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LOUIS ALLIS

LANCER® 44XLP

CENTRIFUGAL PUMP CONTROL SYSTEMS
15 thru 200 Horsepower

Litton LOUIS ALLIS

This instruction manual covers installation, operation, adjustments, and maintenance of the equipment, but does not provide for every possible circumstance that may occur, nor does it define all modifications, variations, or details of the equipment. Should further information be desired or should particular problems develop which are not covered sufficiently herein, please contact your nearest Louis Allis representative.

WARRANTY

Standard products manufactured by the Company are warranted to be free from defects in workmanship and material for a period of one year from the date of shipment, and any products which are defective in workmanship or material will be repaired or replaced, at the option of the Company, at no charge to the Buyer. Final determination as to whether a product is actually defective rests with the Company. The obligation of the Company hereunder shall be limited solely to repair and replacement of products that fall within the foregoing limitations, and shall be conditioned upon receipt by the Company of written notice of any alleged defects or deficiency promptly after discovery within the warranty period, and in the case of components or units purchased by the Company, the obligation of the Company shall not exceed the settlement that the Company is able to obtain from the supplier thereof. No products shall be returned to the Company without its prior consent. Products which the Company consents to have returned shall be shipped f.o.b. the Company's factory. The Company cannot assume responsibility or accept invoices for unauthorized repairs to its components, even though defective. The life of the products of the Company depends, to a large extent, upon type of usage thereof, and THE COMPANY MAKES NO WARRANTY AS TO FITNESS OF ITS PRODUCTS FOR SPECIFIC APPLICATIONS BY THE BUYER NOR AS TO PERIOD OF SERVICE UNLESS THE COMPANY SPECIFICALLY AGREES OTHERWISE IN WRITING AFTER THE PROPOSED USAGE HAS BEEN MADE KNOWN TO IT.

THE FOREGOING WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR A PARTICULAR PURPOSE.

This warranty does not apply to experimental or developmental products.

RECEIPT OF SHIPMENT

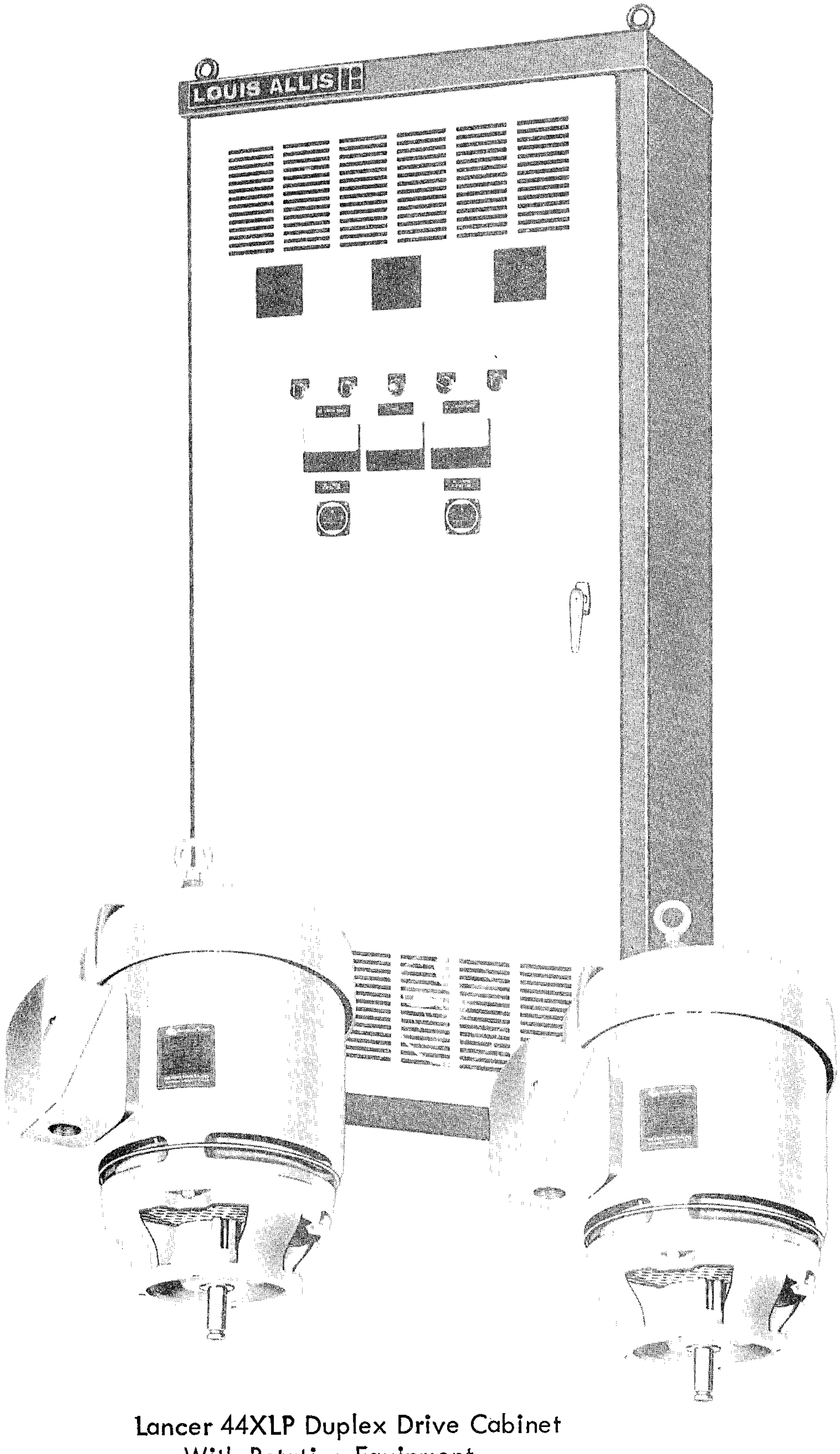
All equipment is tested against defect at Louis Allis and is shipped in good condition. Any damages or shortages evident when equipment is received must be reported immediately to the commercial carrier who transported the equipment. Assistance is available from the nearest Louis Allis district office, if required. Always refer to Louis Allis order number, equipment description and serial number when contacting Louis Allis.

EQUIPMENT STORAGE

For long periods of storage, equipment should be covered to prevent corrosion. Equipment should be stored in a clean, dry location. After storage, insure that equipment is dry and no condensation has accumulated before applying power. All rotating equipment stored longer than three months requires regreasing.

SAFETY FIRST

This equipment has been designed to provide maximum safety for operating personnel. However, hazardous voltages exist within the confines of the enclosure. Installation and servicing should therefore be accomplished by qualified personnel only and in accordance with OSHA regulations.



Lancer 44XLP Duplex Drive Cabinet
With Rotating Equipment

LANCER 44XLP DUPLEX DRIVE INSTRUCTION MANUAL

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SECTION 1

GENERAL

1.1 Purpose and Function

The Lancer 44XLP Adjustable Frequency Drive is a special purpose variable torque drive intended primarily for centrifugal pump applications. The drive is available from 15 to 200 horsepower.

The Drive system includes a variable frequency current source converter, control logic necessary for sequencing operations, associated power switching components, and standard NEMA B design, 460 Volt, three phase induction motors.

The purpose of the drive system is to provide variable speed control of a pump system to match pumping rate with input rate. Through the use of system interface signals coupled to the variable frequency converter and control logic, pumping rate is controlled anywhere from minimum speed single pump up to maximum or rated speed of several pumps in contactor type multiplexing arrangements.

The drive includes protective circuitry which assures adequate protection of the drive system, power line, and operating personnel. The protective features include:

1. Input circuit breakers.
2. Three phase motor overload relays.
3. Electrical and mechanical interlocked motor contactors, for multiplexing or by-pass requirements.
4. Input line filters and SCR suppression networks.
5. Fast acting converter input line fuses.
6. Instantaneous input overcurrent protection.
7. Instantaneous output overvoltage protection.
8. Phase sequence and phase loss protection.
9. Individual thermal protection of converter SCR modules.
10. 24-hour motor alternation to equalize motor wear, in multiplex applications.
11. Grounded control circuit common.

1.2 Performance and Ambient Specifications

1.2.1 Drive

Input Voltage:	460 VAC +10%, -5%, 3 phase, 60 Hz ±2 Hz.
Displacement Power Factor:	Varies with speed and load; typical, 0.86 at rated speed and load.
Continuous Speed Range:	(With torque proportional to speed squared), 10-100% rated speed.
Torque:	A. Continuous torque, proportional to square of speed. Rated torque equals motor full load torque at 100% speed. B. Breakaway torque, 15% rated.
Load Inertia:	3 times rotor inertia, maximum.
Ambient Temperature Range:	10°C to 40°C.
Operating Altitude:	3300 ft. above sea level, maximum.
Drive Service Factor:	1.0
Drive Enclosure (Duplex):	A. Type: NEMA type 1, blower cooled, floor mount. B. Size: 15 through 100 HP - 84" H x 38" W x 20" D. 125-200HP - 84" H x 70" W x 20" D C. Approximate Weight: 15 through 100 HP; 800-1200 pounds. 125 through 200 HP; 1300-1600 pounds.

1.2.2 AC Motors

Type:	Louis Allis NEMA Design B pacemaker induction motor; 460 VAC, 3 phase, 60 Hz, 1.15 Service Factor.
HP:	As specified in drive horsepower rating.
Speed Range:	As specified for drive.
Motor Size & Weight:	Refer to motor dimension drawing.

NOTE: The motors used with the Lancer 44XLP are completely standard NEMA B designed machines, sold and used for constant speed, across-the-line operation. The Lancer 44XLP, however, is uniquely designed for the specific motor on which it is used. The motor's inductance and other electrical parameters become a vital part of the converter's power circuit. Therefore, no motor other than that originally supplied or a confirmed electrically exact duplicate should be operated by the Lancer 44XLP.

Motors of identical speeds and HP and with identical nameplate data are not necessarily identical electrically.

1.2.3 Converter

Output Voltage:	46 to 460 VAC, 3 phase, 3 wire un-isolated.
Output Frequency:	6 Hz to 60 Hz, Adjustable to 66Hz under proper load conditions.
Output Current:	120° step wave type.
Overload Capacity:	Rated momentary and continuous current output is 100% rated motor full load current.
Speed Reference Input:	135 ohm potentiometer, current signal 50 milliamp max., or 0-10 volts DC. Ungrounded and isolated.

1.3 Description of Drive

Figure 1.1 shows the Lancer 44XLP Drive cabinet with its door mounted operators controls and a general view of equipment layout within the cabinet. The unit shown is a 30 HP drive and is typical of single cabinet units 15 through 100 HP. Figure 1.2 is a detailed view of the cabinet interior which shows major component sections. The upper section of the cabinet contains the input and output terminal board for power and control interconnection, control transformers, circuit breakers, contactors, and control relays.

The lower section of the cabinet contains the converter. The converter module has two power sections; the dc or rectifier section on the left and the ac or inverter section on the right.

The silicon controlled rectifiers (SCRs) in each section (rectifier and inverter) of the converter are grouped three on a common anode heat sink (CA) and three on a common cathode heat sink (CK). The SCR's are mounted by clamps to the heat sink and the gate firing printed circuit board is secured to the center of each heat sink assembly. Diodes for the inverter or ac section are stud mounted to three additional heat sink assemblies in the center of the inverter section. The converter modules above 40 HP are blower cooled.

The DC Main, AC Main and DC Regulator printed circuit board assembly is located at the lefthand side of the converter module.

The power supply for the converter regulator circuits is located in the lower lefthand corner of the converter module.

The card rack assembly is located in the lower section of the converter module. This card rack contains three printed circuit cards identified as follows from left to right:

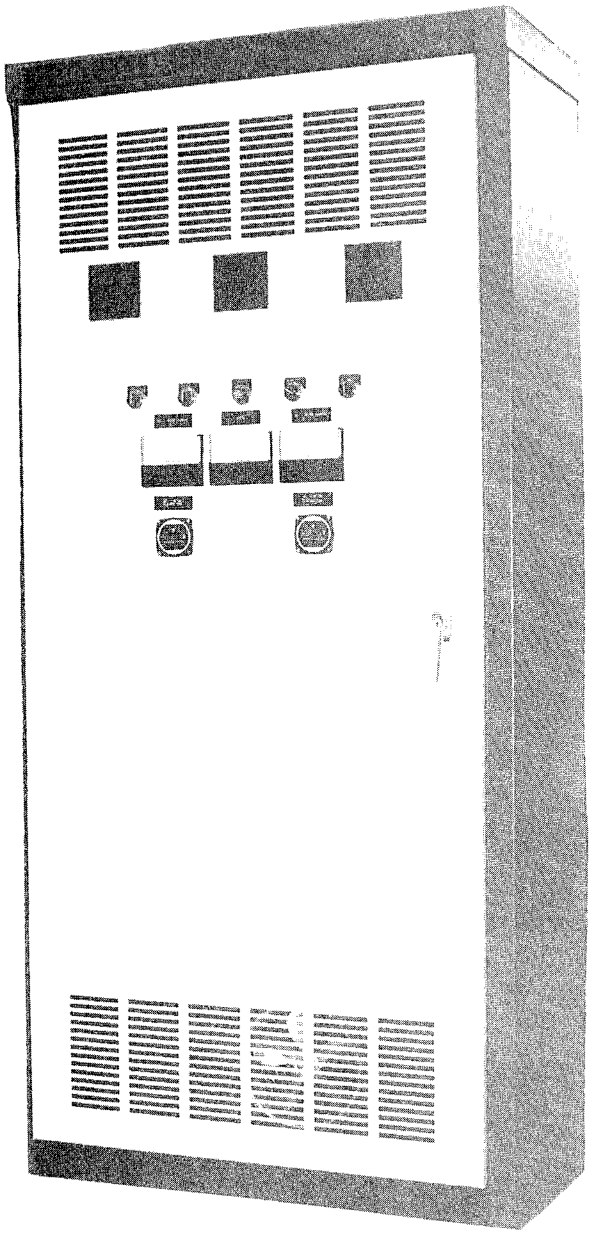
1PC - Fault and Zero Current Detector PCB.

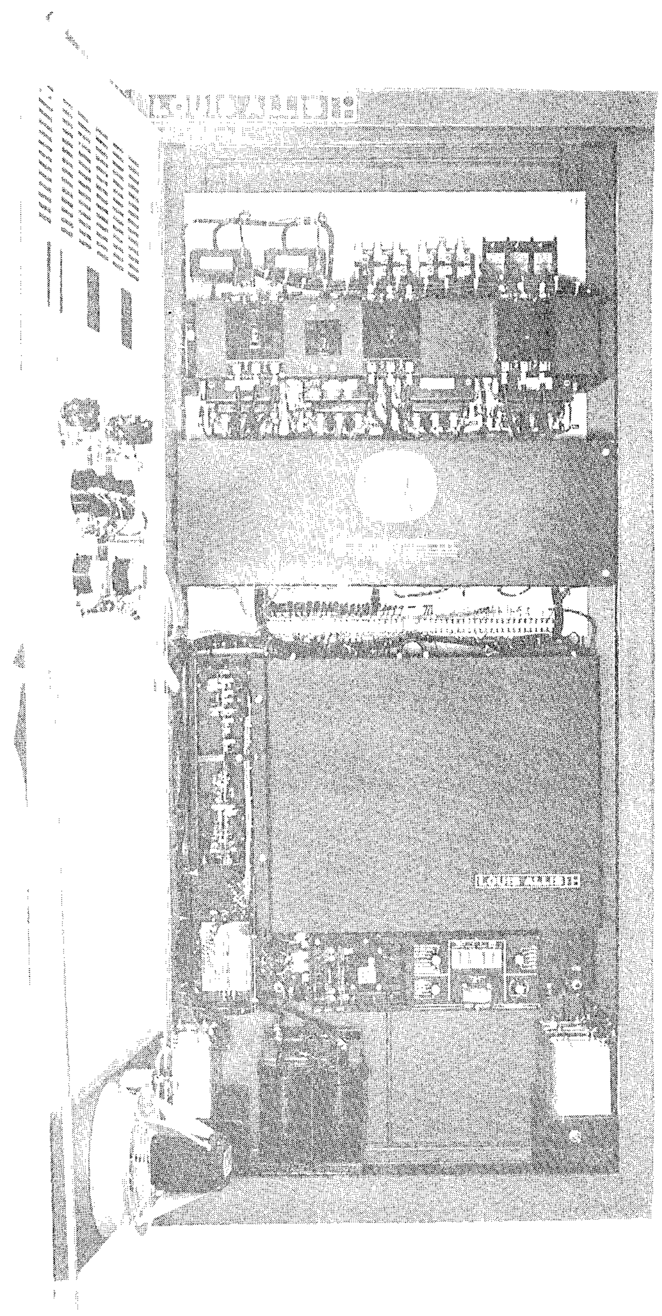
2PC - Linear Acceleration and Transducer Follower PCB.

3PC - Voltage Regulator and Oscillator PCB.

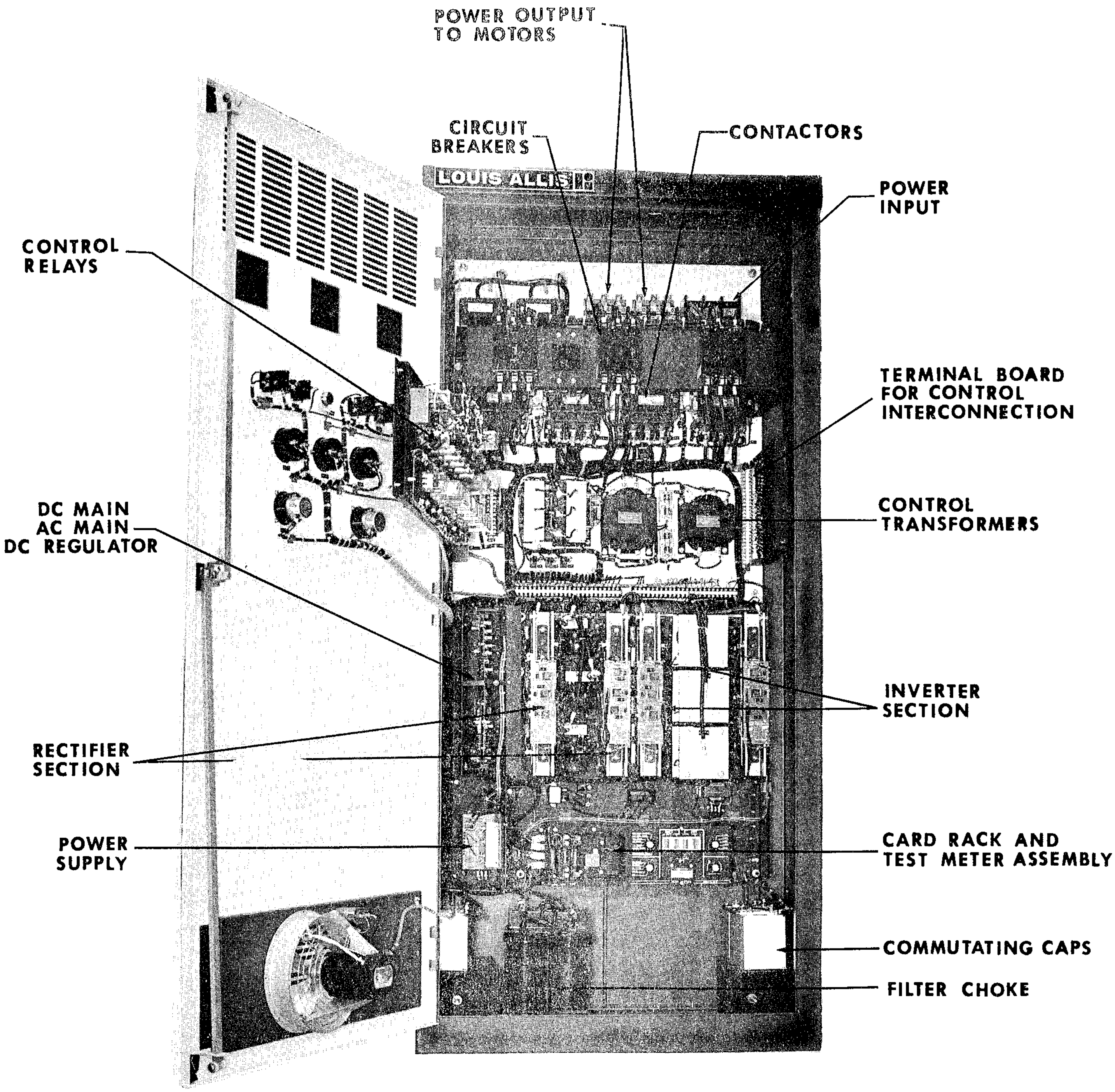
The righthand position of the card rack is designed for the optional, plug-in test module.

The bottom section of the cabinet contains the commutating capacitors, dc link filter choke.





Lancer 44XLP Duplex Drive Cabinet
Figure 1-1



LANCER 44XLP DUPLEX DRIVE CABINET
FIGURE 1-2

Larger Lancer 44XLP Drives supplied in two cabinets, maybe bolted together to form a composite prewired assembly. Function and appearance of components is identical to that described, although location will vary slightly.

The following are optional items, furnished when specified.

1. Test Module: Located within card rack of converter. Provides facility to measure selected converter signals and perform checks of converter DC and AC sections.

2. Motor AC Ammeters: Cabinet door mounted. Provides indication of motor current.

3. Elapsed Time Meters: Cabinet door mounted. Provides cumulative reading of operating hours.

4. Percent Speed Meter: Cabinet door mounted. Provides percent speed indication of motor being operated by converter.

5. Pilot Lights: Cabinet door mounted. Provides visual indication of operating state.

1.4 Pre-Installation Consideration

1.4.1 Receipt of Shipment

All equipment is tested for proper operation and quality at the Louis Allis Company. Any damages or shortages evident when the equipment is received must be reported immediately to the commercial carrier who transported the equipment. Assistance, if required, is available from the nearest Louis Allis District Office. Always refer to Louis Allis order number, equipment description and serial number when contacting the Louis Allis Company. Do not return equipment to the Louis Allis Company without authorization.

1.4.2 Storage and Reshipment Procedures

For long periods of storage, equipment should be covered to prevent corrosion and should be placed in a clean dry location. If possible, equipment should be stored in its original crating. Periodic inspection should be made to insure that the equipment is dry and that no condensation has accumulated. The equipment warranty does not cover damage due to improper storage.

When packing a floor mounted enclosure for reshipment, prepare the enclosure by removing all plug-in components such as sealed relays and printed circuit cards which would be susceptable to shaking loose during transportation. These items should be packed in a small corregated carton individually protected with soft wrapping material and the carton secured to the bottom of the cabinet.

Internal padded bracing should be provided for any components in the cabinet that could break loose or be bent during shipment. Lifting eyebolts should be removed and packed separately.

The cabinet should be bolted to a pallet or skid which provides at least 2" clearance beyond the cabinet sides. In addition, the door mount controls should be framed to provide at least 1" clearance. The entire cabinet should then be wrapped in polyethylene and covered with wax impregnated double walled #350 corregation. Assistance, if required, is available from the nearest Louis Allis District Office.

1.4.3 Items Required But Not Supplied

The following tools and equipment will be desired to install and start up and service the Lancer 44XLP Drive system.

1. Normal hand tools.
2. Electrical installation tools and equipment.
3. Test equipment.
   a. Volt-ohmmeter; Simpson Model 260 or equivalent.
   b. Clamp Ammeter; capable of 2 times maximum rated motor current.
   c. Hand tachometer; suitable for motor speed.
   d. 0-500 VAC Voltmeter; RMS reading, 1% accuracy, iron vane or thermocouple type.

e. Oscilloscope; Tektronics type 422 or equivalent. Requires isolated, vertical input capability.

f. Resistor; 5K ohms, 200 watts with pigtails and clips to discharge power capacitors.

1.4.4 Installation Site

The Lancer 44XLP should be installed in a clean, dry, well ventilated location with clearance and workspace suitable for the NEMA class 1 enclosure, in accordance with applicable code requirements.

1. The unit is designed for normal unattended operation with the cabinet door or doors closed and locked. Contact closure signals are provided for remote, failure status indication.

2. Dissipation from the Lancer 44XLP Drive varies with drive size. Maximum cabinet dissipation is approximately 2200 watts for the 15 HP unit and 8800 watts for the 200 HP unit.

3. Ambient temperature of the site must be within $10^{\circ} - 40^{\circ}C$, $(50^{\circ} - 104^{\circ}F)$.

4. The cabinet may be installed side by side or back-to-back with another unit or be placed with its back against a wall. Front clearance must be sufficient to permit the doors to be fully opened for easy access. Interwiring connections are to be made at the top of the cabinet. Refer to the cabinet outline drawing.

5. Holes for 5/8 inch mounting studs are provided at the bottom of each cabinet.

1.4.5 Handling

The drive is shipped as one assembly bolted to a skid with the cabinet protected with a complete wrap of corregation. Lifting eyebolts have been removed and packed inside the cabinet.

Refer to Section 1.2.2 for size and estimated weights. It is recommended that the drive be moved as close as possible to its final location by fork lift truck, before being unpacked. When lifting by eyebolts, use an adequate bridle when lifting to prevent side forces on the eyebolts. Avoid jolting the equipment during movement or uncrating.

1.4.5 Handling (continued)

The larger HP Lancer 44XLP drives are usually contained in a double cabinet. The cabinets are bolted together and are shipped on a common skid with intercabinet wiring in place as standard procedure.

When lifting a double cabinet drive, use an "I"-beam sling to prevent distortion of the cabinets.

If it is necessary to separate the two cabinets for installation, contact your nearest Louis Allis service representative for assistance in disconnecting and reconnecting the intercabinet wiring.

SECTION 2

INSTALLATION AND STARTUP

2.0 Installation and Startup

This section covers the installation and startup of the Lancer 44XLP Drive. Installation of the Louis Allis motors specified as part of the drive system are covered in separate instructions located elsewhere in this manual.

Each Lancer 44XLP Drive is supplied with a set of wiring diagrams.

2.1 Physical Installation

Install Drive cabinet in location selected based on considerations of Section 1.4.4.

Visually inspect the drive for shipping damage or loose parts. Remove all contact wedges and protective shipping braces. If plug-in relays and printed circuit boards have been removed and packed in a separate carton, each item will have been tagged with proper symbol or specific information for its relocation. Install these items.

2.2 Electrical Hook-up

Refer to the outline drawing for outside cable or conduit entry. Note that transducer signal wiring must be ungrounded and in a separate conduit not containing AC power wiring. Refer to the interconnection diagram for wiring between the cabinet and associated components. Wire size and disconnect devices should conform to applicable codes. Ground the cabinet to a suitable earth ground. Wire in accordance with the Interconnection Diagram. The diagram also indicates normally allowable, maximum cable length between Converter and Motors.

The drive is sensitive to input voltage sequence. If phase sequence is known, connect as follows:

ØA	1TB	(1)
ØB	1TB	(2)
ØC	1TB	(3)

Phase sequence will also be checked on initial startup.

2.3 Startup Procedure

2.3.1 Pre-power Check

Perform the following checks after interconnection wiring has been completed and before applying power to the drive. Lock the main line disconnect switch in open position to insure that there is no power at the drive cabinet. MEASURE INPUT VOLTAGE TO INSURE, WITH DISCONNECT OPEN, NO VOLTAGE EXISTS.

( ) 1. Visually inspect for loose wiring. Make sure that all contact wedges or other shipping devices have been removed.

( ) 2. Manually operate contactors and switches to be sure they are free. Do not alter any of the adjustments on the printed circuit boards or dashpot settings of any time delay relays. These adjustments have been factory set and should not be changed without specific instructions.

( ) 3. Check all transformers for proper connection per the interconnection wiring diagram or per instruction tags.

( ) 4. Check for and remove all remnants of the electrical hookup such as wire slivers, insulation strippings, tools etc.

( ) 5. Check for proper and tight mechanical connections such as printed circuit boards, gate firing leads, and bus connections.

( ) 6. Measure resistance from converter input and output power terminals to cabinet ground. Resistance should be greater than 100K ohms.

CAUTION

Use a Simpson Model 260 or equivalent VOM type meter for resistance checks. Do not use a megger as this could damage the solid state components.

2.3.2 Preliminary Converter Check

The Lancer 44XLP drive has been thoroughly tested and adjusted at the factory. The following procedures insure that the system performs identical to the factory test, after installation. Before performing these procedures, read Sections 3, Operation; and 5, Tests and Adjustments. Refer to Section 6 if problems occur

In this and subsequent subsections, it will be necessary to operate the drive motor. Motors should be installed and the system prepared for operation. Automatic run-stop switches and external circuits and devices associated with the system should be checked for proper operation.

HIGH VOLTAGE WARNING

PERSONNEL WILL ALWAYS BE EXPOSED TO HIGH VOLTAGE WHEN AC INPUT POWER IS APPLIED TO THE CONVERTER WITH THE DOOR OPEN. WHEN MEASURING VOLTAGES IN THE POWER CIRCUIT, ALWAYS FOLLOW THE PROCEDURE GIVEN BELOW AS ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY:

1. Remove ac input power and allow two minutes for capacitors to discharge. Always check for residual voltages and discharge circuits with a voltmeter.

2. Clip multimeter leads to desired voltage check points.

3. Keep hands and head away from power section area. Apply ac input power and record voltage reading.

4. Repeat step (1) above and remove meter leads.

ALWAYS REMOVE AC INPUT POWER WHEN CHECKING AND REPLACING POWER SECTION COMPONENTS AND WHEN REPLACING RELAYS AND PRINTED CIRCUIT BOARDS. ALLOW TWO MINUTES FOR CAPACITORS TO DISCHARGE. ALWAYS CHECK WITH A VOLTMETER FOR ANY VOLTAGES BEFORE ATTEMPTING ANY REPAIRS.

( ) 1. Set the operators controls on the cabinet door as follows:

1CB, 2CB, 3CB	OFF
1SS, 2SS	OFF
3SS	MANUAL
4SS	#1 LEAD
1RH	0% (Minimum)

Check that 4CB inside the cabinet is ON. Close cabinet door.

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( ) 2. Close the external line disconnect switch to apply 460 VAC, 3Ø, 60 Hz power to the Lancer 44XLP Drive cabinet.

( ) 3. Since circuit breaker 4CB is ON, the door mounted blower will start **and the relay logic is energized.**

( ) 4. Close circuit breaker 3CB and perform the run-lockout and converter fault tests of Section 5.2.1.

( ) 5. If the run-lockout circuit does not hold in the run position; i.e., 1PBL on the DC Main PCB continues to glow brightly, open 3CB and the line disconnect switch. Reverse two of the three incoming power leads to the drive cabinet, to correct phase sequence. Reapplying power thru 3CB should result in 1PBL changing to dim glow after a few seconds.

( ) 6. With 3CB energized, check the power supply voltages using either the test module or a VOM per Section 5.2.4.

( ) 7. If the drive is equipped with a test module, turn 3CB OFF and perform the check of rectifier and inverter firing pulses per Section 5.2.5.

2.3.3 HAND - Constant Speed Operation

( ) 1. Set the operators controls on the cabinet door as follows:

1CB, 2CB, 3CB	OFF
1SS, 2SS	OFF
3SS	MANUAL
4SS	#1 LEAD
1RH	0% (Minimum)

Check that 4CB inside the cabinet is ON.

( ) 2. Close 1CB to ON. Then turn 1SS from OFF to HAND. No. 1 motor should operate from line power. Check motor rotation, then de-energize by turning 1SS to OFF. If motor rotation is incorrect, open the line disconnect switch and wait two minutes. Check for zero motor voltage and then reverse any two motor leads.

( ) 3. Turn 2CB to ON, then turn 2SS from OFF to HAND. No. 2 motor should operate from the line. Check motor rotation, then de-energize by turning 2SS to OFF. If motor rotation is incorrect, open line disconnect switch and reverse two motor leads at outgoing terminals.

2.3.4 <u>AUTOMATIC - Constant Speed Operation</u>

( ) 1. Set the operators controls on the cabinet door as follows:

1CB, 2CB	ON
3CB	OFF
1SS, 2SS	OFF
3SS	MANUAL
4SS	#1 LEAD
1RH	0% (Minimum)

Check that 4CB inside the cabinet is ON.

( ) 2. Check that LLSW and HLSW, contacts associated with wet well level interface, are open. Turn 1SS and 2SS to AUTO. Neither motor should run.

( ) 3. Close LLSW. #2 motor should start and run at constant speed from the line. (In normal variable speed operation, #1 motor will be lead motor in this position of 4SS.)

( ) 4. Close HLSW. After a few seconds delay, #1 motor should start and run at constant speed off the line. Open the LLSW and HLSW to stop the motors.

( ) 5. Change 4SS from #1 lead to #2 lead position. Repeat steps 3 and 4 above and note that #1 motor runs on closure of LLSW and #2 motor runs on closure of HLSW.

( ) 6. Open 1CB and 2CB.

2.3.5 AUTOMATIC Variable Speed Operation

( ) 1. Set the operators controls on the cabinet door as follows:

1CB, 2CB, 3CB	ON
1SS, 2SS	AUTO
3SS	MANUAL
4SS	#1 LEAD
1RH	0% (Minimum)

Check that 4CB inside the cabinet is ON.

( ) 2. Close LLSW and note that #1 motor is accelerated to approximately 25% speed. Advance the manual speed potentiometer and note that #1 motor speed is increased. Observe motor current with clamp on meter, or if supplied, the door mounted ammeter for normal readings.

( ) 3. Close HLSW switch and note operation. #1 motor should disconnect from the converter and #2 motor should be started on the converter. #1 motor will be started from line soon after it was disconnected from the converter.

( ) 4. Repeat step 2 and 3 with 4SS in #2 lead position and observe the reverse motor sequence.

( ) 5. Adjust input transducer signal per the procedure of Section 5.3.1.

This completes installation and startup of the Lancer 44XLP Drive System.

Refer to Sections 5 and 6 if problems occur.

Refer to Section 3 for operator's instructions.

SECTION 3

OPERATION

3.0 Operation

The Lancer 44XLP Drive is a static variable speed converter drive designed to control standard induction motors in variable torque applications (such as centrifugal pumps). The Duplex Drive can control one pump motor at variable speed from the converter, or two motors, one at constant speed from the line, and the other at variable speed. Control signals from a programmer or bubbler initiate simplex or duplexing operations. Speed of the converter-controlled motor is set either by a manual speed potentiometer or automatically by a remote transducer signal proportional to the controlled parameter.

HIGH VOLTAGE WARNING

OPERATE THE LANCER 44XLP DRIVE WITH THE CABINET DOOR CLOSED AND LOCKED. HIGH VOLTAGES PRESENT WITHIN THE CABINET ARE DANGEROUS TO PERSONNEL.

3.1 Functional Use of Controls

The description and function of the operator's controls are listed in Table 3.1 and shown in Figure 3.1. Note that the motor ammeters, elapsed time meters, and the percent speed meter are optional items and are furnished only when specified.

3.2 Initial Starting Procedure

NOTE: Before energizing the Lancer 44XLP drive, check that the associated pump system is ready for operation.

( ) 1. Close and lock the cabinet door(s).

( ) 2. Insure that there are no obstructions near the air louvers.

( ) 3. Set the controls as follows:

1CB, 2CB, 3CB	OFF
1SS, 2SS, 3SS	AUTO
4SS	AUTO ALT
1RH	Zero

NOTE: Insure that 4CB inside the cabinet is ON.

( ) 4. Close external line power (460 VAC, 3Ø, 60 Hz) disconnect switch.

NOTE: Cabinet blower is energized and air flow can be detected at cabinet air louvers.

( ) 5. Place 3CB to ON.

NOTE: After a few seconds reset action, the converter is ready for operation.

( ) 6. Place 1CB, then 2CB to ON.

This completes the initial starting procedure. System is now set to operate in a totally automatic manner as described in Section 3.3.

3.3 Normal Automatic Operating Sequence

The following is the normal operating sequence for which the level control, duplex pump system was designed. Refer to Figure 3.2.

1. As flow increases and the wet-well level rises to low level (point A'), the low level switch actuates, causing the lead motor to be connected to the converter. The motor is accelerated from zero to the required speed under linear acceleration control. Motor speed is automatically varied between maximum and minimum speed. in response to the signal from the level transducer to establish a discharge flow to match the wet-well influent rate.

2. With decreased flow and falling wet-well level, the speed decreases to the preset minimum speed. Upon reaching low level shut-off (point A), the differentially set low level switch causes the lead motor to disconnect from the converter and decelerate to stop.

3. Alternately, if the flow increases beyond the capacity of the lead pump operating alone, the hi-level, switch actuates upon reaching hi-level (point B) and causes the lead motor to be disconnected from the converter, await CEMF decay, and then be connected to the fixed frequency AC line to run constant speed. The lag motor is connected to the converter to operate variable speed as was the lead motor.

4. With decrease in flow, the hi-level switch actuates when level falls to a differentially set hi-level shut-off (point B), causing the lag motor to be disconnected from the converter. The lead motor is disconnected from the AC line, awaits CEMF decay, and is then connected to the converter to operate variable speed as described.

3.4 Normal Shutdown Procedure

( ) 1. Place 1CB and 2CB to OFF position.

( ) 2. Place 3CB to OFF position.

NOTE: The cabinet blower and all control circuits are still energized.

( ) 3. To totally de-energize, open external disconnect switch.

3.5 Manual Operation of Motor Under Abnormal Conditions

If fault occurs and motor operation is required, either #1, #2 or both motors may be operated at constant speed without regard to wet-well level as follows:

( ) 1. Place 1CB and/or 2CB to ON position.

( ) 2. Wait 10 seconds before proceeding to next step.

( ) 3. Place the appropriate hand-off-auto switch to HAND position.

3.6 Automatic Operation Under Abnormal Conditions

The pump drive system is designed to operate under fault or abnormal conditions as follows:

1. If power loss is sustained, the pump drive will shutdown safely. On return of power, the system will automatically return to normal operation as dictated by existing wet-well level.

2. If the converter fails, the converter is automatically disconnected and the system continues to operate as a duplex constant speed system based on the low level and high level wet-well contact signals.

3. If one motor is overloaded, overheated or intentionally disabled, the system will continue to operate with the remaining motor.

TABLE 3.1

LANCER 44XLP DUPLEX OPERATORS CONTROLS

NO.	REF. DESIG.	DESCRIPTION	PANEL MARKING	NORMAL OPERATING POSITION	FUNCTION
1	1CB	Circuit Breaker	Line Power #1 Motor	ON	Applies line power to motor #1 for constant speed operation.
2	2CB	Circuit Breaker	Line Power #2 Motor	ON	Applies line power to motor #2 for constant speed operation.
3	3CB	Circuit Breaker	Converter Power #1 and #2 Motor	ON	Applies line power to converter for variable speed operation.
4	1SS	Switch	#1 Motor Hand-Off-Auto	AUTO	Off position disables #1 motor. Hand position provides immediate constant speed operation of #1 motor through 1CB. Auto position provides automatic start-stop sequencing of #1 motor.
5	2SS	Switch	#2 Motor Hand-Off-Auto	AUTO	Off position disables #2 motor. Hand position provides immediate constant speed operation of #2 motor through 2CB. Auto position provides automatic start-stop sequencing of #2 motor.
6	3SS	Switch	Manual-Auto Speed	AUTO	Selects manual speed potentiometer signal or remote automatic level transducer signal.
7	4SS	Switch	#1 Lead - Auto Alt. - #2 Lead.	AUTO ALT	Selects #1 or #2 motor as lead. Auto Alt switches lead motor each 24 hours of use
8	1RH	Potentiometer	Manual Speed		Manual speed potentiometer. Not used for normal-auto operation. Effective only with 3SS in manual position.

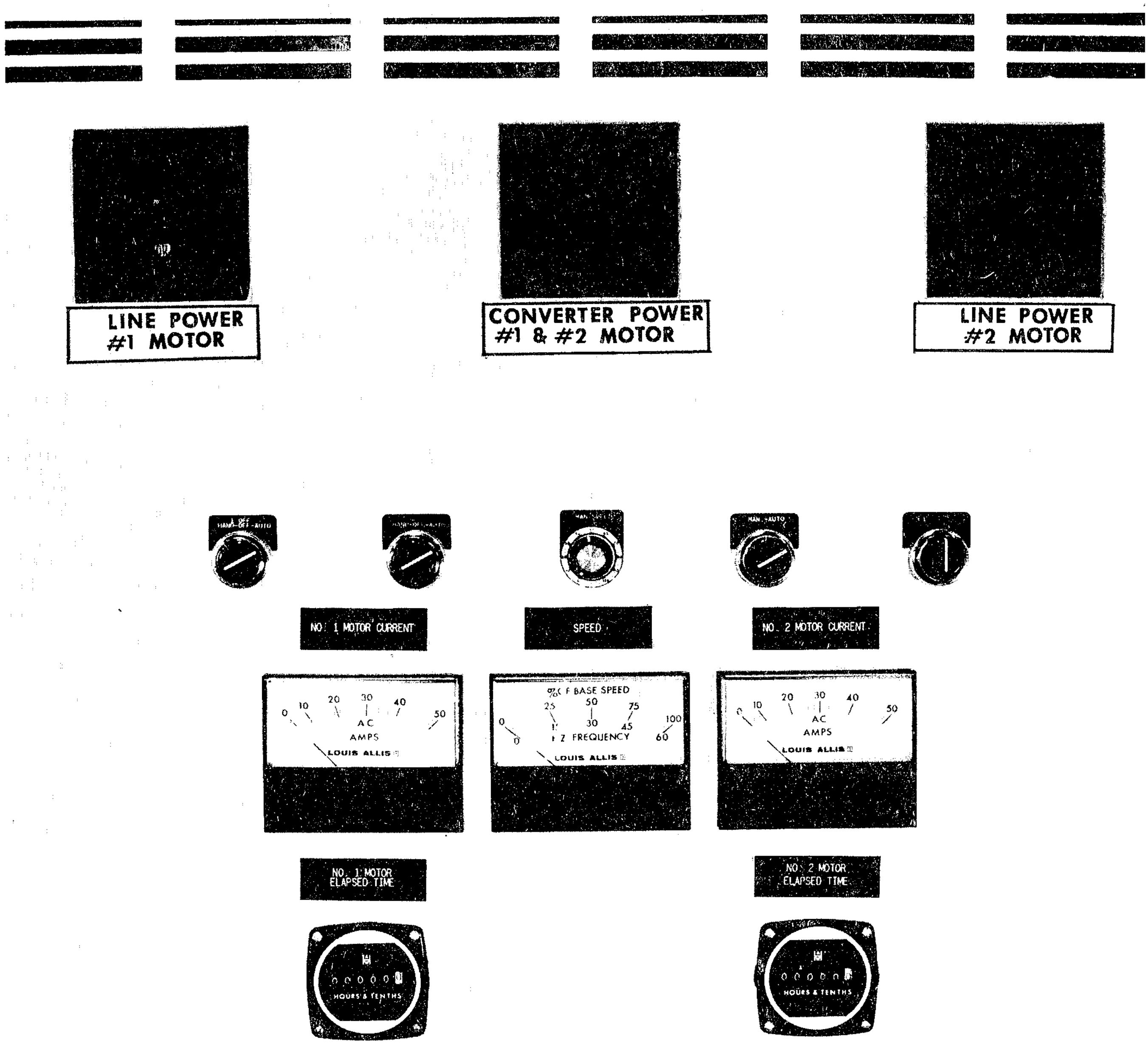
TABLE 3.1

LANCER 44XLP DUPLEX OPERATORS CONTROLS

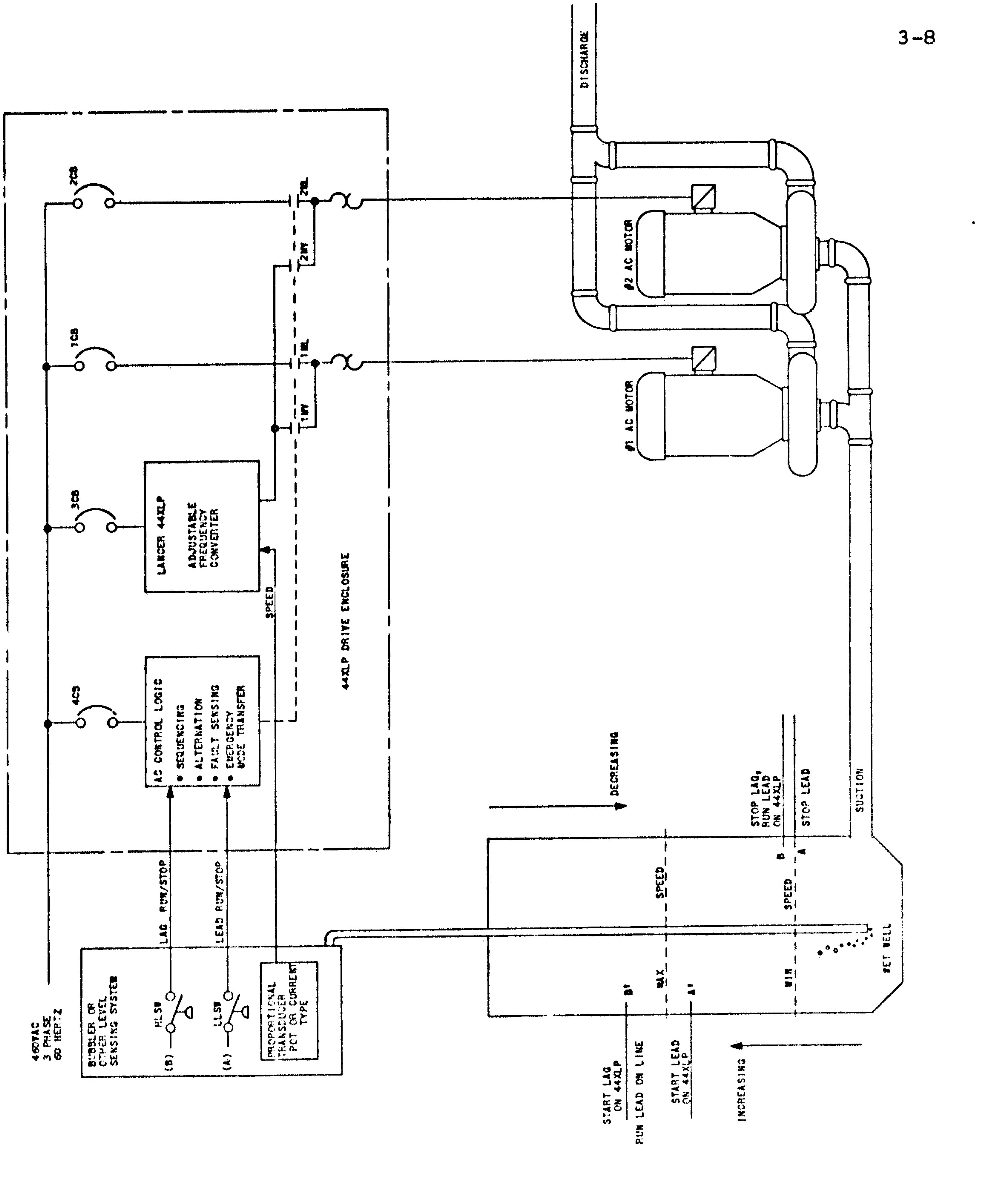
NO.	REF. DESIG.	DESCRIPTION	PANEL MARKING	NORMAL OPERATING POSITION	FUNCTION
9*	1AM	AC Ammeter	#1 Motor Current		Indicates #1 motor current.
10*	1ETM	Hour Meter	#1 Motor Elapsed Time		Indicates #1 motor total operating time.
11*	2AM	AC Ammeter	#2 Motor Current		Indicates #2 motor current.
12*	2ETM	Hour Meter	#2 Motor Elapsed Time		Indicates #2 motor total operating time.
13*	1VTM	Speed Meter	Speed		Indicates percent full speed and frequency of motor operating on converter.
14*	3ETM	Hour Meter	Converter Elapsed Time		Indicates converter total operating time.
15**	3PL	Pilot Light	#1 Motor On		Indicates #1 motor is running.
16**	4PL	Pilot Light	#2 Motor On		Indicates #2 motor is running.
17**	2PL	Pilot Light	Converter On		Indicates Converter is running.
18**	1PL	Pilot Light	Line Power On		Indicates incoming, 460 VAC line power to cabinet is present.

* Items 9 thru 14 are optional items and are furnished only when specified.

** Not Shown.



LANCER 44XLP DUPLEX DRIVE
DOOR MOUNTED OPERATORS CONTROL
FIGURE 3-1



CHANGES	
REMARKS	DATE
REV.	4-5 73

THE LOUIS ALLIS CO. Drives & Systems Division | New Berlin, Wisconsin 53151
Litton

LANCER 44XLP
DUPLEX PUMP DRIVE SYSTEM

C

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FIGURE 3.2

SECTION 4

FUNCTIONAL DESCRIPTION

4.0 Functional Description

4.1 System Block Diagram

Figure 4.1 is a simplified block diagram of the Lancer 44XLP Drive System. 460 VAC, 3Ø, 60 Hz power is applied through two circuit breakers (1CB and 2CB) to two contactors (1ML and 2ML). Circuit breaker (3CB) applies line power to the Lancer 44XLP current source static converter. Converter output may be applied to either of the two pump motors through contactors 1MV and 2MV.

Operation is controlled by the duplex relay logic from the interface low level and high level switches associated with the common wet-well. When the low level switch is closed, the selected lead motor is powered by the converter through its MV contactor. If wet-well level increases to close the high level switch, the lead motor is disconnected from the converter and operated from the line through its ML contactor. At the same time, the lag motor is powered by the converter to operate at the variable speed set by the interface speed signal.

The converter regulator circuits control motor speed by varying the frequency of the inverter and by controlling the current through the DC link. The two major feedback signals to the regulator are a DC link-related current derived from 3Ø current transformers at the input to the controlled rectifier, and motor terminal voltage sensed by a control transformer and rectifier at the output of the inverter. The regulating scheme results in a nominally constant volts per hertz ratio at the motor terminals throughout the frequency range.

The drive contains fault and protective devices such as motor overload relays and thermoguard switches in each rectifier and inverter SCR heat sink power module.

Protective circuits in the converter detect the following conditions:

1. Improper phase sequence or input single phase.

2. Instantaneous overcurrent.

3. Input undervoltage.

4. Output overvoltage.

5. Speed droop beyond preset limit indicative of current limiting condition (overload, failure, etc.).

The converter is disabled if any of the above occur, and the system is transferred to a duplex constant speed operation. To return the system and converter to normal operation, the fault must be eliminated and the protective circuit manually reset.

4.2 Current Source Converter

4.2.1 Controlled Rectifier and Filter

An SCR (silicon controlled rectifier) will conduct current in one direction only (DC), and it will not conduct until it is "turned on" (other terminology used - "gated", "fired") by a gating pulse. These two characteristics make it possible to obtain controlled DC voltage from an AC line. The method is commonly referred to as phase controlled rectification.

The controlled rectifier performs two major functions: it converts AC current to DC current and it varies the amplitude of DC current by controlling the portion of the three phase AC waveform passed, in conjunction with the filter choke.

To simplify the concepts of rectification and amplitude control, a representation of the input voltage from phase A to phase C is shown in Figure 4.2. Since an SCR will not conduct at all until it is gated, the output DC voltage can be varied by controlling the point when gating occurs.

Current control is achieved by regulating the firing angle of the SCR's as explained and by monitoring the actual current flow. The measured amount of current is compared to a current reference and the difference is amplified and used to adjust the firing angle to obtain the desired current.

A simplified schematic diagram for the three phase controlled rectifier bridge and choke filter which comprise the current source is shown in Figure 4.3. The three phase full wave bridge is made up of six SCR's which are gated two at a time.

4.2.2 Inverter

Figure 4.4 is a simplified schematic of a six-step inverter power circuit. SCR's 1 through 6 switch the load current at a rate determined by the inverter control to establish output frequency. Commutation capacitors 1C through 6C store energy necessary for commutation (ceasing SCR conduction by reversing terminal voltage). Series diodes 1RT through 6RT isolate the capacitors from the load. Only two SCR's are on at any one time with each one conducting for 120 degrees. The SCR's are commutated (turned off) when the adjacent SCR's in the next phase are fired in the order numbered.

Figure 4.5A illustrates schematically the conditions in the inverter just before firing 3SCR. Current from the controlled rectifier (DC current source) flows through 1SCR, 1RT, motor phase A, motor phase C, 2RT, 2SCR, and back to the supply. The commutating capacitor between 1SCR and 3SCR has been charged with the polarity shown. When 3SCR is fired, the full capacitor voltage is applied to 1SCR which is then commutated by the reverse voltage. The load current path is shown in Figure 4.5B. This current, which now goes through the capacitor, linearly reverses the capacitor voltage until it is sufficient to cause 3RT to conduct. At this point (see Figure 4.5C), the current begins to transfer from 1RT and phase A to 2RT and phase B until the current in 1RT has been driven to zero, and phase B assumes the full value of DC current (Idc) as shown in Figure 4.5D. Note that the motor inductance plays an important role in the commutation circuit. It is the energy stored in this inductance that performs the commutation by charging the capacitors for the next cycle. The value of commutation capacitance complements the motor inductance. A separate power supply (precharge network) is used to insure capacitor voltages are adequate to commutate the SCR's during starting and very low frequency operation.

The magnitude of current at any point in the inverter is always controlled by the regulated current source (the controlled rectifier and filter). Even when there are two parallel paths for current flow, the sum of these two currents can never be greater than the output current of the rectifier. The inverter controls only the time (frequency) that current is applied to a particular phase of the motor. Note that the regulated DC current between the controlled rectifier and the inverter is always in the same direction. At the DC terminals of the inverter, the average DC voltage will vary with the power demand of the motor. If the motor is unloaded, the DC voltage will be near zero. If the motor is supplying rated horsepower, the DC voltage will be at a maximum value.

The motor CEMF voltage is determined by the response of the motor and load to the applied current and frequency. In general, the motor voltage tends to be sinusoidal with a "spike" at the commutation points. A typical phase current, voltage and commutation capacitor voltage is shown in Figure 4.6.

In certain operating conditions, the energy available for commutation (stored in the motor inductance just before commutation) is more than the converter uses during commutation. Excess energy will cause large voltage excursions on the motor inductance and commutation capacitance. For this reason a voltage clamp circuit is connected to the motor terminals to clip the voltage spikes to reasonable levels. This clamp circuit is a three phase full wave rectifier bridge and capacitor bank serving as a peak rectifier. A clamp resistor loads the peak rectifier and dissipates the excess commutation energy.

4.3 Converter Regulator Circuits

The basic regulator system is shown in Figure 4.7. It consists of a current regulator loop, voltage regulator loop, and current limit circuit to maintain proper motor operation.

The current regulator loop includes the controlled rectifier, filters, inverter, motor windings, motor current feedback, current regulator and rectifier firing circuits. The current reference is established by the voltage regulator. The difference between this reference and the current feedback signal is amplified by the current regulator and applies in the rectifier firing circuits to advance or retard the rectifier SCR firing angle.

Because the DC link current contains ripple generated by the rectifier and the inverter, a voltage compensation feedback is applied to the current regulator. This scheme reduces motor current and voltage fluctuations.

The speed of the motor is controlled by inverter frequency. Inverter frequency is determined by the speed reference generator, variable frequency oscillator and the inverter firing logic.

The speed reference signal, as rate modified by the Linear Acceleration Circuit (LAC), determines the output of the speed reference generator. The output signal from the speed reference generator is used as the control signal for the voltage regulator. The voltage regulator compares this reference with rectified motor terminal voltage. The difference is the control signal for the current regualtor which, in turn, adjusts motor current to maintain terminal voltage consistent with inverter frequency. Because the same reference is used for the variable frequency oscillator and the voltage regulator, the system maintains a nominally constant volts per hertz ratio.

The current limit circuit limits DC link and motor load current to a safe value, preventing overload and motor breakdown. If applied motor load is enough to initiate the limiting condition, output frequency and speed are reduced. While the speed is being reduced, maximum rated current and corresponding torque are maintained until the load drops to within the motor's capabilities. (This is characteristic of variable torque loads only.) Subsequently, if the abnormal load is removed, motor current drops, releasing the current limit circuit, and inverter frequency again responds to the Linear Acceleration Circuit (LAC) signal.

The current limit circuit is designed to limit idle current near 1 Hz and tapering to an adjustable value, 50-100% rated, at 12 Hz and above.

The speed reference signal from a potentiometer or current type transducer is rate controlled by the LAC. Contacts of a dwell timer release the output of the circuit at time of motor start.

The customer has the option to use either a milliamp signal from a current transducer or a voltage signal from a potentiometer transducer as input to the LAC. In addition, a manual speed potentiometer (not shown) is used for test or check-out purposes. A transducer follower circuit provides offset bias and magnitude (ratio) adjustment of the various popular current transducer output signals before application to the LAC circuit.

4.3.1 DC Firing Logic

Figure 4.8 is a simplified block diagram of the regulator and logic circuits for the controlled rectifier portion of the converter. Their function is to generate timed firing pulses for each of the six SCR's. The timing of the firing pulse (with respect to the phase of voltage across a given SCR) is controlled by the current regulator. Except where noted, the circuits shown in Figure 4.8 are located on the DC Main PCB.

Figure 4.9 illustrates the voltage relationships to generate the firing pulses for 1SCR and 4SCR. During the half cycle that L-AC voltage is positive, 1SCR is properly biased to conduct. During the alternate half cycle, 4SCR is properly biased as shown in Figure 4.9A. A voltage reference (V-BN) phase shifted 90 degrees from L-AC is produced by reference generator A (Figure 4.8). Figure 4.9B shows that the reference voltage swings from maximum negative to maximum positive during 1 SCR's possible conduction interval.

A tail end pulse (T.E.), generated from L-BA, is effectively added to the reference voltage to insure that each SCR is fired at least once per cycle (Figure 4.9, D & E). An inhibit voltage prevents firing the SCR's during the half cycle that the anode is negative with respect to cathode. This is done using a portion of L-AC from reference generator A to disable the comparators during the inverse half cycle.

Two current regulator control signals are used, PCR and NCR. PCR is generated by the positive current regulator from the error voltage of the current summing circuit. PCR is an analog voltage that swings between -12 and +12 volts. NCR is the inverse, or compliment of PCR and is produced by the negative current regulator.

The firing pulse for 1SCR is generated in the comparator A circuit. As shown in Figure 4.9D, NCR is compared to the AC reference signal. A trigger pulse is produced at the instant the two amplitudes coincide (X). When NCR is at its most negative level (-12 volts), the trigger pulse occurs early in the 1SCR half cycle. This is the maximum, or advance, firing condition. When NCR is +12 volts, the trigger pulse occurs near the end of 1SCR half cycle. This is the minimum, or retard, condition (Y). Note that the tail end pulse insures triggering of the SCR under full retard conditions.

The trigger pulse for 4SCR is generated in the second half of comparator A using the same reference signal and PCR. Conditions of advance and retard are shown in Figure 4.9E.

Each of the three comparator section produces two outputs. Each output consists of two trigger pulses, 180° apart (Figure 4.9 F & G). Outputs are fed to the double pulse logic circuit, which produces two negative going firing pulses spaced 60° apart for each SCR. The second pulse is the trigger generated for the next higher numbered SCR.

These pulses are fed to each of the pulse amplifiers A through F, and then to the Gate Firing circuits which fire the SCR in proper sequence.

All six trigger pulses are fed to the Rectifier Sync Pulse Generator. The Rectifier Sync pulses are used to synchronize firing of the inverter SCR's.

The control signal for the current regulator is the current reference from the voltage regulator. The controlled signal is the current feedback. This signal is generated from three current transformers at the controlled rectifier input. The current transformers feed the current feedback rectifier to produce I feedback. The Burden resistor is selected per motor size so that 100% rated motor current equals 5.6 volts. The I-FEEDBACK signal is also applied to an overcurrent detector and to the test module.

The voltage feedback to the current summing circuit is to compensate for beat frequencies between line and inverter frequencies. This is an AC signal generated by transformer 3PT in the DC link between rectifier and inverter. The current reference (test mode) signal is used only for open loop tests. It is generated in the test module. The phase-back signal provides a full retard condition of the rectifier bridge and results in zero current output. It is used during starting and shutdown of the converter.

4.3.2 Inverter Firing Logic

The AC Main PCB contains the inverter firing logic as shown in Figure 4.10. Clock pulses (CP) are received from the variable frequency oscillator. These pulses have a repetition rate varying from 6 pulses per second to 400 pulses per second depending on the speed signal. The inverter logic generates trigger pulses for the inverter SCR's in proper sequence to produce the 3 phase power for the motor.

Figure 4.11 shows voltage relationships in the inverter logic. The clock pulses drive a ring-type 3 stage shift register. Each clock pulse advances the count in the register one step and causes a shift in one of the register outputs Q, Q_o, and Q_1. The start-up reset circuit places each register in the proper initial state.

Each Q signal repeats itself once per cycle of the inverter frequency. Thus there are 6 clock pulses per inverter cycle, and 360 Hz variable frequency oscillator output (CP) produces an inverter frequency of 60 Hz.

The shift register signals feed a logic circuit where they are combined to generate SCR firing gates of 120 degree duration. For example, Q_1 and Q signals are combined in an AND type logic gate to produce the gate firing signal for 1SCR. The gates are sequenced for ABC rotation of the motor, and the rate of motor field rotation is a function of CP repetition rate.

Triggering pulses for the inverter SCR's are generated by combining clock pulses with rectifier sync pulses. Thus each inverter SCR receives a firing pulse at the beginning of its 120 degree conduction period and at least one additional firing pulse at the instant a rectifier SCR is fired. This is done to insure a continuous current path through the inverter, since the inverter function is not to control motor current but rather to switch motor phases to control speed.

An inverter inhibit signal is combined with trigger pulses to block SCR firing during starting or converter fault.

The inverter trigger pulses are amplified and then feed gate firing circuits identical to those of the controlled rectifier. Test points are available at the pulse amplifiers.

4.3.3 Voltage Regulator and Oscillator (VR+O)

Figure 4.12 is a block diagram of the Voltage Regulator and Oscillator PCB (VR + O PCB). Transformer 2PT primary is connected across the motor terminals of the inverter, and the transformer secondary feeds a 3Ø bridge rectifier in the VR + O PCB. Rectified motor voltage (100 VDC representing full rated motor volts) is fed to the zero current and fault detector PCB, the Test Module, the voltage regulator, and the speed reference generator.

The main input to the speed reference generator is the LAC signal from the Linear Acceleration and Transducer Follower PCB. Transient feedback from the rectified motor voltage (by way of stability pot circuit) is applied to the speed regulator. Output of the speed reference generator feeds the voltage regulator, speed indicator, variable frequency oscillator, and test point AA.

Output of the variable frequency oscillator is a negative pulse varying in repetition rate from 6 to 400 pulses per second dependent on the speed reference output. The Dwell Frequency Adjustment sets the minimum frequency to approximately 6 Hz (1 Hz inverter frequency). The signal (CP) is fed to Test Point CC and the AC Main PCB.

Inputs to the voltage regulator are the rectified motor voltage and speed reference output. The adjustment 4RH input sets the volts per Hz ratio of the regulator. The output of the voltage regulator (monitored at Test Point BB) is available to the Test Meter Module and voltage regulator output circuit. This output circuit generates the reference signal (monitored at Test Point DD) for the current regulator and the current limit circuit. The I-IDLE adjustment (5RH) sets the no load motor current reference signal. The current reference signal is disabled during test when Test Mode circuits short the voltage regulator output.

The LAC input is applied to the tapered current limit circuit. This circuit provides a tapered current limit ranging from I-IDLE current at 1 Hz (inverter frequency) up to 100% rated motor current at 12 Hz output. Above 12 Hz the current limit circuit may be set within the range of 50 to 100% or rated motor current by means of the I-LIMIT adjustment (6RH). The current limiter circuit reduces the output of the speed reference signal when in the current limiting condition. Its output is available at Test Point FF.

4.3.4 Linear Acceleration and Transducer Follower (LAC + TF)

The Linear Acceleration and Transducer Follower PCB circuits are shown in Figure 4.13. The diagram also shows associated circuits not part of the PCB.

The remote transducer signal representing the system control parameter is applied to the LAC and TF PCB. Ratio and offset adjustments at the input of the transducer follower circuit allow a range of input signal from zero to 50 ma (with 10 ma being the minimum to produce maximum speed) and offset amounts up to ±50 ma. Output of the transducer follower is the speed signal. Zero to -5 volts output produces zero to maximum speed.

The speed signal is applied at the input of the speed amplifier which drives the linear integrator. The output of the linear integrator follows the speed amplifier signal but with a rate limit set by the integrator circuit. Both the acceleration and deceleration rates are adjustable over the range of 4 to 20 seconds for a zero to 100% speed signal step change. Output of the LAC is zero to approximately +10 volts for zero to 100% motor speed. Output of the LAC is clamped to zero volts by the N.C. contact of 1TR. 1TR is a 2 second time delay which is energized through the current phase back relay when the inverter is not in "phase back."

A manual speed potentiometer may also apply an input to the speed signal amplifier through contact switching of the manual-automatic speed relay. Maximum and minimum speed adjustments set the limits of the manual speed pot. A (135 ohm) potentiometer type transducer may be used as an alternate signal source to the current output type. In this case, the remote pot is connected to different terminals provided and made effective in the auto mode by relay contacts. The speed limit potentiometer (factory set) limits the maximum speed of the converter connected motor to a pre-set level when the speed reference signal exceeds the normal maximum operating level. The LAC circuit can also accept a voltage signal, externally conditioned, if necessary to apply zero to 10 volts DC to produce zero to 100% speed.

4.3.5 Fault and Zero Current Detector

The Fault and Zero Current Detector PCB is shown in Figure 4.14. The fault detector portion of this PCB senses excessive speed droop of the motor. If present for more than 1 second, 1SCR will fire and de-energize the relay 1CR. The trip out circuit will hold 1CR de-energized until the reset button 1PBL on this circuit board is pressed or until control power is removed. Rectified motor terminal voltage, representing motor speed, is compared to the scaled speed reference signal (LAC). If the actual motor speed drops more than 20% below the desired speed setting, a signal is fed to the time delay circuit. The under speed adjustment (1RH) sets the circuit threshold, and the scaling adjustment (2RH) equalizes input signals.

The purpose of the zero current detector is to determine near zero motor current condition. The relay (2CR) in this circuit interfaces with the run-stop-sequencing relay circuits to signal that current "phase back" is complete. DC link current (I-FDBK) is applied to the zero current detector where it is compared with a reference set by the zero current adjustment (4RH). Detector output goes positive at an I-FDBK of less than 4 to 10%' of rated motor current, energizing 2CR, which drops the CURRENT PHASE BACK COMPLETED relay to indicate "phase back" complete, and the motor circuit may be opened (if motor disconnect devices exist).

4.3.6 Run Lockout

Figure 4.15 is a block diagram of the Run Lockout and Phase Back circuits. These circuits are located on the DC main PCB.

The Run Lockout circuit is a latch type which provides a contact closure from 1CR to the relay logic indicating a converter fault. The latch circuit can be reset by push-button 1PBL on the circuit board or by removing power for approximately one minute. When the Run Lockout circuit is tripped, it initiates a phase back (full retard) of the controlled rectifier and an inverter inhibit.

Four different fault signals trip the Run Lockout circuit. They are:

1. 200% rated current. (Requires Resetting)

2. Overvoltage trigger from motor voltage clamp circuit. (Requires Resetting)

3. Wrong phase sequence of incoming wire. (Automatic reset when condition is corrected)

4. Single phase condition.

Phase back is also applied to the drive during start and stop operations, controlled by a normally closed contact of the phase back relay in the relay logic circuits. This is independent of the Run Lockout circuit and does not initiate trip.

4.4 Test Module

The test module is an optional plug-in device designed to monitor power supply voltages and control signals while converter is in operation. With the converter shutdown it can be used to check the firing circuits of the controlled rectifier and the inverter. To check the firing circuits, the gate firing plugs are removed from the four gate firing PCB's and plugged into test sockets on the test module assembly. The test module contains a zero center meter, a 5-position function switch, a voltage selector switch, a 6-position SCR selector switch, a volt phase switch, and a current reference potentiometer. A chart is provided to aid in operation and interpretation of test module readings.

With the function switch in the VOLT position, the voltage selector switch may be used to check any of 8 voltages and control signals in the converter.

Two tests may be made in the DC PHASE function. The first is for the presence and amplitude of trigger pulses for each SCR in the controlled rectifier. The two trigger pulses for each SCR are selected by a switch and peak detected for the meter circuit. Meter indication is primarily a function of pulse amplitude.

In the second test, the pulses of each SCR are compared to those for the succeeding SCR in a double peak detecting circuit by closing the VOLT-PHASE switch. Recall that each SCR is triggered by two pulses 60 degrees apart as shown in Figure 4.16. In example B, the double coincidence will produce a greater meter reading than the correct relationship shown in A. In example C, the lack of coincidence will result in a lower meter reading than in A. Each of the SCR trigger pulses is compared to the succeeding SCR pulses to check that they occur in correct sequence.

The Phase Shift (DC only) test checks that the rectifier trigger pulses shift with respect to the phase of the AC line on control of the current regulator. Line reference is used to set a flip-flop circuit and the trigger pulse for 1SCR is used to reset the flip-flop. The portion of the cycle when the flip-flop is in the Q state is metered. The Test Module's Current Reference potentiometer is used to vary the trigger phase relationship while observing the change in meter reading.

The inverter section is also checked for presence of trigger pulses as well as the sequence of pulses between SCR's in the AC phase position of the function switch.

While the inverter section has no phase shift reference, the rotational frequency of the inverter is a function of the manual speed pot (1RH) when in the test mode. A rudimentary check of this function may be made by observing meter reading as the speed potentiometer is varied from its maximum to minimum limits.

4.5 Duplex Logic Circuits

Figure 4.1 illustrates the electrical power flow.

Each motor may be connected to only one 460V source at any time. Transfers are open circuit with reconnect delay to allow CEMF decay.

Three power circuit breakers 1-3CB are provided instead of one large main breaker to enable disconnect of XLP from power for servicing while the remainder of the system continues pumping as a constant speed duplex. By 1CB disconnect and lockout of 1MV by selector switch, #1 motor could be removed for service while the remaining motor continues operation.

Circuit breaker 4CB enables retention of 115 VAC logic power when 1CB, 2CB, or 3CB is opened. This arrangement insures that no power, 460V or 115V, is present in Lancer 44XLP modules when 3CB is opened for service work. Separate 115 VAC by 1PT supplies the converter's 115V power needs, as well as several AC logic relays which interface with converter circuits.

Refer to Figure 3.1 and Table 3.1 for function of the operator's controls. Power for the control logic relays is provided through Circuit Breaker (4CB) 460V branch to 2PT, 115 VAC logic transformer.

If an accessory test module is supplied with the particular order, switch (2SS) will transfer the converter into a test mode when this switch is in any position other than OFF or VOLTS. When in the test mode, the converter is locked out of the system sequence by simulation of a converter fault and automatically transfers to manual speed reference.

The total system's control logic is shown in the Lancer 44XLP Duplex Schematic Diagrams. The following figures show functional subsections of this overall schematic.

Fig. 4.17	Motor Alternation Circuit
Fig. 4.18	Run-Stop Sequence Circuit
Fig. 4.19	Constant Speed Operation
Fig. 4.20	Variable Speed Operation
Fig. 4.21	Protective Circuits
Fig. 4.22	Manual/Automatic Speed Logic

Table 4.2 shows the sequence of relay operation during normal startup and actuation of the low level and high level switches.

TABLE 4.2

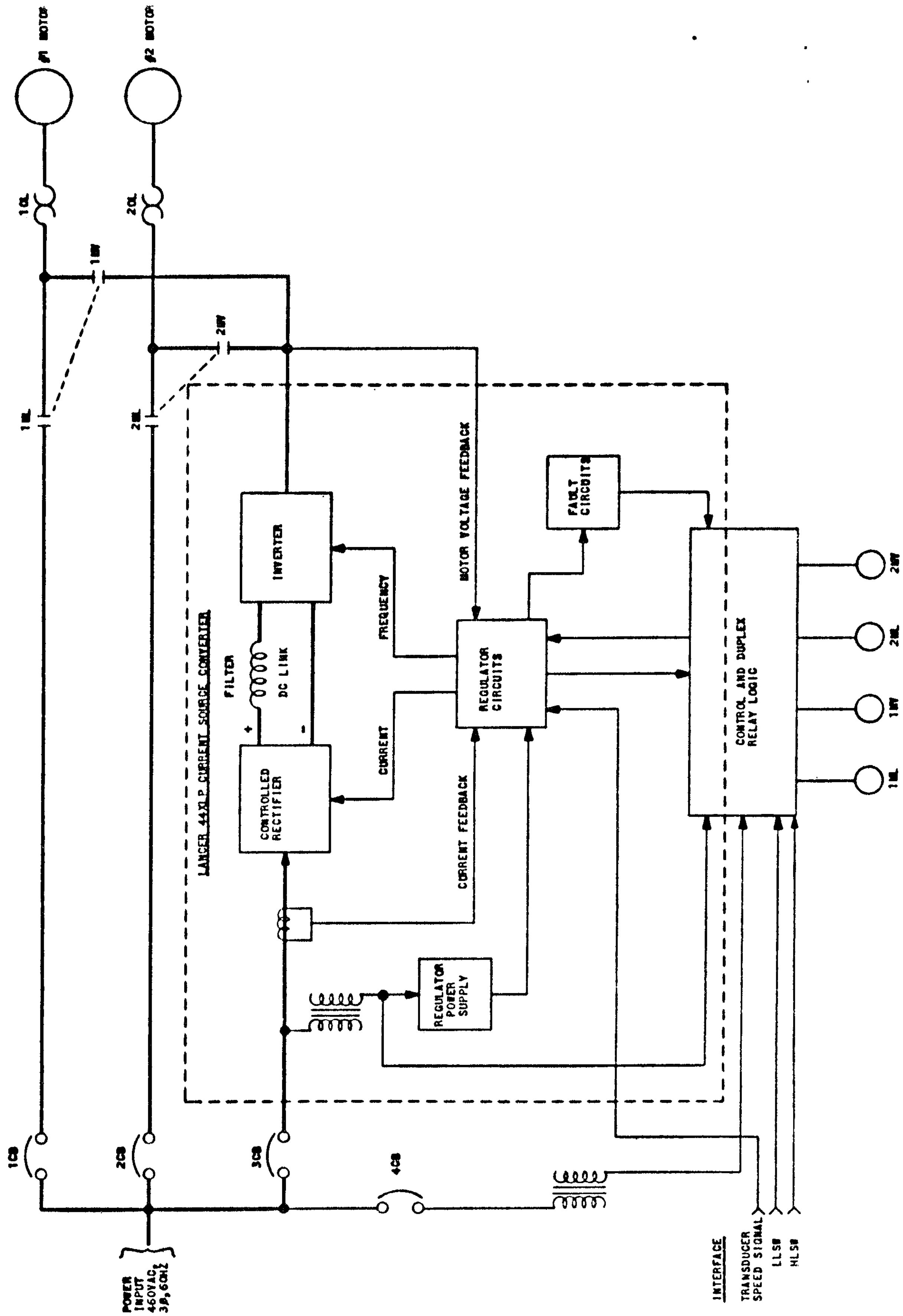
NORMAL AUTOMATIC CONTACTOR TYPE DUPLEXING SEQUENCE
(Coil Status: Energized = XLP, De-energized = $\overline{XLP}$)

SYSTEM ACTION	ELECTRICAL REACTION TIME SEQUENCE (not seconds) 1	2	3	4	5	6	7	8	9	10	FINAL EFFECT OR SIGNIFICANCE TO SYSTEM OPERATION
1. Apply 115/460 VAC	1OLR 2OLR IPCB STR	XLP									No #1 Motor Overload or Overtemp No #2 Motor Overload or Overtemp XLP Choke Current at Zero No XLP Fault Exists Motor Starter Circuit Enabled System Ready to Run
2. Close Low Level Switch	1LD	1XLTR				1MV	IPB				#1 Motor (lead) Commanded to Run Timing Starts (Decay to Zero Speed) #1 Motor Connected to 44XLP Power Output Current Phaseback Release #1 Motor Runs Variable Speed
3. Close High Level Switch a.	HLTR	$\overline{1LD}$	$\overline{1XLTR}$	$\overline{IPB}$	IPBC	$\overline{1MV}$					Command to Run 2 Motors #1 on ACM #2 on XLP Stop Command to #1 ACM on XLP Choke Current Phaseback Applied and Complete #1 Motor Disconnected from XLP
b.		2LD	2XLTR				2MV	IPB			Run Command for #2 ACM on XLP Timing Starts (Decay to Zero Speed) #2 ACM Connected to 44XLP Power Output Current Phaseback Released
c.					1ML						#1 Motor Connected to Line Power #1 ACM Runs Constant Speed
											Total Effect of a, b, &c 2 Motors Operating, One Variable, One Constant Speed.
4. High Level Switch Opens a.	$\overline{HLTR}$	$\overline{2LD}$	$\overline{1ML}$								Command to Run Single Motor (lead) Stop Command to #1 on Line and#2 on XLP #1 Disconnected From Line Power
b.			$\overline{2XLTR}$	$\overline{IPB}$	$\overline{IPBC}$	$\overline{2MV}$					Current Phaseback Applied and Completed. #2 ACM Disconnected From XLP Both Motors Disconnected

TABLE 4.2

NORMAL, AUTOMATIC CONTACTOR TYPE DUPLEXING SEQUENCE
(Coil Status: Energized = XLP, De-energized = XLP)
(cont)

SYSTEM ACTION	ELECTRICAL REACTION TIME SEQUENCE (not seconds) 1	2	3	4	5	6	7	8	9	10	FINAL EFFECT OR SIGNIFICANCE TO SYSTEM OPERATION
c.		1LD									Command to Run #1 ACM on XLP
			1XLTR								Timing Starts (Decay to Zero Speed)
							1MV				#1 ACM Connected to XLP Power
								IPB			Current Phaseback Released
											Total effect of a, b, & c #1 ACM Disconnected and #2 ACM Running Variable Speed. System Returned to Single Motor (lead) Operation on Variable Speed.



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LANCER 44XLP DUPLEX SYSTEM-SIMPLIFIED BLOCK DIAGRAM

FIGURE 4-1

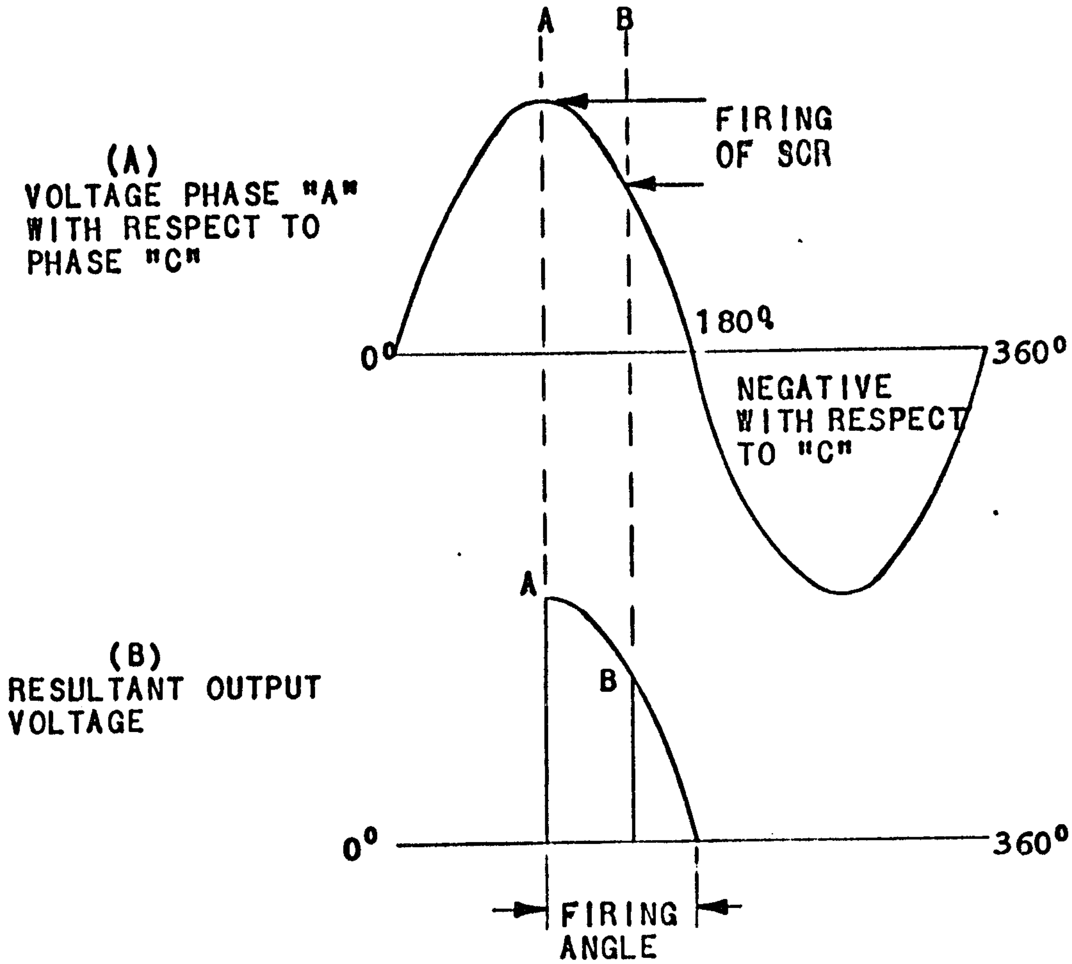
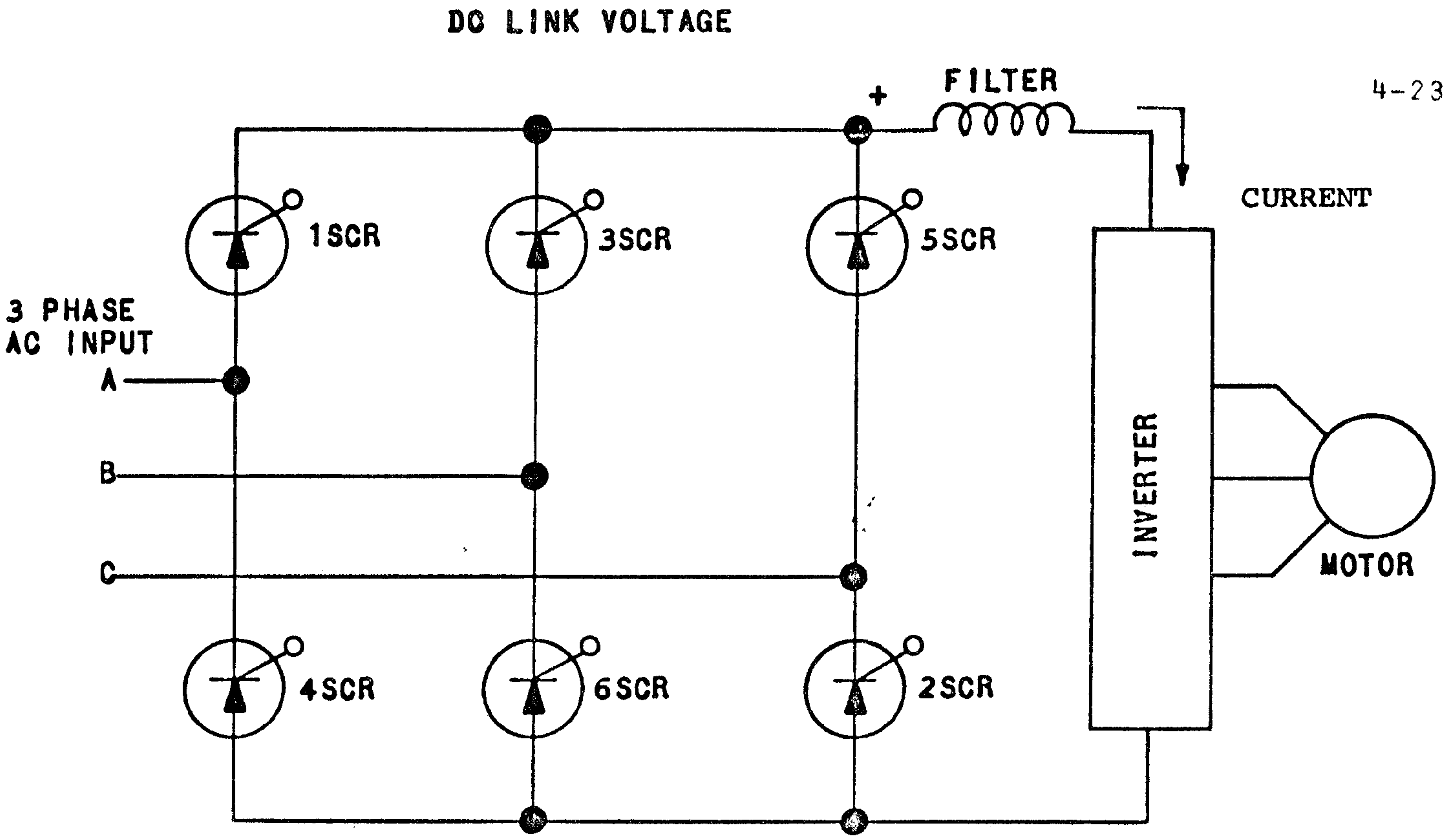

A
B
FIRING
OF SCR
(A)
VOLTAGE PHASE "A"
WITH RESPECT TO
PHASE "C"
180°
0°
360°
NEGATIVE
WITH RESPECT
TO "C"
A
(B)
RESULTANT OUTPUT
VOLTAGE
B
0°
360°
FIRING
ANGLE

FIGURE 4-2



THREE PHASE AC LINE COMBINATIONS	CURRENT PATH
A POSITIVE WITH RESPECT TO B	1SCR THROUGH INVERTER RETURN THROUGH 6SCR
A POSITIVE WITH RESPECT TO C	1SCR THROUGH INVERTER RETURN THROUGH 2SCR
B POSITIVE WITH RESPECT TO C	3SCR THROUGH INVERTER RETURN THROUGH 2SCR
B POSITIVE WITH RESPECT TO A	3SCR THROUGH INVERTER RETURN THROUGH 4SCR
C POSITIVE WITH RESPECT TO A	5SCR THROUGH INVERTER RETURN THROUGH 4SCR
C POSITIVE WITH RESPECT TO B	5SCR THROUGH INVERTER RETURN THROUGH 6SCR

CONTROLLER RECTIFIER AND FILTER
CURRENT SOURCE SCHEMATIC AND
CURRENT PATH

FIGURE 4-3

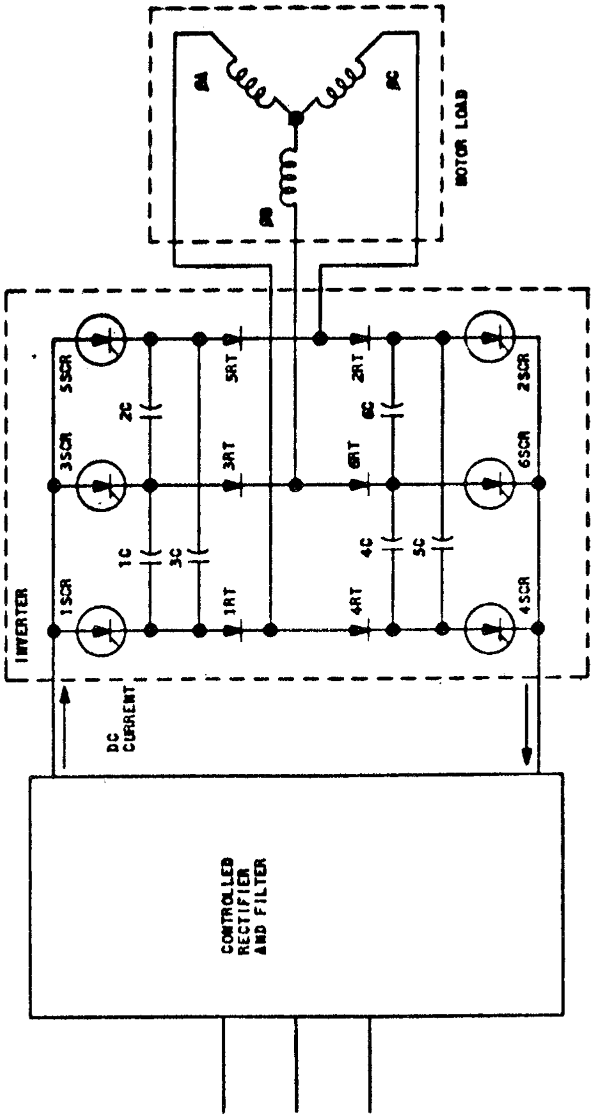


FIGURE 4-4

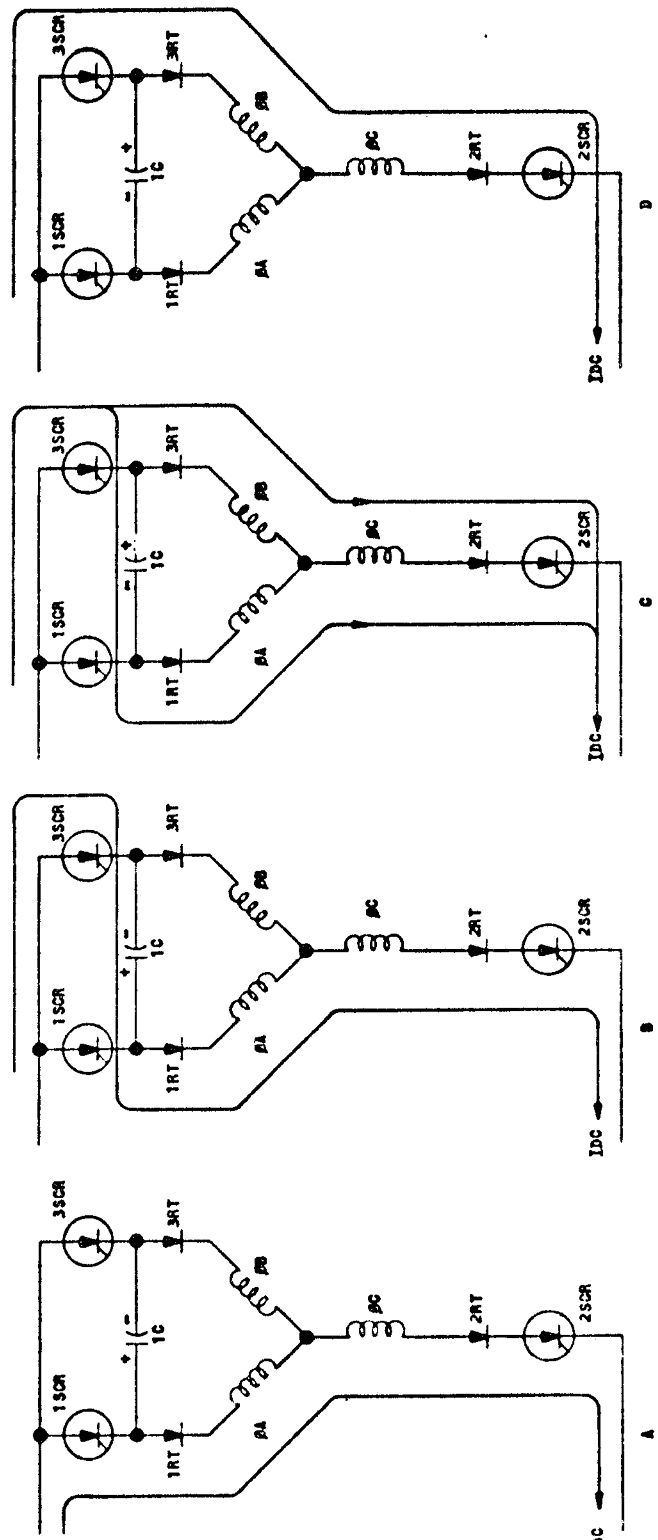


FIGURE 4-5

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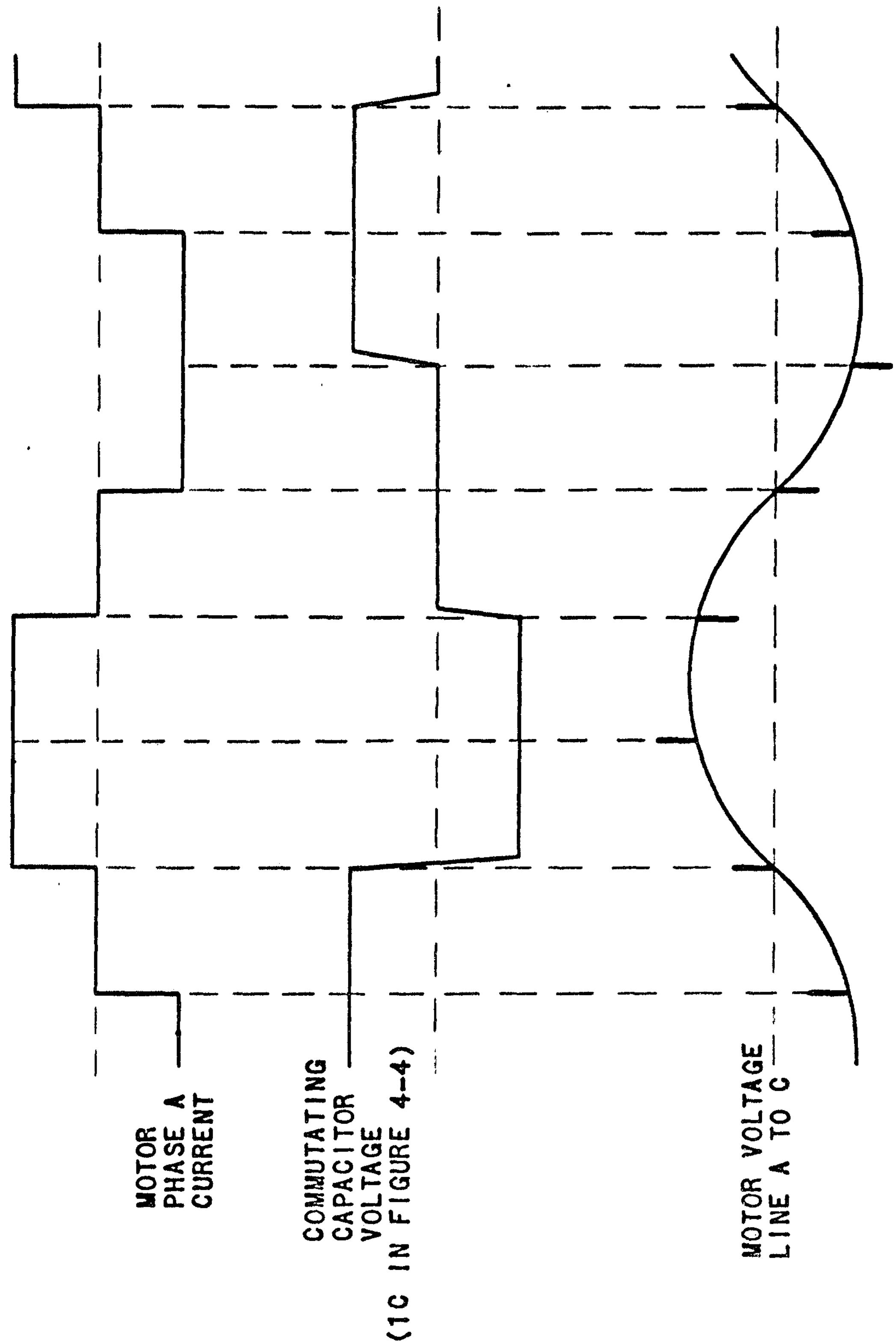
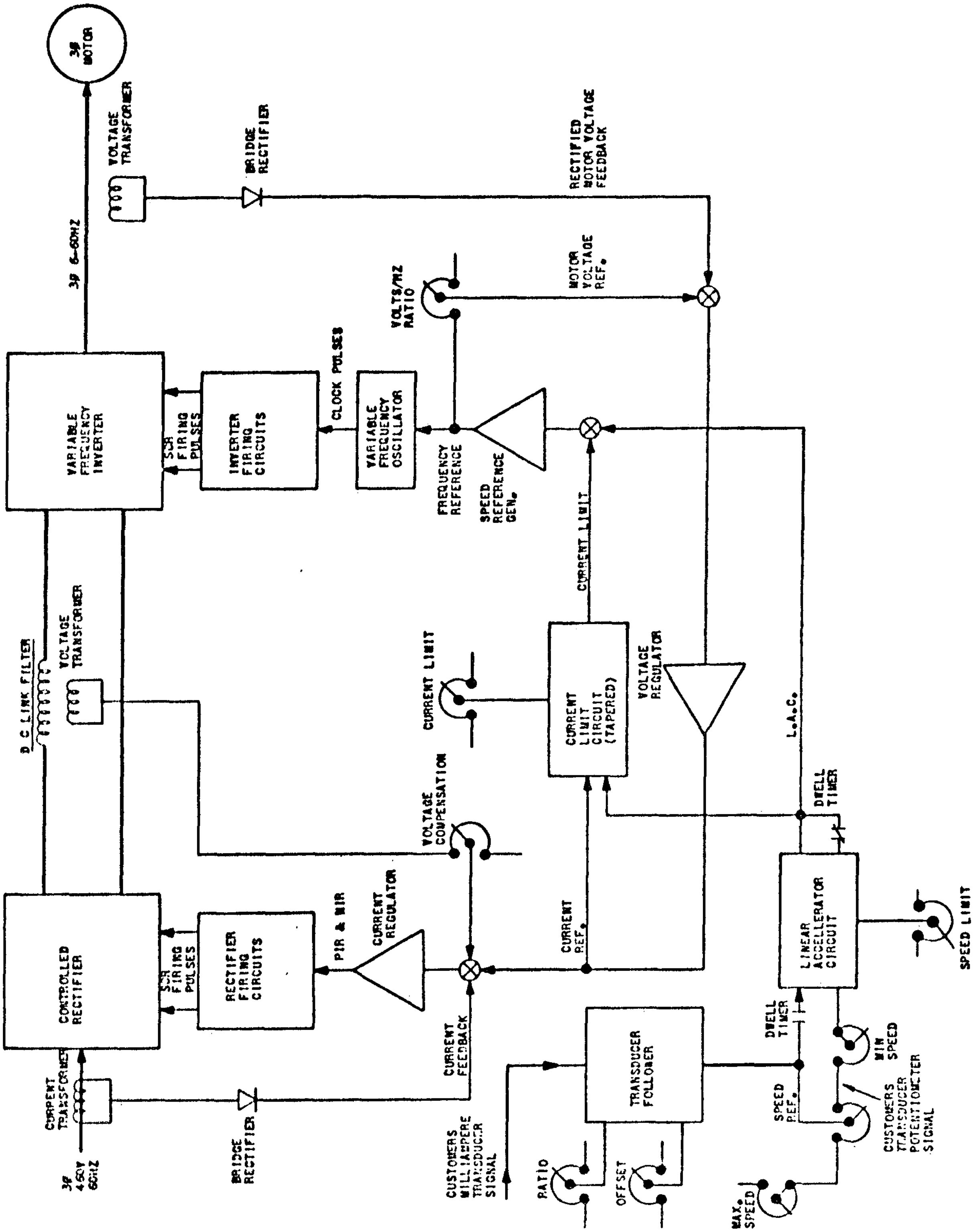
FIGURE 4-4 & 4-5



TYPICAL INVERTER WAVEFORMS

FIGURE 4-6



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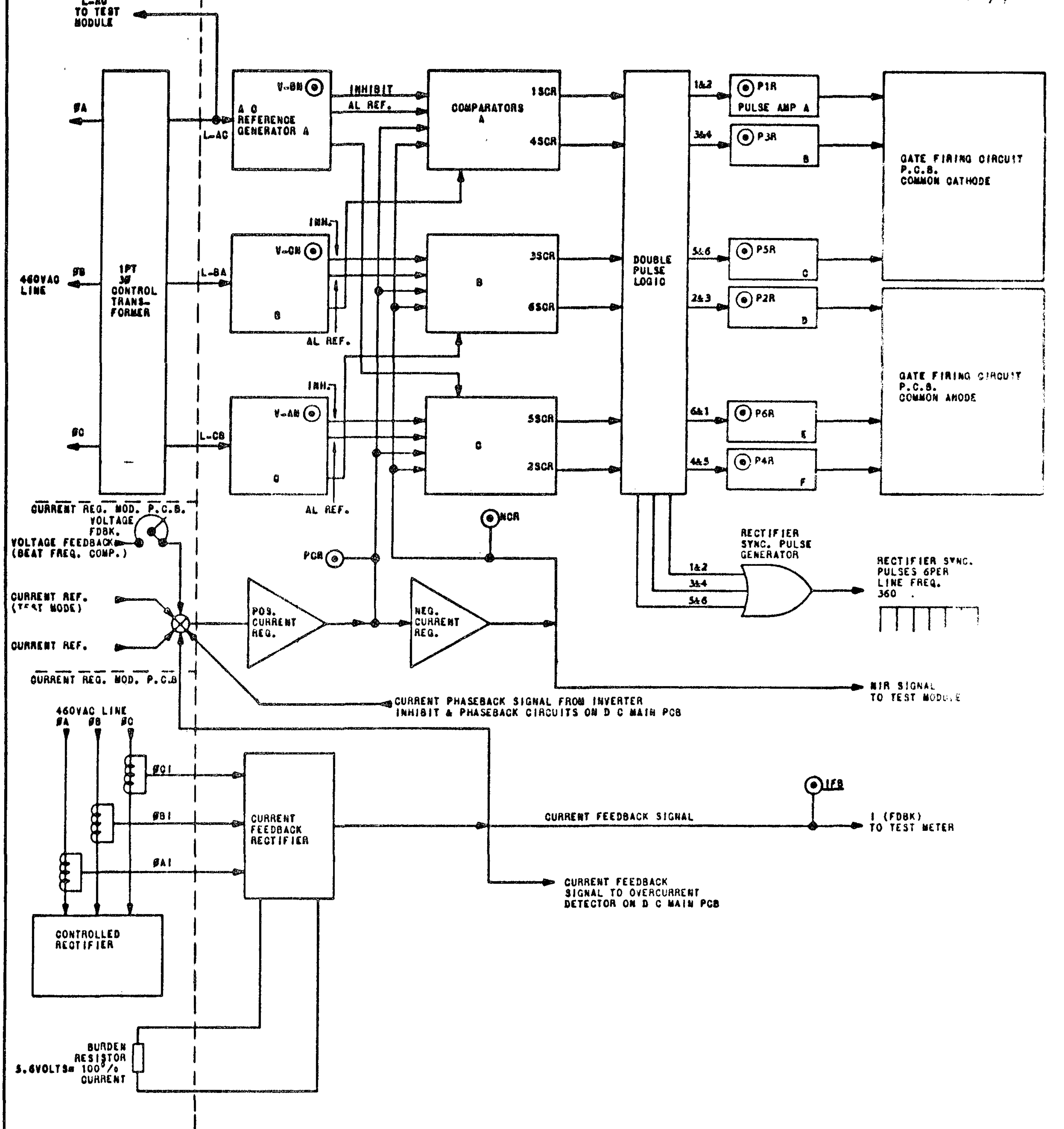
SIMPLIFIED BLOCK DIAGRAM
LANCER 44XLP
CONVERTER REGULATOR CIRCUITS

FIGURE 4-7



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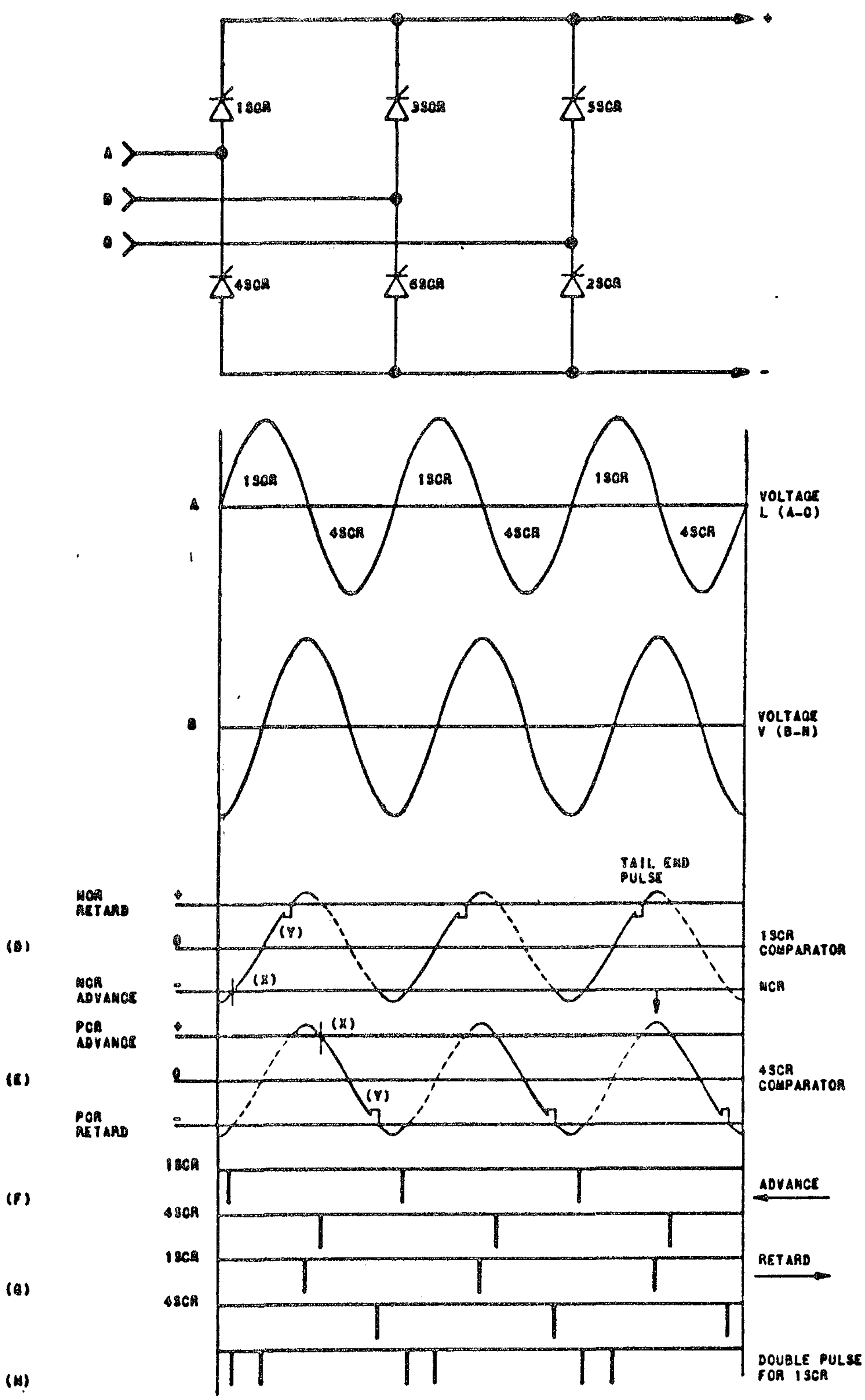
RECTIFIER REGULATOR AND LOGIC SIMPLIFIED BLOCK DIAGRAM (PART OF D C MAIN PCB)

FIGURE 4-8.



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CONTROLLED RECTIFIER
LOGIC WAVEFORMS

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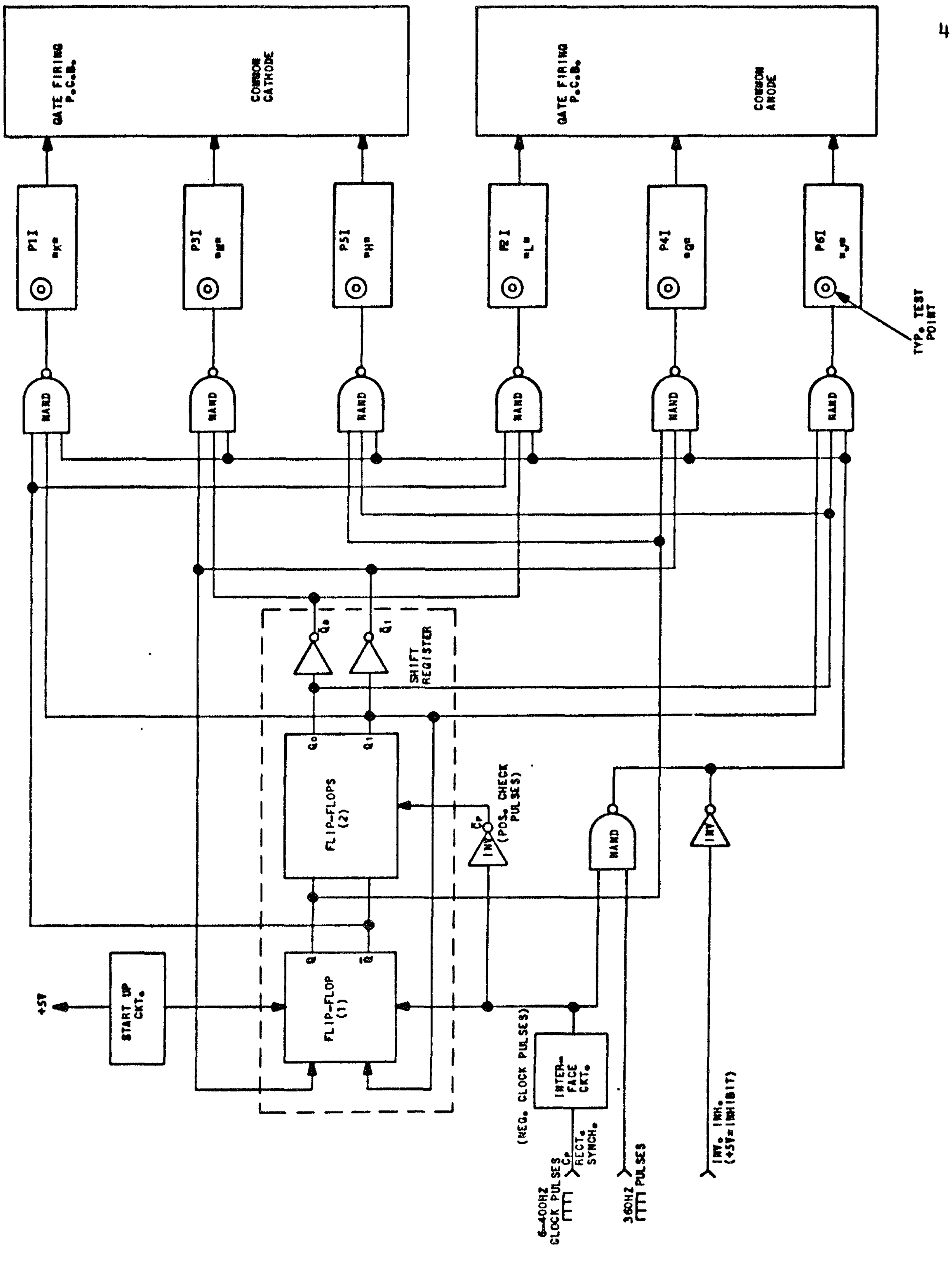

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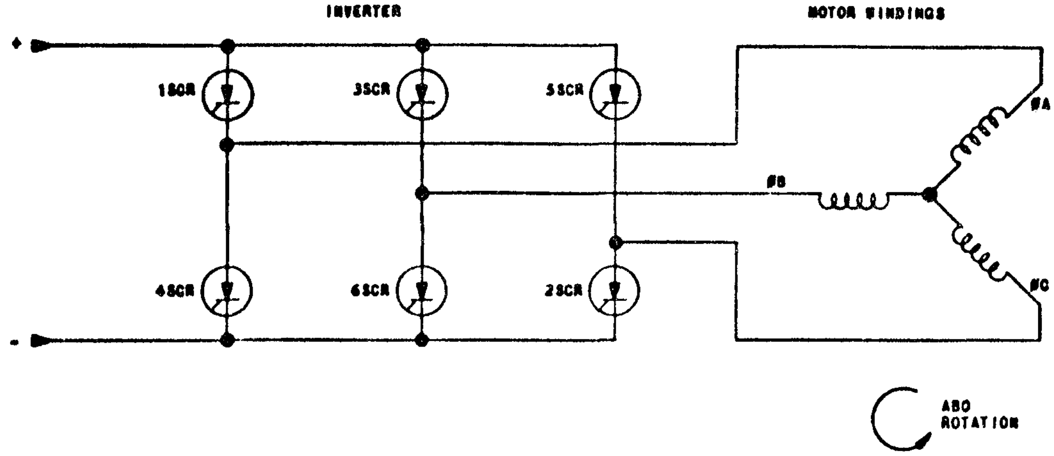
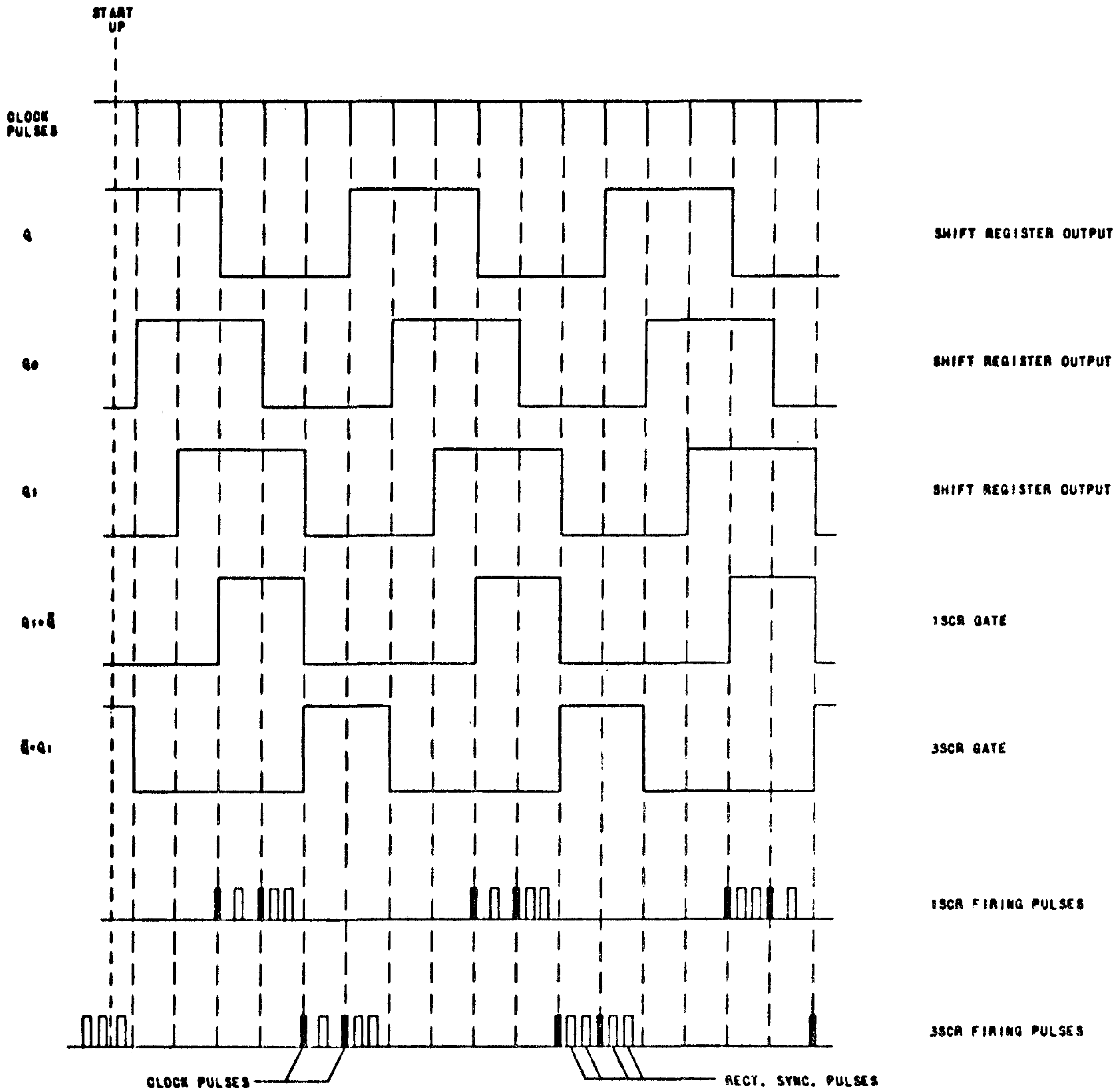
SIMPLIFIED BLOCK DIAGRAM
AC MAIN PCB

C

FIGURE 4-10





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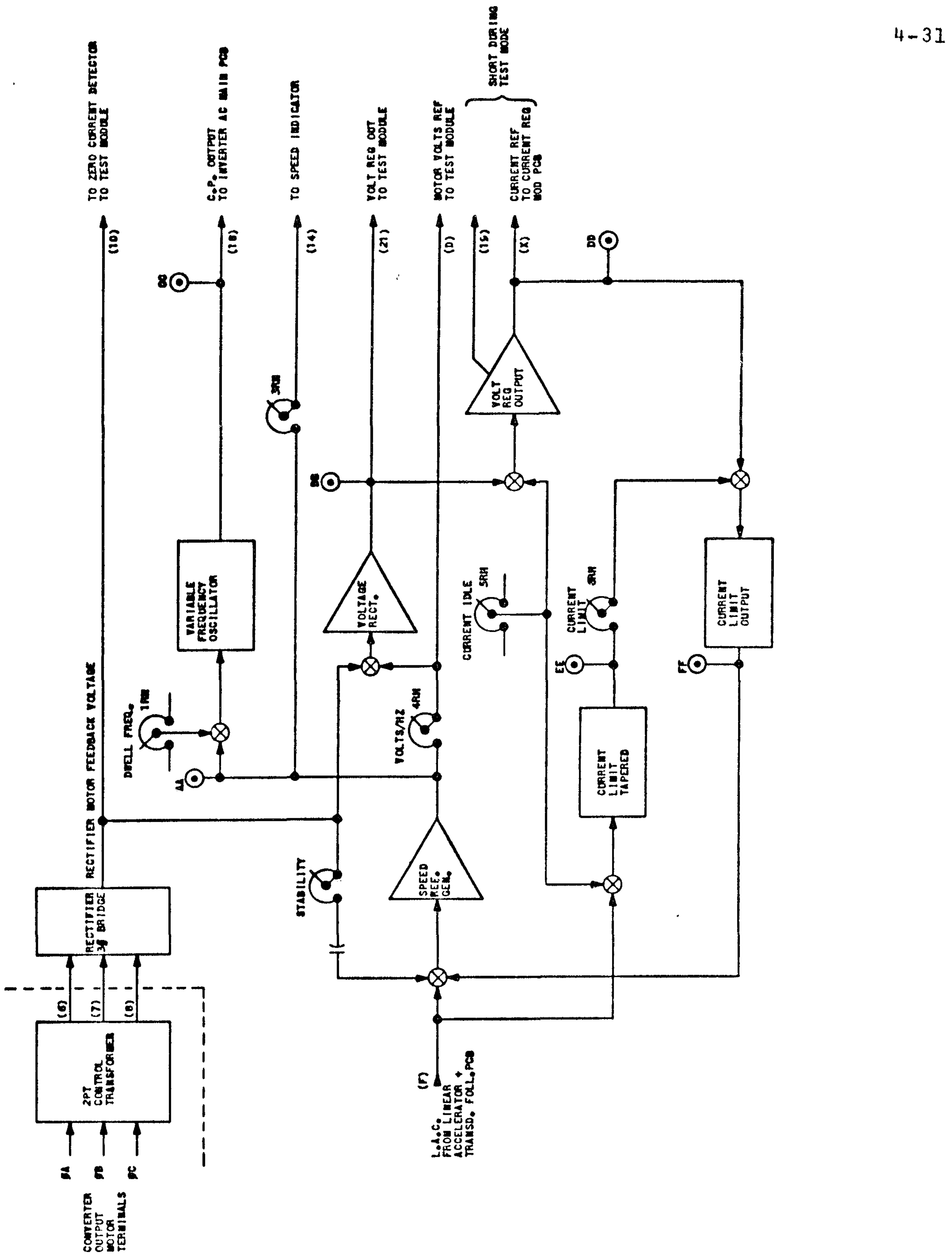
		DR. BY	ENG.	FIGURE 4-11
		CH BY	ISSUED	



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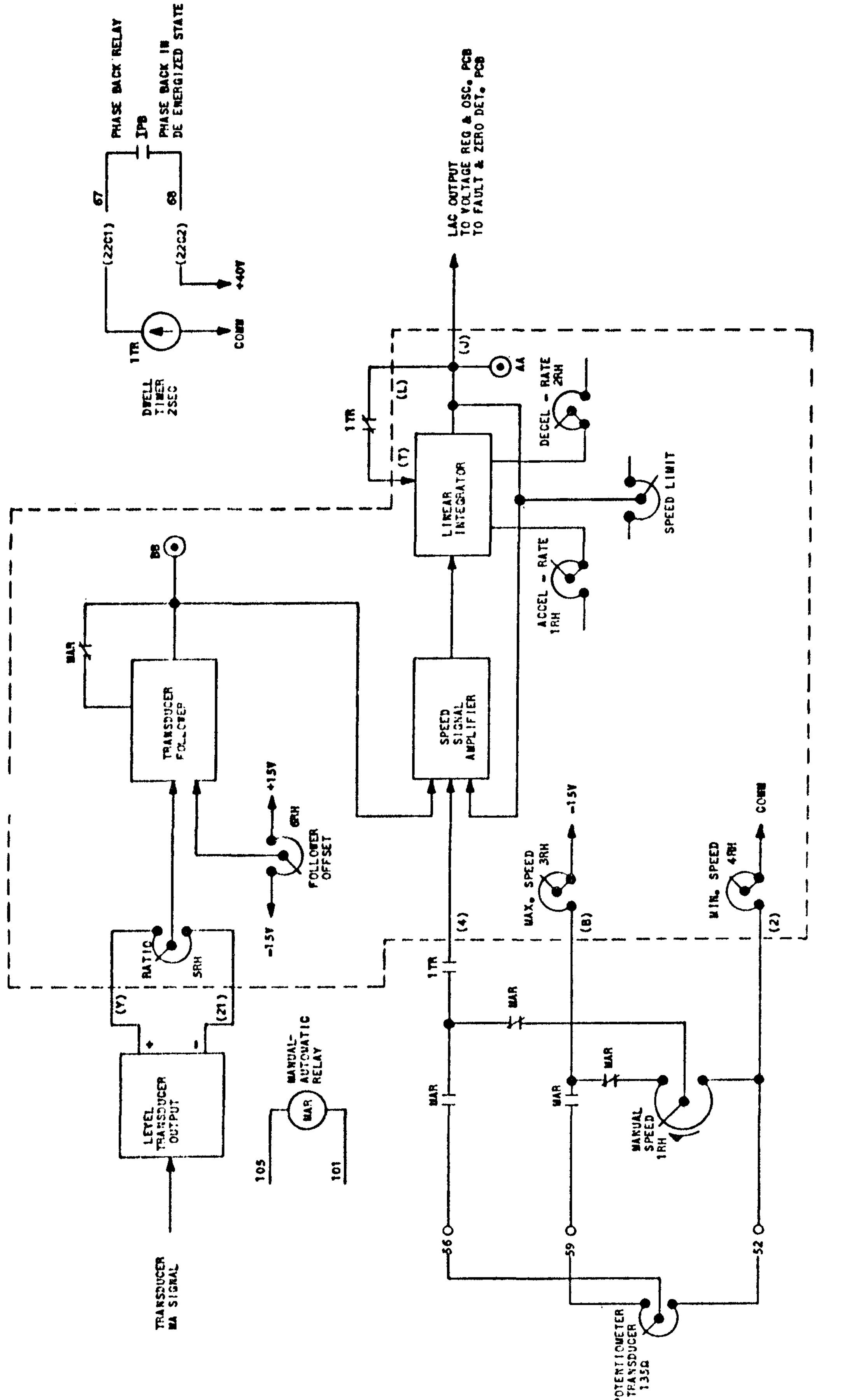
BLOCK DIAGRAM
VOLTAGE REGULATOR AND
OSCILLATOR PCB
3PC OF CARD RACK

C

FIGURE 4-12



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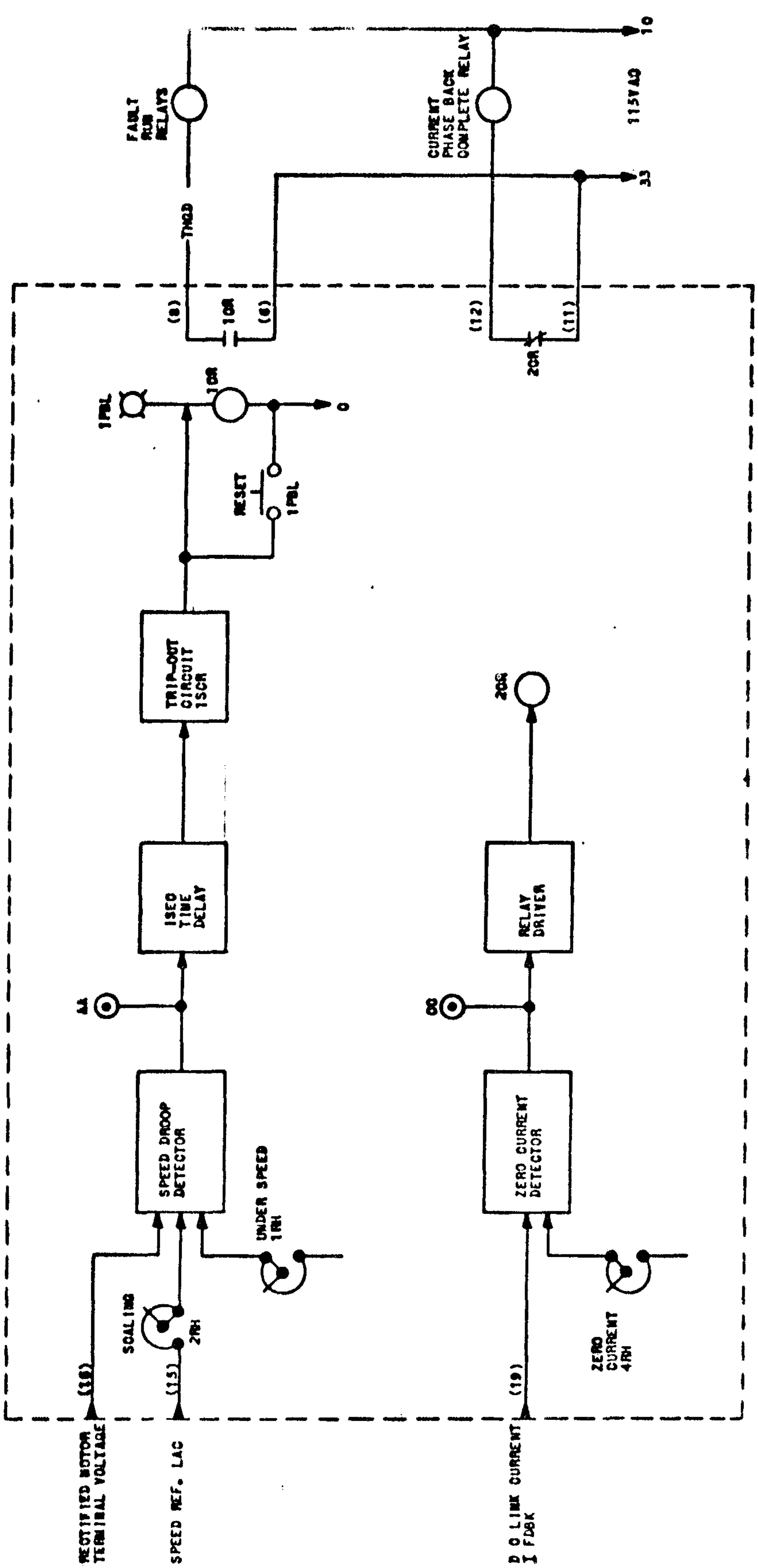
BLOCK DIAGRAM
LINEAR ACCELERATION &
TRANSDUCER FOLLOWER PCB
(2PC OF CARD RACK)

C

FIGURE 4-13



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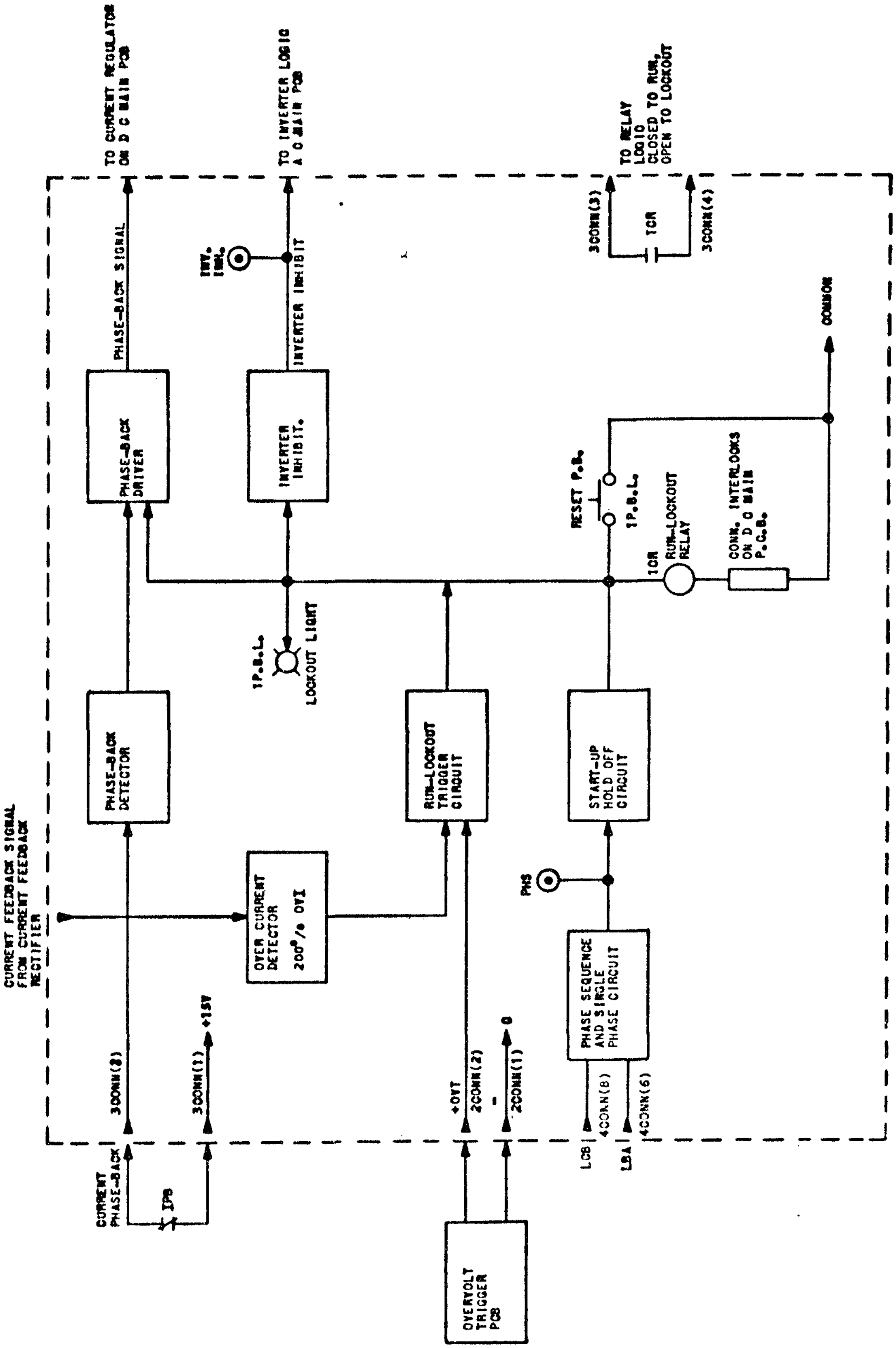
BLOCK DIAGRAM
FAULT AND CURRENT
DET. PCB
(1PC OF CARDRACK)

FIGURE 4-14



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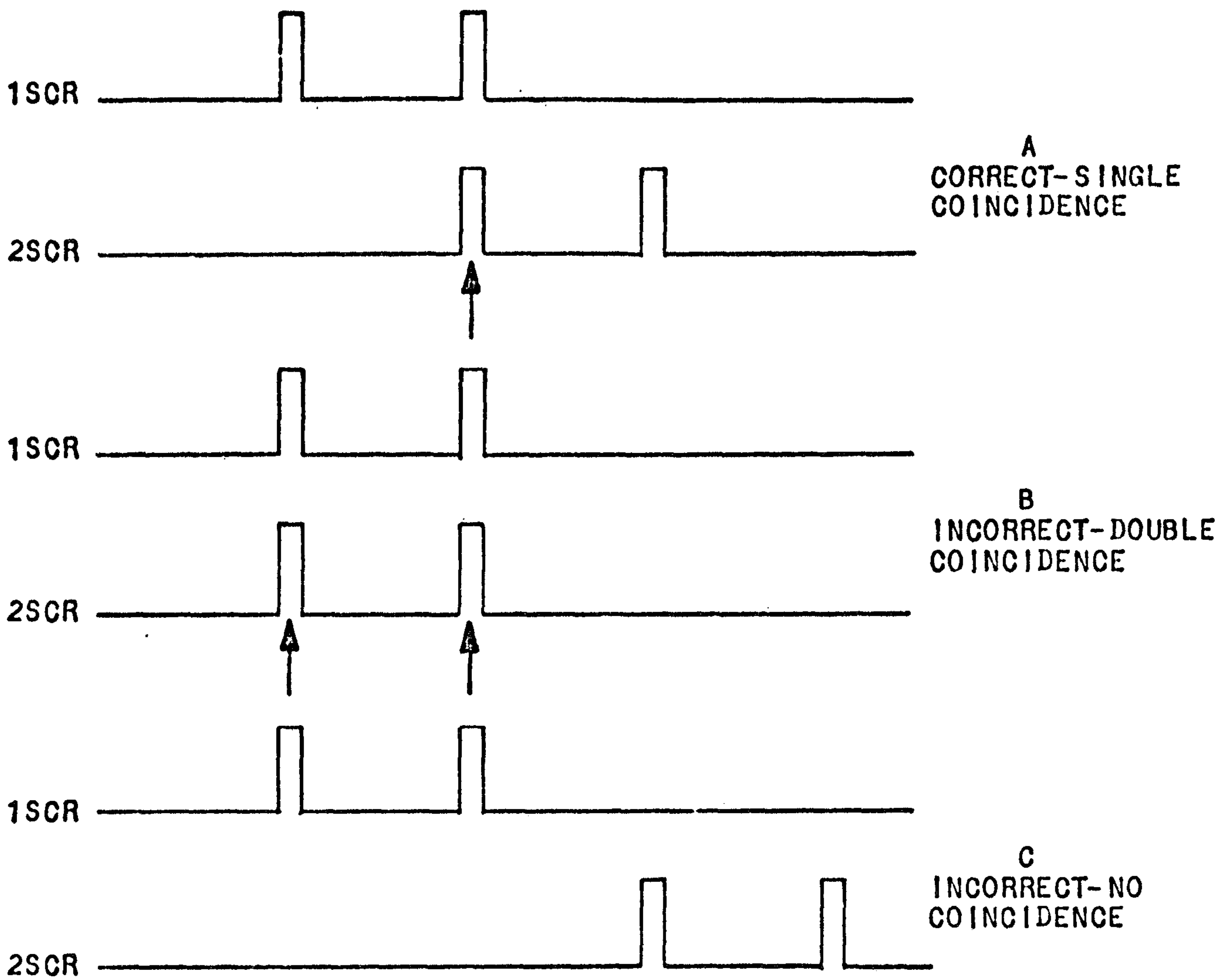
BLOCK DIAGRAM
RUN LOCK-OUT AND CURRENT PHASEBACK
PART OF D C MAIN PCB

FIGURE 4-15



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PULSE SEQUENCE FOR TEST MODULE ANALYSIS

A

FIGURE 4-16

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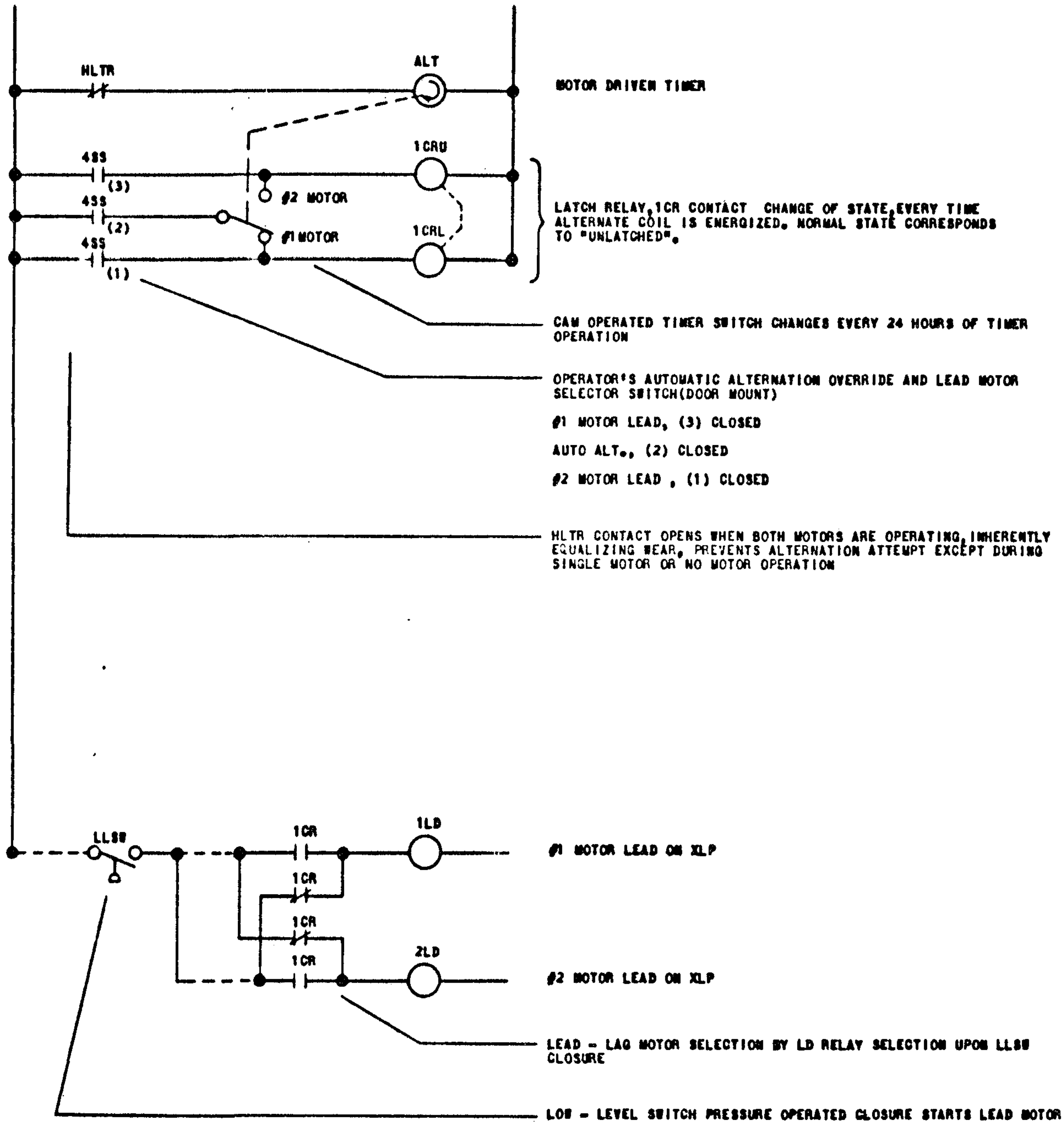

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ALTERNATION CIRCUIT

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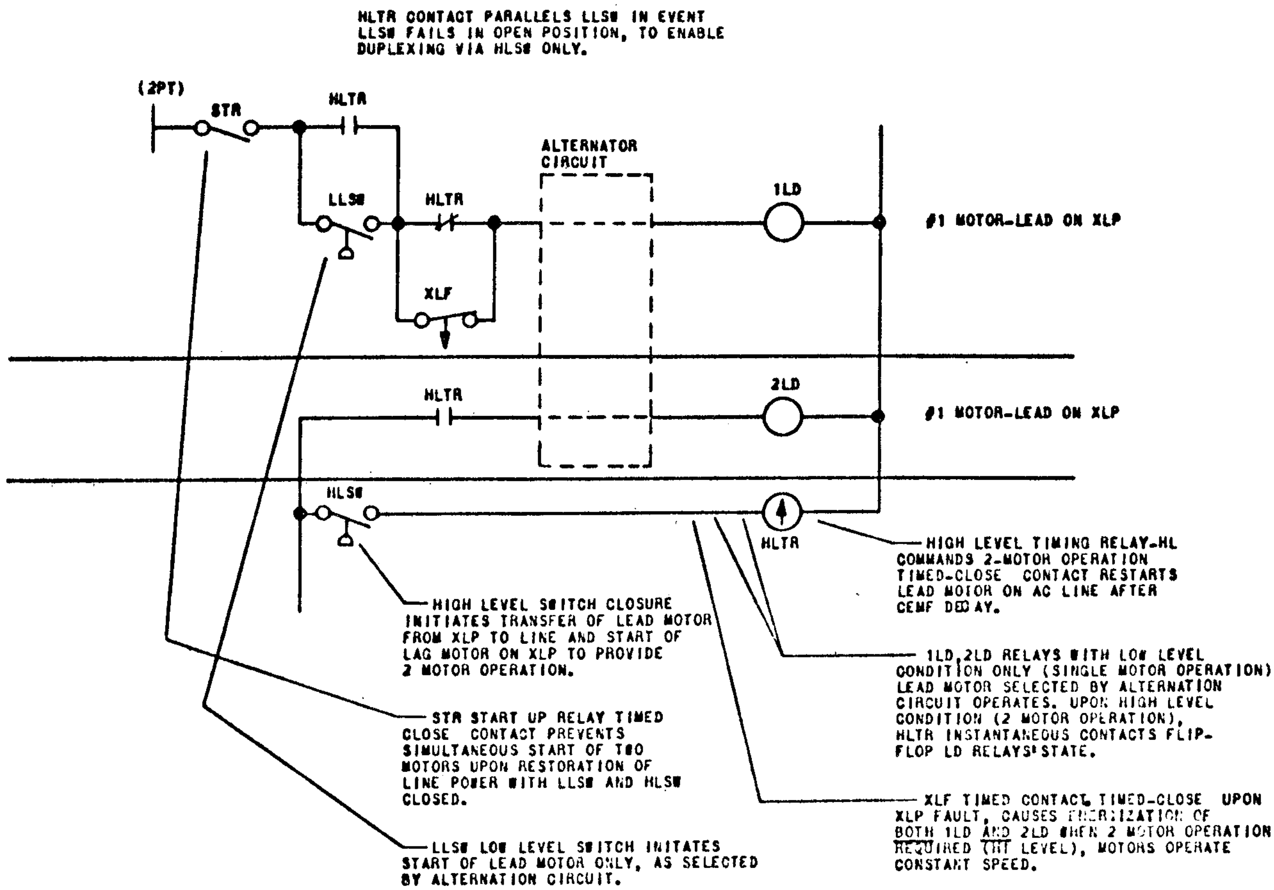
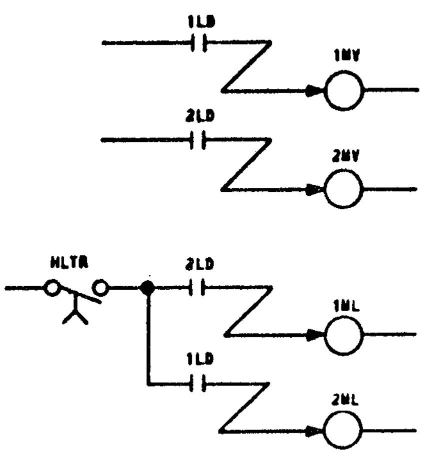
FIGURE 4-





NOTE: LLSW AND HLSW ARE EXTERNAL, PRESSURE OPERATED SWITCHES, ASSOCIATED WITH BUBBLER SYSTEM. MAKE AND BREAK ARE DIFFERENTIALLY SETTABLE.

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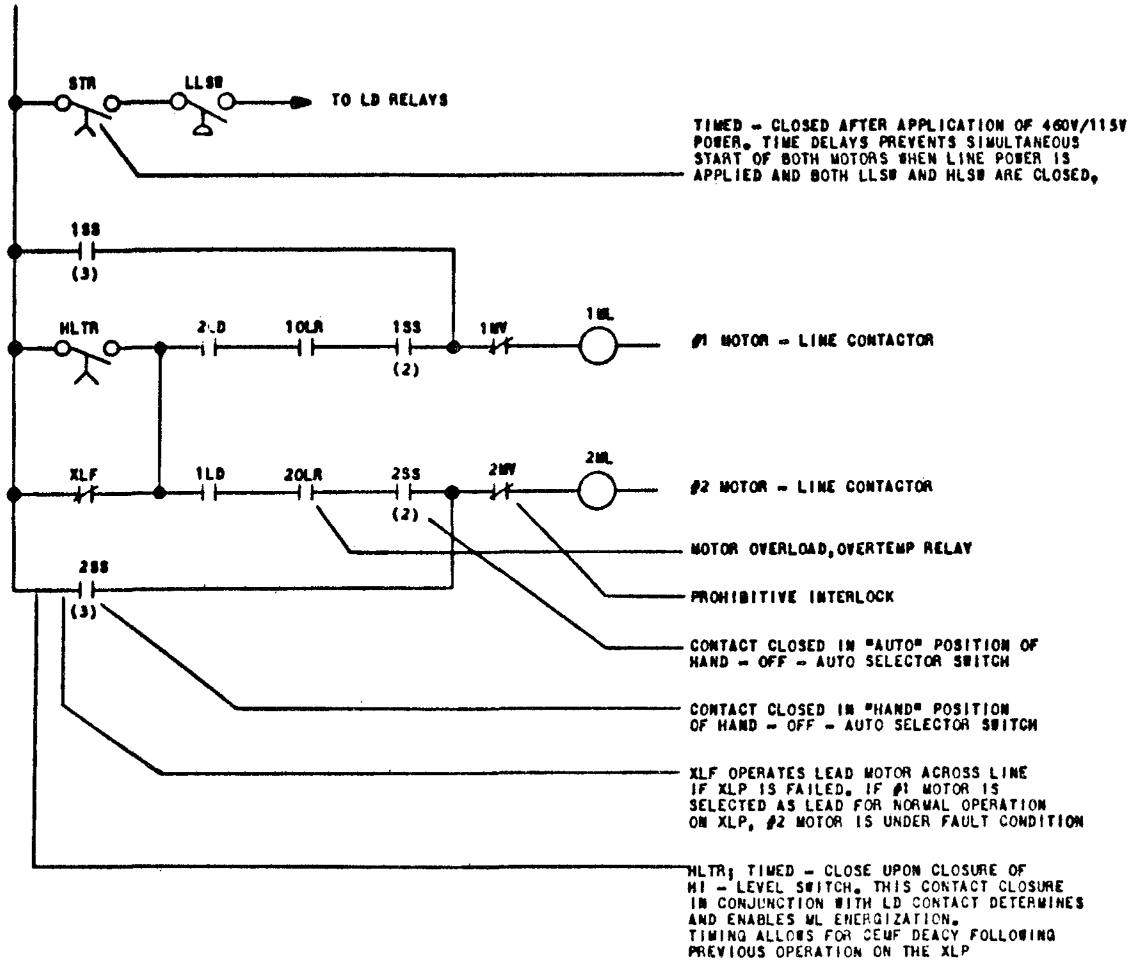
RUN-STOP-SEQUENCE CKT. INTERFACE W/WET WELL LEVEL

C

FIGURE 4-18



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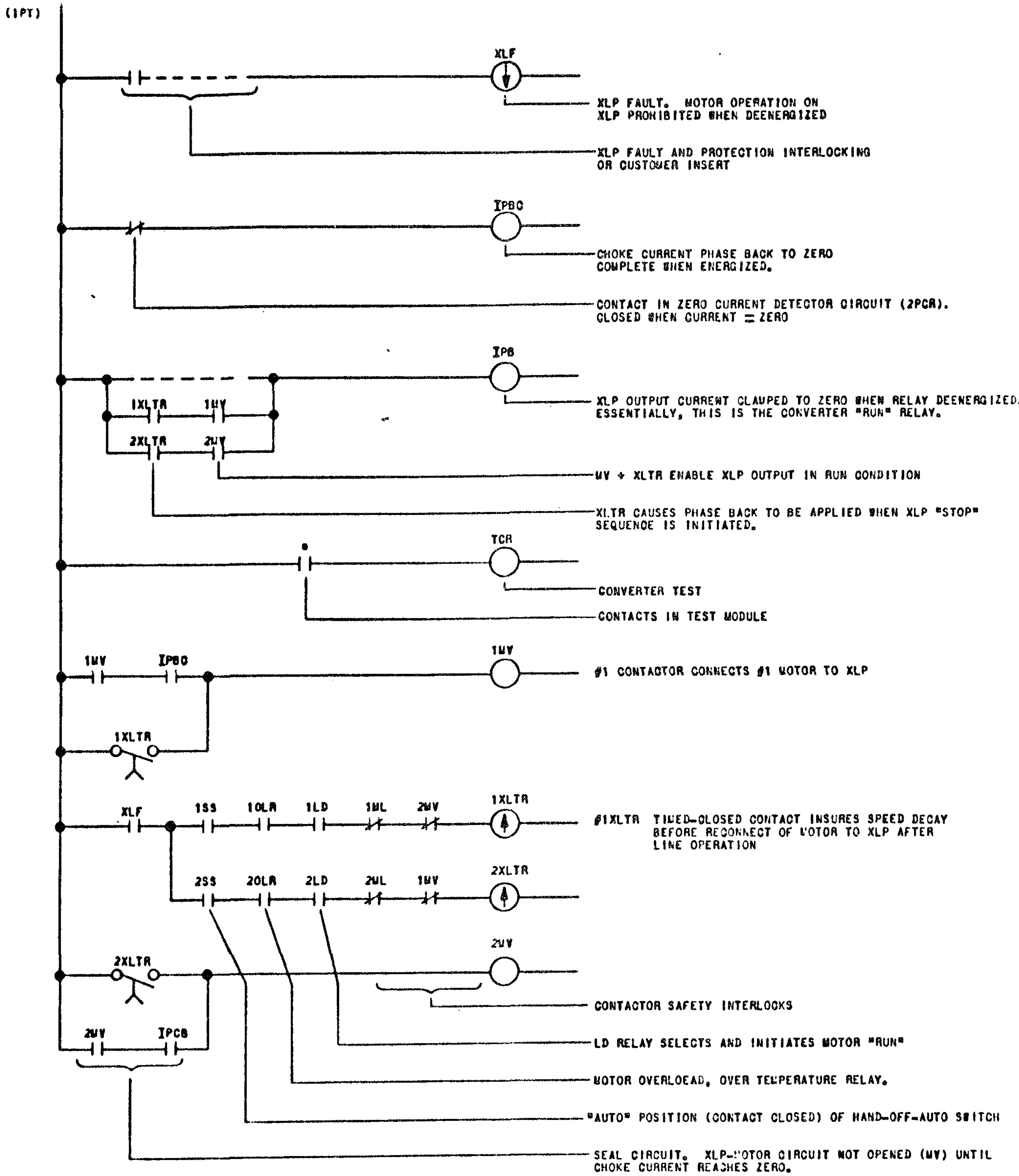
CONSTANT SPEED OPERATION

C

FIGURE 4-19



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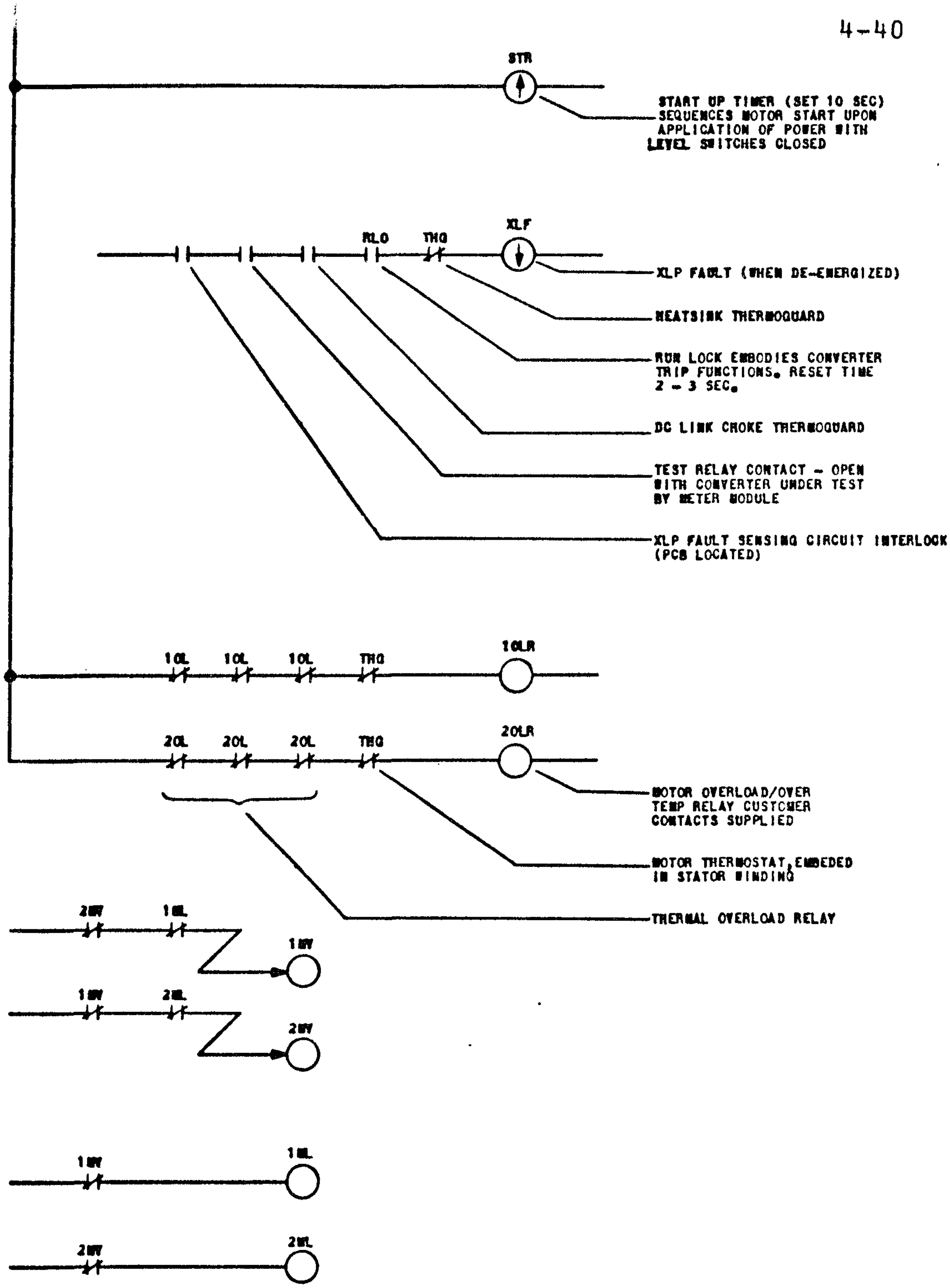
VARIABLE SPEED OPERATION

C

FIGURE 4-20



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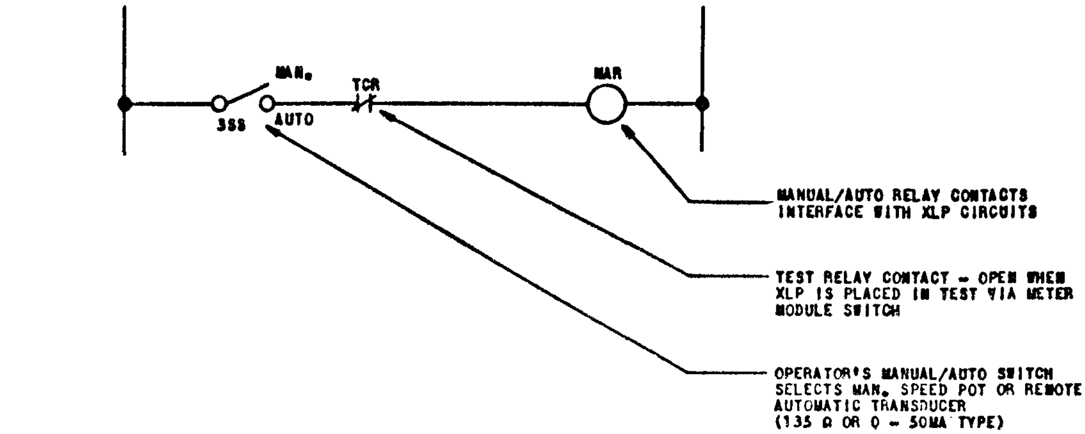
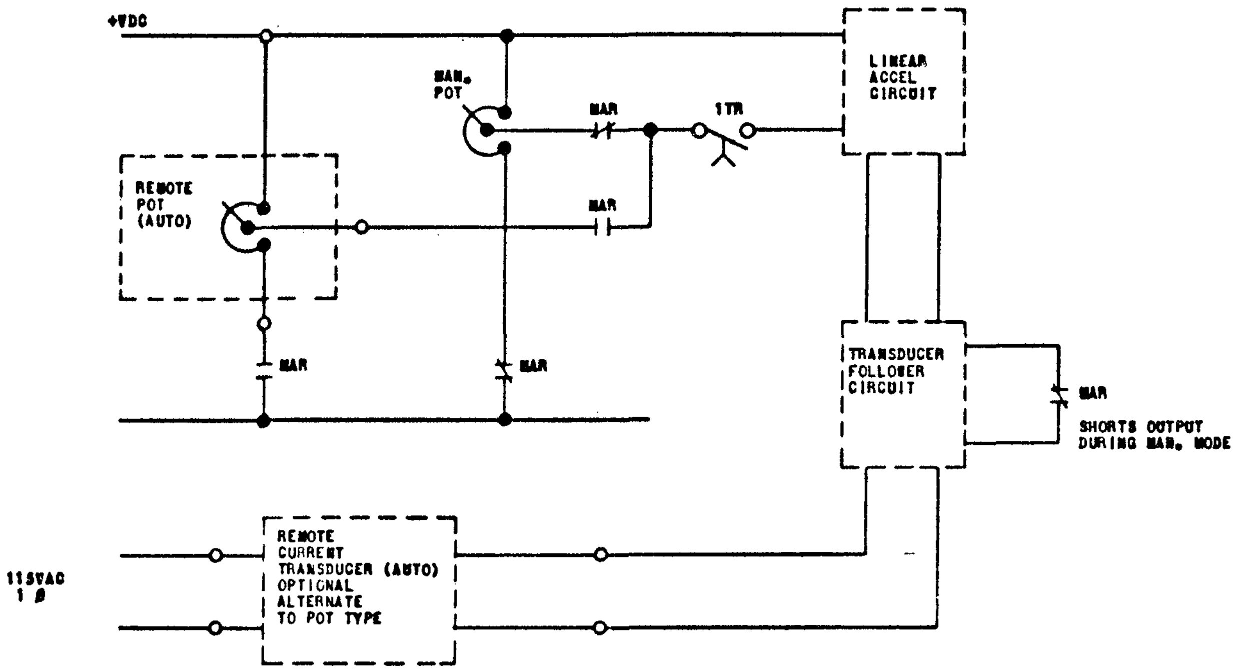
PROTECTION CIRCUITS

FIGURE 4-21





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MANUAL/ AUTO SPEED LOGIC

C

FIGURE 4-[illegible]

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SECTION 5

TESTS AND ADJUSTMENTS

5.0 Tests and Adjustments

This section describes tests and adjustments associated with startup and maintenance of the Lancer 44XLP Drive System. These tests and adjustments are to be performed by competent electrical maintenance personnel familiar with solid state drive systems. It is imperative that personnel familiarize themselves with the previous sections of this Instruction Manual before attempting any tests or adjustments.

Refer to Section 1.4.3 for a list of recommended test equipment.

5.1 Conditions for Test and Adjustment Procedures

5.1.1 Warnings and Cautions

HIGH VOLTAGE WARNING

PERSONNEL WILL ALWAYS BE EXPOSED TO HIGH VOLTAGE WHEN AC INPUT POWER IS APPLIED TO THE CONVERTER WITH THE DOOR OPEN. WHEN MEASURING VOLTAGES IN THE POWER CIRCUIT, ALWAYS FOLLOW THE PROCEDURE GIVEN BELOW; ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.

1. Remove AC input power and allow two minutes for capacitors to discharge. Always check for residual voltages and discharge circuits with a voltmeter.
2. Clip multimeter leads to desired voltage check points.
3. Keep hands and head away from power section area. Apply AC input power and record voltage reading.
4. Repeat step (1) above.
5. Remove meter leads.

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COMPONENT CHECK CAUTION

ALWAYS REMOVE AC INPUT POWER WHEN CHECKING AND REPLACING POWER SECTION COMPONENTS, RELAYS AND PRINTED CIRCUIT BOARDS. ALLOW TWO MINUTES FOR CAPACITOR DISCHARGE. ALWAYS CHECK WITH A VOLTMETER FOR ANY VOLTAGES BEFORE ATTEMPTING ANY REPAIRS.

MEGGER CAUTION

DO NOT USE A MEGGER FOR GROUND OR RESISTANCE CHECKS. THE VOLTAGE GENERATED COULD DAMAGE SOLID STATE COMPONENTS.

COOLING CAUTION

THE LANCER 44XLP DRIVE IS FORCE-AIR COOLED BY A DOOR MOUNTED BLOWER. DO NOT OPERATE THE CONVERTER AT RATED CURRENT OR AT HIGHER THAN 3/4 MAXIMUM SPEED FOR PERIODS LONGER THAN 10 MINUTES WITH THE DOOR OPEN. AFTER RUNNING THE EQUIPMENT, ALLOW AT LEAST THREE TIMES THE OPERATING TIME FOR COOLING.

5.1.2 Test Mode

Most Lancer 44XLP Drives have a Test Mode Configuration for checking out the converter. When placed in Test Mode, the motors are disconnected from the converter and the system (if multiplex or equipped with bypass) operates as a constant speed controller. Speed reference is switched from automatic to manual speed potentiometer on the cabinet door.

When the test module (Section 5.1.3) is available and in place, the converter is automatically placed in Test Mode by module switch during checks of the rectifier or inverter firing pulses. If the test module is not used, the converter may be placed in Test Mode by jumpering the relay logic circuits to energize relay TCR.

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5.1.3 Test Module

The test module is an optional accessory to the Lancer 44XLP Drive and is supplied only when specified. The test module plugs into a pre-wired socket in the card rack assembly; it may be added to most drives originally ordered without it. The test module simplifies many of the checks in this section. Figure 5.1 summarizes the test meter operating procedure. Test procedures in this section include the use of the test meter as well as conventional test equipment.

5.1.4 Operating State for Tests and Adjustments

Five operating levels have been established to place the drive in the proper condition for performing tests and adjustments. The operating level description and setup conditions are listed in Table 5.1.

5.2 Converter Tests

The required operating levels for tests are described in Table 5.1. Table 5.2 summarizes available test points with test reference.

5.2.1 Run-Lockout Test (Operating Level 3, 4, or 5, Table 5.1)

Check the lighted push button (1PBL on the DC Main PCB). When 460 VAC power (with proper phase sequence) is initially applied to the converter, the light should be initially bright, then go dim. While 1PBL is pressed to reset the circuit, the light should be bright. If previously lit, it should dim after 1PBL is momentarily pressed.

The following conditions or equivalent will light 1PBL bright:

1. Wrong input line voltage phase sequence hookup. Test point PHS on the DC Main PCB shows a missing pulse on oscilloscope. (Table 5.2, No. 7)

2. Single phase input line voltage condition. Same test point condition as (1) above. (Table 5.2, No. 7)

3. Momentary converter output overvoltage condition sensed by the overvoltage trigger PCB.

4. Momentary AC input line overcurrent condition (about 200% of I rated).

Any of the above mentioned conditions or the de-energized state of IPB relay (phase back condition) will result in a full retard condition of the current regulator (Table 5.2, No. 5 & 6). The four conditions indicated above also result in a low Inverter Inhibit logic signal on the DC Main PCB (Table 5.2, No. 4).

5.2.2 Converter Fault Test (Operating Level 3, 4, or 5, Table 5.1)

Check the lighted push button (1PBL on the Fault and Zero current printed circuit board, 1PCB). When 460 VAC power is initially applied to the converter, the light should be initially bright, then go dim. While 1PBL is pressed to reset the circuit, the light should be bright and go dim when 1PBL is released.

1PBL will come on brightly and will initiate a converter fault condition through the fault relay XLF if speed droop exceeds 15-20% (Table 5.2, No. 11) for approximately 1 second.

5.2.3 SCR and Diode Resistance Test (Operating level 1 or 2)

CAUTION

The drive must be in operating level 1 or 2 when making this test, converter off and circuits discharged.

The following resistance checks should be made using a Simpson 260 Volt-Ohm Meter or equivalent. Do not use a megger. Reference Table 5.2, No. 1 and 2.

Resistance readings across the rectifier and inverter SCR's may be made at the test points available on the gate firing printed circuit boards. The gate leads must be disconnected at the board before resistance readings are taken. Check the SCR's against the readings shown in Table 5.2.

All except the 150 and 200 horsepower drive contain two series diodes in each inverter leg. Usually one check across each leg is sufficient to check both diodes. The diodes can be checked within the inverter without isolating them by readings between the appropriate motor lead and the uncommon SCR test point. For example:

4RTC + 4RTD	Motor ØA	(lead 50)	and 4SCR cathode TP
6RTC + 6RTD	Motor ØB	(lead 58)	and 6SCR cathode TP
2RTC + 2RTD	Motor ØC	(lead 65)	and 2SCR cathode TP
1RTA + 1RTB	Motor ØA	(lead 50)	and 1SCR anode TP
3RTA + 3RTB	Motor ØB	(lead 58)	and 3SCR anode TP
5RTA + 5RTB	Motor ØC	(lead 65)	and 5SCR anode TP

The shunting resistors and di/dt chokes will have negligible affect on the diode resistance readings. Check the diodes against the resistance readings given in Table 5.2.

These tests may not determine the true condition of an SCR or diode. When readings fall into the questionable or fault areas, do not replace the device until a comparison test is made with a known good device or similar device(s) in the same circuit. Always use the same meter when performing comparison tests.

Remove test equipment, replace SCR gate leads, and replace covers before energizing the converter.

5.2.4 Voltage Checks

By Test Meter Module

Voltage checks of the regulator DC power supply may be made with the converter in Test Mode (operating level 3, Table 5.1). Voltage checks of the feedback and regulator signals should be made under full load conditions or at least under a standardized loading condition that can be repeated at a later date for comparison purposes (operating levels 4 or 5, Table 5.1). Refer to Figure 5.1 for test meter operating procedure.

By Voltmeter

Table 5.4 gives appropriate test points within the converter for similar voltage checks using a VOM.

5.2.5 Rectifier and Inverter Firing Pulse Test (Operating level 3, Table 5.1)

Checks of the firing pulses must be made with the converter in the Test Mode (operating level 3, Table 5.1). They may be made using the test module or by means of an oscilloscope.

By Test Meter Module

When performing these tests using the test module, proceed as follows. These steps are also summarized in Figure 5.1. Initiating these tests may cause the pilot light of the Fault Sensing board to glow brightly. This is normal.

1. Stop and de-energize drive (open converter circuit breaker).

2. Place test meter function switch (2SS) in DC phase position.

3. Remove 6 Conn and 7 Conn from the gate firing boards (Rect. & Inv. Sections) and insert Conns into labelled positions on test meter module.

4. Set Manual Speed pot (1RH) on cabinet door fully clockwise (maximum speed).

5. Close converter circuit breaker.

6. Rotate Test Meter SCR selector SW (3SS) through all positions. The following indications should be observed:

3SS Position	Indication
1SCR	Meter deflection in yellow area, near red limit. (Negative direction)
2SCR	Same as above.
3SCR	" " "
4SCR	" " "
5SCR	" " "
6SCR	" " "

Above meter deflection indicates presence of pulses to gate firing boards.

7. Set Test Meter Volts-Phase switch (4SS) to PHASE position.

8. Rotate SCR selector switch (3SS) through all positions. The following indications should be observed:

P 3SS Position	Indication
1SCR	Meter deflection in yellow area, near green limit. (Negative direction)
2SCR	Same as above.
3SCR	" " "
4SCR	" " "
5SCR	" " "
6SCR	" " "

Above meter deflection indicates pulses to gate firing boards are in proper phase.

9. Set SCR selector switch (3SS) to 1SCR.

10. Set Test Meter Current Reference potentiometer (1RH) fully counterclockwise.

11. Set Function switch (2SS) to PHASE SHIFT DC ONLY. Test Mode Relay may de-energize and re-energize when 2SS positions are changed. This is normal.

12. Rotate Current Reference potentiometer from counterclockwise position to fully clockwise position.

    Meter deflection should vary as Current Reference potentiometer is being rotated. Variation in meter deflection indicates that current regulator is functional.

13. Set Function Switch (2SS) to AC PHASE.

14. Set Volts-Phase Switch (4SS) to VOLTS.

15. Repeat Step 6. Readings may be slightly higher than in Step 11.

16. Set SCR selector Switch (3SS) to 1SCR.

17. Rotate Manual Speed potentiometer on cabinet door fully counterclockwise. Meter deflection should change as Manual Speed potentiometer is being rotated. Return potentiometer to full clockwise position. Indication shown in Figure 5.1 portrays meter reading with Manual speed pot in full clockwise position only.

18. Set Volts-Phase Switch (4SS) to PHASE.

19. Repeat Step 8.

20. Test Complete.
    De-energize drive (open converter circuit breaker.) Set Test Meter Function Switch (2SS) to OFF. Disconnect 6 Conn(s) and 7 Conn(s) from test meter module and connect to proper gate firing boards.

<u>By Oscilloscope</u>

If the accessory test module is not available, the presence, sequence, and control of Rectifier and Inverter SCR firing pulses can be checked with an oscilloscope at various test points. The converter should be operating with the motor connected and loaded and with speed set by the Manual Speed potentiometer (1RH) on the cabinet door (operating level, Table 5.1).

Refer to Table 5.2 for specific waveform information.

A. The presence and sequence of rectifier trigger pulses can be checked at test points P1R through P6R on the DC Main PCB. By synchronizing the oscilloscope to one of the reference voltages such as V-AN, varying the speed potentiometer, the phase advance or retard of the current regulator can be observed.

B. Inverter trigger pulses can be observed at test points P1I through P6I on the AC Main PCB. The oscilloscope should be synchronized from P1I and pulses for each SCR examined in turn to verify proper sequence.

   Regulator control of the inverter can be verified by noting the change in width of the gate interval as the speed potentiometer is varied.

Note also that during each gate interval the second and succeding pulses are synchronizing pulses from the rectifier pulse generator. These pulses are synchronized to the line frequency and have a fixed interpulse interval of 2.78 msec.

5.3 Converter Adjustments (Operating Level 3 and 4) (Field Adjustment)

All converter adjustments are listed in Table 5.3. The condition of the converter while making the adjustments is described by the operating levels of Table 5.1.

The adjustments on the converter printed circuit boards have been segregated into three groupings: Factory Adjustments, Replacement Adjustments, and Field Adjustments.

Factory Adjustments are those that affect operating parameters only within the circuit board on which they are located. Field repairs to a printed circuit board are not recommended or authorized and Factory Adjustments should not be changed. Replacement printed circuit boards will have these adjustments set using factory test facilities.

Replacement Adjustments affect system operating parameters. Initially these adjustments were made on system test of the drive. Procedures are included in this section to perform these adjustments on replacement printed circuit boards.

Field Adjustments are those that will be required to set up the drive for a particular application and must be made on installation. Procedures are included in this section.

5.3.1 Transducer Speed Signal

The Lancer 44XLP Drive is designed for compatibility with an array of speed signal producing devices including potentiometer (slide-wire) type transducers, voltage output transducer, current output (milliamp) type transducers, and equivalent signal programmers.

This procedure entails adjustment of the potentiometers on the linear Acceleration and Transducer Follower PCB, 2PC of the card rack which are utilized with potentiometers and current type transducers. The adjustments are:

1. Maximum Speed, 3RH - Table 5.3, No. 7
2. Minimum Speed, 4RH - Table 5.3, No. 8
3. Ratio, 5RH - Table 5.3 No. 9
4. Follower Offset 6RH - Table 5.3 No. 10

The first two adjustments establish speed range with a 135 ohm potentiometer type transducer and with the manual speed potentiometer; the second two with a current output transducer. Either transducer may be used for speed control in the automatic speed mode. With either speed setting device and in either manual or automatic speed mode, the speed will be varied only between minimum speed as preset by the minimum speed or follower offset adjustment and Maximum speed as preset by the max speed or ratio adjustment.

To perform the adjustment, the automatic transducers should be installed and adjusted for the excursion of output that is expected during the normal operation. The converter will then be adjusted to provide the desired speed at the various output signal levels.

The Adjustments are initially set during factory test so that the 135 ohm potentiometer will provide a speed range from 20 to 100%, and a 0 to 50 ma transducer current signal will provide a 0 to 100% speed range.

A. Current Output Transducer

If a current output type transducer is used, adjust the output of the transducer so that its minimum signal occurs at the level corresponding to desired minimum speed and maximum signal occurs at the level corresponding to desired maximum speed. The following are limits of the transducer ma signal, with which the Follower circuit is compatable.

1. Maximum signal not less than +10ma, not more than +50ma.

2. Minimum signal not greater than 20% of maximum signal nor less than -50ma.

3. Place the Converter in the Normal operating mode, (operating level 5 of Table 5.1).

4. By whatever available method, apply minimum transducer input to the drive and adjust the follower offset control (6RH on 2PC) for the desired minimum speed by hand tachometer, optional door mounted speed meter, or by measuring the voltage at TPAA of 2PC (Table 5.2, No. 20) using a Simpson 260 VOM or equivalent. 100% speed represents approximately +10 volts at TPAA. Adjust the follower offset to provide the desired % of maximum speed; for example, 6.0 volts, if minimum speed is to be set at 60% rated speed.

5. Adjust transducer for maximum signal and adjust the ratio control (5RH on 2PC) for 100% speed or +10 volts at TPAA.

6. Repeat Adjustments 5 and 6 since the controls interact and any adjustment in follower offset will require a recheck and adjustment of the ratio control at 100% speed.

B. Potentiometer Type Transducer and/or Manual Potentiometer

Speed range of the manual speed potentiometer (1RH) on the cabinet door and potentiometer type transducers are controlled by the settings of the minimum and maximum speed adjustments, 3RH and 4RH on 2PC. If a current type transducer is used for the automatic signal, set the range of the Manual Speed potentiometer to coincide with the minimum and maximum speeds set, per the following.

1. Adjust the transducer so that the wiper swings thru the full range between the levels corresponding to desired minimum and maximum speed.

2. Place the Converter in the normal operating mode (Operating level 5 per Table 5.1).

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3. By whatever available method, vary the transducer to minimum (one end of slidewire). Adjust Minimum Speed (4RH on 2PC) for the desired minimum speed as indicated by hand tachometer, optional speed meter or Simpson 260 VOM at TP-AA of 2PC. (+10V at TP-AA represents 100% speed, +5V represents 50%, etc.).

4. Vary the transducer for maximum signal (other end of slidewire) and adjust Maximum Speed (3RH and 2PC) for 100% speed or +10V at TP-AA.

5. Repeat steps 3 and 4 as the adjustments interact.
   NOTE: The range of the Manual Speed potentiometer (1RH on the door of the equipment cabinet) is controlled by the settings of 3RH and 4RH. Its range of speed control may be slightly less than the speeds established using the potentiometer transducer, due to ohmmage variations.

C. <u>Voltage and Programmer Input Signals</u>

Minimum and Maximum speed settings will generally be achieved by external adjustments. Consult other sections of the manual when these signals are employed.

5.3.2 Current Limit Adjustment (Table 5.3, No. 15) (Replacement Adjustment)

During factory test this adjustment is made to match the Lancer 44XLP Drive to a specific model motor. The adjustment and the Volts/Hz Adjustment (Section 5.3.3) will need resetting if the Voltage Regulator and Oscillator PCB is replaced. The current limit adjustment should be made first.

The current limit adjustment is normally set at 105% full rated motor current. Adjust current limit as follows:

1. Initially set the Volts/Hz Adjustment (4RH) for 75% (200 degrees from maximum counterclockwise position).

2. Initially set the I-limit Adjustment (6RH) for 100% (maximum clockwise position).

3. Operate the motors at constant speed from line power at maximum load, if possible, to verify that current is equal to or less than rated current per the motor nameplate; i.e. the motor is not being overloaded. Measure motor current using the motor current meter or a clamp ammeter.

4. Connect a voltmeter (30 VDC scale) between TP-FF (-) of the Voltage Regulator and Oscillator PCB and TP-COM (+) of the DC Main PCB. TP-FF is at 0 or +0.5 volts in the zero state and swings negative when in current limit.

5. Operate the motor in 3 above on the converter (condition 4 or 5, Table 5.1). Adjust the motor speed for 100% rated speed with the Manual Speed potentiometer or the Transducer Signal. Do not exceed 100% speed or the motor current determined in Step 3 above.

6. While monitoring the voltage at TP-FF, slowly turn the I-limit Adjustment (6RH) counterclockwise until TP-FF starts to go negative.

Back the adjustment (clockwise) 5% or 15 degrees beyond this point.

7. Adjustment complete: Shut down the drive and proceed to make the Volts/Hz Adjustment in the next section.

5.3.3 Volts/Hz Adjustment (Table 5.3, No. 13) (Replacement Adjustment)

During factory test this adjustment is made to match the Lancer 44XLP Drive to a specific model motor. This adjustment, and the I-limit adjustment of Section 5.3.2 will need resetting on replacement of the Voltage Regulator and Oscillator PCB. The Current Limit Adjustment should be made first.

The volts per Hz ratio is 460V/60Hz or 7.67 to 1.0. Basically this adjustment is to set the inverter frequency at 60 Hz and adjust 4RH on the voltage regulator and oscillator PCB for an RMS motor terminal voltage of 460 volts.

1. Initially set the Volts/Hz Adjustment (4RH) for 75% or 200 degrees from maximum counterclockwise position.

2. With the drive de-energized, connect a 500 VAC iron vane or thermocouple meter across two of the motor terminals.

3. Energize the drive in operating level 4 or 5 with the motor operating from the converter. Set motor speed to 100% or 60 Hz inverter frequency.

4. Adjust Volts/Hz (4RH) for 460 VAC as measured at the motor terminals.

5. Adjustment complete: Shut down the drive and disconnect test equipment.

5.3.4 Voltage Feedback Adjustment (Table 5.3, No. 1) Replacement Adjustment)

During factory test this adjustment is made to match the Lancer 44XLP Drive to a specific model motor. This adjustment will need resetting if the Rectifier-Inverter Logic PCB assembly is replaced. The adjustment is found on the Current Regulator Mod PCB of the assembly.

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1. Remove the load from the motor.

2. With the drive shut down, connect a 0 - 500 VAC iron vane or thermocouple meter to the motor terminals. Measure motor current using a clamp ammeter.

3. Energize the unloaded motor from the converter, operating level 4 or 5 of Table 5.1. Set the speed for 50% (30 Hz converter output) and 100% (60 Hz converter output). Adjust Voltage Feedback (1RH) for minimum fluctuations in motor voltage and current at the 50% and 100% speed settings.

4. Adjustment complete: Shut down the drive and disconnect test equipment. Recouple the motor to its load.

13.00

11.00

TEST MODULE - OPERATING PROCEDURE

"45T199-0000"

FOR EACH FUNCTION TESTED, FOLLOW THIS SEQUENCE:

1. PLACE DRIVE IN CONDITION DESCRIBED AT RIGHT FOR TEST MODE A OR B.
2. PLACE TEST MODULE SWITCHES (1SS-4SS) IN POSITION INDICATED FOR EACH TEST.
3. COMPARE METER INDICATION TO THAT SHOWN ON THIS CHART. BLACKENED ZONE INDICATES PROPER READING. IF METER INDICATION IS SPEED OR LOAD DEPENDENT (*)CHANGE SPEED TO INSURE INDICATION VARIES.
4. IF INDICATION IS PROPER, PROCEED TO NEXT TEST. IF INDICATION IS IMPROPER, REPEAT TEST FOR ASSURANCE, COMPLETE ALL REMAINING TESTS TO DETERMINE IF ADDITIONAL IMPROPER METER INDICATIONS EXIST, AND PERFORM CORRECTIVE ACTION DESCRIBED. SEE INSTRUCTION MANUAL FOR REPLACEMENT INSTRUCTIONS.
5. TEST COMPLETED:
   - OPEN CONVERTER CIRCUIT BREAKER
   - REMOVE POWER MODULE COVER
   - RETURN 2SS TO OFF POSITION
   - RETURN 6CONN, 7CONN TO PROPER GATE FIRING BOARD
   - REINSTALL POWER MODULE COVER
   - RETURN CURRENT REFERENCE POT (ON TEST MODULE) TO 50 % POSITION
   - CLOSE CONVERTER CIRCUIT BREAKER

TEST MODES:

A. ALL FUNCTIONS WITH THIS SYMBOL MAY BE TESTED WITH DRIVE RUNNING, AND WITHOUT TEST PREPARATION.

B. ALL FUNCTIONS WITH THIS SYMBOL MUST BE TESTED AFTER PREPARING AS FOLLOWS:
- PLACE OPERATORS H-O-A SWITCHES, (IF PROVIDED), IN HAND OR OFF POSITION.
- OPEN CONVERTER CIRCUIT BREAKER
- TURN MANUAL SPEED POT TO FULL CLOCKWISE POSITION.
- REMOVE POWER MODULE COVER
- REMOVE 6CONN AND 7CONN PLUGS FROM RECT/INV SECTION GATE FIRING PCB'S AND INSERT INTO CORRESPONDING CONN PLUGS ON TEST MODULE.
- REINSTALL POWER MODULE COVER
- CLOSE CONVERTER CIRCUIT BREAKER
- PERFORM MODE "B" TESTS

TEST SEQUENCE			TEST MODULE SWITCH POSITIONS				METER INDICATION (*) INDICATES SPEED/LOAD DEPENDENT	CORRECTIVE ACTION
TEST	DESCRIPTION	MODE	1SS	2SS	3SS	4SS	(-) 0 (+)	
1	MOTOR CURRENT REGULATOR ERROR	A	MOTOR CURRENT ERROR	VOLTS	ANY	ANY	*	REPLACE 46S1704-0010 AND/OR 46S1708-0050
2	MOTOR VOLT REGULATOR ERROR	A	MOTOR VOLTS ERROR	VOLTS	ANY	ANY	*	REPLACE 46S1774-0020
3	MOTOR SPEED REFERENCE	A	MOTOR REF VOLTS	VOLTS	ANY	ANY	*	REPLACE 46S1774-0020 AND/OR 46S1775-0020
4	-15V POWER SUPPLY	A	-15VOLTS	VOLTS	ANY	ANY		REPLACE POWER SUPPLY 46S1606-0010
5	+5V POWER SUPPLY	A	+5VOLTS	VOLTS	ANY	ANY		REPLACE POWER SUPPLY 46S1606-0010
6	+15V POWER SUPPLY	A	+15VOLTS	VOLTS	ANY	ANY		REPLACE POWER SUPPLY 46S1606-0010
7	MOTOR FEEDBACK VOLTS	A	MOTOR FEEDBACK VOLTS	VOLTS	ANY	ANY	*	REPLACE 46S1774-0020
8	MOTOR FEEDBACK CURRENT	A	MOTOR FEEDBACK CURRENT	VOLTS	ANY	ANY	*	REPLACE 46S1704-0010
"THE FOLLOWING TESTS REQUIRE PREPARATION AND SHUT DOWN. SEE MODE "B" DESCRIPTION ABOVE."								
9	RECT.SECT. SCR GATE PULSE	B	ANY	DC PHASE	1SCR-6SCR CHECK EACH	VOLTS		REPLACE 46S1704-0010
10	RECT.SECT. SCR GATE PULSE	B	ANY	DC PHASE	1SCR-6SCR CHECK EACH	PHASE		REPLACE 46S1704-0010
11	CURRENT REGULATOR SEE NOTE A	B	ANY	PHASE SHIFT	2SCR	PHASE	*	REPLACE 46S1704-0010
12	INV.SECT. SCR GATE PULSE	B	ANY	AC PHASE	1SCR-6SCR CHECK EACH	VOLTS		REPLACE 46S1705-0010 AND/OR 46S1774-0020
13	INV.SECT. SCR GATE PULSE	B	ANY	AC PHASE	1SCR-6SCR CHECK EACH	PHASE		REPLACE 46S1705-0010 AND/OR 46S1774-0020

NOTE A: ROTATE CURRENT REFERENCE POT ON TEST MODULE OVER FULL RANGE AND CHECK METER INDICATION.

GRN YEL RED YEL GRN

SEE NOTE 2

TEST MODULE 46S1778-0010
SCHEMATIC 45S1778-0010

NOTES:

1. ENTIRE CHART TO BE LAMINATED IN CLEAR PLASTIC WITH .010 LAMINATE ON EACH SIDE.
2. ALL AREAS UP VERTICALLY TO BE SHADED WITH INDICATED COLORS WITH THE EXCEPTION OF AREA SEPARATING CHARTS.

Figure 5.1

REQ'D	MATERIAL	NAME OF PART	SIZE OR DWG. NUMBER	COMP
1	SEE NOTE 1	OPERATING PROCEDURE	13.00 x 11.00 x .020	A

CHANGES		
NO	REMARKS	DATE

Litton THE LOUIS ALLIS CO. Drives & Systems Division — New Berlin, Wisconsin 53151

NAMEPLATE PUMP TEST METER MODULE MODE OF OPERATION

DR. BY EMS 3-6-73 ENG. JRS
CH. BY EEL 3-6-73 ISSUED 3-7-73

45T00199-0000

Table 5.1

OPERATING LEVELS FOR TESTS AND ADJUSTMENTS
(Refer to Section 5.1.4)

OPERATING LEVEL	DESCRIPTION	SET UP CONDITIONS
1	Drive De-energized	1. Place 1CB, 2CB, 3CB OFF. 2. Open external Line Disconnect Switch. 3. Wait 2 minutes, then open Cabinet door. 4. Using 5K ohm, 200 watt Resistor, discharge commutating capacitors 11C and 12C for 5 seconds. 5. Check for 0 VAC at input terminals of converter; 1F, 2F, 3F.
2	Converter OFF #1 and #2 motor operating constant speed Duplex.	1. All operator's controls in normal operating condition, (Table 3.1) except 3CB. Place 3CB on OFF 2. WARNING: 460 VAC will be present in upper secti[illegible] of cabinet. 3. Follow procedures 3, 4, and 5 of (1) above.
3	Converter Test Mode #1 and #2 motor operating constant speed Duplex.	1. All operator's controls in normal operating condition (Table 3.1). 2. WARNING: 460 VAC is present in cabinet. 3. Open door; place test module function switch in any position other than OFF or VOLTS. 3a If not test module, simulate converter test mode by placing jumper in relay logic to energize relay TCR.
4.	Converter ON With motor load, using manual speed potentiometer 1RH to set speed.	All operator's controls in normal operating condition (Table 3.1) except 3SS and 1RH. Place 3S[illegible] in MANUAL.
5	Converter ON Duplex, Automatic.	All operator's controls in normal operating condition (Table 3.1).

TABLE 5.2

LANCER 44XLP TEST POINTS

TEST NO.	TEST POINT	DESCRIPTION OF TESTED FUNCTION	TEST POINT LOCATION	OPERATING LEVEL SEE TABLE 5.1	READING OR WAVEFORM See Note 1	COMMENTS	DISCUSSION SECTION REFERENCE
1	1SCR 3SCR 5SCR Com.	1SCR Anode 3SCR Anode 5SCR Anode Common Cathode	Gate Firing Board Comm. Cathode	1 or 2		Resistance readings only. Do not measure with converter operating. Identical board for rectifier and inverter sections.	5.2.3
	4SCR 6SCR 2SCR Com.	4SCR Cathode 6SCR Cathode 2SCR Cathode Common Anode	Gate Firing Board Common Anode		R x 10K Scale R greater than 20K - SCR ok. R greater than 2K, less than 20K, questionable SCR. R less than 2K, faulty SCR.		
2	2SCR and ϕC Converter Output 4SCR and ϕA Converter Output 6SCR and ϕB Converter Output	2RTC(D) diode(s) 4RTC(D) diode(s) 6RTC(D) diode(s)	Gate Firing Board Common Anode and Converter Outputs, ϕA, ϕB and ϕC	1 or 2	R x 1 Scale Forward Direction 5Ω<R<50Ω- Diode ok. Reverse Direction R>10K = Diode ok. Forward and Reverse direction R<3Ω - Diode faulty.	Resistance reading only. Do not measure with converter operating.	5.2.3
	1SCR and ϕA Converter Output 3SCR and ϕB Converter Output 5SCR and ϕC Converter Output	1RTB(A) diode(s) 3RTB(A) diode(s) 5RTB(A) diode(s)	Gate Firing Board Common Cathode and Converter Outputs, ϕA, ϕB and ϕC				

TABLE 5.2

LANCER 44XLP TEST POINTS

TEST NO.	TEST POINT	DESCRIPTION OF TESTED FUNCTION	TEST POINT LOCATION	OPERATING LEVEL SEE TABLE 5.1	READING OR WAVEFORM See Note 1	COMMENTS	DISCUSSION SECTION REFERENCE
3	IFB	Current Feedback	DC Main PCB	4 or 5	0% rated motor Curr = 0.0 VDC 100% rated motor Curr = +5.6 VDC	Same as Test meter; Volts, position 8.	5.2.4
4	Inv. Inh.	Inverter Inhibit	"	3, 4 or 5	Inhibit = +5.0 VDC Non-inhibit = +0.5 VDC	I PBL will light brightly with inverter inhibit signal.	5.2.1
5	PCR	Positive Current Regulator	"	3, 4 or 5	Full retard = -12 VDC Full Advance = +12 VDC	PCR is compliment or inverse of NCR.	5.2.1
6	NCR	Negative Current Regulator	"	3, 4 or 5	Full retard = +12 VDC Full Advance = -12 VDC	Same as test meter; Volts; Position 1.	5.2.1 5.2.4
7	PHS	Phase Sequence	"	3, 4 or 5	Normal > 8V. Single phase or wrong phase < +6.0 VDC.	Single phase or wrong phase sequence will initiate inverter inhibit and light I PBL.	5.2.1

NOTE 1 Voltages measured are made with respect to circuit common, Test Point TP.

TABLE 5.2

LANCER 44XLP TEST POINTS
(cont)

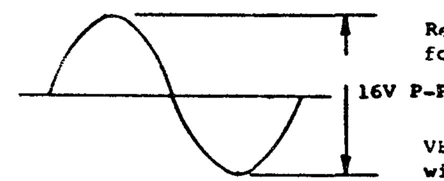
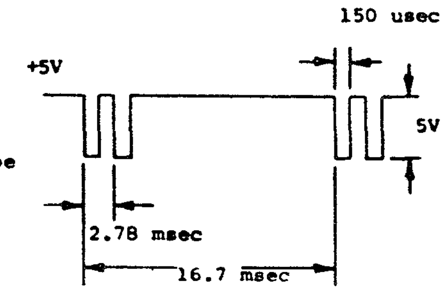
TEST NO.	TEST POINT	DESCRIPTION OF TESTED FUNCTION	TEST POINT LOCATION	OPERATING LEVEL SEE TABLE 5.1	READING OR WAVEFORM See Note 1	COMMENTS	DISCUSSION: SECTION REFERENCE
8	VA-N	Volts Ø A-N	DC Main PCB	3, 4 or 5		Reference voltages for current regulator.	5.2.5
	VB-N	Volts Ø B-N	"	"		VB-N is 120° phase shifted with respect to VA-N.	
	VC-N	Volts Ø C-N	"	"		VC-N is 120° phase shifted with respect to VB-N.	
9	P1R	Pulse, 1SCR, Rect.	"	3 with test meter 4 with oscilloscope		Trigger pulses for each rectifier SCR.	5.2.5
	P3R	Pulse; 3SCR; Rect.	"			P2R is 60° phase shifted with respect to P1R. P3R is 60° phase shifted with respect to P2R etc.	
	P5R	Pulse; 5SCR; Rect.	"				
	P4R	Pulse; 4SCR; Rect.	"				
	P6R	Pulse; 6SCR; Rect.	"				
	P2R	Pulse; 2SCR; Rect.	"				

TABLE 5.2

LANCER 44XLP TEST POINTS
(cont)

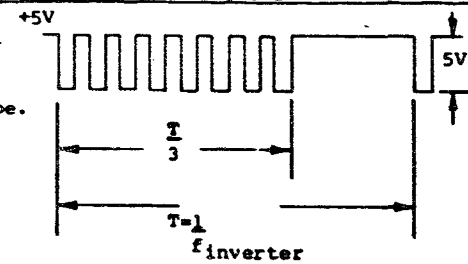
TEST NO.	TEST POINT	DESCRIPTION OF TESTED FUNCTION	TEST POINT LOCATION	OPERATING LEVEL SEE TABLE 5.1	READING OR WAVEFORM See Note 1	COMMENTS	DISCUSSION: SECTION REFERENCE
10	P1I	Pulse; 1SCR; Inverter	AC Main PCB	3 with test meter 4 with oscilloscope.		Trigger pulses for each inverter SCR.	5.2.5
	P3I	Pulse; 3SCR; Inverter	"				
	P5I	Pulse; 5SCR; Inverter	"				
	P4I	Pulse; 4SCR; Inverter	"				
	P6I	Pulse; 6SCR; Inverter	"			First pulse in each train will be displaced 60° of inverter freq. from that of next higher numbered SCR.	
	P2I	Pulse; 2SCR; Inverter	"			Second and succeeding pulses in train will be line frequency synced, and will be 2178 ms apart.	
11	AA	Motor Speed Droop	Fault and Zero Current Detector PCB. 1PC of card rack.	4 or 5	Droop < 15-20% = 0V Droop > 15-20% = >10V	Speed droop greater than 15-20% will trigger converter fault relay (1CR) and light 1 PBL.	5.2.2
13	CC	Zero Current	Fault and Zero Current Detector	3, 4 or 5	Curr < 4-10% I_{rated} = 0V Curr > 4-10% I_{rated} = +10V	Current less than 4-10% I_{rated} energizes zero current relay (2CR).	none
14	AA	Reference Voltage to Variable Freq. Oscillator	Voltage Regulator & Oscillator PCB. 3PC of card rack.	3, 4 or 5	0.0V = 6Hz Osc. +9.0V = 400 Hz Osc.	Approx. inverse of LAC (20 below) when not in I-limit.	

TABLE 5.2

LANCER 44XLP TEST POINTS
(cont)

TEST NO.	TEST POINT	DESCRIPTION OF TESTED FUNCTION	TEST POINT LOCATION	OPERATING LEVEL SEE TABLE 5.1	READING OR WAVEFORM See Note 1	COMMENTS	DISCUSSION: SECTION REFERENCE
15	BB	Positive Voltage Regulator Output	Voltage Regulator & Oscillator PCB. 3PC of card rack.	3, 4 or 5	100% rated current approx. +6V	Same as test meter Volts, Position 2.	5.2.4
16	CC	Clock Pulse Output	"	3, 4 or 5		C.P. rate varies with linear accelerator output. 0 to +.5V LAC = 6 Hz +9.5V LAC = 400 Hz CP = 6 X Inv. Freq.	none
17	DD	Current Ref. Output	"	3, 4 or 5	0% rated current = 0V 100% rated current = -10.0V	Shorted by contact of test relay TCR in current phaseback	none
18	EE	Current Limit Low Speed Taper	"	3, 4 or 5	at 0.V. LAC = 0V + 1.5V LAC = -12V	Taper limit set by I-idle (5RH)	none
19	FF	Current Limiter Output	"	4 or 5	Not limiting = +0.5V Limiting, +0.0V	Point of Current Limit action set by I-limit (6RH).	5.2.2
20	AA	Linear Acceleration Output (LAC)	Linear Accelerator & Transducer Follower PCB. 2PC of card rack.	3 and 4	0% speed = 0V 100% speed = +10V -9.5V	Held at 0V until released by contact of 1TR	5.2.1
21	BB	Transducer Follower Output	"	3 and 4	0% speed = 0V 100% speed = -4.5V (assumes zero offset input condition)	Only used with transducer ma speed signal or external voltage reference	5.2.1

TABLE 5.3

LANCER 44XLP ADJUSTMENTS

NO.	ADJUSTMENT NAME	LOCATION	PURPOSE	OPERATING LEVEL SEE TABLE 5.1	ADJUSTMENT GUIDE SET-UP	ADJUSTMENT TYPE AND REFERENCE
1	Voltage Feedback 1RH	Current Regulator Mod. PCB. Part of DC Main PCB.	Sets level of voltage compensation to minimize beat frequencies.	4 or 5	When operating converter at 30 Hz and 60 Hz with no load on motor; adjusted to minimize motor voltage and current swings.	Replacement Adjustment Section 5.3.4
2	Underspeed 1RH	Fault & Zero Current detector PCB. 1PC of card rack.	Sets drop-out point for underspeed. Works with scaling adjustment.		Set to drop out fault relay for speed droops exceeding 15-20% of rated speed.	Factory Adjustment
3	Scaling 2RH	"	Matches output of linear accelerator circuit to rectified motor feedback voltage.		Set so that at rated speed rectified motor voltage equals scaled LAC.	Factory Adjustment
4	Zero Current 4RH	"	Sets threshold level for zero current detector.		Adjusted to energize zero current relay when dc link current falls to less than 0.05 to 0.1 rated motor current.	Factory Adjustment
5	Acceleration Rate 2RH	Linear Accelerator and Transducer follower PCB. 2PC of card rack.	Sets rate of rise of linear accelerator circuit.		Adjusted for 3 to 4 second rise in linear accelerator output for 100% step change in speed signal.	Factory Adjustment
6	Deceleration Rate 1RH	Linear Accelerator and Transducer follower PCB. 2PC of card rack.	Sets rate of fall of linear accelerator circuit.		Adjusted for 6 to 8 second delay in linear accelerator output for 100-0% step change in speed signal.	Factory Adjustment
7	Maximum Speed 3RH	Linear Accelerator and Transducer follower FCB. 2PC of card rack.	Sets maximum speed of remote or manual speed potentiometer.	3 and 4	Using 135 ohm remote speed potentiometer; adjusted for maximum inverter frequency of 60 Hz.	Field Adjustment Section 5.3.1
8	Minimum Speed 4RH	"	Sets minimum speed of remote or manual speed potentiometers.	3 and 4	Using 135 ohm remote speed potentiometer; adjusted for minimum inverter frequency of 20Hz.	Field Adjustment Section 5.3.1

TABLE 5.3

LANCER 44XLP ADJUSTMENTS
(cont)

NO.	ADJUSTMENT NAME	LOCATION	PURPOSE	OPERATING LEVEL SEE TABLE 5.1	ADJUSTMENT GUIDE SET-UP	ADJUSTMENT TYPE AND REFERENCE
9	Ratio 5RH	Linear Accelerator and Transducer follower PCB. 2PC of card rack.	Sets ratio of transducer current signal to speed.	3 and 4	Adjusted for -5.0 volts output of transducer follower for transducer current signal corresponding to max. speed.	Field Adjustment Section 5.3.1
10	Follower Offset 6RH	"	Sets Zero speed offset of transducer current signal.	3 and 4	Adjusted for 0.0 volts output of transducer follower for transducer current signal corresponding to minimum speed.	Field Adjustment Section 5.3.1
11	Dwell Freq. 1RH	Voltage regulator and Oscillator PCB. 3PC of card rack.	Sets minimum frequency of variable frequency oscillator.		Adjusted for a minimum oscillator frequency of 6 Hz.	Factory Adjustment
12	Max. Speed 3RH	"	Calibrates speed meter circuit.		Adjusted for 1.1 ma at 400 Hz oscillator frequency.	Factory Adjustment
13	Volts/Hz 4RH	Voltage Regulator and Oscillator PCB. 3PC of card rack.	Sets voltage to frequency ratio of converter output.	4	Adjusted for 7.67 volts/Hz at inverter frequency of 60 Hz.	Replacement Adjustment Section 5.3.3
14	I-idle 5RH	"	Sets no load motor current.		Adjusted for 3.0 to 5.0 volts at TP-DD.	Factory Adjustment
15	I-limit 6RH	"	Sets threshold level of current limit circuit.	4	Adjusted for 105% of rated motor current at 60 Hz inverter frequency.	Replacement Adjustment Section 5.3.2
16	Stability	Card Rack	Motor stability under load.		Adjusted for minimum current fluctuation at rated load.	Factory Adjustment
17	Speed Limit 7RH	Linear Acceleration and Transducer Follower PCB. 2PC of card rack	Limits output of Linear Accelerator output		Adjusted to limit output of Linear Accelerator to approx. +8.6V for transducer signals corresponding to max. speed.	Factory Adjustment

TABLE 5.4

TEST METER MODULE TEST POINT TO VOM

TEST POINT CONVERSION

	TEST METER 1SS POSITION	TEST POINTS (See Table 5.2)	VOM COMMON TO T.P. (COMMON ON DC MAIN PCB)	VOLTMETER READING
1.	Motor Current Error Voltage	6	TP-NCR on DC Main PCB	+12 VDC Full Advance
2.	Motor Volts Error Voltage	2	TP-BB on Voltage Reg. & Oscillator PCB	+6 VDC at 100% Rated Current
3.	Motor Reference Volts		Terminal D on Voltage Reg. & Oscillator PCB	+6.7 VDC at 100% speed
4.	-15V		3R in Power Supply	-15 VDC
5.	+5V		1R in Power Supply	+5 VDC
6.	+15V		2R in Power Supply	+15 VDC
7.	Motor Feedback Volts		Terminal 10 on Voltage Reg. & Oscillator PCB	+100 VDC at 100% speed
8.	Motor Feedback Current	3	TP-IFB on DC Main PCB	+5.6 VDC at 100% Rated Current

SECTION 6

MAINTENANCE & TROUBLESHOOTING

6.0 Maintenance & Troubleshooting

HIGH VOLTAGE WARNING

PERSONNEL WILL ALWAYS BE EXPOSED TO HIGH VOLTAGE WHEN AC INPUT POWER IS APPLIED TO THE CONVERTER WITH THE DOOR OPEN. WHEN MEASURING VOLTAGES IN THE POWER CIRCUIT, ALWAYS FOLLOW THE PROCEDURE GIVEN BELOW: ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY.

1. Remove AC input power and allow two minutes for capacitors to discharge. Always check for residual voltages and discharge circuits with a voltmeter.
2. Clip multimeter leads to desired voltage check points.
3. Keep hands and head away from power section area. Apply AC input power and record voltage reading.
4. Repeat step (1) above and remove meter leads.

ALWAYS REMOVE AC INPUT POWER WHEN CHECKING AND REPLACING POWER SECTION COMPONENTS, RELAYS, AND PRINTED CIRCUIT BOARDS. ALLOW 2 MINUTES FOR CAPACITORS TO DISCHARGE. ALWAYS CHECK WITH A VOLTMETER FOR ANY VOLTAGES BEFORE ATTEMPTING ANY REPAIRS.

6.1 Repair & Replacement Procedures

6.1.1 Removal & Replacement of Converter SCRs (Pressure mounted)

Before attempting removal or replacement of a converter SCR, be sure that the converter is de-energized and that all power capacitors have been discharged. Refer to Section 5.2.3 for SCR and diode tests.

To change an SCR, remove the heat sink mounting screws and the bus connection screws. Disconnect the gate leads and extract the heat sink assembly. Refer to Figure 6.1.

Replace a defective SCR as follows:

1. After the heat sink assembly has been removed from the module, remove the clamp bar and lift the SCR from heat sinks.

2. Wipe the heat sink surfaces clean. Remove any burrs or ridges that would prevent proper installation of the new SCR. Wipe bus connection surface clean.

3. Apply joint compound (Penatrox type A or equivalent). Spread compound evenly to cover complete SCR mounting surface. Do not apply excessive amounts as this may short out the gate lead. Apply also to bus connection surface.

4. Install new SCR (making sure that bowed clamp bar is inserted with the ends higher than the center) and tighten clamp bolts finger tight.

   Add 1/2 turn to right-hand bolt.
   Add 1 turn but do not exceed to left-hand bolt.
   Add additional 1/2 turn but do not exceed to right-hand bolt.

   Remove excess compound.

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5. Feed gate leads through to gate firing PCB.

6. Replace heat sink assembly.

7. Replace heat sink mounting screws and bus connection screws.

6.1.2 Removal & Replacement of Inverter Diodes (Stud Mounted)

Before attempting removal or replacement of inverter diodes, be sure that the converter is de-energized and that all power capacitors are discharged.

Refer to Section 5.2.3 for SCR and Diode Tests.

To change an inverter diode, disconnect the inverter output lead at terminal 50, 58 or 65. This terminal is also the heat sink mounting screw. Remove the heat sink assembly for access to the diodes. Refer to Figure 6.2.
Replace defective diodes as follows:

1. Remove nut from diode stud and lift diode from the heat sink with lint-free cloth.

2. Wipe the heat sink surfaces clean with lint-free cloth. Remove any burrs or ridges that would prevent proper installation of the diode.

3. Apply thermal or electrical joint compound (Wakefield Type 120 or equivalent) around, but not in, the diode mounting hole. Spread compound evenly to cover complete diode mounting surface.

4. Install new diode. Tighten mounting nut finger tight, then add an additional one-half turn. Wipe off excess compound.

5. Fasten cathode power lead to standoff.

6. Replace the diode heat sink assembly and complete the inverter output connection.

6.1.3 Removal and Replacement of Printed Circuit Boards

1. Rectifier - Inverter Logic PCB Assembly

   These printed circuit boards are held in a cage at the left side of the converter module. The AC Main and Current Regulator Mod printed circuit boards are permanently fastened to the DC Main Printed Circuit Board.

   All three boards must be removed or replaced as a unit. To remove the board assembly, loosen the lock-down screw which is part of Run-Lockout, reset button and lamp bracket. Slide the printed circuit board assembly part way out, and carefully disconnect the electrical harness at 12 tab connectors. The connectors are identified and keyed to insure proper replacement. The Burden Resistor assembly, which varies with horsepower, is mounted on the DC Main PCB assembly. Consisting of a connector and resistor, this assembly is plugged into 14 Conn. This assembly should be removed and inserted on the replacement PCB assembly.

   Installation is the reverse of the above procedure. When replacing the combination DC Main, AC Main, and Current Regulator Mod printed circuit boards, the Voltage Feedback adjustment (1RH) on the Current Regulator Mod board will have to be performed. Initially, 1RH on the replacement circuit board should be set to the same approximate position as the original circuit board. Refer to the Voltage Feedback Adjustment Procedure, Section 5.3.4 to complete the adjustment on a replacement circuit board.

2. The four Gate Firing printed circuit boards are mounted on the four heat sink assemblies of the rectifier and inverter. To replace one of these circuit boards, remove the tab connector from the board and disconnect the push-on leads from the SCR gates (2 leads from each SCR). Disconnect the thermoguard connection and unsolder the test point leads from each SCR. Remove the mounting screws and lift the printed circuit board from the heat sink assembly. Installation is the reverse of the above procedure.

3. The Overvoltage Trigger printed circuit board is mounted on the output clamp rectifier assembly. To replace this circuit board, disconnect the four leads and remove the circuit board. Replacement is the reverse of this procedure.

4. The card rack assembly, located at the bottom of the converter section, contains three plug-in printed circuit cards as well as the optional test module. The three printed circuit cards are:

   1PC - Fault and Zero Current Detector PCB
   2PC - Linear Accelerator and Transducer Follower PCB
   3PC - Voltage Regulator and Oscillator PCB

   To remove, lift the lock bar and slide the circuit board from the card rack. Replacement is the reverse of this procedure. On replacement, the following adjustments must be set:

   <u>1PC - Fault and Zero Current Detector PCB</u>

   Adjustments Factory Set; do not Field Adjust.

   <u>2PC - Linear Accelerator and Transducer Follower PCB</u>

   1RH - Acceleration - Factory Set; do not Field Adj.

   2RH - Deceleration - " " " " " "

   3RH - Max. Speed - Set Per Section 5.3.1

   4RH - Min. Speed - " " " "

   5RH - Ratio - " " " "

   6RH - Offset - " " " "

3PC - Voltage Regulator and Oscillator PCB

1RH - Dwell Freq. - Factory Set; do not Field Adj.

2RH - Dampening - Not used. Set to 0% (Max. CCW)

3RH - Max. Speed - Factory Set; do not Field Adj.

4RH - Volts/Hz - Set per Section 5.3.3

5RH - I idle - Factory Set; do not Field Adj.

6RH - I limit - Set per Section 5.3.2

The Test Module assembly slides into the right section of the card rack and is secured with screws to the card rack frame. To remove the test module, loosen the screws and slide it out of the card rack.

6.1.4 Printed Circuit Boards - Repair and Return Procedures

Repair of printed circuit boards requires special techniques and test facilities. For this reason field repair is not authorized and replacement of a suspect board is recommended in the troubleshooting procedures.

Defective or questionable printed circuit boards should be sent to The Louis Allis Co., Drives and Systems, 16555 West Ryerson Road, New Berlin, Wisconsin 53151, for repair and test. The printed circuit board should be individually protected with one inch thickness of soft wrapping material before it is packed in a suitable carton. The Louis Allis Co. assumes no responsibility for printed circuit boards returned without proper identifying papers. Contact the nearest Louis Allis District Office for return tags and forms.

Repaired or replacement printed circuit boards are tested and adjusted using factory facilities. Factory adjustment settings have been made and should not be changed in the field unless specifically called for. Refer to Board Replacement Procedures above.

6.1.5 Motor Replacement

If it becomes necessary to replace or repair an AC motor, an exact duplicate is required. See Section 1.2.2.

A. To replace Louis Allis motor, order by nameplate serial number and data from Louis Allis.

B. To replace with other brand, request assistance from nearest Louis Allis district office. Motor electrical data must be evaluated by Louis Allis Co. for duplicity.

C. To rewind original motor, request data from Louis Allis.

CAUTION

An improper motor may cause unsatisfactory operation or damage to the Converter.

6.2 Preventive Maintenance

6.2.1 Cleaning and Lubrication

Preventive Maintenance is primarily a matter of routine inspection and cleaning. The internal cooling fins of the rectifier and inverter heat sinks should be kept clean by brushing while using a vacuum cleaner. Excess dust and dirt accumulation on the heat sinks can cause overheating of the diodes and SCR's. To gain access, remove the cover over the converter section. Insure all power is off.

Periodically clean the cooling fans for the converter section and the door-mounted blower to prevent dirt build-up. At the same time, check that the impellers are free and not binding in the housing. The blower and fans are permanently lubricated, and should be replaced if the shaft does not spin freely.

6.2.2 System Performance Check

Performance of the drive system should be checked and recorded periodically. A recommended checkout procedure is the startup procedure of Section 2.3. In addition, a log should be kept of important voltage and current readings for reference and to key significant shifts in operation. Voltages and currents should be taken under conditions of maximum rated converter load at 100% speed.

In addition to the voltages checked by the test module or VOM per Section 5.2.4, record motor currents and hour meter readings as well as converter hours if these accessory meters are provided.

6.3 Troubleshooting Procedures

Equipment down time and service time can be reduced by advance understanding of the functional description discussed in Section 4 and by following the troubleshooting guides of Section 6.4.

Before beginning a detailed check of the drive, be sure that the AC motor is operating properly and that load conditions do not exceed the drive capability. Many times, problems can be discovered by a visual inspection as outlined in Section 2.3.1.

The troubleshooting procedure of Section 6.4 is basic and covers check-out of the drive from typical operating symptoms.

The intent herein is to isolate the trouble first to a section then to a module or printed circuit board. When in doubt, replace a suspected faulty circuit board, since this normally is less costly than the downtime required to isolate the faulty component on the board.

Refer to Section 6.1.3 for replacement procedures of printed circuit boards.

If a printed circuit board is replaced and the problem is not resolved, reinstall the original board.

Repair should not be attempted to faulty or suspect printed circuit boards. These boards should be sent to the Louis Allis Company for repair or replacement. Refer to Section 6.1.4 for instructions.

6.3.1 System Relay Logic

Troubles in the Duplex Relay Logic can be isolated following the troubleshooting procedures of Sections 6.4.1 and 6.4.2. In addition, Table 6.1 lists all Lancer 44XLP Duplex circuit breakers, switches, relays, and contactors and tells how they are controlled and what they in turn control.

Notation and symbols used in Table 6.1 are as follows:

1. Control elements are listed alphabetically by part symbol.

2. Abbreviations used for contacts are as follows:

   N O = Contact normally open

   N C = Contact normally closed

   N OTC = Contact normally open, timed closed

   N CTO = Contact normally closed, timed open

   #2C = Number 2 contact closed

   SPDT = Single pole double throw contacts

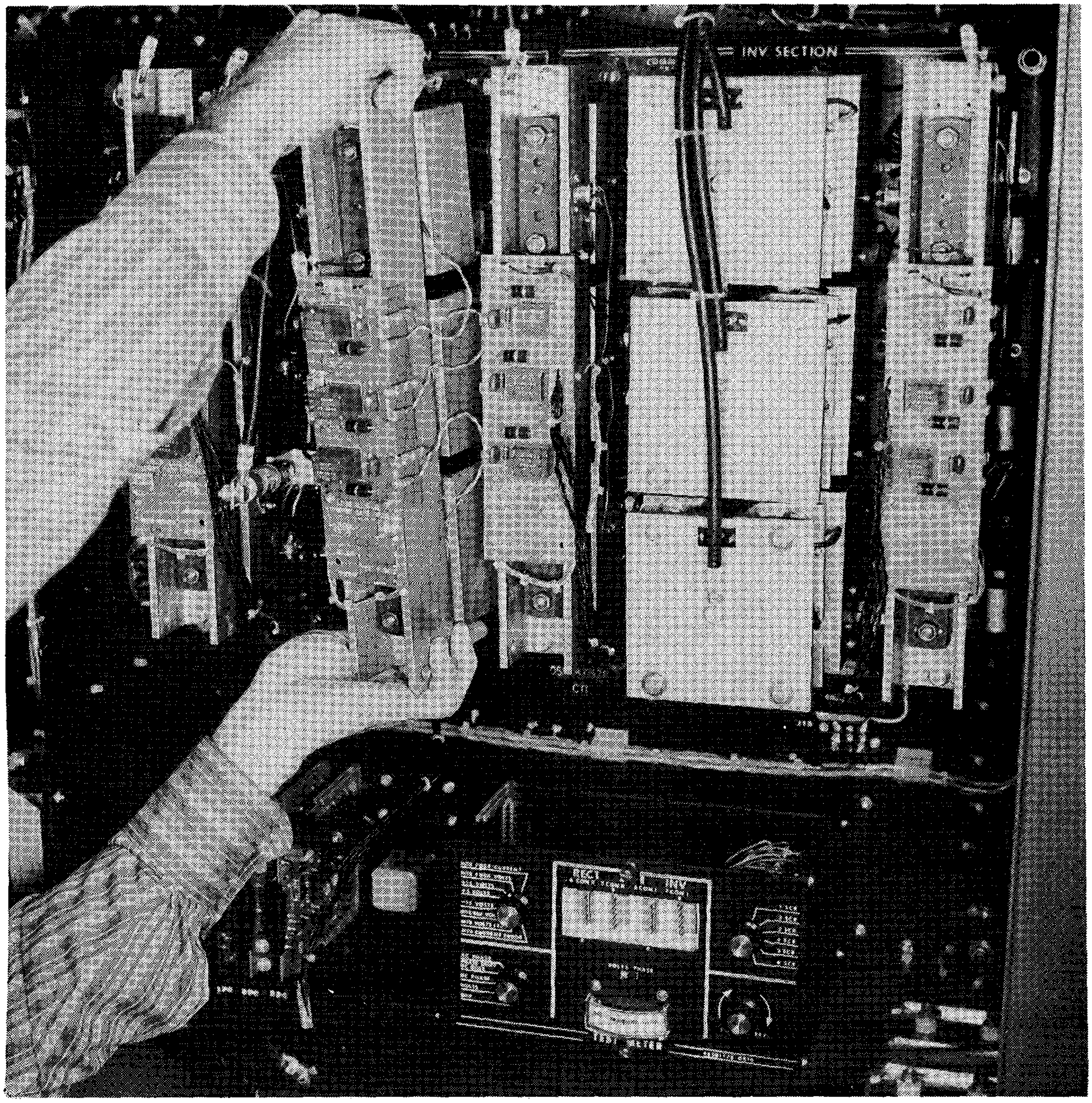
6.3.2 Converter

Troubleshooting the converter circuits will usually be keyed from converter fault condition. The guide of Table 6.4.3 is based on starting from this symptom and progressively checking through the converter section.

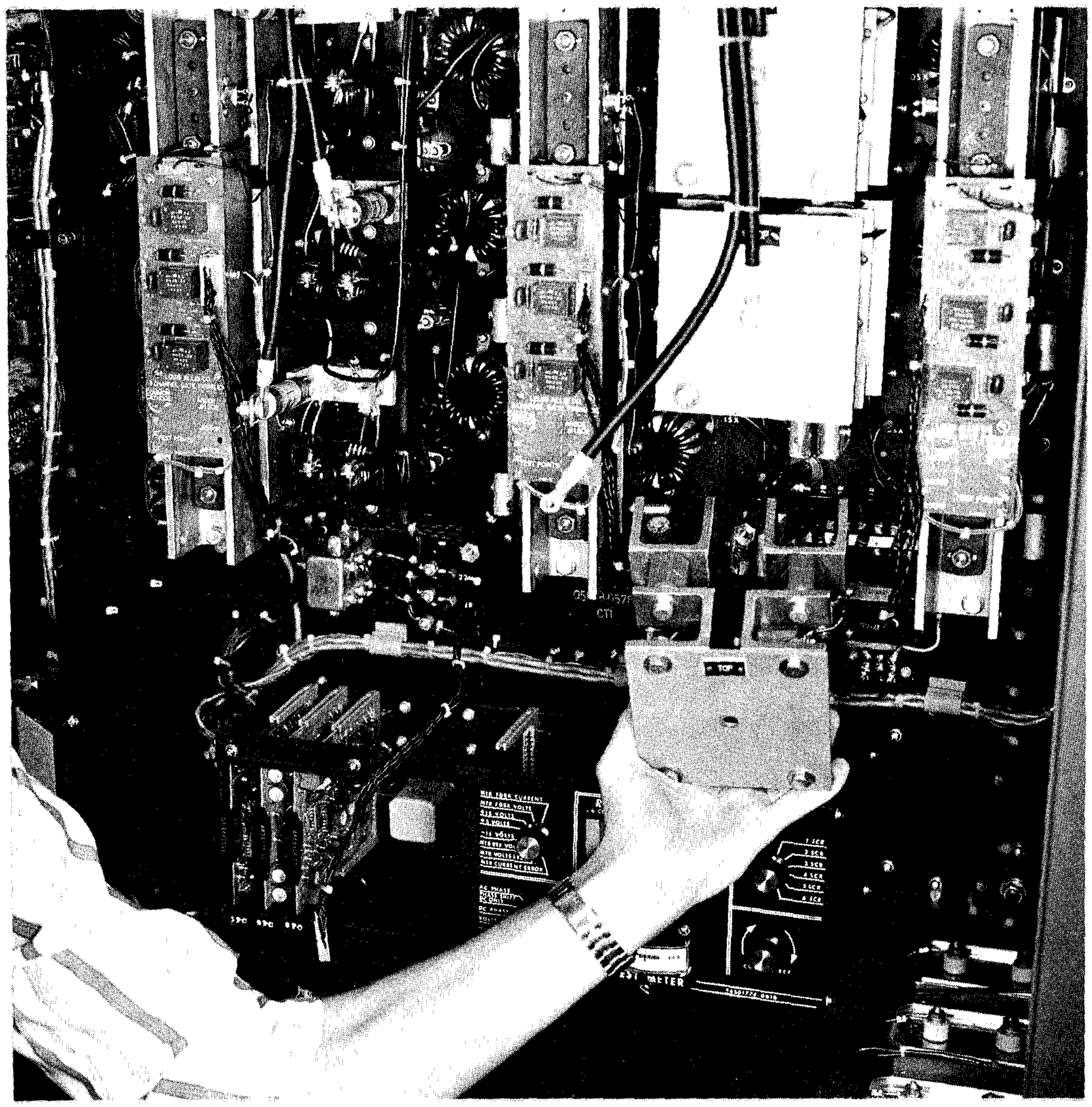
LOUIS ALLIS
DIVISION OF LITTON INDUSTRIES
MILWAUKEE WISCONSIN 53201

6.4 Troubleshooting Guide

Refer to Tables 6.4.1, 6.4.2 and 6.4.3 for troubleshooting "Drive does not Start," "Motor Overload", and "Converter Fault" respectively.



SCR REPLACEMENT
FIGURE 6-1



INVERTER DIODE REPLACEMENT
FIGURE 6·2

Table 6.1
LANCER 44XLP DUPLE DRIVE CONTROL
ELEMENT FUNCTIONING

Part Symbol	NAME	LOCATION	FUNCTION REPRESENTATION	CONTACTS, WIRE #'s, & CONTROLLED PART
ALT	Lead motor alternation	Relay logic assembly	Alternates lead motor every 24 hours of single motor operation.	spd #1: 121-122 1CRL #2: 121-120 1CRU
1CB	#1 motor line circuit breaker	Cabinet door	Provides input line power for constant speed operation of #1 motor. Manual: **OFF-ON**	ØA N/O: 1-7 ØB N/O: 2-8 # 1 motor ØC N/O: 3-9
2CB	#2 motor line circuit breaker	Cabinet door	Provides input line power for constant speed operation of #2 motor Manual: **OFF-ON**	ØA N/O: 1-19 ØB N/O: 2-20 #2 motor ØC N/O: 3-21
3CB	Converter line circuit breaker	Cabinet door	Provides input line power to converter Manual: **OFF-ON**	ØA N/O: 1-4 ØB N/O: 2-5 Converter ØC N/O: 3-6
4CB	Control line circuit breaker	Inside Cabinet	Provides input line power to 115 VAC control circuits. Manual: **OFF-ON**	ØA N/O: 1-80 Relay Logic ØB N/O: 2-79
1CR(rl)	Run-Lockout relay	DC Main PCB	Allows converter operation when energized.	N/O: 89-90 XLF
1CR(cf)	Converter fault relay	Fault & zero current detector PCB	Allows converter operation, when energized	N/O: 33-107 XLF

Table 6-1
LANCER 44XLP DUPLEX DRIVE CONTROL
ELEMENT FUNCTIONING

Part Symbol	NAME	LOCATION	FUNCTION REPRESENTATION	CONTACTS, WIRE #'s, & CONTROLLED PART
2CR	Zero current relay	Fault & zero current detector	Signals that motor current is less than 10% rated current.	N/C: 33-135 IPBC
ICRU	Latch relay	Relay logic assembly	Mecn latch relay provides lead mtr memory on power faulure. Zero state corresponds to ICRU.	Contacts are ICR N/O: 124-125 1LD N/O: 126-127 2LD N/C: 124-127 2LD N/C: 125-126 1LD
HLSW	High level Switch	Wet-well bubbler system	Provides run signal upon closure, stop signal on opening. (differential between close & open)	N/O: 103-130 HLTR
HLTR	High level time delay relay	Relay Logic Assembly	Commands two motor operation. Time delay restarts lead motor on line after CEMF decay.	N/O tc: 103-152 1ML:2ML N/C: 103-119 ALT N/O: 123-162 1LD; 2LD N/C: 123-124 1LD; 2LD
IPB	Current phaseback relay	Relay logic assembly	When energized releases current regulator of converter.	N/C: 64-65 Phase back, DC mai N/C: 67-68 1TR
IPBC	Current phaseback complete relay	Relay logic Assembly	Signals when current phaseback is complete	N/O: 136-33 1MV N/O: 33-150 2MV
1LD	#1 motor lead relay	Relay logic assembly	When energized #1 motor is lead motor on converter	N/O: 140-141 1XLTR N/O: 152-156 2ML

Table 6.1
LANCER 44XLP DUPLEX D E CONTROL
ELEMENT FUNCTIONING

art ymbol	NAME	LOCATION	FUNCTION REPRESENTATION	CONTACTS, WIRE #'s, & CONTROLLED PART
2LD	#2 motor lead relay	Relay logic assembly	When energized #2 motor is lead motor on converter.	N/O: 145-146 2XLTR N/O: 152-153 1ML
LLSW	Low-Level Switch	Wet well bubbler system	Provides run signal upon closure, stop signal upon opening (differential between close & open)	N/O:162-123 1LD;2LD
MAR	Manual Automatic Relay	Relay logic Assembly	Transfers speed control signal from manual speed control on door to remote automatic transducer	N/O: 54-56 Potentiometer Trand. N/O: 54-57 Manual Speed Control N/O: 55-59 Potentiometer Transd. N/C: 55-58 Manual Speed Control
1ML	#1 motor line contactor	Top of Cabinet	Energizes #1 motor from line for constant speed operation.	ØA N/O: 7-10 ØB N/O: 8-11 ØC N/O: 9-12 Auxiliary: N/O: 103-160 1ETM N/C: 141-142 1XLTR N/C: 137-160 1ETM
2ML	#2 motor line contactor	Top of Cabinet	Energize #2 motor from line for constant speed operation.	ØA N/O: 19-22 ØB N/O: 20-23 ØC N/O: 21-24 Auxiliary N/O:103-161 2ETM N/C: 161-149 2ETM N/C: 146-147 2XLTR
1MV	#1 motor converter contactor	Top of Cabinet	Energizes #1 motor from converter for variable speed operation	ØA N/O: 10-16 ØB N/O: 11-17 ØC: N/O: 12-18 Auxiliary N/O: 33-132 IPB N/O:137-136 1MV N/C: 147-148 2XLTR N/C: 151-155 1ML
2MV	#2 motor converter contactor	Top of Cabinet	Energizes #2 motor from converter for variable speed operation.	ØA N/O: 16-22 ØB N/O: 17-23 ØC N/O: 18-24 Auxiliary N/O: 33-133 IPB N/O: 147-150 2MV

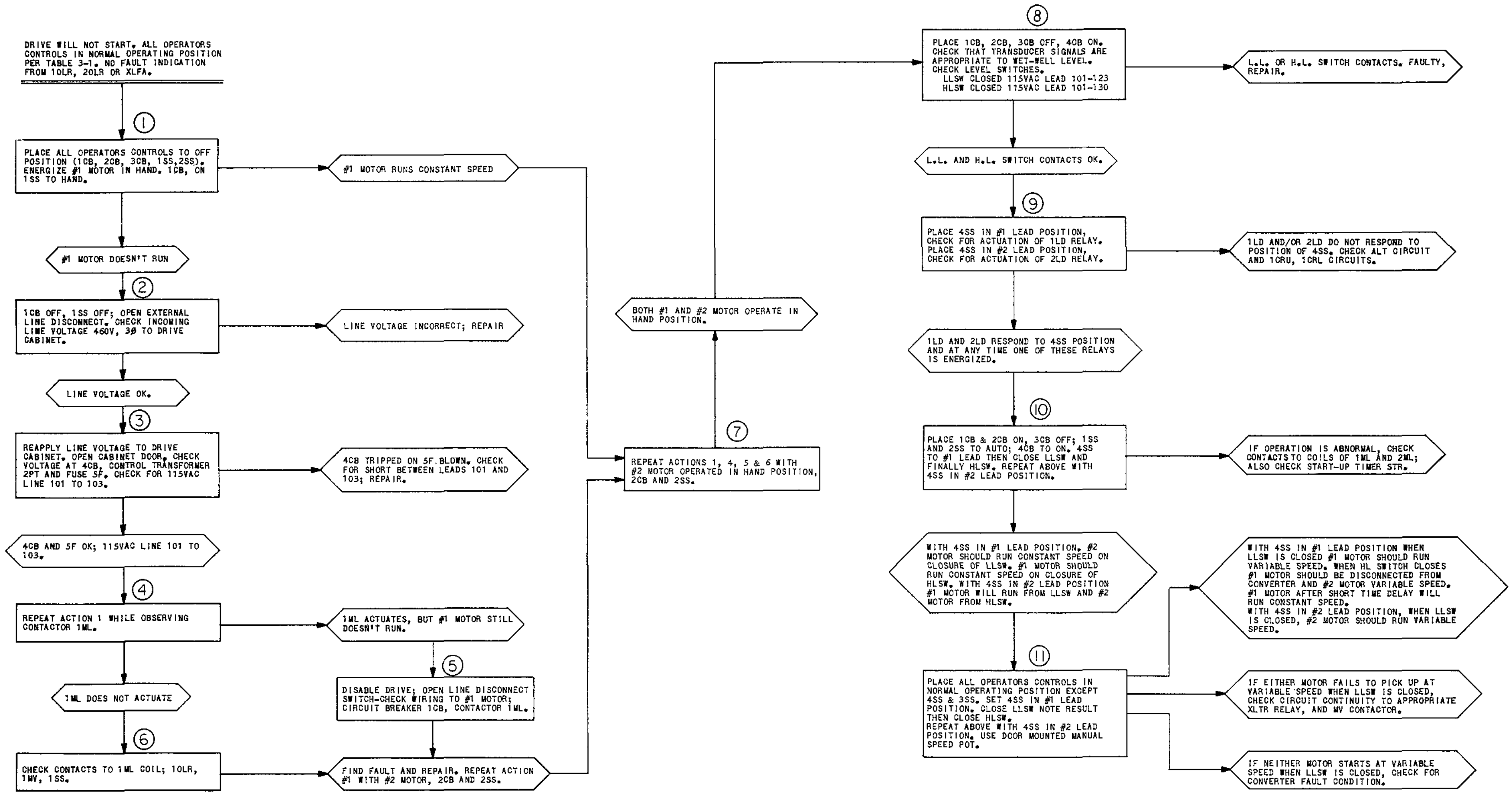
Table 6.1
LANCER 44XLP DUPLEX DRIVE CONTROL
ELEMENT FUNCTIONING

Part Symbol	NAME	LOCATION	FUNCTION REPRESENTATION	CONTACTS, WIRE #'s, & CONTROLLED PART
1CLR	#1 motor overload relay	Relay logic assembly	Provides overcurrent or overtemperature protection for #1 motor.	N/O: 139-140 1XLTR N/O: 154-153 1ML N/O: 171-170 Remote monitor control N/C: 171-172
2OIR	#2 Motor Overload Relay	Relay Logic Assembly	Provides overcurrent or overtemperature protection for #2 motor.	N/O: 144-145 2XLTR N/O: 156-157 2ML N/O: 174-173 Remote Monitor Contact N/C: 174-175
STR	Start Up Time Delay Relay	Relay Logic Assembly	Sequences motor start on application of power with one or both level switches closed.	N/Otc: 103-162 1LD; 2LD
1SS	motor control switch	Cabinet Door	Controls operation of #1 motor. Manual: hand - Off - Auto	Hand #2c: 154-151 1ML Auto #1 c: 138-139 1XLTR #3 c: 103-151 1ML
2SS	#2 motor control switch	Cabinet Door	Controls operation of #2 motor. Manual: HAND - OFF - AUTO	Hand #3 c: 103-158 2ML Auto #1 c: 138-144 2XLTR #2 c: 158-157 2ML
3SS	Manual - Auto Speed Selector Switch	Cabinet Door	Selects manual speed control of automatic level transducer speed signal. Manual: MANUAL - AUTO	Auto: c: 33-104 MAR
4SS	Lead Motor Selector Switch	Cabinet Door	Selects lead motor or automatic alternation of lead motor. Manual: #1 LEAD - AUTO ALT - #2 LEAD	#1 Lead #1 c: 119-122 1CRL Alt Auto #2 c: 119-121 1CRL; 1CRU #2 Lead #3 c: 119-120 1CRU

Table 6.¹

LANCER 44XLP DUPLEX (IVE CONTROL
ELEMENT FUNCTIONING

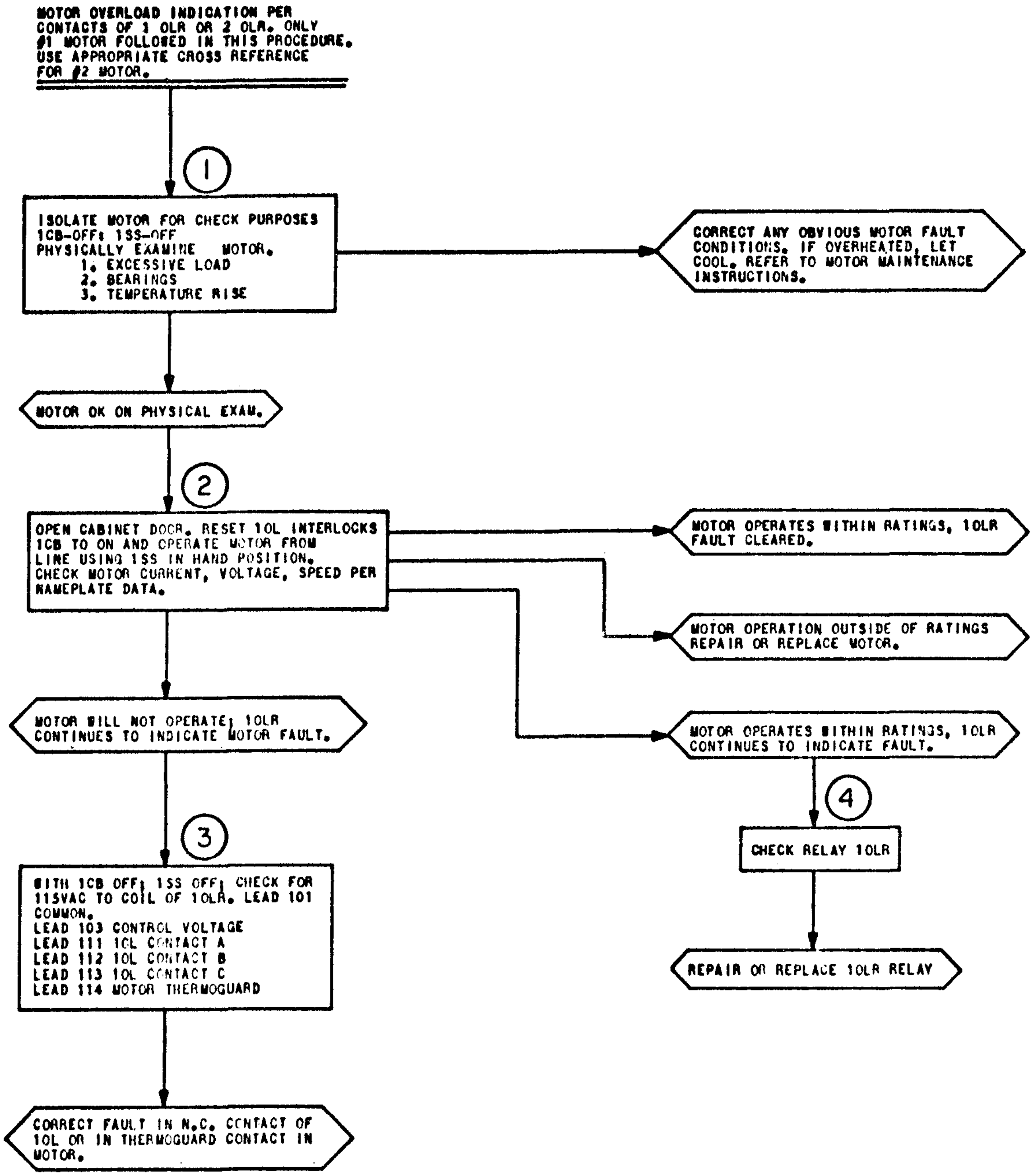
Part Symbol	NAME	LOCATION	FUNCTION REPRESENTATION	CONTACTS, WIRE #'s, & CONTROLLED PART
XLFA	Converter Fault Auxiliary Relay	Relay Logic Assembly	Signals a converter fault when deenergized. Provides contacts for remote monitor.	N/O: 164-165 N/C: 164-163 N/O: 168-167 N/O: 168-169 Remote monitor Contacts
1XLTR	#1 motor time close relay	Relay logic assembly	Provides CEMF and speed decay of #1 motor from line to converter operation.	N/O: 132-134 IPB N/Otc: 33-137 1MV
2XLTR	#2 motor time close relay	Relay Logic Assembly	Provides CEMF and speed decay of #2 motor from line to converter operation.	N/O: 133-134 IPB N/Otc: 33-149 2MV



DRIVE WON'T START

44XLP TROUBLESHOOTING SECTION 6.4

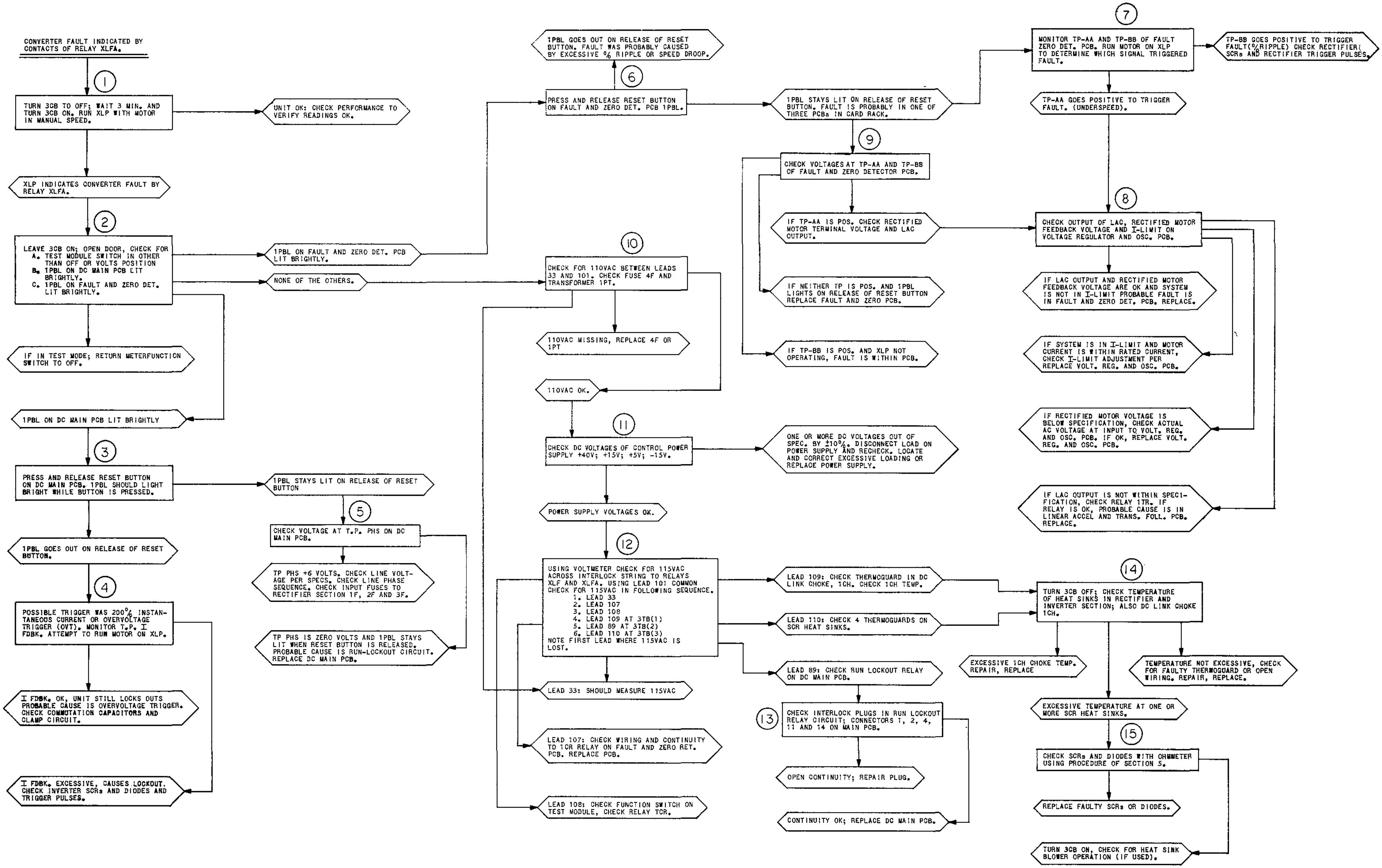
ACTION → RESULT - TABLE 6.4.1



MOTOR OVERLOAD

44XLP TROUBLESHOOTING SECTION 6.4.2

ACTION → RESULT - TABLE 6.4.2



6-21

CONVERTER FAULT

44XLP TROUBLESHOOTING SECTION 6.4

ACTION → RESULT —TABLE 6.4.3

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