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Technical Note **LIGO-T980011-00 - W** 2/26/98

INSTRUCTION MANUAL FOR TRANSREX ISR 2126-1, -2

Transrex Division Gulton Industries

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FERMILAB

ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
RESEARCH DIVISION			1 of 2

SUBJECT

DATA SHEET: TRANSREX 500 KW POWER SUPPLY (BLUE)

NAME: F. Mallie

DATE	REVISION DATE
6/10/71	7/1/85

1. Output

Rating - 500KW, 12Ø, unfiltered with manual taps as follows:

Current-(AMP)	At Voltage(VOLT)		
5000	100	50	25
2500	200	100	50
1250	400	200	100

2. Input

460VAC + 5% - 10%, 3Ø, 60HZ
Breaker 1000 Amp
Full Load Line Current 750 Amp

3. Remote Control and Readout

P.S. can be remotely programmed for current and voltage. Levels depend on selected P.S. taps as follows:

Current Regulate:

P.S. Output Current(AMP)	Remote Reference(Volts)	Remote Readout (Volts)
5000	10	10
2500	5	5
1250	2-½	2-½

Voltage Regulate:

P.S. Output Voltage(Volts)	Remote Reference(Volts)	Remote Readout (Volts)
100	2	2
200	4	4
400	8	8

4. Regulation

Between 20% and 100% of range
Current Regulate < 0.01%
Voltage Regulate < 0.2%

5. Cooling and Heatloss

Water Cooled, 250 PSI Max.

ΔP Required	100 PSI
Flow	5-½ GPM
Max. Watertemp	55°C
Max. Airtemp	55°C
Max. Heatloss to water	40 KW
Max. Heatloss to air	2 KW
P.S. Efficiency	N/A

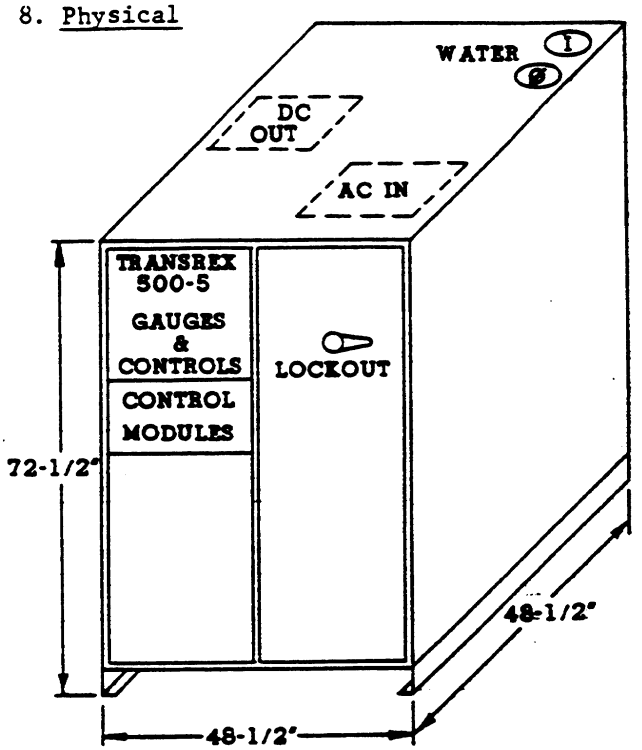
6. Application

Main Ring Magnets, EPB Dipoles, 6-3-120 Dipole, 4Q120 Quadrapole

7. Fermilab Dwg. No.

See Page 2

8. Physical



Weight ∿5900 lbs
Full doors front and rear
Rear door removable
All services from top
Cooling water connections on top
AC Lugs 3-500 to 750 MCM
Cables/Phase 1-600 MCM

Connectors at P.S.

Ref. and Readout - Burndy G6F-18-22SNE
Controls - Burndy G6F-12-88SNE
Interlocks - Burndy G6F-12-88SNE

9. Manufacturer

Transrex (Model #ISR 2125-1)
(Model #ISR 2126-2)

10. Ref.

NAL Spec. NO. 2900-ES-30005

Fermilab

July 22, 1983

TO: Distribution

FROM: Leon Beverly LB.

SUBJECT: POWER SUPPLY A.C. POWER PHASE ROTATION

There are five major type power supplies in the Experimental Areas Department. The correct 480Vac input power phase rotation for these five Power Supplies is the following:

ACME 22.5, ACME 50, and Ling 55 - Phase A-B-C left to right @ top of main circuit breaker, viewed from front of power supply

TR240, TR500, PEI150 -- Phase A-B-C right to left @ top of main circuit breaker, viewed from front of power supply.

LB:mnm

Distribution: R. Trendler/A. Visser
S. Orr/M. Mascione
D. Featherston/F. Rittgarn

NATIONAL ACCELERATOR LABORATORY	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
ENGINEERING NOTE	EAD			1 OF 1

SUBJECT: TRANSREX POWER SUPPLY, 500 KW EXTERNAL CONNECTIONS (TYPICAL)

NAME: L. BEVERLY

DATE: 2/7/73 | REVISION DATE: 2-15-83

J3

BLACK	A	RESET	
GREEN	B	RESET	
BLACK	C	NOT USED	
BLUE	D	NOT USED	
BLACK	L	REMOTE ON	
RED	M	REMOTE ON	
BLACK	N	REMOTE OFF	
WHITE	P	REMOTE OFF	
RED	H	EXT. REFERENCE (−)	
GREEN	G	EXT. REFERENCE (+)	
YELLOW	R	LOCAL/REMOTE	
BLACK	S	LOCAL/REMOTE	
BROWN	T	INTLK COMPLETE	
BLACK	U	INTLK COMPLETE	
ORANGE	V	D.C. ON	
BLACK	W	D.C. ON	
RED	X	NOT USED	
WHITE	Y	NOT USED	

CONNECT TO CONNECTOR SHELL AND PIN E

CONNECTOR, BURNDY G6F 18-22 SNE
FNAL # 1430-3140
CABLE 9 PAIR BELDEN 8774

J4

A	110V	EXT. INT'LK	
B	COMMON	EXT. INT'LK	
C	D.C. ON	EXT. INT'LK	
TO MAGNET INTLK: BLACK	D	int'lk	EXT. INT'LK
TO MAGNET INTLK: RED	E	int'lk	EXT. INT'LK

CONNECTOR, BURNDY G6F 12-88 SNE
FNAL # 1430-3100
CABLE 3 COND. 16 AWG STRANDED
2 SOCKETS REQ NAL # 1430-3700

J1

BLACK	A	+	CURRENT READOUT
GREEN	B	(−)	CURRENT READOUT
BLACK	C	+	VOLTAGE READOUT
RED	D	(−)	VOLTAGE READOUT
WHITE	G		NOT USED
BLACK	H		NOT USED

CONNECTOR, BURNDY G6F12-88 SNE
FNAL # 1430-3100
CABLE 3 PAIR BELDEN 8777

J1 & J3 CONNECTORS REQUIRE SOCKETS, BURNDY RC 20M-13
FNAL # 1430-3680

J2 EXTERNAL CONNECTIONS NOT USED

INSTRUCTION MANUAL

FOR

TRANSREX MODEL ISR 2126-1, 2

Prepared by: January 21, 1972

TRANSREX DIVISION
GULTON INDUSTRIES, INC.
2001 W. ARTESIA BLVD., TORRANCE, CA 90504

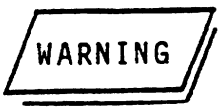
TEL: (213) 327-9224

TABLE OF CONTENTS

SAFETY SUMMARY

480 volts ac is present on the transformer primary tap links. These links are fully exposed inside each of the front doors. The doors are not interlocked. The necessary precautions should be taken during the performance of internal maintenance operations.

480 and 120 volts ac is also present at the convenience outlet and at terminals of T3 and T4.



A warning is used to present information which, if ignored, might result in injury or death to personnel.

A caution is used to present information which, if ignored, might result in damage to the equipment.

Notes: A note is used to emphasize some point or procedure.

SECTION I

DESCRIPTION

1-1 GENERAL

1-2 This manual provides all the information necessary to install, operate and maintain the power supply, identified by the Transrex Model Number, ISR 2126-1, hereafter referred to as the supply.

1-3 PURPOSE

1-4 The supply provides 0 to 100 Vdc at 0 to 5000 amperes to energize resistive and inductive loads from 5 to 100 milliohms with time constants from 0 to 3 seconds.

1-5 PHYSICAL DESCRIPTION

1-6 The supply uses a standard Transrex cabinet 72-1/2 inches high on an angle iron frame that is 48-1/2 inches deep and 48-1/2 inches wide. The unit is designed to operate continuously at full rated loads with water and convection air cooling. Maximum reliability at elevated ambient temperatures requires unrestricted air paths above and to the sides of the unit of 6 inches for the full width and depth of the unit.

1-7 BLOCK DIAGRAM

1-8 The block diagram in Figure 1 depicts interconnection of the major elements of the supply.

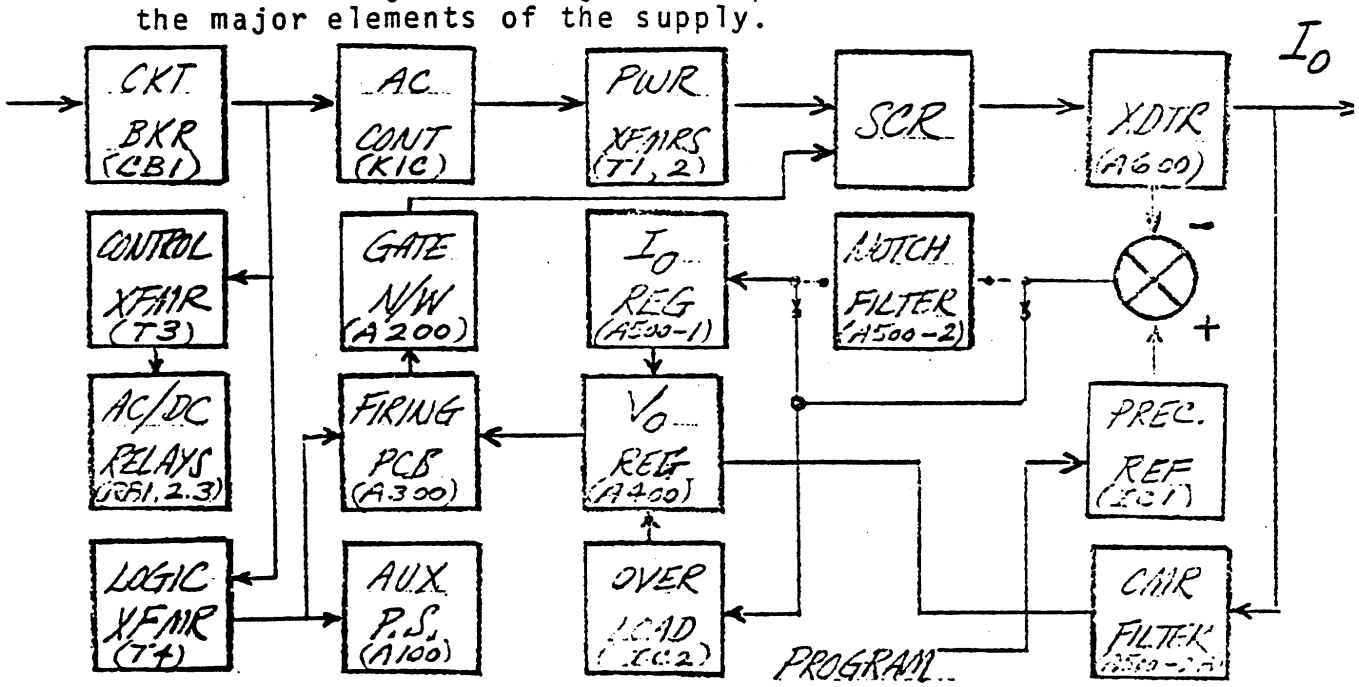


FIGURE 1

1-9 The supply is fully protected with an input circuit breaker and a fault-interlocked contactor. The protection system is fail-safe and self-checking. The precision output current is set by a motor-operated potentiometer. A LOCAL-REMOTE switch permits remote operation of the supply. The supply can be turned on and off at any pre-set current with a smooth rise to the desired current.

1-10 The three phase, four wire, ac input is connected to the input circuit breaker. A contactor applies the input power to two three phase power transformers. The power transformers are connected as two parallel double wye with interphase transformer-rectifiers to provide twelve phase ripple.

1-11 Twelve thyristors (SCR's) provide regulated power to the output. A unique transductor in the output provides an accurate measure of output load current and enables the control circuit to precisely regulate the output current of the supply.

1-12 ELECTRICAL CHARACTERISTICS

1-13 The performance specifications are outlined below:

Input Power:	460 Vac, + 5%, -10%, 3 phase, 4-wire, 60 Hz; 5% maximum line imbalance.
Output:	0 to 100 Vdc, 0 to 48 Vdc, 0 to 23Vdc; (Primary tap changes) 0 to 5000 amps dc on any tap.
Regulation:	Current Mode, +/-0.01% total, including 8-hour stability. Voltage Mode, +/-0.2% total.
Overload Protection:	0 to 110% adjustable current meter relay, and a factory set overload firing latchoff at about 130%.
Environment:	Water cooled with less than 6 gpm at 100 psig. Ambient temperature range 0 to +55°C.
Series Operation:	Three units can be operated in series with two in Voltage Mode, controls at ground.

1-14 The performance specifications of the precision reference voltage supply are outlined below:

Input Voltage: +15 Vdc ±0.2% @ 25 mAdc.
Output: +10.6 Vdc @ 10 mAdc (1 K-ohm potentiometer load, constant.)
Short/Overload Protection: Output current limited to 30 mAdc, continous.
Line Regulation: less than ±0.002% for +5%, - 10% line change to +15 Vdc, preregulating supply.
Temperature Coefficient: less than 0.01% for ambient change from +15°C to +55°C. (Oven Control: less than ±.05°C/°C)

Additional details are given in Section VIII and in test reports.

1-15 The performance specifications of the current transductor are outlined below:

Input Voltage: 460 Vac +5,-10%, 3ø, 60 Hz.
Output: 10 Vdc ±2% @ 5000 Adc.
Stability/Regulation: less than 0.01% of full scale for line changes of +5,-10%, and ambient change from +15°C to 55°C.

1-16 CAPABILITIES AND LIMITATIONS.

1-17 The supply does not employ a power filter in the dc-output. Ripple voltage or current into a resistive load is approximately 20% peak-to-peak at 720 Hz.

1-18 Input power (KVA) can be minimized at reduced output voltages by reconnecting the primary tap-links.

1-19 The maximum KVA input for full load (5000 Amps) on each tap is 690 KVA(100V), 360 KVA(48V), 200 KVA(23V) at 483 Vac input (high line).

1-20 The supply includes common mode rejection of over 200 Vdc in the voltage feedback loop in order to connect three units in series with the controls at ground. Two of three supplies in series would be controlled in the VOLTAGE MODE.

1-21 The output free-wheeling diodes are rated for 5000 Amps continuous to safely accept a power shutdown of one unit in a series arrangement at full load.

SECTION II

INSTALLATION

2-1 GENERAL

2-2 The supply is in a standard 48-1/2 inch cabinet with two 24 inch front doors. Figure 2 is an outline drawing of the important dimensions and the top view shows the input and output connections as required.

2-3 The front and rear air screens are removable for lifting purposes.

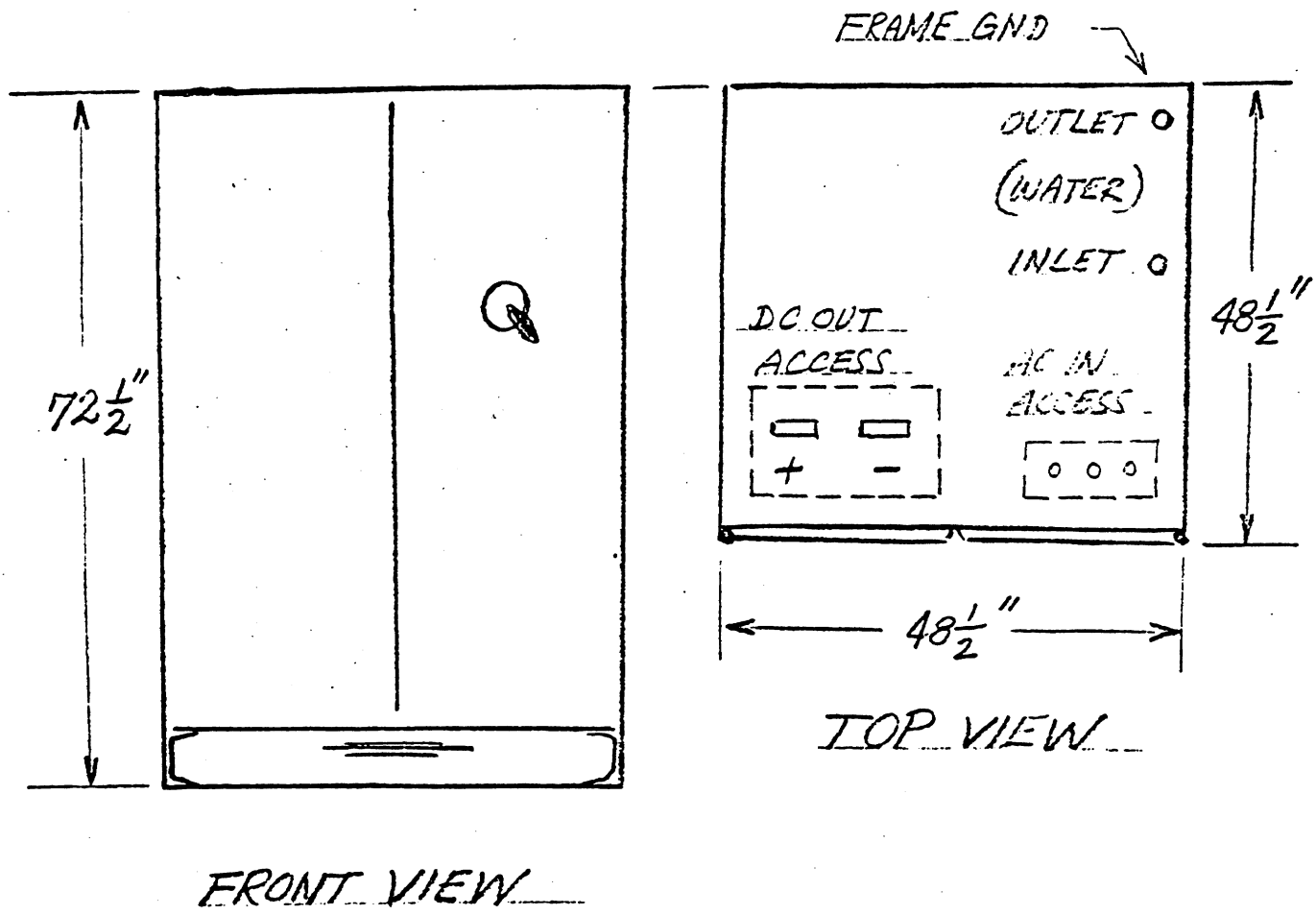


Figure 2 Outline Drawing

2-4 No set up procedures are required and the only precaution required during installation is to ensure that all terminals are securely tightened in their terminal blocks.

2-5 CABLING CONNECTIONS

2-6 The ac input cables connect directly into terminals on the main circuit breaker (CB1).

2-7 The terminals can accept three cables of 500 to 750 MCM each. Two 600 MCM cables are recommended as minimum for full power operations; one 600 MCM cable can be used for operation at lower voltage primary taps (23, 48 Vdc).

2-8 Terminals must be removed to install cables.

2-9 Remove front cover of circuit breaker to remove terminals. (See Section VIII, Components, for details on 1000 Ampere rating NB type TA1201 NB terminals.)

2-10 The dc output cables connect to the (+) and (-) bus bars through the top with front access for bolting. Two holes (9/16 DIA.) at 1 3/4-inch spacing are provided for NAL terminal number 2930-MB-30018.

2-11 CONTROL CONNECTORS

2-12 Interface connectors for remote control, monitoring, and interlocking are provided at the top, front of the supply. These connectors are listed in table 2-1.

Table 2-1 CONTROL CONNECTORS

Connector	Pin No.	Function	Remarks
J1	A	+Current, out	10Vdc: 5000 Adc;
	B	(-) common	10K-ohm minimum loading.
	C	+Voltage, out	10Vdc: 100 Vdc;
	D	(-) common	2K-ohm minimum loading, but short protected.
	E	Pulse 1	Buyers Circuit, pin s,
	F	Pulse 2	pin u of J103.
	G	Motor CW	Control of output level,
	H	Motor CCW	pin s, n of J102.
J2	A	Ext. Voltage (+)	Voltage Loop control,
	B	Ext. Voltage (-)	0 to 10Vdc, input impedance exceeds 1 Meg.
	C	Frame ground	Shield.
J3	A	Reset-Remote	Permits remote reset of
	B	Reset-return	K1C (C-interface relay).

Table 2-1

Connector	Pin No.	Function	Remarks
J3	C	Not used	
	D	Not used	
	L	DC ON-remote	K2C-interface relay
	M	ON-return	enabled in REMOTE contro
	N	DC OFF-remote	K3C-interface relay
	P	OFF-return	enabled in REMOTE contro
	R	Control	jumper, R to S, customer
	S	Control-return	connector interlock.
	T	Interlocks	K15: Interlocks Normal,
	U	Interlock-return	system ready.
	V	Power Supply ON	K14: auxiliary for
	W	PS-ON-return	main contactor, K1C.
	X	Not used	
	Y	Not used	
	E	Ground-Frame	E2-lug to frame.
	G	Reference (+)	Triple, twisted shielded,
	H	Reference (-)	(Shield to frame, E2)
	J	Common	auxiliary input to Level Adjust.
J4	A	120 Vac, 60 Hz	Control power for Magnet
	B	120V-return(gnd)	interlock.
	C	PS-ON	120 Vac, 1 Amp available thru' K1C aux. contacts.
	D	Magnet interlock,	Interlocks K4, relay on
	E	PS-STOP	RB1

2-13 COOLING WATER CONNECTIONS

2-14 Water connections are provided on top of supply with 3/4-inch nipples of brass.

2-15 Minimum water differential pressure of 55 psig is required to provide minimum flow of 4 gpm for full load cooling at ambient temperatures up to $\pm 40^{o}C$.

2-16 At ambient temperatures between +40 and 55°C, 5 1/2 gpm is considered a minimum flow and requires a differential pressure of 100 psig. Flow will not exceed 7 gpm with pressure up to 150 psig.

2-17 The power losses removed by the cooling water are essentially independent of the primary tap configuration and are less than 38 KW.

2-18 DRAINING WATER FOR STORAGE OR REPAIR.

Storage or reshipment of supply requires that the cooling system be drained to prevent damage to the supply.

2-19 Drain all water from cooling system by removing inlet hose and flushing system with warm, dry air for a minimum of 3 minutes with about 100 psig air pressure.

SECTION III

THEORY OF OPERATION

3-1 GENERAL

3-2 The supply uses SCR phase control to efficiently produce and regulate its output. The predominant twelth harmonic ripple current produced with this type control is filtered by the magnet load. Refer to Schematic Drawing number 34270 in Section VI, & block diagram description in Section I.

3-3 The SCR firing pulses are generated by monostable multivibrators. These circuits use ac from the logic transformer to establish a properly timed ramp for 180 degrees of firing angle control.

3-4 The SCR's in the supply are fired through pulse transformers to isolate the control circuit from the SCR's. The firing pulses are power boosted at the gates to assure proper firing of the high current SCR's.

3-5 VOLTAGE CONTROL (Drawing No. 34091, IC1, Q2, Q3, IC4,5,6)

3-6 The supply can be controlled as a constant voltage source in the VOLTAGE mode position of the CONTROL MODE switch (SW3) with 0 to +10 Vdc reference for 0 to full output.

3-7 The voltage loop remains closed in all control modes to provide a fast, lower gain loop capable of minimizing input line power transient effects on the output of the supply.

3-8 The output voltage sensing requires low level ripple filtering since no power filter is used in the supply. The notch filter at 720 Hz and two first order low pass R-C networks provide the ripple attenuation necessary.

3-9 The voltage loop also uses a high common mode rejection circuit to permit ground level control of three, series-connected supplies. (IC4 and R50)

3-10 CURRENT REGULATOR (Drawing No. 34059, IC2)

3-11 In the CURRENT control mode, a voltage precisely proportional to output current is compared to a stable voltage reference in a temperature controlled oven.

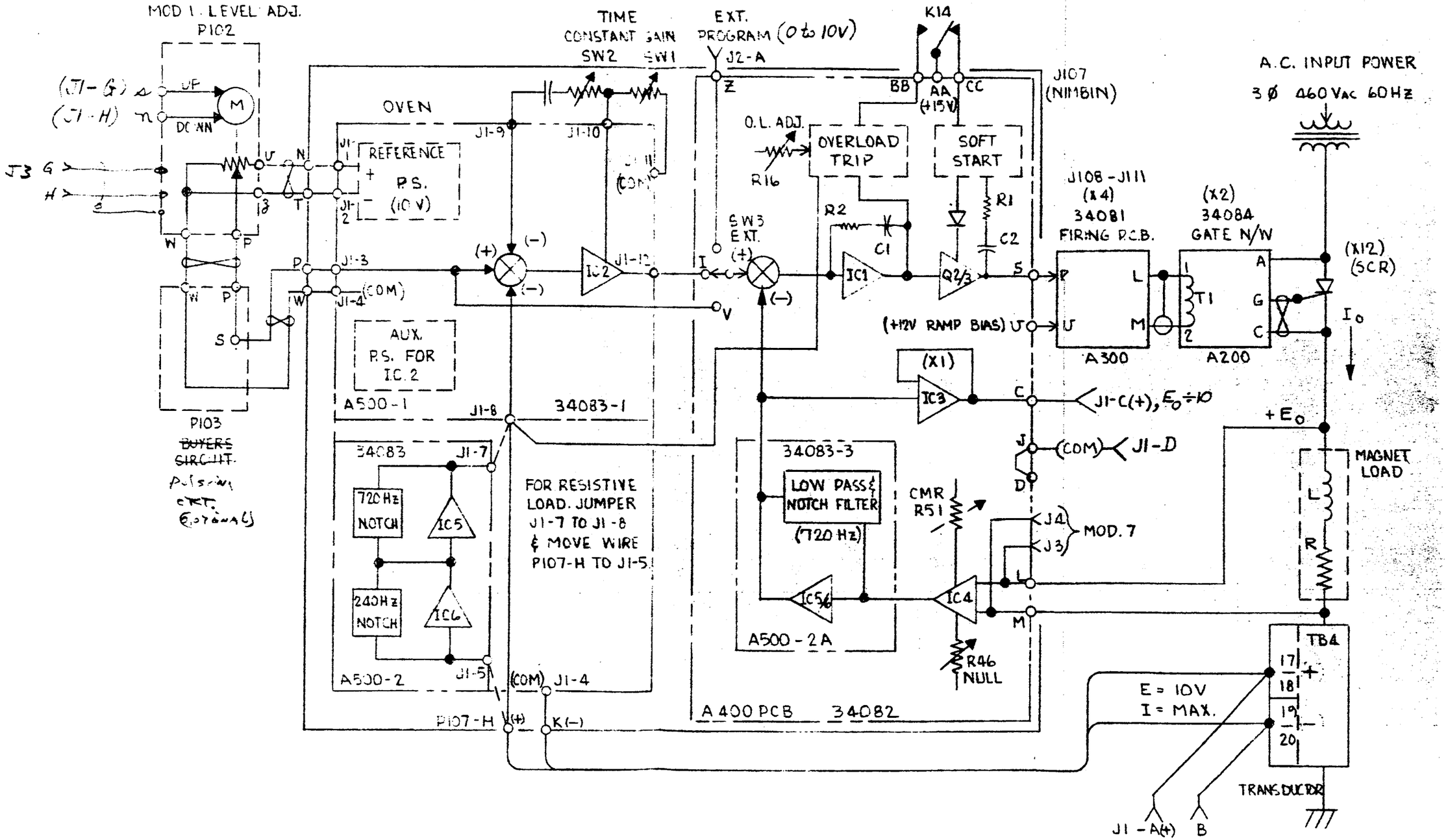


FIGURE 3-1. CONTROL SYSTEM BLOCK DIAGRAM - I.S.R. 2126-1

Rev. A

3-12 The comparison amplifier provides a gain adequate to maintain much better than +/-0.01% regulation independent of output load resistance or tap position of the supply.

3-13 To maintain +/-0.01% current regulation into a resistive load (time constant 0.0), a dual notch filter and two first order low pass R-C networks are used. This filter is also in the oven controlled environment. (A500-2)

3-14 Two regulated supplies are also used in the oven to minimize drift and reduce common mode offset voltages on the comparison amplifier. (Q1, 2, IC4)

3-15 SYSTEM RESPONSE (Figure 3-1: Assembly numbers & terminals)

3-16 The notch filter for the voltage loop has about 100 degrees phase lag at the notch frequency of 720 Hz. The shaping network on the voltage loop amplifier sets the -3 dB response frequency at about 10 Hz. (A500-2A, Assembly 34083-3)

3-17 The closed looped gain of the voltage control exceeds 50 dB, thus providing voltage regulation of about +/-0.1%.

3-18 The loop gain of the overall system in the CURRENT regulation mode exceeds 80 dB and has a gain-bandwidth product in excess of 5 Hz. This bandwidth should provide program response of less than 200 milliseconds for full range control.

3-19 The REGULATOR MODULE controls, GAIN & TIME CONSTANT, maintain the current loop gain roll-off at close to -6 dB per octave independent of magnet resistance and time constant. Thus a simple first order control system is maintained with the essentially first order magnet load and provides a highly stable system response without possibility of overshoot. (See Figure 3-2, System Response.)

3-20 REGULATOR INPUTS (Reference command)

3-21 The supply can be controlled locally or remotely with the motor-pot varying the internal, precision reference, in either current or voltage regulated modes.

3-22 An external reference can be used to control the supply output through either an optional circuit in the motor-pot position J102 or buyers circuit position J103, or through J2-A, B in voltage mode with SW3 in EXTERNAL position.

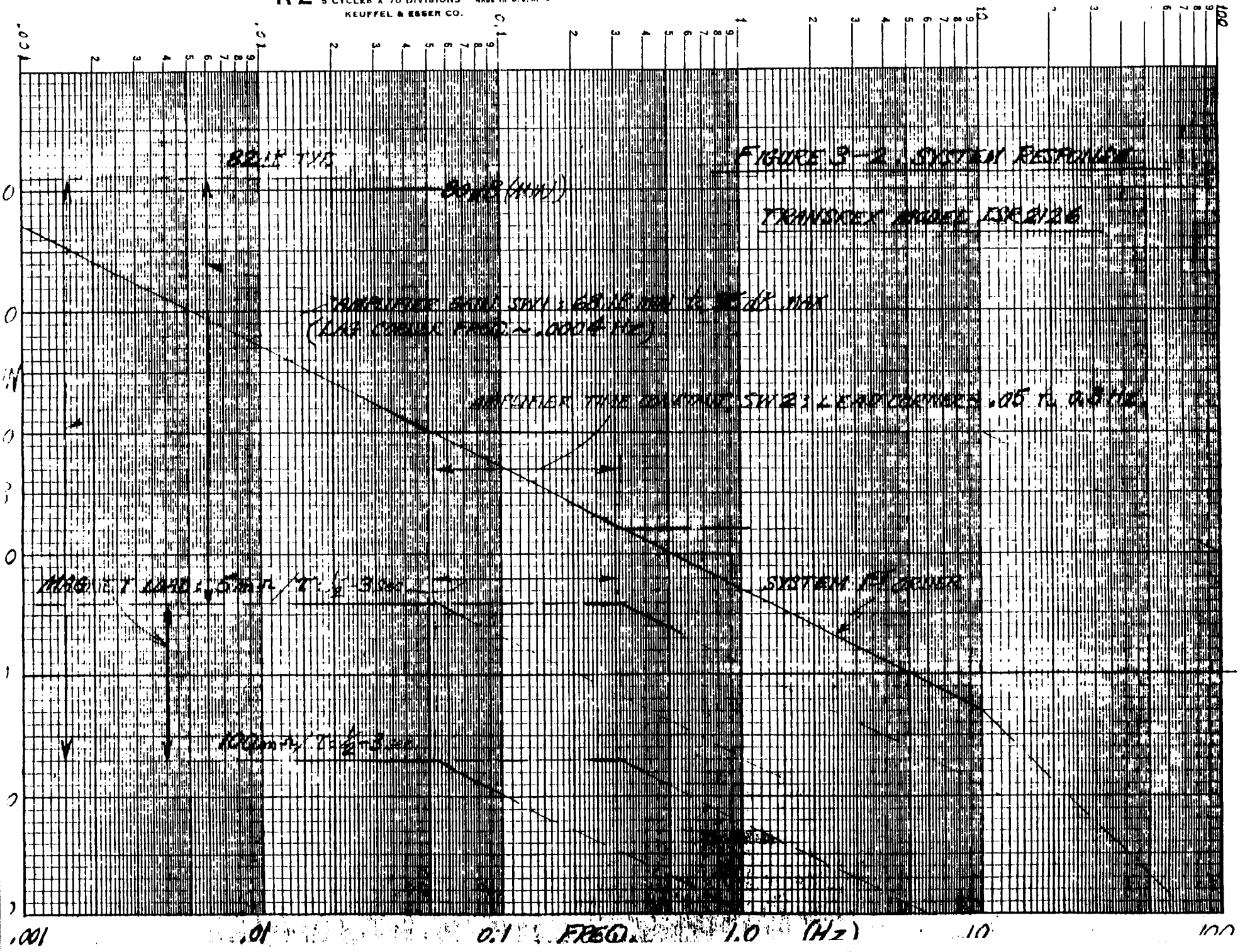


FIGURE 3-2. SYSTEM RESPONSE

3-23 CURRENT TRANSDUCTOR (Drawing No. 34538)

3-24 The dc-dc transductor is a differential saturable reactor that uses feedback balancing to detect the dc load current with an accuracy exceeding 0.01%.

3-25 The feedback current which is an exact ratio of the dc load current is read through a precision resistor array as a voltage to compare to the input voltage reference.

3-26 The differential design provides very high common mode rejection of disturbances, such as ac-line voltage changes.

3-27 The transductor provides complete isolation from the power circuit and responds typically to over 1000 Hz.

3-28 Refer to Transductor bulletin number 32772, appended, for additional discussion and specifications.

3-29 POWER CIRCUIT (Drawing No. 34270)

3-30 The twelve phase power system is achieved by using two power rectifying transformers; one, wye to wye, and, one delta to wye. The two wye secondary systems have 30^{o} phase difference.

3-31 The wye to wye transformer is used as the initial reference phase with +øA being counted number 1. Phasing count is then clockwise, one to 12, each number lagging 30^{o}. The number 12 lagging 330^{o}, or leading 30^{o}, corresponds to the delta +øA'.

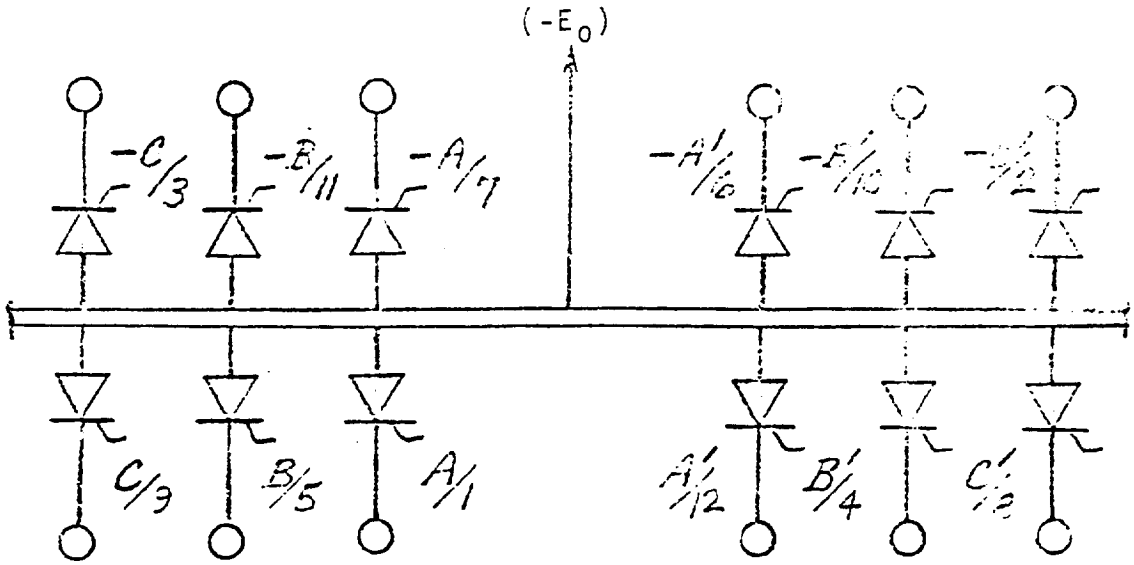
3-32 The SCR Firing Modules (A300) each contain three phases, so phasing logic for the modules is organized as +øA (No. 1), +øB (5), +øC(9); -øA (7), -øB (11), -øC(3); +øA' (12), +øB' (4), +øC' (8); and -øA'(6), -øB' (10), -øC' (2) looking at front of Nimbin, reading left to right. See Figure 3-3.

3-33 Each of the two double wye secondary systems use an interphase transformer (T5,6) to reduce SCR current by forcing conduction for 120^{o} rather than 60^{o}.

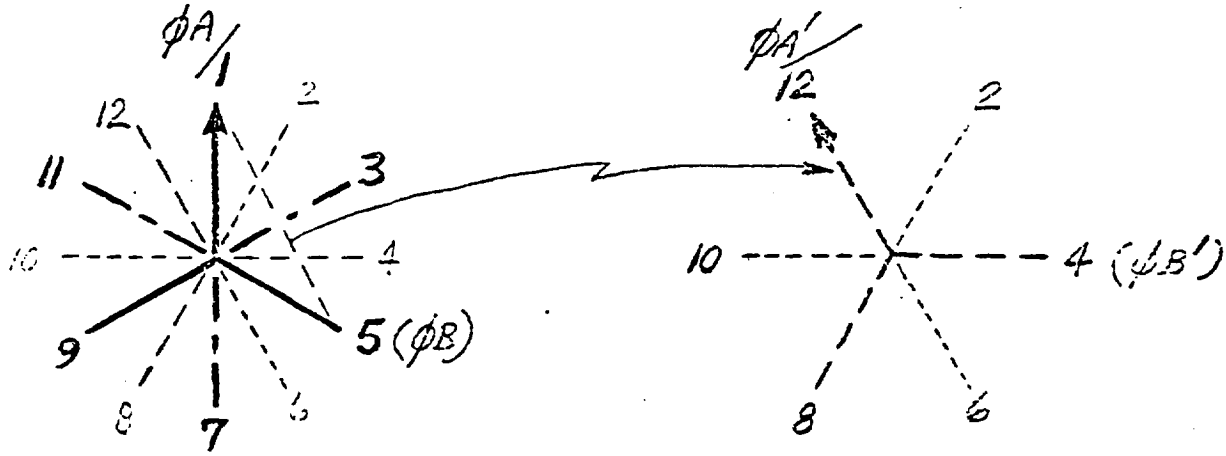
3-34 The two, six phase systems with the 30^{o} phase difference are added in parallel through a third interphase transformer (T7) to produce the 12 phase output power.

3-35 The SCR's are individually protected from output shorts by fuses with $I^{2}t$ ratings less than the SCR's. The SCR's have a minimum $I^{2}t$ of 820,000, and the fuses have a maximum, worst case $I^{2}t$ of 790,000.

SCR PHASE & NUMBER



REAR VIEW of SCR/HEAT SINKS



WYE-WYE: odd numbers

DELTA-WYE: even numbers

Figure 3-3. SCR Location & Phasing

3-36 SCR FIRING CIRCUITS (Drawings 34058 and SK 34085)

3-37 The SCR firing circuits provide "hard" firing to maximize the dI/dt rating of the SCR's used. Hard firing values for the components used in the pulse booster, PCB A 200, are 20 Volts peak, open circuit, and 2 amps into a short circuit with about 0.15 microsecond rise time.

3-38 The fast rise time pulse to the SCR gate is achieved through an isolation, pulse transformer in the following manner: the pulse transformer charges a capacitor (0.15 uF) to 20 volts in a few microseconds and a zener diode then triggers a four amp SCR onto the gate of the power SCR's.

3-39 A ten ohm resistor in series with the energy storing capacitor and the power SCR gate establishes the desired gate current and permits monitoring of the applied gate pulse.

3-40 An additional series resistor with a bypass capacitor limits peak duration and establishes the steady-state current for the remainder of the pulse.

3-41 The firing modules (A300) utilize a linear ramp compared to the control input signal (J108-P) to trigger a monostable multivibrator.

3-42 The pulse from the multivibrator is carried by coax leads to the pulse transformer on the A200 PC-board.

3-43 The ramps are timed by 50 Vac signals from the 12 phase logic transformer (T4). Noise immunity is achieved by using high voltage logic ac with decoupling networks and an eleven volt peak ramp.

3-44 PROTECTION CIRCUITS

3-45 All protective and annunciator circuitry are powered from internal, grounded 120 Vac or -24 Vdc voltages.

3-46 <u>Internal DC Overload</u>

3-47 Internal dc overload is provided as a fast complement to the dc overload meter relay. A buffer amplifier (IC2, Schematic 34091) monitors the transductor output and is adjusted (R16) to trip a solid state switch (SCR1, Q1) to stop all SCR firing at 130% overload.

3-48 The internal dc overload will latch the supply off without visual indication and it can be reset only by manually breaking and making the main input circuit breaker.

3-49 AC Overload

3-50 AC overload detection uses two overload relays (K10, K11) operating from the input line current transformers (CT1,3). These close-tolerance relays require no adjustment and will trip off the supply at 910 to 1100 Amps line current.

3-51 The ac overload relays have a time delay (Curve 2) that permits short term surges without tripping.

3-52 AC Imbalance

3-53 AC imbalance in input lines is detected by an overload relay (k12) connected to respond to neutral current reflecting line imbalance through the three, WYE connected current transformers (CT1, 2, 3) to neutral.

3-54 The trip level for ac imbalance (10%) is adjusted with an adjustable resistor (R9).

3-55 Thermal Overloads

3-56 Thermal overload protection is provided for each SCR (TS2-13), each branch of water outlet (TS17, 18, TS19), each free-wheeling diode (TS14, 15, 16), and the cabinet air temperature (TS1).

3-57 Thermal Protection will trip off the main contactor (K1C and auxiliary K14) at $190^{0} \pm 5^{0}$F for any of the water cooled components and at 172 $\pm 5^{0}$F for the cabinet air temperature monitored at rear connector plate of Nimbin.

3-58 Ground Faults

3-59 Ground faults are detected by an indicating fuse (F13, 1/4 A) turning off a transistor-relay interlock (Q1, K13, DC relay PCB).

3-60 Ground faults can be detected for either (+) or (-) output bus depending on position of grounding switch (SW6).

3-61 GROUNDED OPERATION

3-62 The supply is capable of operating either ungrounded or with either side of the dc output deliberately grounded through a 1/4A fuse and a resistance of 20 ohms (R8). The 20 ohm resistor limits the peak fault voltage to less than 10 volts.

3-63 Indicating lights show the grounding selected with ground switch SW6, mounted inside on the front of the component panel.

3-64 AUXILIARY POWER SUPPLIES (Drawings No. 34072)

3-65 The auxiliary power supplies operate from one transformer (T4) connected by fuses (F10, 11, 12) to the 460 Vac input lines after CB1.

3-66 24 VDC. The 24 Vdc supply is an unregulated, capacitor filtered rectifier rated for 3 Amps continuous.

3-67 +/-15 VDC. The +/-15 Vdc supplies are tracking, series regulators with current limiting fixed at about 400 mA. The supplies are adjusted by one rheostat (R21). The +15 Vdc supply uses a precision monolithic regulator (IC1) boosted to 300 mA continuous rating by Q10. The -15 Vdc supply uses a high gain, single stage transistor (Q11) regulator with zero offset voltage to track the +15 Vdc output. The complementary connected emitter follower pair, Q12 & 13, is current limited by Q14.

3-68 +/-5 VDC. The (+) and (-) 5 Vdc supplies operate exactly as the -15 Vdc supply. The +5 Vdc supply tracks the +15 Vdc supply and the -5 Vdc supply tracks the +5 Vdc. The +/-5 Vdc supplies are rated for 2.2 Amps continuous and are current limited to about 3 Amps by Q3 and Q7, respectively.

SECTION IV

OPERATING INSTRUCTIONS

4-1 GENERAL

4-2 Operating controls and indicators are listed and described in Table 4-1. The locations of operating controls are shown in Figure 4-1.

4-3 OPERATING CONTROLS AND INDICATORS

4-4 The operating controls and indicators provide a sequence for turn on, function and fault indications.

4-5 Two operating controls are not front panel mounted. The cabinet doors are not interlocked and the tap positions for the 23Vdc, 48Vdc, 100Vdc should be visually checked for compliance with desired output range. See TRANSFORMER TAP CHANGE DIAGRAM on inside of door. Second, the ground switch (SW6) should be set as desired: -, 0, +; grounding negative output bus, un-grounding, or grounding positive bus.

WARNING

Lethal voltages are present whenever ac input is applied.

4-6 The indicator lights are grouped in two major arrangements: FAULTS and FUNCTIONS.

4-7 The fault lights are self testing. They will all light when CONTROL POWER (CB2) is turned on. The RESET push-button must be pressed to enable supply if no faults exist.

4-8 PREOPERATING PROCEDURES

4-9 Connect load cables to output (+) and (-) buses.

4-10 Confirm water pressure and/or flow through supply.

4-11 Connect a safety ground to cabinet frame. Bolt to cabinet floor channel at rear side.

TABLE 4-1. OPERATING CONTROLS & INDICATORS

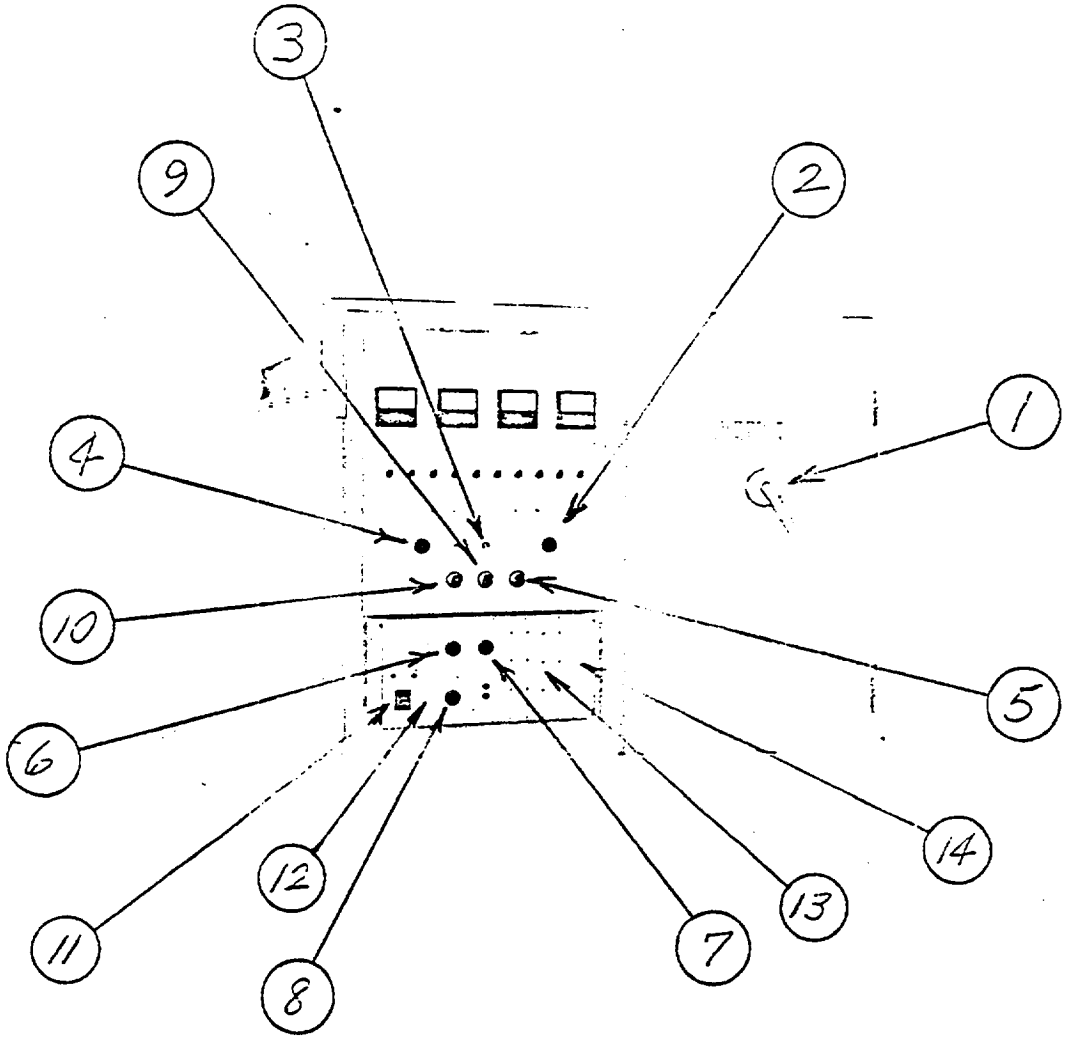
ITEM	CONTROLS & INDICATORS	REF. DES.	FUNCTION
	MAIN FRAME		
1	Main Circuit Bkr.	CB1	Make or break ac input lines.
2	CONTROL POWER	CB2	Power interlocks & start warmup.
3	RESET pushbutton	SW5	Test interlocks & show ready condition.
4	AC ON switch	SW1	Read AC VOLTS & AMPS input.
5	CONTROL switch	SW3	Provide LOCAL or REMOTE dc on & off.
6	DC ON pushbutton	SW2	Turn on dc output (red light is ON).
7	DC OFF pushbutton	SW4	Turn off dc output (green light is OFF).
8	Grounding switch	SW6	Grounds negative or positive bus or floats.
9	DC AMPS knob	M4	Sets red pointer to maximum load current & can trip off main contactor (K1C).
	NIMBIN module		
10	GAIN CONTROL	SW1	Set to MAGNET MILLIOHMS resistance.
11	TIME CONSTANT	SW2	Set to magnet time constant in SECONDS.
12	CONTROL MODE	SW3	Set to desired mode of control.

TABLE 4-1 - Continued

ITEM	CONTROLS & INDICATORS	REF. DES.	FUNCTION
	Fault lights		
13	GND FAULT	DS1	Excessive current to ground, F13 oper
14	DC-OVERCURRENT	DS2	Setting of M4 exceeded.
15	AC-OVERCURRENT	DS3	Indicates fault in ac input circuit.
16	AC IMBALANCE	DS4	Indicates line current imbalance.
17	MAG INTERLOCK	DS5	Magnet conditions not satisfied.
18	AIR OVERTEMP	DS6	Cabinet air temperature excessive.
	WATER OVERTEMP.		
19	BRANCH 1	DS7	Exhaust water temperature high (BROWN
20	BRANCH 2	DS8	" (RED).
21	BRANCH 3	DS9	" (ORANG
22	SPARE	DS10	(Not used).
	Function Lights		
23	AC ON	DS11	Input line energized & CB1 closed.
24	READY	DS12	All interlocks satisfied.
25	+GND	DS13	Indicates SW6 position, +bus to groun
26	-GND	DS14	" -bus to groun
27	UN-GND	DS15	" output busses floating
28	SPARE	DS16	(Not used).

TABLE 4-1 - Continued

ITEM	CONTROLS & INDICATORS	REF. DES.	FUNCTION
	METERS		
	AC INPUT -		
29	AC VOLTS	M1	Indicates ac line voltage 1,2 or 3.
30	AC AMPS	M2	Indicates ac line current 1,2 or 3.
	DC OUTPUT -		
31	DC VOLTS	M3	Indicates dc voltage at output.
32	DC AMPS	M4	Indicates dc current at output.



(1) Main circuit breaker (CB1)
(2) CONTROL, LOCAL-REMOTE (SW3)
(3) CONTROL POWER (CB2)
(4) AC INPUT switch (SW1)
(5) RESET pushbutton (SW5)
(11) Motor potentiometer module
(12) Buyer's circuit
(6) GAIN CONTROL (Mod 7,SW1)
(7) TIME CONSTANT (Mod 7,SW2)
(8) CONTROL MODE (Mod 7,SW3)
(9) DC OFF pushbutton (green,SW4)
(10) DC ON pushbutton (red,SW5)
(13) FIRING MODULE (4-identical)
(14) Prewired spare position.

FIGURE 4-1 OPERATING CONTROLS

4-12 Connect the 460Vac, 3 phase, 60 Hz as indicated to CB1. Securely tighten both front doors.

4-13 Apply power to the ac input lines.

4-14 Select LOCAL position with CONTROL switch (SW3) and set maximum desired output current with control on DC AMPS meter (M4), red pointer.

4-15 Turn CONTROL POWER (CB2) switch off (down).

4-16 Set controls on REGULATOR MODULE to required LOAD RESISTANCE, TIME CONSTANT, and CONTROL MODE.

4-17 TURN ON PROCEDURES

4-18 Turn on main circuit breaker handle (CB1) by pulling down. AC VOLTS meter (M1) should read ac input line voltage and AC ON light (DS11) should be lighted.

4-19 Turn AC INPUT switch (SW1) to check all three phase voltages.

4-20 Turn CONTROL POWER switch (CB2) on (up). All fault lights should be lighted (amber) and ground function light should light confirming setting of SW6, inside cabinet.

4-21 Press RESET pushbutton momentarily and all fault lights should go off. READY light (DS12) and DC OFF light in pushbutton (green, SW4) should be lighted. If all fault lights do not go off, follow trouble shooting procedures for fault lights in Section V.

4-22 Meters, AC AMPS, DC VOLTS, and DC AMPS should read zero.

4-23 WARMUP PROCEDURES

4-24 Oven in REGULATOR MODULE begins heating when CONTROL POWER is on in step 4-20. The thermal time constant of the oven is about 7 minutes.

4-25 The supply will achieve better than +/-0.01% stability from a cold start in approximately 25 minutes.

4-26 OPERATING PROCEDURES

4-27 Press DC ON pushbutton (SW2). AC AMPS meter (M2) may indicate inrush but should return to a reading of less than 850 amperes depending on load and output setting. DC VOLTS (M3) and DC AMPS should rise smoothly to preset values.

4-28 Press DC OFF if any meter shows abnormal value.

4-29 A factory set overload can stop all SCR firing in a few milliseconds if an overload exists. No fault light will light for this dc overload trip off condition. This overload protection is reset by momentarily pressing DC OFF.

4-30 SHUTDOWN PROCEDURES

4-31 Press DC OFF pushbutton (SW4).

4-32 Turn off CONTROL POWER (CB2).

4-33 EMERGENCY SHUTDOWN PROCEDURES

4-34 Turn off CONTROL POWER (CB2) and turn off main circuit breaker (CB1).

SECTION V

MAINTENANCE

5-1 GENERAL

5-2 This section contains all instructions necessary to keep the supply in proper working condition. The supply can be maintained by the procedures given below. Trouble-shooting guides and calibration procedures are included in this maintenance section.

5-3 INSPECTION PROCEDURES

5-4 Visually inspect the supply connections when it is not operating.

5-5 Relay PC-boards, A100 and A200 assemblies use fast-on connections and these should be securely bottomed on their terminal boards.

5-6 Screw connections on meters and terminal blocks should be checked on a 3-month maintenance cycle.

5-7 Water connections should be visually inspected for leaks, cracked hoses, or pulling back from clamp.

5-8 Visual inspection for excessive moisture due to leaks or condensation should be performed on a 3-month maintenance cycle.

5-9 TESTING PROCEDURES

5-10 Testing procedure is a dynamic examination of the equipment. Operate supply by following all procedures given in Section IV.

5-11 This procedure should be performed more frequently if supply is not operated for extended periods or installation area is damp.

5-12 Refer to troubleshooting guide if proper operation is not achieved.

5-13 TROUBLESHOOTING

5-14 Table 5-1 provides information required to isolate troubles.

TABLE 5-1 TROUBLESHOOTING GUIDE

TROUBLE	PROBABLE CAUSE	REMEDY
SCR pulse missing	SCR gate open	Replace SCR, see Part Replacement Instruction
SCR pulse missing	Pulse Transformer open	Replace pulse transformer, check pulse polari
SCR pulse missing	Power Transistor in A300 faulty	Replace transistor or use spare firing module
Output goes off without fault light indication	Factory set overload tripped	Reset with CB2. Adjust trip point, see Adjustments.
SCR fuses open	SCR shorted	Replace SCR and fuses
60 Hz ripple	SCR heatsink loose	Replace SCR, tighten heatsink properly
AC imbalance trips	SCR heatsink loose	Replace & reseat SCR, tighten heatsink.
Ground fuse F13 opens	Cooling water contaminated	Flush water lines and replace filters (facili
DC overcurrent shutdown	M4 terminal screws loose	Tighten & retest with control knob.

Refer to Table 4-1, Operating Controls and Indicators, for direct isolation of most common faults.

The supply can be tested without output power by following operating procedures in Section IV to step 4-25.

5-16 Open loop control of SCR firing pulses can be achieved by removing REGULATOR MODULE and connecting the test fixture shown in Figure 5-1.

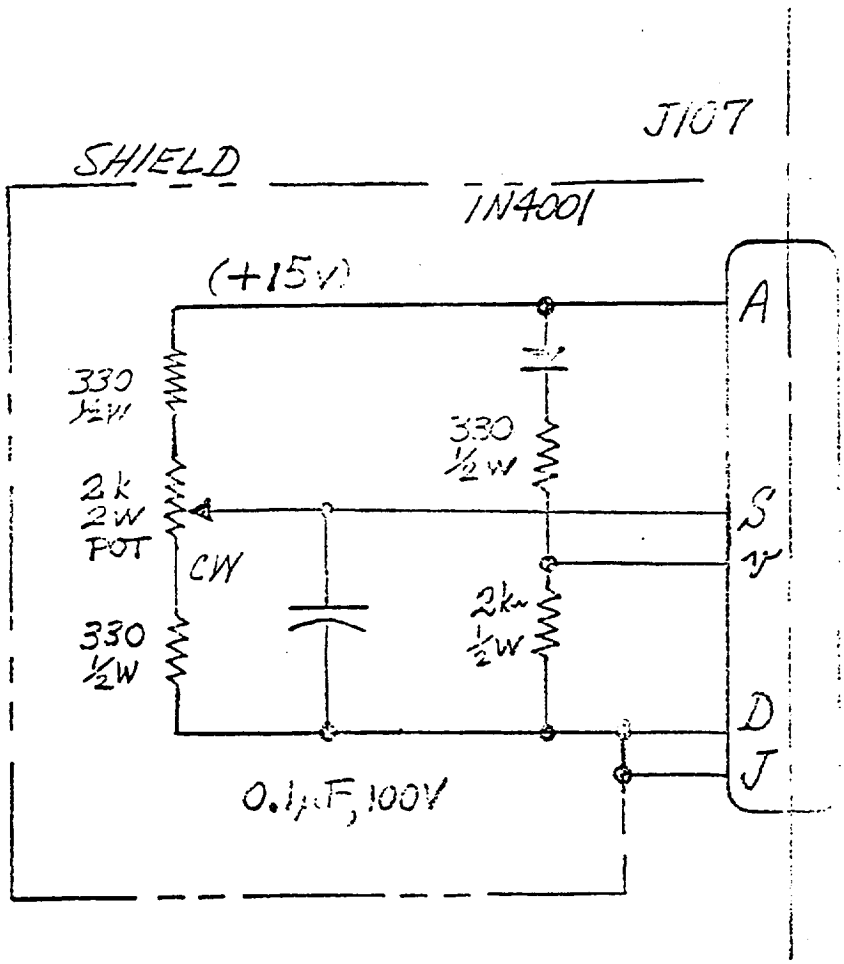


Figure 5-1 TEST FIXTURE (OPEN LOOP CONTROL)

5-17 The test fixture control can shift the gate pulses over the 180 degree SCR control range. The control voltage should read about +10 volts dc at 180 degrees phase-back, which corresponds to zero output, and about +4 volts dc for about 60 degrees phase-back for maximum output of a three phase system.

5-18 An oscilloscope should be used with line synchronization to confirm proper tracking and presence of all twelve gate pulses on the SCR gates.

5-19 Open loop testing with output power is possible with the test fixture.

5-20 Turn test fixture control voltage to about +12 Vdc and press DC ON pushbutton. Oscilloscope should show 720 Hz ripple on output as control voltage is changed from +12 to +4 Vdc.

5-21 Ripple balance should be set at about 30% output. Input test fixture control voltage at about 8-9 Vdc.

5-22 To balance ripple oscilloscope scale should be expanded to amplify the positive peaks and the controls on the FIRING MODULE (A300), +/- ADJUST, A, B, C are adjusted to produce even height peaks. See Figure 3-3.

NOTE

Oscilloscope can monitor output ripple on REGULATOR MODULE (Mod 7) test points (+) and (-).

5-23 Closed loop test should be initially performed after trouble-shooting and repair in the voltage mode.

5-24 During voltage mode operation, monitor output load current at test points J1A(+) and J1B(-), interface connectors indicating transductor output.

CAUTION

Transductor output must be verified before turning system on in current mode. An open in current feedback will cause output to go to maximum at turnon.

5-25 Fault indicating lights isolate most trouble conditions anticipated and open contactor to prevent damage to equipment or load.

5-26 REPAIR PROCEDURES

5-27 Repair procedures are to be performed as a result of inspection or troubleshooting. No special tools are required. When replacing parts during repair, refer to parts replacement instructions (paragraph 5-31).

5-28 Modular construction using the Nimbin for most electronics permits easy removal and replacement.

5-29 Relay PC-boards can be slipped out of plastic tracks by pressing upper edge of plastic up and away from relay PC-board.

5-30 Gate network assembly (A200) is hinged by upper screws and can be swung out and up for repair or replacement of SCR fuses.

5-31 PART REPLACEMENT INSTRUCTIONS

5-32 Thyristor (SCR) replacement is the only component requiring special replacement instructions.

5-33 Remove fuse to faulty SCR first and see Figure 5-2 for replacement instructions.

CAUTION

Thyristors must be tightened properly in heatsink. High ripple and SCR failure can result from improperly seated or tightened SCR's.

5-34 CALIBRATION

5-35 Precision components have been used extensively to minimize calibration adjustments. Measure operating values as noted in Table 5-2 Factory Test Procedures when components are replaced.

5-36 Assemblies requiring adjustment are the Auxiliary Power Supply (A100), Firing Module (A300), Regulator Module (Mod 7, A400, A500), and Transductor Chassis (A600).

Assembly drawings of the PSI clamps are shown below. The force applied to the heat sinks is controlled by the number of turns made on the bolts. The bolts are first tightened "finger" tight using the shaft only of the allen or socket wrench. The ends of the spring bars should have an initial gap of about 2.5 mm (.10") between the bar and the heat sink.

The tables show the number of turns and the tightening sequence for a range of forces between 455 kg. (1,000 lb.) and 1820 kg. (4,000 lb.). This method of assembly will insure that the force applied to the device will be within ±20% of the specified value and that the thermal impedance (junction to heat sink) will be within the value specified on the spec. sheets of the individual devices.

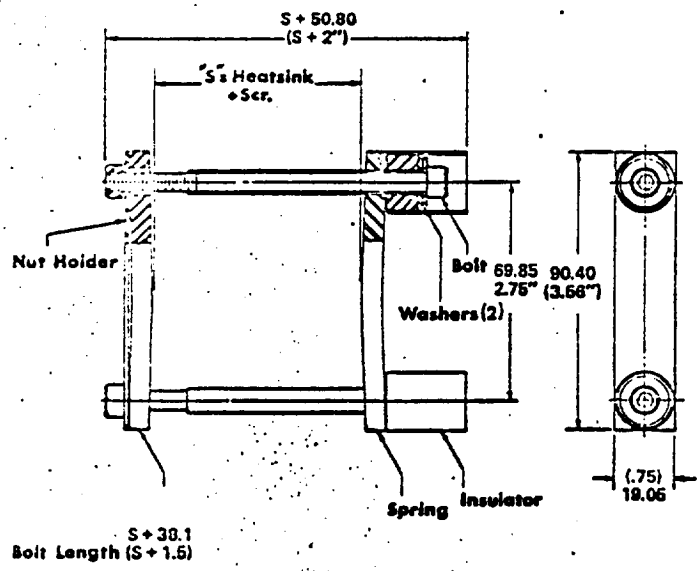
* Bolts should be tightened in one half turn increments.

ASSEMBLY INSTRUCTIONS

910 kg. (2,000 lb.) Clamp

1. Bolt
2. One steel washer
3. Insulator
4. Spring Bar
5. Heat sinks and device
6. Spring Bar
7. Nut holder

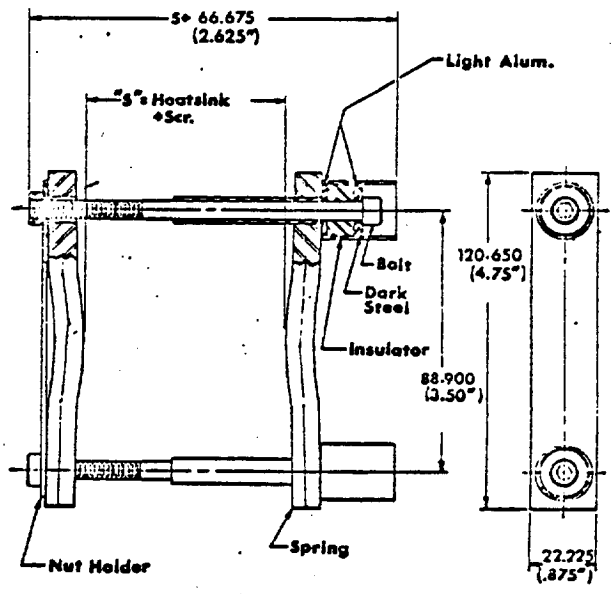
455 kg. (1,000 lb.)		910 kg. (2,000 lb.)	
¼"-20	¼"-28	¼"-20	¼"-28
1-turn	1¼-turn	1½-turn	2-turns



1820 kg. (4,000 lb.) Clamp

1. Bolt
2. Two steel washers
3. Aluminum washer
4. Insulator
5. Aluminum washer
6. Two Spring Bars
7. Heat sinks and device
8. Two Spring Bars
9. Nut Holder

910 kg. (2,000 lb.)		1820 kg. (4,000 lb.)	
¼"-20	¼"-28	¼"-20	¼"-28
1-turn	1½-turn	2-turns	2½-turns *



* NOTE: The SCR used, H1400, is an "ASTRO PACK" requiring 2-1/2-turns.

FIGURE 5-2. SCR HEATSINK CLAMPING

TABLE 5-2. TEST & CALIBRATION PROCEDURES (abstract)

4.0 FUNCTIONAL TEST:

4.1 Main Rectifier Transformers

Verify the following tests performed on each transformer.

	BY	DATE
(a) Turns ratio, polarity check	[illegible]	12-10-71
(b) Dielectric test at 60 Hz for one minute between following terminals and all others connected to ground. Primary 2.5 kV, Secondary 2.5 kV	[illegible]	12-10-71
(c) Excitation current 9/9 amps	[illegible]	12-10-71
(d) Water pressure test at 300 PSI for one hour	[illegible]	12-10-71

4.2 Precision current transductor (A600)

Verify the following by tests performed with 460Vac input ±2%.

(a) Transductor sensing head tested as per test procedure M1023	[illegible]	12/6/71
(b) Control transformer tested as per M1018 for turns ratio, polarity and dielectric test	[illegible]	12/6/71
(c) Measure following voltages on the amplifier board	[illegible]	12/8/71
(1) Pin #1 and #3 40 Volts ± 2 Volts	[illegible]	[illegible]
(2) Pin #1 and #2 -8 Volts ± 1 Volt	[illegible]	[illegible]
(3) Pin #1 and #15 +105 Volts ± 7 Volts	[illegible]	[illegible]
(d) Adjust R13 for 30 Volts ±.5V between Q1 emitter & pin #1	[illegible]	[illegible]

		BY	DATE
(e)	Adjust R21 for zero output of IC1 to pin #1 by shorting pin #6 and cathode of CR27.		12/7
(f)	Measure 0 to 10V ± 1% output at TB4-18 and TB4-19 by changing current through the sensing head from zero to 5000A ± 0.01%.		12/9
(g)	Check linearity ± 0.1%.		12/9
(h)	Check output ripple ≤ 60 mV P/P		
4.3	A100 - Auxiliary Power Supply		
4.4	With loads on A100, increase input voltage to 414 Vac, adjust R21 to set +/-15V and +/-5V to +15.4±.2V; -15.2±.2V, +5.2±.2V; -5.2±.2V. Record all values. +15 15.40 V, -15 -15.20 V, +5 5.25 V, -5 -5.35 V.	SKM	15DEC.71
4.5	Read and record +24Vdc output (25 to 27.5Vdc) 26.2V.	SKM	15DEC.7
4.6	Read and record ac logic voltage (43 ± 2Vac) 44 V.	SKM	15DEC.7
4.7	Increase input voltage to 480Vac, read +/-15V, +/-5V and record: +15 15.40V -15 -15.18, +5 5.30, -5 -5.40. Change must be less than 30 mv.	SKM	15DEC71
4.8	Observe outputs of dc voltage with 502A scope; read and record peak-to-peak ripple and noise voltages: +15 7 mV, -15 8 mV, +5 13 mV, -5 16 mV.		

		BY	DATE
	Peak-to-peak total noise must be less than 30 mV.	SKM	15DEC.71
4.9	Read and record reference dc voltage J107-N(+) to J107-T(-): (Should be 10.3 to 10.8Vdc). 10.60 Vdc.	SKM	15DEC.71
4.10	Record reference voltage at high line: 10.60 Vdc. Change should be less than 200uVdc.	SKM	15DEC.71
4.11	Adjust R10 on A500-PCB to minimize dc voltage at J107-S. Record: < 1 mVdc. Should be less than 1mVdc.	SKM	15DEC71
4.12	Apply 720 Hz ± 1.2 Hz at 3Vac rms to J107-H, and record ac voltage out of filter. 10 mVac. Should be less than 12mVac rms.	SKM	15DEC71
4.13	Apply 240 Hz ± 0.2Hz at 0.2Vac rms to J107-H, and record ac voltage out of filter : < 1 mVac. Should be less than 1mVac rms.	SKM	15DEC71
4.14	Turn SW3 to "voltage" mode (reference pot full ccw); connect J107-L to J107-P; and connect J107-M to J107-J; and minimize the dc output voltage at J107-S by adjusting ~~R90~~ R46 on A400-PCB. Record minimum. < 1 mVdc. Should be less than 10mVdc.	SKM	15DEC71

BY DATE

4.15 Remove jumper from J107-L J107-P and apply 30Vac rms @720Hz±1.2 Hz between J107-L and M. Record ac voltage out of filter: 9.6 mVAC. Should be less than 12mVac rms. SKM 15DEC 71

4.16 Turn SW3 to current-mode and turn R16 on A400-PCB full cw and apply 12-13Vdc to J107-H. Observe dc voltage at SCR1-A while turning R16 slowly ccw. Stop when voltage at SCR1-A drops to zero. Reduce 12-13Vdc input and momentarily open interlocked +15V source. Gradually increase dc input at J107-H and observe that SCR1-A drops to zero when dc input is about 12-13Vdc. SKM 15DEC,7

4.17 Change dc voltage on J108/109-P from 0 to 12 Vdc and record approximate delay angle control on scope: ≥180° (°). Should be greater than 120°. SKM 15DEC.71

4.18 Apply 0 to 12Vdc at J107-P (+) and record output voltage range with rated load at maximum output: 0 (min) to 100 (Max); Vdc min. Should be less than 1Vdc and max. more than tap-rating voltage. SKM 15DEC,71

4.19 Record KVA input at full rated load: 685 kVA. (<~~75.0~~ kVA). (500kw/N) SKM 15DEC 71

4.20 Megger the output bus by applying 500Vdc ≥100M ohms. WM 15DEC71

		BY	DATE
4.21	Operate at full load for ONE HOUR min.	SVH	15 DEC.
4.22	Check entire unit for leaks with water at 300 PSI static pressure for ONE HOUR.	[illegible]	12/12
5.0	FINAL MECHANICAL CHECK		
5.1	Before shipping, drain water out of the unit.	[illegible]	12/21
5.2	Check all mechanical connections after final test and clean up.	[illegible]	12/21
5.3	Release for shipping.	[illegible]	12/21

5-37 A100 dc voltages are all dependent upon the value of the +15Vdc output. Recommended values are given in table 5-2. Adjust R21 to obtain about +15.3 Vdc at A100 terminal.

WARNING

Lethal voltages are present whenever ac input power is applied. Supply is not interlocked.

5-38 A300 adjustments were detailed in maintenance paragraphs on output ripple minimizing.

5-39 REGULATOR MODULE adjustments are possible on A400.

5-40 A400 has three adjustments: Common mode rejection (CMR) pot, R51; IC4 null pot, R46; Internal, factory-set 130% overload trip, R16.

5-41 Adjust null pot R46 by shorting inputs (L) and (M) to common (D). Null output of IC4.

5-42 Adjust CMR pot R51 by connecting (L) and (M) to +27 Vdc supply (C9) and adjust R51 to null output of IC4.

5-43 Adjust overload trip by applying bias voltage of about 12.5 - 13.5 Vdc to J1-8 and turn R16 to just trip SCR1.

5-44 Calibration of oven or oven components and Transductor should be done at the factory. Replace assembly and return for repair and adjustment.

5-45 TRANSDUCTOR ADJUSTMENT (A600)

5-46 Confirm transductor performance by test procedures given in Table 5-2, paragraph 4_2.

5-47 Disconnect all wires to PC-board (34223).

5-48 Disconnect feedback winding on transductor chassis TB4-15 and -16.

5-49 Apply 460 Vac, 3 phase, 60 Hz to TB3-1, 2, 3.

5-50 Measure dc-voltage on C1. Should be 40 ± 3 Vdc.

5-51 Measure dc-voltage on C3. Should be 195 ± 6 Vdc.

5-52 Measure dc-voltage between wire No. 33 and 31. Should be (-) 8 ± 2 Vdc.

5-53 Measure dc-voltage between wire No. 17 and 15. Should be (+) 4.3 ± 0.5 Vdc.

5-54 Measure dc-voltage between wire No. 17 and 16. Should be (-) 4.3 ± 0.5 Vdc.

5-55 Turn input ac-voltage off, and reconnect PC-board.

5-56 Turn input ac-voltage on.

5-57 Adjust R13 to obtain +30 ± 0.5 Vdc between Q1-emitter and PCB-pin #1 (wire No. 33).

5-58 Short CR27-cathode to C8 (+).

5-59 Adjust R21 for minimum voltage between IC1-6 and CR27-cathode.

5-60 Adjust R8 for minimum voltage between CR27-cathode and R17-1.

5-61 Turn input ac-voltage off, and reconnect feedback winding (TB4-15, 16).

5-62 Turn input ac-voltage on with no load through transductor.

5-63 Measure ac-ripple voltage at TB4-18 to TB4-19. Should be less than 20 mVp-p.

5-64 Adjust R18 for minimum ripple with about 10% of rated, full load current.

5-65 Absolute accuracy is fixed by turns ratio and resistor array accuracy. Measure absolute accuracy and linearity with a precision shunt.

5-66 SPECIAL REPAIR INSTRUCTIONS

5-67 The SCR's, free-wheeling diodes, and fuses can be replaced without turning off the water supply or disturbing other SCR's or diodes.

5-68 Water supply must be drained to replace transductor No. 4 or other magnetics T1,2,5,6,7. See section II instructions.

SECTION VIII

COMPONENT SPECIFICATIONS

8-1 GENERAL

8-2 This section provides a complete listing with specifications and descriptions of all major components in the power supply and its subsystems. Table 8-1 includes the manufacturer's name and the part number with the major characteristics of each component. Additional specification data sheets for the components are listed in Table 8-2 and appended to this section.

Table 8-1 Components

Part Name	Manufacturer's Name & P/N	Characteristics
Transductor	Transrex, X5000	Provides 10 Vdc isolated signal at 5000 Adc; Accuracy 0.01% F.S.; Input power: 3Ø, 460Vac,
Precision Reference	Transrex, 34083	Reference Voltage is 10.6 Vdc with 1K-ohm load; Accuracy 0.01%/ 8 hours; Input power: 15 Vdc @ 25 mA.
Oven	Oven Industries, Inc.	Regulate temperature at 68°C; Accuracy ±.15°C Input power: 28Vdc @
Magnetics		
T1, Power Transformer	Transrex 11771-1	460 Vac: 207VCT, 6ø at 725 A/ø, 60Hz.
T2, Power Transformer	Transrex 11771	460 Vac: 207VCT 6ø at 725 A/ø, 60Hz.
T3, Control Transformer	Transrex 11765	480 Vac: 120Vac @ 12A, 22 Vac @ 2A. 60 Hz.
T4, Logic Transformer	Transrex 11764-1	460 Vac: 100VCT, .02A 12ø STAR, 60Hz.
T5,6 Interphase Transformer	Transrex 11772	105VCT, 1250 A/leg, 180Hz, 400 Adc.
T7, Interphase Transformer	Transrex 11773	40 VCT, 2500A/leg, 360Hz.

Part Name	Manufacturer's Name & P/N	Characteristics
Semiconductors		
Thyristor SCR1-12	Power Semiconductor H1400-5	SCR rated 1400 Arms, 500 V
Thyristor SCR1-6	General Electric C107 A1	SCR rated 4 Arms, 100V
Thyristor SCR1	Motorola 2N5060	SCR rated 0.8 Arms, 30V
Diode CR1-3	Power Semiconductor HD2500-3	Rectifier rated 2500 Arms, 300V
Diode	Fairchild 1N4148	Diode rated 400 mA, 75V
Diode	S.S.D.I. 1N5059	Rectifier rated 1 Amp, 200 V, Transient protected.
Diode	1N5624	Rectifier rated 3 Amp, 200 V, Transient protected.
Diode	Motorola 1N825	Zener rated 6.2V at 7.5 mA, Temp. Coeff: ±.002%/°C.
Diode	1N935	Zener rated 9V @ 7.5mA, ±.01%/°C.
Diode	1N4728A	Zener family 1 watt, ±5%
Diode	1N5221B	Zener family 1/2 W, ±5%
Transistor	Motorola 2N2222A	TO-18 Case, NPN Silicon 500 mA, 40 V.
Transistor	Motorola 2N2907A	TO-18 Case, PNP Silicon 500 mA, 60 V.
Transistor	General Electric D44C6	NPN Silicon, 4A, 45V, Plastic Power Pac(TO-66
Transistor	General Electric D45C6	PNP Silicon, 4A, 45V, Plastic Power Pac(TO-66
Transistor	Motorola 2N3055	NPN Silicon, 15 Amps, 60 V, TO-3 Case.

Part Name	Manufacturer's Name & P/N	Characteristics
Integrated Circuits (IC)		
IC	Fairchild U5T7725393	Instrumentation Operational Amplifier (uA725) 8-lead metal can: Low noise.
IC	Fairchild U6A7723393	Voltage Regulator, Precision (uA723)14-pin DIP
IC	Fairchild U9T7741393	Compensated Operational Amplifier (uA741) 8-pin Minidip
IC	National Semiconductor LM301AN	General Purpose Op-Amp, Un-compensated.
Resistors		
Metal Film	Corning RN60C	Precision, ±1%, T.C. less than 50 PPM/°C.
Precision Array	Kelvin Associates K2818PS	Resistor array; Spec E1000: 15 pieces type OM, 120-ohms, ±1%.
Capacitors		
AC Capacitor	General Electric 45F270	2uF, 370 Vac, Pyranol I
Metallized Mylar	IMB Electronic Products, XA16B186J	Metallized polyester: 18 uF ±5%, 100 V; 10,00 meg-ohm/uF.
Orange Drop	Sprague Electric 225P-series	Polyester Film, ±10% tolerance, Epoxy molded PCB mounting.
Relay	Master Electronic Controls, GMP4PDT24D	PC-board mounting equiv alent to P&B type KHU, 24 VDC;
Relay	Controls, GMP4PDT115A	115 VAC.
Relay	Allis-Chalmers 6TA6340K	Pilot Duty, 4 N.O. with Push to test, 120 VAC, 60 Hz coil.
Relay	Heinemann CC1-677-XXA	Normally closed, 3A@120 K10,11: 4.5 Amps, Curv 2;
	CJ-1617-XXA	K12: 0.2 Amp, Curve 2

PART NAME	Manufacturer's Name & P/N	Characteristics
Meters		
AC Voltometer (M1)	Beede, No. 305	Expanded Scale: 275-550 Vac, ±2%, Mirror scale, 3-1/2".
AC Ammeter (M2)	Beede, No. 305	AC ammeter: 0-1000 Amps rms, ±2%, Mirror scale, 3-1/2".
DC Voltmeter (M3)	Beede, No. 305	DC Voltmeter: 0-100 Vdc ±2%, Mirror scale, 3-1/2
DC Ammeter-Relay(M4)	Beede, No. 13-05	Meter-Relay: 0-5500 Adc ±2%, Adjustable trip 10-110%.
Thermostats	Therm-O-Disc 36T21	Open at 190 ±5°F, Close at 170°F
Thermostat	Therm-O-Disc 36T21	Open at 78 ±3°C
Auxiliary Power Supply (A100)	Transrex, 34073	+24 Vdc: Un-regulated, 28 + 2/-3V, 3 Amps, Capacitor Filter; +/-15 Vdc: Regulated ±0.1%, Adjustable with R21, Current limited +/-5 Vdc Regulated ±0.5% to 2.2A. No adjustment; Current limited. See Table 5-2 for test and adjustments.
KLIP-SELS	International Rectifier KSA6 DBF	3 Amps peak, 350 ± 50 V peak clamping; Selenium bi-directional transient suppressor.

APPENDIX B

B-1 HIGH VOLTAGE MODEL ISR-2126-2

B-2 The high voltage model employs secondary links to connect the four, three phase star rectifier sections in series-parallel or in series to obtain 200 Vdc or 400V dc, respectively, in addition to the parallel connection for 100 Vdc output. See Drawing No. D-34563.

B-3 SPECIFICATIONS

B-4 The ISR-2126-2 specifications are the same as the ISR-2126-1 with the following additions:

Maximum power (500 kw) is available from each secondary link configuration, i.e.:

100 Vdc, 5000 Adc max. rated current;
200 Vdc, 2500 Adc max. rated current;
400 Vdc, 1250 Adc max. rated current.

Internal factory set overload changes automatically to lower value (125%) of rated current.

B-5 The SCR-rectifier assembly was modified to permit the series connections. See Drawing No. D-34488.

B-6 The interphase transformer (T7) is bypassed by the secondary links in the 200 V connection, and interphase transformers (T5, T6) are also bypassed in the 400V connection.

B-7 Load sharing in the 400 V-series configuration is natural and efficiency is highest, but line currents contain more eleventh and thirteenth and higher harmonics than when T5, 6 and 7 are used, particularly with a resistive load. See Test Report Data.

B-8 Control function changes for the three link configurations are listed below:

a. Control Door: M3(DC OUTPUT) scale multiplier indicating lamps (X1, X2, X4).

b. Circuit Breaker Door: 100, 200 or 400 Vdc Nameplate-outside; instructions for link changing - inside.

c. Component Board: A900-subassembly.

(1) Add SW7: five pole three position (Centralab #PA 2015)
SW7 functions to change common mode feedback resistors (poles 1 & 2);

change No. [illegible] (pole 3);
change [illegible] light) (pole 4);
change [illegible] overload trip level (pole 5).

(2) Transfer SW6, R8 and F13 to A900 from component board to improve assembly. See Schematic No. SK-34718.

d. Regulator Module:

(1) Add SW4: DPST change gain, X1-X10.

(2) Modify A400 PCB: add network to alter gain of amplifier (IC2)
add amplifier (IC5) to increase gain of current loop by 10-times.

See Schematic No. C-34091, Rev. B; Bill of Material BM-34082-1.

SECTION IX

ADDENDA

9-1 This section contains information on model variations and program performance. Table 9-1 lists the appended data.

TABLE 2-1 DATA

ITEM	APPENDIX	DESCRIPTION
1	A	Model ISR-2126: Six phase system.
2	B	Model ISR-2126-2: 100, 200, 400 Vdc, secondary bus links.

APPENDIX

A-1 SIX PHASE MODEL: ISR-2126

A-2 The six phase model provides the same output power as the model ISR2126-1, but with 360 Hz output ripple at about twice the amplitude for similar operating conditions.

A-3 The input current contains higher amplitude fifth and seventh harmonics with a lower apparent power factor than ISR-2126-1.

A-4 The six phase system uses two SCR's in parallel with one load sharing reactor to assure equal division of load current. See Drawing No. D-34044.

A-5 The regulator module employs notch filters at 120 and 360 Hz rather than 240 and 720 Hz as in the 12-phase model.

CAUTION

Regulator modules are not interchangeable with ISR-2126-1.

A-6 The firing modules are interchangeable but require adjustment to minimize ripple.

FERMILAB

ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
EAD			

SUBJECT: Manufacturer: Transrex, Drawing List
500KW Power Supply

NAME: N.Cuny

DATE: 9-11-84

REVISION DATE:

1. 2816-ED-38519 - Transrex 500KW power supply voltage control (A400) and active filter (A500-A2)
2. 2816-ED-38521 - Transrex 500KW power supply current regulator and oven (A500-1, A500-2)
3. 2816-EC-39623 - Transrex 500KW power supply pulse transformer and gate network A200:2/system, 34217, SK-34085-1
4. 2930-ED-31562 - Transrex 500KW power supply auxiliary power supplies schematic
5. 2930-EE-31573 - Transrex 500KW power supply Model 1SR2126-1,-2 and 2A power supply
   NOT IN THIS PKG
6. 2930-EE-31575 - Transrex 500KW power supply transductor head and control 5000 amps - schematic diagram
   NOT IN THIS PKG
7. 2930-EE-80226 - Transrex 500KW Power supply - Model 1SR2126-1,-2 and -2A control circuit schematic
   NOT IN THIS PKG
8. 6005-ED-172210 - Firing curcuit schematic
9. 2930-EC-80669 - Differential amplifier and pot reference module
10. 6005-ED-172552 - Transrex 240KW & 500KW current regulator
11. 6005-ED-172553 - 500KW transrex voltage regulator
12. 6005-ED-172973 - Soft on/off interface chassis
13. 6005-EC-173115 ALT AUX P.S.

REVISIONS			
SYM	DESCRIPTION	DRAWN / APP'D.	DATE
D	REDRAWN DWG NO. WAS 2816-EC-38519	D.J.	9/12/75
E	REVISED	N.C.	1/30/76

NOTES:
UNLESS SHOWN OTHERWISE:
1. RESISTORS - ½ W 5%
2. CAPACITORS - MF
3. (3) SELECT-IN-TEST
4. 1% RESISTOR - RNGOC
5. CAP. SYMBOL -|(- CURVE SIDE IS BLACK BAND
6. (6) SELECT TO SET E_O MAX.
7. (7) JUMPERS - INDUCTIVE LOAD J1-5 TO J1-6; RESISTIVE LOAD J1-7 TO J1-8
8. (8) GAIN MULTIPLIER ADDED TO A400 PCB FOR ISR2126-2

2930-ED-31596 DOES NOT HAVE THIS UNIT
2930-ED-31563 IS EQUIPPED WITH THIS UNIT

ASSY. 34082-1
(6) X10 OR X10 AMPLIFIER (A400 PCB MOD)

J107/P107
J2-B
J2-A (+)
SW3 EXT.
SW2-P2 CURRENT
VOLTAGE
SW1-11
SW1-12
P107-P
P107-K
P107-H
TRANSDUCER INPUT
(C9 27VDC)
A500-1 & A500-2
J1-8
6-10V
A400 PCB
(+15V)
(-15V)
K14 N.O
K14 N.C.
IC1 LM301
IC2 741C
IC3 741
IC4 741C
IC5 LM301
IC6 LM301
SCR1 2N5060
Q1 2N2222A
Q2 2N2222A
Q3 2N2907A
CR1
CR2 IN5239B (9.1V)
CR3 IN4148
CR4 IN4148
CR5 IN5059
R1 2200
R2 4700
R3 1M 1%
R4 4700
R5 4990 1%
R6 4990 1%
R7 4700
R8 1800
R10 330
R11 10Ω
R12 330
R13 10K
R14 10K
R15 10K CW
R16 5K
R17 324Ω 1%
R18 2000Ω 1%
R19 10Ω
R20 10K
R21 10Ω
R22 10K
R23 1K
R24 1500
R25 10K 1%
R26 2490
R27 1240 1%
R28 825
R29 3320 1%
R30 2490 1%
R31 24.90 1%
R32 30.1K
R36 15K 1%
R39 8060 1%
R40 1500
R41 1800
R42 2.7
R43 2.7
R44 1K
R45 4000 3W 1%
R46 45K 10W 1%
R47 45K 10W 1%
R48 2500 3W
R49 10K
R50 3500
R51 1K
R52 2500 3W
RG1 100
RG2 1K
RG3 100Ω
RG4 1K
RG0 10K
RG1 10K
RG2 1100Ω
C1 .01
C2 68/25
C3 .0047 100V
C4 30PF
C5 .0047 100V
C6 0.27 75V
C8 100 15V
C9 20 50V
C10 200 50V
C12 .27 75V
C15 .047 100V
C16 .015
C17 .09
C18 0.27
C19 0.18
C20 .001
C21 0.1
C24 .047 100V
C27 30PF 1000V
C28 30PF
C29 0.15
C31 20 50V
J1-D(-)
J1-C(+)
SIG COM
E (-15V)
S (OUT) +14.5V +25V
A (+15V)
GAIN MULTIPIER
(IN) J1-12
(OUT) SW3-11
SW4 (X10) (X1)
e3 e1 e2 (COMM.)
J4 (-) TOTAL VOLTAGE OUTPUT (0-400V).
J3 (+) (¾" SPACED JACKS ON MOD-7.)
L (+E_O)
M (-E_O)
P107 J107
P.S. RETURN
E3 CABINET GROUND EARTH (IN MODULE 7)
720 HZ. NOTCH A500-2A ACTIVE FILTER BD.

ITEM NO.	PART NO.	DESCRIPTION	QTY. REQ.
PARTS LIST			

UNLESS OTHERWISE SPECIFIED		ORIGINATOR	TRANSREX 34091
FRACTIONS / DECIMALS / ANGLES		DRAWN	D. JOHNSON 9/12/75
± / ± / ±		CHECKED	P. PIAZZASSO 9/12/75
1. BREAK ALL SHARP EDGES 1/64 MAX.		APPROVED	
2. DO NOT SCALE DWG.		APPROVED	
3. DIMENSIONING IN ACCORD WITH USASI Y14.5 STD's.		USED ON	TRANSREX MODEL ISR 2621-GH5C
√ MAX. ALL MACHINED SURFACES		MATERIAL-	

NATIONAL ACCELERATOR LABORATORY
U.S. ATOMIC ENERGY COMMISSION

EXPERIMENTAL AREAS DEPT.
TRANSREX 500KW POWER SUPPLY
VOLTAGE CONTROL (A400) & ACTIVE FILTER (A500-1 & -2)

SCALE	DRAWING NUMBER	REV.
None	2816-ED-38519	E

BRUNING 40-107

REVISIONS				
SYM	DESCRIPTION	DRAWN / APPD.	DATE / DATE	
C	REDRAWN NO. WAS 2816-EC-38521	D.J. /	3/12/75	
D	REVISED	N.C.	8/11/14	

MODULE 7 - FRONT PANEL

GAIN CONTROL (MAGNET RESISTANCE)

R39	16.2K	(POS.2)
R40	8060	
R41	4640	
R42	3010	
R43	2000	
R44	1330	
R45	931	
R46	634	1% (12)

6 ma (POS.1) (LEAST GAIN)

SW1 (9-POS.)

SW2 (6 POS.) TIME CONSTANT

R47	29.4
R48	59K
R49	88.7K
R50	118K
R51	178K

3 (SECONDS)

NOTES:

UNLESS SPEC. OTHERWISE:
1. RESISTORS: 1/2W, ±5%
2. CAPACITOR: MF.
3. ⚠3: SELECT IN TEST.
4. 1% RESISTOR; RN60C.

J102-P, J102-W, J103, J102-S, J102-V, BIN J107, MODULE 7 P107

A400 PC.B. P107H

A500-1 PCB IN OVEN (ASSEMBLY 340531)

J1-12 OUTPUT, MODE SW. (CURRENT)

COM. (-) J1-11 (REF.)

J1-6/P107-K (XDTR-)

J1-5/P107-H (XDTR+)
RESISTIVE LOAD:
JUMPER J1-7 TO J1-8.
(MAGNET LOAD: REMOVE JUMPER FROM J1-7 & CONNECT J1-8 TO P107-H.

(17.5V)

(-9V)

OVEN DETAIL

NOTE UNLESS SPECIFIED OTHERWISE
1) RESISTORS: 1/2 W 5%
2) CAPACITORS, MF
⚠3 SELECT-IN-TEST
4) 1% RESISTORS RN60C & A400

720 HZ NOTCH — 240 HZ NOTCH — ACTIVE FILTERED A500-2 IN OVEN

ITEM NO.	PART NO.	DESCRIPTION	QTY. REQ.

PARTS LIST

UNLESS OTHERWISE SPECIFIED	ORIGINATOR	TRANSREX 34059	
FRACTIONS DECIMALS ANGLES	DRAWN	D. JOHNSON	9/12/75
± / ± / ± /	CHECKED	P.N. PEACASSO	9/12/75
1. BREAK ALL SHARP EDGES 1/64 MAX.	APPROVED		
2. DO NOT SCALE DWG.	APPROVED		
3. DIMENSIONING IN ACCORD WITH USAS Y14.5 STD'S.	USED ON	TRANSREX MODEL ISR-2126-1	
√ MAX. ALL MACHINED SURFACES	MATERIAL-		

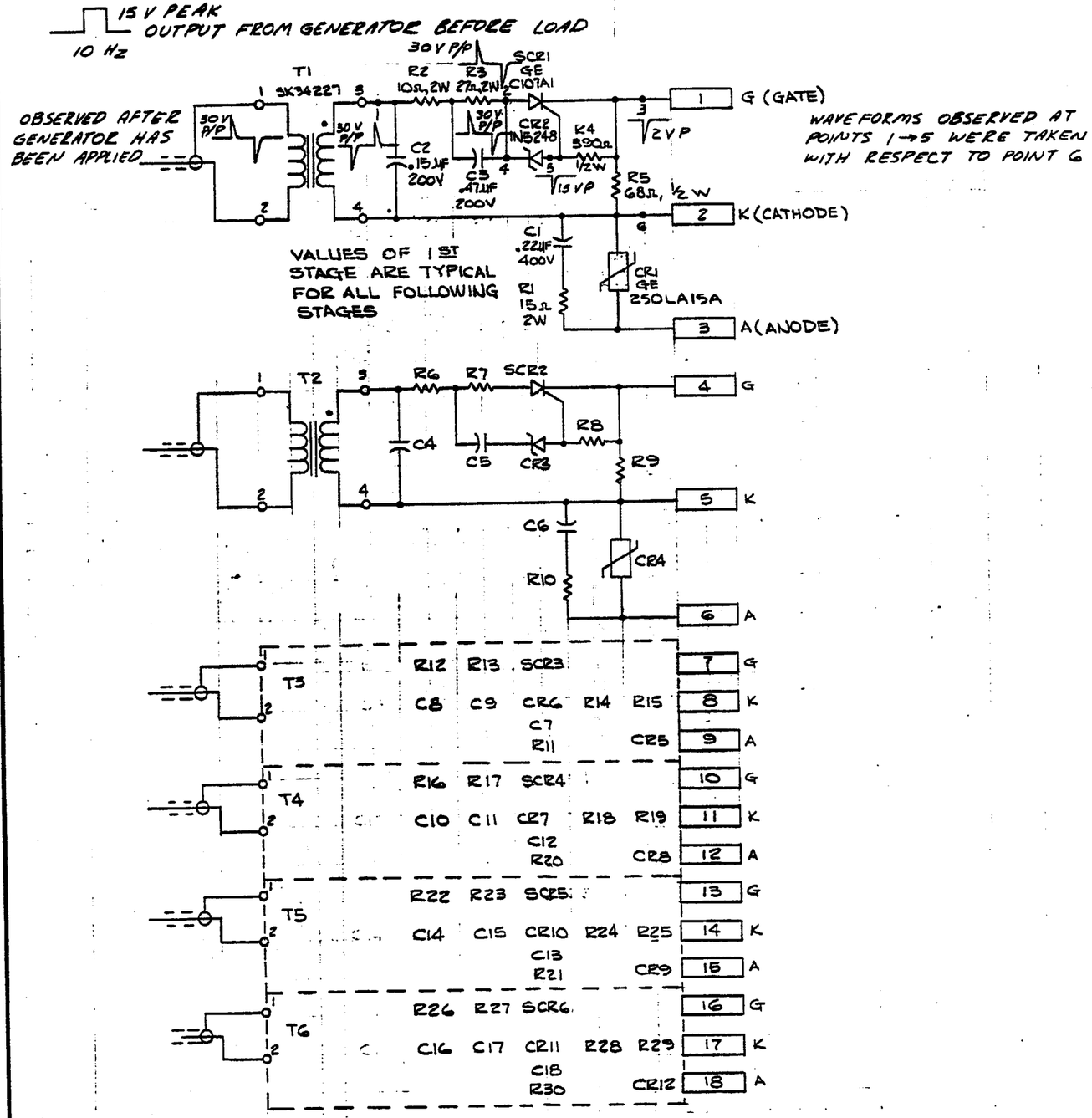
NATIONAL ACCELERATOR LABORATORY
U.S. ATOMIC ENERGY COMMISSION

EXPERIMENTAL AREAS DEPT.
TRANSREX 500KW POWER SUPPLY
CURRENT REGULATOR & OVEN
(A500-1, A500-2)

SCALE	FILMED	DRAWING NUMBER	REV.
None	FC	2816-ED-38521	D

BEUNING 46-107

REVISIONS				
SYM	DESCRIPTION	DRAWN / APPD.	DATE / DATE	
A	UPDATED	FHS	5/1/74	
B	REVISED	N.C.	8/1/64	



BD #34168-1B

ITEM NO.	PART NO.	DESCRIPTION	QTY. REQ.

PARTS LIST

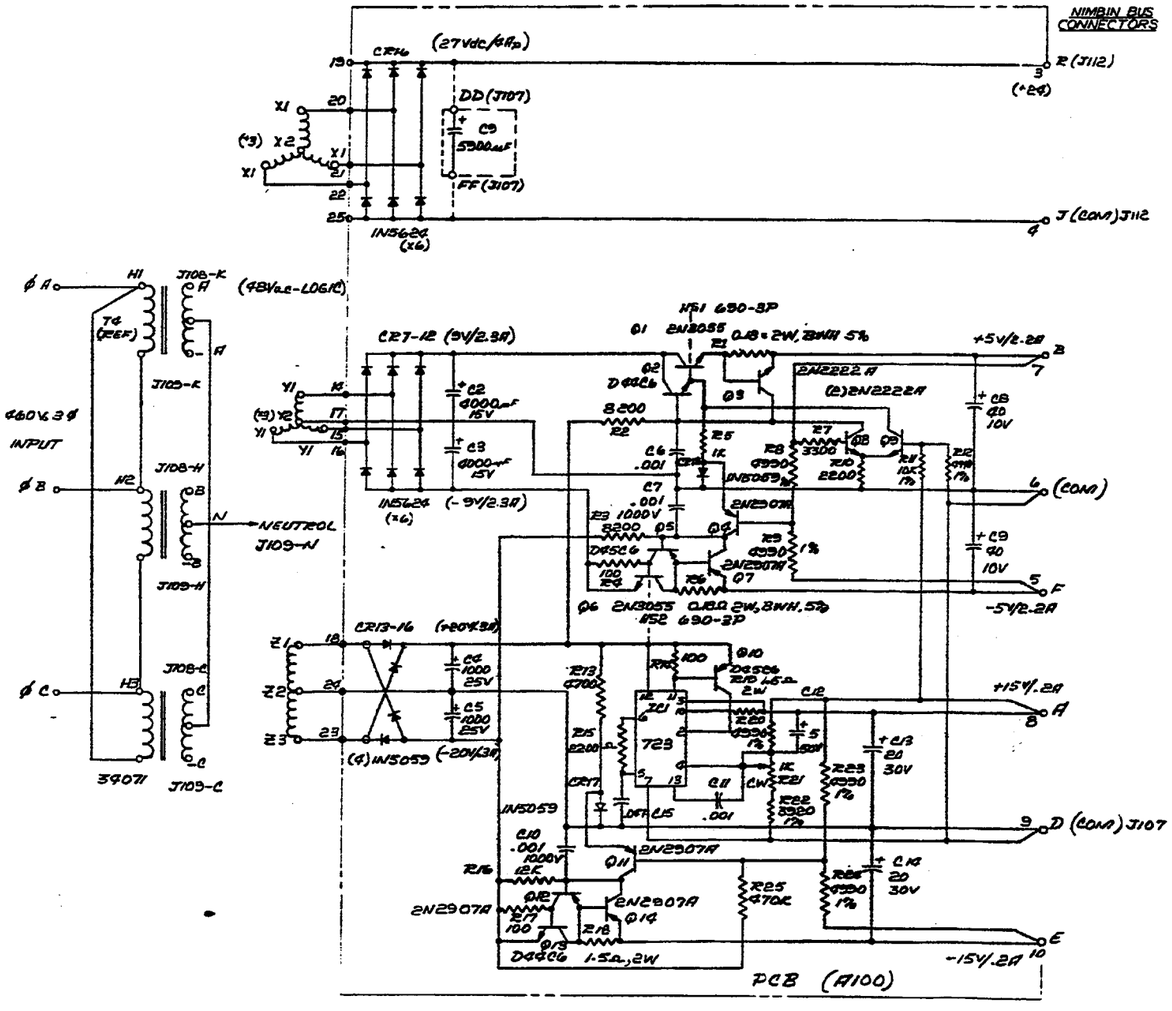
UNLESS OTHERWISE SPECIFIED			ORIGINATOR	TRANSREX SK-34085-1	
FRACTIONS	DECIMALS	ANGLES	DRAWN	P. NFRACASSO	8/8/74
±	±	±	CHECKED		
1. BREAK ALL SHARP EDGES 1/64 MAX.			APPROVED		
2. DO NOT SCALE DWG.			APPROVED		
3. DIMENSIONING IN ACCORD WITH USASI Y14.5 STD's.			USED ON	TRANSREX ASSY 34217 (MODEL 212L) A 200 : 2/SYS.	
√ MAX. ALL MACHINED SURFACES			MATERIAL -		

NATIONAL ACCELERATOR LABORATORY
U.S. ATOMIC ENERGY COMMISSION

EXPERIMENTAL AREAS DEPT.
TRANSREX 500KW POWER SUPPLY
PULSE TRANFORMER & GATE NETWORK
A200 : 2/SYSTEM, 34217, SK-34085-1

SCALE	FILMED	DRAWING NUMBER	REV.
NONE	EA	2816-EC-39623	B

REVISIONS			
SYM	DESCRIPTION	DRAWN / APPD.	DATE
A	REVISED	N.C.	9/12/94



4. FOR 34072-1 DELETE COMPONENTS FOR ±5VDC OUTPUT.
3. 1% RESISTORS: RN60C/D.
2. CAPACITORS: μF.
1. RESISTORS: 1/2 W, 5%.
NOTE: UNLESS OTHERWISE SHOWN:

NOTE:
1. VENDOR SOURCE;
TRANS-REX, EL SEGUNDO, CALIF.
THEIR DWG. NO. D-34072

ITEM NO.	PART NO.	DESCRIPTION	QTY. REQ.
		PARTS LIST	

UNLESS OTHERWISE SPECIFIED	ORIGINATOR	P. WINE	5-6-73
FRACTIONS / DECIMALS / ANGLES	DRAWN	THEO YOUNG	11/20/72
± — / ± — / ± —	CHECKED	P. Wine	5-6-73
1. BREAK ALL SHARP EDGES 1/64 MAX.	APPROVED	P. Wine	5-6-73
2. DO NOT SCALE DWG.	APPROVED		
3. DIMENSIONING IN ACCORD WITH USASI Y14.5 STD's.	USED ON	—	
√ MAX. ALL MACHINED SURFACES	MATERIAL	—	

NATIONAL ACCELERATOR LABORATORY
U.S. ATOMIC ENERGY COMMISSION

EXPERIMENTAL AREAS DEPT.
TRANSREX 500KW POWER SUPPLY
AUXILARY POWER SUPPLIES
SCHEMATIC

SCALE	FILMED	DRAWING NUMBER	REV.
—	A	2930-ED-31562	A

SELNING 40-107

REVISIONS				
ZONE		DESCRIPTION	DATE	APPROVED
		DELETE J4 + J5 R.W	2/24/83	
		DELETE FRAME GROUND R.W	3/3/83	
		CLARIFY FRAME GND + COMMON		
		C24.C25.C26. ADDED R.W	5/16/83	

-5.1V NOMINAL

ØA K (1,7,12,4)

ØB H (5,11,9,10)

ØC C (9,3,8,2)

NEUTRAL N

F.C. INPUT VOLTAGE P

"ONE-SHOT OUTPUT ØA"

"ONE-SHOT OUTPUT ØB"

"ONE-SHOT OUTPUT ØC"

L M S T U V J1 J2 J3

F1 ½A +24V.

R J O A D E +15V. -15V.

4.

3. ⏚ = FRAME GROUND

2. RESISTANCE VALUES ARE IN OHMS, W, ±5%.

1. REAR PANEL FUSE OPTION: F1= LITTLE FUSE 346, ½A R18, R34, R50= 1.5K

NOTES: UNLESS OTHERWISE SPECIFIED

REF. 06-021019 150KW

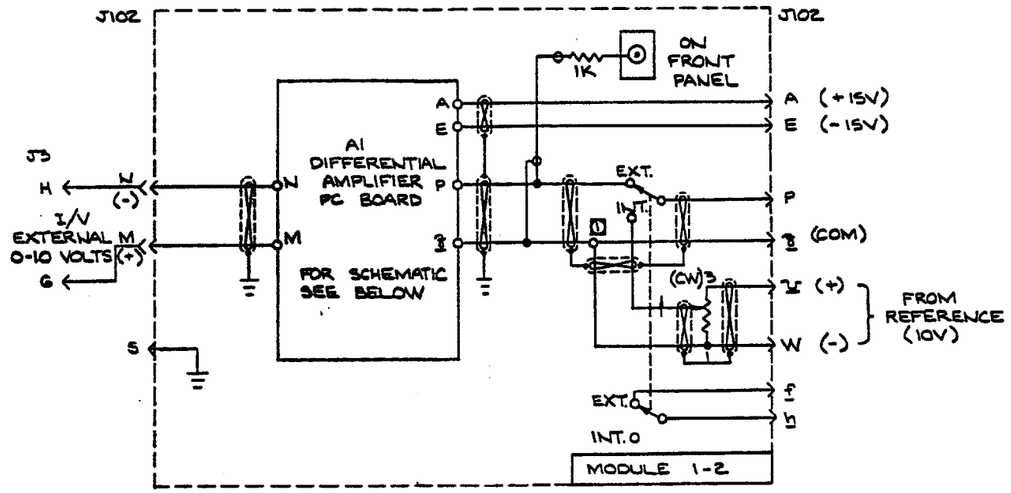
P=EI Power Energy Industries

-SCHEMATIC-

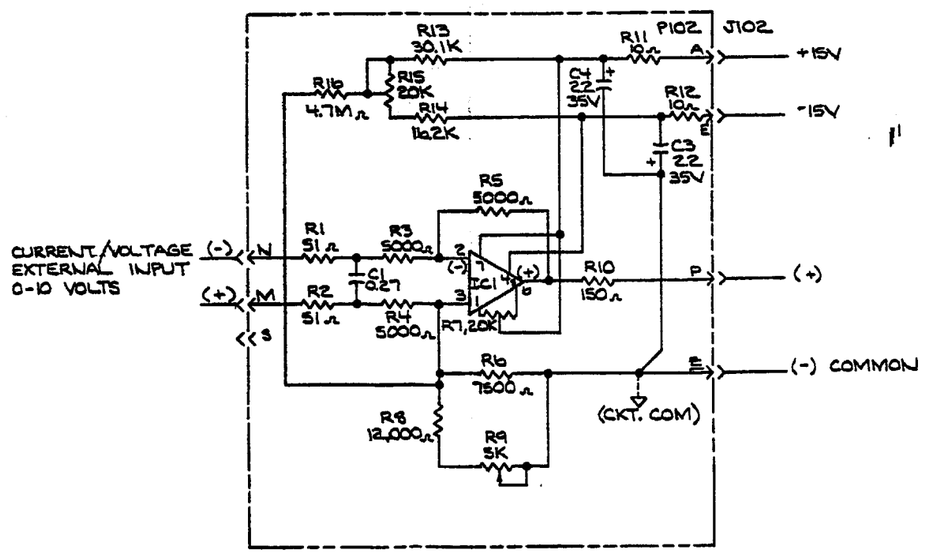
FIRING CIRCUIT

DRAWN	R. WISTAR	1-3-83			
CHECKED	CRM	1/31/83			
ENGINEER					
PROJ. ENG.					
PROJECT APPROVAL		1/31/83	CODE OR IDENT NO. 58877	SIZE D	6005-ED-172210 D
MODEL	USED ON ASSY	PARTS LIST	SCALE NONE	82-138.83-003	SHEET 1 OF 1

REV.	DESCRIPTION	DRAWN / APPD.	DATE
A	REDRAWN		9-21-79



1 SPARE POLE ON SW1 USED AS TIE POINT



ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.

PARTS LIST

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	G. ROSS	
FRACTIONS	DECIMALS	ANGLES	DRAWN	N. CUNY	9-21-79
±	±	±	CHECKED	G. ROSS	9-21-79
			APPROVED		

1. BREAK ALL SHARP EDGES 1/64 MAX.
2. DO NOT SCALE DWG.
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5 STD's.
√ MAX. ALL MACHINED SURFACES

USED ON

MATERIAL-

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

EXPERIMENTAL AREAS DEPT.
DIFFERENTIAL AMPLIFIER & POT REFERENCE MODULE

SCALE	FILMED	DRAWING NUMBER	REV.
		2930-EC-80669	A

A

REV.	DESCRIPTION	DRAWN APPR.	DATE
A	REVISED	N.C.	12/17/85
B	REVISED	N.C.	4/11/86

CURRENT LOOP AMP

GAIN MULTIPLIER
CUTLER-HAMMER TYPE TE7-123

DC GAIN
POS. SHORTING
(1 POL. 12 POS.)
FRONT PANEL
MUST BE CERAMIC WAFER
(CENTRALAB *PA2000)

DAMPING
9 POS. SHORTING
(1 POL. 12 POS.)
FRONT PANEL
MUST BE CERAMIC WAFER
(CENTRALAB *PA2000)

AVERAGE CURRENT TRIP

INSTANTANEOUS CURRENT TRIP

TRANSDUCER FAILURE CKT.

CURRENT READOUT BUFFER

INTERNAL REFERENCE

REGULATOR STATUS MODE SWITCH

REGISTOR ARE TO ACT AS FUSES

ALL RESISTORS 1% UNLESS OTHERWISE INDICATED

ALL RESISTORS ¼ W UNLESS OTHERWISE INDICATED

ALL CAPACITORS ARE EITHER TANTALUM, MYLAR, SILVER MICA, OR POLYESTER FILM

□ TYPICAL LOWER CASE LETTER

-⊖ EXTERNAL CONNECTION POINT ON BOARD

OP-37E, OP-7ET, AND OP-7EZ MAY BE SUBSTITUTED FOR OP-5ET

ALL WIRE IS TEFLON INSULATED, TYPE E, MIL-W-16878

AWG #22 IS USED FOR ±15V AND GROUNDS (A, D, E & J), AWG #24 IS USED FOR ALL OTHER WIRING.

TWISTED PAIR IS BELDEN #83003 OR EQUIV, RED/WHT

1 COND. SHIELDED IS BELDEN #83004 OR EQUIV.

2 COND. SHIELDED IS BELDEN #83318 OR EQUIV.

ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.

PARTS LIST

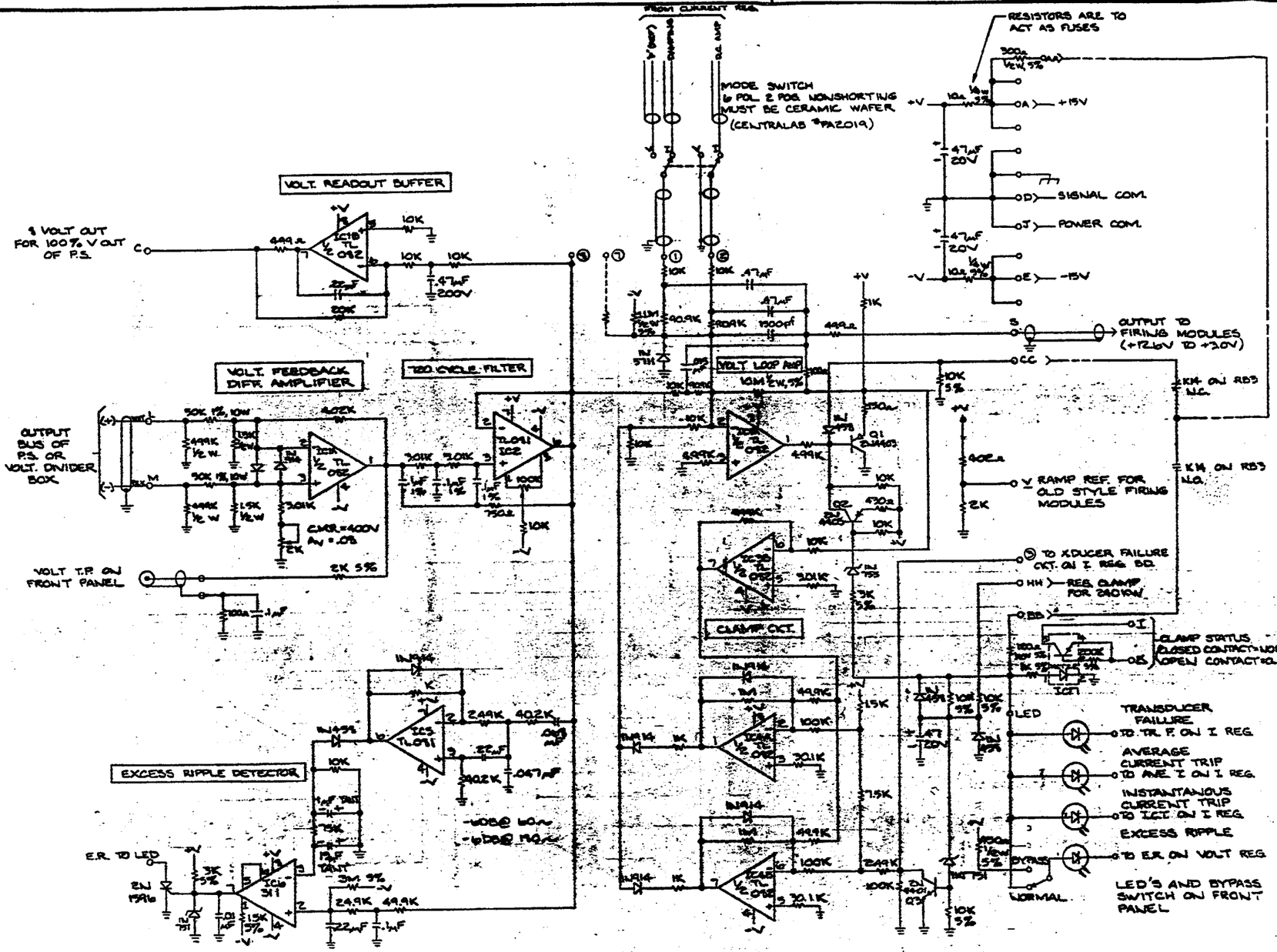
UNLESS OTHERWISE SPECIFIED	ORIGINATOR	W. JASKIERNY	3/29/85
FRACTIONS / DECIMALS / ANGLES	DRAWN	N. CUNY	3/29/85
± / ± / ±	CHECKED		
1. BREAK ALL SHARP EDGES 1/64 MAX.	APPROVED		
2. DO NOT SCALE DWG.	USED ON		
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5 STD's. MAX. ALL MACHINED SURFACES	MATERIAL		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

EXPERIMENTAL AREAS DEPT.
TRANSREX 240KW & 500KW
CURRENT REGULATOR

SCALE	FILMED	DRAWING NUMBER	REV.
		6005-ED-172552	B

REV.	DESCRIPTION	DRAWN / APPD.	DATE
A	REVISED	N.C.	12/17/85
B	REVISED	N.C.	1/2/86
C	REVISED	N.C.	4/10/86



ALL RESISTORS 1% UNLESS OTHERWISE INDICATED
ALL RESISTORS ¼W UNLESS OTHERWISE INDICATED
ALL CAPACITORS ARE EITHER TANTALUM, MYLAR, SILVER MICA, OR POLYESTER FILM

V TYPICAL LOWER CASE LETTER
-O EXTERNAL CONNECTION POINT ON BOARD
ALL WIRE IS TEFLON INSULATED, TYPE E, MIL-W-16878
AWG #22 IS USED FOR ±15V AND GROUNDS (A, D, E & J),
AWG #24 IS USED FOR ALL OTHER WIRING
TWISTED PAIR IS BELDEN #83003 OR EQUIV., RED & WHT.
1 COND. SHIELDED IS BELDEN #83304 OR EQUIV.
2 COND. SHIELDED IS BELDEN #83319 OR EQUIV.

ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.

PARTS LIST

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	W. JASKIERNY	9/20/85
FRACTIONS	DECIMALS	ANGLES	DRAWN	N. CUNY	9/20/85
±	±	±	CHECKED		
1. BREAK ALL SHARP EDGES 1/64 MAX.			APPROVED		
2. DO NOT SCALE DWG.			USED ON		
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5 STD's.			MATERIAL		
√ MAX. ALL MACHINED SURFACES					

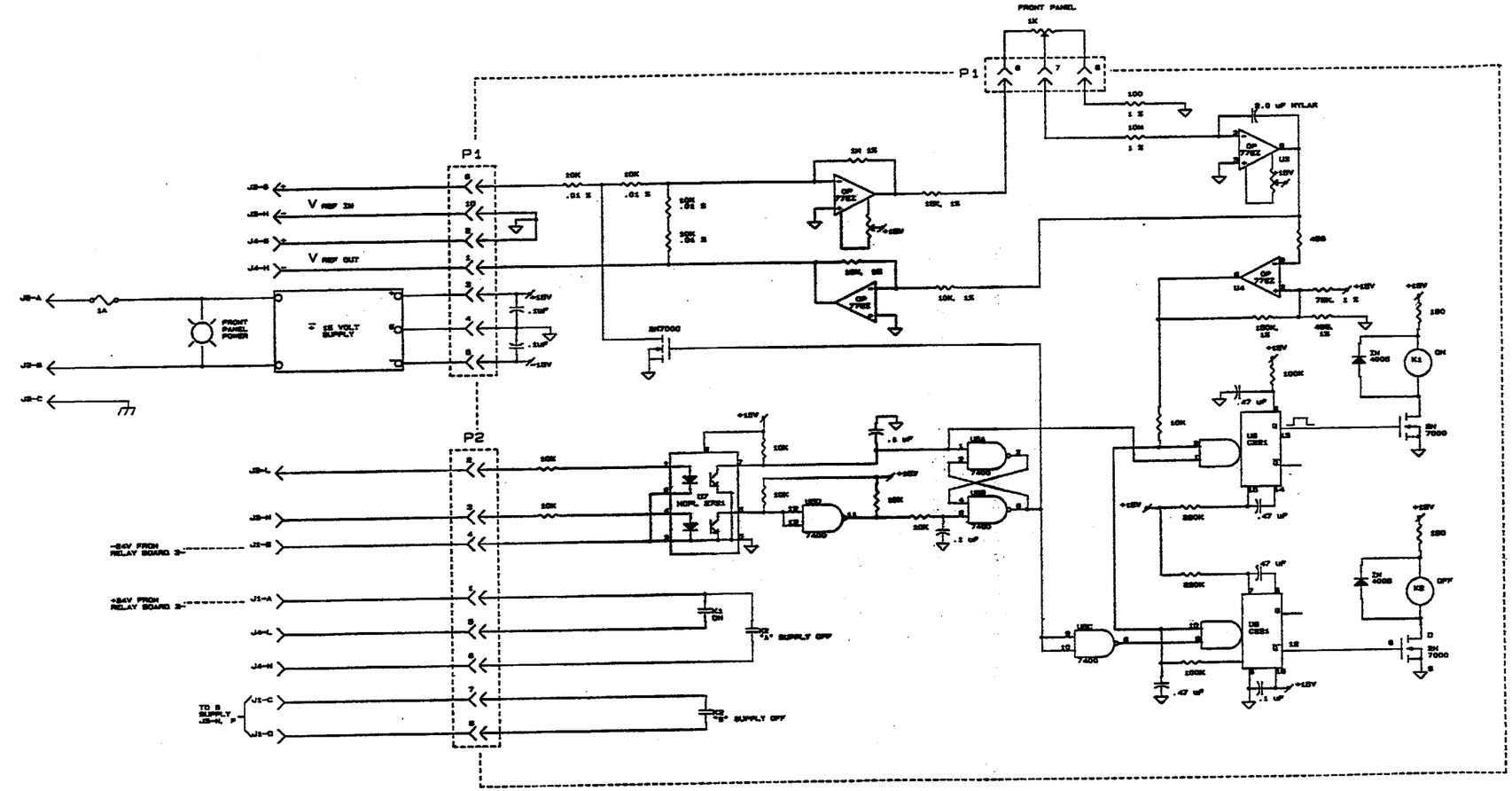
FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

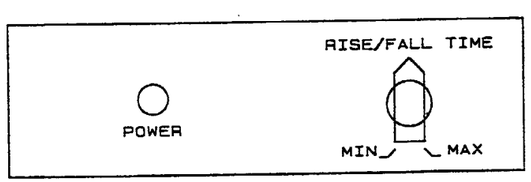
EXPERIMENTAL AREAS DEPT.
500KW TRANSREX
VOLTAGE REGULATOR

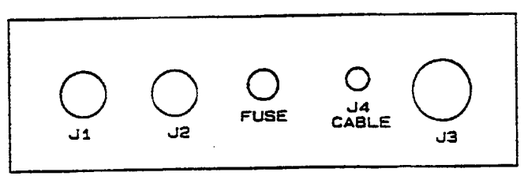
SCALE	FILMED	DRAWING NUMBER	REV.
		6005-ED-172553	G

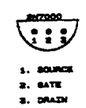
5225T1-03-2002

REV.	DESCRIPTION	DRAWN	DATE
		APPD.	DATE
A	REVISED	N.C.	6/26/91









NOTES:
J3 = 10 PIN MOLEX CONNECTOR
J4 = 8 PIN MOLEX CONNECTOR
J1 = BURNDY 9DB 10-4 PME
J2 = BURNDY MS3120E 18-32
J5 = BURNDY 9DB 18-32 PME
J6 = BURNDY 9DF 18-32 SME TERMINATED ON
8 PAIR BELDEN CABLE #8774
U1 THRU U4 = OP77EZ
U5 = 74S00
U6 = 74C14 - CLAIRE LH44000
ALL RESISTORS 1/4 WATT

ORIGINATOR	STOFFEL	7/11/90	CHECKED	B. MORRISON
DRAWN	CUNY	7/11/90	APPROVED	
FILE NAME	STOFFELA			

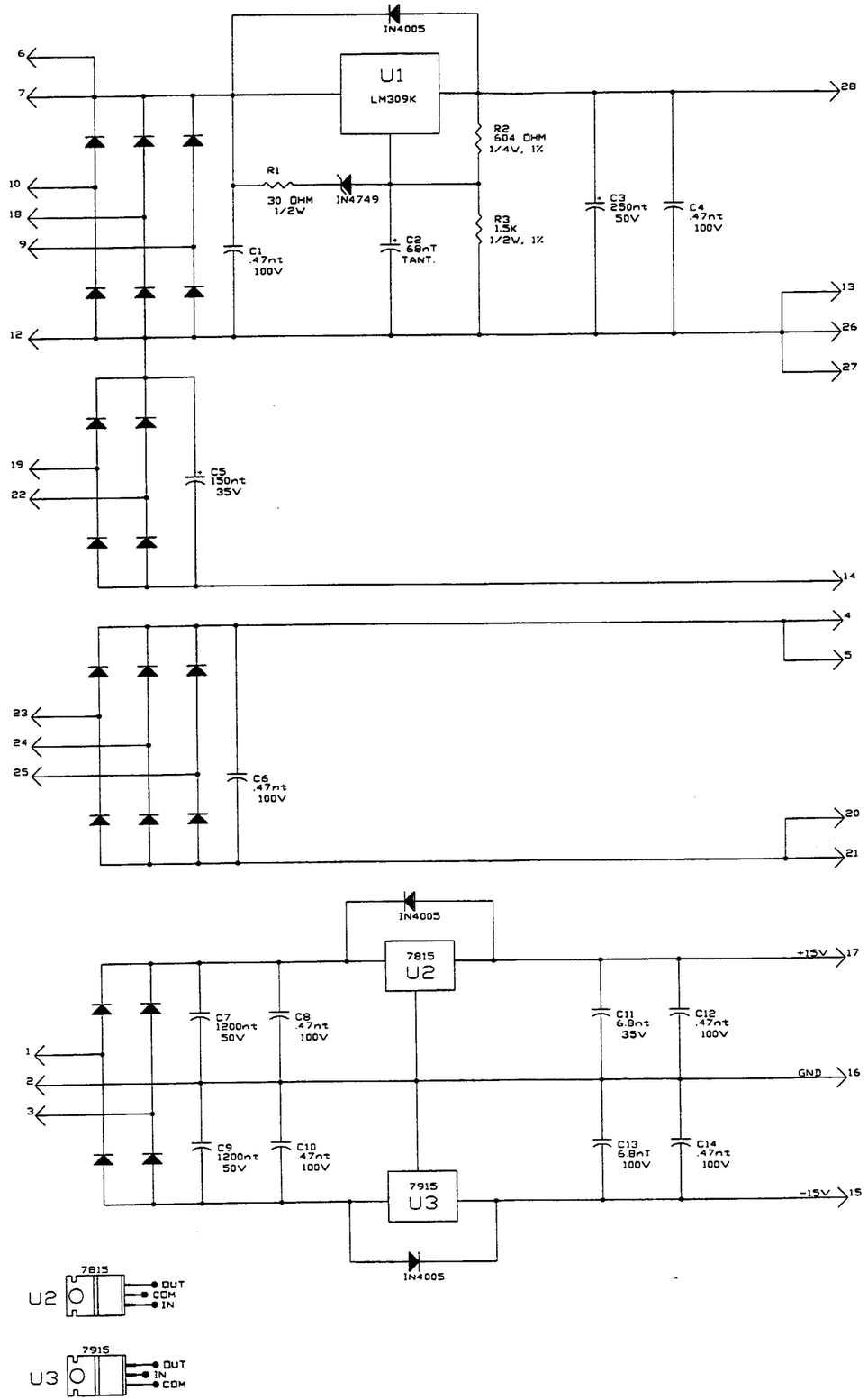
FERMI NAT'L ACCELERATOR LAB
UNITED STATES DEPT OF ENERGY

RESEARCH DIVISION
SOFT ON/OFF
INTERFACE CHASSIS

SCALE	FILMED	DRAWING NUMBER	REV
NONE		6005-ED-172973	A

6TPSM-03-2000

REV.	DESCRIPTION	DRAWN / APPD.	DATE



ORIGINATOR			CHECKED		
DRAWN	N. CUNY	9/24/92	APPROVED		

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

RESEARCH DIVISION
240KW TRANSREX
24V POWER SUPPLY

SCALE	SOFTWARE	DRAWING NUMBER	REV.
NONE	AUTOCAD	6005-EC-173115	