GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL
[ ] REVISION NO. ____

Project No. A-2889 DATE: 4/28/81

Project Director: ~~D. S. Ladd~~ J. Butterworth School/Lab RAIL/RED

Sponsor: FGAN; Wachtberg-Werthhoven, West Germany misc

Type Agreement: Research Project Agreement dated 3/6/81

Award Period: From 3/6/81 To ~~11/6/81~~ ~~3/6/82~~ 11/30/82 (Performance) ____ (Reports)

Sponsor Amount: $54,969* Contracted through:

Cost Sharing: N/A GTRI/~~GIT~~

Title: Development of a Modulator for the 95 GHz FEC-EIA

ADMINISTRATIVE DATA OCA CONTACT Leamon R. Scott

1) Sponsor Technical Contact: Mr. Peter Baars; FGAN Konigstrasse 2;
D-5307 Wachtberg-Werthhoven, West Germany
Phone 011 49 228 852200

2) Sponsor Admin./Contractual Contact: ____

Reports: See Deliverable Schedule Security Classification: N/A

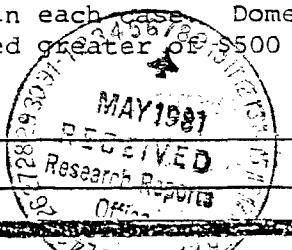
Defense Priority Rating: N/A

RESTRICTIONS

See Attached — 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 sponsor



COMMENTS: Advance Payment of $15K in form of letter of credit (LOC) has been deposited in Trust Company Bank. LOC will be applied against final invoice in an amount depending on the remaining balance at end of project. Prior to modulator shipment, export license and export declaration must be completed. Contact R.Dobb... in OCA for details

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GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 2/10/84

Project No. A-2889 ~~School~~Lab RAIL

Includes Subproject No.(s) _____

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

Sponsor FGAN, Wachtberg-Werthoven, W. Germany

Title Development of a Modulator for the 95 GHz FEC-EIA

Effective Completion Date: 11/30/82 (Performance) --- (Reports)

Grant/Contract Closeout Actions Remaining:

- [x] 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. _____

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Form OCA 60:1028

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

7 July 1981

FGAN
Konigstasse 2
D-5307 Wachtberg - Werthhoven
West Germany

Attention: Peter Baars

Subject: Monthly Contract Technical Report on Project A-2889, covering period 6 March to 31 March 1981.

Gentlemen:

The results and current status of work on the subject project during the referenced performance period are summarized below.

Project Administration

Project A-2889 (Development of a Modulator for the 95 GHz FEC-EIA) has been assigned to the Radar Experimental Division with D. S. Ladd named Project Director. N. C. Currie, J. C. Butterworth, G. M. Conrad, and P. Fenoglio have also been assigned to the project.

Plans for Next Month

The initial design of the FEC-EIO modulator will be completed during April.

Financial Status

The reporting of the financial status of the project will be delayed one month for all monthly reports. The financial status as of 31 March 1981 will be reported in the report covering 1 April to 30 March 1981, etc.

Sincerely,

[redacted]

D. S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

7 July 1981

FGAN
Konigstasse 2
D-5307 Wachtberg - Werthhoven
West Germany

Attention: Peter Baars

Subject: Monthly Contract Technical Report on Project A-2889, covering period 1 April to 30 April 1981.

Gentlemen:

The results and current status of work on the subject project during the referenced performance period are summarized below.

Modulator Design

A preliminary design for the Focus Electrode (FE) pulser was completed and critical circuits were "bread boarded" and tested. The test results indicate that the pulser design will be capable of providing the required pulse voltage and shape.

Plans for Next Month

Work on the pulser circuit will continue. A preliminary design of the DC cathode and bias supplies, high voltage coupling circuit, and EIA heater supplies will be completed.

Financial Status

Expenditures on Project A-2889 in March were $1,302.99.

Sincerely,

[redacted]

D. S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

A-2889

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

7 July 1981

FGAN
Konigstasse 2
D-5307 Wachtberg - Werthhoven
West Germany

Attention: Peter Baars

Subject: Monthly Contract Technical Report on Project A-2889, covering period 1 May to 31 May 1981.

Gentlemen:

The results and current status of work on the subject project during the referenced performance period are summarized below.

Modulator Design

Refinement of the Focus Electrode (FE) pulser design has continued with improvements made in stability and rise and fall times. The DC cathode, bias and FE pulser supplies have been selected and placed on order.

The high voltage coupling circuit has been designed. This circuit has been designed to reduce the cathode droop to less than 10 volts with low energy storage, eliminating the need for crowbar protection. Discussions have been conducted with Varian, Canada regarding the use of this circuit which involves operating the EIA in a pulsed depressed collector mode.

Plans for Next Month

The pulser and power supply design work will continue. The high voltage isolation heater supply will be designed and "bread boarded" and the control circuits will be designed.

Financial Status

Project expenditures for the month of April were $6,222.00, bringing the total expenditures to $7,525.00.

Sincerely,

[redacted]

D. S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

31 July 1981

FGAN
Konigstrasse 2
D-5307 Wachtberg - Werthhoven
West Germany

Attention: Mr. Peter Baars

Subject: Monthly Contract Technical Report on Project A-2889, covering period 1 June to 30 June 1981.

Gentlemen:

The results and current status of work on subject project during the referenced performance period are summarized below.

EIA Testing

A Varian cathode pulsed EIA on loan from the U. S. Army has been incorporated into an existing Georgia Tech modulator for testing. The data obtained will be used to aid in the design of the modulator for the Focus Electrode Controlled EIA.

Modulator Design

The design of the pulser has been finalized. The high voltage isolation power supply for the EIA heater and bias has been designed and breadboarded.

Plans for Next Month

A breadboard of the final design of the pulser will be built and tested. Construction of the control circuits will begin.

Financial Status

Project expenditures for the month of May were $11,102 bringing total expenditures to $18,629.

Respectfully submitted,

[redacted]

David S. Ladd
Project Director

DSL:pmw

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

A-2889

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

22 September 1981

FGAN
Konigstrasse 2
D-5307 Wachtberg - Werthhoven
West Germany

Attention : Mr. Peter Baars

Subject : Monthly Contract Technical Report on Project A-2889, Covering Period 1 July to 30 July 1981

Gentlemen:

The results and current status of work performed on the subject contract during the referenced performance period are summarized below.

EIA Testing

The cathode pulsed EIA on loan from ERADCOM was tested and an accurate measurement of the phase pushing figure was made. The phase pushing figure for the cathode was measured to be 0.18 degrees/volt, which is not as high as the figure of 0.2 degrees/volt which has been used in the design of the modulator. This measurement was made with a 10 mW Gunn Oscillator driving source.

Modulator Design and Construction

Work is continuing on the design of the Focus Electrode pulser. The high voltage isolation power supply has been constructed, tested and layouts for the pulser circuit boards have been completed. Work began on the pulse width and PRF control circuit and the design of the metering and protection circuit was also completed.

Plans for Next Month

The pulser breadboard will be completed and tested and the pulse width and PRF control circuit will be completed. Construction of the metering and protection circuit will begin.

Financial Status

Project expenditures for the month of June were $8,374 bringing total expenditures to $25,361.

Respectfully submitted,

[redacted]

D. S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

23 September 1981

FGAN
Konigstrasse 2
D-5307 Wachtberg - Werthhoven
West Germany

Attention : Mr. Peter Baars

Subject : Monthly Contract Technical Status Report on Project A-2889, Covering Period 1 August to 31 August 1981

Gentlemen:

The results and current status of work on subject project during the referenced performance period are summarized below.

Pulser Testing

The breadboard of the pulser was completed, tested, and excellent results were obtained. The pulse amplitude is continuously variable to a maximum pulse voltage of 3.5 kV and the rise time (10% to 90%) is 20 ns, while the 90% to 10% fall time is 10 ns. Previous measurements made on the Focus Electrode Controlled - Extended Interaction Oscillator indicate that the RF rise and fall time will be on the order of one half the voltage rise and fall time. The minimum RF pulse width should be 20 ns. The droop and ripple across the top of the voltage pulse cannot be accurately determined due to the limits of the available probes, but it appears to be less than 50 volts.

Modulator Construction

The pulse width and PRF control circuit has been completed and tested. A low capacitance isolated driver circuit for the pulser has been designed and breadboarded, and work on a layout for the PC board for the metering and protection circuit has begun.

Plans for Next Month

The isolated driver circuit will be completed and tested with the pulser. Construction of the final model of the pulser unit will begin including the design of the high voltage interface and completion of the metering and protection circuitry. The design of the container for the modulator will be completed for approval by Dr. Baars on his visit on 24 October.

Financial Status

Project expenditures for the month of July were $5,323 bringing total expenditures to $30,685. Expenditures for Materials and Supplies are itemized below. Encumberances for parts on order have not been included.

May	
Misc. Electronics	$ 91
June	
Qty 3 8940 Planar Triode	1,189
Qty 1 Y690 Planar Triode	397
Misc. Electronics	248
	$ 1,8340
July	
Misc. Electronics	$ 228

Respectfully submitted,

[redacted]

D. S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

14 October 1981

FGAN
Konigstrasse 2
D-5307 Wachtberg Werthhoven
West Germany

Attention : Dr. Peter Baars

Subject : Monthly Contract Technical Status Report on Project A-2889, Covering Period 1 September to 31 September 1981

Gentlemen:

The results and current status of work on subject project during the referenced performance period are summarized below.

Pulser Testing

Testing continued on the breadboard pulser during the month which uncovered problems in the original design. Ringing across the top of the pulser could not be eliminated to the ±10 V level required for proper performance of the EIA tube. The design was thus modified to a direct drive, rather than a transformer coupled circuit, and a preliminary test of this circuit indicates that the waveform design goal will be achieved.

Modulator Construction

Delays in the delivery of the high voltage power supplies have delayed construction of the modulator package. In addition, the high voltage interface design has been modified in order to float the pulser at high voltage to eliminate the coupling capacitor which was causing problems during the initial application of high voltage. This modification is not expected to affect the overall modulator package size.

Plans for Next Month

The control unit and protection circuitry will be completed and tested during the next month, and construction of the final model of the redesigned pulse generator will begin. Work will begin on the modulator package in anticipation of a November 30

completion of the entire unit, however, the entire transmitter can not be completed until the EIA is delivered for testing.

Financial Statement

Project expenditures for the month of August were $4,627.69 bringing total expenditures to $35,312.77 not including $2,081.06 of components ordered but not received. Materials and Supplies purchased during the month are itemized below.

H.V. Capacitors	$ 177.29
Misc. Electronic Components (under $100 per order)	358.25
TOTAL	$ 535.84

Respectfully submitted,

[redacted]

David. S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

A-2889

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

16 November 1981

FGAN
Konigstrasse 2
D-5307 Wachtberg Werthoven
West Germany

Attention : Dr. Pete Baars

Subject : Monthly Contract Technical Status Report on Project A-2889, Covering Period 1 October 1981 to 31 October 1981

Gentlemen:

The results and current status of work on subject project during the referenced performance period are summarized below.

Pulser Construction

The modified pulser design required the construction of a dry insulation vacuum impregnation facility which has been completed. This will allow encapulation of the heater isolation transformers and the pulser drive transformer for 25 kV isolation.

The final design and layout of the pulser has been completed and construction of the unit has begun.

Modulator Construction

The modulator box has been machined and is awaiting completion and delivery of all components for final assembly. The overall dimensions of the modulator including the EIA are 45.7 cm x 23.5 cm x 18.4 cm.

Control Unit

The control unit with the fault detection, pulse generator and power control circuits has been completed. The 19 inch rack mounted unit is 21.6 cm high and 32 cm deep. The 15 meter interconnecting cable has also been completed.

Plans for Next Month

Complete the modulator unit and test with a gridded EIO received from Varian for testing. This test will use a laboratory high voltage supply. The compact high voltage supply should be received by November 31, 1981.

Financial Status

Project Expenditures for the month of September were $6,876 bringing total expenditures to $42,189 not including $2,721 of components on order but not received. Materials and Supplies purchased during the month of September consisted of 15 miscellaneous orders totaling $623.48.

Sincerely,

[redacted]

David S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

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

6 January 1982

FGAN
Konigstrasse 2
D5307 Wachtberg Werthhoven
West Germany

Attention : Dr. Peter Baars

Subject : Monthly Contract Status Report on Project A-2889 Covering Period 1 November to 30 November 1981

Gentlemen:

The results and current status of work on the subject project during the referenced period are summarized below.

Modulator Construction and Plans for December

The pulser circuit has been completed and will be tested at ground potential the first two weeks in December. It will then be ready for high voltage encapsulation of the heater, bias and pulser drive transformers. After encapsulation the unit will then be tested at -22 kV. Currently, the high voltage DC power supply has not been received from the vendor so testing of the complete system is not feasible at this time.

Plans For January

The modulator components will be mounted in the modulator box during the first two weeks of January. At that time the construction will be complete, and the unit will be ready for testing with an EIO that has been received from Varian.

Financial Status

Project Expenditures for the month of November were $4,572 bringing total expenditures to $46,761 not including $1,775 for parts on order, but not received. Materials and supplies purchased are listed below.

3 kV Power Supply	$ 369.72
28 V Power Supply	466.87
HV Resistors	130.65
Cable	117.80
Misc Purchases	455.13
	$ 1,540.17

Respectfully submitted,

[redacted]

David S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

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

19 January 1982

FG AN
Konigstrasse 2
D-5307 Wachtberg Werthoven
West Germany

Attention: Dr. Peter Baars

Subject: Monthly Contract Technical Status Report on Project A-2889 Covering the Period 1 December 1981 to 31 December 1981

Gentlemen:

The results and current status of work on subject project during the referenced performance period are summarized below.

Pulser Construction

Problems in the pulser drive circuits have prevented encapsulation of the pulser. The pulser is now operating at a pulse voltage of 3 kV but without the -21 kV cathode voltage.

Modulator Construction

All subunits for the modulator have been built and tested. The -21 kV power supply was scheduled for shipment on 21 December 1981. After receipt of the power supply, the subunits will be tested on a dummy load and then mounted into the modulator box before final testing with the EIA.

Plans for Next Month

The pulser will be encapsulated during the first week of January and tested at high voltage during the second

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Konigstrasse 2
D-5307 Wachtberg Werthoven
West Germany

week. The modulator will be assembled during the last two weeks of January.

Plans for February

After the modulator is assembled and tested with the control unit, the EIA can be tested.

Financial Statement

Project expenditures for the month of November were $4,498, bringing total expenditures to $51,259 not including $2,168 of encumbered funds. This leaves a balance of $1,542 which will be totally expended during December.

Expenditures for materials and supplies are listed below.

High voltage resistors	$131
Fans	104
Miscellaneous purchases	133
Total	$368

Respectfully submitted,

[redacted]

D. S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

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

6 January 1982

Mr. John Carter
DG:ET-GB
Beam Plasma and Display Division
ET&D Lab ERADCOM
Ft. Monmouth, New Jersey 07703

Subject : Contract Funds Status Report for Contract DAAK20-81-K-1001 on Project A-2889 Covering the Period 1 August 1981 to 30 November 1981

Gentlemen:

The financial status of the subject contract for the period from 1 August to 30 November 1981 is summarized below. The delivery of the unit will be delayed 4 months since a FEC-EIA has not been made available as explained in our request for extension of the delivery date.

The estimated cost of completion of the modulator is given. The additional personal services, retirement and overhead funds will be rebudgeted from the excess materials and supply funds. Therefore the modulator/power supply should be completed within budget.

As we discussed during your visit in December there are two options available for completion of the unit: (1) the regenerative drive option and (2) the direct FET drive option for the two planar triodes in the push-pull circuit. The direct option has better long pulse performance while the second has better short pulse performance. Since your visit we demonstrated a 1.2 ns rise time from a single FET operating at 400 volts. These FETs would then be paralled to drive the planar tirodes in a circuit designed to preserve this rise time. The added cost to complete the modulator in the direct FET drive option (2) would be offset by the reduced cost of the power supply and protection circuits required in the regenerative drive, option (1). Since you indicated that the short pulse performance is most important we will proceed with the direct FET drive, option (2) in anticipation of your approval of this approach.

Financial Status

	Budget	Expended or Encumbered	Balance
Personal Services	35,605	27,407	8,198
Retirement	3,763	2,967	796
Materials and Supplies	33,000	5,172	27,828
Travel	700		700
Overhead	26,348	20,471	5,877
Total	99,416	56,107	43,399

Estimated Cost to Complete

Personal Services	21,617
Retirement	2,280
Materials and Supplies	2,500
Travel	700
Overhead	16,213
Total	43,310

Respectfully submitted,

[redacted]

D. S. Ladd
Project Director

Approved:

[redacted]

N. C. Currie, Chief
Radar Experimental Division

GIT/EES Project No. A-2889

94 GHz EIA MODULATOR INSTRUCTION MANUAL

By

G. M. Conrad, D. S. Ladd, and J. C. Butterworth

Prepared for

FGAN

By

Georgia Institute of Technology
Engineering Experiment Station
Atlanta, Georgia 30332

April 1982

TABLE OF CONTENTS

SECTION 1
GENERAL INFORMATION

WARNING

THIS EQUIPMENT EMPLOYS VOLTAGES THAT ARE
EXTREMELY DANGEROUS AND MAY BE FATAL.

EXTREME CAUTION MUST BE EXERCISED

1.1 SCOPE OF MANUAL

This manual describes the installation and operation of a modulator for a 94 GHz focus Electrode Controlled Extended Interaction Amplifier VKB 2449 (EIA). This modulator employs a variable pulse width, saturated push-pull driver circuit which delivers the required drive pulse to the EIA. The radio frequency (RF) pulse produced by this driver circuit results in a minimum of frequency modulation with fast rise and fall times. Section 3 describes the circuits in the modulator. Pulse stability is discussed in Section 4. Section 5 contains operating instructions and procedures to ensure proper operation. Appendix A includes schematic diagrams of the modulator and high voltage power supply control circuit modifications.

1.2 TRANSMITTER DESCRIPTION

The transmitter consists of the control console and the modulator box. Connecting cables allow power and pulse width control signals to be passed from the control console to the modulator box. A rack mountable control console provides the operating controls and enables the selection of pulse width, pulse repetition frequency and high voltage level. The modulator box contains two high voltage supplies, the driver circuit, and the EIA. The modulator box is to be mounted in a suitable location within the limits of the control cable and accessible to waveguide connections for the EIA.Table 1 lists the characteristics of the 94 GHz EIA transmitter.

TABLE 1. TRANSMITTER CHARACTERISTICS

PARAMETER	SPECIFICATION
Output Frequency	94 - 95 GHz
Output Power	1 kW
RF Pulse Width	35 ns - 1μs
Maximum PRF	20 kHz
RF Pulse Rise and Fall Times	10 ns
Maximum Duty Factor	.004
Input Power	220 VAC 47 - 63 Hz

SECTION 2
INSTALLATION AND HOOK-UP

2.1 INSTALLATION

The control console is designed to be mounted in a standard 19-inch rack. The modulator box should be installed in the desired location within the limits of the 50-foot connecting cable. The cable is terminated with 24-pin connectors at each end.

2.2 HOOK-UP

Plug the cable connector in at each cable end between the modulator and control console. With the POWER switch in the OFF position, plug the ac line cord into a 220 Vac, 47-63 Hz, power outlet. The modulator may be powered with 110 Vac by changing the jumper as indicated on the 28 Volt, 4 amp power supply in the control console.

Locate the two BNC connectors, labelled CURRENT MONITOR and INPUT PULSE, on the modulator box. The CURRENT MONITOR connector will allow monitoring of the EIA peak collector current. The output should be terminated in a 50 Ω cable and load. The maximum observed voltage should be 1.0 V which represents 650 mA collector current for the EIA (refer to Varian TEST DATA FOR EXTENDED INTERACTION AMPLIFIER for the device being used). The calibration factor for the CURRENT MONITOR is 650 mA/V when terminated with a 50 Ω load. The INPUT PULSE connector is the input for the pulse drive circuit.

Locate the two BNC connectors labelled PRF TRIGGER and PULSE OUT, on the control console. The PRF TRIGGER connector is the input for a TTL compatible, positive-going pulse of the required PRF (less than 20 kHz). The PULSE OUT connector is for external synchronization. To insure proper operation, the INPUT PULSE should be driven only from the MODULATOR PULSE CONNECTOR at the rear of the control console.

Locate the output flange of the EIA. Remove the plastic cover and connect the required waveguide to ensure proper power dissipation and a VSWR of less than 2.0. The EIA must be driven by a suitable RF source of the proper frequency and power level connected to the input waveguide flange.

SECTION 3
PRINCIPLES OF OPERATION

3.1 GENERAL DESCRIPTION

The purpose of the modulator is to provide a pulse for the EIA ranging from approximately 35 ns to 1 μs in duration. An amplified RF pulse with a minimum of phase modulation is produced by supplying a flat top voltage pulse to the grid of the EIA. The flatness of this pulse is entirely dependent on the saturation characteristics of the driver tube.

3.2 CONTROL CIRCUITRY

The internal operation of the control circuitry is governed by two relays and a set of contacts inside the BEAM CURRENT meter. The meter and relays are de-energized when the modulator is in the OFF mode. The relay and meter contacts are shown in the OFF mode in the Power Control Circuit schematic, Appendix A.

When the ON/OFF switch is set to ON the +5 Vdc and +28 Vdc power supplies are energized. The 28 Vdc energizes the time delay relay (RL1) which initiates the two minute time delay. When the two minute time delay is completed, relay RL1 is energized and the STANDBY light turns on. When the RADIATE switch is pressed, relay RL2 is energized, turning the radiate light on and providing 28 Vdc to the high voltage power supply.

The BEAM CURRENT METER must have power applied from the 110 Vac input tap of the line transformer in the 28 Vdc power supply to switch the internal contacts associated with the maximum and minimum settings on the front of the meter. Contacts 11-12 and 14-15 are normally closed when no over-maximum condition exists. Contacts 21-22 and 24-25 are normally closed when no under-minimum condition is present.

3.3 DRIVER STAGE

Referring to the drawings in Appendix A, the pulsed TTL output of the control console is coupled via a 50 Ω coaxial cable to the PRE-DRIVER stages located on two printed circuit boards in the modulator. The final output of the PRE-DRIVER stage is generated by two VMOS power FETS (IVN 6000). The

PRE-DRIVER is transformer-coupled to the hard-tube driver, consisting of tubes V_1 and V_2. The PRE-DRIVER pulse turns-on tube V_1, which places a positive 3 kV (with respect to bias) pulse on the Focus Electrode (grid) of the EIA. This produces a grid-cathode voltage for the EIA of approximately zero. The end of the pulse is signaled by the PRE-DRIVER which turns off tube V_1 and turns on tube V_2 in a push-pull fashion, thereby removing the 3 kV pulse on the grid of the EIA and returning it to its cut-off bias condition.

3.4 FOCUS CONTROL

The Modulator drawing in Appendix A shows that the Zener string between the plate of V_1 and the cathode of the EIA provides an offset voltage to compensate for the plate-cathode voltage drop and to adjust the focus voltage. Rotation of the 10 position switch (located under the EIA mounting plate) shorts a section of the string, providing voltage steps in 4 to 10 volt increments.

3.5 COLLECTOR CURRENT MONITOR

From the Collector Pulse Isolation circuit and Modulator circuit drawings in Appendix A, note that the printed circuit board for the collector current monitor is located behind the EIA. The peak and average collector current monitor functions are on this circuit board. A 2:16 turns ratio transformer supplies the 50 Ω CURRENT MONITOR output. This output requires a 50 Ω termination for correct calibration as discussed in Section 2.2. The average dc collector current is monitored through the 170 K resistor and the BEAM CURRENT METER. The Collector Current (I_{cs}) is compared against the total high voltage supply current to set a safe operating range for the body current.

3.6 HEATER SUPPLY

The Heater Power Supply drawing shows that both Y690 tubes and the EIA have approximately 14 volts peak-to-peak applied by a switching oscillator circuit. A toroidal transformer encapsulated in insulation material makes up a low capacitance coupler between the oscillator and all three tubes.

The oscillator frequency is approximately 20 kHz. The heater supply printed circuit board is located in the modulator and is supplied by 28 Vdc when the ON/OFF switch is set to ON. The LM 317 regulator allows the output voltage to the filaments to be set at 6.3 V RMS.

3.7 HIGH VOLTAGE POWER SUPPLY MODIFICATIONS

For external control of the high voltage, the variable resistor RP1 was removed from the -22 kV unit, and a modified resistor network was placed in the CONTROL CONSOLE.

During turn-on, the -22 kV power supply was found to overshoot the maximum allowable voltage by approximately 20%. To solve this problem, a 10 μf capacitor was added to the reference voltage circuit to create a three second start-up time with no overshoot. In addition, to ensure this capacitor was fully discharged when going to STANDBY, a diode (1N914) was added to discharge the 10 μf capacitor.

SECTION 4
STABILITY

4.1 PULSE TO PULSE

The principal source of pulse instability is the advanced high voltage -22 kV power supply, which has a slow (1 Hz) variation of as much as 20 V peak-to-peak. The ripple on the EIA cathode at the power supply switching frequency is approximately 5 V peak-to-peak.

4.2 INTRA PULSE

Both the EIA grid-cathode voltage and the cathode-body voltage affect the RF power and phase during the top of the pulse. V_1 is driven to saturation, effectively clamping the grid to the cathode. The combined ripple and drop of the grid-cathode voltage is less than 10 volts.

The two .0025 f 30KV capacitors, one from cathode-to-body (C_{RB}) and the other from cathode-to-collector (C_{KC}), allow separation of the body and collector pulse currents. The droop of V_K is determined only by the body intercept current and can be calculated by

$$\Delta V_K \simeq \frac{I_B \tau}{2500} \text{ Volts}$$

where:

I_B = Body current (mA) and τ = Pulse width (ns)

The droop was confirmed by measuring the RF frequency variation of an extended interaction oscillator (EIO) supplied by Varian. When phase pushing factors are established for an EIA, phase characteristics for the entire Modulator Amplifier can be determined.

SECTION 5
OPERATING INSTRUCTIONS

5.1 OPERATING FEATURES

5.1.1 BEAM CURRENT METER

The maximum and minimum pointers for the BEAM CURRENT METER should be set for a small range of average beam current. If the duty factor of the peak beam current exceeds its nominal value, the BEAM CURRENT METER will indicate that the average collector current is too high. The control circuit will automatically switch to standby, turning off the high voltage power supplies, and the OVER-CURRENT light will illuminate. Appropriate steps such as reducing the PRF, pulse width, or peak beam current should be taken to reduce the average beam current. The STANDBY/RESET switch must be pressed to cancel the OVER-CURRENT condition.

If the minimum-pointer for the BEAM CURRENT METER has been set to some value other than zero, the modulator will automatically switch to STANDBY when the average current decreases below this value and the under-current light will illuminate. The overload circuit is not activated in this case. To switch to radiate once a lower limit on the beam current meter has been set, press the RADIATE switch once again.

In order to insure that the EIA body current remains within proper limits, a collector pulse isolation circuit is incorporated. In the event of an arc or excessive body current being drawn from the -22 kV power supply, the collector pulse isolator circuit deenergizes a fault relay in the control console which returns the modulator to standby. The indication will be the extinguishing of the radiate light.

5.1.2 AUTOMATIC WARM-UP DELAY

A delay of two minutes has been built into the CONTROL CONSOLE to assure that the EIA and hard tubes have the proper warm-up time before high voltage is applied. A time delay relay on the control circuit board sets the minimum required time.

5.2 TURN-ON PROCEDURE

a. Insure that all connections as described in Section 2.2 are securely in place.

b. Set the Beam Voltage Control on the control console to the minimum (counter clockwise).

c. Turn POWER ON/OFF Switch to ON position. The orange ON light should be on. The green STANDBY/RESET light will illuminate AFTER A TWO MINUTE DELAY.

d. Set the minimum set point to 0μA on the BEAM CURRENT METER, and the maximum set point to 80μA on the BEAM CURRENT METER.

e. Set the PULSE WIDTH to the desired position.

f. Press the RADIATE switch. The red RADIATE light should illuminate. If the radiate light fails to illuminate, check the interlocks.

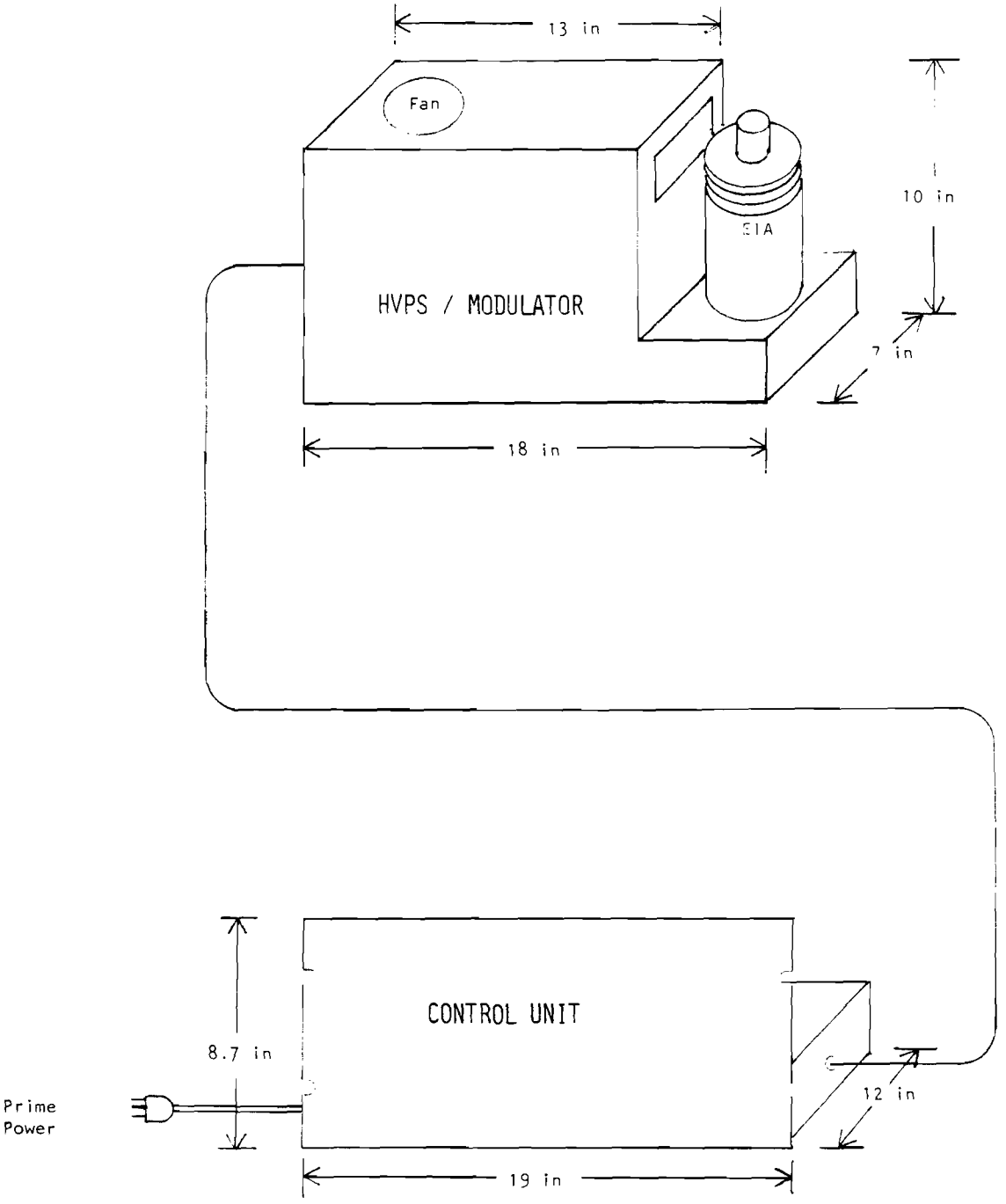
g. While monitoring the RF, set the Beam Voltage adjust potentiometer on the Control Console until the RF is maximized. If there is no RF at this point, refer to Principles of Operation (Section 3).

h. IMPORTANT! Bracket Beam Current per Section 5.1.1.

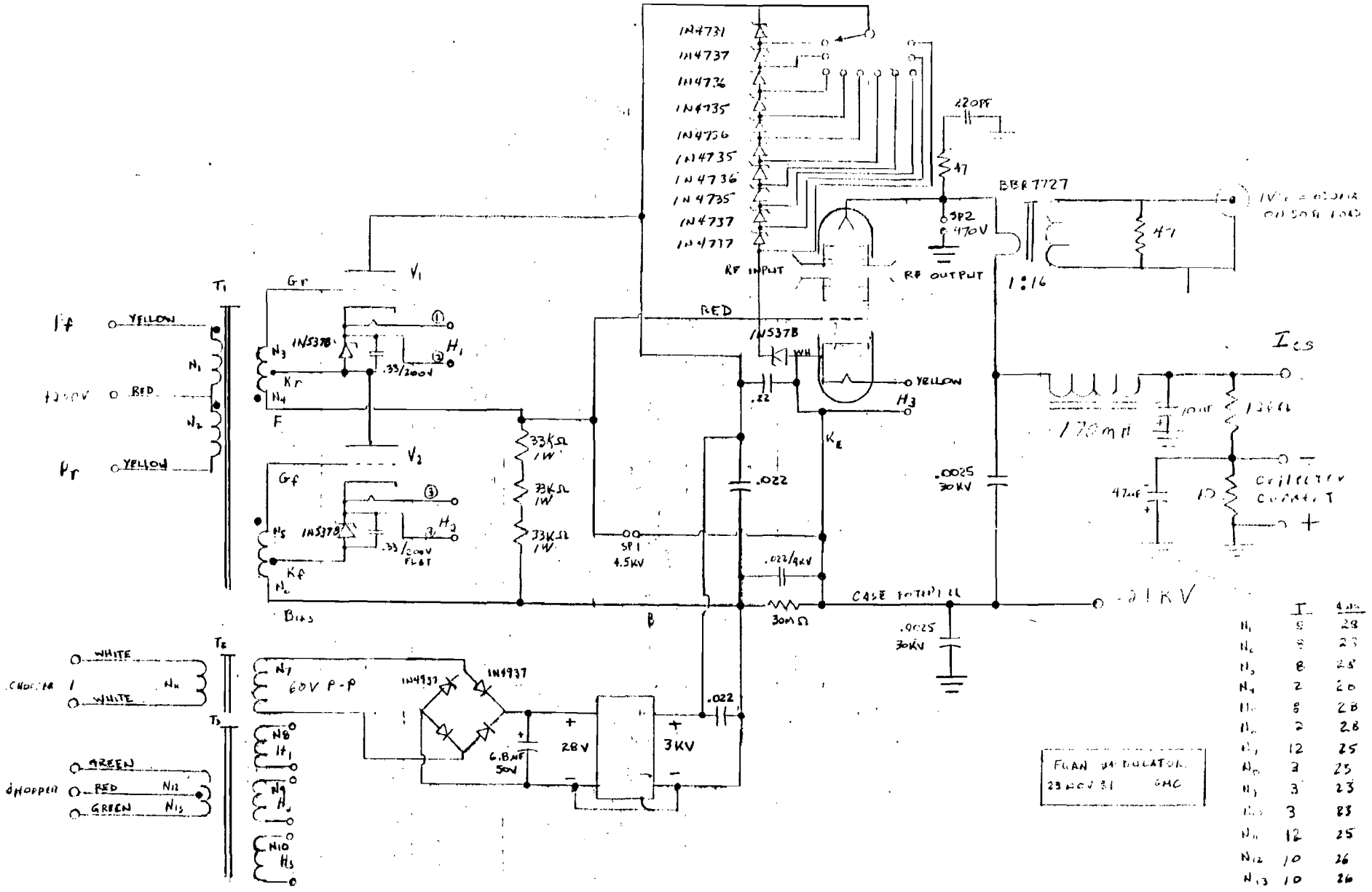
i. Adjust Focus Control for maximum RF Power (Section 3.4).

APPENDIX A

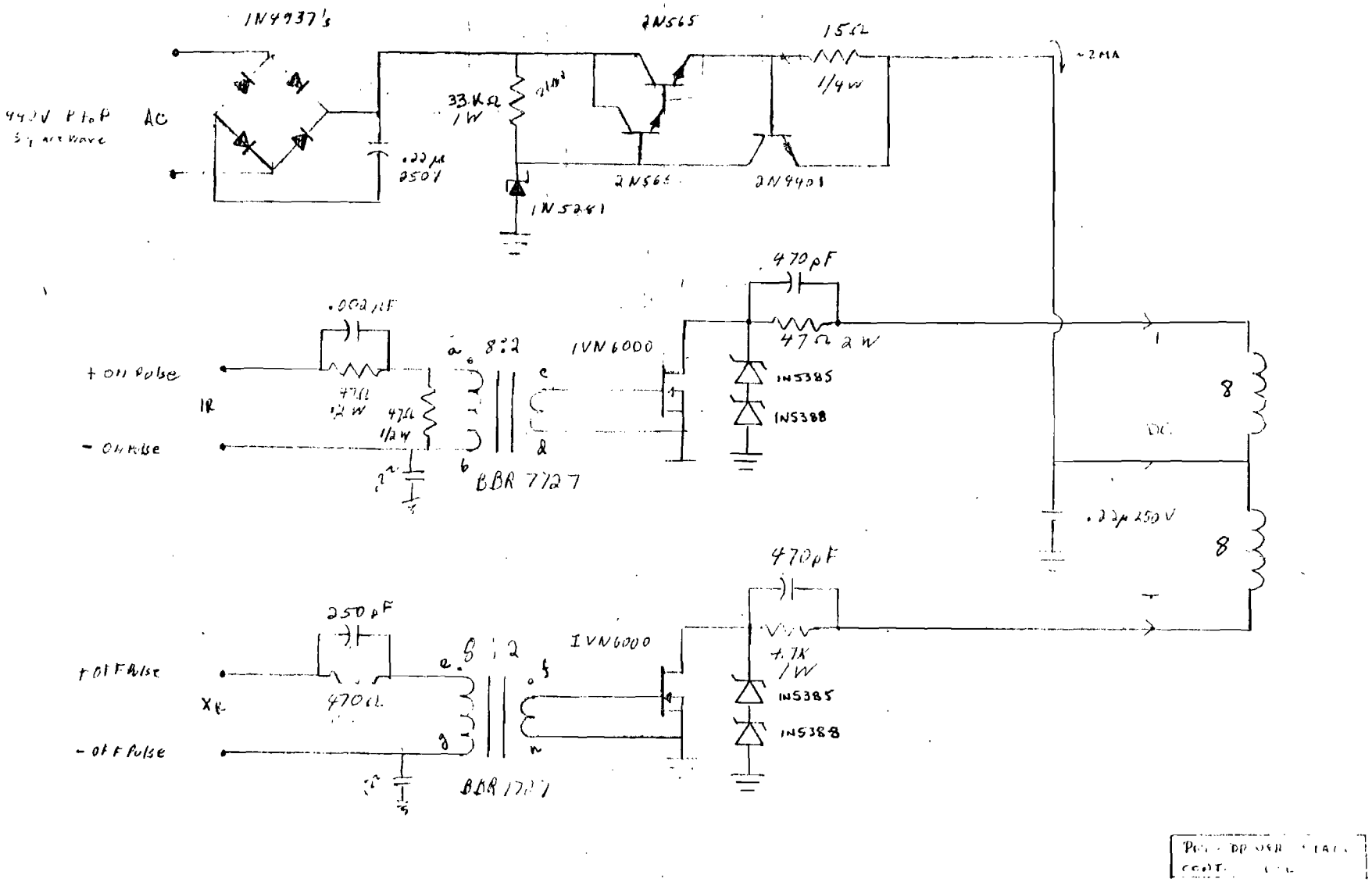
MODULATOR SCHEMATICS



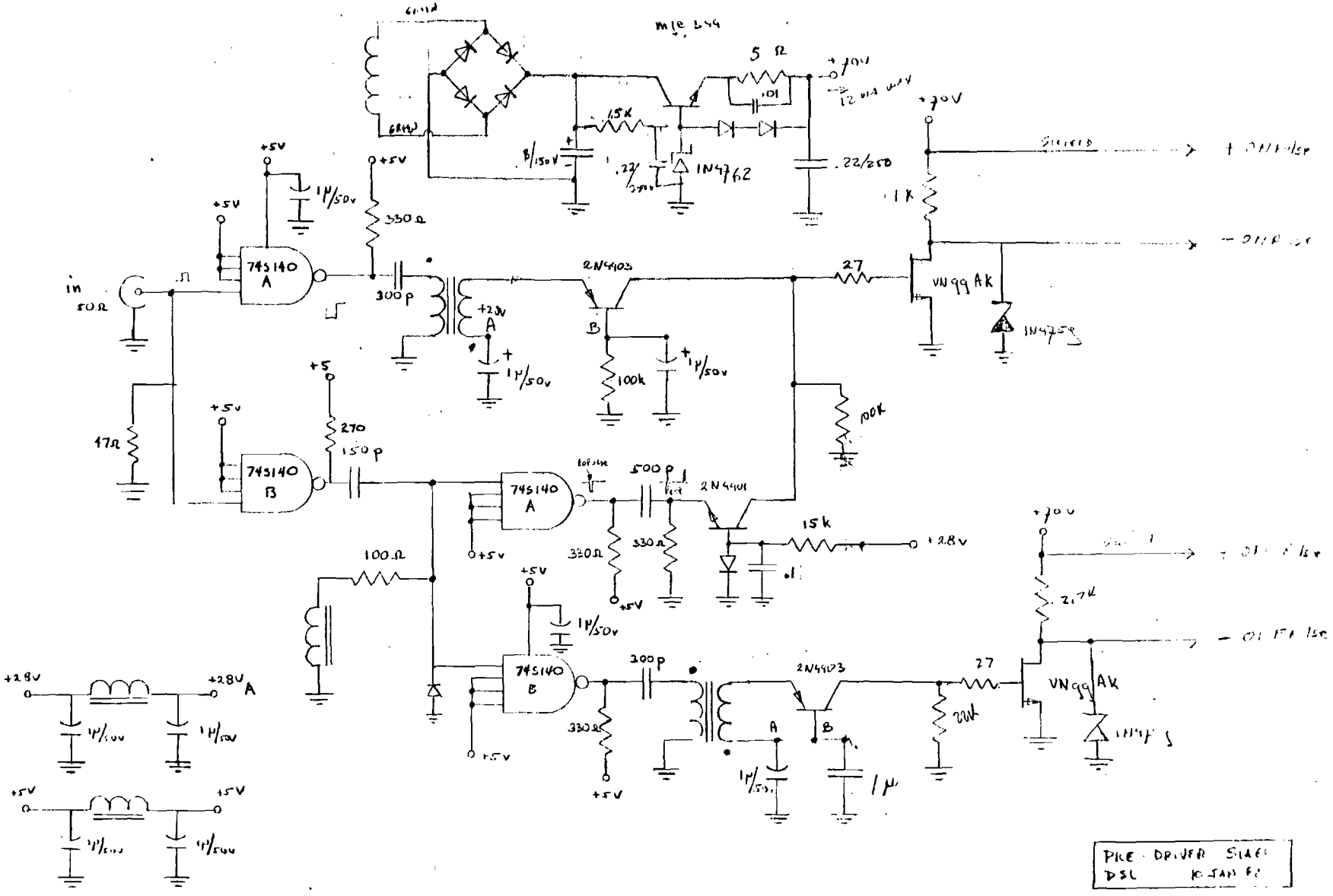
A-1. Modulator and control unit.



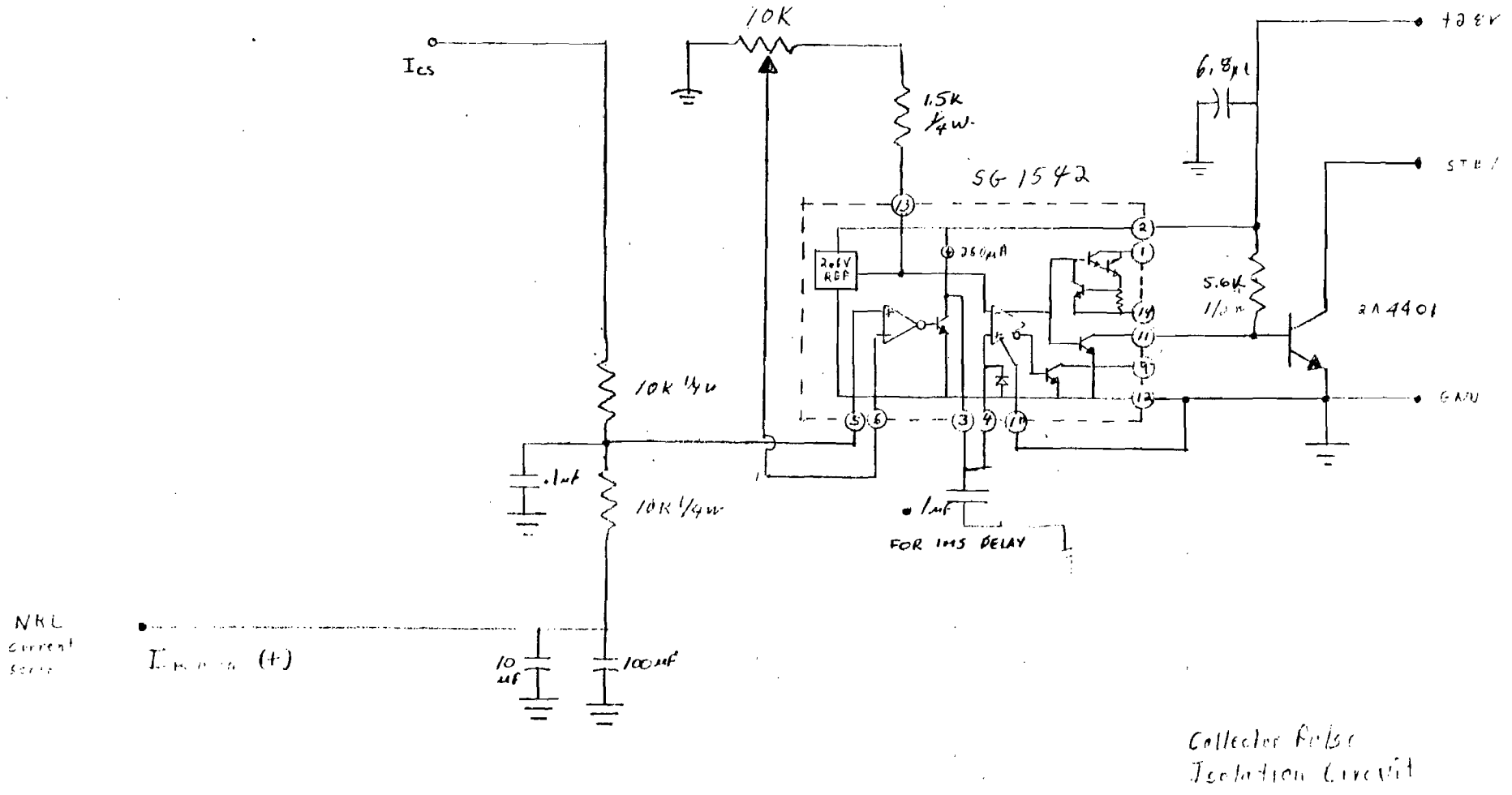
A-2. Modulator and H.V. interface circuit.



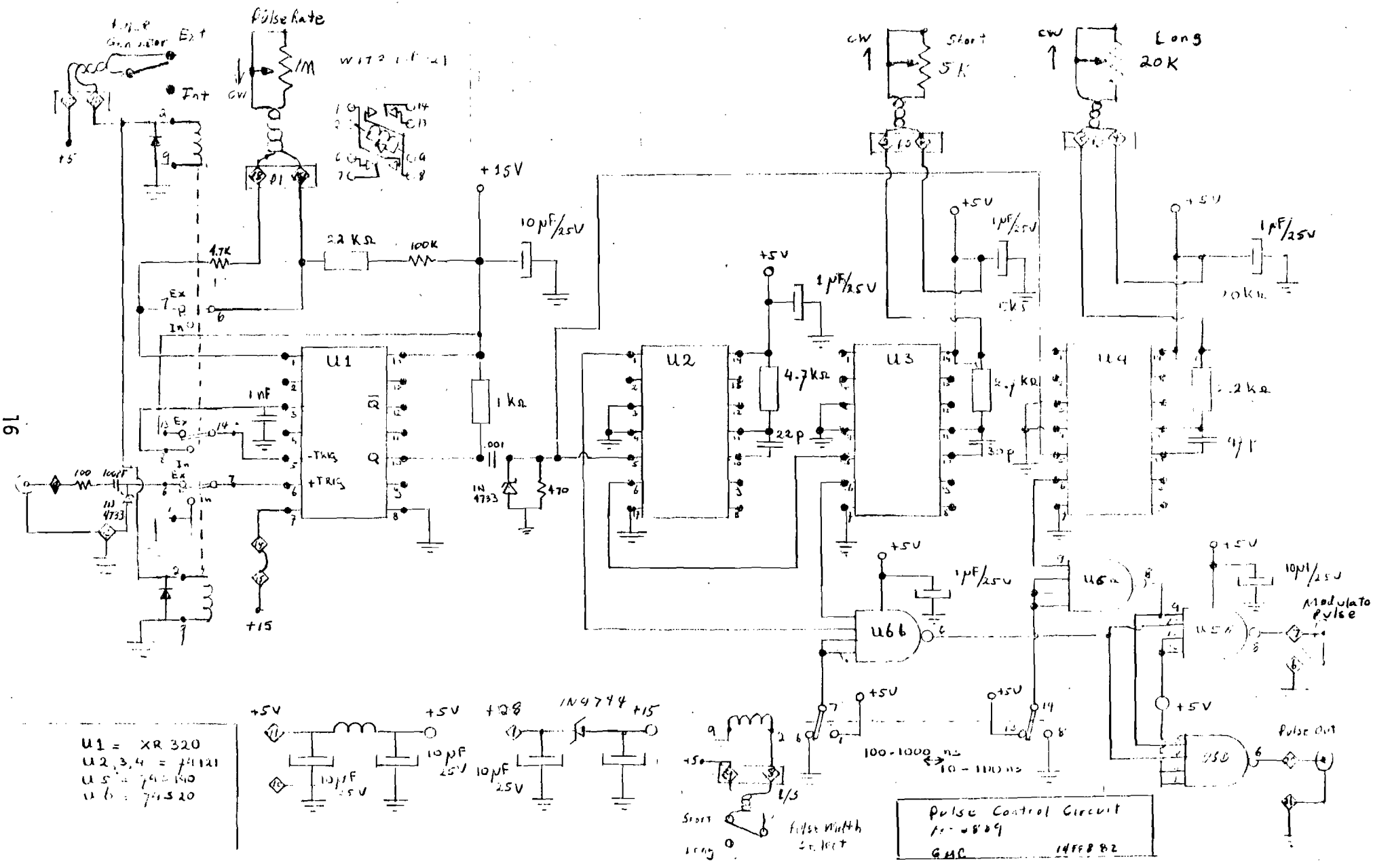
A-3. Modulator driver circuit.



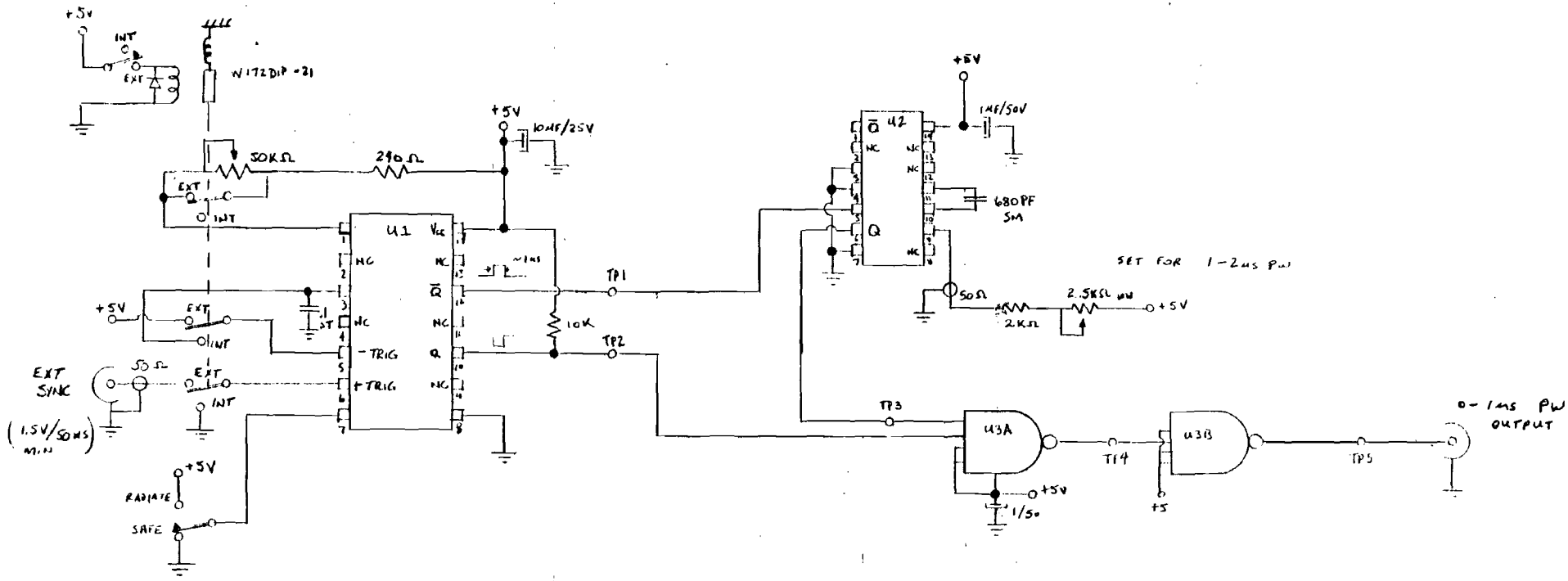
A-4. Pre-driver and +70 V supply.



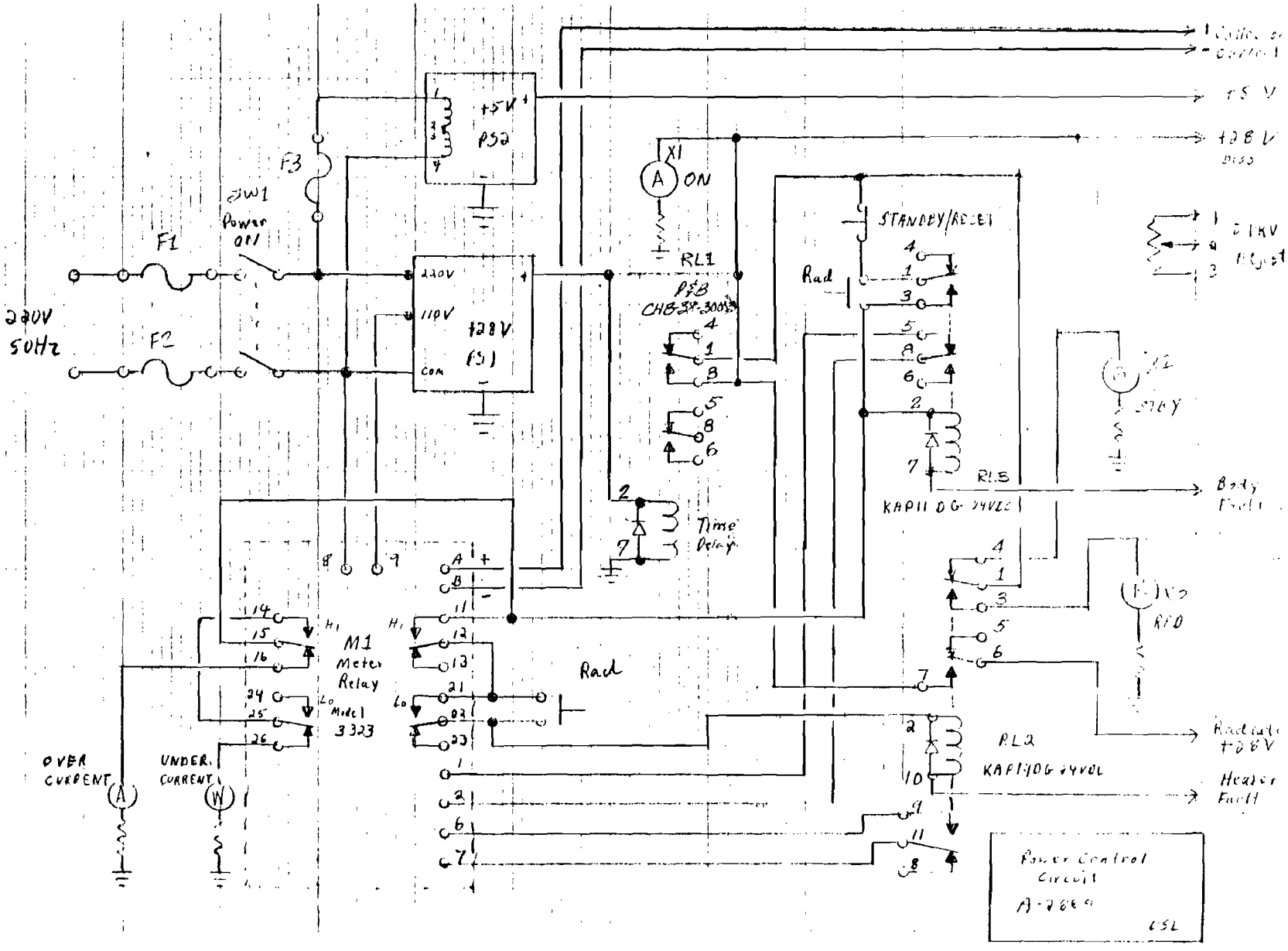
A-5. Collector pulse isolation circuit.



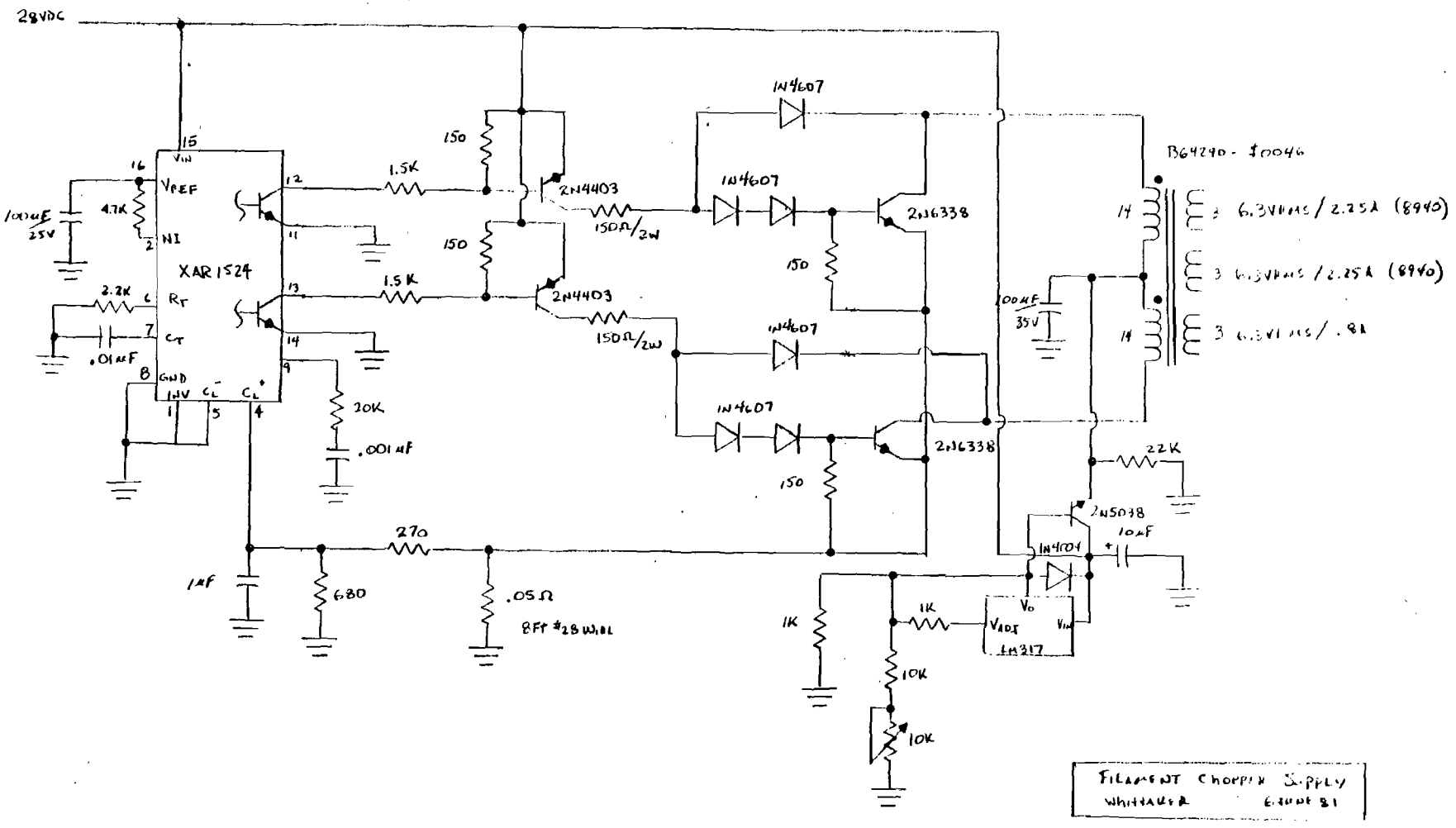
A-6. Pulse control circuit.



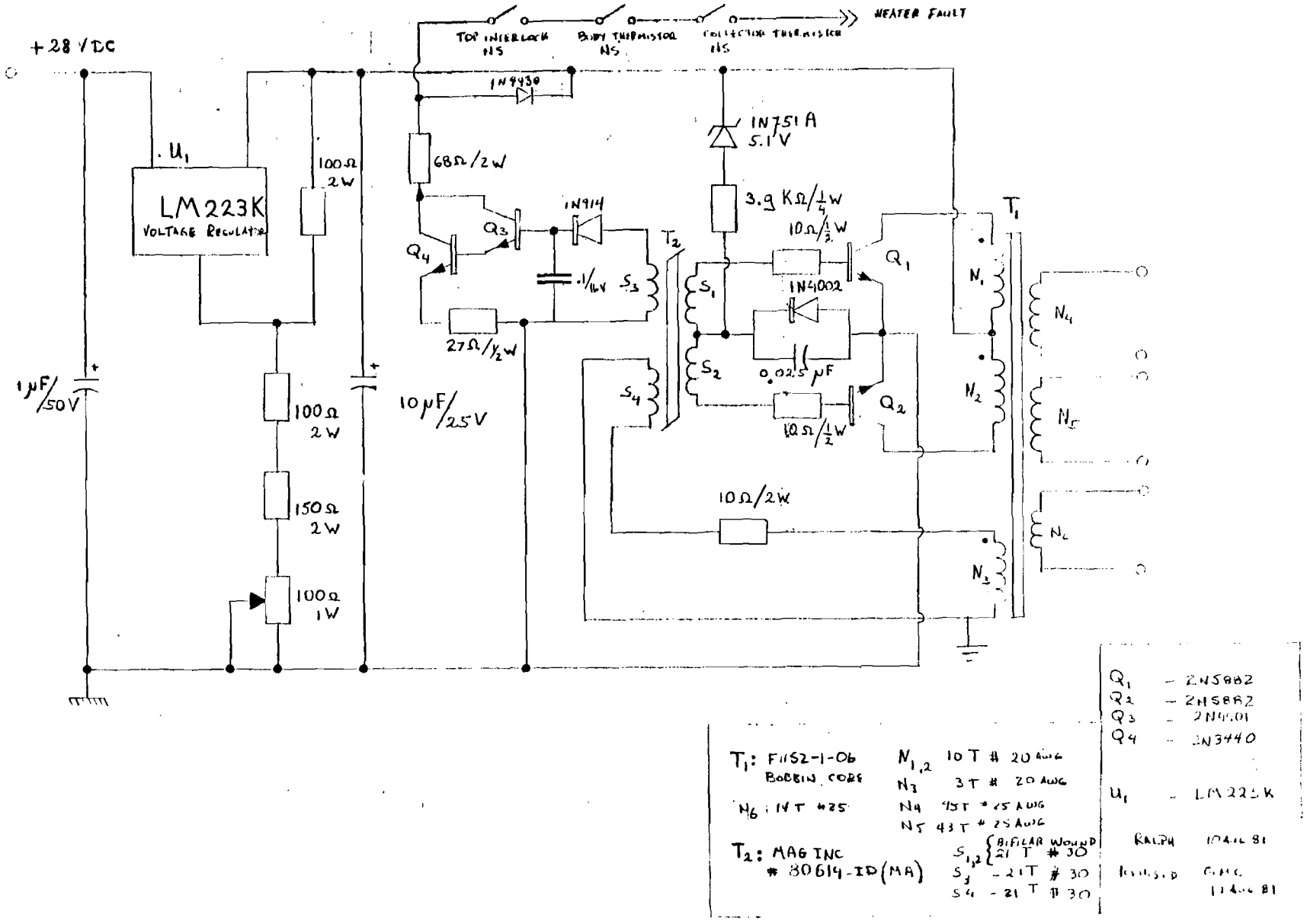
A-7. PRF limited signal generator.



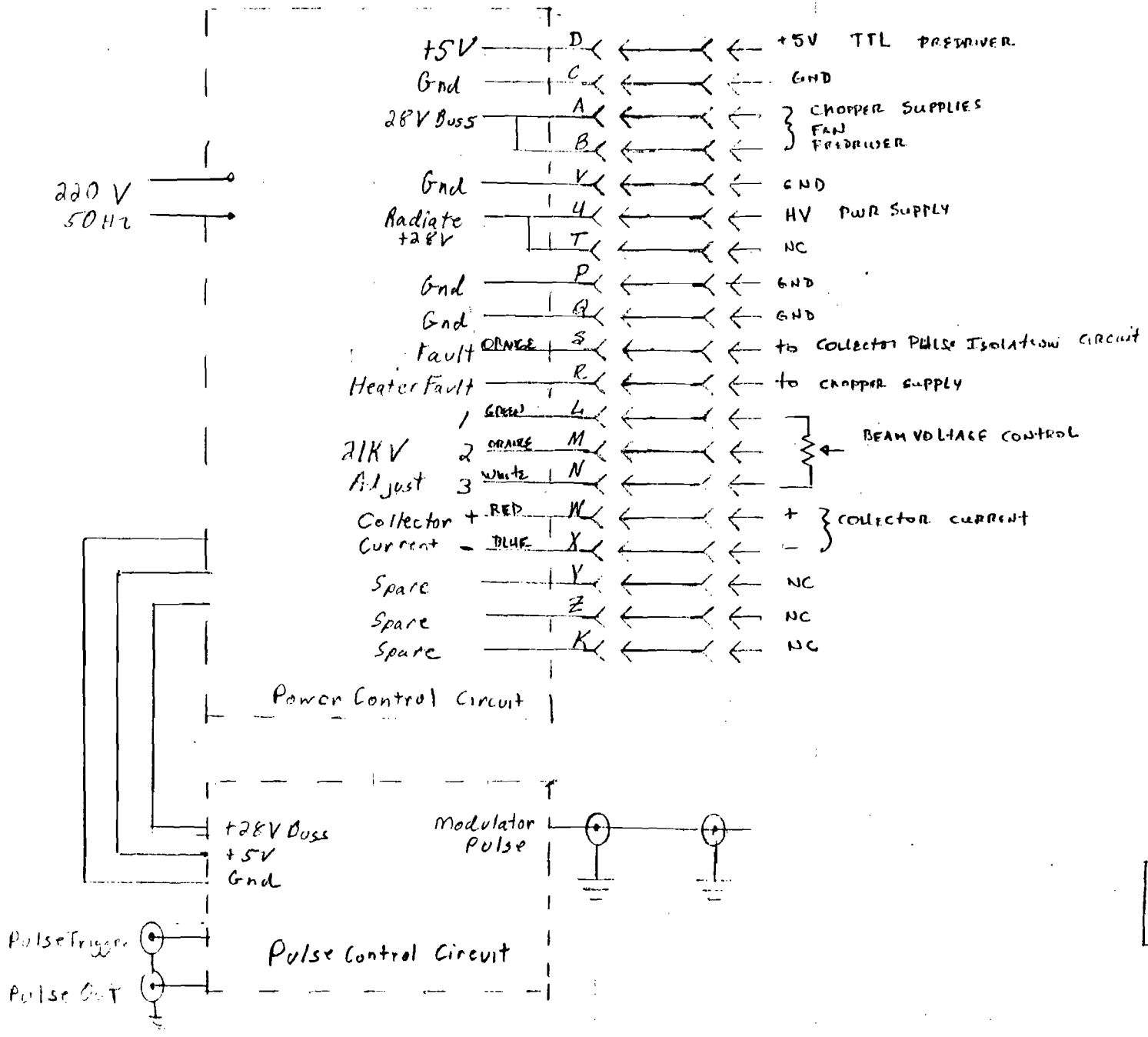
A-8. Power control circuit.



A-9. Filament chopper supply.



A-10. Driver power supply.



BASIC CABLING DIAGRAM
Gmc 1 FEB 82

A-11. Cabling diagram.