MSP Radio Comm
B3850 726-2855
Hangar 1 UPS
for Trunked
Repeater System

# LORAIN

## POWER EQUIPMENT

# INSTRUCTIONS

## INSTALLATION
## OPERATION
## MAINTENANCE

RELIANCE COMM/TEC

LORAIN MODEL WDA502B

ConstAC® UNINTERRUPTIBLE POWER SYSTEM

Spec. No. 5177-316 Serial No. 900

**WARNING**

**This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.**

**NOTE**

**For proper system operation, the external battery used for the ConstAC UPS must be grounded at the positive terminal in compliance with National Electrical Code Article 250 and/or local codes or practices. Refer to the Power Data sheet in this manual for further information.**

**April 14, 1982**

**LORAIN** PRODUCTS
Division of Reliance Electric Co.

## WARRANTY

Seller warrants that the products it manufactures or sells shall be free from defects in material and workmanship during the first 90 days after the product is activated. During said period, Seller will repair or replace any **defective** parts free of charge to Buyer, including any labor costs. In addition, Seller shall repair or replace any defective parts, so discovered by Buyer to be defective within two years from the date of shipment of same, provided Buyer promptly so notifies Seller. In no case shall Seller's liability under this warranty extend beyond two years from the date of shipment of said product. This warranty shall not apply to any products which are misused, modified, repaired, or otherwise abused by Buyer or others. The repair or replacement of defective parts, or the refund of the invoice cost thereof, as shall be determined by Seller in its sole discretion, shall be the limit of Seller's liability hereunder and shall be Buyer's sole and exclusive remedy.

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If the problem has been created by misuse or abuse of the equipment or by malfunction of associated equipment or by environmental conditions, at any time after shipment, the customer will be billed for circuit component and labor.

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# ConstAC® UNINTERRUPTIBLE POWER SYSTEM
# MODEL WDA302B; SPEC. NO. 5176-304-00
# MODEL WDA302B; SPEC. NO. 5176-306-00
# MODEL WDA502B; SPEC. NO. 5177-316-00

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## 1. INTRODUCTION

### General

1.01 The ConstAC® Uninterruptible Power System (UPS) is an automatic standby AC power system which supplies uninterrupted 60 Hz AC power to a load. Under normal operating conditions, the UPS supplies regulated AC to the load using the commercial line as a source. At the same time, an integral battery charger in the UPS maintains the customer-provided battery in a state of full charge.

1.02 In case of commercial AC power failure, the inverter in the UPS immediately provides power to the load without interruption. The inverter is powered from the battery, and supplies the load with 60 Hz sine wave power.

1.03 After restoration of commercial AC power, the system control circuits determine acceptability of the AC line for use as the load power source. When the AC line is within acceptable voltage and frequency limits, the system automatically provides regulated AC to the load using the AC Line as a source. At the same time, the battery charger in the UPS recharges the battery.

1.04 Bypass circuits are provided in the UPS so the load can be connected directly to the commercial AC line. The system performs an automatic bypass if inverter output fails. Manual bypass can be performed if maintenance to the UPS is required.

1.05 This UPS contains various alarm circuits which continuously monitor input and output voltage levels and equipment functions. If an abnormal operating condition occurs, such as a failure in the system, low battery voltage, or loss of AC input power, an alarm indication is provided.

1.06 Meters are provided which indicate battery voltage, battery charge or discharge current, and AC output voltage and current.

Accessories

1.07 A rear dress panel is available for either factory or customer installation. This panel covers exposed mounting hardware on the rear panel of the system.

## 2. INSTALLATION

### Location

2.01 This UPS should be located in a well ventilated area where the ambient air temperature range does not exceed the limits of 0° to 50° C (32° to 122° F). Insure that unrestricted air flow is provided at the front and top of the cabinet.

### Wiring

2.02 Refer to the Power Data Sheet for wire sizes and installer connections. All external wiring, including input, output, and interconnecting wiring between the system and remote status panel is supplied by the customer.

2.03 The external battery used as the DC source for this UPS should be dedicated to that use only with no other DC loads connected. Additionally, only one ConstAC UPS should be connected to any Particular battery.

2.04 If the battery used for this UPS is normally charged by an external rectifier, such as in a central office the charging output of this UPS should be disabled by installation of Charge Eliminate Option (D). Observe the foliowing procedure:

a) Connect a 16 ga. jumper wire to TB4, terminals 8 and 9.

b) Refer to paragraph 3.05, and perform System Startup procedure.

c) Locate the current limit adjustment potentiometer, R46, on the control circuit card mounted on the inside of the system door. R46 is the bottom-most potentiometer at the edge of the circuit card.

d) Monitor battery charging current at the UPS meter panel or use a clamp-on ammeter or current probe around one of the battery leads in the UPS.

e) Adjust potentiometer R46 counterclockwise until the system charging circuits deliver no output current to the battery.

Installation of Option (D) is now complete. The external battery is charged by its dedicated rectifier, and the battery charging circuit in the UPS will not provide any output current.

### External Alarms and Control

2.05 Terminals 1 through 7 of TB4 provide alarm outputs and a means for connecting a remote float/equalize switch. The alarm outputs at terminals I through 5 are extended relay contacts rated at 1.0 ampere, 30 VDC or 120 VAC. A toggle switch or other type of the customer's choice, rated at 3 amperes, 120 VAC, may be connected at terminals 6 and 7 if control of the float and equalize functions is desired at a remote location. Further descriptions of the alarm and control functions follow.

2.06 Charge/Discharge Alarm. One set of relay contacts is available at TB4, terminals I and 2, to operate an external charge/discharge alarm provided by the system user. An open circuit is available when the system is charging the battery. A closed circuit is available when the battery is discharging to provide the inverter with input power.

2.07 Bypass/Inverter Alarm. A set of relay contacts is available at TB4, terminals 3 through 5, to operate an external bypass/inverter alarm provided by the system user. When system bypass circuits are activated, supplying the load directly from the bypass line, an open circuit is present at terminals 3 to 4 and a closed circuit is present at terminals 4 to 5. When system output supplies the load through the AC regulator, using commercial AC input or the inverter as the main AC source, a closed circuit is present at terminals 3 to 4 and an open circuit is present at terminals 4 to 5.

2.08 Remote Float/Equalize Control. Connecting a SPST switch to TB4, terminals 6 and 7, allows the system user to control battery float and equalize functions from a remote location. With the FLOAT/EQUALIZE switch on the system front panel set to the EQUALIZE position, the battery may be charged at equalize voltage by opening the external switch. Closing the external switch provides float voltage to the battery.

## 3. OPERATION

### General

3.01 Under normal conditions with acceptable AC and DC inputs, operation of the UPS is automatic after starting the system and setting all controls to the desired positions. Normally, the commercial AC line supplies the load through a filter and regulator circuit while the battery charger in the UPS float charges an external 24-cell battery. If the AC line fails or voltage or frequency exceeds preset limits, the system inverter automatically provides load power. The source transfer occurs with no break in power.

3.02 Provisions have been made in this system so a bypass circuit can be activated to supply load power while the UPS regulator and inverter circuits are turned off. A synchronous transfer of load power occurs when the bypass circuit is activated.

### Controls and Indicators

3.03 The following controls and indicators are accessible at the front of the UPS for convenient system operation.

a) DC INPUT Switch: DC input power to the inverter can be applied or removed through use of this switch.

b) Mode Selection Switch: This four position rotary switch allows selection of UPS operating mode. The switch positions and modes of system operation are explained as follows:

1) BYPASS SUPPLYING LOAD

a. INVERTER OFF: AC line power is connected to the load through a bypass contactor. All other major circuits are turned off.

b. INVERTER ON: AC line power is connected to the load through a bypass contactor. Inverter and regulator circuits are operating but not supplying load power. The battery charging circuit in the UPS provides charging current to the external battery.

2) REGULATOR SUPPLYING LOAD

a. AUTOMATIC: When the AC line is within acceptable voltage and frequency limits, the static switch connects line power to the AC regulator circuit. Filtered, regulated AC is supplied to the load while the battery charging circuit charges the external battery. The inverter operates in a standby mode, ready to provide load power if the AC line becomes an unacceptable power source.

b. INVERTER ON: The inverter supplies power to the load, obtaining input power from the battery.

c) FLOAT/EQUALIZE Switch: This rocker switch is located on the front panel of the UPS, and allows selection of either float or equalize voltage applied to the battery.

d) Switches S2 and S3: These switches are located on a panel at the right side of the cabinet, behind the front door. Switch S2 connects commercial AC power to the bypass circuit, and S3 connects power to the static switch.

e) Switch S5: This rocker switch is located on the front access door and permits the charging of the input filter capacitors.

f) FLOAT ADJ/EQUALIZE ADJ Potentiometers: These controls are accessible through the front panel, and are located immediately above the FLOAT/EQUALIZE switch. The settings of these potentiometers determine the float and equalize voltages applied to the battery.

g) A number of light emitting diodes (LED's) indicate the status of various inputs, outputs, and portions of the system circuitry. An explanation of each indicator follows:

1) AC LINE NORMAL: This green indicator illuminates when the AC line is within acceptable voltage and frequency limits.

2) STATIC SWITCH CLOSED: When AC line power is applied to the regulator through the static switch, this green indicator illuminates.

3) BYPASS CLOSED: If AC line power is applied to the load through the bypass line, this red indicator illuminates.

4) REGULATOR Output CLOSED: This green indicator illuminates during normal system operation when regulated AC power is available to the load.

5) POWER ON: During normal system operation or if the bypass line is closed, this green indicator illuminates to signify that AC output power is applied to the load.

6) INVERTER/CHARGER ALARM: This red indicator illuminates if a failure occurs in either the inverter or charger circuits of the system.

7) DS1: Illuminates to indicate state of charge during startup procedure.

8) BATTERY Status

a. CHARGE: When the system battery charger supplies current to the battery, or the battery is not discharging during normal system operation, this green indicator illuminates.

b. DISCHARGE: This red indicator illuminates whenever the battery begins discharging for any reason. Usually, battery discharge occurs when the system inverter supplies load power.

c. LOW VOLTAGE SHUTDOWN: This red indicator illuminates if system shutdown occurs after an extended discharge period depletes battery reserve.

3.04 Metering: Meters are provided on the UPS front panel to indicate battery and AC output status. If provided, the meters indicate voltages and currents as follows:

a) BATTERY Status

1) DC VOLTS: This meter indicates battery voltage.

2) DC AMPS: This meter indicates charge and discharge current supplied-to or demanded from the battery, respectively.

b) LOAD Status

1) AC VOLTS: This meter indicates AC output voltage applied to the load.

2) AC AMPS: This meter indicates AC output current drawn by the load.

## System Startup

3.05 Observe the following procedure when starting the UPS, either initially or subsequent to any shutdown.

a) Place DC input switch to the OFF position.

b) Insure that AC and DC inputs are applied to the UPS.

c) Place the mode switch to position BYPASS SUPPLYING LOAD-INVERTER OFF.

DANGER

Hazardous AC voltages capable of producing severe, perhaps fatal electrical shock are present at system components throughout the cabinet. When performing the next step, exercise caution that contact is not made with any exposed electrical termination.

d) Loosen three retaining screws, and open the front door of the system cabinet. Locate switches S2 and S3, and place both switches to the ON position.

e) Close the front door and tighten three retaining screws. If commercial AC power is applied to the system input, power is now available to the load through system bypass circuits.

f) Depress and hold switch S5 located on the front access door to the CAP CHARGE position.

NOTE

DS1 illuminates brightly initially, then slowly dims as the input filter capacitors charge. Hold switch S5 in the CAP CHARGE position until DS1 becomes dim or nearly extinguished, then proceed to the following steps.

g) Release switch S5 and immediately place the DC input switch to the on position.

CAUTION

When operating mode Switch S4, wait five seconds before proceeding to the next switch position to allow operation of the UPS to stabilize. Failure to observe this procedure may result in damage to the UPS.

h) Place the mode switch to position REGULATOR SUPPLYING LOAD-AUTOMATIC. Initially, the inverter circuit operates from battery power as evidenced by illumination of the BATTERY DISCHARGE indicator. After a one minute time delay, the system automatically switches to the AC line as the main source if 'the commercial AC line is within acceptable voltage and frequency limits and begin charging the battery.

i) Approximately three minutes after inverter circuit start-up, the load will be sychronously transfers from bypass input power to a regulated, filtered output power as indicated by the illumination of the green REGULATOR OUTPUT CLOSED L.E.D. indicator.

j) After the UPS accepts the AC line as the main power source and begins sup plying regulated, filtered output to the load, check all status indicators on the system front panel. All green indicators should be illuminated, and all red indicators should be extinguished. Any red indicators illuminated show an alarm condition which should be investigated and corrected. If necessary, refer to the Troubleshooting section of these instructions.

System Shutdown

3.06 System shutdown should be accomplished only when necessary; for example, if maintenance is required or if prolonged AC power failure has depleted battery reserve. Under normal conditions, the UPS should remain in operation after startup, regardless of load requirements for power. The operational features designed into the UPS make it unnecessary to start and stop the system on a daily basis. Should a system shutdown become necessary, observe the following procedure. Perform Steps a) through c) only if UPS shutdown is necessary following total commercial AC power failure with subsequent battery reserve depletion. Perform Steps a) through c) if complete system shutdown with removal of all power is desired.

CAUTION

When operating mode Switch S4, wait five seconds before proceeding to the next switch position to allow operation of the UPS to stabilize. Failure to observe this procedure may result in damage to the UPS.

a) If the mode switch is in either of the REGULATOR SUPPLYING LOAD positions, place the mode switch to the BYPASS SUPPLYING LOAD-INVERTER ON position.

b) Place the mode switch to position BYPASS SUPPLYING LOAD-INVERTER OFF. If commercial AC Power is still applied to the input of the UPS, power is available to the load through the system bypass circuit.

c) Place the DC INPUT switch to the OFF position.

DANCER

Although the inverter, regulator, and battery charger circuits are not operating, AC power may still be applied to the system input. If so, AC voltages capable of producing severe, perhaps fatal electrical shock are still present at various system components.

d) If the load is turned off or can otherwise tolerate complete loss of AC power, the UPS should be totally deenergized before performing any maintenance within the system cabinet. Perform the following steps:

1) Loosen three retaining screws, and open the front door of the system cabinet. Locate switches S2 and S3.

2) Place both switches to the OFF position.

3) Open the external AC and DC disconnect devices to remove all power from the UPS.

e) System shutdown is now complete.

## Manual Load Transfer

3.07 Under normal conditions, the system operator can choose one of two power sources for the load; namely, the commercial AC line used directly, or the regulated AC output of the system using the AC line or inverter as the primary source. Usually, the regulated AC output of the system is used for load power while the, UPS operates in the AUTOMATIC mode. If necessary, a synchronous transfer between power sources without a break in power supplied to the load can be accomplished under the following conditions:

a) The following indicators should be illuminated or extinguished as specified:

1) AC LINE NORMAL: illuminated or extinguished

2) POWER ON: illuminated

3) INVERTER/CHARGER ALARM: extinguished

4) BATTERY CHARGE: either illuminated or extinguished.

5) BATTERY DISCHARGE: either illuminated or extinguished

6) LOW VOLTAGE SHUTDOWN: extinguished

**NOTE**

The state of the BATTERY CHARGE and DISCHARGE indicators depends on the mode of system operation prior to load transfer; however, if the BATTERY DISCHARGE indicator has been illuminated for an extended period of time, transfer to inverter output should not be attempted.

b) Check the indicated value on the DC VOLTS meter. Battery voltage must be greater than 42 VDC before performing a load transfer since the inverter supplies load power momentarily. This step may be disregarded if the BATTERY CHARGE indicator is illuminated.

c) If system indicators meet the conditions in Step a) and other system operating conditions are present as mentioned, place the mode switch to the desired location under BYPASS SUPPLYING LOAD or REGULATOR SUPPLYING LOAD.

**CAUTION**

When operating mode Switch S4, wait five seconds before proceeding to the next switch position to allow operation of the UPS to stabilize. Failure to observe this procedure may result in damage to the UPS.

d) The system transfers to the selected power source automatically after the mode switch is rotated to the desired position.

**CAUTION**

If the inverter is selected as the main power source (REGULATOR SUPPLYING LOAD-INVERTER ON) but the battery is not charged from an external dedicated rectifier, the UPS will operate until battery reserve is depleted and the low voltage shutdown is activated. The inverter may be used as the primary power source, but battery charge must be maintained for prolonged operation in this mode.

## Automatic Shutdown

3.08 The UPS is protected against excessive DC input current by a low voltage shutdown circuit which disables inverrer operation when battery voltage decreases to 42 VDC. Battery voltage can decrease to this level following prolonged commercial AC failure or if the system battery charger circuits fail for any reason. The system may be restored to normal operation following a low voltage shutdown according to the following procedure:

a) Insure that the battery charging circuit in the UPS is functional and that the commercial AC line is within normal limits. Check the DC INPUT switch to insure it is placed in the ON position. If not see Section 3.05.

CAUTION

When operating mode Switch S4, wait five seconds before proceeding to the next switch position to allow operation of the UPS to stabilize. Failure to observe this procedure may result in damage to the UPS.

b) Place the mode switch to position BY-PASS SUPPLYING LOAD-INVERTER ON. Power is available to the load through the bypass circuit.

c) The battery charging circuit recharges the battery in this mode of operation. The battery is fully recharged from a low voltage condition in approximately 2-1/2 hours when a 30-minute reserve battery is used.

Fuse Types and Sizes

3.09 The following tables list the types and ratings of fuses used in the UPS. If replacement becomes necessary, use only the same type and size as listed, or equivalent, for proper equipment protection. In addition to the equipment fuses listed in Tables 3-1 and 3-2, the AC and DC inputs should be fused in accordance with the recommendations in the Power Data sheet.

| Ref. Desig. | Type | Size (Amps) |
|---|---|---|
| F1, F2, F5 | Bussmann AGC3 | 3 |
| F3 | EON 100 | 100 |
| F4 | Gould-Shawmut A50P150 | 150 |
| F6 | Bussmann MDL2 | 2 |
| F7, F8, F9 | Bussmann AGC 1 | 1 |

Table 3-1. WDA302B Fuse Type and Sizes

| Ref. Desig. | Type | Size (Amps) |
|---|---|---|
| F1, F2, F5 | Bussmann ACC3 | 3 |
| F3 | Bussmann NON 150 | 150 |
| F4 | Could-Shawmut A50P300 | 300 |
| F6 | Bussmann MDL2 | 2 |
| F7, F8, F9 | Bussmann ACC 1 | 1 |

Table 3-2. WDA502B Fuse Types and Sizes

## 4. ADJUSTMENTS

### General

4.01 Various control potentiometers are mounted on the main control circuit card in this UPS: however, only the float and equalize voltage adjustment potentiometers are made accessible for user adjustment. Procedures for adjusting the float and equalize voltage levels are given in this section of the manual, and only these adjustments should be attempted by the user. Do not attempt to perform any adjustments not described in this section. Disturbing the settings of any internal factory-adjusted potentiometers will result in degraded system performance or complete system failure. The float and equalize voltage controls are accessible through the front panel, and are located near the FLOAT/EQUALIZE switch. The equipment required for adjustment is listed as follows:

| Test Equipment | Description |
| --- | --- |
| Digital Voltmeter | Fluke Model 8022A or equivalent |
| Insulated Screwdriver or alignment tool | CC Electronics Type 8728A or equivalent |

DANGER

Voltage adjustments are performed while the system is operating. Hazardous voltages capable of producing severe, perhaps fatal electrical shock are present at all components during system operation. Exercise caution that contact is not made with any electrical termination, especially when connecting meter test probes.

Remove watches, rings, and other jewelry before connecting test instruments and making adjustments.

To further avoid the possibility of electrical shock, use only an insulated screwdriver or the alignment tool recommended in the test equipment list when adjusting voltage control potentiometers.

4.02 The following conditions must be satisfied before float and equalize voltage levels can be adjusted.

a) Commercial AC power must be present and within normal limits. Indicator AC LINE NORMAL should be illuminated.

CAUTION

When operating mode Switch S4, wait five seconds before proceeding to the next switch position to allow operation of the UPS to stabilize. Failure to observe this procedure may result in damage to the UPS.

b) The mode switch must be set to one of two positions, either BYPASS SUPPLYING LOAD-INVERTER ON or REGULATOR SUPPLYING LOAD-AUTOMATIC.

c) Option (D) must not be installed. Insure that no jumper wire is connected at TB4, terminals 8 and 9.

NOTE

If Option (D) is installed, disregard the float and equalize voltage adjustment procedure. Installation of this option disables the system battery charger circuits when an external, dedicated rectifier is used to charge the UPS battery.

4.03 Float Voltage Adjustment

a) Loosen three retaining screws, and open the front door of the cabinet.

DANGER

Hazardous voltages are present at all components of the system. Exercise caution that contact is not made with any electrical termination, especially in the next step.

b) Adjust the voltmeter or multimeter to indicate DC voltage within the range of 50 to 60 volts. Connect the meter test leads to the positive and negative terminals of switch S1. Observe correct polarity.

c) Place the FLOAT/EQUALIZE switch on the UPS front panel to the FLOAT position. If a remote FLOAT/EQUALIZE switch is connected to the UPS at TB4, terminals 6 and 7, insure it is placed to the open (EQUALIZE) position. The remote switch must remain in this position during the entire adjustment procedure.

d) While observing the multimeter indication, adjust potentiometer FLOAT AD3 for the proper float output voltage, as listed in Table 4-l.

WARNING

The voltages listed in Table 4-l are those required for 24-cell standard lead-acid batteries only. If a different type of battery is used for the UPS, refer to battery manufacturer's charging data before adjusting float voltage. Incorrect charging voltage can either destroy a battery or result in insufficient reserve.

| Battery Type | Volts per Cell | Total Float Voltage (24-cells) |
|---|---|---|
| Standard Lead-Acid | 2.17 | 52.08V |

Table 4-l. Typical Float Voltages

e) After setting the float output voltage, proceed with the equalize voltage adjustment procedure which follows.

4.04 Equalize Voltage Adjustment

a) Check, and if necessary, adjust the float output voltage as outlined in paragraph 4.03

b) Place the FLOAT/EQUALIZE switch on the UPS front panel to the EQUALIZE position.

c) While observing the multimeter indication, adjust potentiometer EQUALIZE AD3 for the proper equalize output voltage, as listed in Table 4-2.

WARNING

The voltages listed in Table 4-2 are those required for. 24-cell standard lead-acid batteries only. If a different type of battery is used for the UPS, refer to battery manufacturer's charging data before adjusting equalize voltage. Incorrect charging voltage can either destroy a battery or result in insufficient reserve.

| Battery Type | Volts per Cell | Total Equalize Voltage (24-cells) |
|---|---|---|
| Standard Lead-Acid | 2.35 | 56.40V |

Table 4-2. Typical Equalize Voltages

d) After setting the equalize output voltage, return the FLOAT/EQUALIZE switch to the FLOAT position. Check for proper float voltage.

e) Disconnect the meter test leads.

f) Close the UPS front door, then tighten three retaining screws.

4.05 Low Voltage Shutdown Adjustment Procedure: Perform the following procedure to verify that the UPS shuts down if the DC input voltage drops to a value within the range of 41.9 to 41.5 volts DC. If necessary potentiometer R85 may be adjusted to assure the proper low voltage shutdown point.

DANGER

Hazardous AC and DC voltages capable of producing severe, perhaps fatal electrical shock are present at system components throughout the cabinet. When performing the following procedure exercise extreme caution that contact is not made with any energized electrical termination.

**CAUTION**

When operating Switch S4, wait five seconds before proceeding to the next switch position to allow the operation of the UPS to stabilize. Failure to observe this procedure may result in damage to the UPS.

**WARNING**

If this UPS is used in a power system where a low voltage disconnect is set to disconnect the DC input power at 42.0 volts DC, the UPS low voltage shutdown should be reset to approximately 43.0 volts DC. This procedure should be performed to insure that the UPS is shut down before the removal of DC input power.

a) Place the mode selector switch S4 to the INVERTER OFF BYPASS SUPPYLINC LOAD position.

b) Place the DC input Switch S1 to the OFF position.

c) Open the front access door and locate AC input fuse F9 and power supply fuse FI. Fuse F9 is located near the middle right side of the cabinet, while F1 is located near the middle left side of the cabinet.

d) Remove fuses F1 and F9 from their respective fuse holders.

**DANGER**

When performing the following step the polarity of the external power supply is critical. Insure that the connection of the positive and negative leads from the power supply is correct before turning the power supply on, otherwise permanent damage to the control circuit card will result.

e) Locate AC input switches S2 and S3 and place them to the OFF position.

f) Connect an external 0 to 52 volt DC power supply and a digital multimeter to the terminals located on the back of DC voltmeter MI. Observe the polarity indicated on the back of DC voltmeter M 1. Connect the positive lead from the power supply to the terminal labeled (+) and the negative lead of the power supply to the unlabeled terminal on M 1.

g) Turn ON the external DC power supply and adjust the power supply until the DMM indicates 52.0 volts DC.

h) Place the DC input circuit breaker CB1 to the ON position.

i) Place the mode selector switch S4 to the BYPASS SUPPLYING LOAD INVERTER ON position, the UPS should start.

j) Lower the DC voltage from the external power supply until the UPS shuts down and DS7 (Low Voltage Shutdown LED) illuminates.

k) Observe the voltage indicated on the DMM, the voltage indicated should be in the range of 41.5 to 41.9 volts DC. If the voltage indicated on the DMM is not within this range, place the selector switch S4 to the BYPASS SUPPLYING LOAD INVERTER OFF position until DS7 extinguishes.

l) Increase the power supply voltage and place S4 to the BYPASS SUPPLYING LOAD INVERTER ON position. Decrease the voltage from the power supply to the desired level. Adjust potentiometer R85 until the UPS shuts down and DS7 illuminates. Repeat Steps h) through k) as necessary until the UPS shuts down at the desired level.

m) Place switch S4 to the BYPASS SUPPLYING LOAD INVERTER OFF position. Place the DC input circuit breaker CB1 to the off position.

n) Remove the power supply from the back of voltmeter M 1.

o) Replace the fuses removed in Step d), into their respective fuse holders and place switches S2 and S3 to the ON position.

p) Close the front access door, and perform the start-up procedure detailed in Paragraph 3.05, the UPS may now be returned to service.

## 5. CIRCUIT DESCRIPTION

### General

5.01 The ConstAC Uninterruptible Power System contains inverter , battery charger, AC regulator, static switch, and bypass circuits as well as necessary control and alarm circuits. A selector switch mounted on the system front panel and connected to the main control circuits determines the mode of UPS operation, depending on the position chosen by the operator. Unless otherwise specified, this circuit description is presented under the assumption that the system is supplying power to the load in the AUTOMATIC mode.

### Power Circuits

5.02 The power handling Circuits of the UPS are interrelated during normal operation to the extent that the AC line provides power to the load while serving as a source for the battery charging circuits. Simultaneously, the AC regulator insures that regulated, filtered AC is..applied to the load while the inverter circuit operates .in a., standby mode. A breakdown of circuit operation follows.

5.03 Static Switch. The static switch, shown in simplified form in Figure 5-1, consists basically of two silicon controlled rectifiers (SCR's) connected in inverse parallel configuration. These SCR's are triggered into conduction by firing pulses from the gate driver circuits so conduction occurs during alternate half cycles of the AC line, thereby applying the complete sine wave to the AC regulator. When firing pulses are not applied, the SCR's block AC input which occurs, for example, when system bypass circuits are activated. Essentially then, the static switch comprises an electronic switch that enables the application or removal of AC line power to or from the AC regulator circuit.

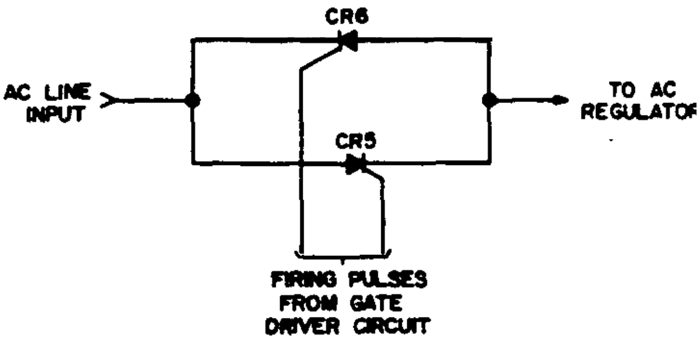



Figure 5-1
Static Switch Schematic Diagram

5.04 AC Regulator. A simplified schematic diagram of the UPS AC regulator circuit is shown in Figure 5-2. Transformer T1 is represented as a saturable reactor, and the 1-4 winding of T1 is shown as a series inductance. Under normal conditions, commercial AC power is applied to the AC regulator circuit through the static switch and inductor L3. The regulator circuit, comprising ferroresonant transformer T1 and associated resonating capacitors, essentially forms a tank circuit resonant at 60 Hz. A substantial amount of energy circulates in the tank circuit, and a portion of this energy is used to supply the load. Circulating energy is sufficient to compensate for line voltages slightly lower or higher than nominal voltage of 117 VAC; therefore, the AC output made available to the load is relatively constant.

5.05 Under normal line voltage conditions with power demands of the load satisfied, a small amount of energy in the AC regulator is still available to charge the external battery. This energy is magnetically coupled through the I-4 winding of T1, resulting in a voltage which is rectified and applied to the battery. A DC regulator in the UPS control circuits determines the charging voltage and current applied to the battery.

5.06 Battery Charger and Inverter. A simplified schematic diagram of the battery charger and inverter circuit is shown in Figure 5-3. During normal system operation with commercial AC power applied to the AC regulator circuit, a portion of the energy available in the resonant tank circuit is magnetically coupled to the I-4 windings of T1. The resultant voltage induced on this winding is rectified by diodes CR5 and CR8. This DC voltage is applied to the battery through a DC filter circuit. Positive battery return connects to the center tap of the I-4 winding of Tl.

5.07 The inverter circuit of the UPS operates continuously and in synchronism with the commercial AC line frequency. The inverter circuit does not supply power to the load when the AC line is used as the primary source. Upon AC line failure or the occurrence of an out of limits condition, the inverter automatically supplies power to the load through the AC regulator. The inverter operates in the following manner: gating pulses generated in the control and gate driver circuits are applied to one SCR, for example, CR7. This SCR switches from a blocking state to conducting state, allowing current to flow through the 3-4 winding of T1, thereby generating the first half cycle of a square wave. At the same time, the commutating capacitor charges to a voltage level of approximately twice battery voltage.

5.08 At the proper time, gating pulses are applied to CR6, switching it from a blocking state to a conducting state. With both SCR's conducting simultaneously, the commutating capacitor discharges then recharges to a voltage level approximately twice that of battery voltage, but of opposite polarity of the previous charge. The commutating capacitor, diode CR8, and inductor L2 form a resonant circuit which generates a commutating pulse of short duration. This pulse reverse biases CR7 which reverts to a blocking state.

5.09 With CR6 still conducting, current flows through the 1-2 winding of Tl, thereby generating the second half cycle of a square wave. The alternate conduction of CR6 and CR7 under direction of the control circuits occurs 60 times per second which generates the 60 Hz square wave impressed on the I-4 winding of T 1.

5.10 Ferroresonant transformer T1 in the AC regulator circuit converts the square wave generated by the inverter into a sine wave of low harmonic distortion. The inherent magnetic characteristics of T1 protect the UPS from faults and short circuits at the output. Furthermore, transformer T1 isolates the DC inverter circuitry from the AC output circuits and supplies the correct output voltage to the load.

## Control Circuits

5.11 The major portion of the system control circuits is contained on circuit card Al. Major subcircuits of Al include the phase detector, VCO, pulse generator and amplifiers, AC sense and debounce, battery charger regulator, bypass control, low voltage shutdown, and alarm circuits. The overall operation of each foregoing circuit is explained in the following text.

5.12 Phase Detector. This circuit detects the phase relationship of the commercial AC line. and inverter AC output, and controls system phase relationships and inverter frequency during the various modes of operation. An AC line reference signal, derived from the secondary winding of T2, is applied to squaring amplifier A 1G 3. Resistor R1 and capacitor C2 shift the phase of the applied signal by 75 degrees. Inverter AC is applied to squaring amplifier A1G2 after being phase shifted 165 degrees by R6, R30,

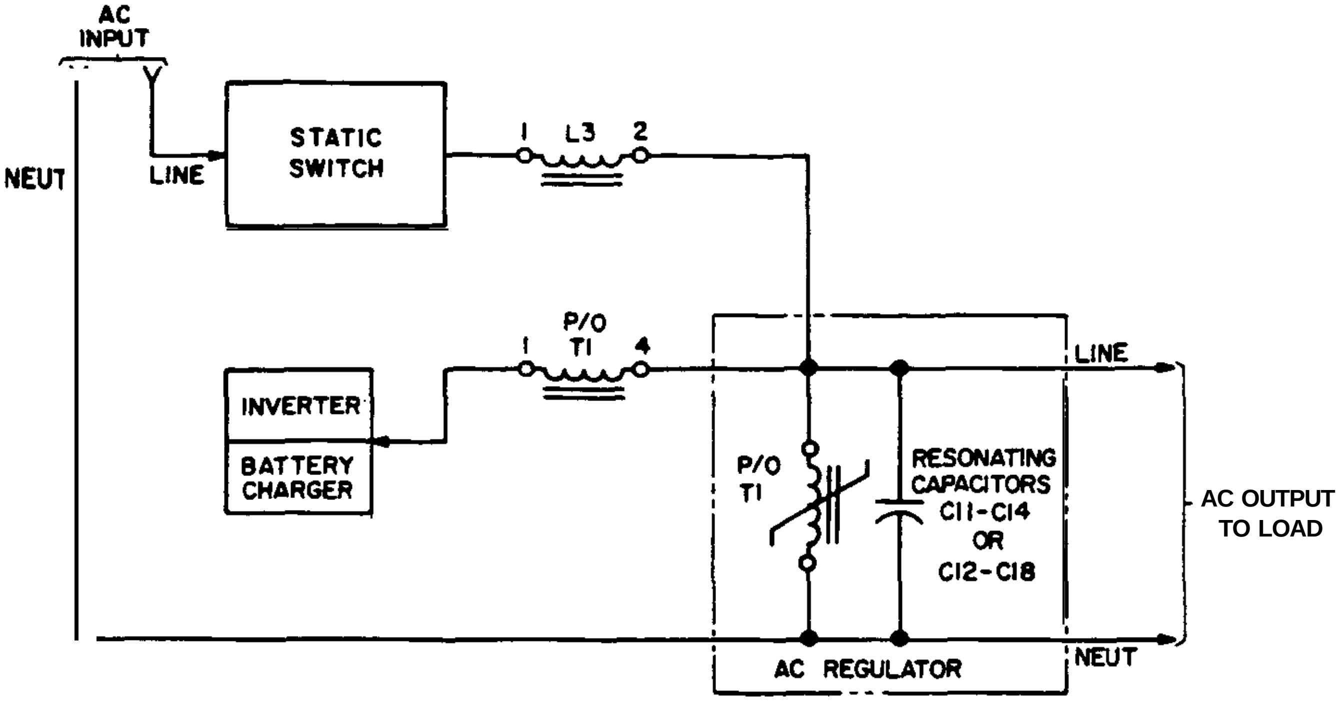



Figure 5-2. Simplified Schematic Diagram: AC Regulator

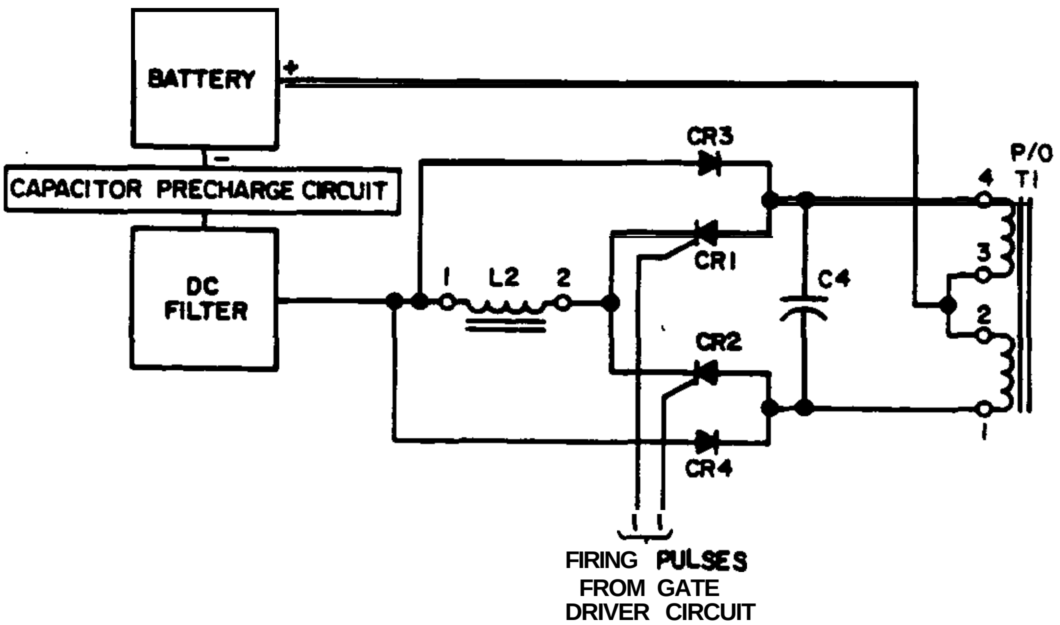



Figure 5-3. Simplified Schematic Diagram: Battery Charger and Inverter

C13, and C14. The outputs of these squaring amplifiers are applied to the inputs of exclusive • OR gate A5G4 which provides a square wave of variable duty cycle to level shifter A1G1. The output from A1G1 is applied to the loop compensation circuit, comprised of A3G1 and associated components, through R20 and R21, and is controlled by analog switch A12. During normal system operation in the Automatic mode with an acceptable AC line, the output from A1G1 is applied to the inverting input of A3G I, and analog switch A 12 is turned off. During operation in any other mode or if the AC line becomes unacceptable for any reason, AI2 is turned on by control signal $\overline{\text{FREERUN}}$. One portion of AI2 clamps the junction of R20 and R21 to ground so the phase detector output signal from A1G1 cannot be applied to A 3G 1. A second section of AI2 connects R22 in parallel with C7 and R24 in the feedback loop of A3G1, thereby discharging loop filter capacitor C7. The output from the loop compensation circuit is applied to the voltage control oscillator (VCO) circuit through R27.

5.13 Voltage Controlled Oscillator. Level shifter A24G 1 and oscillator A2 comprise the VCO circuit which functions as the master clock for system control circuit timing. The basic operating frequency of A2 is determined by CO, R23, and R28. Temperature compensation is provided by CR9 and R29. Operating frequency is modified by A24G1 which functions as a current source or sink depending on system operating conditions during the AUTOMATIC mode of operation. Whenever the inverter is operating during Periods of unacceptable AC line power or total lack of AC input, the output from A24G1 is held at essentially zero volts relative to pin 8 of A2 since the output from the phase detector circuit is damped to ground by A12. An internally generated reference voltage available at pin 10 of A2 is applied to the noninverting input of A24G1 through voltage. divider resistors RI2 and R25. At this time, the free running output frequency of A2 is determined by the combined timing resistance of R23 and R28. The 246 KHz output square wave from A2 is applied to both the debounce circuit and the 120 Hz/3KHz decoder circuit.

5.14 Pulse Generator And Amplifiers. The pulse generator and amplifier circuits produce- the gating pulses used by the inverter and static switch SCRs (silicon controlled rectifiers). The pulse trains or groups are applied to the SCRs as a means of controlling the conduction times of these devices. Two decoder circuits and an enable circuit control the pulse amplifiers. The outputs from all amplifier transistors are applied to the gate driver transformers on circuit card A2.

5.15 The 246 KHz output from oscillator A2 is applied to the clock input of counter A15. This integrated circuit divides the input frequency and supplies two outputs. The Q4, Q5, and Q6 outputs are directly connected to the inputs of AND gate AI 1G3 which outputs a continuous 3KHz pulse train. Emitter follower Q1 serves as a current amplifier for this 3 KHz signal, and drives the inputs of all pulse amplifier stages. The Q11 output of A15, a 120 Hz square wave, is applied to D-type flip-flop A18 through inverter A17G5. Flip-Flop A18 produces two 60 Hz square waves, 180 degrees out of phase, at its Q and $\overline{Q}$ outputs. These outputs alternately serve as current sources and sinks to control the conduction of Q10 and Q1 I through the driver transistors of A21. For example, if output Q is low (ground) and output $\overline{Q}$ is high, diode CR38 is reverse biased and CR40 is forward biased. The 3KHz pulse train applied to R 118 is shunted to ground through CR40, and Q 11 produces no pulse group output to its associated driver transformer. The 3 KHz pulse rain applied to R 117 is allowed to pass through to one of the driver transistors in A21 since CR38 is reverse biased. Output transistor Q10 amplifies this pulse group and applies it to the associated driver transformer. At the next transition of the

120 Hz input to A18, the outputs charge state so Q is high and $\bar{Q}$ is low. Under this condition, Q10 produces no pulse group outputs which Q11 applies an output to its driver transformer. The outputs from Q10 and Q11 drive the gates of the inverter SCRs with 3KHz pulse groups interrupted at a 60Hz rate. These gate drive signals control the basic operating frequency of the inverter power circuits.

5.16 Output transistors QS and Q9 and associated driver circuits function in a manner similar to that described for Q10 and Q11; however, Q8 and Q9 provide continuous 3 KHz pulse train outputs for the static switch SCRs rather that interrupted pulse groups. Cating pulse outputs for the static switch SCRs are enabled or disabled by a clamp transistor in A13, coupled to diodes CR34 and CR35. When control signal SSOFF applied to R 137 is low, transistor Al3 is biased into cutoff which reverse biases CR34 and CR35. This same control signal simultaneously forward biases Q5 to energize the coil of K3. The relay contacts apply power to the CHARGE indicator, remove power from the DISCHARGE indicator, and open the discharge alarm contacts. Since CR34 and CR35 are reverse biased, the 3KHz pulse train is applied to both driver transistors of A21 through R115 and CR47, and to R116 and CR48. Associated output transistors Q8 and Q9 amplify the applied pulse trains and couple them to the gate circuits of the static switch SCRs through separate driver transformers. During periods of inverter only operation, the gating pulses to the static switch SCRs are disabled by applying a high SSOFF control signal to transistor A 13 through R137. This control signal forward biases transistor A13 so the junction of R115 and CR47 is clamped to ground through CR34, and the junction of R 116 and CR48 is clamped to ground through CR35. This clamping function disables application of the 3 KHz pulse trains to Q8 and Q9 so the static switch SCRs remain in a blocking mode. Simultaneously, the high SSOFF control signal biases Q5 into cutoff, deenergizing the coil of K3. The associated contacts apply power to the DISCHARGE indicator, remove power from the CHARGE indicator, and close the discharge alarm contacts.

5.17 Half-Cycle Start Latch. This circuit functions at the moment of inverter startup and momentarily clamps all gate drive signals to the inverter and static switch SCRs to provide a programmed starting sequence. The half-cycle start latch consists of A18, Q3, transistor A13, and associated components. At the moment the inverter circuits are turned on, several circuit functions occur simultaneously. The reset input at pin 10 of A18 is held high for 27 milliseconds, determined by the time constant of R138 and C22. The resulting logic high on the Q output at pin 12 of A18 biases the associated transistor of Al3 into saturation. With transistor A 13 conducting, diodes CR34-CR37 and CR39 are forward biased so the 3 KHz gating pulses for the inverter and static switch SCRs are clamped to ground.

'5.18 When the inverter is turned on, control signal INVON is switched to a +15 volt level. This signal is applied to the D input at pin 9 of A18 through CR41. A8 this time, the $\bar{Q}$ output at pin 12 of A18 is held at logic high to bias transistor Al3 into saturation to maintain the clamp on the gating signal drive circuits. The next positive going leading edge of the 120 Hz signal is clocked into A18 at pin II, forcing the $\bar{Q}$ output at pin 12 low. This signal biases transistor A13 off during the positive portion of the first cycle of the 120 Hz signal, unclamping the gate pulse driver circuits. At the same time, static switch driver transistors Q8 and Q9 remain clamped since control signal SSOFF applied to transistor A 13 through R 137 is high. The $\bar{Q}$ output at pin 2 of A18 remains low to clamp Q10 while the Q output at pin 1 goes high to reverse bias CR40. The 3 KHz gating pulse train is applied to transistor A21 and Q1 I at this time. When the trailing edge of the first cycle of the 120 Hz signal is clocked into pins 3 and II of A18, the Q output at pin 1 goes low to clamp transistor A21 and Q1 I, and the Q output at pin 12 remains low to keep clamp transistor A13 biased into cutoff. With this transistor biased off, the clamp is removed from-all gate driver input lines, and the Q and Q outputs at pins 1 and 2 of A18 regain control of the inverter SCR gate driver transistors. In overall result, this circuit allows one inverter SCR to conduct for only 8.33 milliseconds, with all other SCRs clamped in a nonconducting state. This first half-cycle operation occurs only when the inverter is first started, and has no further affect on circuit operation after that time unless the inverter is turned off by either manual or automatic means.

5.19 Phase Boost Circuit

During a synchronous transfer of load power from the AC line to inverter while the system is loaded at 50% or more of rated output power, the phase boost circuit applies a one millisecond pulse to oscillator A2 to momentarily increase its output frequency. This frequency increase tends to increase output voltage and minimizes voltage sag of the output sine wave while the ferroresonant regulator circuit stabilizes. The phase boost circuit consists of A10, A14G4, Q12, Q13, and associated components. During normal system operation, the output from A5G4 is applied to averaging comparator A14G4 at the inverting input. If system output load does not exceed 50% of rated power, the phase difference between the AC line and inverter AC results in a variable duty cycle square wave input to A14G4 that results in a high output at pin 14. This signal, applied to C29 through R104 and CR43, is of sufficient amplitude to keep C29 fully charged. This voltage level biases Q12 into saturation which removes forward bias from Q13. With Q13 biased into cutoff, a logic high is applied to the reset input of Al2 through R110. The Q output is a logic high under this condition' and reverse biases CR45 so the output frequency of oscillator A2 is not affected.

5.20 If system output is loaded at more than 50% of rated power, a larger phase difference between the AC line and inverter AC occurs. The variable duty cycle square wave output from A5G4 applied to A14G4 is sufficient to drive the output of the averaging amplifier low. Capacitor C 29 discharges and removes forward bias from Q12. This allows application of forward bias to Q13 through R106, resulting in application of a logic low to the reset input of A10. If the system performs a transfer of load power under this condition, a logic high SSOFF signal is applied to the clock input of A10. The Q output immediately undergoes transition from logic high to logic low, and the Q output of A10 undergoes transition from logic low to logic high. The Q output signal serves as a bias source for Q12, and this transistor turns on after C29 charges sufficiently to exceed the breakover voltage of CR44. The time delay in charging is approximately one millisecond. With Q12 biased into saturation, Q13 is biased into cutoff and a logic high is again applied to the reset input of A10. At this time, outputs Q and Q of A10 undergo transition and revert to their former logic levels. The timing constants of R105 and C29 result in a Q output logic low pulse of one millisecond duration. This pulse forward biases CR45 for its duration, and increases the output frequency of A2. This results in increased inverter operating frequency for approximately one millisecond to force system output voltage up during the transfer of load power. After the Q output of A10 undergoes transition from logic low to logic high, the phase boost circuit has no further affect on system operation.

5.21 Battery Charger Regulator System DC output voltage and current are regulated to appropriate values for charging the external battery. Separate amplifier and control circuits are used for voltage and current regulation, but only one loop compensation circuit is used for maintaining circuit stability. The output of the regulator circuit is switched into or out of the phase detector circuit under automatic control of the CHARGE signal. The output of the regulator circuit, consisting of A4G2, A4G3, A12, and A25, modifies the phase difference between inverter AC output and the AC line to control the amount of power available for charging the battery.

5.22 Battery voltage is applied to the inverting input of error amplifier A4G2 through a voltage divider consisting of R35, R38, and R40. The settings of R38 and R40 determine the levels of sampled voltage applied to A4G2 for float and equalize modes of operation. The sampled battery voltage is compared against a reference voltage, applied at the noninverting input of A4G2, generated by CR74, R42, R43, and CR20. The output of A4G2 is the difference voltage appearing at the inputs, and is coupled into the loop compensation circuit through CR21. Amplifier A25 is used to amplify the shunt voltage to a usable level, and this voltage is used as a measurement of DC output current supplied to the battery. The setting of potentiometer R46 determines the current limit point. The output from A25 is coupled into the loop compensation circuit through R50 and R51.

5.23 The loop compensation circuit contains amplifier A4G3 controlled by two sections of analog switch A12. The CHARGE control signal determines the ON or OFF state of A12. During normal system operation with acceptable commercial AC power applied, a logic high CHARGE signal is applied to A17G3 and to the section of A 12 connected across the feedback network around A4G3. 'This section of Al2 is turned off (open) for normal operation. Inverter A17G3 inverts the logic high input signal so the section of A12 in the output line of A4G3 is turned on (closed). This allows the output of A4G3 to increase or decrease the control voltage input of A3G1, thereby serving to control the operating frequency of the VCO circuit. The small changes in frequency translate into changes of output current applied to the battery while the voltage is maintained at a constant value. If the commercial AC line fails or becomes unacceptable for any reason, the CHARGE control signal changes state to a logic low. The section of Al2 in the output line of A4G3 opens so the regulator circuit output does not affect operation of the VCO circuit. Simultaneously, the section of A 12 connected across the feedback loop of A4G3 closes to discharge loop compensation capacitor C 17. Under these operating conditions, the battery charger regulator circuits are disconnected from the phase detector and VCO circuits while the inverter is providing system output power.

5.24 <u>AC Sense</u> The components comprising the AC sense circuit enable inverter synchronization with AC line frequency, and also determine acceptable voltage limits at which the AC line is used as the primary load power source. The input from stepdown transformer T2 is applied to diodes CR1 and CR2 through resistors R8 and R9. The 120 Hz pulsating DC is applied to squaring amplifier A4G1 through a voltage divider consisting of R64 and R68. The setting of potentiometer R64 determines the low limit of acceptable AC line voltage . The square wave output from A4G1 drives a digital filter consisting of NAND gates A22G 1-A22G3 and counter A23 which filters any noise or transient pulses with durations less than or equal to 130 microseconds. The output of counter A23 drives the input of retriggerable monostable multivibrator A7 through NAND gate A22G4 used as an inverter. The output pulses from A7 serve as a clock input to flip-flop A10, and are applied to exclusive - OR gate A5G3 which, in conjunction with R72 and C15, provides a time delay of approximately 7 microseconds. These delayed pulses are applied to inverter A6G6 which provides a reset signal to timer A8. The noninverted output of A5G3 is also used as a reset signal in counter A9. Timer A8, synchronized to the logic low output pulses of A5G3, provides an output to pin 1, the clock input, of A9. The Q2 output of A9 provides a count to the data 'input of A10 through inverter A6 G5. When AC line frequency is within normal limits, the Q output at pin I of Al0 is a logic high. If AC line frequency is out of tolerance, A9 continues counting beyond the Q2 output until the Q7 output undergoes transition from low to high. This output is applied to the data input of A10 through R76 to force the Q output at pin 1 low. If inverter only operation is selected, control signal INV ONLY is applied to the reset input of Al0 through CR46 to force the Q output of pin 1 low. The logic high signal at the Q output of A10, under normal AC line conditions, forward biases driver transistor A13 through R82 to illuminate the AC NORMAL indicator. This same output also functions as one of the control signal inputs to A11G1 in the debounce circuit, and is also applied to inverter A6G1. The output of this inverter is applied to A6G3 through a time delay circuit comprised of CR7, R33, R34, and C8. The output of A6G3 is used as the FREERUN signal which controls operation of the phase detector and loop compensation circuits.

5.25 Debounce Circuit The debounce circuit provides a digital delay which allows a period of time to elapse before the AC line is used as the primary load power source. If the AC line becomes unacceptable at any time during the debounce routine, the circuit automatically resets and again performs the entire routine from the beginning. When the AC line is within acceptable limits, ripple counter A16 is enabled by a reset signal supplied by the AC sense circuit at the output of A6G1. A 60 Hz square wave, derived from the output of AC line squaring amplifier A1G3, is applied to AND gate AIICI. A logic low at the Q13 output of A16 enables gate AIICI through inverter A17G2, and A16 starts counting the number of square wave transitions after application of the reset signal. Approximately 68 seconds must elapse before transition of the Q13 output occurs and becomes a logic high. With the Q13 output high, the output from A17G2 undergoes transition to a logic low which inhibits the 60 Hz square wave output from AIICI. Further counting by A16 is thereby inhibited to complete the debounce routine. If the AC line becomes unacceptable during the 68 second counting period, a reset signal from the AC sense circuit is applied to A16 to restart the counting sequence from the beginning. Following successful completion of the debounce routine, the SSOFF control signal output from A 17G2 becomes a logic low to bias clamp transistor Al3 off. This enables application of the 3 KHz gating signals to driver transistors Q8 and Q9 which control the static switch SCRs, gating these devices into conduction.

5.26 Bypass Control, Inverter Fail, and Low Voltage Detectors. The bypass enable circuits control operation of the bypass contactor and generate various control signals used in other circuits on the control card. The bypass enable circuits respond to OFF or BYPASS commands provided by the mode selector switch, and to control signals generated by the low voltage shutdown and inverter failure detectors. During normal system operation with the REGULATOR SUPPLYING LOAD/AUTOMATIC mode selected, relay K1 is energized to provide a BYPASS ENABLE output signal and a closed bypass alarm contact. This signal controls the state of the output contactor so regulated system AC output, rather than the commercial AC line itself, supplies the load. Under these conditions, the static switch SCRs are enabled, the inverter AC output is locked in synchronism with the commercial AC line, and the battery charger regulator circuits are enabled so the system charges the external battery.

5.27 If a failure occurs in the inverter circuits resulting in application of a fuse alarm signal to the inverter fail detector, the output of comparator A 14G 3 under goes transition from logic low to logic high. This signal reverse biases Q4, and the coil of K I is deenergized. Simultaneously, the output of A14G3 is applied to inverter A6G4 which illuminates the INVERTER ALARM indicator, and forward bias Q7. The INVFAIL control signal output, derived from the collector of Q7, applies a logic high reset signal to counter A16 in the debounce circuit. With the coil of K1 de-energized, the bypass alarm contacts open, and the bypass enable control signal is removed to allow the bypass contactor to connect the bypass AC line, which is unconditioned commercial AC power, to the load. Contacts 12 and 13 of K1 close to illuminate the BYPASS ON indicator and apply a logic high input at pin 6 of A5G2. At this time, the static switch SCR gating signals are disabled, Q5 is reverse biased to deenergized the coil of K3, the DISCHARGE indicator is illuminated, and the discharge alarm contacts are closed.

5.28 If AC line power remains unavailable or unacceptable for extended periods of time, the external battery may become sufficiently discharged to activate the low voltage shutdown circuit. The shutdown circuit also activates the bypass control circuit, regardless of the availability of the commercial AC line. Battery voltage is monitored by comparator A14G2 through a voltage divider consisting oi R84-R87. The setting of potentiometer R85 determines the low voltage shutdown threshold. The output of A14G2 is normally a logic high when battery voltage is greater than the selected shutdown limit. This output signal reverse biases Q2, and is inverted by A17G4. The output from A17G4 is applied to the base of Q14 through CR57, R121, and R146 to bias this transistor on. When Q14 is conducting, the coil of K2 is energized so its contacts apply operating power to all control circuits. Under these conditions, assume that inverter AC output is supplying load power.

5.29 If battery voltage decreases to the selected shutdown level, the output of A 14G 2 changes from a logic high to a logic low. This signal forward biases Q2 so the LOW BATTERY indicator illuminates. Simultaneously, inverter A17G4 provides a logic high output which is coupled to comparator A14G1 through CR58 and R120. The output of A14G1 changes from a logic low to a logic high which reverse biases Q4. The output from A14G1 is coupled to Q4 through steering diode CR24. At this point, circuit operation proceeds in the same manner as if an inverter failure were detected; however, the INVERTER ALARM would remain extinguished. To prevent extremely deep battery discharge, the output of A17G4 is decoupled from Q14 by CR57. Reverse bias is applied to the base of Q14 through R160, and the coil of K2 is de-energized. The contacts of K2 change state when the armature is released to remove battery power from the control card.

5.30 If the system is manually placed in the bypass mode through use of the front panel selector switch, a logic high BYPASS control signal is applied to pin 5 of AX2. This same control signal is applied to comparator A14G1 through steering diode CR65 and R120. At this point, circuit operation proceeds in the same manner as if a low voltage shutdown condition occurred: however, operating power would not be removed from the control circuits, and inverter operation would not be stopped.

5.31 Start-up Sequence Control A special start-up sequence occurs after low voltage shutdown if the mode selector switch is placed to the INVERTER ON or AUTOMATIC position. When commercial AC line power is made available to the system diodes CR15A-CR15D, connected in a full wave bridge configuration, rectify the AC supplied by stepdown transformer T2. Capacitors C 18 and C19 filter the DC output from the bridge, and +15 VDC is made available to the control circuits through normally closed contacts 3-4 of K2. At this time, bypass AC is made available to the load through the bypass contactor. With power applied to the control circuits, the debounce circuit containing A I 1G 1 and A16 begins the countdown routine. Control signals LOCK, LVS, and SSOFF are all logic high so A 1 1G 1 can count the 60 Hz transitions. After 64 seconds have elapsed,, the logic low outputs from Q9, Q10, Q11, and Q12 of AI6 forward bias transistor A13, thereby applying the LVS INH signal to the low voltage shutdown detector, Circuit action ultimately forward biases Q14 to energize the coil of K2, thereby switching battery power to the control circuits. If AC line power remains acceptable, the SSOFF control signal output from A17G2 becomes a logic low 68 seconds after the debounce routine begins, thereby enabling application of the gating pulses to the static switch SCRs. The system locks to the AC line, and the battery charger regulator circuits begin recharging the battery. The system is still maintained in the bypass mode to allow a period of time for battery recharge.

5.32 A timing circuit consisting of A17G1, A19, and associated components determine the time that the system charges the battery following low voltage shutdown and subsequent system restart. This circuit maintains a logic high input to A14G1 through CR65 and CR83, derived from the output of A17G1, for approximately three minutes after application of commercial AC input power. When this output becomes a logic low, the output of A14G1 becomes a logic low to allow application of forward bias to Q4 which energizes the coil of KI. Contacts 12-14 close, applying the BYPASS ENBL control signal to the bypass contactor. This contactor is energized to connect system AC output rather than bypass AC to the load. The start-up sequence ends at this point, and the system resumes normal operation.

5.33 <u>Alarm Circuits</u> The alarm circuits, most of which are contained in the foregoing description, form an integral part of the control circuits and consist of various comparators, amplifiers, and drivers which provide LED indications on the system front panel. The alarm circuits monitor voltage levels, current flow, and status of various portions of the control circuits, providing the operator with a visual indication of system status.

<u>Gate Drivers and Power Supply</u>

5.34 Circuit card A2 contains SCR gate driver isolation transformers and a dual voltage DC power supply. Each pulse transformer, T1 through T4, connects to a pulse amplifier transistor, Q8 through Q11, on the control circuit card. The transformers provide a means of coupling and isolation between the control circuits and the SCR gates in the inverter and static switch. The diodes connected across the primary winding of each transformer reset the core between pulse groups to prevent magnetic saturation of the core material.

5.35 The power supply on circuit card A2 provides regulated -15 and -30 VDC used in the control circuits. These voltages are derived from zener diodes CR13 and CR14 connected to the battery or rectified AC line through circuit card AI. Operational amplifier AI and series-pass transistor Q1 form a voltage regulator circuit which provides approximately 35 VDC to the primary windings of the pulse transformers. Battery or rectified AC line is also used as the source for this 35 volt supply.

<u>Status Relays</u>

5.36 The status relays on circuit card A3 are driven from the alarm and status signals generated by the control circuits. The control signal is applied to a relay driver transistor directly, or to the transistor through an inverter. When a control signal is applied to the base of a driver transistor, that transistor conducts and energizes a relay coil in its collector circuit. Relay contacts either apply or remove voltage at an LED which provides a visual alarm or status indication.

## 6. TROUBLESHOOTING

<u>Introduction</u>

6.01 The troubleshooting information in this section should be used as a guide in localizing failures in the UPS. Before attempting any troubleshooting procedures, the UPS should be disconnected from the load and isolated from any other power equipment. In doing so, the system is isolated from any external equipment failures which may reflect as a trouble symptom.

DANGER

Unless otherwise specified, troubleshooting procedures should be undertaken only after AC and DC power sources to the UPS have been disconnected. AC voltages used in this system can cause severe, perhaps fatal, electrical shock; therefore, service personnel should observe all precautions normally associated with maintenance and repair of electronic equipment.

## Fault Isolation Chart Use

6.02 The fault isolation chart included in these instructions is designed to aid service personnel in locating possible failures in the UPS. The chart is in the form of a flow diagram containing interrogatory and directive statements in diamond-shaped and rectangular geometric figures, respectively. A yes or no response sufficiently answers each inquiry, and the servicing technidan should follow the respective YES or NO line of flow to the next inquiry or directive statement. The directive statements require that the technician perform an adjustment or test to verify certain operational conditions. If the line of flow terminates in a block entitled POSSIBLE CAUSES, the servicing technician should check each cause listed and take apprcpriate corrective action if a faulty component or assembly is located.

## Testing Precautions

DANGER

Do not connect grounded test equipment to any energized component: otherwise, damage to the UPS can result. At the same time, a personnel shock hazard exists since the chassis and case of ungrounded test equipment is energized to the same voltage level as the circuit or component under test. Servicing personnel must exercise caution that simultaneous contact is not made with the test equipment chassis or case and some grounded object when the test equipment is connected to the UPS while it is operating.

## Repair and Replacement Information

DANGER

Insure that all power sources are fully disconnected from the UPS before performing any repair or replacement procedures.

6.03 When a trouble symptom is localized to a faulty circuit card, that particular circuit card should be replaced in its entirety. No attempt should be made to troubleshoot or repair individual drcuit cards.

6.04 If the suspected cause of a trouble symptom is an out of adjustment condition, the particular adjustment setting should be checked or reset using the appropriate adjustment procedure.

6.05 Component failures are sometimes evident during a visual inspection of the circuitry. Obvious trouble symptoms such as loose connections, overheated, discolored, or burned components, open fuses, or burned and melted wire insulation should be corrected and the cause determined before proceeding with more detailed maintenance procedures.

6.06 Various test procedures referenced on the fault isolation chart provide the servicing technician with suggested methods for testing certain circuit components and checking for the presence or absence of certain system control signals. Whenever a numbered test procedure is encountered in the chart, service personnel should refer to that particular test procedure in this section for further troubleshooting information.

6.07 Semiconductor device outlines for diodes and thyristors (SCR's) used in this UPS are shown in Figure 6-l. The outlines are intended to aid servicing personnel in identifying semiconductor terminations during troubleshooting or replacement procedures.

## Test Procedures

6.08 The following test procedures are those referenced by number on the fault isolation chart. By following one of the appropriate procedures, the servicing technician can perform a test on components suspected of failure, or on the system to verify an operating condition. In the operational test procedures, appropriate cautionary statements are inserted where necessary. The servicing technician must observe the contents of each statement and follow normal precautionary procedures necessary when servicing electronic equipment to minimize the possibility of accidental electrical shock.

6.09 Test Equipment. The following test equipment is necessary to perform the procedures in this section:

| | |
|---|---|
| Digital Voltmeter | Fluke Model 8022A or equivalent |
| Oscilloscope | Tektronix Model T921 or equivalent |
| Insulated Screwdriver or alignment tool | CC Electronics type 8728A or equivalent |

6.10 Test Procedure 1. Perform this test when checking a capacitor for opens or shorts.

a) Refer to paragraph 3.06, and perform system shutdown. Insure that AC and DC power sources are disconnected.

b) Allow at least 60-seconds to elapse from time of system shutdown, then disconnect both leads or terminals of capacitor to be tested.

c) Set the digital voltmeter (DVM) for ohmmeter function, using a high resistance range.

d) Momentarily short the capacitor leads or terminals to insure complete discharge. Connect meter test leads to capacitor leads or terminals, and observe indicated resistance. For a good capacitor without any faults, initial resistance is low and gradually increases as capacitor takes a charge. Final resistance is usually several hundred thousand ohms, approaching I megohm. Initial high resistance approaching infinity indicates an open capacitor. Initial and continued low resistance near zero ohms indicates a shorted capacitor. Replace any capacitor which indicates an open or shorted condition.

e) Perform Steps b) through d) on all capacitors suspected of being faulty.

f) When all test are completed, insure that wiring to subject capacitors is properly connected.

g) If no further tests are required, refer to paragraph 3.05 and perform system startup.

6.11 Test Procedure 2. Perform this test when checking a diode for opens or shorts.

a) Refer to paragraph 3.06 and perform system shutdown. Insure that AC and DC power sources are disconnected.

b) Disconnect all wiring from one terminal of the diode to be tested.

c) Set the DVM for ohmmeter function, using 1K resistance range.

d) Connect meter test leads to diode terminals, and note indicated resistance. Reverse test lead connections, and again note indicated resistance. A good diode without any faults indicates a low resistance, typically 0.7K ohms when forward biased, and nearly infinite resistance when reverse biased. A shorted diode typically indicates zero ohms regardless of test lead connections; conversely, an open diode indicates very high resistance regardless of test lead connections. Replace any diode which indicates an open or shorted condition.

e) Perform Steps b) through d) on all diodes suspected of being faulty.

f) When all tests are completed, insure that wiring to subject diodes is properly connected.

g) If no further tests are required, refer to paragraph 3.07 and Perform system startup.

6.12 Test Procedure 3. The following procedure tests the performance of the gate driver/power supply circuit card, A2, under operating conditions.

a) Allow the system to remain in operation, and open the front door of the cabinet after loosening three retaining screws. Locate the gate driver/power supply circuit card, A2, mounted on the inner surface of the front door.

**DANGER**

Voltages capable of producing severe, perhaps fatal, electrical shock are present at various components throughout the UPS. When performing the steps in the balance of this test procedure, exercise extreme caution that contact is not made with any electrical termination. Insure that all test leads and probes are adequately insulated since test connections are made to electrically energized components.

b) Check the power supply portion of circuit card A2 before proceeding with other tests.

1) Set the DVM for voltmeter function. Adjust the instrument range to indicate -15 and -30 VDC.

2) Connect meter common lead to the positive (+) lead of Cl or C3 on circuit card A2. Refer to Figure 6-2.

3) Check for -15 VDC at positive (+) lead of Cl, and for -30 VDC at negative lead of Cl. Allowable voltage tolerance of each supply is ± 10 percent.

4) Connect meter test lead to test point WI, shown in Figure 6-2, the cathode lead of CRI. Voltage at W1 should be -35 VDC, ± 10 percent.

5) If any of the voltages checked is missing or out of tolerance, perform system shutdown procedure and replace circuit card A2.

c) Check the gate driver portion of circuit card A2 using the following steps:

**DANGER**

**Do not use a grounded oscilloscope when performing this procedure; otherwise, damage to the UPS may result. At the same time, a personnel shock hazard exists since the chassis and case of ungrounded, AC-operated test equipment becomes energized to the same voltage level as the circuit under test. Servicing personnel must exercise caution that simultaneous contact is not made with the test instrument chassis or case and some grounded object when the test equipment is connected to the UPS while it is operating.**

1) Adjust oscilloscope vertical sensitivity for 10 volts per Centimeter (10V/cm). Adjust horizontal time base for 2 milliseconds per centimeter (2 ms/cm ).

2) Connect common lead of probe to positive (+) lead of capacitor C2 or C3 on circuit card A2. Refer to Figure 6-2.

3) If checking for gate pulses to inverter SCR's CR6 and CR7, connect oscilloscope probe to test points WI and W2, respectively, shown in Figure 6-2. If checking for gate pulses to static switch

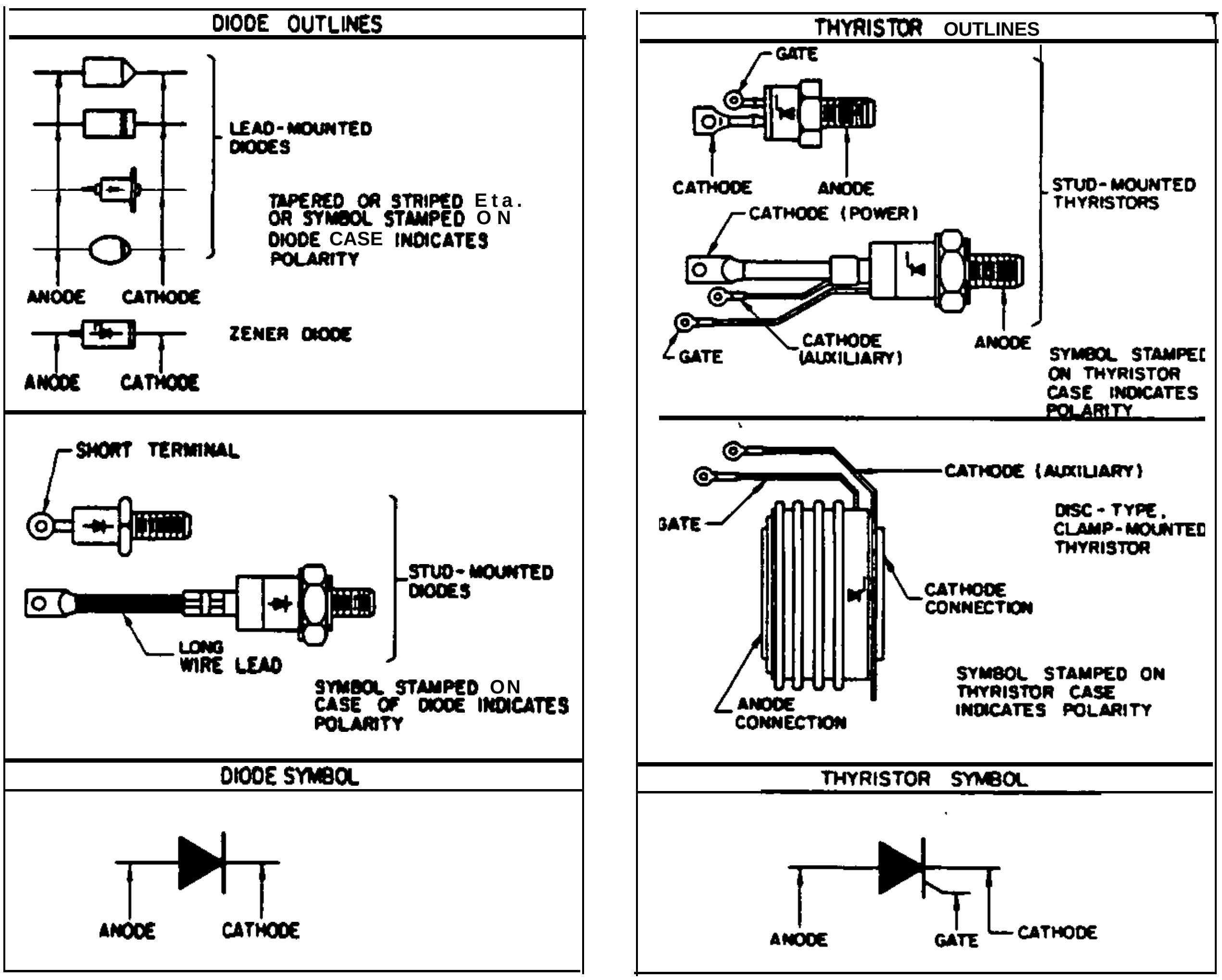



**Figure 6-1. Semiconductor Oultines**

SCR's CR9 and CRIO, connect oscilloscope probe to test points W4 and W 3, respectively, shown in Figure 6-2. The displayed waveform should be approximately the same as that shown in Figure 6-3, except inverted.

4) Any pulse group missing or distorted indicates a -fault on either circuit card AZ or Al. Replace A2 first; if the trouble symptom is not cleared, then replace control circuit card A 1.

5) If all pulse groups are present at W1 through W4 on circuit card A2 but the trouble symptom persists, check for the SCR gating waveform at the gate and cathode terminals of CR6, CR7 or CR9, CRIO. If this test is performed, connect the probe common lead to the cathode (K) terminal of the device under test. Connect the oscilloscope probe to the gate lead of each SCR being checked.

6) The gating waveform displayed should be the same as that shown in Figure 6-3. If any waveform is missing, replace circuit card A2.

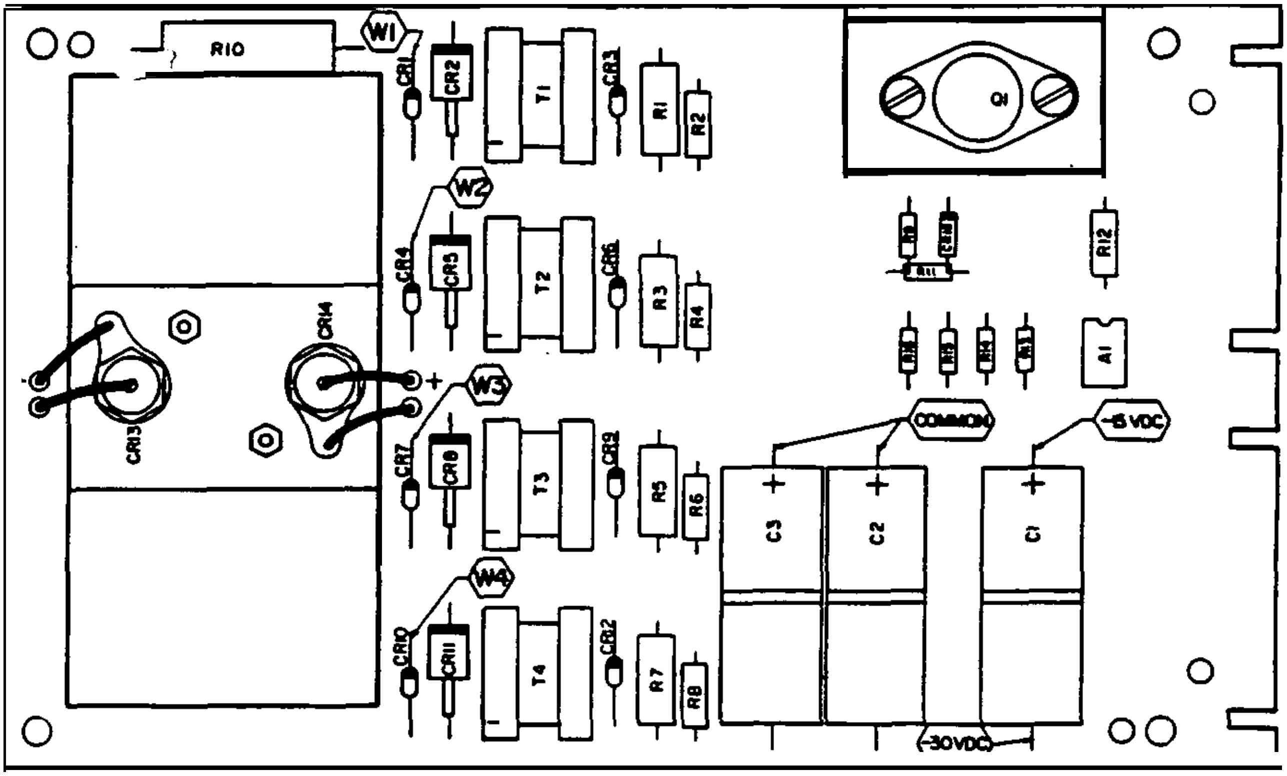
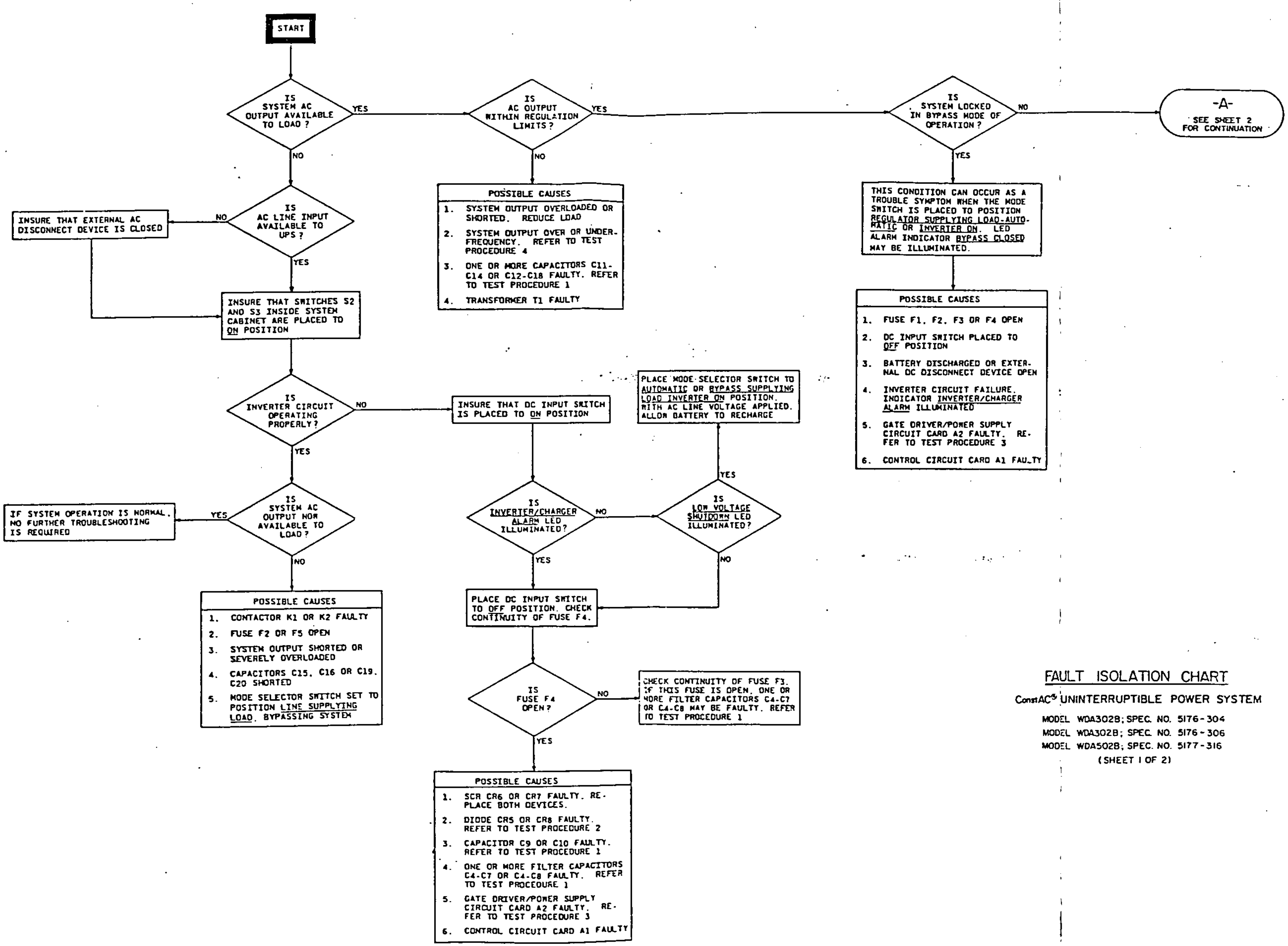


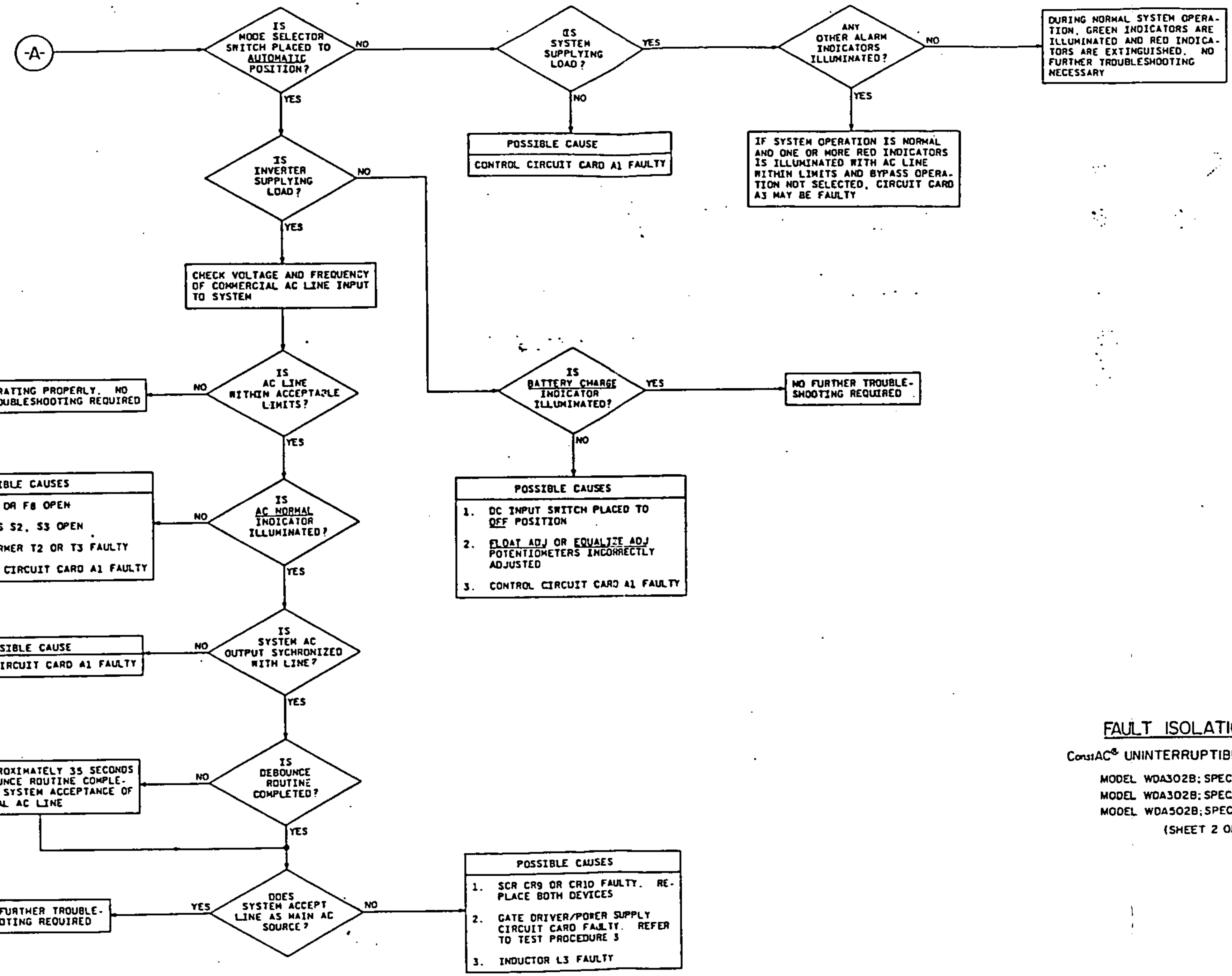

Figure 6-2. Gate Driver/Power Supply Circuit Card




FAULT ISOLATION CHART

ConstAC$^S$ UNINTERRUPTIBLE POWER SYSTEM

MODEL WDA302B; SPEC. NO. 5176-304
MODEL WDA302B; SPEC. NO. 5176-306
MODEL WDA502B; SPEC. NO. 5177-316
(SHEET 1 OF 2)




FAULT ISOLATION CHART

ConstAC® UNINTERRUPTIBLE POWER SYSTEM

MODEL WDA302B; SPEC. NO. 5176-304
MODEL WDA302B; SPEC. NO. 5176-306
MODEL WDA502B; SPEC. NO. 5177-316
(SHEET 2 OF 2)

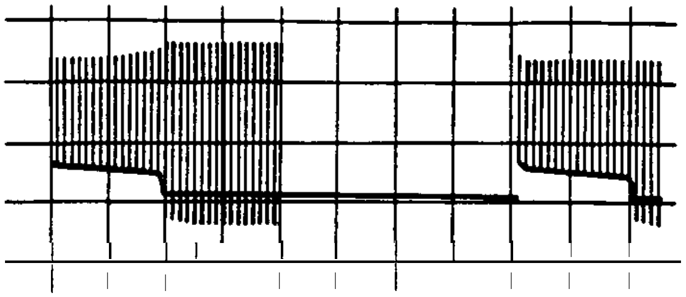


Figure 6-3. Gating Pulse Waveform

6.13 Test Procedure 4. Observe the following procedure when checking and adjusting inverter frequency.

a) If UPS is already operating, place mode selector switch to BYPASS SUPPLYING LOAD-INVERTER ON position.

b) Release three retaining screws and open front door of cabinet. Place switch S3 to the OFF position.

DANGER

Voltages capable of producing severe, perhaps fatal, electrical' shock are present at various components throughout the UPS. When performing the steps in the balance of this test procedure, exercise extreme caution that contact is not made with any electrical termination. Insure that all the leads and probes are adequately insulated since test connections are made to electrically energized components.

c) Adjust oscilloscope to monitor a 60 Hz sine wave of approximately 55 volts peak-to-peak amplitude. The triggering source for the oscilloscope should be the line (60 Hz AC) or an external, stable 60 Hz source.

d) Insure that the oscilloscope is not grounded through the power cord if an AC-operated instrument is being used. Connect the probe common lead to circuit card AI test point TP5. Connect the oscilloscope probe to test point TP2. Refer to Figure 6-4 for test point locations.

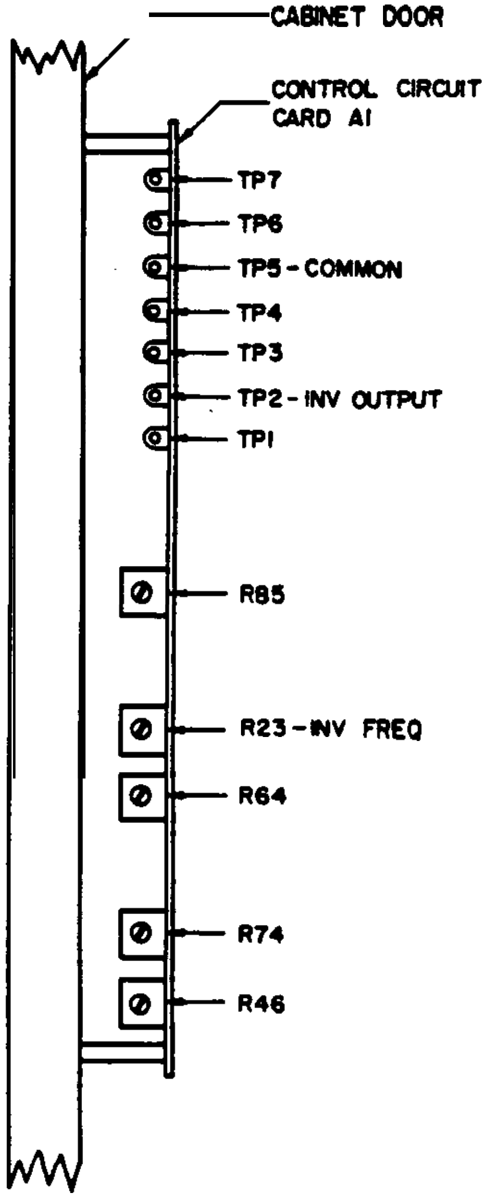



Figure 6-4. Potentiometer and Test Point Locations

e) Observe the waveshape on the oscilloscope. If the line is used as. the triggering source, the waveshape should be stationary on the CRT. If any other type of triggering is used, measure the period of one wavelength. It should be 16.66 milliseconds at 60 HZ.

f) If inverter output frequency is other than 60 Hz exactly, adjust potentiometer R23 (INV FREQ) until correct output frequency is attained.

**WARNING**

Do not attempt adjustment of any other potentiometers on circuit card Al. Only R23 should be adjusted.

g) After adjustment is completed, place switch S3 to the ON position. Place mode selector switch to AUTOMATIC position.

h) Wait approximately 35 seconds for completion of system debounce routine. System should accept line as main AC source.

i) Check system operation. No red alarm indicators should be illuminated at this time. Check system output under load and at no load for proper voltage, nominally 117 VAC at unity power factor.

j) After all tests are completed, disconnect oscilloscope probe. System may be returned to service if operation is normal.

APPENDIX

RECORD OF INSTRUCTION CHANGES

| ISSUE OR DATE | ECN | DESCRIPTION OF CHANCE |
|---|---|---|
| 2 | - , | Spec. No. 5176-306 added. |
| 3 | 183-8172 | Circuit card A I changed from a 4864-221 to a 4864-4 19. The accessory meter panel is now standard. |
| | | CONVERSION TO LAMPS |
| D1 | 183-8907 | Circuit card AI changed from 4864-419-00 to 4864-732-00. Remove status panel deleted. |
| EI | 183-8783 | Slow Charge Circuit |
| F1 | - | Reworded Paragraph 2.03 for clarity. |
| G1 | - | Low Voltage Shutdown Adjustment Procedure added. |

LORAIN PRODUCTS

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Productos Lorain de Mexico. S.A. de C.V.. Apartado Postal 77001
TEL. 576-82-77/TLX /01774308 (1774308 LORME)

RELIANCE COMM/TEC

# REPLACEMENT OF DISC-TYPE THYRISTORS AND DIODES USING CLAMP ASSEMBLY 2868-234-00 OR 2868-235-00

CONTENTS PAGE



## 1. GENERAL

1.01 These instructions provide a step-by-step procedure for replacement of disc-type thyristors or diodes. These semiconductors are used in various types LORAIN® equipment, and the procedures outlined in these instructions should be followed to correctly replace disc-type thyristors or diodes.

1.02 Refer to Figure 1 for identification outlines of the disc-type thyristor and diode. The replacement device should be compared to the outline drawing prior to replacement. Identify the polarity and type of the replacement semiconductor to insure that the new diode or thyristor is correctly installed in its heatsink.

1.03 Figure 2 provides an illustration showing force gauge use during the replacement procedure. Refer to Figures 2A through 2C during installation to insure that correct mounting force is exerted on the replacement diode or thyristor.

## 2. REQUIRED TOOLS AND MATERIALS

2.01 The following tools and materials are required to replace a "disc-type" semiconductor:

| Quantity | Description |
|---|---|
| 1 Set | Socket wrenches with ratchet handle and extension; 3/8 or 1/2 inch drive |
| 1 | Screwdriver; medium sized flate blade |
| 1 | Force gauge; L.P. Part No. 6774-007-00 |
| 1 Container | Thermal joint compound; Wakefield Engineering, Inc., Type 120 (L.P. Part No. 1762-510-00), or equivalent |

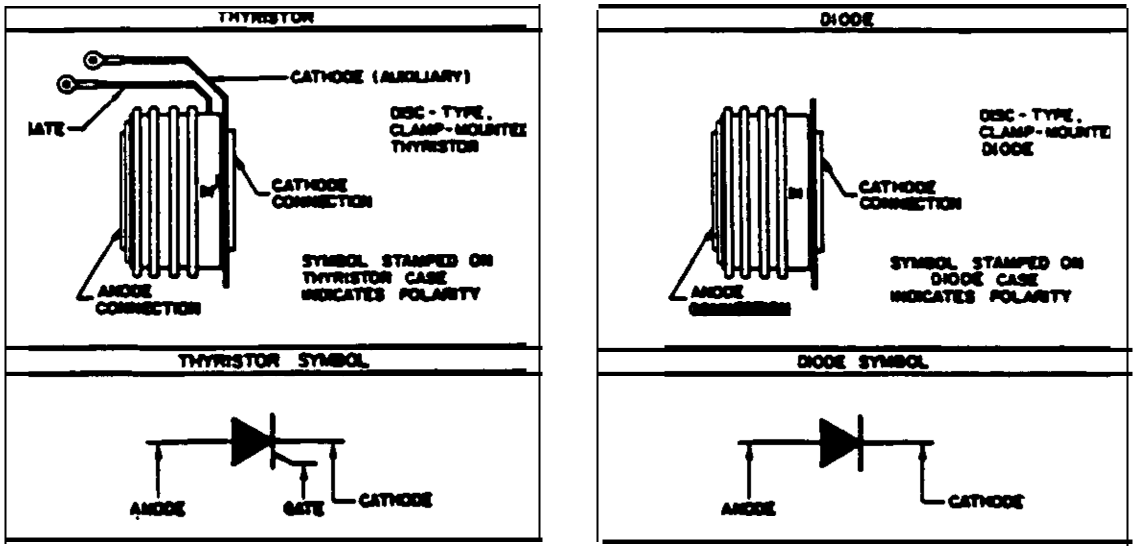
## 3. INSTALLATION PROCEDURE

3.01 Remove all sources of power to the equipment requiring repair. Open all AC and/or DC input and output circuit breakers or switches according to the Stopping Procedure in the appropriate instruction manual. Open the external disconnect on protective device prior to the replacement procedure.

### NOTE

Refer to the Schematic Diagram of the equipment being repaired. Insure that the equipment is completely isolated from all power sources. In some instances, it may be necessary to remove input, output, and control fuses to completely isolate the equipment from any power source.

# FIGURE I
## SEMICONDUCTOR IDENTIFICATION OUTLINES



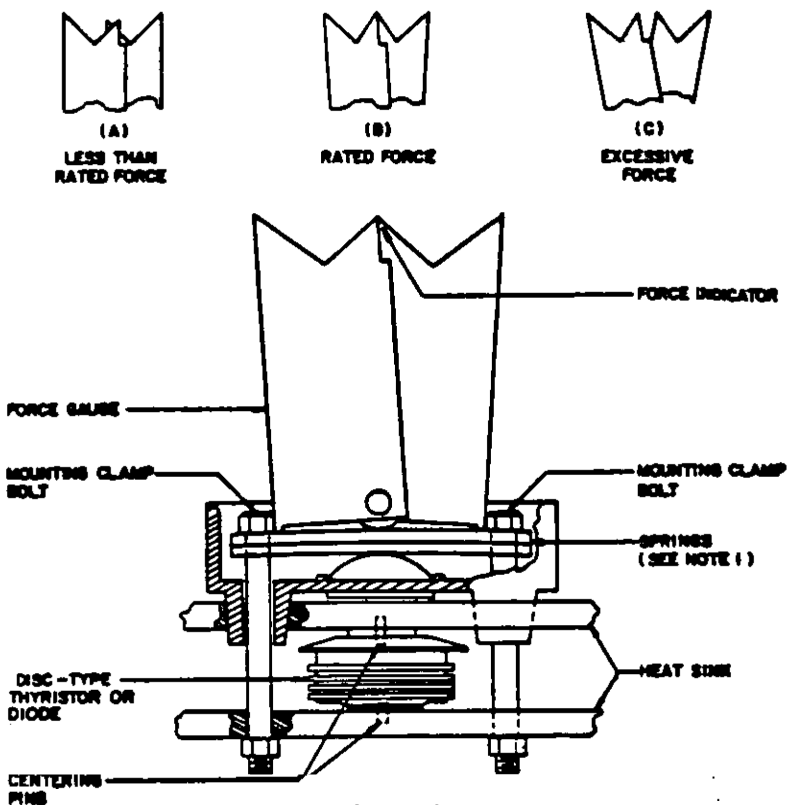




FIGURE 2

CUT-AWAY VIEW OF "DISC-TYPE" SEMICONDUCTOR INSTALLATION DETAILS

NOTE I: CLAMP ASSEMBLY (L.P.C. PART NO. 2868-234) HAS TWO SPRINGS.
CLAMP ASSEMBLY (L.P.C. PART NO. 2868-235) HAS FOUR SPRINGS.

## DANCER

Hazardous voltage may be present within the cabinets of some LORAIN equipment after input and output power sources have been disconnected. Servicing personnel must exercise extreme caution that contact is not made with interconnection terminal blocks or any portion of the circuitry other than the diode or thyristor assembly requiring repair.

3.02 Open the equipment access doors or covers and remove any inner protective grilles or covers to gain access to the diode or thyristor assembly. Proceed as follows:

a) If a thyristor is being replaced, disconnect the cathode (K) and gate (G) leads from their terminal board. These leads are usually red and white wires, and are connected to a terminal board mounted on the heatsink near the thyristor.

b) Loosen and remove the two mounting clamp bolts. The clamp, heatsink, and semiconductor may now be removed from the equipment.

## NOTE

NOTE THE POLARITY OF THE FAULTY SEMICONDUCTOR BEFORE REMOVING IT FROM ITS HEATSINK.

c) One mounting surface is the anode connection, whereas the other mounting surface is the cathode connection. The polarity of the device is usually indicated by a symbol stamped on the ceramic portion of the device. Refer to the Identification Outlines (Figure 1) if any doubt exists concerning the polarity of the device. It may be necessary to remove circuit wiring or loosen a busbar connection from the heatsink before it can be removed from the equipment.

d) Remove the faulty semiconductor from its heatsink. Using a clean rag or paper towel clean both portions of the heatsink assembly to remove any thermal compound residue.

e) If a thyristor is being replaced, carefully inspect the gate lead connection at the pin entering the ceramic body of the thyristor. It is of utmost importance that this connection is tight. If this connection point is suspected of being loose, carefully solder the push-on-connector to the pin to insure good electrical contact.

f) Apply a thin coating of thermal joint compound to the mounting surfaces of the replacement semiconductor.

## WARNING

Do not apply an excessive amount of thermal joint compound on the mounting surfaces of the replacement device. The compound possesses electrical insulating qualities, and may prevent the semiconductor device from functioning properly if an excessive amount is applied. A thin, almost transparent coating is adequate.

g) Install the replacement device on the heatsink, observing correct polarity and insuring it is correctly centered on the pins imbedded in the heatsinks. Replace the mounting clamp bolts, and secure them finger-tight only.

h) Using a force gauge (L.P. Part No. 6774-007-00) placed against the clamp springs as shown in Figure 2, tighten the mounting clamp bolts alternately, 1/4 turn at a time. The bolts should be tightened equally until the force gauge indicates rated force is applied as shown in Figure 2 (B).

**NOTE**

If excessive force is applied by over-tightening the tinting clamp bolts, as shown by the force gauge indication in Figure 2 (C), completely loosen the two bolts and repeat the tightening process. Never attempt to adjust spring tension by backing off the bolts since the force gauge may provide a false indication in this case.

i) When the mounting clamp bolts are 'correctly tightened, remove the force gauge. Reconnect any wiring removed from the heatsinks, insure that all hardware used to make electrical connections is tightened securely.

j) If replacing a thyristor, reconnect gate and cathode leads to their respective terminals. Refer to the equipment Wiring Diagram (T-drawing) for details.

**WARNING**

insure that these leads are connected to the proper terminal board connection points, or damage to the equipment and semiconductor device may result when power is applied.

**NOTE**

On the gate and cathode lead terminal board, the cathode connection is usually marked "K" and the gate connection is usually marked "G". If any doubt exists regarding the correct connection points, refer to the equipment wiring diagram.

3.03 After all electrical connections have been made, replace any protective grilles or covers which were previously removed. Close the equipment access doors or covers.

3.04 Restore input power to the equipment, and insure that any output disconnect or protective devices are connected or reset for normal operation. If necessary, refer to the Starting Procedure in the appropriate instruction manual to restore the equipment to normal operation.

APPENDIX

RECORD OF INSTRUCTION CHANGES

| ISSUE OR DATE | ECN | DESCRIPTION OF CHANGE |
| --- | --- | --- |
| DI | 183-7444 | Revised to reflect current instruction format. |

LORAIN PRODUCTS

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*In Mexico* —
Productos Lorain de Mexico. S.A. de C.V.. Apartado Postal 77001
TEL. 576-82-77/TLX./01774308 (1774308 LORME)

RELIANCE COMM/TEC

# 1. SPECIFICATION

1.1 **GENERAL:** The LORAIN® ConstAC® Uninterruptible Power System (UPS) provides single phase AC power to the load. The system includes an inverter, battery charging capability, AC disconnect means, and an AC voltage regulato contained in a common cabinet. This UPS is listed by Underwriters Laboratories Inc. under Standard 1012 for powe conversion equipment in a controlled environment.

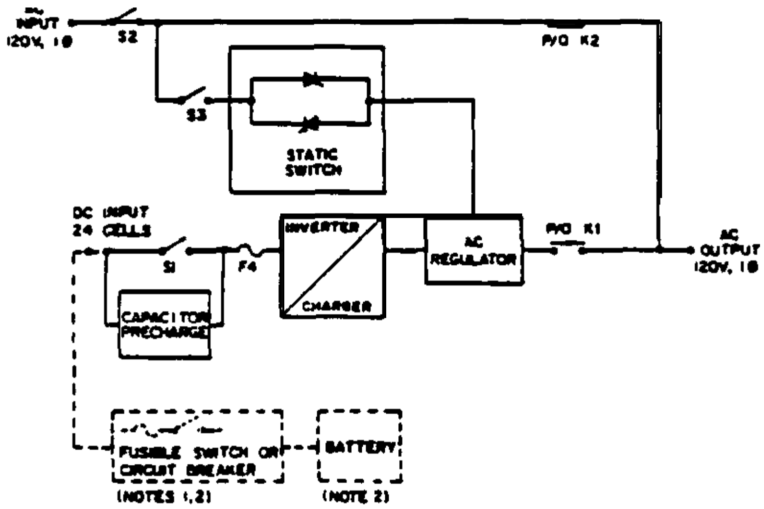
1.2 **MODES OF OPERATION**

**1.2.1 Normal:** When the commercial AC line voltage and frequency are within acceptable limits, the UPS is a batter charger and line filter. Commercial AC line is applied through the static switch to the AC regulator/filter whic supplies filtered regulated AC to the load. The inverter/charger maintains (floats) or recharges an externa customer furnished battery.

**1.2.2 Line Failure:** During line disruptions such as blackouts, brownouts, interrupts, transients, or frequenc variations, the static switch disconnects the commercial AC line allowing the inverter, which derives power fron the batteries, to continue to supply filtered regulated AC power to the load. No break in load power occurs upo failure of the AC line. When the line disruption ends, the UPS monitors the commercial AC line fo approximately 30 seconds, to insure that the line is stable, then returns to normal operation.

**1.2.3 Bypass:** Load power is obtained directly from the commercial AC line, bypassing the inverter and regulato circuits. Load power is not interrupted during transfer.

1.3 **ONE LINE DIAGRAM**




**NOTES:**

1. A fusible switch or circuit breaker, provided by the customer, should be connected between the battery and DC input terminals of the system. The device should be rated for an interrupting capacity in amperes at least 10 times the ampere-hour capacity of the battery. Refer to the Installer's Information Notes for required amperage ratings of the protective device. A slow acting fuse or circuit breaker capable of withstanding momentary surge currents is necessary.

2. Dotted lines indicate equipment and wiring not furnished with the system.

PD5177-3

| ISSUE | CHG. NO. | DESCRIPTION |
|---|---|---|
| P1 | — | NOV 02 1987 BP PARAGRAPH 4.1.2 CORRECTED M. ... 11-2-87 |
| N1 | 183-9588 | RELAY CONTACT RATING ON TB4 CHANGED DEC 1 1 1986 BP |

REVISIONS

**LORAIN PRODUCTS**
LORAIN, OHIO
RELIANCE COMM/TEC

**POWER DATA**

ConstAC® UNINTERRUPTIBLE POWER SYSTE

MODEL WDA302B, SPEC. NO. 5176- 304-

MODEL WDA502B, SPEC. NO. 5177- 316 -

| DR BY | DATE | GRP LDR. | DATE | PD5176-304 |
|---|---|---|---|---|
| | 12-9-81 | | 12/7/81 | |
| CH BY | DATE | APP BY | DATE | |
| | | | 12-7-81 | |
| ENGR BY | DATE | | | PAGE 1 |
| | 12-15-81 | | | |

# 1. SPECIFICATION

## 1.4 OUTPUT RATINGS

### 1.4.1 System AC Output:

(A) **Capacity:** 3000 volt-amperes for Model WDA302B; 5000 volt-amperes for Model WDA502B.

(B) **Voltage:** 120 volts, 60 Hz, single phase.

(C) **Regulation:** Output voltage remains within the range of 110 to 126 volts over specified AC and DC input ranges from no load to full load at 0.8 power factor leading or lagging.

(D) **Harmonic Distortion:** The total harmonic distortion of system output sine wave does not exceed 5% from no load to full load.

(E) **Frequency Stability:**

(1) System output is synchronized to commercial AC line when line frequency is within the range of 60 ± 0.9 Hz.

(2) If commercial AC line fails or frequency exceeds specified limits, the free-running inverter frequency remains within the range of 60 ± 0.3 Hz.

### 1.4.2 Battery Charger Output:

(A) **Voltage:** Adjustable from 49.9 to 58.75 VDC for charging a 23 or 24 cell battery. A FLOAT/EQUALIZE switch on the system front panel allows the manual selection of either the float or equalize output voltage. Separate potentiometers allow independent adjustment of the float and equalize output voltages.

(B) **Regulation:** Steady state DC output voltage remains within ± 0.5% of the adjusted voltage over the AC input range and from no load to full load.

(C) **Current:** 18 amperes for Model WDA302B; 30 amperes for Model WDA502B.

## 1.5 INPUT RATINGS

### 1.5.1 System AC Input:

(A) **Voltage:** 100 to 127 volts with output power factor of 0.8 leading or lagging. Refer to Paragraph 1.10.1.

(B) **Frequency:** AC input frequency applied to the system must remain within the limits of 60 ±0.9 Hz. Refer to Paragraph 1.10.1 for additional information.

(C) **Typical Input Data:**

MODEL WDA302B

| AC Input Voltage | Load | Amperes | Watts | Battery Charging Current DC Amperes | Efficiency % |
|---|---|---|---|---|---|
| 100 | 0<br>50%<br>100% | 11.0<br>20.7<br>36.2 | 443<br>1933<br>3533 | 0<br>0<br>0 | 0<br>77.6<br>84.9 |
| 117 | 0<br>50%<br>100% | 5.5<br>17.2<br>31.0 | 453<br>1983<br>3453 | 0<br>0<br>0 | 0<br>75.6<br>86.9 |
| 127 | 0<br>50%<br>100% | 5.0<br>16.5<br>29.3 | 473<br>2033<br>3533 | 0<br>0<br>0 | 0<br>73.8<br>84.9 |

# 1. SPECIFICATION

1.5.1 (C) **Typical Input Data (CONT'D)**

MODEL WDA502B

| AC Input Voltage | Load | Amperes | Watts | Battery Charging Current DC Amperes | Efficiency % |
|---|---|---|---|---|---|
| 100 | 0<br>50%<br>100% | 15.4<br>32.2<br>60.6 | 710<br>3070<br>5980 | 0<br>0<br>0 | 0<br>76.2<br>84.4 |
| 117 | 0<br>50%<br>100% | 6.7<br>26.6<br>11.6 | 735<br>1120<br>6060 | 0<br>0<br>0 | 0<br>75.6<br>86.8 |
| 127 | 0<br>50%<br>100% | 7.8<br>26.0<br>51.0 | 770<br>3170<br>6080 | 0<br>0<br>0 | 0<br>75.1<br>86.8 |

(D) **Maximum Input Current:**

(1) Model WDA302B:

(a) 40.0 amperes: output loaded to 3 KVA at 117 VAC with 18 ampere battery charging current.

(b) Does not exceed 45.7 amperes at 100 VAC input with the system output overloaded while charging battery at 18 amperes.

(2) Model WDA502B:

(a) 64 amperes with the output loaded to 5 KVA at 117 VAC with 30 ampere battery charging current.

(b) Does not exceed 74.9 amperes at 100 VAC input with the system output overloaded while charging battery at 30 amperes.

**1.5.2 System DC Input:**

(A) **Model WDA302B:**

(1) **Voltage:** 42 to 56.4 volts.

(2) **Current:** Does not exceed 85.1 amperes at 42 volts.

(3) **Typical Input Data:**

| System Load | Inverter DC Amperes at 1.75 Volts/Cell |
|---|---|
| No Load | 10.8 |
| Half Load | 59.2 |
| Full Load | 85.1 |

| DC Input | Inverter Efficiency % |
|---|---|
| 42 Volts | 84.2 |
| 48 Volts | 84.5 |
| 52 Volts | 83.6 |

# 1. SPECIFICATION

1.5.2 **System DC Input** (CONT'D)

(B) **Model WDA502B:**

(1) **Voltage:** 42 to 56.4 volts.

(2) **Current:** Does not exceed 147 amperes at 42 volts.

(3) **Typical Input Data:**

| | Inverter |
|---|---|
| System Load | DC Amperes at 1.75 Volts/Cell |
| No Load | 17.0 |
| Half Load | 74.5 |
| Full Load | 146.8 |

| | Inverter |
|---|---|
| DC Input | Efficiency % |
| 42 Volts | 82.0 |
| 48 Volts | 84.0 |
| 52 Volts | 85.3 |

1.6 **STANDARD FEATURES**

1.6.1 **DC Input Protection:**

(A) **Precharge Circuit:** These UPS systems are equipped with a precharge circuit which charges the DC capacitors prior to starting the UPS.

(B) **Model WDA302B:**

(1) Double pole 225 ampere disconnect opens both DC input leads.

(2) 150 ampere fuse provides instantaneous overload protection for inverter thyristors.

(C) **Model WDA502B:**

(1) Double pole 225 ampere disconnect opens both DC input leads.

(2) 300 ampere fuse provides instantaneous overload protection for inverter thyristors.

1.6.2 **Output Protection:** Inherent magnetic characteristics of ferroresonant transformer protects system against excessive overloads and short circuits. Instantaneous short circuit conditions may result in operation of an inverter fuse.

1.6.3 **Metering:** The UPS is equipped with four meters which monitor battery voltage, charge/discharge current, load voltage and load current. Each meter is a 2.5 inch rectangular type, with a 2.41 inch scale length, at ±2% accuracy.

(A) **Model WDA302B:**

DC Voltmeter: 0-75 volts DC

DC Ammeter: 150-0-150 amperes DC

AC Voltmeter: 0-150 volts AC

AC Ammeter: 0-50 amperes AC

(B) **Model WDA502B:**

DC Voltmeter: 0-75 volts DC

DC Ammeter: 200-0-200 amperes DC

AC Voltmeter: 0-150 volts AC

AC Ammeter: 0-75 amperes AC

**1.6.4 Indicators:** The following indicators are located on the system front panel.

(A) **BYPASS CLOSED:** A red indicator illuminates whenever load power is supplied through the bypass circuit rather than the system AC regulator. Simultaneously, an open circuit is present at TB4, terminals 3 and 4, and a closed circuit is present at TB4, terminals 4 and 5.

(B) **LOW VOLTAGE SHUTDOWN:** A red indicator illuminates when automatic inverter shutdown results from low battery voltage.

(C) **INVERTER/CHARGER ALARM:** A red indicator illuminates if a fault occurs in the inverter/battery charger circuit which results in an open fuse.

(D) **POWER ON:** A green indicator illuminates whenever DC input is applied to the system and AC output power is supplied to the load.

(E) **CHARGE:** A green indicator illuminates and an open circuit is available at TB4, terminals 1 and 2 whenever the system supplies charging current to the battery.

(F) **DISCHARGE:** A red indicator illuminates and a closed circuit is available at TB4, terminals 1 and 2 whenever the battery supplies input power to the inverter.

(G) **REGULATOR ON:** A green indicator illuminates when the system supplies load power through the AC regulator, using either the commercial AC line or inverter as the source.

(H) **AC LINE NORMAL:** A green indicator illuminates whenever commercial AC power applied to the system is within the acceptable voltage and frequency limits.

(I) **STATIC SWITCH CLOSED:** A green indicator illuminates whenever the static switch is enabled, supplying commercial AC power to the load through the AC regulator circuit. A closed circuit is available at TB4, terminals 3 and 4, and an open circuit is present at TB4, terminals 4 and 5.

(J) **DS1:** Illuminates to indicate the state of charge on the DC filter capacitors during the startup procedure.

**1.6.5 Selector Switch:** A four position rotary switch on the system front panel allows manual selection of system operational modes. The function of each position is described as follows:

(A) **REGULATOR SUPPLYING LOAD:**

(1) **AUTOMATIC:** Commercial AC power supplies the load through the static switch and AC regulator, and charges the battery when voltage and frequency are within acceptable limits. If AC line fails in this mode, inverter automatically supplies load with no break in output power.

(2) **INVERTER ON:** Inverter operates from battery power and supplies AC to load, regardless of commercial AC line status. Inverter failure results in automatic transfer to bypass circuits.

(B) **BYPASS SUPPLYING LOAD:**

(1) **INVERTER ON:** Commercial AC power supplies load through bypass circuit while system charges the battery.

(2) **INVERTER OFF:** Commercial AC power supplies load through bypass circuit. Inverter/charger circuit is disabled.

# 1. SPECIFICATION

## 1.7 ENVIRONMENTAL RATINGS

1.7.1 **Operating Temperature Range:** 0 ° C to 50 ° C (32 ° F to 122 ° F)

1.7.2 **Storage Temperature Range:** -40 ° C to 85 ° C (-40 ° F to 185 ° F)

1.7.3 **Heat Dissipation:** 127 VAC input with system output fully loaded:

(A) **Model WDA302B:** 1545 Btu/hr

(B) **Model WDA502B:** 2796 Btu/hr

1.7.4 **Ventilation Requirements:** Ventilation openings in cabinet must be unobstructed and the temperature of the air entering the cabinet must not exceed 50 ° C (122 ° F).

1.7.5 **Audible Noise:** The audible noise at any point five feet from any vertical surface of the UPS does not exceed 67DB "A" weighting when measured with a General Radio 1551C sound level meter (or equivalent) conforming to ANSI S1.4. Refer to Paragraph 1.10.2.

## 1.8 ACCESSORIES

1.8.1 **Rear Dress Panel:** Part No. 3517-556-00; covers protruding hardware from recessed rear panel of system.

## 1.9 RELATED DOCUMENTATION

1.9.1 Schematic Diagram:

(A) Model WDA302B: SD-5176-304-00

(B) Model WDA502B: SD-5177-316-00

1.9.2 Wiring Diagram:

(A) Model WDA302B: T-5176-304-00

(B) Model WDA502B: T-5177-316-00

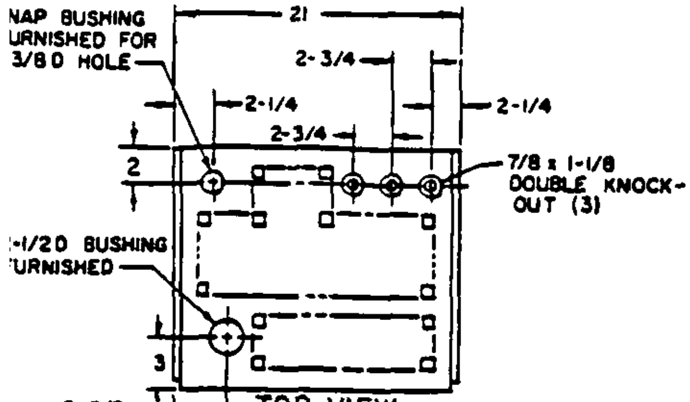
1.9.3 Instructions: Section 4204

## 1.10 SPECIFICATION NOTES

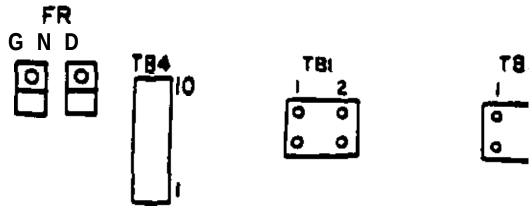
1.10.1 If AC input voltage and/or frequency variations exceed the specified limits, this UPS automatically disconnects from the input line and operates from battery power. If a particular application of this UPS requires operation from an AC source that may be expected to exceed specified frequency and voltage limits, such as an engine - alternator, consult the factory.

1.10.2 This parameter is guaranteed by engineering design and test, and is not production tested.

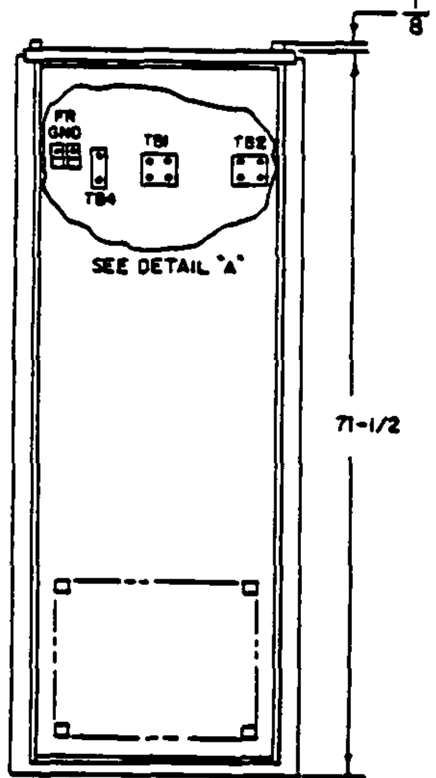
## 2. DIMENSIONS



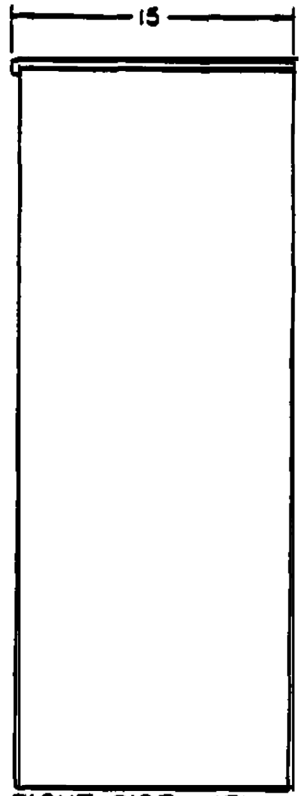

TOP VIEW
FIG. 3



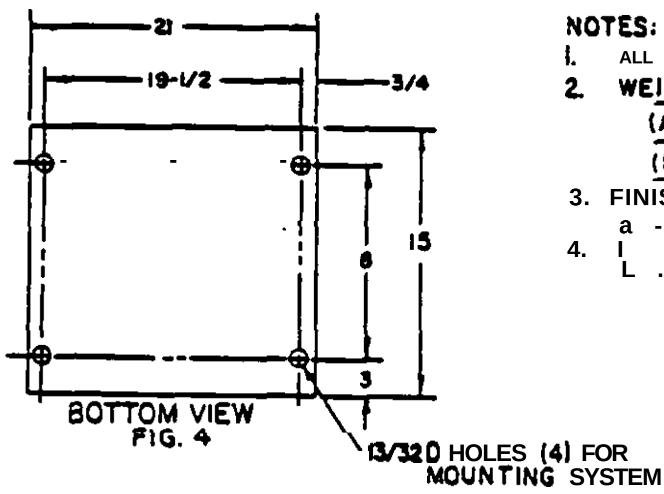

DETAIL "A"




FRONT VIEW
FIG. 1




RIGHT SIDE VIEW
FIG. 2




BOTTOM VIEW
FIG. 4

**NOTES:**

1. ALL DIMENSIONS ARE IN INCHES
2. WEIGHT

| WEIGHT | WDA3028 | WDA5028 |
|---|---|---|
| (A) SHIPPING: | 610 LBS | 830 LBS |
| (B) NET: | 495 LBS | 690 LBS |

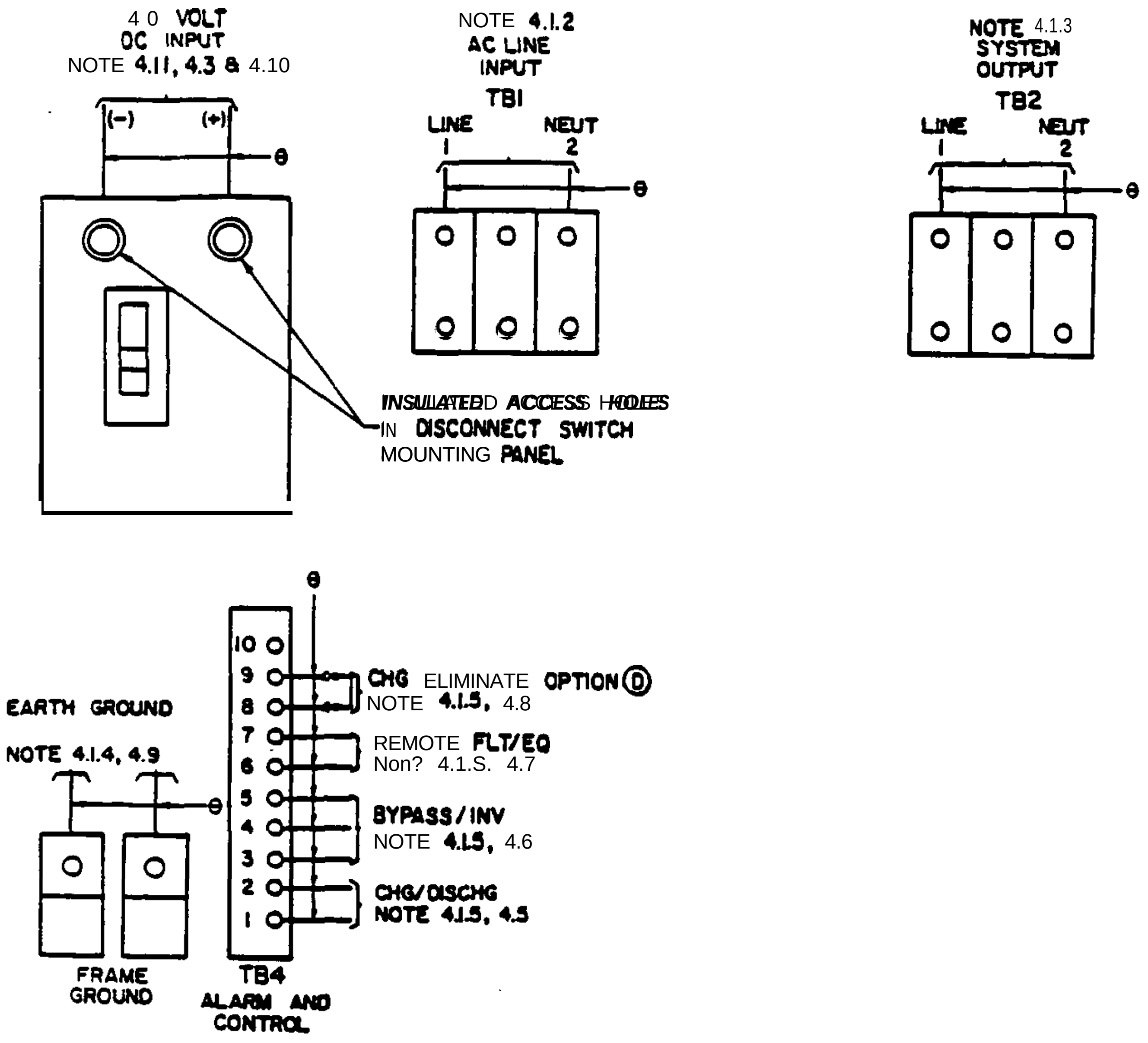
3. FINISH: EQUIPMENT LIGHT GRAY
4. ▭ INDICATES VENTILATING GRILLE

PD 5177- 316-(

PD5176-304-

# 3. INSTALLER'S CONNECTIONS

## 3.1 MODEL WDA302B

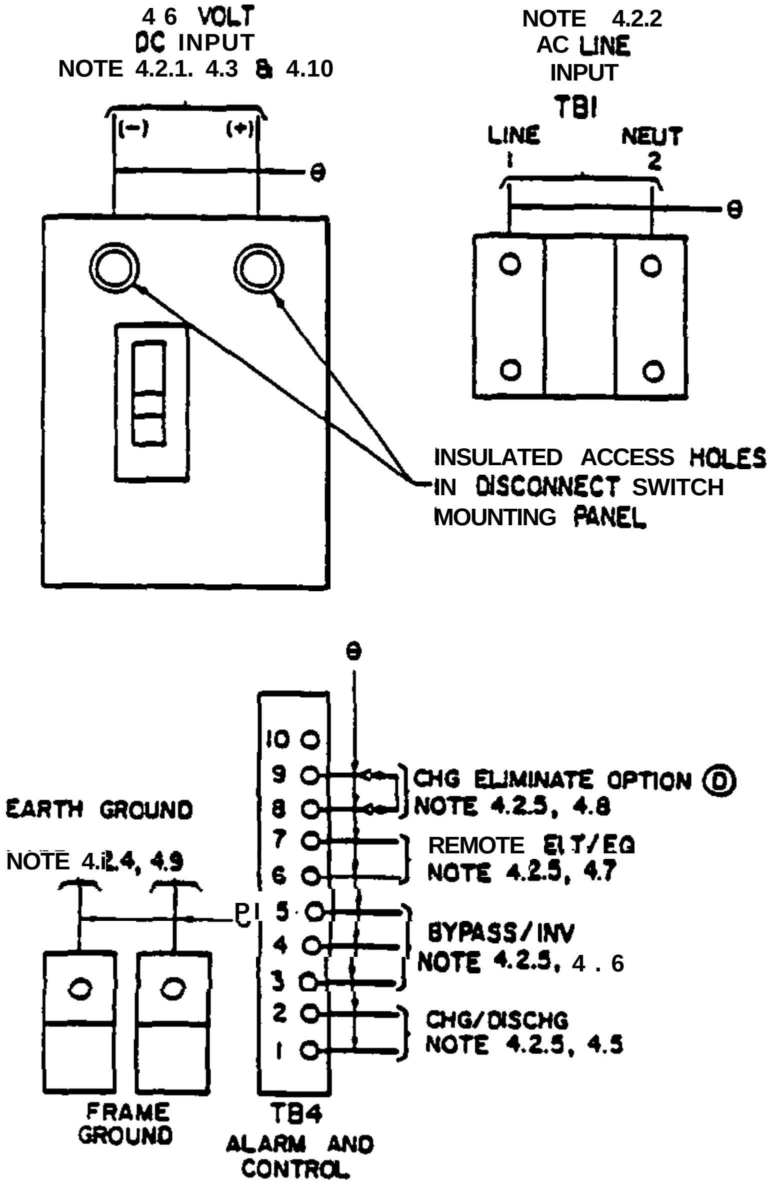



'05177-316-00

'05176-304-00

# 3. INSTALLER'S CONNECTIONS

## 3.2 MOOEL WDA502B




PD5177-316-00

PD5176-304-00

# 4. INSTALLER'S INFORMATION NOTES

**4.1 MODEL WDA302B**

**4.1.1**

| DC INPUT TO DISCONNECT SWITCH S1 | | | | |
|---|---|---|---|---|
| Terminals | | Loop Length | Recm Wire | Recm |
| Capacity | Type | Ft. Note 4.3 | Size | Fusing |
| 6 Ga. to 3/0 Ga. | 5/16-inch Allen socket screw | 88 | 1 Ga. | 125 Amp |
| | | 112 | 1/0 Ga. | |
| | | 140 | 2/0 Ga. | |

**4.1.2**

| AC LINE INPUT (TB1) | | | |
|---|---|---|---|
| Terminals | | Recm | Recm |
| Capacity | Type | Wire Size | Fusing |
| 18-2 Ga. | Saddle Clamp | 6 Ga. | 60 Amp |

**4.1.3**

| SYSTEM OUTPUT (TB2) | | |
|---|---|---|
| Terminals | | Recm |
| Capacity | Type | Wire Size |
| 18-2 Ga. | Saddle Clamp | 8 Ga. |

**4.1.4**

| FRAME GROUND (FR CNO, | | |
|---|---|---|
| Terminals | | Recm |
| Capacity | Size | Wire Size |
| 1/0-14 Ga. | Saddle Clamp | 6 Ga. |

**4.1.5**

| ALARM AND CONTROL (TB4) | | |
|---|---|---|
| Terminals | | Recm |
| Capacity | Type | Wire Sire |
| 16 Ga. Max. | 6-32 Screw | 16 Ga. |

# 4. INSTALLER'S INFORMATION NOTES

**4.2 MODEL WDA502B**

**4.2.1**

| DC INPUT TO DISCONNECT SWITCH S1 | | | | |
|---|---|---|---|---|
| Terminals | | Loop Length | Recm Wire | Recm |
| Capacity | Type | Ft. Note 4.3 | Size | Fusing |
| 6 Ga. to 3/0 Ga. | 5/16-inch Allen socket screw | 100 | 3/0 Ga. | 200 Amp |

**4.2.2**

| AC LINE INPUT (TB1) | | | |
|---|---|---|---|
| Terminals | | Recm | Recm |
| Capacity | Type | Wire Size | Fusing |
| 4-2/0 Ga. | Saddle Clamp | 4 Ga. | 50 Amp |

r.2.3

| SYSTEM OUTPUT (TB2) | | |
|---|---|---|
| Terminals | | Recm |
| Capacity | Type | Wire Size |
| 4-2/0 Ga. | Saddle Clamp | 4 Ga. |

**4.2.4**

| FRAME GROUND (FR GND) | | |
|---|---|---|
| Terminals. | | Recm |
| Capacity | Size | Wire Sire |
| 1/0-14 Ga. | Saddle Clamp | 6 Ga. |

**4.2.5**

| ALARM AND CONTROL (TB4) | | |
|---|---|---|
| Terminals | | Recm |
| Capacity | Type | Wire Size |
| 16 Ga. Max. | 6-32 Screw | 16 Ga. |

# 4. INSTALLER'S INFORMATION NOTES

4.3 DC input wiring is sufficient to restrict voltage drop to one volt or less at rated current for loop lengths shown. Loop length is the sum of positive and negative lead lengths.

4.4 Wire sizes based on recommendations of the National Electrical Code Table 310-16 for copper wire at 75 °C conductor temperature, operating in an ambient of 30 °C. For operation in ambient higher than 30 °C, apply derating factors listed in Table 310-16 of the National Electrical Code.

4.5 Terminals 1 and 2 of TB4 are connected internally to a relay contact, rated at 1.0 amp, 30 VDC. An open circuit is present when the system is charging the battery, and a closed circuit is present while battery is discharging to supply inverter input power.

4.6 Terminals 3 through 5 of TB4 are connected internally to relay contacts rated at 1.0 amp, 30 VDC. When system bypass circuits are activated, an open circuit is present at terminals 3 and 4, and a closed circuit is present at terminals 4 and 5. When system output supplies the load, using either the AC line or inverter as the primary source, a closed circuit is prsent at terminals 3 and 4, and an open circuit is present at terminals 4 and 5.

4.7 An external SPST switch connected to terminals 6 and 7 of TB4 can be used for remote control of battery float and equalize function. With FLOAT/EQUALIZE switch on system front panel set to EQUALIZE position, the battery may be charged at equalize voltage by providing an open circuit at TB4, terminals 5 and 6. Closing the circuit at these terminals provides float voltage to the battery.

4.8 Connect a jumper to TB4 terminals 8 and 9 to disable the battery charging feature of the system. Refer to instruction form for complete description and adjustment details.

4.9 This terminal must be connected to earth ground, not power system neutral. Equipment grounding conductor size based on recommendations of the National Electrical Code Table 250-95 for copper wire. If aluminum or copper clad aluminum grounding conductor is used, refer to Table 250-95 for increased conductor size.

4.10 For proper system operation, the positive terminal of the external battery must be grounded in compliance with National Electrical Code Article 250 and/or local codes or practices.

4.11 $\ominus$-indicates wiring furnished and connected by customer.

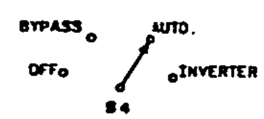
## PARTS LIST

| REF. DESIG. | DESCRIPTION | L.P. PART NO. | QUANTITY PER MODEL: WDA 5028 | SPARE PARTS QTY. LEVEL: MINIMUM | ON SITE | DEPOT |
|---|---|---|---|---|---|---|
| C1, C2 | 0.01UF, 250V AC | 2714-502 | 2 | | | |
| C21 | 6.0UF, 660V AC | 2714-560 | 1 | | | |
| C4-8 | 60000UF, 75V DC | 2731-595 | 5 | | | |
| C9 | 0.5UF, 660V AC | 2714-525 | 1 | | | |
| C10 | 40UF, 400V DC | 2716-362 | 1 | | | |
| C11 | 9UF, 370V AC | 2714-578 | 1 | | | |
| C12-18 | 50UF, 600V AC | 2714-767 | 7 | | | |
| C22 | 1UF, 250V AC | 2714-539 | 1 | | | |
| C19, C20 | 0.25UF, 600V DC | 2715-257 | 2 | | | |
| C23 | 0-30UF, 660V AC | FACT. SEL | 1 | | | |
| C24 | 2UF, 100V DC | 2713-198 | 1 | | | |
| C25 | 1.5KUF, 75V DC | 2731-235 | 1 | | | |
| C30, C31 | 0.1UF, 250V AC | 2714-513 | 2 | | | |
| CR4 | DIODE | 2812-310 | 1 | | | |
| CR5, 8 | DIODE | 2814-238 | 2 | | | |
| CR6, CR7 | THYRISTOR | 2863-255 | 2 | | | |
| CR9, 10 | THYRISTOR | 2864-127 | 2 | | | |
| CR11 | ZENER 3.6V 5W | 2834-414 | 1 | | | |
| F1, 2, 5 | 3A, 250V AGC-3 | 2483-233 | 3 | | | |
| F3 | 150 AMP, 250V, NON150 | 2483-541 | 1 | | | |
| F4 | 300 AMP, 500V, | 2485-427 | 1 | | | |
| F6 | 2 AMP, 125V, MDL-2 | 2484-233 | 1 | | | |
| F7, 8, 9 | 1AMP, 250V, AGC-1 | 2483-222 | 3 | | | |
| F10 | 10 AMP 250V | 2483-258 | 1 | | | |
| L1 | INDUCTOR, FILTER | 4411-574 | 1 | | | |
| L2 | INDUCTOR, COMM. | 4411-134 | 1 | | | |
| L3 | INDUCTOR, LINE | 4415-042 | 1 | | | |
| L4 | INDUCTOR, C.M. | 4431-135 | 1 | | | |
| L5 | INDUCTOR, C.M. | 4431-136 | 1 | | | |
| L6 | INDUCTOR, DIFF. | 4411-174 | 1 | | | |
| A1 | P.C. CONTROL CARD | 4864-732 | 1 | | | |
| A2 | POWER SUPPLY & GATE DRIVE CARD | 4864-222 | 1 | | | |
| A5, A6 | R C NETWORK | 2881-118 | 2 | | | |
| K1, 2 | RELAY, 50A | 2561-437 | 2 | | | |
| K3 | RELAY, 48VDC COIL | 2543-797 | 1 | | | |
| K4, 5 | RELAY, 120V COIL | 2546-482 | 2 | | | |
| R1 | 200A/50MV SHUNT | 2982-714 | 1 | | | |
| R2 | 300 OHM, 25W | 2656-548 | 1 | | | |
| R3 | 3.9K, 10W | 2652-841 | 1 | | | |
| R4 | 15K, 1W | 2635-680 | 1 | | | |
| R5 | 25 OHM, 10W | 2652-437 | 1 | | | |
| R6 | 10 OHM, 10W | 2652-427 | 1 | | | |
| R11 | 3.3K 1/2W | 2615-275 | 1 | | | |
| R10 | 5.1 OHM, 22W | 2663-667 | 1 | | | |
| R12 | 10 OHM, 25W | 2663-710 | 1 | | | |
| S3, 2 | 100A, SPST | 2513-852 | 2 | | | |
| S1 | 225A, DC DISCONNECT | 2513-860 | 1 | | | |
| S4 | 1 POLE 4 POSITION | 2521-143 | 1 | | | |
| S5 | 2 POLE 2 POSITION | 2513-316 | 1 | | | |
| T1 | POWER XFMR | 4561-013 | 1 | | | |
| T2, 3 | SIGNAL XFMR | 4443-621 | 2 | | | |
| T4 | CURRENT XFMR | 2413-211 | 1 | | | |
| DS1 | RED L.E.D | 2818-127 | 1 | | | |
| M1 | DC VOLTS 0-75 | 2943-425 | 1 | | | |
| M2 | DC AMPS 200-0-200 | 2923-487 | 1 | | | |
| M3 | AC VOLTS 0-150 | 2953-415 | 1 | | | |
| M4 | AC AMPS 0-75 | 2933-419 | 1 | | | |
| RV1 | 250V VARISTOR | 2676-341 | 1 | | | |
| B1 | 120V FAN | 2431-548 | 1 | | | |

* INDICATES THE PART OR ASSEMBLY IS LISTED MORE THAN ONCE, USE THE RECOMMENDED SPARE QUANTITY WHERE THE ITEM FIRST APPEARS.

NOTES:

1. WHEN THE BATTERY IS BEING CHARGED, TERMINALS 1 & 2 OF TB4 WILL BE OPEN. WHEN BATTERY IS BEING DISCHARGED, 1 & 2 OF TB4 WILL BE SHORTED. THIS CIRCUIT CAN WITHSTAND 120VAC OR 28V DC & CONDUCT 0.5 AMPS MAXIMUM.
2. WHEN THE ConstAC ® SYSTEM IS IN BYPASS MODE, TERMINALS 3 & 4 OF TB4 WILL BE OPEN, & 4 & 5 SHORTED. WHEN IN AN INVERTER MODE, TERMINALS 3 & 4 OF TB4 WILL BE SHORTED, & 4 & 5 OPEN. THIS CIRCUIT CAN WITHSTAND 120VAC OR 28V DC & CONDUCT 0.5 AMPS MAXIMUM.
3. WHEN LOCAL FL/EQ SWITCH ON A1 IS SET TO EQUALIZE, SYSTEM CAN BE PUT INTO FLOAT REMOTELY BY SHORTING BETWEEN TERMINALS 6 & 7 OF TB4. REMOVING THE SHORT WILL PUT THE SYSTEM INTO EQUALIZE.
4. RESERVED
5. WIPER OF S4 (PIN 5) IS +15VDC WITH RESPECT TO COMMON OF A1 (4864-221)




6. OPTION (D) IS PROVIDED WHEN ConstAC ® SYSTEM IS WORKING IN CONJUNTION WITH AN EXTERNAL BATTERY CHARGER.
   POT. R46 ON A1 IS ADJUSTED FOR ZERO BATTERY CURRENT WHEN STATIC SWITCH IS OPERATED.

## REVISIONS

1 NEW → JAN 25 1982

1A 2-15-82 D.A.C.
METER ASSY. PART NO. UPDATED

2 1837807 5-13-82 D.A.C.
C12-C18 WAS 2714-766
MAY 18 1982

3 1837886 10-9-82 T.F.M.
C24 ADDED, DESIG RV1 WAS MOV1.

4 1837653 4-15-83 T.F.M.
C21, 22, 23, 25, L4, R10, M1, 2, 3 & 4 ADDED; C2, CR2, 3 & OPTION B REMOVED; T1 WAS 4561-011, T4 WAS CT1, NOTE 4 RESERVED.

5 1838172 9-14-83 TJI
A1 WAS 4864-221; R7, 8 REMOVED
OCT 5 1983 BP

CONVERSION TO LAMPS

F1 1838903 3-11-85 J.R.
CHGD K4 COIL WIRING.
MAR 22 1985 BP

G1 1838907 7-12-85 TJI
A1 WAS 4864-419; RSP ASSY DELETED
JUL 15 1985 BP

H1 1838783 9/25/85 R.L.
SLOW CHARGE CIRCUITRY ADDED
DEC 1985 BP

J1 1830096 10-29-87 JR
EMI SUPPRESSION UPDATED.
L4, C19, C20, C21, C22 CHANGED.
C3 REMOVED & L5, L6, C1, C2, C30, C31 ADDED.
DEC 10 1987 BP

J2 5-19-88 JR
CONNECTION POINT OF CAP. C9 CORRECTED PER W. COLLEY
MAY 20 1988 BP

J3 9-13-88 G.R.F.
ADDED PT. NO. SD5177-319-00 PER O. LYONS.
SEP 14 1988 BP

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181-7095 UL VERSION

SCHEMATIC DIAGRAM FOR MODEL WDA5028

LORAIN PRODUCTS CORPORATION
LORAIN, OHIO

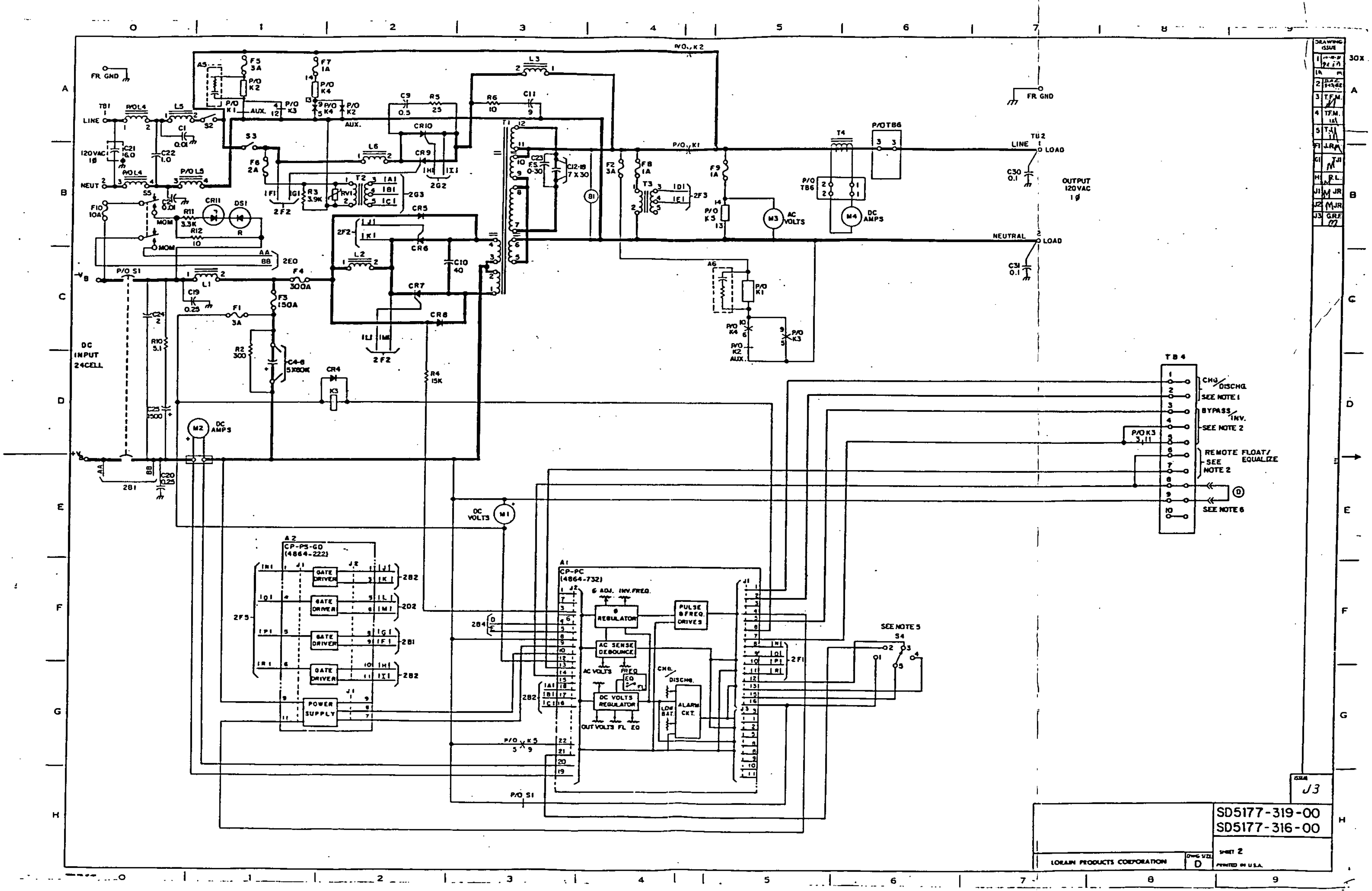
| | |
|---|---|
| DESIGN S. HUSSEY | J3 |
| J. REESE | 10-23-81 |
| S. Hussey | 1-19-82 |
| CHECKED BY | DATE |
| APPROVED | DATE |
| STANDARD | |

SIZE D

SD5177-319-00
SD5177-316-00

SHEET 1 OF 2

PRINTED IN U.S.A.


SD5177-319-00
SD5177-316-00
LORAIN PRODUCTS CORPORATION
SHEET 2
PRINTED IN U.S.A.
D
J3
DC INPUT 24CELL
OUTPUT 120VAC 1Ø
A2 CP-PS-GD (4864-222)
A1 CP-PC (4864-732)
GATE DRIVER
POWER SUPPLY
PULSE & FREQ. DRIVES
AC SENSE DEBOUNCE
DC VOLTS REGULATOR
ALARM CKT.
TB4
REMOTE FLOAT/ EQUALIZE
SEE NOTE 5
SEE NOTE 6

## COMPONENT LIST

### CAPACITORS

| | DESIG | CODE |
|---|---|---|
| (3) | C1,2,3 | (2731-166) 250UF,25V |

### DIODES

| | DESIG | CODE |
|---|---|---|
| (4) | CR1,4,7,10 | (2812-223) IN5059 |
| (4) | CR2,5,8,11 | (2836-117) IN3020A,10V |
| (4) | CR3,6,9,12 | (2812-220) A114B |
| | CR13 | (2836-257) IN2979RA,15V |
| | CR14 | (2836-258) IN2979A, 15 V |
| | CR15 | (2835-411) IN4736A,6.8V |

### INTEGRATED CIRCUITS

| DESIG | CODE |
|---|---|
| A1 | (2871-103) 741C |

### RESISTORS

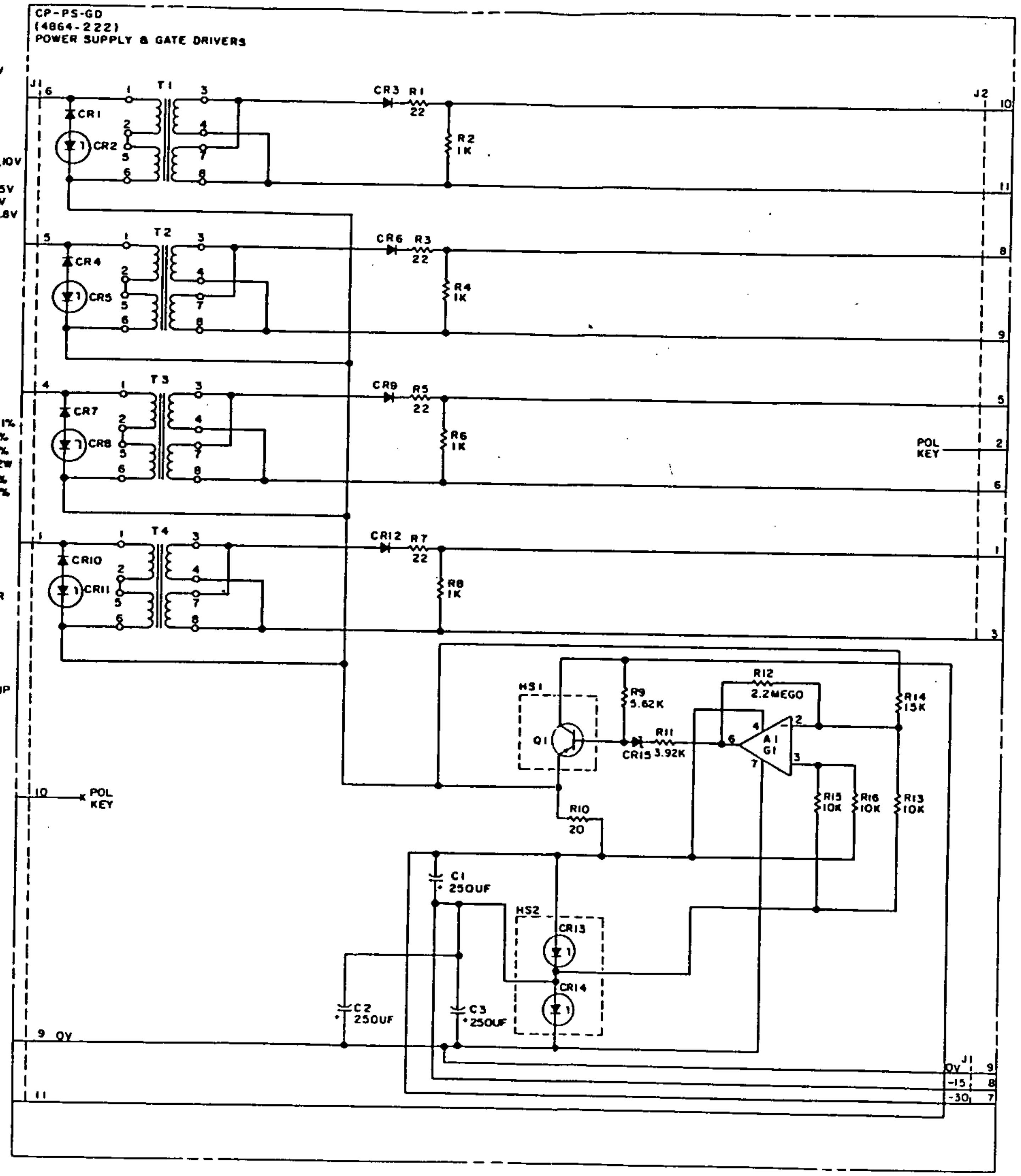
| | DESIG | CODE |
|---|---|---|
| (4) | R1,3,5,7 | (2651-135) 22 Ω,3W,5% |
| (4) | R2,4,6,8 | (2615-263) 1K,1/2W |
| | R 9 | (2634-636) 5.62K, 1/4W, 1% |
| | R10 | (2652-433) 20 Ω, 11W,5% |
| | R11 | (2634-627) 3.92K,1/4W,1% |
| | R12 | (2615-343) 2.2 MEGO, 1/2W |
| (3) | R13,15,16 | (2634-648) 10K,1/4W,1% |
| | R14 | (2634-656) 15K,1/4W,1% |

### TRANSFORMERS

| | DESIG | CODE |
|---|---|---|
| (4) | T1-4 | (4471-007) PULSE XFMR |

### TRANSISTOR

| DESIG | CODE |
|---|---|
| Q1 | (2844-080) 2N6299 PNP DARL. |




## CIRCUIT DESCRIPTION

THIS CARD CONSISTS OF CIRCUITRY REQUIRED TO REGULATE SUPPLY VOLTAGES AND PROVIDE ISOLATED DRIVES TO FOUR SCR GATES.

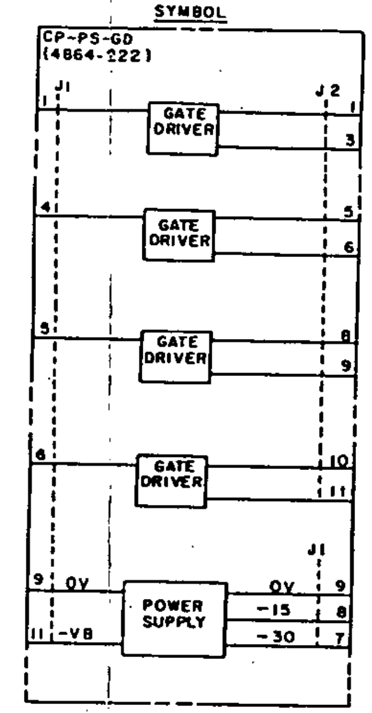
THE SUPPLY REGULATES 24 CELL VOLTAGE TO -30V AND -15V REFERENCED TO + BAT. THE MAX RIPPLE VOLTAGE IS 50mV. Q1 AND A1 CONFIGURATION REGULATE BAT. INPUT CURRENT TO APPROXIMATELY 170mA FROM 42V - 56V AND SUPPLY APPROXIMATELY 35V TO PRIMARY OF PULSE XFMRS.. ON 60 CELL SYSTEMS, A 510 Ω/25W RESISTOR IS PLACED IN SERIES WITH $-V_{BAT}$ AND J1-11.

THE DRIVERS ARE THE INTERFACE TO THE SCR FROM THE DRIVE ELECTRONICS. THE PRIMARYS OF THE PULSE XFMRS ARE PULLED HIGH TO 0V. MAX DUTY CYCLE IS 12.5%. MAX PULSE WIDTH IS 40 µSEC. 10/90 RISE TIME 1 µSEC. WHEN USING 4864-162 DRIVER CONFIGURATION. OPEN CIRCUIT VOLTAGE AT J2 CONNECTOR IS + 10 VOLTS.

### MANUFACTURING REFERENCES

| CATEGORY | NUMBER |
|---|---|
| ASSEMBLY DRAWING | 4864-222 |
| P.W. BOARD | 3158-449 |
| CONNECTOR ON FRAME | |

### SYMBOL




NOTES:

1. UNLESS OTHERWISE SPECIFIED, RESISTANCE VALUES ARE IN OHMS AND CAPACITANCE VALUES ARE IN MICROFARADS; VALUES PRECEDED BY THE SYMBOL + (PLUS) OR – (MINUS) ARE IN VOLTS.
2. CODES IN PARENTHESES AS (2731-166) REPRESENT L.P.C. PART NUMBERS.

### REVISIONS

| | |
|---|---|
| 1 | NEW FEB 19 1981 |
| 2 | 1837510 4-16-81 T.T. R9 CHANGED |
| 3 | 1837827 7-12-82 T.F.M. R9 & R11 WERE 825Ω & 1K RESP. |
| 4 | 1837922 1-7-83 D.A.C. CORRECT J1 & J2 P/N NUMBERS |
| 5 | 1838403 5/7/84 R.L. Q1 WAS 2844-043, R9 WAS 2634-605, R10 WAS 2651-488, R11 WAS 2634-608, CR15 ADDED. |
| 6 | 1838590 6-18-84 T.F.M. R9, R11 & CR15 WERE 2634-623, 2634-597 & 2836-235 RESP. JUN 19 1984 |

181-7172

SCHEMATIC DIAGRAM FOR POWER SUPPLY & GATE DRIVERS

| | |
|---|---|
| DESIGN | S.HUSSEY |
| DRAWN BY | J.TUTTLE |
| DATE | 2-16-81 |
| STANDARD | |

LORAIN PRODUCTS CORPORATION
LORAIN, OHIO

DWG SIZE D

SD4864-222

SHEET 1 OF 1

| UNIT QTY. | REF. DESIG. | PART NO. | PART DESCRIPTION | |
|---|---|---|---|---|
| 1 | SW1 | 2513-40200 | | 20VAC/DC |
| 3 | K1 | 2543-44200 | 48V. RELAY | |
| | K2 | 2543-44200 | 48V. RELAY | |
| | K3 | 2543-44200 | 48V. RELAY | |
| 1 | R54 | 2634-56700 | 221 | 1/4W |
| 1 | R42 | 2634-57000 | 274 | 1/4W |
| 1 | R43 | 2634-59400 | 825 | 1/4W |
| 10 | R11 | 2634-60900 | 1.82K | 1/4W |
| | R122 | 2634-60900 | 1.82K | 1/4W |
| | R124 | 2634-60900 | 1.82K | 1/4W |
| | R126 | 2634-60900 | 1.82K | 1/4W |
| | R128 | 2634-60900 | 1.82K | 1/4W |
| | R130 | 2634-60900 | 1.82K | 1/4W |
| | R135 | 2634-60900 | 1.82K | 1/4W |
| | R81 | 2634-60900 | 1.82K | 1/4W |
| | R89 | 2634-60900 | 1.82K | 1/4W |
| | R87 | 2634-60900 | 1.82K | 1/4W |
| 2 | R44 | 2634-61900 | 2.74K | 1/4W |
| | R47 | 2634-61900 | 2.74K | 1/4W |
| 5 | R28 | 2634-62300 | 3.32K | 1/4W |
| | R82 | 2634-62300 | 3.32K | 1/4W |
| | R86 | 2634-62300 | 3.32K | 1/4W |
| | R98 | 2634-62300 | 3.32K | 1/4W |
| | R99 | 2634-62300 | 3.32K | 1/4W |
| 8 | R104 | 2634-63400 | 5.11K | 1/4W |
| | R156 | 2634-63400 | 5.11K | 1/4W |
| | R157 | 2634-63400 | 5.11K | 1/4W |
| | R158 | 2634-63400 | 5.11K | 1/4W |
| | R159 | 2634-63400 | 5.11K | 1/4W |
| | R36 | 2634-63400 | 5.11K | 1/4W |
| | R8 | 2634-63400 | 5.11K | 1/4W |
| | R9 | 2634-63400 | 5.11K | 1/4W |
| 9 | R115 | 2634-63600 | 5.62K | 1/4W |
| | R116 | 2634-63600 | 5.62K | 1/4W |
| | R117 | 2634-63600 | 5.62K | 1/4W |
| | R118 | 2634-63600 | 5.62K | 1/4W |
| | R121 | 2634-63600 | 5.62K | 1/4W |
| | R140 | 2634-63600 | 5.62K | 1/4W |
| | R146 | 2634-63600 | 5.62K | 1/4W |
| | R60 | 2634-63600 | 5.62K | 1/4W |
| | R92 | 2634-63600 | 5.62K | 1/4W |
| 28 | R103 | 2634-64800 | 10K | 1/4W |
| | R106 | 2634-64800 | 10K | 1/4W |
| | R108 | 2634-64800 | 10K | 1/4W |
| | R109 | 2634-64800 | 10K | 1/4W |
| | R110 | 2634-64800 | 10K | 1/4W |
| | R123 | 2634-64800 | 10K | 1/4W |
| | R125 | 2634-64800 | 10K | 1/4W |
| | R127 | 2634-64800 | 10K | 1/4W |
| | R129 | 2634-64800 | 10K | 1/4W |
| | R131 | 2634-64800 | 10K | 1/4W |
| | R133 | 2634-64800 | 10K | 1/4W |
| | R136 | 2634-64800 | 10K | 1/4W |
| | R137 | 2634-64800 | 10K | 1/4W |
| | R154 | 2634-64800 | 10K | 1/4W |
| | R160 | 2634-64800 | 10K | 1/4W |
| | R170 | 2634-64800 | 10K | 1/4W |
| | R171 | 2634-64800 | 10K | 1/4W |
| | R3 | 2634-64800 | 10K | 1/4W |
| | R33 | 2634-64800 | 10K | 1/4W |
| | R4 | 2634-64800 | 10K | 1/4W |
| | R50 | 2634-64800 | 10K | 1/4W |
| | R61 | 2634-64800 | 10K | 1/4W |
| | R66 | 2634-64800 | 10K | 1/4W |
| | R67 | 2634-64800 | 10K | 1/4W |
| | R72 | 2634-64800 | 10K | 1/4W |
| | R80 | 2634-64800 | 10K | 1/4W |
| | R82 | 2634-64800 | 10K | 1/4W |
| | R95 | 2634-64800 | 10K | 1/4W |
| 5 | R20 | 2634-65200 | 12.1K | 1/4W |
| | R78 | 2634-65200 | 12.1K | 1/4W |
| | R87 | 2634-65200 | 12.1K | 1/4W |
| | R90 | 2634-65200 | 12.1K | 1/4W |
| | R93 | 2634-65200 | 12.1K | 1/4W |
| 1 | R45 | 2634-65500 | 14.3K | 1/4W |
| 2 | R48 | 2634-65600 | 15K | 1/4W |
| | R75 | 2634-65600 | 15K | 1/4W |
| 2 | R29 | 2634-65700 | 16.9K | 1/4W |
| | R37 | 2634-65700 | 16.9K | 1/4W |
| 9 | R107 | 2634-66400 | 20.5K | 1/4W |
| | R134 | 2634-66400 | 20.5K | 1/4W |
| | R162 | 2634-66400 | 20.5K | 1/4W |
| | R56 | 2634-66400 | 20.5K | 1/4W |
| | R57 | 2634-66400 | 20.5K | 1/4W |
| | R59 | 2634-66400 | 20.5K | 1/4W |
| | R68 | 2634-66400 | 20.5K | 1/4W |
| | R76 | 2634-66400 | 20.5K | 1/4W |
| | R79 | 2634-66400 | 20.5K | 1/4W |
| 2 | R70 | 2634-66500 | 22.1K | 1/4W |
| | R84 | 2634-66500 | 22.1K | 1/4W |
| 3 | R105 | 2634-67000 | 27.4K | 1/4W |
| | R52 | 2634-67000 | 27.4K | 1/4W |
| | R88 | 2634-67000 | 27.4K | 1/4W |
| 5 | R1 | 2634-68100 | 47.5K | 1/4W |
| | R10 | 2634-68100 | 47.5K | 1/4W |
| | R148 | 2634-68100 | 47.5K | 1/4W |
| | R155 | 2634-68100 | 47.5K | 1/4W |
| | R6 | 2634-68100 | 47.5K | 1/4W |
| 1 | R102 | 2634-68800 | 68.1K | 1/4W |
| 12 | R12 | 2634-69600 | 100K | 1/4W |
| | R13 | 2634-69600 | 100K | 1/4W |
| | R14 | 2634-69600 | 100K | 1/4W |
| | R144 | 2634-69600 | 100K | 1/4W |
| | R168 | 2634-69600 | 100K | 1/4W |
| | R25 | 2634-69600 | 100K | 1/4W |
| | R27 | 2634-69600 | 100K | 1/4W |
| | R34 | 2634-69600 | 100K | 1/4W |
| | R39 | 2634-69600 | 100K | 1/4W |
| | R5 | 2634-69600 | 100K | 1/4W |

| UNIT QTY. | REF. DESIG. | PART NO. | PART DESCRIPTION | |
|---|---|---|---|---|
| | R7 | 2634-69600 | 100K | 1/4W |
| | R94 | 2634-69600 | 100K | 1/4W |
| 4 | R35 | 2634-69700 | 95.3K | 1/4W |
| | R65 | 2634-69700 | 95.3K | 1/4W |
| | R69 | 2634-69700 | 95.3K | 1/4W |
| | R71 | 2634-69700 | 95.3K | 1/4W |
| 2 | R100 | 2634-70300 | 133K | 1/4W |
| | R26 | 2634-70300 | 133K | 1/4W |
| 5 | R15 | 2634-70800 | 165K | 1/4W |
| | R16 | 2634-70800 | 165K | 1/4W |
| | R19 | 2634-70800 | 165K | 1/4W |
| | R53 | 2634-70800 | 165K | 1/4W |
| | R91 | 2634-70800 | 165K | 1/4W |
| 1 | R163 | 2634-70900 | 182K | 1/4W |
| 5 | R101 | 2634-71400 | 221K | 1/4W |
| | R111 | 2634-71400 | 221K | 1/4W |
| | R147 | 2634-71400 | 221K | 1/4W |
| | R169 | 2634-71400 | 221K | 1/4W |
| | R22 | 2634-71400 | 221K | 1/4W |
| 3 | R138 | 2634-71900 | 274K | 1/4W |
| | R63 | 2634-71900 | 274K | 1/4W |
| | R77 | 2634-71900 | 274K | 1/4W |
| 4 | R167 | 2634-72300 | 332K | 1/4W |
| | R21 | 2634-72300 | 332K | 1/4W |
| | R41 | 2634-72300 | 332K | 1/4W |
| | R51 | 2634-72300 | 332K | 1/4W |
| 6 | R151 | 2634-73100 | 499K | 1/4W |
| | R17 | 2634-73100 | 499K | 1/4W |
| | R24 | 2634-73100 | 499K | 1/4W |
| | R30 | 2634-73100 | 499K | 1/4W |
| | R31 | 2634-73100 | 499K | 1/4W |
| | R49 | 2634-73100 | 499K | 1/4W |
| 1 | R113 | 2634-74500 | 1MEG | 1/4W |
| 1 | R58 | 2635-66000 | 4.99K | 1W |
| 1 | R112 | 2635-71600 | 90.9K | 1W |
| 1 | R120 | 2635-75000 | 422K | 1W |
| 1 | R55 | 2652-45200 | 75 | 11W |
| 2 | R141 | 2668-60100 | 0 | 1/4W |
| | R142 | 2668-60100 | 0 | 1/4W |
| 1 | R23 | 2675-11400 | 2K | 1/2W. POT |
| 3 | R64 | 2675-12100 | 20K | 1/2W. POT |
| | R74 | 2675-12100 | 20K | 1/2W. POT |
| | R85 | 2675-12100 | 20K | 1/2W. POT |
| 1 | R46 | 2675-12400 | 2K | 1/2W. POT |
| 2 | R38 | 2675-12600 | 50K | 1/2W. POT |
| | R40 | 2675-12600 | 50K | 1/2W. POT |
| 1 | C26 | 2713-22400 | 0.033UF | 200VDC |
| 1 | C1 | 2715-10600 | 0.1UF | 63VDC |
| 2 | C16 | 2715-11100 | 0.22UF | 100VDC |
| | C2 | 2715-11100 | 0.22UF | 100VDC |
| 2 | C13 | 2715-11400 | 0.33UF | 100VDC |
| | C20 | 2715-11400 | 0.33UF | 100VDC |
| 1 | C7 | 2715-11900 | 1UF | 100VDC |
| 1 | C17 | 2715-13000 | 2.2UF | 100VDC |
| 1 | C25 | 2724-12900 | 330PF | 500VDC |
| 1 | C15 | 2724-14600 | 680PF | 1000VDC |
| 10 | C12 | 2724-50900 | 0.1UF | 50VDC |
| | C14 | 2724-50900 | 0.1UF | 50VDC |
| | C22 | 2724-50900 | 0.1UF | 50VDC |
| | C29 | 2724-50900 | 0.1UF | 50VDC |
| | C41 | 2724-50900 | 0.1UF | 50VDC |
| | C42 | 2724-50900 | 0.1UF | 50VDC |
| | C46 | 2724-50900 | 0.1UF | 50VDC |
| | C47 | 2724-50900 | 0.1UF | 50VDC |
| | C52 | 2724-50900 | 0.1UF | 50VDC |
| | C53 | 2724-50900 | 0.1UF | 50VDC |
| 4 | C54 | 2724-54200 | 470PF | 50VDC |
| | C55 | 2724-54200 | 470PF | 50VDC |
| | C56 | 2724-54200 | 470PF | 50VDC |
| | C57 | 2724-54200 | 470PF | 50VDC |
| 9 | C4 | 2724-55000 | 1KPF | 50VDC |
| | C44 | 2724-55000 | 1KPF | 50VDC |
| | C45 | 2724-55000 | 1KPF | 50VDC |
| | C48 | 2724-55000 | 1KPF | 50VDC |
| | C49 | 2724-55000 | 1KPF | 50VDC |
| | C5 | 2724-55000 | 1KPF | 50VDC |
| | C50 | 2724-55000 | 1KPF | 50VDC |
| | C51 | 2724-55000 | 1KPF | 50VDC |
| | C9 | 2724-55000 | 1KPF | 50VDC |
| 1 | C11 | 2724-57500 | 5600PF | 50VDC |
| 6 | C10 | 2724-58000 | 10KPF | 50VDC |
| | C27 | 2724-58000 | 10KPF | 50VDC |
| | C28 | 2724-58000 | 10KPF | 50VDC |
| | C36 | 2724-58000 | 10KPF | 50VDC |
| | C37 | 2724-58000 | 10KPF | 50VDC |
| | C40 | 2724-58000 | 10KPF | 50VDC |
| 2 | C3 | 2724-63800 | 120PF | 100VDC |
| | C35 | 2724-63800 | 120PF | 100VDC |
| 2 | C18 | 2731-15100 | 150UF | 40VDC. ELECT. |
| | C19 | 2731-15100 | 150UF | 40VDC. ELECT. |
| 1 | C39 | 2737-10500 | 0.22UF | 35VDC. TANT. |
| 2 | C43 | 2737-12000 | 1UF | 35VDC. TANT. |
| | C8 | 2737-12000 | 1UF | 35VDC. TANT. |
| 1 | C31 | 2737-12900 | 2.2UF | 35VDC. TANT. |
| 2 | C32 | 2737-13700 | 10UF | 35VDC. TANT. |
| | C38 | 2737-13700 | 10UF | 35VDC. TANT. |
| 5 | C21 | 2737-13900 | 22UF | 35VDC. TANT. |
| | C23 | 2737-13900 | 22UF | 35VDC. TANT. |
| | C24 | 2737-13900 | 22UF | 35VDC. TANT. |
| | C33 | 2737-13900 | 22UF | 35VDC. TANT. |
| | C34 | 2737-13900 | 22UF | 35VDC. TANT. |
| 1 | C30 | 2737-14600 | 47UF | 35VDC. TANT. |
| 52 | CR1 | 2811-10100 | 1N4148 | |
| | CR10 | 2811-10100 | 1N4148 | |
| | CR11 | 2811-10100 | 1N4148 | |
| | CR12 | 2811-10100 | 1N4148 | |
| | CR13 | 2811-10100 | 1N4148 | |
| | CR16 | 2811-10100 | 1N4148 | |
| | CR17 | 2811-10100 | 1N4148 | |

| UNIT QTY. | REF. DESIG. | PART NO. | PART DESCRIPTION | |
|---|---|---|---|---|
| | CR18 | 2811-10100 | 1N4148 | |
| | CR19 | 2811-10100 | 1N4148 | |
| | CR2 | 2811-10100 | 1N4148 | |
| | CR22 | 2811-10100 | 1N4148 | |
| | CR23 | 2811-10100 | 1N4148 | |
| | CR24 | 2811-10100 | 1N4148 | |
| | CR3 | 2811-10100 | 1N4148 | |
| | CR33 | 2811-10100 | 1N4148 | |
| | CR34 | 2811-10100 | 1N4148 | |
| | CR35 | 2811-10100 | 1N4148 | |
| | CR36 | 2811-10100 | 1N4148 | |
| | CR37 | 2811-10100 | 1N4148 | |
| | CR38 | 2811-10100 | 1N4148 | |
| | CR39 | 2811-10100 | 1N4148 | |
| | CR40 | 2811-10100 | 1N4148 | |
| | CR41 | 2811-10100 | 1N4148 | |
| | CR42 | 2811-10100 | 1N4148 | |
| | CR43 | 2811-10100 | 1N4148 | |
| | CR46 | 2811-10100 | 1N4148 | |
| | CR52 | 2811-10100 | 1N4148 | |
| | CR53 | 2811-10100 | 1N4148 | |
| | CR55 | 2811-10100 | 1N4148 | |
| | CR56 | 2811-10100 | 1N4148 | |
| | CR57 | 2811-10100 | 1N4148 | |
| | CR58 | 2811-10100 | 1N4148 | |
| | CR59 | 2811-10100 | 1N4148 | |
| | CR60 | 2811-10100 | 1N4148 | |
| | CR61 | 2811-10100 | 1N4148 | |
| | CR63 | 2811-10100 | 1N4148 | |
| | CR64 | 2811-10100 | 1N4148 | |
| | CR65 | 2811-10100 | 1N4148 | |
| | CR66 | 2811-10100 | 1N4148 | |
| | CR67 | 2811-10100 | 1N4148 | |
| | CR68 | 2811-10100 | 1N4148 | |
| | CR69 | 2811-10100 | 1N4148 | |
| | CR7 | 2811-10100 | 1N4148 | |
| | CR70 | 2811-10100 | 1N4148 | |
| | CR71 | 2811-10100 | 1N4148 | |
| | CR72 | 2811-10100 | 1N4148 | |
| | CR76 | 2811-10100 | 1N4148 | |
| | CR79 | 2811-10100 | 1N4148 | |
| | CR80 | 2811-10100 | 1N4148 | |
| | CR81 | 2811-10100 | 1N4148 | |
| | CR82 | 2811-10100 | 1N4148 | |
| | CR83 | 2811-10100 | 1N4148 | |
| 3 | CR20 | 2812-11000 | 1N459A | |
| | CR21 | 2812-11000 | 1N459A | |
| | CR45 | 2812-11000 | 1N459A | |
| 1 | CR9 | 2812-22200 | 1N4003 | |
| 4 | CR15A | 2812-33000 | 1N4820 | |
| | CR15B | 2812-33000 | 1N4820 | |
| | CR15C | 2812-33000 | 1N4820 | |
| | CR15D | 2812-33000 | 1N4820 | |
| 4 | DS2 | 2818-12400 | LED. RED | |
| | DS4 | 2818-12400 | LED. RED | |
| | DS7 | 2818-12400 | LED. RED | |
| | DS9 | 2818-12400 | LED. RED | |
| 5 | DS1 | 2818-14100 | LED. GREEN | |
| | DS3 | 2818-14100 | LED. GREEN | |
| | DS5 | 2818-14100 | LED. GREEN | |
| | DS6 | 2818-14100 | LED. GREEN | |
| | DS8 | 2818-14100 | LED. GREEN | |
| 1 | CR27 | 2834-40200 | 1N4371 | 2.7V. ZENER |
| 1 | CR6 | 2834-40500 | 1N746 | 3.3V. ZENER |
| 1 | CR74 | 2835-32500 | 1N823 | 6.2V. ZENER |
| 5 | CR44 | 2835-41100 | 1N4736A | 6.8V. ZENER |
| | CR47 | 2835-41100 | 1N4736A | 6.8V. ZENER |
| | CR48 | 2835-41100 | 1N4736A | 6.8V. ZENER |
| | CR49 | 2835-41100 | 1N4736A | 6.8V. ZENER |
| | CR50 | 2835-41100 | 1N4736A | 6.8V. ZENER |
| 5 | Q1 | 2841-03600 | 2N5088 | |
| | Q12 | 2841-03600 | 2N5088 | |
| | Q13 | 2841-03600 | 2N5088 | |
| | Q15 | 2841-03600 | 2N5088 | |
| | Q6 | 2841-03600 | 2N5088 | |
| 2 | Q2 | 2843-03600 | 2N5087 | |
| | Q7 | 2843-03600 | 2N5087 | |
| 3 | Q14 | 2843-11000 | 2N5400 | |
| | Q4 | 2843-11000 | 2N5400 | |
| | Q5 | 2843-11000 | 2N5400 | |
| 4 | Q10 | 2844-06300 | TIP127 | |
| | Q11 | 2844-06300 | TIP127 | |
| | Q8 | 2844-06300 | TIP127 | |
| | Q9 | 2844-06300 | TIP127 | |
| 1 | A8 | 2871-00100 | 555 TIMER | |
| 1 | A2 | 2871-05100 | FUNCTION GEN | |
| 3 | A1 | 2871-11500 | OPAMP | |
| | A14 | 2871-11500 | OPAMP | |
| | A4 | 2871-11500 | OPAMP | |
| 3 | A24 | 2871-13100 | OPAMP | |
| | A25 | 2871-13100 | OPAMP | |
| | A3 | 2871-13100 | OPAMP | |
| 1 | A11 | 2875-32500 | MC14073BCP | |
| 2 | A13 | 2875-40100 | CA3081 | |
| | A21 | 2875-40100 | CA3081 | |
| 2 | A10 | 2876-10100 | FLIP-FLOP | |
| | A18 | 2876-10100 | FLIP-FLOP | |
| 1 | A7 | 2876-20200 | CD4538 | |
| 1 | A22 | 2876-30100 | CD4011 | |
| 1 | A5 | 2876-30400 | CD4070 | |
| 2 | A17 | 2876-31000 | INVERTER | |
| | A6 | 2876-31000 | INVERTER | |
| 2 | A15 | 2876-50100 | COUNTER | |
| | A16 | 2876-50100 | COUNTER | |
| 2 | A23 | 2876-50200 | COUNTER | |
| | A9 | 2876-50200 | COUNTER | |
| 1 | A19 | 2876-50800 | COUNTER | |
| 1 | A12 | 2876-80500 | ANALOG SW. | |

MANUFACTURING REFERENCES

| CATEGORY | NUMBER |
|---|---|
| ASSEMBLY DRAWING | 4864-732-00 |
| P.W.BOARD | 3156-717-00 |
| CONNECTOR ON FRAME | |

ISSUE CHANGES & REVISIONS

A1 JUN 11 1985 BP M

B1 1839494 7-23-86 O.A.C.
C2.C16 WERE 2715-11000. C13.C20 WERE 2715-11300. C7 WAS 2715-12100. C17 WAS 2715-12900
SEP 16 1986 7-29-86

C1 1830052 10-7-87 G.R.F.
SW1 WAS PT. NO. 2513-45300
OCT 22 1987

NOTES

1. UNLESS OTHERWISE SPECIFIED.RESISTANCE VALUES ARE IN OHMS.CAPACITANCE VALUES ARE IN MICROFARADS.VALUES PRECEDED BY THE SYMBOL +(PLUS) OR -(MINUS) ARE IN VOLTS
2. CODES SHOWN AS. 2513-453 REPRESENT LORAIN PART NUMBERS

1817332 CADD

DESIGN R.COLLEY — C1
DRAWN BY C.CHEVALIER DATE 4-1-85
CHECKED BY R.COLLEY DATE 6-11-85
D.CHEVALIER
APPROVED BY D.J.BECKER DATE 6-11-85
STANDARD

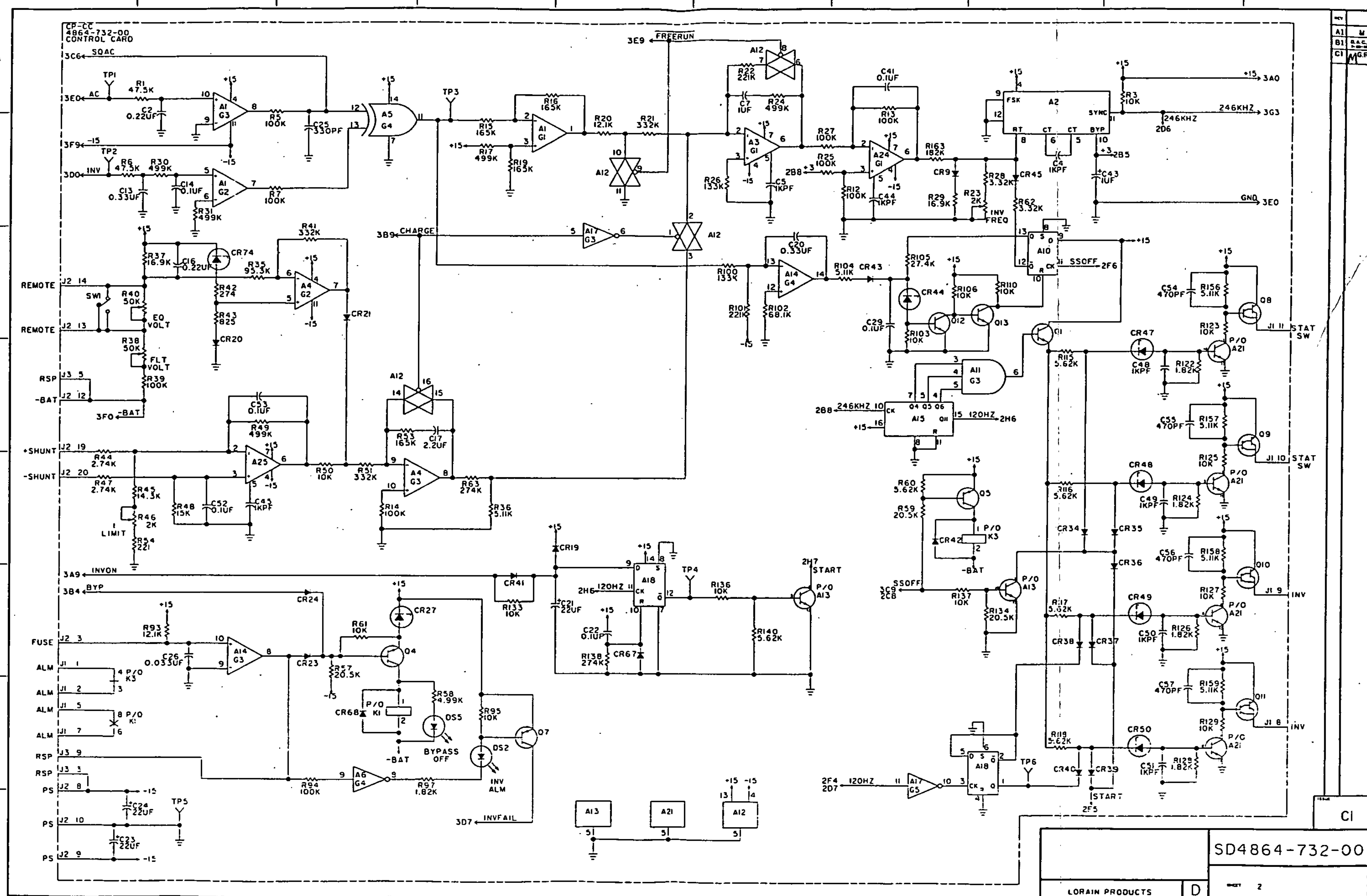
SCHEMATIC DIAGRAM FOR CONTROL CARD

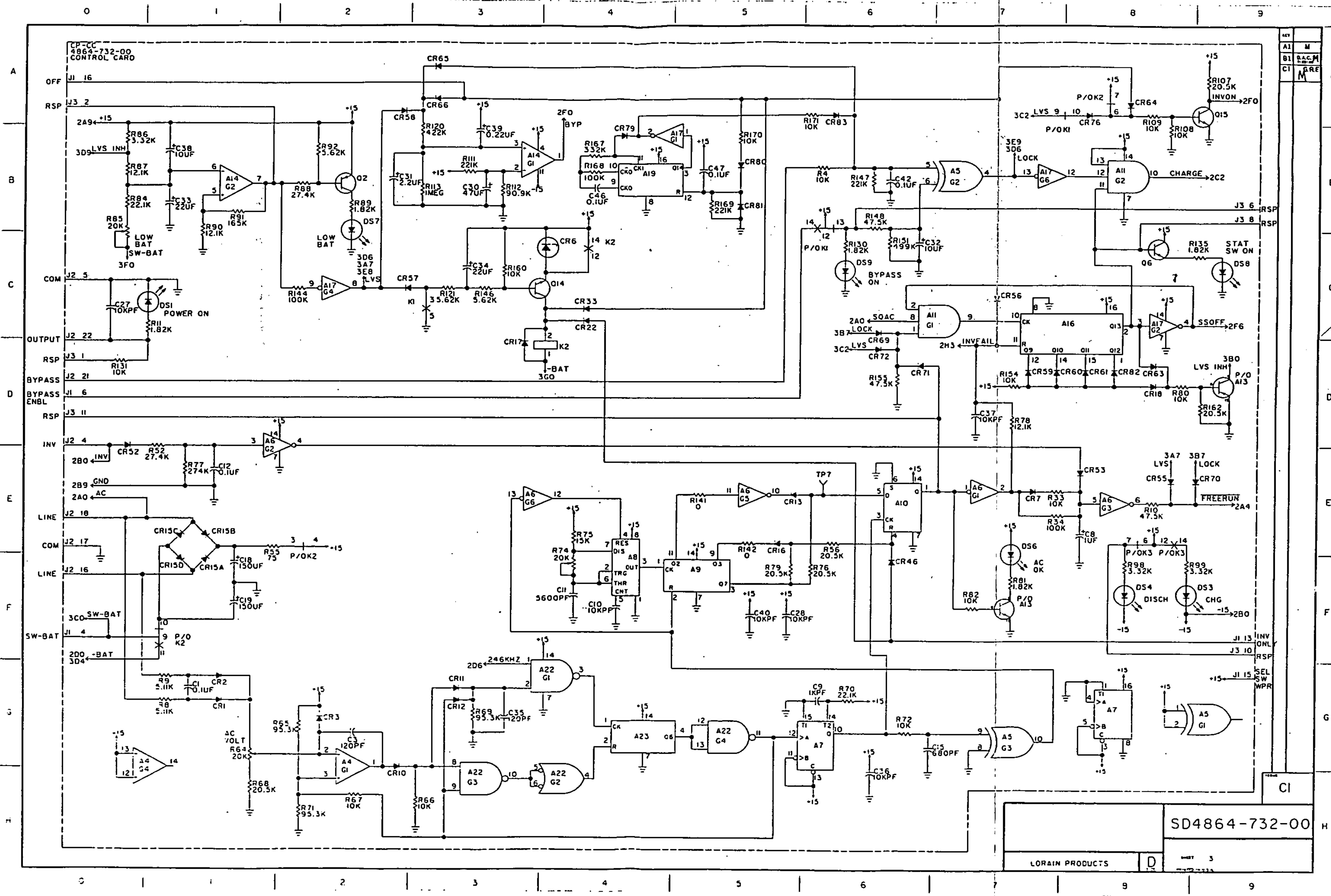
LORAIN PRODUCTS
LORAIN, OHIO
RELIANCE COMM/TEC

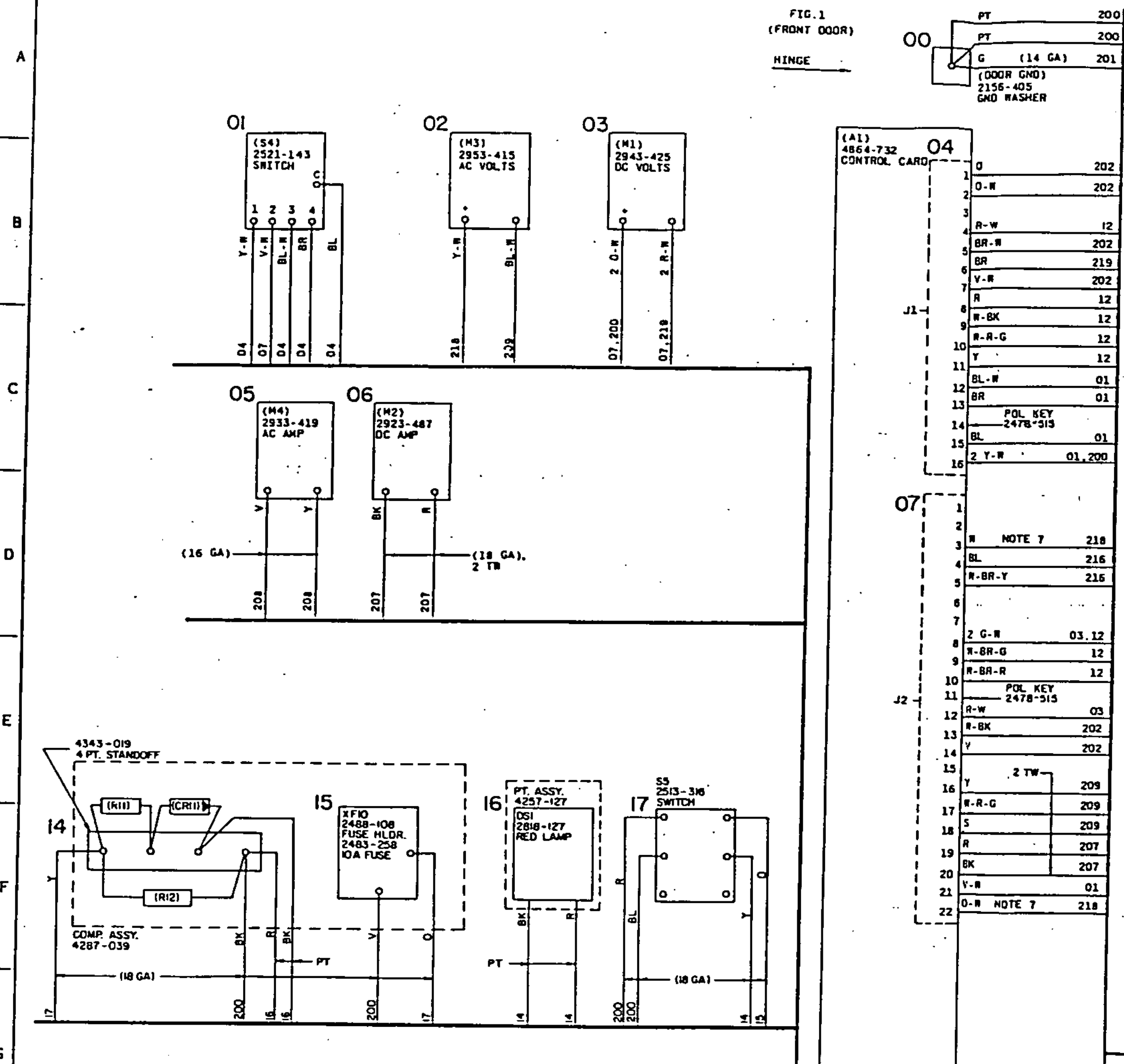
D

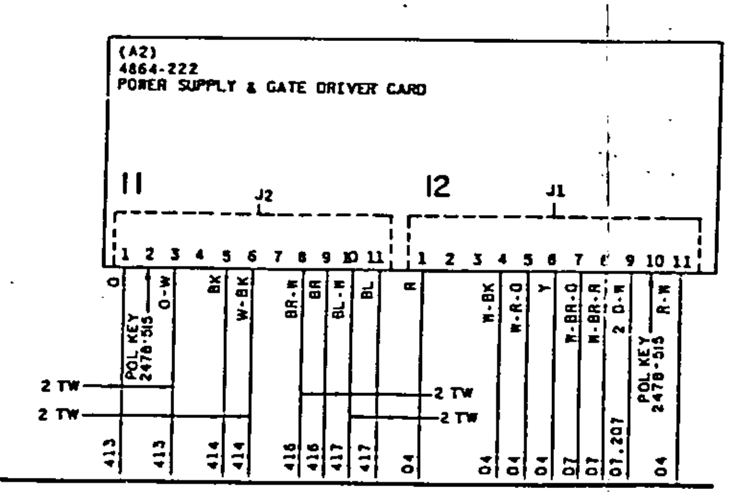
SD4864-732-00

SHEET 1 OF 3


CP-CC
4864-732-00
CONTROL CARD
SOAC
FREERUN
CHARGE
REMOTE
REMOTE
SW1
EQ VOLT
FLT VOLT
RSP
-BAT
+SHUNT
-SHUNT
LIMIT
INVON
BYP
FUSE
ALM
ALM
ALM
ALM
RSP
RSP
PS
PS
PS
BYPASS OFF
INV ALM
INVFAIL
START
SSOFF
246KHZ
120HZ
INV FREQ
STAT SW
STAT SW
INV
INV
GND
CI
SD4864-732-00
LORAIN PRODUCTS
D


CP-CC
4864-732-00
CONTROL CARD
OFF
RSP
COM
OUTPUT
BYPASS
BYPASS ENBL
INV
LINE
SW-BAT
LOW BAT
POWER ON
BYPASS ON
STAT SW ON
AC OK
DISCH
CHG
CHARGE
INVON
SSOFF
FREERUN
LVS INH
LOCK
SOAC
INVFAIL
246KHZ
AC VOLT
INV ONLY
SEL SW WPR
SD4864-732-00
LORAIN PRODUCTS
D
C1





MANUFACTURING NOTES:

1. ALL WIRING SHALL BE 22 GA STRANDED, UNLESS OTHERWISE SPECIFIED.
2. 01-INDICATES TERMINAL NEAREST MOUNTING SURFACE.
3. PT-LEADS WHICH ARE PART OF COMPONENT OR SUBASSEMBLIES.
4. 2 TW-TWO WIRES SHALL BE TWISTED TOGETHER.
5. O-INDICATES LEAD IS A JUMPER.
6. BB-INDICATES BUS BAR.
7. THESE WIRES ARE PART OF THE AC WIRE HARNESS (4993-185) AND HAVE TO BE HAND INSERTED IN THE SOCKET AND PLUG AS SHOWN IN THE T-DRAWING.
8. ——•—— -INDICATES SPLICE
9. CR2 AND CR3 ARE MOUNTED ON SAME HEAT SINK, WHICH IS INSULATED FROM GND.
10. MOUNTED WITH THERMAL COMPOUND, NO INSULATOR; BETWEEN TWO HEAT SINKS WHICH ARE INSULATED FROM GROUND, USING A 2000 LB CLAMP (LPC PT NO. 2868-235) WHICH IS INSTALLED PER LPC ASSY PROCEDURE NO. 2868-235 SH. 2 AND 3.
11. CR9 AND CR10 ARE MOUNTED ON INDIVIDUAL HEAT SINK WHICH IS INSULATED FROM GND BY GLASTIC MTG PNL.
12. "R" WIRE STRIPED END TO BE SLEEVED TIE SECURED TO HARNESS.
13. RESERVED
14. RESERVED
15. RESERVED
16. THESE WIRES ARE PART OF THE DC WIRE HARNESS (4993-184) AND HAVE TO BE HAND INSERTED IN THE SOCKET AND PLUG AS SHOWN IN THE T-DWG.

REVISIONS

| | | | |
|---|---|---|---|
| R1 | 1830352 | 3-7-88 | G.R.F. |
| | SHEET 2, ADDED LOC. NUMBERS, SHEET 3 & 5 CORRECTED WIRE DESTINATIONS, SHEET 4 ADDED JUMPERS TO STATIC SWITCH ASSY. | MAR 21 1988 | |
| S1 | 1830396 | 4-5-88 | G.R.F. |
| | CORRECTED WIRING AT LOC. 214. | APR 14 1988 | |
| S2 | | 9-13-88 | G.R.F. |
| | ADDED PT. NO. T5177-319-00 PER O. LYONS. | SEP 14 1988 | |

PIGTAIL COMPONENT INFORMATION

| REF DESIG | LPC PART NO. | VALUE | LOC |
|---|---|---|---|
| R11 | 2615-275 | 3.3K | 14 |
| R12 | 2663-710 | 10 | 14 |
| CR11 | 2834-414 | | 14 |

181-7095

WIRING DIAGRAM FOR MODEL WDA5028

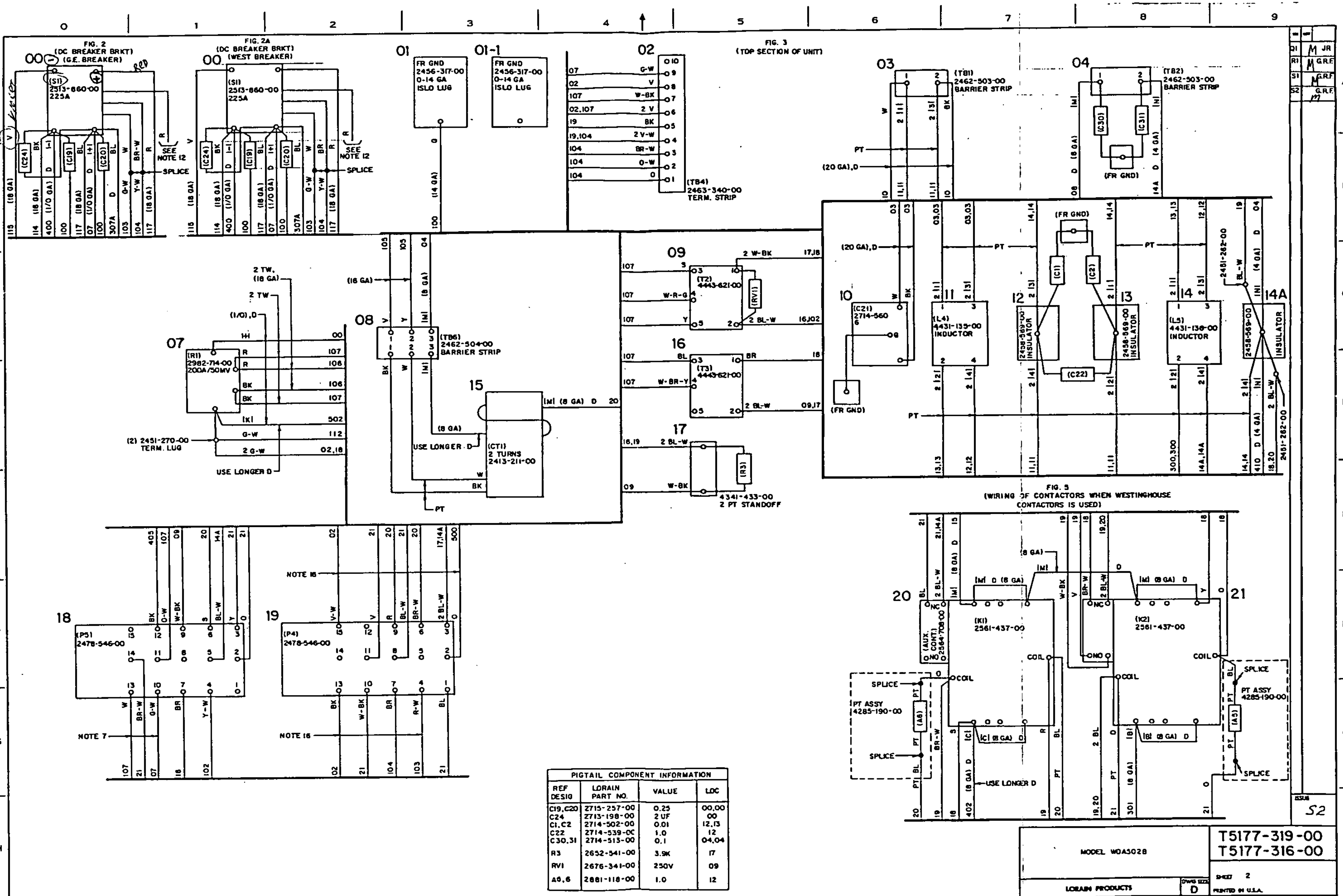
| | |
|---|---|
| DESIGN | A. MARCUCCI |
| DRAWN BY | J. REESE |
| DATE | 10-23-81 |
| CHECKED BY | A. Marcucci |
| DATE | 1-21-82 |
| APPROVED BY | |
| DATE | 1-25-82 |
| RATING | STANDARD |

LORAIN PRODUCTS CORPORATION
LORAIN, OHIO

D

T5177-319-00
T5177-316-00

SHEET 1 OF 6




| PIGTAIL COMPONENT INFORMATION | | | |
|---|---|---|---|
| REF DESIG | LORAIN PART NO. | VALUE | LOC |
| C19,C20 | 2715-257-00 | 0.25 | 00,00 |
| C24 | 2713-198-00 | 2 UF | 00 |
| C1,C2 | 2714-502-00 | 0.01 | 12,13 |
| C22 | 2714-539-0C | 1.0 | 12 |
| C30,31 | 2714-513-00 | 0.1 | 04,04 |
| R3 | 2652-541-00 | 3.9K | 17 |
| RV1 | 2676-341-00 | 250V | 09 |
| A6,6 | 2881-118-00 | 1.0 | 12 |

MODEL WOA5028

T5177-319-00
T5177-316-00

SHEET 2

LORAIN PRODUCTS

DWG SIZE D

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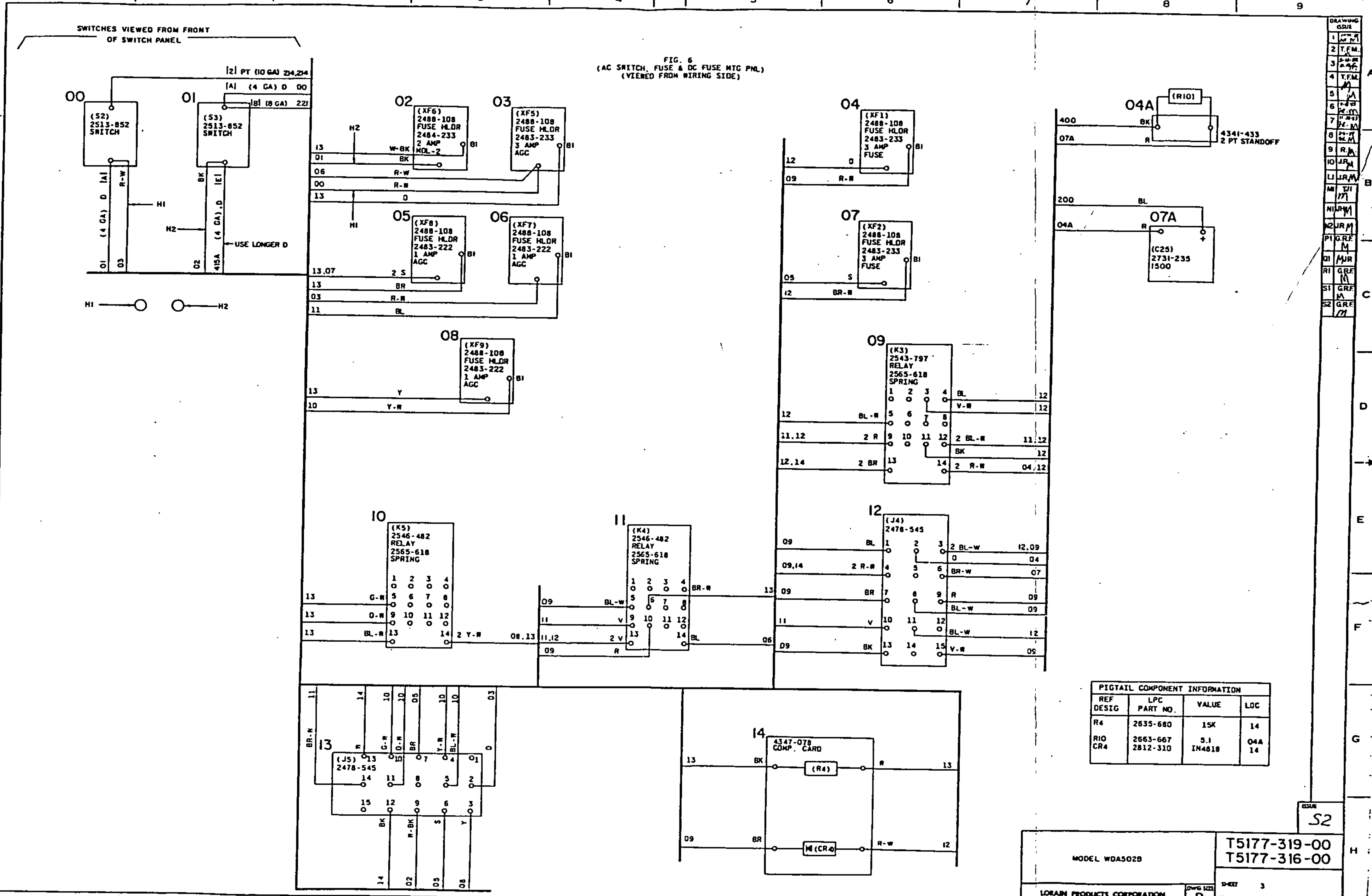
ISSUE S2




| PIGTAIL COMPONENT INFORMATION | | | |
|---|---|---|---|
| REF DESIG | LPC PART NO. | VALUE | LOC |
| R4 | 2635-680 | 15K | 14 |
| R10<br>CR4 | 2663-667<br>2812-310 | 5.1<br>IN4818 | 04A<br>14 |

MODEL WDA502B

T5177-319-00
T5177-316-00

ISSUE S2

SHEET 3

LORAIN PRODUCTS CORPORATION

DWG SIZE D

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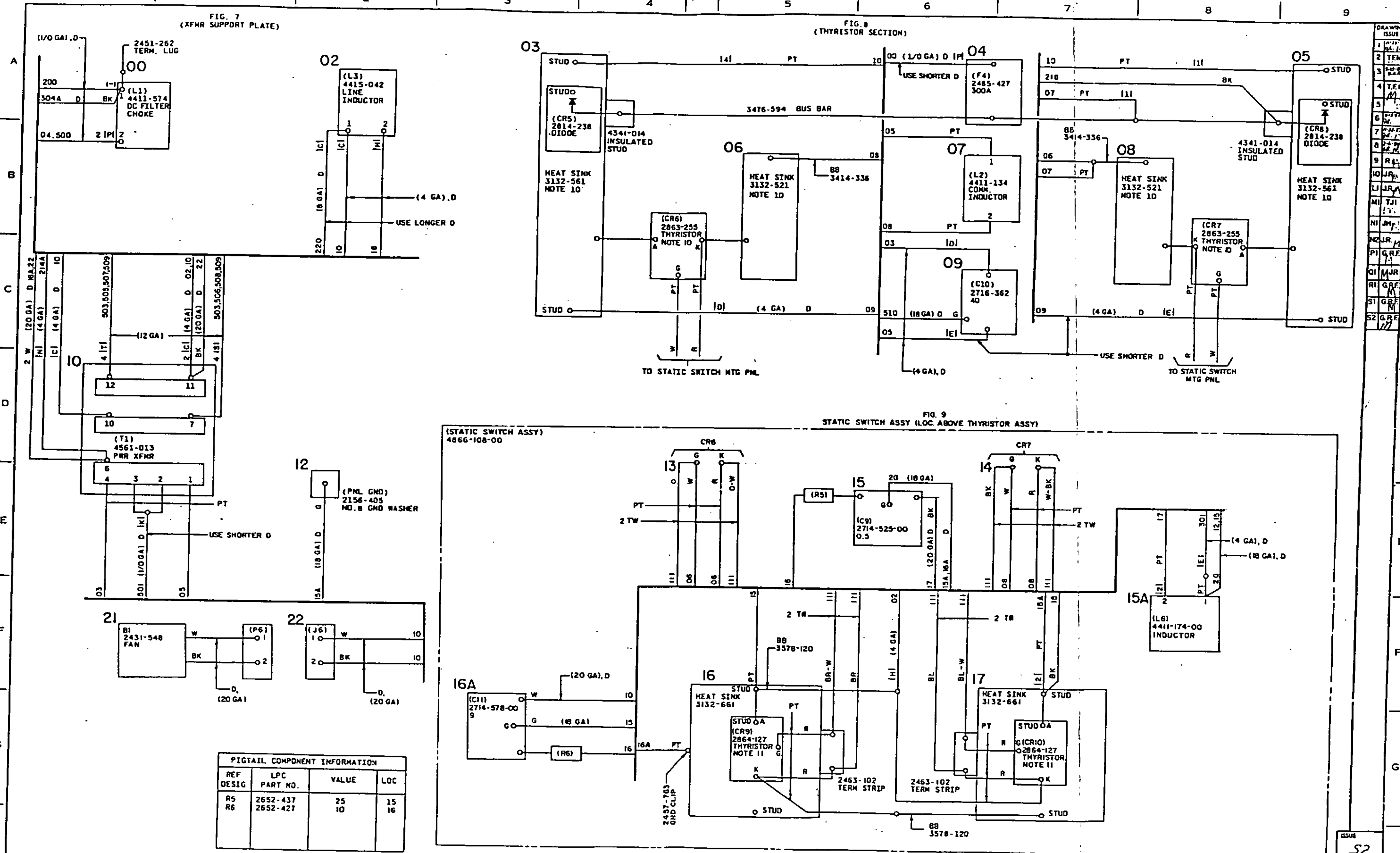


| PIGTAIL COMPONENT INFORMATION | | | |
|---|---|---|---|
| REF DESIG | LPC PART NO. | VALUE | LOC |
| R5<br>R6 | 2652-437<br>2652-427 | 25<br>10 | 15<br>16 |

ISSUE S2

MODEL WDA502B

T5177-319-00
T5177-316-00

LORAIN PRODUCTS CORPORATION

DWG SIZE D

SHEET 4

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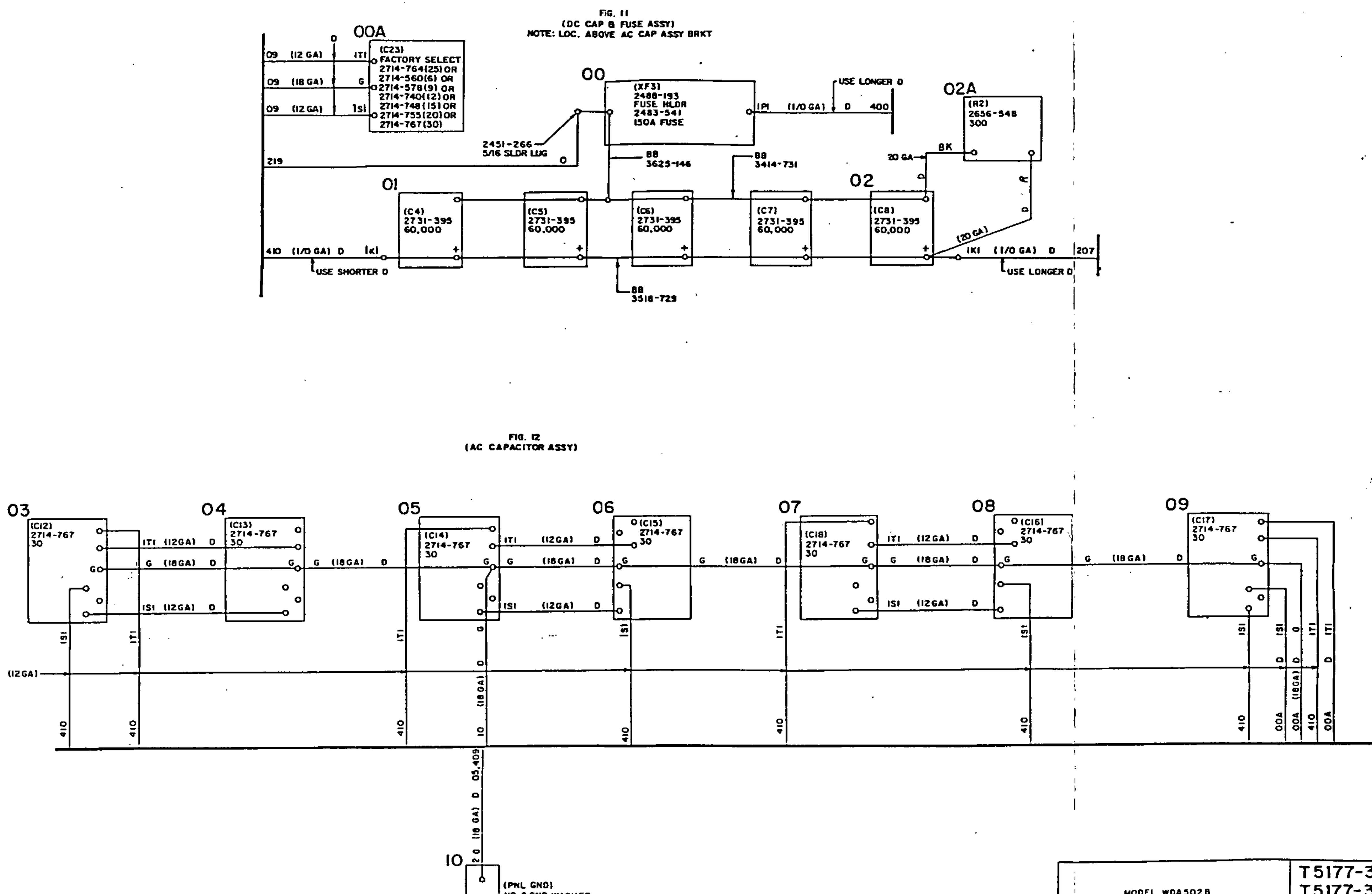


MODEL WDA502B

T5177-319-00
T5177-316-00

LORAIN PRODUCTS CORPORATION

DWG SIZE D

SHEET 5

ISSUE S2

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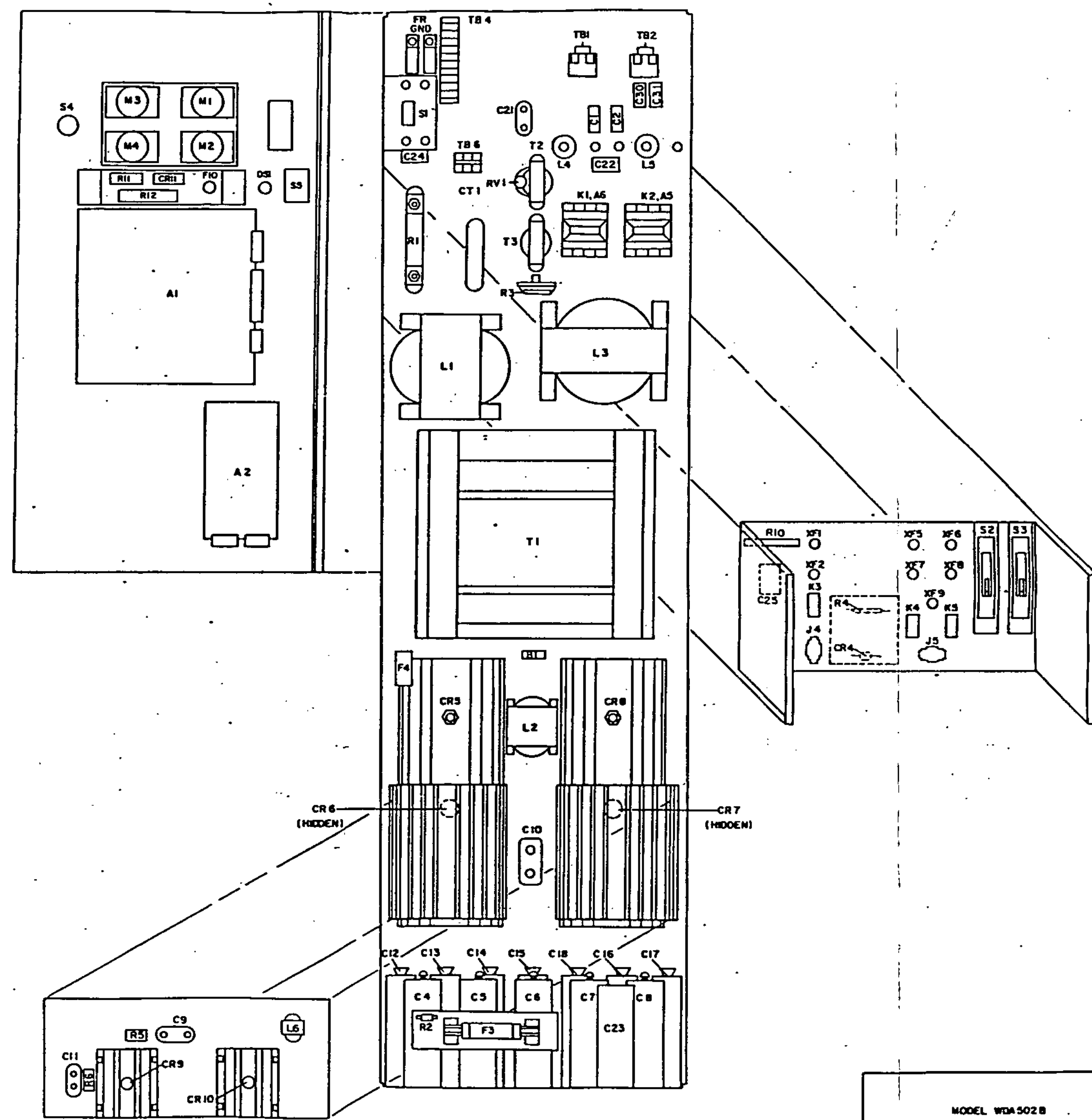
FIG.13
(COMPONENT LOCATION)




ISSUE S2

MODEL WDA502B

LORAIN PRODUCTS CORPORATION

DWG SIZE D

T5177-319-00
T5177-316-00

SHEET 6

PRINTED IN U.S.A.

FOR PARTS OR SERVICE, CONTACTTHE NEAREST
LORAIN REGIONAL SERVICE CENTER

OHIO REGIONAL SERVICE CENTER
1122 F St./PLT #5
Lorain, Ohio 44052-2293
Telephone: 2167288-l 122
FAX: 216/288-1141

CONNECTICUT REGIONAL SERVICE CENTER
9-A Old Windsor Road
Bloomfield, Connecticut 06002
Telephone: 20377261990
FAX: 20377261943

ILLINOIS REGIONAL SERVICE CENTER
245 Roosevelt Road, Bldg. 7, Units 49, SO
West Chicago, Illinois 60185
Telephone: 31272315775
FAX: 312/231-4570

GEORGIA REGIONAL SERVICE CENTER
5555 Oakbrook Parkway, Suite 540
Norcross, Georgia 30093
Telephone: 404/449-0840
FAX: 404/449-1061

COLORADO REGIONAL SERVICE CENTER
4010 Youngfield Street
Wheat Ridge, Colorado 80033
Telephone: 303/422-6213
FAX: 303/421-9310

MARYLAND REGIONALSERVICE CENTER
9140 Guilford Road, Suite M
Columbia, Maryland 21046
Telephone: 301/498-6422
FAX: 301/498-0809

SOUTHERN CALIFORNIA REGIONALSERVICE CENTER
3001 Red Hill, Bldg. 6. Suite 109
Costa Mesa, California 92626
Telephone: 71475404395
FAX: 714/540-6038

TEXAS REGIONAL SERVICE CENTER
2044 North Highway 360
Grand Prairie, Texas 75050
Telephone: 214/660-5986
FAX: 214/660-7381

NORTHERN CALIFORNIA REGIONALSERVICE CENTER
2074 O'Toole Ave.
San Jose, California 95131
Telephone: 40874351303
FAX: 408/435-1309

CANADIAN SERVICE CENTER
122 Edward Street
St. Thomas, Ontario, Canada N5P1Z2
Telephone: 519/631-0780
FAX: 519/631-0359

PACIFIC NORTHWESTSERVICE CENTER
15247 N.E. 90th Street
Redmond, Washington 98052
Telephone: 206/883-7912
FAX: 206/885-1 120

## INFORMATION REQUEST

- ☐ Please contact me about the following programs.
- ☐ Please send me more information about the following programs.
- ☐ Please add me to your mailing list for future service announcements.

- ☐ Parts Kits
- ☐ Fuse Kits
- ☐ Training Schools
- ☐ Repair Service
- ☐ Product Revision Upgrades
- ☐ ____________
- ☐ Software/Hardware Maintenance
- ☐ Annual Maintenance Contracts
- ☐ Power Evaluation Programs (PEP)
- ☐ PowerTherm SM Thermographic Analysis
- ☐ ____________
- ☐ ____________

COMMENTS: ____________

Name & Title: ____________
Tel. Co. Name: ____________
Address: ____________
City: ____________ State: ____________ Zip: ____________ Ph.% ____________

## LORAIN SERVICE CAN ALSO PROVIDE:

- IN-SHOP REPAIR

- FIELD SERVICE REPAIR

- MAINTENANCE CONTRACTS
  - ★ Power Equipment
  - ★ Software/Hardware

- POWER EVALUATION PROGRAM (PEP)
  - ★ Power Analysis for the Entire Power Room

- POWERTHERM℠ THERMOGRAPHIC SURVEY
  - ★ Infrared Scanning for your Power Room

- TRAINING
  - ★ Factory
  - ★ Customer Site
  - ★ Slide/Cassette or Video

- PARTS KITS AND FUSE KITS

- SPARE FUSE HOLDER

- SPECIALIZED TEST EQUIPMENT
  - ★ Ringing Generator Test Set-Model LS2000 (Includes loads, metering, digital frequency counter)
  - ★ 130V Converter Test Load - Model LS1000 (Variable loads to 6 amps)

- POWER UPGRADE AND MODERNIZATION (E & I)
  - ★ Includes engineering, fabrication and complete installation

Contact your nearest LORAIN Regional Service Center
for more information,

NOTES:

1. RACKS MUST BE LEVEL
2. LEVELING SPACERS MUST BE 1½" SQUARE (SUPPLIED BY THE INSTALLER).
3. TIGHTEN ALL BOLTS TO 50 FT. LBS.
4. SEE DRAWING 76L077 FOR ASSEMBLY

| QTY. | DESCRIPTION | PART NO. | DRAWING NO. |
|---|---|---|---|
| 2/2 | FRAME | 2200/2201 | 78L020 |
| 2 | BRACE | 2169 | 76L007-68 |
| 4 | INSULATOR x 28 | 2170 | 76L006 |
| 4 | CHANNEL x 28 | 2164 | 78L075 |
| 8 | LOCKNUT, ½-13 | 2171 | 78L077 |
| 12 | HEX. HD. CAPSCREW, ½-13 x 1 | 2173 | |
| 4 | HEX. NUT, ½-13 | 2174 | |
| 12 | EXTERNAL TOOTH L'WASHER, ½ | 2175 | |

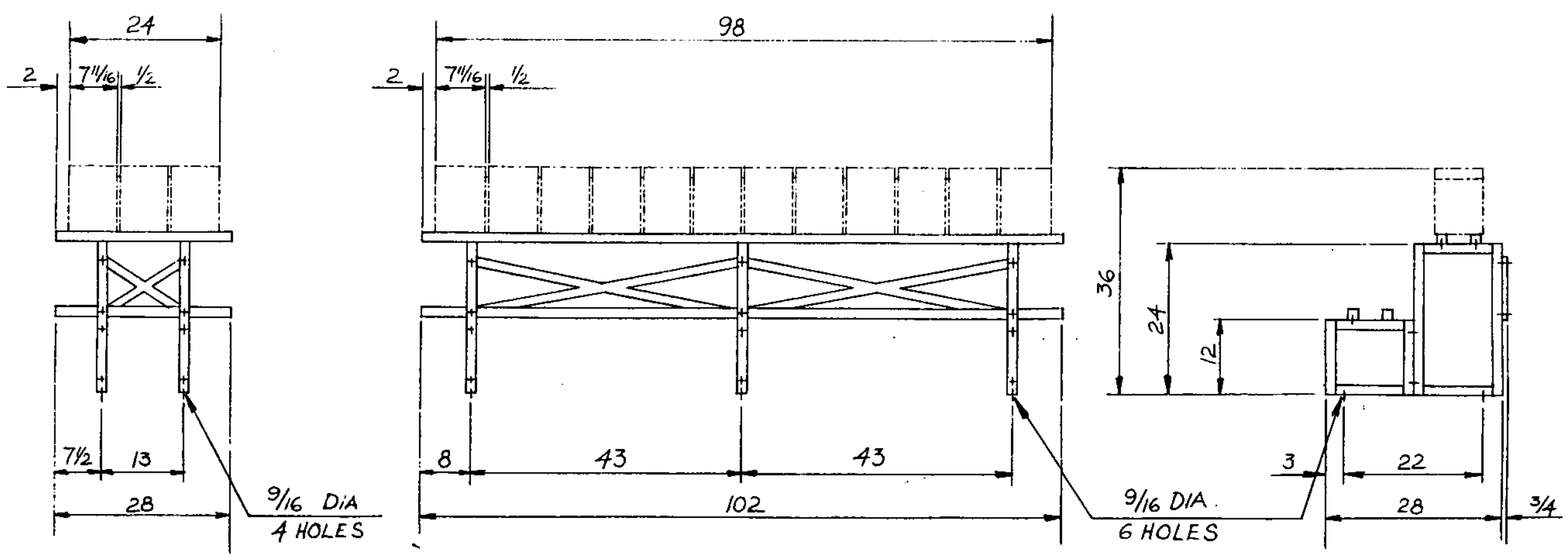
G.U. RACK PART NO. RG 2406 A
" " " " RG 4406 A

EST. WT. 47 LBS.

| QTY. | DESCRIPTION | PART NO. | DRAWING NO. |
|---|---|---|---|
| 3/3 | FRAME | 2200/2201 | 78L020 |
| 4 | BRACE | 2169 | 76L007-163 |
| 4 | INSULATOR x 102 | 2170 | 76L006 |
| 4 | CHANNEL x 102 | 2164 | 78L075 |
| 12 | LOCKNUT, ½-13 | 2171 | 78L077 |
| 18 | HEX. HD. CAPSCREW, ½-13 x 1 | 2173 | |
| 6 | HEX. NUT, ½-13 | 2174 | |
| 18 | EXTERNAL TOOTH L'WASHER, ½ | 2175 | |

G.U. RACK PART NO. RG 2424 A
" " " " RG 4424 A

EST. WT. 117 LBS.




BASIC

| | | | |
|---|---|---|---|
| DO NOT SCALE DRAWING | THIRD ANGLE PROJECTION | DIMENSIONS ARE IN INCHES | |
| NOTICE: THIS DRAWING IS FURNISHED FOR REFERENCE ONLY. THE FURNISHING OR POSSESSION OF THIS DRAWING OR ANY REPRODUCTIONS THEREOF, DOES NOT CONVEY ANY MANUFACTURING RIGHTS. | | UNLESS OTHERWISE SPECIFIED, TOLERANCES ARE: ONE PLACE ±0. TWO PLACE ±0. THREE PLACE ±0. ANGLES ± ° SCREW THREADS SHALL PROVIDE 70-75% OF FULL THREADS | |
| MATERIAL SEE B/M'S | | FILE DIVISION | ASSY DWG |
| TITLE TWO STEP BATTERY RACK ASSEMBLY 6/32 OF "G" SERIES | | SH | C |
| SCALE ¾"=1' | REF INFO | ENGR | DATE | APVD RAH | DATE 2-11-80 |
| DWR TIEN JAN | DATE 2-8-80 | CHK RH | DATE 2-11-80 | DWG NO 80L047 |
| GLOBE BATTERY DIVISION of GLOBE UNION, Inc., Milwaukee | | | |

| LTR | REVISION DESCRIPTION | DATE | DWR | APVD | LTR | REVISION DESCRIPTION | DATE | DWR | APVD | LTR | REVISION DESCRIPTION | DATE | DWR | APVD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

FORM C-18AF

DWG NO C