OPERATORS' MANUAL

Model 4601 B

Serial No. ________

ELECTRONIC
DEVELOPMENT
CORPORATION
BOSTON, MASS
MADE IN U S A

WARRANTY

The ELECTRONIC DEVELOPMENT CORPORATION (EDC) warrants to the original purchaser each instrument manufactured by them to be free from defects in material and workmanship. This warranty is limited to servicing, repairing and/or replacing any instrument or part thereof returned to the EDC factory for that purpose in accordance with the instructions set forth below; and furthermore to repair or replace all materials, except tubes, fuses, transistors and other semi-conductor devices which shall within one year of shipment to the original purchaser be returned to the EDC factory and upon examination be deemed defective.

EDC instruments may not be returned to the factory under the terms of this warranty without the prior authorization of the EDC Service Department. All instruments returned to EDC for service hereunder should be carefully packed and shipped. All transportation charges shall be paid by the purchaser.

EDC reserves the right to discontinue instruments without notice and to make changes to any instrument at any time without incurring any obligation to so modify instruments previously sold.

This warranty is expressly in lieu of all other obligations or liabilities on the part of EDC. No other person or persons is authorized to assume in the behalf of EDC any liability in the connection with the sale of its instruments.

CAUTION: The instrument you have purchased is a precision instrument manufactured under exacting standards. Any attempts to repair, modify or otherwise tamper with the instrument by anyone other than an EDC employee or authorized representative may result in this warranty becoming void.

FACTORY SERVICE REQUEST
and
AUTHORIZATION

WARRANTY SERVICE

Instruments may be returned only on prior authorization. Please obtain a RETURN AUTHORIZATION NUMBER either directly from the factory or from an authorized E.D.C. Representative. (See General Instructions below.)

CHARGEABLE REPAIRS

If requested, an estimate of charges will be submitted prior to repairs. We suggest that you request a RETURN AUTHORIZATION NUMBER to facilitate handling.

GENERAL INFORMATION

A) Please provide the following information in order to expedite the repair:

1) Indicate MODEL
2) Serial Number
3) Complete description of the trouble: Symptoms, measurements taken, equipment used, lash-up procedures, attempted repairs, suspected location of failure and any other pertinent information.

B) Freight Charges must be prepaid.

C) The RETURN AUTHORIZATION NUMBER should be noted on your documentation.

MODEL 4601
USERS MANUAL

TABLE OF CONTENTS

SECTION 1
DESCRIPTION OF INSTRUMENT
MODEL 4601

1.0.0 GENERAL DESCRIPTION

1.0.1 The Precision AC Voltage Standard Source is an inexpensive, highly versatile Reference Voltage Source, designed to meet the needs of computer systems and standards laboratories. The unit has a specified absolute voltage accuracy and is laboratory calibrated against an AC measuring system having traceability accuracy to a precision DC Standard having a calibration of 0.002%. The calibration of this unit is traceable to the NBS through reference standards maintained at Electronic Development Corporation, and calibrated periodically.

1.0.2 Frequency calibration is obtained by calibrating against a standard having a resolution of 0.1 ppm.

1.0.3 The instrument is a highly accurate Voltage Reference which can be used in standard laboratories for calibration meters, scopes, and other AC voltage measuring devices. Its output capacity also enables it to be used for precise voltage control of single phase devices such as motors, relays, stepping switches,etc. Calibration of amplifiers is simplified by eliminating the need of input monitoring devices which makes this instrument practical for production testing of input-output devices.

1.0.4 The unit is short circuit protected. An automatic over-load protection circuit is activated in the event of a short circuit. Removal of the short and resetting the unit restores normal operation.

1.0.5 The unit has provisions for an external oscillator input. This permits the use of a frequency source which has insufficient output to drive the device to be calibrated, but having the desired frequency characteristics to be used in the calibration. External oscillators must be capable of delivering 3 volts rms into a 100 K load at the external input terminals of the AC Voltage Standard.

1.1.0 APPLICATIONS

1.1.1 One of the major applications of the AC Standard Source is in device calibration. Constant monitoring of the Standard is not required. This eliminates several additional pieces of equipment formerly required in AC calibration set ups. The reduction of calibration source errors permits calibration to more precise, and in many cases, more realistic specifications.

1.1.2 Devices requiring moderate power from the calibrating source are now readily calibrated and/or controlled to:

Calibrate AC instruments precisely
Calibrate DVM
Calibrate Thermocouple Voltmeters
Drive AC Transducer
Drive Resolvers
Drive Gyros
Watt Meters (with additional EDC instruments)

1.1.3 The light weight of the unit makes it a desirable laboratory instrument, as it may be hand carried from station to station. The only set up required of the operator, is to select and dial the frequency and voltage outputs desired.

1.2.0 <u>ELECTRICAL SPECIFICATIONS</u>

1.2.1 Voltage Ranges:Ac rms 1000 V, 100 V, 10 V, 1 V and 100 mV with 20% over ranging. The 100 mV is attained via a precision divider network which is selected by a front panel rotary switch. The range selected is indicated by a lighted, moving decimal point.

1.2.2 Resolution: 1 ppm on all ranges.

1.2.3 Voltage Accuracy: Limit of Error method*: All peripheral specifications, i.e., error for line and load changes, temperature change, drift and noise are listed for information and are *non-additive to the accuracy statement.

NOTE: Customer may specify the calibration frequency. No Charge at time of purchase. The accuracies stated are at all frequencies and at all voltage settings:

1000 V, 100 V, 10 V Ranges: ±(0.05% of setting +0.005% range)
1 V and 100 mV Ranges : ±(0.05% of setting +0.05% range)

1.2.4 Voltage Stability:

8 hrs. ±(0.0075% of setting +0.001% of range)
6 mo. ±(0.015% of setting +0.005% of range)

1.2.5 Compliance Current (Max.) 1000 V range: 50 mA
100 V range: 500 mA
10 V & 1 V ranges: 2A
(Loading) 100 mV range: minimal current (see output impedance).

1.2.6 Output Impedance: 1000 V, 100 V, 10 V,1 V ranges: 1 milliohm
100 mV range: 10Ω (constant at all settings)

1.2.7 Regulation to load: 0.005% *(non-additive)

1.2.8 Regulation to line: 0.0025% *(non-additive)

1.2.9 Over-load protection- Automatic-trip, lighted front panel indicator, push-button reset.

1.2.10 Frequency Range: 45 Hz to 1 kHz

Internal: Four internal frequencies, factory installed: 50 Hz, 60 Hz, 400 Hz, and 1000 Hz.

External: This instrument accepts the frequencies within 45 Hz to 1 kHz from an external oscillator. Input amplitude between 3 V and 5 V which may be monitored by the "operate level" lights on the "AC" series instrument.

1.2.11 Frequency Accuracy: 0.001%

1.2.12 Frequency Stability: ± 0.0005% 8 hours

1.2.13 Distortion: 0.5% This is LIMIT of distortion throughout the entire bank of the frequency 45 Hz to 1 kHz at all VOLTAGE settings.

1.2.14 Amplitude Modulation: <0.02% rms of output voltage at 59 and 61 Hz.

1.2.15 Operation Limit Temperature:
0 degrees C to 50 degree C T.C - 0.002%/°C

Nominal Operating Temperature:
2°C to 30°C

1.2.16 Power: 300 W, 105 - 125 Vac, 50/60 Hz or
210 - 240 Vac, 50/60 Hz

1.3.0 <u>MECHANICAL SPECIFICATIONS</u>

1.3.1 Size: 19" x 7" x 13 3/4": 48.26 x 17.78 x 34.93cm

1.3.2 Weight: 50 lbs.; 18.14 kg

2.0.0 INSTALLATION

2.0.1 The instrument is designed for mounting in a standard 19" wide rack and is also available for bench mounting. No additional modification to the unit is necessary for either installation.

2.0.2 All units are supplied with handles and weigh only 40 pounds. The overall size is 7" high, 19" wide and 13 3/4" deep.

Power requirements are 105-125 VAC, or 210-250 VAC 60 Hz or 50 Hz. Transformer is tapped for other input voltages.

2.0.3 The unit is designed to be easily transported from one lab to another and to be in operation in less than one minute from turn on time.

2.0.4 This unit is self-contained and needs no further unpacking other than connecting the power.

CAUTION

UNUSED TAPS ON HIGH VOLTAGE
OUTPUT TRANSFORMER MAY BE AS
HIGH AS 1000 VOLTS!!!

SECTION III

3.0.0 OPERATION OF THE INSTRUMENT

3.0.1 Set the 110/220 switch on the rear panel. The power cord of the standard source should be plugged into any convenient outlet of 115 VAC or 230 VAC, 50-60 Hz.

3.0.2 The Level lights on the front panel will indicate the correct operation of the internal oscillators. If an external oscillator is used, it is adjusted at this time, until the green LED is illuminated. If the internal oscillator is to be used, frequency selection should be made at this time.

3.0.3 The desired output voltage is now selected by the range and decade switches. The load is connected to the output terminals. The "operate" push button switch may now be depressed. This applies the pre-set voltage to the output terminals.

> IMPORTANT: For optimum performance in "External Osc. Mode" adjustments of level and major (decade) frequency changes must be made with the unit in "STAND BY"!! Red LED on. An attempt to adjust the input level with the unit in OPERATE may cause distortion in the output of the unit or an erroneous output VOLTAGE!!!

3.0.4 It is good practice to make large voltage and load changes in the STANDBY mode. Under some conditions the above changes can cause over voltage of 15% of the desired output.

3.0.5 In the event of an overload of 50% or a short circuit the unit automatically recycles itself to "STANDBY" mode. Depressing the "OPERATE" switch with the short or overload still present at the output terminals will cause the unit to return to "STANDBY" immediately.

3.1.0 FRONT PANEL CONTROLS

3.1.1 Power Switch: Rocker ON-OFF line power.

3.1.2 Stand By: Illuminated momentary push-button places unit in STANDBY mode.

> CAUTION: Unit should be placed in "STAND BY" before connecting or disconnecting load, and before turning off unit.

3.1.3 Operate: Illuminated momentary push-button places unit in OPERATE mode.

3.1.4 Frequency Select: Five position rotary switch selects one of up to 4 internal frequencies. This switch also provides a means to select an externally applied oscillator.

3.1.5 Range Switch: Five position rotary switch selects the desired range. The ranges are: 100 mV, 1 V, 10 V, 100 V, and 1,000 V. One may span from 10% to 120% of full scale range with the decade switches. The MSD can not be dialed to zero.

3.1.6 Decade Switches: The decade switches are used to select the desired output voltage. The place value of each switch is referenced to the decimal light. For example: In the 1,000 V range, if all other switches were set at 10 and the MSD switch at 1, the output voltage would be 211.110 volts rms. It is possible to resolve any output selected in one millivolt step.

3.1.7 Level LED's: The level LED's monitor the output of the oscillator buffer. The correct operating level is indicated when the green led is on by itself. This may also be used to set the input level of an external oscillator.

3.2.0 <u>Operation as a Voltage Source</u>

3.2.1 The precision AC Voltage Source has been designed to provide a rugged, simple damage proof tool for electronics labs and industries. When using the instrument as a precision reference standard source, these steps should be followed: Set the 110-220 switch to the desired setting. Connect the power cord to a power source, 115 VAC or 230 VAC, 50-60 HZ. Connect the output of the unit as required.
Hz.

NOTE: In some applications it may be necessary to isolate the chassis from line common - however, this is not recommended. Connect the external oscillator to the "external" terminals if it is to be used.

3.2.2 Turn the POWER SWITCH on.

3.2.3 Select frequency with the "FREQUENCY" select switch, observing the level LED's for correct indication. If external position is used, adjust external OSC amplitude until the green LED is on.

3.2.4 Select range with the "RANGE" select switch.

3.2.5. Dial the desired output voltage on each decade switch.

3.2.6. Press the OPERATE switch, the green light indicates the output of the Voltage Source is connected to the output terminals.

4.0.0 4601 THEORY OF OPERATION

4.1.0 INTRODUCTION

As shown in the block diagram the model 4601 is conveniently broken down into functional blocks.

4.2.0 POWER SUPPLY (Schematic B-4038)

Pins 9, 10 & 11 of the power transformer drive a bridge rectifier. The + output of the bridge drives a 7815 regulator to provide +15 volts. It also drives an 8.2 volt zener diode to provide +24 volts. The - output of the bridge drives a 7915 regulator to provide -15 volts. The orange, green and black wires from the power transformer drive a second bridge rectifier to provide ±50 volt for the P.A.

NOTE: The ±50 volt supply is not ground referenced, the voltages are with respect to P.A. out.

4.3.0 CONTROL CIRCUIT OPERATION (B-4038)

4.3.1 The control circuit consists of Z7, an operational amplifier connected as a comparator, Z10 a dual D flip-flop,, Z9, which is used as a dual high sink current inverter, and K4, a 4PDT relay. Two momentary contact front panel switches activate the circuits into its two modes of operation.

4.3.2 The comparator Z7 is normally biased so its output (pin 6) is negative. Upon initial turn on of the unit, a +15 volt pulse is momentarily applied to Z7-pin 3, through C20. Z7-pin 6 will momentarily go to +15 V, resetting Z10B. Hence on initial turn on the unit will be in the standby state. Depressing the operate switch generates a positive clock pulse on Z10B-pin 11, and a high on Z10B-pin 9 putting the unit into the operate state. In the operate state the green operate light is turned on and K4 is energized. Depressing the standby switch generates a positive clock pulse on Z8B-pin 11 and a low on Z8B-pin 9, and drives the unit into the standby state.

4.3.3 If the unit is in the operate state and an overcurrent condition is present in the output stage, the voltage generated across the .33 ohm source resistors will drive the output of Z7 positive and the unit will be driven into the standby state. If Z2 is against its positive "stop", Z7's output will also be driven positive.

4.3.4 When the unit is in the standby state, the primary of output transformer is disconnected from the output stage and Z2-pin 6, the integrator output is driven negative. The function of the integrator is described in section 4.6.0. When the unit is in operate state, the primary of the output transformer is connected to the output stage and the integrator resumes normal operation.

CAUTION: UNIT SHOULD BE PLACED IN "STAND BY" BEFORE CONNECTING OR DISCONNECTING LOAD, AND BEFORE TURNING OFF UNIT.

4.4.0 BASIC OSCILLATOR (Schematic B-4078)

4.4.1 The AC voltage standard source operates at any one of four selectable internal frequencies; 50 Hz, 60 Hz, 400 Hz, 1,000 Hz and one externally generated. This selection is made with the front panel frequency select switch.

4.4.2 SQUAREWAVE REFERENCE

4.2.2.1 Z15, consists of a 3.58 mHz crystal oscillator and divider which produces a 100 Hz output reference and drives the REF INP of phase locked loop Z17.

4.4.2.2. VCO OUT of Z17 drives the C input of the two decade counter Z20. The digital inputs of Z20 are programmed with the frequency switch.

4.4.2.3 The PE OUT of Z20 drives the PCII INP of Z17.

4.4.2.4 The VCO OUT of Z17 is 10 x the desired frequency and drives the CLK INP of decade divider Z21.

4.4.2.5 The OUT of Z21 is the squarewave reference of the desired frequency.

4.4.3 SINEWAVE PHASE LOCKED LOOP

The following section is a description of the circuitry which phase locks the sinewave oscillator to the squarewave reference.

4.4.3.1 The square wave reference drives the reference input of phase comparator, Z27.

4.4.3.2 The sinewave output of Z28 is clipped by comparator Z24 and drives the PCII input of Z27.

4.4.3.3 The PCII output of Z27 drives a lead-lag RC filter, which in turn drives the gate of FET follower.

4.4.3.4 The source of the FET follower drives the LED of the light variable resistor, is the frequency tuning element of the bridged-T oscillator, which is Z19.

4.4.3.5 Capacitors appropriate to the frequency range are connected by K1.

4.4.4 Sinewave Oscillator amplitude Control Loop

The following section is a description of the circuitry which regulates the amplitude of the sine wave oscillator.

4.4.4.1 The sinewave output of Z19 is amplified by Z28 which drives the input of peak detector, Z23.

4.4.4.2 The output of Z23 drives the input of OTA, Z18. The + input of Z18 is driven by the sinewave plus an additional + bias. The output of Z18 is a positive going pulse of approximately 5% duty cycle, centered on the positive peak of the sinewave.

4.4.4.3 The output of Z18 drives the gating input of OTA, Z16. The - input of Z16 is driven by a +2.3 V D.C. reference voltage. The + input of Z16 is driven from the sinewave output of Z28. The current output pulse of Z16 is a measure of the deviation of the peak sinewave amplitude from its desired value.

4.4.4.4 The output of Z16 drives the error point of integrator, Z14. If the sinewave amplitude is too high the integrator output will slew negatively, and vice-versa.

4.4.4.5 The output of Z14 drives the Y+ input of multiplier, Z13. Z13 controls the sinewave amplitude by regulating the gain from the output of Z19 back to its + input.

4.5.0 D.C. REFERENCE CIRCUIT (Schematic B-4038)

4.5.1 Q4, Q5, precision reference diode D1 and associated circuitry form a precision +DC reference in the range of 6.1 to 6.3 volts.

4.5.2 The +DC reference sources 100 uA into the error point of Z1.

4.5.3 The output of Z1 is fed back to its error point through a precision 6-decade switch selectable resistor network. The output of Z1 is a precision-DC Voltage in the range of -1 to -12 volts.

4.6.0 A.G.C. CIRCUIT (Schematic B-4037)

4.6.1 The output of the D.C. reference circuit sinks a current from the error point of the integrator, Z2.

4.6.2 The active half-wave rectifier, Z3, sources a current into the error point of Z2.

4.6.3 If the A.C. output voltage is too low, the integrator output will slew more positive, and vise versa. When the AC output voltage is correct the integrator output stops slewing and stays at an equilibrium positive voltage.

4.6.4 The VCA control voltage is fed into the + input of Z4. The output of Z4 drives the LED of the Cds light variable resistor, U9. The LED current is sensed logarithmically by 4 diodes in series and is connect to the - input of Z4. This arrangement produces a gain which is approximately exponential with control voltage, minimizing the control voltage dynamic range required and compensates for varying characteristics of U9. The output of Z5 drives the input of the P.A.

4.6.5 In the standby mode the integrator output is driven negative by K3. This eliminates an output overshoot when the unit is put back in the operate mode.

4.7.0 POWER AMPLIFIER (Schematic B-4037)

4.7.1 The P.A. consists of operational amplifier Z6, Q1, a P-channel power F.E.T., Q2 an N-channel power F.E.T., and associated components. As mentioned previously the ±50 volt supplies are developed with respect to P.A. out. If Q1 is turned more on, and Q2 turned more off, P.A. out will go more positive and vice versa. This arrangement allows the F.E.T. gates to be at near ground potential and allows for a simplified drive stage. R(22) adjusts the idle current. The PA output drives the output transformer through K4B, when the unit is in the operate mode.

4.8.0 RANGE AND OUTPUT SWITCHING (Schematic B-3990)

4.8.1 Range Switch

4.8.1.1 S1A-1 ½ drives the decimal point lights.

4.8.1.2 S1A-7 ½ drives the unit to standby between ranges.

4.8.1.3 S1B-1 ½ selects the feedback resistor into the active rectifier.

4.8.1.4 S1B-7 ½ connects the feedback resistor to the high sense terminal on all ranges except the 100 mV range. On this range the feedback is sensed at the input of the 100 mV divider network.

4.8.1.5 S1C-1 ½ selects the proper output transformer secondaries for the various ranges. On the 100 mV range the output selected is the output of the divider.

4.6.1.6 S10-7 % connects signal ground (SG) to the low sense terminal on all ranges except the 100 mV range. On this range SG is connected to the low end of the divider.

5.0.0 MAINTENANCE

5.1.0 CALIBRATION OF THE AC STANDARD

5.2.1 The circuits requiring calibration in the AC standard are:

1. Basic Oscillator
2. DC Reference Amplifier
3. MSD DC Feedback Resistors
4. AC/DC Zero
5. Full Scale Calibration

5.3.0 EQUIPMENT REQUIRED:

a. Frequency counter
b. Digital voltmeter Datron 1071 or equivalent
c. Transfer standard Ballentine 1600A or equivalent
d. Oscillator KROHN-HITE 400 or equivalent
e. Distortion analyzer, KROHN-HITE 6800 or equivalent

NOTE: All calibration adjustments should be made with the Power Amplifier fuses REMOVED, until final output calibration is to be made. Refer to Drawing B-4249.

5.4.0 BASIC OSCILLATOR

5.4.1 Frequency Calibration.

Connect a frequency counter between 3.58 mHz TP and ground. Adjust C1 for a reading of 3.579500 ±5 Hz. Connect frequency counter between OSC. OUT and ground. Check accuracies for all frequencies. They should be within 0.001%. NOTE: For most accurate readings, measure the period of all frequencies.

5.4.2 Sinewave Phase Locked Loop Testing

Synchronize the oscilloscope from the squarewave reference test point. Connect the oscilloscope to oscillator out. Check for phase lock on all frequency ranges.

5.4.3 Oscillator Level Adjustment

Place unit in standby. Remove Z28. Connect an external oscillator between Z28-Pin 6 and ground. Connect a DVM to TP2 and ground. Set the oscillator amplitude so that the voltage at TP2 is 3 volts. Adjust R34 so that the set light just goes off and the low light comes on. Vary the oscillator amplitude, check that the appropriate lights come on for the following voltges at TP2:

V at TP2	Light
V < 3	Low
3< V. <5	Set
V> 5	HI

5.5.0 DC Reference Circuit

1. With the unit in STANDBY and the MSD to one, place a DVM across the Reference Zener and adjust R4 to the voltage on the tag.

2. Remove the low sense link, place a DVM between the two black terminals. Adjust R6 for a null reading. Remove DVM and replace the sense link.

3. Connect a DVM between -DC out and signal ground. Adjust R1 for a reading of one volt.

4. Dial MSD to 3 and adjust the pots directly behind the MSD to the voltages corresponding with the number of the Pot. Pot. # 3 to 3 volts. Dial MSD to 2, adj. Pot. #2 to 2 volts, and so on for the rest of them (5,7,9,11). when finished, remove meter.

MSD SWITCH (FRONT VIEW)

11	9	7	5	3	2

5.6.0 Rectifier Zero

With the unit in standby, and in the 10 volt range, connect a D.V.M. between rectifier output and signal ground. Adjust R20 for a null reading.

5.7.0 P.A. Idle Current

Replace P.A. fuses with the unit in standby, connect a D.V.M. acrcss one of the .33 ohm resistors. Adjust R22 for a reading of 17 mV.

5.8.0 Output Calibration

1. Connect an A.C. DVM or thermal transfer standard across the output terminals. Set the range to 10 V, and frequency to 1 kHz. Dial up a 10 on the MSD. Adjust R13 for a reading of 10 V R.M.S. Dial up a 1 on the MSD. Adjust R24 for a reading of 1 V R.M.S. Repeat the sequence several times if necessary as R13 and R24 are interacting. Check the linearity by checking the AC output at MSD settings of 1-10.

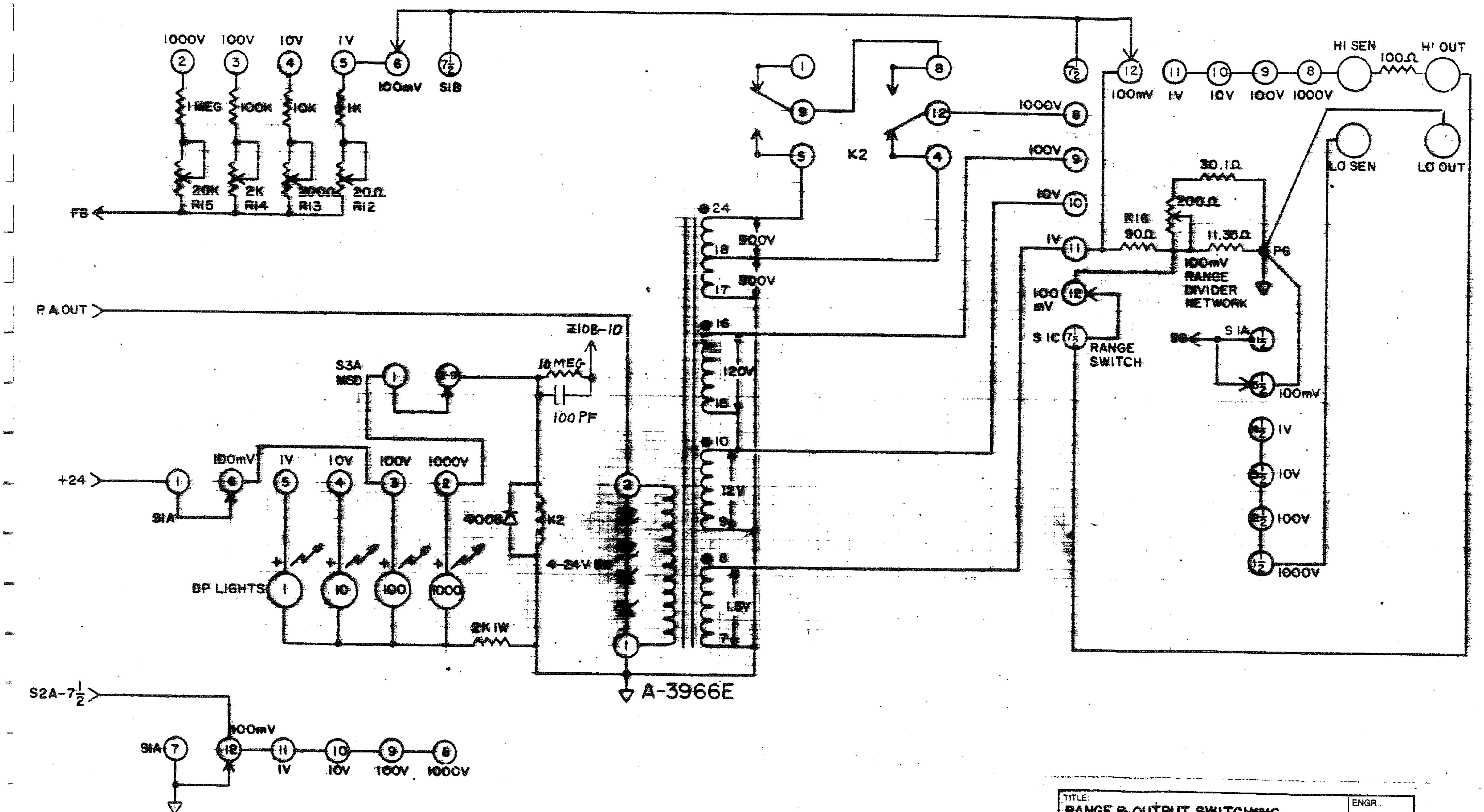
2. Set range to 1 V scale, and adjust R12 to exactly 1 V R.M.S.

3. Set range to 100 V scale, and adjust R14 to exactly 100 V R.M.S.

4. Set range to 1000 V scale, and adjust R15 to exactly 1000 R.M.S.

(CAUTION: WHEN IN 1000 V SCALE, PUT MSD TO ONE AND DIAL UP SLOWLY.)

5. Set range to 100 mV and adjust R16 on the relay board for exactly 100 mV R.M.S.



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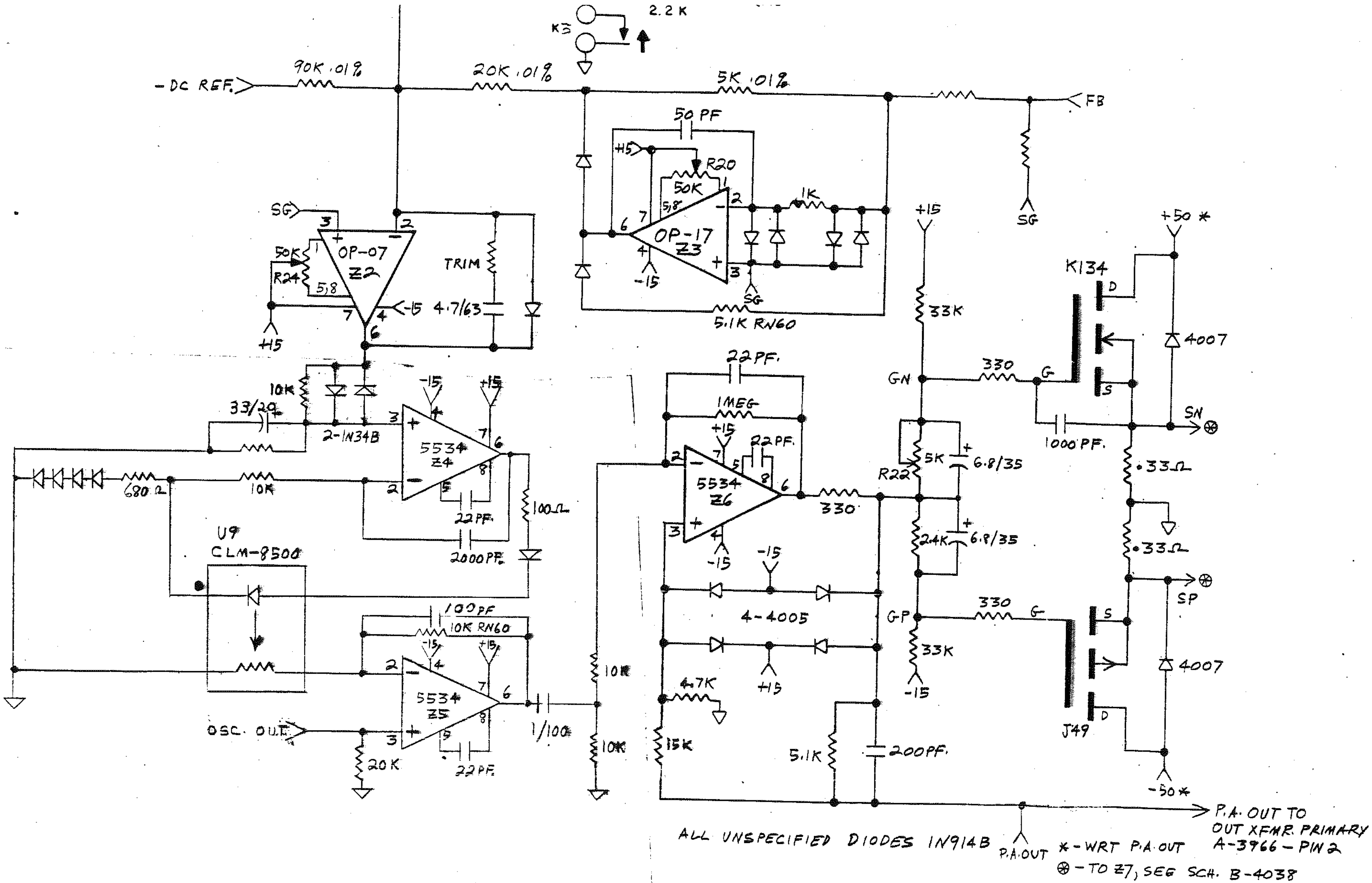
	DATE: 8 JAN 87	MODEL: 4601	



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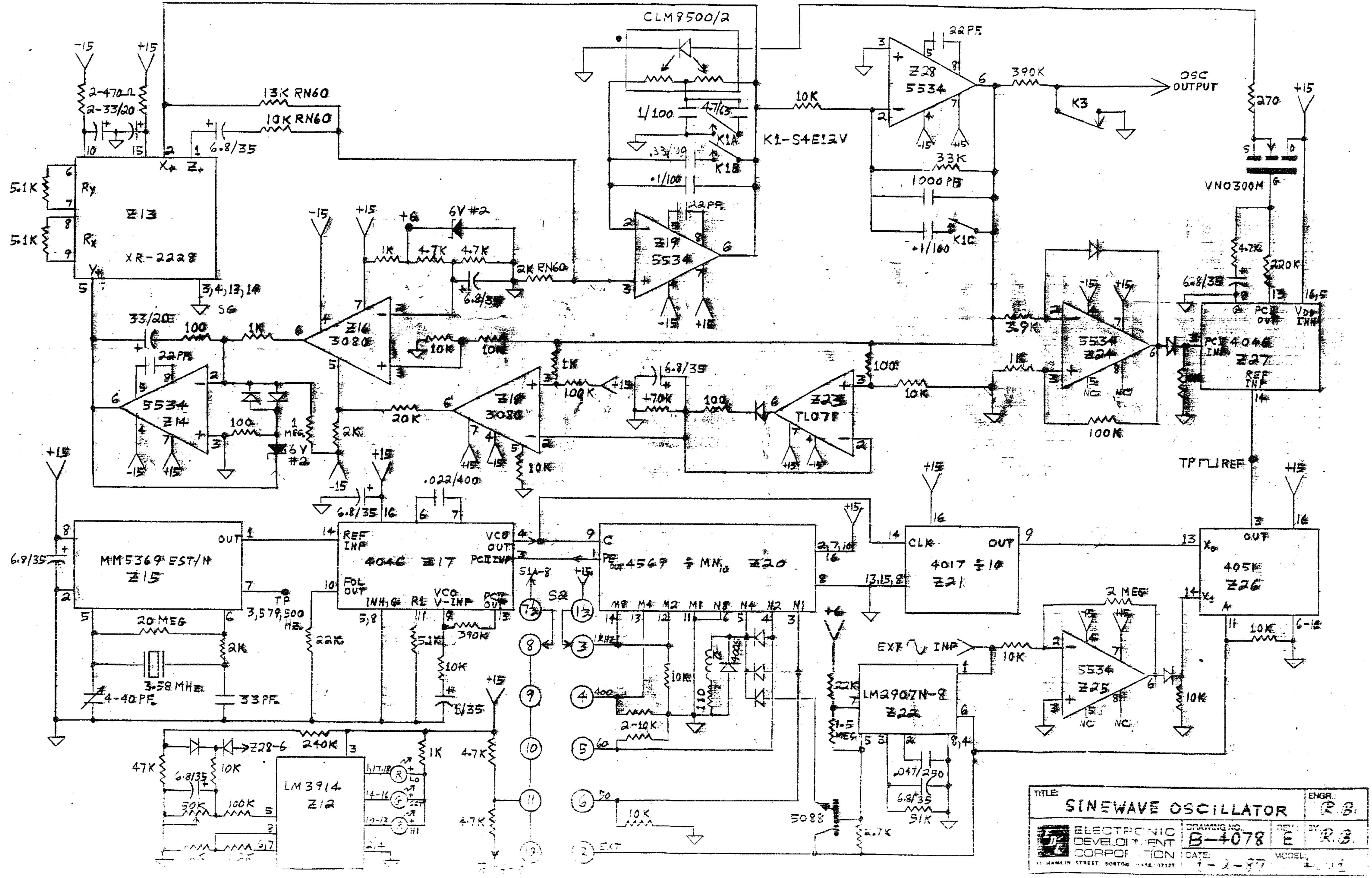
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K3
K1-S4E12V
K1A
K1B
K1C
VN0300M
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Z19 5534
Z16 3080
Z14 5534
Z18 3080
Z23 TL071
Z24 5534
Z27 4046
Z17 4046
Z15 MM5369 EST/N
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3.58 MHz
Z20 4569 ÷ MN
Z21 4017 ÷10
Z26 4051
Z25 5534
Z22 LM2907N-8
Z12 LM3914
EXT INP
TP REF
S1A-8
S2
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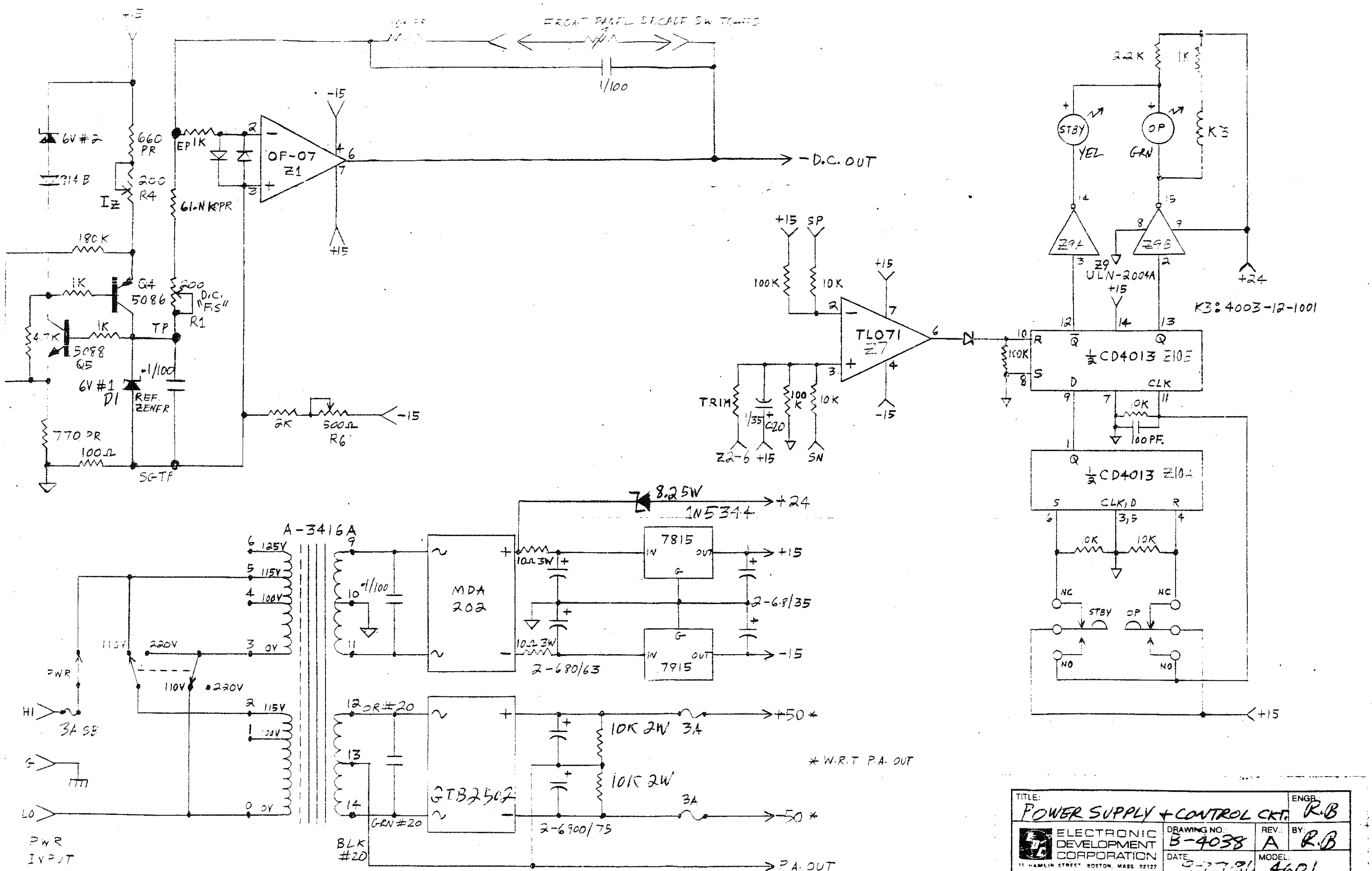
BY R.B.
DATE: 1-2-87



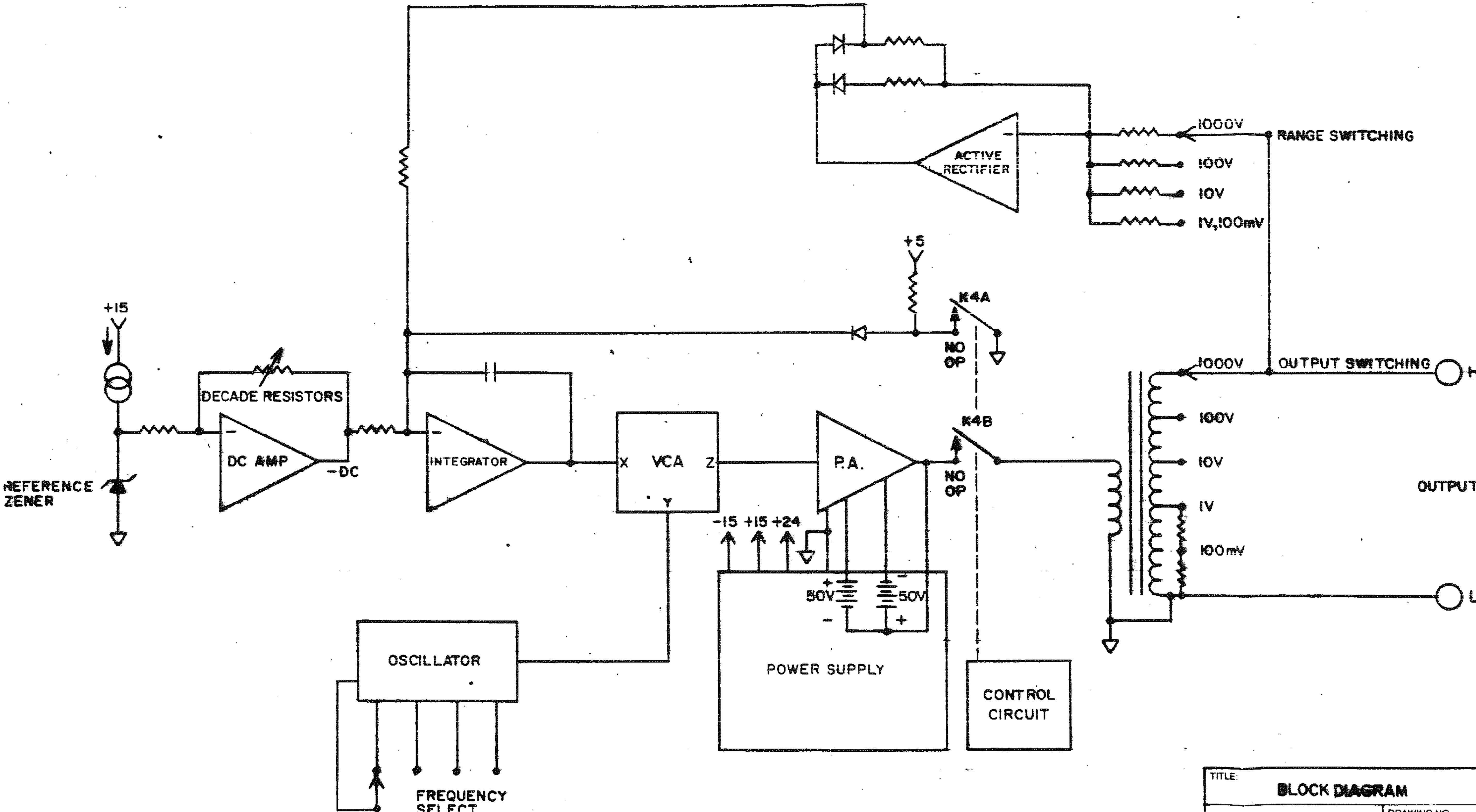
TITLE: POWER SUPPLY + CONTROL CKT.

ENGR: R.B

ELECTRONIC DEVELOPMENT CORPORATION
11 HAMLIN STREET BOSTON, MASS. 02127

DRAWING NO.: B-4038 | REV.: A | BY: R.B

DATE: 9-27-81 | MODEL: 4601



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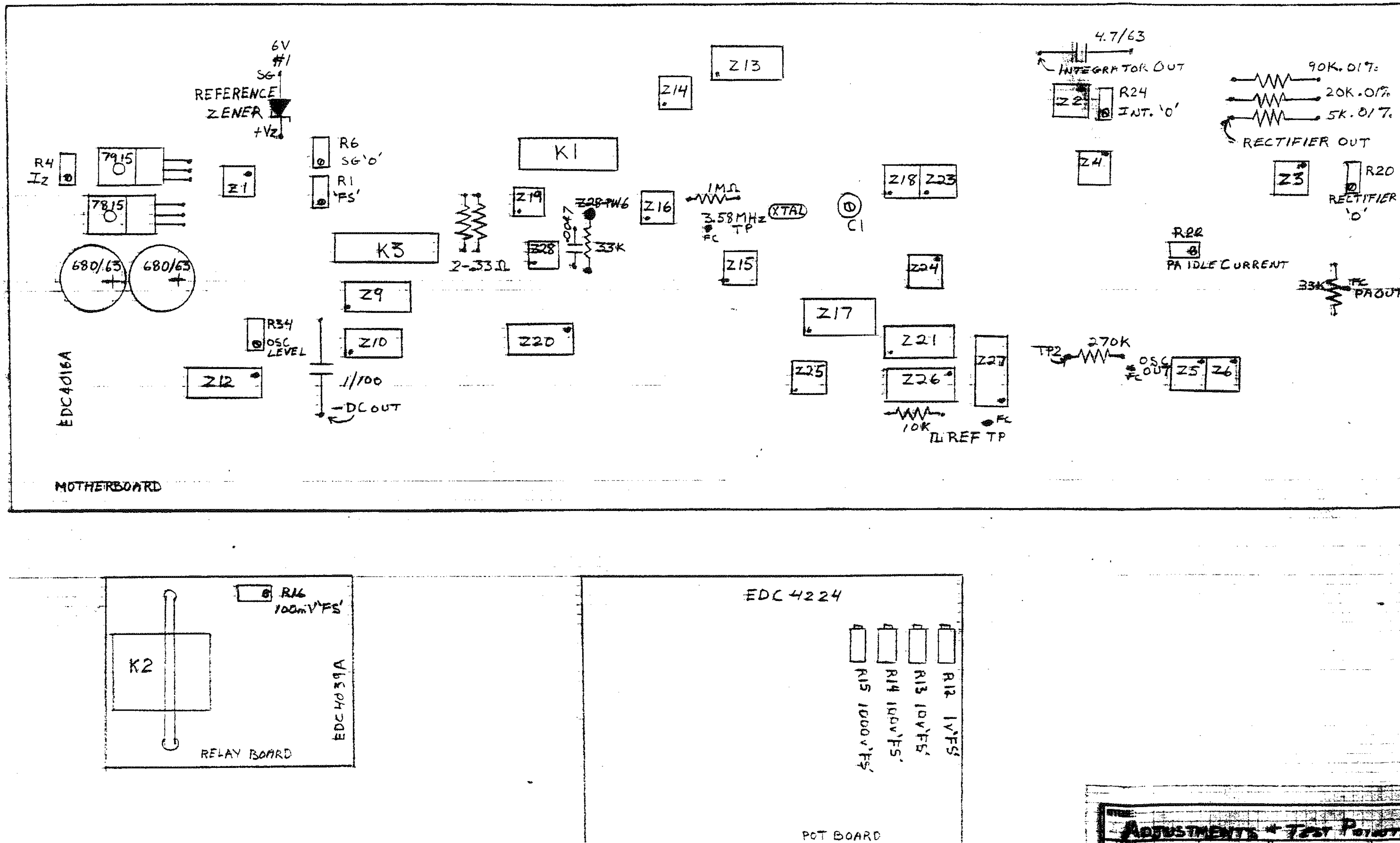

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