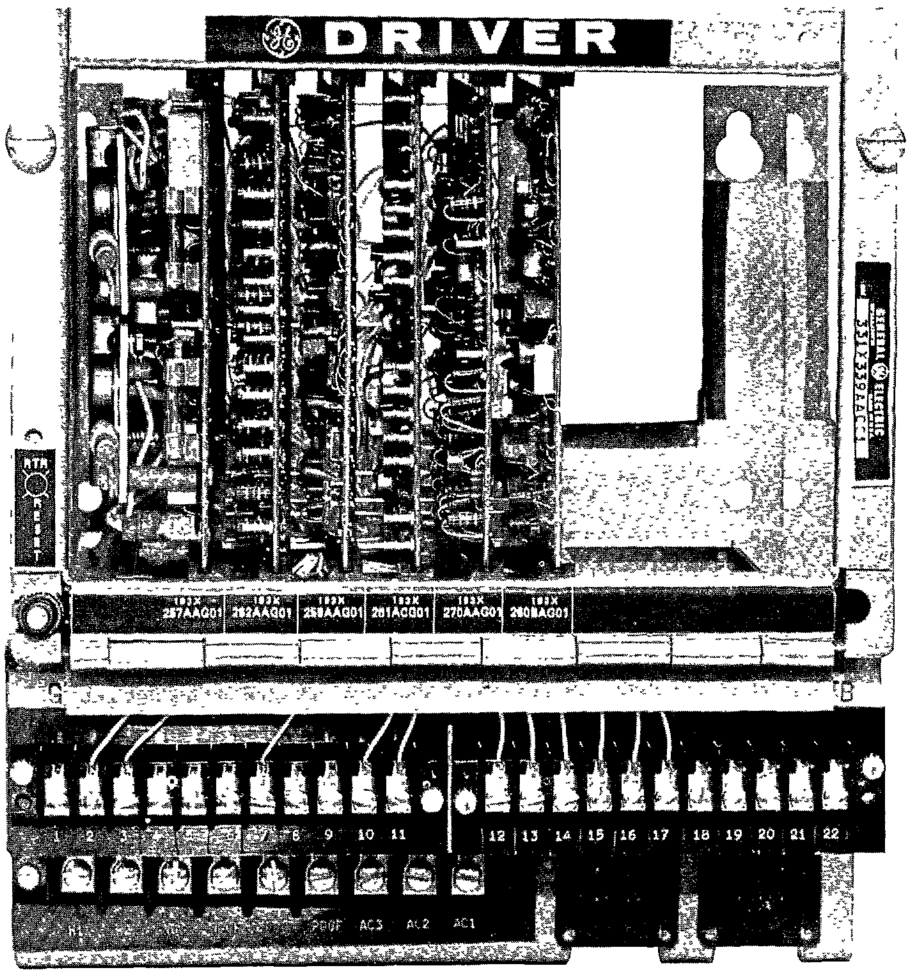
INSTRUCTIONS

GEK-24921

FOUR QUADRANT DRIVER

INSTALLATION — OPERATION — MAINTENANCE



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

GENERAL ELECTRIC

WARNING

HIGH VOLTAGE. ELECTRIC SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. WHETHER THE AC VOLTAGE SUPPLY IS GROUNDED OR NOT, HIGH VOLTAGES TO GROUND WILL BE PRESENT AT MANY POINTS WITHIN THE SCR DRIVE. EXTREME CARE MUST BE EXERCISED IN THE SELECTION AND USE OF TEST INSTRUMENTS.

OPERATORS SHOULD NOT STAND ON GROUNDED SURFACES NOR BE IN CONTACT WITH GROUND WHEN APPLYING TEST INSTRUMENTS TO TEST POINTS. WHEN INSTRUMENTS SUCH AS OSCILLOSCOPES ARE USED TO WORK ON LIVE EQUIPMENT, GREAT CAUTION MUST BE USED. WHEN ONE OF THE INSTRUMENT LEADS IS CONNECTED TO THE CASE OR OTHER METAL PARTS OF THE INSTRUMENT, THIS LEAD SHOULD NOT BE CONNECTED TO UNGROUNDED PART OF THE SYSTEM UNLESS THE INSTRUMENT IS ISOLATED FROM GROUND AND ITS METAL PARTS TREATED AS LIVE EQUIPMENT. USE OF AN INSTRUMENT HAVING BOTH LEADS INSULATED FROM THE CASE PERMITS GROUNDING OF THE CASE EVEN WHEN MEASUREMENTS MUST BE MADE BETWEEN TWO LIVE PARTS.

EXTREME CARE SHOULD BE TAKEN WHILE ATTEMPTING TO ADJUST, TROUBLESHOOT OR MAINTAIN ANY DRIVE SYSTEM DESCRIBED HEREIN.

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INTRODUCTION

THE PRIMARY FUNCTION OF THE GENERAL ELECTRIC FOUR QUADRANT DRIVER IS TO MAINTAIN THE OUTPUT VOLTAGE OF THE SCR CONVERSION MODULES PROPORTIONAL TO THE DRIVER INPUT BY CONTROLLING THE FIRING ANGLE OF THE SCR'S. INCLUDED IN THE FOUR QUADRANT DRIVER, IS A REGULATED POWER SUPPLY AND A MONITORING FUNCTION WHICH WILL PREVENT FURTHER OPERATION IF ANY OF SEVERAL FAULT CONDITIONS OCCUR. THESE FUNCTIONS ARE PROVIDED BY THE BASIC PARTS SHOWN IN THE FOLLOWING ILLUSTRATIONS.

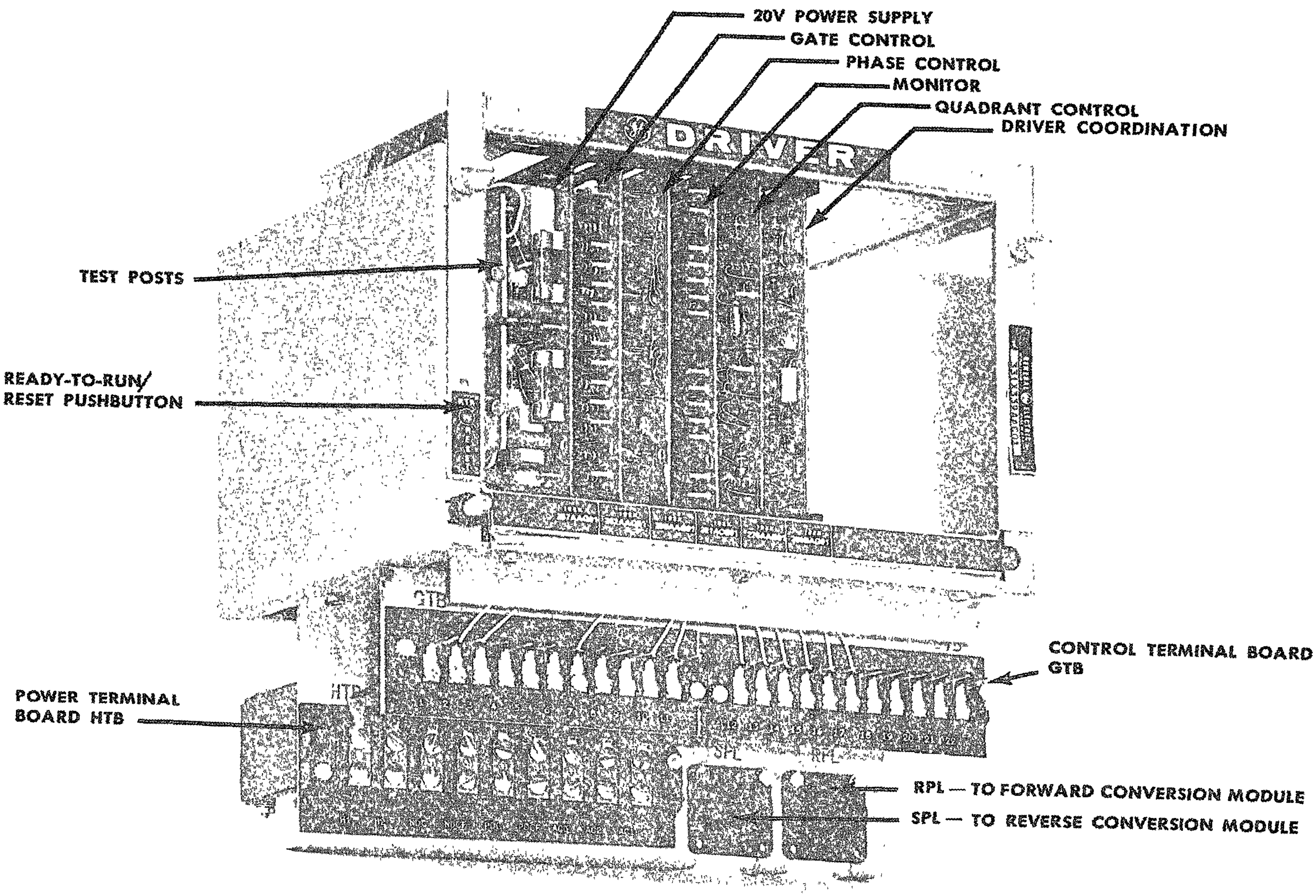


FIGURE 1. DRIVER — FRONT VIEW
(Typical size)

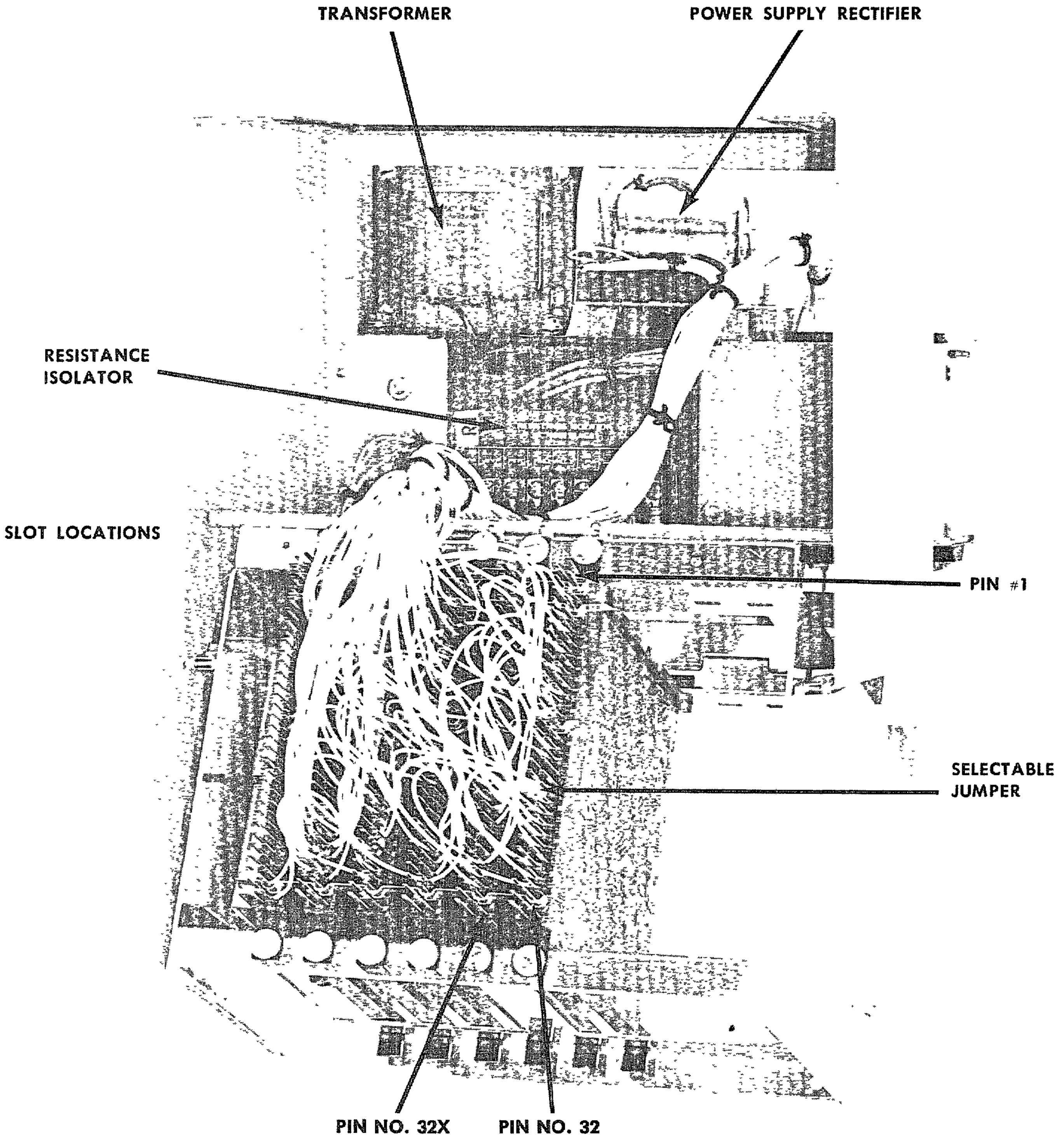


FIGURE 2. DRIVER — FRONT VIEW
(Rack pulled out)

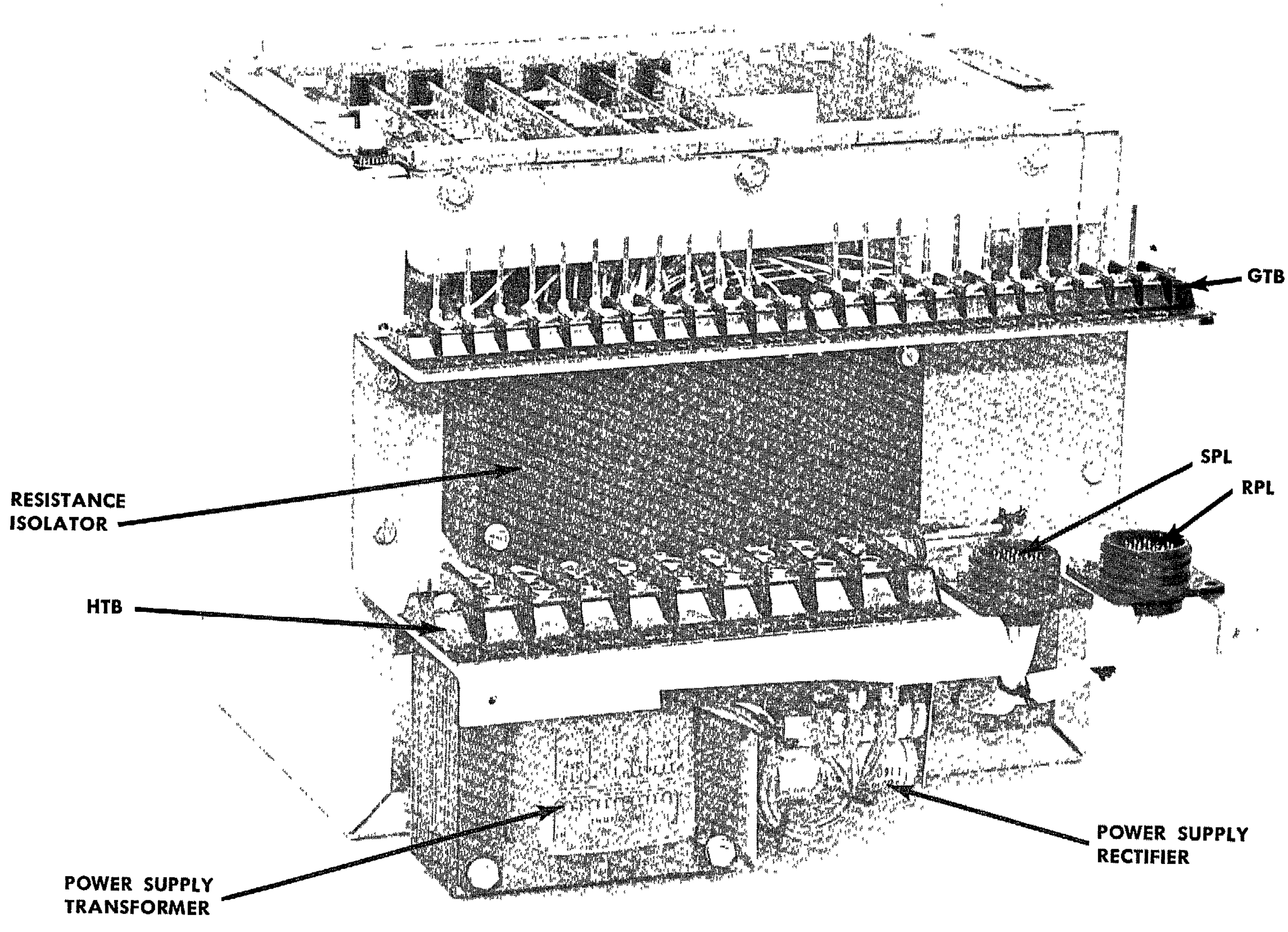


FIGURE 3. DRIVER — BOTTOM VIEW

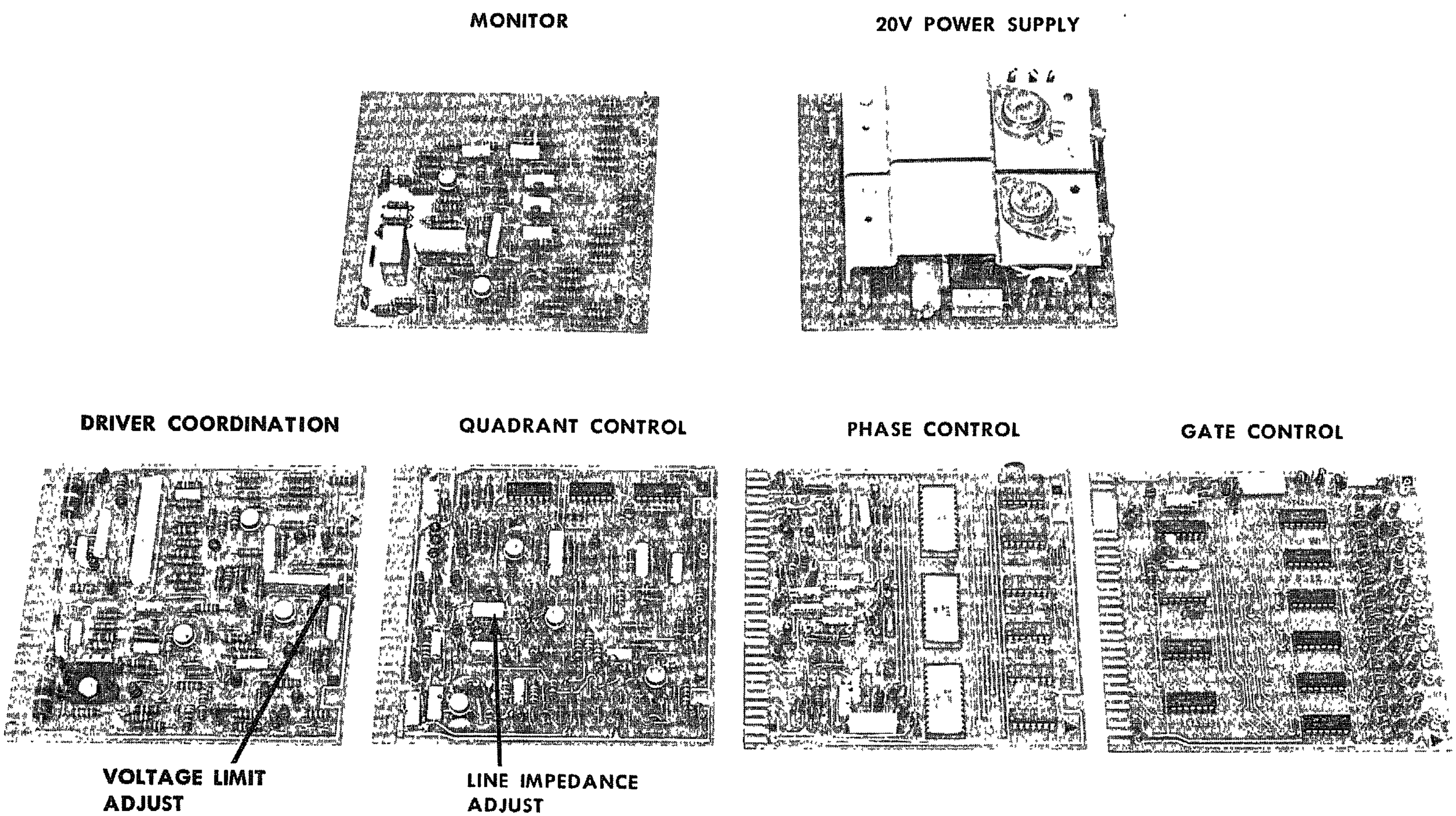


FIGURE 4. DRIVER CARDS

PRINCIPLES OF OPERATION

VOLTAGE CONTROL SECTION

The voltage control portion of the driver is shown on the signal flow diagram (Figure 5) and is a closed loop consisting of the Driver Coordination card, the Quadrant Control card, the Phase Control card, and the Gate Control card providing signals to the conversion modules. When the voltage control is operating properly, the conversion module output voltage is proportional to the input voltage on DR, the driver reference, as long as the current in the conversion module is less than the driver current limit level and voltage limit setting.

MONITOR SECTION

The Monitor portion of the driver consists of the Monitor card, the ready-to-run/reset button, and part of the Resistance Isolator. Three types of fault conditions will trip the Monitor function and cause the drive to shut down; System faults (SYS), Instantaneous overcurrent (IOC), or conversion module overtemperature (TEMP). When any of these conditions occur, the appropriate indicator is illuminated, the fault relay contact F will open, and a signal is sent to the voltage control to shut down the driver. The driver will remain in a shutdown condition until the RTR/Reset button is depressed and released. Depressing the RTR/Reset button will always cause the F relay contact to open and shut down the driver, even if a fault condition had not occurred. Whenever the F contact is closed, the RTR indicator will be illuminated and the driver is ready-to-run.

The system fault indicator or SYS will trip if the input phase sequence is incorrect, if a loss of phase (loss of fuse) has occurred, or if a trip signal was applied to the SYS auxiliary input. It will also trip if power fuse opens.

The instantaneous overcurrent (IOC) will trip at a peak current in the conversion module selected.

The module overtemperature indicator TEMP will trip whenever either thermostat in the modules opens or, if either the RPL or SPL connector is not plugged in.

The driver preconditioning input, 1CST, is an auxiliary input to the Monitor card. As long as 1CST is positive, the driver is shut down; but the F relay contact remains closed and RTR remains illuminated. The primary signals in the driver may be monitored from the test posts located on the Monitor card. A selectable jumper is provided so any signal in the driver may be measured.

POWER SUPPLY SECTION

The power supply portion consists of a low voltage transformer, a power supply rectifier, and a 20 volt power supply card. The outputs are protected against both overcurrent and overvoltage with two fuses on the 20 volt power supply card.

CONNECTIONS

INPUT/OUTPUT

All connections to the driver are made through a control terminal board (GTB), a power terminal board (HTB), and two 28-pin connectors (RPL and SPL). For a typical installation, RPL is connected to the matching connector in the forward conversion module, and SPL is connected to the reverse module. Normally, the right hand module is the forward module.

POWER TERMINAL BOARD CONNECTIONS (HTB)

AC1, AC2 and AC3 are connected to T1, T2, T3 3-phase inputs to the conversion module.

PDCF is connected to the P1 or positive output terminal of the forward conversion module.

NDCF is connected to the P2 or negative output terminal of the forward conversion module.

PDC is connected to the P2 or negative output of the reverse conversion module.

NDC is connected to the P1 or positive output of the reverse conversion module.

H1 and H2 are connected to the 115V AC control power.

CONTROL TERMINAL BOARD CONNECTIONS (GTB)

Term. Bd. Point		Description
GTB2	–20V	This terminal is the negative output from the 20 volt power supply. It will supply up to 100 mA at –20V DC.
GTB3	+20V	This terminal is the positive output from the 20 volt power supply. It will supply up to 100 mA at +20V DC.

CONTROL TERMINAL BOARD CONNECTIONS (GTB)

Term. Bd. Point		Description
GTB4	REF (DR.)	This terminal is the reference input to the driver. As this input changes from zero to 10V DC, the conversion module output voltage will change from zero to rated voltage (see drive nameplate for rating). For +10V DC, the output voltage will be in the forward direction.
GTB8	COM	This is the common point for the driver. All voltages on GTB are measured from this point.
GTB10 GTB11	F F	A Contact from the fault relay on the Monitor card is connected between these two points. Under normal operating conditions this contact is held closed. Any fault condition detected by the Monitor card will cause this contact to open (see section on Monitor).
GTB13	CFB	The scaled current feedback signal is available at this point, and may be used to drive a load indicator. The output voltage is approx. 2.5V at rated current. CFB will be positive when the current is flowing in the forward module.
GTB15	SYS	This point is an auxiliary input to the Monitor card. If a +20V signal is momentarily applied, the Monitor card will initiate a fault shutdown and drop out the F relay (see section on Monitor).
GTB17	−30V	This point is connected to the unregulated DC input to the power supply card. It will be used only in very specialized applications (refer to system elementary if this point has been used).
GTB22	1CST	This point is the driver preconditioning input. As long as positive voltage is applied, the firing pulses to the conversion module are inhibited.

STANDARD PARAMETER SELECTIONS

Several design parameters may be modified in the Driver by selectively adding wire jumpers between pins in the backplane. A list of these standard selections is shown below. In addition to these standards, additional parameter modifications may have been furnished to meet a particular drive requirement. Refer to the system elementary to determine exactly what has been furnished on a particular drive. These selections have been made at the factory and,will not normally need to be changed.

Standard Selections for:	Connect on: Phase Control Card
1a. 60 Hz	None
1b. 50 Hz	26 - 27
	Driver Coordination Card
2a. Driver Curr. Limit, less than 75HP	None
2b. Driver Curr. Limit, more than 75HP	20 - 32
2c. No Driver Curr. Limit	20 - 31

SEQUENCE OF OPERATION

Figure 5 is a block diagram of the driver which indicates the main signal flow. Refer to the complete driver elementary diagram for further information.

POWER SUPPLY

115V AC is applied to the primary of the transformer which has a 24-0-24 secondary. The power supply rectifier card rectifies and filters the 24V AC and provides the 20V power supply card with unregulated ±30V DC. This voltage may be between ±22V DC and ±40V DC depending upon the input line voltage and the power supply loading. The 20V power supply card regulates this voltage to ±20V DC. The ±20V DC output may be monitored from two test posts on the power supply card.

MONITOR

The 3-phase input is applied to the resistance isolator, which provides two high impedance outputs to the Monitor card for phase sequence detection. If the phase sequence is incorrect, a trip signal is initiated on SYS. The conversion module output is applied to the resistance isolator on PDC, PDCF, NDC and NDCF. PDC and NDC provide high impedance inputs to the driver coordination card to develop voltage feedback VFB, for the voltage control. PDCF and NDCF provide high impedance inputs to the monitor card, which contains the identical circuit. The monitor card compares the VFB signal from the driver coordination card with its internally generated signal. If there is a difference, the monitor card generates a trip signal on SYS. A difference in voltage will occur whenever a DC power fuse is open. If a positive voltage is momentarily applied to the SYS auxiliary input, a trip signal on SYS is initiated.

Whenever the current in the conversion module exceeds the IOC level, the Driver Coordination card sends a signal to the Monitor card to initiate an IOC trip signal.

The overtemperature trip input is connected to common through the RPL and SPL harnesses and the conversion module thermoswitch. If this input is not connected to common, a TEMP trip signal is initiated.

Whenever a trip signal is encountered, the appropriate indicator is illuminated and a latch is set. The latch will remain set until the RTR/Reset button is depressed or the 115V AC input is removed.

Whenever a trip signal is encountered or the RTR/Reset button is depressed, the F relay will be de-energized, opening the F contact and turning off the RTR indicator.

The driver voltage control will be shutdown unless the shutdown signal is held to common by the Monitor card. The shutdown signal will be released from common whenever a trip signal is encountered, the RTR/Reset button is depressed, the auxiliary input 1CST is positive, or the Monitor card is removed.

VOLTAGE CONTROL

Driver Coordination Card

The conversion module output is applied to the Resistance Isolator on PDC and NDC, which provides a high impedance input to the differential amplifier on the Driver Coordination card to develop a voltage feedback signal VFB. The difference between this VFB signal and the driver reference DR is amplified by the driver error amplifier and may be monitored at DERR. Under normal running conditions, the firing angle of the SCR's in the conversion module is a direct function of DERR.

The VLIM adjustment will limit the amount of reference applied which in turn limits the maximum output voltage available.

A voltage signal proportional to current in the conversion module is returned thru the RPL and SPL connectors to the Driver Coordination card. This current feedback signal is used by the IOC detector and the driver current limit circuit. The output of the IOC detector goes to the Monitor card to initiate an IOC trip (see Monitor function).

The output from the Driver Coordination card to the Phase Control card, the Phase Control reference PCR, will be equal in magnitude to DERR unless a shutdown signal is encountered which forces PCR to zero, the driver is in current limit, or the driver is transferring from one conversion module to the other.

Quadrant Control Card

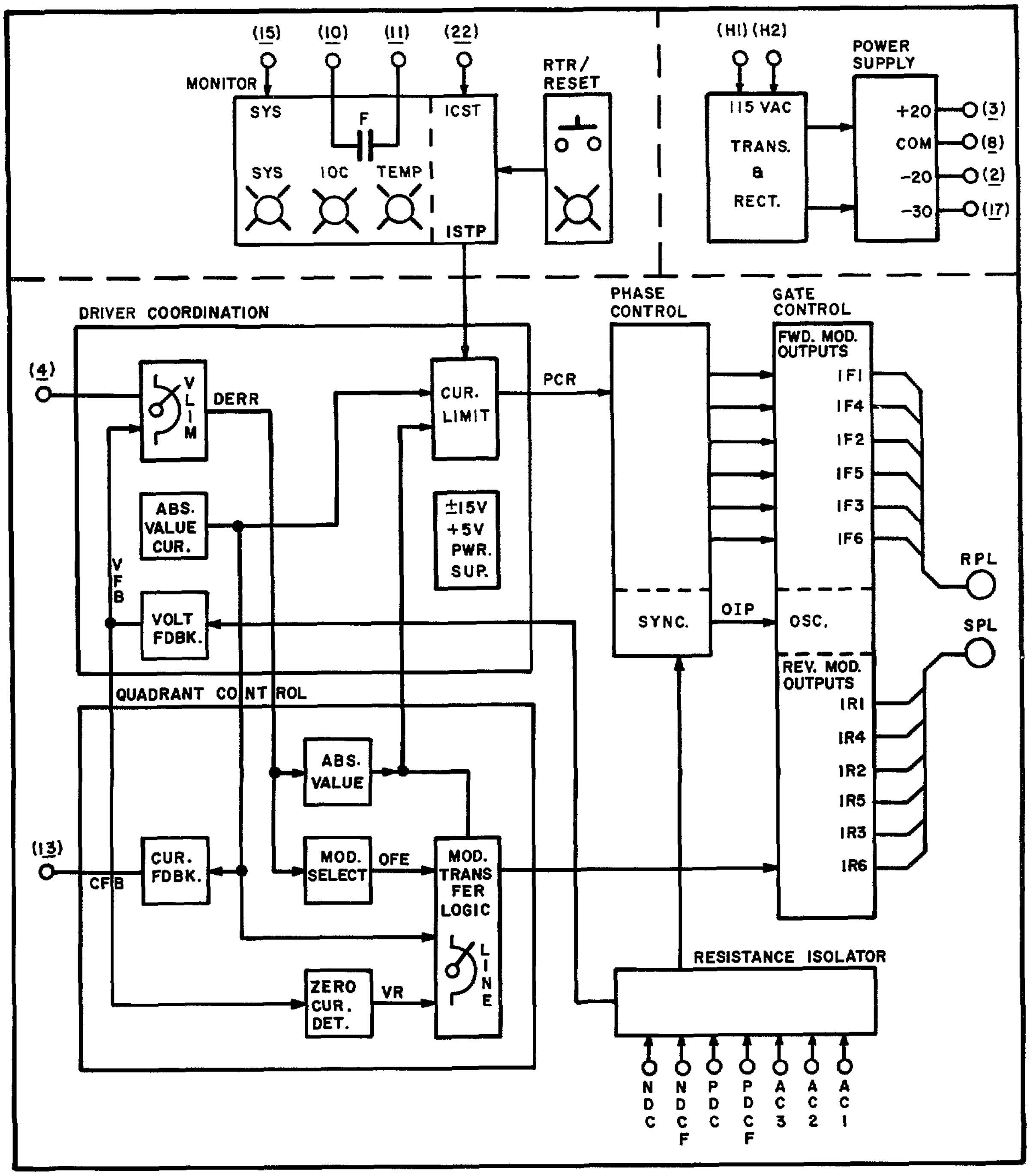
In a four quadrant drive, only one conversion module is receiving output pulses at a time. The Quadrant Control card contains the circuitry to determine which module should be on, and controls the transfer from one module to the other.

The polarity of the driver error DERR determines which module should be running. When DERR is negative, the forward module signal OFE is zero, and the drive will be operating in the forward module. When the polarity of DERR changes from negative to positive, OFE will change to positive 5 volts, and the transfer logic is initiated. As the conversion modules are connected in anti-parallel, the current in the modules must be zero prior to transferring control from one module to the other. When the transfer logic is initiated by OFE, PCR is driven to zero, calling for zero current, until the voltage ripple signal VR indicates that the current has reached zero. At this time the switching signals FI and RI are sent to the Gate Control card and PCR is released.

In some special applications, compensation for the input line impedance is required. The LINE potentiometer is used to provide this adjustment. Refer to the system elementary in these applications. If not specified, LINE is normally set at its midpoint.

Phase Control Card

The three-phase input voltage is applied to the Resistance Isolator, and the high impedance signals are sent to the Phase Control card to develop line synchronized ramps. Internal comparators compare the Phase Control reference PCR to the individual ramps to generate six outputs to the Gate Control



SIGNAL FLOW DIAGRAM
GENERAL ELECTRIC FOUR QUADRANT DRIVER

card which are phase shifted from the AC line in direct proportion to the value of PCR. Each time that an output is generated, an initial pulse, OIP, is also initiated to resynchronize the oscillator on the Gate Control card.

Gate Control Card

The Gate Control card contains the oscillator, the tail-end truncation circuits, and the output buffer amplifiers. Two switch circuits are also included: forward inhibit FI and reverse inhibit RI. These switches will prevent output pulses from going to either conversion module when activated.

TYPICAL VOLTAGES AND WAVEFORMS

Voltage measurements should never be made directly at the pins in the card backplane. In many instances, accidental shorting of adjacent pins can cause severe damage to the driver and may cause the motor shaft to run at top speed or cause fuse or SCR failures. The moveable jumper is provided so that any point in the backplane may be monitored from the SEL test post on the front of the Monitor card.

Card tabs are located in the following manner:
(Card location or card slots are alphabetic from left to right).

With the card rack tipped out, the top right-hand tab of each card receptacle is tab #1, and the bottom right hand tab is #32.

For the receptacles with two columns of pins, the right-hand side is numbered from #1 thru #32 and the left-hand side is numbered from #1X thru #32X. For example, tab ID26X is the 26th tab from the top of the left-hand column of tabs on the receptacle located in the fourth location from the left when the card rack is open.

VOLTAGE TABLE

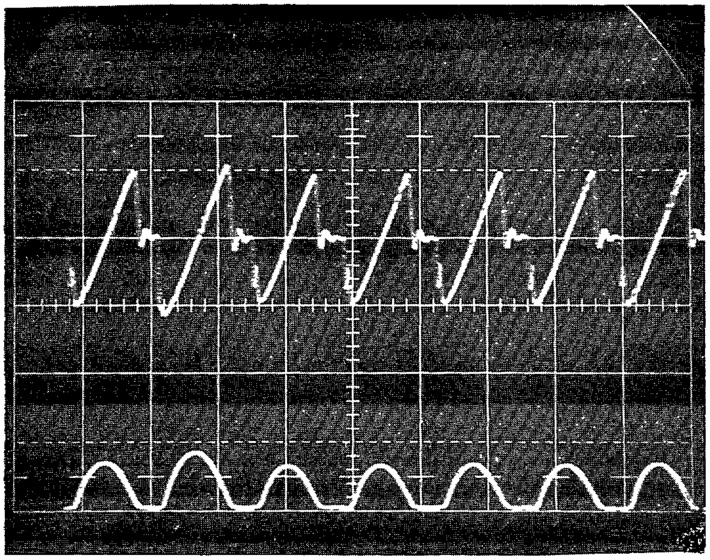
Monitor Test Point Name	Voltage Range	Operating Condition
DR	−9 to 0 to +9 volts	
VFB	+5 to 0 to −5 volts	Conversion module voltage change from negative rated to positive rated voltage.
DERR	+6 to 0 to −6 volts	
PCR	+6 to 0 to +6 volts	
CFB	−2.5 to 0 to +2.5 volts	Conversion module current change from rated current in the reverse module to rated current in the forward module.
+20V	+19.9 to +20.1	All normal conditions.
−20V	−19.9 to −20.1	
1CST	0 or +2 volts	When 1CST is positive, the driver is preconditioned, PCR is 0, and the output pulses 1F1 thru 1F6 and 1R1 thru 1R6 are inhibited.
SYS Pin #1E07	0	If SYS is momentarily connected to +20 volts, the SYS indicator will illuminate and 1STP will go positive, shutting down the drive.
1STP Pin #1E06	0 or +8 volts	The driver will be shut down whenever 1STP is positive.

Quadrant Control Card Test Point Name	Voltage Range	Operating Condition
OFE	0 to +5 volts	When OFE is zero, the forward module is running.

WAVEFORMS

The following waveforms are typical for a drive running at 1/2 to 2/3 voltage under varying load conditions. It is not expected that these waveforms can be reproduced exactly on any particular drive. (i.e., the voltage levels may differ by ±20%, etc.) but the waveforms should be similar.

Any oscilloscope may be used to measure these waveforms, but an oscilloscope with a DC to 1 MHz input and a triggered sweep synchronized to the AC line is preferable. The SYNC test post on the Monitor card is provided to furnish a line synchronized output signal to any oscilloscope which does not have line synchronization.

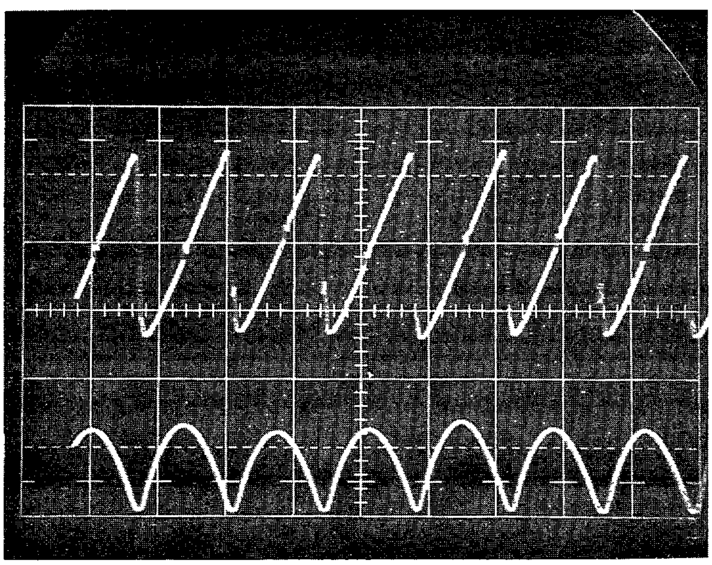


2 msec./div.

Top: VFB voltage feedback (1V/div.)
Bottom: CFB current feedback (1V/div.)

Drive operating at 40% voltage, discontinuous current.

FIGURE 6. MONITOR CARD

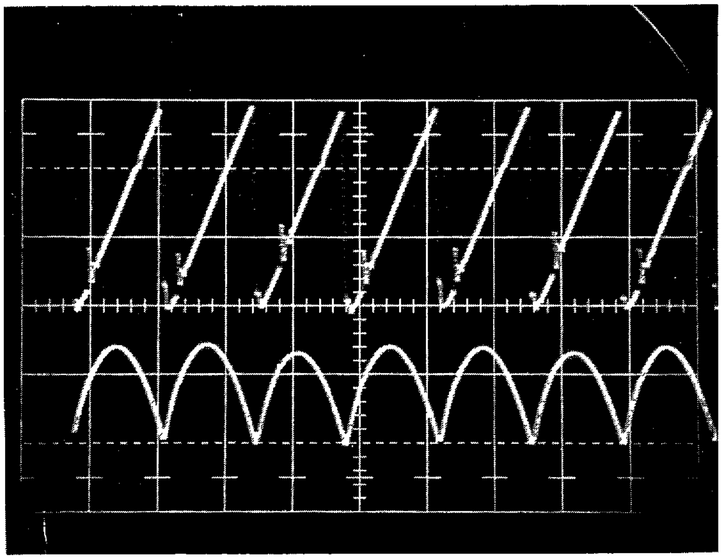


2 msec./div.

Top: VFB (1V/div.)
Bottom: CFB (1V/div.)

Drive operating at 40% voltage, continuous current.

FIGURE 7. MONITOR CARD

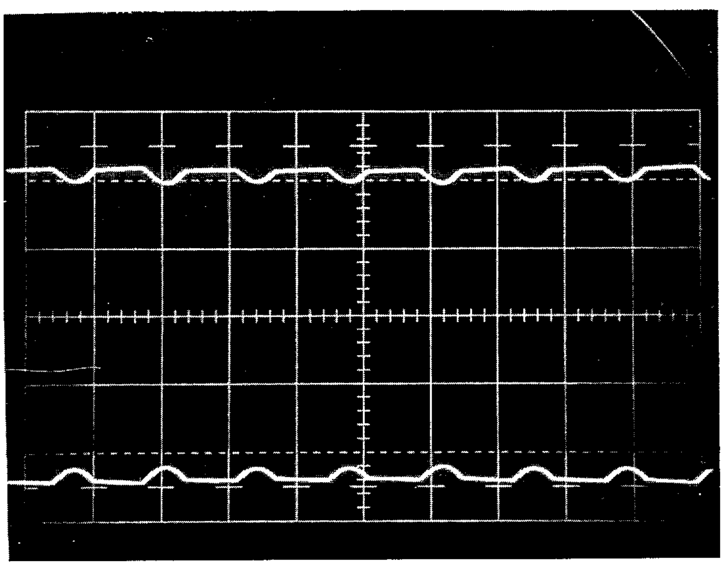


2 msec./div.

Top: VFB (1V/div.)
Bottom: CFB (1V/div.)

Drive operating at 40% voltage, heavy continuous current.

FIGURE 8. MONITOR CARD

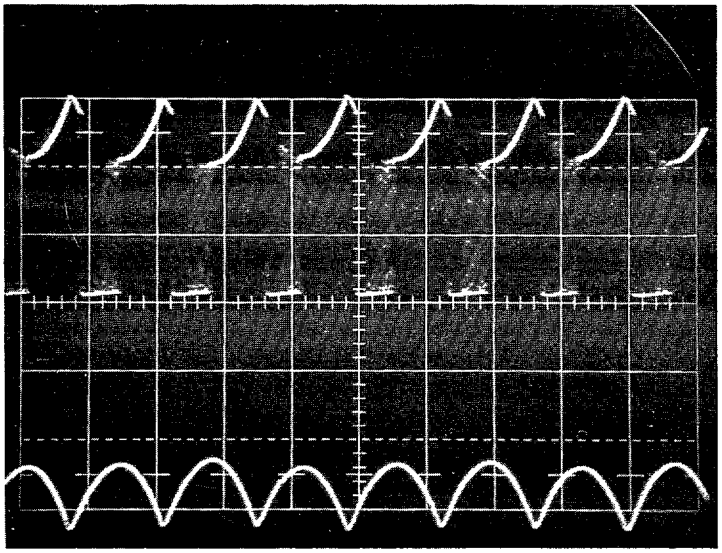


2 msec./div.

Top: PCR Phase Control Ref. (2V/div.)
Bottom: DERR Driver Error (2V/div.)

Drive operating at light load.

FIGURE 9. MONITOR CARD

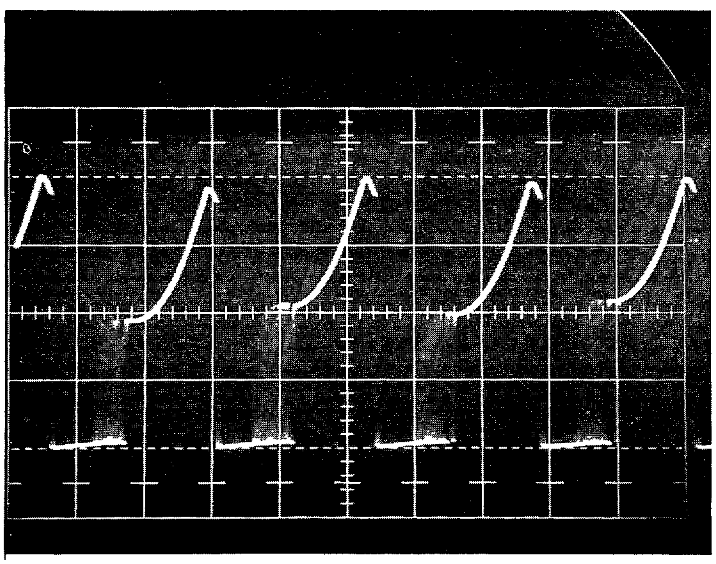


2 msec./div.

Top: PCR (1V/div.)
Bottom: DERR (1V/div.)

Drive current has been increased. The "holes" in PCR indicate that the driver current limit circuit is functioning. As the current is increased the hole widens until only a single point is left. When this occurs, the driver is in current limit.

FIGURE 10. MONITOR CARD

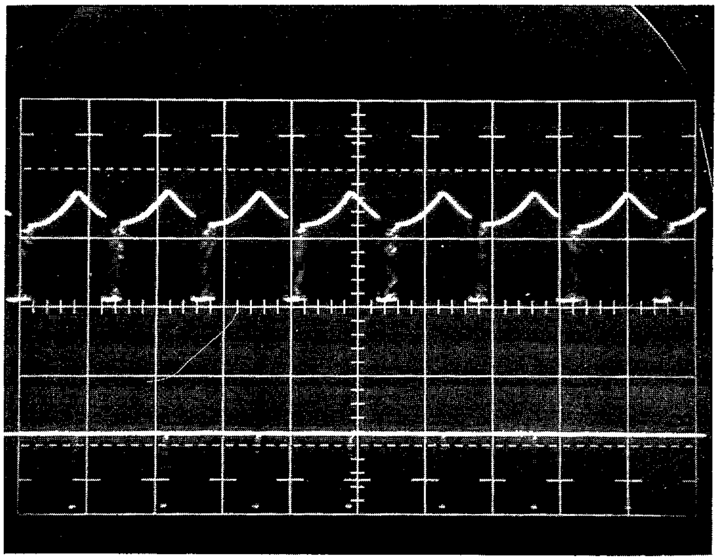


1 msec./div.

PCR (1V/div.)

Drive running at 50% voltage, 50% current.

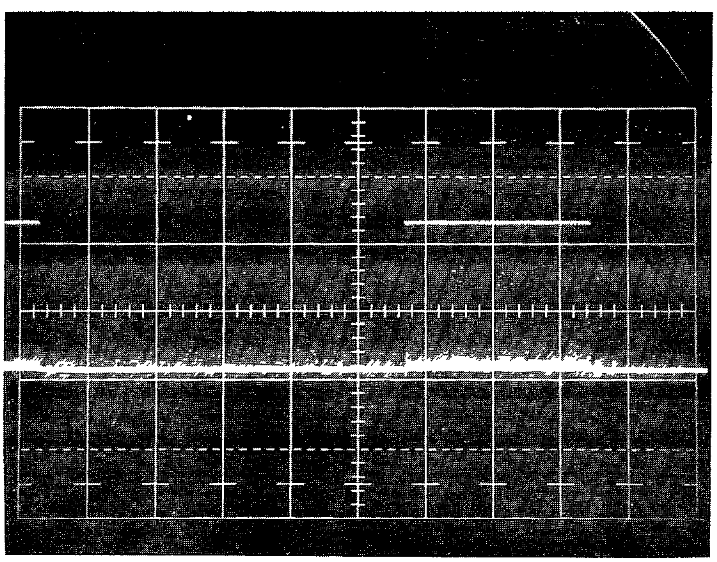
FIGURE 11. MONITOR CARD



2 msec./div.

Top: PCR (2V/div.)
Bottom: OIP Initial Pulse (5V/div.)

FIGURE 12. MONITOR CARD



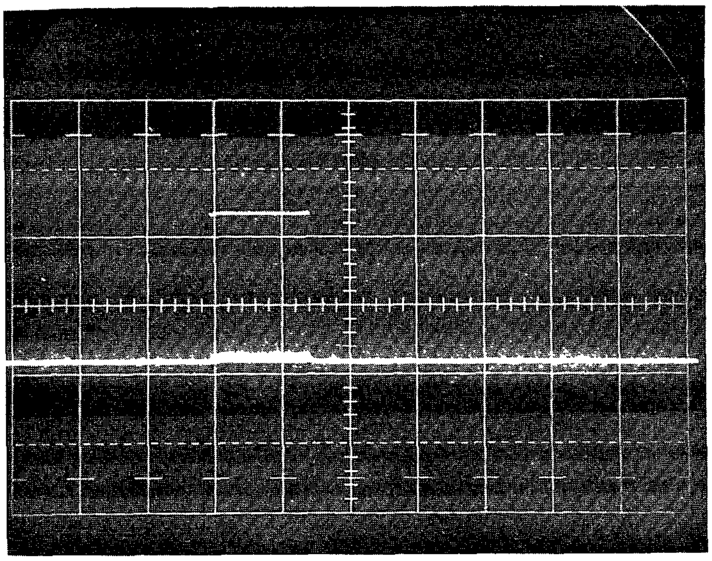
2 msec./div.

Outputs 1F1 thru 1F6 (10V/div.)

The drive is operating at 50% voltage.

The output firing order is 1-6-2-4-3-5-1. There will be a 60 degree time displacement between each output and the one preceding it.

FIGURE 13. GATE CONTROL CARD



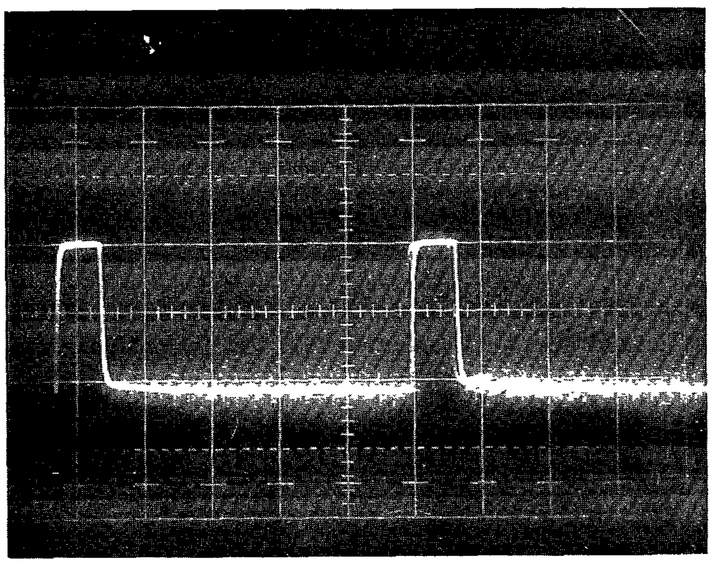
2 msec./div.

Outputs 1F1 thru 1F6 (10V/div.)

Drive operating at zero volts and zero current.

The width of the output pulse train will vary from 62 degrees to 120 degrees as the SCR's are phased forward.

FIGURE 14. GATE CONTROL CARD

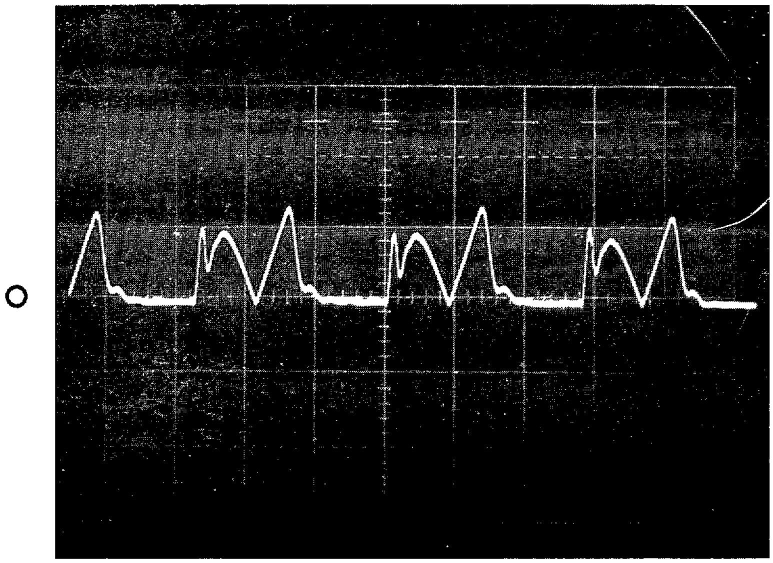


20 µsec./div.

Outputs 1F1 thru 1F6 (10V/div.)

Typical waveform of individual pulses in the output pulse train.

FIGURE 15. GATE CONTROL CARD

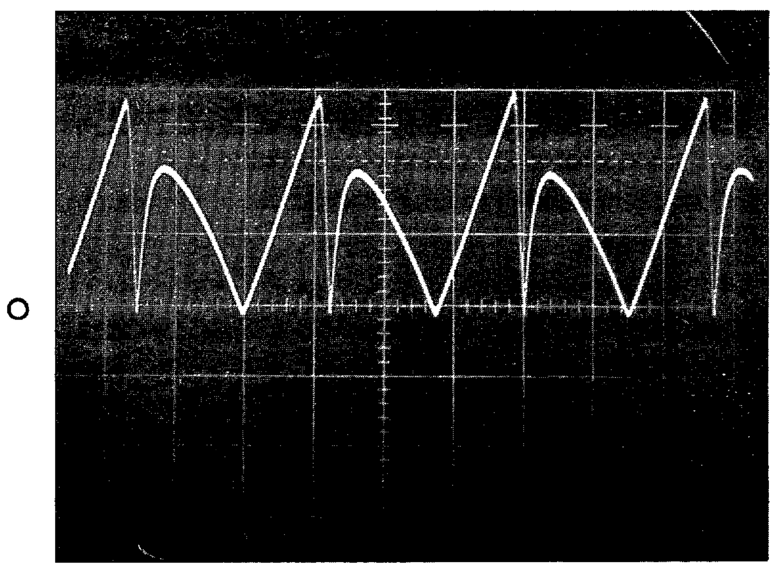


1 msec./div.

VR Voltage Ripple (2V/div.)

VR is the absolute value of the ripple voltage on the conversion module output. When the ripple voltage is zero, the current in the module is zero.

FIGURE 16. QUADRANT CONTROL CARD



1 msec./div.

VR Voltage Ripple (2V/div.)

Typical of VR when the current is continuous.

FIGURE 17. QUADRANT CONTROL CARD

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