
003	1.0000	122505-001	SENSOR BRACKET PAINTED



NOTE:

1. USE FIXTURE PROVIDED BY ENGINEERING TO SET SENSOR POSITION SO THAT END OF SENSOR (ITEM 1) EXTENDS .33 +.000/-.020 BEYOND BRACKET (ITEM 3).
2. TRIM SENSOR LEADS TO 5" BEFORE TERMINATING.
3. USE LOCTITE (29003-000) ON SENSOR NUTS.

				H.P.N.		DESCRIPTION	ITEM
			PJC	APPROVED	CHRISTMAN	DATE	5-10-90
			CHKD	ENGINEER	CHRISTMAN	SCALE	NONE
		PEB	CDC	DRAWN BY	CDC	DATE	05/10/90
		2-51	5-50	MATERIAL		FINISH	
		151-700	104-404	TOLERANCE UNLESS NOTED			
		800	A	REV	EORN	DATE	
				DECIMALS	FRACTIONS	ANGLES	
				.XX	+	+	
				.XXX	+	+	
				FILE NO.		DRAWING NO.	SHEET
				201644-X		201644-000	1 OF 1
				CADKEY			SIZE
							B



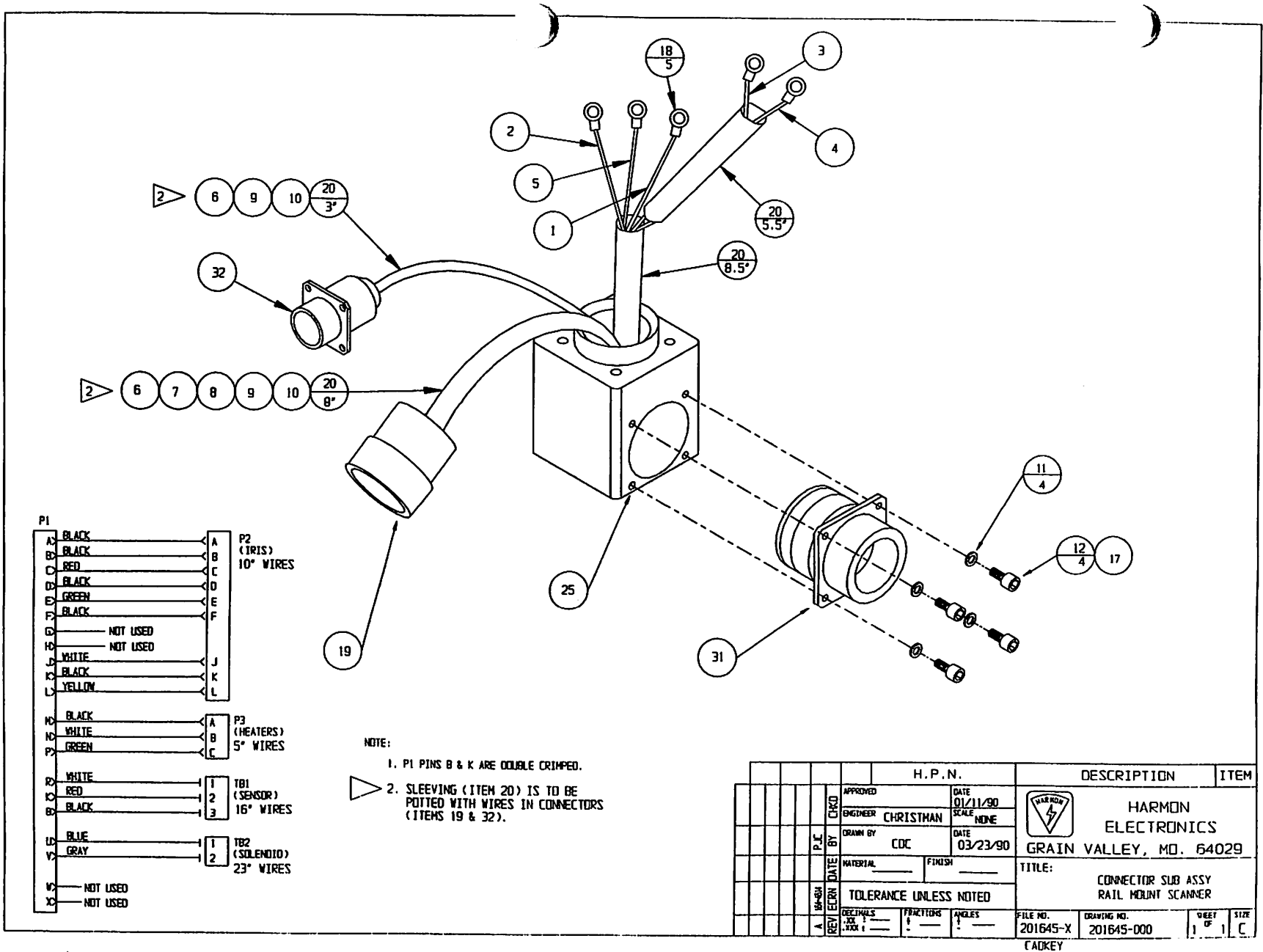
**HARMON
ELECTRONICS**
GRAIN VALLEY, MO. 64029

TITLE:
SENSOR ASSEMBLY
RAIL MOUNT SCANNER

PARENT: 201645-000

DESC: ASSY CONNECTOR

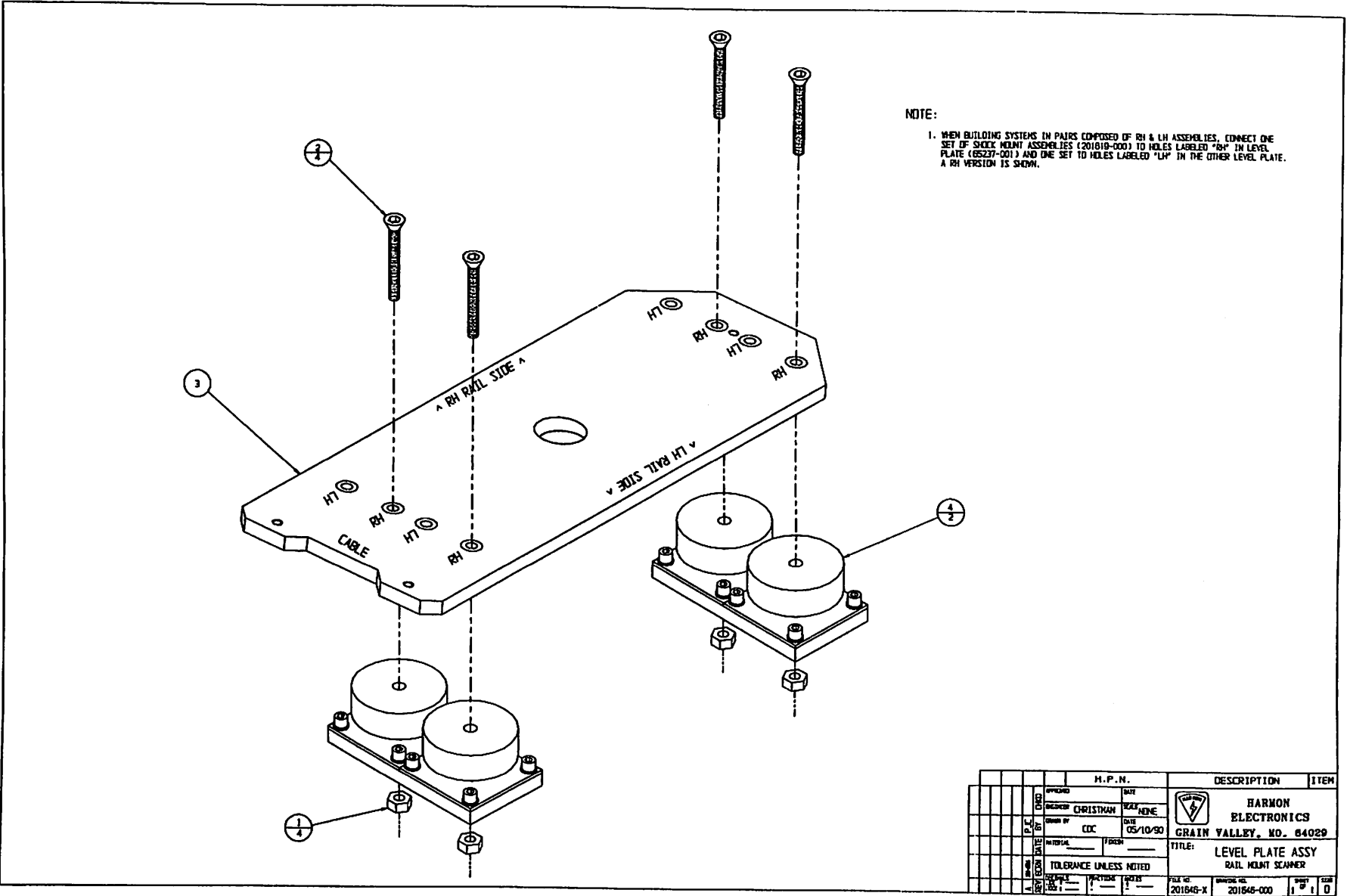
DIN	USAGE	COMP_PART	COMP_DESC
001	1.4167	012100-5000	WIRE 20AWG INS BLK
006	4.5833	012100-6000	WIRE 18AWG INS BLK
002	1.4167	012122-5000	WIRE 20AWG INS RED
007	0.8333	012122-6000	WIRE 18AWG INS RED
008	0.8333	012144-6000	WIRE 18AWG INS YEL
009	1.2500	012155-6000	WIRE 18AWG INS GRN
003	1.9167	012166-5000	WIRE 20AWG INS BLU
004	1.9167	012188-5000	WIRE 20AWG INS GRY
005	1.4167	012199-5000	WIRE 20AWG WHT
005	1.2500	012199-6000	WIRE 18AWG INS WHT
011	4.0000	013002-012	WASHER 4 INTL SS
012	4.0000	013427-3412	SCREW 4-40 X 3/8 SHC SS
017	0.0000	029003-000	ADHESIVE LOCTITE #242
018	5.0000	032368-1018	TERM RNG #6 22-16 AWG RED
019	1.0000	032995-002	PLUG GE SCANNER
020	2.0833	033223-022	SLEEVING 3/8 ID BRAIDED FIBERG
025	1.0000	065247-000	CONN BLOCK
031	1.0000	132109-000	CONN BLOCK RCPT
032	1.0000	132110-000	HEADER RCPT



PARENT: 201646-000

DESC: ASSY LEVEL PLATE

DIN	USAGE	COMP_PART	COMP_DESC
001	4.0000	013356-000	NUT 1/4-20 PREVAILING LOCK CPS
002	4.0000	013848-024	SCREW 1/4-20 X 1-1/2 SHF SS
003	1.0000	065237-001	PLATE LEVEL W/HELICOILS
004	2.0000	201619-000	ASSY SHOCK MOUNT



H.P.N.										DESCRIPTION		ITEM
APPROVED		DATE		 HARMON ELECTRONICS GRAIN VALLEY, MO. 64029						TITLE:	LEVEL PLATE ASSY RAIL MOUNT SCANNER	
DESIGNED BY CHRISTIAN		SCALE NONE										
DRAWN BY CDC		DATE 05/10/90										
MATERIAL		FINISH										
TOLERANCE UNLESS NOTED												
QUANTITY		FRACTIONS		NOTES		PLA NO. 201848-X		DRAWING NO. 201848-000		SHEET 1	OF 1	
CADKEY												

PARENT: 201959-000

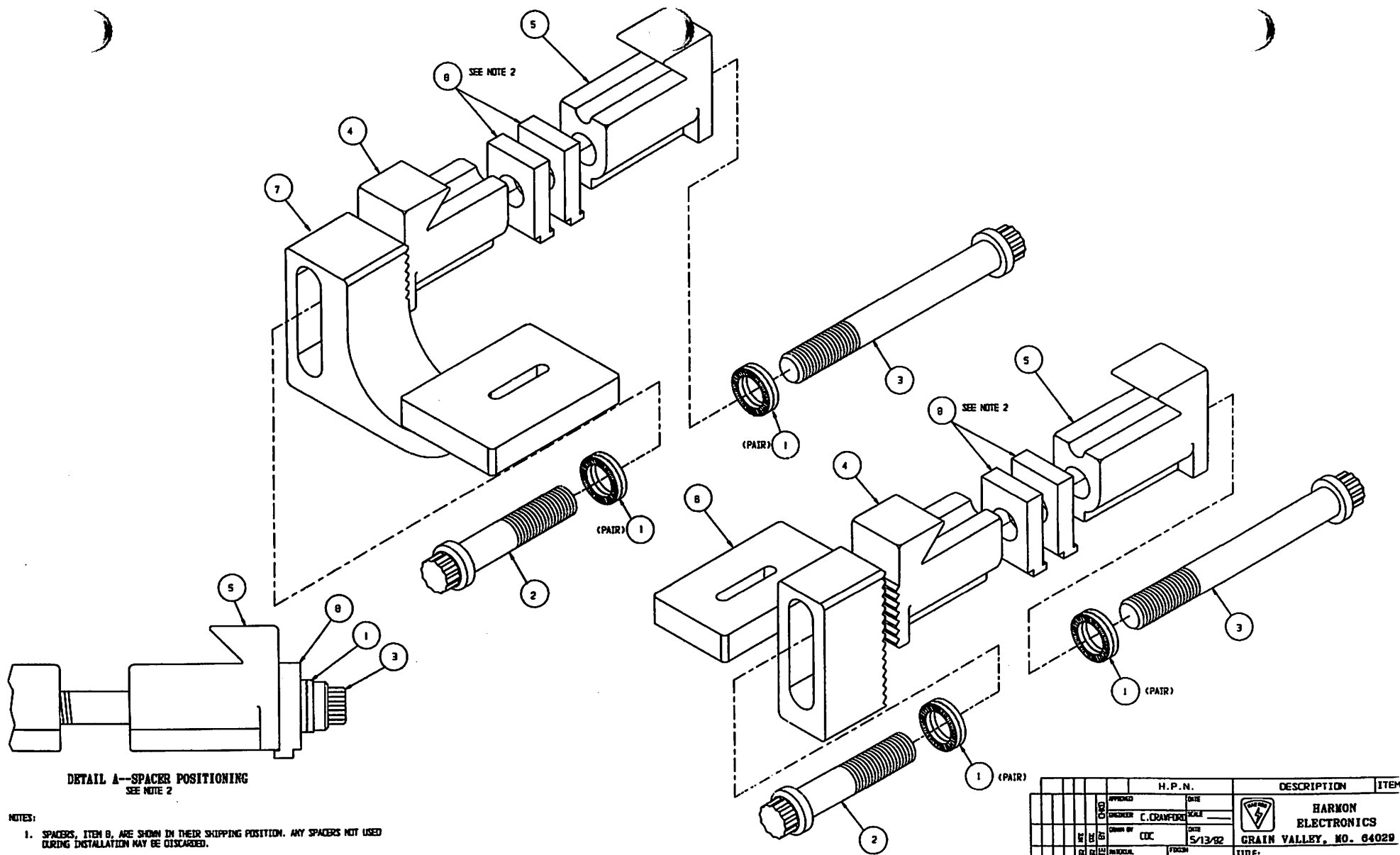
DESC: ASSY RMS TRACK CLAMP SUB LH

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOL
001	4.0000	013351-008	WASHER 3/4 LOCK PAIR ZPS	
002	2.0000	013354-009	SCREW 3/4-10 X3-1/2 CBC CPS	
003	2.0000	013354-015	SCREW 3/4-10 X 6-1/2 CBC CPS	
004	2.0000	022537-002	CLAMP TRACK PART 1 PLATED	
005	2.0000	022537-004	CLAMP TRACK PART 2 PLATED	
007	1.0000	022579-003	CLAMP PART 3 MACH W/FIN LH	
006	1.0000	022580-003	CLAMP PART 4 MAC H W/FIN LH	
008	4.0000	065239-001	CLAMP SPACER PLATED	

PARENT: 201960-000

DESC: ASSY RMS TRACK CLAMP SUB RH

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOL
001	4.0000	013351-008	WASHER 3/4 LOCK PAIR ZPS	
002	2.0000	013354-009	SCREW 3/4-10 X3-1/2 CBC CPS	
003	2.0000	013354-015	SCREW 3/4-10 X 6-1/2 CBC CPS	
004	2.0000	022537-002	CLAMP TRACK PART 1 PLATED	
005	2.0000	022537-004	CLAMP TRACK PART 2 PLATED	
007	1.0000	022579-005	CLAMP PART 3 MACH W/FIN RH	
006	1.0000	022580-005	CLAMP PART 4 MACH W/FIN RH	
008	4.0000	065239-001	CLAMP SPACER PLATED	



H.P.N.										DESCRIPTION		ITEM																																																																																																																						
<table border="1"><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr><tr><td>APPROVED</td><td colspan="4"></td><td colspan="4">DATE</td><td rowspan="4"></td><td rowspan="4">HARMON ELECTRONICS GRAIN VALLEY, MO. 64029</td><td rowspan="4"></td></tr><tr><td>DESIGNED BY</td><td colspan="4">C. CRAWFORD</td><td colspan="4">SCALE</td></tr><tr><td>DRAWN BY</td><td colspan="4">COC</td><td colspan="4">DATE</td></tr><tr><td colspan="4">5/13/92</td><td colspan="4"></td></tr><tr><td colspan="4">TOLERANCE UNLESS NOTED</td><td colspan="4">TITLE:</td><td colspan="4">RAIL MOUNTED SCANNER, RIGHT HAND TRACK CLAMP SUB ASSY.</td></tr><tr><td colspan="4">FILE NO.</td><td colspan="4">DRAWING NO.</td><td colspan="4">SHEET</td><td colspan="4">OF</td></tr><tr><td colspan="4">201950-X</td><td colspan="4">201950-000</td><td colspan="4">1</td><td colspan="4">1</td></tr><tr><td colspan="4">CADDY</td><td colspan="4"></td><td colspan="4"></td><td colspan="4"></td></tr></table>	1	2	3	4	5	6	7	8	9	10	11	12	APPROVED					DATE					HARMON ELECTRONICS GRAIN VALLEY, MO. 64029		DESIGNED BY	C. CRAWFORD				SCALE				DRAWN BY	COC				DATE				5/13/92								TOLERANCE UNLESS NOTED				TITLE:				RAIL MOUNTED SCANNER, RIGHT HAND TRACK CLAMP SUB ASSY.				FILE NO.				DRAWING NO.				SHEET				OF				201950-X				201950-000				1				1				CADDY																																			
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PARENT: 226899-000

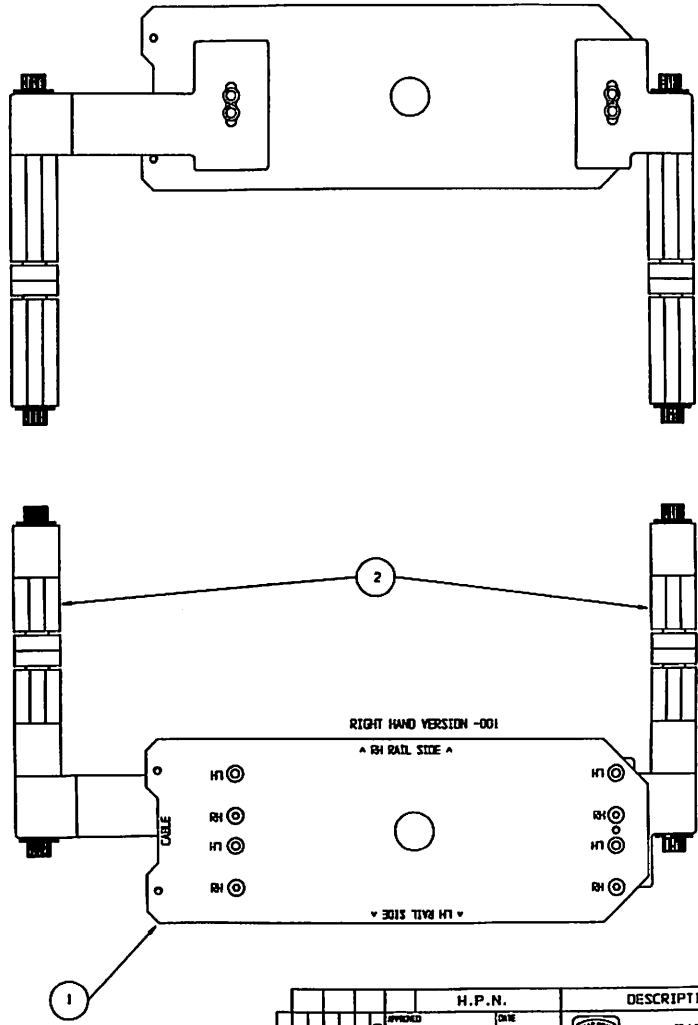
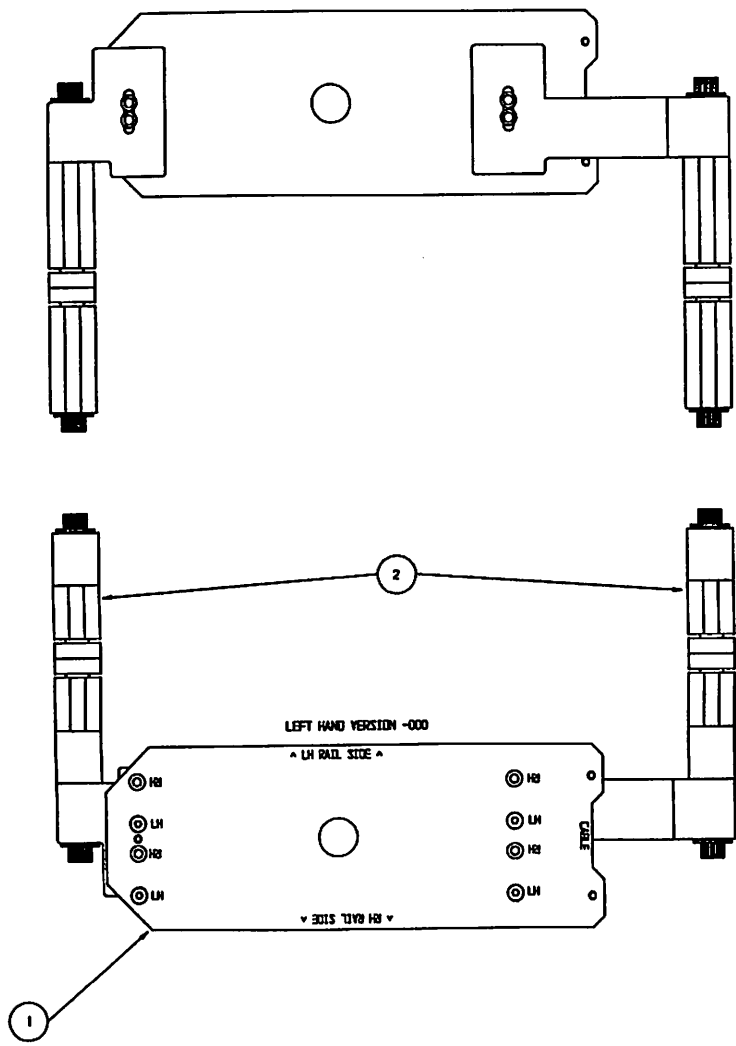
DESC: ASSY RMS TRACK CLAMP LH

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOL
001	1.0000	201646-000	ASSY RMS LEVEL PLATE LH	
002	1.0000	201959-000	ASSY RMS TRACK CLAMP SUB LH	

PARENT: 226899-001

DESC: ASSY RMS TRACK CLAMP RH

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOL
001	1.0000	201646-001	ASSY RMS LEVEL PLATE RH	
002	1.0000	201960-000	ASSY RMS TRACK CLAMP SUB RH	

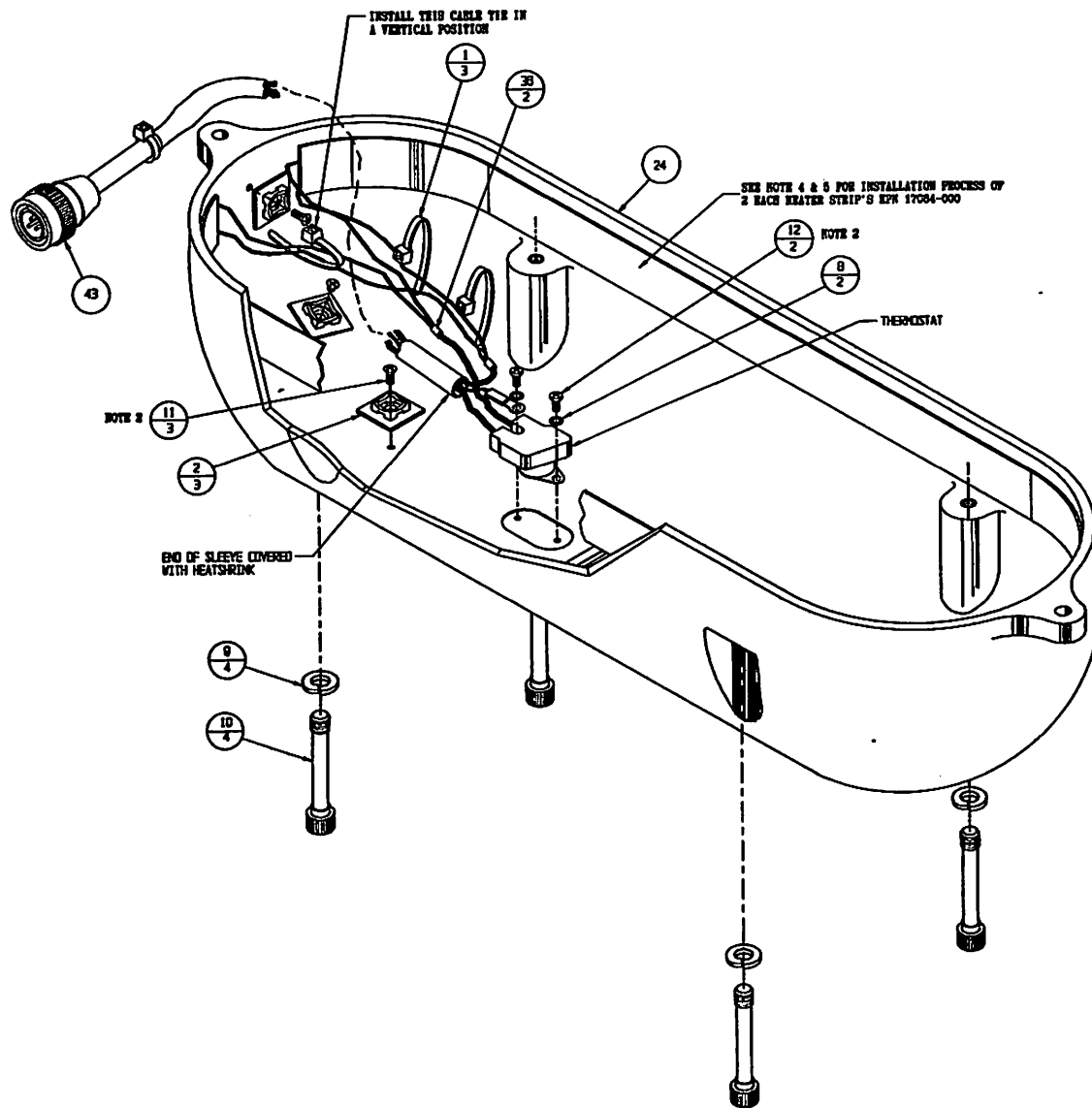


H.P.N.				DESCRIPTION		ITEM
APPROVED	DATE	SCALE	NONE	 HARMON ELECTRONICS GRAIN VALLEY, MO. 64029		1
DESIGNED BY	DATE	5/12/92				
BY	DATE	DATE		TITLE:		
DATE	DATE	DATE		TRACK CLAMP ASS'Y RIGHT & LEFT HAND RAIL MOUNT SCANNER		
TOLERANCE UNLESS NOTED				FILE NO.		
				DRAWING NO.		
				226899-X		
				226899-000/001		
				SHEET		
				OF		
				1		
				0		

PARENT: 226426-000

DESC: ASSY SCAN RAIL MNT COVER SUB

DIN	USAGE	COMP_PART	PART DESCRIPTION
001	3.0000	005019-A18	CABLE TIE 5-1/2" BLACK
002	3.0000	005683-000	CABLE TIE HOLDER
008	2.0000	013002-011	WASHER 6 INTL SS
009	4.0000	013030-002	WASHER 5/16 SPL SS
010	4.0000	013355-000	SCREW 5/16-18 X 2-1/4 CAPTIVE
011	3.0000	013491-3608	SCREW 6-32 X 1/4 PFH SS
012	2.0000	013492-3608	SCREW 6-32 X 1/4 PPH SS
024	1.0000	022538-003	COVER PNTD W/CLEAR COAT
030	0.0000	029003-000	ADHESIVE LOCTITE #242
036	2.0000	132129-000	SPLICE SEALED SOLDER
043	1.0000	201643-000	ASSY HEATER CONNECTOR



NOTES:

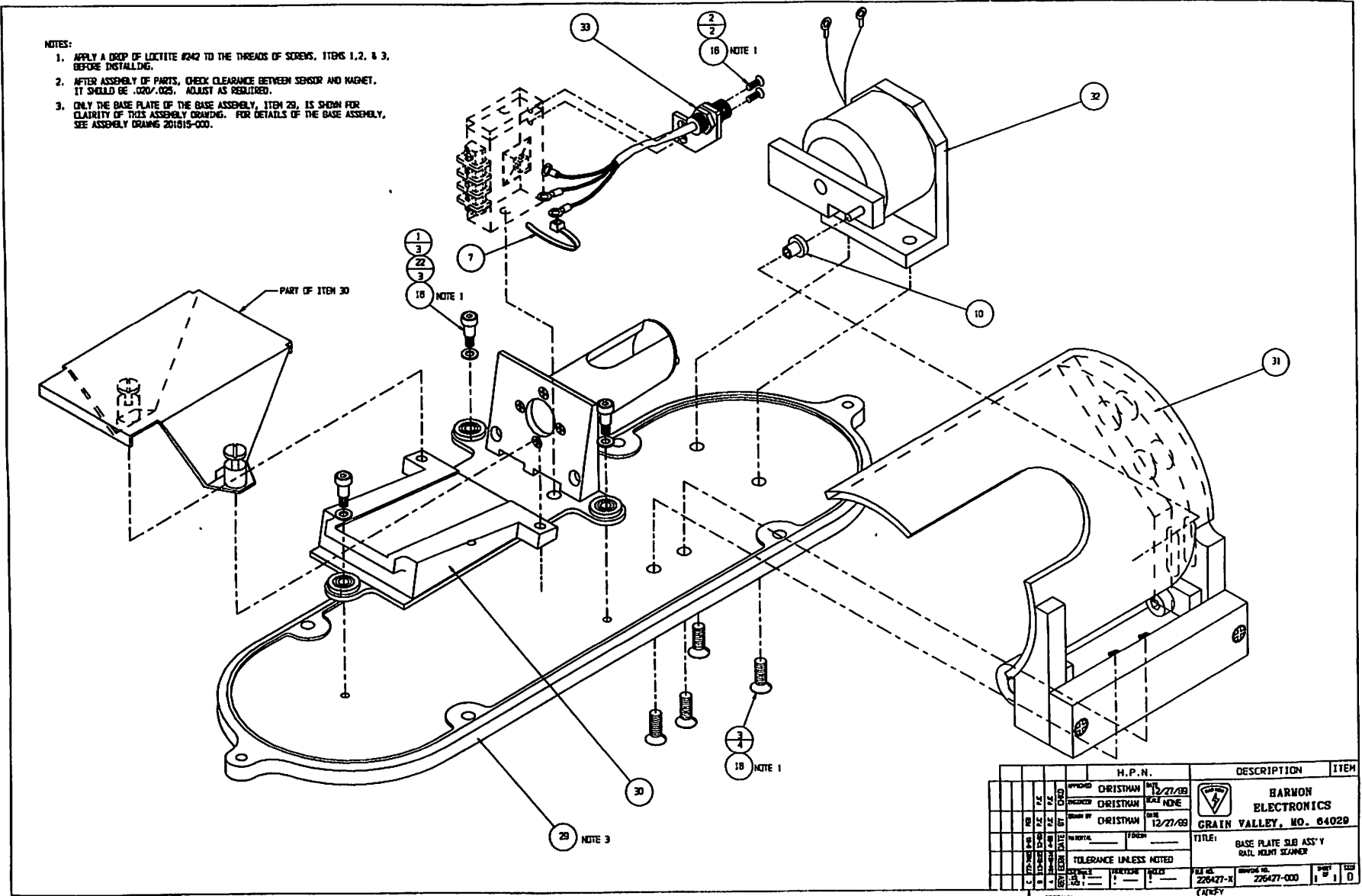
1. SPlice ONE WIRE FROM EACH HEATER STRIP, ITEM 18, TO THE LOOSE WIRE FROM THE THERMOSTAT USING A SEALED SOLDER SPLICE, ITEM 36. SPlice THE OTHER TWO HEATER WIRES TO THE WHITE WIRE FROM THE HEATER CONNECTOR ASSEMBLY, ITEM 43, USING A SEALED SOLDER SPLICE, ITEM 36.
2. APPLY A DROP OF LOCTITE #242, ITEM 30, TO THE THREADS OF SCREWS, ITEMS 11 AND 12, BEFORE INSTALLING.
3. ONCE SPLICES ARE MADE AND THE THERMOSTAT IS INSTALLED, DRESS CABLE ASSEMBLY AND HEATER WIRES TOGETHER AND CABLE TIE, ITEM 1, TO PREVIOUSLY INSTALLED PADS, ITEM 2. TOP TIE MUST BE INSTALLED IN A VERTICAL POSITION.
4. TO INSTALL HEATER STRIP'S IN MANUFACTURING
 - A. SAND BLAST INSIDE OF COVER ITEM 24
 - B. SAND SURFACE 1/ 60 OR 80 GRIT EMERY PAPER WHERE HEATER STRIP'S WILL BE PLACED
 - C. MASK AREA FROM TOP EDGE OF CASTING DOWN TO BOSSES ALL AROUND INSIDE OF CASTING.
 - D. PAINT INSIDE OF CASTING 1/ FLAT BLACK ENAMEL
 - E. REMOVE MASKING TAPE & BAKE PAINT
 - F. CLEAN SURFACE WHERE HEATER STRIP'S WILL GO WITH ISOPROPYL ALCOHOL USING A LINT FREE CLOTH. THEN LET ALCOHOL AIR DRY.
(MAKE SURE RESIDUE FROM MASKING TAPE IS REMOVED)
 - G. REMOVE THE CREPE PAPER FROM HEAT STRIP. POSITION HEATER AS SHOWN AND WITH A ROLLER CAREFULLY PRESS OUT ALL AIR POCKETS.
 - H. COVERS MUST BE BURNED IN FOR 3 DAYS
5. PREPARATION OF CASTING'S FOR VULCANIZING HEATER STRIP'S TO COVER.
 - A. REPEAT STEP 4A THRU 4F.

H.P.N.				DESCRIPTION		ITEM
APPROVED	CHRISTIAN	DATE	12-20-89		HARMON ELECTRONICS GRAIN VALLEY, MO. 64029 TITLE: RAIL MOUNTED SCANNER, COVER SUB ASSEMBLY	
DESIGNED	CHRISTIAN	DATE	NONE			
DATE	11-20-89					
DESIGNED	VOHACK	DATE				
TOLERANCE UNLESS NOTED						
FILE NO.	226426-X	ENGINEER NO.	226426-000	SHEET	1	D
CADDY						

PARENT: 226427-000

DESC: ASSY BASE SUB

DIN	USAGE	COMP_PART	COMP_DESC
007	1.0000	005019-A18	CABLE TIE 5-1/2" BLACK
022	3.0000	013074-000	WASHER 1/4 FLT .562 OD BR NI
001	3.0000	013327-120	SCREW 10-32 X 3/8 SHOULDER SS
002	2.0000	013491-3612	SCREW 6-32 X 3/8 PFH SS
003	4.0000	013848-112	SCREW 5/16-18 X 3/4 SH FLT
010	1.0000	020119-000	BEARING DRIVE PIN
016	0.0000	029003-000	ADHESIVE LOCTITE #242
029	1.0000	201615-000	ASSY BASE PLATE SUB
030	1.0000	201616-000	ASSY CRADLE SUB
031	1.0000	201617-000	ASSY SHUTTER SUB
032	1.0000	201618-000	ASSY SOLENOID
033	1.0000	201644-000	ASSY SENSOR



PARENT: 225807-000

DESC: ASSY TLK/HBD/HWD CPU

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOLS
021	2.0000	003174-007	IC LM239J IND COMP 14DIP U27 U28	
015	1.0000	003309-000	IC 54LS00J MIL 2IN NAND 14DIP U15	
068	1.0000	003309-002	IC SN54LS02J MIL 2IN NOR 14DIP U16	
022	1.0000	003309-005	IC 54LS05J MIL HEX IND 14DIP U29	
016	2.0000	003309-008	IC 54LS08J MIL 2IN NAND 14DIP U18 U33	
017	1.0000	003309-020	IC 54LS20J MIL 4IN NAND 14DIP U20	
011	3.0000	003309-032	IC 54LS32J MIL 2IN OR 14DIP U8 U17 U24	
020	1.0000	003309-074	IC 54LS74J MIL DFF 14DIP U23	
012	3.0000	003309-138	IC 54LS138J MIL 3-8 DEM 16DIP U9 U10 U30	
010	6.0000	003309-244	IC 54LS244J 3ST BUF 20DIP U7 U11 U19	U25 U26
010	60000	003309-244	IC 54LS244J 3ST BUF 20DIP U31	
014	1.0000	003309-245	IC 54LS245J 3ST TRAN 20DIP U14	
013	2.0000	003309-373	IC 54LS373J MIL OCT DFF 20DIP U12 U13	
018	1.0000	003324-060	IC 4060 IND CTR/DIV 16DIP U21	
019	1.0000	003324-071	IC 4071 IND 2IN OR 14DIP U39	
001	1.0000	061275-000	PC BD TLK/HBD/HWD CPU	
053	2.0000	002101-1002	RES MF 1/10W 10K OHM 1% R37 R45	
051	2.0000	002101-2002	RES MF 1/10W 20K OHM 1% R43 R46	
052	1.0000	002101-2491	RES MF 1/10W 2490 OHM 1% R47	
050	1.0000	002101-3012	RES MF 1/10W 30.1K OHM1% R27	
046	2.0000	002127-102	RES CF 1/4W 1K OHM 5% R29 R40	
047	4.0000	002127-103	RES CF 1/4W 10K OHM 5%	

			R32	R33	R34	R35
042	1.0000	002127-104	RES CF 1/4W 100K OHM 5%			
			R21			
000	2.0000	002127-154	RES CF 1/4W 150K OHM 5%			
			R23	R25		
039	12.0000	002127-202	RES CF 1/4W 2K OHM 5%			
			R4	R5	R12	R14 R22
039	12.0000	002127-202	RES CF 1/4W 2K OHM 5%			
			R28	R44	R49	R52
039	12.0000	002127-202	RES CF 1/4W 2K OHM 5%			
			R60	R61		
044	1.0000	002127-203	RES CF 1/4W 20K OHM 5%			
			R17	R53	R54	
043	1.0000	002127-204	RES CF 1/4W 200K OHM 5%			
			R30			
049	1.0000	002127-302	RES CF 1/4W 3K OHM 5%			
			R39			
044	1.0000	002127-304	RES CF 1/4W 300K OHM 5%			
			R24			
000	2.0000	002127-471	RES CF 1/4W 470 OHM 5%			
			R36	R62		
000	8.0000	002127-472	RES CF 1/4W 4.7K OHM 5%			
			R26	R38	R42	R48 R50
000	8.0000	002127-472	RES CF 1/4W 4.7K OHM 5%			
			R56	R57	R58	
040	4.0000	002127-513	RES CF 1/4W 51K OHM 5%			
			R11	R18	R31	R41
030	2.0000	001000-043	CAP TANT DIP 25V 10UF 20% RAD			
			C5	C13		
031	1.0000	001023-4013	CAP CER MONO 50V .0047UF10%RAD			
			C17			
035	1.0000	001023-4018	CAP CER MONO 50V .22UF 10% RAD			
			C26			
026	18.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD			
			C1	C2	C3	C4 C6
026	18.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD			
			C7	C8	C9	C12 C14
026	18.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD			
			C16	C18	C122	C23 C24
026	18.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD			
			C25	C27	C29	
027	1.0000	001023-4033	CAP CER MONO 50V .022UF 10%RAD			
			C10			
032	1.0000	001305-6200	CAP SIL MICA 500V 20PF 5% RAD			
			C19			
028	2.0000	001323-002	CAP CER 100V .01UF 10% RAD			

		C11 C15
057	1.0000 002126-128	RES SIP NET 4.7K OHM
		R19
000	1.0000 002126-132	RES SIP NET 10K OHM 6 PIN COM
		R13
061	2.0000 002126-319	RES SIP NET 1K OHM 10 PIN COM
		R10 R20
060	4.0000 002126-323	RES SIP NET 2K OHM 10 PIN COM
		R2 R8 R16 R55
059	2.0000 002126-328	RES SIP NET 4700 OHM 10 PIN CO
		R1 R6
053	3.0000 002126-332	RES SIP NET 10K OHM 10 PIN COM
		R7 R9 R15
054	1.0000 002206-001	RES WW 2W .1 OHM 5%
		R3
000	1.0000 003234-002	IC LM236 IND 2.5VREF 8DIP
		U32
003	1.0000 003464-000	IC 8031 IND UPRO 40DIP
		A1
024	1.0000 004081-001	XSTR 2N4403 PNP 40V .6A TO92
		Q1
025	1.0000 004143-001	XSTR 2N4401 NPN 40V .6A TO92
		Q2
063	1.0000 011036-000	DIODE 1N5908 6V TS
		CR1
062	1.0000 011047-018	DIODE 1N483B RECT 70V 200MA
		CR2
076	0.9000 012007-000	WIRE BUS 22AWG
065	50.0000 014061-1058	BEAD GLASS .034 ID .0970 .074L
071	3.0000 032805-002	HEADER PIN 2 POS
082	2.0000 032805-003	HEADER PIN 3 POS
083	1.0000 032805-006	HEADER PIN 6 POS
081	2.0000 032834-000	CONN SHUNT 2 POS LOW PROFILE
075	0.7000 033064-4000	TUBING NO 22 TEFLON RED
001	1.0000 080774-069	PROC HBD PROCESSOR BD TEST
006	2.0000 132018-006	SCKT IC 28PIN .6W
		U1 U2
007	4.0000 132018-007	SCKT IC 28PIN .6W
		U3 U4 U5 U6
033	1.0000 900019-000	CAP 33PF DM5EC330J
		C20
029	1.0000 900063-000	CAP .0022 UF CW15A222K
		C28
023	1.0000 900222-000	CONN ISBX BUSS LMRO1 VH 18-E01
		S01
008	2.0000 003692-000	IC TC5516 IND SRAM 2KX8 24DIPW

		U1	U2
077	2.0000 013008-014	WASHER 4 FLT SS	
078	2.0000 013009-3401	NUT 4-40 HEX SS	
079	2.0000 013030-005	WASHER 4 SPL SS	
080	2.0000 013492-3412	SCREW 4-40 X 3/8 PPH SS	
067	1.0000 015059-000	CRYS 9 MHZ	
		Y1	
005	1.0000 900074-000	SWITCH 4 POLE DIP	
		S1	
064	1.0000 900080-000	LED RED 555-2001	
		DS1	
034	1.0000 900084-000	CAP TRIMMER 538-011B-2.5-11 PF	
		C21	
069	1.0000 900178-000	CARD PULLER SAE 6200	

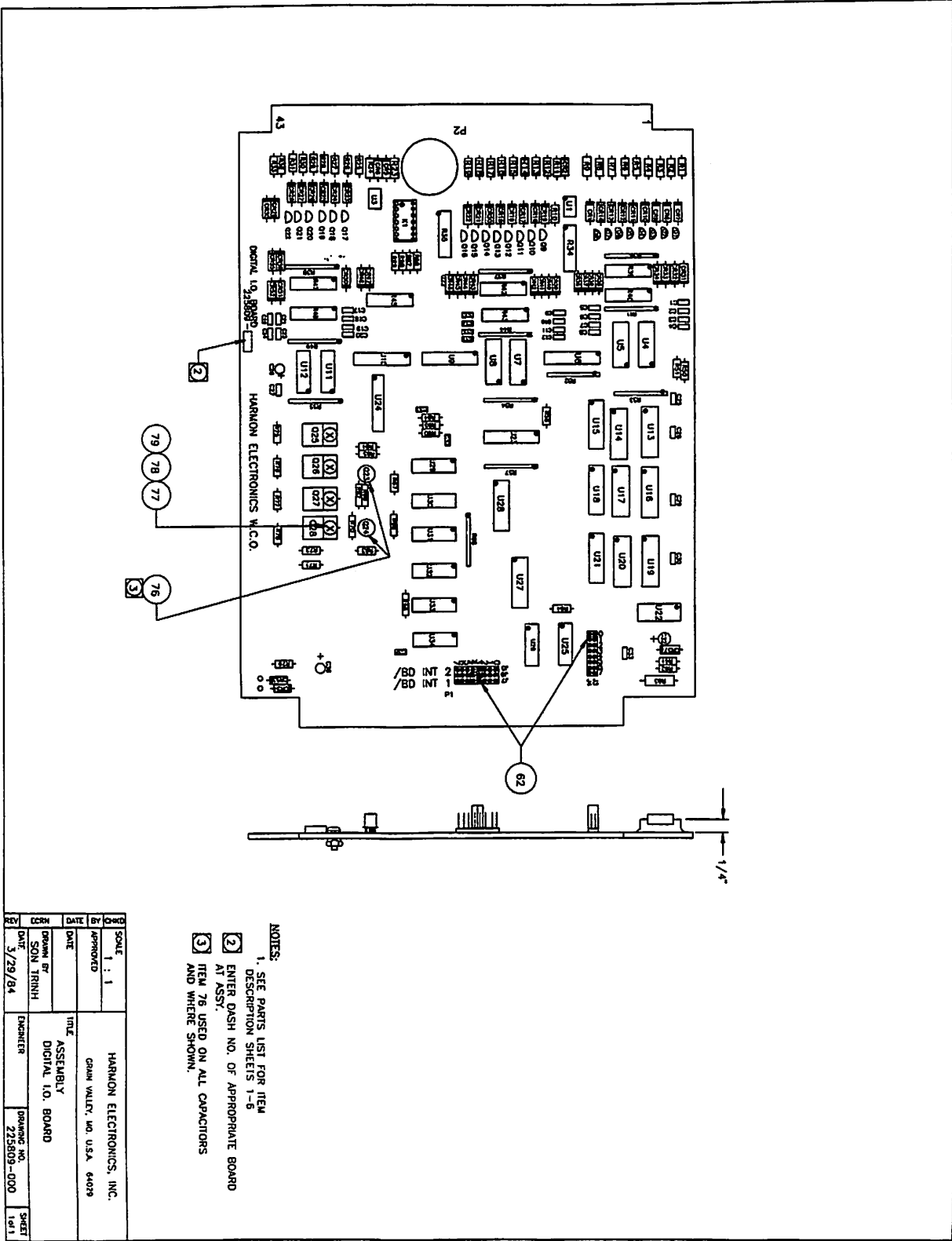
PARENT: 225809-000 DESC: ASSY TLK/HBD/HWD DIGITAL I/O

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOLS				
002	6.0000	003174-007	IC LM239J IND COMP 14DIP	U4	U5	U7	U8	U11
002	6.0000	003174-007	IC LM239J IND COMP 14DIP	U12				
014	2.0000	003309-002	IC SN54LS02J MIL 2IN NOR 14DIP	U31	U32			
015	1.0000	003309-032	IC 54LS32J MIL 2IN OR 14DIP	U34				
009	2.0000	003309-038	IC 54LS38J MIL 2IN NAND 14DIP	U19	U20			
011	3.0000	003309-138	IC 54LS138J MIL 3-8 DEM 16DIP	U25	U26	U33		
013	2.0000	003324-001	IC 4001 IND 2IN NOR 14DIP	U29	U30			
008	2.0000	003324-043	IC 4043 IND NOR RS LAT 16DIP	U17				
007	2.0000	003324-070	IC 4070 IND 2IN XOR 14DIP	U13	U14			
001	1.0000	061277-000	PC BD HBD/HWD/TLK DIGITAL I/O					
070	6.0000	002078-014	RES NET 1.5W 2K OHM 2%	R34	R35	R39	R42	R45
070	6.0000	002078-014	RES NET 1.5W 2K OHM 2%	R47				
000	1.0000	002101-1002	RES MF 1/10W 10K OHM 1%	R89				
000	1.0000	002101-2002	RES MF 1/10W 20K OHM 1%	R88				
034	2.0000	002127-102	RES CF 1/4W 1K OHM 5%	R51	R58			
039	2.0000	002127-103	RES CF 1/4W 10K OHM 5%	R69	R70			
051	2.0000	002127-152	RES CF 1/4W 1.5K OHM 5%	R82	R83			
037	1.0000	002127-153	RES CF 1/4W 15K OHM 5%	R60				
036	12.0000	002127-202	RES CF 1/4W 2K OHM 5%	R56	R61	R64	R66	R67
036	12.0000	002127-202	RES CF 1/4W 2K OHM 5%	R68	R75	R76	R77	R78
036	12.0000	002127-202	RES CF 1/4W 2K OHM 5%	R84	R85			
031	2.0000	002127-302	RES CF 1/4W 3K OHM 5%					

055	1.0000	002127-393	RES CF 1/4W 39K OHM 5% R10 R24 R87	
035	2.0000	002127-472	RES CF 1/4W 4.7K OHM 5% R59 R62	
056	1.0000	002127-823	RES CF 1/4W 82K OHM 5% R86	
033	1.0000	002127-912	RES CF 1/4W 9.1K OHM 5% R50	
000	1.0000	011018-05A	DIODE 1N4733A ZEN 1W 5.1V 5% CR23	
026	23.0000	011047-018	DIODE 1N483B RECT 70V 200MA CR31 CR32 CR33 CR34 CR35	
026	23.0000	011047-018	DIODE 1N483B RECT 70V 200MA CR36 CR37 CR38 CR39 CR40	
026	23.0000	011047-018	DIODE 1N483B RECT 70V 200MA CR41 CR42 CR43 CR44 CR45	
026	23.0000	011047-018	DIODE 1N483B RECT 70V 200MA CR46 CR47 CR48 CR50 CR51	
026	23.0000	011047-018	DIODE 1N483B RECT 70V 200MA CR52 CR55 CR56	
021	1.0000	001000-023	CAP TANT DIP 20V 47UF 20% RAD C32	
019	2.0000	001000-043	CAP TANT DIP 25V 10UF 20% RAD C26 C36	
017	25.0000	001023-4012	CAP CER MONO 50V .047UF 10%RAD C1 C2 C3 C4 C5	
017	25.0000	001023-4012	CAP CER MONO 50V .047UF 10%RAD C6 C7 C8 C9 C10	
017	25.0000	001023-4012	CAP CER MONO 50V .047UF 10%RAD C11 C12 C13 C14 C15	
017	25.0000	001023-4012	CAP CER MONO 50V .047UF 10%RAD C16 C17 C18 C19 C20	
017	25.0000	001023-4012	CAP CER MONO 50V .047UF 10%RAD C21 C22 C23 C24 C25	
020	8.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD C27 C28 C29 C30 C31	
020	8.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD C33 C37 C38	
072	3.0000	002078-006	RES NET 1.5W 100K OHM 2% R48 R40 R43	
042	5.0000	002126-323	RES SIP NET 2K OHM 10 PIN COM R36 R37 R38 R52 R65	
074	3.0000	002126-328	RES SIP NET 4700 OHM 10 PIN CO R55 R53 R54	
044	4.0000	002126-332	RES SIP NET 10K OHM 10 PIN COM	

			R41	R44	R49	R57	
000	2.0000	002129-7100	RES CF 1/2W 10 OHM 5%				
			R71	R73			
000	1.0000	002129-7109	RES CF 1/2W 1 OHM 5%				
			R79				
000	1.0000	002129-7201	RES CF 1/2W 200 OHM 5%				
			R26				
000	23.0000	002129-7209	RES CF 1/2W 2.0 OHM 5%				
			R1	R2	R3	R4	R5
000	23.0000	002129-7209	RES CF 1/2W 2.0 OHM 5%				
			R6	R7	R8	R12	R13
000	23.0000	002129-7209	RES CF 1/2W 2.0 OHM 5%				
			R14	R15	R16	R17	R18
000	23.0000	002129-7209	RES CF 1/2W 2.0 OHM 5%				
			R19	R27	R28	R29	R30
000	23.0000	002129-7209	RES CF 1/2W 2.0 OHM 5%				
			R31	R32	R33		
000	2.0000	002129-7302	RES CF 1/2W 3000 OHM 5%				
			R11	R25			
000	2.0000	002129-7470	RES CF 1/2W 47 OHM 5%				
			R9	R23			
040	1.0000	002206-000	RES WW 2W .51 OHM 5%				
			R63				
006	6.0000	003220-373	IC 74C373 PLA OCT LAT 20DIP				
			U6	U9	U10	U15	U18
006	6.0000	003220-373	IC 74C373 PLA OCT LAT 20DIP				
			U21				
012	2.0000	003309-244	IC 54LS244J 3ST BUF 20DIP				
			U27	U28			
004	2.0000	003310-001	IC 4N46 IND OPTO 6DIP				
			U1	U3			
003	3.0000	003317-244	IC 74HC244 IND 3ST BUF 20DIP				
			U22	U23	U24		
048	2.0000	004062-002	XSTR 2N3440 NPN 250V 1A TO39				
			Q23	Q24			
025	21.0000	011013-035	DIODE 1N6284A 1.5KE36A TS PLA				
			CR27	CR28			
025	21.0000	011013-035	DIODE 1N6284A 1.5KE36A TS PLA				
			CR7	CR8	CR9	CR10	CR11
025	21.0000	011013-035	DIODE 1N6284A 1.5KE36A TS PLA				
			CR12	CR13	CR14	CR15	CR16
025	21.0000	011013-035	DIODE 1N6284A 1.5KE36A TS PLA				
			CR17	CR18	CR19	CR20	CR21
025	21.0000	011013-035	DIODE 1N6284A 1.5KE36A TS PLA				
			CR22	CR23	CR24	CR25	CR26
000	2.0000	011013-043	DIODE 1N6288A 1.5KE51A TS PLA				

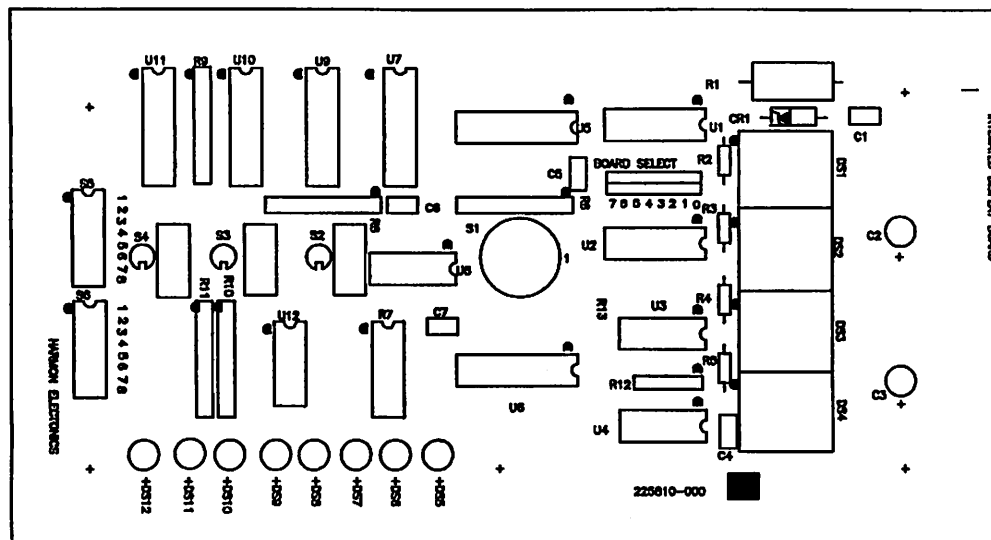
023	2.0000 011018-14A	CR29 CR30 DIODE 1N4742A ZEN 1W 12V 5%
028	1.0000 011036-000	CR1 CR5 DIODE 1N5908 6V TS
024	4.0000 011043-006	CR57 DIODE 1N4007 RECT 1KV 1A
077	4.0000 013492-3408	CR2 CR6 CR53 CR54 SCREW 4-40 X 1/4 PPH SS
076	16.0000 014061-1058	BEAD GLASS .034 ID .0970 .074L
000	72.0000 014061-1058	BEAD GLASS .034 ID .0970 .074L
063	5.0000 032805-008	HEADER PIN 8 POS
000	3.0000 032834-000	CONN SHUNT 2 POS LOW PROFILE
060	1.0000 132018-001	SCKT IC 14PIN .3W
049	2.0000 900137-000	K1 TRANSISTOR TIP117
050	2.0000 900138-000	Q25 Q28 TRANSISTOR TIP112
046	21.0000 900161-000	Q26 Q27 TRANSISTOR MPSA26
046	21.0000 900161-000	Q1 Q2 Q3 Q4 Q5 TRANSISTOR MPSA26
046	21.0000 900161-000	Q6 Q7 Q8 Q9 Q10 TRANSISTOR MPSA26
046	21.0000 900161-000	Q11 Q12 Q13 Q14 Q15 TRANSISTOR MPSA26
046	21.0000 900161-000	Q16 Q18 Q19 Q20 Q21 TRANSISTOR MPSA26
052	1.0000 007170-004	Q22 RLY W172 DIP-3
079	4.0000 013002-012	WASHER 4 INTL SS
078	4.0000 013009-3401	NUT 4-40 HEX SS
000	1.0000 080774-112	PROC TLK/HBD/HWD DGTL I/O TEST



PARENT: 225810-000 DESC: ASSY TLK/HBD/HWD DISPLAY BOARD

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOLS
000	3.0000	002127-202	RES CF 1/4W 2K OHM 5%	
			R3 R13	
002	2.0000	002127-472	RES CF 1/4W 4.7K OHM 5%	
			R4 R5	
003	1.0000	003309-002	IC SN54LS02J MIL 2IN NOR 14DIP	
			U4	
004	3.0000	003309-032	IC 54LS32J MIL 2IN OR 14DIP	
			U3 U8 U12	
005	2.0000	003309-138	IC 54LS138J MIL 3-8 DEM 16DIP	
			U1 U2	
006	1.0000	061278-000	PC BD WCO-35 DISPLAY	
000	2.0000	001000-043	CAP TANT DIP 25V 10UF 20% RAD	
001	5.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD	
			C1 C4 C5 C6 C7	
002	1.0000	002078-004	RES NET 1.5W 470 OHM 2%	
			R7	
003	1.0000	002126-323	RES SIP NET 2K OHM 10 PIN COM	
			R6	
004	3.0000	002126-328	RES SIP NET 4700 OHM 10 PIN CO	
			R8 R10 R11	
005	1.0000	002126-332	RES SIP NET 10K OHM 10 PIN COM	
			R9	
026	1.0000	002206-002	RES WW 2W .2 OHM 5%	
007	1.0000	003220-373	IC 74C373 PLA OCT LAT 20DIP	
			U6	
008	2.0000	003309-244	IC 54LS244J 3ST BUF 20DIP	
			U5 U7	
009	3.0000	003317-244	IC 74HC244 IND 3ST BUF 20DIP	
			U9 U10 U11	
010	1.0000	011036-000	DIODE 1N5908 6V TS	
012	14.0000	014061-1058	BEAD GLASS .034 ID .0970 .074L	
000	15.0000	014061-1058	BEAD GLASS .034 ID .0970 .074L	
013	2.0000	032805-008	HEADER PIN 8 POS	
014	1.0000	032834-000	CONN SHUNT 2 POS LOW PROFILE	
015	1.0000	035674-000	SCHEM TLK/HBD/HWD DISPLAY BD	
020	1.0000	002126-128	RES SIP NET 4.7K OHM	
024	2.0000	008057-000	DISP ALPHA/NUM 4CHAR LED	
			DS2 DS3	
011	8.0000	011113-000	LED 5592101001 HE-RED 3V SNAPN	
			DS5 DS6 DS7 DS8 DS9	
011	8.0000	011113-000	LED 5592101001 HE-RED 3V SNAPN	
			DS10 DS11 DS12	

000	4.0000	013074-000	WASHER 1/4 FLT .562 OD BR NI
017	1.0000	900002-000	SWITCH TOG ON/OFF MTA-106E-PC S2
018	2.0000	900003-000	SWITCH TOG ON/OFF MTA-106G-PC S3 S4
019	2.0000	900029-000	SOCKET 16 CONTACTS 516-AG10F-2 SS SG
021	2.0000	900073-000	SWITCH 8 POLE DIP 206-8 S5 S6
022	2.0000	900087-000	SOCKET DISPLAY 300-14-AA-B-LL DS1 DS4
023	1.0000	900091-000	SWITCH ROT 513361-12-C S1
000	1.0000	080774-111	PROC HBD DISPLAY BOARD TEST



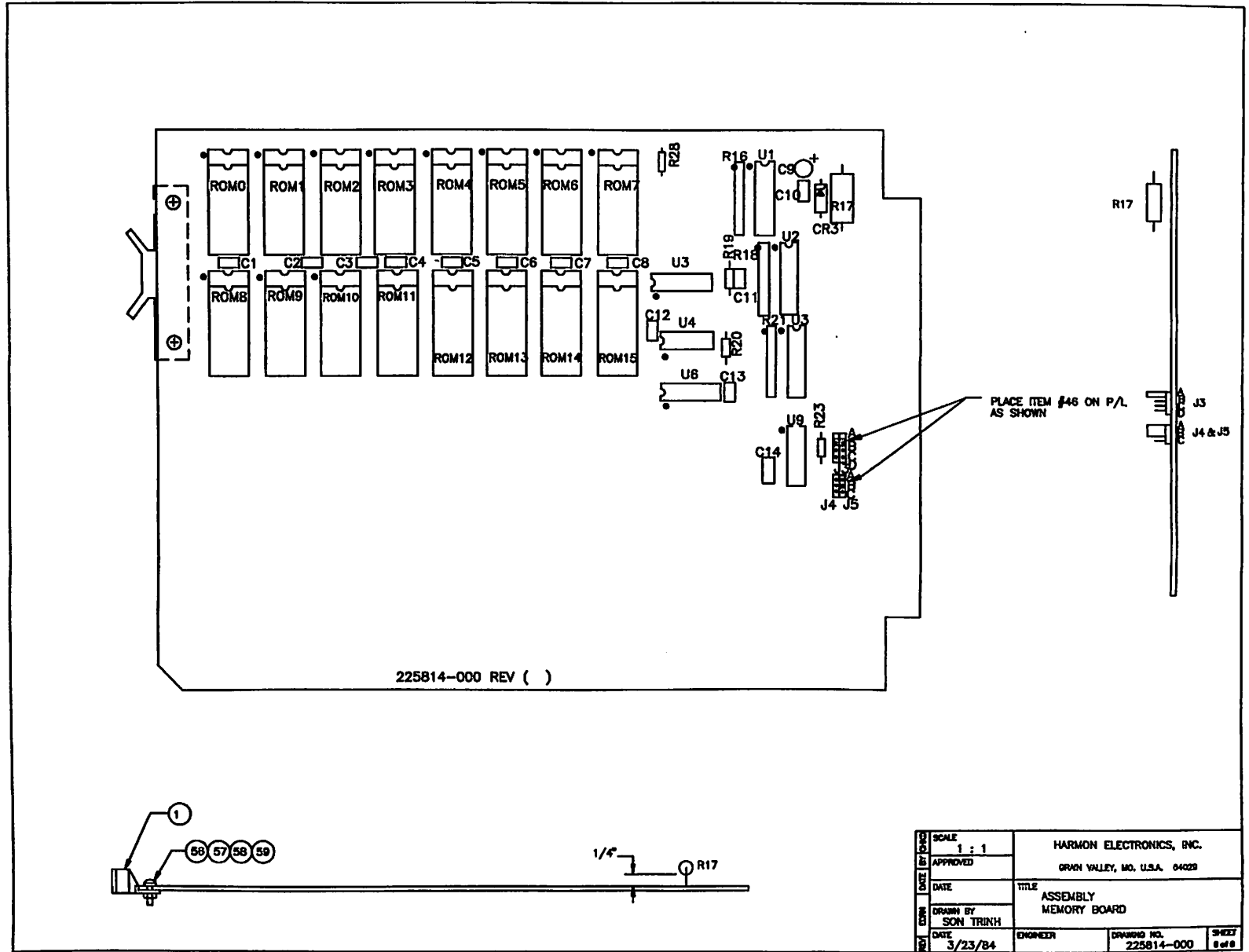
REV A 12/14/82 ADDED R12 & R13
 REV B 12/28/82 UNGROUNDED 44-3 TIED
 1/10/82 EXCHANGED ENABLE LINES

1	SCALE	1 : 1	HARMON ELECTRONICS, INC.
2	APPROVED		GREEN VALLEY, MD. U.S.A. 94038
3	DATE		TITLE
4	DESIGNED BY		INTEGRATED DISPLAY BOARD
5	DATE		CHECKED
6			DRAWING NO. 225810-000
7			SHEET 1 of 1

PARENT: 225814-000 DESC: ASSY TLK/HBD/HWD MEMORY BOARD

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOLS
000	1.0000	001000-043	CAP TANT DIP 25V 10UF 20% RAD	
			C9	
000	13.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD	
			C1 C2 C3 C4 C5	
000	13.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD	
			C6 C7 C8 C9 C10	
000	13.0000	001023-4025	CAP CER MONO 50V .1UF 10% RAD	
			C11 C12 C13 C14	
000	2.0000	002126-323	RES SIP NET 2K OHM 10 PIN COM	
			R16 R21	
000	1.0000	002126-332	RES SIP NET 10K OHM 10 PIN COM	
			R18	
000	2.0000	002127-202	RES CF 1/4W 2K OHM 5%	
			R19 R23	
000	2.0000	002127-472	RES CF 1/4W 4.7K OHM 5%	
			R20 R28	
000	1.0000	002206-001	RES WW 2W .1 OHM 5%	
			R17	
000	1.0000	003309-032	IC 54LS32J MIL 2IN OR 14DIP	
			U4	
000	3.0000	003309-138	IC 54LS138J MIL 3-8 DEM 16DIP	
			U3 U6 U9	
000	3.0000	003309-244	IC 54LS244J 3ST BUF 20DIP	
			U1 U2 U5	
000	1.0000	011036-000	DIODE 1N5908 6V TS	
			CR3	
000	28.0000	014061-1058	BEAD GLASS .034 ID .0970 .074L	
000	2.0000	032805-003	HEADER PIN 3 POS	
000	2.0000	032805-004	HEADER PIN 4 POS	
000	2.0000	032834-000	CONN SHUNT 2 POS LOW PROFILE	
000	1.0000	061282-000	PC BD TLK/HBD/HWD MEMORY	
000	16.0000	132018-007	SCKT IC 28PIN .6W	
			ROM0 ROM1 ROM2 ROM3 ROM4	
000	16.0000	132018-007	SCKT IC 28PIN .6W	
			ROM5 ROM6 ROM7 ROM8 ROM9	
000	16.0000	132018-007	SCKT IC 28PIN .6W	
			ROM10 ROM11 ROM12 ROM13 ROM14	
000	16.0000	132018-007	SCKT IC 28PIN .6W	
			ROM15	
000	2.0000	013008-014	WASHER 4 FLT SS	
000	2.0000	013009-3401	NUT 4-40 HEX SS	
000	2.0000	013030-005	WASHER 4 SPL SS	

000	2.0000	013492-3412	SCREW 4-40 X 3/8 PPH SS
000	1.0000	900178-000	CARD PULLER SAE 6200
000	0.0000	035678-000	SCHEM TLK/HBD/HWD MEMORY BD
000	1.0000	080774-114	PROC TALKER MEMORY BOARD TEST



PARENT: 225815-000 DESC: ASSY TALKER SPEECH BD

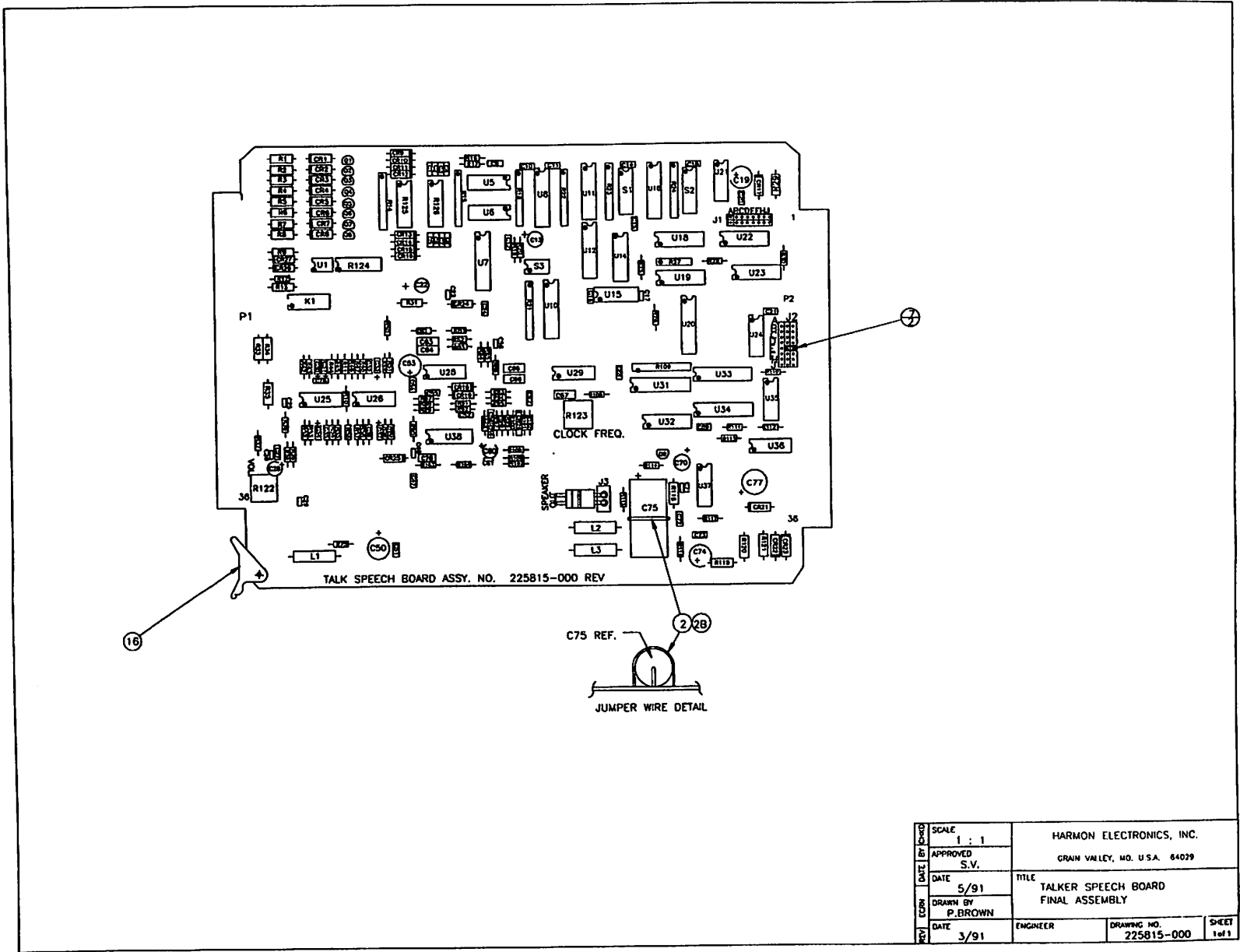
DIN	USAGE	COMP_PART	COMP_DESC	SYMBOLS
092	1.0000	003072-001	IC LM380N COM AUD OP 14DIP U37	
094	1.0000	003098-000	IC MC3517CER VOIC ENC/DEC 16DP U38	
091	1.0000	003137-002	IC LM224J CER OPAMP 14DIP U28	
090	4.0000	003174-007	IC LM239J IND COMP 14DIP U5 U6 U25 U26	
105	1.0000	003309-002	IC SN54LS02J MIL 2IN NOR 14DIP U24	
000	1.0000	003309-032	IC 54LS32J MIL 2IN OR 14DIP U35	
107	1.0000	003309-038	IC 54LS38J MIL 2IN NAND 14DIP U36	
103	3.0000	003309-138	IC 54LS138J MIL 3-8 DEM 16DIP U19 U22 U23	
097	1.0000	003324-013	IC 4013 MIL DFF 14DIP U21	
101	1.0000	003324-014	IC 4014 IND 8BIT SHFT REG 16DP U32	
099	1.0000	003324-022	IC 4022 IND CTR/DIV 16DIP U18	
100	1.0000	003324-073	IC 4073 IND 3IN AND 14DIP U15	
098	1.0000	003324-094	IC 4094 IND SHF/ST BUS 16DIP U14	
001	1.0000	061283-000	PC BD TALKER SPEECH	
043	3.0000	002101-1002	RES MF 1/10W 10K OHM 1% R81 R84 R85	
041	1.0000	002101-1502	RES MF 1/10W 15K OHM 1% R80	
044	2.0000	002101-3012	RES MF 1/10W 30.1K OHM1% R86 R98	
053	7.0000	002127-102	RES CF 1/4W 1K OHM 5% R17 R19 R102	R104 R114
053	7.0000	002127-102	RES CF 1/4W 1K OHM 5% R117 R118	
062	10.0000	002127-103	RES CF 1/4W 10K OHM 5% R38 R47 R55	R56 R93
062	10.0000	002127-103	RES CF 1/4W 10K OHM 5% R96 R103 R105	R108 R111
070	1.0000	002127-104	RES CF 1/4W 100K OHM 5%	

		R91		
076	1.0000 002127-105	RES CF 1/4W 1M OHM 5%		
		R48		
063	1.0000 002127-123	RES CF 1/4W 12K OHM 5%		
		R107		
054	1.0000 002127-132	RES CF 1/4W 1.3K OHM 5%		
		R94		
071	1.0000 002127-134	RES CF 1/4W 130K OHM 5%		
		R90		
064	1.0000 002127-153	RES CF 1/4W 15K OHM 5%		
		R20		
056	10.0000 002127-202	RES CF 1/4W 2K OHM 5%	R26	R37
		R10 R11 R25		
056	10.0000 002127-202	RES CF 1/4W 2K OHM 5%	R112	R113
		R43 R58 R110		
066	3.0000 002127-203	RES CF 1/4W 20K OHM 5%		
		R44 R60 R115		
072	5.0000 002127-204	RES CF 1/4W 200K OHM 5%	R57	R59
		R39 R45 R52		
049	1.0000 002127-301	RES CF 1/4W 300 OHM 5%		
		R50		
057	2.0000 002127-302	RES CF 1/4W 3K OHM 5%		
		R12 R99		
068	2.0000 002127-303	RES CF 1/4W 30K OHM 5%		
		R87 R97		
073	1.0000 002127-304	RES CF 1/4W 300K OHM 5%		
		R46		
050	1.0000 002127-391	RES CF 1/4W 390 OHM 5%		
		R89		
058	2.0000 002127-472	RES CF 1/4W 4.7K OHM 5%		
		R100 R101		
059	4.0000 002127-512	RES CF 1/4W 5.1K OHM 5%		R95
		R36 R53 R88		
069	1.0000 002127-513	RES CF 1/4W 51K OHM 5%		
		R42		
074	1.0000 002127-514	RES CF 1/4W 510K OHM 5%		
		R75		
000	2.0000 002127-621	RES CF 1/4W 620 OHM 5%		
		R92 R106		
060	1.0000 002127-622	RES CF 1/4W 6.2K OHM 5%		
		R49		
061	1.0000 002127-912	RES CF 1/4W 9.1K OHM 5%		
		R16		
079	1.0000 002129-7109	RES CF 1/2W 1 OHM 5%		
		R121		
086	1.0000 002129-7302	RES CF 1/2W 3000 OHM 5%		

		R13	
011	1.0000 002129-7470	RES CF 1/2W 47 OHM 5%	
		R9	
082	2.0000 002129-7479	RES CF 1/2W 4.7 OHM 5%	
		R119 R120	
022	12.0000 011047-018	DIODE 1N483B RECT 70V 200MA	
		CR9 CR10 CR11 CR12 CR13	
022	12.0000 011047-018	DIODE 1N483B RECT 70V 200MA	
		CR14 CR15 CR16 CR18 CR19	
022	12.0000 011047-018	DIODE 1N483B RECT 70V 200MA	
		CR25 CR26	
015	1.0000 001000-025	CAP TANT DIP 20V 100UF 20% RAD	
		C77	
005	6.0000 001000-043	CAP TANT DIP 25V 10UF 20% RAD	
		C13 C19 C22 C50 C64	
005	6.0000 001000-043	CAP TANT DIP 25V 10UF 20% RAD	
		C74	
008	4.0000 001023-4018	CAP CER MONO 50V .22UF 10% RAD	
		C27 C35 C47 C58	
014	23.0000 001023-4025	CAP CER MONO 50V .1UF 10% RAD	
		C10 C11 C12 C14 C15	
014	23.0000 001023-4025	CAP CER MONO 50V .1UF 10% RAD	
		C16 C18 C20 C21 C24	
014	23.0000 001023-4025	CAP CER MONO 50V .1UF 10% RAD	
		C32 C36 C51 C54 C55	
014	23.0000 001023-4025	CAP CER MONO 50V .1UF 10% RAD	
		C57 C62 C68 C69 C72	
014	23.0000 001023-4025	CAP CER MONO 50V .1UF 10% RAD	
		C73 C76 C78	
003	1.0000 001023-4026	CAP CER MONO 50V .0022UF 10% RAD	
		C17	
009	4.0000 001023-4033	CAP CER MONO 50V .022UF 10% RAD	
		C25 C26 C29 C71	
004	8.0000 001025-013	CAP TANT DIP 35V 1UF 10% RAD	
		C28 C30 C31 C33 C34	
004	8.0000 001025-013	CAP TANT DIP 35V 1UF 10% RAD	
		C37 C60 C70	
012	2.0000 001323-002	CAP CER 100V .01UF 10% RAD	
		C23 C48	
011	11.0000 001323-011	CAP CER 50V .047UF 10% RAD	
		C1 C2 C3 C4 C5	
011	11.0000 001323-011	CAP CER 50V .047UF 10% RAD	
		C6 C7 C8 C9 C59	
011	11.0000 001323-011	CAP CER 50V .047UF 10% RAD	
		C61	
030	1.0000 002078-006	RES NET 1.5W 100K OHM 2%	

		R126			
029	2.0000	002078-014	RES NET 1.5W 2K OHM 2%		
			R124 R125		
045	2.0000	002101-2492	RES MF 1/10W 24.9K OHM1%		
			R82 R83		
034	1.0000	002126-123	RES SIP 5@ 2K OHM BUSSED 6 PIN		
			R27		
033	2.0000	002126-323	RES SIP NET 2K OHM 10 PIN COM		
			R14 R109		
031	4.0000	002126-328	RES SIP NET 4700 OHM 10 PIN CO		
			R21 R23 R24 R18		
032	2.0000	002126-332	RES SIP NET 10K OHM 10 PIN COM		
			R15 R22		
075	2.0000	002127-754	RES CF 1/4W 750K OHM 5%		
			R51 R54		
000	2.0000	002129-7102	RES CF 1/2W 1K OHM 5%		
			R33 R35		
000	1.0000	002129-7202	RES CF 1/2W 2K OHM 5%		
			R31		
000	8.0000	002129-7209	RES CF 1/2W 2.0 OHM 5%		
			R1 R2 R3 R4 R5		
000	8.0000	002129-7209	RES CF 1/2W 2.0 OHM 5%		
			R6 R7 R8		
000	1.0000	002129-7241	RES CF 1/2W 240 OHM 5%		
			R34		
000	1.0000	002129-7279	RES CF 1/2W 2.7 OHM 5%		
			R116		
036	1.0000	002155-103	RES VAR CER 1/2W 10K OHM 20%		
			R123		
078	1.0000	002206-000	RES WW 2W .51 OHM 5%		
			R29		
095	3.0000	003220-373	IC 74C373 PLA OCT LAT 20DIP		
			U7 U31 U34		
104	2.0000	003309-244	IC 54LS244J 3ST BUF 20DIP		
			U20 U33		
000	1.0000	003310-001	IC 4N46 IND OPTO 6DIP		
			U1		
096	5.0000	003317-244	IC 74HC244 IND 3ST BUF 20DIP		
			U8 U10 U11 U12 U16		
102	1.0000	003324-047	IC 4047 IND MONO MUV 14DIP		
			U29		
026	1.0000	004143-000	XSTR 2N4400 NPN 40V .6A TO92		
			Q9		
021	8.0000	011013-035	DIODE 1N6284A 1.5KE36A TS PLA		
			CR1 CR2 CR3 CR4 CR5		
021	8.0000	011013-035	DIODE 1N6284A 1.5KE36A TS PLA		

		CR6 CR7 CR8
017	2.0000 011018-14A	DIODE 1N4742A ZEN 1W 12V 5%
		CR24 CR27
018	1.0000 011036-000	DIODE 1N5908 6V TS
		CR17
020	3.0000 011043-006	DIODE 1N4007 RECT 1KV 1A
		CR22 CR23 CR28
019	1.0000 011061-231	DIODE 1N5355B ZEN 18V 5W 5%
		CR21
002	0.3000 012007-000	WIRE BUS 22AWG
027	132.0000 014061-1058	BEAD GLASS .034 ID .0970 .074L
023	5.0000 032805-008	HEADER PIN 8 POS
007	2.0000 032834-000	CONN SHUNT 2 POS LOW PROFILE
028	0.2000 033064-4000	TUBING NO 22 TEFLON RED
048	1.0000 132018-001	SCKT IC 14PIN .3W
037	1.0000 900048-000	RES VARIABLE 10K (VOLUME)
		R122
010	4.0000 900069-000	CAP .0022UF 5% CD19FD222J03
		C63 C64 C65 C66
013	1.0000 900070-000	CAP .001UF 5% CD19FD102J03
		C67
110	3.0000 900125-000	CHOKER RF IRON CORE 39UH
		L1 L2 L3
108	1.0000 900134-000	CONN 2 PIN RIGHT
		J3
025	8.0000 900161-000	TRANSISTOR MPSA26
		Q1 Q2 Q3 Q4 Q5
025	8.0000 900161-000	TRANSISTOR MPSA26
		Q6 Q7 Q8
006	1.0000 900200-000	CAP 40V 140UF 601D147G040FE4
		C75
016	1.0000 005599-000	EJECTOR W/ROLL PIN
109	1.0000 007170-004	RLY W172 DIP-3
		K1
111	2.0000 900073-000	SWITCH 8 POLE DIP 206-8
		S1 S2
112	1.0000 900074-000	SWITCH 4 POLE DIP
		S3
000	1.0000 080774-110	PROC TALKER SPEECH BOARD TEST



SCALE	1 : 1	HARMON ELECTRONICS, INC.		
APPROVED	S.V.	GRAIN VALLEY, MO. U.S.A. 64029		
DATE	5/91	TITLE TALKER SPEECH BOARD FINAL ASSEMBLY		
DRAWN BY	P.BROWN			
DATE	3/91	ENGINEER	DRAWING NO.	SHEET
			225815-000	1 of 1

PARENT: 226171-000

DESC: ASSY SERVO INTERFACE BD

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOLS	
000	1.0000	002127-821	RES CF 1/4W 820 OHM 5 % R43		
095	1.0000	013002-012	WASHER 4 INTL SS		
096	1.0000	013009-3401	NUT 4-40 HEX SS		
097	1.0000	013492-1414	SCREW 4-40 X 7/16 PPH ZPS		
098	1.0000	033064-8000	TUBING NO 14 TEFLON RED		
000	1.0000	033255-000	FISH PAPER SERVO OVRLY BD		
028	1.0000	002101-1001	RES MF 1/10W 1K OHM 1 % R10		
000	1.0000	002101-1301	RES MF 1/10W 1.30K OHM1 % R5		
011	1.0000	002101-1501	RES MF 1/10W 1500 OHM 1 % R45		
024	1.0000	002101-2000	RES MF 1/10W 200 OHM 1 % R4		
022	1.0000	002101-2491	RES MF 1/10W 2490 OHM 1 % R2		
092	1.0000	002101-4990	RES MF 1/10W 499 OHM 1 % R8		
055	1.0000	002127-100	RES CF 1/4W 10 OHM 5 % R99		
077	5.0000	002127-101	RES CF 1/4W 100 OHM 5 % R69 R86 R92	R97	R98
036	6.0000	002127-102	RES CF 1/4W 1K OHM 5 % R21 R28 R33	R40	R49
036	6.0000	002127-102	RES CF 1/4W 1K OHM 5 % R50		
053	2.0000	002127-103	RES CF 1/4W 10K OHM 5 % R65 R82		
034	4.0000	002127-104	RES CF 1/4W 100K OHM 5 % R19 R31 R62	R79	
049	2.0000	002127-105	RES CF 1/4W 1M OHM 5 % R57 R74		
090	4.0000	002127-154	RES CF 1/4W 150K OHM 5 % R59 R61 R76	R78	
029	4.0000	002127-201	RES CF 1/4W 200 OHM 5 % R13 R14 R70	R87	
037	6.0000	002127-203	RES CF 1/4W 20K OHM 5 % R22 R34 R54	R58	R71
037	6.0000	002127-203	RES CF 1/4W 20K OHM 5 % R75		
021	1.0000	002127-279	RES CF 1/4W 2.7 OHM 5 %		

		R1			
054	2.0000 002127-302	RES CF 1/4W 3K OHM 5%			
		R66 R83			
089	2.0000 002127-303	RES CF 1/4W 30K OHM 5%			
		R60 R77			
080	2.0000 002127-333	RES CF 1/4W 33K OHM 5%			
		R94 R96			
048	2.0000 002127-334	RES CF 1/4W 330K OHM 5%			
		R56 R73			
051	2.0000 002127-513	RES CF 1/4W 51K OHM 5%			
		R93 R95			
052	4.0000 002127-753	RES CF 1/4W 75K OHM 5%			
		R63 R64 R80	R81		
047	2.0000 002127-754	RES CF 1/4W 750K OHM 5%	R55	R72	
000	5.0000 002129-7101	RES CF 1/2W 100 OHM 5%			
		R16 R24 R25	R36	R37	
000	2.0000 002129-7103	RES CF 1/2W 10K 5%			
		R7 R12			
000	2.0000 002129-7153	RES CF 1/2W 15K 5%			
		R26 R38			
000	2.0000 002129-7301	RES CF 1/2W 300 OHM 5%			
		R29 R41			
057	1.0000 003137-002	IC LM224J CER OPAMP 14DIP			
		U2			
056	1.0000 003469-001	IC SG2526J IND PWM 16DIP			
		U1			
064	6.0000 011047-018	DIODE 1N483B RECT 70V 200MA			
		CR1 CR6 CR41 CR42 CR45			
064	6.0000 011047-018	DIODE 1N483B RECT 70V 200MA			
		CR46			
002	1.0000 062025-000	PC BD SERVO INTERFACE			
017	8.0000 001000-051	CAP TANT DIP 20V 10UF 20% RAD			
		C1 C2 C3 C8 C13			
017	8.0000 001000-051	CAP TANT DIP 20V 10UF 20% RAD			
		C31 C42 C53			
014	1.0000 001049-064	CAP CER 50V .22UF 10% RAD			
		C29			
020	1.0000 001065-022	CAP ELEC 40V 200UF AXL			
		C20			
005	2.0000 001323-001	CAP CER 200V 100PF 10% X7R RAD			
		C21 C25			
009	5.0000 001323-002	CAP CER 100V .01UF 10% RAD			
		C5 C52 C64 C70 C71			
012	14.0000 001323-003	CAP CER 50V .1UF 10% RAD			
		C6 C7 C9 C11 C12			
012	14.0000 001323-003	CAP CER 50V .1UF 10% RAD			

			C14	C19	C30	C32	C39
012	14.0000	001323-003	CAP CER 50V .1UF 10% RAD				
			C40	C41	C54	C4	
007	1.0000	001323-006	CAP CER 100V 2200PF 10% RAD				
			C18				
003	2.0000	001323-007	CAP CER 200V 33PF 10% RAD				
			C45	C57			
006	8.0000	001323-009	CAP CER 200V 470PF 10% RAD				
			C22	C26	C44	C46	C48
006	8.0000	001323-009	CAP CER 200V 470PF 10% RAD				
			C56	C58	C60		
008	4.0000	001323-010	CAP CER 100V .0047UF 10% RAD				
			C49	C51	C61	C62	
000	2.0000	001333-000	CAP POWERLYTIC 400V 47UF AXL				
			C35	C36			
031	1.0000	002007-007	RES CC 1W 10 OHM 10%				
			R90				
045	2.0000	002007-055	RES CC 1W .1M OHM 10%				
			R52	R53			
046	2.0000	002102-1001	RES FIXED PRECISION 1K OHM 1%				
			R48	R51			
042	3.0000	002127-000	RES CF 1/4W 0 OHM 5%				
			R42	R67	R84		
035	2.0000	002127-202	RES CF 1/4W 2K OHM 5%				
			R20	R32			
091	2.0000	002127-205	RES CF 1/4W 2M OHM 5%				
			R100	R101			
000	1.0000	002129-7202	RES CF 1/2W 2K OHM 5%				
			R17				
000	2.0000	002129-7203	RES CF 1/2W 20K 5%				
			R46	R47			
000	1.0000	002129-7204	RES CF 1/2W 200K 5%				
			R15				
058	2.0000	003467-000	IC LM101A MIL OPAMP TO5				
			U3	U4			
062	2.0000	004062-002	XSTR 2N3440 NPN 250V 1A TO39				
			Q7	Q9			
000	1.0000	005599-000	EJECTOR W/ROLL PIN				
066	6.0000	011018-33A	DIODE 1N4761A ZEN 1W 75V 5%				
			CR15	CR17	CR19	CR24	CR27
066	6.0000	011018-33A	DIODE 1N4761A ZEN 1W 75V 5%				
			CR28				
067	6.0000	011114-026	DIODE 1N5309 C-REG .6W 3MA				
			CR16	CR18	CR20	CR25	CR26
067	6.0000	011114-026	DIODE 1N5309 C-REG .6W 3MA				
						CR29	
000	8.0000	014061-1058	BEAD GLASS .034 ID .0970 .074L				

070	2.0000	016173-000	XFMR T1,T2 T1 T2
071	1.0000	016174-000	XFMR T4 T4
072	2.0000	032805-002	HEADER PIN 2 POS E2 E3
073	2.0000	032805-003	HEADER PIN 3 POS E4 E5
097	4.0000	032834-000	CONN SHUNT 2 POS LOW PROFILE
001	1.0000	035757-000	SCHEM SERVO INTERFACE BD
000	1.0000	080774-003	PROC PWB SERVO INTERFACE
093	1.0000	900086-000	SOCKET 14 PIN 300-14-CC-B-LL
018	3.0000	900684-000	CAP 300V 15UF 39D156F300EL4 C17 C23 C27
083	1.0000	900694-000	HEADER LOCKING 09-75-1078 J3
078	1.0000	900696-000	RES 2W 2 OHM 5% R91
010	4.0000	900698-000	CAP 600V .01UF 431P10396 C24 C28 C34 C38
019	8.0000	900699-000	CAP 35V 20UF 10 % 33MM2005K035 C47 C50 C59 C63
013	1.0000	900702-000	CAP 400V .1UF 431P10494 C16
015	2.0000	900703-000	CAP 200V 1UF 431P10592 C43 C55
026	1.0000	900708-000	RES 2W 3 OHM R6
065	22.0000	900711-000	DIODE 1N4937 CR2 CR3 CR4 CR5 CR7
065	22.0000	900711-000	DIODE 1N4937 CR8 CR9 CR10 CR11 CR12
065	22.0000	900711-000	DIODE 1N4937 CR13 CR14 CR21 CR34 CR35
065	22.0000	900711-000	DIODE 1N4937 CR36 CR37 CR38 CR39
065	22.0000	900711-000	DIODE 1N4937 CR33 CR30 CR40
061	6.0000	900713-000	IC MPF 960 Q3 Q4 Q5 Q6 Q12
061	6.0000	900713-000	IC MPF 960 Q13
004	4.0000	900718-000	CAP 500V 47PF CM04ED470J03 C10 C15 C33 C37
068	3.0000	900720-000	INDUCTOR 55UH L1 L2 L3
069	1.0000	900721-000	TRANS T3 32245

		T3
000	1.0000 D226171-000	ASSY SERVO INTERFACE BOARD
023	3.0000 002188-001	RES VAR CER 1/2W 1K OHM
		R3 R9 R44
040	2.0000 002188-002	RES VAR CER 1/2W 10K OHM
		R27 R39
038	4.0000 002188-003	RES VAR CER 1/2W 100K OHM
		R23 R35 R68 R85
059	1.0000 003230-001	IC LM217 IND ADJ TO3
		Q1
060	2.0000 003470-002	IC L200T MIL 1.5AMPR ADJ TO3
		Q2 Q11
081	1.0000 004081-001	XSTR 2N4403 PNP 40V .6A TO92
		Q14
063	2.0000 004145-000	XSTR TIP47 PNP 350V 1A TO220
		Q8 Q10
086	8.0000 013009-3601	NUT 6-32 5/16 HEX SS
084	2.0000 013492-3614	SCREW 6-32 X 7/16 PPH SS
088	0.0010 029312-001	HEATSINK COMPOUND #340
000	1.0000 125036-000	LABEL DANGER HIGH VOLTAGE
075	1.0000 201155-000	ASSY COMPENSATION MODULE
		CM1

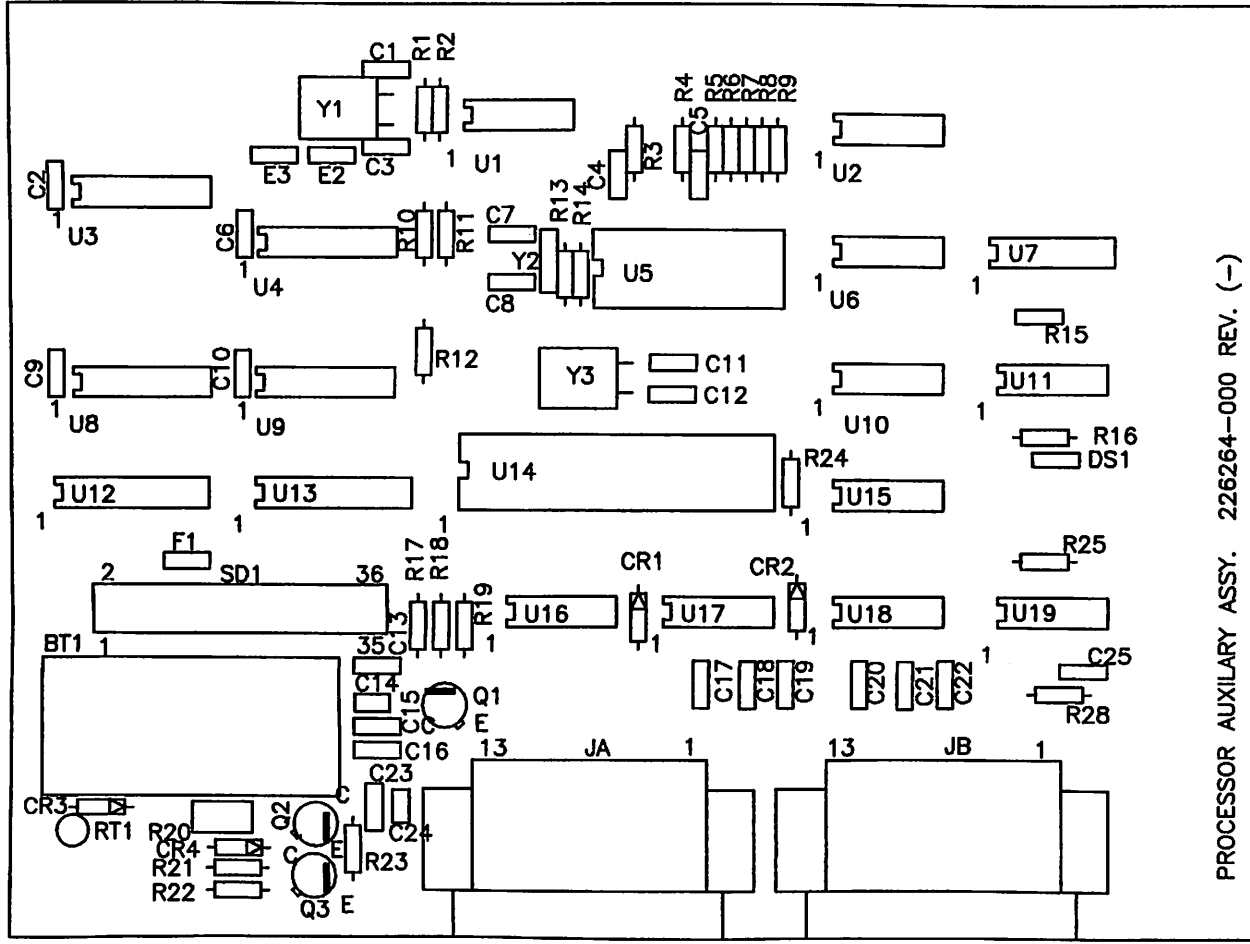
PARENT: 226264-000

DESC: ASSY TLK/HBD/HWD TIME/DATE SER

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOLS
043	7.0000	002127-102	RES CF 1/4W 1K OHM 5%	
			R8 R9 R17 R18 R19 R23 R26	
047	3.0000	002127-103	RES CF 1/4W 10K OHM 5%	
			R10 R11 R12	
048	1.0000	002127-104	RES CF 1/4W 100K OHM 5%	
			R1	
044	1.0000	002127-152	RES CF 1/4W 1.5K OHM 5%	
			R21	
045	6.0000	002127-202	RES CF 1/4W 2K OHM 5%	
			R3 R5 R6 R7 R17 R25	
042	2.0000	002127-471	RES CF 1/4W 470 OHM 5%	
			R16 R22	
046	2.0000	002127-472	RES CF 1/4W 4.7K OHM 5%	
			R4 R24	
007	2.0000	003309-008	IC 54LS08J MIL 2IN NAND 14DIP	
			U6 U11	
004	2.0000	003309-032	IC 54LS32J MIL 2IN OR 14DIP	
			U2 U19	
009	1.0000	003309-033	IC 54LS33J MIL 2IN NOR 14DIP	
			U10	
003	1.0000	003317-002	IC 74HCO2 IND 2IN NOR 14DIP	
			U1	
008	1.0000	003329-138	IC 74HCT138 IND 3-8 MUX 16DIP	
			U7	
000	1.0000	003329-245	IC 74HCT245 IND B/L TRAN 20DP	
			U13	
000	1.0000	003329-373	IC 74HCT373 INDD LAT 20DIP	
			U12	
006	1.0000	003468-000	IC MC146818 IND RTC 24DIP	
			U5	
005	4.0000	003471-000	IC X2212 IND 256X4 NVSRAM 18DP	
			U3 U4 U8 U9	
014	2.0000	003472-000	IC SN55188 MIL LN DRVR 14DIP	
			U17 U18	
000	1.0000	003473-000	IC 8530 MIL COMM CTRL 40DIP	
			U14	
001	1.0000	062034-000	PC BD TLK/HBD/HWD TIME/DATE IO	
039	2.0000	001000-043	CAP TANT DIP 25V 10UF 20% RAD	
			C14 C24	
032	1.0000	001323-000	CAP CER 200V 10PF 10% X7R RAD	
			C7	
036	2.0000	001323-002	CAP CER 100V .01UF 10% RAD	

000	8.0000	001323-003	C4 C5 CAP CER 50V .1UF 10% RAD C2 C6 C9 C10 C13 C1 C5 C16 C23
033	4.0000	001323-004	CAP CER 200V 18PF 10% RAD C1 C3 C11 C12
034	1.0000	001323-005	CAP CER 200V 22PF 10% RAD C8
035	6.0000	001323-008	CAP CER 200V 330PF 10% RAD C17 C18 C19 C20 C21 C22
050	2.0000	002127-206	RES CF 1/4W 20M OHM 5% R2 R14
049	1.0000	002127-304	RES CF 1/4W 300K OHM 5% R13
041	1.0000	02129-7510	RES CF 1/2W 51 OHM 5% R20
017	2.0000	004081-001	XSTR 2N4403 PNP 40V .6A TO92 Q1 Q2
018	1.0000	004143-001	XSTR 2N4401 NPN 40V .6A TO92 Q3
019	2.0000	011044-000	DIODE 1N5819 SCH RECT 40V 1A1 CR3 CR4
029	1.0000	012007-009	WIRE BUS 24AWG
000	14.0000	014061-1058	BEAD GLASS .034 ID .0970 .074L
028	3.0000	032805-003	CONN HDR 1X3PIN MAL .1CN E1 E2 E3
031	3.0000	032834-000	CONN SHUNT 2POS .1CN
002	1.0000	035826-000	SCHEM TLK/HBD/HWD TIME/DATE IO
000	1.0000	080613-000	PROC HBD TIME/DATE COMM TEST
052	1.0000	080774-004	PROC SERIAL IO-REAL TIME CLOCK
021	1.0000	900080-000	LED RED 555-2001 DS1
013	2.0000	900725-000	IC SN55189AJ RS232C RECEIVER U15 U16
026	2.0000	900734-000	CONN 25 PIN DBP25SA JA JB
040	1.0000	900749-000	CAP 100PF CD15FD101F03 C25
022	1.0000	002031-009	RES THERMISTOR 50 OHM RT1
050	4.0000	005471-306	SPACER 4-40 X .25 X .5 RND SS
020	2.0000	011043-006	DIODE 1N4007 RECT 1KV 1A CR1 CR2
024	1.0000	015033-010	CRYS 32.768KHZ .003% Y2
030	1.0000	017060-000	BATT 3.6V

027	1.0000	900680-000	BT1 CONN 36 POS SD1
023	2.0000	900728-000	CRYSTAL 4MHZ MPC18-2 Y1 Y3



PROCESSOR AUXILIARY ASSY. 226264-000 REV. (-)

SCALE	1 : 1	HARMON ELECTRONICS, INC.		
BY	APPROVED	GRAIN VALLEY, MO. U.S.A. 64029		
DATE	DATE	TITLE		
EDRN	DRAWN BY	PC DESIGN B77		
DATE	ENGINEER	PROCESSOR AUX.BD.		
REV	DATE	DRAWING NO.	226264-006	SHEET 1 of 1

PARENT: 226348-007

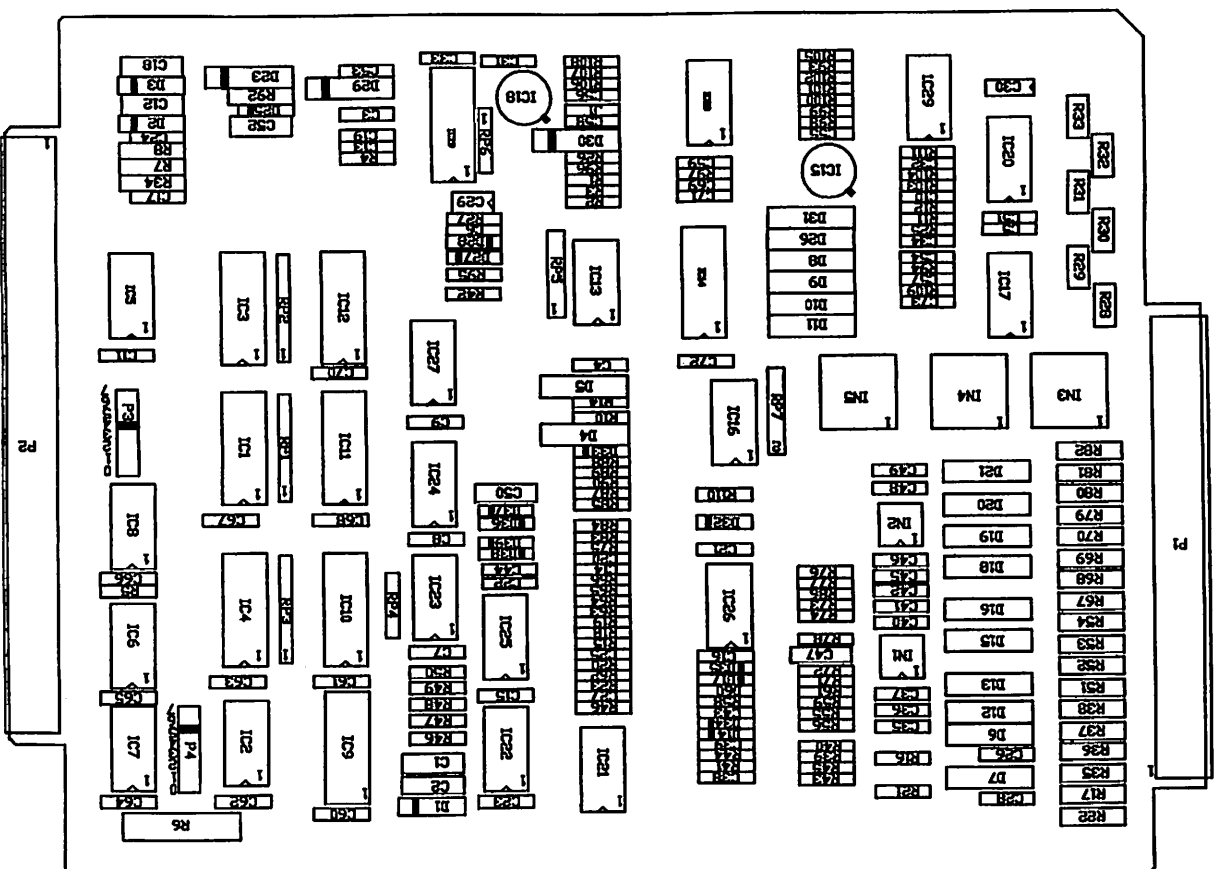
DESC: ASSY HBD/HWD ANALOG II I/O BAS

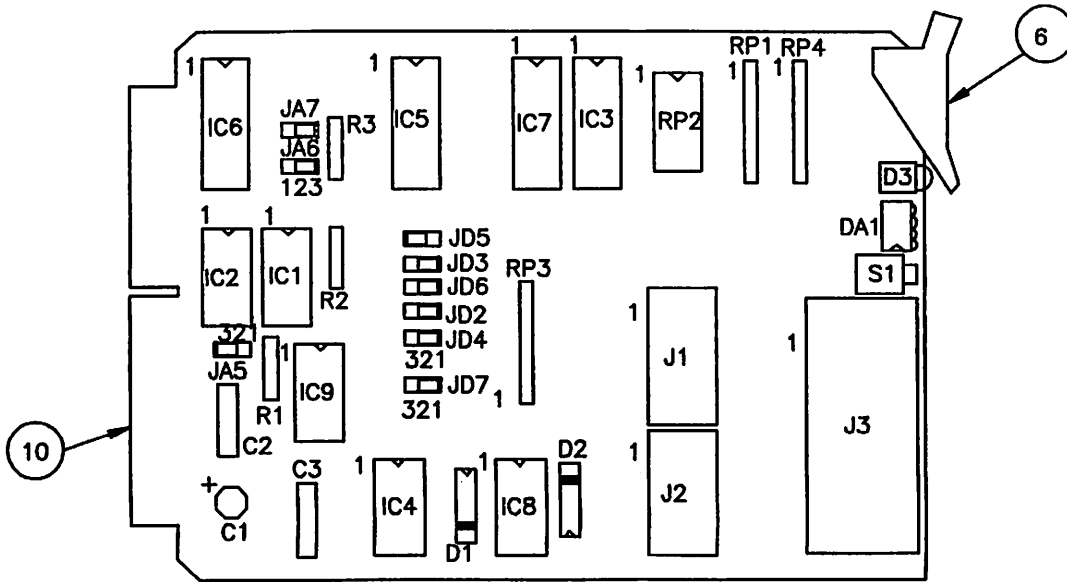
DIN	USAGE	COMP PART	COMP_DESC	SYMBOLS
002	2.0000	001249-012	CAP CER SPIN 100V .01UF 20% 25 C26 C28	
004	6.0000	001258-038	CAP CER SPIN 50V .01UF 10% X7R C25 C27 C37 C38	C42
004	6.0000	001258-038	CAP CER SPIN 50V .01UF 10% X7R C43	
005	10.0000	001258-042	CAP CER SPIN 50V .022UF 10% X7 C35 C36 C40 C41	C45
005	10.0000	001258-042	CAP CER SPIN 50V .022UF 10% X7 C46 C48 C49 C54	C57
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C3 C4 C5 C6	C7
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C8 C9 C10 C11	C13
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C14 C15 C16 C17	C19
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C20 C21 C22 C23	C24
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C31 C32 C33 C34	C39
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C44 C51 C53 C55	C56
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C58 C59 C60 C61	C62
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C63 C64 C65 C66	C67
037	45.0000	001258-062	CAP CER SPIN 50V .1UF 10% X7R C68 C69 C70 C72	C73
006	2.0000	001258-070	CAP CER SPIN 50V .22UF 10% X7R C47 C50	
011	3.0000	002101-1002	RES MF 1/10W 10K OHM 1% R99 R102 R108	
012	1.0000	002101-1052	RES MF 1/10W 10.5K OHM1% R107	
015	5.0000	002101-2001	RES MF 1/10W 2000 OHM 1% R10 R14 R18	R23 R27
016	2.0000	002101-3162	RES MF 1/10W 31.6K OHM 1 R98 R101	
018	1.0000	002101-4531	RES MF 1/10W 4530 OHM 1% R96	
051	1.0000	002101-5902	RES MF 1/10W 59K OHM 1% R26	
050	1.0000	002101-9531	RES MF 1/10W 9530 OHM 1%	

			R97		
019	5.0000	002127-102	RES CF 1/4W 1K OHM 5%		
			R11 R93 R100	R104	R106
020	16.0000	002127-103	RES CF 1/4W 10K OHM 5%		
			R25 R39 R40	R42	R43
020	16.0000	002127-103	RES CF 1/4W 10K OHM 5%		
			R45 R55 R56	R59	R61
020	16.0000	002127-103	RES CF 1/4W 10K OHM 5%		
			R71 R73 R77	R83	R85
020	16.0000	002127-103	RES CF 1/4W 10K OHM 5%		
			R89		
021	5.0000	002127-104	RES CF 1/4W 100K OHM 5%		
			R15 R20 R46	R48	R64
022	2.0000	002127-105	RES CF 1/4W 1M OHM 5%		
			R94 R109		
023	2.0000	002127-153	RES CF 1/4W 15K OHM 5%		
			R44 R60		
024	6.0000	002127-202	RES CF 1/4W 2K OHM 5%		
			R1 R2 R3	R5	R95
024	6.0000	002127-202	RES CF 1/4W 2K OHM 5%		
			R110		
025	4.0000	002127-203	RES CF 1/4W 20K OHM 5%		
			R41 R58 R76	R88	
026	2.0000	002127-204	RES CF 1/4W 200K OHM 5%		
			R50 R65		
027	2.0000	002127-303	RES CF 1/4W 30K OHM 5%		
			R72 R84		
028	3.0000	002127-392	RES CF 1/4W 3.9K OHM 5%		
			R49 R62 R66		
029	2.0000	002127-470	RES CF 1/4W 47 OHM 5%		
			R16 R21		
030	5.0000	002127-472	RES CF 1/4W 4.7K OHM 5%		
			R4 R47 R63	R75	R86
000	1.0000	002127-473	RES CF 1/4W 47K OHM 5%		
			R111		
031	4.0000	002127-514	RES CF 1/4W 510K OHM 5%		
			R74 R78 R87	R90	
033	1.0000	002129-7100	RES CF 1/2W 10 OHM 5%		
			R34		
035	1.0000	002129-7301	RES CF 1/2W 300 OHM 5%		
			R92		
034	2.0000	002129-7470	RES CF 1/2W 47 OHM 5%		
			R17 R22		
010	16.0000	002129-7472	RES CF 1/2W 4.7K OHM 5%		
			R35 R36 R37	R38	R51
010	16.0000	002129-7472	RES CF 1/2W 4.7K OHM 5%		

		R52	R53	R54	R67	R68
010	16.0000	002129-7472	RES CF 1/2W 4.7K OHM 5%			
			R69	R70	R79	R80
010	16.0000	002129-7472	RES CF 1/2W 4.7K OHM 5%			R81
			R82			
032	2.0000	002129-7479	RES CF 1/2W 4.7 OHM 5%			
			R7	R8		
040	2.0000	003137-002	IC LM224J CER OPAMP 14DIP			
			IC13	IC21		
019	1.0000	003265-002	IC ADC0803 IND 8BIT A/D 20DIP			
			IC19			
043	2.0000	003317-003	IC 74HC03 IND 2IN NAND 14DIP			
			IC23	IC27		
051	3.0000	003317-032	IC 74HC32 IND 2IN OR 14DIP			
			IC2	IC5	IC8	
044	1.0000	003317-086	IC 74HC86 IND XOR 14DIP			
			IC24			
045	2.0000	003317-138	IC 74HC138 IND 3-8 DEM 16DIP			
			IC6	IC7		
022	3.0000	003317-244	IC 74HC244 IND 3ST BUF 20DIP			
			IC1	IC3	IC4	
021	4.0000	003317-374	IC 74HC374 IND DFF LAT 20DIP			
			IC9	IC10	IC11	IC12
041	2.0000	003324-051	IC 4051 IND SNGL 8CHAN 16DIP			
			IC17	IC20		
042	3.0000	003324-052	IC 4052 IND DIF ACHAN MUL 16DP			
			IC16	IC28	IC29	
048	3.0000	003476-000	IC LM219 IND COMP 14DIP			
			IC22	IC25	IC26	
018	1.0000	003523-000	IC AD7226BQ IND 8BIT D/A 20DIP			
			IC14			
055	10.0000	011002-003	DIODE 1N914B FAS RCV 100V 150M			
			D14	D17	D28	D33
055	10.0000	011002-003	DIODE 1N914B FAS RCV 100V 150M			
			D35	D36	D37	D38
062	2.0000	011018-06A	DIODE 1N4734A ZEN 1W 5.6V 5%			D39
			D27	D32		
059	1.0000	011018-07A	DIODE 1N4735A ZEN 1W 6.2V 5%			
			D25			
030	1.0000	035955-000	SCHEM HBD/HWD ANALOG II I/O			
065	1.0000	061435-000	PC BD HBD/HWD ANALOG II I/O			
040	1.0000	080819-000	PROC HBD/HWD ANALOG II I/O TST			
003	5.0000	001152-099	CAP TANT SOL 25V 10UF 10% AXL			
			C1	C2	C12	C18
002	1.0000	001305-5201	CAP SIL MICA 500V 200PF 2% RAD			C52
			C30			

001	1.0000	001305-6680	CAP SIL MICA 500V 68PF 5% RAD C29	
017	2.0000	002101-3001	RES MF 1/10W 3K OHM 1% R19 R24	
005	1.0000	002126-123	RES SIP 5@ 2K OHM BUSSED 6 PIN RP4	
006	1.0000	002126-323	RES SIP NET 2K OHM 10 PIN COM RP3	
007	2.0000	002126-332	RES SIP NET 10K OHM 10 PIN COM RP1 RP2	
008	1.0000	002126-432	RES SIP NET 10K 6 PIN RP6	
012	1.0000	002126-523	RES SIP NET 2K OHM 8 PIN ISO RP7	
009	1.0000	002126-532	RES SIP NET 10K OHM 8 PIN RP5	
010	1.0000	002206-000	RES WW 2W .51 OHM 5% R6	
016	1.0000	003177-002	IC REF-02H COM 5VREG TO78 IC15	
017	1.0000	003477-000	IC LF256 IND MONO OPAMP TO99 IC18	
056	1.0000	011013-019	DIODE 1N6276A 1.5KE16A TS PLA	
059	2.0000	011013-020	DIODE 1N6277 1.5KE18 TS PLA D2 D3	
057	12.0000	011013-102	DIODE 1N6268C 1.5KE7.5C TS PLA D8 D9 D10 D11	D12
057	12.0000	011013-102	DIODE 1N6268C 1.5KE7.5C TS PLA D13 D15 D16 D18	D19
057	12.0000	011013-102	DIODE 1N6268C 1.5KE7.5C TS PLA D20 D21	
058	2.0000	011013-115	DIODE 1N6274CA 1.5KE13CA TS PL D6 D7	
060	1.0000	011036-000	DIODE 1N5908 6V TS D1	
000	4.0000	014061-1058	BEAD GLASS .034 ID .0970 .074L	
027	2.0000	032049-001	SCKT IC 8 PIN .1CN .3W	
025	4.0000	032805-008	HEADER PIN 8 POS P3 P4	
026	2.0000	032834-000	CONN SHUNT 2 POS LOW PROFILE	
028	3.0000	900086-000	SOCKET 14 PIN 300-14-CC-B-LL IN3 IN4 IN5	
011	6.0000	002249-000	RES POT VERT MNT 10K S-TURN R28 R29 R30 R31	R32
011	6.0000	002249-000	RES POT VERT MNT 10K S-TURN R33	

[illegible]



SCALE	1 : 1	HARMON ELECTRONICS, INC. GRAIN VALLEY, MO. U.S.A. 64029		
APPROVED	GOODWYN			
DATE	1/21/87	TITLE DCP-2 ACCESSORY BOARD ASSEMBLY PRINT		
DRAWN BY	D.LANNING			
DATE	8/27/86	ENGINEER JOHN McNEIL	DRAWING NO. 226444-000	SHEET 1 of 1

PARENT: 226459-000

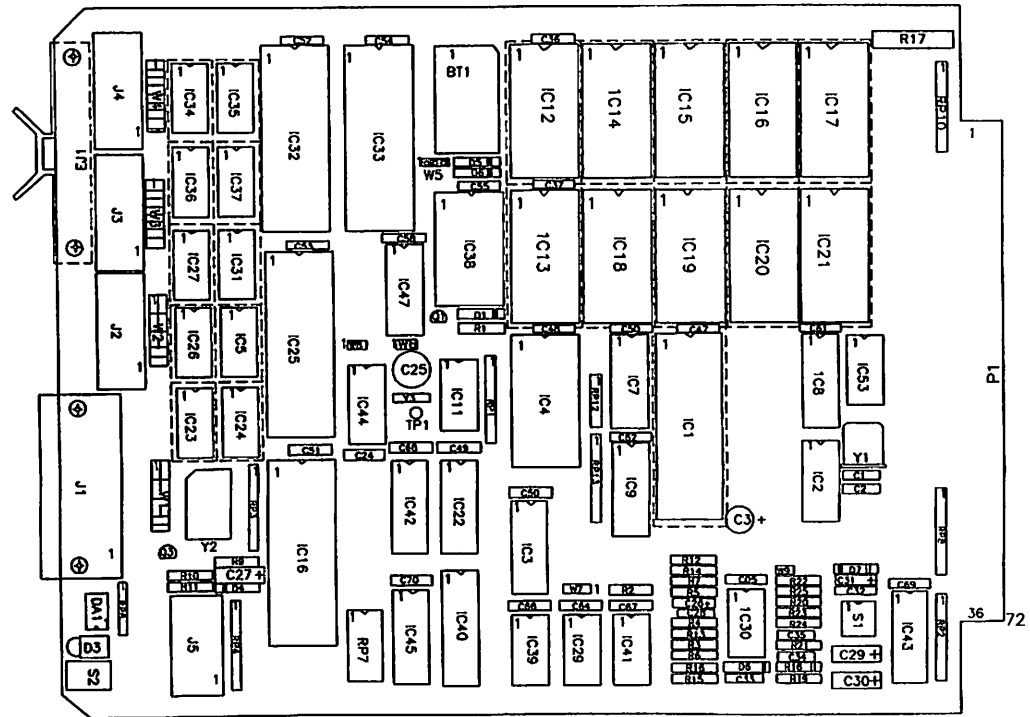
DESC: ASSY DCP-3 CPU

DIN	USAGE	COMP_PART	COMP_DESC	SYMBOLS
076	1.0000	002078-016	RES DIP 16 PIN 330K RP7	
044	1.0000	003174-007	IC LM239J IND COMP 14DIP IC30	
043	1.0000	003317-000	IC 74HC00 IND 2IN NAND 14DIP IC29	
048	2.0000	003317-032	IC 74HC32 IND 2IN OR 14DIP IC39 IC41	
035	1.0000	003317-138	IC 74HC138 IND 3-8 DEM 16DIP IC11	
053	2.0000	003329-244	IC 74HCT244N IND OCT BUF 20DP IC43 IC45	
033	1.0000	003329-245	IC 74HCT245 IND B/L TRAN 20DP IC9	
032	2.0000	003329-373	IC 74HCT373 IND D LAT 20DIP IC7 IC8	
050	1.0000	003329-374	IC 74HCT374N IND OCT DFF 20DP IC42	
027	1.0000	003511-000	IC 82C84 IND CLK DRV 18DIP IC2	
028	1.0000	003512-000	IC 82C88 IND BUS CTRL 20DIP IC3	
051	1.0000	003532-000	IC MSM6242 COM RTC 18DIP IC44	
002	1.0000	061546-000	PC BD DCP-3	
017	3.0000	001249-012	CAP CER SPIN 100V .01UF 20% 25 C33 C34 C35	
018	23.0000	001249-028	CAP CER SPIN 50V .1UF 20% 25U C32 C36 C37 C47	C48
018	23.0000	001249-028	CAP CER SPIN 50V .1UF 20% 25U C49 C50 C51 C52	C53
018	23.0000	001249-028	CAP CER SPIN 50V .1UF 20% 25U C54 C55 C58 C60	C61
018	23.0000	001249-028	CAP CER SPIN 50V .1UF 20% 25U C62 C64 C65 C66	
018	23.0000	001249-028	CAP CER SPIN 50V .1UF 20% 25U C67 C68 C69 C70	
011	2.0000	001299-010	CAP CER SPIN 25V 10PF 5% COG 1%	
			R23	
071	1.0000	002101-3012	RES MF 1/10W 30.1K OHM1%	

			R24			
060	7.0000	002127-103	RES CF 1/4W 10K OHM 5%			
			R1 R2 R12	R14	R21	
060	7.0000	002127-103	RES CF 1/4W 10K OHM 5%			
			R22 R25			
061	4.0000	002127-104	RES CF 1/4W 100K OHM 5%			
			R3 R4 R6	R7		
069	1.0000	002127-203	RES CF 1/4W 20K OHM 5%			
			R18			
064	1.0000	002127-222	RES CF 1/4W 2.2K OHM 5%			
			R11			
062	1.0000	002127-331	RES CF 1/4W 330 OHM 5%			
			R9			
090	1.0000	002127-391	RES CF 1/4W 390 OHM 5%			
			R19			
061	1.0000	002127-472	RES CF 1/4W 4.7K OHM 5%			
			R5			
063	1.0000	002127-473	RES CF 1/4W 47K OHM 5%			
			R10			
065	2.0000	002127-513	RES CF 1/4W 51K OHM 5%			
			R13 R20			
019	2.0000	011002-001	DIODE 1N914 FAS RCV 100V 150MA			
			DI D4			
000	1.0000	001000-043	CAP TANT DIP 25V 10UF 20% RAD			
			C3			
014	2.0000	001152-048	CAP TANT SOL 10V 10UF 10% AXL			
			C26 C31			
015	1.0000	001152-052	CAP TANT SOL 10V 22UF 10% AXL			
			C27			
016	2.0000	001152-064	CAP TANT SOL 15V 10UF 10% AXL			
			C29 C30			
012	2.0000	001299-017	CAP CER SPIN 25V 22PF 5% COG			
			C24 C78			
067	1.0000	002101-2212	RES MF 1/10W 22.1K OHM1%			
			R16			
066	1.0000	002101-2742	RES MF 1/10W 27.4K OHM1%			
			R15			
075	1.0000	002126-113	RES SIP NET 330 OHM 6 PIN			
			RP6			
077	1.0000	002126-132	RES SIP NET 10K OHM 6 PIN COM			
			RP12			
073	6.0000	002126-332	RES SIP NET 10K OHM 10 PIN COM			
			RP2 RP3 RP4 RP13	RP8		
073	6.0000	002126-332	RES SIP NET 10K OHM 10 PIN COM			
			RP10			
072	1.0000	002126-344	RES SIP NET 100K OHM 10 PIN CO			

		RP1
049	1.0000 003317-154	IC 74HC154 IND 4-16 MUX 24DIP
		IC40
029	1.0000 003513-000	IC 82C59 IND INTRPT CTRL 28DP
		IC4
090	1.0000 003517-000	IC 82C54 IND TMR 24DIP
		IC38
059	2.0000 004220-000	XSTR VN2222LL NFET 60V.2A TO92
		Q1 Q3
078	1.0000 009237-091	SWITCH PB NO MOM RED
		S2
023	1.0000 011005-103	DIODE 1N5223B ZEN .5W 2.7V 5%
		D8
022	1.0000 011005-112	DIODE 1N5232B ZEN .5W 5.6V 5%
		D7
020	1.0000 011022-000	LED HLMP-5030 RED 12V RT ANG
		D3
021	2.0000 011044-000	DIODE 1N5819 SCH RECT 40V 1A1
		D5 D6
024	1.0000 011086-000	LED 555-4001 RED 2V BAR
		DA1
008	4.0000 014061-1058	BEAD GLASS .034 ID .0970 .074L
095	0.0100 029023-001	ADHESIVE RTV 108 SEALANT
091	5.0000 032249-010	SCKT IC 40PIN .6W .1CN GLD
084	3.0000 032805-002	HEADER PIN 2 POS
		W6 W8 W9
083	2.0000 032805-003	HEADER PIN 3 POS
		W5 W7
082	8.0000 032805-008	HEADER PIN 8 POS
		W1 W2 W3 W4
009	33.0000 032834-000	CONN SHUNT 2 POS LOW PROFILE
058	1.0000 032888-002	CONN .1 X .1 16 PIN
		J5
057	3.0000 032888-003	CONN .1 X .1 20 PIN
		J2 J3 J4
056	1.0000 032997-003	CONN D 25 SOCKET RCPT
		J1
096	0.5000 033000-001	SLEEVING 24 VINYL
092	10.0000 132018-001	SCKT IC 14PIN .3W
080	10.0000 132018-007	SCKT IC 28PIN .6W
038	1.0000 200628-001	ASSY EPLD ADDRESS LATCH
		IC22
052	1.0000 200628-002	ASSY EPLD WATCHDOG
		IC47
013	1.0000 001009-000	CAP VAR CER 9 TO 35PF
		C25

068	1.0000 002206-001	RES WW 2W .1 OHM 5%		
		R17		
039	5.0000 003225-005	IC 65C188 IND LN DRV 14DIP		
		IC23 IC26 IC27 IC34 IC36		
030	5.0000 003226-005	IC 65C189 IND LN REC 14DIP		
		IC5 IC24 IC31 IC35 IC37		
026	1.0000 003510-000	IC 80C88 IND UPRO 40DIP		
		IC1		
037	8.0000 003515-000	IC 43256 COM 32X8 RAM 28DIP		
		IC14 IC15 IC16 IC17 IC18		
037	8.0000 003515-000	IC 43256 COM 32X8 RAM 28DIP		
		IC19 IC20 IC21		
034	4.0000 003516-000	IC 82C50A IND ASYN COMM 40DIP		
		IC10 IC25 IC32 IC33		
025	1.0000 009135-041	SWITCH DIP SPST 4 POLE T/B SL		
		S1		
088	1.0000 015033-010	CRYS 32.768KHZ .003%		
		Y3		
086	1.0000 015092-000	CRYS 15.36MHZ		
		Y1		
087	1.0000 015093-000	CRYS 1.8432MHZ		
		Y2		
081	1.0000 032045-000	TEST POINT TURRET 1502-2		
		TP1		
093	1.0000 033212-002	INSULATOR T*3 FOAM 1/2" X 2"		
094	4.0000 013002-012	WASHER 4 INTL SS		
007	4.0000 013009-3401	NUT 4-40 HEX SS		
004	2.0000 013492-3412	SCREW 4-40 X 3/8 PPH SS		
005	2.0000 013678-410	SCREW 4-40 X 5/16 PFH SS		
000	10.0000 014061-1058	BEAD GLASS .034 ID .0970 .074L		
010	1.0000 017102-000	BATTERY LITHIUM LTC-7P		
		BT1		
003	1.0000 900178-000	CARD PULLER SAE 6200		
001	1.0000 035943-000	SCHEM DCP-3		
000	1.0000 080774-030	PROC DCP-3 V1.3 TEST		



SCALE	1 : 1	HARMON ELECTRONICS, INC.		
		GRAIN VALLEY, MO. U.S.A. 64029		
APPROVED	J UTTERBACK	TITLE DCP-3 CPU BOARD ASSEMBLY PRINT		
DATE	02/23/93			
DRAWN BY	CALAY/DRAFT			
DATE	02/23/93	ENGINEER	DRAWING NO.	SHEET
		JEFF UTTERBACK	226459-000	1 of 1

PARENT: 225850-000

DESC: ASSY PROCESSOR PWR SUPPLY

DIN	USAGE COMP_PART	COMP_DESC
051	3.0000 005019-017	CABLE TIE 4L NAT
050	3.0000 005448-000	TAB MOUNTING .203 DIA NYLON
040	1.0000 005449-208	SPACER MF 6-32 X 1/2 DIA NYLON
028	1.0000 005664-000	CLAMP CAP MOUNTING
020	1.0000 010051-002	BREAKER CIRCUIT 3A PUSH BUTTON
019	1.0000 010051-003	BREAKER CIRCUIT 5AMP
021	1.0000 010051-004	BREAKER CIRCUIT 12AMP
029	1.0000 011113-000	LED 5592101001 HE-RED 3V SNAPIN
012	0.5000 012355-6000	WIRE 18AWG TFLN INS GRN EE
065	0.5000 012399-6000	WIRE 18AWG TFLN INS WHT EE
042	0.8000 012696-000	WIRE 10 AWG WHT
052	1.0000 013002-010	WASHER 10 INTL SS
059	4.0000 013002-014	WASHER 8 INTL SS
047	44.0000 013008-013	WASHER 6 FLT SS .281
057	4.0000 013008-021	WASHER 8 FLT SS
049	18.0000 013009-3601	NUT 6-32 5/16 HEX SS
048	14.0000 013030-006	WASHER 6 SPL SS
062	1.0000 013039-001	NUT 10-32 X 3/8 HX SS
023	2.0000 013106-2128	SCREW 6-32 SPCL
000	1.0000 013113-003	NUT 6-32 NYLON LOCK SS
033	3.0000 013491-3408	SCREW 4-40 X 1/4 PFH SS
034	17.0000 013491-3612	SCREW 6-32 X 3/8 PFH SS
035	2.0000 013491-3628	SCREW 6-32 X 7/8 PFH SS
044	22.0000 013492-3612	SCREW 6-32 X 3/8 PFH SS
045	10.0000 013492-3616	SCREW 6-32 X 1/2 PFH SS
046	4.0000 013492-3624	SCREW 6-32 X 3/4 PFH SS
056	5.0000 013492-3716	SCREW 8-32 X 1/2 PFH SS
081	4.0000 013492-3908	SCREW 10-32 X 1/4 PFH SS
082	1.0000 013496-1912	SCREW 10-32 X 3/8 PPH SS
002	1.0000 016168-000	XFMR 241-8-1803
001	4.0000 016169-000	XFMR
063	0.0000 029023-001	ADHE RTV 108 SEALANT
043	5.0000 032283-7017	TERM RNG #10 STUD #12-10 N/INS
024	3.0000 032368-1018	TERM RNG #6 22-16 INS RED
000	1.0000 032870-000	OUTLET 250VAC 15A 3POS WALL
037	1.0000 032999-000	TERM STRP LOG 3POS .375CN
083	0.4000 033001-04C	SLEEVING HSHRINK 1/8 CLR
054	1.2000 033001-06C	SLEEVING HSHRINK 1/4 CLR
055	0.4000 033063-5000	TUBING NO 20 TEFLON NATURAL
084	0.0500 033064-6000	TUBING NO 18 TEFLON RED
000	0.2000 033229-008	TUBING 3/4" THERMOFIT CLEAR
009	1.0000 065043-000	CHASSIS WC0-2 RUNNER

PARENT: 225850-000

DESC: ASSY PROCESSOR PWR SUPPLY

DIN	USAGE	COMP_PART	COMP_DESC
031	1.0000	065093-000	ROD THREADED
015	1.0000	121479-003	PANEL HASP REAR W/SS
010	1.0000	121480-008	BRKT HASP HTSK MTG W/INSERTS
014	1.0000	121512-001	PANEL SIDE SUPPORT W/FINNISH
011	1.0000	121525-010	CHASSIS HASP PWR SPLY W/SS
013	1.0000	121529-002	BRKT HASP PS CONN W/INSERTS
053	1.0000	125162-000	LABEL PSSB-13 1-1/2 X 3-3/16
000	2.0000	200599-000	ASSY RES PWR 25W 1 OHM/301MTGB
038	1.0000	225926-000	ASSY PROCESSOR WIRE HARNESS AC
039	1.0000	225928-000	ASSY PROCESSOR WIRE HARNESS DC
016	1.0000	226055-000	ASSY REGULATOR
085	7.0000	900013-000	RING LUG #6 18 AWG NON-INSULAT
007	1.0000	900033-000	STRIP TERMINAL CLOSED BACK
041	1.0000	900067-000	STRIP MARKER MS5-141
022	1.0000	900098-000	BREAKER CIRCUIT 5 AMP JA2T3A53
026	2.0000	900126-000	COIL 68UH 5 AMP
006	2.0000	900149-000	DIODE MDA 2504 RECT
027	2.0000	900189-000	CLAMP 4586-97A
003	1.0000	900191-000	CAP 25V 30000 UF
004	2.0000	900192-000	CAP 40V 8700 UF
036	2.0000	900194-000	CAP 600V .1UF 715P10456LD3
008	1.0000	900214-000	ARRESTOR SURGE T11-317B
061	1.0000	900320-000	LUG 8 STUD 12-10 AWG NON-INS
018	4.0000	900323-000	JACK 450-3359-01-0349

PARENT: 226055-000

DESC: ASSY REGULATOR

DIN	USAGE	COMP_PART	COMP_DESC	SYM
017	0.2000	012311-6000	WIRE 18 AWG TFLN INS BRN	
013	12.0000	013002-011	WASHER 6 INTL SS	
01	12.0000	013492-3628	SCREW 6-32 X 7/8 PPH SS	
011	0.0250	029312-001	HEATSINK COMPOUND #340	
016	0.1000	033001-04C	SLEEVING HSHRINK 1/8 CLR	
002	1.0000	065044-002	HEATSINK HASP MOD RID PLTD	
001	1.0000	225813-000	ASSY REGULATOR BD	
010	2.0000	900008-000	WASH SHLDR TFL 2711-18527-T140	
018	1.0000	900013-000	RING LUG #6 18 AWG NON-INSULAT	
015	1.0000	900017-000	RECEPT 42718-1 OR 42428-2	
014	1.0000	900040-000	MTG PAD SIL-PAD 1000(1009-105)	
009	1.0000	900094-000	DIODE 1N2813RA ZENER	CR1
004	1.0000	900111-000	PROTECTOR OVER VOLT L-12-OV-5	U4
005	1.0000	900112-000	REGUALTOR VOLTAGE LAS39U	U3
006	1.0000	900113-000	REGULATOR VOLTAGE LAS14U	U2
007	1.0000	900114-000	REGULATOR VOLTAGE LAS18A12	U1
008	1.0000	900150-000	DIODE 1N2823A ZENER	CR2

PARENT: 250431-000

DESC: ASSY HBD SCAN POWER SUPPLY

DIN	USAGE	COMP_PART	COMP_DESC	SYM
012	2.0000	001331-000	CAP FILM 600V .1UF 10% RAD	
042	1.0000	010051-001	BREAKER CIRCUIT 1A PBUTTON	
000	1.0000	010051-003	BREAKER CIRCUIT 5 AMP	
000	0.5000	012632-599	WIRE 16 AWG STRD CU WHT	
018	1.0000	012674-000	WIRE AC POWER CORD #17255	
041	3.0000	013002-010	WASHER 10 INTL SS	
000	2.0000	013008-012	WASHER 10 FLT SS	
000	16.0000	013008-013	WASHER 6 FLT SS .281	
040	17.0000	013008-021	WASHER 8 FLT SS	
000	4.0000	013009-3601	NUT 6-32 X 5/16 HEX SS	
050	6.0000	013009-3702	NUT 8-32 HES SM SS	
000	14.0000	013030-006	WASHER 6 SPL SS	
049	11.0000	013030-007	WASHER 8 SPL SS	
053	2.0000	013030-008	WASHER 10 SPL SS	
047	4.0000	013039-001	NUT 10-32 X 3/8 HX SS	
000	4.0000	013491-3612	SCREW 6-32 X 3/8 PFH SS	
032	8.0000	013492-3612	SCREW 6-32 X 3/8 PPH SS	
031	6.0000	013492-3616	SCREW 6-32 X 1/2 PPH SS	
030	2.0000	013492-3624	SCREW 6-32 X 3/4 PPH SS	
039	5.0000	013492-3712	SCREW 8-32 X 3/8 PPH SS	
051	4.0000	013492-3716	SCREW 8-32 X 1/2 PPH SS	
000	2.0000	013492-3728	SCREW 8-32 X 7/8 PPH SS	
038	1.0000	013492-3932	SCREW 10-32 X 1 PPH SS	
037	4.0000	013836-000	NUT 6-32 HEX ACORN SS	
016	1.0000	025485-000	LABEL FCC RULES (47CFR PART 15)	
046	1.0000	025721-000	LABEL GENERAL PURPOSE S/N	
000	4.0000	032368-000	TERM RNG TNG #6 #22-16 INS RED	
000	1.0000	032870-000	OUTLET 250VAC 15A 3POS WALL	
000	1.3000	033001-06C	SLEEVING HSHRINK 1/4 CLR	
003	1.0000	121531-003	PANEL HBD PS FRONT W/SS	
001	1.0000	121532-003	CHASSIS HBD PWR SPLY SILKSCRN	
000	2.0000	200599-001	ASSY RES PWR 50W .2 OHM/301MTB	
002	1.0000	225889-000	ASSY HBD SCANNER REGULATOR BD	
058	1.0000	226266-000	ASSY HARNESS P/S	
017	1.0000	900031-000	TERMINAL STRIP 76006-049	
007	1.0000	900092-000	BREAKER CIRCUIT 2 POLE 10 AMP	CB1
008	2.0000	900149-000	DIODE MDA 2504 RECT	CR1
005	1.0000	900180-000	TRANSFORMER 241-8-56	T1
006	1.0000	900181-000	TRANSFORMER 241-8-28	T2

PARENT: 250431-000

DESC: ASSY HBD SCAN POWER SUPPLY

DIN	USAGE	COMP_PART	COMP_DESC
000	1.0000	900188-001	CAP 100V 1700UF
023	1.0000	900189-000	CLAMP 4586-97A
011	1.0000	900214-000	ARRESTOR SURGE T11-317B
026	1.0000	900333-000	TAB, MOUNTING TA1S8
014	1.0000	900662-000	TERM STRIP 305306-NL-MP-09
015	1.0000	900667-000	TERMINAL STRIP COVER CV306

PARENT: 225889-000

DESC: ASSY HBD SCANNER REGULATOR

DIN	USAGE	COMP_PART	COMP_DESC	SYM
028	2.0000	001023-4018	CAP CER MONO 50V .22UF 10%	C2,C3
024	2.0000	001023-4036	CAP CER MONO 100V .1UF 10%	C5,C8
019	1.0000	002021-31A	RES CC 2W 1K OHM 5%	R1
017	2.0000	002029-065	RES CC 1W 47 OHM 5%	R4,R5
018	1.0000	002029-104	RES CC 1W 2K OHM 5%	R2
021	1.0000	002101-1210	RES MF 1/10W 121 OHM 1%	R7
022	1.0000	002101-1501	RES MF 1/10W 1.5K OHM 1%	R8
023	1.0000	002188-001	RES VAR CER 1/2W 1K OHM	R9
037	1.0000	003230-001	IC LM217 IND ADJ TO3	U1
000	4.0000	005240-6622	SPACER 6-32 X 1/4 THRD ROLLOVER	
005	8.0000	005491-301	SPACER SWG 6 ID X 1/4 OD X 3/16	
032	1.0000	011018-21A	DIODE 1N4749A ZEN 1W 24V 5%	CR4
031	1.0000	011043-006	DIODE 1N4004 RECT 1KV 1A	CR5
000	0.2500	012122-6000	WIRE 18AWG INS RED	
000	0.2500	012199-6000	WIRE 18AWG INS WHT	
000	0.3000	012322-6000	WIRE 18AWG TFLN INS RED	
000	0.2000	012399-6000	WIRE 18AWG TFLN INS WHT EE	
012	4.0000	013002-011	WASHER 6 INTL SS	
039	1.0000	013002-015	WASHER 1/4 INTL SS	
014	8.0000	013113-003	NUT 6-32 NYLON LOCK SS	
010	4.0000	013492-3620	SCREW 6-32 X 5/8 PPH SS	
011	8.0000	013492-3624	SCREW 6-32 X 3/4 PPH SS	
040	1.0000	013514-1001	NUT 1/4-28 HEX ZPS	
041	1.0000	029312-001	HEATSINK COMPOUND #340	
001	1.0000	061361-000	PC BD SCANNER REGULATOR	
000	1.0000	065056-001	HEATSINK VHBD PWR SPLY MACH	
000	1.0000	065056-002	HEATSINK HBSD PWR SUPPLY	
007	5.0000	900011-000	SPACER SWAGE 3/8 X 1/2 RND BRS	
009	4.0000	900056-000	SOCKET W/SOLDER PIN	
030	1.0000	900088-000	VARISTOR MOV 56V 300A SURGE	RV1
029	1.0000	900125-000	CHOKE RF IRON CORE 39 UH	L1
008	1.0000	900132-000	CONN WAFER W/GOLD PLATED PIN	
033	3.0000	900151-000	DIODE 1N5366B ZEN 39V 5W 5%	CR1
034	1.0000	900152-000	DIODE 1N3334RB ZEN 50W 56V 5%	CR6
036	1.0000	900154-000	TRANSISTOR 2N6059 NPN POWER	Q1
020	2.0000	900195-000	RES WIRE WND 5W 270 OHM 5%	R3,R6
025	1.0000	900196-000	CAP 200V .1UF 192P10492	C1
026	1.0000	900197-000	CAP 100V 10UF 112D106C3100G1	C4
027	2.0000	900198-000	CAP 100V 180UF 601D187F100JJ4	C6,C7
004	8.0000	900227-000	BUSHING INSUL 103 MTG	
015	1.0000	900315-000	TERMINAL STRIP	TB1
038	1.0000	900350-000	TERMINAL SOLDER	



Model 3800 (IRIS) Preamplifier

User's Guide

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PRELIMINARY

This document is in a preliminary form for internal discussion and development planning use at Harmon Electronics, Inc.

Harmon Electronics, Inc. reserves the right to make changes to any specification herein to improve the function or design of the product. All changes to this specification are under the administration of the Harmon Electronics Engineering department.

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Introduction

The Model 3800 preamplifier is an electronic device used in hot box detector systems to measure the heat of bearings on a moving train. It provides the conversion of heat energy into a voltage which is amplified before being transmitted to the hot box detector.

Throughout this document, the Model 3800 is also referred to as **IRIS**, which is an acronym for **InfraRed Imaging Sensor**.

This user's guide has been organized into three major sections that detail the operation and usage of IRIS.

- The first section explains the basic theory of operation of the IRIS preamplifier and how it measures heat. Attention is focused on measuring the heat of passing bearings.

Details of individual component operation is not given. IRIS is constructed using surface-mount technology and contains no user-serviceable parts or adjustments. Repair or replacement of components requires specialized equipment and a comprehensive and extensive calibration process.

- The second section contains information on using IRIS with the Harmon Hot Box Detector including the Rail-Mount Scanner.
- The last section contains a series of appendices that summarize the specifications of IRIS, define a glossary of terms used, and presents a short essay on the nature of temperature and heat.

Conventions

- All temperatures are given in degrees Celsius (°C), unless otherwise explicitly stated. See the appendices and glossary for a complete description of the different types of temperature terms.

Section 1 - Basic Theory of Operation

IRIS uses pyroelectric detector technology to measure the temperature of objects in its field-of-view. Digital filtering and other mathematical techniques are used to reduce microphonic effects while maintaining high speed operation.

IRIS can determine the temperature of any object. But, its primary purpose is to measure the temperature of bearing journals on a passing train. Wheel gate signals are applied to IRIS to tell it when to measure heat so that it doesn't measure the temperature of unwanted objects.

IRIS determines the temperature of a bearing by measuring the amount of infrared radiation it emits. The radiation is collected and focused upon a pyroelectric detector by an optical lens system. A small electrical signal is generated by the detector that is proportional to the amount of radiation received. The signal is amplified and then filtered to remove electrical noise. The resulting signal is then *digitized* by an Analog-to-Digital converter (ADC) that converts the analog voltage into a series of digital numbers.

Unwanted microphonic signals (noise) are removed from the data by digital processing. A correction factor is applied to the data to compensate for the change in gain of the pyro due to its own temperature. The data is then sent to a Digital-to-Analog converter that converts the numbers back into an analog voltage for application to the input of the hot box detector.

Optical system

The optical system of IRIS is a meniscus lens composed of germanium glass with a germanium coating. Germanium glass acts as an optical bandpass filter that passes only the wavelengths of infrared between 2 to 18 microns. This prevents other wavelengths of radiation, such as visible light, from striking the detector and causing measurement errors. The lens coating increases the efficiency of the lens by allowing more radiation to pass through the lens and not be reflected back into space.

The lens has a 'f' number of approximately 1, that is, its diameter is very close to its focal length. The radiation is focused on a small hole (field stop) in the pyro housing. Precise mechanical tolerances are used to position the field stop at a point called the *minimum blur spot*.

By controlling the size of the field stop and its distance from the lens, the field-of-view of IRIS can be accurately controlled. The field-of-view or *spot size* at 40 inches from the face of IRIS is 1.5 inches plus or minus 0.5 inches. The spot size decreases at distances closer to IRIS. But, the amount of radiation received remains constant as long as the object being measured completely fills the spot.

The usable focal length for IRIS is between 18 and 42 inches. The spot size will increase for objects beyond 42 inches and radiation from objects other than the target will be collected resulting in measurement errors. Objects closer than 18 inches to IRIS will be

out-of-focus. Radiation received from outside the ideal spot size will contribute too much to the total, again resulting in measurement errors.

The Infrared energy is focused on the front of a metal housing that contains the pyroelectric detector. The housing contains two holes, one larger than the other. The smaller hole is the field stop as explained in the preceding paragraphs. The larger hole allows radiation from the LED to strike the detector element for integrity testing.

Detector Assembly

The detector assembly consists of a pyroelectric detector with an internal amplifier and an external preamplifier board that is mounted in a fixed, rigid mount.

Pyroelectric detector

Incoming Infrared radiation is focused upon the sensing element of a pyroelectric detector, or *pyro*. A pyro is an AC device that develops an electric charge when a change in heat is applied to it. That is, it responds only to changes in heat and not absolute heat levels. As time progresses with no change in heat, the charge will drop back to zero.

An analogy would be an electrical capacitor. When a constant electric voltage is applied to a capacitor, current immediately flows through the capacitor but decreases with time until the voltage across the capacitor is constant and the current is zero. A pyro works in a similar fashion but heat is the driving force instead of voltage. The time it takes for the charge to deplete by 63% is called the *thermal time constant* and is analogous to the electrical time constant in the capacitor example. The thermal time constant is a result of the time-rate of heat arrival versus the time-rate of detector thermalization and is usually measured in milliseconds or even seconds.

A pyro also has an electrical time constant that is a result of its' own internal capacitance of a built-in amplifier and the type of material used for the detecting element. Therefore, the response of a pyro to varying heat can be described by both an electrical and a thermal time constant. The -3 dB point of these time constants is called the *breakpoint*.

Though a pyro has good responsivity relative to other types of detectors, the amount of energy striking the detector from a 100 °C bearing is only about 300 nanowatts. A very large amount of gain is necessary to amplify this signal to reasonable levels for measurement. Pyros typically include a low-noise amplifier encapsulated in the same package as the sensing element to increase the signal. The amplifier may operate in either a voltage or a current mode. Voltage mode provides better initial responsivity but it falls off as the frequency of the signal (speed with which a bearing passes) increases. Current mode provides a lower responsivity but yields a flat response eliminating the need for frequency compensation. IRIS uses a pyro operating in the current mode.

The size of the detector element is also important. The amount of noise generated and the detectivity of the detector are inversely proportional to the square root of the

detector's area. Doubling the detector's area will increase the noise by a factor of 1.4 and reduce the detectivity by the same amount. The detector should be as small as possible to maximize the detectivity yet large enough to view the correct size field.

The pyro used in IRIS has a built-in amplifier to boost the extremely small signal generated by the detecting element by approximately 650 million times. The feedback resistor used in this type of high gain circuit is so large that it has a higher resistance than air. The detector and amplifier are packaged together in a container that is sealed and filled with an inert gas such as argon or nitrogen. This prevents excessive noise by limiting variations in the feedback resistance path of the amplifier.

A material that passes infrared radiation is used as a 'window' to seal the detector package. IRIS employs detectors with window materials that pass the required infrared wavelengths, are non-hygroscopic (don't absorb water readily), are low loss, and are non-poisonous.

Preamplifier

The pyro is physically mounted to the preamplifier board (not to be confused with the entire IRIS preamp). The small signal from the pyro is further amplified by a factor of 22 to bring the signal up into a range that allows for gain adjustments with sufficient signal headroom. The gain is adjusted to yield 1/2 volt peak-to-peak for a 70° delta heat signal.

Mounting

Pyros tend to be microphonic due to their piezoelectric construction. They generate an output when they are subjected to physical movement such as shock and/or vibration. Different methods of construction are used by various manufacturers to reduce the amount of microphonic signals. Some of these methods are proprietary or patented. Most involve suspending the pyro element above the surrounding enclosure. However, a balance between shock isolation ("springiness") and thermalization must be reached that provides the fastest response time in comparison to reducing the microphonic error signal.

The pyro is mounted inside a cavity surrounded by 'O'-rings of a specific durometer (hardness factor) to provide additional dampening of vibration and hold the detector within mechanical tolerances for the optical system. Additional shock isolation is achieved by filling the cavity with a special silicon gel compound that allows the pyro and preamp board assembly to 'float'. This mounting is designed to keep the pyro in its proper position, provide the proper electrical isolation to reduce noise, and seal the unit against moisture penetration.

Reference shutter

A pyro can only measure the difference in heat between two objects because it is an AC device. IRIS must know the temperature of one of the two objects. By knowing the

temperature of one object and the difference between it and another object, the temperature of the other object can be found. A passing bearing is the unknown object while the reference shutter is the known object.

The shutter rotates, alternately allowing the pyro to view the target and the shutter blade, thereby generating an AC signal. When the bearing is in view, the processor measures the voltage generated by the pyro due to its seeing a change from the temperature of the shutter blade to the temperature of the bearing.

Because the optical path tolerances are very small, it is necessary for the processor to know precisely when the shutter blade begins to block the view of the bearing. The optocoupler on the analog board provides this feedback. When the shutter blade is in the pyro's view it is out-of-focus through the field stop hole. The surface area of the blade is just wide enough to provide complete blockage at one point in its rotation but not so wide that it covers too much of the bearing on a high speed train. The pyro's field-of-view diverges rapidly. This means that the shutter blade must be held to a tolerance of 4-thousandths of an inch concentricity.

*** NOTE ***

Handling or forcibly blocking the shutter blade will cause the blade to become 'out-of-round' resulting in jitter in the output signal.

An 8 3/16" diameter bearing is in view for only 11.6" of linear travel, given a scan angle of 45°. This translates into only 5 milliseconds on a 130 MPH train. The width of the shutter blade is set by the pyro's field-of-view and response times. The blade needs to pass in front of the pyro long enough for the processor to read the heat of the blade but not so long that it blocks the bearing. It must pass in front of the pyro in much less than 5 milliseconds. The motor speed is set by design to have the blade pass in front of the pyro 150 times per second. The width of the blade causes the bearing to be blocked for less than 670 milliseconds every 6.6 milliseconds.

LED

An Infrared LED is used to periodically test the integrity of the pyroelectric detector and the electronic signal paths. It is mounted at approximately a 45° angle on the digital board. This position allows the LED to radiate energy directly on the pyro detector element via the larger hole in the pyro housing yet not block the incoming radiation from the target.

The slightest movement of the LED from its fixed position will significantly alter the amount of radiation falling on the detector. This is due to the fact that the pyro must be exposed to very low levels (microwatts) of radiation without being overdriven yet strong enough to provide sufficient resolution for accurate measurements.

The LED is a special type of device that has a very linear negative temperature coefficient. It radiates at a wavelength of 800 nanometers (near-infrared). The amount of radiation it emits increases in a linear fashion as its ambient temperature decreases.

The wavelength does not change over the specified operating temperature. The need for high linearity comes from the requirement of using the LED as a calibration check.

The LED is the single calibration reference present in IRIS and must be accurate at all temperatures. A table of calibration adjustment factors is stored in non-volatile memory that relate specifically to each individual unit's LED. Even though all LEDs are linear, their output as received by the pyro varies depending on the LED construction variance, positioning, and current draw as determined by part tolerance of the drivers. The calibration adjustment factors for each individual IRIS preamp are determined by a factory process involving high accuracy temperature chambers and automated processes.

An IRIS must be recalibrated if any parts are modified, changed, or removed. It must also be recalibrated if the digital board is moved because of the positioning of the LED on the bottom of the board.

Analog Board

The analog board contains, as its name implies, the analog circuitry portion of IRIS. It has a lowpass filter for the heat signal, a variable-gain amplifier, power supplies and regulation, an optocoupler used to determine the reference shutter position, a temperature sensor, and input/output terminations.

The heat signal arriving from the pyro preamplifier is filtered to remove noise and reduce microphonic-induced signals. The signal then enters an amplifier block that boosts the signal to approximately 1 volt peak-to-peak. The gain of this stage is controlled by a non-volatile potentiometer (NOVPOT) in the feedback loop that is under processor control. The processor adjusts the gain of the amplifier during the factory calibration process.

The position of the reference shutter is determined by the optocoupler and the signal sent to the processor for synchronization. The position of the optocoupler is critical due to the very fine tolerances of the optical path.

The temperature sensor generates a voltage representing the internal temperature of the IRIS components, especially the pyro. The output of the pyro is dependent on its own operating temperature. Compensation factors are stored in non-volatile memory for each one-half degree C. They are applied to the digitized heat signal to compensate for the pyro's lower output when it is at cooler temperatures. This insures a flat response to radiation across the entire operating temperature range of the IRIS unit. These factors are computed and programmed into each individual IRIS as part of the factory calibration process.

A small DC-to-DC converter is used to create ± 7 volts for use by the pyro preamplifier board.

After processing by the analog board, the heat signal is routed to the digital board where it is converted into a digital number by the processor's onboard analog-to-digital converter (ADC).

Digital Board

The digital board contains all the digital electronics portion of the IRIS preamplifier. It has an Intel 80196KB microprocessor, 64K bytes of EPROM containing the program instructions for the microprocessor, 8K bytes of RAM for working storage, a watchdog timer/low voltage reset circuit, and support components. Also on the digital board are FET transistor drivers for interfacing to external signals, the integrity check LED, a digital-to-analog converter, a RS232C serial port, and the reference shutter motor driver.

The IRIS preamplifier has been designed to withstand 20 g shocks and continue operating. Heavy screws applied with Loctite (™) are used liberally to assemble all components. The digital board is attached with 8 screws to prevent movement from vibration. An extra screw is used on both sides of the connector running from the digital to analog boards to reduce wear of the connector's contacts.

Digital-to-Analog Converter (DAC)

A simple Digital-to-Analog Converter is implemented using a simple lowpass reconstruction filter. The CPU has a pulse-width modulation (PWM) output that generates a fixed-frequency square wave signal. It can vary the on time versus the off time of the signal in 256 steps, one of them being completely off (no signal). A voltage is developed by passing the square wave through the lowpass filter. The voltage developed is linear with respect to the duty cycle; the higher the on time of the square wave the higher the voltage.

This voltage is sent to the HBD and is proportional to the amount of bearing heat measured. The output voltage range is 0 to 5 volts representing a bearing heat of 0° to 118.5°C above ambient, or 42 mV per degree C.

The input of the Harmon HBD is capacitively-coupled and contains a peak-hold circuit to capture the maximum voltage developed during a bearing passage. This requires an AC or pulsed DC signal to be used. The DAC output of IRIS is turned on only during the **GATE ON** period of bearing measurement and turned off after the bearing passes.

Input/Output signals

The digital board processes all of the input and output signals from the HBD (except power and ground). These signals are:

- | | | |
|----------------------|---|---|
| External Temperature | - | input from external ambient air temperature monitor. Used to compensate for IRIS itself being at a temperature above ambient in a heated scanner. |
| Gate On | - | pulsed signal that indicates when a heat reading of a bearing is to begin. |
| Gate Off | - | pulsed signal that indicates when a heat reading of a bearing is to stop. |
| Integrity | - | prepares unit for heat measurement by starting the shutter blade motor and sending the results of the last integrity test during the first two wheel gates. |
| Receive | - | RS-232C serial port receiver signal. |
| Heat | - | analog voltage output signal that represents the heat of the target. Enabled only during the wheel gate. |
| Transmit | - | RS-232C serial port transmitter signal. |

Software operation

The software operation of IRIS is split into 3 operating modes:

- 1) Idle
- 2) Heat measurement
- 3) Integrity test

Idle mode

The IRIS processor remains in an idle mode until triggered by the external integrity signal or a **GATE ON** signal. Commands and data requests may be issued and received from IRIS only while it is in the idle mode.

Every two minutes, IRIS leaves the idle mode temporarily to perform an integrity test of itself after which it reenters the idle mode. The results of this test are reported at the time of the next train arrival.

Idle mode is entered upon power-up of the unit and after the timeout period has expired when measuring heat.

Heat measurement mode

IRIS enters the heat measurement mode when it receives a signal on the external integrity test line or a **GATE ON** signal. The processor is reset, the shutter motor is turned on, and all working variables and timers are initialized in preparation for measuring heat. IRIS remains in this mode until a time period has elapsed with no wheel gate signals or another signal is received on the integrity test line. If the unit times out, the processor is reset, the integrity test timer is reset to begin self-tests every 2 minutes, and the processor enters the idle mode.

The reference shutter motor and software that establishes the reference heat levels require almost 2 seconds to stabilize. Heat measurements made before this 2 second period has expired will not be accurate.

If the external integrity test signal is received during a train passage, the first 2 wheel gates from the HBD will be used to send the results of the last integrity test. This will be evident by one or two false alarms in the train. Insure that the HBD's integrity relay, track circuit, and cabling are in good working order and are not generating false integrity test signals to IRIS.

The **GATE ON** and **GATE OFF** signal pair indicate when a bearing is in the target view and a heat measurement is to be made and the result sent to the HBD. A **GATE OFF** signal should always follow a **GATE ON** signal. The gating allows IRIS to send a pulsed-DC analog signal to the HBD's AC-coupled, peak-hold circuits. IRIS will timeout and return to an idle condition when the **GATE ON** and **GATE OFF** signal pair has not been received for a given time period.

IRIS relies upon a timer to provide a timeout period to indicate when a train has left the detector site. When IRIS has not received a wheel gate within 14 seconds, it returns to an idle state. If a train stops on top of the detector long enough or slows down to a speed below the minimum speed threshold of the detector, IRIS will timeout. As soon as the train starts moving again above the minimum speed, IRIS will restart and generate two integrity pulses for the first two axles that pass.

HBD systems that employ an island circuit to determine train presence will show the two integrity pulses as very high heat causing 2 alarms. This is because the HBD knows the train is still there but IRIS doesn't.

Heat measurement process

The processor converts the analog voltage from the pyro into a digital number representing the amount of heat difference between the target and the reference shutter. But, the amplitude of this voltage depends on the temperature of the pyro itself. The temperature of the reference shutter is determined by the internal temperature sensor on the analog board. It is assumed that (after thermal equilibrium has been reached) the internal temperature sensor represents the temperature of the blade. The emissivity of the blade remains constant throughout the life of IRIS and any differences from one unit to another are corrected through factory calibration.

The temperature of the bearing above (or below) the reference shutter temperature is computed. The value is then corrected by a factor that compensates for the temperature coefficient of the pyro. The internal temperature of IRIS is used to index a table of correction factors created during the factor calibration process for each individual pyro.

The absolute temperature of the bearing is then computed by adding the temperature difference measured to the known internal temperature. The external temperature signal is measured and the difference between the absolute bearing temperature and the external ambient temperature is computed. This yields the temperature of the bearing above the outside ambient air temperature. The two step process of finding the absolute temperature of the bearing and then converting it back into a differential temperature is used because IRIS may be mounted in a heated enclosure where the internal temperature of IRIS may not be the same as the outside air temperature.

The final heat value is maintained continuously. It is sent to the DAC for output to the HBD only when requested by the wheel gate signals.

IRIS is calibrated at the factory so that the HBD will record 15 mm of heat when it is measuring a near-perfect blackbody target that is 70°C above the outside ambient air temperature. This equates to 4 2/3 degrees Celsius per millimeter.

The analog output of IRIS is from 0 to 5 volts representing 0 to 25.4 mm (or 118.5°C). This equates to 42 millivolts per degree C or 197 millivolts per millimeter. It is a DC level that is applied to the detector only during a wheel gate making it look like a pulsed DC voltage that can be measured by the peak-hold circuits of the HBD's analog board.

Response time

The electrical components in the heat signal path have been designed to provide the fastest response time possible (less than 1 millisecond). The analog output signal is constant within 400 mV (2 mm) when measuring trains that are stationary or moving up to 130 MPH.

The accuracy of heat measurement with an IRIS is plus or minus one millimeter or $4\frac{2}{3}$ degrees C. IRIS measures heat with a $\frac{1}{2}$ degree C of precision but filtering and smoothing of the signal to remove microphonics and noise limits IRIS to a $4\frac{2}{3}$ °C accuracy.

Measurement error sources

Sun loading

Trains running for a long period of time with one side being exposed to sunlight will run slightly hotter on that side than the side running in shadow. Radiation from the sun is both absorbed and reflected by the bearings.

Atmospheric effects

The radiation region measured by IRIS is approximately 8 to 14 μm . Although infrared is approximately 750 nm up to 1000 μm , the region from 750 nm to 8 μm is susceptible to filtering by compounds in the air, e.g. water vapor and carbon dioxide. The maximum amount of energy radiated for low temperature bodies near 20° C is centered around 10 μm .

Bearing emissivity

Some bearings are 'blacker' than others. The higher the emissivity of a bearing, the more radiation will be transmitted resulting in a higher heat reading.

Temperature compensation

The IRIS feature of temperature compensation allows IRIS to be heated above the outside air temperature to reduce mirror and lens fogging and remove snow from the scanner housing. This process of heating helps maintain a clear view path. The external ambient temperature sensor reports the true air temperature from which IRIS adjusts the heat output signal to compensate for the difference in its own temperature and the real ambient air temperature.

Integrity test mode

IRIS performs a self-check of its circuits and operating parameters every two minutes that it is not measuring heat. The two minutes begin after heat measurement stops (timeout after a train leaves) and continues until IRIS is interrupted to begin measuring heat again. The integrity test can be interrupted at any time. Each integrity test cycle consists of 14 discrete tests. A failure of any one test will cause an overall integrity test failure.

When a request for heat measurement is received (via the external integrity test input signal), the overall result of the last complete integrity test is reported as a voltage level to the HBD on the first two wheel gates. The HBD generates these 2 false wheel gates during the approach time of the train. The HBD interprets these two voltage pulses as an overall pass or fail of the IRIS preamp. For additional information on what it expects to see for these 2 heat pulses, refer to the Hot Box Detector documentation.

Integrity test results

IRIS sends the result of the last complete integrity test out the serial port as two hexadecimal ASCII characters when a request for heat measurement is received. The results of each of the 14 individual tests is encoded in these two characters. The following table shows each test, its associated bit pattern (in hex), the minimum and maximum values (if applicable), and the units. These characters may be captured by connecting any device capable of receiving a RS232C serial data stream and printing or displaying the characters.

Integrity 1

Test	Bit pattern	min.	max.	units
12 volts	0x01	10.5	12.5	volts
5 volts	0x02	4.75	5.25	volts
RAM memory	0x04	P/F	P/F	
Program CRC	0x08	P/F	P/F	
Shutter motor	0x10	130	170	Hertz
DAC output	0x20	0.5	4.0	volts
Pyro offset	0x40	2.0	3.0	volts
Pyro noise	0x80	-	0.7	volts

Integrity 2

Test	Bit pattern	min.	max.	units
Not used	0x01	-	-	
Internal temperature	0x02	0.2	4.8	volts
External temperature	0x04	0.2	4.6	volts
Frequency response	0x08	*	*	
Not used	0x10	-	-	
NOVPOT	0x20	*	*	
LED	0x40	*	*	
Optocoupler	0x80	P/F	P/F	

- * these tests have specific design characteristics that are tested at the factory. In the field, the integrity test insures that these parameters are still within tolerance. The numbers are dimensionless.

P/F Indicates that the test either passes or fails.

Note that each character may be the combination of multiple failures. For example, if the 12 volts was too low and the DAC output also failed the integrity 1 character would be 0x21 (the sum of 0x01 and 0x20).

All integrity failures are recorded in the internal memory of IRIS in the event log. This log may be accessed with the IRISTEST program that runs on an IBM PC compatible computer. The log is maintained as long as power is applied to the unit.

***** NOTE *****

If an integrity failure is suspected in IRIS,

DO NOT TURN OFF THE POWER

until the event log has been examined and recorded.

Integrity test failures

- | | | |
|---------------|---|--|
| 12 volts | - | Indicates that the 12 volt supply to IRIS is too low or too high. Check the 12 volt supply voltage connections at the detector, at the end of the scanner cable, and at the IRIS connector. In some cases, an internal connection to IRIS may be damaged or broken resulting in a low voltage condition. |
| 5 volts | - | Indicates that the internal 5 volt supply in IRIS is too high or too low. The internal 5 volts is derived from the 12 volts. If there is also a 12 volt failure, check it first to see if that cures the problem. If the 12 volts is not failing, then IRIS has had an internal failure. |
| RAM memory | - | Indicates that the internal random-access memory of the processor has failed. |
| Program CRC | - | Indicates that the program instruction memory of the processor has become corrupted. |
| Shutter motor | - | Indicates that the reference shutter motor is turning too fast or too slow. Can be the result of a failure of the 5 volt or 12 volts. If these haven't failed, then the motor is most likely worn and becoming 'sticky'. |
| DAC output | - | Indicates that the Digital-to-Analog Converter that sends the heat signal to the hot bearing detector has failed. |
| Pyro offset | - | Indicates that the pyro, pyro preamplifier board, or the pyro power supply circuit has failed. May also indicate that the shutter motor driver circuit has failed and the motor is turning all the time. |

- Pyro noise - Indicates a failure in the heat processing path that allows too much electrical noise to interfere with an accurate heat measurement.
- Internal temp. - Indicates that the internal temperature sensor used to compensate for component temperature dependencies has failed.
- External temp. - Indicates that the external temperature sensor input has failed. This may be the result of the ambient temperature probe not receiving power or a damaged cable running from the HBD to the IRIS. Check the ambient temperature probe power and output voltages and ring-out the cable running to the scanners.
- Freq. response - Indicates that the pyro cannot respond properly to different frequencies (train speeds).
- NOVPOT - Indicates that the internal non-volatile potentiometer used to adjust the gain of the IRIS has failed. Should only be seen during factory calibration.
- LED - Indicates that the integrity check LED has failed. The optical path integrity has been compromised and is uncertain. Proper calibration of IRIS is unknown.
- Optocoupler - Indicates that the reference shutter position sensor has failed or that the motor will not turn at all.

Section 2 - IRIS Application

IRIS may be used in any application requiring infrared heat to be measured within 5°C accuracy. The predominant use of IRIS is in measuring the heat of bearings on trains in motion. Some applications also measure the heat of wheel rims to detect stuck brakes.

Installation

IRIS is designed to fit in both the Harmon Tie-Mount Scanner and the Harmon Rail-Mount Scanner using the appropriate hardware.

Before installing IRIS in the scanner, check the scanner's alignment with the track. IRIS' view spot needs to be within 1/4" of the center of the target spot. Refer to the HBD Installation instructions for details of these procedures.

*** IMPORTANT ***

IRIS must be secure and properly aligned. Insure that the hold-down clamp is properly seated and the guide pins on the front of IRIS are fully inserted in the mounting plate.

*** CAUTION ***

Use care when installing or removing IRIS from the rail-mount scanner. The IRIS mounting plate is suspended by three small shock isolators that may be easily torn.

Insure that the mirror is clean and free of contaminants. A brand-new, clean mirror will cause a 10% loss in energy. The components of the IRIS system have been designed so that the surface temperature of the calibrated heat source will yield the correct output.

Cabling

Erratic operation or heat readings from IRIS may be the result of incorrect cabling or intermittent connections within the cable. Check all cabling for correctness according to the installation diagrams. Make voltage measurements directly on the end of the cable that attaches to IRIS to insure that proper power supply voltages are present.

Rail 'pumping' may weaken the connection of the cable to the scanner housing possibly causing the connector contacts to become intermittent. Repair or temporarily replace the cable to isolate a suspected problem.

IN5 networks

Using IRIS with the Harmon HBD requires the use of a specific IN5 network that is different than the IN5 used when connecting the HBD to the Model 38 preamp. If the heat levels appear to be abnormally high or low, check to make sure that the proper IN5 is installed.

Power supply

The 12 volt DC power supply for IRIS must be capable of supplying enough current to prevent the voltage from dropping below 11.5 volts. For a hot bearing/hot wheel detector where four IRISes are used, it is recommended that a separate, stand-alone power supply be used to either provide the needed 12 volts for the IRISes. Another option is to use a separate power supply to source the protective shutters and HBD relays then use the HBD's 'AUX 12v' to supply power to IRIS.

The biggest current draw will be when all four IRISes start their motors. This requires a little over 1 amp of current. The surge should not drop the voltage.

Ambient temperature probe

Make sure that an external ambient temperature probe is connected to the HBD and that power is being supplied or the heat readings will be off. For two rack installations, make sure the HBD that supplies power to the ambient temperature probe is on.

Approach length

IRIS requires 2.5 seconds to turn on the reference shutter motor and come up to speed before it can accurately measure heat. When planning the location of advance transducers or the length of a track circuit, allow enough distance that the fastest train through the detector will provide a minimum 2.5 seconds of approach length. Refer to the HBD System Installation drawings.

Powerup

Allow at least 2 minutes after powering-up the HBD system to give IRIS enough time to perform an initial integrity test. If a train (real or test) arrives within 2 minutes of powering-up the system, the integrity test will always show good integrity results.

This is NOT the case when the system is reset. The results of the last valid integrity test are maintained across resets until the next power-down, power-up cycle.

Calibration

IRIS has a 'thermal time constant' of approximately 25 minutes. In five (5) time constants, or approximately 2 hours, the temperature of IRIS and its reference shutter will have stabilized to within 99% of the temperature of the environment in which it is placed.

IRIS must be mounted in the scanner and powered-up with the snow heaters (if used) powered on for a minimum of 2 hours before calibrating. This period is used for the IRIS to reach thermal equilibrium with the heated scanner. The reference shutter blade must be at the same temperature as the scanner housing and the pyroelectric detector.

It is recommended that the Harmon Calibrated Heat Source be used when installing IRIS into an HBD system. It provides an evenly heated surface that is less subject to wind cooling than older and other models. The larger surface area requires less accurate positioning of the heat block on the scanner lid.

The heat source should be allowed a minimum of 30 minutes to warm up to the correct temperature after turning it on. Allow a few more minutes if the air temperature is very low (below 0°C). Ensure that the ambient temperature sensor of the heat source is in free air. Clip to the rail or any large metal surface not in direct sunlight. It should not contact the ground, ballast or lay in snow.

The heat source blackbody should be placed on the scanner lid centered over the hole. It may have to be positioned slightly toward one end or the other of the lid to completely fill the view area. The 'light beam' enters the scanner at a 45° angle causing the heat spot to be elongated into an oval. Sliding the blackbody slightly toward one end of the lid will allow the blackbody to completely fill the view spot. Slide the blackbody back and forth within an inch of center to peak the heat reading while in 'CHOP' mode.

The heat readings with the Harmon Calibrated Heat Source with the HBD in CHOP mode should be approximately 14 to 16 millimeters (or 65°C to 75°C). The difference between the heat reading from one rail to another should be within 1 mm (or 5°C).

IRIS communications

Communication with IRIS is accomplished through an asynchronous serial port like those found on most computers today. It is fixed to operate at 9600 baud, 8 bits, 1 stop bit, and no parity.

When connecting a cable to IRIS from another serial port, insure that the transmit and receive wires are connected properly. Make sure that the signal ground is also connected. If there is communication, swap the transmit and receive wires. A 'NULL MODEM' adapter can also be used.

The IRISTEST program is used to send commands and check the status of an IRIS unit. It can be used to examine the internal event log of IRIS, perform an integrity test on demand, and measure heat of a target manually. Refer to the documentation of the IRISTEST program for information on how to use the program.

Appendix A - Specification Summary

Physical dimensions

5 1/2" (13.97 cm) long
2 5/8" (6.67 cm) tall
3 1/8" (7.94 cm) wide

Weight

Approx. 2 lbs. or 0.9 kilograms

Operating Voltage

11.5 to 12.5 volts

Operating Current

150 mA continuous
250 mA motor start

Measurement accuracy and precision

°C precision
±5°C accuracy
Train speed 0 to 130 MPH

Operating Temperature

-40°C to +85°C

Startup time on train approach

2 seconds (minimum)

Timeout period

14 seconds

Appendix B - Thermodynamics and Hot Bearings

This is a short essay on the nature of temperature and heat and their use in hot box detector systems. Emphasis is placed on the practical, macroscopic considerations of how heat is generated, transferred, and measured (thermodynamics) rather than on quantum theory (statistical mechanics).

Temperature

For processes in which heat is involved the physical laws relating pressure, volume, temperature, internal energy (heat), and entropy (among others) form the basis for the science of *thermodynamics*.

Temperature is a term that we usually apply to that property of an object when we speak of how 'hot' or 'cold' the object is. Our sense of touch is the simplest way to distinguish hot objects from cold objects. In fact, temperature is related to a number of different variables such as, pressure, volume, entropy, and heat. Given two objects of equal pressure and volume (such as a steel object), heat is the primary factor in determining how hot one object is compared to another.

When two objects of different temperatures are placed in contact with each other, they will, after some period of time, assume the same temperature that is somewhere in between the initial temperatures of the two objects. The objects are then said to be in *thermal equilibrium*.

Heat

Heat is the energy that flows from one object to another because of a temperature difference between them. Heat is not a property of an object in the sense that we can assign a value to the amount of heat "contained" in the object. It is simply a measure of the amount of energy that moves between two objects that causes a temperature difference. Heat energy is transferred from one object to another by conduction, convection, evaporation, and radiation.

Conduction takes place by direct physical contact. Heat flows from one body to another directly. Friction is an example of conduction. The degree of success an object has to transfer heat is called its *thermal conductivity* and is related primarily to the density of the object (pressure and volume).

Convection is heat transfer by fluid motion between regions of unequal density. One example is the common saying that "hot air rises". Convection is largely a result of the pressure and volume of the fluid.

Evaporation occurs as one material is formed into a vapor by another material. The "wind chill factor" that we use in the winter months describes the cooling effect of wind removing moisture from our skin. It is also affected primarily by pressure and volume.

Radiation

Radiation transfers heat between objects through means that are described by quantum physics. Light is one form of radiation that transfers heat. When an object becomes very hot, we often speak of it as being "red hot" or even "white hot". By far, the greatest percentage of heat is transferred to or from an object by radiation. The frequency or wavelength of the radiation is directly related to the temperature of the object. According to Planck's radiation formula, the frequency of the radiation increases as the temperature of an object increases (see Figure 1). For objects near 20°C (293°K), the maximum amount of radiation emitted is between 8 and 14 micrometers (microns) in wavelength.

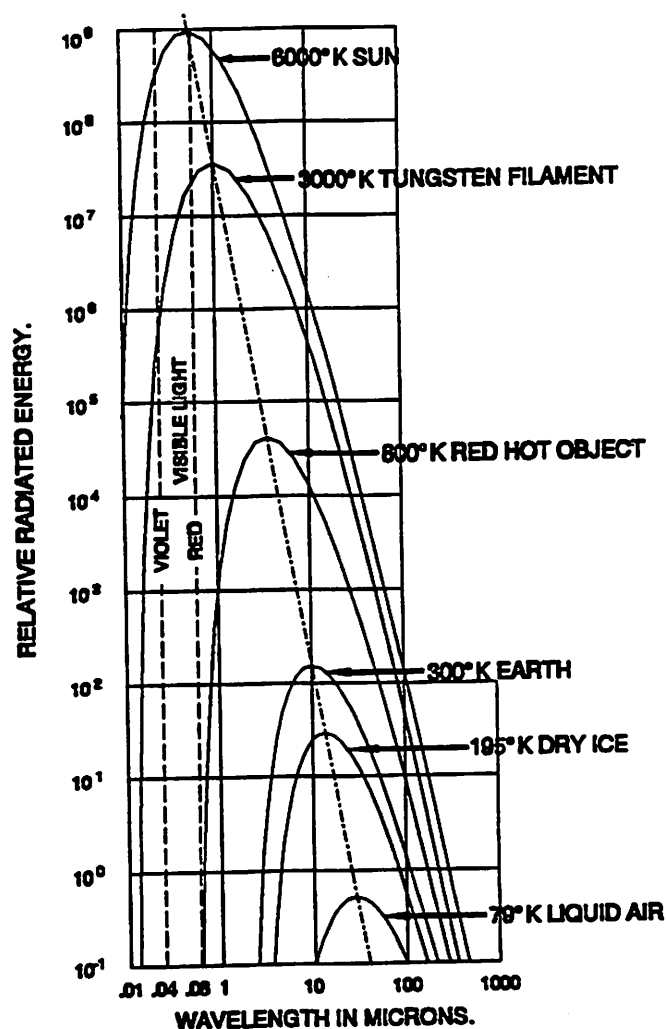


Figure 1
Spectral Characteristics of Blackbody Radiation
from Objects at Different Temperatures

This region of energy lies between microwaves and visible light and is called *infrared* (see Figure 2). Visible light is in a fairly narrow band of wavelengths around 0.4 to 0.7 microns.

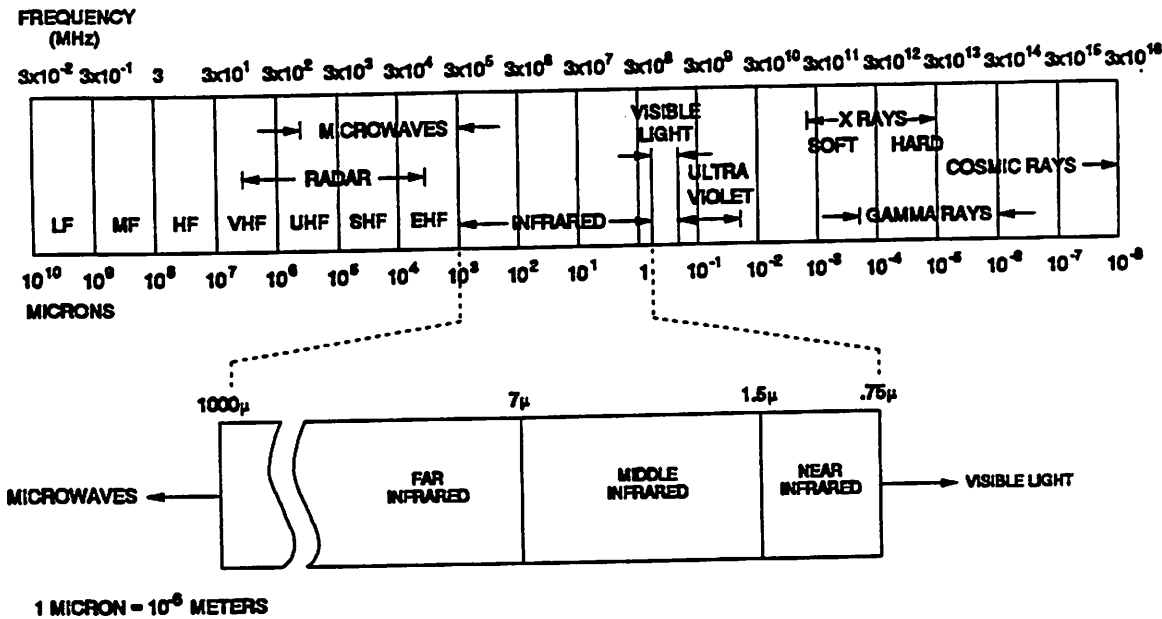


Figure 2
Location of the Infrared Region in the Electromagnetic Spectrum

Today's wayside detectors determine bearing heat by measuring the amount of infrared radiation it emits. Various materials are used as windows or lenses to filter the incoming radiation to prevent unwanted radiation, such as visible light, from striking the detector. Germanium is a commonly used material because it passes infrared energy in the range of 2 to 18 microns.

Emissivity

Emissivity is the term used when speaking of how well an object radiates heat. Emissivity is a number that ranges from 0 to 1.0. The higher the emissivity of an object, the more heat that can be transferred by radiation to or from the object. An emissivity of 1.0 would be a perfect radiator or absorber of heat. An object with an emissivity of 1.0 is called a "perfect blackbody" (which doesn't exist in reality). An object with an emissivity of 0 would be a perfect reflector. Figure 3 illustrates the emissivity of some different types of materials.

When measuring the temperature of a passing bearing, emissivity plays an important role in the accuracy of the measurement. Bearings which are shiny or polished will emit less heat energy than ones that are rusty or blackened by grease and other materials.

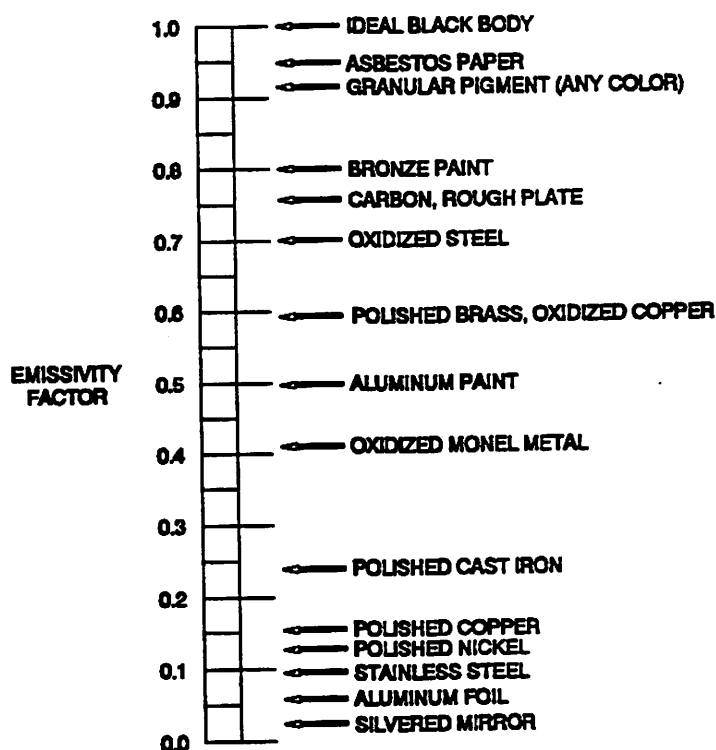


Figure 3
Emissivity Values for Various Common Materials

Detector types

Devices which measure Infrared radiation and generate an electrical output fall into two general families or groups of detectors; thermal and quantum.

Quantum, or photoelectric, detectors actually measure the photons of the radiation striking the detector. They have many advantages but one large disadvantage; almost

all are sensitive to radiation in the 8 to 14 μm range only when cooled to extremely low temperatures with materials such as liquid nitrogen.

Three of the most common thermal detectors are thermistor bolometers, pyroelectric detectors, and thermopiles. Thermopiles have a very slow response time compared to the other two types of detectors which limits its suitability for use in hot box detectors. Bolometers are rugged but are slower in response time than a pyroelectric detector. They also require high operating voltages and are not as sensitive as pyroelectric detectors. The response time limits the accuracy of the detector as measurement times decrease (faster trains). Pyroelectric detectors have a very fast response time and utilize low voltages but may suffer from *microphonic* effects when subjected to high vibration or shock.

Appendix C - Temperature scales

There are three temperature scales in common use today: Fahrenheit, Celsius (formerly called "centigrade"), and Kelvin. Fahrenheit is the most familiar to people in the United States while Celsius is used in most of the rest of the world. Kelvin is a temperature scale used primarily by scientists.

The Kelvin scale has an absolute zero of 0° K. All molecular motion is at a minimum at this temperature. By definition, the 'triple point' of water is established at 273.16° K. The triple point is the temperature at which water, at a standard pressure and density, can exist as ice, liquid water, and vapor.

The Celsius temperature scale is based upon the Kelvin scale but the triple point is at 0.01° C. By experiment the temperature at which ice and air-saturated water are in equilibrium at atmospheric pressure—the ice point—proves to be 0.00° C and the temperature at which steam and liquid water are in equilibrium at 1-atm pressure—the steam point—proves to be 100° C. The relationship between Kelvin and Celsius is then

$$^{\circ}\text{C} = ^{\circ}\text{K} - 273.15$$

The Fahrenheit scale is rarely used in scientific or engineering work. The relationship between the Fahrenheit and Celsius scale is defined to be

$$^{\circ}\text{F} = 32^{\circ}\text{F} + 9/5^{\circ}\text{C}$$

From this relation it can be seen that 0° C equals 32° F, 100° C equals 212° F, and that one Fahrenheit degree is exactly 5/9 as large as one Celsius degree. The conversion from Fahrenheit into Celsius can be expressed as

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \cdot 5/9^{\circ}\text{F}$$

The '32' factor should NOT be used when converting differential temperatures between Fahrenheit and Celsius. For example, assume that the air temperature is 25° C and that a bearing's heat is measured that is 10° C above ambient. This means that the bearing's absolute temperature would be 35° C or 95° F.

$$32^{\circ}\text{F} + 9/5 \cdot 35^{\circ}\text{C} = 95^{\circ}\text{F}$$

25° C (air temperature) would be 77° F. The bearing is 18° F above ambient (in Fahrenheit). You cannot convert the 10° C delta heat reading to the Fahrenheit scale by using

$$32 + 9/5 \cdot 10 = 50 \quad \text{WRONG!}$$

but using,

$$9/5 \cdot 10^{\circ}\text{C} = 18^{\circ}\text{F} \quad \text{RIGHT}$$

When you convert absolute temperatures between scales, use the '32' factor. Do not use the factor when converting delta temperatures.

Appendix D - Glossary of Terms and Abbreviations

This appendix defines some of the terms and abbreviations used throughout this document in the context of IRIS.

Abbreviations

°C	- degrees Celsius
°F	- degrees Fahrenheit
°K	- degrees Kelvin
ADC	- Analog to Digital Converter
cm	- centimeter
mA	- milliampere
mV	- millivolt
mm	- millimeter
nm	- nanometer
μm	- micrometers (or microns)

Terms

ambient temperature	· The temperature of an object's surroundings. Usually refers to the outside air temperature but may refer to the temperature surrounding an electrical component.
Analog-to-Digital Converter	· A circuit which samples a given voltage and compares it to an established reference. The relationship between the two is represented by a binary number.
calibration	· A factory process that scales the output voltage of IRIS as a function of the amount of infrared energy being measured.
external temperature	· The outside ambient air temperature.
internal temperature	· The temperature inside the IRIS unit. Equivalent to the temperature of the reference shutter blade and the environmental temperature of the pyro.
LED	· Light Emitting Diode. Used in IRIS to provide an integrity check of the pyro and its associated circuits.
micrometer	· One-millionth of a meter. Also called a micron.
micron	· One-millionth of a meter. Also called a micrometer.
nanometer	· One-billionth of a meter.

- preamplifier
- Refers to either the IRIS preamplifier itself or to the small circuit board inside which hold the pyro and provides amplification of the small heat signal measured by the pyro.
- pyro
- Pyroelectric detector. Generates a voltage proportional to the difference in infrared radiation emitted by two objects.
- reference shutter
- An object of known temperature that is used to establish a reference level when measuring a target object. Spins continuously while measuring heat in the IRIS preamplifier.
- target temperature
- The temperature of the object being measured, usually a bearing although it may be a wheel in some applications.

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REPLACE THIS PAGE WITH SITE LAYOUT DRAWINGS

PARENT: 200508-000

DESC: ASSY HEATED MIRROR

DIN	USAGE COMP_PART	COMP_DESC
002	2.0000 032991-001	TERM SPR SPADE #6 22-16AWG RED
001	1.0000 121565-003	MIRROR W/HEATER

PARENT: 200561-000

DESC: ASSY CRADLE W/O MIRROR & BASE

DIN	USAGE COMP_PART	COMP_DESC
014	2.0000 013008-018	WASHER 6 FLT .315
000	4.0000 013008-021	WASHER 8 FLT SS
010	2.0000 013030-006	WASHER 6 SPL SS
008	4.0000 013030-007	WASHER 8 SPL SS
007	2.0000 013492-3612	SCREW 6-32 X 3/8 PPH SS
005	4.0000 013492-3716	SCREW 8-32 X 1/2 PPH SS
004	1.0000 121500-002	MTG BAR PRE-AMP MACH W/PAINT
001	1.0000 121567-002	CRADLE MTG HBD W/FINISH & INSR
002	1.0000 121573-002	CRADLE BOOTOM PLTG W/INSERTS
003	1.0000 201429-000	ASSY HBD HOLD DOWN STRAP .88

PARENT: 200571-000

DESC: ASSY JUMPER WIRE PROTECT SHUTT

DIN	USAGE COMP_PART	COMP_DESC
002	0.2500 012632-555	WIRE 16 AWG STRD CU GRN
001	2.0000 032991-001	TERM SPR SPADE #6 22-16 AWG RED

PARENT: 225930-016

DESC: ASSY TERMINAL STRIP COMPONENTS

DIN	USAGE COMP_PART	COMP_DESC
002	1.0000 011043-006	DIODE 1N4007 RECTIFIER
001	2.0000 032991-001	TERM SPR SPADE #6 22-16 AWG RED
003	0.0830 033063-5000	TUBING NO 20 TEFLON NATURAL

PARENT: 226398-000

DESC: ASSY PAD HEATER

DIN	USAGE COMP_PART	COMP_DESC
000	1.0000 017080-000	HEATER PAD
002	2.0000 032991-301	TERM SPR SPADE #6 26-22AWG

PARENT: 121523-002

DESC: PLATE UNIV HBD SCAN BASE W/INS

DIN

USAGE COMP_PART

COMP_DESC

001

4.0000 013893-712

INSERT STUD 5/16-18 X 3/4 SS

000

1.0000 121523-001

PLATE BASE MACH'D W/PLTG

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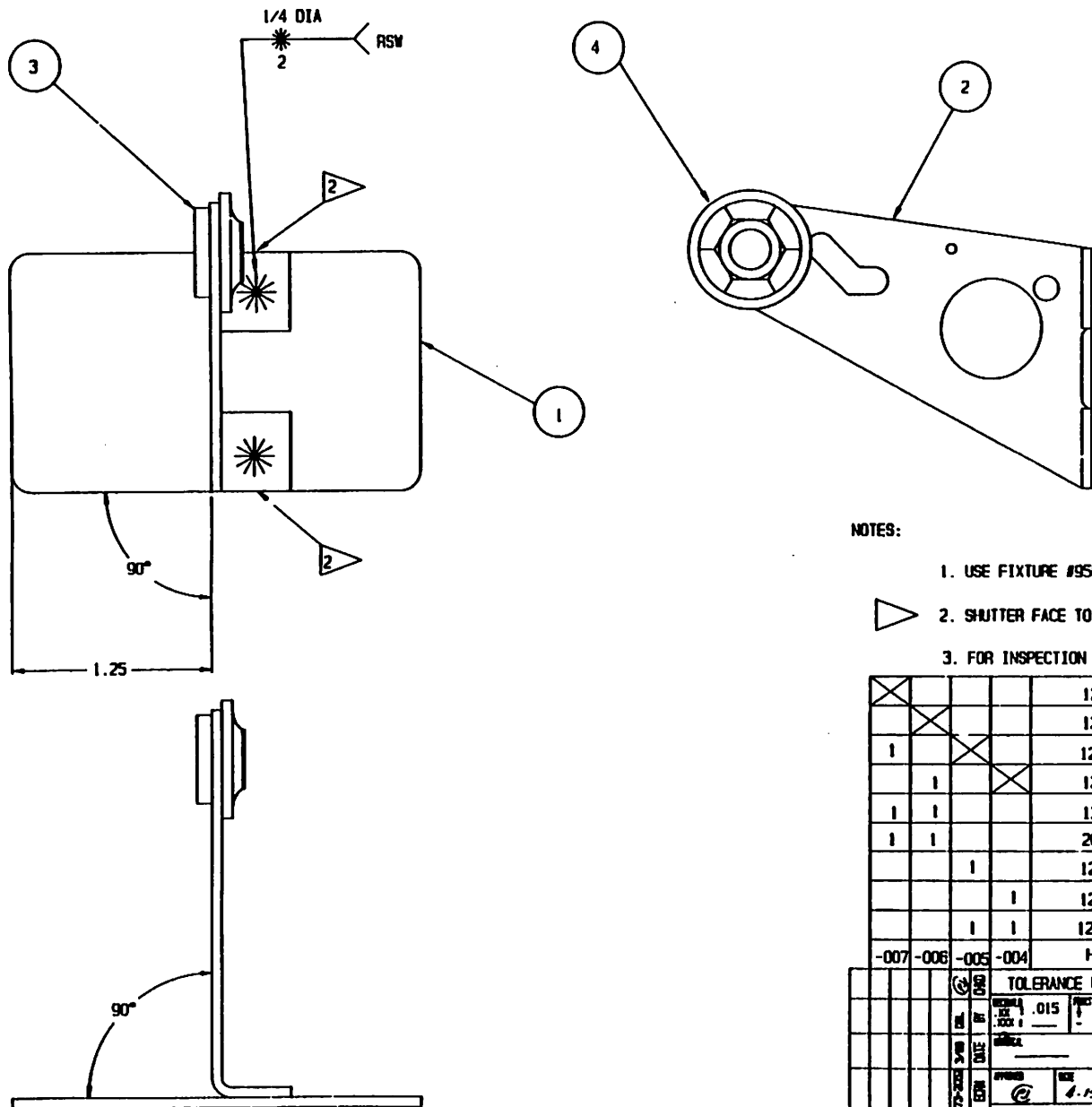
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003	1.0000 020124-000	BUSHING SHUTTER SAE 660 BRONZE
000	1.0000 121696-004	WELDMENT SHUTTER LH

PARENT: 121696-007

DESC: WELDMENT SHUTTER W/BUSHING RH

004	1.0000 013283-003	NUT 3/8" ID PUSH
003	1.0000 020124-000	BUSHING SHUTTER SAE 660 BRONZE
000	1.0000 121696-005	WELDMENT SHUTTER RH



NOTES:

1. USE FIXTURE #95695-000 FOR INCOMING INSPECTION.
2. SHUTTER FACE TO BE FLUSH WITH TABS ON SHUTTER ARM, BOTH SIDES.
3. FOR INSPECTION PURPOSES, REFER TO DIMENSIONS ON DWG 121900-002/003.

						121696-007	ASSY. WELDMENT V/BUSHING RH	
						121696-008	ASSY. WELDMENT V/BUSHING LH	
I		X				121696-005	WELDMENT, SHUTTER RH (SHOWN)	
	I		X			121696-004	WELDMENT, SHUTTER LH	
I	I					13283-003	PUSHNUT FASTENER 3/8 ID	4
I	I					20124-000	BUSHING	3
			I			121900-003	ARM, SHUTTER RH (SHOWN)	2
				I		121900-002	ARM, SHUTTER LH (SYM. OPP)	2
			I	I		121899-000	FACE, SHUTTER	I
-007	-006	-005	-004			H.P.N.	DESCRIPTION	ITEM
						TOLERANCE UNLESS NOTED FRACTIONAL DECIMALS .015 FRACTIONS 1/16 MILS I° FINISH _____ TYPICAL _____	HARMON ELECTRONICS GRAIN VALLEY, MO. 64029	
						DRAWN BY @ DATE 4-15-68 SCALE 2:1 CHECKED BY [signature] DATE 3/12/68 BY DARRYL LANNING	TITLE: ASSY. WELDMENT PROTECTIVE SHUTTER HBD	
A	117-2004	3-WB	ECON	DATE	REV	SHEET NO. DARRYL LANNING	DRAWING NO. 121696-004/007	SHEET # I ° I

CADKEY

PARENT: 200477-002

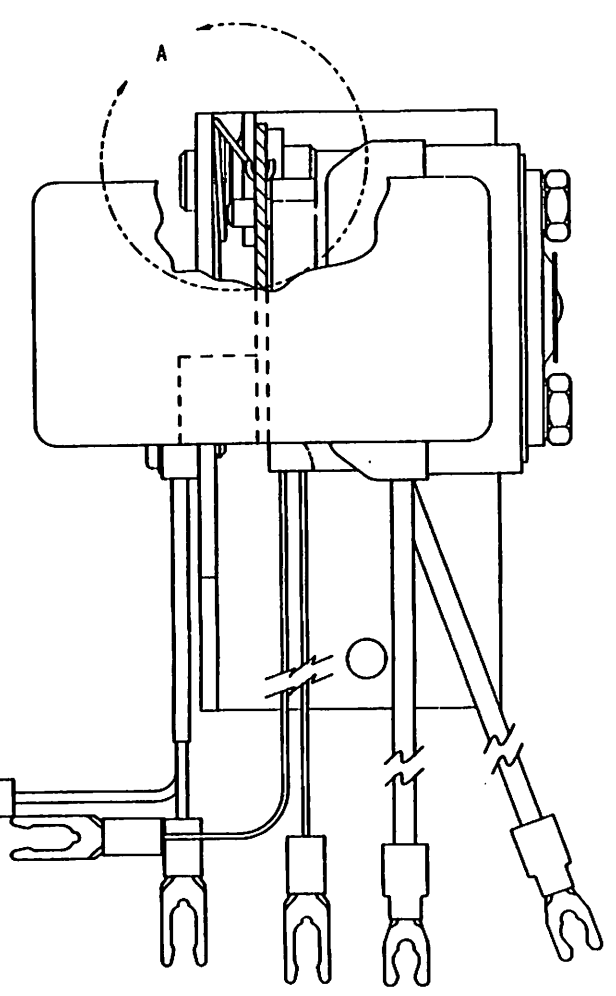
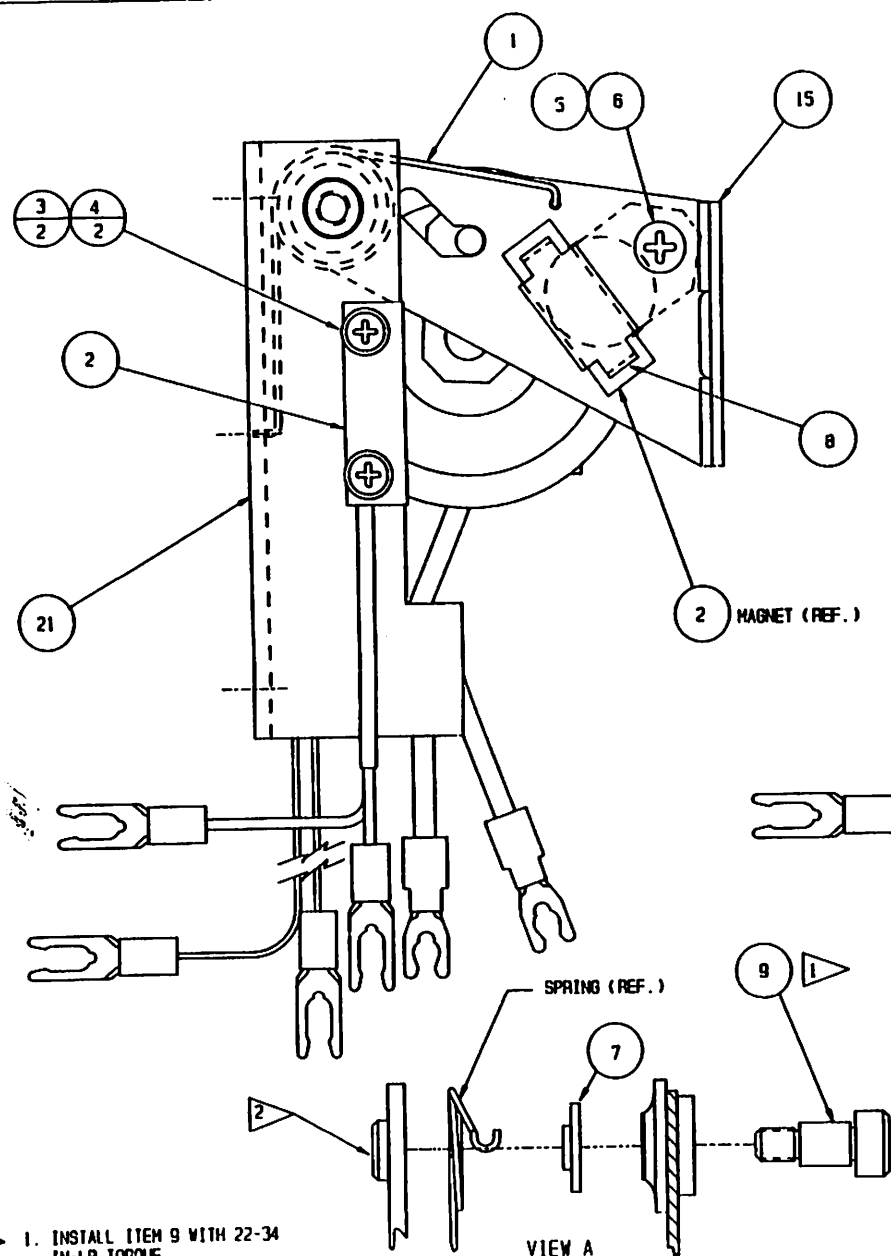
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000	2.0000 013002-012	WASHER 4 INTL SS
009	1.0000 013327-019	SCREW 10-32 X 5/16 SHC SHLDR
000	2.0000 013492-3410	SCREW 4-40 X 5/16 PPH SS
000	1.0000 013492-3608	SCREW 6-32 X 1/4 PPH SS
000	0.0000 029003-000	ADHESIVE LOCTITE #242
000	0.0001 029003-002	ADHESIVE LOCTITE #290
015	1.0000 121696-006	WELDMENT SHUTTER W/BUSHING LH
000	1.0000 121964-001	CLAMP MAGNET
000	1.0000 200689-000	ASSY SWITCH SEALED
021	1.0000 201407-002	ASSY SOLENOID LH

PARENT: 200477-003

DESC: ASSY SHUTTER SOLENOID RH

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000	2.0000 013002-012	WASHER 4 INTL SS
009	1.0000 013327-019	SCREW 10-32 X 5/16 SHC SHLDR
000	2.0000 013492-3410	SCREW 4-40 X 5/16 PPH SS
000	1.0000 013492-3608	SCREW 6-32 X 1/4 PPH SS
000	0.0001 029003-002	ADHESIVE LOCTITE #290
015	1.0000 121696-007	WELDMENT SHUTTER W/BUSHING RH
000	1.0000 121964-001	CLAMP MAGNET
000	1.0000 200689-000	ASSY SWITCH SEALED
021	1.0000 201407-003	ASSY SOLENOID LH



NOTES:

- 1. INSTALL ITEM 9 WITH 22-34 IN-LB TORQUE.
- 2. APPLY 29003-002 TO INSERT AFTER PROPER TORQUE HAS BEEN APPLIED

VIEW A
EXPLODED VIEW

		200477-003		SOLENOID ASSY (SHOWN) RH	
		200477-002		SOLENOID ASSY (SYN. OPP.) LH	
		-003-002		H.P.N.	
		TOLERANCE UNLESS NOTED		DESCRIPTION	
				ITEM	
				HARMON ELECTRONICS	
				GRAIN VALLEY, MO. 64029	
				TITLE:	
				ASSY. SOLENOID/SHUTTER	
				PROTECTIVE SHUTTER HBD	
		APPROVED PJC		DATE 4/15/88	
		BY DARREL LANNING		DATE 3/17/88	
		DRAWN BY CHRISTIAN		DATE 200477-002/003	
				PAGE 1 OF 1	

CADKEY

PARENT: 200485-002

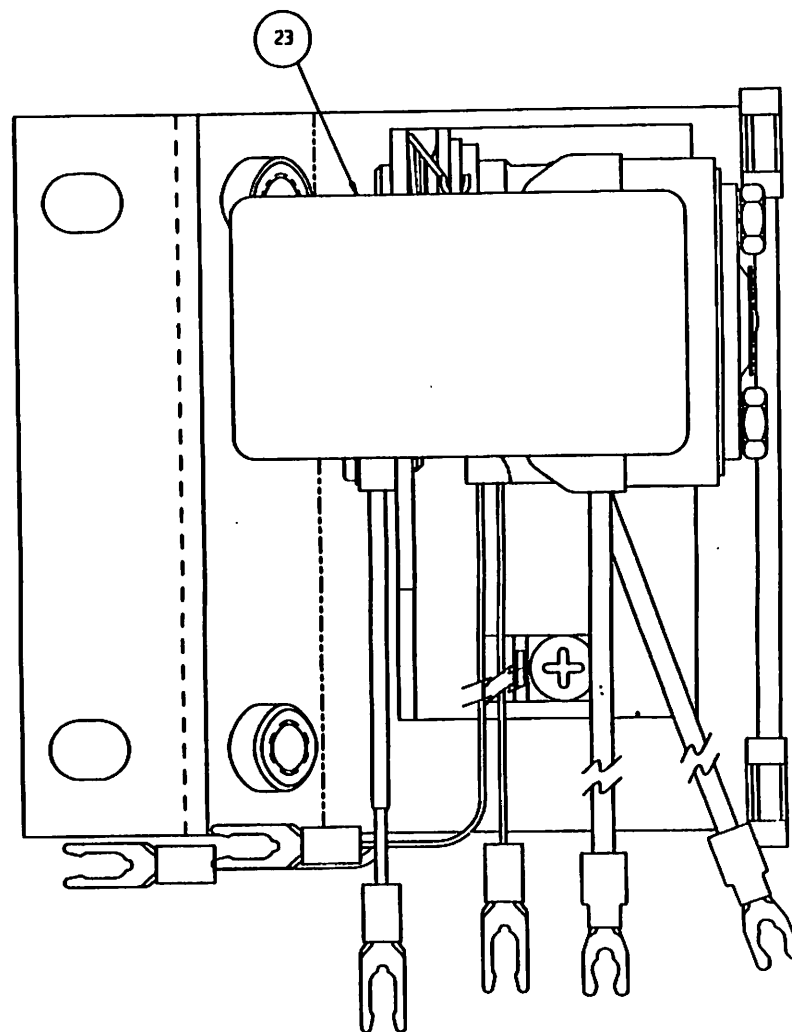
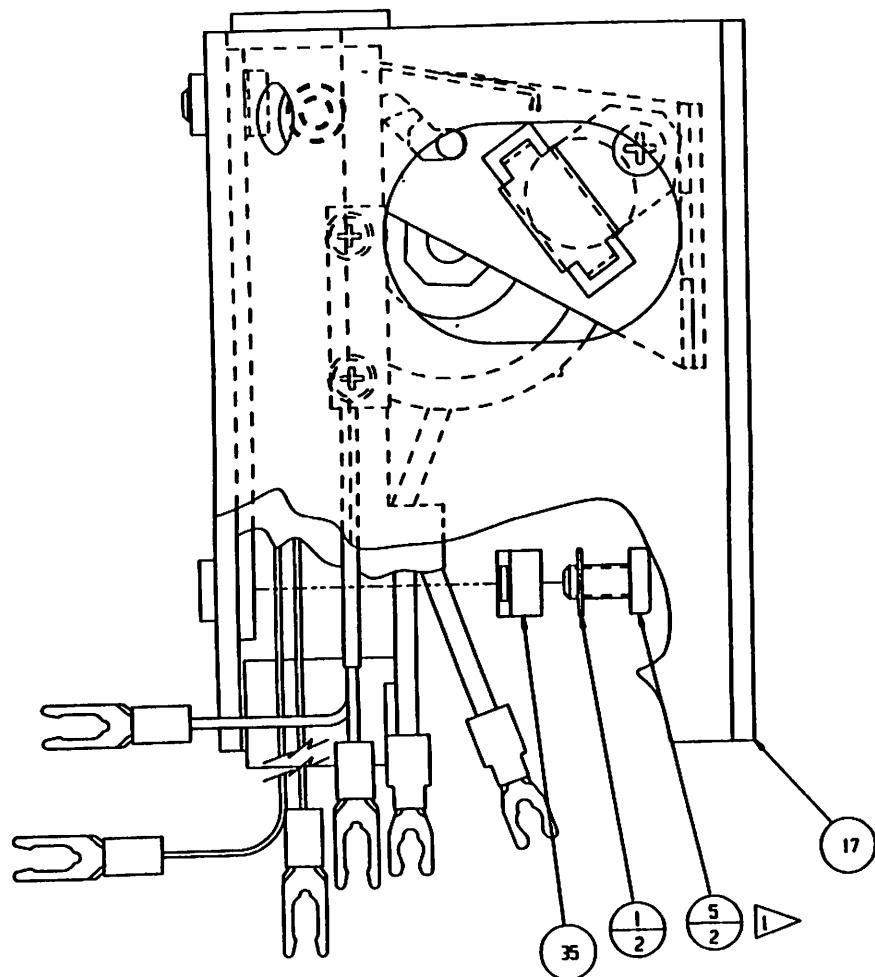
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005	2.0000 013492-3912	SCREW 10-32 X 3/8 PPH SS
000	2.0000 013914-000	CLIP U TINNEMAN
011	0.0000 029003-000	ADHESIVE LOCTITE #242
000	0.1250 033001-06C	SLEEVING HEAT SHRINK 1/4 CLR
017	1.0000 121902-008	PLATE BAFFLE W/INSERT/PRIME LH
023	1.0000 200477-002	ASSY SHUTTER/SOLENOID LH

PARENT: 200485-003

DESC: ASSY BAFFLE/SHUTTER RH

035	1.0000 005448-000	TAB MOUNTING .203 DIA NYLON
001	2.0000 013002-010	WASHER 10 INTL SS
005	2.0000 013492-3912	SCREW 10-32 X 3/8 PPH SS
000	2.0000 013914-000	CLIP U TINNEMAN
011	0.0000 029003-000	ADHESIVE LOCTITE #242
000	0.1250 033001-06C	SLEEVING HEAT SHRINK 1/4 CLR
017	1.0000 121902-009	PLATE BAFFLE W/INSERT/PRIME RH
023	1.0000 200477-003	ASSY SHUTTER/SOLENOID RH



NOTE:

- ▷ 1. APPLY LIQUID LOCKING COMPOUND (ITEM 11) TO THE SEVEN JOINTS (ITEM 5) DURING ASSEMBLY.

[illegible]

PARENT: 200573-004

DESC: ASSY THERMOSTAT

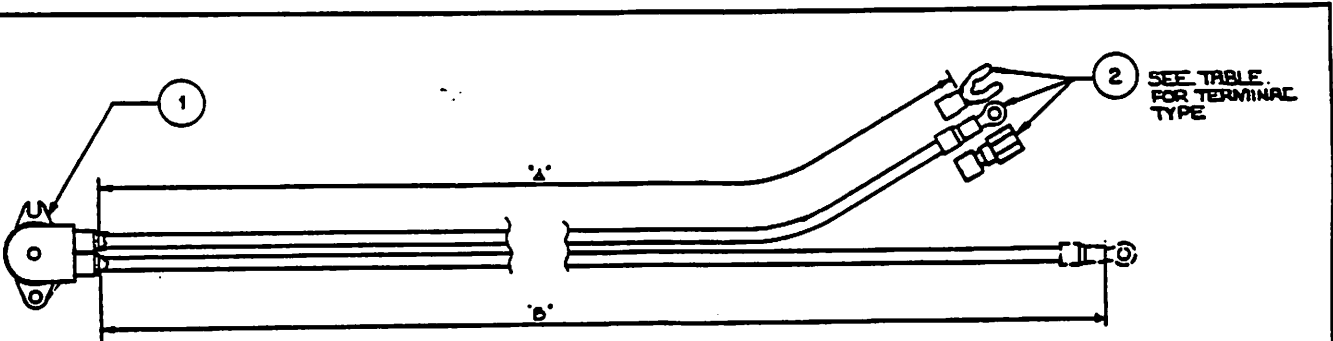
DIN	USAGE COMP_PART	COMP_DESC
001	1.0000 009185-005	THERMOSTAT ELMWOOD
000	2.0000 032991-001	TERM SPR SPADE #6 22-16AWG RED

LIST NO: 200573-004 REV: A00 DESC: ASSY THERMOSTAT
AWING NO: D200573-XXX L/T: 000 RELEASE NO: 0389753

EQ	DIN	USAGE	SZ	REV	PART NUMBER	PART DESCRIPTION	ER NO
00	001	1.0000	A	A00	009185-005	THERMOSTAT ELMWOOD	0389753*
00	000	2.0000	B	C00	032991-001	TERM SPR SPADE #6 22-16AWG RED	0389753*

* END OF DISPLAY ***
INQUIRY : PART () REV () SYMBOLS ()

| Mon Jan 06 08:46 | 9600 baud | Page | 1 | 80 |



H.P.N.	"A" DIM	"B" DIM	THERMOC. PIN	TERMI. PIN	TERMI. TYPE
-000	5.00 ± .25	5.00 ± .25	3185-005	32368-100	RNG TNG
-001	5.00 ± .25	6.00 ± .125	3185-005	32368-105	RNG TNG
-002	5.12 ± .125	5.12 ± .125	3185-002	32730-000	FRSTON
-003	5.12 ± .125	5.12 ± .125	3185-004	32730-000	FRSTON
-004	5.00 ± .125	5.00 ± .125	3185-005	32291-001	SPROE

H. P. N.		DESCRIPTION		ITEM
TOLERANCE UNLESS NOTED		HARMON INDUSTRIES, INC.		
FRACTIONAL DECIMAL ANGLES		Grain Valley, Mo. U.S.A. 64029		
DATE 3-1-85		TITLE: THERMOSTAT ASSY -		
SCALE 1:1		FIXED TEMPERATURE		
DATE 2/26/86	DATE 2/26/86	DATE 2/26/86	DATE 2/26/86	

PRINTED ON: 2/26/86

PARENT: 200689-000

DESC: ASSY SWITCH SEALED

DIN

USAGE COMP_PART

COMP_DESC

000

1.0000 009264-001

SWITCH SEALED W/MAGNET

000

2.0000 032991-301

TERM SPR SPADE #6 26-22AWG

LIST NO: 200689-000

REV: A00

DESC: ASSY SWITCH SEALED

DRAWING NO: NO DRAWING

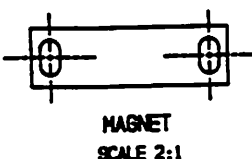
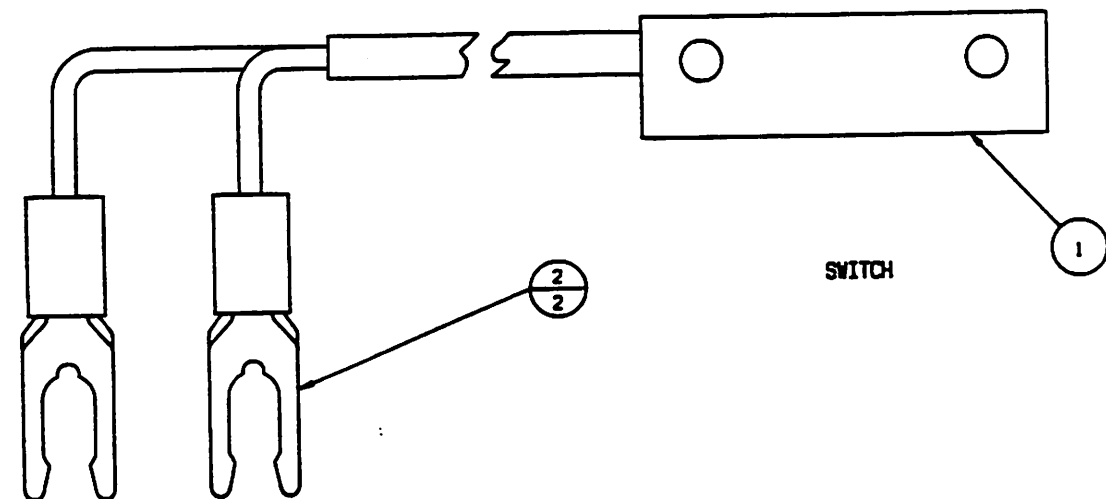
L/T: 000

RELEASE NO: 1732052

SEQ	DIN	USAGE	SZ	REV	PART NUMBER	PART DESCRIPTION	ER NO
010	000	1.0000	B	A00	009264-001	SWITCH SEALED W/MAGNET	1732052*
010	000	2.0000	B	C00	032991-301	TERM SPR SPADE #6 26-22AWG	1732052*

** END OF DISPLAY ***

INQUIRY : PART () REV () SYMBOLS ()



H.P.N.				DESCRIPTION	ITEM
TOLERANCE UNLESS NOTED				HARMON ELECTRONICS	
				GRAIN VALLEY, MO. 64029	
				FILE ASSY. SWITCH SEALED	
				W/MAGNET	
DARREL LANNING 3/18/88				CHRISTIAN	200689-000
				CADKEY	1 1

PARENT: 200905-000

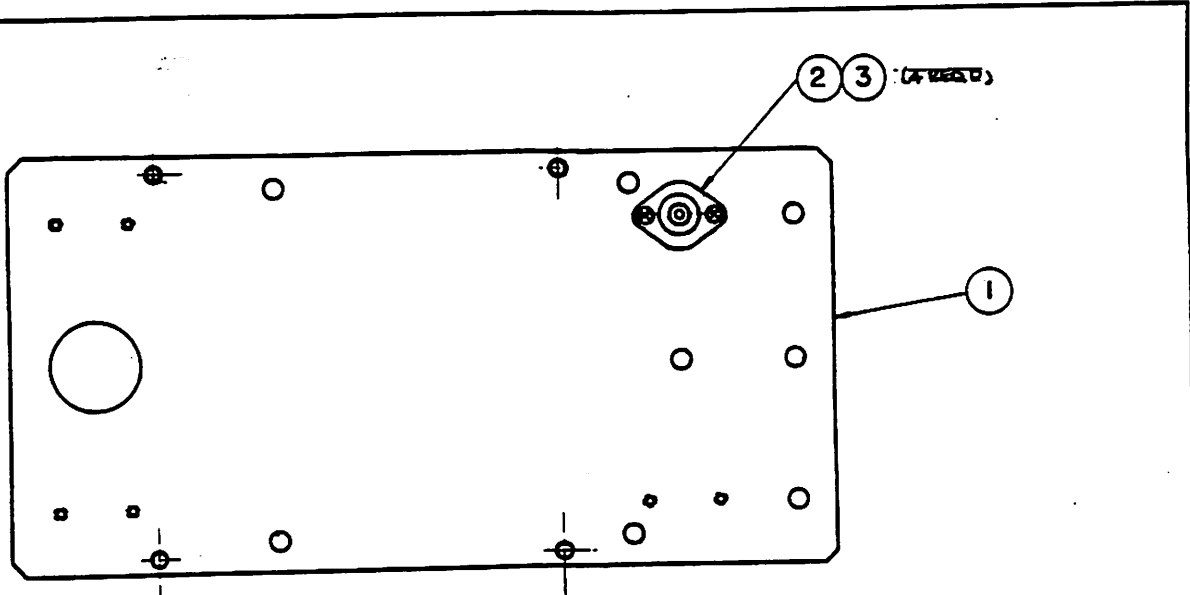
DESC: ASSY HBD UNIV SCAN BASE PLATE

DIN	USAGE COMP_PART	COMP_DESC
003	4.0000 005632-002	MOUNT LORD HTO-3 SHOCK
002	8.0000 013491-3732	SCREW 8-32 X 1 PFH SS
001	1.0000 121523-002	PLATE UNIV HBD SCAN BASE W/INS

LIST NO: 200905-000 REV: B00 DESC: ASSY HBD UNIV SCAN BASE PLATE
AWING NO: D200905-000 L/T: 000 RELEASE NO: 0047471

EQ	DIN	USAGE	SZ	REV	PART NUMBER	PART DESCRIPTION	ER NO
00	003	4.0000	A	A00	005632-002	MOUNT LORD HTO-3 SHOCK	0047471*
00	002	8.0000	B	N00	013491-3732	SCREW 8-32 X 1 PFH SS	0059009
00	001	1.0000	D	H00	121523-002	PLATE UNIV HBD SCAN BASE W/INS	0059009

*** END OF DISPLAY ***
INQUIRY : PART () REV () SYMBOLS ()

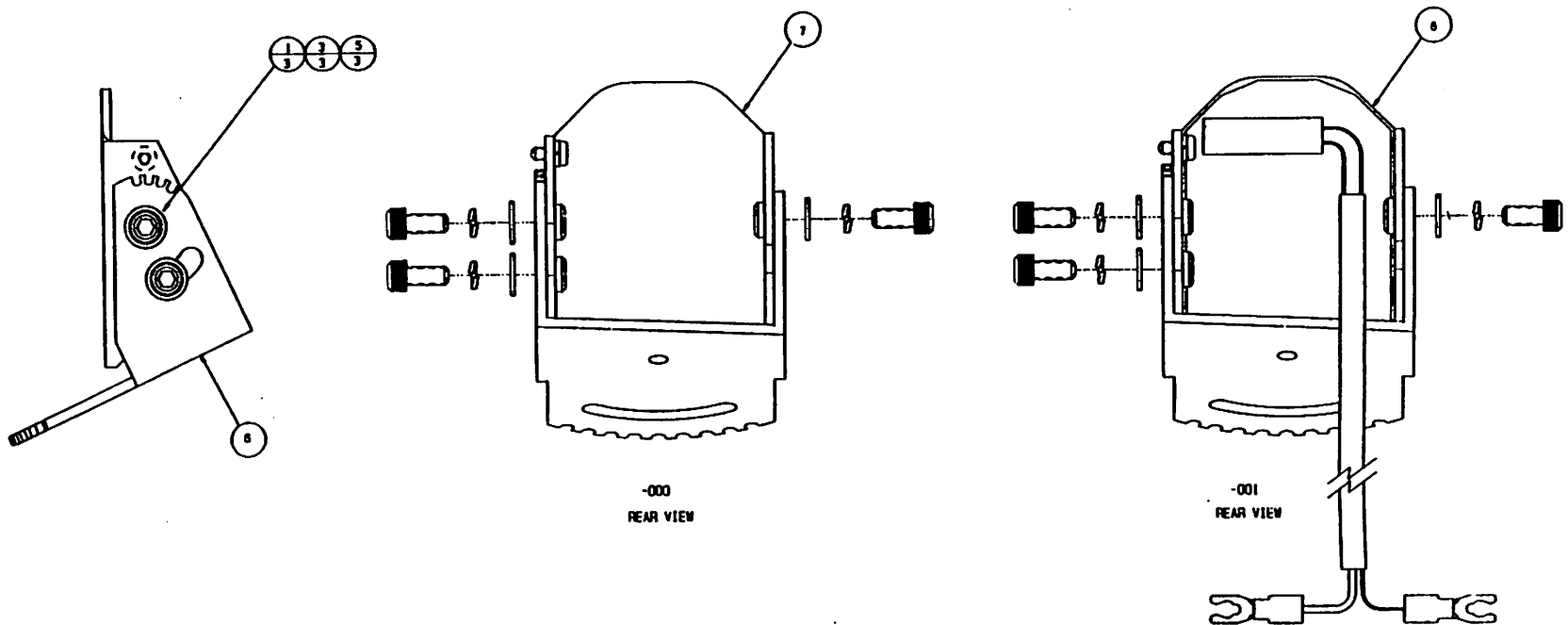


H. P. N.				DESCRIPTION	ITEM
TOLERANCE UNLESS NOTED				HARMON INDUSTRIES, INC.	
				Grain Valley, Mo. U.S.A 64029	
				TITLE: BASE PLATE ASSY.	
				UNIVERSAL HBD SCANNER	
PART USED ON:				200905-000	1

PARENT: 201199-001

DESC: ASSY MIRROR W/HEAT

DIN	USAGE COMP_PART	COMP_DESC
000	3.0000 013008-021	WASHER 8 FLT SS
003	3.0000 013030-007	WASHER 8 SPL SS
001	3.0000 013427-3712	SCREW 8-32 X 3/8 SHC SS
006	1.0000 121566-002	BRKT HBD MIRROR PIVOT PAINT
008	1.0000 200508-000	ASSY HEATED MIRROR



-000
REAR VIEW

-001
REAR VIEW

H. P. N.										DESCRIPTION		ITEM
APPROVED BY <u>R OYER</u> DATE <u>6/2/89</u>											HARMON ELECTRONICS GRAIN VALLEY, MO. 64029	1
DESIGNED BY <u>E. DEVLIN</u> DATE <u>2:1</u>												
CHECKED BY <u>DARREL LAMMING</u> DATE <u>6/2/89</u>												
TOLERANCE UNLESS NOTED										TITLE: ASSY MIFFOR W & W/D HEATER		
REV <u>1</u> PART NO. <u>701199-X</u> QUANTITY <u>1</u>										PART NO. <u>701199 000/001</u> QUANTITY <u>1</u>		
REV <u>1</u> KEY <u>0</u>										REV <u>1</u> KEY <u>0</u>		

PARENT: 201407-002

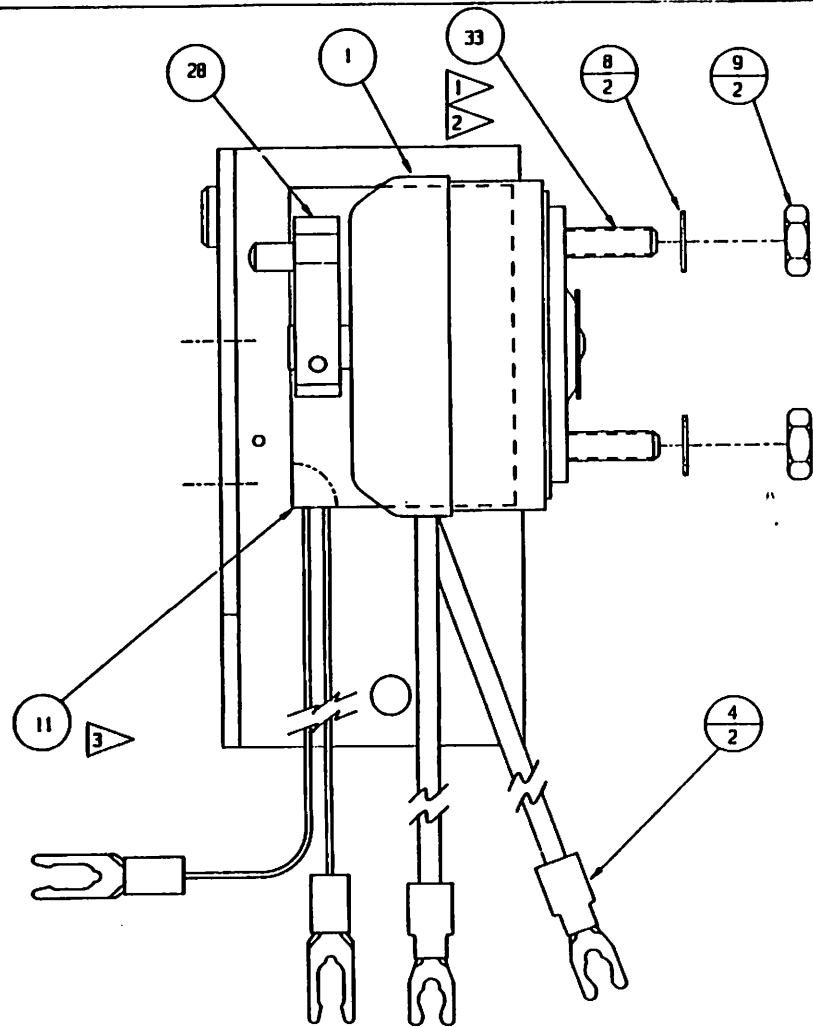
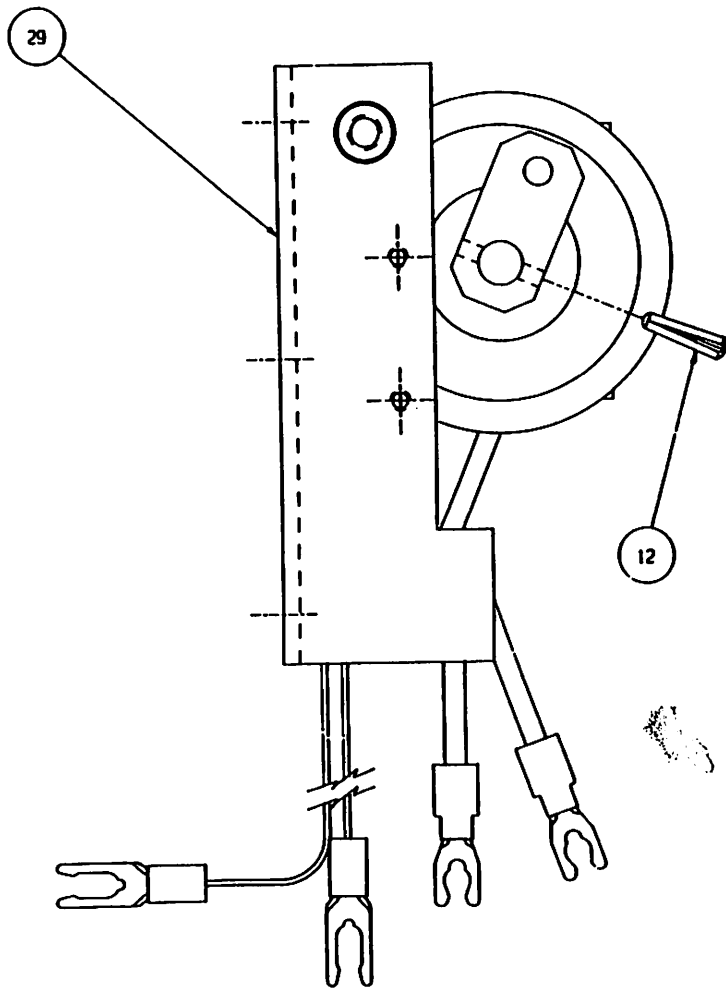
DESC: ASSY SOLENOID LH

DIN	USAGE COMP_PART	COMP_DESC
001	1.0000 007174-000	RLY ROTARY SOLENOID SEALED LH
008	2.0000 013002-014	WASHER 8 INTL SS
009	2.0000 013009-3701	NUT 8-32 HEX SS
012	1.0000 013330-006	PIN GROOVED TYPE A
000	0.0000 023003-000	ADHESIVE LOCTITE #242
004	2.0000 032991-001	TERM SPR SPADE #6 22-16AWG RED
028	1.0000 065190-001	DRIVE ARM HBD PROT SHTR W/PIN
000	1.0000 122628-005	BRKT PROT SHUT FORMED LH IRID
011	1.0000 226398-000	ASSY PAD HEATER

PARENT: 201407-003

DESC: ASSY SOLENOID RH

001	1.0000 007174-001	RLY ROTARY SOLENOID SEALED LH
008	2.0000 013002-014	WASHER 8 INTL SS
009	2.0000 013009-3701	NUT 8-32 HEX SS
012	1.0000 013330-006	PIN GROOVED TYPE A
033	0.0000 029003-000	ADHESIVE LOCTITE #242
004	2.0000 032991-001	TERM SPR SPADE #6 22-16AWG RED
028	1.0000 065190-001	DRIVE ARM HBD PROT SHTR W/PIN
000	1.0000 122628-006	BRKT PROT SHUT FORMED RH IRID
011	1.0000 226398-000	ASSY PAD HEATER



NOTES:

- 1. THREADED STUDS MUST HAVE LIQUID LOCKING COMPOUND (ITEM 33) APPLIED DURING ASSY.
- 2. AFTER INSTALLING SOLENOID (ITEM 1) ON BRACKET (ITEM 29) CUT SOLENOID MOUNTING STUDS FLUSH WITH NUT (ITEM 9).
- 3. LOCATE HEATER PAD IN AREA SHOWN.

201407-003		SOLENOID ASSY (SHOWN) LH	
201407-002		SOLENOID ASSY (SYM. OPP.) RH	
-003 -002		H.P.N.	
TOLERANCE UNLESS NOTED		DESCRIPTION	ITEM
HARMON ELECTRONICS		GRAIN VALLEY, MO. 64029	
TITLE: ASSY, SOLENOID		PROTECTIVE SHUTTER HBD	
DRAWN BY: DARREL LANNING		DATE: 3/17/88	SCALE: 2:1
CHECKED BY: CHRISTIAN		DATE: 201407-002/003	SHEET 1 OF 1

CADKEY

PARENT: 226048-002

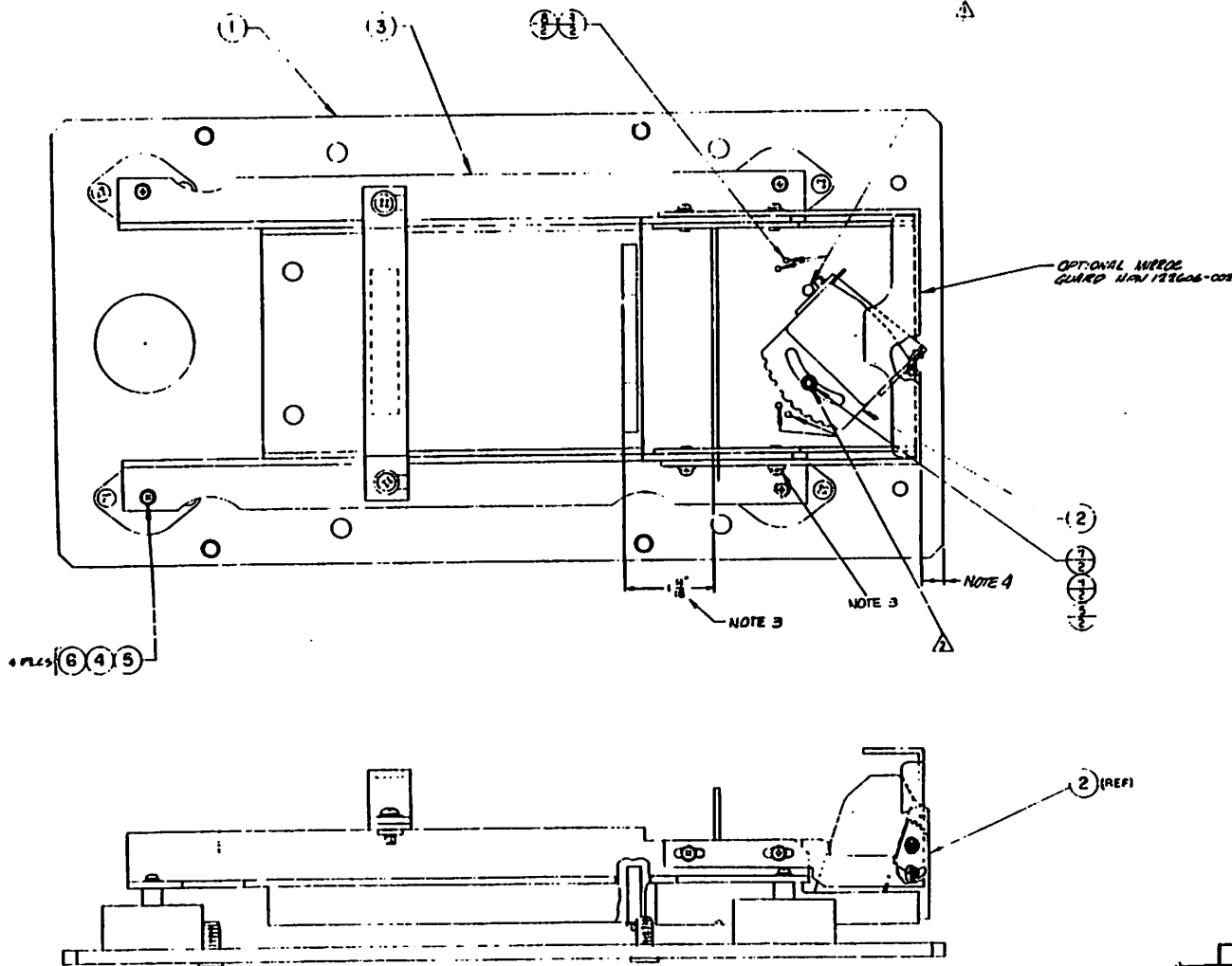
DESC: ASSY UNI SCAN CRADLE LH W/HMIR

DIN	USAGE COMP_PART	COMP_DESC
000	6.0000 013008-021	WASHER 8 FLT SS
009	2.0000 013030-005	WASHER 4 SPL SS
005	6.0000 013030-007	WASHER 8 SPL SS
007	2.0000 013427-3712	SCREW 8-32 X 3/8 SHC SS
008	2.0000 013492-3412	SCREW 4-40 X 3/8 PPH SS
006	4.0000 013492-3716	SCREW 8-32 X 1/2 PPH SS
000	1.0000 122606-002	MIRROR GUARD HBD FORM
003	1.0000 200561-000	ASSY CRADLE W/O MIRROR & BASE
001	1.0000 200905-000	ASSY HBD UNIV SCAN BASE PLATE
002	1.0000 201199-001	ASSY MIRROR W/HEAT

PARENT: 226048-003

DESC: ASSY UNI SCAN CRADLE RH W/HMIR

000	6.0000 013008-021	WASHER 8 FLT SS
009	2.0000 013030-005	WASHER 4 SPL SS
005	6.0000 013030-007	WASHER 8 SPL SS
007	2.0000 013427-3712	SCREW 8-32 X 3/8 SHC SS
008	2.0000 013492-3412	SCREW 4-40 X 3/8 PPH SS
006	4.0000 013492-3716	SCREW 8-32 X 1/2 PPH SS
000	1.0000 122606-002	MIRROR GUARD HBD FORM
003	1.0000 200561-000	ASSY CRADLE W/O MIRROR & BASE
001	1.0000 200905-000	ASSY HBD UNIV SCAN BASE PLATE
002	1.0000 201199-001	ASSY MIRROR W/HEAT



NOTES:

1. DOOR TO BE USED FOR LEFT HAND OPPOSITE AS SHOWN.
2. DOOR TO BE USED FOR RIGHT HAND AS SHOWN.
3. RE-USE EXISTING HARDWARE WHEN INSTALLING OPTIONAL WIRE GUARD. CHECK TO SEE THAT THE 1" MIN. DIMENSION HAS BEEN MAINTAINED AFTER GUARD IS INSTALLED.
4. WIRE GUARD MUST BE POSITIONED SO THAT THERE IS NO CLEARANCE TO PERMIT ANY INTERFERENCE BETWEEN THE GUARD AND THE LID WHEN THE LID IS INSTALLED. A MINIMUM OF 5/16" IS REQUIRED.

H. P. N.		DESCRIPTION	
1	2	TOLERANCE UNLESS NOTED	
3	4	REVISION	DATE
5	6	1	1/15/85
7	8	2	2/28/84
9	10	3	2/28/84
11	12	4	2/28/84
13	14	5	2/28/84
15	16	6	2/28/84
17	18	7	2/28/84
19	20	8	2/28/84
21	22	9	2/28/84
23	24	10	2/28/84
25	26	11	2/28/84
27	28	12	2/28/84
29	30	13	2/28/84
31	32	14	2/28/84
33	34	15	2/28/84
35	36	16	2/28/84
37	38	17	2/28/84
39	40	18	2/28/84
41	42	19	2/28/84
43	44	20	2/28/84
45	46	21	2/28/84
47	48	22	2/28/84
49	50	23	2/28/84
51	52	24	2/28/84
53	54	25	2/28/84
55	56	26	2/28/84
57	58	27	2/28/84
59	60	28	2/28/84
61	62	29	2/28/84
63	64	30	2/28/84
65	66	31	2/28/84
67	68	32	2/28/84
69	70	33	2/28/84
71	72	34	2/28/84
73	74	35	2/28/84
75	76	36	2/28/84
77	78	37	2/28/84
79	80	38	2/28/84
81	82	39	2/28/84
83	84	40	2/28/84
85	86	41	2/28/84
87	88	42	2/28/84
89	90	43	2/28/84
91	92	44	2/28/84
93	94	45	2/28/84
95	96	46	2/28/84
97	98	47	2/28/84
99	100	48	2/28/84

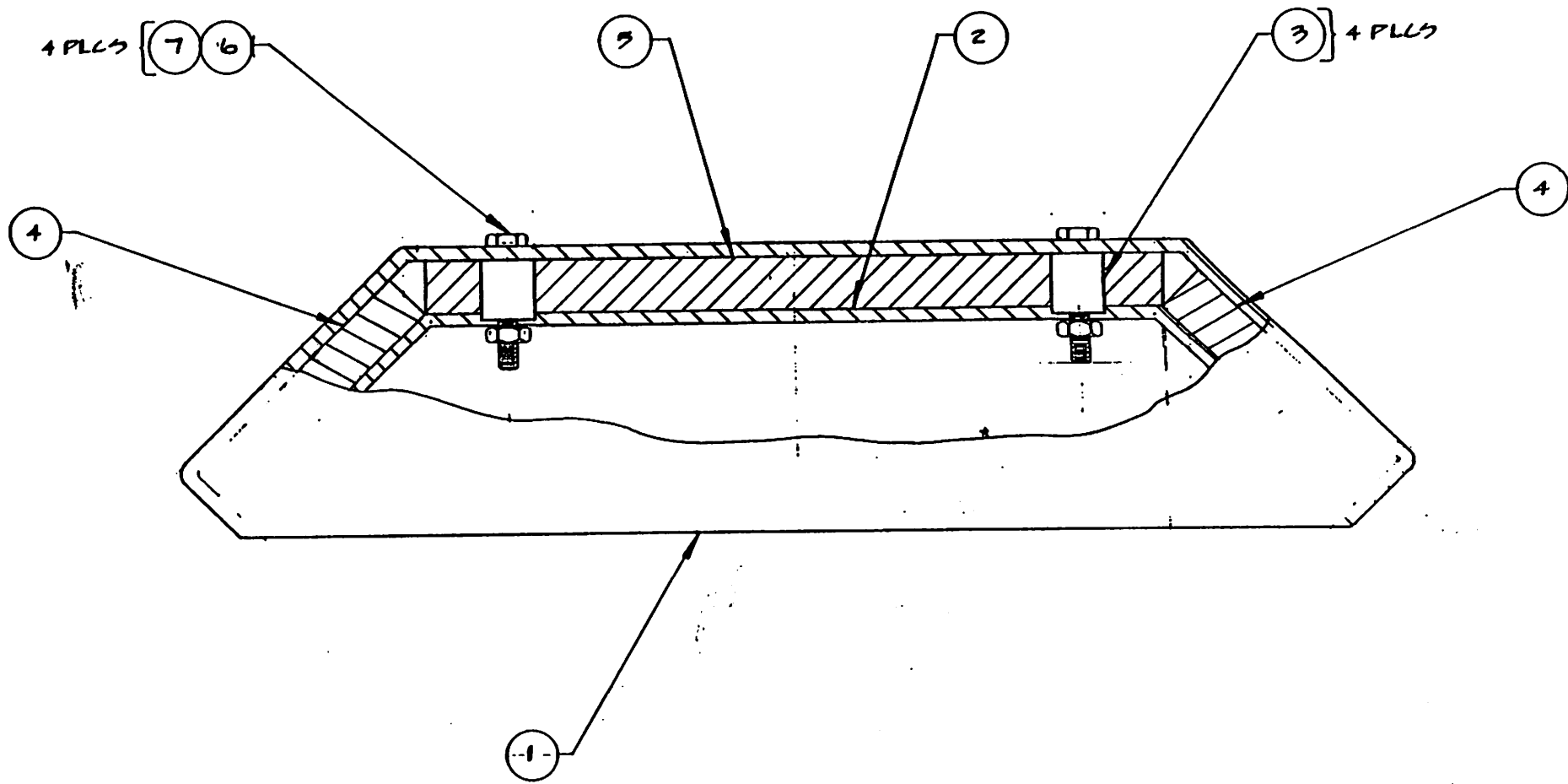
PERMIT TO USE ON: 250 505-1000



PARENT: 226049-000

DESC: ASSY SHIELD HEAT

DIN	USAGE COMP_PART	COMP_DESC
003	4.0000 005629-001	SPACER .56 X .500 X .281 PHEN
007	4.0000 013113-006	NUT 1/4-20 NYLON LOCK SS
006	4.0000 013194-001	SCREW 1/4-20 X 1-1/8 HHC SS
005	1.0000 040105-000	INSULATION CENTER HEAT SHIELD
004	2.0000 040107-000	INSULATION HEAT SHIELD SIDE
002	1.0000 121521-001	BASE HEAT SHIELD MACH W/FINISH
001	1.0000 121522-001	WELDMENT HEAT SHIELD PLATED



				H. P. N.		DESCRIPTION		ITEM
				TOLERANCE UNLESS NOTED		HARMON INDUSTRIES, INC. Grain Valley, Mo. U. S. A 64029		
				DECIMALS XX ± .1 XXX ± .001	FRACTIONS ± 1/16 ± 1/32			
				MATERIAL		FINISH	TITLE: HEAT SHIELD ASSEMBLY	
				APPROVED S.J.F.	DATE 11/21/85	SCALE NONE		
				DRAWN BY V. Damyane		DATE 8-10-84	ENGINEER H. DEWILL	DRAWING NO. 226049-000
				REL.	1			SHEET OF 1

PARENT: 226394-002

DESC: ASSY PROT SHUTTER LH

DIN	USAGE COMP_PART	COMP_DESC
001	4.0000 005019-A18	CABLE TIE 5-1/2" BLACK
002	2.0000 005449-206	SPACER MF 6-32 X 3/8 HEX SS
008	2.0000 013002-011	WASHER 6 INTL SS
010	2.0000 013030-002	WASHER 5/16 SPL SS
009	2.0000 013041-003	WASHER 5.16 FLT SS
011	2.0000 013113-003	NUT 6-32 NYLON LOCK SS
017	2.0000 013384-1832	SCREW 10B X1 HEX/WASHER ZINC
012	2.0000 013437-3216	SCREW 5.16-18 X 1/2 SET SS
014	2.0000 013492-3616	SCREW 6-32 X 1/2 PPH SS
015	2.0000 013492-3620	SCREW 6-32 X 5/8 PPH SS
016	2.0000 013854-110	SCREW 5/16 X 5/8 SHC SS
013	2.0000 013894-007	RIVET 1/8 X .565 POP CLOSED
021	2.0000 017120-000	HEATER ROD 100W 120V
000	1.0000 017120-000	LABEL 115 VOLTS
031	0.0000 029003-000	ADHESIVE LOCTITE #242
000	0.0012 029010-000	CHEMICAL PLIOBOND #20 (GLUE)
000	2.0000 031170-101	GASKET W/PSA
000	2.0000 031170-000	GASKET EXTRUDED
041	1.0000 032336-7109	TERM BLOCK BARRIER 164-STD-9
000	2.0000 032991-001	TERM SPR SPADE #6 22-16AWG RED
048	1.0000 040125-000	COVER TERMINAL BLOCK
000	2.0000 040203-000	INSULATOR PROTECTIVE SHUTTER
055	1.0000 065178-004	SHUTTER CASTING MACH LH
100	1.0000 080844-000	PROC HBD ELECT TEST
040	1.0000 132021-008	MARKER STRIP 9 POSITION
061	1.0000 200485-002	ASSY BAFFLE/SHUTTER LH
062	1.0000 200571-000	ASSY JUMPER WIRE PROTECT SHUTT
063	1.0000 200573-004	ASSY THERMOSTAT
069	1.0000 225930-016	ASSY TERMINAL STRIP COMPONENTS

PARENT: 226394-003

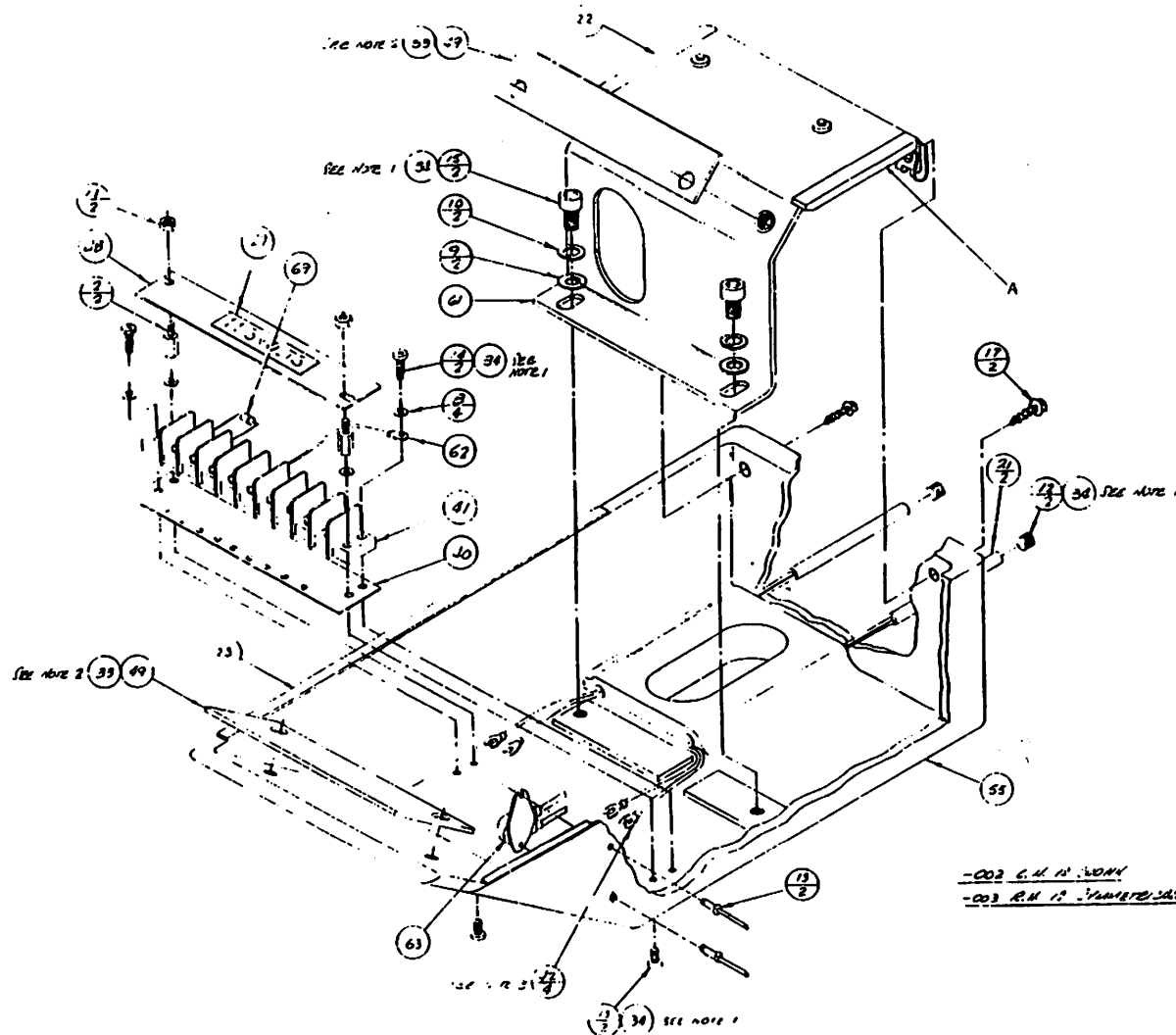
DESC: ASSY PROT SHUTTER RH

DIN	USAGE COMP_PART	COMP_DESC
001	4.0000 005019-A18	CABLE TIE 5-1/2" BLACK
002	2.0000 005449-206	SPACER MF 6-32 X 3/8 HEX SS
008	2.0000 013002-0111	WASHER 6 INTL SS
010	2.0000 013030-002	WASHER 5/16 SPL SS
009	2.0000 013041-003	WASHER 5/16 FLT SS
011	2.0000 013113-003	NUT 6-32 NYLON LOCK SS
017	2.0000 013384-1832	SCREW 10B X 1 HEX WASHER ZINC
012	2.0000 013437-3216	SCREW 5/16-18 X 1/2 SET SS
014	2.0000 013492-3616	SCREW 6-23 X 1/2 PPH SS
015	2.0000 013492-3620	SCREW 6-32 X 5/8 PPH SS
016	2.0000 013854-110	SCREW 5/16-18 X 5/8 SHC SS
013	2.0000 013894-007	RIVET 1/8 X .565 POP CLOSED
021	2.0000 017120-000	HEATER ROD 100W 120V
000	1.0000 025813-000	LABEL 115 VOLTS
034	0.0000 029003-000	ADHESIVE LOCTITE #242
000	0.0012 029010-000	CHEMICAL PLIOBOND #20(GLUE)
000	2.0000 031170-101	GASKET W/PSA
000	2.0000 031171-000	GASKET EXTRUDED
041	1.0000 032336-7109	TERM BLOCK BARRIER 164-STD-9
000	2.0000 032991-001	TERM SPR SPADE #6 22-16AWG RED
048	1.0000 040125-000	COVER TERMINAL BLOCK
000	2.0000 040203-000	INSULATOR PROTECTIVE SHUTTER
055	1.0000 065178-005	SHUTTER CASTING MACH RH
100	1.0000 080844-000	PROC HBD ELECT TEST
040	1.0000 132021-008	MARKER STRIP 9 POSITION
061	1.0000 200485-003	ASSY BAFFLE/SHUTTER RH
062	1.0000 200571-000	ASSY JUMPER WIRE PROTECT SHUTT
063	1.0000 200573-001	ASSY THERMOSTAT
069	1.0000 225930-016	ASSY TERMINAL STRIP COMPONENTS

LEVEL:

1. HARRY LEADS (ITEM 33) TO BE PLACED TO THE RIGHT OF THE UNIT IF IT IS PLACED TO THE RIGHT.
2. HARRY LEADS (ITEM 33) TO THE LEFT OF THE UNIT IF IT IS PLACED TO THE LEFT.
3. LAY LEADS OF EXH. NUMBER AND LEADS TO THE UNIT IF THE UNIT IS PLACED.

VIE N A



-002 C.M. H. 300V
-003 R.H. 12. 1/2" DIA. 1/2" DIA. 1/2" DIA.

H P N				DESCRIPTION		ITEM
TOLERANCE UNLESS NOTED				HARMON INDUSTRIES, INC.		
DIMENSIONS				Grain Valley, Mo U S A 64029		
TITLE				1/2" DIA. 1/2" DIA. 1/2" DIA.		
DATE				1/2" DIA. 1/2" DIA. 1/2" DIA.		
DRAWN BY				1/2" DIA. 1/2" DIA. 1/2" DIA.		
CHECKED BY				1/2" DIA. 1/2" DIA. 1/2" DIA.		
APPROVED BY				1/2" DIA. 1/2" DIA. 1/2" DIA.		
DATE				1/2" DIA. 1/2" DIA. 1/2" DIA.		
1/2" DIA. 1/2" DIA. 1/2" DIA.				1/2" DIA. 1/2" DIA. 1/2" DIA.		



PARENT: 250385-014

DESC: ASSY UNI SCAN LH W/HTD MIRROR

DIN	USAGE COMP_PART	COMP_DESC
001	4.0000 005019-A18	CABLE TIE 5-1/2" BLACK
002	4.0000 005358-001	CLAMP CABLE RELEASABLE
003	4.0000 005448-000	TAB MOUNTING .203 DIA NYLON
005	4.0000 005629-000	SPACER 1.62 x .750 x .375 PHEN
011	8.0000 013008-013	WASHER 6 FLT SS .281
012	4.0000 013008-022	WASHER 5/16 FLT SS
013	4.0000 013016-007	SCREW 5/16-18 X 2-1/4 HEX HD S
014	12.0000 013030-002	WASHER 5/16 SPL SS
015	8.0000 013030-006	WASHER 6 SPL SS
000	4.0000 013041-003	WASHER 5/16 FLT SS
016	8.0000 013492-3610	SCREW 6-32 X 5/16 PPH SS
017	4.0000 013854-112	SCREW 5/16-18 X 3/4 SHCS SS
023	1.0000 065112-001	HOUSING HBD SCANNER MACH
024	4.0000 065115-001	ANCHOR BAR HBD PLATED
030	1.0000 226048-002	ASSY UNI SCAN CRADLE LH W/MIR
031	1.0000 226049-000	ASSY SHIELD HEAT
032	1.0000 226394-002	ASSY PROT SHUTTER LH
001	4.0000 005019-A18	CABLE TIE 5-1/2" BLACK
002	4.0000 005358-001	CLAMP CABLE RELEASABLE
003	4.0000 005448-000	TAB MOUNTING .203 DIA NYLON
005	4.0000 005629-000	SPACER 1.62 X .750 X .375 PHEN
011	8.0000 013008-013	WASHER 6 FLT SS .281
012	4.0000 013008-022	WASHER 5/16 FLT SS
013	4.0000 013016-007	SCREW 5/16-18 X 2-1/4 HEX HD S
014	12.0000 013030-002	WASHER 5/16 SPL SS
015	8.0000 013030-006	WASHER 6 SPL SS
000	4.0000 013041-003	WASHER 5/16 FLT SS
016	8.0000 013492-3610	SCREW 6-32 X 5/16 PPH SS
017	4.0000 013854-112	SCREW 5/16-18 X 3/4 SHCS SS
023	1.0000 065112-001	HOUSING HBD SCANNER MACH
024	4.0000 065115-001	ANCHOR NAR HBD PLATED
030	1.0000 226048-003	ASSY UNI SCAN CRADLE RH W/HMIR
031	1.0000 226049-000	ASSY SHIELD HEAT
032	1.0000 226394-003	ASSY PROT SHUTTER RH