

PROJECT ADMINISTRATION DATA SHEET

ORIGINAL

REVISION NO. _____

Project No. A-3492

GTRI/~~G&T~~

DATE 6 / 13 / 83

Project Director: J. C. Butterworth

C6

~~School~~/Lab

RAIL-DD

Sponsor: Philips Elektronikindustrier AB

Type Agreement: Rev. 1 to P.O. No. D21-247145

Award Period: From 3/15/83 To 12/14/83 (Performance) _____ (Reports)

Sponsor Amount:

This Change 2/24/84

Total to Date

Estimated: \$ 94,294

\$ 94,294

Funded: \$ _____

\$ _____

Cost Sharing Amount: \$ None

Cost Sharing No: N/A

Title: Power Supply Modulator

ADMINISTRATIVE DATA

OCA Contact William F. Brown

Ext. 4820

1) Sponsor Technical Contact:

2) Sponsor Admin/Contractual Matters:

Bengt Broman-DV-LAAH/MAJA

Philips Elektronikindustrier AB

Defense Electronics

Sensors and CM Department

Radar S-175 88

JARFALLA, Sweden

Defense Priority Rating: N/A

Military Security Classification: N/A

(or) Company/Industrial Proprietary: _____

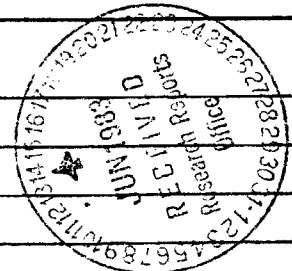
RESTRICTIONS

See Attached N/A Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval - Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of \$500 or 125% of approved proposal budget category.

Equipment: Title vests with None proposed

COMMENTS:



COPIES TO:

- Project Director
- Research Administrative Network
- Research Property Management
- Accounting

- Procurement/EES Supply Services
- Research Security Services
- Reports Coordinator (OCA)
- Research Communications (2)

- GTRI
- Library
- Project File
- Other I. Newton

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 6/25/84

Project No. A-3492 ~~Research~~ Lab RAIL-DD

Includes Subproject No.(s) _____

Project Director(s) J. C. Butterworth GTRI / ~~GTR~~

Sponsor Philips ElektronikIndustrie

Title Power Supply Modulator

Effective Completion Date: 2/24/84 (Performance) 2/24/84 (Reports)

Grant/Contract Closeout Actions Remaining:

- None
- Final Invoice or Final Fiscal Report
- Closing Documents
- Final Report of Inventions
- Govt. Property Inventory & Related Certificate
- Classified Material Certificate
- Other _____

Continues Project No. _____ Continued by Project No. _____

COPIES TO:

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- Project File
- Other _____

ENGINEERING EXPERIMENT STATION

Georgia Institute of Technology

A Unit of the University System of Georgia

Atlanta, Georgia 30332

30 May 1983



N. 701
SR-342

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #1 on Georgia
Tech/EES Project A3492, Period Covering 15 March
through 30 April 1983, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

Figure 1 is a milestone bar chart that outlines the essential tasks of the work that will be performed. The milestones illustrated in this bar chart will serve as a reference for future progress reporting.

The average power required by the modulator has been calculated to be about 70 watts. Georgia Tech/EES hereby recommends the use of a Spellman high voltage power supply (HVPS). Manufacturer's specifications for the Spellman RHR series of HVPS are contained in Attachment I. A RHR series supply is illustrated in Figure 2 along with its dimensions. Figure 3 is a three-view sketch of the modulator with dimensions.

Figure 4 is a revised outline of a possible packaging scheme for the radar system. The cabinet dimensions (manufactured or supplied by Philips) suggested in this drawing are those of a BUD AGC-9280 cabinet. Manufacturer's specifications for this line of cabinets are also contained in Attachment I. The cabinet accepts 19" (48.26 cm) panels for rack mounting, thereby allowing mounting of the Spellman HVPS. The control circuitry, low-voltage power supply, and the potted sections of the modulator will be contained in a rectangular aluminum enclosure with dimensions of 25.4 cm x 25.4 cm x 42 cm. The modulator can be rack mounted on one side only to allow for mounting the EIO and waveguide runs to the antenna. The overall height of the cabinet (76 cm) would allow for the mounting of two 30.5 cm antennas with 14 cm separation with no overhang of the antennas around the edges of the cabinet. The remaining area of the cabinet (approximately 28 cm x 53 cm x 54 cm) can be used for the radar receiver.

Page 2 of 2
A3492 Status Report

As of 30 April, the funds expended for the project totaled \$8,229.56,
or 8.73% of the total amount funded for the contract.

Sincerely,



J. C. Butterworth
Project Director

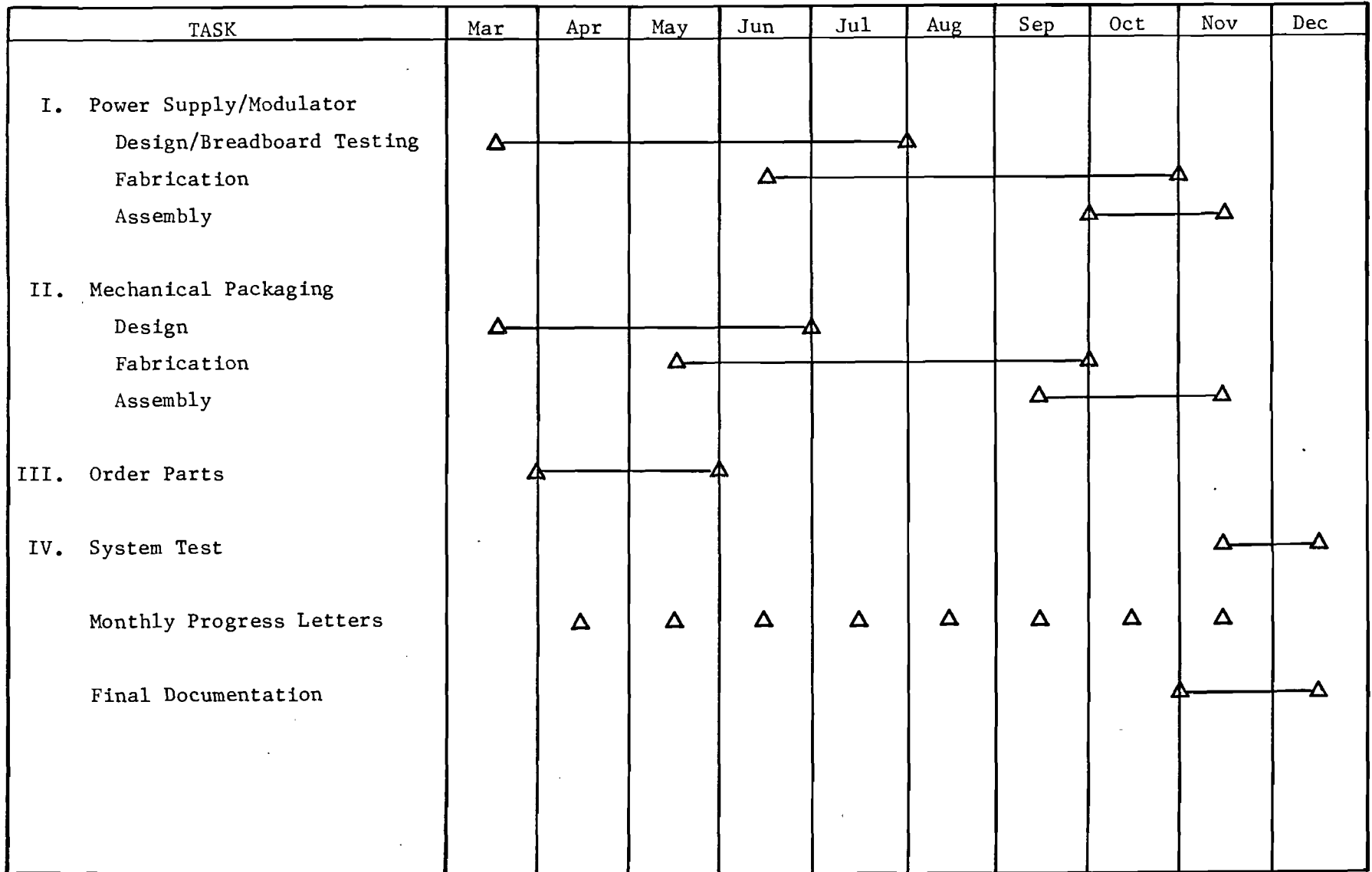
JCB/vcy

Approved:



C. E. Brown
Chief, Development Division
RAIL

Figure 1. Task Milestones



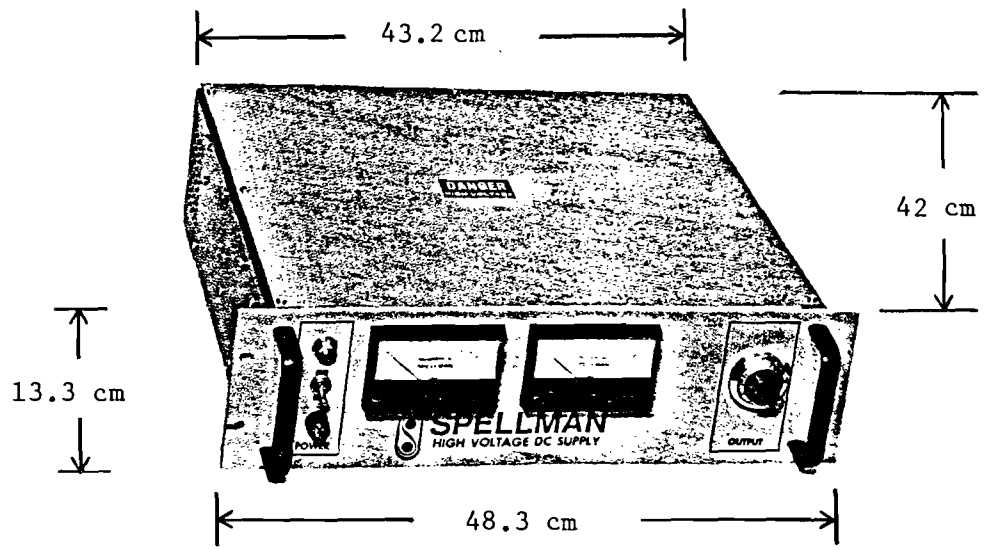


Figure 2. Example of Spellman RHR series high voltage power supply.

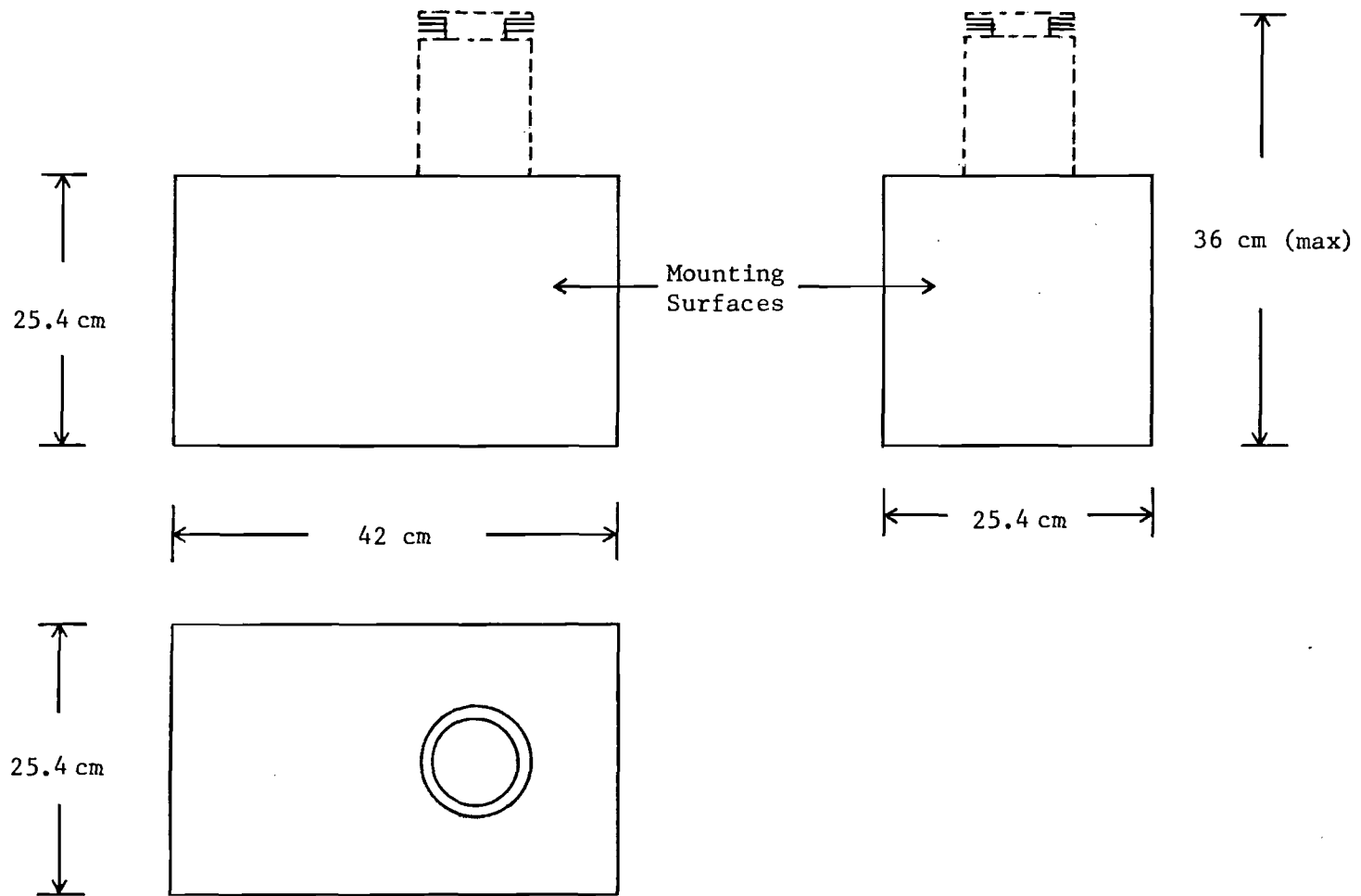


Figure 3. Outline of dimensions for the modulator.

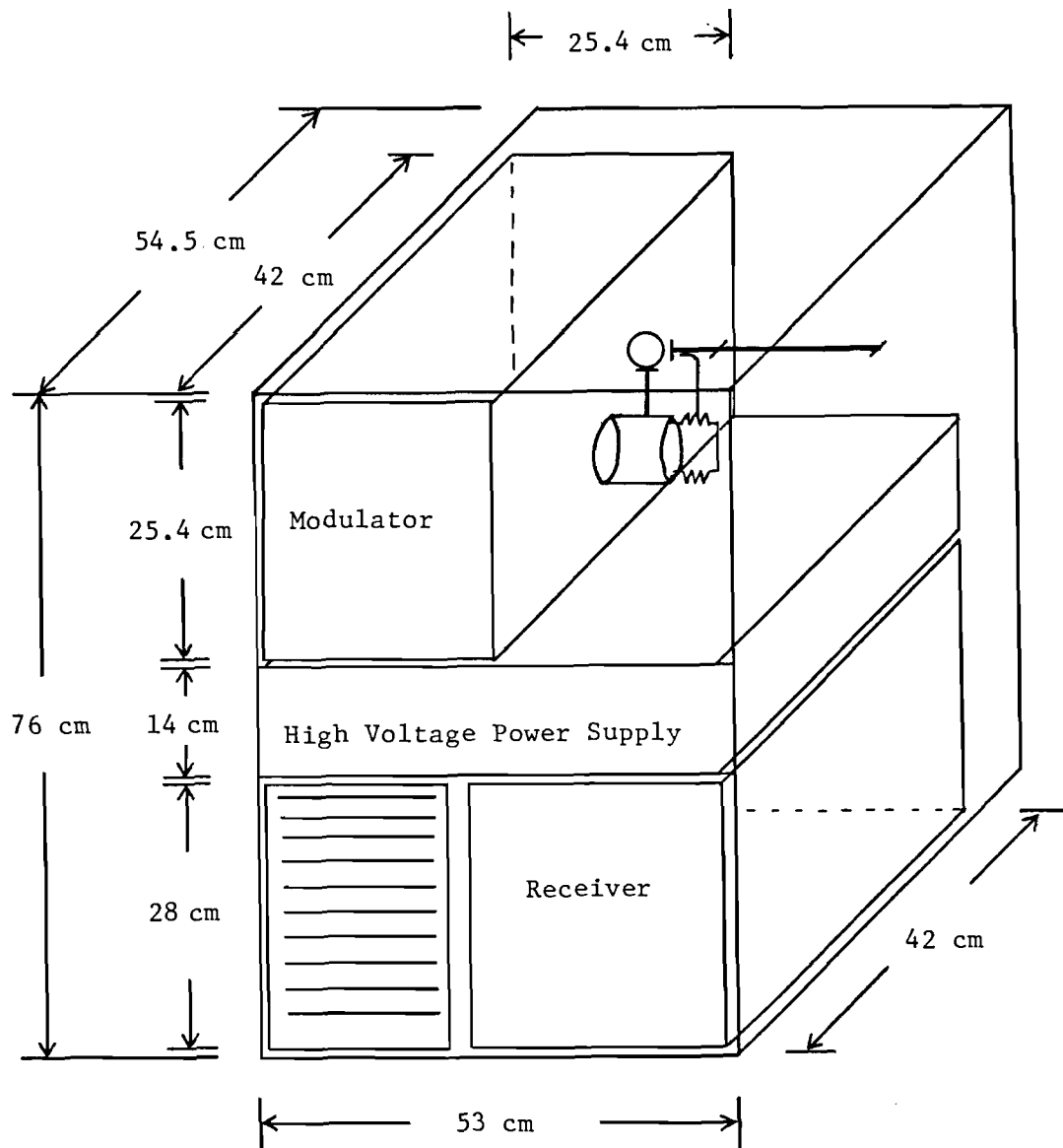
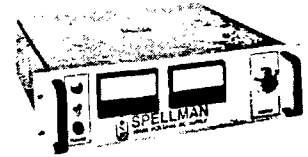


Figure 4. Outline of radar system packaging.

ATTACHMENT I
Manufacturer's Specifications

RHR LINE OF REGULATED HIGH VOLTAGE POWER SUPPLIES



APPLICATIONS

- CRT DISPLAYS
- CAPACITOR CHARGING
- LASERS
- ELECTRON MICROSCOPES
- IONIZATION CHAMBERS
- CORONA TESTING
- OEM
- ELECTROSTATIC FLOCKING AND SPRAYING

FEATURES

- ALL SILICON, SOLID STATE DESIGN
- 0.01% REGULATION/0.02% RIPPLE
- OVERLOAD AND SHORT CIRCUIT PROOF
- SMALL SIZE
- LIGHT WEIGHT
- LOW COST
- THREE YEAR WARRANTY
- INSULATION FAULT DETECTION
- X-RAY SUPPLIES
- ION IMPLANTATION
- ALL-PURPOSE LAB SUPPLIES
- ELECTRON BEAM ACCELERATORS

SPECIFICATIONS

OUTPUT VOLTAGE: Continuously adjustable over entire range from zero to rated voltage by means of ten-turn potentiometer. Resolution better than 250 ppm. Finer resolution available on special order.

INPUT VOLTAGE: 105-125 Volts AC, 55-65 Hz, single phase. Other inputs available on request. See options.

REGULATION: Load: 0.01% +1V, for full load change.
Line: ±0.01% ±1V, for ±10% change.

RIPPLE: 0.02% +2 volts, RMS. 0.1% RMS on 100KV models and above.

POLARITY: Positive, Negative, and Reversible with respect to ground available.

STABILITY: 0.02% +2 volts per hour, 0.05% +5 volts per eight hours.

TEMPERATURE COEFFICIENT (PER °C): 0.02% +2 volts.

TEMPERATURE RANGE: Operating: -20°C to +55°C
Storage: -40°C to +85°C

OVERLOAD PROTECTION: All units are overload, short circuit and arc protected by means of fast acting, self restoring, current limiting circuitry. Overload tripout (OL) option available. (See next page) Surge limiting resistors included.

AC POWER INPUT PROTECTION: Control Fuse.

CONTROLS: AC ON Toggle Switch, AC ON Indicator, Output Adjust—Ten-turn potentiometer with locking read-out dial.

METERING: Single range voltmeter, 2% accuracy. Single range ammeter, 2% accuracy.

PHYSICAL CHARACTERISTICS: All units in this series up to 100KVDC output are designed for rack mounting. Panels are 19" wide with standard notching. Units are fully enclosed for desk or table top operation. Optional bench mounting cabinet available. High voltage sections of higher voltage units are contained in a plexiglas tubular enclosure mounted on a base cabinet. The high voltage electrode is located at the top of the structure.

OUTPUT CABLE: All models up through 100KVDC are provided with 6 feet of shielded high voltage cable. The cables are designed with a plug arrangement so that they are easily removed from the mating receptacle located on the rear of the power supply.

CURRENT LIMITING: This is supplied as standard on all models. No suffix letters are required in the model number. This feature automatically limits the load current to approximately 110% of rated load regardless of the overload imposed upon the power supply. The power supply continues to operate at any overload condition including a short circuit by automatically reducing the output voltage as required to maintain the current limit. The unit is self-restoring to its normal operating level when the overload condition is removed. The voltage cut-off characteristic is quite sharp and approaches the ideal characteristic of a voltage-current regulator with automatic crossover.

FIXED POLARITY MODELS

Max. Ratings	Model Number	H x W x D	Wt. (lbs.) / Wt. (kg.)
KV MA Watts			Net / Ship / Net / Ship
5 2 10	RHR-5P10 RHR-5N10	(133x483x419) 5x19x16 5/8	25 30 12 14
5 6 30	RHR-5P30 RHR-5N30	(133x483x419) 5x19x16 5/8	30 35 14 16
5 10 50	RHR-5P50 RHR-5N50	(133x483x419) 5x19x16 5/8	30 35 14 16
5 20 100	RHR-5P100 RHR-5N100	(267x483x419) 10x19x16 5/8	55 65 25 30
10 1 10	RHR-10P10 RHR-10N10	(133x483x419) 5x19x16 5/8	25 30 12 14
10 3 30	RHR-10P30 RHR-10N30	(133x483x419) 5x19x16 5/8	30 35 14 16
10 6 60	RHR-10P60 RHR-10N60	(133x483x419) 5x19x16 5/8	30 35 14 16
10 10 100	RHR-10P100 RHR-10N100	(133x483x419) 5x19x16 5/8	30 35 14 16
10 20 200	RHR-10P200 RHR-10N200	(267x483x419) 10x19x16 5/8	55 65 25 30
15 0.5 10	RHR-15P10 RHR-15N10	(133x483x419) 5x19x16 5/8	25 30 12 14
15 2 30	RHR-15P30 RHR-15N30	(133x483x419) 5x19x16 5/8	25 30 12 14
15 4 50	RHR-15P50 RHR-15N50	(133x483x419) 5x19x16 5/8	30 35 14 16
15 8 100	RHR-15P100 RHR-15N100	(133x483x419) 5x19x16 5/8	30 35 14 16
15 1 225	RHR-15P225 RHR-15N225	(267x483x419) 10x19x16 5/8	55 65 25 30
20 1 50	RHR-20P10 RHR-20N10	(133x483x419) 5x19x16 5/8	25 30 12 14
20 3 30	RHR-20P30 RHR-20N30	(133x483x419) 5x19x16 5/8	25 30 12 14
20 6 60	RHR-20P60 RHR-20N60	(133x483x419) 5x19x16 5/8	30 35 14 16

Max. Ratings	Model Number	H x W x D	Wt. (lbs.) / Wt. (kg.)
KV MA Watts			Net / Ship / Net / Ship
20 6 120	RHR-20P120 RHR-20N120	(133x483x419) 5x19x16 5/8	30 35 14 16
20 12 240	RHR-20P240 RHR-20N240	(267x483x419) 10x19x16 5/8	55 65 25 30
30 0.33 10	RHR-30P10 RHR-30N10	(133x483x419) 5x19x16 5/8	25 30 12 14
30 1 30	RHR-30P30 RHR-30N30	(133x483x419) 5x19x16 5/8	25 30 12 14
30 2 60	RHR-30P60 RHR-30N60	(133x483x419) 5x19x16 5/8	30 35 14 16
30 4 120	RHR-30P120 RHR-30N120	(133x483x419) 5x19x16 5/8	30 35 14 16
30 5 150	RHR-30P150 RHR-30N150	(133x483x419) 5x19x16 5/8	50 55 23 25
30 8 240	RHR-30P240 RHR-30N240	(267x483x419) 10x19x16 5/8	55 65 25 30
40 0.75 30	RHR-40P30 RHR-40N30	(133x483x419) 5x19x16 5/8	40 45 18 21
40 1.5 60	RHR-40P60 RHR-40N60	(133x483x419) 5x19x16 5/8	40 45 18 21
40 3 120	RHR-40P120 RHR-40N120	(133x483x419) 5x19x16 5/8	40 45 18 21
40 6 240	RHR-40P240 RHR-40N240	(267x483x419) 10x19x16 5/8	60 70 27 32
50 5 25	RHR-50P25 RHR-50N25	(133x483x419) 5x19x16 5/8	40 45 18 21
50 1 50	RHR-50P50 RHR-50N50	(133x483x419) 5x19x16 5/8	40 45 18 21
50 3 150	RHR-50P150 RHR-50N150	(133x483x419) 5x19x16 5/8	55 60 25 27
50 5 250	RHR-50P250 RHR-50N250	(267x483x419) 10x19x16 5/8	60 70 27 32
60 5 30	RHR-60P30 RHR-60N30	(133x483x419) 5x19x16 5/8	40 45 18 21

Max. Ratings	Model Number	H x W x D	Wt. (lbs.) / Wt. (kg.)
KV MA Watts			Net / Ship / Net / Ship
60 1 60	RHR-60P60 RHR-60N60	(133x483x419) 5x19x16 5/8	40 45 18 21
60 2 120	RHR-60P120 RHR-60N120	(133x483x419) 5x19x16 5/8	40 45 18 21
60 4 240	RHR-60P240 RHR-60N240	(267x483x419) 10x19x16 5/8	60 70 27 32
80 1 80	RHR-80P80 RHR-80N80	(222x483x419) 8x19x16 5/8	52 62 24 28
80 3 240	RHR-80P240 RHR-80N240	(356x483x419) 14x19x16 5/8	72 82 33 38
100 1 100	RHR-100P100 RHR-100N100	(222x483x419) 8x19x16 5/8	52 62 24 28
100 1.5 150	RHR-100P150 RHR-100N150	(222x483x419) 8x19x16 5/8	68 78 31 36
100 2 200	RHR-100P200 RHR-100N200	(356x483x419) 14x19x16 5/8	72 82 33 38
150 1 150	RHR-150P150 RHR-150N150	(864x559x457) 34x22x18	125 300 57 136
150 2 300	RHR-150P300 RHR-150N300	(864x559x457) 34x22x18	145 320 66 145
200 5 100	RHR-200P100 RHR-200N100	(1016x559x457) 40x22x18	150 340 68 155
200 1 200	RHR-200P200 RHR-200N200	(1016x559x457) 40x22x18	170 360 77 164
300 5 150	RHR-300P150 RHR-300N150	(1220x559x457) 48x22x18	175 370 80 168
300 1 300	RHR-300P300 RHR-300N300	(1220x559x457) 48x22x18	200 400 91 182
400 5 200	RHR-400P200 RHR-400N200	(1554x559x457) 60x22x18	225 450 102 205
400 1 400	RHR-400P400 RHR-400N400	(1554x559x457) 60x22x18	225 450 102 205

REVERSIBLE POLARITY MODELS

Max. Ratings	Model Number	H x W x D	Wt. (lbs.) / Wt. (kg.)
KV MA Watts			Net / Ship / Net / Ship
5 2 10	RHR-5P10 RHR-5N10	(133x483x419) 5x19x16 5/8	25 30 12 14
5 6 30	RHR-5P30 RHR-5N30	(133x483x419) 5x19x16 5/8	30 35 14 16
5 10 50	RHR-5P50 RHR-5N50	(133x483x419) 5x19x16 5/8	30 35 14 16
5 20 100	RHR-5P100 RHR-5N100	(267x483x419) 10x19x16 5/8	55 65 25 30
10 1 10	RHR-10P10 RHR-10N10	(133x483x419) 5x19x16 5/8	25 30 12 14
10 3 30	RHR-10P30 RHR-10N30	(133x483x419) 5x19x16 5/8	30 35 14 16
10 6 60	RHR-10P60 RHR-10N60	(133x483x419) 5x19x16 5/8	30 35 14 16
10 10 100	RHR-10P100 RHR-10N100	(133x483x419) 5x19x16 5/8	30 35 14 16
10 20 200	RHR-10P200 RHR-10N200	(267x483x419) 10x19x16 5/8	55 65 25 30
15 0.5 10	RHR-15P10 RHR-15N10	(133x483x419) 5x19x16 5/8	25 30 12 14
15 2 30	RHR-15P30 RHR-15N30	(133x483x419) 5x19x16 5/8	25 30 12 14
15 4 50	RHR-15P50 RHR-15N50	(133x483x419) 5x19x16 5/8	30 35 14 16
15 8 100	RHR-15P100 RHR-15N100	(133x483x419) 5x19x16 5/8	30 35 14 16
15 1 225	RHR-15P225 RHR-15N225	(267x483x419) 10x19x16 5/8	55 65 25 30
20 1 50	RHR-20P10 RHR-20N10	(133x483x419) 5x19x16 5/8	25 30 12 14
20 3 30	RHR-20P30 RHR-20N30	(133x483x419) 5x19x16 5/8	25 30 12 14
20 6 60	RHR-20P60 RHR-20N60	(133x483x419) 5x19x16 5/8	30 35 14 16

Max. Ratings	Model Number	H x W x D	Wt. (lbs.) / Wt. (kg.)
KV MA Watts			Net / Ship / Net / Ship
20 3 60	RHR-20P60 RHR-20N60	(133x483x419) 5x19x16 5/8	30 35 14 16
20 6 120	RHR-20P120 RHR-20N120	(133x483x419) 5x19x16 5/8	30 35 14 16
20 12 240	RHR-20P240 RHR-20N240	(267x483x419) 10x19x16 5/8	55 65 25 30
30 1 30	RHR-30P30 RHR-30N30	(133x483x419) 5x19x16 5/8	25 30 12 14
30 2 60	RHR-30P60 RHR-30N60	(133x483x419) 5x19x16 5/8	30 35 14 16
30 4 120	RHR-30P120 RHR-30N120	(133x483x419) 5x19x16 5/8	30 35 14 16
30 5 150	RHR-30P150 RHR-30N150	(133x483x419) 5x19x16 5/8	55 60 25 27
30 8 240	RHR-30P240 RHR-30N240	(267x483x419) 10x19x16 5/8	60 70 27 32
40 7.5 30	RHR-40P30 RHR-40N30	(133x483x419) 5x19x16 5/8	40 45 18 21
40 15 60	RHR-40P60 RHR-40N60	(133x483x419) 5x19x16 5/8	40 45 18 21
40 3 120	RHR-40P120 RHR-40N120	(133x483x419) 5x19x16 5/8	40 45 18 21
40 6 240	RHR-40P240 RHR-40N240	(267x483x419) 10x19x16 5/8	60 70 27 32
50 5 25	RHR-50P25 RHR-50N25	(133x483x419) 5x19x16 5/8	40 45 18 21

Max. Ratings	Model Number	H x W x D	Wt. (lbs.) / Wt. (kg.)
KV MA Watts			Net / Ship / Net / Ship
50 1 50	RHR-50P50 RHR-50N50	(222x483x419) 8x19x16 5/8	52 57 24 26
50 3 150	RHR-50P150 RHR-50N150	(222x483x419) 8x19x16 5/8	70 75 32 34
50 5 250	RHR-50P250 RHR-50N250	(356x483x419) 14x19x16 5/8	75 85 34 39
60 5 60	RHR-60P60 RHR-60N60	(133x483x419) 5x19x16 5/8	52 57 24 26
60 1 60	RHR-60P60 RHR-60N60	(133x483x419) 5x19x16 5/8	52 57 24 26
60 2 120	RHR-60P120 RHR-60N120	(133x483x419) 5x19x16 5/8	52 57 24 26
60 4 240	RHR-60P240 RHR-60N240	(267x483x419) 10x19x16 5/8	75 85 34 39
80 1 80	RHR-80P80 RHR-80N80	(222x483x419) 8x19x16 5/8	52 57 24 26
80 3 240	RHR-80P240 RHR-80N240	(356x483x419) 14x19x16 5/8	75 85 34 39
100 1 100	RHR-100P100 RHR-100N100	(222x483x419) 8x19x16 5/8	52 57 24 26
100 1.5 150	RHR-100P150 RHR-100N150	(222x483x419) 8x19x16 5/8	70 80 32 36
100 2 200	RHR-100P200 RHR-100N200	(356x483x419) 14x19x16 5/8	75 85 34 39

Notes:

All weights calculated in nearest lb or kg. All measurements in parenthesis are in millimeters.

HIGHER POWER UNITS AVAILABLE.
CONSULT FACTORY

RHR LINE OPTIONS

The RHR line is available with most combinations of the options listed below. The appropriate code letters are suffixed to the model number.

- | | | | | | |
|---|-------|--|----------|--|-------|
| ● OVERLOAD TRIP-OUT (OL) | (OL) | ● 100 VOLT INPUT (50-60 Hz) | (100) | ● PARALLEL OPERATION (PM) | (PM) |
| ● REMOTE VOLTAGE PROGRAMMING (RVC) | (RVC) | ● FOCUS TAP (F) | (F) | ● SLAVED BIPOLAR (\pm) OPERATION (BPM) | (BPM) |
| ● BENCH CABINET (C) | (C) | ● REMOTE RESISTANCE PROGRAMMING (RC) | (RC) | ● FLOATING GROUND (FG) | (FG) |
| ● CURRENT REGULATION (CR) | (CR) | ● REMOTE MONITOR TERMINALS (TP) | (TP) | ● INHIBIT CIRCUIT (IC) | (IC) |
| ● 220 VOLT INPUT (50-60 Hz) (220) | (220) | ● REMOTE CONTROL PANEL (RCP) | (RCP) | ● SLOW START (SS) | (SS) |
| Additional Options: (not described below) | | | | | |
| ● OVERVOLTAGE PROTECTION (OV) | (OV) | ● ADJUSTABLE CURRENT LIMIT (FRONT) (CLF) | (CLF) | ● EXTERNAL INTERLOCK (EI) | (EI) |
| ● ADJUSTABLE OL (FRONT) (OLF) | (OLF) | ● ADJUSTABLE CURRENT LIMIT (REAR) (CLR) | (CLR) | | |
| ● ADJUSTABLE OL (REAR) (OLR) | (OLR) | ● EXTRA LENGTH OUTPUT CABLE (1N.) (LL ()) | (LL ()) | | |

● OVERLOAD TRIP-OUT (OL)

The OVERLOAD TRIP-OUT protection feature rapidly "crowbars" the power supply when the load current exceeds approximately 110% of the rated load. A fast acting, latching circuit, removes power to the oscillator, thereby turning off the high voltage. The power supply must be reset by OFF-ON activation of the main AC power switch. When the OVERLOAD TRIP-OUT (OL) option is provided, it replaces the normally standard CURRENT LIMITING feature. See CURRENT LIMITING section above for additional information.

Add Suffix letters (OL) at the end of the basic model number when this option is desired.

If an overload trip-out level less than the power supply rated current is desired, this limit, in milliamperes, is specified in parenthesis following OL; i.e. OL(4) = 4 milliamperes trip-out. NOTE: Values as low as 0.25 milliamperes may be selected as standard.

● REMOTE VOLTAGE PROGRAMMING (RVC)

This option enables the power supply to be controlled either by the standard front panel control or by an external low voltage DC signal source. The output voltage is directly proportional to the input voltage with linearity and proportionality better than 1% of full scale. The programming voltage polarity is always positive, regardless of the output polarity of the power supply.

A barrier type terminal board is provided on the rear of the chassis for connection to the external source. When properly connected for remote programming, the front panel control serves as an adjustable voltage limit.

Add suffix letters RVC at the end of the basic model number when this option is desired.

Unless otherwise specified, the ratio of input to output is such that 0 to +6VDC controls the output from 0 to rated kilovolts. If a control voltage other than 6 volts is desired, any value desired between 6 and 250 volts DC may be specified in parenthesis after the option letters; i.e. RVC(10) specifies a 0 to 10 volt programming signal. The programming source must provide at least 100 microamperes at maximum input.

Slew rate of output is approx. 0.5 sec. "up" and 2 sec. "down."

● BENCH CABINET (C)

A deluxe styled rack cabinet is available for all models. The base dimensions are 22" wide x 18" deep. Height is selected to fit individual unit height. Two-tone blue-gray color scheme is standard. Carrying handles are located conveniently on the sides of the cabinet for easy handling.

Add suffix letter (C) at the end of the basic model number when this option is desired.

● CURRENT REGULATION (CR)

OUTPUT CURRENT AND VOLTAGE: Both current and voltage regulation with automatic cross-over are provided. The current and voltage ratings are the same as corresponding standard RHR model. Output current is adjustable from zero to rated current over the full voltage compliance range from zero to rated voltage. A front panel mounted 10-turn potentiometer provides resolution of 250 ppm for the current control. A single turn pot is provided for voltage adjustment.

CURRENT REGULATION: $\pm 0.1\%$ for any current setting between 25% and 100% of rated value for a load variation from 10% to 100% of full voltage compliance

VOLTAGE REGULATION: $\pm 0.05\%$ for line and load variations.

PROTECTION: The power supply output is protected by the automatic cross-over circuitry and will operate safely into any load between open and short circuit.

RIPPLE: 0.1% RMS of output voltage

Other characteristics are similar to standard RHR voltage regulation specifications

This type of unit is particularly suitable for gas laser excitation since the supply can provide a relatively high open circuit voltage for starting the plasma discharge. Once the arc has formed, the supply automatically operates in a constant current mode at any preset level. Add suffix letters (CR) at the end of the basic model number when this option is desired.

● 220 VOLT INPUT (50-60 Hz) (220)

Nominal input voltage between 220 and 250 volts RMS, 50-60 Hz, single phase can be accommodated with this option. Input current must be calculated based on approximately 50% efficiency. Add suffix (220) at the end of basic model number when this option is desired.

● 100 VOLT INPUT (50-60 Hz) (100)

Nominal input voltage between 100 and 130 volts RMS, 50-60 Hz, single phase can be accommodated with this option. Input current must be calculated based on approximately 50% efficiency. Add suffix (100) at the end of basic model number when this option is desired.

● FOCUS TAP (F)

This option provides for a separate, supplementary output. The auxiliary voltage is obtained by including a DC to DC supply selected from the Spellman RM line of modules. Any 1.5 watt unit with voltage rating to 15KVDC may be selected. Specifications for this supplementary output are in accordance with RM line data.

Voltage control is provided on the front panel by means of a single turn potentiometer. If the RC, Remote Control, option is ordered for the main output, then provision is made for remote control of the auxiliary output also.

Suffix letter F(max KV) appears at the end of the basic model number when this option is provided. The number in the parenthesis is the rated maximum output voltage of the RM module. The polarity of the module is POSITIVE unless otherwise specified. The focus option is available on 30KV and 40KV models only.

● REMOTE RESISTANCE PROGRAMMING (RC)

This option permits the output voltage to be controlled by either an external potentiometer (3 terminals) or the front panel 10-turn control potentiometer. A barrier type terminal board is mounted on the rear of the chassis for connection to an external potentiometer. When wired in accordance with the appropriate schematic, the front panel control is switched out, and the remote potentiometer assumes control. A 5000 ohm potentiometer is required, although fixed resistor dividers of equivalent value may be used. A shielded, insulated cable with a twisted pair should be used, with the shield connected to common. Up to 100 feet of cable is permitted. Add suffix (RC) at the end of the basic model number when this option is desired.

● REMOTE MONITOR TERMINALS (TP)

BNC connectors are provided on the rear of the chassis for remote monitoring of voltage and current. The voltage monitor circuit provides a 1 volt signal corresponding to maximum rated voltage accurate to 1%. The current monitor circuit is taken across a 100 ohm resistor (100mV/mA). The current monitor reads true load current and does not include any internal bleeder or regulator drain. Add suffix letters (TP) at the end of the basic model number when this option is desired.

● REMOTE CONTROL PANEL (RCP)

Any standard model may be supplied with the control panel removed from the basic supply. Terminal boards are added to the basic supply on the rear of the chassis and to the control panel so that the two parts are readily interconnected. 15 feet of appropriately shielded interconnection cable is provided. The control panel contains an AC power switch, fuse, and pilot light, kilovoltmeter, milliammeter and 10-turn control potentiometer. Add suffix letters (RCP) at the end of the basic model number when this option is desired. NOTE that all models with output voltage of 150KVDC or greater are supplied with the REMOTE CONTROL PANEL as standard

● PARALLEL OPERATION (PM)

Any model in the RHR line can be used as a "master" controller for parallel operation of up to three "slave" units of the same rating from either the RHR or UHR line. Whether the "slave" units are from the RHR or UHR units, the overall characteristics of the parallel system are governed by the specifications of the RHR

"master" supply and are the same as standard specifications except for ripple which will deteriorate to the UHR levels. Current imbalance between units is less than 10% and no derating is required for total current capability of the parallel system.

Each power supply unit may be used independently, if desired, by simple rearrangement of terminal board connections. Add suffix (PM) after the standard model number for the "master" supply. Add suffix (PS) after the standard model number for the "slave" supplies. Up to three "slaves" can be controlled by one "master".

● SLAVED BI-POLAR (\pm) OPERATION (BPM) and (BPS)

Any positive polarity model in the RHR line can be used as a "master" for "tracking" control of the negative polarity equivalent RHR model. Thus, one control provides adjustment of both supplies from zero to rated output voltage. The negative polarity output "tracks" the positive output within $\pm 1\%$ from 10% to rated output voltage. All specifications for regulation, ripple, etc. are governed by individual unit characteristics. Add suffix (BPM) and (BPS) after standard model number for positive and negative polarity units respectively.

● FLOATING GROUND (FG)

The FLOATING GROUND feature isolates the "low end" return of the power supply with respect to ground. Nominal insulation of 70 volts RMS is provided for the "floating" terminal. The terminal is also bypassed to chassis ground by a one megohm resistance, a 0.1mfd. capacitance, and a neon glow lamp whose breakdown voltage is nominally 85 volts (type NE2).

The purpose and application of the FLOATING GROUND option is to permit the user to "ground" or "return" the low end of the power supply at a point within his system which will suppress undesirable ground loop currents.

In some instances, the user may desire to monitor the load current with accurate instrumentation. For this situation, the user can insert his own current monitoring circuitry between the "FLOATING GROUND" terminal and "system" ground. This may consist simply of an appropriate milliammeter or microammeter, or alternatively, a current sensing resistor which can be calibrated with a sensitive digital or differential voltmeter, as desired. It should be understood, however, that a low impedance return to ground must be provided by the user for proper operation of the power supply. One thousand ohms or less is quite appropriate, and ten thousand ohms would be an acceptable value, if necessary. Check with our Engineering Department for further information. Add suffix (FG) after the standard model number when the FLOATING GROUND option is desired.

● INHIBIT CIRCUIT (IC)

The INHIBIT CIRCUIT option requires that a separate low DC signal voltage be applied to the appropriate terminals on the rear of the supply in order to enable the unit to turn on. Further, when the signal voltage is removed, the high voltage turns off. The signal level for ON is at least five (5) volts (but not higher than fifty (50) volts, unless otherwise specified), and for OFF, the signal level must drop below 0.5 volts. This is compatible with TTL logic and other computer-interface arrangements. Add suffix (IC) after the standard model number when the INHIBIT CIRCUIT option is desired.

● SLOW START (SS)

The SLOW START option causes the output voltage of the power supply to ramp upwards to its operating voltage setting when the unit is turned on. The rise is fairly linear so that the time to reach the operating level is approximately proportional to the control setting. The normal rise time is approximately 30 seconds for maximum output, but other rise times from 10 to 60 seconds may be specified by adding the appropriate number after the suffix letters.

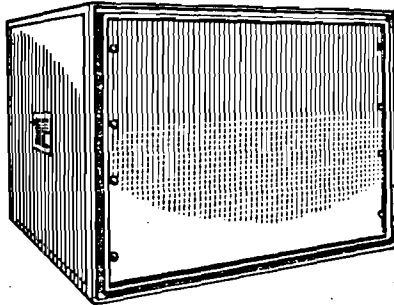
This option also has an additional feature in that after an overload has occurred, and the output voltage has been reduced by the current limiting protection circuit, the subsequent automatic recovery to normal operation when the overload condition has been removed, follows the same slow rise as the initial start-up. Add suffix (SS) after the standard model number when the SLOW START option is desired.

WARRANTY:

3 YEAR WARRANTY FOR ALL RHR/RHSR MODELS

● All parts ● All labor ● Consult factory for warranties on other Spellman products ● Copy of Warranty available on request

BUD



CLASSIC II CABINETS

Double-rimmed brushed aluminum extrusion frames front. Recessed chrome handles attached to two steel flanges extending along interior, provide carrying safety and support. Clear inside depth, 20 $\frac{1}{4}$ " ; overall depth, 21 $\frac{1}{4}$ " ; overall width, 20 $\frac{3}{4}$ ". Takes 19" panels. Made of .060 aluminum; frame, 6063-T aluminum trusions. Front and rear mounting rails tapped 10-32 EIA universal spacing. Two 16 ga. vertically adjustable chassis supports. B-50, S2 and S4 blowers fit cabinets. For gray texture (GT) or royal blue (RB) cabinets use white door. Comes assembled with two aluminum handles and four feet.

CABINETS

GT Stk. No.	RB Stk. No.	Type AGC	Height Inches	Wt Lbs.	Panel Ht. In.	1-2	3-4	5-7
80W689	91F1684	9267	7 $\frac{1}{8}$	29 $\frac{1}{4}$	5 $\frac{1}{8}$	227.25	204.55	181.60
80W691	91F1685	9268	8 $\frac{1}{4}$	30 $\frac{1}{2}$	7 $\frac{1}{8}$	233.50	210.15	186.60
80W693	91F1686	9269	10 $\frac{1}{8}$	32 $\frac{1}{4}$	8 $\frac{1}{8}$	239.35	215.40	191.60
80W695	91F1687	9270	12 $\frac{1}{8}$	33 $\frac{1}{4}$	10 $\frac{1}{8}$	240.30	216.25	192.25
80W697	91F1688	9271	14 $\frac{1}{8}$	34 $\frac{1}{4}$	12 $\frac{1}{8}$	248.40	233.55	198.70
80W699	91F1689	9272	15 $\frac{1}{8}$	35	14 $\frac{1}{8}$	254.20	228.80	203.30
80W701	91F1690	9273	17 $\frac{1}{8}$	36	15 $\frac{1}{4}$	259.20	233.30	207.35
80W703	91F1691	9274	19 $\frac{1}{8}$	36 $\frac{1}{4}$	17 $\frac{1}{8}$	264.85	238.35	211.90
80W705	91F1692	9275	21 $\frac{1}{8}$	37 $\frac{1}{4}$	19 $\frac{1}{8}$	267.30	240.55	213.85
80W707	91F1693	9276	22 $\frac{1}{8}$	38 $\frac{1}{2}$	21 $\frac{1}{4}$	271.50	244.35	217.20
80W681	91F1694	9277	24 $\frac{1}{8}$	39 $\frac{1}{2}$	22 $\frac{1}{4}$	285.25	256.75	228.20
80W683	91F1695	9278	26 $\frac{1}{8}$	40 $\frac{1}{4}$	24 $\frac{1}{8}$	288.60	259.75	230.90
80W685	91F1696	9279	28 $\frac{1}{8}$	41 $\frac{1}{4}$	26 $\frac{1}{8}$	292.50	263.25	234.00
80W687	91F1697	9280	29 $\frac{1}{8}$	42	28 $\frac{1}{8}$	298.50	268.65	238.60

Doors are available; if required contact your local Newark office.



ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

30 May 1983

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #2 on Georgia
Tech/EES Project A3492, Period Covering 1 May
through 31 May 1983, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

On 21 April, a telex was received from Philips acknowledging the dimensions of the modulator enclosure and the use of the Spellman high voltage power supply (HVPS) as discussed in Progress Letter #1. In the telex Philips also requested the weight of the modulator and the HVPS as well as the maximum separation between the two units. The requested information was given to Philips via a phone conversation on 26 April and also in a telex on 28 April. It was determined that the HVPS weighs 14 kg. The maximum modulator weight was reported as 9 kg; Georgia Tech will try to hold the modulator weight to 7 kg. These figures do not include the weight of the EIO (about 3 kg). The maximum separation between the modulator and the HVPS was reported as being 1.5 meters.

The extended interaction oscillator (EIO), serial number E0343C3, was received from Varian Canada, Inc., on 10 May. A Spellman -30 kV, 120 W HVPS has been ordered as well as the -3 kV power supply and the planar triodes for the modulator. Most of the electronic components for the modulator have also been ordered. The detailed design of the modulator is well under way and breadboarding will begin during the next reporting period as ordered parts are received.

Page 2 of 2
A3492 Status Report

Funds expended and encumbered for the project during the month of May totaled \$7,442.03 or 7.9% of the total amount funded for the contract. As of 31 May, the total amount expended and encumbered for the project totaled \$15,671.60 or 16.6% of the total amount funded.

Sincerely,



J. C. Butterworth
Project Director

JCB/vcy

Approved:



C. E. Brown
Chief, Development Division
RAIL



ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

11 July 1983

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #3 on Georgia
Tech/EES Project A3492, Period Covering 1 June
through 30 June 1983, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

The detailed design of the modulator is almost complete. The digital pulse driver, control and protection circuitry, low voltage power supply (LVPS), and the high voltage (HV) section of the modulator have all been designed. Only the switching regulators for the HV (floating) switching mode LVPS remain to be designed in detail. The digital pulse driver and the control and protection circuitry have been breadboarded.

The Spellman high voltage power supply (HVPS) has been received as have many smaller electronic components. The -3kV power supply and the planar triodes for the modulator remain to be delivered. Breadboarding of the HV section of the modulator will begin upon receipt of the planar triodes.

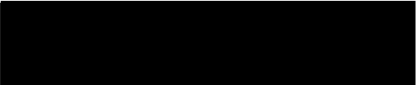
Work planned for the next reporting period includes finishing the detailed circuit design and breadboarding and testing the remaining circuits.

Sincerely,


J. C. Butterworth
Project Director

JCB/vcy

Approved:


C. E. Brown
Chief, Development Division
RAIL



Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION

Atlanta, Georgia 30332
9 August 1983

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #4 on Georgia
Tech/EES Project A3492, Period Covering 1 July
through 31 July 1983, Purchase Order D21-247145

Gentlemen:


Progress made on the referenced purchase order for the dates listed is as outlined below.

The digital pulse driver circuitry has been breadboarded and tested. This circuit receives the sync input signal, allows an adjustment for varying the pulsewidth, and forms "start" and "stop" pulses which are optically coupled to the floating deck modulator which operates the planar triode switch tubes that pulse the RF tube. Testing has also begun on the breadboard of the control and protection circuitry.

The planar triodes for the floating deck modulator have been received. The -3 kV pulser power supply was supposed to be delivered by the end of June; a phone call was made to the vendor who moved the delivery date to mid-August.


Work planned for the next reporting period includes completing testing of the control and protection circuitry. The detailed design of the mechanical packaging configuration will be completed to a point where the two modulator circuit boards can be laid out.

Sincerely,


J. C. Butterworth
Project Director

JCB/vcy

Approved:


C. E. Brown
Chief, Development Division
RAIL



Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION

Atlanta, Georgia 30332

6 September 1983

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #5 on Georgia
Tech/EES Project A3492, Period Covering 1 August
through 31 August 1983, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

The mechanical packaging design has been completed to a point where the modulator circuit boards have been dimensioned and can now be laid out and constructed. The ground referenced section of the focus voltage generator has been breadboarded. Testing is still under way on the control and protection circuitry. The -3 kV pulser supply was finally received late in the month.

Work planned for the next reporting period includes winding all transformers and laying out and constructing the two modulator deck boards. All transformers, breadboards, and the modulator deck boards will be integrated for a system test.

Sincerely,

J. C. Butterworth
Project Director

JCB/vcy

Approved:

C. E. Brown
Chief, Development Division
RAIL



Georgia Institute of Technology

ENGINEERING EXPERIMENT STATION

Atlanta, Georgia 30332
4 October 1983

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #6 on Georgia
Tech/EES Project A3492, Period Covering 1 September
through 30 September 1983, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

All four high voltage interface transformers have been wound. Molds are now being made to facilitate potting the transformers, since the cores will be floating at the beam potential (about -21 kV). The complementary output square wave generator which drives all four push-pull switch mode power converters has been breadboarded and tested.

The four isolation transformers will be potted and mounted on four identical circuit cards. Using identical cards means that only one layout needs to be designed, which saves time and money in the fabrication process. The layout is almost complete and these boards will be fabricated along with the two modulator deck boards during the first part of the next reporting period.

The ground referenced low voltage power supply has been breadboarded. This supply consists of linear series voltage regulators and will be tested under load during the next reporting period.

Problems have arisen in obtaining the 20 ns short pulse called for in the technical specifications. These problems were discussed during a telephone conversation with Mr. Bengt Broman on 30 September. The result of this conversation was an agreement to change the design goal for the short pulse performance to 50 ns.

It was discovered after purchasing the optical couplers now being used that a 30 ns trailing edge distortion is introduced in the optical transmit-receive system that prohibits receiving a 20 ns trigger or start pulse at the floating deck modulator. In order to achieve any reasonable short pulse

performance it was necessary to use two trigger pulses for the start pulse, the leading edges of which were used to define the actual start pulse. Combining these pulses requires several TTL logic circuits floating with the modulator at about -21 kV. These circuits are likely to be very susceptible to the noise generated by nearby high level circuitry; therefore, an effort is being made to purchase some faster and better optical links that will supersede the use of the TTL circuitry in the high voltage section of the modulator. The use of these new links will also decrease the present size of the ground referenced trigger circuitry. Whether to use these newer optical couplers will be decided upon during the next reporting period.

As of August 31, the funds expended and encumbered totaled \$33,795.08, or about 36% of the total amount funded. The rate of expenditure of funds will increase in the remaining months as the project moves from its design phase into its construction phase.

Sincerely,



J. C. Butterworth
Project Director

JCB/vcy

Approved:



C. E. Brown
Chief, Development Division
RAIL



Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

8 November 1983

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #7 on Georgia
Tech/EES Project A3492, Period Covering 1 October
through 31 October 1983, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

The two floating deck modulator boards have been fabricated and are now being assembled. The four circuit boards that the four high voltage isolation transformers will be mounted on have also been fabricated and are being assembled. The digital pulse driver board, the control board, and the protection board have been laid out and are now being fabricated. The low voltage power supply board has been fabricated and assembled; the cold plate that the voltage regulators will be mounted on is being assembled.

The floating deck modulator enclosure has been fabricated. This is the assembly that will be potted around. The outer or main enclosure is being fabricated.

Work on the documentation package has begun. The operations manual that will accompany the modulator assembly will include operating instructions, an engineering discussion that will allow Philips' engineers to make repairs or modifications to the modulator with the knowledge of how the various circuits work, schematics, mechanical drawings, parts location diagrams, and parts lists.

Page 2 of 2
Monthly Technical Status Report
A3492

As of 31 October, the funds expended and encumbered totaled \$59,140.45 or approximately 63% of the total amount funded. The final construction phase of the project will result in a large increase in the rate of expenditure of funds.

Sincerely,



J. C. Butterworth
Project Director

JCB/vcy

Approved:



C. E. Brown
Chief, Development Division
RAIL



Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

8 December 1983

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #8 on Georgia
Tech/EES Project A3492, Period Covering 1 November
through 30 November 1983, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

The digital pulse driver board, protection board, power supply chopper board, and the control board have been fabricated and assembled. The digital pulse driver board has been fully tested; the other three boards have been partially tested. The interconnect board (the board which interconnects the four previously mentioned circuit boards) has been designed and is being fabricated.

The main enclosure for the modulator unit has been fabricated and will be assembled during the next reporting period.

A no-cost extension was requested in a telephone conversation on 11 November. The dates for the acceptance test were moved to the week of January 23, 1984. A no-cost extension until the 8th week of 1984 has been received by the Georgia Tech Office of Contract Administration.

Sincerely,

J.C. Butterworth

JCB/bc

Approved:

C.E. Brown
Chief, Development Division
Radar and Instrumentation Laboratory



Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

11 January 1984

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #9 on Georgia
Tech/EES Project A3492, Period Covering 1 December
through 31 December 1983, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

The interconnect board, on which the power supply chopper, digital pulse driver, control and protection boards mount, has been fabricated and assembled. Three of the four switching power supplies have been tested. The high voltage modulator decks have been assembled and partially tested.


A telex was sent on 23 December 1983 notifying Philips that the hardware would not be ready for the acceptance test scheduled on 23 January 1984 but would be finished by 24 February 1984, which is the contractual end date of the no-cost extension.

Sincerely,


J. C. Butterworth
Project Director

JCB/vcy

Approved:


C. E. Brown
Chief, Development Division
RAIL



A-3402

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

9 February 1984

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Attention: Bengt Broman

Subject: Power Supply/Modulator Development

Reference: Monthly Technical Status Report #10 (Final) on Georgia
Tech/EES Project A3492, Period Covering 1 January
through 31 January 1984, Purchase Order D21-247145

Gentlemen:

Progress made on the referenced purchase order for the dates listed is as outlined below.

Integration of the modifications to the Spellman high voltage power supply have begun. The modifications include the following:

1. Addition of the low voltage power supply, which includes two transformers, two filter capacitors, and one circuit board.
2. Modification of the front panel to include radiate/standby controls and indicators, fault indicators, and pulsewidth control.
3. Addition of a multi-pin connector on the back panel to enable cabling of voltages and control signals to and from the modulator enclosure.

The enclosure that houses the high voltage section of the modulator has been remade out of plexiglass and aluminum. The original design dictated an all-aluminum enclosure that would have been entirely surrounded by potting material for high voltage isolation from the outer enclosure. It was determined that problems could arise in performing the actual potting process; therefore, only the bottom plate was made aluminum for heat transfer purposes and the remainder of the enclosure is now made out of plexiglass. Only the bottom half of the enclosure will now be surrounded by potting material; this will help facilitate removal of the top of the enclosure and servicing the modulator.

Work on the documentation package is continuing. Finalized schematics and parts location drawings are being done and will be finished early next month. The final revisions to the operations manual should also be made early next month.

Scheduled work for next month includes the final assembly and potting of the modulator, along with final testing. The final typing and assembly of the operations manual will also be completed.

As confirmed in a telex sent to Philips on 13 January, the date for the acceptance test has been moved to 26 March 1984.

As of 31 January 1984, the total amount of funds expended and encumbered totalled \$84,054.62, or approximately 89% of the total amount funded.

Sincerely,



J. C. Butterworth
Project Director

JCB/vcy

Approved:



C. E. Brown
Chief, Development Division
RAIL

OPERATIONS MANUAL FOR POWER SUPPLY/MODULATOR

T. V. Wallace

Submitted to:

Philips Elektronikindustrier AB
S-175 88
JARFALLA, Sweden

Under Purchase Order D21-247145

Submitted by:

GEORGIA INSTITUTE OF TECHNOLOGY
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

23 February 1984

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SECTION 1
INTRODUCTION

Under Purchase Order D21-247145, the Georgia Institute of Technology/Engineering Experiment Station (GIT/EES) of Atlanta, Georgia (USA), developed a radar modulator/high voltage power supply for the Philips Elektronik-industri AB of Jarfalla, Sweden. The modulator/power supply was originally built for integration with Philips 9LV200MK2 series of radars and is intended for use with a Varian Canada Bridged Extended Interaction Oscillator (EIO). This manual describes the maintenance and operation of the modulator/power supply assembly and also includes an engineering discussion on its theory of operation. Appendices are included that contain schematics, parts location drawings, parts lists, and manufacturers' data sheets for selected parts.

*** DANGER - HIGH VOLTAGE - USE EXTREME CAUTION ***

Figure 1 is a block diagram of the modulator/power supply assembly. Caution must be taken at all times when working near the modulator/power supply assembly due to the presence of high voltage. A TTL circuit receives the synchronization signal and generates three pulses that are optically coupled to the floating-deck modulator. Optical coupling is used to isolate the low-level digital circuitry from the modulator deck which floats at about -21 kV. These three optically-coupled pulses define the length of the high voltage pulse. The control and protection circuits are solid state circuits that control and monitor the status of the modulator. The formation of the optically-coupled pulses and the high-voltage pulse, the operation of the control and protection circuits, and the low-voltage and high-voltage power supplies are discussed in more detail in Section 3.

The modulator accepts an input synchronization signal and generates a high voltage pulse relative to each rising edge of the synchronization signal. Therefore, the pulse repetition frequency (PRF) of the synchronization

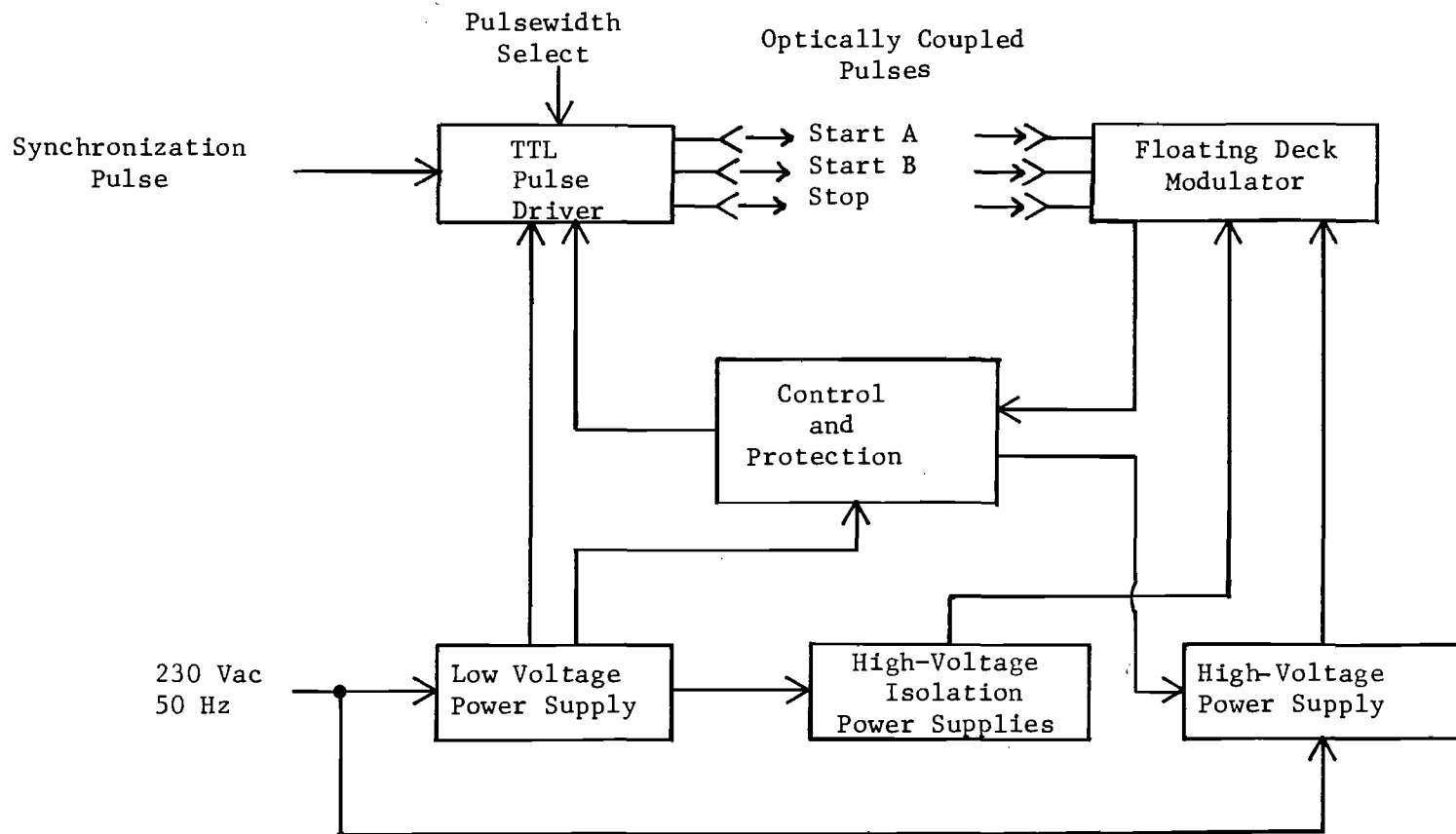


Figure 1. Block diagram of modulator/power supply assembly.

signal equals that of the high voltage pulse train. The necessary characteristics of the synchronization signal and the characteristics and power requirements of the modulator/power supply assembly are listed in Table 1.

TABLE 1. MODULATOR/POWER SUPPLY SPECIFICATIONS

Input Synchronization Signal:

Amplitude	+6 ± 2 V
Pulse Length	0.7 ± 0.3 μs
Rise Time	< 100 ns
Load Impedance	50-75 ohm
Pulse Repetition Frequency	1-20 kHz

Pulse Width	35-200 ns
Power Requirements	230 VAC, 50 Hz

Size	Modulator	42 cm x 15.6 cm x 25.4 cm
	Power Supply	41.3 cm x 13.3 cm x 43.2 cm
Weight	Modulator	14.5 kg
	Power Supply	20 kg

SECTION 2

MAINTENANCE AND OPERATION

2.1 INTRODUCTION

This section discusses the maintenance and operation procedures necessary for safe and proper utilization of the modulator/power supply. This discussion can be used to train operators how to USE the assembly; however, only qualified engineering personnel should be allowed to disassemble or modify the modulator or power supply. A detailed discussion of the theory of operation of the assembly is included in Section 3 to aid engineering personnel and should be referenced before performing maintenance or making modifications.

2.2 MAINTENANCE AND SETUP PROCEDURE

The modulator/power supply assembly consists of the following items: modulator enclosure, power supply enclosure with front panel, multiconductor cable, coaxial cable, and high-voltage cable. To set up the system for operation, all three cables must be connected between the two enclosures, the AC line cord from the power supply enclosure must be connected to a grounded 230 VAC outlet, and the high voltage power supply must be connected to a good chassis ground.

Figure 2 is an illustration of the modulator enclosure. The left side plate must be removed to service the interior of the enclosure. Figure 3 is a view of the interior of the modulator assembly with the side plate removed and shows the location of various major components and circuits. The exposed plexiglass plate must be removed to work on the floating deck modulator. Because of the high voltage, care must be taken when working inside the modulator enclosure; **THE INTERIOR OF THE PLEXIGLASS MODULATOR ENCLOSURE FLOATS AT THE BEAM POTENTIAL (-21 kV)**. The bottom of the enclosure is surrounded by potting material. If any of this material is cut away it must be replaced before application of high voltage to the modulator. The bottom

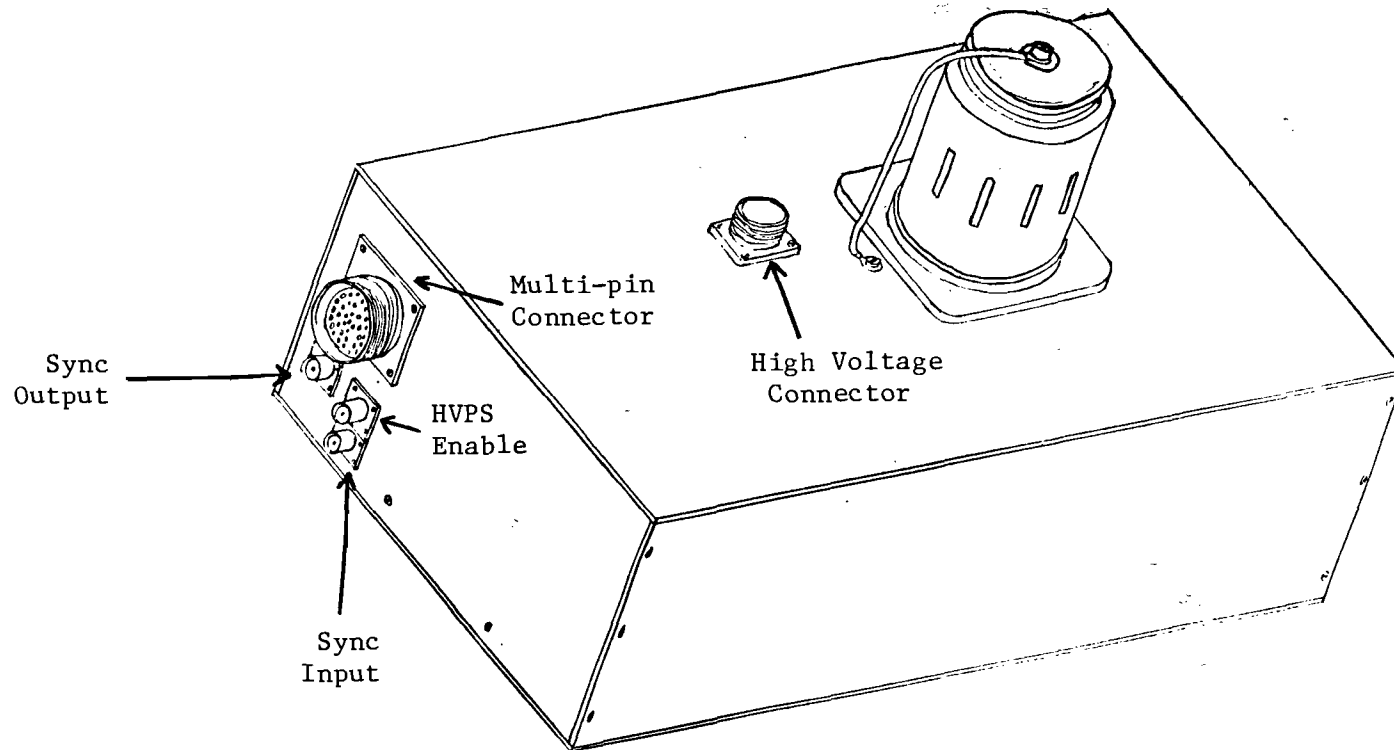


Figure 2. Modulator enclosure.

(Left side plate is underneath in this view)

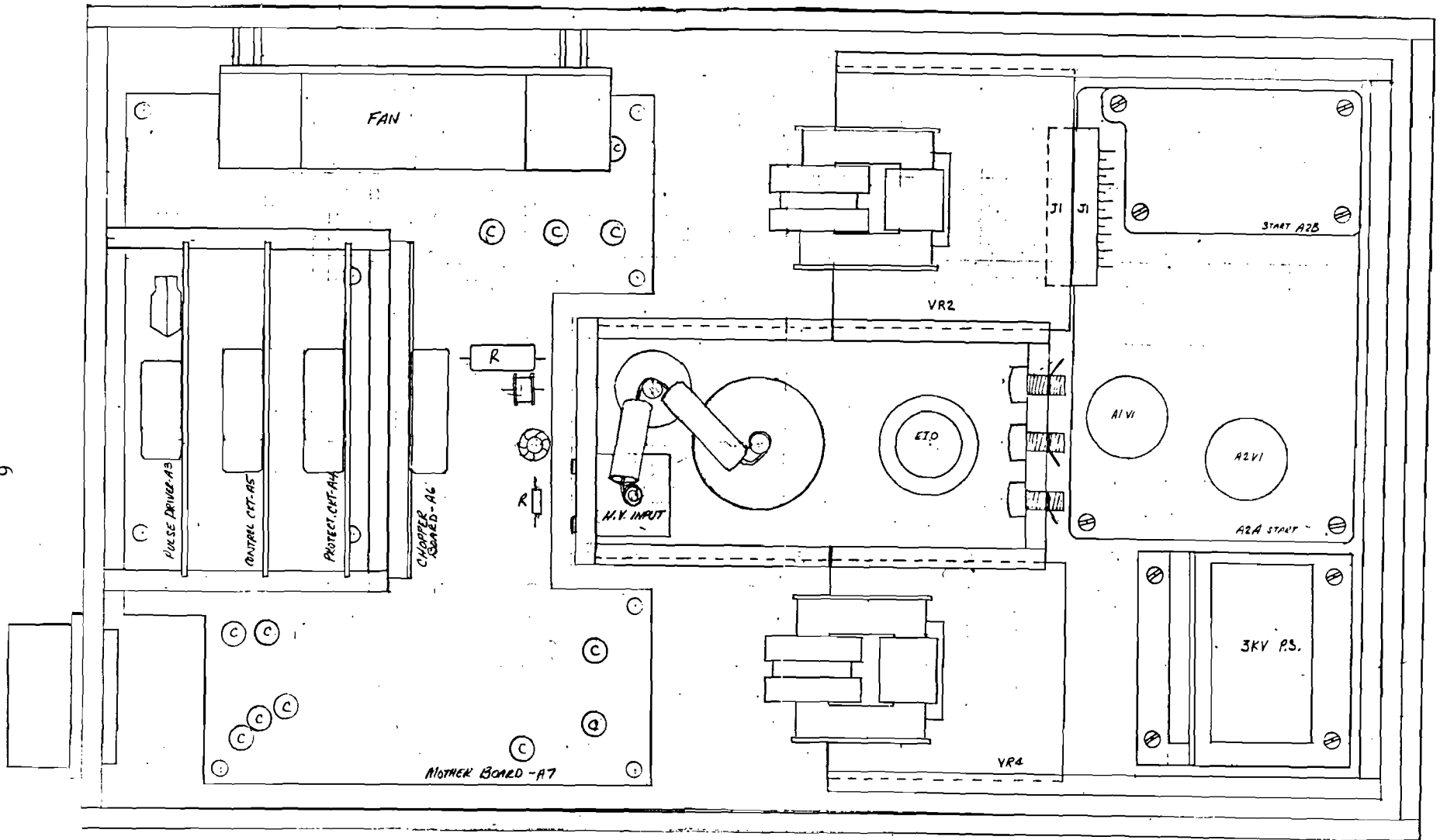


Figure 3. Interior of modulator assembly.

plate of the modulator enclosure is made of aluminum; special care must be taken when working with this plate since it floats at the beam potential of -21 kV.

Care must be taken when mounting the modulator assembly so as not to interfere with any interior components, especially the high voltage section. Mounting screws placed on the side plates opposite the high voltage section should not penetrate the potting material; they can penetrate only the depth of the outer aluminum plate (.25 inches). Care must also be taken not to interfere with the location of any other interior components, such as the fan and the four circuit cards, when inserting mounting screws into the side plates, that are not adjacent to the high voltage section.

Figure 4 is an illustration of the front panel of the power supply assembly. The power supply enclosure is designed for rack mounting in a standard 19 inch (48.3 cm) rack. The top cover of the supply can be removed for servicing.

2.3 OPERATION

DANGER - HIGH VOLTAGE - USE EXTREME CAUTION

When the assembly is fully set up, it is ready for operation. The front panel of the high voltage power supply, illustrated in Figure 4, contains all operator controls and indicators. Each control and indicator lamp is discussed individually, and then a standard power-up procedure is summarized to aid in the training of operators.

2.3.1 FRONT PANEL CONTROLS AND INDICATORS

The following is a discussion of the function of each control and indicator on the front panel of the power supply.

- 1) ON/OFF SWITCH - Applies prime power (230 VAC) when in the ON position.
- 2) ON/OFF LAMP - Is lit when prime power is applied.

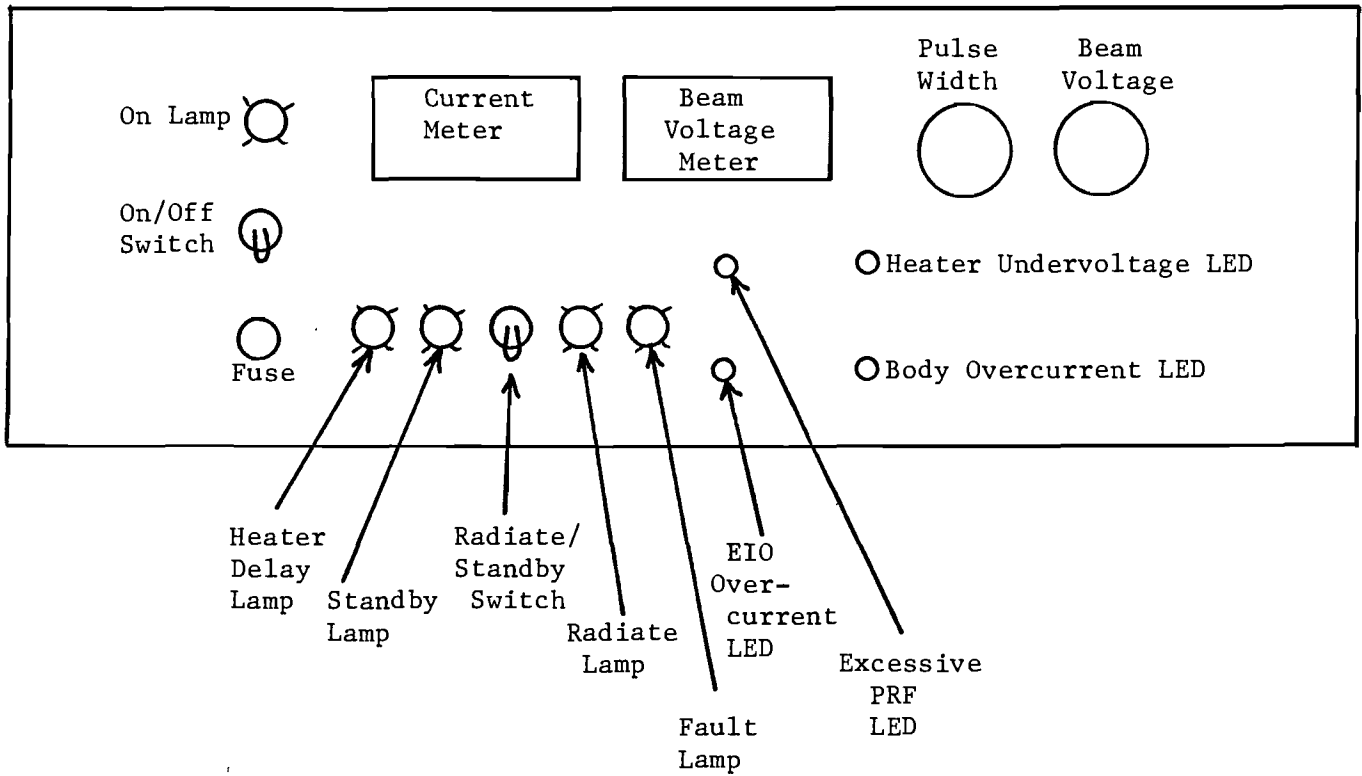


Figure 4. Power supply front panel.

- 3) HEATER DELAY LAMP - Stays lit for approximately two minutes after application of prime power. This delay allows the heaters of the RF tube and the planar triodes in the modulator to warm up so that the tubes operate properly when high voltage is applied. During the heater delay period, the system is automatically prevented from radiating in order to protect the tubes. After the heater delay the system automatically goes to STANDBY.
- 4) RADIATE/STANDBY SWITCH - Selects status of modulator. If the Heater Delay has timed out, switching to RADIATE applies high voltage to the modulator. If an attempt is made to go to RADIATE while in Heater Delay, the system will automatically ignore the attempt. After the Heater Delay, the system will go to STANDBY even though the switch remains in the RADIATE position. Switching to STANDBY cuts off the high voltage and also clears faults (see Fault Lamp for further explanation).
- 5) RADIATE/STANDBY LAMP - Indicates the status of the modulator, regardless of the RADIATE/STANDBY switch position.
- 6) FAULT LAMP - Lights up when a fault condition is detected by the protection circuit in the modulator. Four conditions are tested and faults are indicated by light emitting diodes (LEDs) (Fault LEDs are described next). When a fault is detected, the Fault lamp is lit along with the LED corresponding to that fault, and the system automatically reverts to STANDBY, shutting off high voltage to the modulator. When the fault condition is removed or corrected, the fault can be cleared by toggling the RADIATE/STANDBY switch to STANDBY (if the fault is encountered while in STANDBY, the switch must be moved to RADIATE and then back to STANDBY in order to clear the fault. Since a fault condition exists, toggling the switch to RADIATE first will not cause the system to go to RADIATE). If a fault is encountered at power on, it will automatically clear itself after 6 seconds unless the fault still exists.

7) FAULT LED'S

- a) Excessive PRF - The system will fault if the frequency of the synchronization signal is greater than the maximum design specification of 20 kHz. To clear this fault, decrease the frequency of the input synchronization signal and toggle the RADIATE/STANDBY switch as described above.
 - b) Heater Undervoltage - This indicates a low heater voltage in the RF tube. Operating an RF tube at high voltage with a low heater voltage can damage its cathode. If toggling the RADIATE/STANDBY switch does not clear the fault, the modulator must be inspected by qualified engineering personnel to determine the cause of undervoltage.
 - c) EIO Overcurrent - This indicates an excessive current drain on the high voltage power supply. If toggling the RADIATE/STANDBY switch does not clear the fault, the modulator/power supply must be inspected by qualified engineering personnel to determine the cause of the excessive current drain.
 - d) Body Overcurrent - This indicates an excessive absorption of power by the body of the RF tube, which can lead to its destruction. If toggling the RADIATE/STANDBY switch does not clear the fault, the modulator must be inspected by qualified engineering personnel to determine the cause of the fault (possibly a defocused beam).
- 8) PULSE WIDTH DIAL - This dial controls a multiturn potentiometer which sets the output pulsewidth. Table 2 correlates the dial setting with the actual output pulse width.
- 9) BEAM VOLTAGE DIAL - This dial controls the output of the high voltage power supply (0-25 KVdc) and sets the beam voltage of the RF tube.
- 10) BEAM VOLTAGE METER - Indicates the level of negative beam voltage applied.

- 11) CURRENT METER - Indicates the total amount of current drawn from the high voltage power supply (beam current plus body current).

2.3.2 SUMMARY OF POWER UP PROCEDURE

Table 3 summarizes the operating procedures for the modulator/power supply.

TABLE 2. PULSE WIDTH SETTINGS
(beam voltage set at 18.5 kV)

<u>Setting on Pulse Width Dial</u>	<u>Output Pulse Width</u>
00 (minimum)	35 ns
045	50 ns
332	100 ns
646	150 ns
975	200 ns
1000 (maximum)	205 ns

TABLE 3. SUMMARY OF OPERATION

CAUTION - HIGH VOLTAGE - USE EXTREME CAUTION

<u>Operator Action</u>	<u>Modulator/Power Supply Status</u>	<u>Operator Response</u>
Turn Power Switch ON	Power lamp lit	
	Heater Delay Lamp Lit for 2 Minutes	
	Fault lamp and an LED possibly on - will auto- matically clear after 6 seconds unless fault still exists	If fault does not auto- matically clear, attempt to clear it manually by toggling the Radiate/Standby switch. If the fault can not be cleared, shut off power and have engineering personnel determine cause of fault
	After 2 minute delay Heater Delay lamp goes out, Standby lamp comes on	
	Modulator now ready to Radiate	
Switch to RADIATE	Standby lamp goes out Radiate lamp comes on High voltage is applied to modulator	
Set Beam Voltage to Desired Level		

TABLE 3. SUMMARY OF OPERATION (CONTINUED)

<u>Operator Action</u>	<u>Modulator/Power Supply Status</u>	<u>Operator Response</u>
Set Pulse Width to Desired Level	A fault occurs	Attempt to clear fault by toggling Radiate/ Standby switch to Standby. If this does not clear fault have engineering personnel determine cause of fault
	If no faults occur, the modulator can be switched to and from Radiate with the Radiate/Standby switch	
Switch to Standby	Radiate lamp goes out Standby lamp comes on	
Turn Power OFF		

SECTION 3 THEORY OF OPERATION

This section is intended to aid the engineering personnel whose task is to make repairs or modifications to the modulator/power supply assembly. The paragraphs that follow discuss the theory of operation of the various individual circuits in the modulator. References are made to the schematic diagrams located in Appendix A to clarify the discussion. The basics of operation and the system block diagram, both in Section 1.2, should be reviewed before reading further in this section.

3.1 GENERATION OF OPTICALLY COUPLED PULSES

The high voltage pulse generated by the floating deck modulator is defined by the three optically coupled logic pulses generated by the Pulse Driver. Optical coupling is used to isolate the high voltage at the modulator deck from the ground referenced logic circuits used to form the pulses. Optical coupling provides better noise immunity and better isolation than commonly used pulse transformers.

The schematic diagram of the Pulse Driver is shown in Figure A-1 in Appendix A. The inputs to the circuit are the external synchronization signal and the pulsewidth adjust level from the front panel. A timing diagram is included in Figure 5 to illustrate the following discussion.

Integrated circuit (IC) one-shot U1a forms a positive pulse on the rising edge of the synchronization input defined by $.7C_1$ multiplied by the sum of the resistances R3 and the Pulsewidth Adjust potentiometer. This pulse is inverted in U2, a DS0026 MOS clock driver chip. The manufacturer's data sheets for the DS0026 are included in Appendix C. The high output current capability of the DS0026 is used to drive delay line U3, since normal TTL circuits can not supply enough current to drive these delay lines. The manufacturers data sheets on these delay lines are also included in Appendix C. NOR gate U4b combines the inverted pulse with its delayed version, producing a shorter positive level pulse than that produced by one-

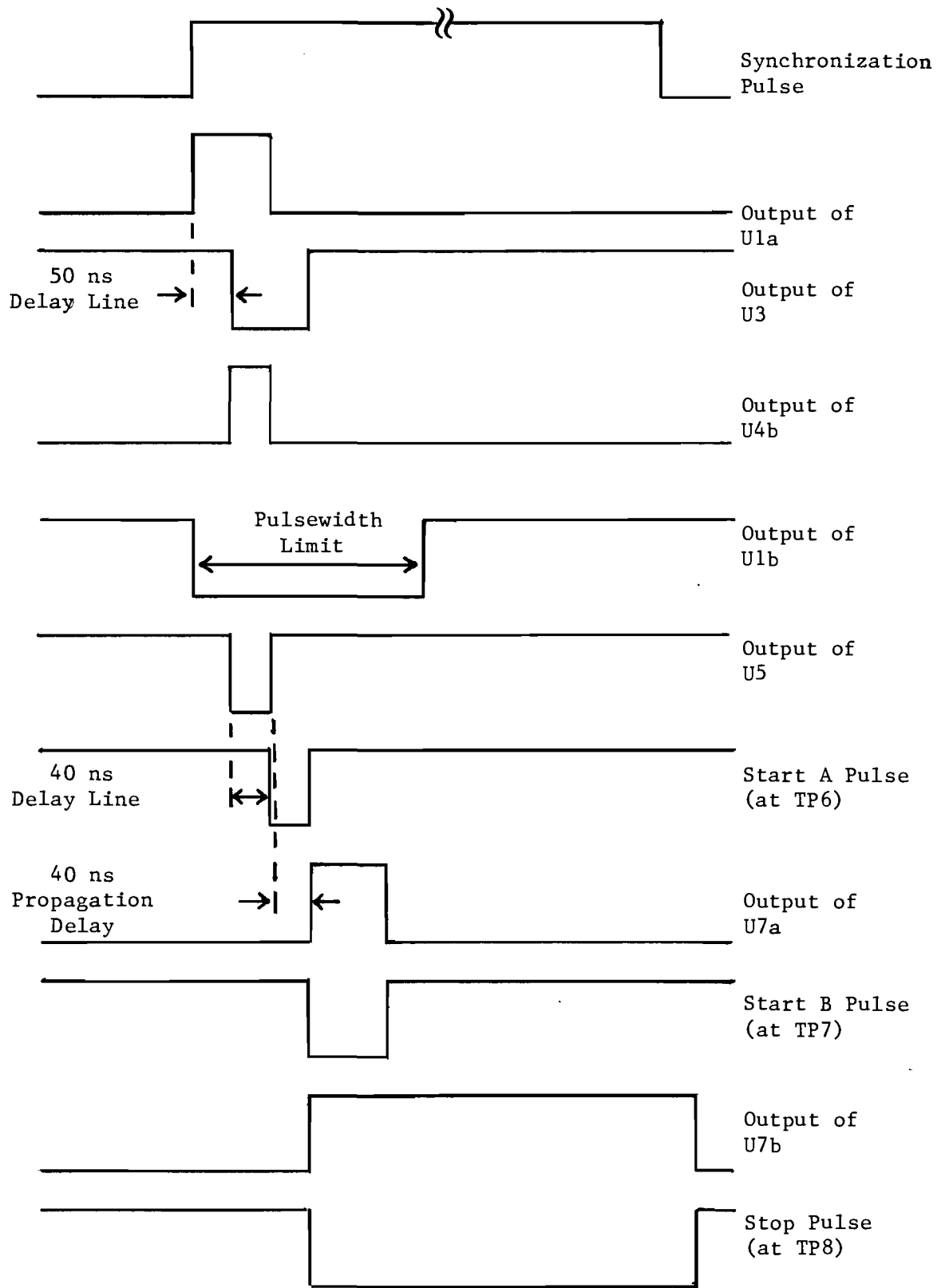


Figure 5. Timing diagram for pulse driver circuit.

shot U1a. This pulse is inverted with NOR gate U4c and combined with the output of one-shot U1b via NOR gate U4a. The output of U1b is a low level pulse which limits the pulsewidth set by U1a to a maximum value set by R2 and C3. The output of U4a is a positive pulse which is inverted in U5, another DS0026 driver, at TP5. The output of U5 drives delay lines U6 and U8 and is the input to one-shot U7a.

The output of U5 is delayed through U6; when the output of U6 goes low, the open collector output transistor of U9 conducts and allows current to flow through the LED in optical transmitter U11. This current flow produces the low level pulse START A (which can be viewed at TP6) that is optically coupled to the modulator deck.

The end of the pulse at TP5, i.e., its rising edge, causes one-shot U7a to form a positive pulse which triggers the START B pulse in the same manner as START A was formed. The leading edges of these two start pulses define the width of the pulse applied to the gates of the power FET's in the modulator. The two pulses are necessary because there is a 30 ns distortion at the receiver end of the optical link that prohibits receiving very short pulses. The logic used to combine the START A and START B pulses in the modulator is discussed in Section 3.2.

The rising edge of the delayed output of U8 triggers one-shot U7b, which forms the STOP pulse for the modulator in the same manner as START A and START B were formed. The use and significance of all three of these optically coupled pulses are discussed in the operation of the high voltage floating section of the modulator assembly.

3.2 FLOATING DECK MODULATOR OPERATION

Figure 6 is a simplified diagram of a floating deck modulator. Planar triode V_1 is referred to as the ON tube, while triode V_2 is called the OFF tube. Subsequently, the two circuit boards are referred to as the START deck and the STOP deck, respectively. As illustrated in Figure 7, when V_1 turns on, the grid-cathode voltage of the EIO rises from its cutoff bias of -3 kV to near 0 V with a rise time, t_r , set by the plate-to-cathode resis-

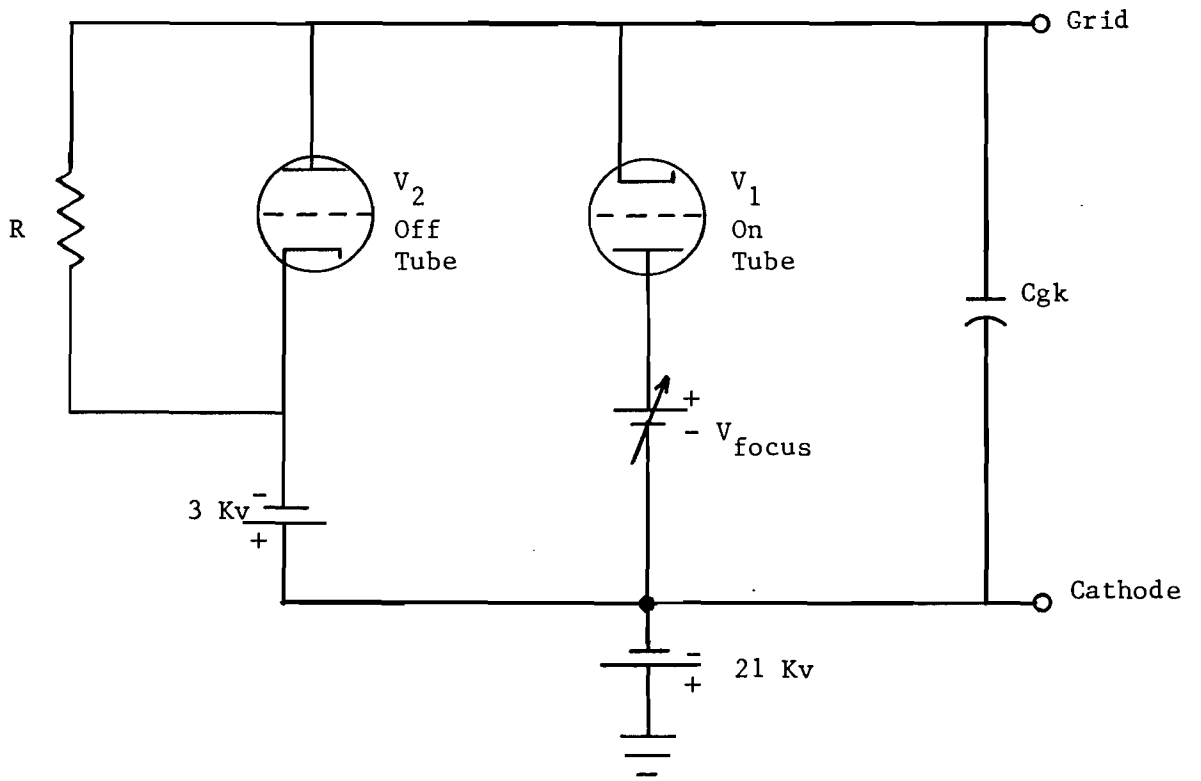


Figure 6. Simplified diagram of a floating deck modulator.

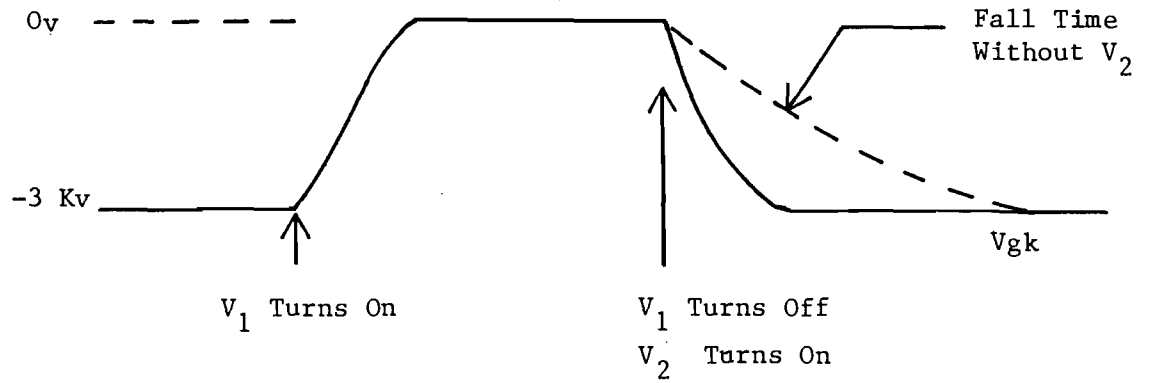


Figure 7. EIO grid to cathode voltage during pulse.

tance of V_1 and the sum of the EIO grid-cathode capacitance plus any stray circuit capacitance, or

$$t_r \approx 2.2 \times r_{pk_1} \times (C_{gk} + C_{stray}). \quad (1)$$

The adjustable focus voltage compensates for the voltage drop across V_1 during the pulse, allowing the focus grid potential to be set very close to the cathode potential for proper operation. The focus grid of the EIO focuses the electron beam formed by the electron gun structure in much the same way as an optical lens focuses a light source into a narrow beam. When the grid is driven out of cutoff, the beam is defocused. Energy in the defocused beam is absorbed by the body, causing undesirable body current which can damage the EIO. The focus grid will properly focus the electron beam when the focus grid potential equals the cathode potential. Therefore, proper setting of the focus voltage and minimizing the rise and fall times of the grid pulse will minimize body dissipation.

The high voltage pulse is terminated when V_1 cuts off and V_2 turns on. The OFF or "tailbiter" tube forms a low impedance ($r_{pk_2} \ll R$) discharge path for the EIO and stray capacitances which results in a good fall time for the pulse. If V_2 were not present, the fall time of the pulse would be extremely long, set by R and C_{gk} instead of r_{pk_2} and C_{gk} . The output synchronization pulse is a sample of the collector current of the EIO; this pulse will be present only when the system is in radiate. Monitoring this signal will give an indication of proper modulator operation.

3.2.1 FORMATION OF THE PULSE

The schematic for the entire high voltage referenced section of the modulator is given in Figure A-3. Optically coupled pulses START A and START B are received and combined with digital logic to form a pulse with a width determined by the difference between the leading edges of the two pulses. This is necessary because the optical transmit-receive system introduces a trailing edge distortion, illustrated in Figure 8, that prohibits receiving very short pulses. Figure 8 also illustrates the form of the

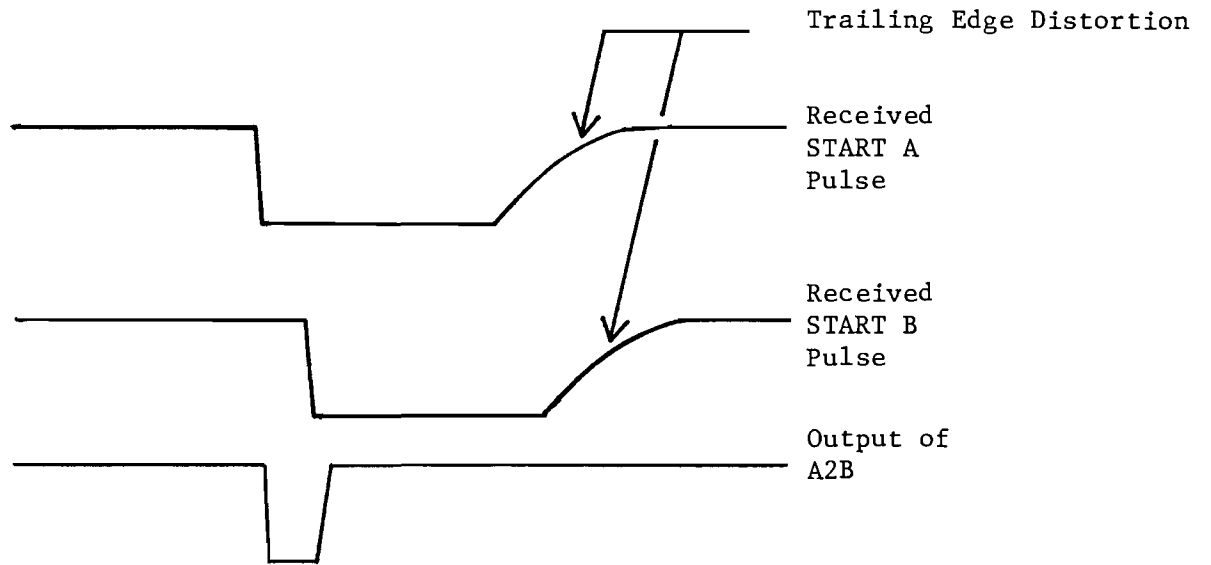


Figure 8. Illustration of trailing edge distortion of received optical pulses.

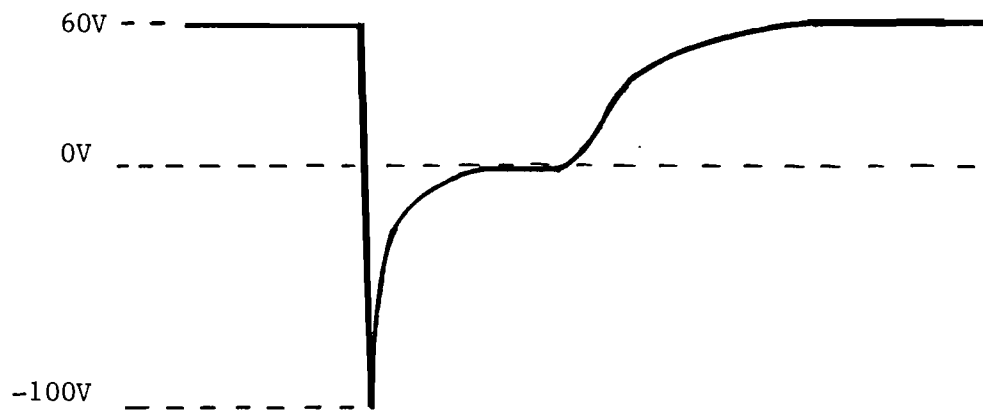


Figure 9. Shape of pulse at cathode of planar triodes.

output of circuit board A2B, which is mounted on the upper deck circuit board A2A.

The output of circuit board A2B forms the input to a set of three open collector drivers which drive a set of three DS0026 MOS clock drivers. The MOS drivers turn on three IVN6000CNT power MOSFETs, which pull down the cathode of the 8847A planar triode, thereby turning it on. The R-C network which connects the drains of the MOSFETs to the cathode of the planar triode sets the pulse shape at the cathode of the triode. Figure 9 illustrates the correct shape of the pulse at the cathode of the planar triode. The initial spike allows the triode to conduct a large surge of current that quickly charges up the EIO grid-cathode capacitance in order to obtain a good rise time. After the spike, the cathode settles to a level that keeps the tube in saturation for the flattest possible pulse. After the START pulse is finished, the cathode rises to a bias level set by the zener diode CR3.

The optically coupled STOP pulse forms the input to a MOS driver. No digital logic is needed here since the duration of the STOP pulse is not very critical. The operation of the STOP deck parallels that of the START deck and will not be repeated here. The formation of the high voltage pulse resulting from switching the planar triodes was discussed in Section 3.2.

3.3 PROTECTION CIRCUITRY

Due to the high cost of high power RF tubes, tube protection is an important aspect of modulator operation. The schematic of the protection circuitry is given in Figure A-7. The basic theory of operation of this circuit is to compare the monitored signals to a stable reference voltage using comparators. When the monitored signals reach critical levels, a comparator will change state, toggle and latch a flip-flop, and send a low level logic signal to the control circuitry indicating that a fault condition exists. Four signals are monitored: the synchronization signal pulse repetition frequency (PRF), the center tap voltage of the isolation transformer (T_1) that supplies the EIO heater voltage, the total EIO current, and the EIO body current.

The specification for the maximum operating PRF is 20 kHz. The protection circuitry will indicate a fault condition if the synchronization signal PRF exceeds 20 kHz. The synchronization signal triggers one-shot U1 which forms a fixed-width pulse which is then inverted and integrated. Therefore, the DC level obtained from the integration is a function of frequency only.

If the EIO heater voltage gets too low, the cathode of the EIO can be damaged when high voltage is applied to the tube. The center tap voltage that supplies the EIO heater voltage is monitored to give an indication if the EIO heater voltage drops below its minimum value. The center tap voltage is divided down with precision resistors, and this level is compared with a stable reference voltage.

The high voltage power supply has a floating ground terminal which allows for insertion of current monitoring circuitry between it and ground. The total EIO current flows from the floating ground terminal and through R_{10} . The collector or beam current flows out through pin J4-3, leaving the body current to flow through R_{11} . If the total current or body current of the EIO gets too high, one of the comparators will trigger and a fault will be declared.

The use of the Fault signal and the method used to reset a fault will be discussed next in a discussion of the control circuitry.

3.4 CONTROL CIRCUITRY

The schematic of the control circuitry is given in Figure A-9. The circuit operates as follows. Application of prime power at the front panel causes a rising edge at pin 2 of U3, a precision timer IC, which causes it to trigger a two minute (heater delay) low level logic pulse at its output pin 9. This logic "0" pulse causes flip-flop U7a to stay cleared which allows the circuit to prevent the modulator from going to the radiate mode while in heater delay.

Inverters U6a and U6b debounce the Radiate/Standby switch. Toggling this switch to Radiate causes a low to high transition at the clock input, pin 3, of flip-flop U7a. This sets the flip-flop unless the clear input,

pin 1, is low. In other words, the system can not go to radiate during heater delay, if a fault is present, or if the switch is in the Standby position. Switching to Standby automatically clears the flip-flop, taking the system out of the radiate mode.

The HVPS Enable signal is sent to the high voltage power supply. In the Radiate mode, this signal is a 15 V level that turns on the high voltage. When the system reverts to Standby or is in Heater Delay, this signal is approximately 0 V and disables the high voltage power supply.

Application of prime power also causes another precision timer U4 to trigger a six second logic "1" pulse. The purpose of this pulse is to automatically reset the protection circuitry after power-up, since the modulator will probably come on in a fault condition. This six second pulse is exclusive-ORed with the debounced setting of the Radiate/Standby switch. If this switch is in the Standby position at power up, as it should be, the circuit will automatically clear faults after the six seconds. If the switch is left in the Radiate position, the faults will not automatically be cleared; however, to go to Radiate would require switching to Standby first, which would clear the fault anyway. After the six second pulse ends, switching to Standby will clear any faults, as long as they are not still present at the time the attempt to reset is made.

When a fault is encountered, the Fault signal from the protection circuitry goes low and causes the Reset Command to go low and latch up the flip-flops within the protection circuitry. Switching to Standby clocks flip-flop U7b and sets it, causing the Reset Command to go high, unlatches the flip-flops in the protection circuitry, and therefore clears the fault if it is no longer present. If the fault is still present it will not be cleared; the cause of the fault should then be determined.

3.5 HIGH VOLTAGE ISOLATED POWER SUPPLIES

Several voltages are necessary for operation of the floating deck modulator. These include heater voltages for the planar triodes and RF tube, +28 V for the -3 kV bias supply, the focus voltage, +5 V, +18 V, and +300 V

for the various circuits used to form and amplify the pulse. since the entire START deck follows the 3 kV swing of the grid pulse, the operating voltages for the START and STOP decks must be isolated from each other. Four isolation transformers supply the necessary operating voltages to the floating deck modulator. Table 4 lists how the various voltages are distributed among the four isolation transformers.

TABLE 4. DISTRIBUTION OF HIGH VOLTAGE
ISOLATION TRANSFORMER VOLTAGES

<u>Transformer</u>	<u>Secondary Voltages</u>
T1	Operating voltages for STOP deck; +300 V, +18 V, +5 V Heater voltages for planar triode and RF tube
T2	+28 V for -3 kV bias supply
T3	Operating voltages for START deck; +300 V, +18 V, +5 V Heater voltage for planar triode
T4	Focus voltage

The secondary voltages of the four transformers are supplied by the center-tapped primaries of four driven push-pull power converters. The schematic for the push-pull converters is given in Figure A-11 in Appendix A. The schematics of the four transformers are given in Figures A-13 and A-14. In Figure A-11, U1 is a SG1525A complementary output square wave generator, and U3 is a DS0026 MOS driver which drives the gates of all eight switching FET's. The FET's used are the IRF520, and manufacturers' data

sheets for them and for the SG1525A and DS0026 are included in Appendix C. The center-taps of T1, T3, and T4 are adjustable via voltage regulators in the low voltage power supply; the center-tap of T2 is +24 V, since additional regulation is supplied by the input of the -3 kV supply itself.

3.6 HIGH VOLTAGE POWER SUPPLIES

3.6.1 BEAM SUPPLY

The high voltage power supply used to supply the beam voltage (-21 kV) was manufactured by the Spellman High Voltage Electronics Corporation. The manufacturer's instruction manual for this high voltage power supply is given in Appendix D and includes the specifications and schematics for the power supply.

Several modifications have been made to the beam supply. One modification was the inclusion of the low voltage power supply within the high voltage power supply enclosure. The additional connector was added to the back of the supply to allow for a cable that carries voltages from the low voltage supply and commands from the front panel switches to the modulator and carries status and control signals from the modulator back to the front panel. Figure 10 is a sketch of the location of the additional components within the Spellman supply.

3.6.2 BIAS AND PULSER SUPPLY

The bias and pulser supply is a -3 kV supply made by the Advanced High Voltage Corporation. The manufacturer's specifications for this power supply are given in Appendix C. This supply provides the -3 kV grid bias necessary to keep the EIO cutoff. Formation of the 3 kV pulse is described in Section 3.2. The -3 kV supply is located within the modulator assembly.

3.7 LOW VOLTAGE POWER SUPPLY

The low voltage power supply assembly is located within the high voltage power supply. The schematic for the low voltage power supply is

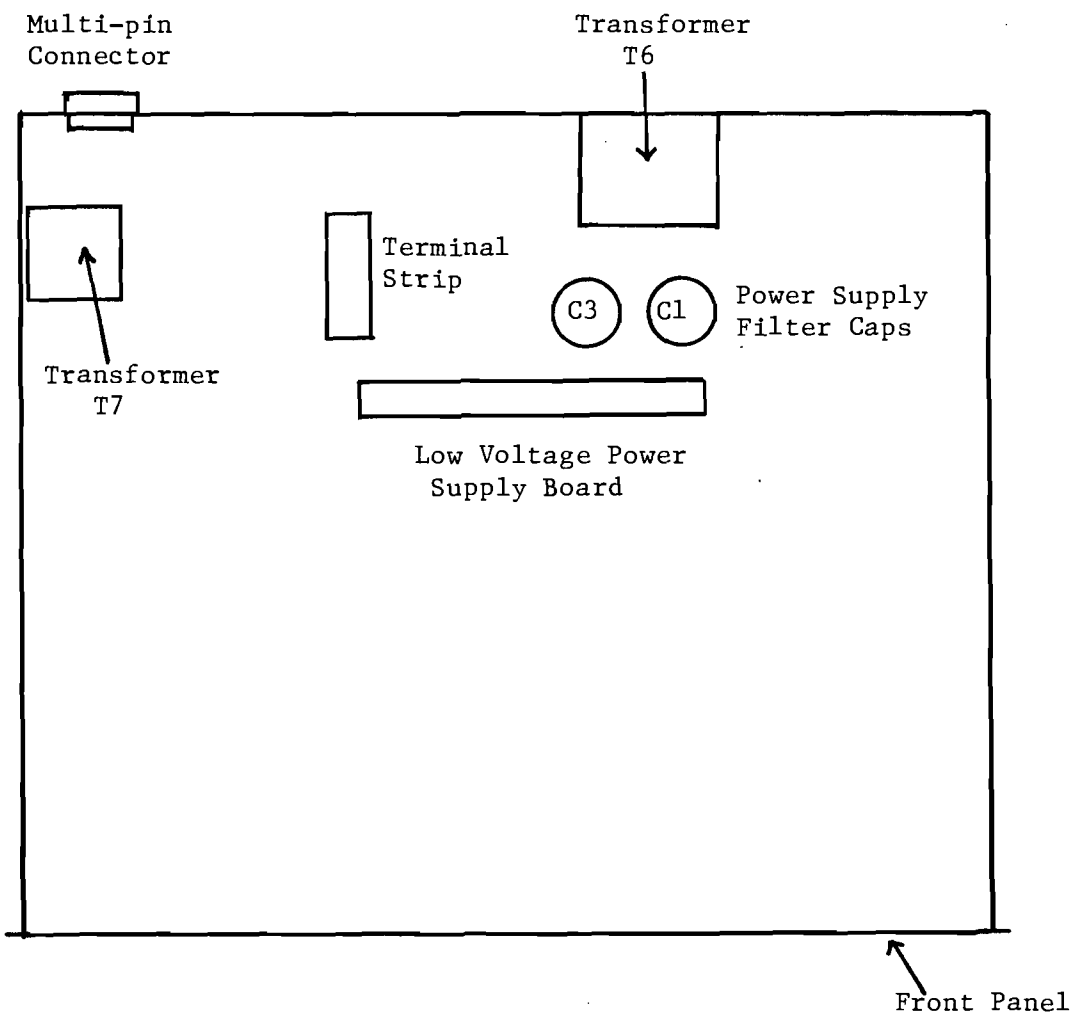


Figure 10. Location of added components to high voltage power supply (top view).

given in Figure A-19. The power supply consists of two 230 V to 24 V transformers followed by appropriate filtering and regulating circuits. Transformer T6 supplies power for the center taps of the isolation transformers and also for the fan within the modulator and the lamps on the front panel of the high voltage power supply. Transformer T7 supplies power for the control, protection, pulse driver, and push-pull converter circuits.

3.8 INTERCONNECTING CABLES

Three cables connect the modulator and the high voltage power supply. A multiconductor cable carries DC power supply voltages and control and status commands to and from the modulator and beam supply front panel. A BNC cable carries the HVPS Enable command from the control circuitry in the modulator to the beam supply. The high voltage cable connects the beam supply to the floating deck modulator. A diagram for the interconnection board is given in Figure A-21. Note that input and output synchronization signal BNC jacks are located on the modulator assembly.

3.9 TROUBLESHOOTING

This section deals with the four fault conditions that result in automatic shutdown of the modulator. The majority of service required for the system should deal with these four conditions. Each fault is discussed individually along with possible causes for the fault. This should help minimize repair time.

3.9.1 EXCESSIVE PRF

This fault occurs when a synchronization signal with a frequency greater than 20 kHz is applied to the modulator. Decreasing the frequency of the input signal should clear this fault. If it does not, refer to the discussion in Section 3.3 dealing with this condition. A possible circuit failure might be a faulty one-shot setting; adjust potentiometer R_1 (see Figure A-7), for a 26.5 μ s pulse at TP2. If this does not correct the circuit, check for failure of the integrated circuits used.

3.9.2 EIO HEATER UNDERVOLTAGE

This fault occurs when the center tap voltage of isolation transformer T1 gets too low indicating that the secondary voltage that supplies the heater voltage for the EIO has also dropped. Possible causes for this fault are excessive power drain by the other secondaries of T1, or maladjustment or failure of the voltage regulator Q6 that supplies the center tap voltage (see Figure A-21).

3.9.3 TOTAL EIO AND BODY OVERCURRENT

The protection circuitry (Figure A-7), samples the total current flowing from the high voltage power supply. This current flows through R₁₀, and the collector current flows back out of the circuit, leaving the body current to flow to ground through R₁₁. Total EIO overcurrent can result from an arc within the EIO. Body overcurrent results from an improperly focused beam. Adjusting the focus voltage via the voltage regulator Q5 that feeds the center tap of isolation transform T4 should correct any beam defocusing.

SECTION 4

SUMMARY

This operations manual was written with the following as goals:

- 1) To provide sufficient explanation of the operation of the modulator/ power supply assembly so that operators can be easily trained; and
- 2) To provide detailed explanation, including diagrams and schematics of the individual circuits within the modulator. This discussion should aid Philips' engineers who wish to modify or repair the assembly.

All circuit schematics and parts location drawings for each circuit board are given in Appendix A. Parts lists for the various circuits are given in Appendix B. Manufacturers' specification sheets for selected components are given in Appendix C. The instruction manual for the -21 kV beam supply is given in Appendix D.

APPENDIX A
SCHEMATICS AND PARTS LOCATION DIAGRAMS

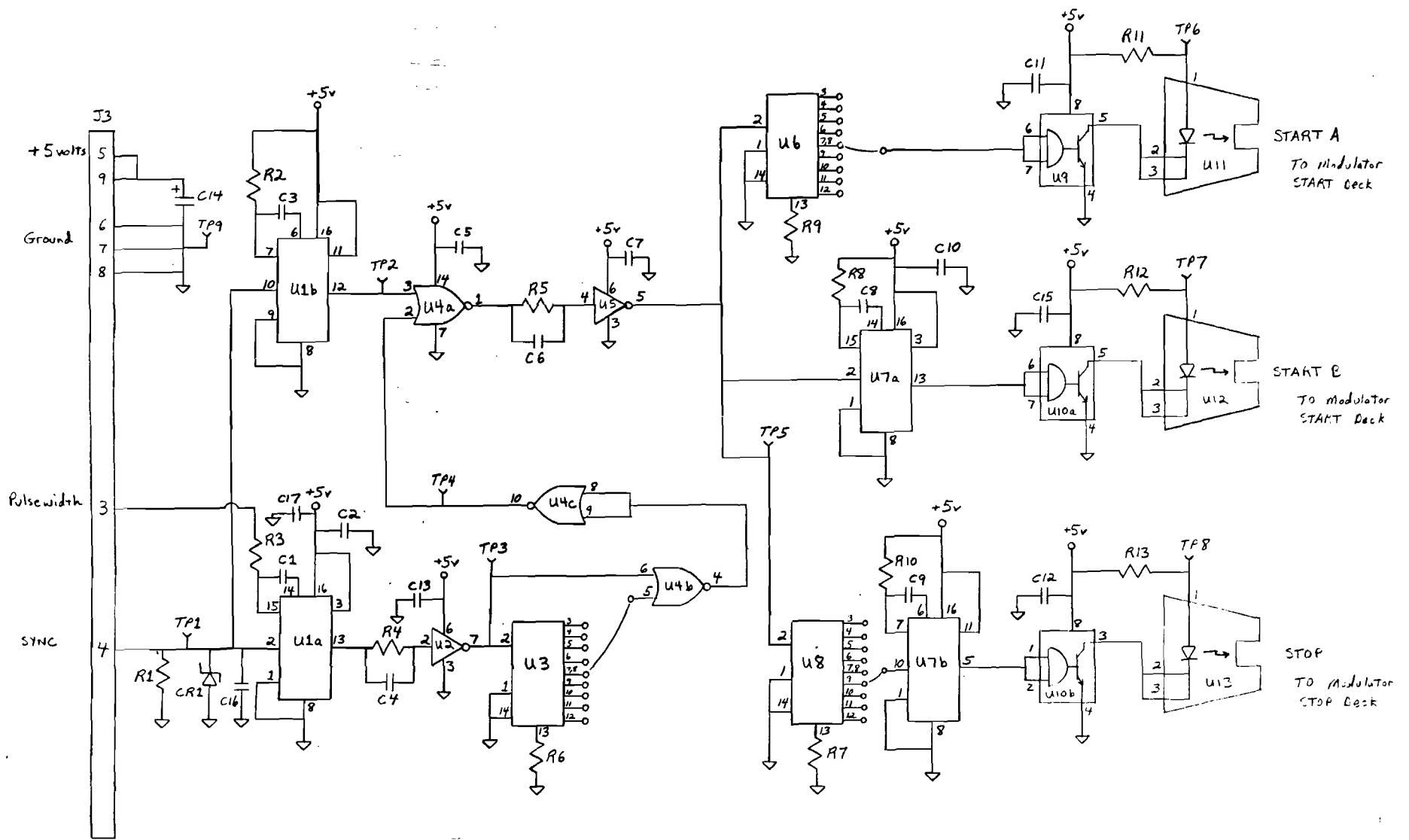


Figure A-1. Schematic diagram for Pulse Driver Circuit.

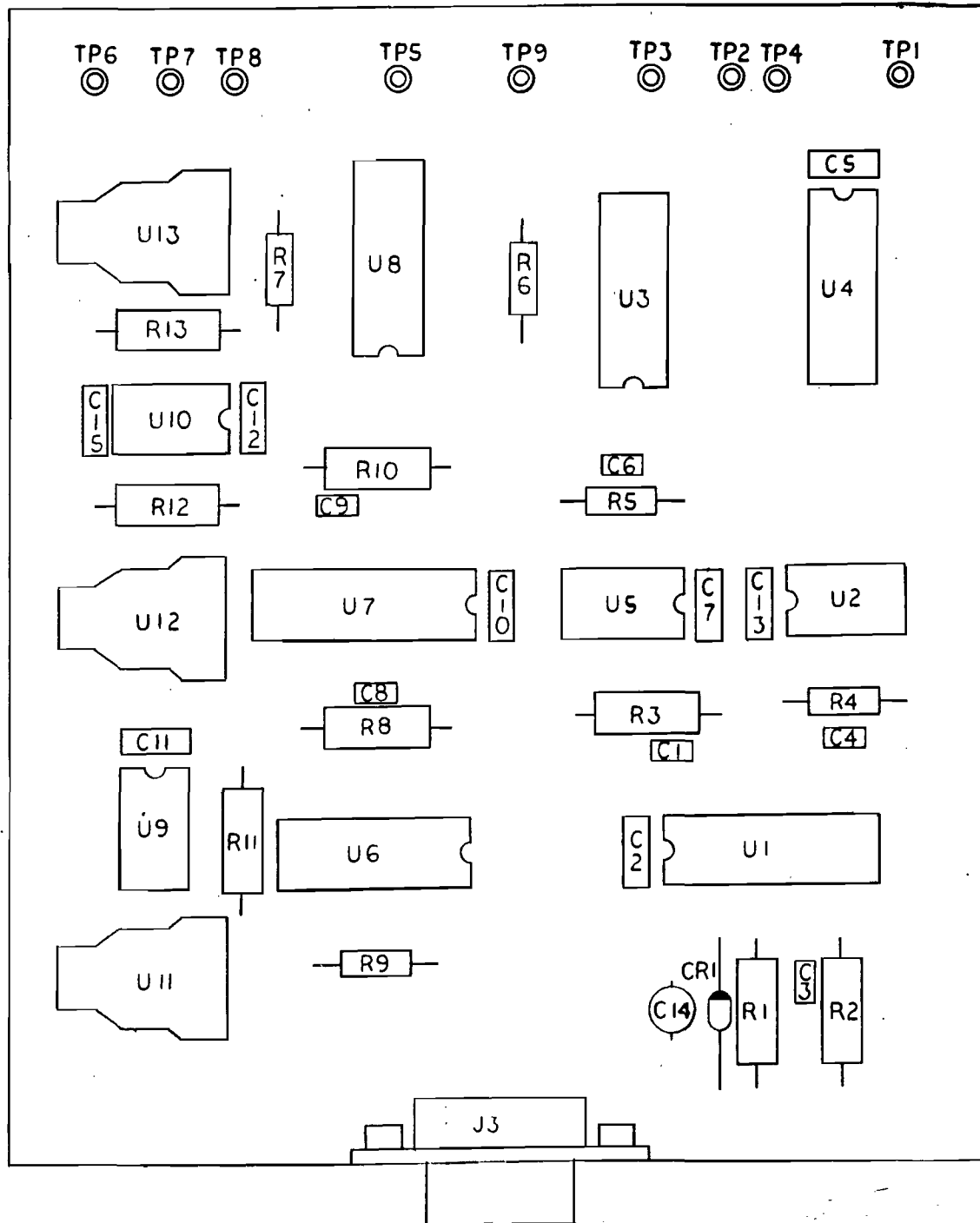


Figure A-2. Parts location diagram for Pulse Driver Circuit.

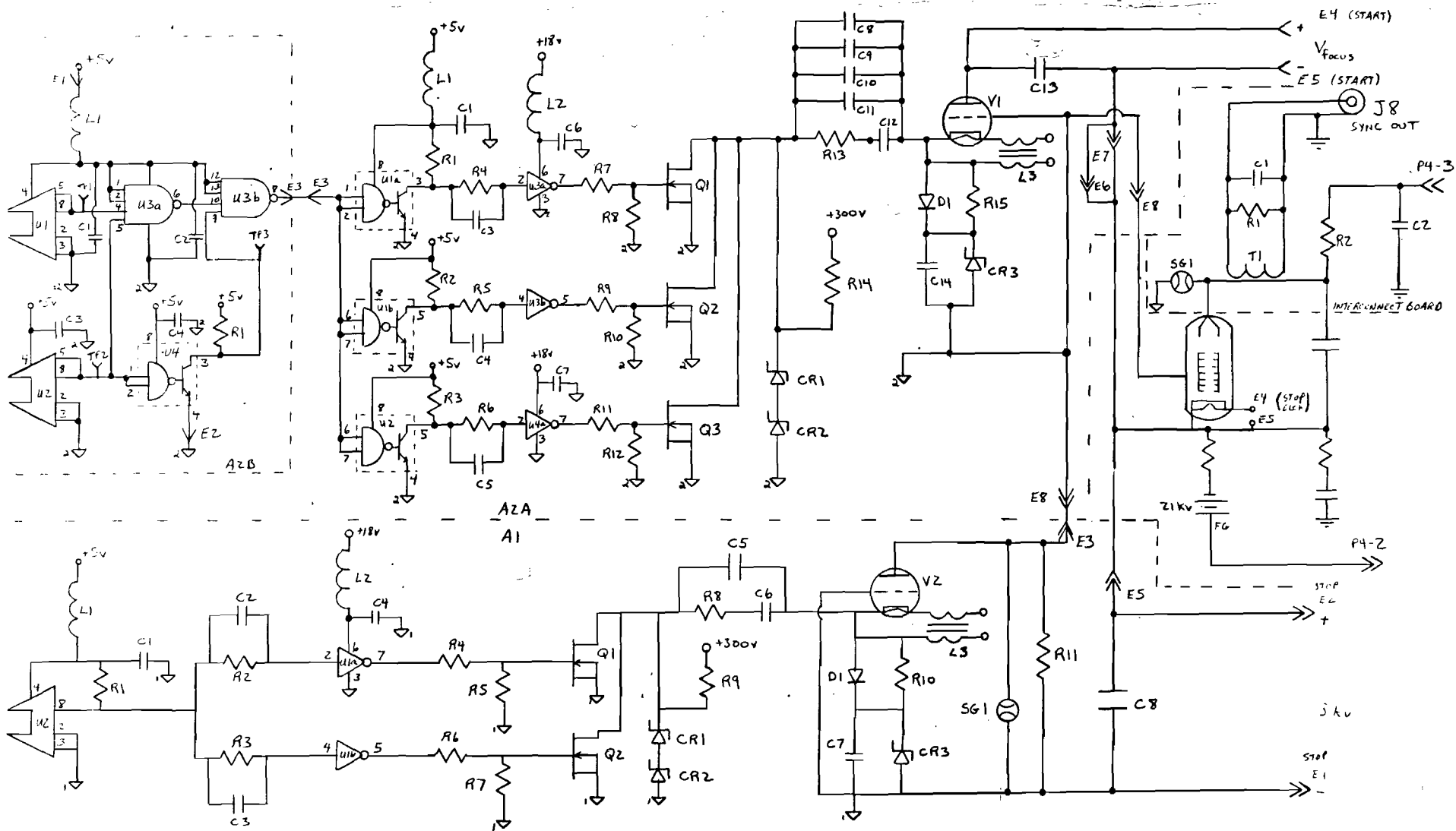


Figure A-3. Schematic diagram for modulator circuitry.

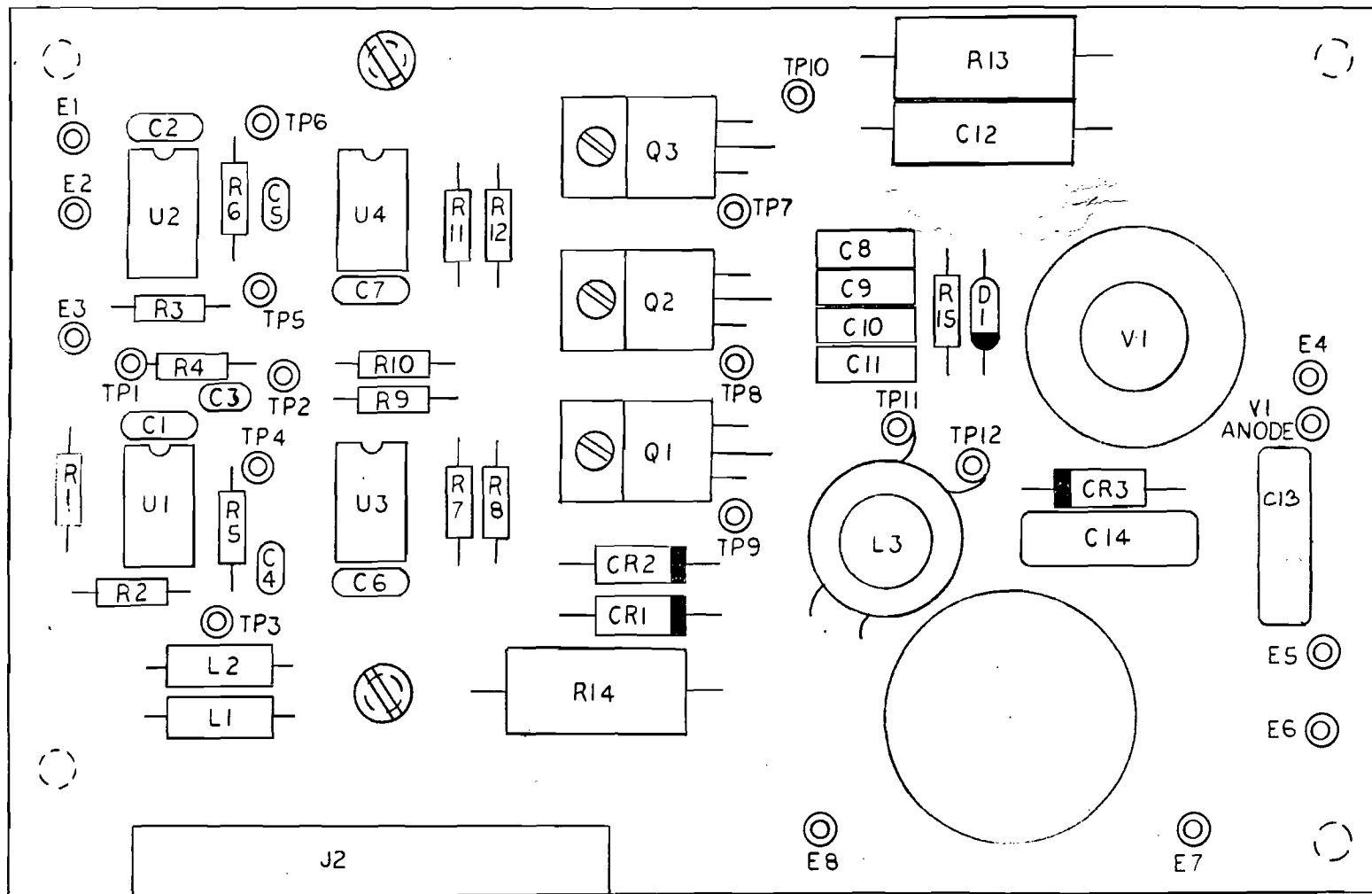


Figure A-4. Parts location diagram for modulator Start Deck A2A.

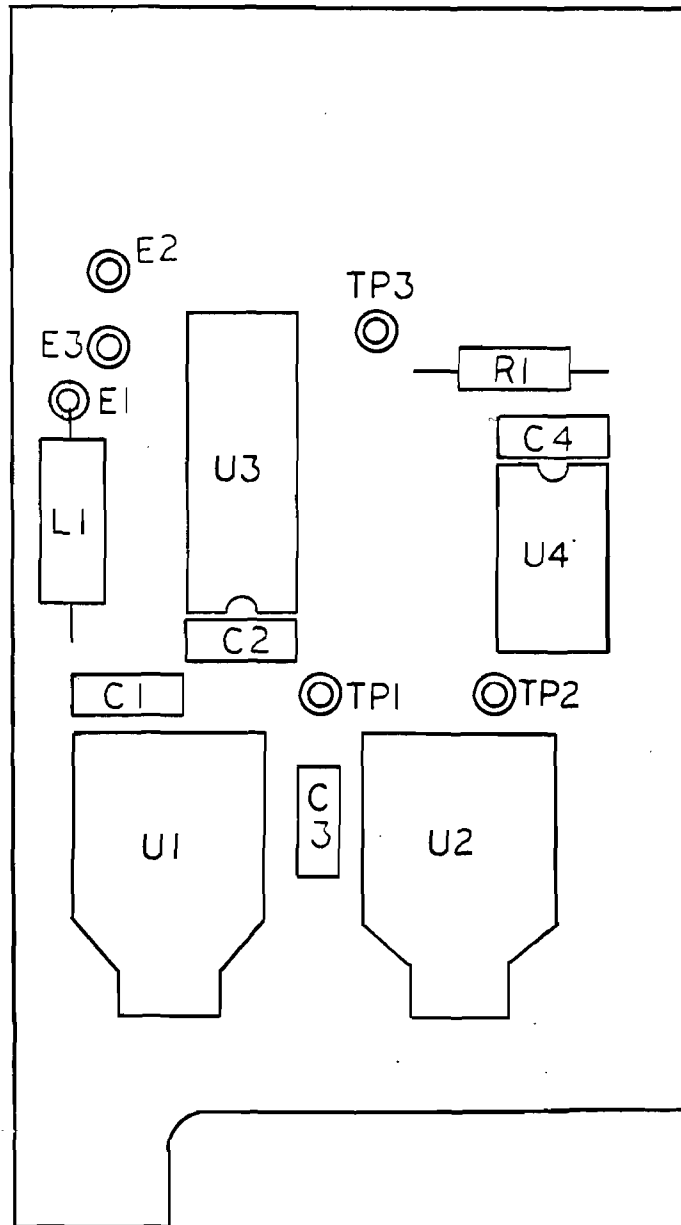


Figure A-5. Parts location diagram for modulator Start Deck A2B.

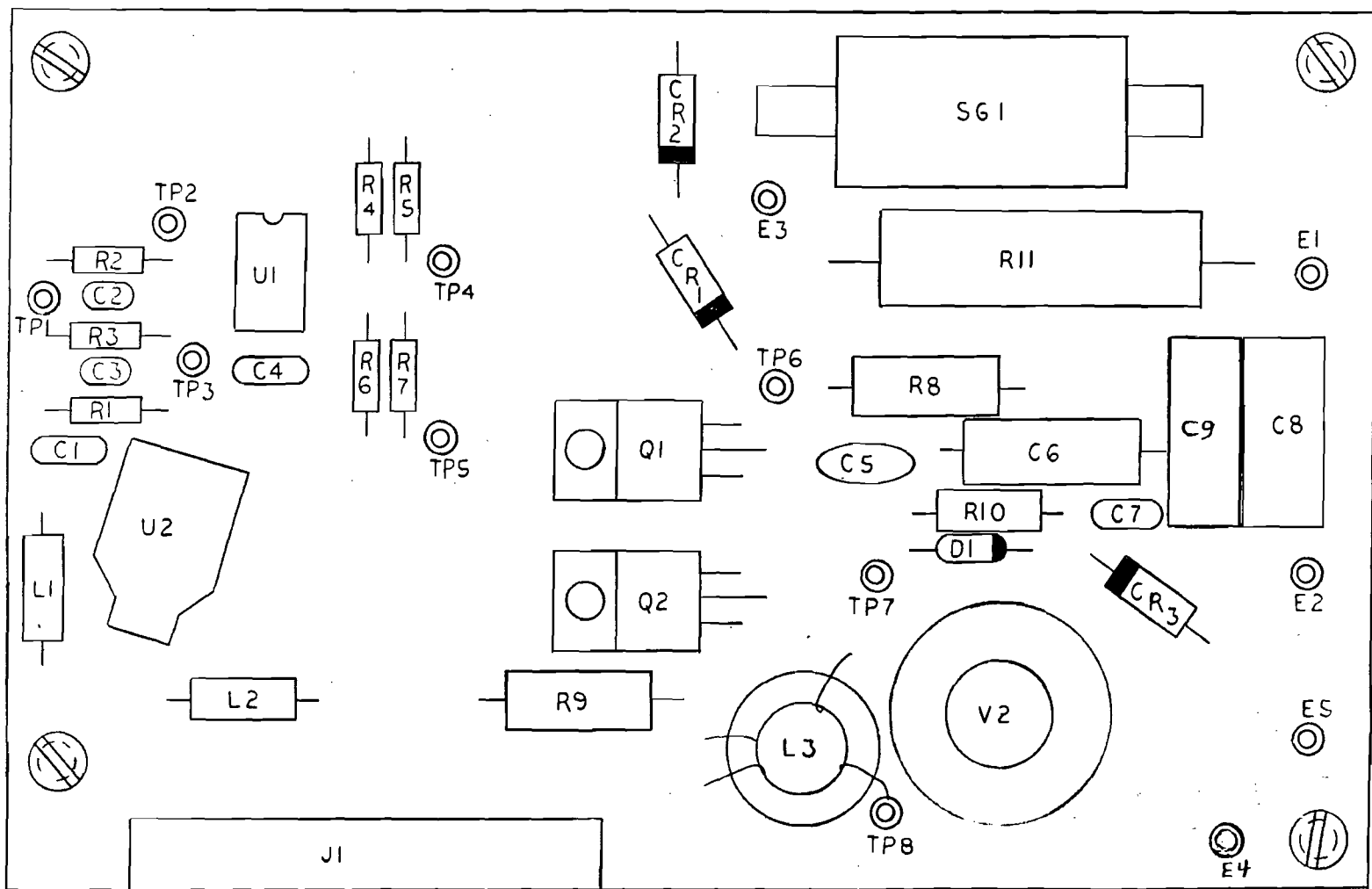


Figure A-6. Parts location diagram for modulator Stop Deck.

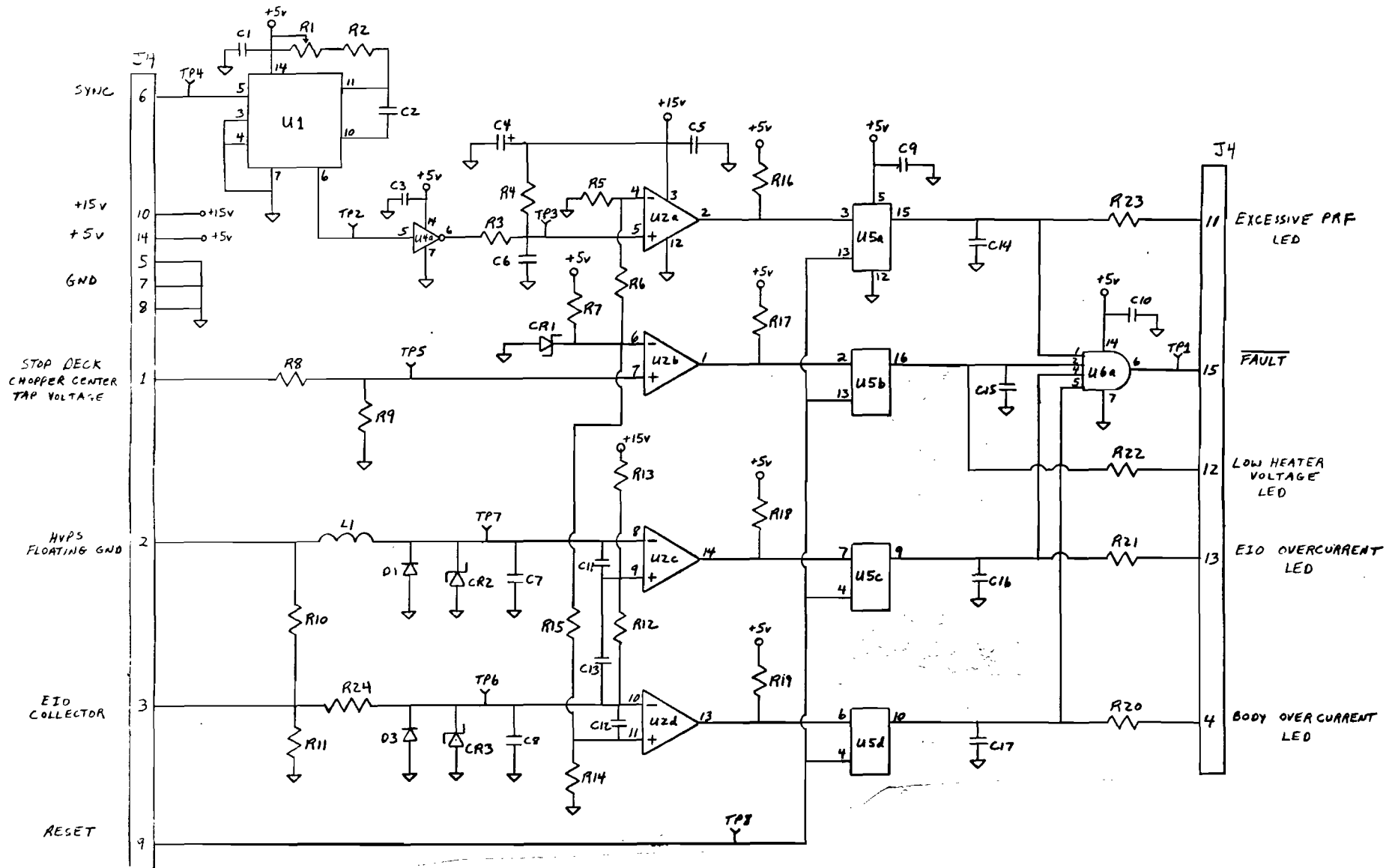


Figure A-7. Schematic diagram of Protection circuit.

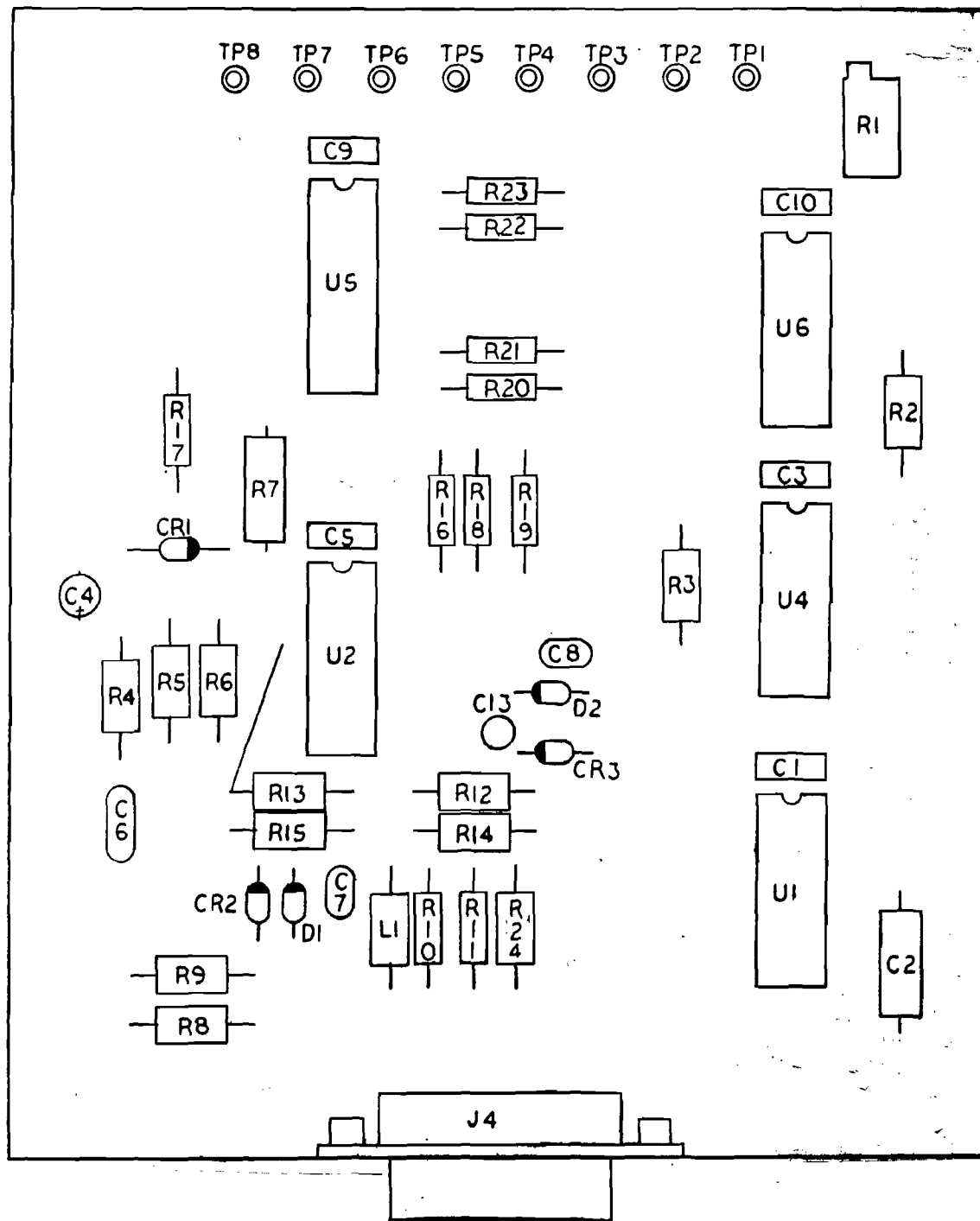


Figure A-8. Parts location diagram for Protection circuit.

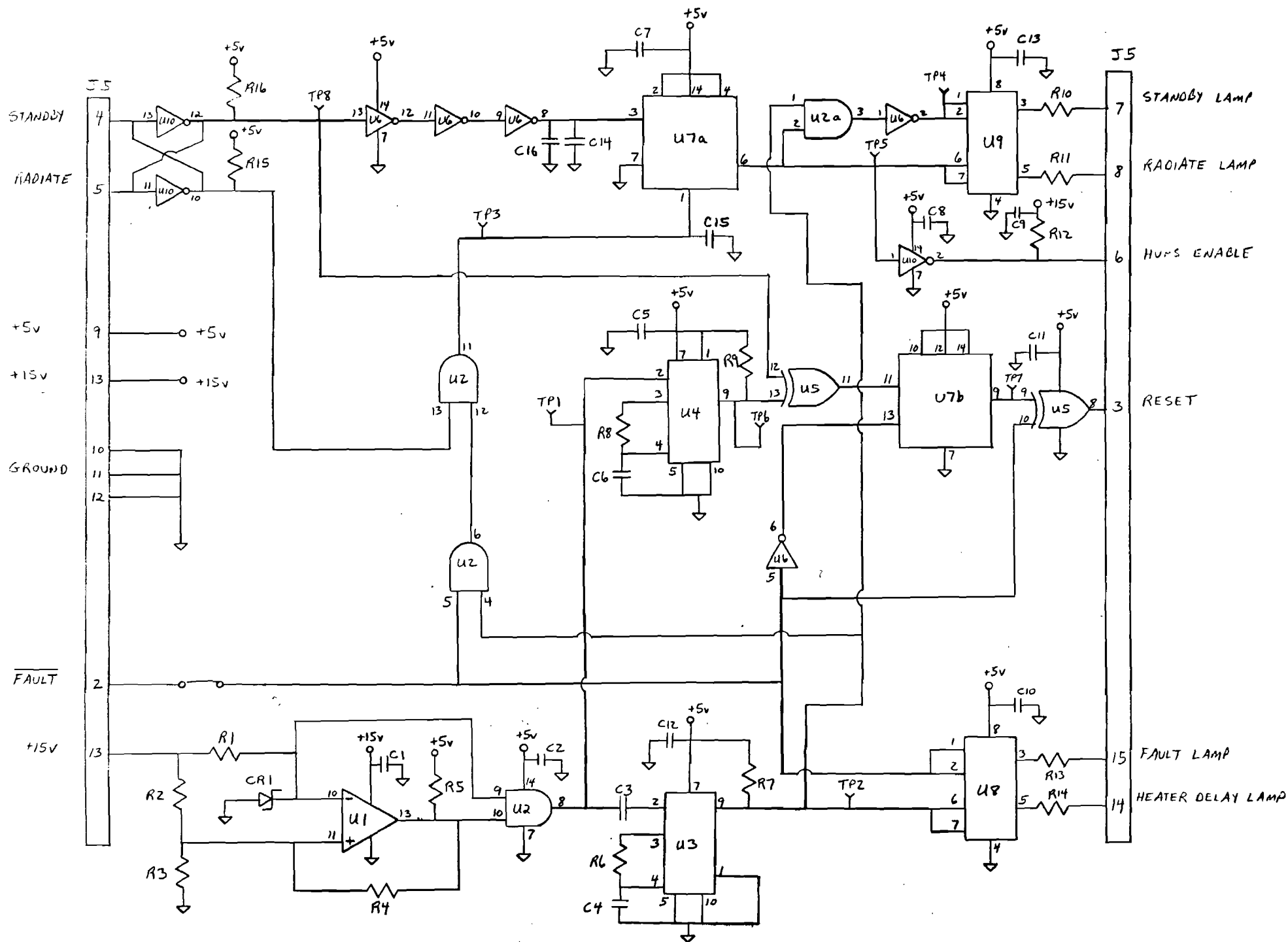


Figure A-9. Schematic diagram for Control circuit.

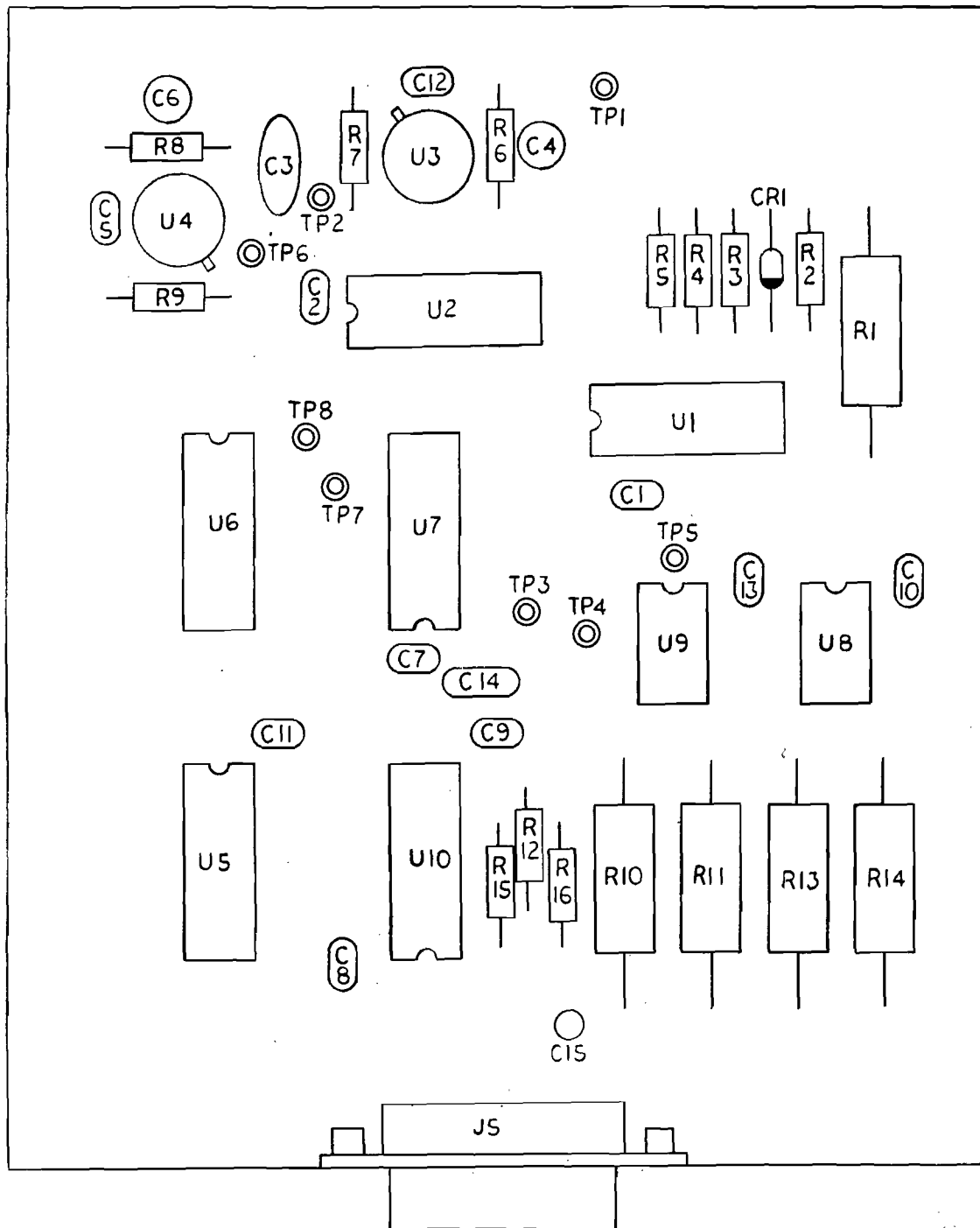


Figure A-10. Parts location diagram for Control circuit.

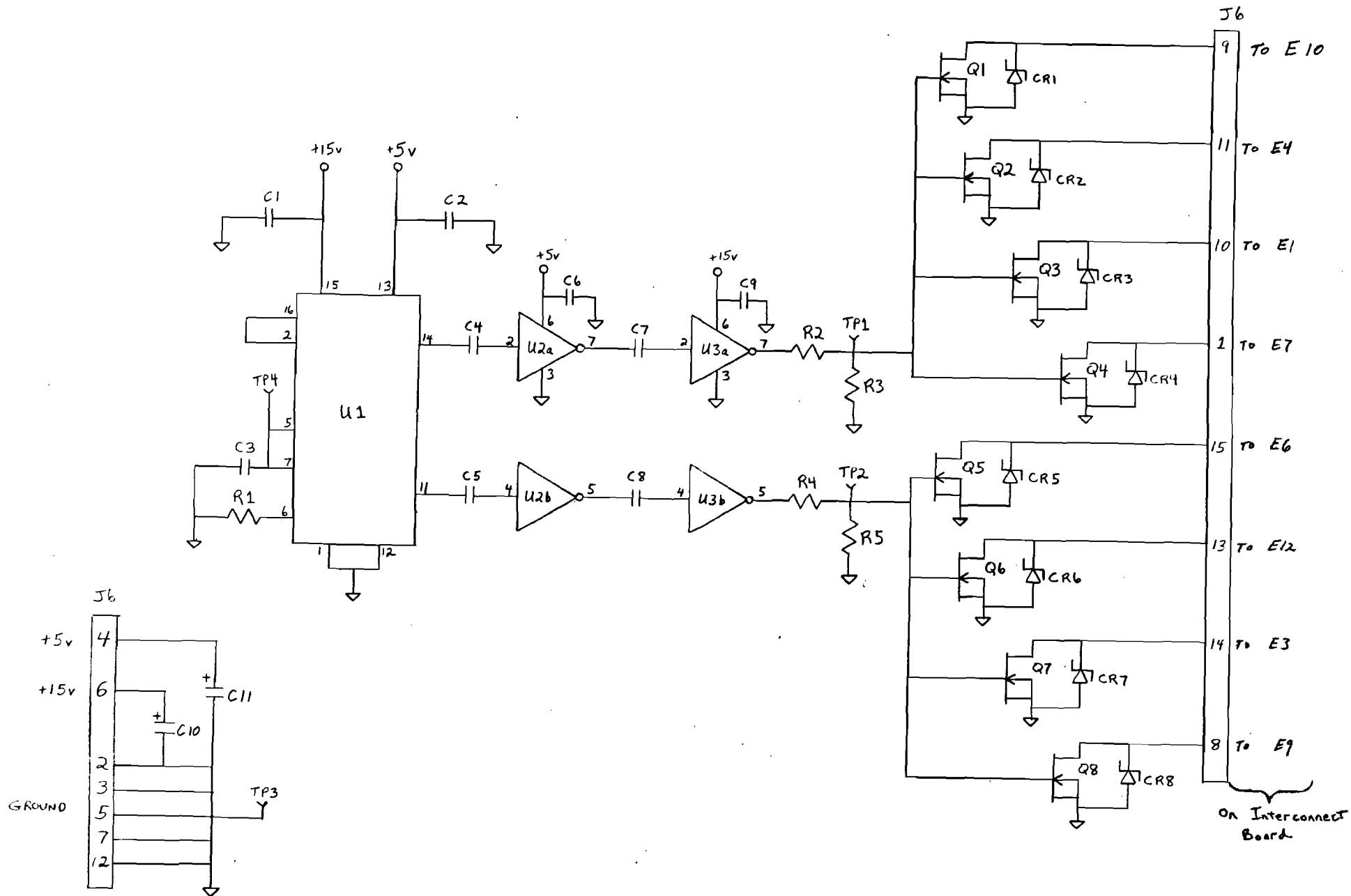


Figure A-11. Schematic diagram of push-pull power converter (chopper) circuit.

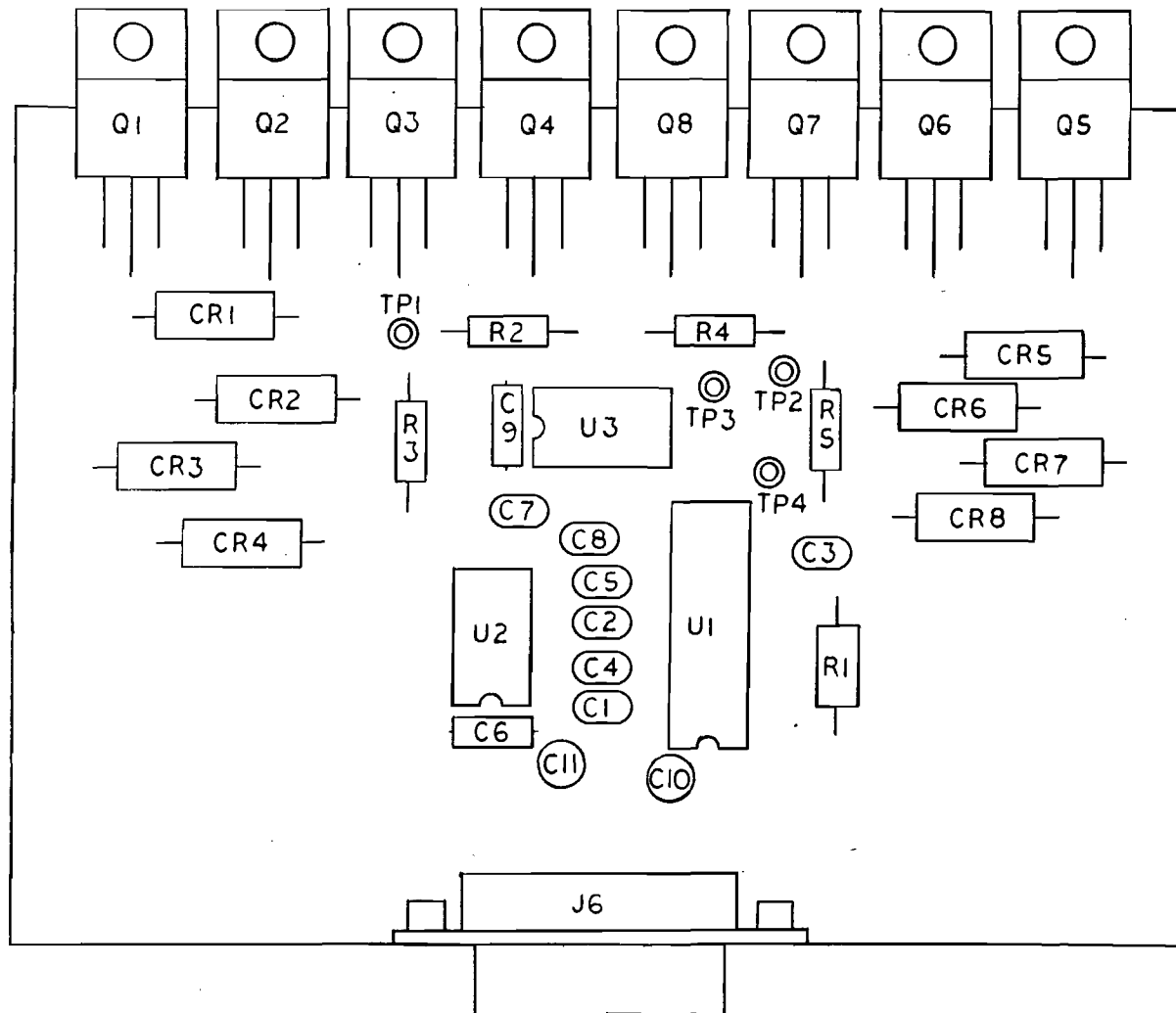


Figure A-12. Parts location diagram for push-pull power converter (chopper) circuit.

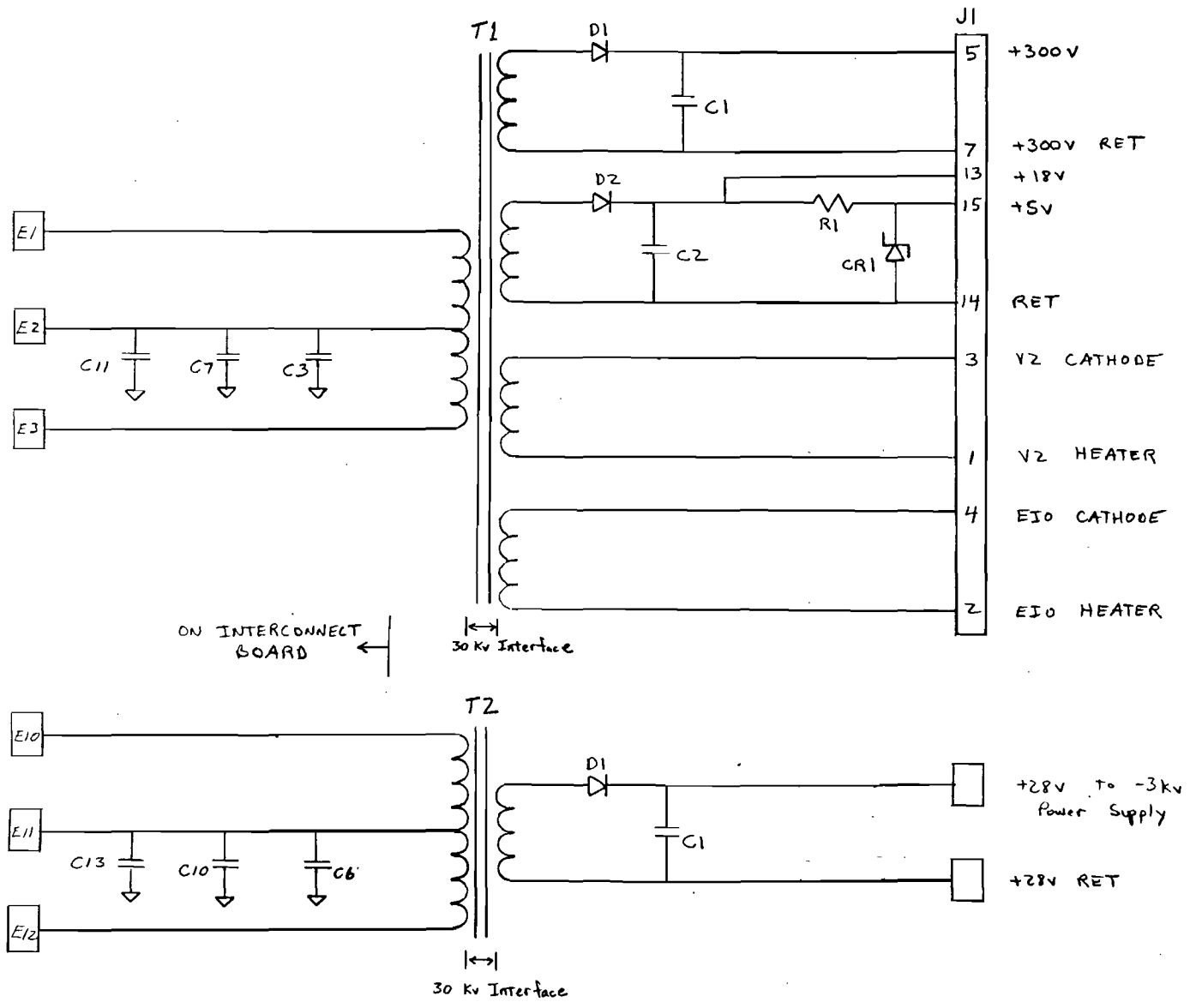


Figure A-13. Schematic diagram for isolation transformer supplies T1 and T2.

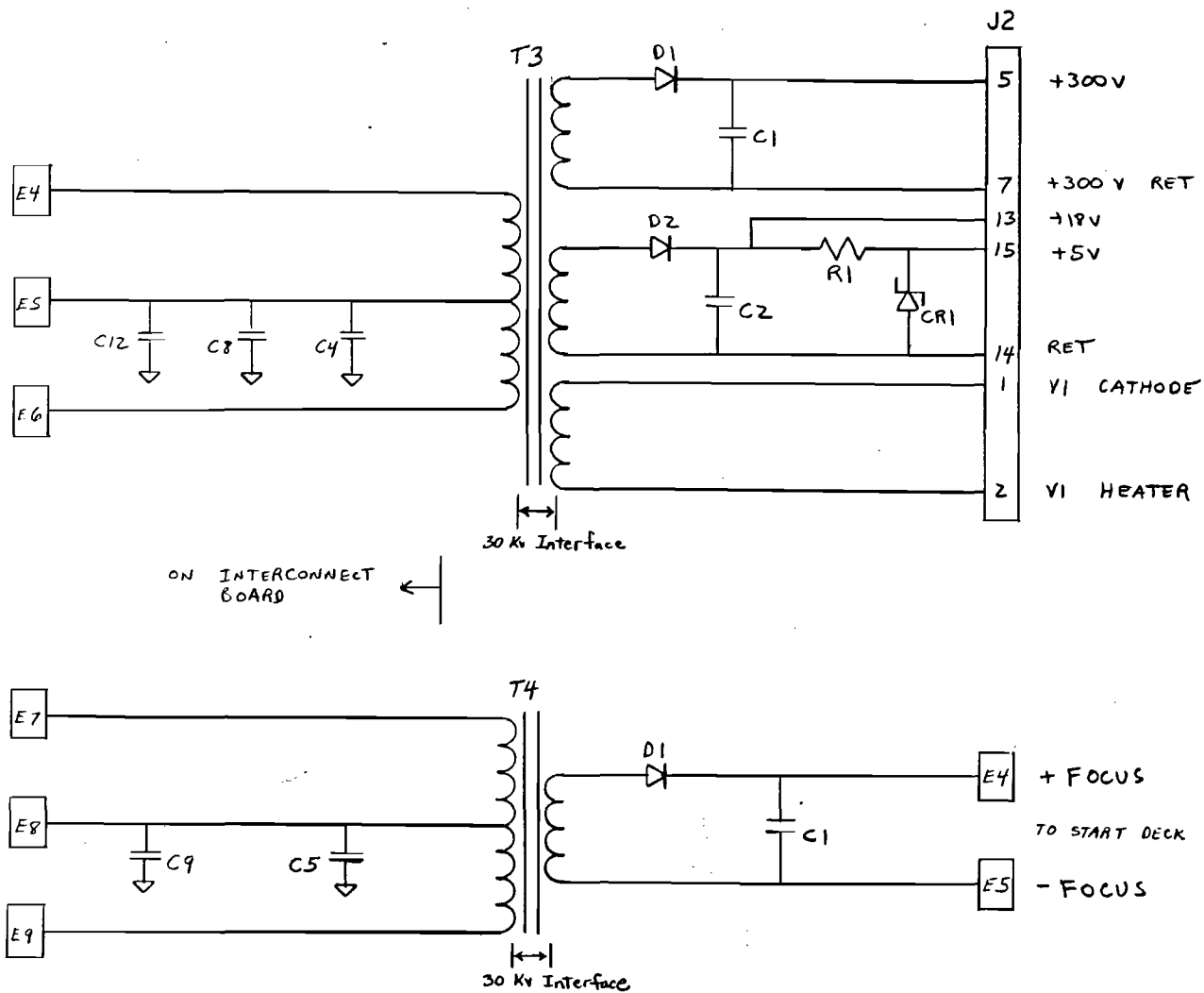


Figure A-14. Schematic diagram of isolation transformer supplies T3 and T4.

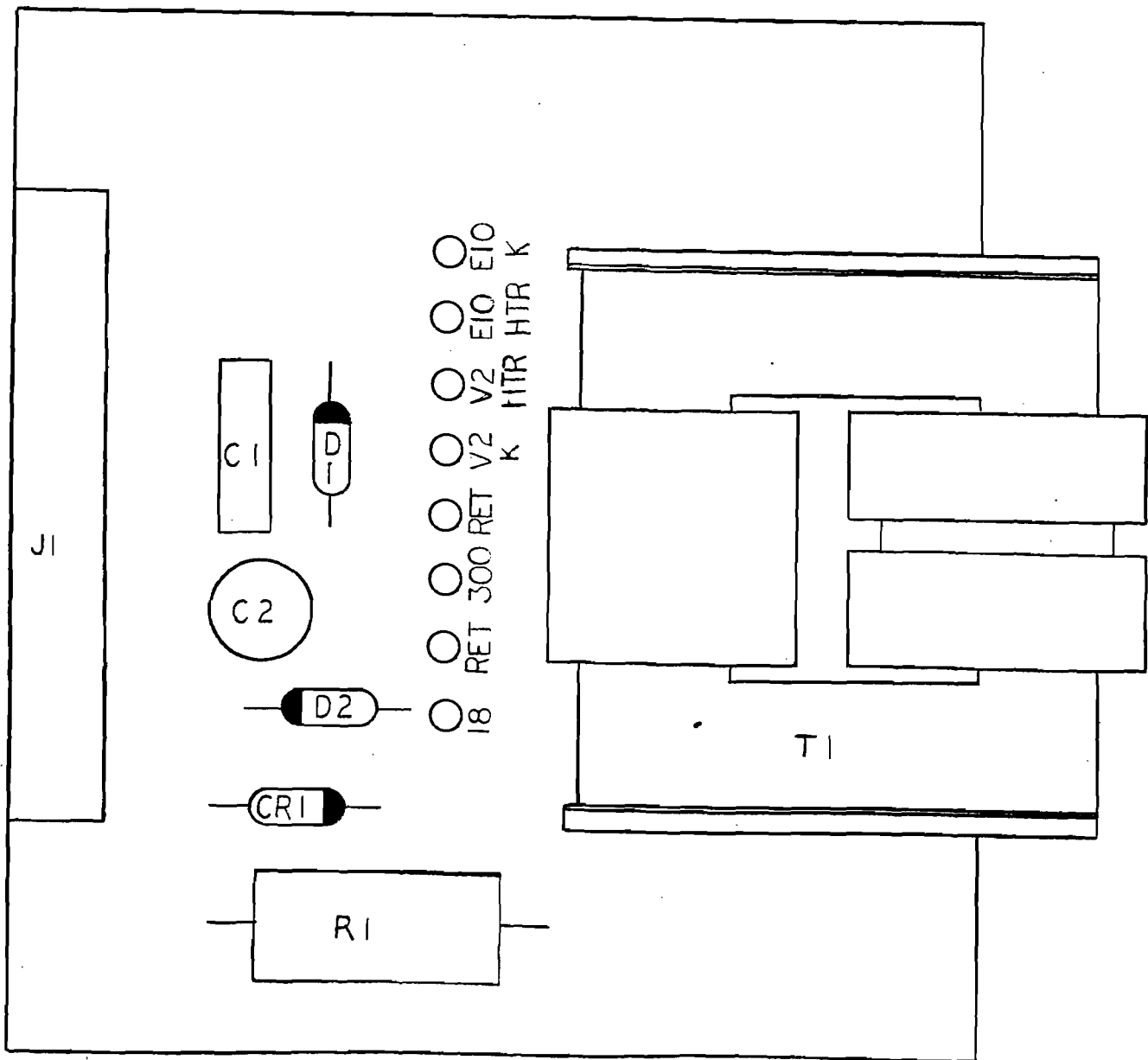


Figure A-15. Parts location diagram for isolation transformer supply T1.

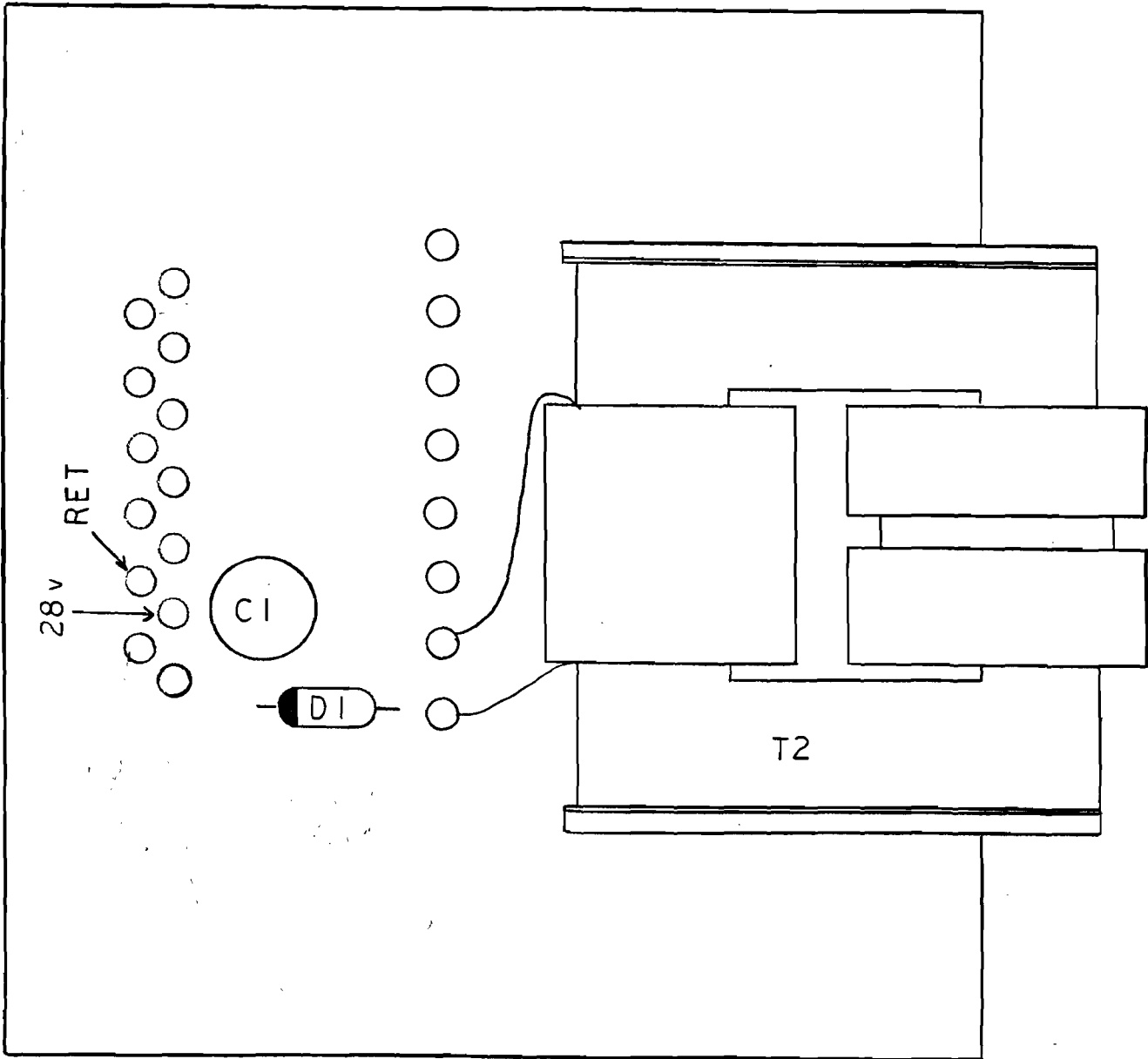


Figure A-16. Parts location diagram for isolation transformer supply T2.

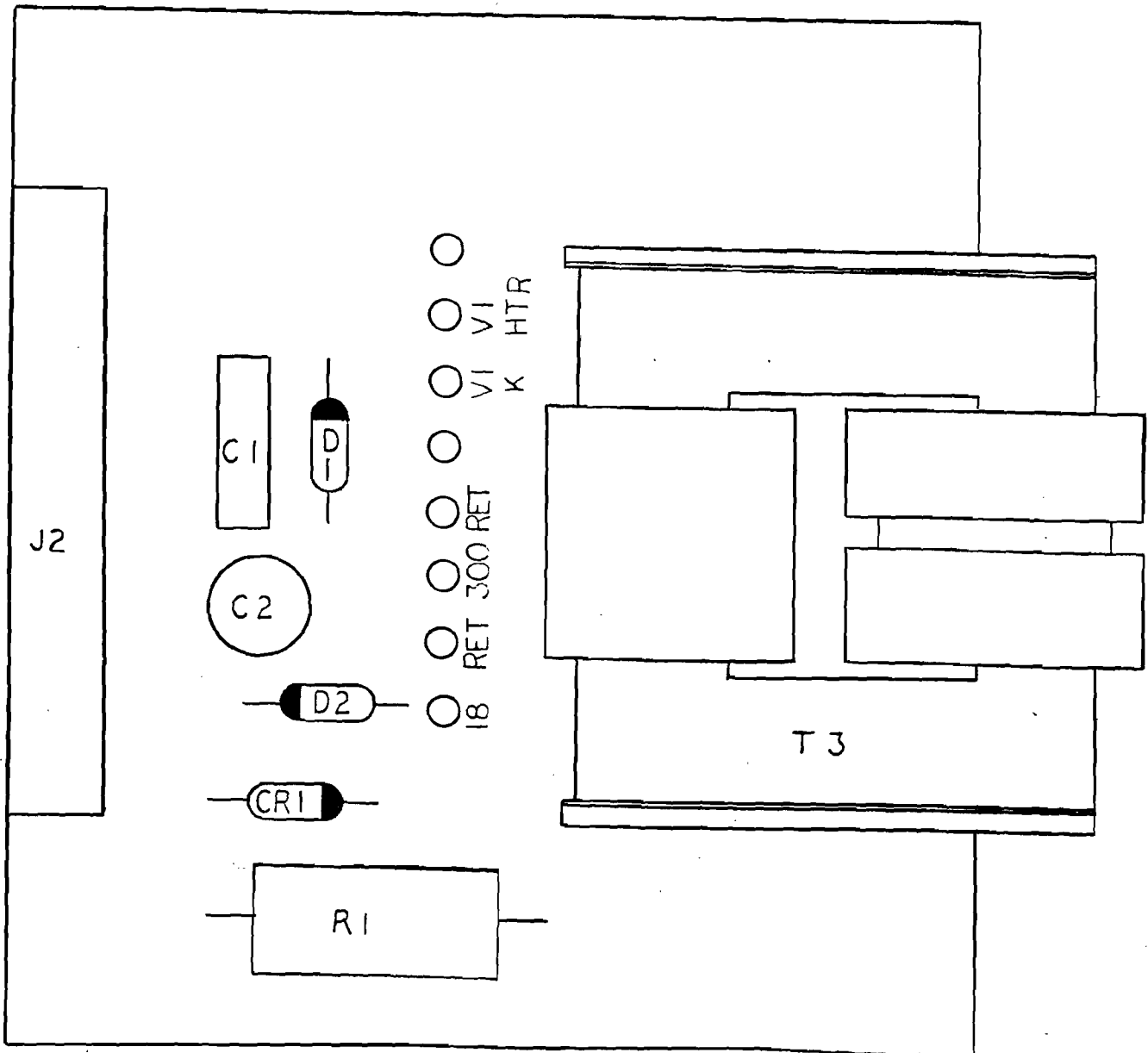


Figure A-17. Parts location diagram for isolation transformer supply T3.

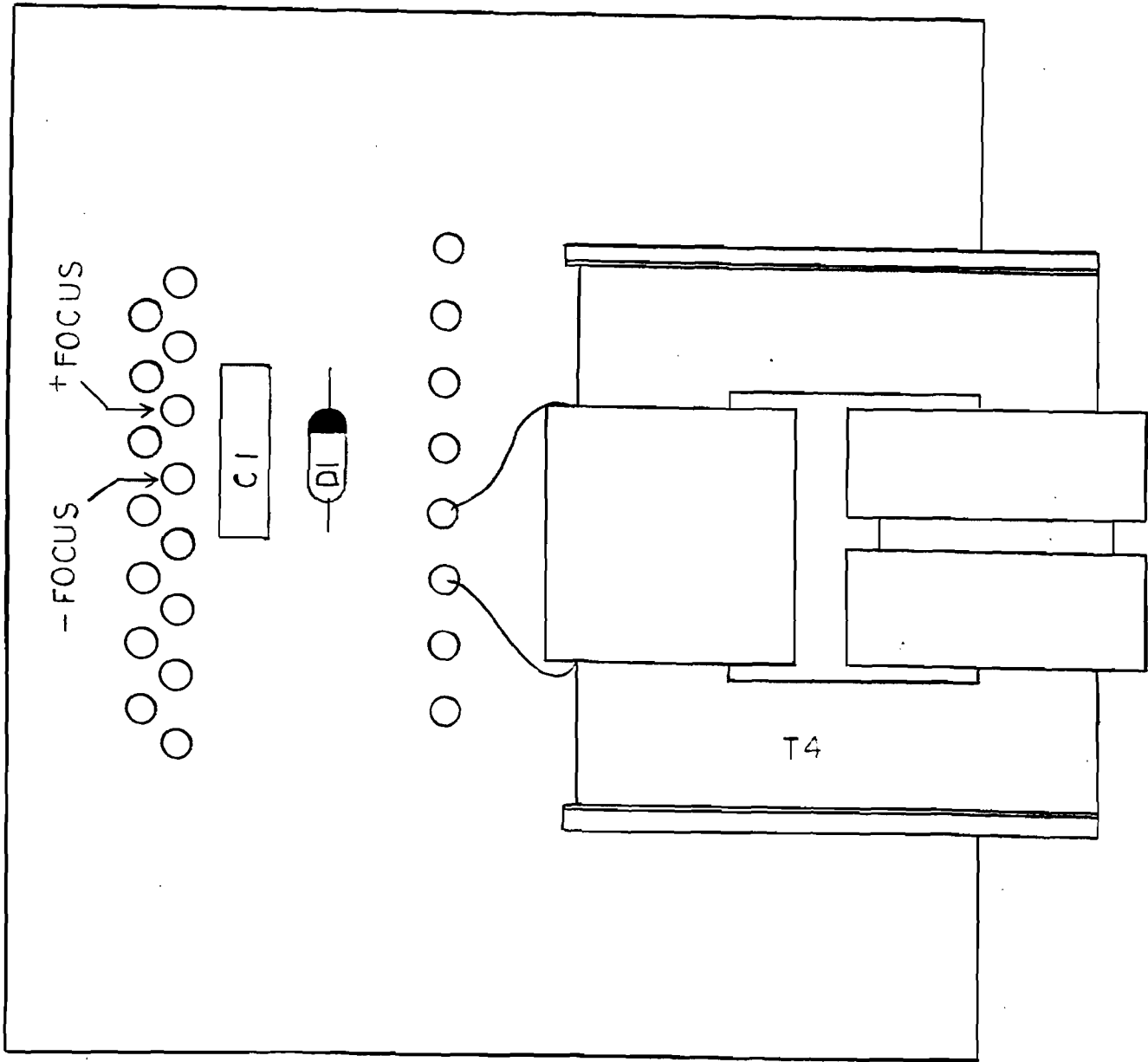


Figure A-18. Parts location diagram for isolation transformer supply T4.

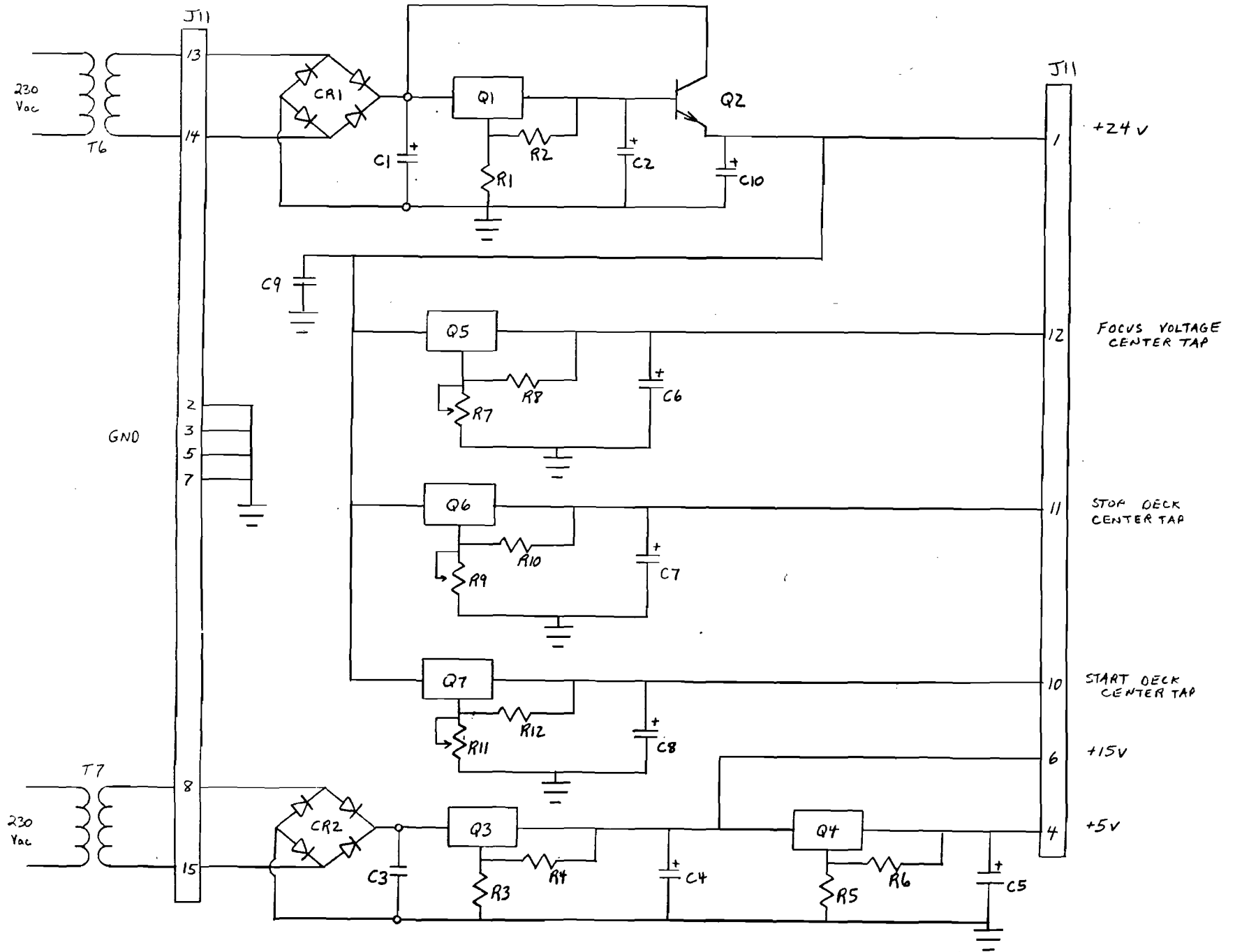


Figure A-19. Schematic diagram of Low Voltage Power Supply.

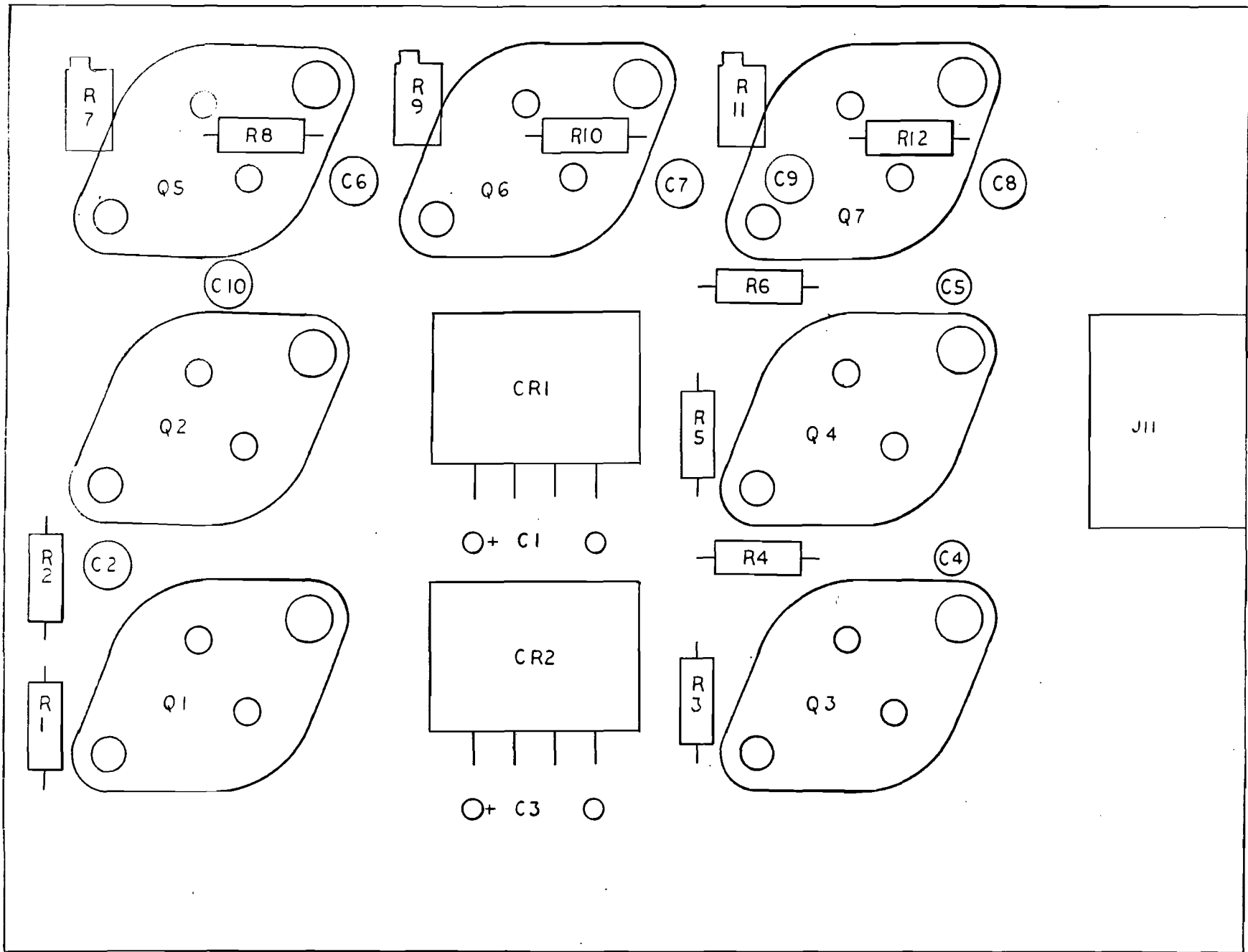


Figure A-20. Parts location diagram of Low Voltage Power Supply.

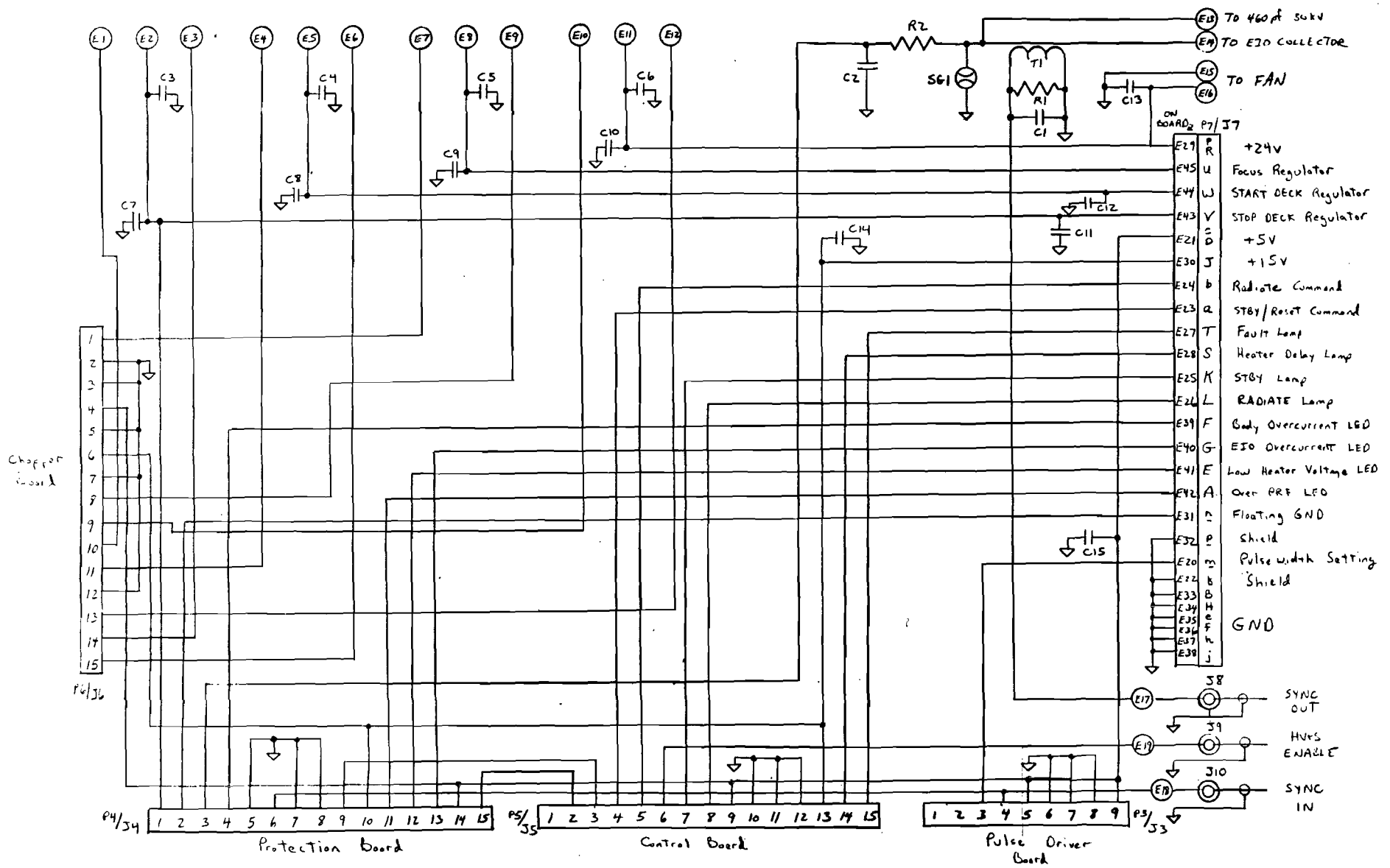


Figure A-21. Schematic diagram of Interconnect Board.

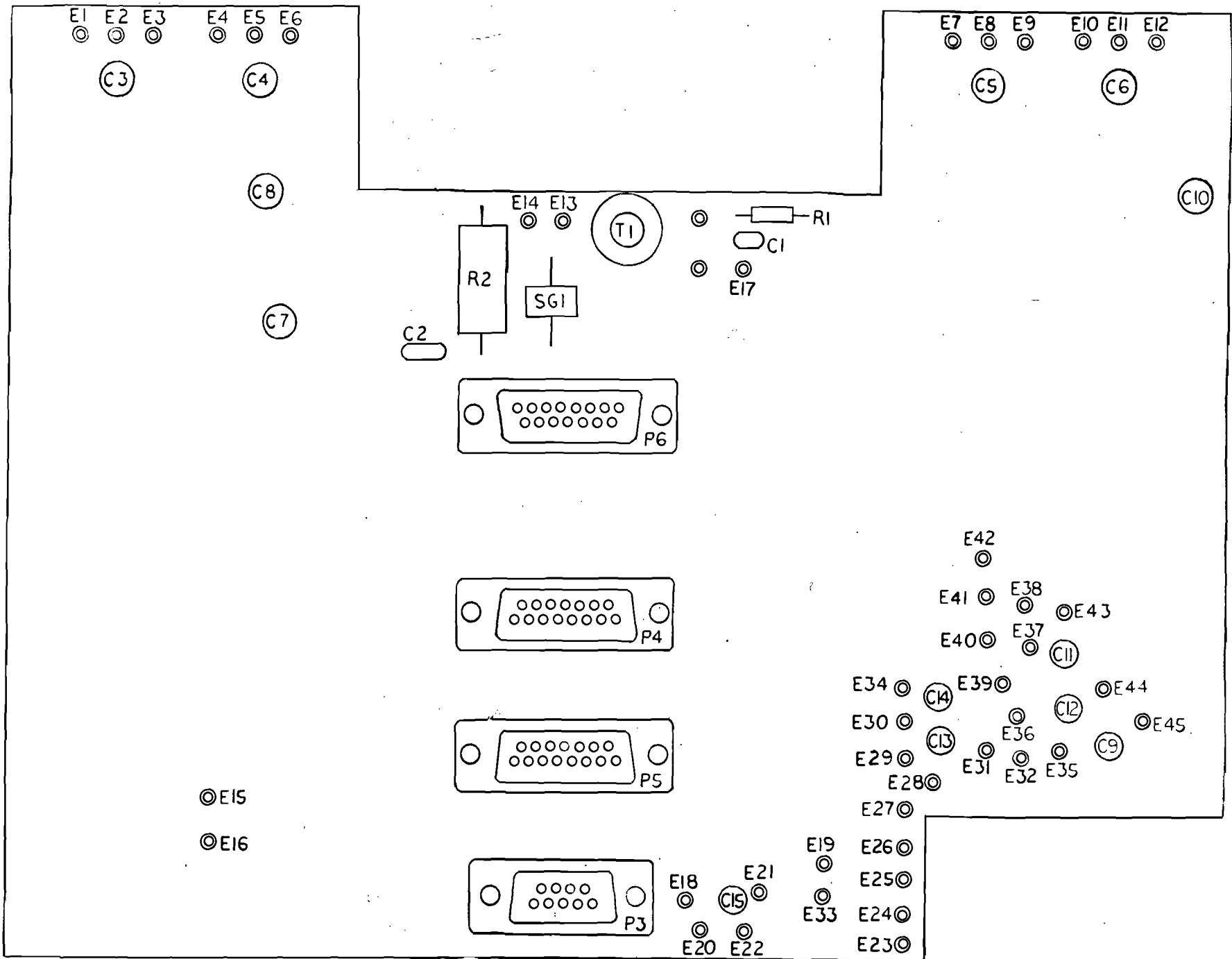


Figure A-22. Parts location diagram for Interconnect Board.

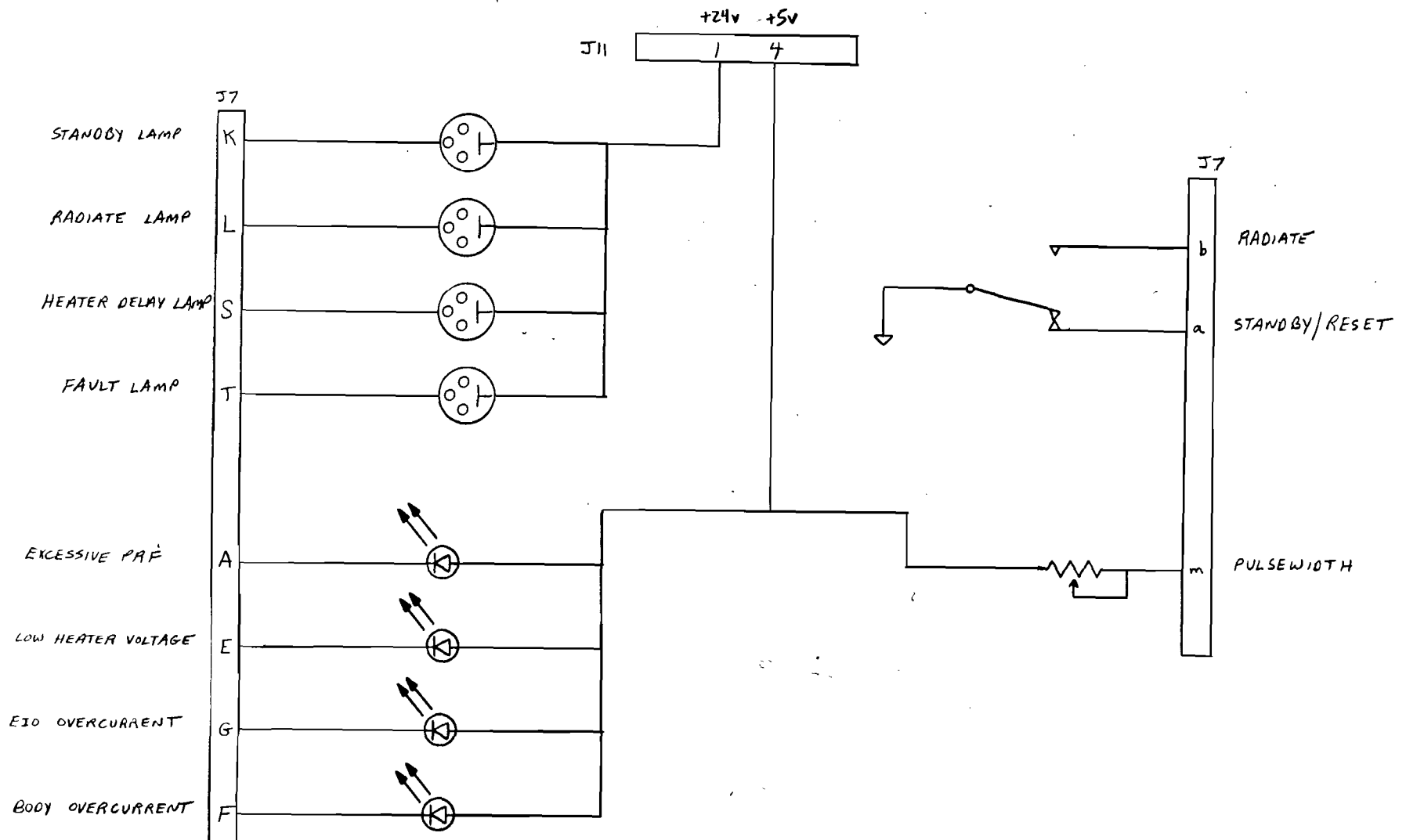


Figure A-23. Schematic diagram of wiring modifications made to Spellman Power Supply front panel.

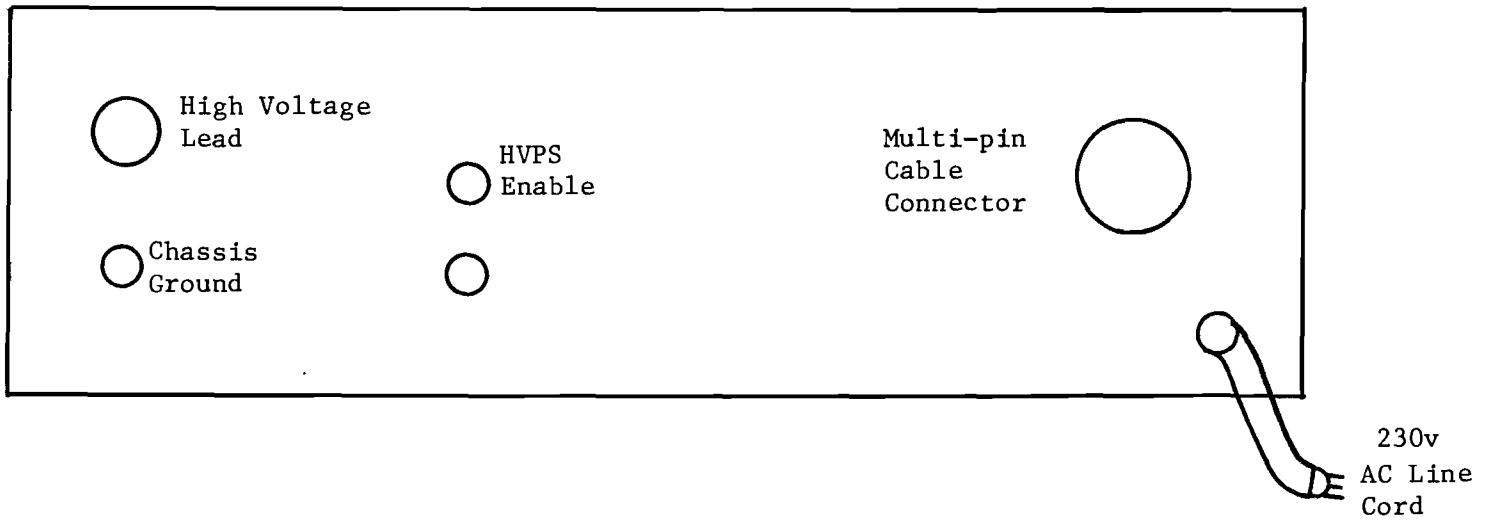


Figure 24. View of back panel of power supply showing connector designations.

TABLE A-1. CABLE PIN ASSIGNMENTS FOR CABLE BETWEEN
MODULATOR AND POWER SUPPLY

<u>Pin #</u>	<u>Signal</u>	<u>Destination in Power Supply</u>	<u>Destination in Modulator</u>
A	Excessive PRF	Cathode of Excessive PRF LED	Protection: J4-11
B	GND		
C,D	+5 V	LVPS: J11-4 Front Panel LED's Pulsewidth Potentiometer	Pulse Driver J3-5,9 Control: J5-9 Protection: J4-14 Chopper: J6-4
E	Low Heater Voltage	Cathode of Low Heater Voltage LED	Protection: J4-12
F	Body Overcurrent	Cathode of Body Overcurrent LED	Protection: J4-4
G	EIO Overcurrent	Cathode of EIO Overcurrent LED	Protection: J4-13
H	GND		
J	+15 V		Control: J5-13 Protection: J4-10 Chopper: J6-6
K	STBY LAMP	Low Side of STANDBY LAMP	Control: J5-7
L	RADIATE LAMP	Low Side of RADIATE LAMP	Control: J5-8
P	N/C		
R	N/C		
M,N	+24 V	LVPS: J11-1 Front Panel Lamps	Interconnect: E-29
S	Heater Delay Lamp	Low Side of Heater Delay Lamp	Control: J5-14
T	Fault Lamp	Low Side of Fault Lamp	Control: J5-15
U	Focus Regulator Voltage	LVPS: J11-12	Interconnect: E45
V	Stop Deck Regulator Voltage	LVPS: J11-11	Protection: J4-1 Interconnect: E43
W	Start Deck Regulator Voltage	LVPS: J11-10	Interconnect: E44
X	N/C		
Z	N/C		

TABLE A-1. CABLE PIN ASSIGNMENTS FOR CABLE BETWEEN
MODULATOR AND POWER SUPPLY (CONTINUED)

<u>Pin #</u>	<u>Signal</u>	<u>Destination in Power Supply</u>	<u>Destination in Modulator</u>
a	STBY/RESET Command	Front Panel Switch	Control: J5-4
b	Radiate Command	Front Panel Switch	Control: J5-5
c	Spare		
d	Spare		
e	GND		
f	GND		
g	N/C		
h	GND		
j	GND		
k	Shield	GND	GND
m	Pulsewidth Setting	Front Panel Potentiometer	Pulse Driver: J3-3
n	Floating Ground	Back Panel	Protection: J4-2
p	Shield	GND	GND
r	Spare		
s	Spare		

APPENDIX B
PARTS LISTS

PARTS LIST		LIST TITLE: Pulse Driver		CONTRACT NO:		DATE: 1/10/84	
FIND NO.	PART NUMBER	QTY RQD	DESCRIPTION	REF DESIG.	PAGE OF		
					NOTES		
			49.9Ω 1%	R1			
			7.5kΩ 1%	R2			
			2 kΩ 1%	R3			
			3.9kΩ	R4, R5			
			100Ω 1/8w 1%	R6, R7			
			2.61kΩ 1%	R8			
			100Ω 1/8w 1%	R9			
			4.99kΩ 1%	R10			
			47.5Ω 1%	R11-R13			
			39 pf	C1			
			.22 μf	C2			
			47 pf	C3			
			.001 μf	C4			
			.22 μf	C5			
			.001 μf	C6			
			.22 μf	C7			
			47 pf	C8			
			120 pf	C9			
			.22 μf	C10-C13			
			10 μf 25v tantalum	C14			
			.22 μf	C15			
			270 pf	C16			
			.01 μf	C17			
	1N4733A		5.1 v zener	CR1			
	DM74LS221		Dual one-shot	U1, U7			
	DS0026		MOS Clock Driver	U2, U5			
	PE9825		Delay Line	U3, U6, U8			
	74S02		Quad NOR Gate	U4			
	75451		NAND Driver	U9			
	75452		AND Driver	U10			
	HFBR-0500		Optical Transmitter	U11-U13			
	DAE15PA		15 pin D connector	J3			

PARTS LIST		LIST TITLE: Modulator Start Deck A2A		CONTRACT NO:		DATE: 1/10/84	
FIND NO.	PART NUMBER	QTY RQD	DESCRIPTION	REF DESIG.	PAGE OF		
					NOTES		
	75451		NAND Driver	U1,U2			
	DS0026		MOS Clock Driver	U3,U4			
	IVN6000CNT		MOSFET Transistor	Q1-Q3			
	8847A		Planar Triode	V1			
	1N5378		100v 5watt zener	CR1			
	1N5388		200v 5watt zener	CR2			
	1N5371		60 v 5watt zener	CR3			
	1N4937		Diode	D1			
			.22 uf	C1,C2			
			100 pf	C3-C5			
			.22 uf	C6,C7			
			390 pf	C8-C11			
			.15 uf 400v	C12			
			.22 uf 250v	C13			
			.047uf 400v	C14			
			20Ω	R1-R3			
			3.9kΩ	R4-R6			
			10Ω	R7,R9R11			
			150Ω	R8,R10R12			
			390Ω 2watt	R13			
			1.5kΩ 2watt	R14			
			330Ω	R15			
			Inductor choke, 100 μh	L1,L2			
			Toroid inductor, 3 turns bif.	L3			
			planar triode heatsink				
		3	mica insulator			for Q1-Q3	
	Elco 8129		15 pin connector.	J2			

PARTS LIST		LIST TITLE: Modulator Stop Deck	CONTRACT NO:	DATE: 1/10/84	
FIND NO.	PART NUMBER	QTY RQD	DESCRIPTION	REF DESIG.	PAGE OF NOTES
	DS0026		MOS Clock Driver	U1	
	HFBR-0500		Optical Receiver	U2	
	IVN6000CNT		MOSFET Transistor	Q1,Q2	
	8847A		Planar Triode	V2	
			100 μ h choke	L1,L2	
			Toroid inductor, 16 turns bif.	L3	
			1 k Ω	R1	
			3.9k Ω	R2,R3	
			10 Ω	R4,R6	
			1k Ω	R5,R7	
			430 Ω	R8	
			4.3k Ω	R9	
			1k Ω $\frac{1}{2}$ watt	R10	
			30k Ω 10 watt	R11	Caddock
	1N5378		100v 5watt zener	CR1	
	1N5388		200v 5watt zener	CR2	
	1N5371		60 v 5watt zener	CR3	
	1N4937		Diode Rectifier	D1	
			.22 μ f	C1,C4	
			1000 pf	C2,C3	
			.005 μ f 1kv	C5	
			.15 μ f 400v	C6,C7	
			.022 μ f	C8	
			.01 μ f	C9	
	UBT4.0		Spark Gap 4kv	SG1	
			planar triode heatsink		
			mica insulator		for Q1,Q2
	Elco 8129		15 pin connector	J1	

PARTS LIST		LIST TITLE: Protection Circuit		CONTRACT NO:		DATE: 4/1/84	
FIND NO.	PART NUMBER	QTY RQD	DESCRIPTION	REF DESIG.	PAGE OF NOTES		
			10 k Ω pot	R1			
			2.0 k Ω 1%	R2			
			499 Ω 1%	R3			
			5.11 k Ω 1%	R4			
			17.4 k Ω 1%	R5			
			10.0 k Ω 1%	R6			
			20 Ω $\frac{1}{2}$ watt	R7			
			15k Ω 1%	R8			
			5.6k Ω	R9			
			300 Ω 1%	R10			
			953 Ω 1%	R11			
			27.4k Ω 1%	R12			
			280k Ω 1%	R13			
			18.2k Ω 1%	R14			
			40.2k Ω 1%	R15			
		4	3.9k Ω	R16-R19			
		4	51 Ω	R20-R23			
			3010 Ω 1%	R24			
			100 μ h	L1			
	1N914		diode	D1,D2			
	1N4730		3.9 volt zener	CR1			
	1N4733	2	5.1 volt zener	CR2,CR3			
		5	.22 μ f	C1,C3,C5,C9,C10			
			1200 pf polystyrene	C2			
			22 μ f 25 v tantalum	C4			
		2	1 μ f 50 v tantalum	C6,C13			
		2	4.7 μ f 25v tantalum	C7,C8			
		2	.01 μ f	C11,C12			
		4	.1 μ f	C14-C17			
	74121		One-shot	U1			
	LM339		Quad Comparator	U2			
	7406		Hex Inverter	U4			
	7475		Quad D Latch	U5			
	7421		Dual 4-input AND Gate	U6			
	DAE15PA		15 pin D connector	J4			

APPENDIX C
MANUFACTURER'S SPECIFICATION SHEETS



TECHNICAL DATA

8847
8847A

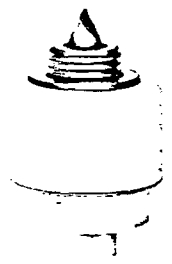
HIGH-MU
PLANAR TRIODES

The 8847 and 8847A are miniature, ceramic/metal, rugged planar triodes for advanced airborne and space applications up to 3.5 GHz.

The 8847A is identical to the 8847 in all respects except that the required heater power is reduced by 25%. The tube should be used where input power consumption and heat dissipation are of major concern.

Either tube may be used as an amplifier, oscillator, or frequency multiplier in the CW, grid- or plate-pulsed mode, as well as a modulator or regulator tube. In addition to low interelectrode capacitances, high transconductance and amplification factor, the 8847 and 8847A have an anode designed to enhance frequency stability and an arc-resistant cathode, both assuring stable, reliable and long-life operation under adverse conditions.

The 8847 and 8847A are supplied without radiator and may be conduction, convection, heat sink, or liquid cooled. Radiators for forced-air cooling permitting an anode dissipation up to 150 watts, can be furnished on separate order.



GENERAL CHARACTERISTICS¹

ELECTRICAL

Cathode:Oxide Coated, Unipotential

Heater: Voltage	6.3 ± 0.3 V
8847 Current, at 6.3 volts	1.30 A
8847A Current, at 6.0 volts	0.95 A
Transconductance (Average):	
I _b = 160 mA (200 mA/cm ²)	38 mmhos
Amplification Factor (Average):.....	75
Direct Interelectrode Capacitances (Grounded Cathode) ²	
Grid-Cathode	9.5 pF
Plate-Cathode	0.06 pF
Grid-Plate	1.40 pF
Cut-off Bias ³	-30 V max.

1. Characteristics and operating values are based upon performance tests. These figures may change without notice as the result of additional data or product refinement. EIMAC Division of Varian should be consulted before using this information for final equipment.
2. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.
3. Measured with one milliampere plate current and a plate voltage of 1 kVdc.

(Effective 6-1-70) © 1970 by Varian

Printed in U.S.A.

**MECHANICAL****Maximum Overall Dimensions:**

Length	1.370 in; 34.75 mm
Diameter	0.785 in; 19.94 mm
Net Weight	0.56 oz; 16.0 gm
Operating Position	Any

Maximum Operating Temperature:

Ceramic/Metal Seals	250°C
Anode Core	250°C
Cooling	Conduction, convection, forced-air ¹ or liquid
Terminals	Coaxial, special

ENVIRONMENTAL

Shock, 11 ms, non-operating	60 G
Vibration, operating, all axes 55 to 500 Hz	10 G
Altitude, max (in suitable designed circuit)	70,000 ft.

CW RF POWER AMPLIFIER OR OSCILLATOR**MAXIMUM RATINGS/ABSOLUTE VALUES**

DC PLATE VOLTAGE	2500 VOLTS
DC GRID VOLTAGE	-150 VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE	
Grid negative to cathode	-400 VOLTS
Grid positive to cathode	30 VOLTS
DC PLATE CURRENT	250 MILLIAMPERES
DC GRID CURRENT	45 MILLIAMPERES
PLATE DISSIPATION ¹	150 WATTS
GRID DISSIPATION	1.5 WATTS
FREQUENCY	3.0 GIGAHERTZ

- Using one of the EIMAC radiators shown on the cooling curves.
- For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Devices Field Office, or the Product Manager, Eimac-Division of Varian, Salt Lake City, Utah.

**GRID PULSED OR PLATE PULSED
AMPLIFIER OR OSCILLATOR****MAXIMUM RATINGS/ABSOLUTE VALUES**

DC PLATE VOLTAGE (GRID PULSED)	3000 VOLTS
PEAK PULSE PLATE VOLTAGE (PLATE PULSED)	3500 VOLTS
DC GRID VOLTAGE	-150 VOLTS
INSTANTANEOUS PEAK GRID-CATHODE VOLTAGE	
Grid negative to cathode	-700 VOLTS
Grid positive to cathode	175 VOLTS
PULSE PLATE CURRENT	5.0 AMPERES
PULSE GRID CURRENT	2.5 AMPERES
PLATE DISSIPATION ¹	150 WATTS
GRID DISSIPATION	1.5 WATTS
FREQUENCY	3.5 GIGAHERTZ
PULSE DURATION ²	6 μsec
DUTY FACTOR ²	.0033

REPRESENTATIVE OPERATION**Grid-Pulsed rf Power Oscillator (1.6 GHz)**

DC Plate Voltage	3000 Vdc
Peak Plate Current	3.0 a
DC Grid Voltage (Approx.)	-90 V
Peak Grid Current	1.0 a
Filament Voltage	6.3 V
Useful Power Output (Approx.)	3000 w
Bandwidth (1db)	40 MHz
Plate Efficiency	33%



PULSE MODULATOR OR PULSE AMPLIFIER SERVICE

MAXIMUM RATINGS/ABSOLUTE VALUES

DC PLATE VOLTAGE	3500	VOLTS
PEAK PLATE VOLTAGE	4000	VOLTS
DC GRID VOLTAGE	-150	VOLTS
INSTANTANEOUS PEAK		
GRID-CATHODE VOLTAGE		
Grid negative to cathode	-750	VOLTS
Grid positive to cathode	150	VOLTS
PULSE CATHODE CURRENT	7.5	AMPERES
DC PLATE CURRENT	150	MILLIAMPERES
PLATE DISSIPATION ¹	150	WATTS
GRID DISSIPATION	1.5	WATTS
PULSE DURATION	6	μ s
DUTY FACTOR0033	
CUT-OFF MU	60	

1. Using one of the EIMAC radiators shown on the cooling curves.
2. For application requiring longer pulse duration and/or higher duty cycle consult the nearest Varian Electron Tube and Device Field Office, or the Product Manager Eimac-Division of Varian, Salt Lake City, Utah.

RANGE VALUES FOR EQUIPMENT DESIGN

	<u>Min.</u>	<u>Max.</u>
Heater current at 6.3 volts (8847)	1.20	1.40 A
Heater current at 6.0 volts (8847A)	0.85	1.05 A
Cathode Heating Time	60	--- sec.
Interelectrode Capacitances ¹ (grounded cathode connection)		
Grid-Cathode	8.5	10.5 pF
Plate-Cathode	---	0.06 pF
Grid-Plate	1.2	1.6 pF

1. Capacitance values for a cold tube as measured in a special shielded fixture. When the cathode is heated to the proper temperature, the grid-cathode capacitance will increase from the cold value by approximately 1 pF due to thermal expansion of the cathode.

APPLICATION

COOLING - The 8847 and 8847A can be cooled by conduction, convection, forced-air or liquid cooling. The tubes are designed to permit high-temperature operation up to the limit indicated. However, if long life is the prime objective, tube terminal and seal temperatures should be kept well below 250°C. If forced-air cooling is provided, auxiliary air flow, apart from the air flowing through the radiator, should be provided to cool the tube envelope and other tube terminals. Some conduction cooling is always provided

through the contact terminals. However, these terminals usually exhibit poor heat transfer, often having a temperature gradient across them as high as 50°C. Cooling curves are given for the three radiators which are suitable for use with the 8847 and 8847A.

For further details on cooling or other aspects of tube operation, refer to the "Application Notes for Planar Triodes" bulletin which can be obtained on request.

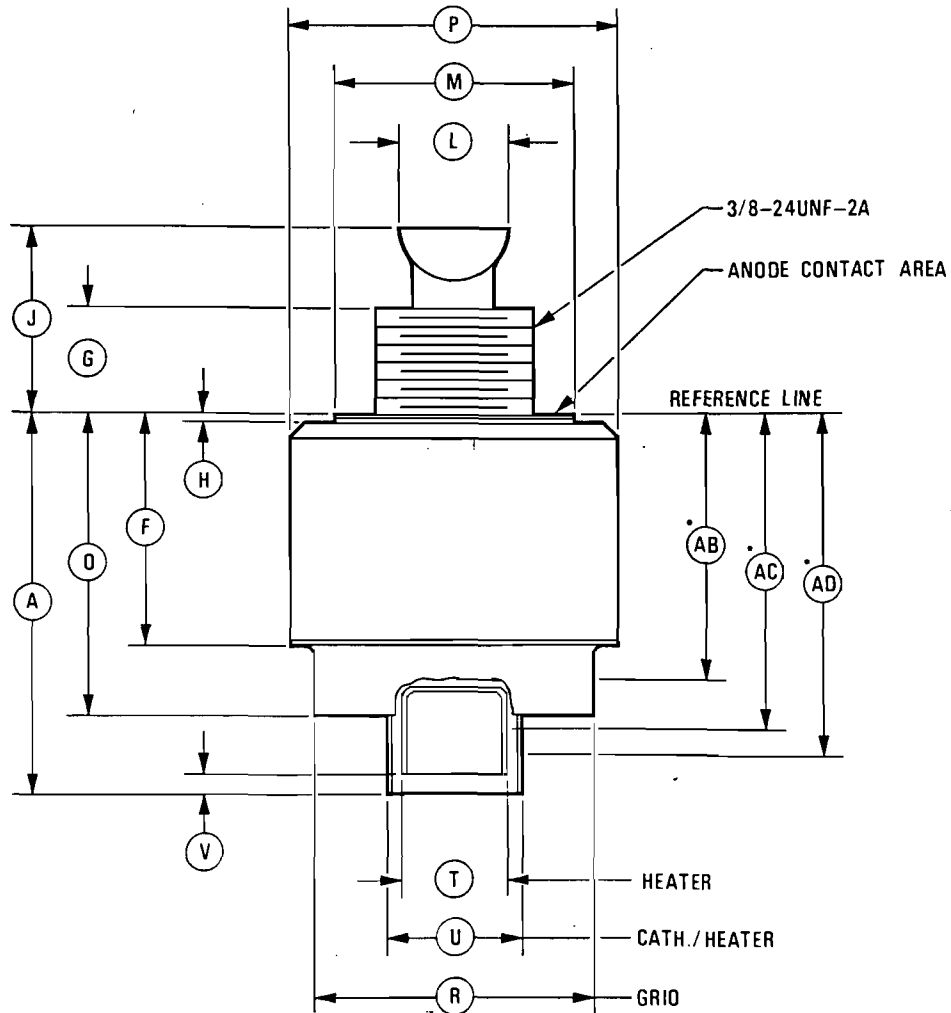


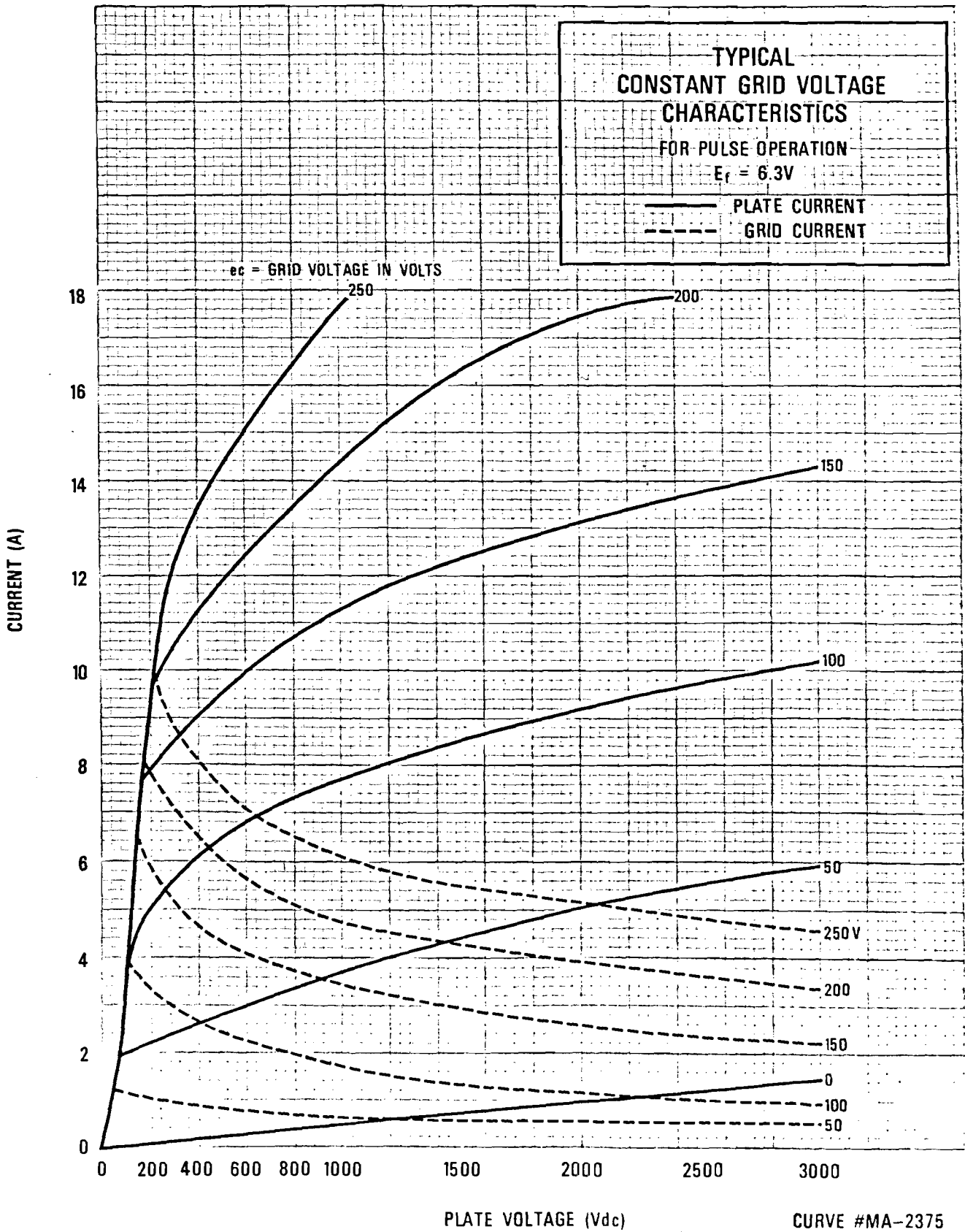
DIMENSIONAL DATA							
DIM.	INCHES			MILLIMETERS			
	MIN.	MAX.	REF.	MIN.	MAX.	REF.	
A	--	1.020	--	--	25.91	--	
D	0.740	0.800	--	18.80	20.32	--	
F	--	0.570	--	--	14.48	--	
G	0.150	0.170	--	3.81	4.32	--	
H	--	0.040	--	--	1.02	--	
J	--	0.350	--	--	8.90	--	
L	--	0.260	--	--	6.60	--	
M	0.545	0.570	--	13.84	14.48	--	
P	0.775	0.785	--	19.69	19.94	--	
R	0.650	0.670	--	16.51	17.02	--	
T	0.210	0.225	--	5.33	5.72	--	
U	0.310	0.330	--	7.87	8.38	--	
V	--	0.040	--	--	1.07	--	
AB	0.590	0.740	--	14.99	18.80	--	
AC	0.760	0.885	--	19.30	22.48	--	
AD	0.800	0.975	--	20.32	24.77	--	

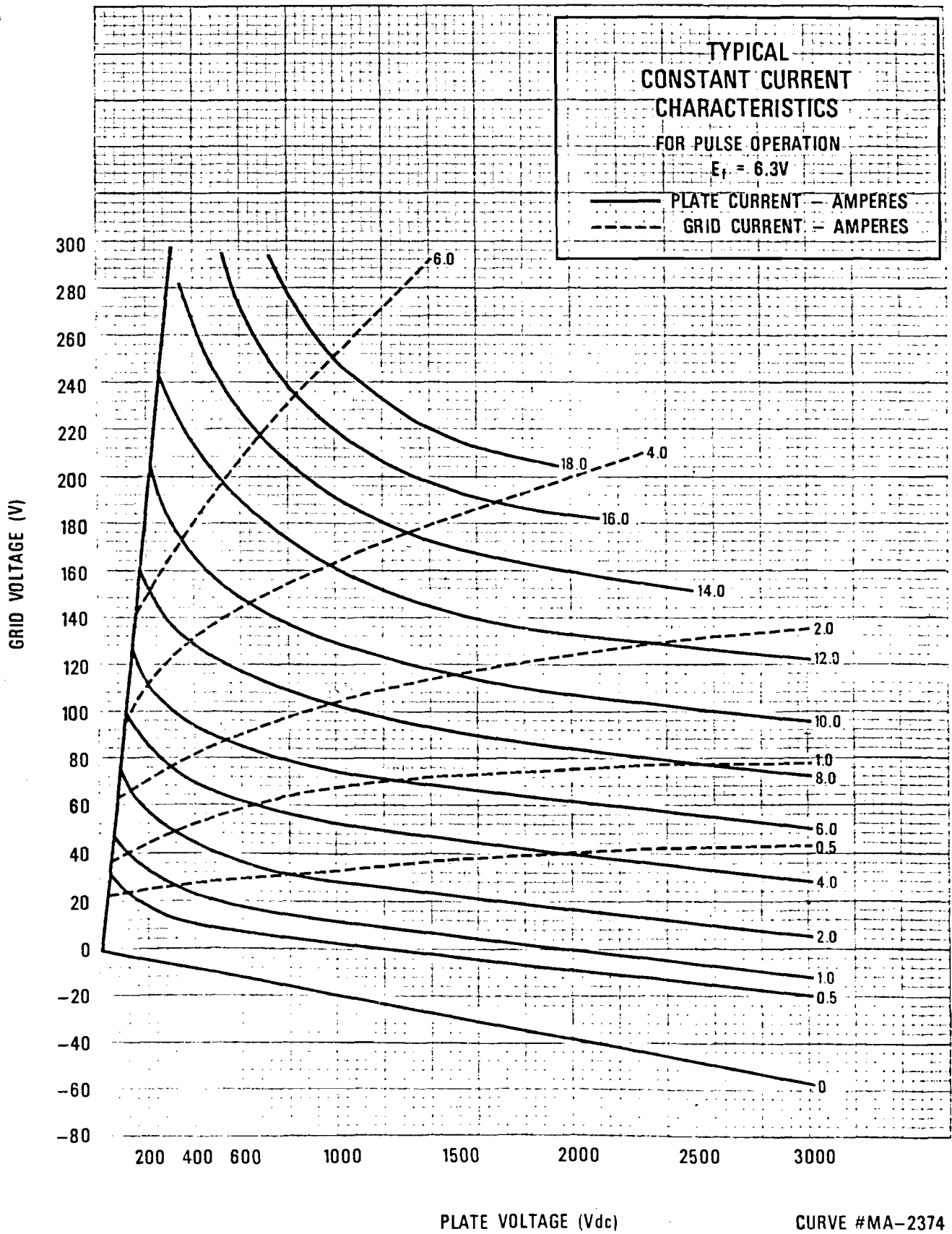
NOTES:
 1. REF DIMENSIONS ARE FOR INFO ONLY & ARE NOT REQUIRED FOR INSPECTION PURPOSES.

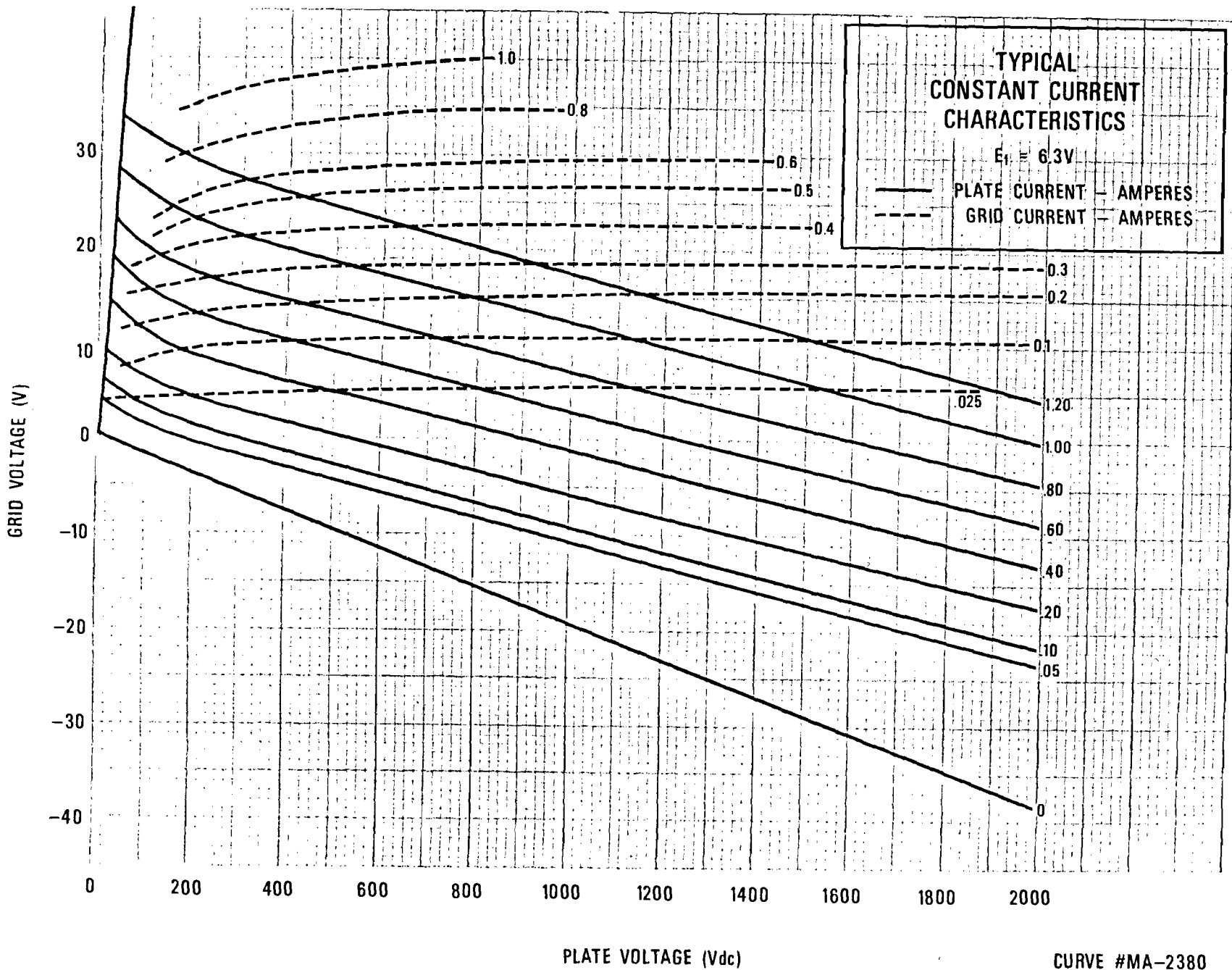
NOTES:

1. ANODE FLANGE IS ELECTRICAL CONTACT. STUD IS FOR HEAT TRANSFER.
2. (*) DISTANCE FROM REFERENCE SURFACE TO THE CENTER OF CONTACT AREA.
3. METRIC EQUIVALENTS ARE TO THE NEAREST .01 mm, ARE GIVEN FOR GENERAL INFORMATION ONLY, AND ARE BASED ON 1 INCH = 25.4 mm.
4. CONCENTRICITY BETWEEN GRID TERMINAL AND CATHODE/HEATER TERMINAL RESPECTIVELY TO THE ANODE STUD TO BE 0.020 TIR MAX. MEASUREMENT TO BE MADE WITH EIMAC GAGE JA-21685G WHICH MUST SEAT AGAINST THE ANODE FLANGE.



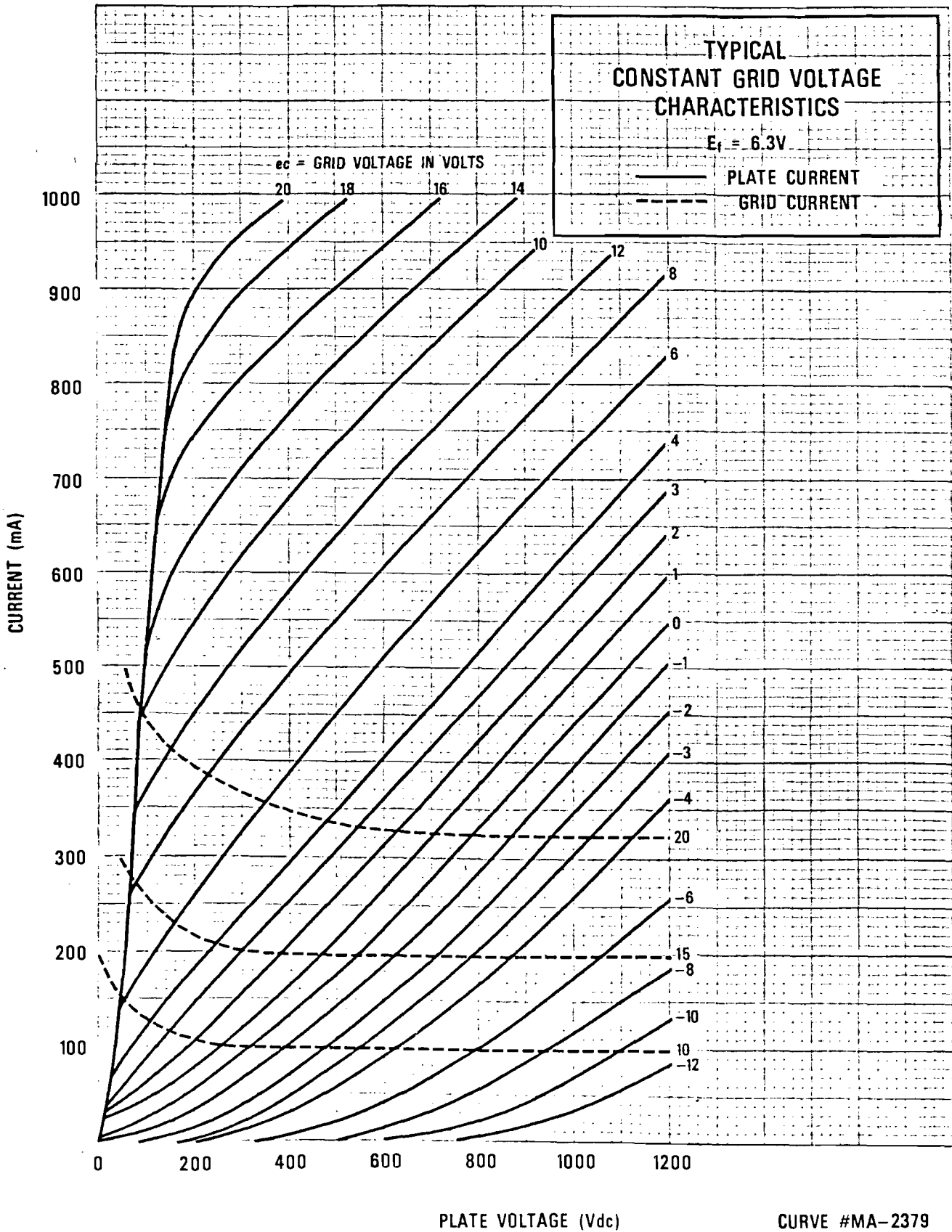






8847/8847A





CURVE #MA-2379



**HEWLETT
PACKARD**

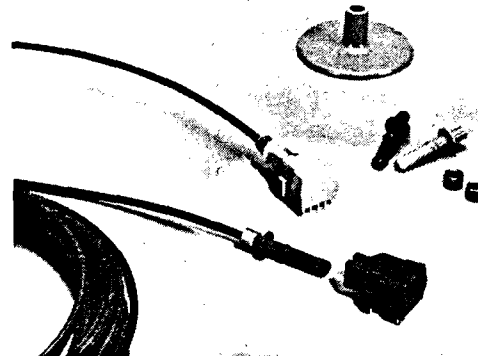
SNAP-IN FIBER OPTIC LINK

**HFBR-0500
TO
HFBR-4595**

TECHNICAL DATA JANUARY 1983

Features

- LOW COST PLASTIC DUAL-IN-LINE PACKAGE
- SNAP-IN CONNECTOR
- 665 nm EMITTER OPTIMIZED FOR PLASTIC CABLE
- EASY FIELD TERMINATIONS
- SHIELDED RECEIVER FOR HIGH NOISE IMMUNITY
- OPERATION TO 22 METRES — GUARANTEED OVER TEMPERATURE
- DC TO 5 MBaud DATA RATE
- LSTTL/TTL COMPATIBLE OUTPUT LEVEL
- CHOICE OF INTERNAL PULL-UP OR OPEN COLLECTOR OUTPUT
- STANDARD OR SPECIAL LENGTH CABLES
- SINGLE +5V RECEIVER POWER SUPPLY
- COLOR CODED TRANSMITTER AND RECEIVER
- SIMPLEX AND ZIP CORD STYLE DUPLEX CABLE



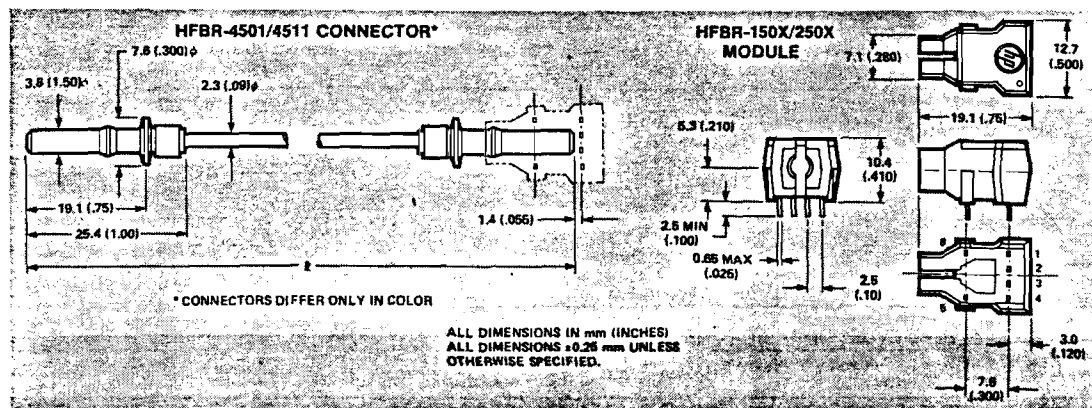
Applications

- EMC REGULATED SYSTEMS (FCC, VDE)
- INTER/INTRA-SYSTEM DATA LINK
- STATIC PROTECTION
- HIGH VOLTAGE ISOLATION
- MEDICAL EQUIPMENT
- SECURE DATA COMMUNICATIONS

Description

The HFBR-0500 series is a complete family of fiber optic link components for configuring low-cost, short distance digital data transmission links. These components are designed to mate with plastic snap-in connectors and low-cost plastic fiber cable. Link design is simplified by the logic compatible receivers and the ease of terminating the plastic fiber cable. The key parameters of links configured with the HFBR-0500 family are fully guaranteed. The HFBR-0500 evaluation kit contains all the components and literature necessary to evaluate a working link.

Mechanical Dimensions



Ordering Guide

Connected Plastic Fiber Optic Cable

Single Channel	Dual Channel	Length* (metres)
HFBR-3500**	HFBR-3600**	Customer Specified
HFBR-3501	---	0.1
HFBR-3502	HFBR-3602	0.5
HFBR-3503	HFBR-3603	1
HFBR-3504	HFBR-3604	5
HFBR-3505	HFBR-3605	10
HFBR-3506	HFBR-3606	15
HFBR-3507	HFBR-3607	20
HFBR-3508	HFBR-3608	25

*All cable lengths are +10%, -0% tolerance.

**HFBR-3500, HFBR-3600 Ordering Information

These cable assemblies of customer specified length, have factory installed connectors. The length must be specified in 1 metre increments. The mandatory OPT 001, specifies the number of assemblies of equal length ordered.

EXAMPLE: To order 3 Duplex cable assemblies, 21 metres each, specify

HFBR-3600 Quantity 63
OPT 001 Quantity 3

Modules/Connectors

HFBR-1501/1502 Transmitters
HFBR-2501/2502 Receivers
HFBR-4501 Gray Connector/Crimp Ring
HFBR-4511 Blue Connector/Crimp Ring

Unconnected Plastic Fiber Optic Cable

Single Channel	Dual Channel	Length* (metres)
HFBR-3589	HFBR-3689	25
HFBR-3590	HFBR-3690	100
HFBR-3591	HFBR-3691	500

HFBR-4595 Polishing Kit

Polishing Fixture — Abrasive Paper

HFBR-0500 Evaluation Kit

HFBR-1501 Transmitter (Gray)
HFBR-2501 Receiver (Blue)
HFBR-3504 5m Connected Cable
HFBR-4501 Connector/Crimp Ring (Gray)
HFBR-4511 Connector/Crimp Ring (Blue)
HFBR-4595 Polishing Kit
Technical Literature

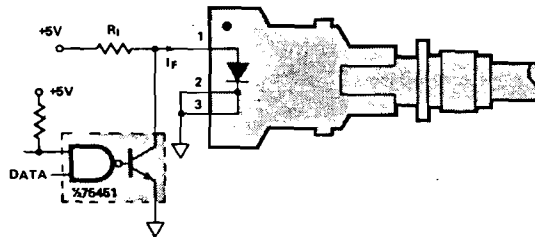
Link Design Considerations

The first step in designing the link is to choose either the HFBR-1501/2501 or the HFBR-1502/2502 Transmitter/Receiver pair based on the data-rate and distance requirements. The value of the transmitter drive current, I_f , must be determined next from Figure 2. For the HFBR-1501/2501 pair (Figure 2A), note that there is an upper as well as a lower limit on the value of I_f for any given distance. The dotted lines in Figure 2A and Figure 2B represent pulsed operation. When operating in the pulsed mode, the conditions in Note 1 must be met.

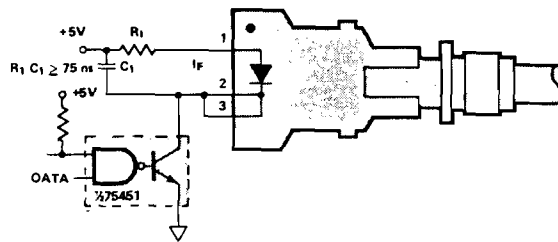
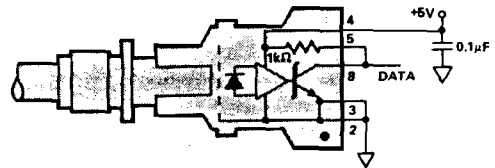
After selecting a value for the transmitter drive current I_f , the value of R_1 in Figure 1 can be calculated as follows:

$$R_1 = \frac{V_{CC} - V_f}{I_f}$$

For the HFBR-1502/2502 pair, the value of the capacitor, C_1 (Figure 1B), must be chosen such that $R_1 C_1 \geq 75 \text{ ns}$.



A. HFBR-1501/HFBR-2501 Link (5 MBaud, $\leq 10\text{m}$)



B. HFBR-1502/HFBR-2502 Link (1 MBaud, $\leq 22\text{m}$)

Figure 1. Typical Circuit Configuration

Recommended Operating Conditions

Parameter	Symbol	Min.	Max.	Units	Ref.
AMBIENT TEMPERATURE	T_A	0	70	$^{\circ}\text{C}$	
TRANSMITTER					
Peak Forward Current	$I_{F PK}$	10	750	mA	Note 1
Avg. Forward Current	$I_{F AV}$		60	mA	
RECEIVER					
Supply Voltage	V_{CC}	4.75	5.25	V	Note 2
Fan-Out (TTL)	N		5		
CABLE					
Long Term Bend Radius	r	35		mm	Note 3
Long Term Tensile Load	F_T		1	N	

System Performance

Parameter	Symbol	Min.	Typ. (17)	Max.	Units	Conditions	Ref.
HFBR-1501/HFBR-2501							
Data Rate		dc		5	MBd	$BER \leq 10^{-9}$	
Transmission Distance	l	10			m	$I_{F PK} = 60 \text{ mA}, 0-70^{\circ}\text{C}$	
		17			m	$I_{F PK} = 60 \text{ mA}, 25^{\circ}\text{C}$	
Propagation Delay	t_{PLH}			140	ns	$R_L = 560\Omega, C_L = 30 \text{ pF}$	Fig. 5, 3
	t_{PHL}			140	ns	$-21.6 \leq P_R \leq -9.5 \text{ dBm}$	Note 4
Pulse Width Distortion	t_{SK}		30		ns	$P_R = -15 \text{ dBm}$	Fig. 4 Note 5

HFBR-1502/HFBR-2502							
Data Rate		dc		1	MBd	$BER \leq 10^{-9}$	
Transmission Distance	l	16			m	$I_{F PK} = 60 \text{ mA}, 0-70^{\circ}\text{C}$	
		23			m	$I_{F PK} = 60 \text{ mA}, 25^{\circ}\text{C}$	
Transmission Distance (50% Duty Factor Max.)	l	22			m	$I_{F PK} = 120 \text{ mA}, 0-70^{\circ}\text{C}$	
		29			m	$I_{F PK} = 120 \text{ mA}, 25^{\circ}\text{C}$	
Propagation Delay	t_{PLH}			250	ns	$R_L = 560\Omega, C_L = 30 \text{ pF}$	Fig. 5, 3
	t_{PHL}			140	ns	$P_R = -24 \text{ dBm}$	Note 4
Pulse Width Distortion	t_{SK}		80		ns	$P_R = -24 \text{ dBm}$	Fig. 4 Note 5

HFBR-150X/250X							
EMI Immunity			8000		V/m	$BER \leq 10^{-9}$	

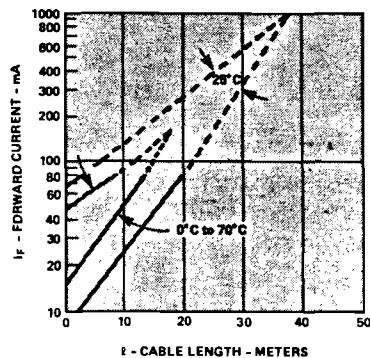


Figure 2A. System Performance with HFBR-1501 and HFBR-2501

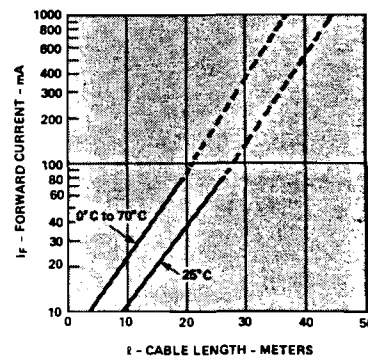
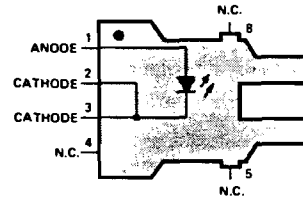


Figure 2B. System Performance with HFBR-1502 and HFBR-2502

Transmitters

The gray plastic HFBR-1501/1502 Transmitter modules incorporate a 665nm LED targeted at the low attenuation window for the HFBR-3500/3600 plastic fiber optic cable. The transmitters can be easily interfaced to standard TTL logic. The optical power output of the HFBR-1501/1502 is specified at the end of 0.5m of cable.

HFBR-1501/1502 Transmitter



Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units	Ref.
Storage Temperature	T _S	-40	+75	°C	
Operating Temperature	T _A	0	+70	°C	
Lead Soldering Cycle	Temp		260	°C	Note 6
	Time		10	sec	
Peak Forward Input Current	I _{F PK}		1000	mA	Note 7
Average Forward Input Current	I _{F AV}		80	mA	
Reverse Input Voltage	V _R		5	V	

Electrical/Optical Characteristics (Cont.) 0°C to +70°C Unless Otherwise Specified

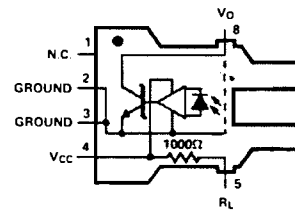
Parameter	Symbol	Min.	Typ. (17)	Max.	Units	Conditions	Ref.
Transmitter Output Optical Power	HFBR-1501	P _T	-14.8	-8.4	dBm	I _F = 60mA, 0-70°C	Note 8
		P _T	-11.7	-9.3	dBm	I _F = 60mA, 25°C	Note 9
	HFBR-1502	P _T	-13.6	-5.5	dBm	I _F = 60mA, 0-70°C	
		P _T	-10.4	-6.4	dBm	I _F = 60mA, 25°C	
Output Optical Power Temperature Coefficient	$\frac{\Delta P_T}{\Delta T}$		-0.028		dB/°C		
Peak Emission Wavelength	λ_{PK}		665		nm		
Forward Voltage	V _F	1.45	1.67	2.02	V	I _F = 60 mA	
Forward Voltage Temperature Coefficient	$\frac{\Delta V_F}{\Delta T}$		-1.37		mV/°C		
Effective Diameter	D _T		1		mm		
Numerical Aperture	N.A.		0.5				
Reverse Input Breakdown Voltage	V _{BR}	5.0	12.4		V	I _F = -10 μA, T _A = 25°C	
Diode Capacitance	C _D		86		pF	V _F = 0, f = 1 MHz	

WARNING: When viewed under some conditions, the optical part of the Transmitter may expose the eye beyond the Maximum Permissible Exposure recommended in ANSI Z-136-1, 1981. Under most viewing conditions there is no eye hazard.

Receivers

The blue plastic HFBR-2501/2502 Receiver modules feature a shielded integrated photodetector and wide bandwidth DC amplifier for high EMI immunity. A Schottky clamped open-collector output transistor allows interfacing to common logic families and enables "wired-OR" circuit designs. The open collector output is specified up to 18V. An integrated 1000 ohm resistor internally connected to V_{CC} may be externally jumpered to provide a pull-up for ease-of-use with +5V logic. The combination of high optical power levels and fast transitions falling edge could result in distortion of the output signal (HFBR-2502 only), that could lead to multiple triggering of following circuitry. Optical power waveshaping circuitry as in Figure 1B may be required for proper link operation.

HFBR-2501/2502 Receiver



Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units	Ref.
Storage Temperature	T _s	-40	+75	°C	
Operating Temperature	T _A	0	+70	°C	
Lead Soldering Cycle	Temp		260	°C	Note 6
	Time		10	sec	
Supply Voltage	V _{CC}	-0.5	7	V	
Output Collector Current	I _O		25	mA	
Output Collector Power Dissipation	P _{OD}		40	mW	
Output Voltage	V _O	-0.5	18	V	
Pullup Voltage	V _{RL}	-0.5	V _{CC}	V	

Electrical/Optical Characteristics (Cont.) 0°C to +70°C Unless Otherwise Specified

Parameter	Symbol	Min.	Typ. ⁽¹⁷⁾	Max.	Units	Conditions	Ref.	
Receiver Input Optical Power Level for Logic "0"	HFBR-2501	P _{R(L)}	-21.6		-9.5	dBm	0-70°C, V _{OL} = 0.5V I _{OL} = 8 mA	Note 9, 10
			-21.6		-8.7	dBm	25°C, V _{OL} = 0.5V I _{OL} = 8 mA	
	HFBR-2502	P _{R(L)}	-24			dBm	0-70°C, V _{OL} = 0.5V I _{OL} = 8 mA	
			-24			dBm	25°C, V _{OL} = 0.5V I _{OL} = 8 mA	
Input Optical Power Level for Logic "1"	P _{R(H)}			-43	dBm	V _{OH} = 5.25V, I _{OH} ≤ 250 μA	Note 9	
High Level Output Current	I _{OH}		5	250	μA	V _O = 18V, P _R = 0	Note 16	
Low Level Output Voltage	V _{OL}		0.4	0.5	V	I _{OL} = 8 mA, P _R = P _{RL MIN}	Note 16	
High Level Supply Current	I _{COH}		3.5	6.3	mA	V _{CC} = 5.25V, φ _R = 0	Note 16	
Low Level Supply Current	I _{COL}		6.2	10	mA	V _{CC} = 5.25V, P _R = -12.5 dBm	Note 16	
Effective Diameter	D _R		1		mm			
Numerical Aperture	N.A. _R		0.5					
Internal Pull-Up Resistor	R _L		1000		Ohms			

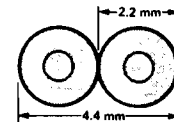
Plastic Fiber Cable

The HFBR-3500/3600 series cables contain 1mm diameter plastic fibers. These cables are extremely easy to connector. Simplex (HFBR-3500) and Duplex (HFBR-3600) cables are available with or without factory installed connectors.

Simplex



Duplex



Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Units	Ref.
Storage Temperature	T _S	-40	+75	°C	
Installation Temperature	T _I	-20	+70	°C	
Tensile Force	(Single Channel)	F _T	50	N	Note 11
	(Dual Channel)	F _T	100	N	
	Cable/Connector	F _T	5	N	
Bend Radius	r	10		mm	Note 12
Flexing			1000	Cycles	Note 13
Impact	m		1	kg	Note 14
	h		15	mm	

Electrical/Optical Characteristics 0°C to +70°C Unless Otherwise Specified

Parameter	Symbol	Min.	Typ. (17)	Max.	Units	Conditions	Ref.
Link Coupling Variation	$\Delta\alpha_{LC}$		0.9	2.0	dB		Note 15
Cable Attenuation	α_0	0.3	0.45	0.63	dB/m	@665 nm Source NA = 0.5	
Numerical Aperture	N.A.		0.5			$l > 2$ m	
Diameter, Core	D _C		1.0		mm		
Diameter, Jacket	D _J		2.2		mm	Simplex Cable	
Delay	t _{pd}		5.0		nsec/m		
Mass per Unit Length/Channel	m/l		4.6		g/m	Without Connectors	
Cable Leakage Current	I _L		1		nA	10 kV, l = 0.1m	

CABLE TERMINATIONS

Connecting the cable is accomplished with the Hewlett-Packard HFBR-4595 Polishing Kit consisting of a Polishing Fixture and 600 grit abrasive paper. No adhesive material is needed to secure the cable in the connector, and the connector can be used immediately after polishing.

Connectors may be easily installed on the cable ends with readily available tools. Materials needed for the terminating procedure are:

- 1) HFBR-3500/3600 Fiber Optic Cable
- 2) HFBR-4595 Polishing Fixture, 600 grit sand paper
- 3) HFBR-4501 Connector crimp ring (gray)
- 4) HFBR-4511 Connector crimp ring (blue)
- 5) Industrial Razor Blade
- 6) 16 gauge latching wire strippers
- 7) Crimp Tool, AMP 90364-2

The zip cord structure of the HFBR-3600 duplex cable permits easy separation of the channels. The channels should be separated approximately 50 mm back from the ends to permit connecting and polishing.

After cutting the cable to the desired length, strip off approximately 7 mm (0.275 in) of the outer jacket with the 16 gauge wire strippers.

Place the crimp ring and connector over the end of the cable;

the fiber should protrude about 3 mm (0.120 in) through the end of the connector. Carefully position the ring so that it is entirely on the connector and then crimp the ring in place with the crimping tool.

NOTE: Place the gray connector on the cable end to be connected to the transmitter and the blue connector on the cable end to be connected to the receiver to maintain the color coding (both connectors are the same mechanically).

Any excess fiber protruding from the connector end may be trimmed with the razor blade; however, the trimmed fiber should extend at least 1.5 mm (0.060 in) from the connector end.

Insert the connector fully into the polishing fixture with the connector end protruding from the bottom of the fixture.

NOTE: The four dots on the bottom of the polishing fixture are wear indicators. Replace the polishing fixture when any dot is no longer visible.

Using a figure-eight motion of the polishing fixture on the 600 grit abrasive, trim the fiber and the connector until the connector is flush with the end of the polishing fixture. The fiber end should be flat and smooth with no large irregularities.

The cable can now be used.

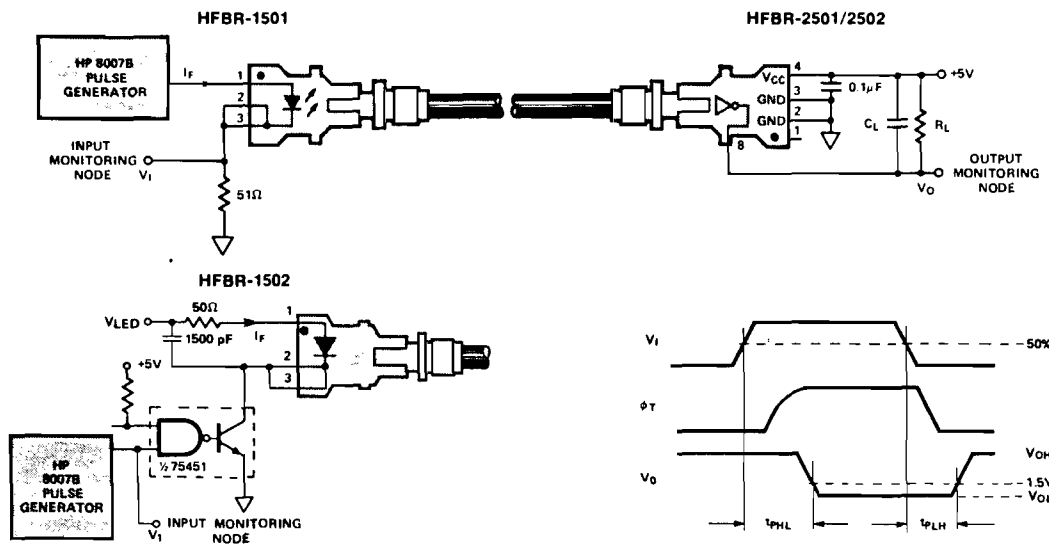


Figure 3. AC Test Circuit

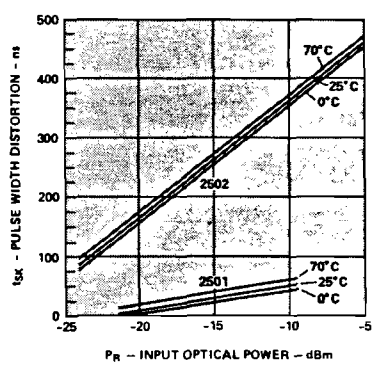


Figure 4. Pulse Width Distortion vs. Optical Power

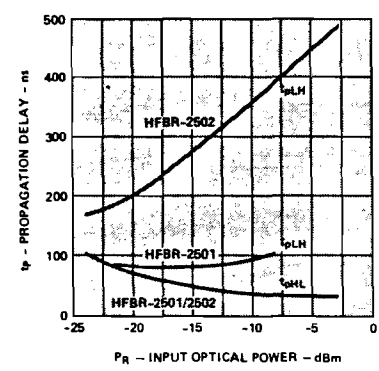


Figure 5. Propagation Delay vs. Optical Power

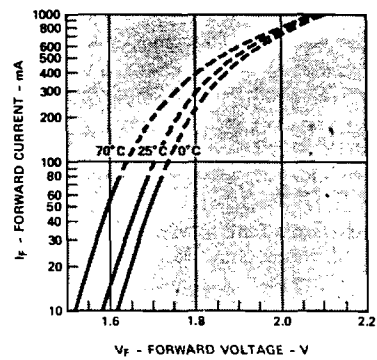


Figure 6. Forward Current vs. Forward Voltage

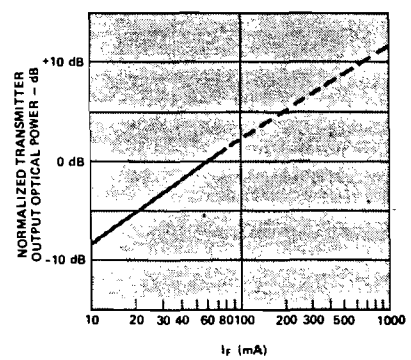


Figure 7. Normalized Transmitter Output Optical Power vs. Input Current

Optic Power Measurement

The optical power at the end of the HFBR-3500 series Fiber Optic Cable can be easily measured using a large area Radiometer such as the EG&G-550, Photodyne 88XL, or United Detector Technology S550, that has been calibrated at 665 nm.

The output optical power for the Transmitter has been specified at the end of 0.5 metres of HFBR-3500 Fiber Optic Cable and can therefore be easily measured using one of the above instruments.

Extended Distance Operation

Distances greater than 22m (0 - 70° C), are achievable by using high peak current pulses to drive the Transmitter. I_{FAV} must be limited to 80 mA and I_{FPK} to 1000 mA. The pulse width must be controlled. (Note 1).

Figure 8 shows a simple circuit suitable for RS-232 applications using the HFBR-1502 Transmitter and HFBR-2502 Receiver for 30 metre operation.

$I_{FPK} = 500$ mA (From Figure 2B, $\ell = 31$ m); $I_{FAV} = 25$ mA at a Data Rate of 55 Kbd or less, Pulse Width Distortion < 25% (4.5μ s max.)

NOTE: I_{FPK} up to 1000 mA may be used for distances up to 35m.

An MOS clock driver may be used to provide transient current sinking capability up to 1000 mA.

Even longer distances can be achieved using specially selected components — contact your local Hewlett-Packard Sales Representative.

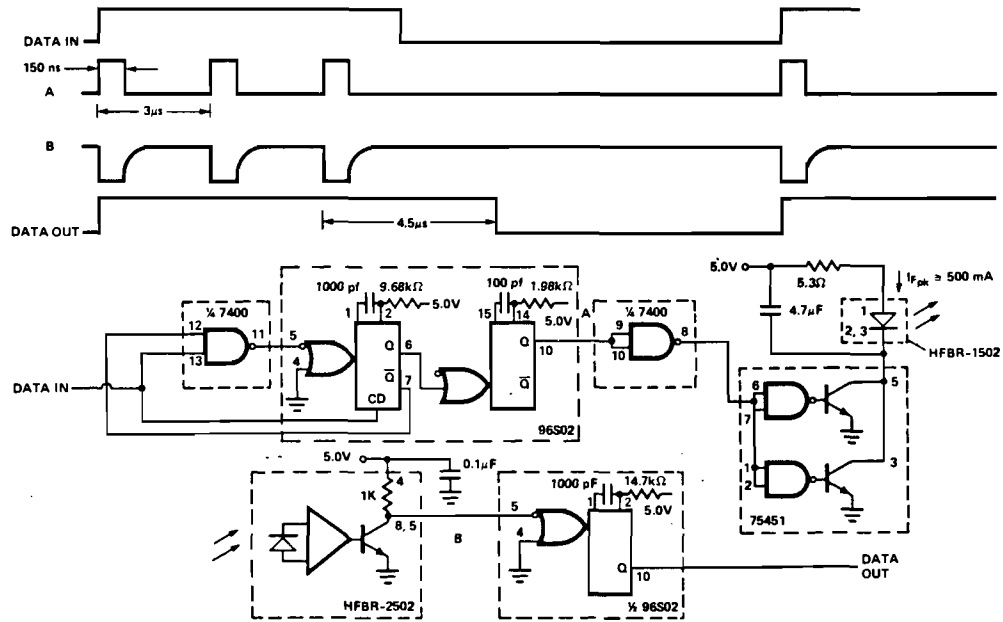


Figure 8. Pulsed Operation

NOTES:

- For $I_{FPK} > 80$ mA, the duty factor must be such as to keep $I_{FAV} \leq 80$ mA. In addition, for $I_{FPK} > 80$ mA, the following rules for pulse width apply:
 $I_{FPK} \leq 160$ mA : Pulse width ≤ 1 ms
 $I_{FPK} > 160$ mA : Pulse width $\leq 1 \mu$ s
- It is essential that a bypass capacitor (0.01 μ F to 0.1 μ F ceramic) be connected from pin 3 to pin 4 of the receiver. Total lead length between both ends of the capacitor and the pins should not exceed 20 mm.
- See cable absolute maximum ratings for short-term bend radius and tensile load.
- The propagation delay of 1m of cable (4.5 ns) is included.
- $t_{SK} = t_{PLH} - t_{PHL}$; $R_L = 560\Omega$; $C_L = 30$ pF.
- 1.6 mm below seating plane.
- 1 μ s pulse, 20 μ s period.
- Measured at the end of 0.5m HFBR-3502 Fiber Optic Cable with a large area detector.
- Optical flux, P (dBm) = $10 \log P (\mu W) / 1000 \mu W$.
- Measured at the end of HFBR-3500 Fiber Optic Cable with large area detector.
- Less than 30 minutes.
- Less than 1 hour, non-operating.
- 90° bend on 10 mm radius mandrel.
- 1 Kg weight dropped from 15 mm height on 2.5 mm radius mandrel laid on cable.
- Included in P_T and P_R .
- R_L is open.
- Typical data at 25° C, $V_{CC} = 5$ V_{dc}.



IVN6000 CN Series IVN6000 TN Series 500V n-Channel Enhancement-mode Vertical Power MOSFETs

FEATURES

- High speed, high current switching
- Inherent current sharing capability when paralleled
- Directly interfaces to CMOS logic
- Extended safe operating area
- Inherently temperature stable

ABSOLUTE MAXIMUM RATINGS

($T_A = 25^\circ\text{C}$ unless otherwise noted)

Drain-source Voltage	
IVN6000 CNR, TNR	395V
IVN6000 CNS, TNS	400V
IVN6000 CNT, TNT	450V
IVN6000 CNU, TNU	500V
Drain-gate Voltage	
IVN6000 CNS, TNS	400V
IVN6000 CNT, TNT	450V
IVN6000 CNU, TNU	500V
Continuous Drain Current (Note 1)	
IVN6000 CNS, CNT	2A
IVN6000 CNU, CNR	1.75A
IVN6000 TNS, TNT	1.0A
IVN6000 TNU	0.9A
Peak Drain Current (see note 2)	
CN devices	6A
TN devices	5A
Gate-source Voltage	
	$\pm 30\text{V}$
Thermal Resistance, Junction to Case	
CN devices	3.13°C/W
TN devices	10°C/W
Continuous Device Dissipation at (or below)	
25°C Case Temperature, CN devices	30W
TN devices	12.5W
Linear Derating Factor	
CN devices	320mW/°C
TN devices	100mW/°C
Operating Junction	
Temperature Range	-55°C to +150°C
Storage Temperature Range	-55°C to +150°C
Lead Temperature	
(1/16" in. from case for 10 sec)	+300°C
Reverse Diode Continuous Forward Current	
CN devices	2A
TN devices	1A
Reverse Diode Peak Forward Current	
CN devices	6A
TN devices	5A

Note 1. $T_C = 25^\circ\text{C}$; limited by $r_{DS(on)}$ and maximum power dissipation.

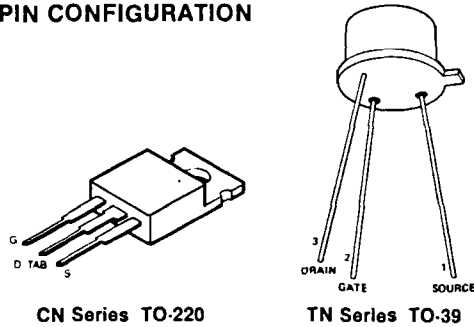
Note 2. Maximum pulse width 80 μ sec maximum duty cycle 1.0%.

Note 3. The Drain-source diode is an integral part of the MOSFET structure.

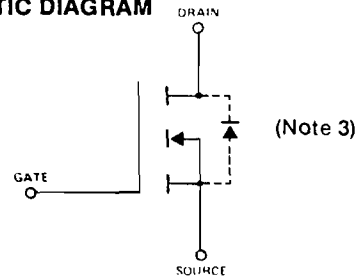
APPLICATIONS

- Switching power supplies
- DC to DC inverters
- Motor controllers
- Power amplifiers
- RF amplifiers

PIN CONFIGURATION

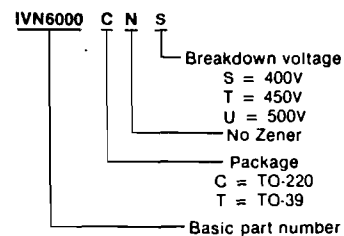


SCHEMATIC DIAGRAM



Body internally connected to source.
Drain common to case.

ORDERING INFORMATION



See 6000 Geometry.

IVN6000 CN Series

INTERMIL

ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS			UNIT	
			MIN.	TYP.	MAX.		
Drain-Source Breakdown Voltage IVN6000 CNR, TNR IVN6000 CNS, TNS IVN6000 CNT, TNT IVN6000 CNU, TNU	BV _{DSS}	V _{GS} = 0V I _D = 100 μA	395			V	
			400				
			450				
			500				
Gate-Threshold Voltage	V _{GS(th)}	V _{DS} = V _{GS} , I _D = 10mA	2		5		
Gate-Body Leakage Current	I _{GSS}	V _{GS} = 30V		10	100	nA	
Zero Gate Voltage Drain Current	I _{DSS}	V _{DS} = Maximum Rating, V _{GS} = 0V T _J = 125°C (Note 2)		0.2	2	mA	
ON Drain Current ⁽¹⁾	I _{D(on)}	V _{DS} = 50V, V _{GS} = 15V	CN devices	4			A
			TN devices	3			
Static-Drain Source ON Resistance ⁽¹⁾ IVN6000 CNR IVN6000 CNS, CNT IVN6000 CNU	r _{DS(on)}	V _{GS} = 15V, I _D = 1A			5.0	Ω	
	r _{DS(on)}	V _{GS} = 15V, I _D = 1A			3.5		
					4.0		
Forward Transconductance ⁽¹⁾	g _{fS}	V _{DS} = 200V, I _D = 1.5A	0.8	1.1		mho	
Input Capacitance	C _{iSS}	V _{DS} = 100V, f = 1.0 MHz, (Note 2) V _{GS} = 0V		220	275	pF	
Output Capacitance	C _{oSS}			22	30		
Reverse Transfer Capacitance	C _{rSS}			6	10		
Rise Time	t _r	V _{DS} = 200V, I _D = 1.0A, See Switching Times Test Circuit			10	ns	
Fall Time	t _f	V _{GS} = 15V, R _{gen} = 6Ω			10	ns	
Slew Rate	SR	V _{GS} = 0V, V _{DS} = 80% of rating		100		V/ns	

Note 1: Pulse test 80μs, 1% duty cycle.

Note 2: Sample test only.

REVERSE DIODE CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS			UNIT
			MIN.	TYP.	MAX.	
Forward Voltage Drop	V _f	Forward Current = 2A		0.85	1.1	V
Reverse Recovery Time	t _{rr}	I _{wf(pk)} = I _{rev(pk)} Recovery to 50%		200		ns
Recovered Charge	Q _{rr}	T _J = 150°C, I _{wf(pk)} = 2A		400		nC

Note 3: See 6000 family characteristic curves.



DS0026, DS0056 5 MHz Two-Phase MOS Clock Drivers

General Description

DS0026/DS0056 are low cost monolithic high speed two phase MOS clock drivers and interface circuits. Unique circuit design provides both very high speed operation and the ability to drive large capacitive loads. The device accepts standard TTL/DTL outputs and converts them to MOS logic levels. They may be driven from standard 54/74 series and 54S/74S series gates and flip-flops or from drivers such as the DS8830 or DS17440. The DS0026 and DS0056 are intended for applications in which the output pulse width is logically controlled; i.e., the output pulse width is equal to the input pulse width.

The DS0026/DS0056 are designed to fulfill a wide variety of MOS interface requirements. As a MOS clock driver for long silicon-gate shift registers, a single device can drive over 10k bits at 5 MHz. Six devices provide in-out address and precharge drive for a 8k by 16-bit 1103 RAM memory system. Information on the correct usage of the DS0026 in these as well as other systems is included in the application note AN-76A.

The DS0026 and DS0056 are identical except each driver in the DS0056 is provided with a V_{BB} connection to supply a higher voltage to the output stage. This aids

in pulling up the output when it is in the high state. An external resistor tied between these extra pins and a supply higher than V^+ will cause the output to pull up to $(V^+ - 0.1V)$ in the off state.

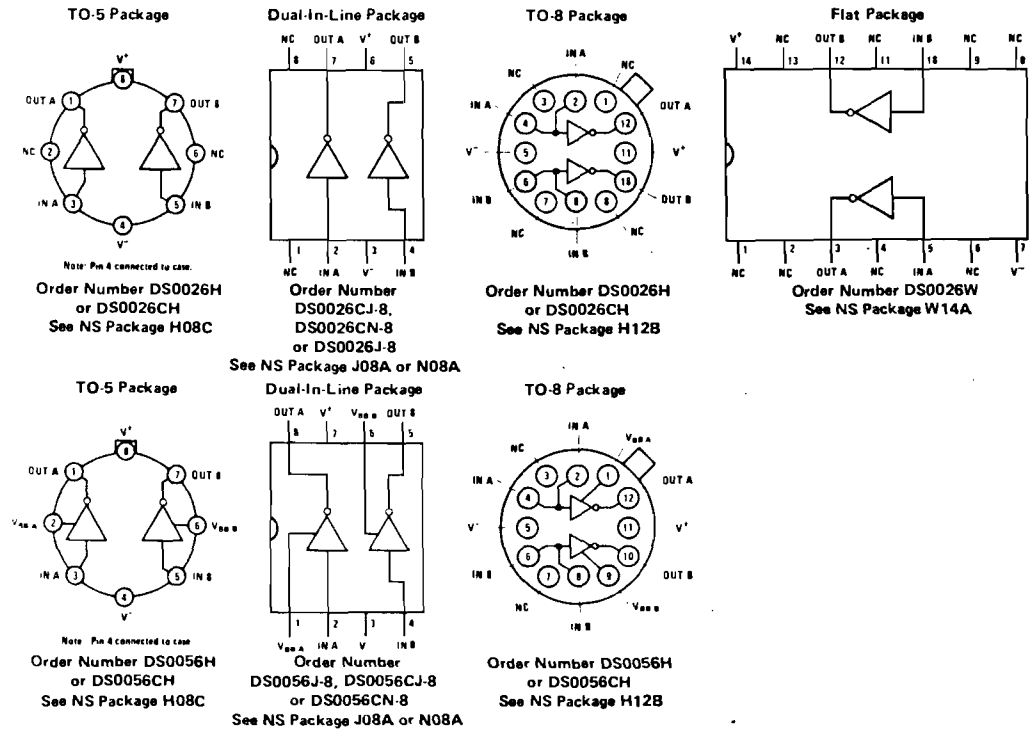
For DS0056 applications, it is required that an external resistor be used to prevent damage to the device when the driver switches low. A typical V_{BB} connection is shown on the next page.

These devices are available in 8-lead TO-5, one watt copper lead frame 8-pin mini-DIP, and one and a half watt ceramic DIP, and TO-8 packages.

Features

- Fast rise and fall times—20 ns with 1000 pF load
- High output swing—20V
- High output current drive—±1.5 amps
- TTL/DTL compatible inputs
- High rep rate—5 to 10 MHz depending on power dissipation
- Low power consumption in MOS "0" state—2 mW
- Drives to 0.4V of GND for RAM address drive

Connection Diagrams (Top Views)



Absolute Maximum Ratings (Note 1)

$V^+ - V^-$ Differential Voltage	22V	Operating Temperature Range	-55°C to +125°C
Input Current	100 mA	DS0026, DS0056	0°C to +70°C
Input Voltage ($V_{IN} - V^-$)	5.5V	DS0026C, DS0056C	-65°C to +150°C
Peak Output Current	1.5A	Storage Temperature Range	300°C
		Lead Temperature (Soldering, 10 seconds)	

Electrical Characteristics (Notes 2 and 3)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IH} Logic "1" Input Voltage	$V^- = 0V$	2	1.5		V
I_{IH} Logic "1" Input Current	$V_{IN} - V^- = 2.4V$		10	15	mA
V_{IL} Logic "0" Input Voltage	$V^- = 0V$		0.6	0.4	V
I_{IL} Logic "0" Input Current	$V_{IN} - V^- = 0V$		-3	-10	μA
V_{OL} Logic "1" Output Voltage	$V_{IN} - V^- = 2.4V$		$V^+ - 0.7$	$V^- + 1.0$	V
V_{OH} Logic "0" Output Voltage	$V_{IN} - V^- = 0.4V, V_{BB} \geq V^+ + 1.0V$	DS0026	$V^+ - 1.0$	$V^+ - 0.7$	V
		DS0056	$V^+ - 0.3$	$V^+ - 0.1$	V
$I_{CC(ON)}$ "ON" Supply Current	$V^+ - V^- = 20V, V_{IN} - V^- = 2.4V$ (Note 6) (one side on)	DS0026	30	40	mA
		DS0056	12	30	mA
$I_{CC(OFF)}$ "OFF" Supply Current	$V^+ - V^- = 20V, V_{IN} - V^- = 0V$	70°C	10	100	μA
		125°C	10	500	μA

Switching Characteristics ($T_A = 25^\circ C$) (Notes 5 and 7)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS	
t_{ON} Turn-on Delay	(Figure 1)	5	7.5	12	ns	
	(Figure 2)		11		ns	
t_{OFF} Turn-off Delay	(Figure 1)		12	15	ns	
	(Figure 2)		13		ns	
t_r Rise Time	(Figure 1), (Note 5)	$C_L = 500 pF$		15	18	ns
		$C_L = 1000 pF$		20	35	ns
	(Figure 2), (Note 5)	$C_L = 500 pF$		30	40	ns
		$C_L = 1000 pF$		36	50	ns
t_f Fall Time	(Figure 1), (Note 5)	$C_L = 500 pF$		12	16	ns
		$C_L = 1000 pF$		17	25	ns
	(Figure 2), (Note 5)	$C_L = 500 pF$		28	35	ns
		$C_L = 1000 pF$		31	40	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: These specifications apply for $V^+ - V^- = 10V$ to $20V, C_L = 1000 pF$, over the temperature range of $-55^\circ C$ to $+125^\circ C$ for the DS0026; DS0056 and $0^\circ C$ to $+70^\circ C$ for the DS0026C, DS0056C.

Note 3: All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min on absolute value basis.

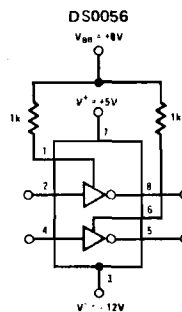
Note 4: All typical values for the $T_A = 25^\circ C$.

Note 5: Rise and fall time are given for MOS logic levels; i.e., rise time is transition from logic "0" to logic "1" which is voltage fall.

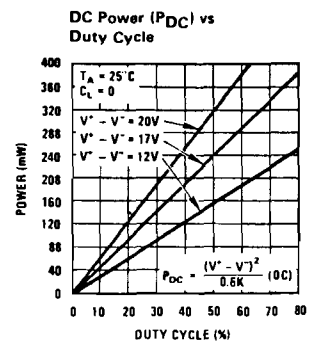
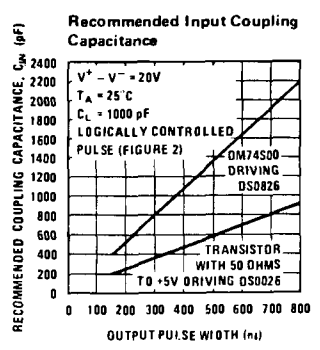
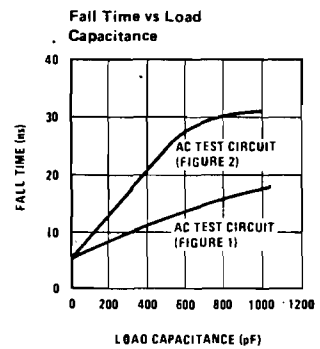
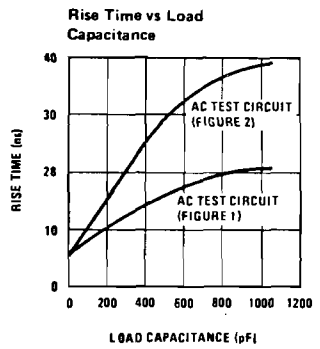
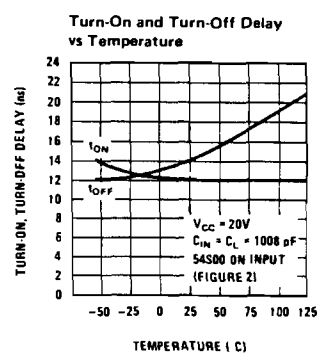
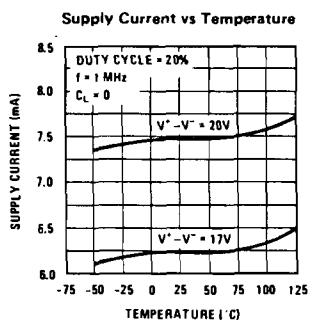
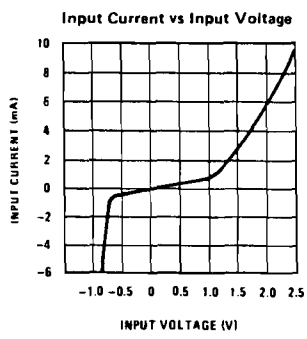
Note 6: I_{BB} for DS0056 is approximately $(V_{BB} - V^-)/1 k\Omega$ (for one side) when output is low.

Note 7: The high current transient (as high as 1.5A) through the resistance of the external interconnecting V^- lead during the output transition from the high state to the low state can appear as negative feedback to the input. If the external interconnecting lead from the driving circuit to V^- is electrically long, or has significant dc resistance, it can subtract from the switching response.

Typical V_{BB} Connection



Typical Performance Characteristics



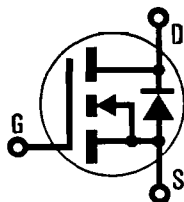
INTERNATIONAL RECTIFIER

HEXFET® TRANSISTORS **IRF520**

IRF521

IRF522

IRF523



N-Channel

100 Volt, 0.3 Ohm HEXFET TO-220AB Plastic Package

The HEXFET® technology is the key to International Rectifier's advanced line of power MOSFET transistors. The efficient geometry and unique processing of the HEXFET design achieve very low on-state resistance combined with high transconductance and great device ruggedness.

The HEXFET transistors also feature all of the well established advantages of MOSFETs such as voltage control, freedom from second breakdown, very fast switching, ease of paralleling, and temperature stability of the electrical parameters.

They are well suited for applications such as switching power supplies, motor controls, inverters, choppers, audio amplifiers, and high energy pulse circuits.

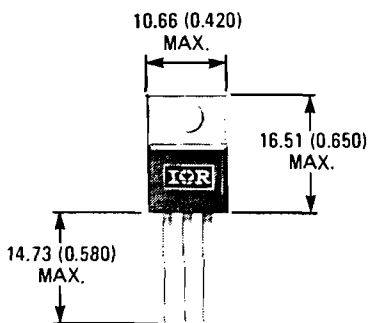
Features:

- Compact Plastic Package
- Fast Switching
- Low Drive Current
- Ease of Paralleling
- No Second Breakdown
- Excellent Temperature Stability

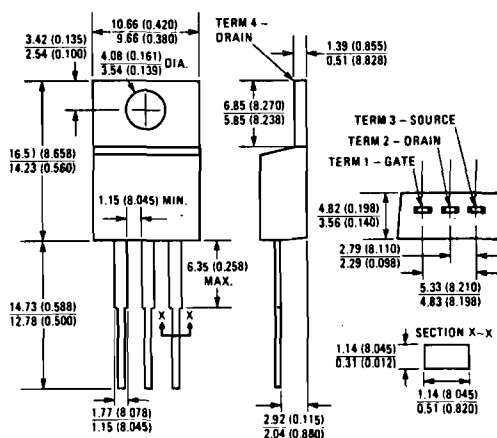
Product Summary

Part Number	V _{DS}	R _{DS(on)}	I _D
IRF520	100V	0.30Ω	8.0A
IRF521	60V	0.30Ω	8.0A
IRF522	100V	0.40Ω	7.0A
IRF523	60V	0.40Ω	7.0A

CASE STYLE AND DIMENSIONS



ACTUAL SIZE



Case Style TO-220AB
Dimensions in Millimeters and (Inches)

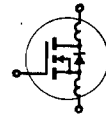
IRF520, IRF521, IRF522, IRF523 Devices

Absolute Maximum Ratings

Parameter	IRF520	IRF521	IRF522	IRF523	Units
V_{DS} Drain - Source Voltage ①	100	60	100	60	V
V_{DGR} Drain - Gate Voltage ($R_{GS} = 1\text{ M}\Omega$) ①	100	60	100	60	V
$I_D @ T_C = 25^\circ\text{C}$ Continuous Drain Current	8.0	8.0	7.0	7.0	A
$I_D @ T_C = 100^\circ\text{C}$ Continuous Drain Current	5.0	5.0	4.0	4.0	A
I_{DM} Pulsed Drain Current ③	32	32	28	28	A
V_{GS} Gate - Source Voltage	± 20				V
$P_D @ T_C = 25^\circ\text{C}$ Max. Power Dissipation	40 (See Fig. 14)				W
Linear Derating Factor	0.32 (See Fig. 14)				W/K
I_{LM} Inductive Current, Clamped	(See Fig. 15 and 16) $L = 100\mu\text{H}$				A
	32	32	28	28	
T_J Operating Junction and T_{stg} Storage Temperature Range	-55 to 150				$^\circ\text{C}$
Lead Temperature	300 (0.063 in. (1.6mm) from case for 10s)				$^\circ\text{C}$

Electrical Characteristics @ $T_C = 25^\circ\text{C}$ (Unless Otherwise Specified)

Parameter	Type	Min.	Typ.	Max.	Units	Test Conditions
BV_{DSS} Drain - Source Breakdown Voltage	IRF520 IRF522	100	—	—	V	$V_{GS} = 0\text{V}$ $I_D = 250\mu\text{A}$
	IRF521 IRF523	60	—	—	V	
	ALL	2.0	—	4.0	V	
$V_{GS(th)}$ Gate Threshold Voltage	ALL	2.0	—	4.0	V	$V_{DS} = V_{GS}$, $I_D = 250\mu\text{A}$
I_{GSS} Gate-Source Leakage Forward	ALL	—	—	500	nA	$V_{GS} = 20\text{V}$
I_{GSS} Gate-Source Leakage Reverse	ALL	—	—	-500	nA	$V_{GS} = -20\text{V}$
I_{DSS} Zero Gate Voltage Drain Current	ALL	—	—	250	μA	$V_{DS} = \text{Max. Rating}$, $V_{GS} = 0\text{V}$
		—	—	1000	μA	$V_{DS} = \text{Max. Rating} \times 0.8$, $V_{GS} = 0\text{V}$, $T_C = 125^\circ\text{C}$
$I_{D(on)}$ On-State Drain Current ②	IRF520 IRF521	8.0	—	—	A	$V_{DS} > I_{D(on)} \times R_{DS(on) \text{ max.}}$, $V_{GS} = 10\text{V}$
	IRF522 IRF523	7.0	—	—	A	
	ALL	—	—	—	—	
$R_{DS(on)}$ Static Drain-Source On-State Resistance ②	IRF520 IRF521	—	0.25	0.30	Ω	$V_{GS} = 10\text{V}$, $I_D = 4.0\text{A}$
	IRF522 IRF523	—	0.30	0.40	Ω	
	ALL	—	—	—	—	
g_{fs} Forward Transconductance ②	ALL	1.5	2.9	—	S (①)	$V_{DS} > I_{D(on)} \times R_{DS(on) \text{ max.}}$, $I_D = 4.0\text{A}$
C_{iss} Input Capacitance	ALL	—	450	600	pF	$V_{GS} = 0\text{V}$, $V_{DS} = 25\text{V}$, $f = 1.0\text{MHz}$
C_{oss} Output Capacitance	ALL	—	200	400	pF	See Fig. 10
C_{rss} Reverse Transfer Capacitance	ALL	—	50	100	pF	
$t_{d(on)}$ Turn-On Delay Time	ALL	—	20	40	ns	$V_{DD} = 0.5 BV_{DSS}$, $I_D = 4.0\text{A}$, $Z_0 = 50\Omega$
t_r Rise Time	ALL	—	35	70	ns	See Fig. 17
$t_{d(off)}$ Turn-Off Delay Time	ALL	—	50	100	ns	(MOSFET switching times are essentially independent of operating temperature.)
t_f Fall Time	ALL	—	35	70	ns	
Q_g Total Gate Charge (Gate-Source Plus Gate-Drain)	ALL	—	10	15	nC	$V_{GS} = 15\text{V}$, $I_D = 10\text{A}$, $V_{DS} = 0.8 \text{ Max. Rating}$. See Fig. 18 for test circuit. (Gate charge is essentially independent of operating temperature.)
Q_{gs} Gate-Source Charge	ALL	—	6.0	—	nC	
Q_{gd} Gate-Drain ("Miller") Charge	ALL	—	4.0	—	nC	
L_D Internal Drain Inductance	ALL	—	3.5	—	nH	Measured from the contact screw on tab to center of die.
		—	4.5	—	nH	Measured from the drain lead, 6mm (0.25 in.) from package to center of die.
L_S Internal Source Inductance	ALL	—	7.5	—	nH	Measured from the source lead, 6mm (0.25 in.) from package to source bonding pad.



Thermal Resistance

Parameter	ALL	—	—	3.12	K/W	
R_{thJC} Junction-to-Case	ALL	—	—	3.12	K/W	
R_{thCS} Case-to-Sink	ALL	—	1.0	—	K/W	Mounting surface flat, smooth, and greased.
R_{thJA} Junction-to-Ambient	ALL	—	—	80	K/W	Free Air Operation

IRF520, IRF521, IRF522, IRF523 Devices

Source-Drain Diode Ratings and Characteristics

I_S	Continuous Source Current (Body Diode)	IRF520	—	—	8.0	A	Modified MOSFET symbol showing the integral reverse P-N junction rectifier.
		IRF521	—	—	7.0	A	
I_{SM}	Pulse Source Current (Body Diode) ③	IRF520	—	—	32	A	
		IRF521	—	—	28	A	
V_{SD}	Diode Forward Voltage ②	IRF520	—	—	2.5	V	$T_C = 25^\circ\text{C}, I_S = 8.0\text{A}, V_{GS} = 0\text{V}$
		IRF521	—	—	2.3	V	$T_C = 25^\circ\text{C}, I_S = 7.0\text{A}, V_{GS} = 0\text{V}$
t_{rr}	Reverse Recovery Time	ALL	—	280	—	ns	$T_J = 150^\circ\text{C}, I_F = 8.0\text{A}, dI_F/dt = 100\text{A}/\mu\text{s}$
Q_{RR}	Reverse Recovered Charge	ALL	—	1.6	—	μC	$T_J = 150^\circ\text{C}, I_F = 8.0\text{A}, dI_F/dt = 100\text{A}/\mu\text{s}$
t_{on}	Forward Turn-on Time	ALL	Intrinsic turn-on time is negligible. Turn-on speed is substantially controlled by $L_S + L_D$.				

- ① $T_J = 25^\circ\text{C}$ to 150°C . ② Pulse Test: Pulse width $< 300\mu\text{s}$, Duty Cycle $< 2\%$. ③ Repetitive Rating: Pulse width limited by max. junction temperature. See Transient Thermal Impedance Curve (Fig. 5).

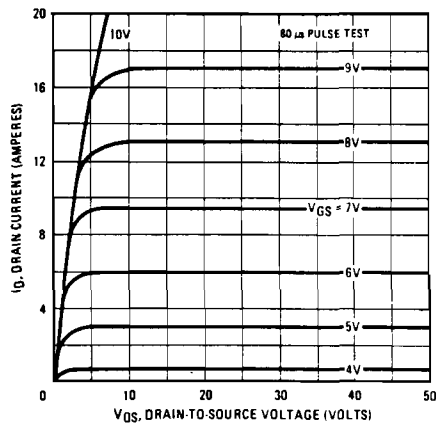


Fig. 1 – Typical Output Characteristics

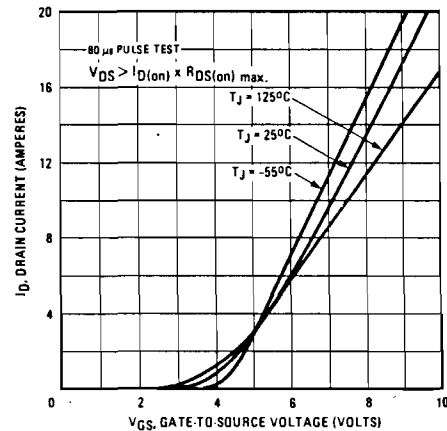


Fig. 2 – Typical Transfer Characteristics

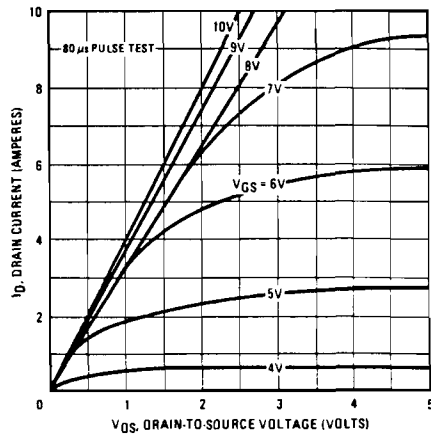


Fig. 3 – Typical Saturation Characteristics

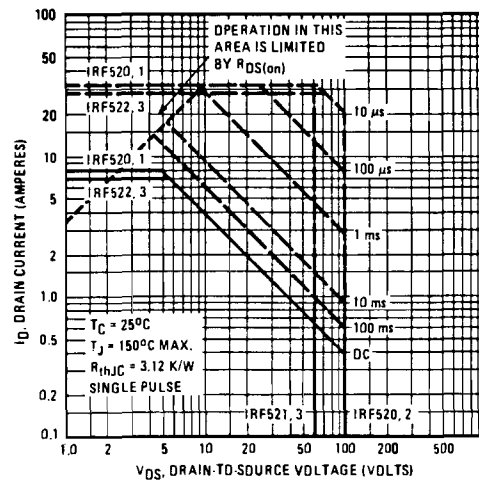


Fig. 4 – Maximum Safe Operating Area

IRF520, IRF521, IRF522, IRF523 Devices

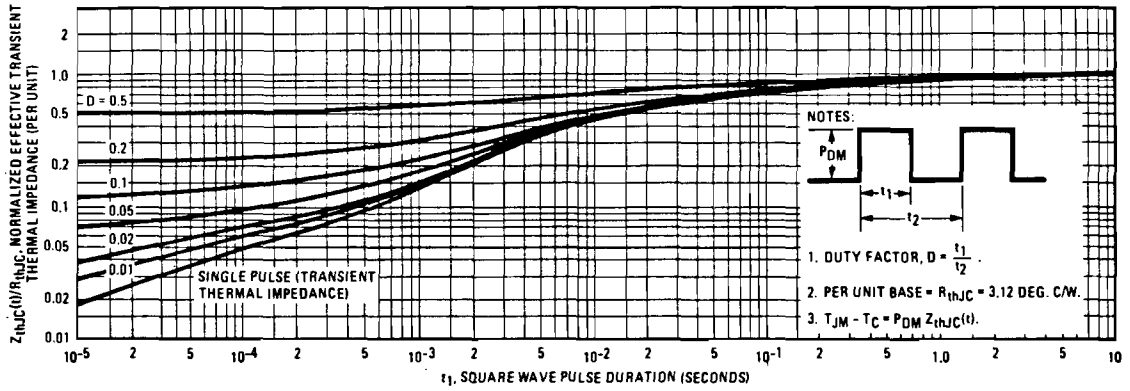


Fig. 5 – Maximum Effective Transient Thermal Impedance, Junction-to-Case Vs. Pulse Duration

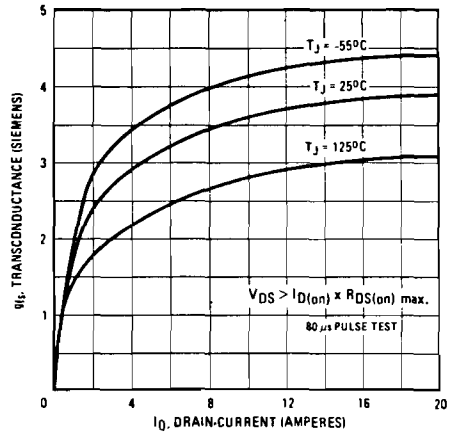


Fig. 6 – Typical Transconductance Vs. Drain Current

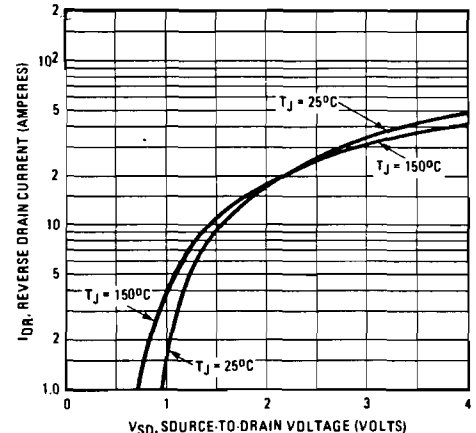


Fig. 7 – Typical Source-Drain Diode Forward Voltage

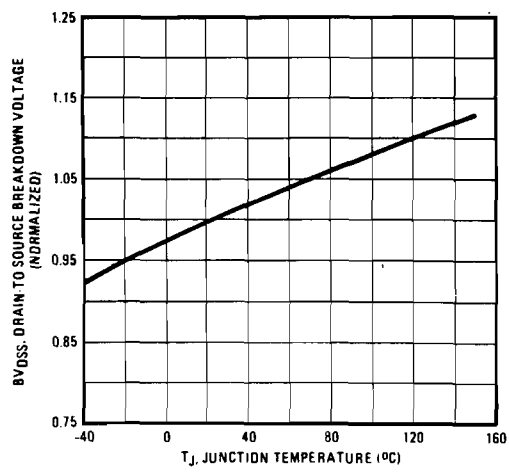


Fig. 8 – Breakdown Voltage Vs. Temperature

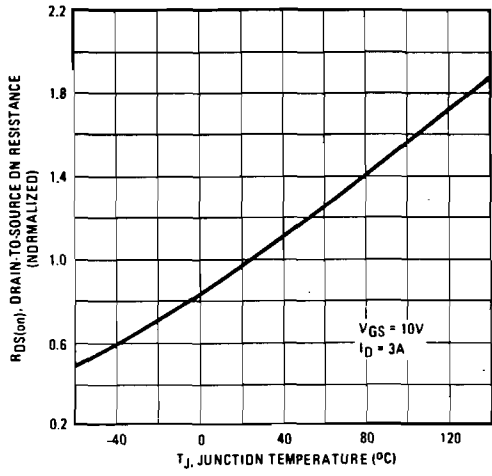


Fig. 9 – Normalized On-Resistance Vs. Temperature

IRF520, IRF521, IRF522, IRF523 Devices

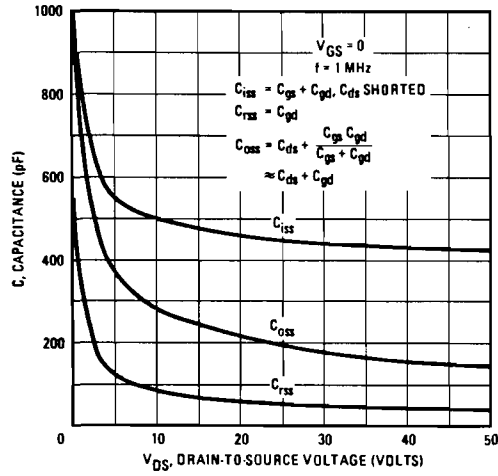


Fig. 10 - Typical Capacitance Vs. Drain-to-Source Voltage

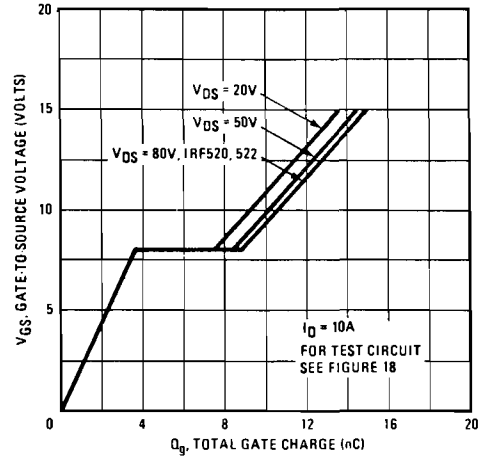


Fig. 11 - Typical Gate Charge Vs. Gate-to-Source Voltage

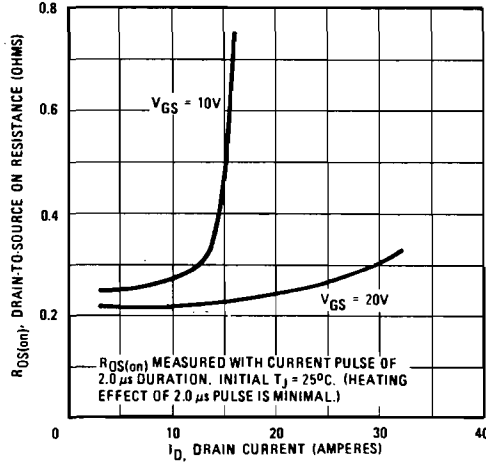


Fig. 12 - Typical On-Resistance Vs. Drain Current

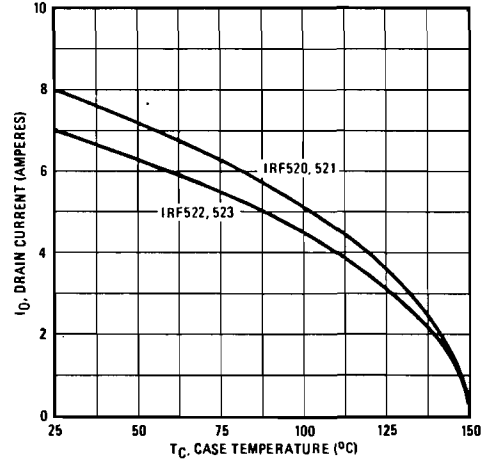


Fig. 13 - Maximum Drain Current Vs. Case Temperature

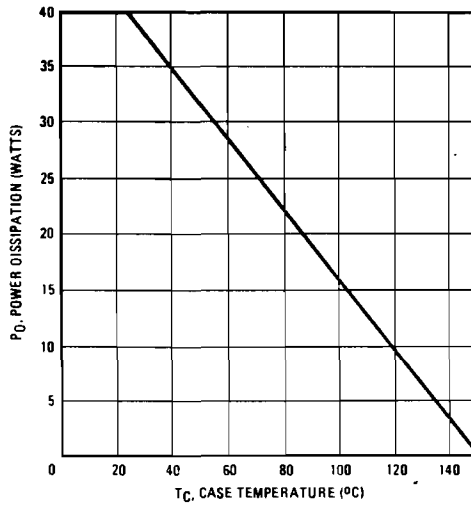


Fig. 14 - Power Vs. Temperature Derating Curve

Regulating Pulse Width Modulators

ADVANCED DATA

Performance data described herein represent design goals.
Final device specifications are subject to change.

SG1525A/2525A/3525A
SG1527A/2527A/3527A

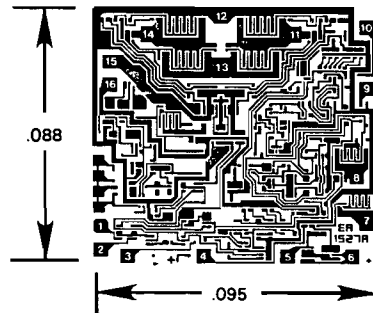
DESCRIPTION

The SG1525A/1527A series of pulse width modulator integrated circuits are designed to offer improved performance and lowered external parts count when used to implement all types of switching power supplies. The on-chip +5.1 volt reference is trimmed to $\pm 1\%$ initial accuracy and the input common-mode range of the error amplifier includes the reference voltage, eliminating external potentiometers and divider resistors. A Sync input to the oscillator allows multiple units to be slaved together, or a single unit to be synchronized to an external system clock. A single resistor between the C_T pin and the Discharge pin provides a wide range of deadtime adjustment. These devices also feature built-in soft-start circuitry with only a timing capacitor required externally. A Shutdown pin controls both the soft-start circuitry and the output stages, providing instantaneous turn-off with soft-start recycle for slow turn-on. These functions are also controlled by an undervoltage lockout which keeps the outputs off and the soft-start capacitor discharged for input voltages less than that required for normal operation. Another unique feature of these PWM circuits is a latch following the comparator. Once a PWM pulse has been terminated for any reason, the outputs will remain off for the duration of the period. The latch is reset with each clock pulse. The output stages are totem-pole designs capable of sourcing or sinking 100 mA. The SG1525A output stage features NOR logic, giving a LOW output for an OFF state. The SG1527 utilizes OR logic which results in a HIGH output level when OFF.

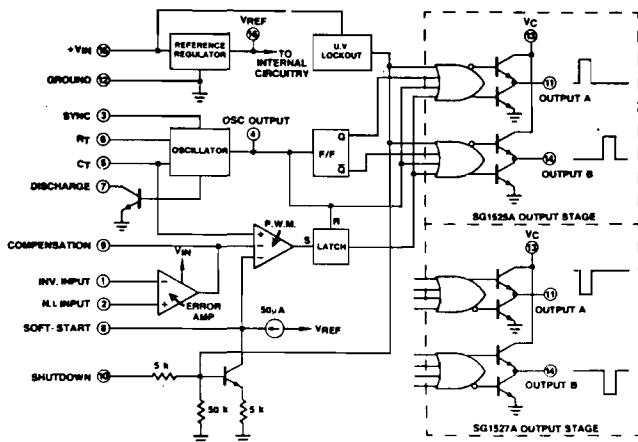
FEATURES

- 8 to 35 volt operation
- 5.1 volt reference trimmed to $\pm 1\%$
- 100 Hz to 500 kHz oscillator range
- Separate oscillator sync terminal
- Adjustable deadtime control
- Internal soft-start
- Input undervoltage lockout
- Latching P.W.M. to prevent multiple pulses
- Dual 100 mA source/sink output drivers

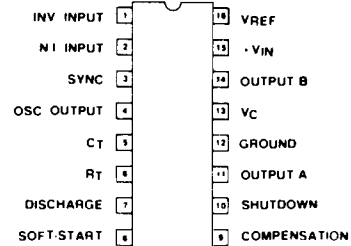
CHIP LAYOUT



BLOCK DIAGRAM

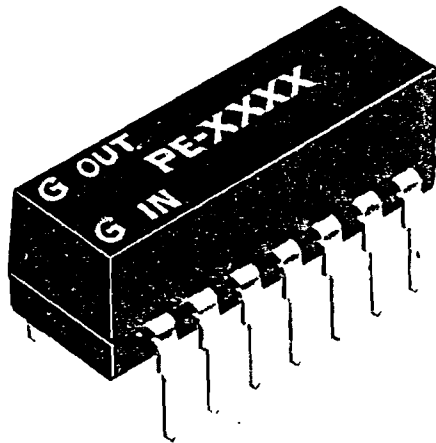


CONNECTION DIAGRAM TOP VIEW



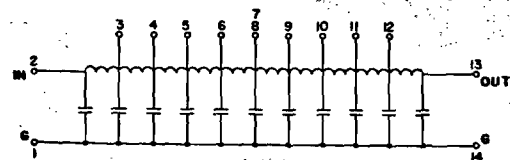
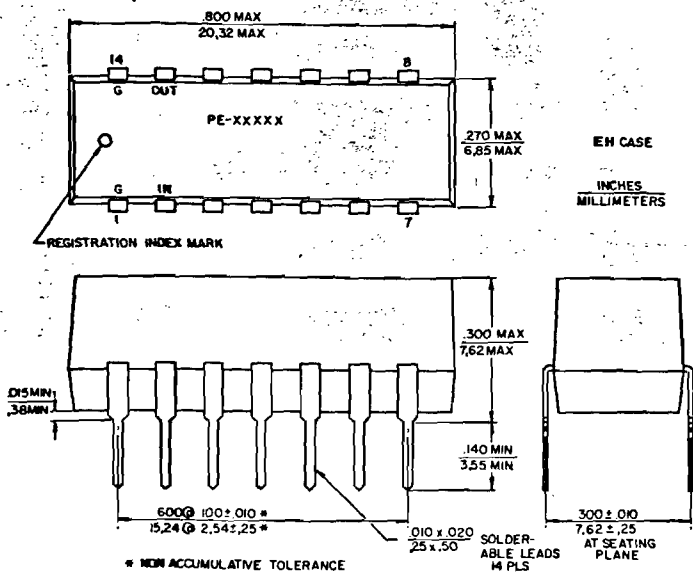
J-PACKAGE
TO-116

D-I-P DELAY LINES

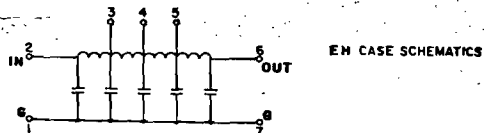


- **FAST RISE TIME** — all delay lines feature fast rise time and low distortion.
- **DESIGNED FOR AUTOMATIC HANDLING** — this series of delay lines is fully compatible with automatic handling and insertion equipment.
- **PACKAGING** — all units are transfer molded and will meet applicable sections of MIL-D-23859 and MIL-STD-202C.
- **RATING RANGE** —
 Temperature Coefficient
 Peak Pulse Voltage

Approximately 100 PPM/°C
50 volts



for
PE-9821-
9829



for
PE-20410-
20419

ELECTRICAL SPECIFICATIONS*

Catalog Number	Impedance Z_0 (ohms $\pm 10\%$)	Total Delay (ns $\pm 5\%$)	No. of Taps	Delay Per Tap (ns ± 3 ns)	Rise Time (ns max.)	Total Delay/ Rise Time Ratio (min.)	Distortion (% max.)	Attenuation (% max.)
9821	50	50	10	5(± 2 ns)	8.5	6	10	1.6
9822	50	100	10	10	17	6	10	3.8
9823	50	125	10	12.5	21	6	10	6.5
9824	100	50	10	5(± 2 ns)	8.5	6	10	2.0
9825	100	100	10	10	17	6	10	4.0
9826	100	125	10	12.5	21	6	10	7.0
9827	100	150	10	15	25	6	10	8.0
9828	100	200	10	20	34	6	10	10.0
9829	100	250	10	25	42	6	10	12.0
20410	100	10	4	2.5(± 1 ns)	4	3	15	5
20411	100	20	4	5.0(± 2 ns)	7	3	15	5
20412	100	30	4	7.5(± 2 ns)	10	3	15	5
20413	100	40	4	10	14	3	15	5
20414	100	50	4	12.5	17	3	15	5
20415	100	60	4	15	20	3	15	5
20416	100	70	4	17.5	24	3	15	5
20417	100	80	4	20	27	3	15	5
20418	100	90	4	22.5	30	3	15	5
20419	100	100	4	25	34	3	15	5

*Electrical Specifications Per E.I.A. Standard (RS - 242)

ADVANCED HIGH VOLTAGE CO., INC.

14532 ARMINTA AVE. • VAN NUYS, CALIF. 91402 • PHONE: (213) 997-7222

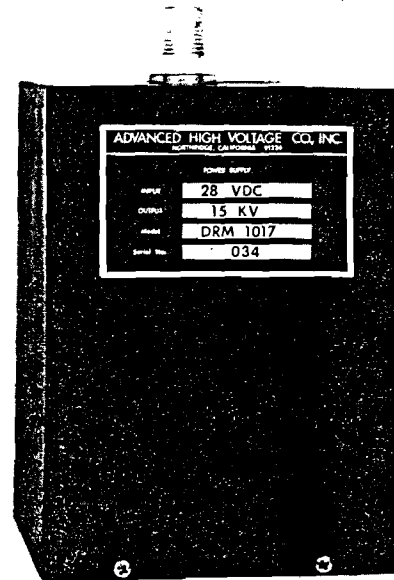
DRM SERIES
 DC operated HV Module
 800V to 22KV @ 15 watts 28VDC
 input, load and line regulated

APPLICATIONS

CRT displays, image converters & similar photo-tube applications. General high voltage uses where close regulation, low ripple and small size are important.

FEATURES

- Module type high voltage supply.
- All solid state silicon.
- Features line and load regulation.
- Low ripple.
- Short-circuit proof, output will recover upon removal of short.
- Floating HV return. May be floated up to 500V from case or input.
- Magnetically shielded.
- Serviceable low voltage section.
- Encapsulated high voltage section.



SPECIFICATIONS

- Input: 28 VDC nominal.
- Output: 800 V to 22 KV Adjustable $\pm 10\%$.
- Regulation — Line: < 0.1%. Load: < 0.1%.
- Combined L/L: < 0.1%.

- Ripple: < 0.1% rms
- Operating temperature: -20°C to $+65^{\circ}\text{C}$
- Package: MIL-T-27 case.

Model Number	Input KV	Output KV	Output MA	Case SMT	Model Number	Input KV	Output KV	Output MA	Case SMT
DRM 1015	0.8	18	1.5	GA	DRM 165	7.5	2	1.5	GA
DRM 115	1	15	1.5	GA	DRM 175	10	2	1.5	JA
DRM 125	1.5	10	1.5	GA	DRM 185	12.5	2	1.5	JA
DRM 135	2.5	6	1.5	GA	DRM 195	15	2	1.5	JA
DRM 145	5.5	4	1.5	GA	DRM 205	18	2	1.5	JA
DRM 155	8	3	1.5	GA	DRM 215	22	2	1.5	JA

MODIFICATIONS AND SPECIALS

Special DRM can be factory adjusted to any output voltage not listed, 200 V to 22 KV. Other specifications apply. Other input voltages. Very low ripple figures. Wider adjustment range.

Output externally programmable, voltage or resistance. Negative output polarity.

Units can be supplied with reverse input voltage protection or automatic selection of proper input polarity.

Units can be supplied foamed or epoxy-filled to withstand extreme environmental shock conditions.

OPERATING INSTRUCTIONS FOR DRM & DUM SERIES

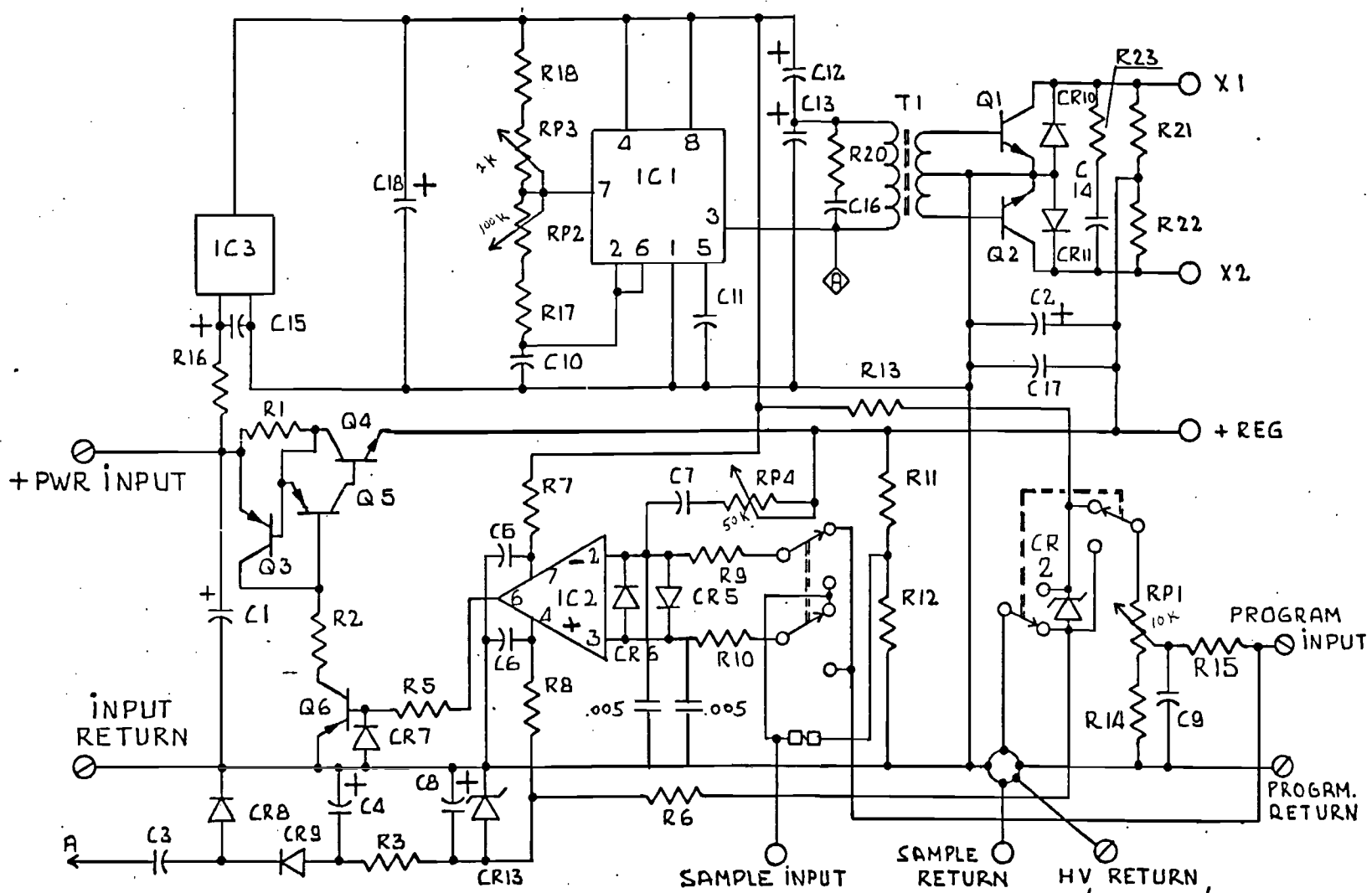
1. The High Voltage output is on the top of the unit either a wire (high voltage lead) or a connector. The color of the lead has no bearing on the output polarity. The nameplate states the voltage and the polarity.
2. Other connections are on the bottom of the unit:
 - Pin 1 = Program input, 0 to 6.2 volts, the same polarity as the high voltage.
 - Pin 2 = Input return (negative DC).
 - Pin 3 = Positive DC input (+28 VDC)
 - Pin 4 = High voltage return.
 - Pin 5 = Program return.
3. To facilitate initial testing, unit is shipped with the output voltage adjusted to the nameplate voltage under a "no load" condition. Only the DC input (pin 3 & 2) need be connected to the unit for an operational check. Unit is designed for installation into systems and therefore does not contain reverse polarity protection.
4. The remote program capability is activated by connecting a low impedance drive voltage to the program input (pin 1). The program return lead goes to pin 5. Program voltage is approximately 6 volts for the nameplate output voltage, and of the same polarity. Program input impedance is approximately 100 Kohm. A low impedance program voltage automatically overrides the voltage set-in by trimpot RP 1.
5. Input return, high voltage return and program return are common and internally connected together. In the installation, they must be run separately in order to avoid ground loops. (During a high voltage short circuit, large amplitudes are present on the high voltage return and could damage the semiconductors used in the low-voltage section of the unit).
6. The case of the unit should normally be connected to the HV return, but may be floated within 500 volts of the input leads.
7. The bottom plate of the unit carries heat-generating components and should be installed on a flat metal surface. Heat-conducting paste should be used to insure good heat transfer. Heatsinking must limit the bottom plate temperature to 65°C, even during short circuits, where as much as 50 watts could be dissipated. (Only some units).

8. The 8-32 mounting screws must not penetrate more than one quarter of an inch (1/4") into the bottom plate.

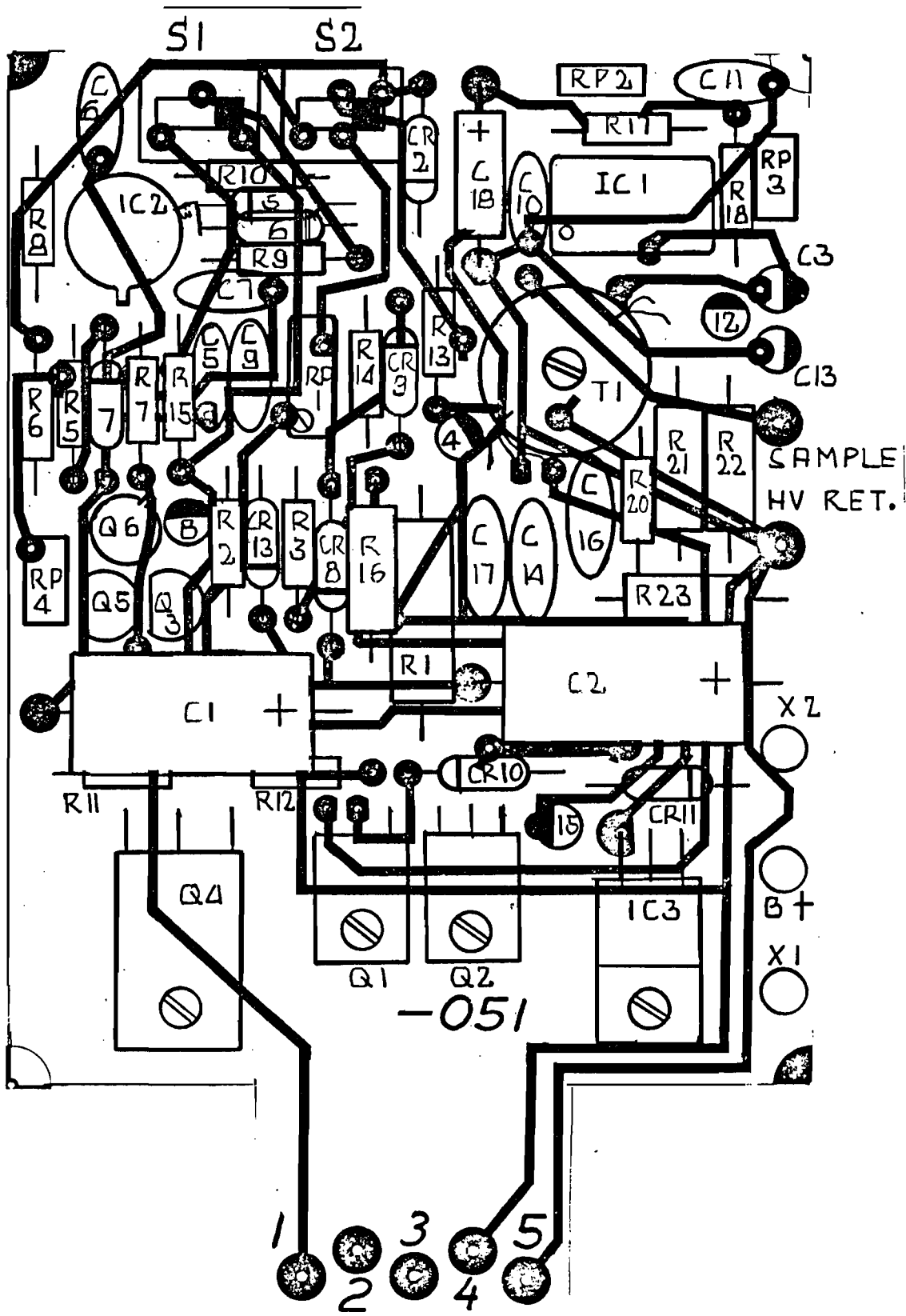
9. The internal current limiting is set by R1. A lower-than-standard value of current limiting can be obtained by increasing R1. (Roughly .47 ohm for 1 Ampere input current). Smaller values of R1 can also be used on the units with -19 option. (This option supplies a 30 watt output on the DRM & DUM series of supplies).

10. Unit should be fused with 1.5 A, slo-blo, except the -19 units, which need a 3 A fuse. The purpose of the fuse is to protect external wiring and other equipment.

11. Unit is shielded and the connections contain some RFI decoupling. If RFI is a problem, choke/capacitor filters should be installed at the input and output connections. The unit's switching frequency is also adjustable with trimpot RP 2. A synch pulse can also be introduced at pin 5 of IC 1, now bypassed, to keep the oscillator locked to an external clock.



S/D DRM/DUM SERIES
JJR 5-10-77



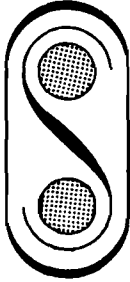
PARTSLIST DRM/DUM BOARDS (-050 &-051)

Item	Qty	Description	Part Number	Manufacturer	Ref #
1	2	Cap. Elyt, 100/40		Siemens	C1, 2
2	6	Cap. Tant 1/35	T368 A105M035 AS	Kemet	C3,4,8, C12,13,15
3	7	Cap. Ceram. .01/100		AE	C5,6,7,9 C11,14,17
4	1	Cap. Mica .001/200		CD	C10
5	1	Cap. Ceram. .0022/100		AE	C16
6	1	Cap. Elyt. 22/16		Siemens	C18
7	1	Zener, Ref.	1N825A	Transitron	CR2
8	5	Diode, signal	1N914		CR5,6,7,8,
9	2	Rectifier	1N4003	Mot	CR10, 11
10	1	Zener, 10V, 400mW	1N5240	Mot	CR13
11	1	Oscillator IC	NE555V	Signetics	IC1
12	1	Op-Amp	741 HC	Fairchild	IC2
13	1	Regulator	78M15UC	Fairchild	IC3
14	2	Transistor, Power	2N5192	Mot	Q1,2
15	2	Transistor, signal	2N4002	Mot	Q3, 5
16	1	Transistor, power	MJE 3055	Mot	Q4
17	1	Transistor, signal	2N2222	Mot	Q6

18	1	Trimpot, 10K	Piher	RP1
19	1	Trimpot, 100K	Piher	RP2
20	1	Trimpot, 2 K	Piher	RP3
21	1	Trimpot, 50K	Piher	RP4
22	1	Resistor, WW .47 ohm, 10% BWH	Ohmite	R1
23	1	Resistor CC, 2.2 K, 1/4 W, 10%	AB	R2
24	2	Resistor CC 22 ohm. 1/4W, 10%	AB	R3, 16
25	2	Resistor CC 1 K, 1/4 W, 10%	AB	R5, 20
26	1	Resistor MF, 483 ohm, 1% MK-2		R6
27	2	Resistor, CC, 100 ohm, 1/4W, 10%	AB	R7, 8
28	3	Resistor, CC, 10K, 1/4W, 10%	AB	R9, 10, 17
29	1	Resistor, CC, 18K, 1/4W, 10%	AB	R11
30	1	Resistor, CC, 6.2K, 1/4W, 10%	AB	R12
31	1	Resistor, MF, 1.31 K, 1%, RN55C	Mepco	R13
32	1	Resistor, MF, 13.7K, 1%, RN55C	Mepco	R14
33	1	Resistor, CC, 82K, 1/4W, 10%	AB	R15
34	1	Resistor, CC, 270 ohm, 1/4W, 10%	AB	R18
35	2	Resistor, CC, 1K, 1/2W, 10%	AB	R21, 22
36	1	Resistor, CC, 330 ohm, 1/2W, 10% SIT	AB	R23

37	1	Transformer bobbin 120:20:20		AHV	T1
38	2	Core-halves, transformer 1408 UG41408F		Mag Inc	T1
39	2	Switch, DPDT			S1
40	1	Heatsink	4800-000-017	AHV	
41	1	P.C. Board, complt.	-050/051	AHV	
42	1	Insulator, heatsink	-071	AHV	
43	1	Insulating washer, transformer	-072	AHV	
44	2	Insulator, Mica	B08853A001	MOT	
45	2	Insulator, Mica		MOT	
46	2	Insulator, Nylon	B51547F015	MOT	
47	4	Screw, 4-40X5/8 BH			
48	1	Screw, 4-40X1/2 BH			
49	5	Nut, 4-40, sml pattern			
50	1	Washer, flat, #4, sml pattern			
51	1	Washer, flat, #4, regular			
52	2	Washer, compression, #4	B52200F003	MOT	
53	2	Washer, compression, #6		MOT	

APPENDIX D
INSTRUCTION MANUAL FOR HIGH VOLTAGE POWER SUPPLY



SPELLMAN
HIGH VOLTAGE ELECTRONICS CORPORATION

7 FAIRCHILD AVENUE, PLAINVIEW, NEW YORK 11803 • 516-349-8686

I N S T R U C T I O N
M A N U A L

MODEL RHR 30K120/F9/220/IC
High Voltage Power Supply
SERIAL NO.: SP C-2877
DATE PRODUCED: 6/83

OUR FOURTH DECADE OF LEADERSHIP IN HIGH-VOLTAGE TECHNOLOGY.

• TWX: 510-221-2155 • Cable address: SPELLTRON, PLVW.



WARNING

THIS EQUIPMENT EMPLOYS VOLTAGES THAT ARE DANGEROUS
AND MAY BE FATAL. EXTREME CAUTION MUST BE EXERCISED
WHEN WORKING WITH THIS EQUIPMENT.

Correspondence and ordering Spare Parts

1. Each Spellman Power Supply has an identification label on the rear of the chassis (or on one surface of the housing, in modular supplies) that bears its model and serial number.
2. When requesting engineering or applications information, reference should be made to this model and serial number, as well as to the component symbol number(s) shown on the applicable schematic diagram, if specific components or circuit sections are involved in the inquiry.
3. When ordering spare parts, the information described in paragraph 2 should be given in addition to the 6 digit Spellman part number that appears on the schematic.

Examples: 1. When requesting engineering data:

"...voltage across Capacitor C2, for serial No. S6584 of Model RHR30P60 power supply."

2. When ordering that component:

"... one (1) Spellman Part No: 105423-1, Capacitor C2 for Serial No. S6584 of Model RHR30P60 power supply."



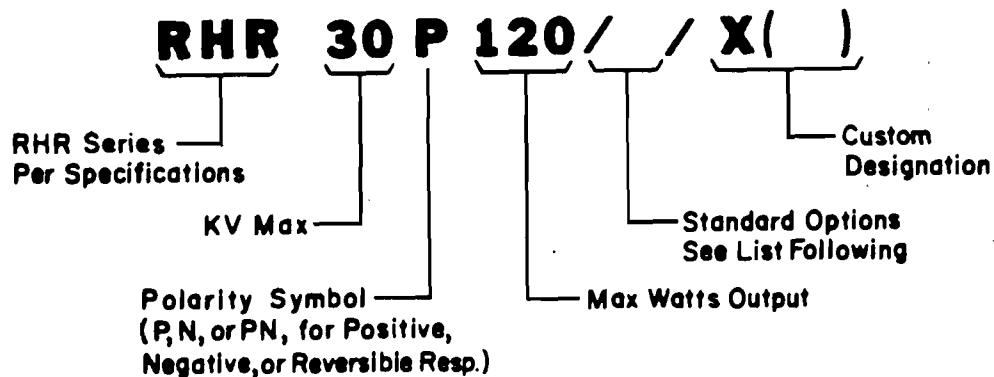
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I.1 GENERAL

The Spellman RHR line high-voltage power supplies described herein provide continuously adjustable, well-regulated high-voltage DC for use in the industrial, aerospace, computer, research, and instrumentation fields. The units feature 0.01% regulation, 0.02% ripple, and are available with a choice of positive, negative or reversible high voltage output polarity. Numerous configurations and options are available; the model-number explanation below covers the standard variations, as well as custom modifications.





I.2 RHR LINE OPTIONS

The RHR line is available with any combination of the options listed below. The appropriate code letters are suffixed to the model number, which is given on the title page as well as the name plate on the unit for this specific power supply.

CURRENT LIMITING	(CL)
OVERLOAD TRIP-OUT	(OL)
REMOTE VOLTAGE PROGRAMMING	(RVC)
BENCH CABINET	(C)
CURRENT REGULATION	(CR)
220 VOLT INPUT (50-60 Hz)	(220)
100 VOLT INPUT (50-60 Hz)	(100)
FOCUS TAP	(F)
BCD DIGITAL REMOTE PROGRAMMING	(BCD)
REMOTE RESISTANCE PROGRAMMING	(RC)
REMOTE MONITOR TERMINALS	(TP)
REMOTE CONTROL PANEL	(RCP)
PARALLEL OPERATION	(PM)
SLAVED BIPOLAR (\pm) OPERATION	(BPM)
FLOATING GROUND	(FG)

CURRENT LIMITING (CL)

DESCRIPTION:

This option automatically limits the load current to approximately 110% of rated load regardless of the overload imposed upon the power supply. The power supply continues to operate at any overload condition including a short circuit by automatically reducing the output voltage as required to maintain the current limit. The unit is self-restoring to its normal operating level when the overload condition is removed. The voltage cut-off characteristic is quite sharp and approaches the ideal characteristic of a voltage-current regulator with automatic crossover.

The CURRENT LIMITING option is supplied as standard on all models. No suffix letters are required in the model number.

APPLICATION NOTES:

The CURRENT LIMITING option should be selected when the load is erratic and can exceed the power supply rating frequently. In such situations, the reset requirement of the OVERLOAD TRIP-OUT option, described below, can be an annoyance. A typical example of this situation is a CRT which experiences occasional arc-overs. When the arc occurs, the CURRENT LIMITING circuit forces the output voltage to drop rapidly (depending on the load impedance). This helps the arc to extinguish and permits the power supply to regain its normal operating level.

continued . . .



I.2 RHR LINE OPTIONS (continued)

CURRENT LIMITING is also desirable for capacitive load conditions. Frequently referred to as a "capacitor charger" type application, the CURRENT LIMITING option provides essentially a constant current charge. The standard OVERLOAD TRIP-OUT option, on the other hand, would cut-off in most cases due to excessive initial inrush current.

SPECIFICATION INFORMATION:

The CURRENT LIMITING option is provided as standard on all RHR models. Suffix letters are not required in the model number. Note that when the OVERLOAD TRIP-OUT (OL) option is provided, it replaces the standard CURRENT LIMITING option. If a current limit level less than the power supply rated current is desired, this limit, in milliamperes is specified in parenthesis following the CL; i.e. CL(4) = 4 milliamperes limit. NOTE: Values as low as 0.25 milliamperes may be selected as standard.

OVERLOAD TRIP-OUT (OL)

DESCRIPTION:

The OVERLOAD TRIP-OUT protection feature rapidly "crowbars" the power supply when the load current exceeds approximately 110% of the rated load. A fast acting, latching circuit, removes power to the oscillator, thereby turning off the high voltage. The power supply must be reset by OFF-ON activation of the main AC power switch.

When the OVERLOAD TRIP-OUT (OL) option is provided, it replaces the normally standard CURRENT LIMITING feature. See CURRENT LIMITING section above for additional information.

APPLICATION NOTE:

This protection arrangement provides the utmost in safety for personnel, load, and power supply. The trip-out is extremely sensitive and rapid, and will turn off the supply even for short-duration arcs in the load. This option should be selected in any situation where the inconvenience of having to "reset" the supply when occasional load arc-overs occur is acceptable.

SPECIFICATION INFORMATION:

Suffix letters (OL) appear at the end of the basic model number when this option has been provided.

If an overload trip-out level less than the power supply rated current is desired, this limit, in milliamperes, is specified in parenthesis following OL; i.e. OL(4) = 4 milliamperes trip-out. NOTE: Values as low as 0.25 milliamperes may be selected as standard.

continued



I.2 RHR LINE OPTIONS (continued)

REMOTE VOLTAGE PROGRAMMING (RVC)

DESCRIPTION:

This option enables the power supply to be controlled by an external low voltage DC source. The output voltage is directly proportional to the input voltage with linearity and proportionality of 1% of full scale. The programming voltage polarity is always positive, regardless of the output polarity of the power supply.

The physical arrangement of this option is that a barrier type terminal board is provided on the rear of the chassis. Schematic information covering this option is provided at the back of this instruction manual and details the necessary inter-connection wiring changes to permit normal operation using the front panel control, or disabling this control to allow for application of the programming voltage. Note that the programming voltage polarity should always be positive, regardless of power supply output voltage polarity. Shielded cable should be used for the programming voltage to prevent pick-up.

SPECIFICATION INFORMATION:

Suffix letters RVC appear at the end of the basic model number when this option has been provided.

Unless otherwise specified, the ratio of input to output is such that 0 to +6VDC controls the output from 0 to rated kilovolts. If a control voltage other than 6 volts is desired, any value desired between 10 and 250 volts DC may be specified in parenthesis after the option letters; i.e. RVC(10) specifies a 0 to 10 volt programming signal.

BENCH CABINET (C)

DESCRIPTION:

A deluxe styled rack cabinet is available for all models. The base dimensions are 22" wide x 18" deep. Height is selected to fit individual unit height. Two-tone blue-gray color scheme is standard. Carrying handles are located conveniently on the sides of the cabinet for easy handling.

SPECIFICATION INFORMATION:

Suffix letter (C) appears at the end of the basic model number when this option has been provided.

continued



I.2 RHR LINE OPTIONS (continued)

CURRENT REGULATION (CR)

DESCRIPTION:

OUTPUT CURRENT AND VOLTAGE:

Same as corresponding standard RHR model. Output current is adjustable from zero to rated current over the full voltage compliance range from zero to rated voltage. A front panel mounted 10-turn potentiometer provides resolution of 250 ppm for the current control.

CURRENT REGULATION:

$\pm 0.1\%$ for any current setting between 25% and 100% of rated value for a load variation from 10% to 100% of full voltage compliance.

PROTECTION:

The power supply output voltage is limited to a maximum of 110% of rated voltage in the event of an open circuited load.

RIPPLE:

0.1% RMS of output voltage

Other characteristics are similar to standard RHR voltage regulation specifications.

APPLICATION NOTE:

This type of unit is particularly suitable for gas laser excitation since the supply can provide a relatively high open circuit voltage for starting the plasma discharge. Once the arc has formed, the supply automatically operates in a constant current mode at any preset level.

SPECIFICATION INFORMATION:

Suffix letters (CR) appear at the end of the basic model number when this option is provided.

continued



I.2 RHR LINE OPTIONS (continued)

220 VOLT INPUT (50-60 Hz) (220)

DESCRIPTION:

Nominal input voltage between 220 and 250 volts RMS, 50-60 Hz, single phase can be accommodated with this option. Input current is approximately 1.0, 1.5 and 2 amperes RMS for 30, 60 and 120 watt models respectively.

SPECIFICATION INFORMATION:

Suffix (220) appears at the end of basic model number when this option is provided.

100 VOLT INPUT (50-60 Hz) (100)

DESCRIPTION:

Nominal input voltage between 100 and 130 volts RMS, 50-60 Hz, single phase can be accommodated with this option. Input current is approximately 1.5, 3 and 5 amperes RMS for 30, 60 and 120 watt models respectively.

SPECIFICATION INFORMATION:

Suffix (100) appears at the end of basic model number when this option is provided.

FOCUS TAP (F)

DESCRIPTION:

This option provides for a separate, supplementary output. The auxiliary voltage is obtained by including a DC to DC supply selected from the Spellman RM line of modules. Any 1.5 watt unit with voltage rating to 24KVDC may be selected. Specifications for this supplementary output are in accordance with RM line data.

Voltage control is provided on the front panel by means of a single turn potentiometer. If the RC, Remote Control, option is ordered for the main output, then provision is made for remote control of the auxiliary output also.

SPECIFICATION INFORMATION:

Suffix letter F(max KV) appears at the end of the basic model number when this option is provided. The number in the parenthesis is the rated maximum output voltage of the RM module. The polarity of the module is POSITIVE unless otherwise

continued



I.2 RHR LINE OPTIONS (continued)

FOCUS TAP (F)

specified.

EXAMPLE: RHR3OP120F(6). This model number indicates that module RM6P1500D (4-6KV at 250 microamperes) is included within standard Model RHR3OP120.

BCD DIGITAL REMOTE PROGRAMMING (BCD)

DESCRIPTION:

This option is supplied in the form of a separate programmer adaptor with all necessary connectors and cables for interconnection to the basic high voltage power supply. The programmer module is designed for rack mounting in standard 19" wide cabinetry. It is 3-1/2" high and 6-1/2" deep and may be mounted either above or below the basic power supply, or at any convenient remote location.

SPECIFICATIONS:

All standard RHR characteristics for regulation, ripple, etc. are not affected by the addition of the programmer module.

OUTPUT VOLTAGE:

Digitally programmable by contact closures at a rear mounted terminal board on the programmer module. Four decades using BCD, 1-2-4-8 code are provided. Contact closures are made to the 16 terminal positions of BCD coding (with respect to common) in any desired combination. The output voltage is then the sum of all the selected terminals. Increments are based on the particular voltage rating of the supply. For 10KV models, the decades cover 1,2,4,8/ 10,20,40,80/ 100,200,400,800/ 1000,2000,4000,8000 volts. For 5KV models, the same increments are available except that the 8000 volt position is deleted. For models above 10KV, the decades have a minimum increment of 10 volts. For example, a 30KV model would have selectable values of 10,20,40,80/ 100,200,400,800/ 1000,2000,4000,8000/ 10,000, 20,000 volts. Accuracy of output voltage is 0.25% of setting from 10% to 100% of rated voltage.

PROTECTION:

Current limiting is provided on all units to permit operation on capacitive loading. The standard front panel 10-turn potentiometer functions as an over-voltage limiter selector when the BCD module is connected. When the module is disconnected, the basic supply reverts to standard control from the front panel.



I.2 RIR LINE OPTIONS (continued)

BCD DIGITAL REMOTE PROGRAMMING (BCD)

APPLICATION NOTE:

This model has been used successfully in conjunction with a punch-card programmer. The punched holes correspond to the required output voltage.

SPECIFICATION INFORMATION:

Suffix (BCD) appears at the end of basic model number when this option is provided.

REMOTE RESISTANCE PROGRAMMING (RC)

DESCRIPTION:

This option permits the output voltage to be controlled by either an external potentiometer (3 terminals) or the front panel 10-turn control potentiometer. A barrier type terminal board is mounted on the rear of the chassis for connection to an external potentiometer. When wired in accordance with the appropriate schematic, the front panel control is switched out, and the remote potentiometer assumes control. A 5000 ohm potentiometer is required, although fixed resistor dividers of equivalent value may be used. A shielded, insulated cable with a twisted pair should be used, with the shield connected to common. Up to 100 feet of cable is permitted.

SPECIFICATION INFORMATION:

Suffix (RC) appears at the end of the basic model number when this option has been provided.

REMOTE MONITOR TERMINALS (TP)

DESCRIPTION:

BNC connectors are provided on the rear of the chassis for remote monitoring of voltage and current. The voltage monitor circuit provides a 1 volt signal corresponding to maximum rated voltage accurate to 1%. The current monitor circuit is taken across a 100 ohm resistor (100mV/mA)

SPECIFICATION INFORMATION:

Suffix letters (TP) appear at the end of the basic model number when this option has been provided.

continued



I.2 RHR LINE OPTIONS (continued)

REMOTE CONTROL PANEL (RCP)

DESCRIPTION:

Any standard model may be supplied with the control panel removed from the basic supply. Terminal boards are added to the basic supply on the rear of the chassis and to the control panel so that the two parts are readily interconnected. 15 feet of appropriately shielded interconnection cable is provided. The control panel contains an AC power switch, fuse, and pilot light, kilovoltmeter, milliammeter, and 10-turn control potentiometer.

SPECIFICATION INFORMATION:

Suffix letters (RCP) appear at the end of basic model number when this option has been provided. NOTE that all models with output voltage of 150KVDC or greater are supplied with the REMOTE CONTROL PANEL as standard.

PARALLEL OPERATION (PM)

DESCRIPTION:

Any model in the RHR line can be used as a "master" controller for parallel operation of up to three "slave" units of the same rating from either the RHR or UHR line. Whether the "slave" units are from the RHR or UHR units, the overall characteristics of the parallel system are governed by the specifications of the RHR "master" supply and are the same as standard specifications except for ripple which will deteriorate to the UHR levels. Current unbalance between units is less than 10% and no derating is required for total current capability of the parallel system.

Each power supply unit may be used independently, if desired, by simple rearrangement of terminal board connections.

SPECIFICATION INFORMATION:

Suffix (PM) appears after the standard model number for the "master supply". Suffix (PS) appears after the standard model number for the "slave" supplies. Up to three "slaves" can be controlled by one "master".

continued



I.2 PHR LINE OPTIONS (continued)

SLAVED BI-POLAR (+) OPERATION (BPM) and (BPS)

DESCRIPTION:

Any positive polarity model in the PHR line can be used as a "master" for "tracking" control of the negative polarity equivalent PHR model. Thus, one control provides adjustment of both supplies from zero to rated output voltage. The negative polarity output "tracks" the positive output within $\pm 1\%$ from 10% to rated output voltage. All specifications for regulation, ripple, etc. are governed by individual unit characteristics.

SPECIFICATION INFORMATION:

Suffix (BPM) and (BPS) appear after standard model number for positive and negative polarity units respectively.

FLOATING GROUND (FG)

DESCRIPTION:

The FLOATING GROUND feature isolates the "low end" return of the power supply with respect to ground. Nominal insulation of at least 100 volts RMS is provided for the "floating" terminal. The terminal is also bypassed to chassis ground by a one megohm resistance, a 0.1mfd. capacitance, and a neon glow lamp whose breakdown voltage is nominally 85 volts (type NE2).

The purpose and application of the FLOATING GROUND option is to permit the user to "ground" or return the low end of the power supply at a point within his system which will suppress undesirable ground loop currents.

In some instances, the user may desire to monitor the load current with accurate instrumentation. For this situation, the user can insert his own current monitoring circuitry between the "FLOATING GROUND" terminal and "system" ground. This may consist simply of an appropriate milliammeter or microammeter, or alternatively, a current sensing resistor which can be calibrated with a sensitive digital or differential voltmeter, as desired. It should be understood, however, that a low impedance return to ground must be provided by the user for proper operation of the power supply. One thousand ohms or less is quite appropriate, and ten thousand ohms would be an acceptable value, if necessary. Check with our Engineering Department for further information.

SPECIFICATION INFORMATION:

Suffix (FG) after the standard model number indicates that the FLOATING GROUND option is provided.

continued



I. 3 DESCRIPTION

Spellman RHR line of high voltage power supplies provide a continuously adjustable source of well-regulated DC voltage. The DC output voltage is continuously adjustable from near zero to its rated maximum by means of a 10-turn front panel OUTPUT VOLTAGE control. The supplies operate from a standard 115 Volt AC line, are regulated, blower cooled and have excellent ripple filtering. The rack mounted RHR can be provided in a cabinet ("C" Option) for bench use.

These power supplies employ a sophisticated, modern, solid-state RF high-voltage circuit to provide an optimum combination of electrical performance, reliability and economy. The AC input is rectified, filtered, and fed to a Class C RF oscillator circuit employing silicon power transistors. A feedback loop that controls the driver - and, hence, the amplitude of the output voltage - consists of a wideband RF amplifier with variable gain controlled by the output of a differential operational amplifier. The input signal to the operational amplifier is the difference between a stabilized, temperature-compensated, zener-diode reference voltage and an accurately determined sample of the DC output voltage. The output of the RF oscillator is rectified and filtered in a solid-state multiplier - a doubler, quadrupler, etc., depending on the output voltage rating.

The RHR rack mounting models have front panels notched for mounting in a standard relay rack or cabinet. The "C" option models are RHR/s mounted in steel rack cabinets. The AC line power enters the power supply by means of a standard line cord, the line end of which is equipped with a 3-prong grounded plug.

On Models rated up to and including 100KV DC, the DC output is available at a high-voltage connector on the rear of the unit, and a matching output cable is provided. The DC output of models rated over 100KV is provided on a toroidal, anti-corona, high-voltage termination. A separate ground binding post is always provided, and should always be used.

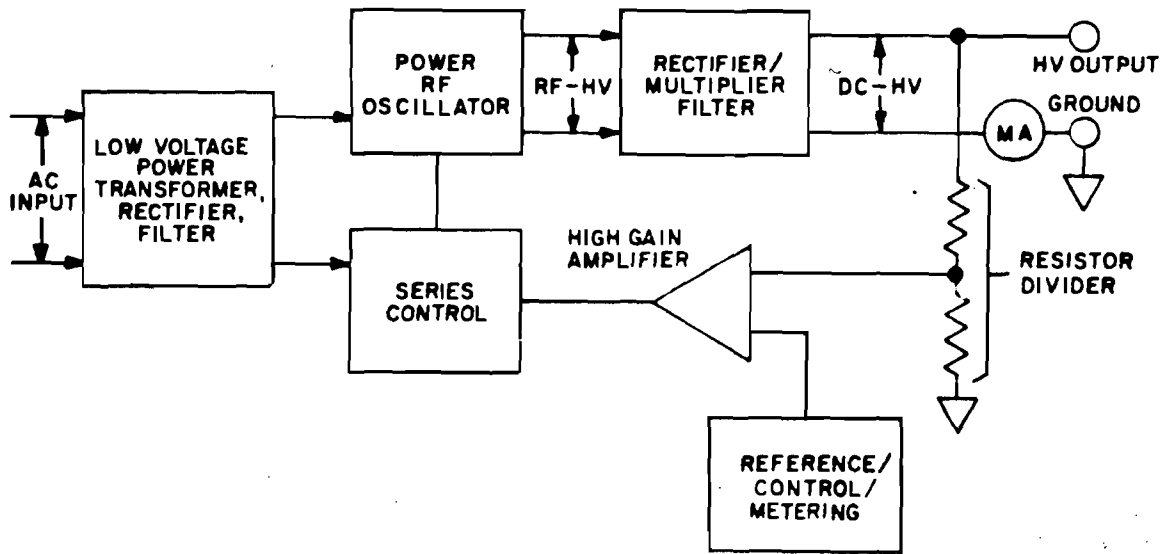
The RHR line power supplies are furnished with either positive, negative, or reversible output polarity with respect to ground. A simple procedure is described in Section I.5 for reversing the output polarity on units with this feature ("PN" style).

continued



I.3 DESCRIPTION (continued)

If desired, the power supply may be interlocked by breaking one or both sides of the incoming AC line. AC transients resulting from interlock switching will not damage the equipment.



Simplified Block Diagram



I.4 UNPACKING AND INSPECTION

First inspect package exterior for evidence of rough handling in transit. If none, proceed to unpack ... CAREFULLY. After removing the supply from its shipping container, remove the top dust cover and inspect thoroughly for evidence of damage. (In cabinet models, remove the supply from its cabinet in order to inspect it.) Remove the jumper connections from the meter terminals. These are installed prior to shipment to "damp" the meters against vibrations which may occur in transit. If the units are reshipped at a later date, a similar process should be used.

IMPORTANT

In cases of damage due to rough handling in transit, notify the carrier immediately, if damage is evident from appearance of package.

Under any circumstances, do not destroy or remove any of the packing material used in a damaged shipment. Carrier companies will usually not accept claims for damaged material unless they can inspect the damaged item and its associated packing material. Claims must be made promptly - certainly within five days of receipt of shipment.

Check out the power supply as outlined as paragraph I,5 and fill out the Warranty Registration card accompanying the unit. Mail the Warranty Registration card promptly.



1.5 INSTALLATION AND OPERATION

After the equipment has been placed or mounted in position, the following procedure should be followed to connect and operate the equipment.

WARNING

THIS EQUIPMENT EMPLOYS VOLTAGES THAT ARE DANGEROUS AND MAY BE FATAL. EXTREME CAUTION MUST BE EXERCISED WHEN WORKING WITH THIS EQUIPMENT.

A 3-PRONG GROUND PLUG IS PROVIDED FOR CONNECTION TO AC LINE. IF A GROUNDED RECEPTACLE IS NOT AVAILABLE, USE AN ADAPTER AND CONNECT THE THIRD WIRE TO A GOOD GROUND - PREFERABLY A WATER SYSTEM GROUND.

ALWAYS MAKE CERTAIN THAT THE RETURN LINE FROM THE LOAD IS CONNECTED TO THE GROUND BINDING POST AT THE REAR OF THE UNIT. A GOOD EXTERNAL WATER SYSTEM GROUND SHOULD ALSO BE CONNECTED TO THIS BINDING POST.

- A) For reversible polarity models (PN, in model number), open the top cover to set the output polarity as desired. In models up to 30KV DC, the high voltage assembly is fastened to the chassis in heavy duty retainer clips. For shipping purposes, the assembly is strapped to the clips by plastic cable ties. For fixed polarity models it is not necessary to remove the ties. For reversible polarity models, it is necessary to remove these ties to reverse the polarity.

Operating polarity is identified by appropriate labels on the high voltage assembly. To change the polarity, unsnap the leads from the two ends of the assembly, lift the assembly out of the lower retainer clip, and finally pull it away from the upper clip. The assembly should now be free. Rotate it through 180° and replace the assembly in the retainer clips, reversing the above step-by-step procedure. Snap the high voltage leads back on to the assembly, and finally screw the cover back down on to the unit.

For higher voltage models, the polarity reversal is effected by the interchange of leads in a plug/receptacle configuration - two plugs and two jack/receptacles are located at the high voltage assembly. The plugs are identified so that polarity is easily determined. Interchanging the plugs in the two jacks reverses the polarity.

- B) Set the "POWER" switch to the OFF position.
- C) Check the input voltage rating on the name-plate of the supply and make certain that this is the rating of the available power source.
- D) Connect the high-voltage output cable and ground return lead to the load.
- E) Connect the input cable to the power source.

continued



I.5 INSTALLATION AND OPERATION (continued)

- F) If this supply has a focus output, connect the focus voltage cable from the load to the FOCUS output connector at the rear of the unit.
- G) Rotate OUTPUT VOLTAGE control to fully counter-clockwise position. (This is optional, but desirable to prevent damage to external equipment caused by inadvertent overvoltage setting. Not required if correct setting has already been determined.)
- H) Apply input power to the supply by setting POWER switch to ON (up) position.
- I) Rotate OUTPUT VOLTAGE control clock-wise until voltmeter indicates desired output voltage (Monitor output current, to be sure maximum rating is not exceeded).
- J. (For supplies with Focus outputs only.) Adjust FOCUS VOLTAGE control clock-wise, until desired focus voltage is obtained.
- K) To shut down supply, set POWER switch to OFF (down) position.

WARNING!

DO NOT HANDLE THE LOAD UNTIL IT HAS BEEN DISCHARGED
CHECK KILOVOLT METER!

(NOTE: FOCUS TAP IS NOT METERED IN STANDARD DESIGNS.
USE EXTERNAL METER TO CHECK FOR SAFE CONDITIONS BEFORE
HANDLING HIGH VOLTAGE WIRING!)



I.6 SPECIFICATIONS

INPUT: _____ to _____ volts, 50/60 Hertz, 1 phase.
The full load input current is approximately _____ amperes at full load, 0.8 power factor.

OUTPUT - MAX. RATINGS
Voltage and Current Ranges: 0 - _____ kilovolts DC at 0 - _____ milliamperes;
Output polarity is _____ with respect to ground.

REGULATION -

STATIC LOAD: $\pm 0.01\%$ +1V, whichever is greater; NL to FL, at nominal line voltage.

STATIC LINE: $\pm 0.01\%$ +1V, whichever is greater; 105 to 125V input at fixed load within rating.

WORST CASE: $\pm 0.02\%$ +2V, whichever is greater; for any combination of above.

RIPPLE: 0.02% RMS +2V RMS whichever is greater.
RMS = p-p/2.82

STABILITY: 0.02%/hour, 0.05%/8 hrs., at rated output voltage.

<u>ENVIRONMENTAL DATA</u>	<u>OPERATING</u>	<u>STORAGE</u>
Ambient Temperature:	-10 to +60°C	-25 to +71°C
Relative Humidity:	0 to 70%	0 to 90%
Temperature Stability:	Maximum change in output voltage is 0.01%/°C at rated voltage from 0 to 60°C.	

METERS: 3-1/2" rectangular; $\pm 2\%$ fs accuracy for current, $\pm 3\%$ fs combined meter and multiplier accuracy for voltage.

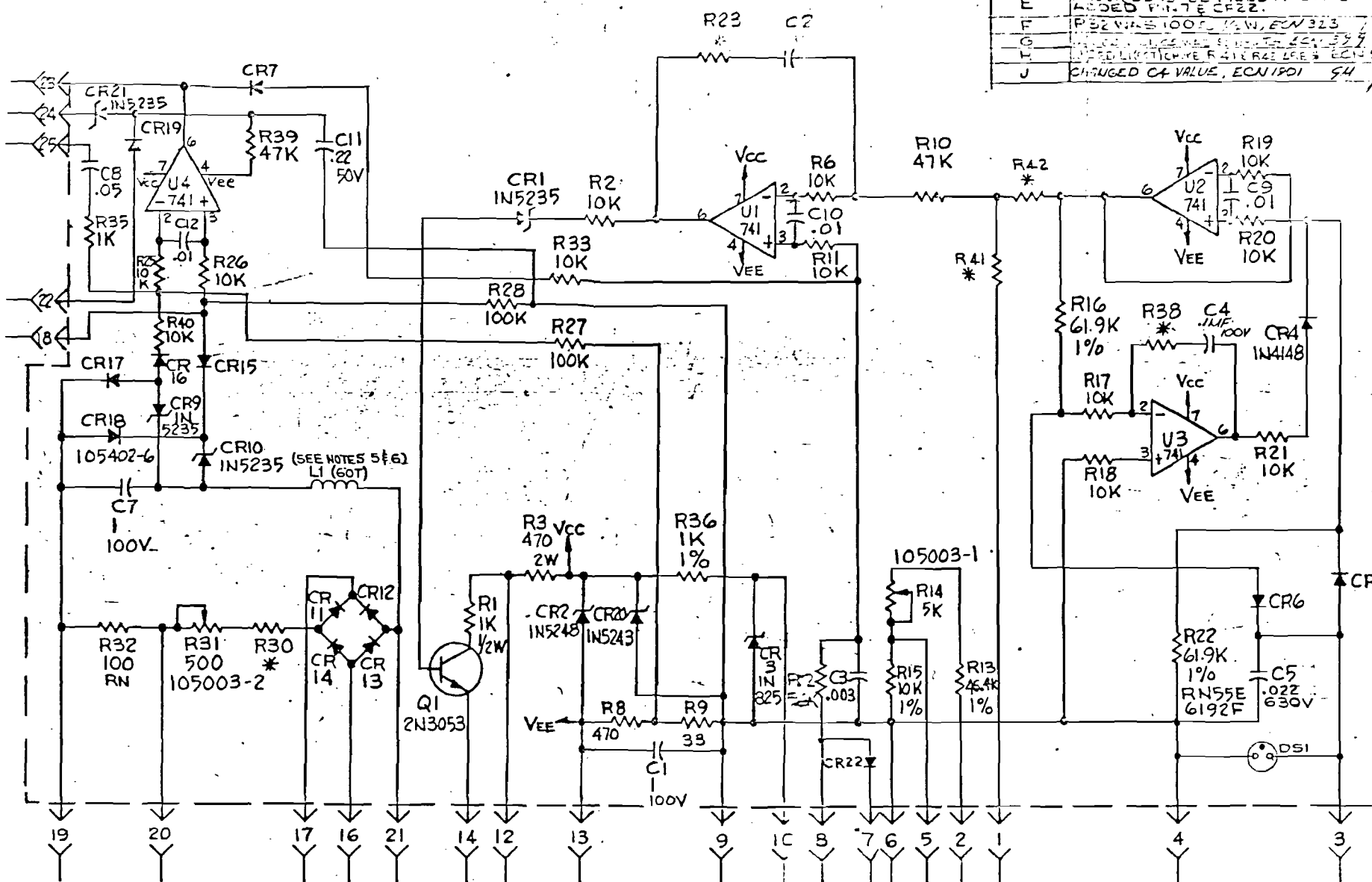
CONTROLS: AC power switch, fuse, pilot light, 10-turn high voltage control -0.02% resolution.

PROTECTION: Current limiting is provided as standard on all models. Refer to OPTIONS, Section I.2 for full description of the CURRENT LIMITING protection system, as well as other optional protection arrangements.

SIZE: 19" wide standard rack panel with standard notching 16-1/2" deep, _____" high.

WEIGHT: _____ lbs. net, _____ lbs. shipping

LTR	DESCRIPTION	DATE	BY
E	REVISIONS FILED IN E		
F	ADDED PART CR22		
G	R32 WAS 100K 1/4W, ECN 323	2-14	
H	REMOVED CONNECTIONS FROM J2 PIN 23		
I	ADDED LATCHING RATE R22 USE ECN 323		
J	CHANGED CA VALUE, ECN 1501	5-4	

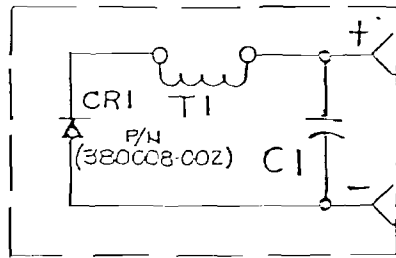


- NOTES:
- UNLESS OTHERWISE SPECIFIED
 - RESISTOR VALUES ARE IN OHMS 1/4 W ± 10%.
 - CAPACITOR VALUES ARE IN MICROFARADS.
 - DIODES ARE TYPE IN4002.
 - * INDICATES FACTORY SELECTED COMPONENT.
 - ALL 6 DIGIT NUMBERS ARE SPELLMAN STANDARD PARTS AND ARE RECOMMENDED AS SPARE PARTS.
 - OVERLOAD (OL) - FOR OL OPTION: L1 IS USED, J2 PIN 23 IS CONNECTED TO J2 PIN 24 J2 PIN 18 IS CONNECTED TO J2 PIN 22
 - CURRENT LIMIT (CL) - FOR CL OPTION: L1 MAY BE REPLACED BY JUMPER. REMOVE CONNECTION J2 PIN 23 TO J2 PIN 24 & J2 PIN 18 TO J2 PIN 22. J2 PIN 23 IS CONNECTED TO J2 PIN 25.

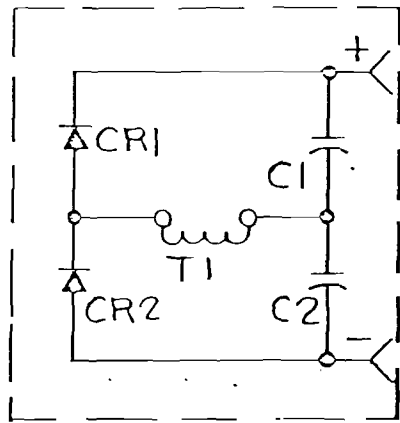
AMPL. ASSY	4010B1-100
TITLE	REV. NO.
USED ON	

UNLESS OTHERWISE SPECIFIED	DRAWN	DATE	TITLE	SCHEMATIC AMPLIFIER RHR/UHR	SPELLMAN HIGH VOLTAGE ELECT. CORPORATION
CLEARANCES ARE IN INCHES	DESIGNER				
TOLERANCES ON DIMENSIONS DECIMALS ANGLES	CHECKED				
FRACTIONS DECIMALS ANGLES	ENGINEER				
	APPROVED				
	DO NOT SCALE DIMS	SCALE	1" = 1" P.C. 05		

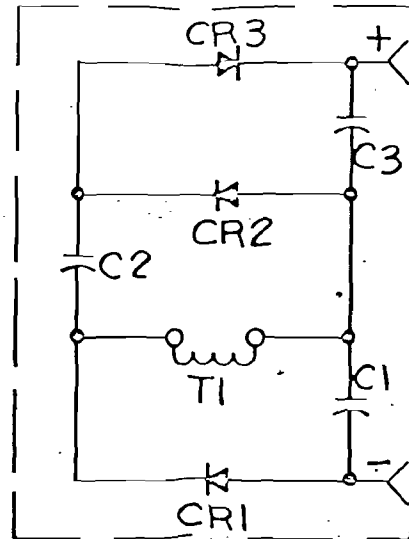
301090-100



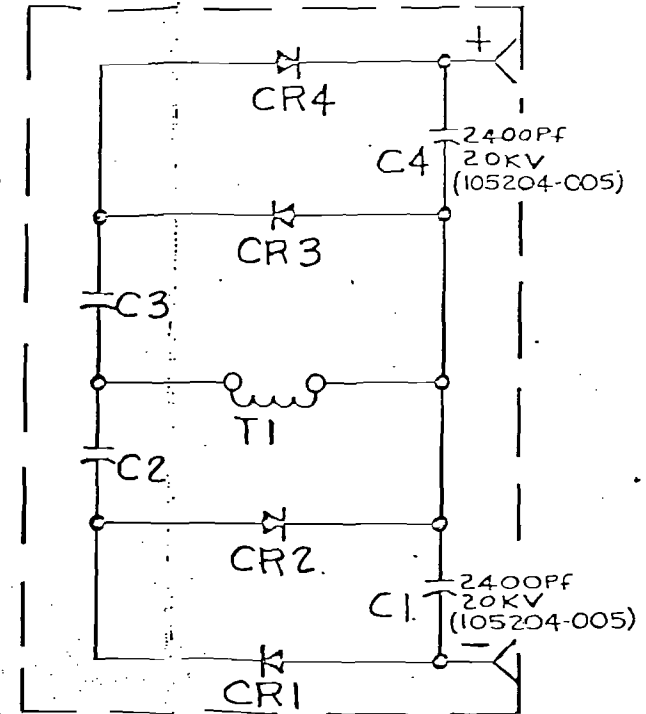
5KV (HALF WAVE)



10KV (DOUBLER)



15KV (TRIPLER)



20, 25 & 30KV (QUADRUPLER)

SYM	REVISION'S	DATE
A	T2B WAS T1 SEE ECN # 172	11/12/76
C	T1 WAS T2B, 20, 25 & 30KV WAS 20 & 30KV, ADDED -001 ECN # 233	1B.
D	SEE ECN 332	3-1-77
E	SEE ECN. 493	12/5/77
F	SEE ECN 1452	12/1/80

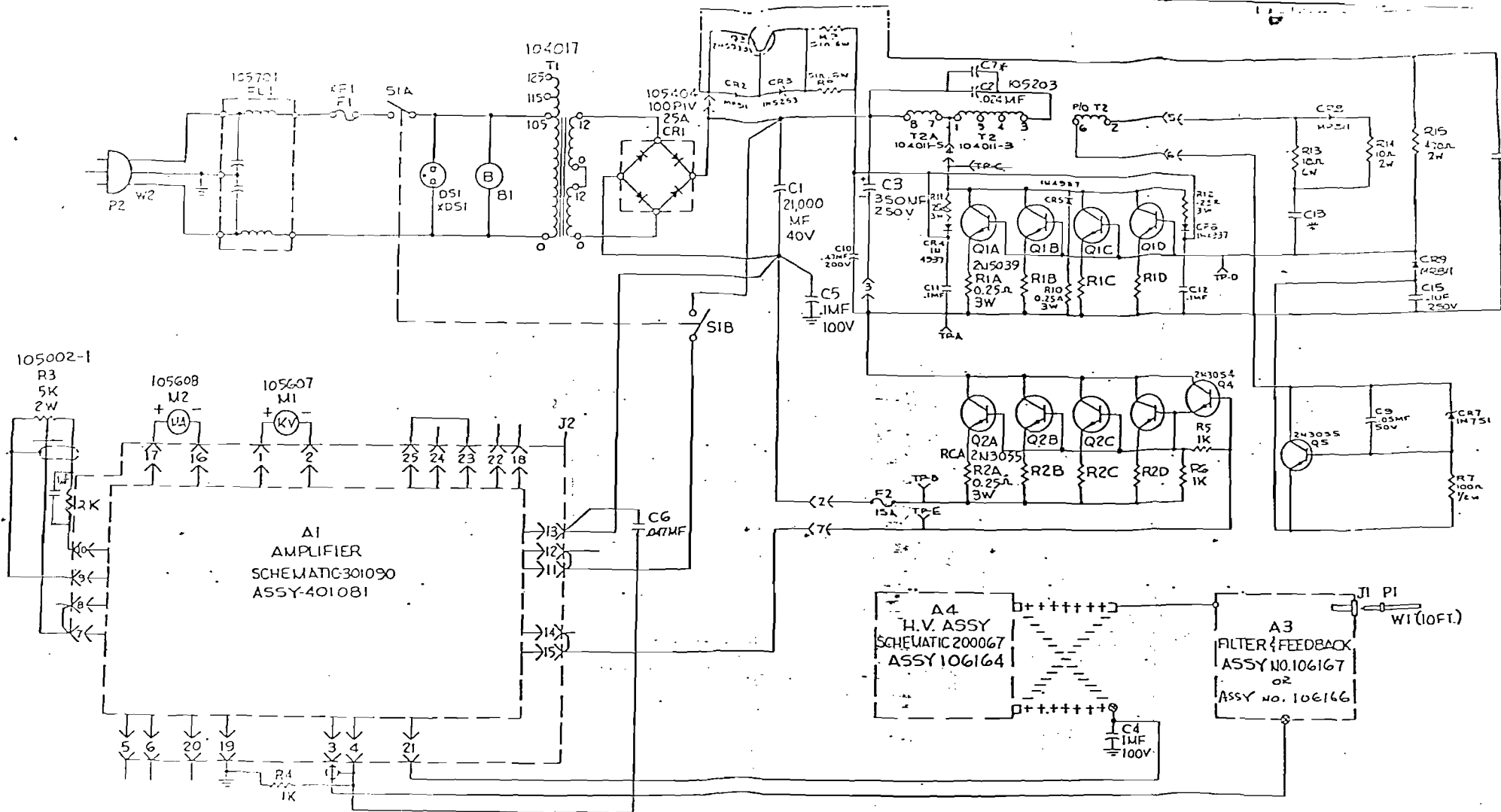
NOTES: (UNLESS OTHERWISE SPECIFIED)

1. T1 IS ELECTROMAGNETICALLY COUPLED TO T2. SEE MAIN ASSY SCHEMATIC.
2. ALL CR'S ARE 105402-008
ALL C'S ARE 105204-023
ALL T1 ARE 301590-006
3. ALL 6 DIGIT NUMBERS ARE SPELLMAN STANDARD PARTS AND ARE RECOMMENDED AS SPARE PARTS. FOR ADDITIONAL INFORMATION ON THESE PARTS, CONTACT SPELLMAN.

H.V. ASSY	401770-TAB
TITLE	NUMBER
USED ON	

UNLESS OTHERWISE SPECIFIED	DATE	TITLE
DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± .01 ± .005 ± .01	20/73	SCHEMATIC HIGH VOLTAGE ASSY
MATERIAL	29/73	
PROTECTIVE FINISH	3/04/77	
	1/73	

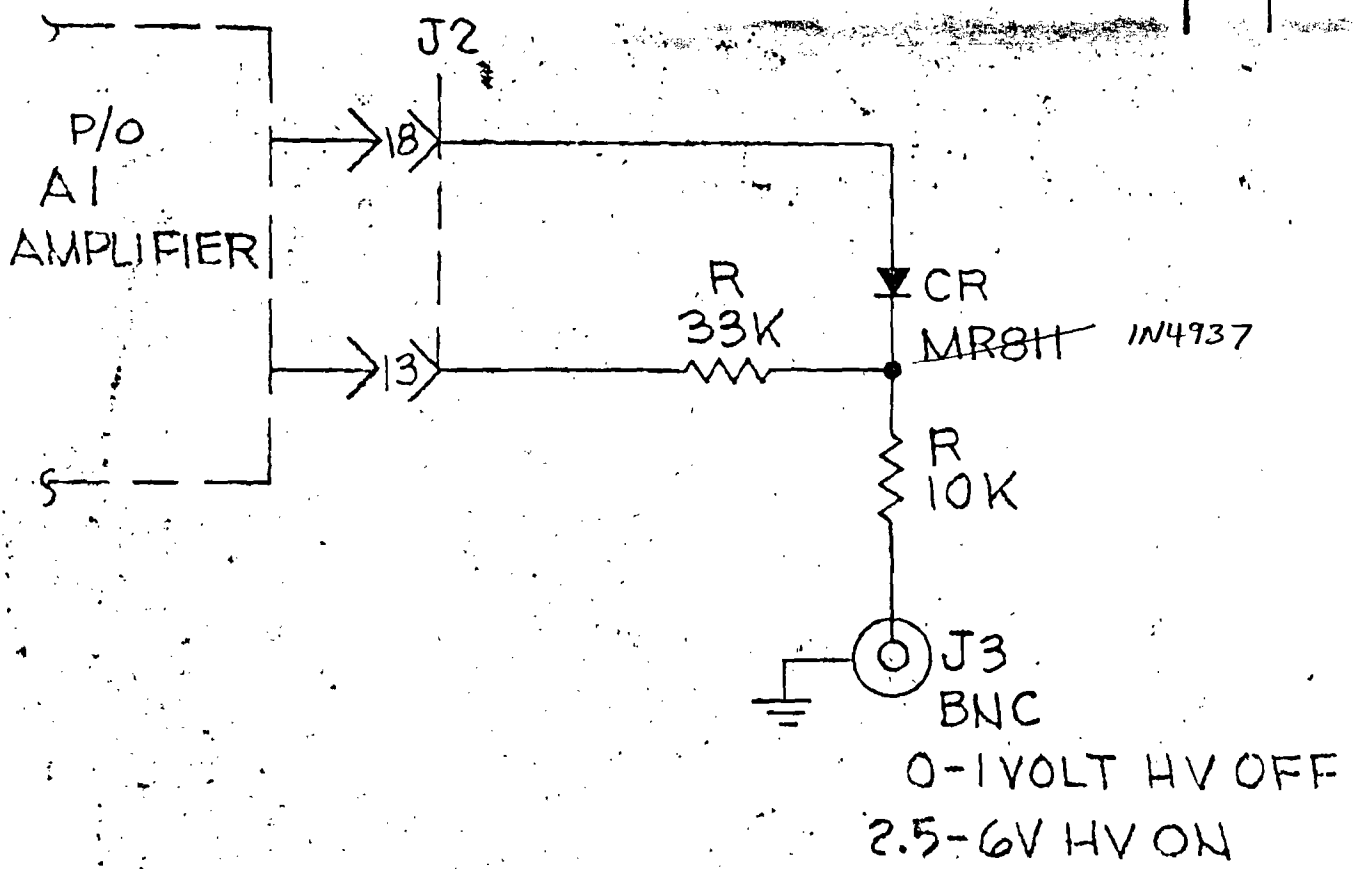
SPELLMAN
HIGH-VOLTAGE ELECTRONICS
CORPORATION
7 FAIRCHILD AVE., PLAINFIELD, N.J. 07061
1B



R10 0.1K 1/2W 100125
 R11 0.1K 1/2W 100125

SCHEMATIC
 POWER SUPPLY
 ASSY NO. 106166

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL

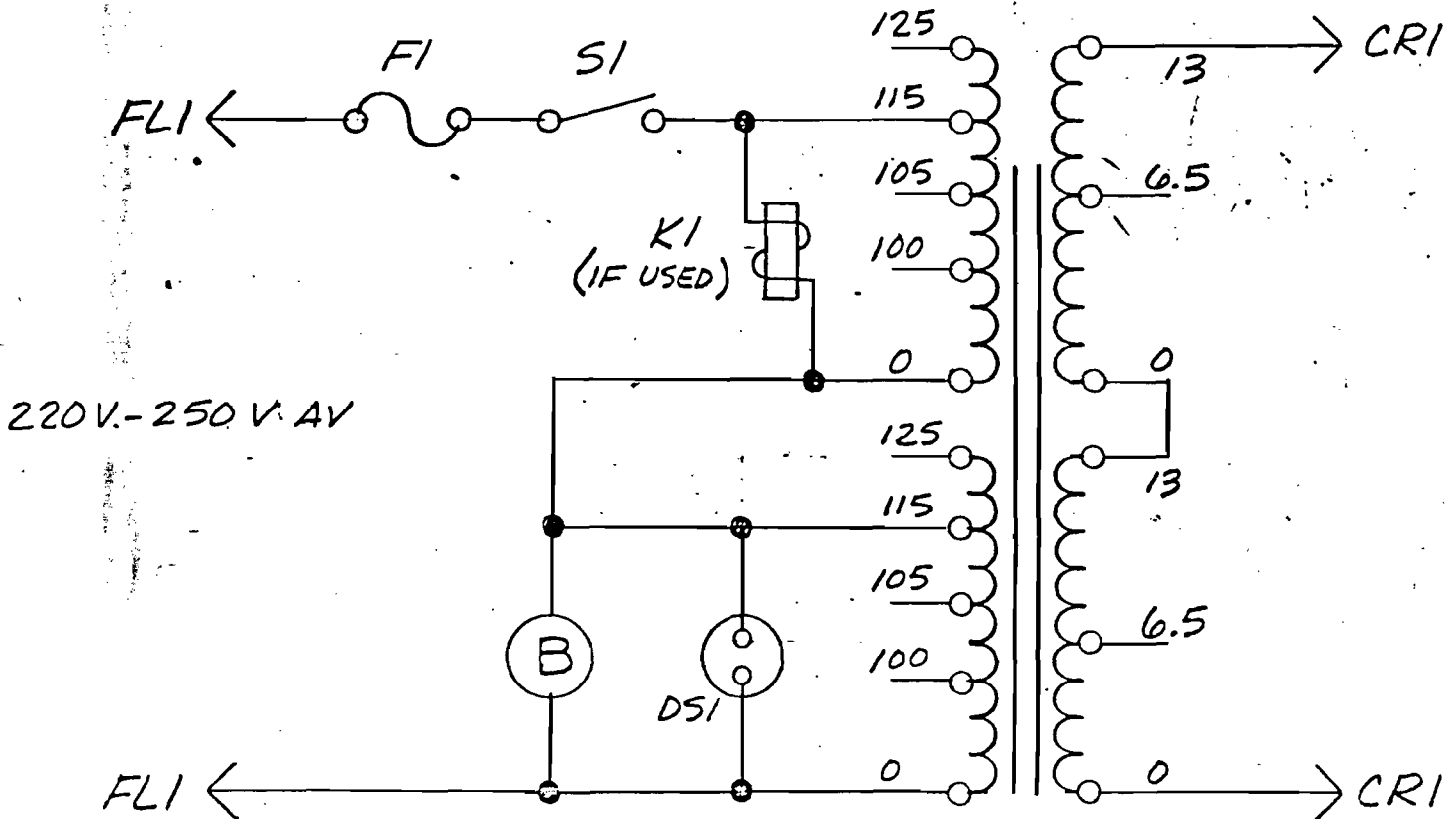


M/F


UNLESS OTHERWISE SPECIFIED	DRAFTSMAN <i>gyl</i>	DATE 16 July 75	TITLE IC OPTION	SPELLMAN HIGH-VOLTAGE ELECTRONICS CORPORATION 1930 ADEL AVE., BRONX, N Y 10469
	DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± ± ±	DESIGNER		
MATERIAL	ENGINEER	APPROVED	DWG SIZE A	100194
PROTECTIVE FINISH	DO NOT SCALE DWG	SCALE	WT	SH OF 1

APPLICATION		REVISION			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVED
		B	REVISED & REDRAWN ECV 1270	5-15-80	M

T1 104017-035

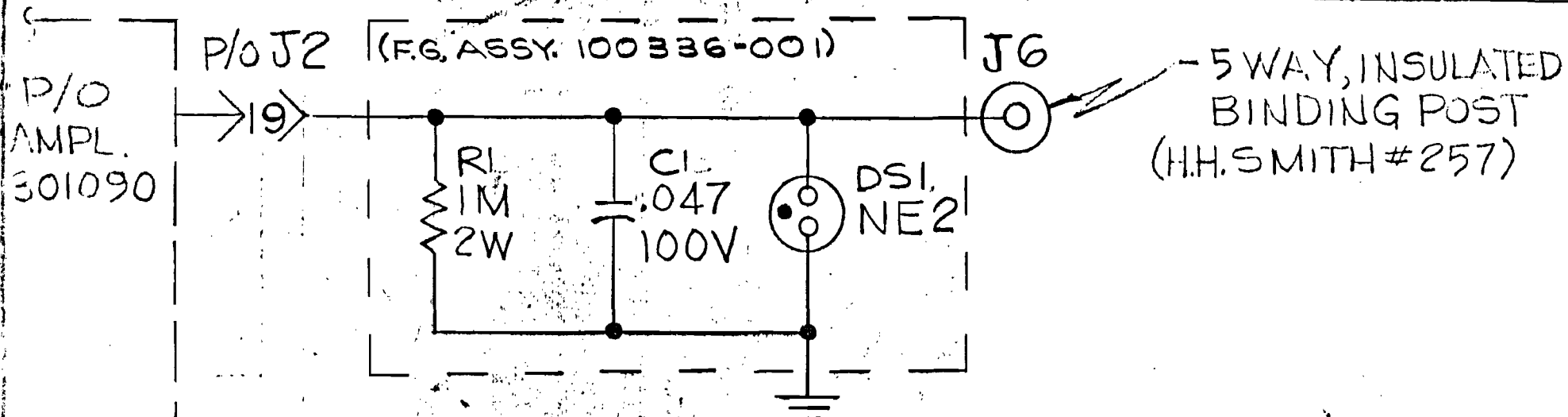


M/F

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES ± .XX ± .1 ± .1 ± .XXX ± .1	CONTRACT NO.		 SPELLMAN HIGH VOLTAGE ELECTRONICS CORPORATION 7 FAIRCHILD AVENUE, PLAINVIEW, NEW YORK 11803
	APPROVALS	DATE	
MATERIAL	DRAWN	M. MAHOUEY	5-15-80
	CHECKED	[REDACTED]	5/15/80
FINISH	DESIGN		
	PROJ. ENG.	[REDACTED]	5-15-80
DO NOT SCALE DRAWING	PROPRIETARY INFORMATION	SCALE: +	SIZE A CODE IDENT NO. IN788 DRAWING NO. 100098-001
		PART CODE: 06	SHEET 1 OF 1

220 V OPTION
RHR, UHR & RH5R

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVAL
A	ADDED 1K RESISTOR	25 JUN 74	
B	TERM. # 1. REMOVED FROM NOTE 1	12/10/75	
C	SEE ECN #415	10/29/80	



NOTE:
1. TERMINAL 19 REMOVED FROM GROUND.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES ± ± ±	DRAFTSMAN <i>EVB</i>	DATE 26 NOV 73	TITLE FLOATING GROUND OPTION (FG) MODEL RHREUHF	SPELLMAN HIGH-VOLTAGE ELECTRONICS CORPORATION 1930 ADEE AVE., BRONX, N. Y. 10469	
	DESIGNER	CHECKER <i>[Signature]</i>		11/26/73	DWG SIZE A
MATERIAL	ENGINEER <i>[Signature]</i>	4/28/76	SCALE	SH	OF
PROTECTIVE FINISH	APPROVED <i>[Signature]</i>	4/28/76	WT		
DO NOT SCALE DWG					