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UNION SWITCH & SIGNAL

A member of ANSALDO Group
5800 Corporate Drive, Pittsburgh, PA 15237

SERVICE MANUAL 6591

INSTALLATION, OPERATION *and* MAINTENANCE

DIRECT DIGITAL

CARSPACE SYSTEM

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ANSALDO Transporti

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SECTION I

CAR SPACE SYSTEM

1. 1 PURPOSE

The Car Space System is intended for application in classification yards as a car space, data logging and signal conversion device. The Car Space System is a data acquisition system that supplies analog track fullness information to the remote I/O RTP data interface for conversion to digital data to be interpreted by the Host CPU that is controlling the Hump Yard.

1.2 GENERAL DESCRIPTION (Refer to Figure 1-1 for the simplified equipment diagram)
The car space system is subdivided into two sections: the trackside signal input circuitry, and the tower equipment.

1.2.1 Trackside Signal Input Circuitry

The Trackside Signal Input Circuitry consists of: a 30/1 track transformer, a 2/1 signal reference transformer, a 600 ohm resistor and a surge suppressor per each track. Eight signal transformers and eight surge suppressors are packaged in an assembly referred to as the wayside transformer. Each wayside transformer can be used to service a maximum of eight tracks.

1.2.2 Tower Equipment

The Tower Equipment consists of the **Car Space Rack** (Figure 1-2). This is the signal processing center for the total system and is interfaced with the wayside signal input circuitry, and the RTP A/D gate card. The rack contains an analog electronics cardfile, consisting of Phase Detector PCB's, an address board, a driver board. In addition, the rack contains a Lambda power supply assembly. Track signal data is received from the wayside circuitry and translated to an appropriate analog signal level to be sent to the external RTP A/D converter. The digital output of the A/D is then sent to the host computer for interpretation.

1.3 SPECIFICATIONS

A. Track Coupling Transformer **US&S P/N N451154-0101** (Figure 7-4)

Electrical:	50 V.A. @ 60 Hz
Physical Size:	17-1/2" x 6" x 4-1/2
Ratio:	30/1

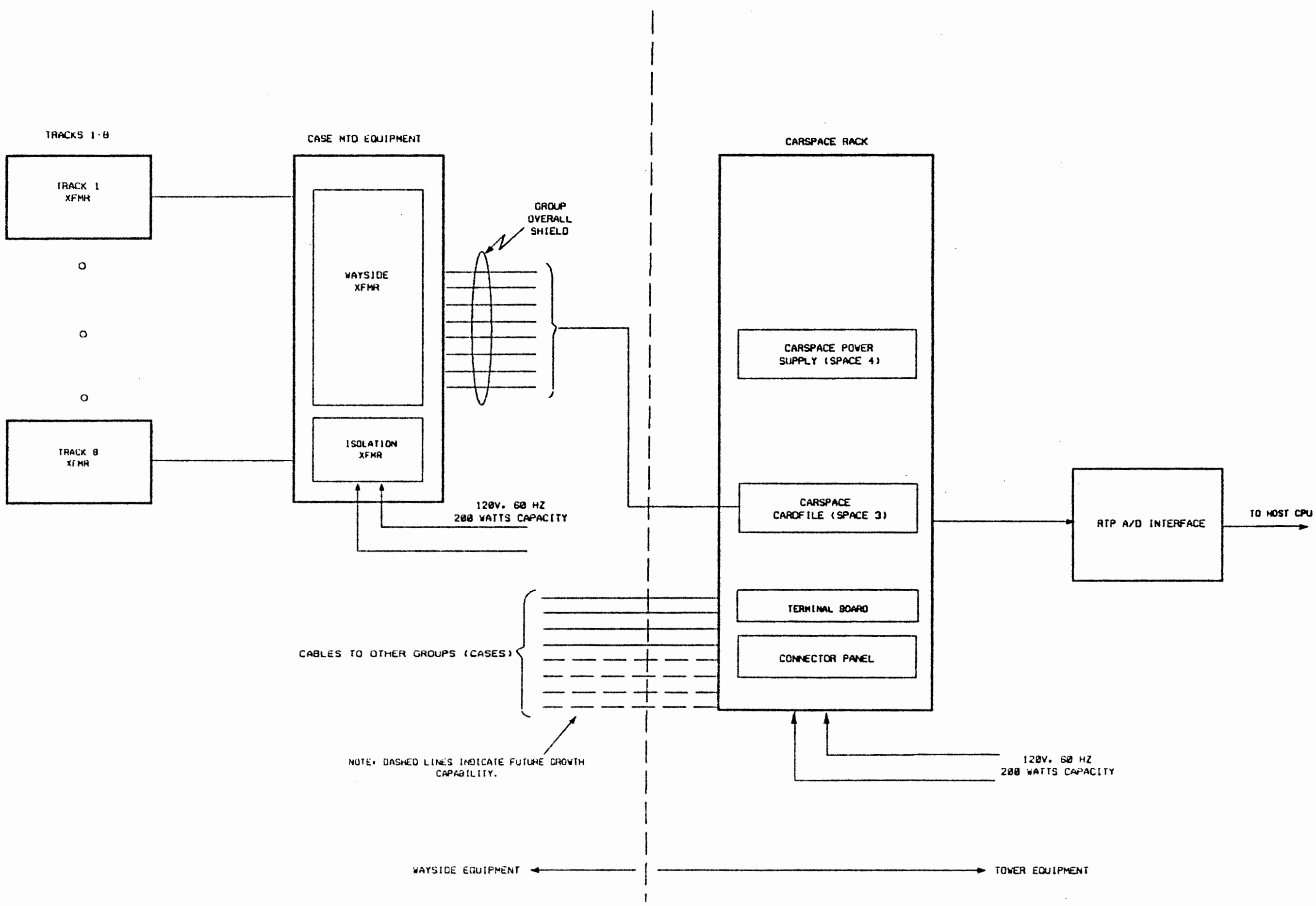


Figure 1-1: Simplified Equipment Diagram of Carspace System

(#) - Ref Fig 7-6

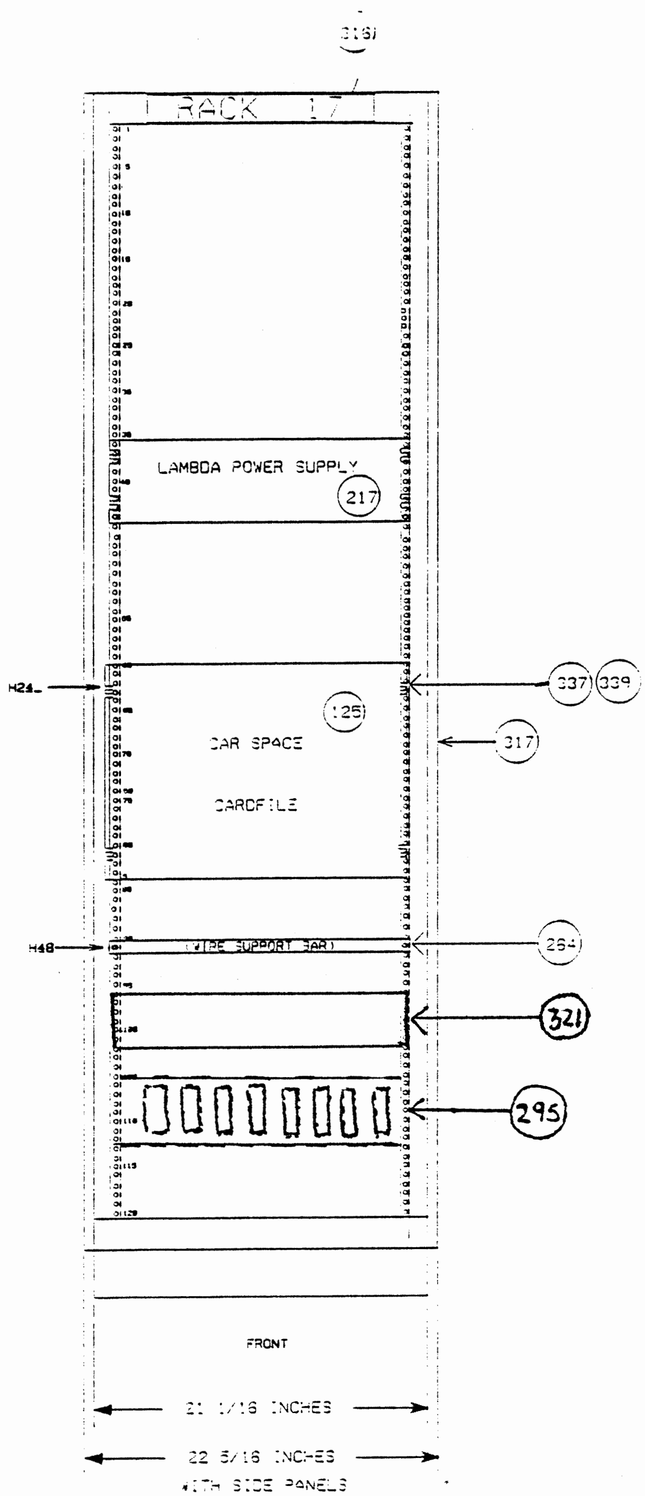


Figure 1-2: Carspace System Rack

1.3.1 Wayside Equipment(cont'd)

B. Wayside Transformer **US&S P/N N451492-0101** (Figure 7-5) contains 8 Surge Suppressors and 8 Signal Transformers

Electrical: 500 W @ 120 V, 60 HZ.
Physical Size: 7-5/8" x 9-37/64" x 10-1/8"
Ratio: 2/1

1.3.2 Tower Equipment

A. Car Space Rack (Figure 7-6, Equipto Challenger) **P/N I92Y01A17**

Electrical: 200 W @ 120 V, 60 Hz.
Physical Size: 85.80" H x 21.06" W x 36.00" D

B. Lambda Power Supply Assembly

Electrical:
Input: @ 117 V RMS +10%, 60 HZ.
Output: 1) +15V @ 0-3A.
2) -15V @ 0-3A.

Physical Size: 5-3/16" H x 21" D x 19" W
Weight: 27 lb

C. Carspace Cardfile Assembly **US&S P/N N451056-5501**

Cardfile Contains;

Driver Board (1) **US&S P/N N451441-8902**
Address Board (1) **US&S P/N UJ793100-0019**
Phase Detector Boards (*) **US&S P/N N451441-3101**

* - One per group of eight tracks

SECTION II

CONTROLS AND INDICATORS

2.1 CAR SPACE RACK (Refer to Figure 1-2)

When operating from any of the system data terminals within the yard control system software operating system, it is possible to monitor the activity of the carspace system by typing in various commands at the system prompt.

2.1.1 CSPI MODE OPERATION

CSPI is the name of the routine which reads and displays carspace track information on a continuous basis. This routine is selected from within the DIO I/O interface test program.

(1) To run DIO, Log in on the system terminal, and type "DIO" at the system prompt.

(2) A menu will appear on the screen with several utility program options. Select menu option "Car Space Input" by typing "CSPI" next to the ">>>" prompt* followed by <RTN>. This will access the carspace test program that allows the verification of all signal interfaces between the Carspace Rack and the Host Computer/RTP.

(3) You will be prompted for a track range. Type "1,8" (for P1; "9,16" for P2, etc..) followed by <RTN>. For a single track number, just enter number.

(4) You will be prompted to select repeat mode. Type "y" followed by <RTN>.

(5) The Driver output voltage, raw value (binary A/D output), and converted value (feet) will be displayed until another key is hit.

(6) When verification of tracks 1-8 is complete, hit <ESC> to return to menu.

SECTION III

THEORY OF OPERATION

3.1 GENERAL THEORY (Refer to Figure 3-1 for the General System Block Diagram)

3.1.1 Car Space Measurement

The car space measurement equipment measures the distance on a storage track from a given reference point (usually clearance point) to the point of last standing shunt on that track (as produced by the last car on the track). The operation of the car space circuits utilizes the effect of electrical phase relationship reflected from the rails of a track. An alternating current applied to the rails of a track will encounter an impedance composed of resistive and inductive components. This current lags in time when compared to the voltage across a series resistor in the circuit. The inductance of the track varies directly with its length, so that the shunt produced by the last standing car determines how much inductance is offered by the track as a circuit component.

When the track is full, the inductive effect will be almost non-existent, and a comparison of these circuit currents with the voltage drop across the circuit's series resistor will be found to be very close to zero degrees of phase shift. Similarly when the track is empty, there is a relatively large amount of inductance in the circuit and the track current will lag the system voltage. Circuits are provided which will measure the amount of phase shift occurring between the two input signals from the track, and therefore, phase shift is the variable used to measure track length.

3.1.2 Car Space System

The Car Space System is a data acquisition system designed to provide "track fullness" information, (as a derived function of externally developed track associated phase angle measurements) for a maximum of 72 tracks, to any or all three independent requesting stations. The system utilizes separate and continuously energized phase detector circuits which are multiplexed in a cascaded fashion for identification of a given track in a given group. The selected analog information from the phase detector is sent to an external A/D converter. The A/D converter output is sent to the Yard system Host CPU. The Host CPU controls the scanning of the phase detectors, stores the digital data, and outputs the data upon request to any of the the yard system stations.

3.2 DETAILED THEORY (Refer to Figure 3-2 and 3-3 for the Detailed System Block Diagrams)

3.2.1 Wayside Circuitry

By proper connection of the Wayside Circuitry, the phase angle signals are made to be direct indications of the available car spaces on a track. For any given track at a given location, a range of 0 to 3,069 feet (of available distance to last standing car, or shunt, on the track) has its own particular corresponding range of phase angle degrees, (0 degrees to some particular value). The phase angle pairs are terminated in the Car Space Rack Phase Detector, processed by the external RTP A/D Converter, run through the pre-programmed Host computer, and used to calculate as track fullness data.

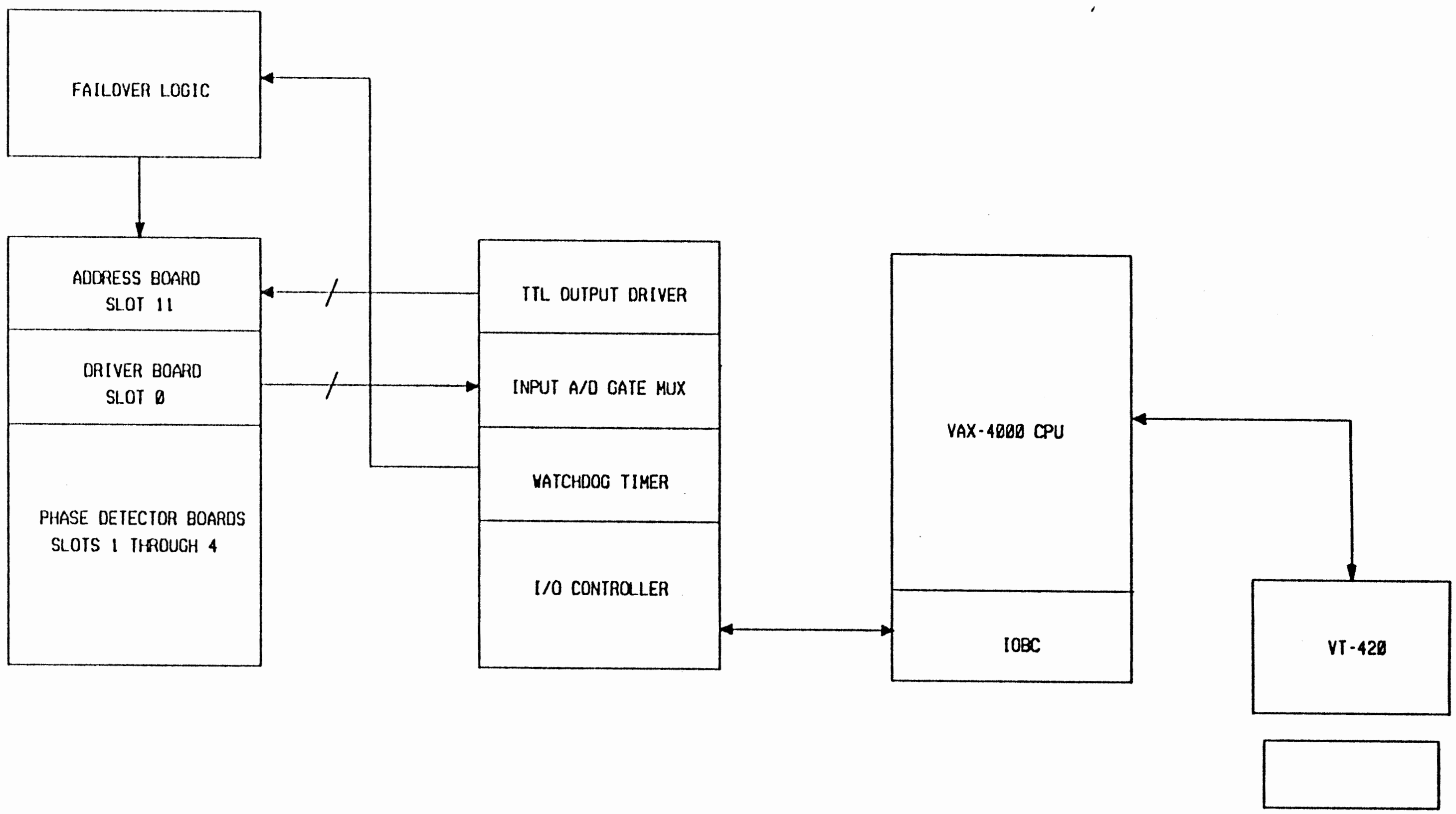


Figure 3-1: General System Block Diagram

3.2.2 Carspace Rack

The Car Space Rack is wired to accomodate a phase detector for each track -- with eight successive tracks defining a "group". Each group has its own Phase Detector PCB. A maximum of nine groups can be wired into the rack. Depending on the number of tracks used in the yard, one rack could contain one Phase Detector PCB as a minimum, to nine Phase Detector PCB's as a maximum

In each phase detector circuit on this PCB, the phase angle information is coupled between the phase comparator and the low-pass filter by an optical coupler. This optical isolation scheme eliminates any direct connection between the rack's filtered analog voltages and outside interference. In addition, separate power supplies are provided on both sides of the opto-coupler to prevent coupling of noise by a common power supply.

Each Phase Detector PCB has a multiplexer (referred to as the "track mux") to channel the analog phase angle information to the driver PCB. Each Phase Detector PCB has like channels addressed simultaneously by the 4 bit address PCB output. The track mux selects the specific phase detector circuit on the Phase Detector PCB. The output of the track Mux is forwarded to the driver board for amplification. The resultant DC analog signal is then sent to the RTP A/D converter for digital conversion. This is a 12 bit binary equivalent (+/- 1/2 LSB) of the input analog phase angle information.

This parallel 12 bit binary phase angle information is routed to the Host CPU and is converted to a digital value of "available car spaces" for the corresponding addressed track. The "available car space" data for each of the tracks is stored and then updated by the Host Computer once a second. In this way, any or all of the requesting stations can retrieve the most up-to-date track fullness information.

The Host Computer Completes a full scan of the yard once every second. The scan begins with the selection of the address of the first phase detector circuit (track number one) The driver board output voltages (One for each Phase Detector PCB) are then sent to the RTP A/D Converter. The analog voltages are then converted to binary and stored to memory . The Host CPU then goes back and repeats the phase detector multiplexer and conversion routine for the next channel.

This repetition continues until all eight of the tracks on each board are read. After all of the phase detector channels are read, the Host CPU scans the two reference voltages (full scale and half scale) on each Phase Detector PCB to verify validity of data. These references are compared to the programmed voltage references and if a discrepancy occurs, the fail bit for that board is set. After one second the scan is reinitiated and the sequence is repeated.

3.3 SUBSYSTEM DETAILED THEORY

3.3.1 Operation of the Phase Detector P.C.B. (Refer to Section VI Figure 6-7)

The Phase Detector PCB #UN451441-3101 uses an LM319 dual highspeed comparator to compare the phase difference between the two incoming signals. RC filtering and diode limiting are provided on the inputs of the comparator to provide for transient protection and noise reduction. One of the RC filters contains a potentiometer for varying the phase of its input signal and hence provides a zero set for the comparator. The comparator's open collector output drives the Hewlett Packard 5082-4351 highspeed optical coupler directly. The output of the optical coupler is wired through a resistor to an LM309, 5 volt referenced source. The output of the optical coupler is a fixed pulse amplitude with a 60 Hz repetition rate which varies in width with a phase change.

The filter is a 1 Hz . low-pass, two pole Butterworth type using one half of a 747 dual op-amp (operational amplifier) for its active element. Pulses from the optical coupler are fed into the filter and its narrow bandwidth removes everything except the DC component of the pulses. The second half of the 747 is an amplifier with a gain potentiometer to adjust the full scale reading of the filter output. An offset potentiometer connected to the non-inverting input of the filter op-amp is used to compensate for the saturation voltage of the optical isolator transistor and to null out the combined offset voltages of the filter and amplifier op-amps.

The eight channels of phase detectors and filter amplifiers are fed into a Burr Brown MPC16S sixteen channel C/MOS analog multiplexer. The multiplexer has a four bit BCD digital input code which is used to select the desired channel. Channels one through eight of the multiplexer are used for the phase detector signals, channel nine is connected to the five volt reference source, channel ten is connected through a two to one voltage divider to the five volt reference, and channels eleven through sixteen are not used and are tied to ground.

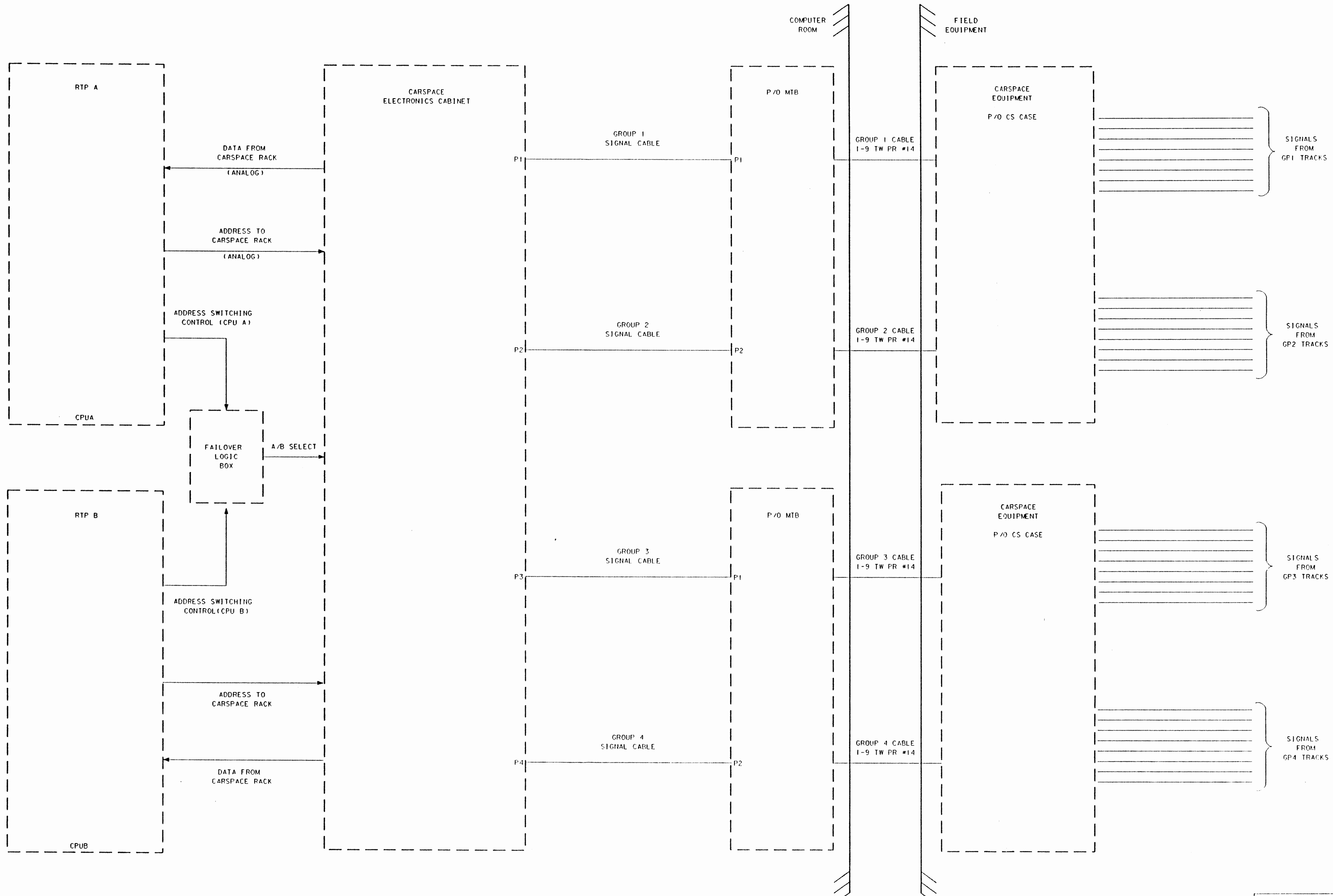
3.3.2 Operation Of The Address P.C.B.

The Carspace address board is an interface to isolate a four-bit address of an output of the external main yard(dual) computer or dual digital I/O subsystem from the Carspace system. Isolation is accomplished using opto-isolators and separate input and output power supplies. The circuitry required to switch the address data from CPU A to CPU B is included. Control of the switching is via external input.

The secondary purpose of the Address PCB is to fuse and route the Carspace system clean Power "A" supply, (plus and minus 15 volt) power feeds to the remainder of the Carspace cardfile.

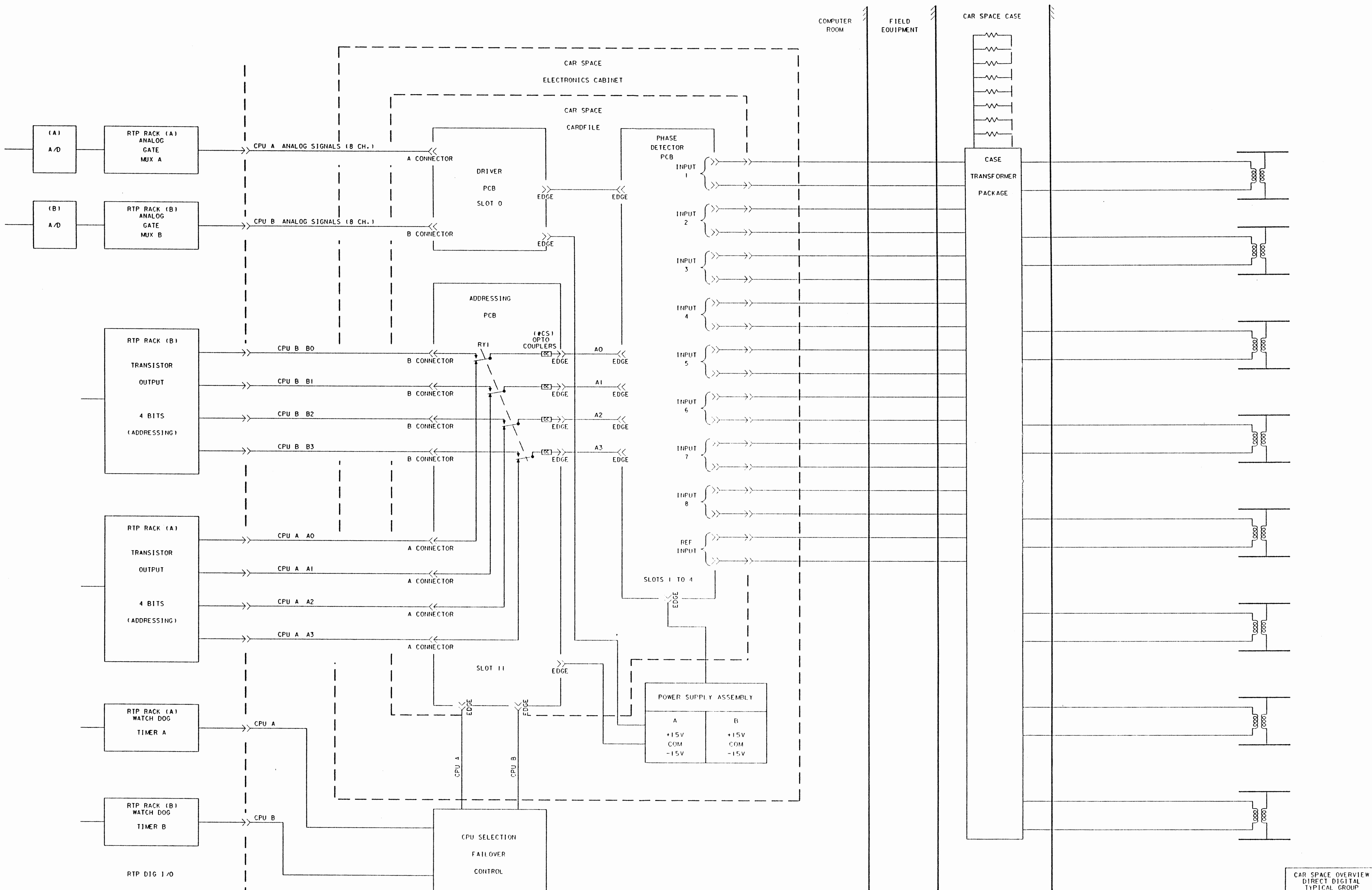
3.3.3 Operation Of The Driver P.B.C.

The driver board contains 16 independently connected LM 759 Op amp circuits. Each one of these is designed to amplify the low-level analog output current of the phase detector board. Each Op_Amp is capable of producing as much as 325 ma of drive current to an externally connected load. This non-inverting follower configuration of the OP Amp circuit causes the output signal to remain very stable under a variety of loading conditions. Because of the feedback design used for this configuration, it is a unity voltage gain circuit. There is one LM759 Op Amp circuit used for each Phase detector P.C.B.



CAR SPACE LAYOUT
DIRECT DIGITAL
4-GROUPS

FIG. 3-2 | DWG



CAR SPACE OVERVIEW DIRECT DIGITAL TYPICAL GROUP 8 TRACKS

FIG. 3-3 DWG

3-7/8

3.3.4 Operation of the Wayside Circuitry (Refer to Figure 3-4)

The operation of the wayside circuitry is best described by the use of vector diagrams. By using vectors, a true relationship between phase angle and track length can be determined.

The line voltage (EOA) is equal to the sum of the voltage drops across the track transformer (EBA) and the wayside resistor (EOB). EBA varies directly with the number of car spaces available. As the car spaces increase the track impedance and EBA increase, and as the car spaces decrease, the track impedance and EBA decrease. When EBA increases, EOB decreases causing angle "one" to increase. When EBA decreases EOB increases causing angle "one" to decrease.

The relationship of phase angle to the measurement of track length can be determined by observing the instantaneous polarity and turns ratio of the wayside transformer. EBC is opposite in phase and equal to one half of EOA as shown by the vector diagram of Figure 3-6 .

Vectoriallly, Figure 3-4 is described by:

NOTE: Z ' is the reflected impedence felt through the 30/1 track transformer.

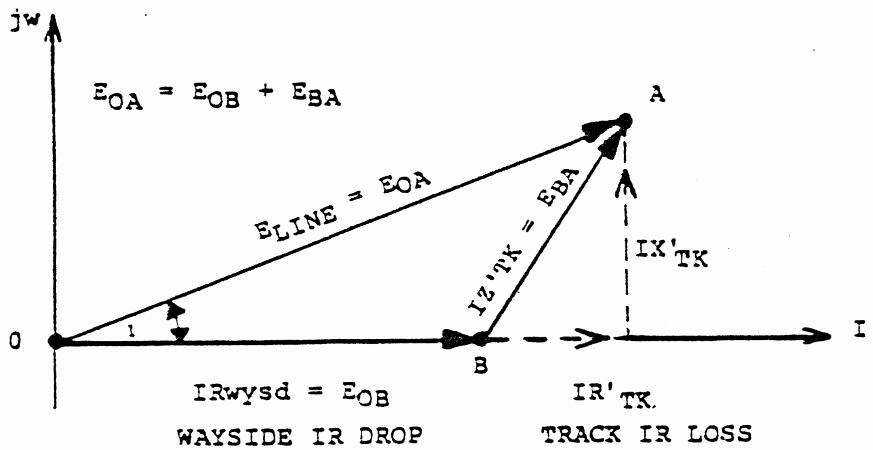


Figure 3-5. Vector Relationship of the Track Transormer Voltage Drop (E_{BA}), the Wayside Resistor Voltage Drop (E_{OB}), and the Line Voltage (E_{OA}).

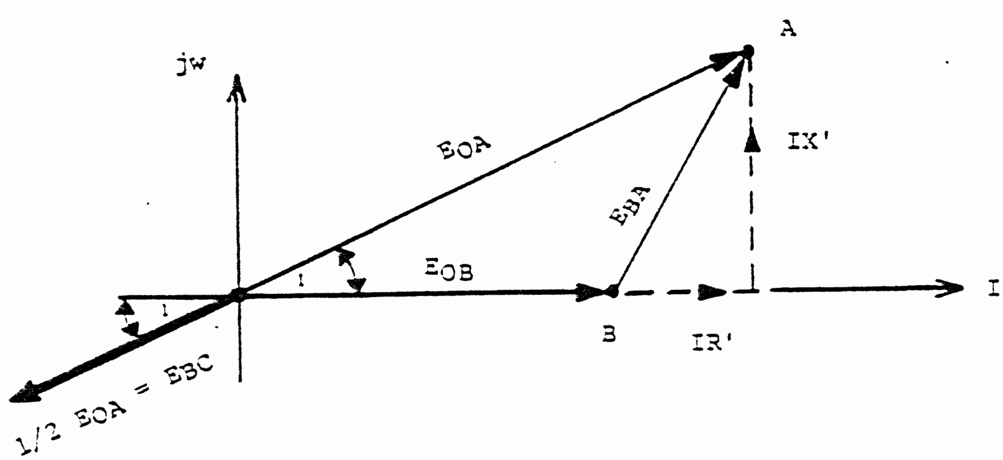


Figure 3-6. Vector Relationship Between E_{OA} and E_{BC} Added to Figure 3-5.

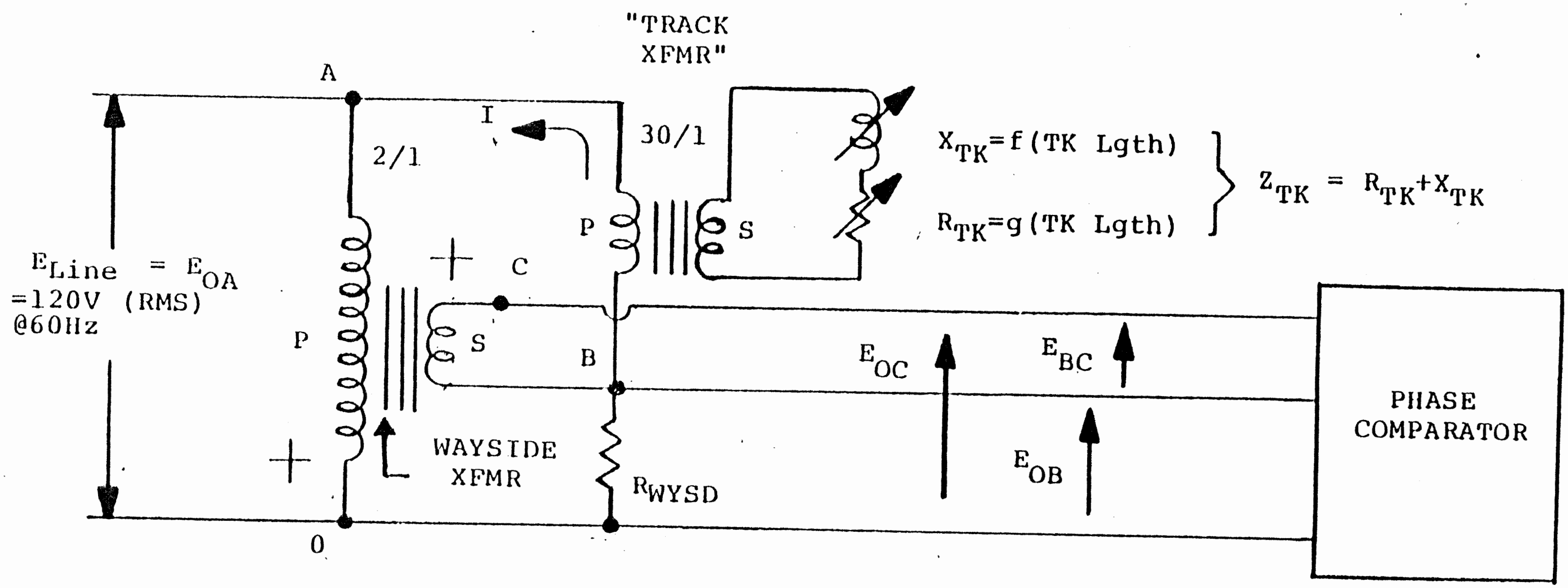


Figure 3-4. Typical Wayside Circuit Diagram for a Single Track

On the Vector diagram, transferring vector EBC to Point "B" produces:

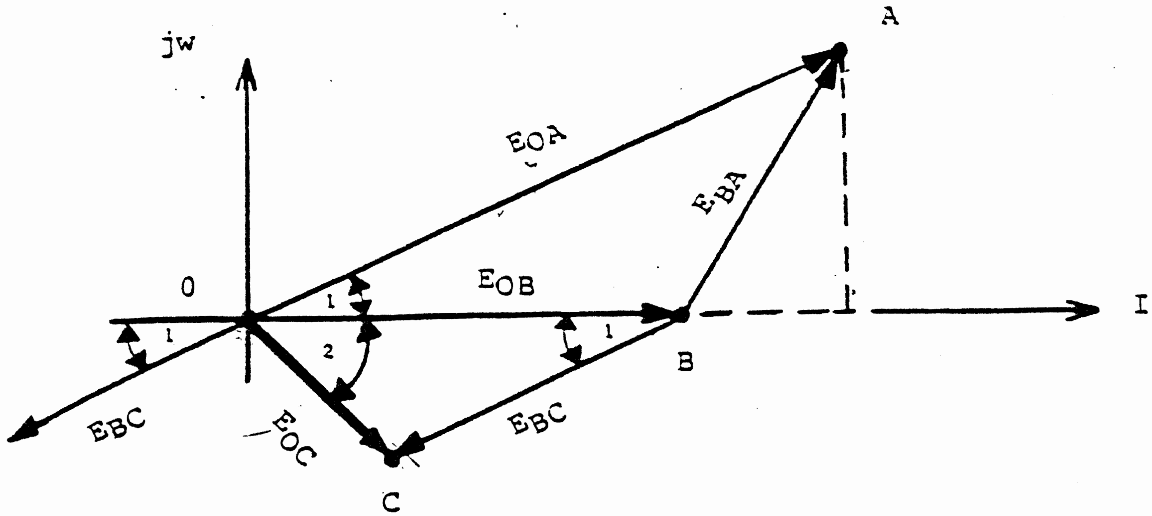


Figure 3-7
Vector Relationship Between Phase Angle and Car Spaces Available. Added to Figure 3-6

Vector EOC is equal to the sum of EOB and EBC. Angle "two" represents the phase shift between EOB and EOC, which is the car space data sensed by the phase detector. By considering the extremes of track length for a minimum and a maximum value, note that angle "two" varies directly with angle "one" and EBA, and inversely with EOB . Hence, phase angle and track length (car spaces availabl~e) are directly related to each other.

3.3.5 Operation of Dual Power Supply

Refer to Lambda Service Manual.

SECTION IV

INSTALLATION

4.1 INSTALLATION CHECKOUT PROCEDURES

Upon completion of the wayside and tower equipment installation, perform the following procedures for making the Car Space System operationally acceptable.

(l) Inspect and test the integrity of insulated joints, "far end" shunts and rail bonds (if used) of each track. Also at this time, check that undesired track shunting paths do not exist.

(2) Verify that the proper track connections are made (the circuitry for track #1 indeed connects to track #1 and not to track #2 or #3, etc).

(3)Verify that the proper track transformer polarity connections are made (adjacent rails of adjacent tracks are in phase for similar track shunting conditions).

(4)Perform the calibration procedures of Section V, "Calibration of the Car Space System".

SECTION V

CALIBRATION AND TEST PROCEDURES

5.1 GENERAL (REFER TO FIGURE 5-1)

Calibration of this system is determined by comparing observed output readings with respect to controlled input signals. For proper calibration of this system, the power supplies must be properly adjusted, each of the Phase Detector PCB's must be properly zero and gain adjusted, and then the total system checked and adjusted. The carspace system performance will vary with changes in climate, therefore, seasonal re-calibration of the system is suggested.

The following procedure should be followed whenever attempting to calibrate the carspace system. This procedure will cause a false "distance to go" reading to be sent to the yard computer. It is suggested that the track be empty or, at a minimum, open to approximately 950 feet. The track should be blocked and the switch ahead of the track transformer should be spiked. Calibration and trouble analysis of the equipment used in this system necessitates that maintenance personnel have a working background in electronics including theory and fundamental troubleshooting procedures. Failure to obtain the correct readings from previous steps will require troubleshooting not covered in this write-up.

5.2 POWER SUPPLIES

5.2.1 Power Supply Adjustments

Apply power to Carspace Rack. Turn Lambda Power Supply on. Verify +15V +/- .15V on the following extender card pins: A22, AZ, B1, BA. Verify -15V +/- .15V on A18, AV, B5 and BE. Verify Common on A6, AF, B3, and BC. Adjust Power Supply outputs as necessary per Lambda Product Manual. Maintain per Lambda Product Manual.

5.3 CARSPACE SYSTEM CALIBRATION

NOTE: Refer to Section VI, General, for the recommended test equipment needed to perform the following procedures.

5.3.1 Data Terminal Set-up Procedure

following the procedure described in Section II of this manual, set up the data terminal to display carspace information on the screen. This will be required while performing the system calibration procedure.

5.3.2 System Calibration Procedure

This procedure is for calibration purposes only and is not intended as a troubleshooting guide. It is therefore assumed that the carspace system has been working correctly and all wiring and components have been previously verified. For total system calibration, start with tracks #(1-8) Phase Detector PCB and check from track #1 to track #32 sequentially. Refer to Figure 6-7, Phase Detector Troubleshooting Guide. The following stepwise procedure is written for calibrating any one channel on any one Phase detector PCB. Specific pin number information is provided in Table 1 below.

	PCB Channel No.							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Zero Potentiometer	R1	R7	R13	R19	R25	R31	R37	R43
Offset Potentiometer	R97	R98	R99	R100	R101	R102	R103	R104
Gain Potentiometer	R105	R106	R107	R108	R109	R110	R111	R112
Comparator output test point	TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8
PCB board output test point	TP18	TP19	TP20	TP21	TP22	TP23	TP24	TP25

Table 5-1: Phase Detector PCB Output Test Points And Potentiometers for Channels 1-8.

1.) "Power Off" the instrumentation card file.

2.) Remove the Phase Detector PCB to be adjusted, insert Extender card, and re-insert the Phase Detector PCB into the extender card connector.

3.) "Power On" the car space cases (breakers on fuses in).

4.) "Power On" the Instrumentation Card File.

5.) Connect a DVM positive lead to pin A16 of PCB under test. Connect negative lead to TP26. Adjust R147 until the meter reads 5.00 V +/- 0.02 V.

CAUTION: STEP 6 INVOLVES WORKING WITH 120 V. ANY CONNECTIONS SHOULD BE MADE WITH 120 V POWER TURNED OFF.

6.) a.) **Option 1**: Unplug Wayside input connectors (P1 - P8). Connect Carspace Simulator output cable to input connector (P1-P8) for channel under test. Jumper input pin B to input Pin C with the common wire on Signal Pin Ref. for channel under test. (See Table 5-2). Confirm two sine waves are in phase with a dual trace scope on Pin B21 (Channel 1 scope probe) and B22 (Channel 2 scope probe) with respect to B20. Disconnect scope probes and common lead.

Option 2: *Remove 120 V power from case.* Disconnect the signal C (Sig C) wire at the case transformer N451492-0101, Terminal C (C1-C8) for track under test. Place this wire in parallel with Signal B (Sig B) at Terminal B (B1-B8). Apply 120 V power to case. Confirm two sine waves are in phase with a dual trace scope on Pin B21 (Channel 1 scope probe) and B22 (Channel 2 scope probe) with respect to B20. Disconnect scope probes and common lead when finished.

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Signal PIn Ref.	B20	B17	B14	B11	BX	BU	BR	BM
Signal Pin B	B21	B18	B15	B12	BY	BV	BS	BN
Signal Pin C	B22	B19	B16	B13	BZ	BW	BT	BP

TABLE 5-2

b.) Connect the Positive scope lead to the comparator output for the track under calibration (See Table 5-1). Place the negative scope lead at TP17. Observe the 15 Volt (approx.) pulse. Adjust Zero Potentiometer (bottom row of pots) until the pulse width decreases to the point where it disappears.

c.) Return The Sig. C wire back to its original position on the case transformer as required.

8.) a.) Adjust the gain potentiometer for this track (top most row of pots) 5 turns clockwise from its most counter-clockwise setting.

b.) Connect a DVM positive lead to the PCB output Test pin for this track (See Table 5-1) negative lead should be connected to TP 26 for all measurements.

c.) Place a good shunt across the rails at the connections to the track transformer for the track under calibration. Make sure connections are clean and tight.

d.) Adjust offset pot for this track (middle row of pots) so that the DVM reads 0.000 VDC. Make sure data terminal display reads 0 Feet. Adjust as necessary to zero display.

e.) Disconnect the shunt from the track.

9.) a.) Measure the rail and permanently mark it with paint at 900 feet from the track transformer leads. Place the shunt tightly at this point.

b.) Adjust the gain potentiometer for the track under test (top most row of pots) such that the data terminal display reads 900 feet. Note: Normal drift about this number is typically within +/- 5 feet. The measured pulse width at the comparator output for this track (See table 5-1) is typically between .9 and 1 millisecond. Typical voltage is 1.5 volts.

10.) a.) Measure the rail and permantly mark it with paint at 600 feet from the track transformer leads. Place the shunt tightly at this point.

b.) The data terminal display should read 600 feet +/- 55 feet (1 standard car length) Note: The display will normally drift within +/- 5 feet over time. The carspace system accuracy is contingent upon the quality of cable, cable connections, rail, rail shunts, and especially rail bonds. The carspace accuracy is relatively linear to to the calibration point of 900 feet, then increasing in error to the end shunt. This is normal.

c.) Remove test shunt from 600 ft. point. Verify that the data display reads the distance to go to the last car, or if empty, the end of track length to the double end shunts.

11.) Repeat steps 7 -10 on the next channel of the Phase Detector PCB.

12.) Repeat steps 1 - 11 on the next Phase Detector Board.

SECTION VI

MAINTENANCE

6.1 GENERAL

Trouble analysis of the equipment used in this system necessitates that maintenance personnel have a working back-ground in electronics including theory and fundamental troubleshooting procedures.

The following test equipment, or equivalent, is recommended for equipment troubleshooting:

Multimeter	Simpson	260
Digital Voltmeter	Fluke Fairchild	8000A 7000
Oscilloscope with two 10:1 Divider Probes	Tektronix	465
Two Extender Cards	US&S	UN451441-1101

Two Rail Shunts - 7 ft. long with heavy rail clamps (.06 ohm or less)

6.2 BASIC TROUBLESHOOTING TECHNIQUES

The troubleshooting procedures for the total system are arranged in an order that checks the simple possibilities before proceeding with extensive troubleshooting. The first few checks below assure proper connection, operation and calibration. If the trouble is not located by these checks. the remaining Field Maintenance or Sub-System Trouble Analysis procedures for locating the defective sub-system or PCB can be used. When the defective part is located, it should be replaced following the replacement procedures given under Corrective Maintenance.

(a) *Check Control Settings*

Incorrect control settings can indicate a trouble that does not exist. Make sure that all of the system controls are set properly. For example: Is all of the power being supplied to the Car Space Rack, wayside circuits, displays?

(b) *Check Associated Equipment*

Before proceeding with the troubleshooting of the Car Space Rack, check that the equipment used in conjunction with this rack is operating correctly. Check that the signal lines are properly connected and that the inter-connecting cables are not defective.

(c) *Visual Check*

Visually check all of the car space sub-systems. Many troubles can be located by visual indications such as unsoldered connections, broken wires, a damaged circuit board, damaged components, etc. Make sure that all of the cable cards and connectors are coupled and fully seated.

(d) *Isolate the Trouble to a Circuit*

To isolate the trouble to a circuit, note the trouble symptom. The symptom often identifies the circuit in which the trouble is located.

(e) *Check Power Supplies*

If all of the circuits are operating incorrectly, the trouble may be in the power supply. However, a defective component elsewhere in the unit can appear as a power supply failure and may also affect the operation of other circuits. The Lambda Service Manual lists the tolerances of the LND-W-152 power supplies in this system.
If the power supply voltage is within the listed tolerance, the supply is considered working correctly. If the power supply voltage is outside the listed tolerance, the supply is either misadjusted or operating incorrectly.

6.3 FIELD MAINTENANCE PROCEDURES

The possible trouble symptoms can be generalized into two categories:

(I) A failure in the "front end" of the system which would be indicated by faulty data to an entire group(s).

(2) One of the tracks displays the wrong car space data as compared to the actual known car space availability reported by the others.

Using this generality, the common failure symptoms of the Car Space System can be identified as follows:

(1) Bad Data being sent to Terminal Display (Refer to Figure 6-1)

(2) Routine Calibration Indicates Faulty Readings. (Refer to Figure 6-2).

Troubleshooting flow charts for locating and correcting a problem, have been developed for each of the symptoms listed above. The symbol functions used in the flow charts are standard and are defined in Table 6-1.

NOTE

Before applying the flow charts for trouble analysis, check the basic troubleshooting techniques of this section .

CAUTION

120V, 60HZ, AC EXISTS ON THE INPUT PAIR TO THE FRONT END OF THE PHASE DETECTOR PCB'S.

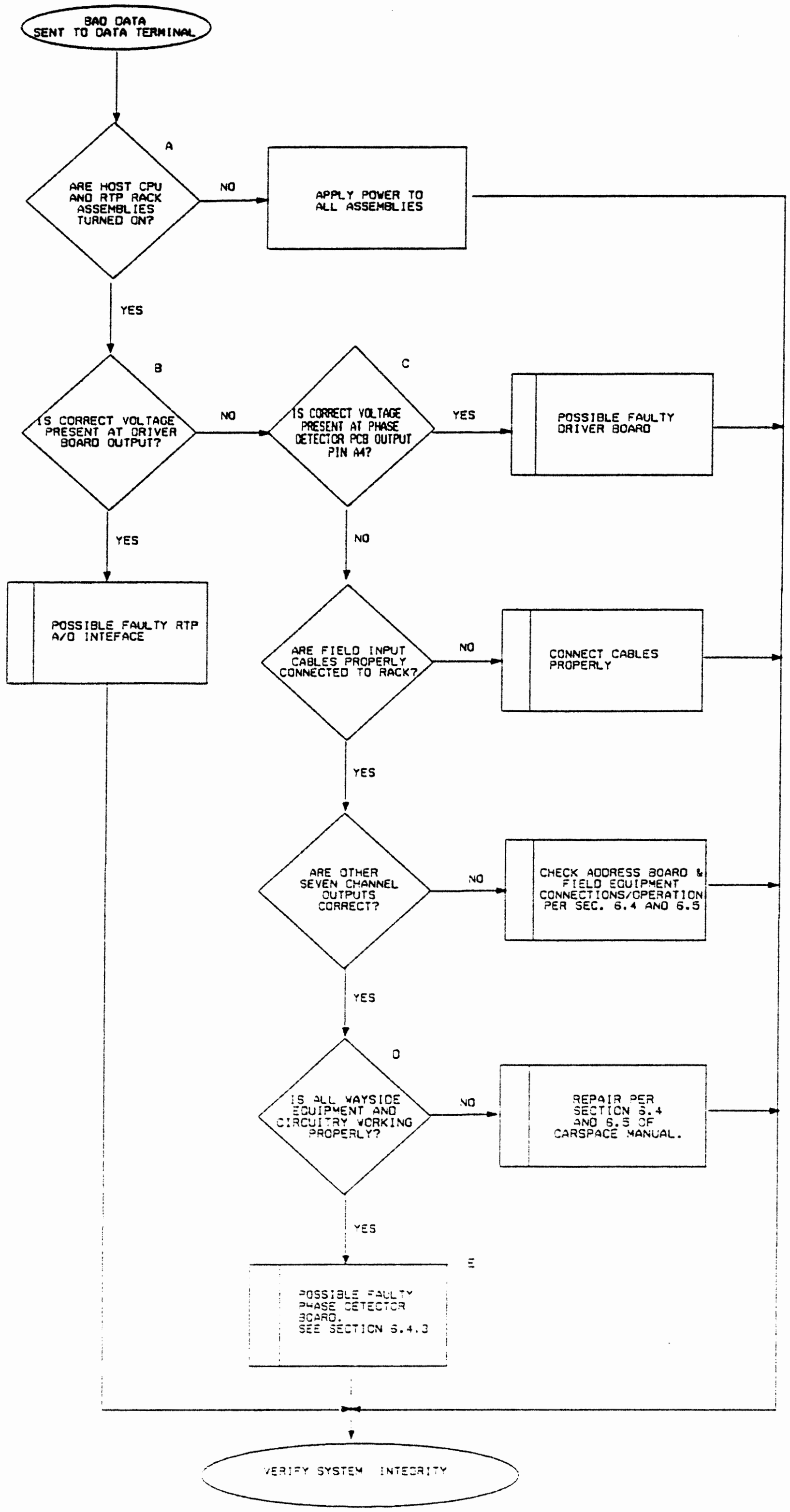


Figure 6-1: Bad Data Sent To Terminal Display

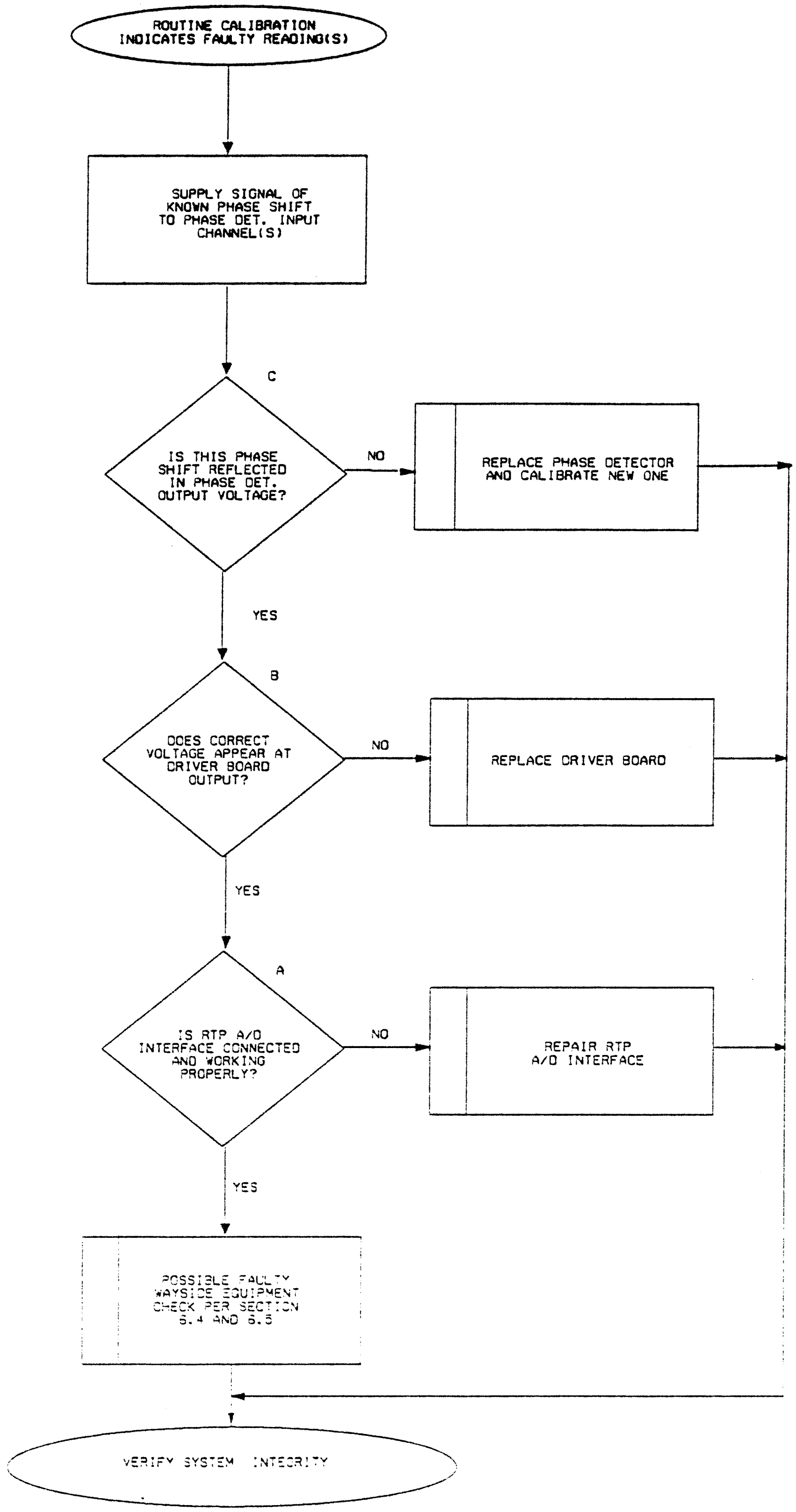
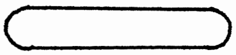
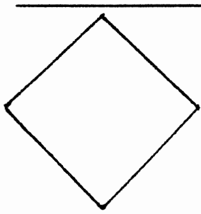
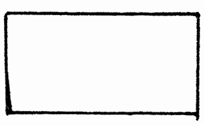
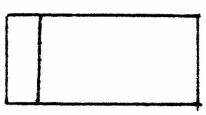


Figure 6-2: System Calibration Indicates Faulty Readings

6.3.1 Flow Chart Support

Ref. A - It is possible that the RTP rack(s) may not be powered up, or that one of the A/D cards is not plugged in. The gate card is located at word 91, and the A/D card is located at word 88. Also, make sure that host computer is up and running.

Ref. B - Use a DMM to read analog voltage at output of driver board. This voltage should be between 1 and 4 volts depending on the distance to the last standing car on the track. Refer to attached Driver board schematic (N451441-89E) for output pin assignment information

SYMBOL	STANDARD DEF.	COMMENTS
	"Terminal Box"	Used For Starting and finishing a Flowchart
	"Decision Box"	The next logical question in the troubleshooting procedure is asked here and in such a way that either a "yes" or a "no" is the only possible answer.
	"Process Box"	Describes the next logical process or operation to be perfromed.
	"Subroutine Box"	Tells the Maintenance Personnel to perform one of the referenced trouble-shooting procedures.

*ALL OF THE BLOCKS IN THE FLOW CHART ARE REFERENCED WITH LETTERED DESIGNATIONS, WHICH ARE DEFINED IN THIS SECTION UNDER FLOW CHART SUPPORT.

Table 6-1. Flow Chart Symbol Functions

Ref. C - Use a DMM to read analog voltage at output the Phase detector board. This voltage should be between 1 and 4 volts depending on the distance to the last standing car on the track. Refer to attached Phase detectorboard schematic (N451441-3101) for output pin assignment information, and Section 6.4.3 of this manual for troubleshooting guidelines.

Ref. D- Does all of the wayside equipment and circuitry prove good? By performing the steps included in the Wayside Circuitry Troubleshooting Guide of this section, the equipment and circuitry for the wayside can be checked.

Ref. E - Calibrate the Phase Detector PCB. Perform the procedures of Section V, Phase Detector Calibration. If board still does not work properly, repair and test per US&S spec. EU-6346

6.4 SUB-SYSTEM TROUBLE ANALYSIS

NOTE
The schematics for all of the sub-systems and their interconnections are included at the end of this section.

6.4.1 General

Once the problem is traced to a particular sub-system, one of the following steps can be performed:

(I) Replace the defective sub-system with a known good spare.

(2) Repair the defective sub-system as per the following procedures.

WARNING
MAKE SURE POWER IS OFF BEFORE REMOVING ANY SUB-SYSTEM, OR DAMAGED COMPONENTS MAY RESULT.

6.4.2 Wayside Circuitry (Refer to Section III, Operation of the Wayside Circuitry)

(I) Determine that all of the lightning arrestors and surge suppressors are not leaky, and the fuses are not blown.

(2) Make certain that the following voltages agree: (Refer to Figure 3-4)

(a) EOA = 120V rms ("E Line" of the WaysideTransformer Primary)
(b) EBC = 60v rms ("E Secondary" of the Wayside Transformer is equal to one-half of EOA). If not, the wayside transformer or its connections are faulty and should be repaired or replaced.
(c) Remove one secondary lead from the track connection of the track transformer

$$Esec = \frac{EAB}{30}$$

The secondary voltage of the track transformer should be equal to 1/30 of the primary voltage. If not, the track transformer or its connections are faulty and should be repaired or replaced.

(3) Check the value of the 600 ohm resistor and verify circuit continuity between the main terminal board and the track transformer.

(4) If able to change the location of the last standing shunt on the track in question, do so, and check that the phase angle variation between EOC and EOB agrees approximately with the relation described by the graph of Figure 6-6. Make a quick check by making and breaking a shunt across the secondary of the track transformer and observing that the phase angle goes to zero when shunted.

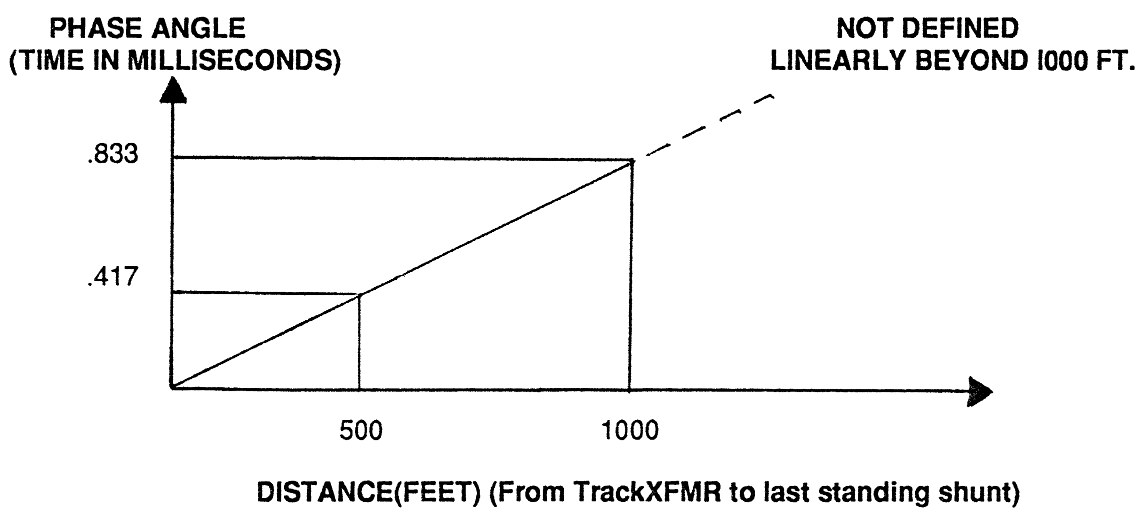


Figure 6-3. Phase Angle In Relation To Distance Graph

6.4.3 Phase Detector P.C.B.

The Phase Detector PCB consists of two main sections: the Phase Detector Circuit and the Multiplexer. Each section is checked out as follows:

(a) The Phase Detector Circuit

(I) Perform the Phase Detector Calibration Procedures of Section V to determine if the circuit is operating correctly. Satisfactory completion of the calibration procedures indicates that the circuit is operating correctly. Any error that develops during the calibration procedures indicates a circuit failure that can be corrected by performing the following trouble analysis steps.

6.4.3 Phase Detector P.C.B.(cont'd)

(2) Refer to Figure 6-4, and with an oscilloscope make a point to point comparison of the specified points.

(3) Determine which components are faulty and replace them. Repair any loose or damaged connections.

(b) The Multiplexer

If the Multiplexer is suspected of being the problem, compare the output signal to the input signal of the multiplexer by addressing the proper channel and monitoring the output. If the output does not correspond to the addressed input, the multiplexer chip (IC25), or its connections are faulty.

6.4.4 Address board P.C.B.

If the Address Board P.C.B. is suspected of being faulty, refer to US&S Test Spec. EU-7995 sheets 8-10 for detailed testing instructions.

6.4.5 Driver Board P.C.B.

If the Driver Board P.C.B. is suspected of being faulty, refer to Section V of US&S Test Spec EU-7782 for detailed testing instructions.

6.5 DETAILED CIRCUIT AND COMPONENT TESTING

6.5.1 General

A) Check Voltage and Waveforms

Often the defective component can be located by checking for the correct voltage or waveform in the circuit. Typical voltages and waveforms are presented through out this manual.

NOTE

Voltages and waveforms given in this manual are not absolute and may vary slightly between units.

B) Check Individual Components

The following procedures describe methods of checking the individual components in the Car Space Sub-System. Components which are soldered in place are best checked by disconnecting one end. This isolates the measurement from the effects of the surrounding circuitry.

(l) Transistors

The best check of transistor operation is actual performance under operating conditions. If a transistor is suspected of being defective, it can best be checked by substituting a new component or one which has been checked previously. However, be sure that circuit conditions are not such that a replacement transistor might also be damaged. If substitute transistors are not available, use a dynamic tester (such as Tektronix Type 575). Static-type testers are not recommended since they do not check operation under simulated operating conditions.

(2) Diodes

A diode can be checked for an open or shorted condition by measuring the resistance between terminals. With an ohmmeter scale having an internal source of between 800 millivolts and 3 volts, the resistance should be very high in one direction and very low when the leads are reversed.

CAUTION

DO NOT USE AN OHMMETER SCALE THAT HAS A HIGH INTERNAL CURRENT. HIGH CURRENTS MAY DAMAGE THE DIODE. DO NOT MEASURE SCHOTTKY DIODES WITH AN OHMMETER: USE A SUBSTITUTE DIODE.

(3) Resistors

Check the resistors with an ohmmeter. Check the Electrical Parts List for the tolerance of the resistors used in this instrument. Resistors normally do not need to be replaced unless the measured value varies widely from the specified value.

(4) Transformers

Check for open transformers by checking continuity with an ohmmeter. Shorted or partially shorted transformers can usually be found by checking the waveform responses when high-frequency signals are passed through the circuit. Partial shorting often reduces high-frequency response (roll-off).

(5) Capacitors

A leaky or shorted capacitor can best be detected by checking resistance with an ohmmeter on the highest scale. Do not exceed the voltage rating of the capacitor. The resistance reading should be high after the initial charge of the capacitor. An open capacitor can best be detected with a capacitance meter or by checking whether the capacitor passes AC signals.

C) Repair and Readjust the Circuit

If any defective parts are located, follow the replacement procedures given in this section. Be sure to check the performance of any circuit that has been repaired or that has had any electrical components replaced.

6.5.2 Soldering Techniques

WARNING

DISCONNECT THE UNIT FROM THE POWER SOURCE
BEFORE SOLDERING

Circuit Boards

Use ordinary 60/40 rosin core solder and a 35 to 40 watt grounded pencil type soldering iron on the circuit boards. The tip of the iron should be clean and properly tinned for best heat transfer to the solder joint. A higher wattage soldering iron may separate the wiring from the base material.

The following techniques should be used to replace a component on a circuit board. Most of the components can be replaced without removing the boards from the unit.

1. Grip the component lead with long-nose pliers. Touch the soldering iron to the lead at the solder connection. Do not lay the iron directly on the board.

2. When the solder begins to melt, pull the lead out gently. This should leave a clean hole in the board. If not, the hole can be cleaned by reheating the solder and placing a sharp object such as a toothpick into the hole to clean it out. A vacuum-type desoldering tool can also be used for this purpose.

3. Bend the leads of the new component to fit the holes in the board. If the component is replaced while the board is mounted in the unit, cut the leads so they will just protrude through the board. Insert the leads into the holes in the board so the component is firmly seated against the board (or as positioned originally). If it does not seat properly, heat the solder and gently press the component into place.

4. Touch the iron to the connection and apply a small amount of solder to make a firm solder joint. Do not apply too much between the component body and the solder joint with a pair of long nose pliers or other heat sink.

5. Clip the excess leads that protrude through the board.

6. Clean the area around the solder connection with a flux-remover solvent. Be careful not to remove information printed on the board.

6.5.3 Circuit Board Replacement

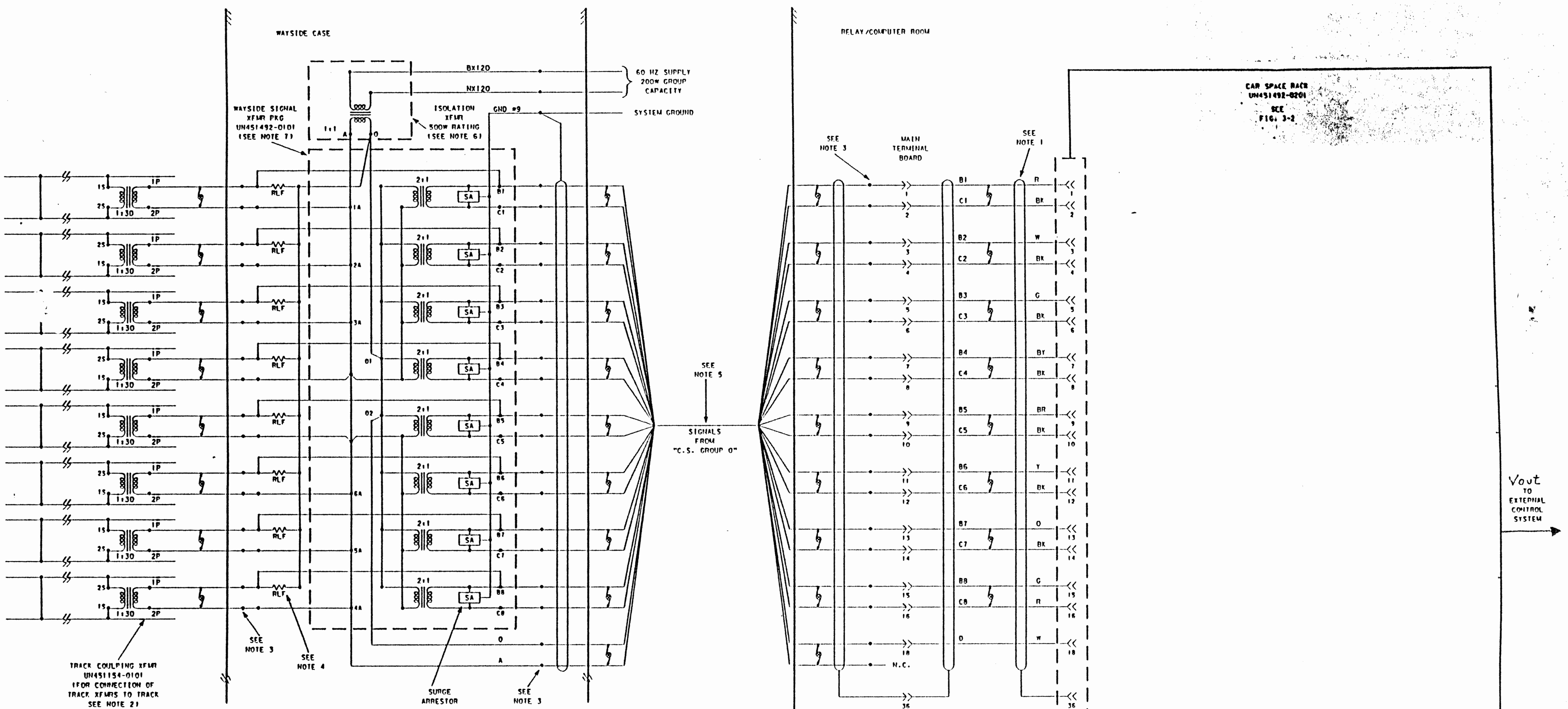
If the circuit board is damaged beyond repair, the entire assembly including all soldered-on components, can be replaced. Part numbers are given In the Mechanical Parts List for the completely wired board. Observe the soldering precautions given in the soldering techniques of this section. If the bottom side of the board must be reached or if the board must be moved to gain access to other areas of the unit, only the mounting screws need to be removed. The inter-connecting wires on the PCB can quickly be disconnected to allow the board to be removed.

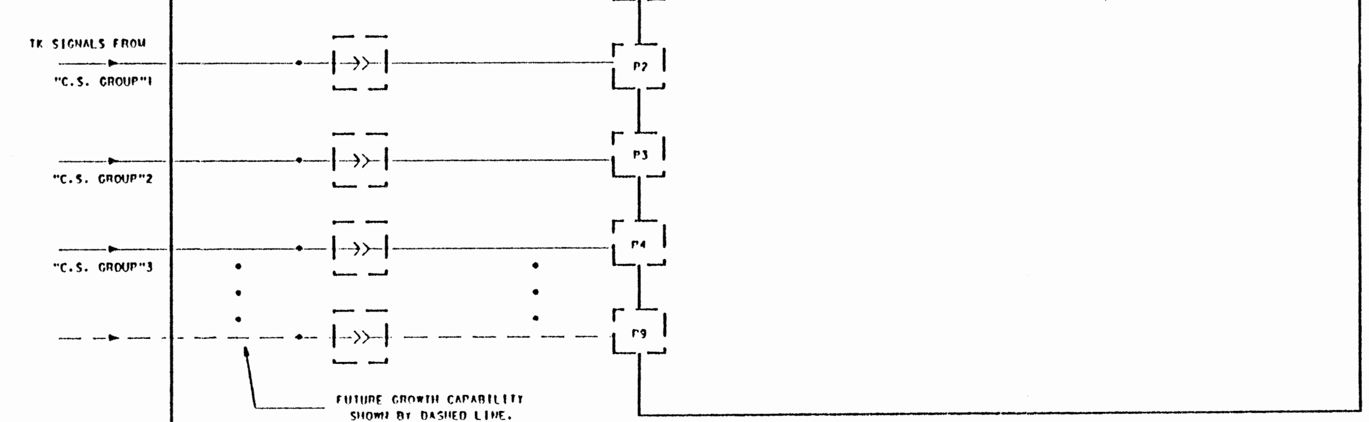
WARNING

MAKE SURE THAT THE POWER IS TURNED OFF BEFORE REMOVING OR INSERTING A PCB. THIS PROCEDURE WILL PREVENT FURTHER CIRCUIT DAMAGE.

6.6 SCHEMATIC DIAGRAMS

Application Drawings and PCB schematics for the Car Space System are provided to aid the maintenance personnel in system troubleshooting.





NOTES:

1. THESE CABLES TO BE SUPPLIED BY CUSTOMER. SEE FIG. 6-13 FOR PIN ASSIGNMENTS.
2. TO MINIMIZE "CROSS TALK EFFECT", THE TRACK TRANSFORMERS SHOULD BE CONNECTED AS SHOWN SO THAT ADJACENT RAILS OF ADJACENT TRACKS WILL BE IN PHASE FOR SIMILAR TRACK CONDITIONS.
3. AT THESE POINTS APPLICATION OF LIGHTING PROTECTION (SPECIFICALLY TO BACK-UP THE SURGE ARRESTORS USED IN THE "SIGNAL XFMR" PACKAGE) IS ADVISABLE.
4. LINE FEED RESISTOR (RLF) TO BE 600 OHM, 50W,1%. IT IS SUGGESTED THAT ALL THESE RESISTORS BE MOUNTED ON A 1/4" ALUMINUM HEAT SINK.
5. A. THIS WEATHER PROOF CABLE MUST BE A DEDICATED CABLE CONSISTING OF 9 TWISTED PAIR - (PREFEPABLY) #14 CONDUCTOR - WITH BUT OVERALL SHIELD. (ALSO SUPPLIED BY CUSTOMER.)
   B. VIA FIELD WIRING THE SEQUENCE OF TRACK NUMBERS IN THE YARD MUST BE MADE TO AGREE WITH THE NUMBERING SEQUENCE OF PHASE DETECTOR CIRCUITS WITHIN THE CAR SPACE RACK. (I.E. THE FIRST 8 SEQUENTIAL PHASE DETECTOR CHANNELS ARE DEDICATED TO THE FIRST 8 YARD-TRACK-NUMBERS-SIMILARLY FOR THE SECOND 8 ETC. FURTHERMORE IF TRACKS 4, 5, & 6 IN THIS FIRST GROUP DO NOT PHYSICALLY EXIST - BECAUSE THEY ARE FUTURE TRACKS - THEN PHASE DETECTOR CHANNELS 4, 5, & 6 CANNOT BE USED AND THEN TRACK #7'S INPUT PAIR GETS CONNECTED TO PHASE DETECTOR CHANNEL #7 INPUT-SIMILARLY FOR #8 ETC.)
6. APPLY 1 TRANSFORMER PER GROUP OF NO MORE THAN 8 TRACKS (THIS XFMR TO BE SELECTED BY PROJECT ENG)
7. APPLY 1 TRANSFORMER PACKAGE PER GROUP OF NO MORE THAN 8 TRACKS.
8. THIS CABLE TO BE SUPPLIED AND INSTALLED BY ENGINEERING. SEE FIGURE 6-17 FOR SIGNAL PIN-OUT INFORMATION.

CARSPACE SYSTEM
PHYSICAL LAYOUT
AND APPLICATION INFORMATION

Fig 6-4

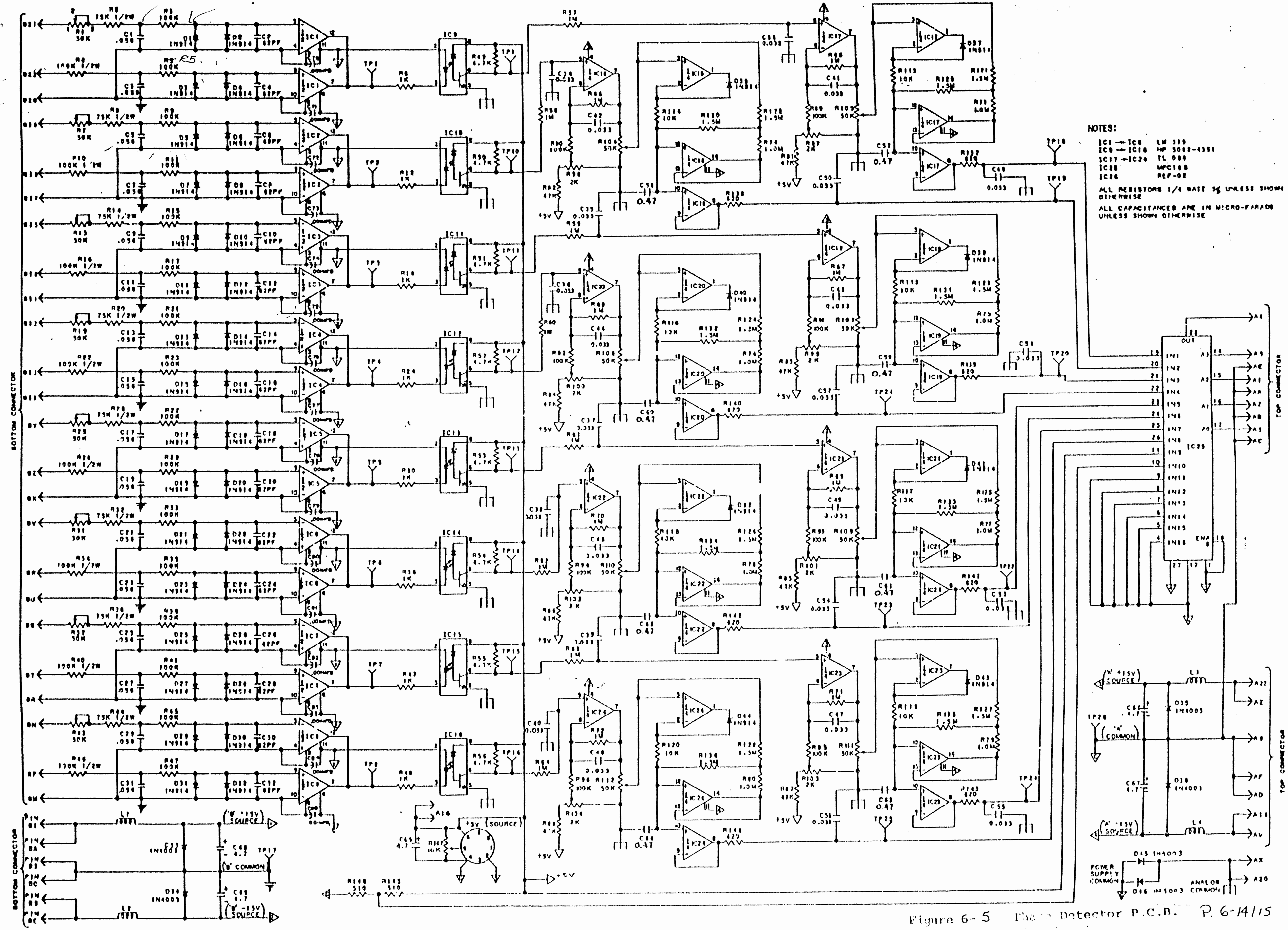


Figure 6-5 Phase Detector P.C.B.

NOTE: Typical Phase Detector Channel with waveforms corresponding to a 60 Hz signal input having a F.S. phase shift.

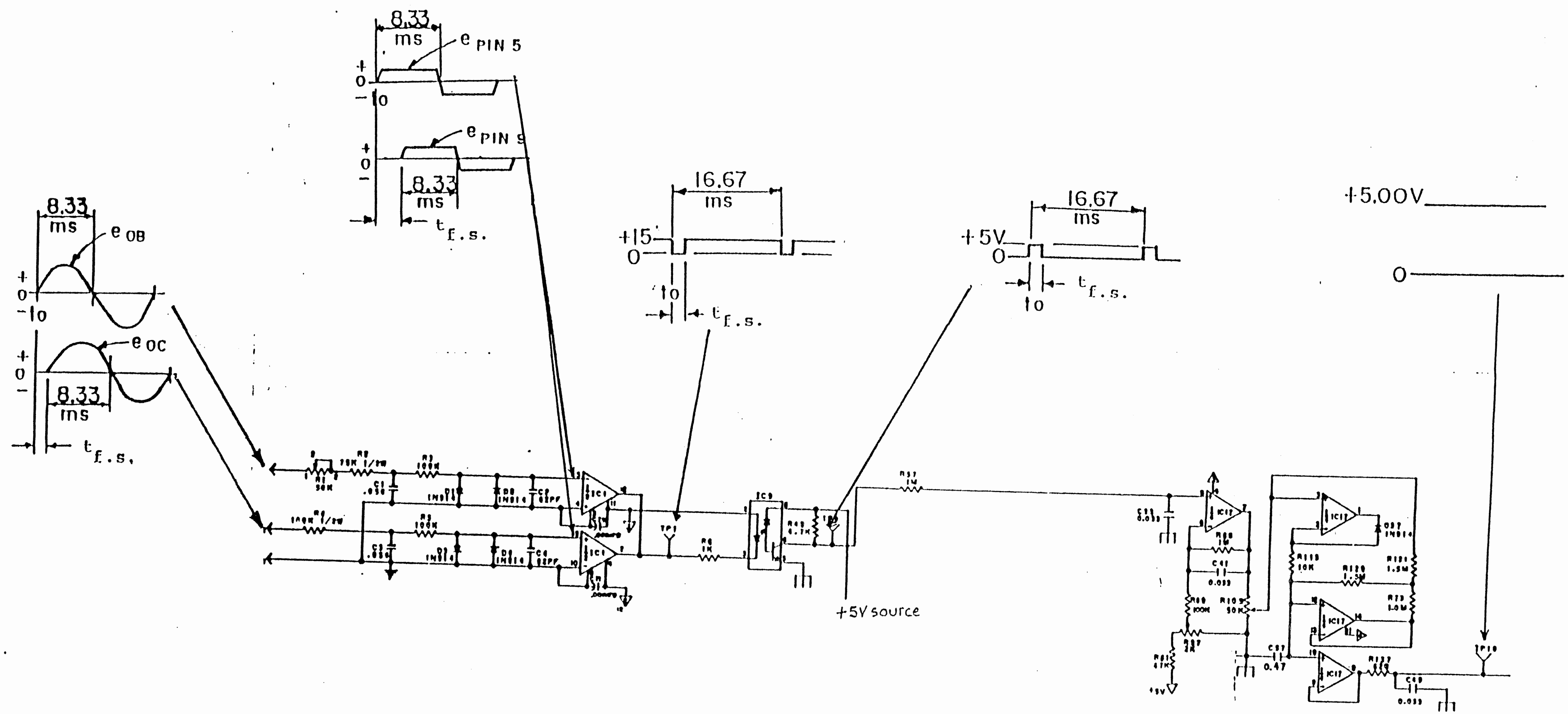
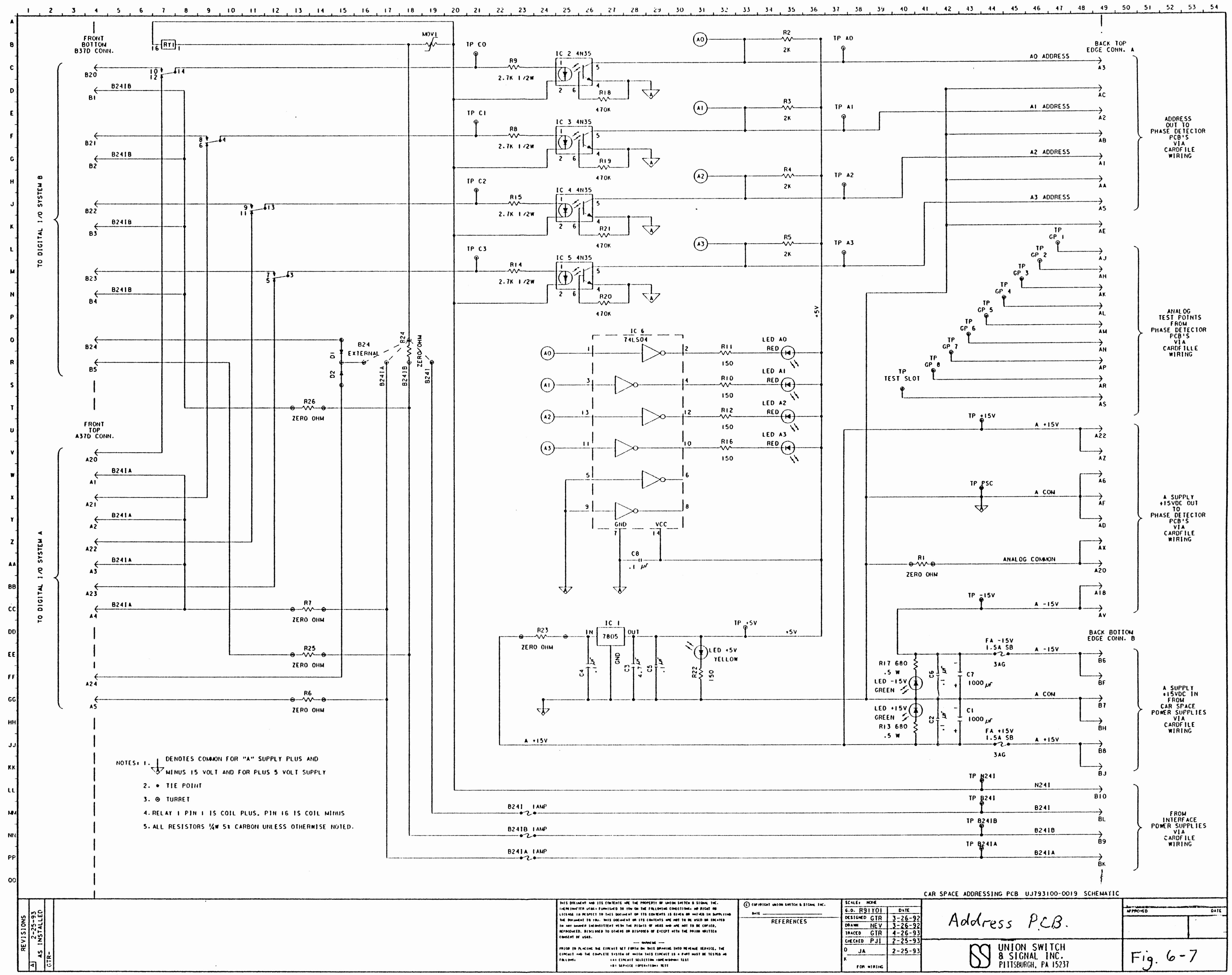


Figure 6-6 Phase Detector Troubleshooting Guide

P. 16/17



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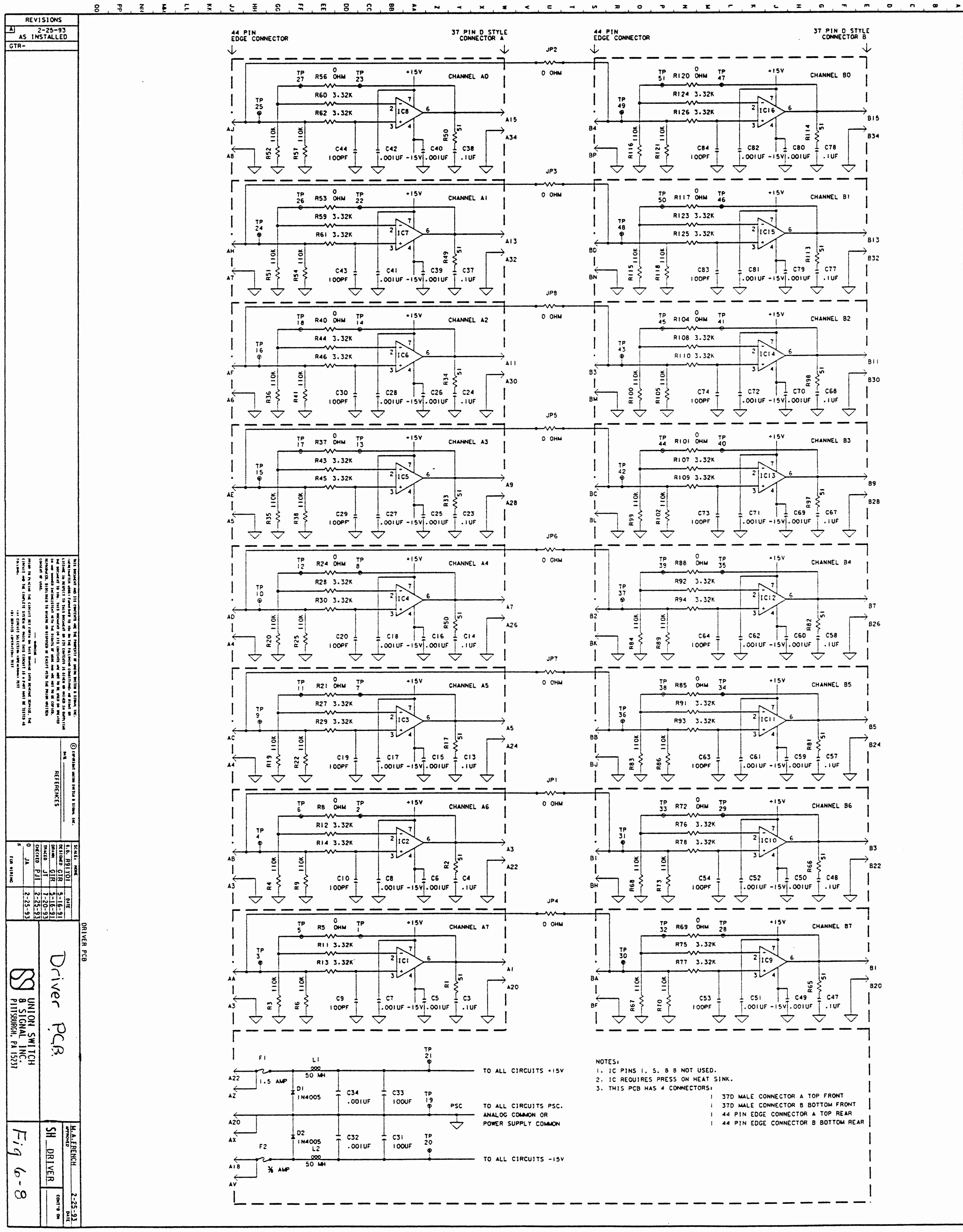

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P 20/21

SECTION VII
PARTS LIST

7.1 GENERAL

When it becomes necessary to replace components during unit maintenance, the following procedures should be followed in obtaining replacement parts:

a) Standard Parts

ll electrical and mechanical part replacements for this unit can be obtained through your US&S local Field Office or Representative. However, many of the standard electronic components can be obtained locally in less time than required to order them from US&S . Before purchasing or ordering replacement parts, check the parts lists for the value, tolerance, rating and description.

NOTE

When selecting replacement parts, it is important to remember that the physical size and shape of a component may affect its performance in the instrument, particularly at high frequencies. All replacement parts should be direct replacements unless it is known that a different component will not adversely affect system performance.

b) Special Parts

In addition to the standard electronic-components, some special components may be used in this unit. These components are manufactured or selected by US&S to meet specific performance requirements or are manufactured for US&S in accordance with our specifications. These special components are indicated in the Electrical Parts List by an asterisk preceding the part number. Most of the mechanical parts used in this instrument have been manufactured by US&S. Order all special parts directly from your local US&S Field Office or Representative.

c) Ordering Parts

When ordering replacement parts from US&S include the following information:

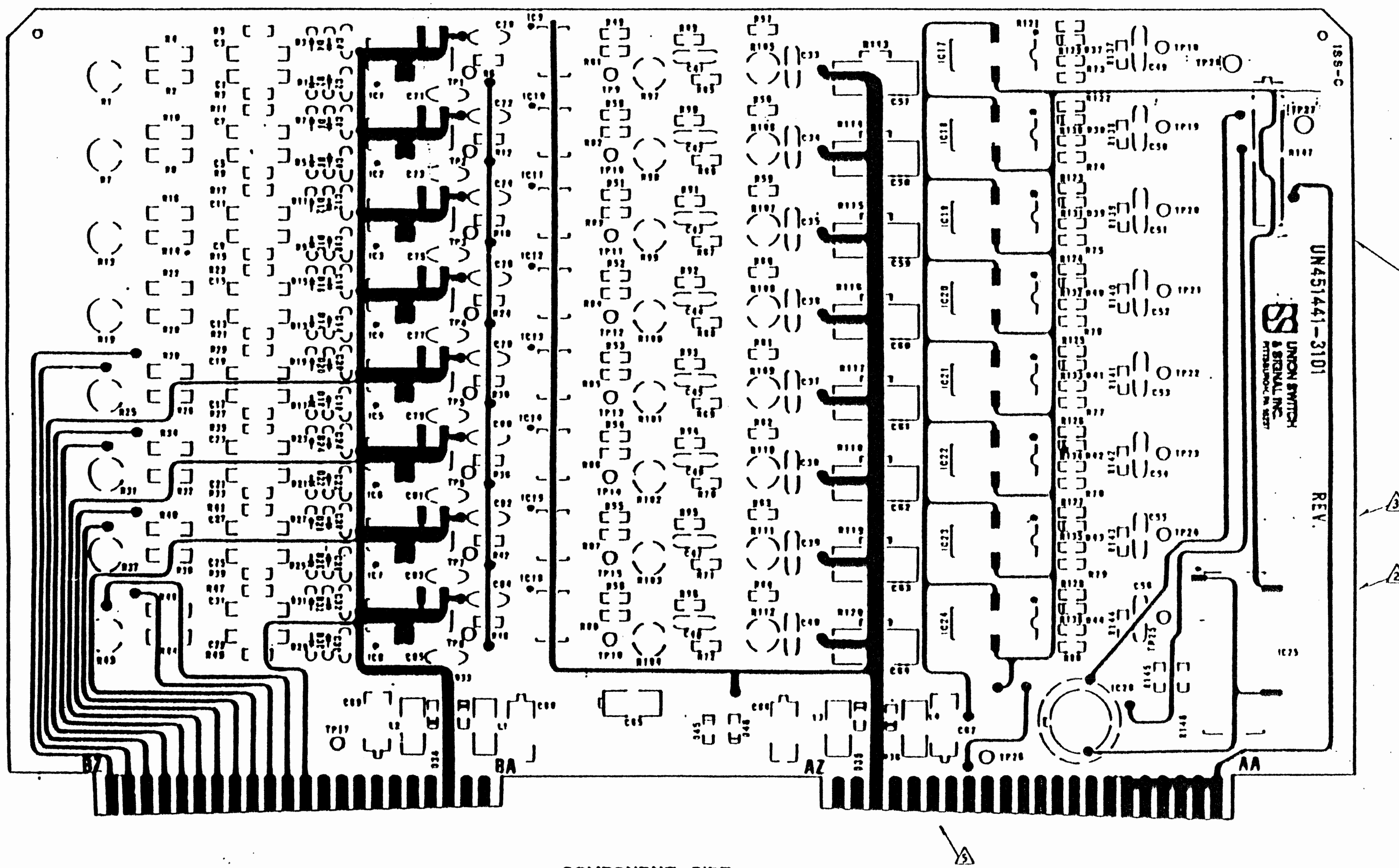
1. Unit nomenclature.
2. Unit serial number.
3. A description of the part.
4. US&S Part Number (Uxxxxxx-xxxx)

7.2 PARTS LIST ILLUSTRATIONS

The following parts lists are provided in the order listed.

LEGEND	NUMBER	U/M	QUANTITY	T	IDENTIFICATION		DESCRIPTION	T	DRAWING			D451019	
	1	I	1.	J	776417	0063	PCB, ETCHED	R	451442	18			
	2	I	2.	J	560539		EJECTOR-W/PIN-PC BD					0C02	E
[illegible]	3	I	16.	J	620860	0027	POTENT 50 K OHMS						
[illegible]	4	I	8.	J	721174		RES 75K OHMS, 1/2 W						
SEE ⚠	5	I	24.	J	735137		RES 100K 5 TOL 1/4 W						
[illegible]	6	I	8.	J	720938		RES 100K OHMS 1/2 W						
[illegible]	7	I	8.	J	735031		RES 1K OHMS 1/4W						
R49-R56	8	I	8.	J	735034		RES 4.7K OHMS 1/4 W						
R81-R88	9	I	8.	J	735038		RES 47K 1/4 W						
R137-R144	10	I	8.	J	735049		RES 820 OHMS 1/4 W						
R147	11	I	1.	J	620327		POTENT 10K		3068	487			
R145, R146	12	I	2.	J	735510	0107	RES 562 OHMS RN60						
IC1-IC8	13	I	8.	J	115029	0136	IC-LM358N DUAL OPAMP						
IC9-IC16	14	I	8.	J	115023	0134	INT CKT-ISOLTR 6N139						
IC17-IC24	15	I	8.	J	115029	0157	INT CKT TL084						
IC25	16	I	1.	J	115029	0135	IC MPG-MS MPLX CMOS						
IC26	17	I	1.	J	115025	0158	INTCKT REF-02					0204	H
IC26	18	I	1.	J	792239		HEAT SINK NO NF 207					0202	A
D1-D32, D77-D84	19	I	40.	J	726031		DIODE IN914A						
D33-D36, D81-D84	20	I	6.	J	723555		DIODE IN4003 200V						
[illegible] C1-C31	21	I	16.	J	709144	0036	CAP .068 MFD 200V						
[illegible] C2-C32	22	I	16.	J	709145	0101	CAP 82 PF						
C33-C56	23	I	24.	J	706417		CAP .033 MFD 50V						
C57-C64	24	I	8.	J	709055		CAP .47MFD, 200V					0201	J
C65-C69	25	I	5.	J	706422		CAP 4.7 MFD 35VDC						
C70-C85	26	I	16.	J	706241		CAP .001 MFD 500 VDC						
TP1-TP28	27	I	28.	J	703575		PIN FORMED 61097						
	28												
L1-L4	29	I	4.	J	709161		CHOKE-#VK200 10/3B						
	30	B	1.5	A	043183		W-22 BARE TINNED COP					0205	E11
IC26	31	I	1.	J	792668		PAD, IC MTG 8P CIRC.					0106	H
IC25	32	I	1.	J	725890		SOCKET-28 PIN TERM						
R97-R104	33	I	8.	J	620830	0020	POTENT 1K OHMS						
R57-R80	34	I	24.	J	735300		RES 1M 1/4 W						
R113-R120	35	I	8.	J	736053		RES 10K 1/4 W						
R121-R136	36	I	16.	J	735484		RES 1.5M 1/4 W						

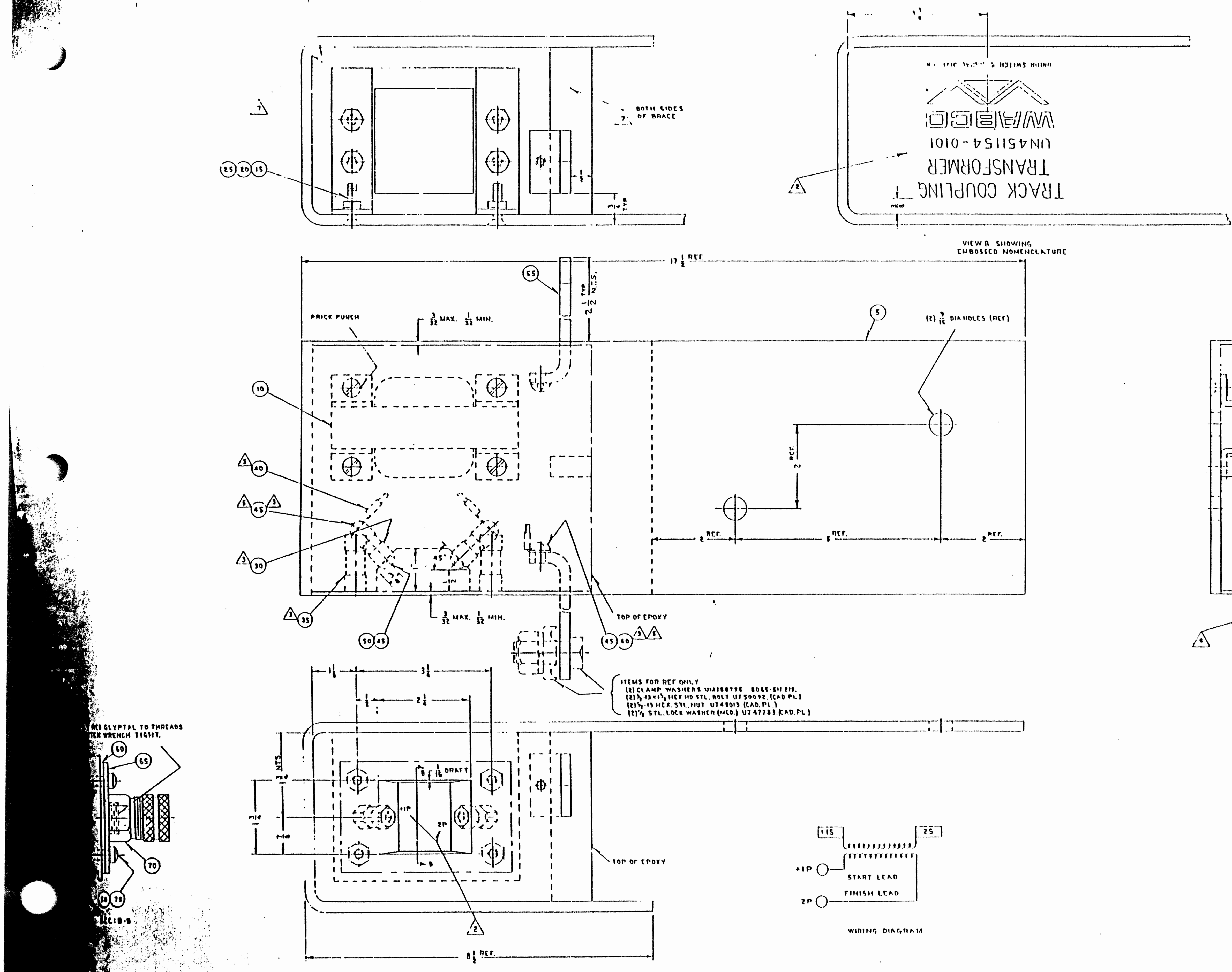
LOCATION OF PIN THRUS (4X) REQ'D. ⚠5



COMPONENT SIDE

Figure 7-1. Phase Detector PCB Component Layout and Parts List

ITEM	QTY	PART NO	DWG.	SH	DESCRIPTION
5	1	UM451155 0102	D451155	01	ASSY COVER
10	1	UN435754	C8605	45	TRANSFORMER
15	4	UJ571195			SC #12-24 x 1 FLAT HD STL TP
20	4	UJ480641			NUT, #12-24 HEX STL TP
25	4	UJ47669			WASHER, #12 LOCK STL TP
30	2	UM451005 0101	B451005	01	INSERT
35	4	UM451005-0102	B451005	01	INSERT
40	4	UJ730044	8064	975	TERMINAL
45	4	UJ516051			SC 1/4-20 x 1/2 RD BR MACH NP
50	6	UJ47792			WASHER, 1/4 INT LOCK PH BZ NP
55	2	UM451155-0103	D451155	01	BRACKET
60	1	UM398299	B35051	66	GASKET
65	1	UM398298	B35038	75	PLATE, COVER
70	1	UJ712059			GRIP, CABLE (WITH CHASE NIPPLE)
75	4	UJ51205			SC. 1/4-20 x 1/4 FIL. BR MACH. NP
80	><	UD451006-0101	B451006	03	NOMENCLATURE FOR MOLD
85	P35	UA41643			COMPOUND, CASTING
90	><	CUS154			ASSY & TEST SPEC



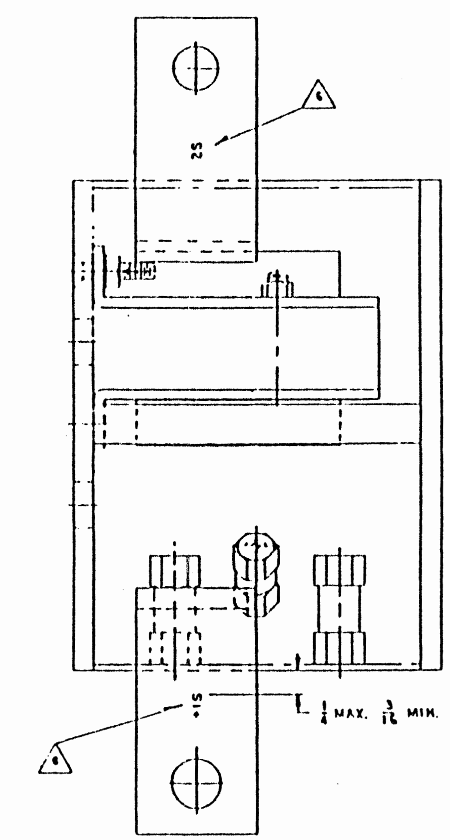
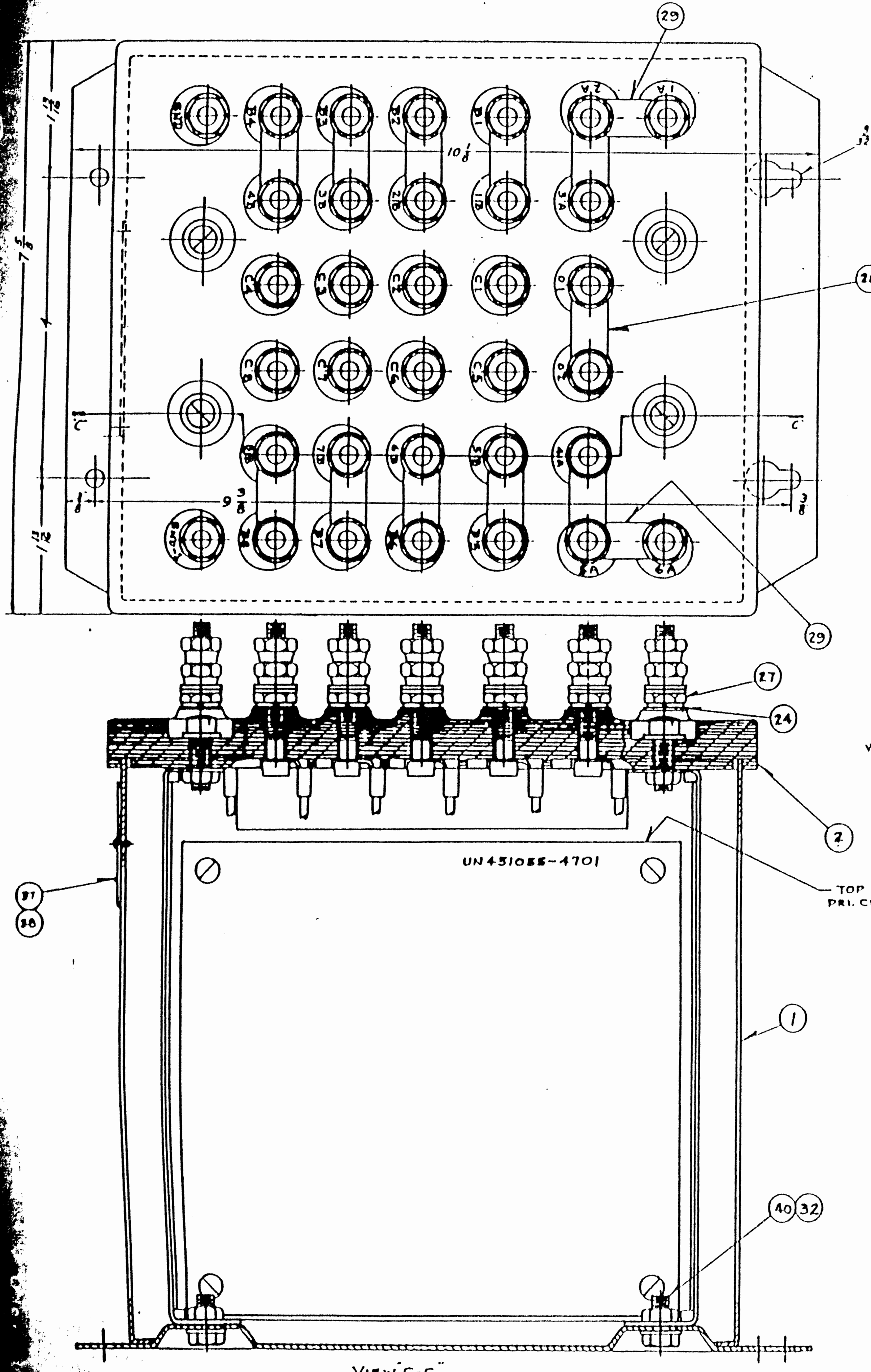
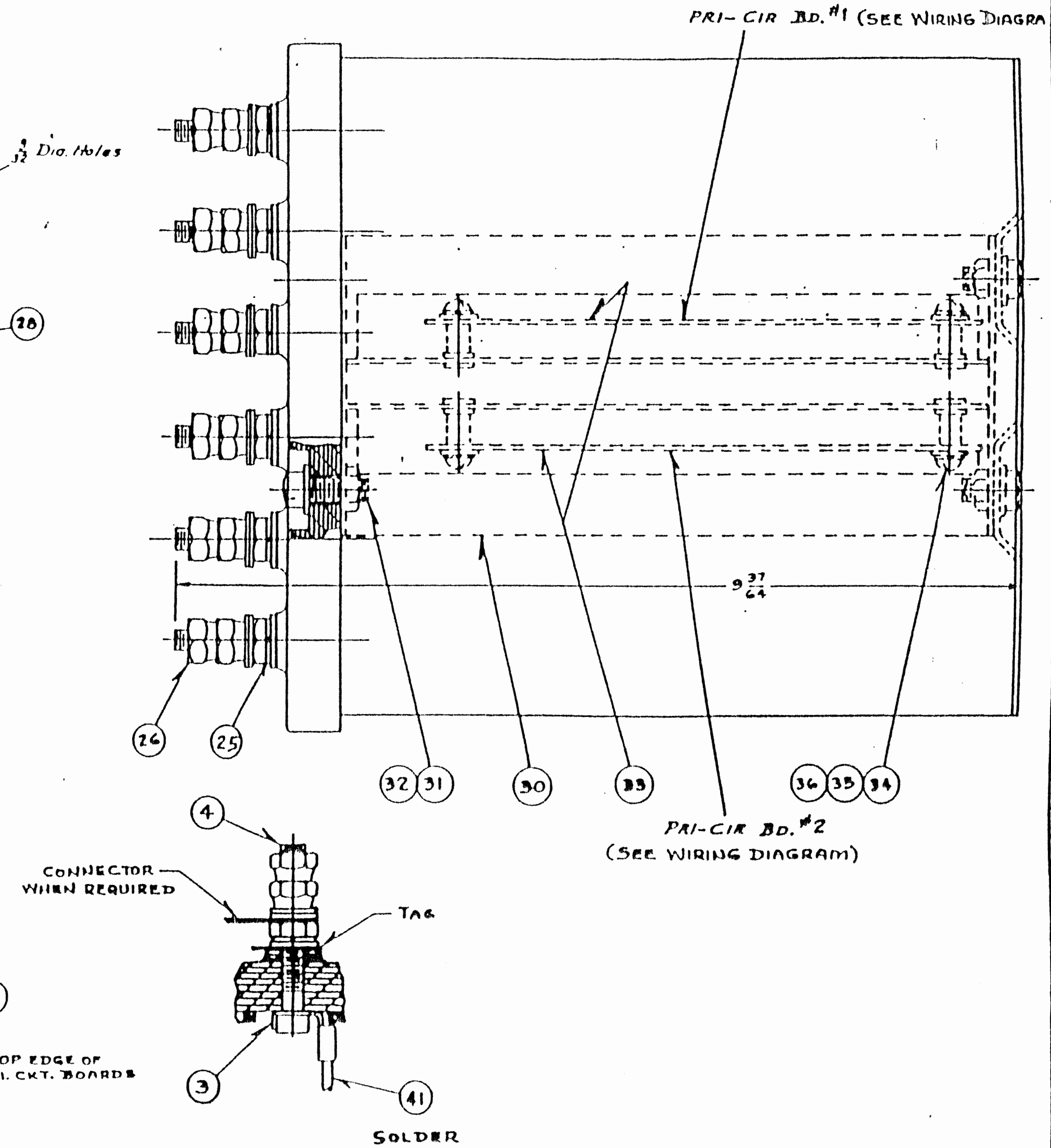


Figure 7-4. Track Transformer Assembly Component Layout and Parts List





FOR WIRING AND CIRCUIT DIAGRAM SEE D451493-SH.04.

TEST & INSPECT PER SPEC. EU-6138.

...UCED IN PART FROM D451469-SH.02

ITEM NUMBER	GROUP U/M	QUANTITY UNITS	QUANTITY DEC	T	PART IDENTIFICATION NUMBER	SEE GROUP SW/III	DESCRIPTION
1		1 .	0	H	235099		COVER
2		1		J	077841		BOARD, TERMINAL
3		22		M	178714		TERMINAL
4		34		M	115706		POST, TERMINAL
5		1		J	075510	0014	TAG-WHT MKG B1
6		1		J	075510	0015	TAG-WHT MKG B2
7		1		J	075510	0129	TAG-WHT MKG 1A
8		1		J	075510	0002	TAG-WHT MKG A
9		1		J	075510	1048	TAG-WHT MKG C2
10		1		J	075510	1049	TAG-WHT MKG C3
11		1		J	075510	1050	TAG-WHT MKG C4
12		1		J	075510	1154	TAG-WHT MKG B4
13		1		J	075510	1166	TAG-WHT MKG B5
14		1		J	075510	0025	TAG-WHT MKG C1
15		1		J	075510	0679	TAG-WHT MKG B3
16		1		J	075510	1167	TAG-WHT MKG C5
17		1		J	075510	0566	TAG-WHT MKG GND
18		1		J	075510	1202	TAG-WHT MKG B6
19		1		J	075510	1203	TAG-WHT MKG B7
20		1		J	075510	1204	TAG-WHT MKG B8
21		1		J	075510	1205	TAG-WHT MKG C6
22		1		J	075510	1206	TAG-WHT MKG C7
23		1		J	075510	1207	TAG-WHT MKG C8
24		102		J	047818		WSHR-PLATE STL
25		34		J	047775		WSHR-1/4 LOCK STL
26		68		M	029101		NUT-BINDING
27		34		M	029103		NUT-CLAMP
28		11		M	120343		CONNECTOR, TERMINA-
29		2		M	047280		CONNECTOR, TERMIN
30		1		N	451493	0301	CHASSIS
31		4		J	052200		SCR-1/4-20x3/4 FIL STL
32		8		J	047801		WSHR-1/4 STL PLATE
33		2		N	451055	4701	PCB-WAYSIDE TRANF.
34		8		J	052565		SCR-10-32x1/2 RD STL
35		8		J	475077		WSHR-10 STL PLATE
36		8		J	047733		WSHR-10 STL LOCK
37		1		M	451425	0001	PLATE, NAME
38		2		J	052644		SCR-2 x 3/16 RD STL
39		23		J	731443		TERMINAL-INS. FASTON
40		4		J	050012		SCR-1/4-20 x 1/2 HEX CAP
41	B	12		A	043525	0005	WIRE-16 PVC WHITE
42		1		J	075510	0155	TAG-WHT MKG 2A
43		1		J	075510	0580	TAG-WHT MKG GND-1
44		1		J	075510	0181	TAG-WHT MKG 3A
45		1		J	075510	0198	TAG-WHT MKG 4A
46		1		J	075510	0215	TAG-WHT MKG 5A
47		1		J	075510	0216	TAG-WHT MKG 6A
48		1		J	075510	0602	TAG-WHT MKG 01
49		1		J	075510	0603	TAG-WHT MKG 02
50		1		J	075510	0130	TAG-WHT MKG 1B
51		1		J	075510	0156	TAG-WHT MKG 2B
52		1		J	075510	0182	TAG-WHT MKG 3B
53		1		J	075510	0199	TAG-WHT MKG 4B
54		1		J	075510	0216	TAG-WHT MKG 5B
55		1		J	075510	0227	TAG-WHT MKG 6B
56		1		J	075510	0237	TAG-WHT MKG 7B
57		1		J	075510	0246	TAG-WHT MKG 8B
58		30		J	703302		TIE, CABLE

Figure 7-5. Wayside Transformer Assembly Component Layout and Parts List

ITEM	APP TAG •	QUANTITY	TOTAL	US & S PART •	PART • MANUFACTURER DISTRIBUTOR	VENDOR MANUFACTURER DISTRIBUTOR	DESCRIPTION	ORDERED: REQUESTED BY	REQUESTED	DATE REQUESTED	RECEIVED
1	321		1	UN377777	UN377777	US & S	TERMINAL PANEL WITH TWO BOARDS PER GROUP SEE DRAWING F80094 SH 5 FOR DETAILS	ENGR. DEPT.	N		
2	295		1	N451075-5701	N451075-5701	US & S	9-WAY 36 PIN CONNECTOR PANEL. SEE DWG. 451075 SH. 57	ENGR. DEPT.			
3	259		4	J709004	J709004	US & S	36 PIN CONNECTOR.	ENGR. DEPT.			
4	125		1	N451056-5501	N451056-5501	US & S	24 SLOT CARDFILE WITH BUSS BARS. PCBS CALLED OUT SEPARATELY	ENGR. DEPT.			
5	217		1	CR92Y04002	CR92Y04002	LAMBDA	LAMBDA POWER SUPPLY ASSEMBLY DUAL +/- 15V SUPPLY , 3A	ENGR. DEPT.			
6	299		1	C NUMBER NEEDED	SPECIAL ORDER	WIEDMULLER	TERMINAL BLOCK ASSEMBLY	ENGR. DEPT.			
7	317		1	SPECIAL ORDER	SPECIAL ORDER	EQUIPTO	CHALLENGER EQUIPMENT RACK. 36 IN. DEEP W/ PLEX DOOR	ENGR. DEPT.			
8	316		2	N/A	N/A	US & S	RACK NAME TAG (CUSTOMIZED PER RACK AS REQUIRED) 9 CHARACTER	ENGR. DEPT.			
9	337		20	N/A	80D102-05	EQUIPTO	MAR-PROOF SCREW (EQUIPTO) 10BX5/8 IN.	ENGR. DEPT.			
10	338		3 FT.	CR91Y012297	CGP-2 23N3659	SPC TECH NEWARK	GROMMET CONTINUOUS GROMMET ROLL FOR 19-12 GUAGE (.037" - .015") (100 FT. ROLL MIN. PURCHASE)	ENGR. DEPT.			
11	264		4	N308947-001		US&S	CABLE SUPPORT TIE BAR FOR 19" RACK, 18.25" HOLE CENTER TO HOLE CENTER	ENGR. DEPT.			
12	339		20	CR91Y012105	80-0401-03	EQUIPTO	SPEED NUT NUTS FOR 10B SCREW	BULK			
13	340		22	J475121-0111		US&S	1/4 LOCK WASHER	BULK			
14	341		22	J480211-0108		US&S	1/4-20 NUT	BULK			
15	342		22	J475120-0112		US&S	1/4 PLATE WASHER	BULK			
16	343		22	J500136-0112		US&S	1/4-20X1/2 IN. SCREWS	BULK			
17	121		4	N451441-3101		US&S	PHASE DETECTOR PCBS	ENGR. DEPT.			
18	122		1	N451441-8902		US&S	CARSPACE DRIVER PCB	ENGR. DEPT.			
19	123		1	UJ793100-0019		US&S	CARSPACE ADDRESS PCB	ENGR. DEPT.			
20	124		1	N451441-1101		US&S	DUAL EXTENDER PCB	ENGR. DEPT.			

APPTAB-CARSPACE SYSTEM

REVISIONS
XX-XX-92 AS INSTALLED

REFERENCES

SCALE: NONE
DESIGNED
DRAWN
TRACED
CHECKED
FOR WIRING

ITALIAN STATE RAILWAY
CERVIGNANO YARD
CLASSIFICATION YARD
CIRCUITS

UNION SWITCH & SIGNAL INC.
PITTSBURGH, PA 15237

APPROVED
DATE
SH K 700Z
CONT'D ON

T1496

T1486:486K700Z.ATF

Fig 7-6

P 7-13/14