



# INSTRUCTIONS

GEK-38312 (2-13)

# HEAVY MAINTENANCE INSTRUCTIONS PERFORMANCE AND FAULT INDICATION ELECTRONICS PANEL TYPE FL134

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These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.



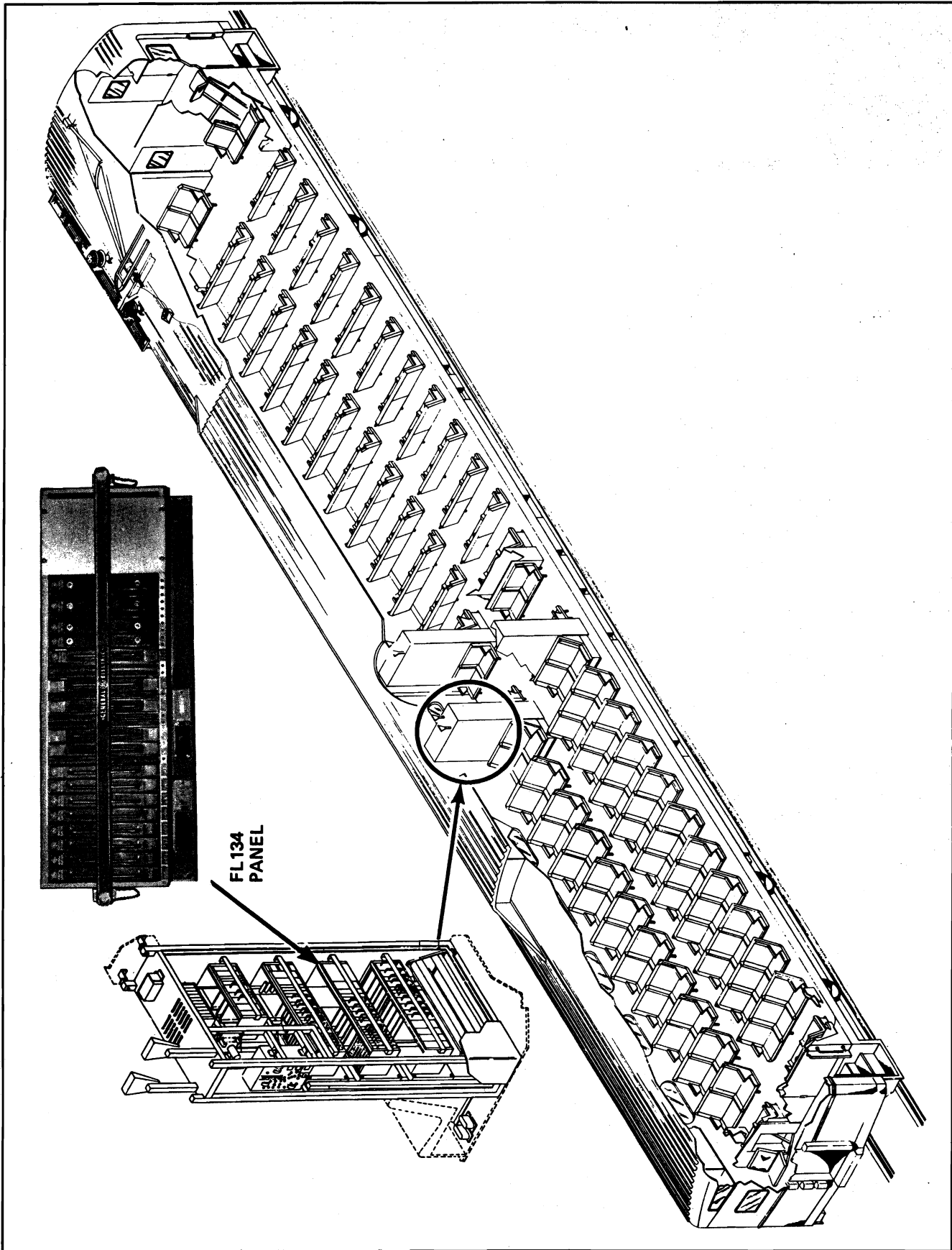


FIG. 13-50. 17FL134 PANEL LOCATION ON THE CAR. E-19493

## INTRODUCTION

### SCOPE

This publication contains the information necessary to maintain, repair and test the 17FL134A1 performance and fault indication electronics panel, its thirteen circuit card assemblies, and other panel-mounted components.

### DESCRIPTION

The 17FL134A1 performance and fault indication electronics panel (See Fig. 13-50) is a metal fabricated assembly containing thirteen circuit card assemblies and other panel-mounted components. This panel monitors the operation of the propulsion, wheelslip and motor-alternator sub-systems. The sub-system operational information is then displayed on a 17FM329A1 display panel by thirty-three lamps, five meters and two counters.

The 17FL134A1 panel monitors thirty-three signals which operate lamps on the display panel. If a fault input is received on panel pins T-14, T-15, or T-16, twenty-nine of the lamps on the 17FM329 panel will latch in the condition they were in when the fault input was received. These lamps will remain latched until the reset button on the FM329 display panel is depressed. Two lamps on the FM329 display panel are self-latching and therefore not affected by the fault input latch system. The remaining two lamps on the display panel are non-latching.

The FL134 panel also provides signals to drive five meters and two counters on the FM329 display panel. The five meters consist of the following:

1. Main Transformer Primary Current Meter
2. Traction Motors 1 and 2 Current Meters
3. Traction Motors 3 and 4 Current Meters
4. Motor-Alternator Output Voltage Meter
5. Motor-Alternator Output Frequency Meter.

The two counters consist of the following:

1. Wheelslip Truck "A"
2. Wheelslip Truck "B".

The following circuit cards are contained in the FL134 panel:

**CAUTION:** *Power should be removed when pulling or replacing electronic cards to prevent electrical card damage.*

### FD601 Latching Lamp Driver Card (See Fig. 13-51)

This card contains five identical SCR lamp driver circuits. When the proper inputs are applied, the lamp driver circuits provide returns to illuminate indicator lamps located on the FM329 display panel. When a lamp is illuminated, a latch function within each lamp driver maintains illumination after the controlling input is removed. The lamp may then be turned off by removing anode voltage from SCR, normally done by FD602 Card, or, a manual reset process.

The FD601 card also has a lamp test input which tests all lamp driver circuits and a clamp input which disables all of the lamp driver inputs.

Inputs to this card consist of the following:

1. Pin 7 is a return for all incoming and outgoing signals.
2. A +37.5 vdc input on pin 8 activates lamp driver No. 1.
3. A +37.5 vdc input on pin 14 activates lamp driver No. 2.
4. A +37.5 vdc input on pin 20 activates lamp driver No. 3.
5. A +37.5 vdc input on pin 26 activates lamp driver No. 4.
6. A +37.5 vdc input on pin 32 activates lamp driver No. 5.
7. Pin 4 is a lamp test input. A +37.5 vdc input on pin 4 tests all lamp driver circuits.
8. Pin 2 is a clamp input. A 0 vdc input on pin 2 disables all of the lamp drivers inputs.

Outputs from this card consist of the following:

1. Pin 12 provides a return to an indicator lamp from lamp driver No. 1.



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2. Pin 18 provides a return to an indicator lamp from lamp driver No. 2.
3. Pin 24 provides a return to an indicator lamp from lamp driver No. 3.
4. Pin 30 provides a return to an indicator lamp from lamp driver No. 4.
5. Pin 36 provides a return to an indicator lamp from lamp driver No. 5.

**FD602 Power Oscillator Card (See Fig. 13-52)**

The FD602 power oscillator card is a free-running power oscillator which provides power to a number of SCR lamp driver units located on FD601 cards. The input voltage is a nominal +37.5 vdc and the output is a 0 to +37.5 vdc rectangular waveform with approximately 10 milliseconds ON time and 0.7 milliseconds OFF time. The output current is limited to 2.0-3.0 amps.

Inputs to this card consist of the following:

1. Pin 7 is a return for all incoming and outgoing signals.
2. Pin 8 receives +37.5 vdc to operate the card circuitry.

The output from this card is a 0 to +37.5 vdc rectangular waveform on pin 34 with approximately 10 milliseconds ON time and 0.7 milliseconds OFF time.

**FD713 Transformer and Blower Failure Detector Card (See Fig. 13-53)**

This card provides the necessary logic to detect a failure in the blower and transformer cooling system. The FD713 card monitors several voltages and provides two lamp driver outputs, one for a blowers failure indicator and one for a transformer cooling failure indicator. Both the BLOWERS failure indicator and the XFMR COOLING failure indicator are located on the FM329 display panel. Before any output can be provided by the FD713 card, a MAC1 (Motor-Alternator Contactor No. 1) interlock signal and an initiate signal from the FBR (Fail Blower Relay) coil must be present.

Inputs to this card consist of the following:

1. Pin 44 is a return for all incoming and outgoing signals.
2. Pin 4 receives +37.5 vdc to operate the card circuitry.

3. Pin 32 requires a +37.5 vdc signal from MAC1 for the card to produce an output signal.
4. Pin 42 requires a +37.5 v pulse from the FBR coil for the card to produce an output signal.
5. Pin 8 requires a 0 vdc input to illuminate the BLOWERS failure indicator.
6. Pin 12 requires a +37.5 vdc input to illuminate the BLOWERS failure indicator.
7. Pin 16 requires a 0 vdc input to illuminate the XFMR COOLING failure indicator.

Outputs from this card consist of the following:

1. Pin 24 provides a +30 vdc signal to illuminate the XFMR COOLING failure indicator.
2. Pin 26 provides a +25 vdc signal to illuminate the BLOWERS failure indicator.

**FD715 Hot Ignitron Detector and Lamp Driver Card (See Fig. 13-54)**

This card has two inputs which are connected across a temperature-controlled switch on each ignitron tube. If a voltage appears at one input, but not the other, one of these switches has opened and an output is produced.

The FD715 card also has a latching lamp driver circuit which provides a return to illuminate an indicator lamp located on the display panel. When the lamp is illuminated, a latch function maintains illumination after the controlling input is removed. The lamp may then be turned off by a manual reset process.

This card also has a lamp test input to test the lamp driver circuit and a clamp input to disable the lamp driver.

Inputs to the hot ignitron detector circuit consist of the following:

1. Pin 44 is a return for the detector circuit.
2. Pin 30 receives +37.5 vdc to operate the detector circuit.
3. Pin 34 receives +37.5 vdc to activate the detector circuit.
4. Pin 38 receives +37.5 vdc to prevent an output from the detector circuit. Zero vdc on pin 38 causes an output from the detector circuit.

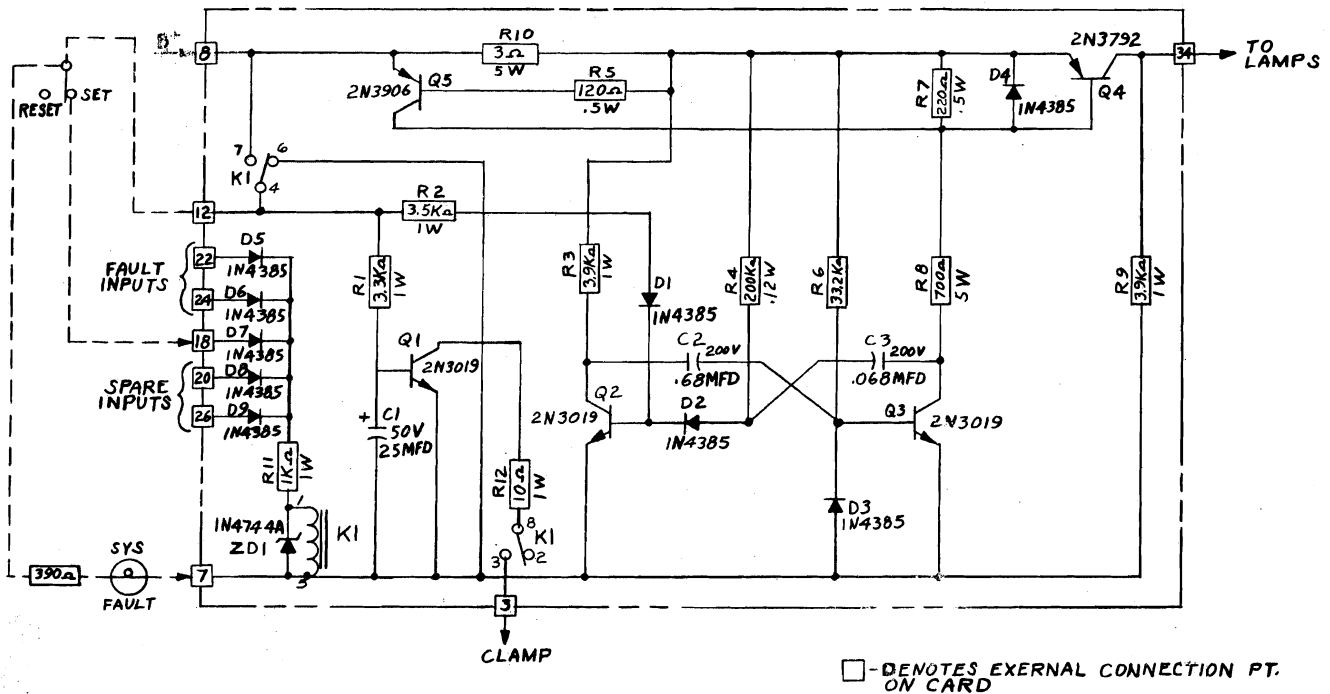
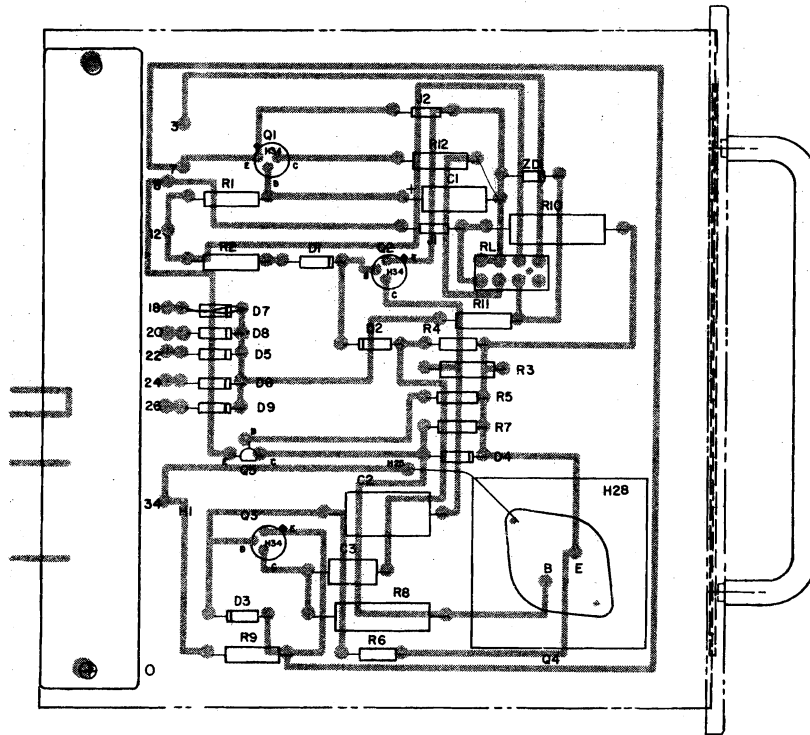
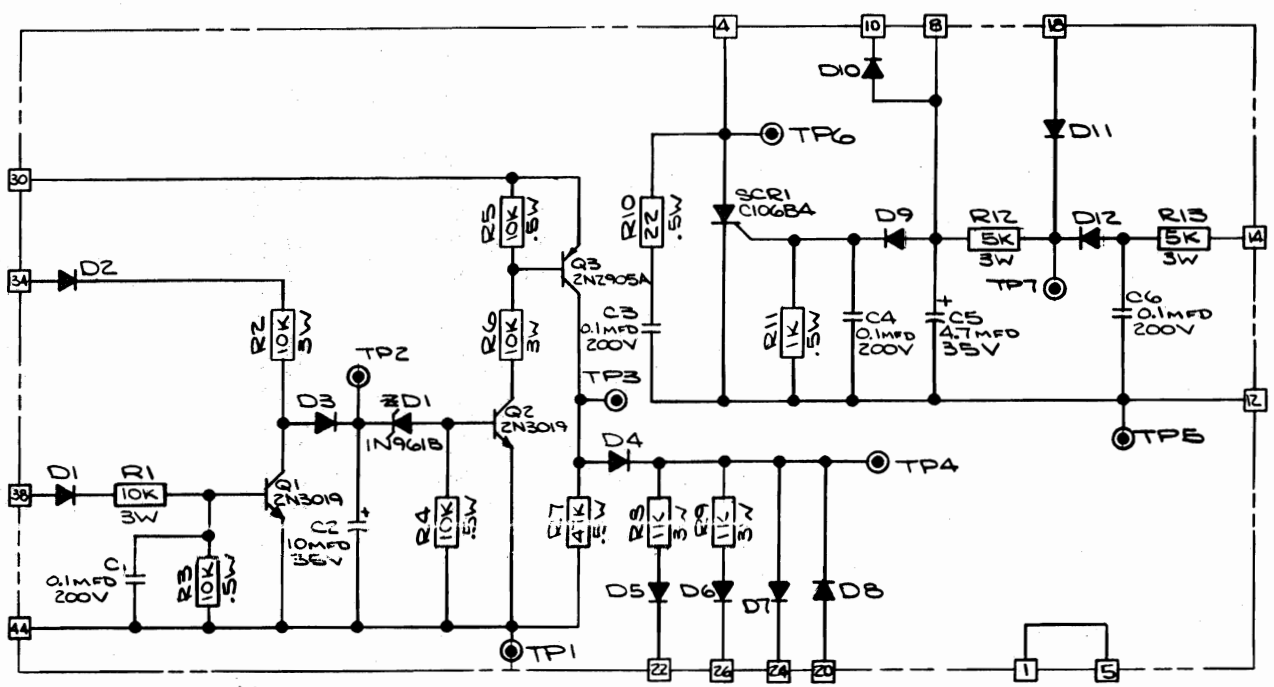
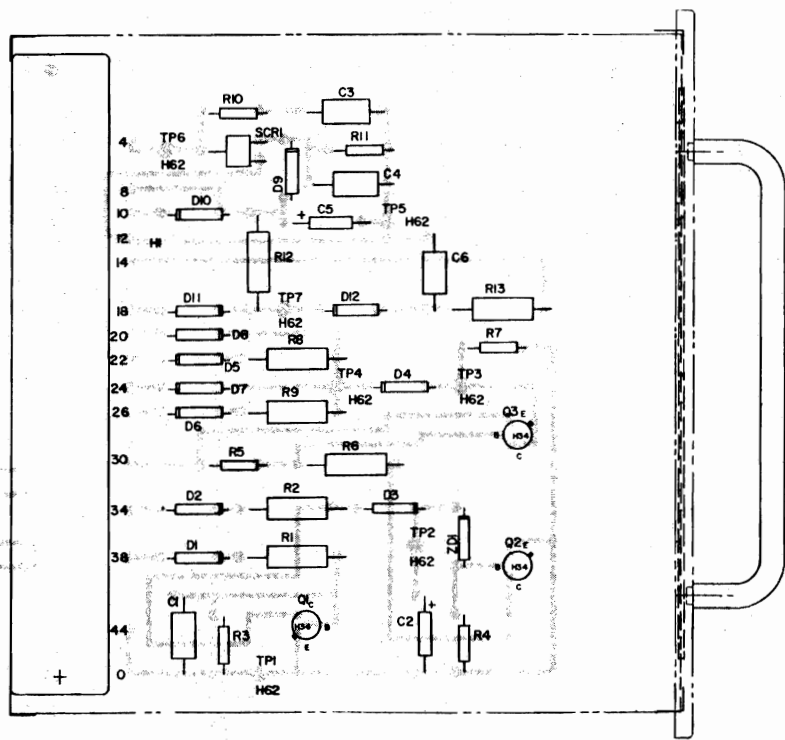


FIG. 13-52. CIRCUIT LAYOUT FD602 POWER OSCILLATOR CARD. E-19551





NOTE:  
 1. □ - DENOTES EXTERNAL CONN. PT. ON CARD.  
 2. ALL DIODES IN4385 UNLESS OTHERWISE SPECIFIED.

FIG. 13-54. CIRCUIT LAYOUT FD715 HOT IGNITRON DETECTOR AND LAMP DRIVER CARD. E-19641

Outputs from the hot ignitron detector circuit consist of 0 or +37.5 vdc on pins 22, 24 and 26. The presence of +37.5 vdc on pins 22, 24 and 26 indicates a hot ignitron tube.

Inputs to the latching lamp driver circuit consist of the following:

1. Pin 12 is a return for the lamp driver circuit.
2. A +37.5 vdc input on pin 14 causes an output from the lamp driver circuit.
3. Pin 18 is the lamp test input. A +37.5 vdc input on pin 18 tests the lamp driver circuit.
4. Pin 10 is a clamp input. A 0 vdc on pin 10 disables the lamp driver inputs.

The output from the lamp driver circuit is on pin 4, which provides a return to illuminate an indicator lamp.

#### **FD716 Wheel slip Driver and Inverter Card (See Fig. 13-55)**

This card contains two driver circuits, each of which operates an electro-mechanical counter and energizes a lamp. Both the counters and the lamps are located on the display panel. The FD716 card also contains two inverter circuits which are used to operate lamp driver inputs on a FD601 card and a diode matrix to isolate several other inputs.

Inputs to this card consist of the following:

1. Pin 44 is a return for all incoming and outgoing signals.
2. Pin 16 receives +37.5 vdc to operate the card circuitry.
3. The application of +37.5 vdc to pin 18 activates driver circuit No. 1.
4. The application of +37.5 vdc to pin 34 activates driver circuit No. 2.
5. The application of +37.5 vdc to pin 20 activates both driver circuits.
6. The application of +37.5 vdc to pin 38 activates inverter circuit No. 1.

7. The application of +37.5 vdc to pin 42 activates inverter circuit No. 2.

8. Pins 2, 4, 6, 8, 10 and 12 are inputs to an OR circuit.

Outputs from this card consist of the following:

1. Pin 22 is an output from driver circuit No. 1 and provides a return to illuminate a wheelslip light located on the display panel.
2. Pins 24 and 26 are outputs from driver circuit No. 1 and provide a signal to operate a 24 vdc wheelslip counter located on the display panel.
3. Pin 32 is an output from driver circuit No. 2 and provides a return to illuminate a wheelslip light located on the display panel.
4. Pins 28 and 30 are outputs from driver circuit No. 2 and provide a signal to operate a 24 vdc wheelslip counter located on the display panel.
5. Pin 36 is the output from inverter circuit No. 1.
6. Pin 40 is the output from inverter circuit No. 2.
7. Pin 14 is the output from the multi-input OR circuit.

#### **FD717 Resistor-Diode Card (See Fig. 13-56)**

This card contains twenty-six isolating diodes and series-dropping resistors which are used in conjunction with the FD601 latching lamp driver cards. Twenty-two of these series resistor-diode circuits are fed by a 0 to +37.5 vdc rectangular waveform on pin 44. The four other series resistor-diode circuits are used for self-latching and non-latching lamps. These four series resistor-diode circuits are normally fed by +37.5 vdc.

#### **FD718 Metering Card (See Fig. 13-57)**

This card provides the interface circuits for meters to monitor motor current, motor-alternator output frequency and motor-alternator output voltage.

The inputs and outputs for this card consist of the following:

1. Pins 2 and 10 receive a 1000 Hz square wave signal proportional to the current in CMRX1. Pins 4 and 12 produce a dc current proportional to the CMRX1 output current to drive a 0-1 ma dc meter. A 20 volt

peak-to-peak (v p-p) square wave signal applied to pins 8 and 10 will produce a current of 0.6 ma through a 40 ohm load on pins 4 and 12.

2. Pins 16 and 18 receive a 1000 Hz square wave signal proportional to the current in CMRX2. Pins 14 and 20 produce a dc current proportional to the CMRX2 output current to drive a 0-1 ma dc meter. A 20 v p-p square wave signal applied to pins 16 and 18 will produce a current of 0.6 ma through a 40 ohm load on pins 14 and 20.

3. Pins 34 and 36 receive 230 vac, 60 Hz power from one phase of the alternator. Pins 30 and 32 produce a dc current proportional to the alternator output frequency to drive a 0-1 ma dc meter. A 230 vac RMS, 60 Hz signal applied to pins 34 and 36 will produce a current of 0.5 ma through a 40 ohm load on pins 30 and 32.

4. Pins 24 and 26 receive a 0-20 vac signal proportional to the primary transformer current. Pins 22 and 28 produce a dc current proportional to the primary transformer current to drive a 0-1 ma dc meter. A 20 vac RMS signal applied to pins 24 and 26 will produce a current of 0.8 ma through a 40 ohm load on pins 22 and 28.

## MAINTENANCE AND REPAIR

Components mounted on this panel do not require scheduled maintenance. The panel should be kept free of dirt and all connections kept tight. In the event of failure, consult the Inspection and Repair section for additional information.

### REMOVAL FROM THE CAR (See Fig. 13-50)

1. Open the Electronic Locker No. 1 door.
2. Disconnect the car wiring from the panel by unplugging the connectors.
3. Remove the four sets of mounting hardware.
4. Lift the panel off the mounting studs and remove to a suitable work area.

### DISASSEMBLY (See Fig. 13-58)

1. Loosen the stud (8) on the ends of the retaining bar (2) and allow the bar to hang on the bead chain (23).
2. Unplug all of the electronic cards (27 thru 39) from the weldment (1) by pulling outward on the card handle.

3. Remove the covers (5, 6) from the weldment (1) by removing the mounting hardware (19, 20, 21, 22).

4. Remove the back panel cover (40) from the weldment (1) by removing the four sets of mounting hardware. (20, 21, 22).

5. Remove the P.C. Board (14) from the panel (26) by removing the wires from the terminal board (12). Then remove the two sets of mounting hardware (18, 19, 20, 21, 22).

6. Remove the terminal board (12) from the P.C. Board (14) by removing the two sets of mounting hardware (19, 20, 21, 22).

7. Remove the components from the P.C. Board (14) per instructions under Inspection and Repair.

8. Remove the capacitor (16) from the panel (26) by disconnecting the wires from the capacitor and loosening the bracket (3) hardware (19, 21, 22). Then, lift the capacitor (16) out of the bracket assembly.

9. Remove the brackets (3) from the panel (26) by removing the three sets of mounting hardware (19, 20, 21, 22).

10. Remove the inductor (15) from the panel (26) by removing the four sets of mounting hardware (19, 20, 21, 22).

11. Remove the thyrector (13) from the panel (26) by removing the two sets of hardware (19, 21, 22) fastening the wires to the thyrector (13), and by removing the mounting hardware (19, 20, 21) fastening the thyrector to the bracket (3).

12. Remove the wires from the terminal block (7).

13. Remove the terminal block (7) and card guide (4) by removing the two sets of bottom hardware (19, 20, 21, 22) and the two sets of top hardware (20, 21, 22).

14. Remove the wires from the connector (11).

15. Remove the connector (11) from the weldment (1) by removing the four guide pins (25).

## INSPECTION AND REPAIR

Visually inspect for the following:

1. Dirty or corroded connector contacts

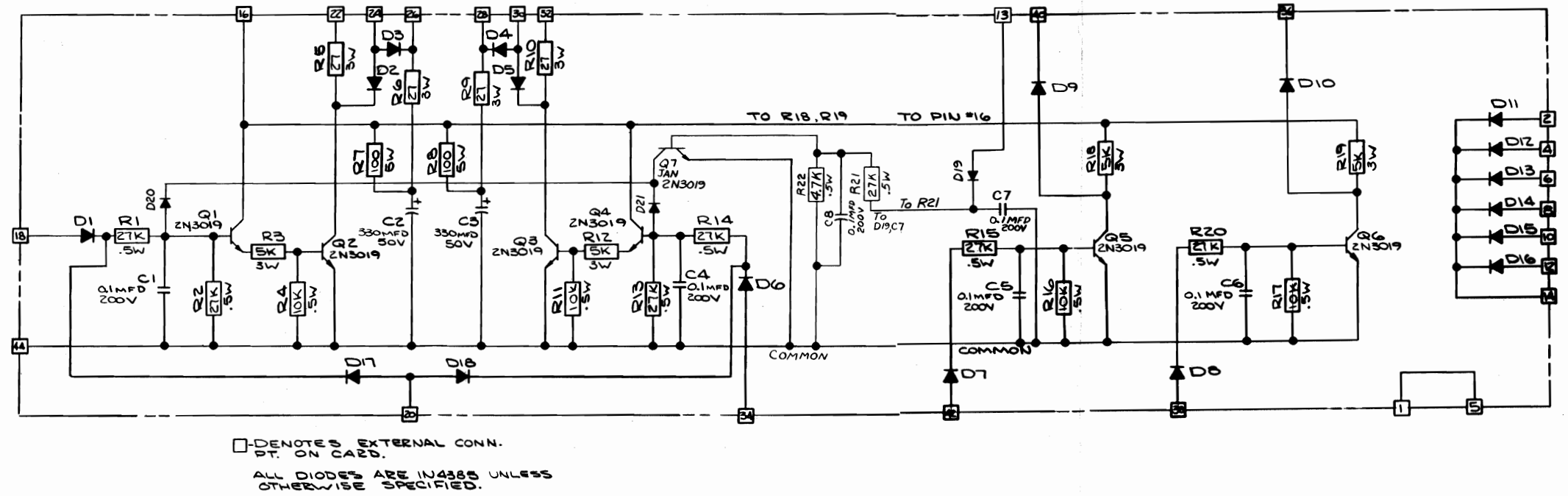
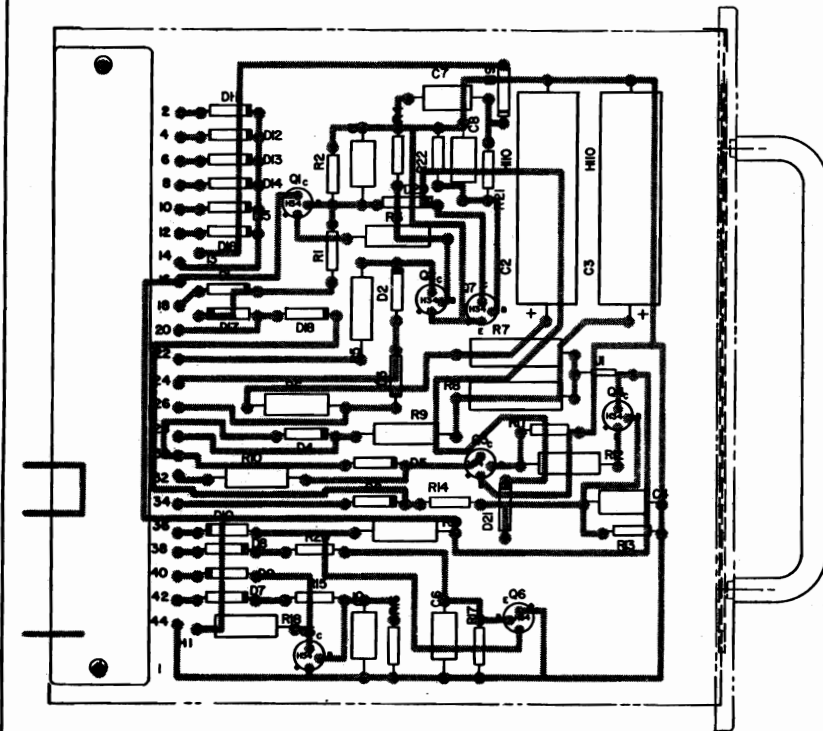


FIG. 13-55. CIRCUIT LAYOUT FD716 WHEELSLIP DRIVER AND INVERTER CARD. E-19642

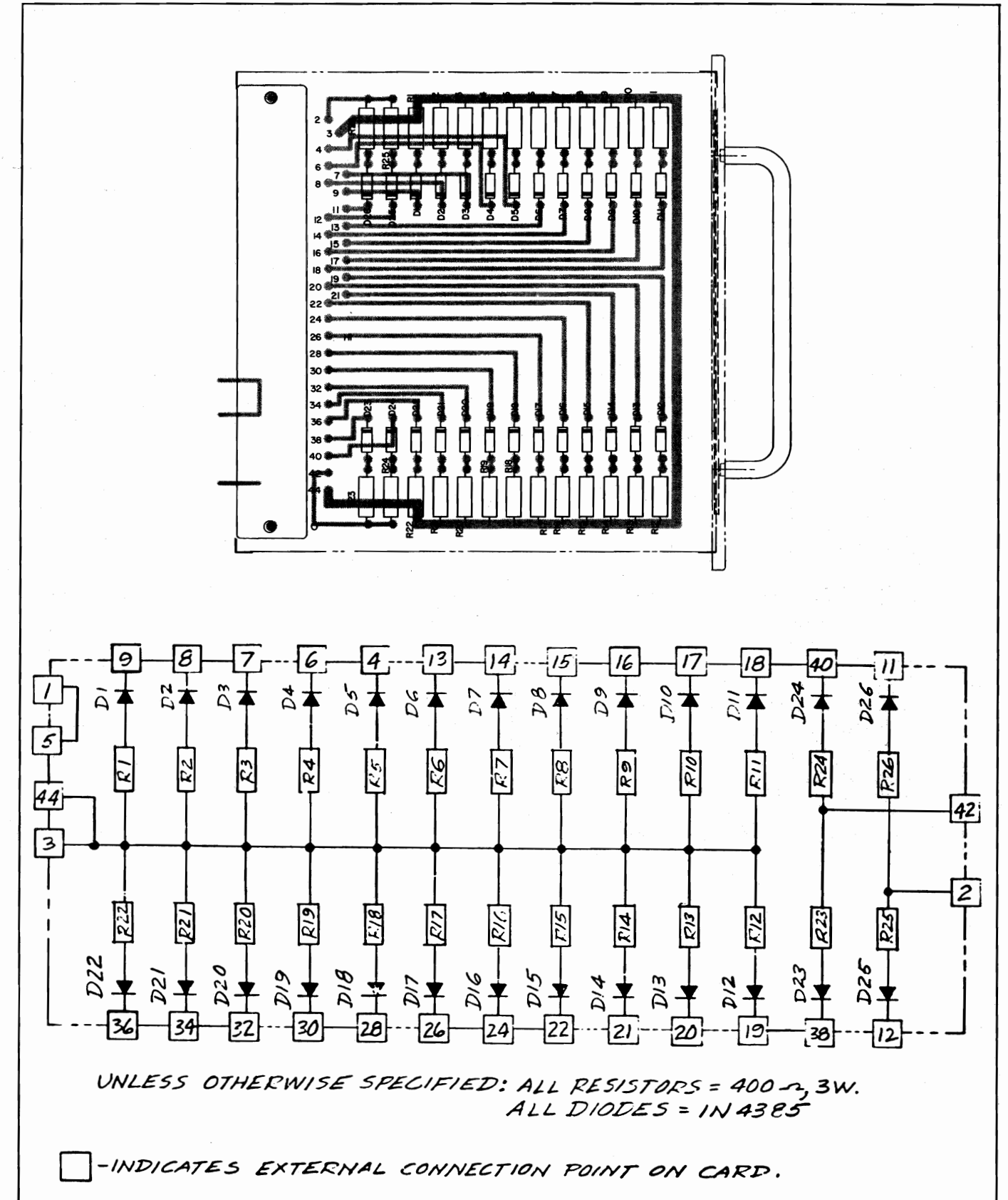


FIG. 13-56. CIRCUIT LAYOUT FD717 RESISTOR DIODE CARD. E-19643

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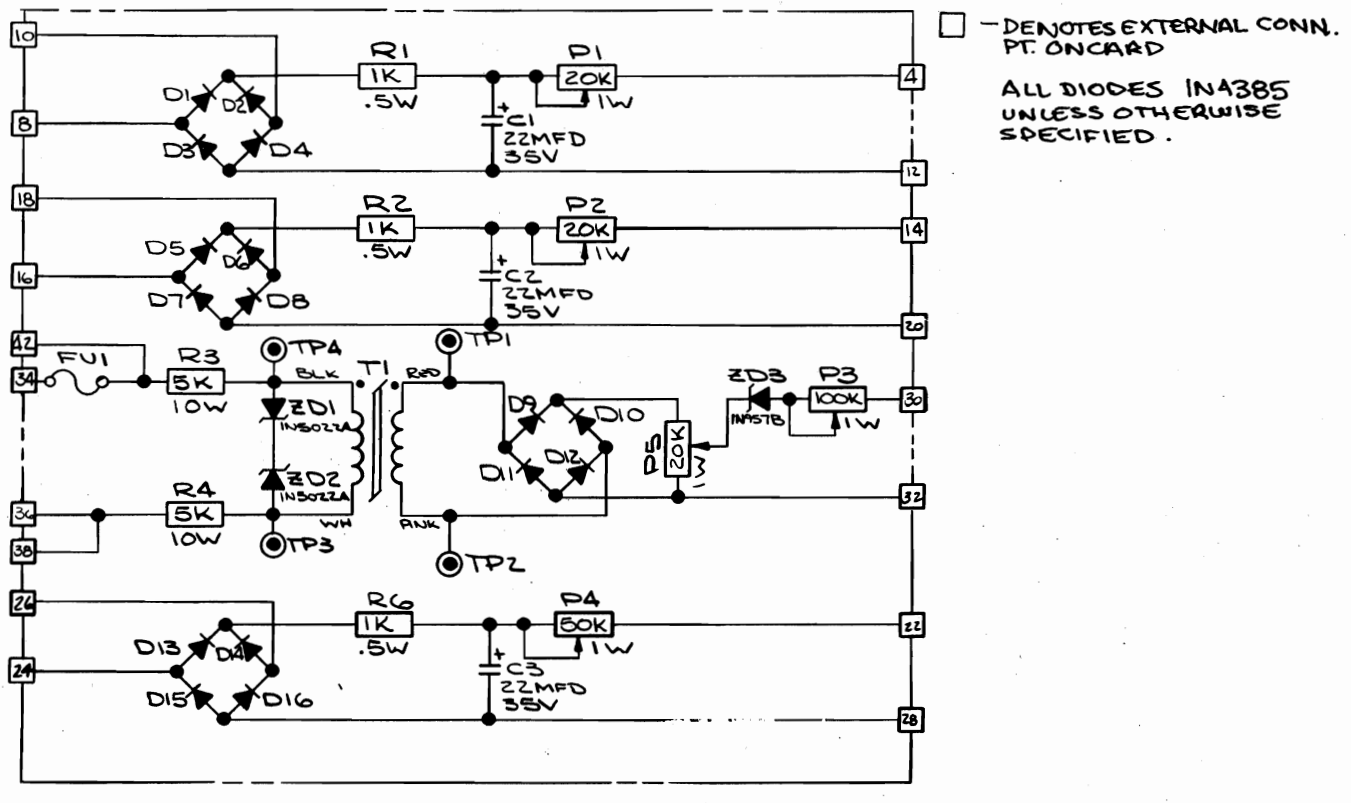
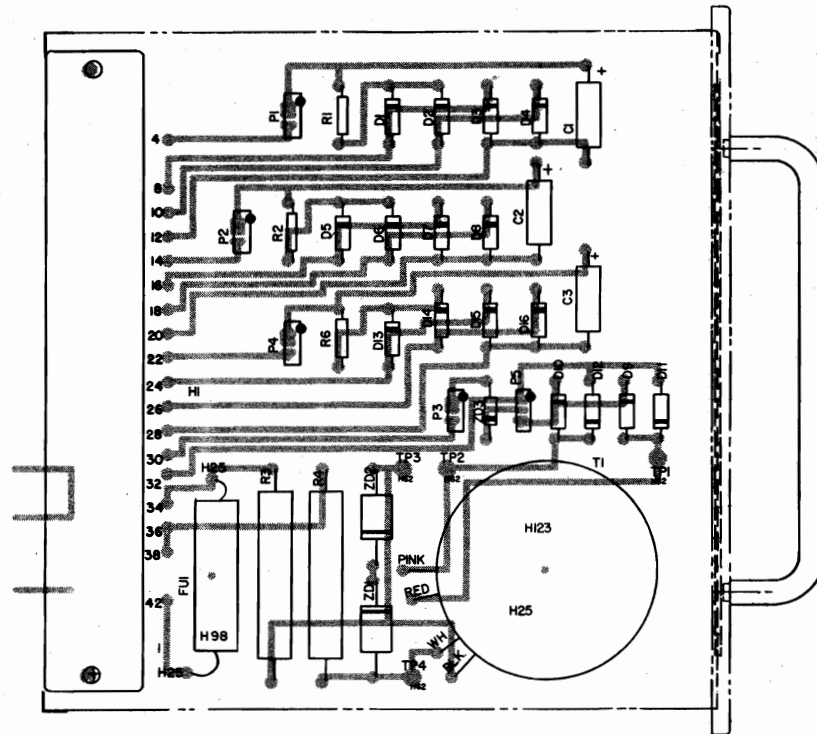


FIG. 13-57. CIRCUIT LAYOUT FD718 METERING CARD. E-19644

HEAVY MAINTENANCE INSTRUCTIONS,  
 GEK-38312 (2-13), PERFORMANCE & FAULT INDICATION ELEC. PANEL, TYPE FL134

REF.	DESCRIPTION
1	BOX WELD
2	RET. BAR
3	BRACKET
4	GUIDE
5	COVER
6	COVER
7	TERM. BLK.
8	STUD. WASHER
9	SPLIT WASHER
10	NAMEPLATE
11	CONNECTOR
12	TERMINAL BOARD
13	THYRECTOR
14	P.C. BOARD
15	INDUCTOR
16	CAPACITOR
17	RESISTOR
18	SPACER
19	NUT
20	WASHER
21	LOCKWASH.
22	SCREW
23	BEAD CHAIN
24	INDICATING PLATE
25	GUIDE PIN
26	PANEL
27	ELECTRONIC CARD
28	ELECTRONIC CARD
29	ELECTRONIC CARD
30	ELECTRONIC CARD
31	ELECTRONIC CARD
32	ELECTRONIC CARD
33	ELECTRONIC CARD
34	ELECTRONIC CARD
35	ELECTRONIC CARD
36	ELECTRONIC CARD
37	ELECTRONIC CARD
38	ELECTRONIC CARD
39	ELECTRONIC CARD
40	BACK PANEL COVER

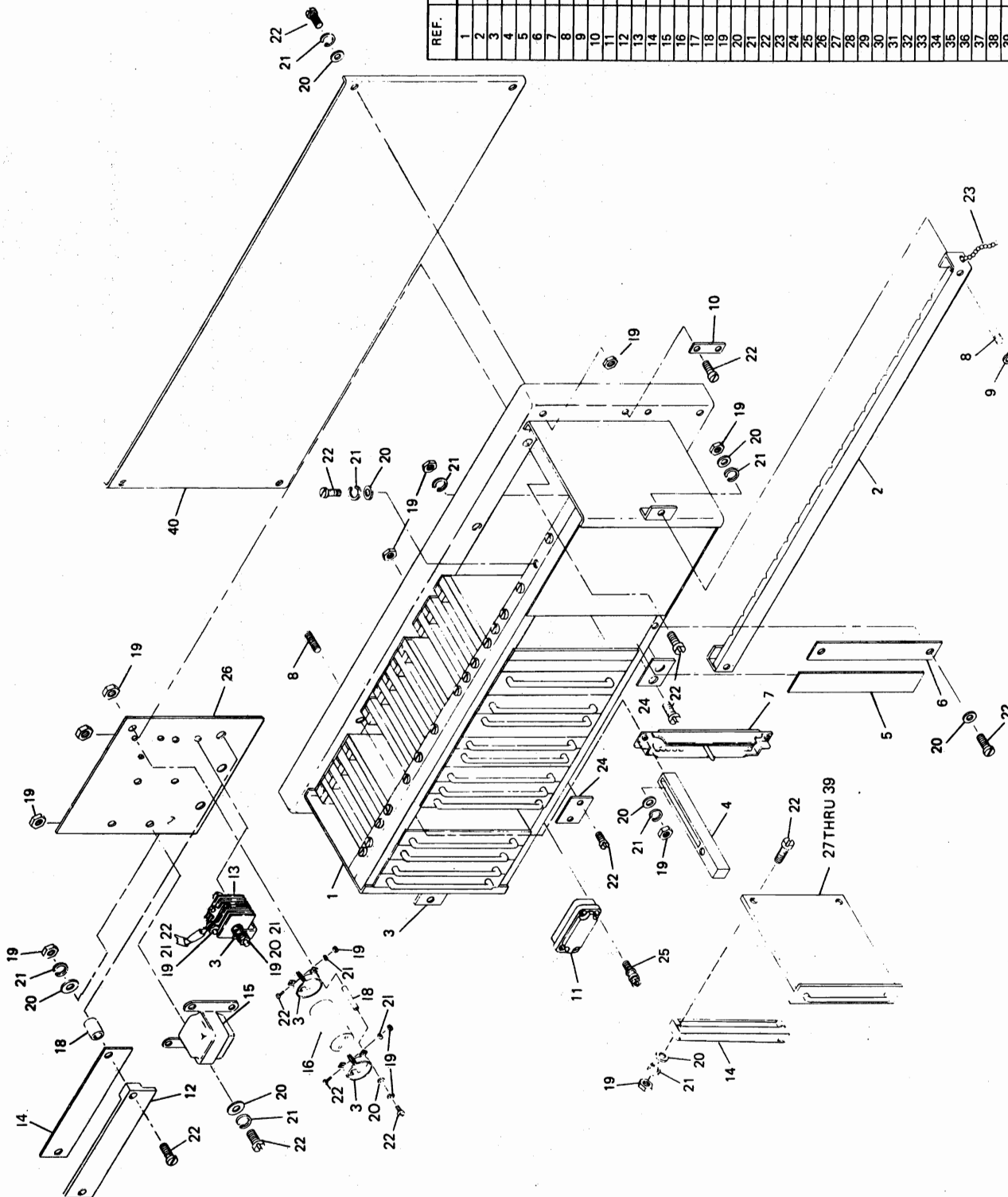


FIG. 13-58. EXPLODED VIEW FL134 PANEL. E-19645

2. Broken or discolored components
3. Broken wires or printed circuit streets
4. Loose screws and nuts.

Tighten and repair as necessary. If a visual inspection fails to reveal the problem, refer to the Panel Test section for additional information.

Repair will generally consist of replacement of hardware, wires and/or components. The following information is provided as a guide for component replacement.

#### Card Component Replacement

##### Removing Plastic Coating

Before a component is removed from a card it must be freed from its plastic coating and its leads unsoldered. This plastic coating holds the components to the card and seals them from moisture and dirt accumulation that may cause current leakage.

The point of a small knife used to score the plastic around the component and its leads. Gently pry the plastic loose and thus free the component from the card.

**NOTE:** *Scrape the plastic coating from the lead wires of semiconductors to provide a clean metal surface on which to attach a heatsink before unsoldering leads.*

##### Unsoldering and Resoldering Leads

Semiconductors (transistors, diodes, rectifiers, etc.) are subject to heat damage. Soldering produces sufficient heat to destroy semiconductors unless precautions are taken. Whenever possible, use a heatsink to protect semiconductors during soldering operations.

A heatsink can be anything that absorbs heat to prevent damage. One type of heatsink can be a pair of needle nose pliers with a rubber band wrapped around the jaws to provide clamping force.

Before applying a heatsink to a component, scrape the plastic coating from the lead wires so that the heatsink is not insulated from the lead. Attach a heatsink as close to the card as possible to reduce the effect of heat that bypass the heatsink.

Do not apply the heatsink to the solder terminal. It must be applied to the component lead to be effective.

Position the heatsink so that the component lead can be quickly withdrawn from the printed circuit card as solder melts. This will restrict heat build up in the semiconductor lead.

### CIRCUIT AND COMPONENT TEST

#### TEST EQUIPMENT REQUIRED

See Table I.

#### PANEL TEST

The panel test consists of independent operational checks for each card and a diagram for the panel-mounted components and the panel wiring. Since most problems are likely to occur within the cards, troubleshooting would be most efficiently accomplished by utilizing the panel description information to determine which card or cards are suspected to be causing the problem and performing an operational check on the most suspected card first. Usually, the panel-mounted components and the panel wiring cause the least amount of problems, so these would normally be checked after all the cards. The panel interconnection diagram is shown on Fig. 13-65. Test equipment needed to perform each card check is listed in Table I.

**CAUTION:** *Do not check panel circuits or components with a bell set. Inductive voltages can cause failure of semiconductor components.*

#### CARD TEST

##### FD601 Card Operational Check (See Fig. 13-51)

1. Connect test circuit to the FD601 card shown in Fig. 13-59.
2. Connect the probe end of the 400 ohm resistor to pin 12.
3. Turn on and set the 24-45 vdc power supply for 44.9 to 45.1 vdc.
4. Connect the +45 vdc probe to pin 4 and observe lamp illumination.
5. Remove the +45 vdc probe from pin 4 and observe that lamp remains illuminated.
6. Momentarily turn off the 24-45 vdc power supply. Observe that lamp remains off when power supply is turned back on.

TABLE I

EQUIPMENT	FD716	FD601	FD717	FD602	FD718	FD713	FL134	FD715
	Power Supply, 37.5 vdc, 500 ma	1		1	1		1	
Power Supply, 60 vdc, 250 ma		1					1	1
Power Supply, 20 v RMS, 20 ma, 60 Hz					1			
Power Supply, 230 v RMS, 25 ma, 60 Hz					1			
Square Wave Oscillator, 20 v p-p, 10 ma, 1000 Hz					1			
Sine Wave Oscillator, 20 v p-p, 10 ma, 1000 Hz							1	
Digital Multimeter, Fluke Model 8000A or equivalent	1	1	1	1	1	1	1	1
Dual Trace Oscilloscope, Tektronix Type 214 or equivalent	1	1	1	1	1	1	1	1
Impedance Bridge, General Radio Type 1650-B, or equivalent							1	
Indicator Lamp, 28 v, 40 ma lamp No. 327 or equivalent	1	1						1
Resistors	10 ohm, 1/2w, 5%							1
	40 ohm, 1/8w, 1%					1		
	1k ohm, 1/2w, 5%						1	
	3k ohm, 1w, 5%						1	
	3.9k ohm, 1w, 5%	1		1				
	220 ohm, 5w, 5%	1						
	400 ohm, 5w, 5%	1		1	1			1
50 ohm, 30w, 5%				1				

7. Connect +45 vdc probe to pin 8 and observe lamp illumination.

8. Remove the +45 vdc probe from pin 8 and observe that lamp remains illuminated.

9. Momentarily turn off the 24-45 vdc power supply. Observe that lamp remains off when power supply is turned back on.

10. Connect the 24-45 vdc power supply return probe to pin 3.

11. Connect the +45 vdc probe to pin 4 and observe that lamp remains off.

12. Remove the +45 vdc probe from pin 4 and connect it to pin 8. Observe that lamp remains off.

13. Remove the 24-45 vdc power supply return probe from pin 3.

14. Set the 24-45 vdc power supply for 23.9 to 24.1 vdc.

15. Connect the +24 vdc probe to pin 4 and observe lamp illumination.

16. Remove the +24 vdc probe from pin 4 and observe lamp remains illuminated.

17. Momentarily turn off the 24-45 vdc power supply. Observe that lamp remains off when power supply is turned back on.

18. Connect the +24 vdc probe to pin 8 and observe lamp illumination.

19. Remove the +24 vdc probe from pin 8 and observe that lamp remains illuminated.

20. Momentarily turn off the 24-45 vdc power supply. Observe that lamp remains off when power supply is turned back on.

21. Turn off the 24-45 vdc power supply.

22. Test lamp driver No. 2 by substituting pins 14 for 8 and 18 for 12. Repeat Steps 2 through 21. The lamp test input (pin 4), the clamp input (pin 3), and the return input (pin 7) are common to all five lamp drivers.

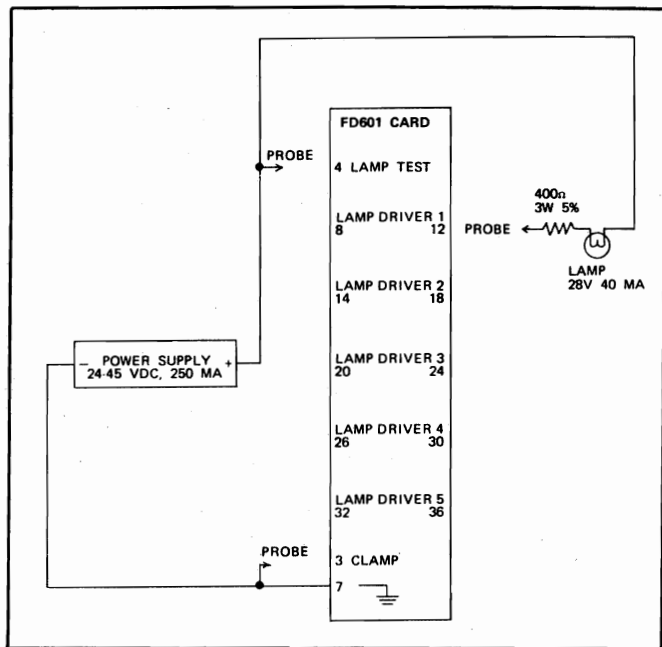


FIG. 13-59. TEST CIRCUIT FD601 CARD. E-19646

23. Test lamp driver No. 3 by substituting pins 20 for 8 and 24 for 12. Repeat Steps 2 through 21. The lamp test input (pin 4), the clamp input (pin 3), and the return input (pin 7) are common to all five lamp drivers.

24. Test lamp driver No. 4 by substituting pins 26 for 8 and 30 for 12. Repeat Steps 2 through 21. The lamp test input (pin 4), the clamp input (pin 3), and the return input (pin 7) are common to all five lamp drivers.

25. Test lamp driver No. 5 by substituting pins 32 for 8 and 36 for 12. Repeat Steps 2 through 21. The lamp test input (pin 4), the clamp input (pin 3), and the return input (pin 7) are common to all five lamp drivers.

26. Disconnect all test equipment from the FD601 card.

#### FD602 Card Operational Check (See Fig. 13-52)

1. Connect a 50 ohm, 30w, 5% resistor between pins 7 and 34.

2. Connect the positive terminal of a 37.5 vdc, 1.5 amp power supply to pin 8. Connect the negative terminal of the power supply to pin 7.

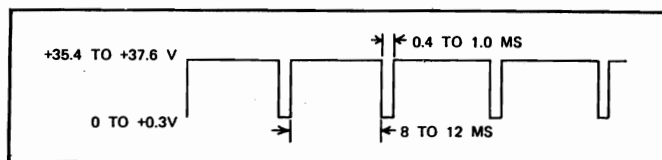


FIG. 13-60. WAVEFORM FD602 CARD. E-19647

3. Turn on and set the dc power supply for 37.4 to 37.6 vdc.

4. Using an oscilloscope, check pin 34, using pin 7 as a return, for the waveform shown in Fig. 13-60.

5. Turn off the 37.5 vdc power supply.

6. Connect one end of a 1k, 2w, 5% resistor to pin 3. Connect the other end of the 1k resistor to the positive terminal of the 37.5 vdc power supply.

7. Connect the positive terminal of the 37.5 vdc power supply to pin 22.

8. Turn on and set the dc power supply for 37.4 to 37.6 vdc.

9. Measure for 0 to 1.0 vdc between pins 3 (+) and 7 (-).

10. Using an oscilloscope, observe pin 34, using pin 7 as a return, for +35.4 to +37.6 vdc with no oscillations.

11. Turn off the 37.5 vdc power supplies.

12. Remove the connection between the 37.5 vdc power supply and pin 22.

13. Turn on and set the dc power supply for 37.4 to 37.6 vdc.

14. Using an oscilloscope, observe pin 34, using pin 7 as a return for the waveform shown in Fig. 13-60.

15. Turn off the 37.5 vdc power supply.

16. Repeat Steps 7 through 15, substituting pin 18 for pin 22.

17. Repeat Steps 7 through 15, substituting pin 24 for pin 22.

18. Insure the +37.5 vdc power supply is turned off, and remove all test equipment from the FD602 card.

#### FD713 Card Operational Check (See Fig. 13-53)

1. Connect a +37.5 vdc, 500 ma power supply to pins 4 (+) and 44 (-).

2. Turn on and set the dc power supply for 37.4 to 37.6 vdc.

3. Measure for 0 to 1.0 vdc between the following pins:

- a. 24 (+) and 44 (-)
- b. 26 (+) and 44 (-)
- c. 28 (+) and 44 (-).

4. Turn off the +37.5 vdc power supply.

5. Connect the positive terminal of the +37.5 vdc power supply to pins 16, 32 and 42. Insure the 37.5 vdc power supply is also connected to pins 4 (+) and 44 (-).

6. Turn on and set the dc power supply for 37.4 to 37.6 vdc.

7. Measure for 0 to 0.5 vdc between pins 24 (+) and 44 (-).

8. Remove the +37.5 vdc connection from pin 16.

9. Measure for 30.9 to 32.3 vdc between pins 24 (+) and 44 (-).

10. Remove the +37.5 vdc connection from pin 42.

11. Measure for 30.9 to 32.3 vdc between pins 24 (+) and 44 (-).

12. Remove the +37.5 vdc connection from pin 32.

13. Measure for 0 to 0.5 vdc between pins 24 (+) and 44 (-).

14. Apply +37.5 vdc to pin 12.

15. Measure for 0 to 1.0 vdc between pins 26 (+) and 44 (-).

16. Apply +37.5 vdc to pin 32.

17. Measure for 31.7 to 33.7 vdc between pins 26 (+) and 44 (-).

18. Measure for 29.7 to 31.7 vdc between pins 28 (+) and 44 (-).

19. Remove the +37.5 vdc from pin 12.

20. Measure for 0 to 1.0 vdc between pins 26 (+) and 44 (-).

21. Measure for 0 to 1.0 vdc between pins 28 (+) and 44 (-).

22. Connect a jumper wire between pins 8 and 44.

23. Measure for 30.0 to 31.4 vdc between test point TP4 (+) and pin 44 (-).

24. Measure for 25.1 to 27.1 vdc between pins 26 (+) and 44 (-).

25. Measure for 23.1 to 25.1 vdc between pins 28 (+) and 44 (-).

26. Remove the +37.5 vdc from pin 32.

27. Measure for 0 to 1.0 vdc between pins 26 (+) and 44 (-).

28. Measure for 0 to 1.0 vdc between pins 28 (+) and 44 (-).

29. Turn off the +37.5 vdc power supply and remove all test equipment from the FD713 card.

#### **FD715 Card Operational Check (See Fig. 13-54)**

1. Connect a 37.5 vdc, 500 ma power supply to pins 30 (+) and 44 (-).

2. Turn on and set the dc power supply for 37.4 to 37.6 vdc.

3. Measure for 0 to 0.1 vdc between the following pins:

- a. 20 (+) and 44 (-)
- b. 22 (+) and 44 (-)
- c. 24 (+) and 44 (-)
- d. 26 (+) and 44 (-).

4. Apply +37.5 vdc to pin 34, using pin 44 as a return.

5. Measure for 35.5 to 37.0 vdc between the following pins:

- a. 22 (+) and 44 (-)
- b. 24 (+) and 44 (-)
- c. 26 (+) and 44 (-).

6. Measure for 0 to 1.0 vdc between pins 20 (+) and 44 (-).

**HEAVY MAINTENANCE INSTRUCTIONS,  
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7. Apply +37.5 vdc to pin 38 using pin 44 as a return.
8. Measure for 0 to 0.1 vdc between the following pins:
  - a. 20 (+) and 44 (-)
  - b. 22 (+) and 44 (-)
  - c. 24 (+) and 44 (-)
  - d. 26 (+) and 44 (-).
9. Remove the +37.5 vdc from pin 38.
10. Measure for 35.5 to 37.0 vdc between the following pins:
  - a. 22 (+) and 44 (-)
  - b. 24 (+) and 44 (-)
  - c. 26 (+) and 44 (-).
11. Turn off the +37.5 vdc power supply, and disconnect all test equipment from the FD715 card.
12. Measure one end of a 400 ohm, 3w, 5% resistor to pin 4.
13. Connect one end of a 28 v, 40 ma indicator lamp to the free end of the 400 ohm resistor.
14. Connect the free end of the 28 v, 40 ma indicator lamp to the positive terminal of a 37.5 vdc power supply.
15. Connect the negative terminal of the 37.5 vdc power supply to pin 12.
16. Connect a 24 to 45 vdc, 100 ma power supply to pins 14 (+) and 12 (-).
17. Turn on and set the 37.5 vdc power supply connected to the indicator lamp for 37.4 to 37.6 vdc.
18. Insure the indicator lamp is not illuminated.
19. Turn on and set the 24-45 vdc power supply connected to pins 14 (+) and 12 (-) for 23.9 to 24.1 vdc.
20. Insure the indicator lamp is illuminated.
21. Turn off the 24-45 vdc power supply connected to pins 14 (+) and 12 (-).
22. Insure the indicator lamp remains illuminated.
23. Turn off the 37.5 vdc power supply connected to the indicator lamp for approximately 1 second, then turn back on.
24. Insure the indicator lamp in NOT illuminated.
25. Turn off the 37.5 vdc power supply connected to the indicator lamp, and insure the 24-45 vdc power supply connected to pins 14 (+) and 12 (-) is also turned off.
26. Connect a 10 ohm, 1/2w, 5% resistor between pins 10 and 12.
27. Turn on and set the 37.5 vdc power supply connected to the indicator lamp for 37.4 to 37.6 vdc.
28. Turn on and set the 24-45 vdc power supply connected to pins 14 (+) and 12 (-) for 44.9 to 45.1 vdc.
29. Insure the indicator lamp is NOT illuminated.
30. Turn off both dc power supplies.
31. Remove the 10 ohm, 1/2w, 5% resistor from pins 10 and 12.
32. Repeat Steps 17 through 24.
33. Turn off the +37.5 vdc power supply connected to the indicator lamp and insure the 24-45 vdc power supply connected to pins 14 (+) and 12 (-) is also turned off.
34. Remove all test equipment from the FD715 card.

**FD716 Card Operational Check (See Fig. 13-55)**

1. Connect a 220 ohm, 5w, 5% resistor between pins 24 and 26.
2. Connect one end of a 400 ohm, 3w, 5% resistor to pin 22.
3. Connect the free end of the 400 ohm, 3w, 5% resistor to one end of a 28 v, 40 ma indicator lamp.
4. Connect the free end of the 28 v, 40 ma indicator lamp to the positive terminal of a 37.5 vdc, 500 ma power supply.

**HEAVY MAINTENANCE INSTRUCTIONS,  
GEK-38312 (2-13), PERFORMANCE & FAULT INDICATION ELEC. PANEL, TYPE FL134**

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5. Connect the 37.5 vdc power supply to pins 16 (+) and 44 (-).
6. Turn on and set the 37.5 vdc power supply for 37.4 to 37.6 vdc.
7. Insure the indicator lamp is NOT illuminated.
8. Measure 0 to 0.1 vdc between pins 26 (+) and 24 (-).
9. Apply +37.5 vdc to pin 18 using pin 44 as a return.
10. Insure the indicator lamp illuminates.
11. Measure 20.2 to 26.2 vdc between pins 26 (+) and 24 (-).
12. Remove the +37.5 vdc from pin 18.
13. Insure the indicator lamp is NOT illuminated.
14. Measure 0 to 0.1 vdc between pins 26 (+) and 24 (-).
15. Apply +37.5 vdc to pin 20, using pin 44 as a return.
16. Repeat Steps 10 through 14, substituting pin 20 for pin 18.
17. Turn off the 37.5 vdc power supply, and remove all test equipment from the FD716 card.
18. Connect a 220 ohm 5w, 5% resistor between pins 28 and 30.
19. Connect one end of a 400 ohm, 3w, 5% resistor to pin 32.
20. Connect the free end of the 400 ohm, 3w, 5% resistor to one end of the 28 v, 40 ma indicator lamp.
21. Connect the free end of the 28 v, 40 ma indicator lamp to the positive terminal of a 37.5 vdc, 500 ma power supply.
22. Connect the 37.5 vdc power supply to pins 16 (+) and 44 (-).
23. Turn on and set the 37.5 vdc power supply for 37.4 to 37.6 vdc.
24. Insure the indicator lamp is NOT illuminated.
25. Measure 0 to 0.1 vdc between pins 28 (+) and 30 (-).
26. Apply +37.5 vdc to pin 34, using pin 44 as a return.
27. Insure the indicator lamp illuminates.
28. Measure 20.2 to 26.2 vdc between pins 28 (+) and 30 (-).
29. Remove the +37.5 vdc from pin 34.
30. Insure the indicator lamp is NOT illuminated.
31. Measure 0 to 0.1 vdc between pins 28 (+) and 30 (-).
32. Apply +37.5 vdc to pin 20, using pin 44 as a return.
33. Repeat Steps 27 through 31, substituting pin 20 for pin 34.
34. Turn off the 37.5 vdc power supply, and remove all test equipment from the FD716 card.
35. Connect a 37.5 vdc, 100 ma power supply to pins 16 (+) and 44 (-).
36. Turn on and set the 37.5 vdc power supply for 37.4 to 37.6 vdc.
37. Measure 36.0 to 37.5 vdc between pins 36 (+) and 44 (-).
38. Apply +37.5 vdc to pin 38, using pin 44 as a return.
39. Measure 0 to 0.5 vdc between pins 36 (+) and 44 (-).
40. Remove the +37.5 vdc from pin 38.
41. Measure 36.0 to 37.5 vdc between pins 36 (+) and 44 (-).
42. Measure 36.0 to 37.5 vdc between pins 40 (+) and 44 (-).
43. Apply +37.5 vdc to pin 42, using pin 44 as a return.
44. Measure 0 to 0.5 vdc between pins 40 (+) and 44 (-).
45. Remove the +37.5 vdc from pin 42.
46. Measure 36.0 to 37.5 vdc between pins 40 (+) and 44 (-).

47. Turn off the 37.5 vdc power supply, and remove all test equipment from the FD716 card.

48. Connect the negative terminal of a 37.5 vdc, 100 ma power supply to pin 14.

49. Connect one end of a 3.9k, 1w, 5% resistor to the positive terminal of the 37.5 vdc power supply.

50. Turn on and set the 37.5 vdc power supply for 37.4 to 37.6 vdc.

51. Connect the free end of the 3.9k, 1w, 5% resistor to pin 2.

52. Measure 0 to 1.0 vdc between pins 2 (+) and 14 (-).

53. Remove the connection between the 3.9k, 1w, 5% resistor and pin 2.

54. Repeat Steps 51, 52 and 53, substituting pins 4, 6, 8, 10 and 12 for pin 2.

55. Turn off the 37.5 vdc power supply, and remove all test equipment from the FD716 card.

56. Connect one end of a 3.9k, 1w, 5% resistor to pin 14.

57. Connect the positive terminal of a 37.5 vdc, 100 ma power supply to the free end of the 3.9k, 1w, 5% resistor.

58. Turn on and set the 37.5 vdc power supply for 37.4 to 37.6 vdc.

59. Connect the negative terminal of the 37.5 vdc power supply to pin 2.

60. Measure 36.0 to 37.5 vdc between pins 14 (+) and 2 (-).

61. Remove the connection from the negative terminal of the 37.5 vdc power supply to pin 2.

62. Repeat Steps 59, 60 and 61, substituting pins 4, 6, 8, 10 and 12 for pin 2.

63. Turn off the 37.5 vdc power supply and remove all test equipment from the FD716 card.

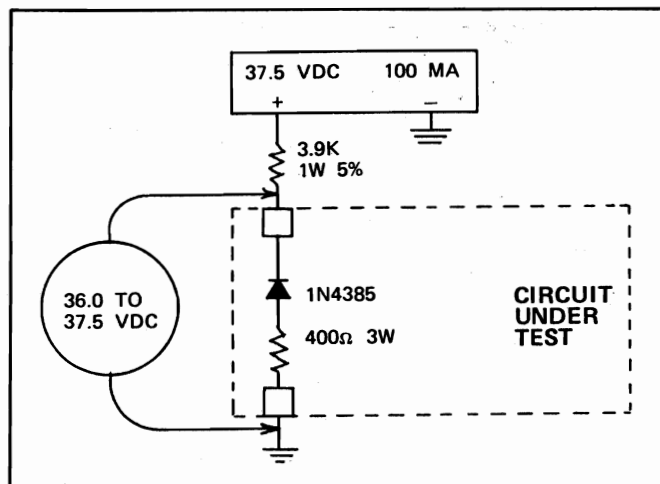


FIG. 13-61. TEST CIRCUIT NO.1 FD717 CARD. E-19648

**FD717 Card Operational Check (See Fig. 13-56)**

1. Connect test circuit No. 1, shown in Fig. 13-61, to the FD717 card.
2. Turn on and set the dc power supply for 37.4 to 37.6 vdc.
3. Measure 36.0 to 37.5 vdc between the points indicated on the Fig. 13-61 diagram.
4. Check all resistor-diode combinations on the FD717 card in the same manner as described in Steps 1, 2 and 3.
5. Turn off the dc power supply and disconnect all test equipment from the FD717 card.
6. Connect test circuit No. 2, shown in Fig. 13-62, to the FD717 card.

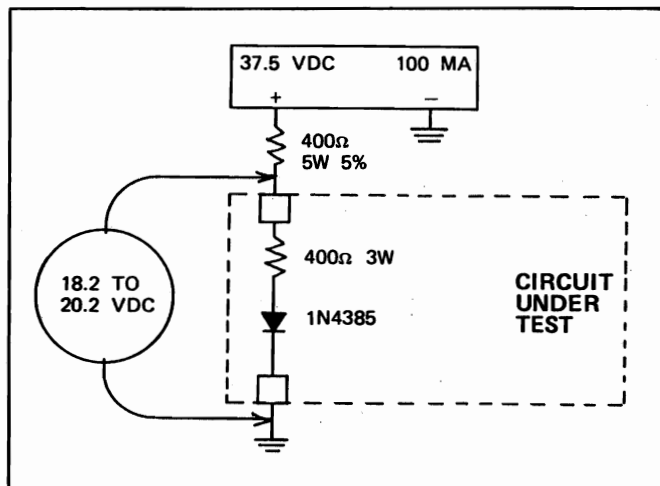


FIG. 13-62. TEST CIRCUIT NO.2 FD717 CARD. E-19649

## HEAVY MAINTENANCE INSTRUCTIONS,

### GEK-38312 (2-13), PERFORMANCE & FAULT INDICATION ELEC. PANEL, TYPE FL134

7. Turn on and set the dc power supply for 37.4 to 37.6 vdc.

8. Measure 18.2 to 20.2 vdc between the points indicated on the Fig. 13-62 diagram.

9. Check all resistor-diode combinations on the FD717 cards in the same manner as described by Steps 6, 7 and 8.

10. Turn off the dc power supply and disconnect all test equipment from the FD717 card.

13. Turn on and set the 60 Hz power supply connected to pins 24 and 26 for 19.9 to 20.1 v RMS at 59-61 Hz.

14. Measure 31.5 to 32.5 millivolts dc between pins 22 (+) and 28 (-). This value may be adjusted with potentiometer P4.

15. Turn off the 60 Hz power supply and disconnect all test equipment from the FD718 card.

16. Connect a 40 ohm, 1/8w, 1% resistor between pins 30 and 32.

#### FD718 Card Operational Check (See Fig. 13-57)

1. Connect a 40 ohm, 1/8w, 1% resistor between pins 4 and 12.

2. Connect a 20 v p-p, 10 ma, 1000 Hz square wave oscillator to pins 8 and 10.

3. Turn on and set the square wave oscillator connected to pins 8 and 10 for 19.9 to 20.1 v p-p at 999-1001 Hz.

4. Measure 23.5 to 24.5 millivolts dc between pins 4 (+) and 12 (-). This value may be adjusted with potentiometer P1.

5. Turn off the square wave oscillator and disconnect all test equipment from the FD718 card.

6. Connect a 40 ohm, 1/8w, 1% resistor between pins 14 and 20.

7. Connect a 20 v p-p, 10 ma, 1000 Hz square wave oscillator to pins 16 and 18.

8. Turn on and set the square wave oscillator connected to pins 16 and 18 for 19.9 to 20.1 v p-p at 999-1001 Hz.

9. Measure 23.5 to 24.5 millivolts dc between pins 14 (+) and 20 (-). This value may be adjusted with potentiometer P2.

10. Turn off the square wave generator and disconnect all test equipment from the FD718 card.

11. Connect a 40 ohm, 1/8w, 1% resistor between pins 22 and 28.

12. Connect a 20 v RMS, 20 ma, 60 Hz power supply to pins 24 and 26.

**WARNING:** *The circuits on this card can be energized to 230 vac. Use extreme caution when performing this check. Electrical shock can cause serious or fatal injury. Proper precautions should be observed by personnel performing this troubleshooting.*

17. Connect a 230 v RMS, 25 ma, 60 Hz power source to pins 34 and 36.

18. Turn on and set the 60 Hz power source connected to pins 34 and 36 for 229 to 231 v RMS at 59-61 Hz.

19. Measure 19.5 to 20.5 millivolts dc between pins 30 (+) and 32 (-). This value may be adjusted with potentiometer P3.

20. Turn off the 60 Hz power source, and remove all test equipment from the FD718 card.

#### FL134 Panel Components

##### Operational Check (See Fig. 13-65)

1. Insure FL134 panel terminals E-60, E-61, E-62, E-63 and E-92 are disconnected from all external circuit loads.

2. Check the capacitors on this panel by measuring the capacitance with an impedance bridge. Care should be exercised to consider parallel impedances when performing these measurements.

3. Check the D1 diode on this panel by using a 20 v p-p, 1000 Hz, sine-wave oscillator; a 1000 ohm, 1/2w, 5% resistor; and a dual trace oscilloscope. Construct the diode test circuit shown in Fig. 13-63. The waveform between points B and C shows the diode conducting in the forward direction and blocking in the reverse direction.

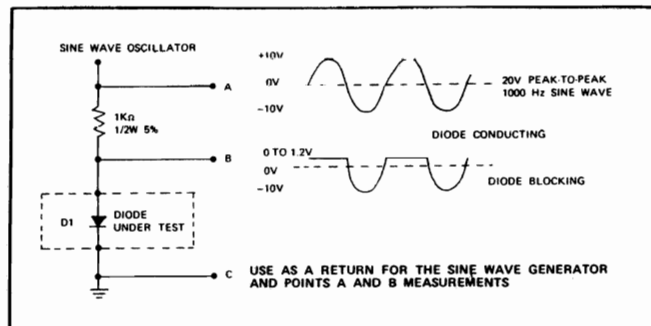


FIG. 13-63. DIODE TEST CIRCUIT. E-19825

4. Check zener diode ZD1 by using a 60 vdc, 25 ma power supply; a 3k ohm, 1w, 5% resistor; and a digital multimeter. Construct the ZD1 test circuit shown in Fig. 13-64. ZD1 should regulate at 48 to 54 vdc between its cathode (+) and anode (-).

**ASSEMBLY (See Fig. 13-58)**

1. Install the bracket (3) onto the panel (26), and torque the three sets of mounting hardware (19, 20, 21, 22) to 22-27 in.-lb.
2. Set the capacitor (16) into the bracket (3), and tighten the mounting hardware (19, 21, 22).
3. Install the inductor (15) onto the panel (26), and torque the four sets of mounting hardware to 22-27 in.-lb.
4. Install the thyrector (13) onto the bracket (3), and torque the mounting hardware (19, 20, 21) to 14-17 in.-lb.

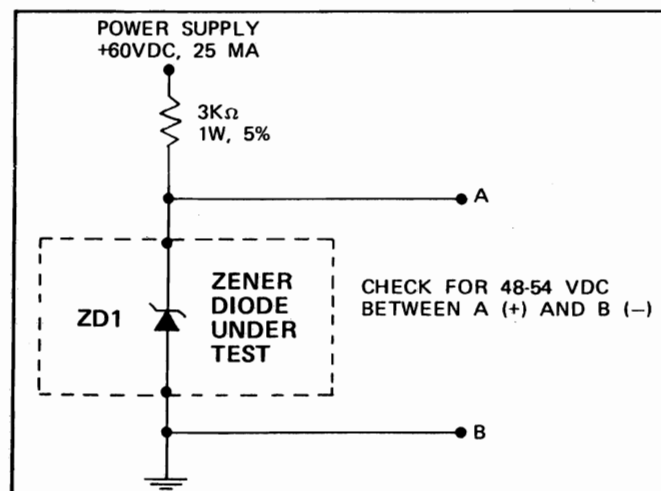


FIG. 13-64. ZENER DIODE TEST CIRCUIT.  
E-19826

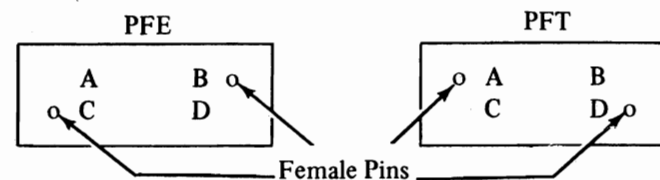
5. Install the terminal board (12) onto the P.C. board (14), and torque the two sets of mounting hardware (19, 20, 21, 22) to 22-27 in.-lb.

6. Install the P.C. board (14) onto the panel (26), and torque the two sets of mounting hardware (19, 20, 21, 22) to 22-27 in.-lb.

**NOTE:** Insure that the spacers (18) are in position.

7. Install the connector (11) onto the weldment (1), and tighten the four guide pins (25).

**NOTE:** Insert the female guide pins in the connector as shown:



8. Install the terminal block (7) and the card guide (4) onto the weldment (1). Torque the two sets of bottom mounting hardware (19, 20, 21, 22) to 22-27 in.-lb., and the two sets of top mounting hardware (20, 21, 22) to 14-17 in.-lb.

9. Wire the panel per the Interconnection Diagram, Fig. 13-65.

10. Plug the cards (27 thru 39) into their respective slots on the weldment (1). Insure the cards are fully seated in their sockets.

11. Install the covers (5, 6) onto the weldment (1), and torque the mounting hardware (19, 20, 21, 22) to 22-27 in.-lb.

12. Install the retaining bar (2) on the weldment (1) and tighten the stud (8).

**NOTE:** Insure the notches in the retaining bar engage the card handles for positive locking of the cards into the weldment.

**INSTALLATION ON THE CAR**

1. Open the Electronic Locker No. 1.
2. Lift the panel onto the mounting studs, and torque the hardware to 27-33 in.-lb.
3. Plug the car body wiring onto the connectors on the weldment. Tighten the holding screws to effect a positive connection.

**SPECIAL TOOLS**

See Table I.

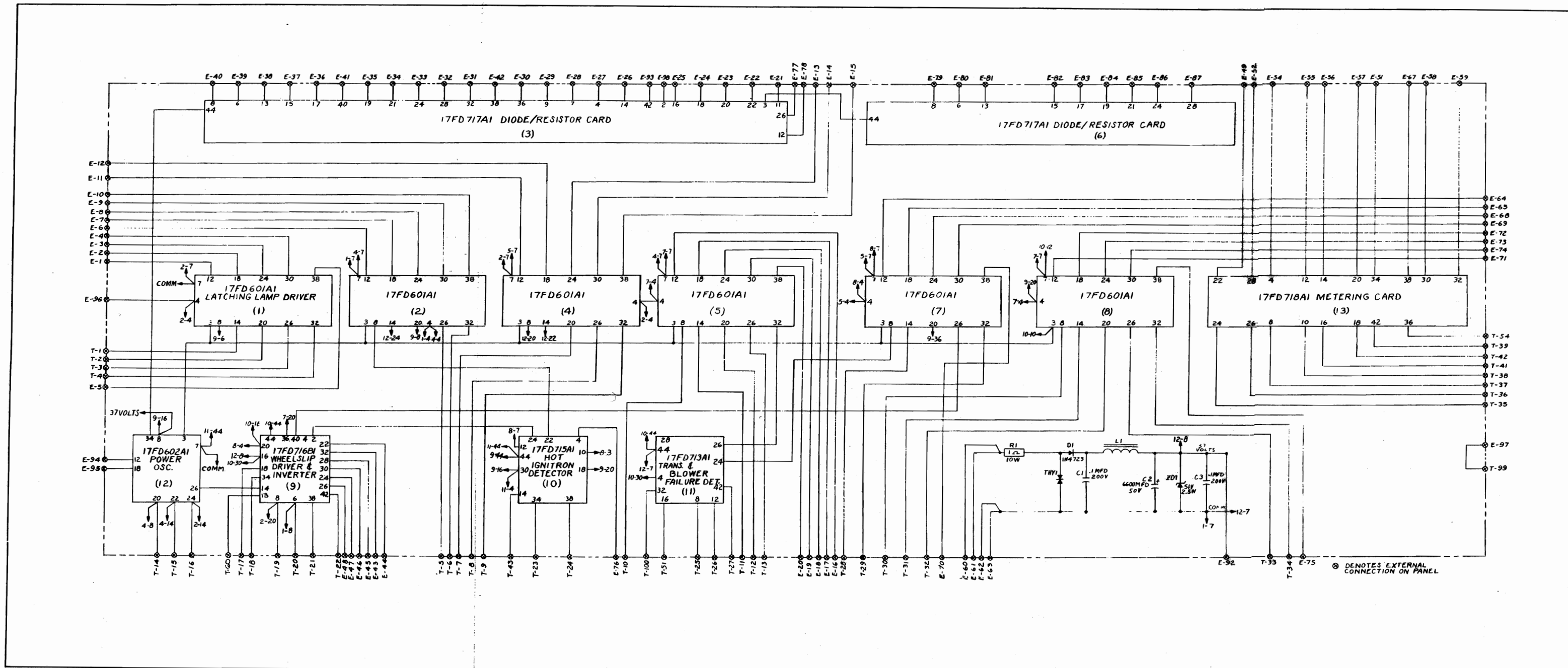


FIG. 13-65. INTERCONNECTION DIAGRAM FL134 PANEL (41R965639).