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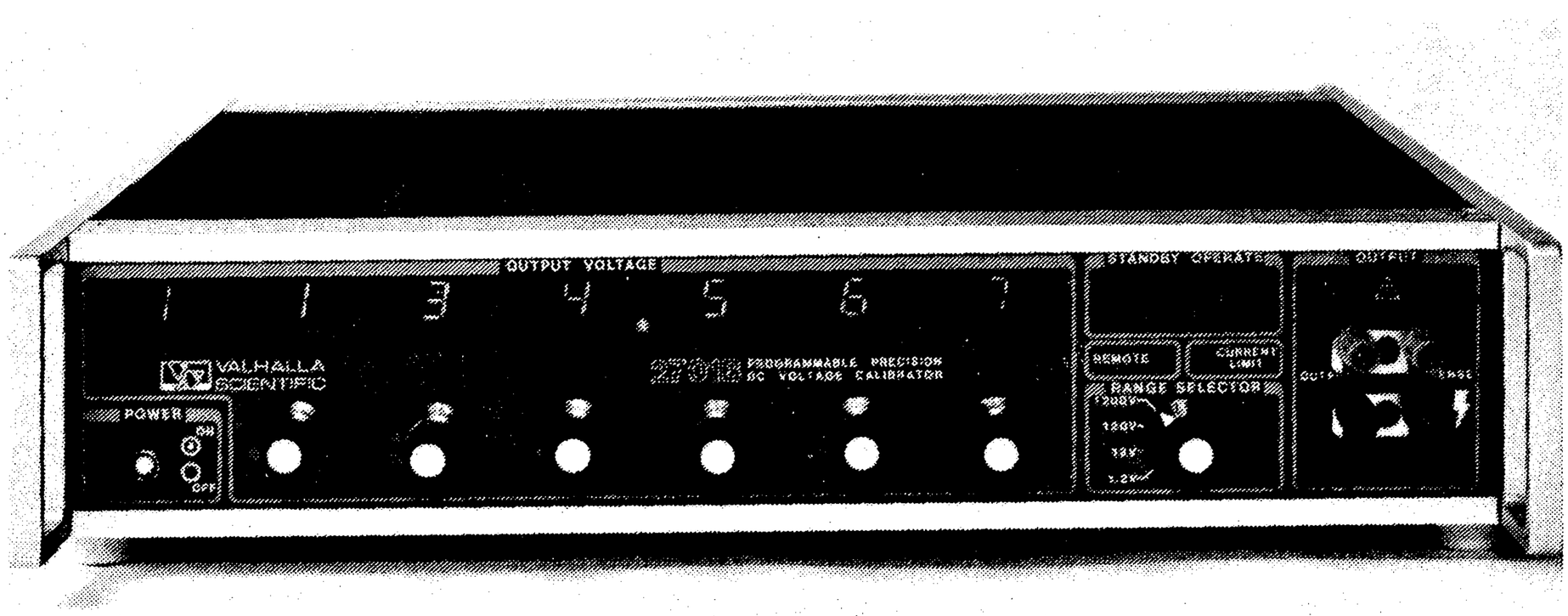
2701 B

Programmable Precision DC Voltage Calibrator

Operating and Maintenance Manual



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CERTIFICATION

Valhalla Scientific, Inc. certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. Valhalla Scientific, Inc. further certifies that its calibration measurements are traceable to the National Bureau of Standards to the extent allowed by NBS's calibration facility.

WARRANTY

The warranty period for this instrument is stated on your invoice and packing list. Please refer to these to determine appropriate warranty dates. We will repair or replace the instrument during the warranty period provided it is returned to Valhalla Scientific, Inc. freight prepaid. No other warranty is expressed or implied. We are not liable for consequential damages. Permission and a return authorization number must be obtained directly from the factory for warranty repair returns. No liability will be accepted if returned without such permission.

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SPECIFICATIONS

DC VOLTAGE RANGES	1.2V 12V 120V 1200V
RESOLUTION	1μV 10μV 100μV 1mV
ACCURACY (25°C ±3°C)	± 10ppm of setting ± 4 ppm of range ± 2μV
TEMPERATURE COEFFICIENT	1 ppm/°C.
STABILITY	5 ppm/30 days.
RIPPLE AND NOISE	4 ppm of range ± 2 μV pk to pk (.1Hz to 10Hz)
LOAD REGULATION	10 ppm from no load to full load.
CURRENT	20mA
SETTLING TIME	3ms/V of change ascending and descending for changes < 100V plus 300ms. 10ms/V for descending changes greater than 100V.
WARM UP TIME	Within 30 ppm of final value within 15 seconds, 30 minutes to rated accuracy
ISOLATION	Optical: Output may float up to 500 volts from chassis potential.
SHORT CIRCUIT PROTECTION	Current limits at 25 milliamperes and automatically switches to standby after 100 milliseconds overload.
OPERATIONAL ENVIRONMENT	0 to 50°C, 0 to 80% relative humidity, to 10,000 ft.
STORAGE ENVIRONMENT	−20 to +85°C, 0 to 95% relative humidity, 30,000 ft.
FULL SCALE VOLTAGE	1222221 (Decimal point ignored).
POWER REQUIREMENTS	40 watts at 115 or 230 VAC, ±10%, 50 to 60 Hz.
WEIGHT	18 pounds net; 25 pounds shipping weight.
SIZE	17 inches W, 3-1/2 inches H, 14 inches deep.

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SECTION I - GENERAL INFORMATION

1.1 DESCRIPTION

1.2 Valhalla Scientific's Model 2701B Programmable Precision DC Calibrator is a highly stable precision DC voltage source. Front panel switches permit selection of output voltages from 1 microvolt through 1,222.221 volts in four ranges, with a resolution of one part in one million.

1.3 The instrument uses a precision reference for output control. The voltage level of this reference is dependent on the duty cycle of a digital pulse generator which, in turn, is controlled by the front panel voltage selection switches. Since this technique eliminates the shortcomings of conventional resistive voltage dividers, the accuracy and stability of the instrument are independent of switch control resistance. Digital control of the pulse generator greatly simplifies remote voltage selection through an optional IEEE-488 interface.

1.5 OPTIONAL EQUIPMENT

1.6 A number of optional equipment items are available to increase the utility of the Model 2701B Programmable Precision DC Calibrator. These are described in the following paragraphs.

1.7 OPTION "TL-3" IEEE-488

1.8 Option IEEE-488 permits control of the Model 2701B through the IEEE-488 General Purpose Interface Bus. The bus coupler is mounted inside the instrument and a 24-pin IEEE-488 connector and address switch are mounted on the rear panel. This option may be installed at the time the instrument is purchased or may be incorporated as a factory retrofit. Installation and operating instructions are contained in Section VI.

1.9 OPTION C

1.10 Option C is a 48 inch shielded cable with a dual banana plug on one end, and alligator clips on the other.

1.11 OPTION BBC

1.12 Option BBC is a 48 inch shielded cable with dual banana plugs on both ends.

1.13 OPTION PRM

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1.14 Option PRM enables the output polarity of the Model 2701B to be reversed via the IEEE-488 interface.

1.15 MODEL 2704

1.16 The Model 2704 is a precision 100:1 resistive voltage divider. When used with the Model 2704, the 2701B will provide 0.12 volts full scale with 0.1 microvolt resolution on its 12 volt range, and 12 millivolt full-scale with 10 nanovolt resolution on its 1.2 volt range.

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SECTION II - INSTALLATION

2.1 INTRODUCTION

2.2 This section of the manual contains information for receiving inspection and installation of the Model 2701B Programmable Precision DC Voltage Calibrator.

2.3 INITIAL INSPECTION

2.4 If the shipping container shows evidence of intransit damage, such damage should be immediately brought to the attention of the carrier and the nature of the damage noted on the bill of lading.

2.5 Unpack the instrument and retain the shipping container until the instrument has been inspected for possible damage in shipment. If in-shipment damage is observed, notify the carrier and obtain his authorization for repairs before returning the instrument to the factory. If the shipping container shows evidence of damage in transit, but the instrument does not, it may be advisable to perform the calibration procedure of Section V to determine that the instrument has not sustained internal damage.

2.6 POWER REQUIREMENTS

2.7 The instrument requires 115 or 230 volts AC, 50-60 Hz, at 40 watts. A detachable line cord with appropriate connector is provided.

2.8 INSTALLATION

2.9 Installation requires only that the line cord be plugged into a power receptacle. The instrument output appears on two banana jacks on the front panel. Two additional banana jacks serve as sensing inputs. These should be connected directly across the load terminals when the resistance of the leads between instrument output and the load will produce a significant voltage drop. The sensing inputs cause the instrument to maintain the voltage across the load at that selected with the front panel switches. The sensing jacks are, otherwise, connected to their respective voltage jacks, using the straps provided. If the optional IEEE-488 interface is installed, the instrument may be connected to a computer or controller through the IEEE-488 24-pin connector on the rear panel.

2.10 The Model 2701B is intended to be operated in environments where the temperature does not exceed 50°C (122°F). If higher temperatures are anticipated, external means must be provided to maintain the temperature around the Model 2701B at or below 50°C.

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SECTION III - OPERATION

3.1 INTRODUCTION

3.2 This section of the manual contains complete operating instructions for the Model 2701B Programmable Precision DC Voltage Calibrator.

3.3 FRONT PANEL CONTROLS AND INDICATORS

3.4 A push-on, push-off switch at the left of the front panel connects the external power source (115/230 VAC at 50/60 Hz) to the instrument's internal supply circuits. Six twelve-position, rotary switches are located to the right of the power switch. Each controls a single decade (plus overrange and carry) of the output voltage selection. The switches are arranged in descending order, with the control for the least significant decade on the right. The switch knobs have a transparent skirt on which position numbers are silk screened. A white area, silk screened on the panel, highlights the number at the top of the skirt in each switch position.

3.5 A seven-segment LED display device is located directly above each switch to indicate the value selected in that decade. The seventh LED, located above the power switch, displays a "1" if the most significant decade switch is set at or above "10". The displays indicate the voltage selected by the switches when the instrument is in the operate mode. The knob skirt numbers indicate the selected output value when the instrument is in the standby mode, since the displays then show only zeros.

3.6 A four-position rotary range selection switch is located to the right of the voltage selection switches. Full scale ranges of 1.2 volts, 12 volts, 120 volts, and 1200 volts are selectable and the selected range is indicated by illumination of one of four LED's indicating decimal point position.

3.7 Two pushbutton switches are located above the range switch to select standby and operate modes. One of two LED's will be illuminated to indicate the mode of operation; a third LED (REMOTE) indicates when the instrument is being remotely controlled. The CURRENT LIMIT LED is illuminated when excess current is flowing in the output.

3.8 REAR PANEL FEATURES

3.9 The line cord connector and the AC power fuseholder are located on the rear panel of the instrument. If the IEEE-488 Interface is installed, a 24-pin interface connector and an address switch will also be located on the rear panel. Consult the IEEE-488 interface option for instructions on setting the device address switch.

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3.10 OPERATING PROCEDURE

3.11 Turn on power, wait five seconds then press the OPERATE pushbutton. Select the desired range. Note that the decimal point will move from one digit display to another as the range switch is moved from one position to another. Set the six voltage selection switches so that the desired voltage is indicated by the seven-segment displays. **Press the STANDBY button to remove the output voltage before making any connections at the output terminals.**

CAUTION

The voltage at the front panel output and sense terminals, when operating on the 120 and 1200 volt ranges, is dangerous to life. Contact with these terminals while the instrument is in the operate mode may result in serious injury or death. The user should exercise extreme caution to insure that the instrument is in the stand-by mode before connecting or disconnecting leads to the output or sense terminals.

3.12 Each rotary decade switch has positions from 0 to 11. To prevent display ambiguity when a switch is placed in position 10 or 11, a carry is automatically transferred to the next most significant decade, adding one to that decade.

3.13 In the event of an overload, where the current is in excess of 20 milliamperes, but less than 25 milliamperes, the CURRENT LIMIT LED will be illuminated. If current is increased above 25 milliamperes, the instrument will automatically switch to the STANDBY mode after 100 milliseconds. The STANDBY indicator will be illuminated and the voltage, and the selected voltage display, will be reduced to zero. Operation may be resumed by reducing the current requirements of the load and pressing the OPERATE button.

3.14 In some applications, the resistance of the leads between the instrument and the load may cause the voltage across the load to be significantly less than that appearing at the instrument output terminals. To maintain the voltage across the load at the value selected, with the Model 2701B front panel switches, external sense terminals have been provided so that true four-wire regulation may be used. To utilize this feature, disconnect the straps between the output and sense terminals. Connect the positive sense terminal to the positive terminal of the load. Connect the negative sense lead to the negative terminal of the load. Since current flow in the sense

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leads is negligible, the voltage at the sense inputs is that appearing across the load. The instrument then automatically adjusts its output voltage to compensate for the voltage drop in the output leads and to maintain the selected output voltage at the load terminals.

3.15 Instructions for remote operation through an IEEE-488 General Purpose Interface Bus are provided in the IEEE-488 Interface Option manual. Note that for safety reasons, the front panel STANDBY and OPERATE pushbuttons continue to operate in the remote mode.

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SECTION IV - THEORY OF OPERATION

4.1 GENERAL

4.2 This section of the manual provides functional and detailed descriptions of the circuits of the Model 2701B Programmable Precision DC Calibrator. The functional descriptions are referenced to the block diagram of Figure 4-1, and are intended to assist the user in gaining a general understanding of the instrument prior to study of the detailed circuit descriptions. The material of this section, together with that of Section V, will provide the information necessary for maintenance of the instrument.

4.3 FUNCTIONAL DESCRIPTION

4.4 The Model 2701B comprises a coarsely regulated switching power supply feeding a series regulator. The output of the regulator is controlled by a precision variable reference voltage. A fixed voltage is precisely divided to produce the precision reference voltage. The division of the fixed voltage is accomplished, using digital techniques, by switching the reference on for a precise percentage of the time, determined by the setting of the front panel voltage selection switches. This produces a series of pulses with an average DC level precisely related to the pulse width. An oven-stabilized voltage reference provides the fixed voltage. The accuracy of the instrument is primarily determined by the stability of this voltage and is in the order of 0.0015%. The following circuit descriptions are arranged under headings corresponding to the designators in Figure 4-1.

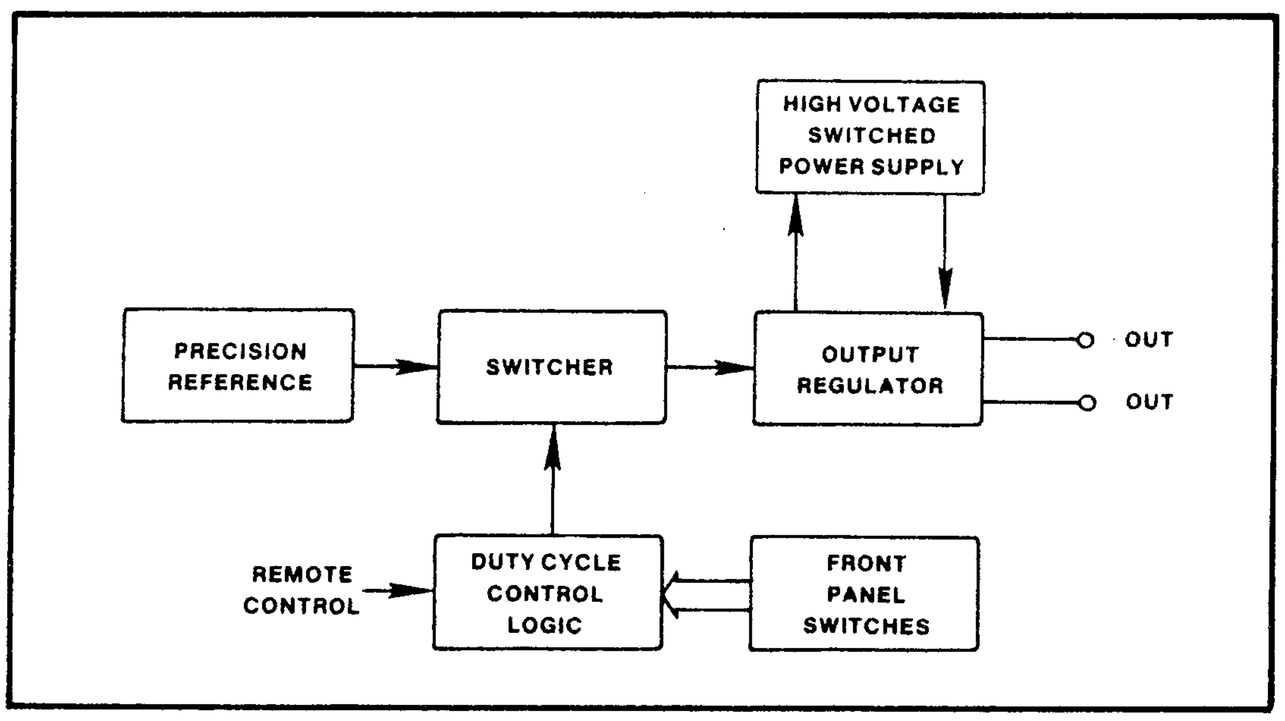

Figure 4-1. Block Diagram, Model 2701B Precision DC Voltage Calibrator.

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4.5 SWITCHING POWER SUPPLY

4.6 The primary power source for the series regulator is a 1500 volt, full-wave, filtered power supply. The circuit is conventional except that primary power to the power transformer is electronically switched. By interrupting the power input, the switching circuit provides coarse regulation of the power supply output at approximately 100 volts above the desired instrument output voltage. This feature minimizes the power dissipated in the series regulator. The circuit is designed to switch only at the time of zero crossing of the AC sine wave input.

4.7 SERIES REGULATOR

4.8 The series regulator consists of a group of transistors connected in series between the output of the switching power supply and the output terminals. An operational amplifier provides the control that determines the voltage drop across the transistors and, thus, the voltage appearing at the output terminals. When the sensing terminals are connected directly to the output terminals, the feedback to the operational amplifier causes it to compare the voltage at the output terminals with the reference voltage. The output of the operational amplifier forces the voltage at the output terminals to the level of the reference. If the sense inputs are connected across the load terminals, the comparison is between the voltage across the load terminals and the reference voltage. The selected output voltage is then maintained across the load and the voltage at the instrument output terminals will rise to whatever level is necessary to compensate for the drop in the leads between the output terminals and the load terminals.

4.9 DIGITALLY CONTROLLED VARIABLE REFERENCE

4.10 The variable reference consists of an ultraprecise, variable duty cycle pulse generator driving an electronic switch of single pole, double throw configuration. The output of the switch alternates between a fixed, precise voltage level and ground. The pulse duty cycle is precisely determined by the duty cycle of the pulses driving the switch and the amplitude is determined by the precise voltage input level. Thus the average voltage level of the pulse train, after filtering, is precisely proportional to the pulse duty cycle. The duty cycle of the pulse generator is determined by BCD counter circuits, described in the following paragraph, which are controlled by the front panel switches or, alternately, by a remote controller through the optional IEEE-488 Interface.

4.11 CONTROL LOGIC

4.12 In response to signal inputs from front panel push-buttons, the control logic selects standby or operate modes, and automatically selects standby when an overload occurs. A

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remote enable input from the optional IEEE-488 Interface will disable the front panel voltage selection switches and transfer control to an external controller.

4.13 DETAILED CIRCUIT DESCRIPTION

4.14 This section provides a detailed description of each circuit of the 2701B DC Calibrator. Unless otherwise specified, the reference designators appearing in this section are those of the schematic diagrams, Figures 5-3 and 5-4. Where multiple circuit IC's are involved, the individual circuits are identified by their output terminal numbers. For example, IC44-10 identifies that circuit of quad NOR gate IC44 that has its output connected to pin 10.

4.15 To facilitate an understanding of circuit operation, a simplified diagram of the high-voltage power supply and output regulator circuits is included as Figure 4-2. Its purpose is to provide an overall view of the circuit interconnections. It is not intended to replace the complete schematics, although the reader may wish to refer to this diagram as well as those of Figures 5-3 and 5-4. Note that all circuit components are not included in Figure 4-2 and, also, that some that are may not be identified.

4.16 SWITCHING POWER SUPPLY

4.17 The switching power supply provides the power for the instrument's series regulator which provides the output voltage. Primary power is applied to transformer T1 through a diode bridge consisting of diodes CR42 through CR45. Transistor Q20, connected across the DC output terminals of the diode bridge, is driven by Q19. Q19 is driven, through optical isolator IC6, from comparator IC3 and zero crossing detector IC5. The bridge acts as an open circuit unless Q20 is conducting. When Q20 is turned on, the bridge conducts in both directions, permitting the primary AC to pass to the transformer. With Q20 conducting continuously, the bridge consistng of CR50 through CR53, connected to the secondary of T2, rectifies the AC, providing approximately 1500 volts DC to filter capacitors C9 through C12. Lower voltages are produced when Q20 does not conduct continuously. Resistors R128-R145 equalize the voltage across the filter capacitors. Note, as shown in Figure 4-2, that the high voltage power supply has a resistance path from positive to negative which is tapped to provide a ground connection. The drop across the resistance from positive to ground will be maintained at approximately 100 volts by the circuit of IC3 and IC5. IC2 utilizes the drop across the resistance connected from ground to the negative terminal as a sense input to the summing junction at its non-inverting input.

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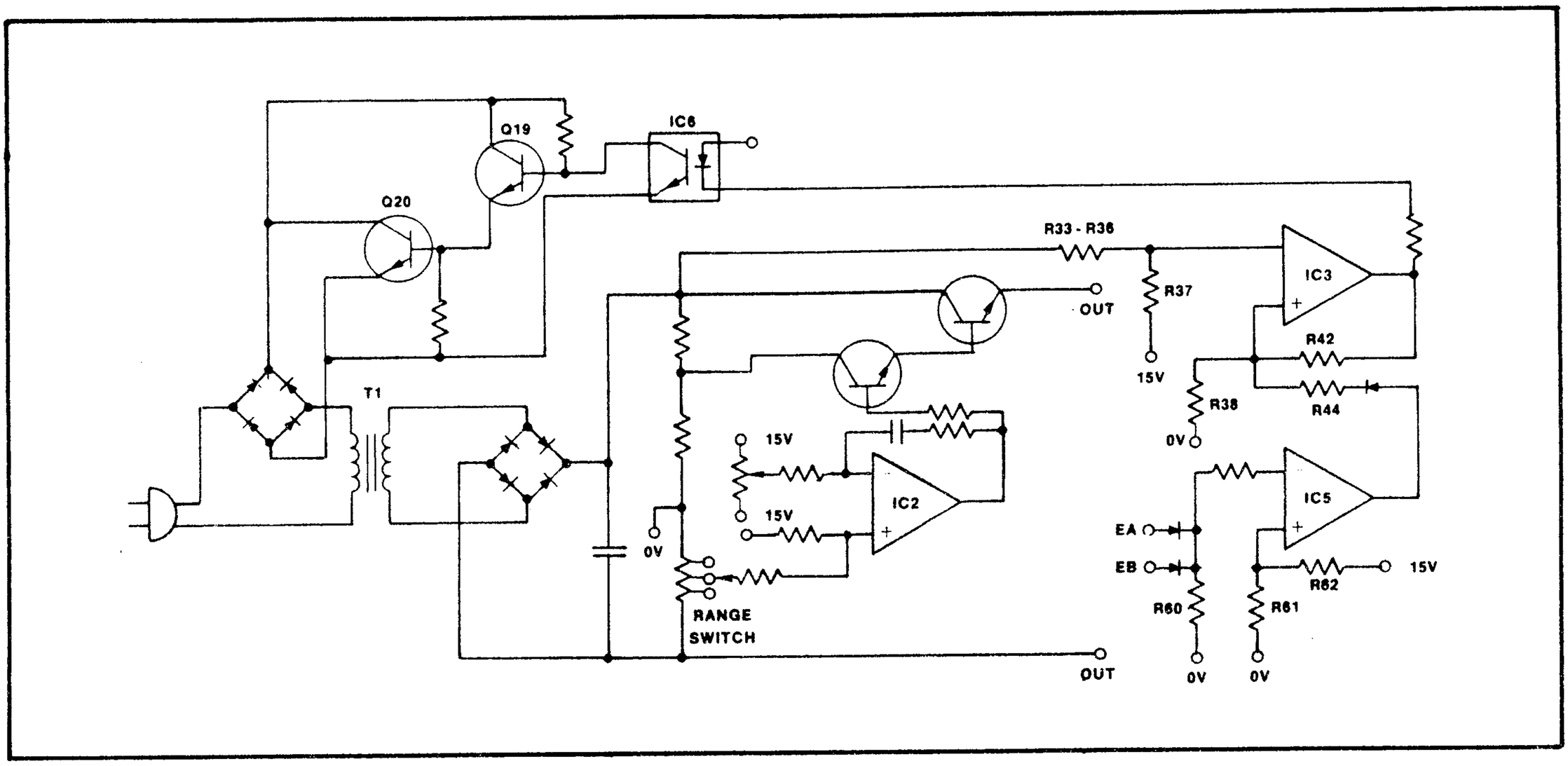

Figure 4-2. Simplified Schematic Diagram,
Model 2701B Precision DC Voltage Calibrator.

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4.18 Power supply switching is controlled by a gated comparator circuit comprised of operational amplifier IC3 and associated components. The output of the comparator can change state only during the zero crossings of the AC input sine wave.

4.19 CR11 and CR12 are connected to opposite ends of a secondary winding of T1. Thus, during a narrow "window" that extends to either side of the zero crossing point of the AC input, the inverting input of IC5 will be high, forcing its output high. This will forward bias CR8 and apply a fixed bias of approximately +2.5 volts at the inverting input of IC3 to which the voltage at the junction of R36 and R37 is compared. If the junction voltage is lower than that at the non-inverting input, the output of IC3 will be forced high, turning off the LED in optical isolator IC4 which will place (or maintain) Q20 in conduction. If the junction voltage is higher than that at the non-inverting input, the output of IC3 will go low, turning on the LED in IC4 which will turn off Q20. When the AC input to CR11 or CR12 moves outside the "window", the output of IC5 goes low, back biasing CR8 and removing the bias from the non-inverting input of IC3. This allows the positive feedback, through R42, to hold the output of IC3 at the high or low limit to which it was driven as a result of the input comparison. Thus, between zero-crossings of the AC input, the output of IC3 remains at one limit or the other.

4.20 The resistor values of the voltage divider are chosen so that whenever the voltage drop across the total resistance exceeds 100 volts, the output of IC3 will go low, turning on the LED in IC6. When the voltage drop falls below 100 volts, the output of IC3 goes high turning off the LED in IC6 which causes Q20 to conduct. The switching power supply output is thus maintained such that the drop across the series regulator transistor bank is maintained at approximately 100 volts.

4.21 When the operator selects a higher output voltage, the switching power supply can respond rapidly by allowing Q20 to conduct continuously until the selected voltage is reached. Zener diode CR7 prevents the voltage applied to the inverting input of IC3 from exceeding 6.2 volts. A selected decrease in voltage can only be accomplished by discharging the filter capacitors. To provide a quick discharge path, a winding on T2 is rectified by CR54 and filtered by C14, producing approximately 500 volts DC. The output of this supply is connected to the negative output of the switching power supply through R132. The result is that even at moderate output voltages, the filter capacitors can be discharged quickly with this reverse current. The current flow is from ground through CR55, the transformer secondary, C14 and R132.

4.22 SERIES REGULATOR

4.23 The series regulator reduces the output of the switching power supply to the precise voltage selected with the front

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panel switches. It also limits the output current to 25 milliamperes if a short circuit is applied to the output terminals. If the overload exists for approximately 100 milliseconds, it provides an output to the control logic to place the instrument in the standby mode. The series regulator consists of transistors Q7 through Q18, operational amplifiers IC2 and IC4, and optical isolator IC7. IC2 is a precision instrumentation amplifier.

4.24 The odd numbered transistors drive the bases of the even numbered transistors which pass the instrument's output current. Voltage regulation is provided by Q17 and Q18. Under steady-state conditions, the drop across Q7 through Q18 is held to approximately 100 volts by the switching power supply as described in 4-17. Therefore, the voltage at the collector of Q18 is at approximately 17 volts. For a brief period after a sudden decrease in output voltage selection, the drop across the series regulator will be much greater than 100 volts, as discussed in paragraph 4-20. During such periods, the entire string of transistors will safely share the large voltage drop and the power dissipation.

4.25 IC2 serves as a comparator controlling Q17 and Q18. The output of the variable reference is compared with a voltage that is proportional to the instrument's output voltage. Contacts of relays K1 and K2 select the appropriate combination of R39, R40, R41, R45 and R46 for each of the instrument's voltage ranges so that the voltage at the junction of R39 and R40 is within the input range of IC2. The contacts of K1 are closed for the 12 volt range, the contacts of K2 are closed for the 1200 volt range and the contacts of both relays are open for the 120 volt range.

4.26 The current from the series regulator flows through R14. When the current reaches approximately 25 milliamperes, the voltage drop across R14 is sufficient to forward bias CR2 and DS8, pulling Q17 and Q18 toward cutoff. This portion of the circuit limits the output current if a short circuit occurs. DS8 is the front panel OVERLOAD indicator and is illuminated when the current exceeds 20 milliamperes. IC4 monitors the voltage at the non-inverting input of IC2. The voltage at that point is nominally zero because the negative input of the divider balances the positive reference voltage. If a short circuit occurs, the output voltage drops and the voltage at the non-inverting input of IC3 swings positive. R51 and C5 delay IC4's reaction to this change for approximately 100 milliseconds. The output of IC4-6 then goes high, turning on the LED in optical isolator IC7. The photo-transistor in IC7 then conducts, grounding the input to NOR gate IC44-11. The instrument is then placed in the standby mode in the same manner as if the STANDBY push button had been pressed.

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4.27 DIGITALLY CONTROLLED VARIABLE REFERENCE

4.28 The variable reference provides a very precise voltage which is proportional to the settings of the front panel voltage select switches, or to BCD inputs through the optional IEEE-488 interface. It consists of IC1, IC8 through IC42, IC47, DS1 through DS7, and Q1 through Q4. IC47 is highly accurate, oven-stabilized +7 volt reference. Field effect transistors Q2 and Q4 form a single pole double throw switch. Their output feeds reference filter IC1 via R18 and R20. When Q2 conducts, the switch output is connected to the 7 volt reference. When Q4 conducts, the switch output is connected to ground. A variable reference is produced at the output of the switch by alternately switching on Q2 and Q4, using a pulse of precisely adjustable duty cycle. To illustrate, a 50% duty cycle pulse would result in a reference voltage of 3.5 volts; a 25% duty cycle pulse would produce 1.75 volts, and so on.

4.29 There are two variable duty cycle pulse generators in the variable reference circuit. One is controlled by the three highest order switch decades, the other by the low order switch decades. The operation of the latter is typical of both, and will be described in detail. The block diagram of Figure 4-3 shows how the integrated circuits in this section are interconnected.

4.30 A crystal-controlled, one megahertz clock, IC42, drives a pair of three-decade counters which both run continuously. The reference counter, IC18 through IC20, consists of three TTL up-down counters connected in the down-count mode. Each time the count reaches 000, the reference counter outputs a pulse. The pulse is the clock input to one half of dual D flip flop IC13. The data input of IC13 is grounded, so that the pulse resets the flip flop. The same pulse is also the LOAD input of the presettable counter which consists of counters IC32 through IC34 connected in the count-down mode. Each time the presettable counter reaches count 000, it outputs a pulse to the SET input of flip flop IC13.

4.31 The parallel data inputs of IC32-IC34 are fed indirectly from the voltage selection switches, or the optional IEEE-488 interface, in the following manner. BCD voltage selection codes from the switches, or from the IEEE-488 interface, are fed to the address inputs of IC39 through IC41, which are 256-bit, programmable read-only memories (PROM's). These are the control PROM's and are organized as thirty-two 8-bit words. They are programmed to convert BCD at their address inputs to seven-segment display codes at their data outputs, to furnish a carry to the next higher order decade for inputs of ten or eleven and to provide an output one number higher than the BCD input when a carry is received from a lower order decade.

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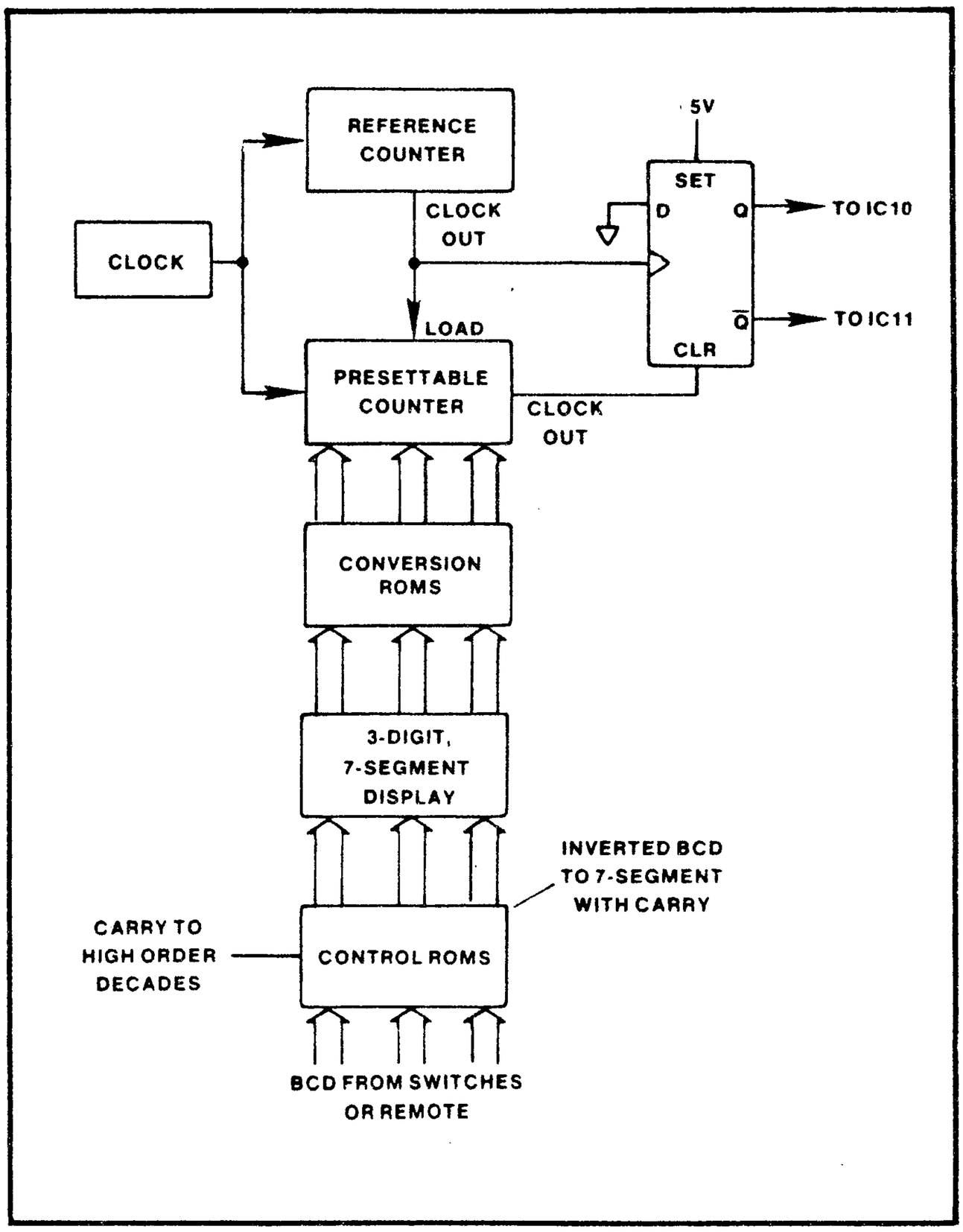

Figure 4-3. Block Diagram, Variable Reference Source.

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4.32 The data outputs of the control PROM's drive seven-segment displays DS5 through DS7, and feed the inputs of conversion ROM's IC32 through IC34. The conversion ROM's are CMOS seven-segment to BCD converters. The outputs of the conversion ROM's are always BCD numbers between 000 and 999, because all carries have been performed by the control PROM's. These outputs are fed to the parallel data inputs of the presettable counter.

4.33 A typical counting sequence occurs as follows. An input number, less than 999, is placed on the data inputs of the presettable counter. When the reference counter next reaches the count of 000, the input number is loaded into the presettable counter. The reference counter is next at 999, and the presettable counter is at the input number. The two counters count down simultaneously. The presettable counter, since it was loaded with a number less than 999, reaches its terminal count first, setting flip flop IC13. Later, the reference counter reaches 000, resetting IC13. The process is then repeated, and continues at a rate of 1000 times per second. The output of the flip flop is a pulse with a 1000 Hz repetition rate. The duty cycle of the pulse is proportional to the BCD digits at the control PROM inputs. Selecting 999 yields a pulse with a duty cycle of 99.9%; selecting 500 produces a 50% duty cycle, etc.

4.34 The Q and Q outputs of flip flop IC13 control the conduction periods of FET switch transistors Q2 and Q4, to which they are coupled through optical isolators IC10 and IC11, respectively. Q2 is connected to the 7 volt reference, and Q4 is connected to ground. At the point where the two FET's are connected together, a series of positive-going pulses are produced with their peaks at precisely +7 volts and their negative peaks at 0 volts. The duty cycle is identical to the output of IC13. The pulse passes through R16, R18, R20, R21, R23 and R24 to the junction of C3 and C7. The circuit of IC1 is a capacitance multiplier that filters the pulse input, producing an output that is the average value of the pulsed input. This average voltage is dependent on the input duty cycle, which is determined by the front panel switch settings and may be any of 1000 precisely repeatable values.

4.35 The high order section of the variable reference consists of reference counters IC14 through IC17, presettable counters IC21 through IC24, conversion ROM's IC28 through IC31, displays DS1 through DS4, and control PROM's IC35 through IC38. The high order counters differ from the previous description in the following respects. First, there is a fourth decade. Its purpose is to accept a carry from the next decade; therefore, there is no switch connected to it. Display DS1 is driven by its control PROM, IC35, and displays a "0" or a "1".

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4.36 Second, the reference counter is loaded to the count of 1299 each time it reaches 0000. This requires the use of both halves of dual flip flop IC12. One half functions as does IC13, loading the presettable counter, while the other is used to provide the reference counter's clock pulse. The data input of IC12 is tied to ground. When the reference counter reaches 0000, it drives the clock input of IC12, resetting it. The output at IC12-5 then loads the counter. IC12 is set one count later by the signal from the 1-MHz system clock. As a result, the reference counter counts down from 1299 to 0000, then, a few nanoseconds later, it is again preset to 1299 to begin a new cycle. There are a total of 1300 counts in the sequence.

4.37 The switch transistors for the high order portion of the variable reference are Q1 and Q3. The outputs of the high order and low order switches are combined at the junction of R16, R17 and R18. Note that the ratio of the series combination of R18 and R20 to R17 is 1300:1 with R18 set at midrange. this ratio establishes the relative weights of the pulses from the high order and low order decades. The two pulses are combined in a 1300:1 ratio, filtered as described in paragraph 4-34 and provided some additional filtering by R25 and C4. The filtered voltage is applied to the non-inverting input of IC2. The output of IC2 is then applied to the base of Q17 as the reference voltage for series regulator, as described in paragraph 4-26.

4.38 CONTROL LOGIC

4.39 The control logic selects standby, operate and remote modes in response to control inputs. Operate and standby may be selected using front panel push buttons. Standby may also be selected automatically, as described in paragraph 4-26. The remote mode may be selected only by an external device through the optional IEEE-488 interface. The control logic consists of one half of a CMOS dual D flip flop, IC43, and a CMOS quad NOR gate, IC44, and transistors Q5, 6, 21, 22 and 23.

4.40 When the OPERATE push button is pressed, it places a logic low on IC44-1 and IC44-2. A high is produced at IC44-3, which operates the set input of the flip flop IC43, setting its pin 12 low. Pin 12 is connected to IC44-8. Since the output of IC44-9 is always low unless the system is in the remote control mode, a high is produced at IC44-10. This turns on Q6, placing a ground on the wipers of all the voltage select switches. With ground applied to their wipers, the switches produce inverted (ground true) BCD codes. The control ROMs, IC35 through IC41, are programmed to accept the inverted codes.

4.41 When the STANDBY push button is pressed, it resets flip flop IC43 which sets its pin 12 low. The switch wipers are pulled up by R121 causing all of the inputs to the control

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ROM's to be high. Since all of the inputs to the ROM's are zeros, the output of the instrument drops to zero. Pin 12 of IC43 is also connected to the base Q21. Q21, when turned on, completes the circuit for the STANDBY LED, DS13, and turns Q22 off. When Q21 is turned off, Q22 is turned on and completes the circuit for the OPERATE LED.

4.42 Remote control is initiated by placing a low, from the IEEE-488 interface, on IC44-6. This low turns on Q23 to complete the circuit for the REMOTE LED, DS12.

4.43 INSTRUMENT POWER SUPPLY

4.44 The instrument power supply, as distinguished from the switching power supply, provides power for the instrument's internal circuits.

4.45 The operational amplifiers in the instrument are powered by positive and negative 15-volt supplies. The power source is transformer T2. Its output is rectified by diodes CR56 to CR59 and filtered by C15 and C18. IC45 and IC46 regulate the two rectified outputs to +15 volts and -15 volts respectively.

4.16 A positive 12 volt unregulated supply, consisting of CR46, CR47 and C19, provides power to the range-select relay coils. Power for the logic ICs and displays comes from an unregulated +5 volt supply consisting of CR48, CR49 and C20.

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SECTION V - MAINTENANCE

2701B CALIBRATION

5.1 INTRODUCTION

5.2 This section provides maintenance information for the Model 2701B Programmable Precision DC Calibrator. Included are a recommended test equipment list and calibration procedures.

5.3 RECOMMENDED TEST EQUIPMENT

5.4 This procedure requires the following items of test equipment:

Digital Voltmeter	Guildline 9574 (1 microvolt sensitivity with accuracy of 0.01% or better).
Calibration System	Guildline 9936

or the following:

Precision Kelvin-Varley Voltage Divider	John Fluke Model 720A
Voltage Reference Standard	John Fluke Model 731B
Null Detector	John Fluke Model 845AB

5.5 CALIBRATION PROCEDURE

5.6 The following procedure should be performed at routine intervals to insure that the instrument remains within specified limits. In addition, calibration should be performed whenever repairs have been completed involving accuracy determining components.

CAUTION

The voltage at the front panel output and sense terminals may be dangerous to life. Contact with the terminals while the instrument is in the operate mode may result in serious injury or death. The user should exercise extreme caution to insure that the instrument is in the standby mode before connecting or disconnectig leads to the output or sense terminals.

5.7 If the Guildline Calibration System is used, refer to its operation manual for instructions on equipment connections. If

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other equipment is used, connect it to the 2701B as in Figure 5-1. Verify that the sense terminals of the Model 2701B are strapped to their respective output terminals.

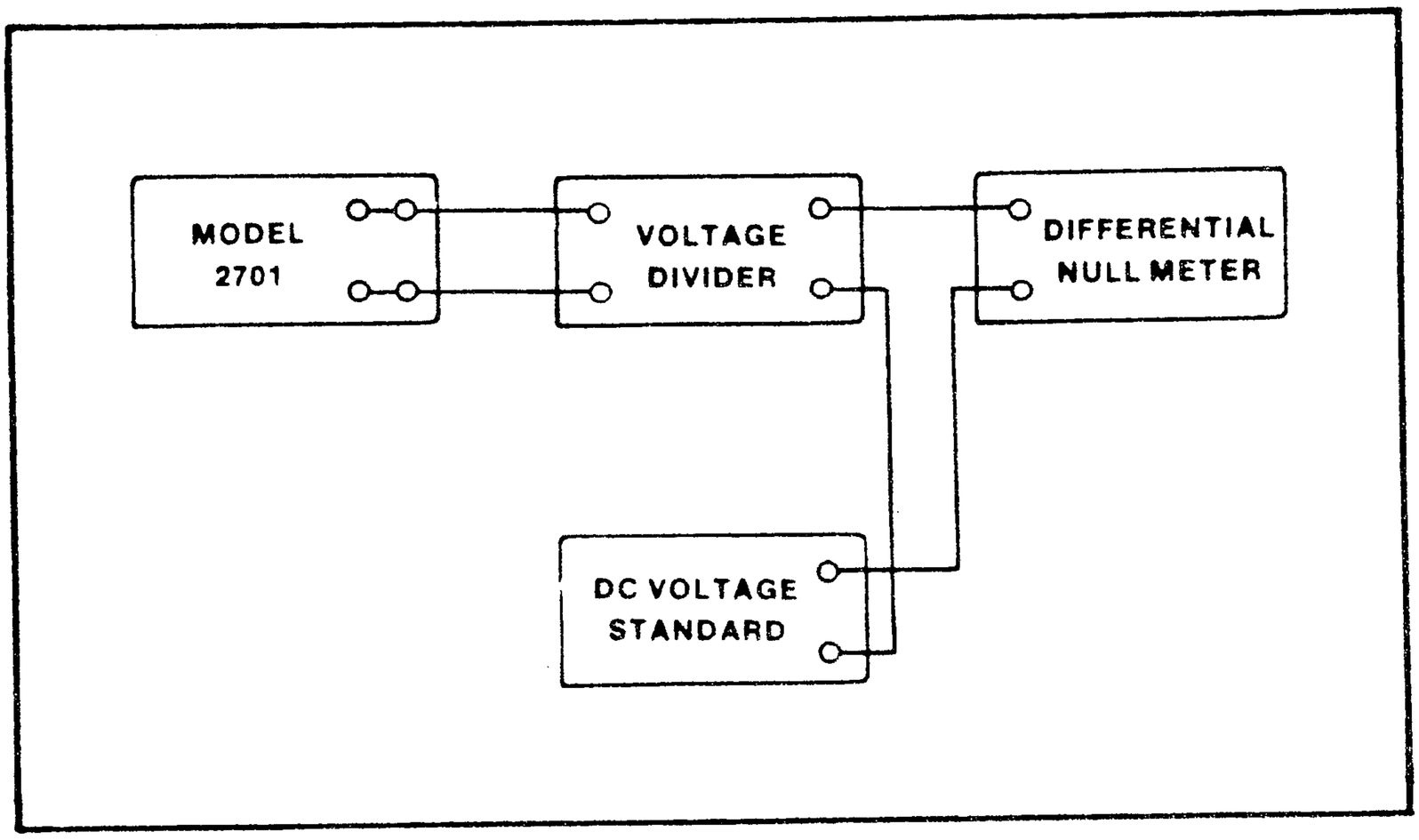

Figure 5-1. Test Equipment Connections.

5.8 CALIBRATION SET-UP

5.9 Connect the 2701B per Figure 5-1. Apply power to the 2701B, ensure the 2701B is in standby and in the 1.2V range. Allow 1 hour for warm up stabilization. Note: Keep 2701B Top Cover in place during calibration.

5.10 ZERO CALIBRATION

5.11 Substitute the voltage standard with a short circuit.

5.12 Set the voltage divider to 0.99999X.

5.13 With the 2701B in the 1.2 volt range, adjust R26 for a null detector reading of less than $\pm$2 microvolts.

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5.14 Select the 12. volt range and adjust R157 for a null detector reading of less than ±20 microvolts.

5.15 LINEARITY CALIBRATION

5.16 Connect the output terminals of the 2701B to the DVM. Select the 12 volt range and press the OPERATE push button on the 2701B.

5.17 Set the output switches of the 2701B to 0000999.

5.18 Adjust R18 for a DVM reading of 9.990 millivolts.

5.19 Set the rightmost output switch to 10, so the 999's will carry to 0001000.

5.20 Adjust R148 for a DVM reading of 10.00 millivolts.

5.21 Repeat the steps of paragraphs 5-17 through 5-20 until optimum accuracy is achieved.

5.22 FULL SCALE CALIBRATION

5.23 Reconnect the test equipment as in Figure 5-1.

5.24 Set reference standard for 10 volts output.

5.25 Place the 2701B in the 12 volt range and set its switches to 10.00000. Set the voltage divider to .99999X.

5.26 Ensure the 2701B is in operate mode and adjust R23 for a null detector reading of less than ±50 microvolts on the null detector.

5.27 Place the 2701B in the 1.2 volt range and set the Reference Standard to 1 volt. Ensure the voltage divider is still set to .99999X.

5.28 Ensure the 2701B is in the operate mode and adjust R158 for a null of less than ±5 microvolts on the null detector.

5.29 Set the voltage divider to 0.10000. Set the Reference Standard for 10 volts. Place the 2701B in standby and switch to the 120 volt range.

5.30 Place the 2701B in the operate mode and adjust R41 for a null less than ±50 microvolts on the null detector.

5.31 Place the 2701B in the standby mode. Set the voltage divider to 0.01000. Switch the 2701B to the 1200 volt range.

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5.32 Place the 2701B in the operate mode. Allow 3 minutes for the 2701B to settle then adjust R46 for a null less than ±50 microvolts on the null detector.

5.33 Repeat the steps in paragraphs 5-22 through 5-32 allowing the 2701B to settle until accuracy is achieved.

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SECTION VI

2701B IEEE-488 OPERATION INSTRUCTIONS

6.0 GENERAL

6.1 This manual contains information regarding the operation of options TL-3 IRP and PRM.

The TL-3 option is a full talk/listen IEEE-488 (1981) interface with the capability of full control of the 2701B and options.

The option IRP is an additional option giving the capability of controlling an external current source such as the Valhalla 2500EP.

The option PRM is an additional option giving the capability of controlling the polarity of the 2701B's output voltage.

These options are factory fitted as ordered.

6.2 BUS OPERATION

6.3 IEEE-488, AN EXPLANATION OF THE BUS

The reader that is unfamiliar with the IEEE-488 standard will want to review the following paragraphs which provide explanations of the terms, commands and some examples. For a complete explanation of the requirements the reader should refer to the IEEE-488 standard itself.

6.4 DEFINITIONS

The following are the definitions of the terms used in describing the IEEE-488 interface bus.

BI-DIRECTIONAL BUS : A "highway" used for two-way communication, both input and output data being conveyed on the same lines.

BUS : A data link which is usually a set several wires within a multi-wire cable.

BIT PARALLEL : Used to describe data which is present simultaneously on a number of wires in a bus.

BYTE : A group of data bits (usually 8) which is treated as a single item of data.

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BYTE SERIAL	:	Information, in bit-parallel bytes, transfered between devices sequentially.
DEVICE DEPENDANT MESSAGE	:	A message containing data/commands specifically for a recipient device.
HANDSHAKE	:	A sequence of signals controlling the transfer of data over a bus. Each condition in turn must occur before the next.
INTERFACE	:	The part of an instrument or system which enables it to be connected to another via a bus.
INTERFACE MESSAGE	:	A message that is for interface management.
LOCAL OPERATION	:	Operation of a device by its front panel controls, also known as MANUAL CONTROL.
REMOTE OPERATION	:	Operation of a device under the control of another via a bus.

The IEEE-488 interfacing standard (also known as IEC DTC66 (WG3), ANSI MC1-1, GPIB, HP-IB, etc) defines a bi-directional bus for interconnecting programmable instrumentation in a bit-parallel, byte serial manner. It determines limitations as follows:

A maximum of 15 devices may be interconnected by a single bus.

The total bus length may not exceed 20 meters or the number of devices multiplied by two, whichever is shorter.

Maximum transmission rate is 1 megabyte per second.

All bus data is digital.

Of the devices on the bus, only one may be a controller, exercising control over all other devices and also capable of operating as a "talker" or a "listener". The other devices may be listeners (only able to receive data), talkers (only able to transmit data) or both (as 2701B is). The controller addresses other devices and commands them to listen, talk or neither (as required). Only a single device may talk at any one time.

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The interconnecting cable contains 16 signal wires and 8 ground wires linking all devices into a complete system. The cable connectors consist of a plug/socket combination that enable "daisy-chaining" of units.

The 16 signal wires comprise:

8 data wires (DIO 1 through 8)

5 management wires (ATN, EOI, SRQ, IFC and REN)

3 handshake wires (DAV, NRFD and NDAC)

It should be noted that all wires use "inverse logic", i.e. a low level is used to indicate a true state, while a high level indicates false.

ATN - Is asserted by the controller whenever an address or an interface message is present on the bus.

EOI - Is asserted by the talker to indicate the last byte of data, or it may be asserted by the controller (with the ATN wire asserted) to poll the state of the devices on the bus.

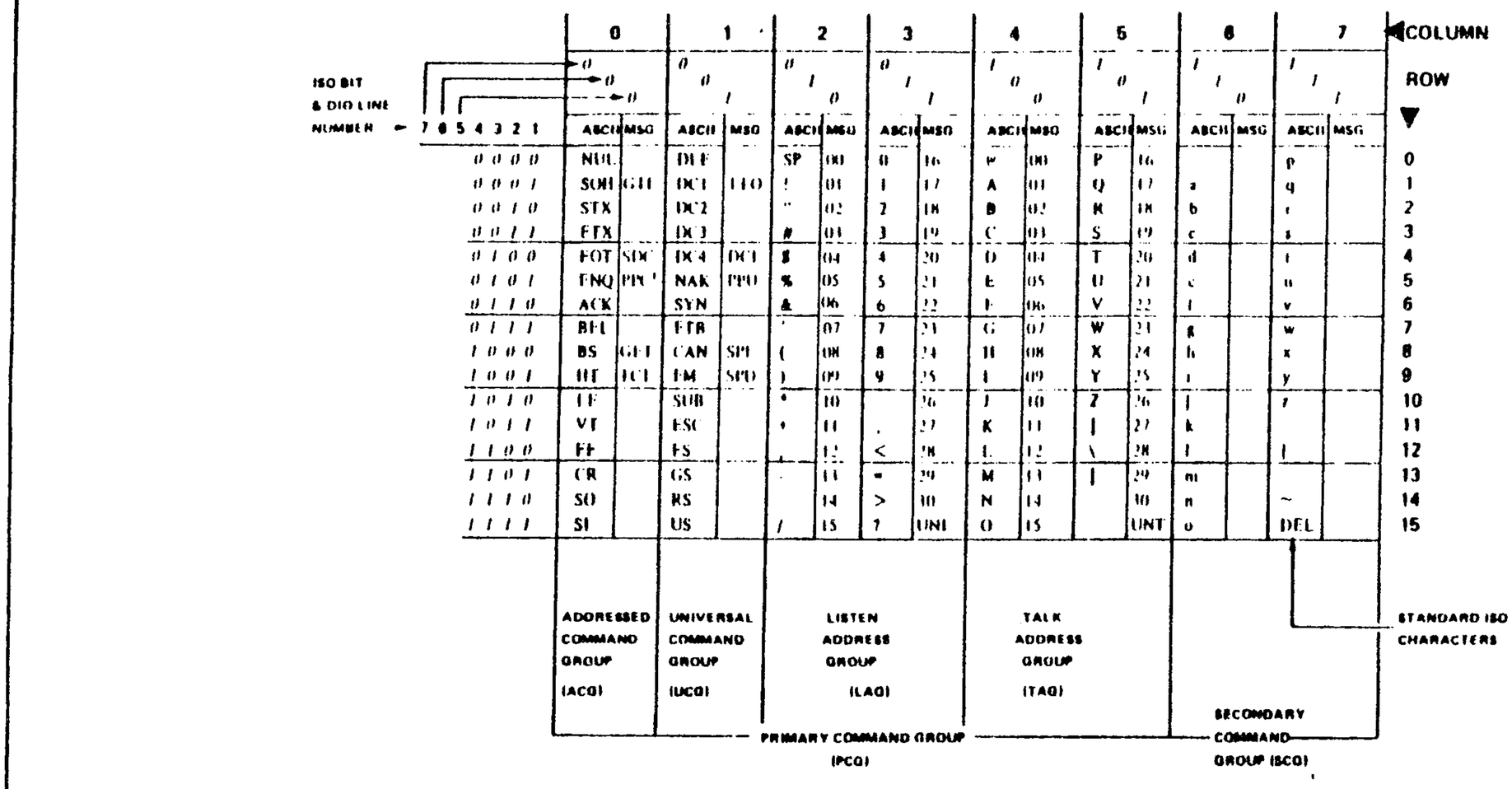
SRQ - May be driven by any device on the bus. When asserted it is normally used to indicate to the controller that a device requires attention.

IFC - Is driven by the controller to initialize the interfaces of all devices on the bus.

REN - Is driven by the controller to indicate to all devices on the bus that they may (or may not) enter the REMOTE state.

The transfer of data on the bus is controlled by the 3 handshake wires such that the bus speed is reduced to that of the slowest device. The talker first waits for all devices to be ready to accept data (NRFD false) then puts the data on the bus with DAV true. It then waits for all devices to accept the data (NDAC becoming false). This process is repeated for every byte to be transfered.

Data is sent in 8-bit bytes on the DIO wires, usually (as in 2701B) using the ISO-7 standard ASCII characters. Table 6-1 lists the ASCII character set. Note that the table is divided into two main groups, the Primary Command Group and the Secondary Command Group. The Secondary Command Group is unused in the 2701B.



[1] Requires Secondary Command

Notes

1. Device Address messages shown in decimal
2. Message codes are

DCL	Device Clear	LLO	Local Lockout	SDC	Selected Device Clear
GET	Device Trigger	PPC	Parallel Poll Configure	SPD	Serial Poll Disable
GTL	Go to Local	PPU	Parallel Poll Unconfigure	SPE	Serial Poll Enable

Table 6-1. ASCII Character Codes.

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The Primary Command Group is divided into 4 sub-groups as follows:

1) Addressed Command Group - commands applied only to addressed devices.

2) Universal Command Group - commands applied to all devices on the bus.

3) Listen Address Group - commands addressing listeners.

4) Talk Address Group - commands addressing talkers.

All data/commands in the above groups are sent with ATN asserted. Data with ATN false is "Device Dependent".

6.5 GENERAL 2701B BUS BEHAVIOR

6.6 Input Buffer

All incoming device-dependent data to the 2701B is placed in an input buffer as it is received. No action is taken on this data until any one of the valid delimiters is received. When the delimiter is received, then the data contained in the input buffer is decoded, actioned and the data erased. Input data is held off until the complete input buffer has been decoded and actioned.

Should an invalid character be detected in the input buffer, then the contents are only decoded and actioned up to that character, the rest being erased. An SRQ may be asserted at this time if required by the user. The valid input delimiters are Carriage Return or EOI asserted with the last character.

6.7 Output Buffer

An output buffer is continuously updated (even when in LOCAL) with the present state of the 2701B. This data may be read by the controller at any time.

6.8 IEEE Address

The address of the 2701B within the bus is set by means of a set of switches on the rear-panel. These switches form the address by a binary code (ON=1) as shown on the rear-panel. The user should note that the state of the switch is only read at the application of power to the 2701B.

6.9 REMOTE/LOCAL States

At power-up the 2701B will be in the LOCAL state, i.e., the front-panel controls are fully operational. In order for the 2701B to enter the REMOTE state the following sequence of events must occur (as stipulated by the IEEE-488 standard):-

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1) The REN (Remote ENable) wire must be true (pulled low).

2) The 2701B must receive its listen address.

With an HP85 computer this is achieved by the statement REMOTE 709 (assuming the 2701B address is set to 9). In all future examples an address of 9 is assumed as is an HP85 controller.

When the 2701B is in REMOTE the REMOTE indicator on the 2701B front panel will be illuminated and all front-panel controls except POWER, OPERATE and STANDBY will be inoperative.

The controller may return the 2701B to the LOCAL state at any time by unasserting the REN wire (LOCAL 7 for the HP85), by sending the character "L", or by device clear.

6.10 SIMPLE COMMANDS AND EXAMPLES

6.11 Non-free Format Commands

6.12 "V" Command - Voltage Display.

For compatibility with previous 2701B IEEE-488 interface products this unit has the capability of receiving a 6 character output voltage command. This command is of the form Vxxxxxx. Each x represents the character whose least significant 4-bits are the digit required in that decade of the 2701B's display in order to provide the required output.

For example: the string V123456 - will cause Ø123456 to be displayed
V:23456 - will cause 1Ø23456 to be displayed
V::3456 - will cause 11Ø3456 to be displayed

The user is referred to Table 6-1 for exact details of the LS 4-bits of the above characters.

6.13 "R" Command - Range Command

The range of the 2701B may be commanded by a 2-character command. This takes the form Rx. The digit x may be between Ø and 3 representing:

Ø - 1.2V range
1 - 12V range
2 - 12ØV range
3- 12ØØV range

This range command is usually used in conjunction with the Vxxxxxx command shown above.

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e.g. sending the string R1V:ØØØØØ - will cause an output of 1ØV.

6.14 "I" Command - IRP and/or PRM Option Control

This command is used to directly control the control of the option IRP and PRM. This command takes the form Ixy. The first digit x is the control of the IRP option and takes the following meaning when used with a 25ØØEP:

9 - 1ØØuA range
: - 1mA range
; - 1ØmA range
< - 1ØØmA range
= - 1A range
> - 1ØA range
Ø,1,2,3,4,5,6,7,8,? cause no 25ØØEP range to be selected.

The second digit y is used to control polarity with the PRM option. If the least significant bit of the code is a Ø (e.g. Ø,2,4,6,8, etc.) then a positive output polarity is obtained while if the least significant bit of the code is a 1 (e.g., 1,3,5,7,9, etc.) then a negative polarity output is obtained.

The user should note that, independant of which option(s) is fitted both x and y are required.

e.g. The string
- IØØ - will command no 25ØØEP range, positive output
- IØ1 - will command no 25ØØEP range, negative output
- I9Ø - will command 1ØØuA 25ØØEP range, positive output

6.15 Previous 2701B IEEE compatability.

This TL-3 option is fully compatable with previous versions of this interface. The above mentioned commands are the only commands utilized by the previous version of this interface. If the user had previously used the "oddities" of the previous version then some modifications may be required and the user should note the following changes:

1) A delimiter is required - either Carriage Return
   or EOI with the last character
   or Group Execute Trigger

2) The previous version would take the next 6 characters after the "V", or 2 characters after the "I", or 1 character after the "R". This version will not update data which is missing -

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e.g. The string V: - will cause the last 5 decades to not be changed, only setting the first 2 to "1Ø".

6.16 Free-format Commands.

6.17 Voltage Control

The required output voltage from the 2701B may be directly controlled by utilizing the "VO" command. This command takes the form VO followed by the required voltage in free-format numeric form (no range command is required). The following are some examples of the string of characters that the 2701B will accept:

VO+1.234567	-	will cause +1.23456 volts to be output
VO1.234567	-	will cause +1.23456 volts to be output
VO-1.5e+1	-	will cause -15 volts to be output
VO-1.5E+1	-	will cause -15 volts to be output
VO+1.6e-3	-	will cause +Ø.ØØ16 volts to be output

The user should note that entry of the numeric value may be in any commonly used format and is delimited by any character not normally used in numeric fields.

The user should also note that the commands in section 6.4.1 above may be used in conjunction with the VO command if required.

6.18 Current Control

The required output current from a 2701B+25ØØEP combination may be directly controlled by utilizing the "IO" command. This command takes the form IO followed by the required current (in milliamps) in any form. The following are some examples of the string of characters that the 2701B will accept:

IO+Ø.Ø6	-	will cause an output of +6ØuA
IO1ØØØØ	-	will cause an output of +1ØA
IO-1e4	-	will cause an output of -1ØA
IO1E-2	-	will cause an output of +1ØuA

The user should note that entry of the numeric value may be in any commonly used format and is delimited by any character not normally used in numeric fields.

The user should also note that the commands in section 6.4.1 above may be used in conjunction with the IO command if required.

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6.19 Standby/Operate Mode Control

In contrast to previous versions, this version of the TL-3 interface has the capability of controlling the STANDBY/OPERATE status of the 2701B's output. Every output command received by the 2701B causes operate to be selected and the command string "S" will cause standby to be selected.

The string	R2V:ØØØØØ	-	will cause 1ØØV OPERATE to be selected
	R2V:ØØØØØ5	-	will cause 1ØØV STANDBY to be selected
	S	-	will cause STANDBY to be selected
	V	-	will cause OPERATE at the previously used output to be selected.

6.20 Reading the Output

This version of the 2701B option TL-3 enables the user to read the present output of the 2701B (or 2701B+25ØØEP if required). The string sent by the 2701B is of the following format:-

sn.nnnnnnEsn xxo

where s is the applicable polarity
n is the numeric value
xx is "V" if IRP is commanding no range, "mA" if an IRP range is commanded. o is a space if in OPERATE, "*" if in STANDBY.

While the numeric data is correct with the 2701B in LOCAL or REMOTE, the exponent is only available in REMOTE (set to Ø in LOCAL).

6.21 ADVANCED COMMANDS AND EXAMPLES

6.22 Output Delimiter Control

The output string shown in 6.4.3 above may have one of various delimiters. The delimiter used is commanded by the "E" command-

The string	EØ	-	Causes (Carriage Return), (Line Feed)
	E1	-	Causes (Carriage Return), (Line Feed with EOI)
	E2	-	Causes (Carriage Return)
	E3	-	Causes (Carriage Return with EOI)
	E4	-	Causes EOI with the last character

to be output following (or with) the last character.

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6.23 Serial Poll Control/Response

If required by the user, the 2701B may assert SRQ upon attempted decode of an invalid command. This is controlled by the use of the "Q" command.

The string	Q∅	-	Causes no SRQ's to be generated.
	Q1	-	Causes an SRQ to be generated upon attempted decode of an invalid command.

The response to a serial poll will be a null byte if the 2701B was not requesting service and will have the least significant bit set if it was. The most significant bit is set if the 2701B is in REMOTE.

6.24 USEFUL HINTS

6.25 Polarity Changing

The PRM option in the 2701B operates by reversing the output terminals of the 2701B. Thus, it is not recommended to change polarity while the output is at a voltage of over 1∅∅ volts. If a polarity change with over 1∅∅V is required the user is recommended to reduce the output, delay for 5mS per V and then command the polarity change.

Examples (using HP85 controller)

```
Output was at +1∅∅∅V, requires to change to -1∅V
OUTPUT71∅;"VO1∅∅"
WAIT 5∅∅∅
OUTPUT71∅;"VO-1∅"

Previous output voltage held in variable A
Output required held in variable B
1∅ IF ABS(A)<1∅∅ THEN 1∅∅
2∅ C=A/1∅                    (Ensures output less than 1∅∅V)
3∅ OUTPUT71∅;"VO",C          (Note 2701B will ignore spaces)
4∅ WAIT 5*ABS(C)
1∅∅ OUTPUT71∅;"VO",B
```

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SECTION VII - PARTS LISTS

7.1 GENERAL

The parts lists of this section are reproductions of factory parts lists. The designators are those of the diagrams in Section V. When ordering replacement parts, provide the reference designator, manufacturer's part number, manufacturer's name and Valhalla part number if contained in the parts list. The manufacturer is identified in the parts list by a federal stock number. A list of manufacturer's federal stock codes is provided as an appendix to this manual for identification of manufacturer's.

Valhalla Scientific Inc.	PARTS LIST	CHASSIS ASSEMBLY	MODEL 2701B	DWG NO 2701-400	REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
1	J 1,2	5-10001	BINDING POST, RED	SUPERIOR	BP21RC	2					
2	J 3,4	5-10003	BINDING POST, BLK	SUPERIOR	BP21BC	2					
3			MAIN P.C.B.	53504	2701-601	1					
4			DISPLAY P.C.B.	53504	2701-600	1					
5											
6	S 10	5-03030	PUSH BUTTON SWITCH	SCHADOW	ZFFA200 BLK YEL 2UEE	1					
7	S 11	5-03034	115/230 SLIDE SWITCH	82389	47227LFR	1					
8		5-10430	STANDOFF, 1/4" MF HEX, 5/16 LG	RAF	4531-632-SS-O	2					
9	T 1	4-20025	HIGH VOLTAGE TRANSFORMER	53504	2701-012	1					
10	T 2	4-20026	POWER TRANSFORMER	53504	2701-013	1					
11	F 1	5-04007	FUSE 1/2A		1/2A SLO-BLO	1					230V OPERATION
12	F 1	5-04002	FUSE 1A	75915	1A SLO-BLO	1					115V OPERATION
13		5-10166	LINE FILTER, AC RECPT.	CORCOM	6EF1	1					
14		5-10067	POWER CORD	ELECTROCORD	39806	1					
15		5-10291	R.P. HOLE PLUG	83330	3091	4					FOR REAR POST
16	XF 1	5-10018	FUSE HOLDER, PNL MT	75915	342004A	1					
17		5-10201	NUMBER SKIRT	95146	AW5-310	6					
18		5-10202	COLLET KNOB	95146	AS1-352-W3-302	7					
19		5-10203	POINTER SKIRT	95146	AW5-382	1					
20			SCREW, CAD,PHIL,PAN,HD		6-32 x 9/16	4					
21			SCREW, CAD,PHIL FLAT,HD	82°	6-32 x 3/8	11					
22			SCREW, BLK PHIL PAN HD		4-40 x 1/2	4					
23			SCREW, CAD PHIL PAN HD		8-32 x 1/2	8					

NOTES:

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PARTS LIST

CHASSIS ASSEMBLY | MODEL 2701B | DWG NO 2701-400 | REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
24			SCREW, CAD PHIL FLAT HD	82°	8-32 x 1/2	4					FOR RACK EARS
25			SCREW, CAD PHIL PAN HD		6-32 x 3/8	12					
26		5-10086	WASHERS GND LUG	83330	1412-6	1					
27			WASHERS INTERNAL STAR		#6	16					
28			WASHERS SPLIT-LOC		#6	7					
29			WASHERS SPLIT-LOC		#4	4					
30			WASHERS INTERNAL STAR		#8	16					
31			SCREW, CAD, PAN, HD		6-32 x 1/2	10					
32			NUTS, RADIO HEX		6-32	13					
33			NUTS, RADIO HEX		4-40	4					
34			NUTS, STD HEX		8-32	8					
35		5-10015	RUBBER FEET	83330	701-BLK	4					
36		4-10332	CORNER BLOCK	53504	2724-204	4					
37		4-10476	FRONT PANEL	53504	2701-100	1					
38		4-10291	REAR PANEL	53504	2701-208	1					
39		4-10459	SIDE RAIL	53504	2701-215	2					
40		4-10288	MOUNTING BRACKET	53504	2701-211	2					
41		4-10318	COVERS TOP/BOTTOM	53504	2724-203	2					
42		4-10277	MOUNTING EARS	53504	2714-206	2					
43		4-10333	BEZEL	53504	2724-205	4					
44		4-10305	BUTCH PLATE IEEE	53504	4300-213	1					
45		4-10257	BUTCH PLATE IRP	53504	2701-206	1					
46			#6 RING LUG	06383	PV20-6R	8					

NOTES.

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Valhalla Scientific Inc.	PARTS LIST	CHASSIS ASSEMBLY	MODEL 2701B	DWG NO 2701-400	REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
47			WIRE:								
48			RED, 34"		20 AWG	1					
49			WHITE, 16"		20 AWG	1					
50			GREEN, 4"		20 AWG	1					
51			BLACK, 34"		20 AWG	1					
52			YELLOW, 8"		20 AWG	1					
53			RED, 39"		18 AWG	1					
54			ORANGE, 12"		20 AWG	1					
55			GRAY, 28"		18 AWG	1					
56			BLACK, 24"		18 AWG	1					
57											
58			HI VOLTAGE CABLE	COLUMBIA	3399	1					
			RED, 15"								
59											
60			#8 RING LUG	06383	PV20-8R	2					
61		5-10261	TIE DOWN BLOCK	06383	ABM2S-A	1					
62			WASHER, SPLIT LOG		#8	8					FOR X FORMER
63			SCREW,PHIL,FLAT HD,STAIN		6-32 x 1/2	8					
64			SCREW,BLK,PHIL,PAN HD		6-32 x 1/4"	2					
65			SCREW,CAD,PHIL,FLAT 82"		6-32 x 1/2"	3					
66											
67											
68											

NOTES: SHT 4 is ASSY DWG.

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Valhalla Scientific Inc.	PARTS LIST	MAIN P.C.B. ASSEMBLY	MODEL 2701B	DWG NO 2701-601	REV K

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
1	C1	2-20009	CAP, MICA 470pf	81349	CM05FD471J03	1					
2	C41	2-60001	CAP, MYLAR .22µf			1					
3	C2	2-80003	CAP, .22µf, POLY,1500V			1					
4	C4	2-90004	CAP, MYLAR .01µf	14752	625B1A103J	1					
5	C5, 29, 37, 38	2-90005	CAP, POLY .1µf/50V	14752	625B1A104J	2					
6	C8	2-10004	CAP, CERM .02µf/500V			1					
7	C9,10,11,12	2-40009	CAP, ELEC 47µf/450V			4					
8	C13, 14, 36	2-40011	CAP, ELEC 10µf/350V	56389	TVA-1604	3					
9	C15	2-40010	CAP, ELEC 1000µf/25V	56289	TVA-1211	1					
10	C16, 19	2-40008	CAP, ELEC 470µf/25V	56289	TVA-1209	2					
11	C17,21,26,27	2-30001	CAP, TAN 10µf/25V	05397	T360B106M025AS	7					
	28,32,35										
12	C20	2-40012	CAP, ELEC 15,000/10V	Illinois	159TTA0010B	1					
13	C22-25, 6	2-10000	CAP, CERM.005µf,100V	56289	5GAD50	5					
14	C39, 40	2-10012	CAP, CERM .02µf/1KV	56289	5GA-S20	2					
15	C3, C7	2-50000	CAP, POLY .22µf	FDYNE	FSA .22µf 10%	2					
16	CR 1-6, 46-49	3-20002	DIODE, RECT	04713	IN4001	14					
	56-59										
17	CR 7,62,63	3-20005	DIODE, ZENER 6V	04713	IN5234	3					
18	CR 8,11,40,41,64	3-20000	DIODE	04713	IN4148	6					
	12										
19	CR9, 10	3-20006	DIODE	07263	FD300/IN3595	2					
20	CR42-45,54,55,61	3-20015	DIODE RECT	04713	IN4007	7					

NOTES

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Valhalla Scientific Inc.	PARTS LIST	MAIN P.C.B. ASSEMBLY	MODEL 2701B	DWG NO 2701-601	REV K

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
21	CR 50-53, 60	3-20016	DIODE HV	04713	MR250-2	5					
22											
23	IC 2	3-30111	IC OP-AMP	32293	1CL7650ICPD or IJD	1					
24	IC 3,4,5,1	3-30074	IC OP-AMP	27014	LF356H	4					
25	IC 6	3-30094	IC OPTO-ISO	28480	4N45	1					
26	IC 8,9,10,11	3-30093	IC OPTO-ISO	28480	HCPL-2601	4					
27	IC 12, 13	3-30095	IC DUAL D FLIP-FLOP	01295	74LS74	2					
28	IC 14-27	3-30047	IC UP-DOWN COUNTER	02335	74LS190N	14					
29	IC 28-34	3-30080	IC 7 SEGMENT TO BCD	27014	74C915	7					
30	IC 42	3-30059	IC QUAD NAND	86684	74LSOON	1					
31	IC 43	3-30026	IC DUAL D FLIP-FLOP	86684	CD4013BE	1					
32	IC 44	3-30024	IC QUAD NOR	86684	CD4001BE	1					
33	IC 45	3-30036	IC REG +15V	27014	LM340T-15	1					
34	IC 46	3-30037	IC REG -15V	27014	LM320T-15	1					
35	IC 47	3-30096	IC REFERENCE	27014	LM199AH	1					
36	IC 48	3-30034	IC REG POS	27014	LM340T-5	1					
37	IC 49	3-30042	IC REG +5V (TO-3)	27014	LM7805CK	1					
38	IC 7	3-30084	IC OPTO-ISO	27014	IL-1	1					
39											
40											
41											
42											
43											

NOTES:

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Valhalla Scientific Inc.	PARTS LIST	MAIN P.C.B. ASSEMBLY	MODEL 2701B	DWG NO 2701-601	REV K

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
44	Q 1,2,3,4	3-10016	TRANSISTOR FET	17856	VN66AK	4					
45											
46	Q 7-18	3-10015	TRANSISTOR NPN	04713	MJE3439	12					
47	Q 19	3-10018	TRANSISTOR NPN	18722	T1P50	1					
48	Q 20	3-10017	TRANSISTOR POWER	16758	DTS-801 or 2N6543	1					
49											
50											
51											
52	K 1,2,3,	5-03043	LOW THERMAL EMF RELAY	71707	CR3221-12-810	3					
53											
54	R123, 124, 125	1-30019	RES FXD 100K 1 W 5%	81349	RC32GF273J	3					
55	R 1,3,5,7,9,13,	1-01081	RES FXD 100K 1/4W 5%	81349	RC07GF104J	9					
	52,58,155										
56	R 2,4,6,8,10,	1-01041	RES FXD 1K 1/4W 5%	81349	RC07GF102J	12					
	12,38,48,32,57										
	150,151										
57	R 14	1-01014	RES FXD 39Ω 1/4W 5%	81349	RC07GF390J	1					
58	R 15, 149	1-30011	RES FXD 1K 10W	91637	RS-10-1K	2					
59	R 16, 19, 21		FACTORY SELECT			3					
60	R 17	1-20016	RES FXD 1K .05% 2PPM	00002	J110-1K	1					
61	R 18	1-50024	RES VAR 100K	73138	68WR-100K	1					
62	R 20	1-10111	RES FXD 1.24M 1%	81349	RN60C1244F	1					
63	R22, 161	1-01070	RES FXD 33K 1/4W 5%	81349	RC07GF333J	2					

NOTES

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Valhalla Scientific Inc.	PARTS LIST	MAIN P.C.B. ASSEMBLY	MODEL 2701B	DWG NO 2701-601	REV K

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
64	R 23	1-50033	RES VAR 50Ω	73138	68WR-50	1					
65	R 24, 30	*1-20109	RES FXD 49.75k, .01%	05347	1-20065	2					
66	R 25, 135	1-20035	RES FXD 5K .01%			2					
67	R 26, 157, 158	1-50028	RES VAR 50K	73138	68WR - 50K	3					
68	R 27	1-01089	RES FXD 300K 1/4W 5%	81349	RC07GF304J	1					
69	R 28	1-01007	RES FXD 10Ω 1/4W 5%	81349	RC07GF100J	1					
70	R 29	1-01045	RES FXD 2K 1/4W 5%	81349	RC07GF202J	1					
71	R 44, 47	1-01053	RES FXD 4.7K 1/4W 5%	81349	RC07GF472J	2					
72	R 33,34,35,36	1-01087	RES FXD 240K 1/4W 5%	81349	RC07GF244J	4					
73	R 37	1-01083	RES FXD 150K 1/4W 5%	81349	RC07G154J	1					
74	R 39	*1-20109	RES FXD 200K .01%	05347	1-20066	1					
75	R 40A, 40B	*1-20109	RES FXD 899.75Ω .01%	05347	1-20067	2					
76	R 42, 62	1-01063	RES FXD 15K 1/4W 5%	81349	RC07GF153J	2					
77	R 43,59,60,63	1-01061	RES FXD 10K 1/4W 5%	81349	RC07GF103J	8					
	64,65,146,31										
78	R 45	*1-20109	RES FXD 19.995K .01%	05347	1-20068	1					
79	R 46	1-50018	RES VAR 10 Ω	73138	68WR - 10	1					
80	R 49	1-01047	RES FXD 2.4K 1/4W 5%	81349	RC07GF242J	1					
81	R 51,161	1-01119	RES FXD 10M 1/4W 5%	81349	RC07GF106J	2					
82	R 53,54,55,56	1-01031	RES FXD 390Ω 1/4W 5%	81349	RC07GF391J	4					
83	R 61, 156	1-01021	RES FXD 100Ω 1/4W 5%	81349	RC07GF101J	2					
84	R 41	1-50013	RES VAR 1K	73138	68WR - 1K	1					
85											

NOTES: * R24, R30, R39, R40A, R40B, R45 and R160 are a matched set.

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Valhalla Scientific Inc.	PARTS LIST	MAIN P.C.B. ASSEMBLY	MODEL 2701B	DWG NO 2701-601	REV K

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
86	R 50, 69	1-01049	RES FXD 3K 1/4W 5%	81349	RC07GF302J	2					
87	R 126	1-01033	RES FXD 470Ω 1/4W 5%	81349	RC07GF471J	1					
88	R 127	1-01026	RES FXD 220Ω 1/4W 5%	81349	RC07GF221J	1					
89	R128-131,142-145	1-01085	RES FXD 200K 1/4W 5%	81349	RC07GF204J	8					
90	R 132	1-30012	RES FXD 500K 1% 6W	Caddock	MS260-500K	1					
91	R 133, 134	1-01108	RES FXD 3M 1/4W 5%	81349	RC07GF305J	2					
92	R 147	1-30013	RES FXD 100Ω 1/2W	81349	RC20GF101J	1					
93	R 148	1-50012	RES VAR 10K	73138	68WR-10K	1					
94	R 153	1-30014	RES FXD 47K 1W	81349	RC32GF473J	1					
95	R 159	1-10048	RES FXD 1MΩ .01%	81349	RN55C1004F	1					
96	R 160	*1-20109	RES FXD 20608Ω .01%	05347	1-20109	1					
97	Y 1	5-02000	1MHz CRYSTAL		HC6-1MHz	1					
98											
99		4-30053	P.C. BOARD MAIN	53504	2701-701	1					
100		5-10025	HEAT SINK	13103	6003B-2	2					
101			SILICON GREASE			AR					
102		5-10229	WASHER, BERYLLIA		CG3835-1	2					
103	P 1-8		22 AWG WIRE .05LG			8					
104		5-10019	CABLE TIES	51705	WRN 3 1/2	4					
105		5-10221	CABLE TIES	51705	WRN 7	1					
106			SCREW PHIL PAN, CAD		4-40-1/4	3					
107			WASHER SPLIT LOCK		#4	3					
108		4-10032	PANEL STIFFNER	53504	4004-202	1					

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Valhalla Scientific Inc.	PARTS LIST	MAIN P.C.B. ASSEMBLY	MODEL 2701B	DWG NO 2701-601	REV K

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
109			SCREW PHIL PAN		6-32 x 3/8	4					
110			WASHER, SPLIT LOCK		#6	4					
111			NUT, HEX		6-32	4					

Valhalla Scientific Inc.	PARTS LIST	DISPLAY PCB ASSEMBLY	MODEL 2701B	DWG NO 2701-600	REV G

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
1	C 31	2-30004	CAP, TAN luf	05397	T360B105M01AS	1					
2											
3	CR 12-36	3-20000	DIODE	04713	IN4148	25					
4											
5											
6	DS 1-7	5-01010	DISPLAY 0-9	28480	5082-7650	7					
7	DS 8,9,10,11,12	5-01011	LED - RED	28480	5082-4655	6					
8	DS 13										
9											
10											
11	IC 35-41	3-50000	IC PROM	01295	74S288N	7					
12	Q6	3-10013	TRANSISTOR	27014	2N4401	1					
13	Q 21, 22,5	3-10014	TRANSISTOR DARLINGTON	27014	2N5305	3					
14	Q 23	3-10010	TRANSISTOR PNP	04713	2N4402	1					
15	R136, 137	1-01041	RES FXD 1K 1/4W 5%	81349	RC07GF102J	2					
16	R 66	1-01053	RES FXD 4.7K 1/4W 5%	81349	RC07GF472J	1					
17	R 70	1-01063	RES FXD 15K 1/4W 5%	81349	RC07GF153J	1					
18	R 140, 141	1-01061	RES FXD 10K 1/4W 5%	81349	RC07GF103J	2					
19											
20	R 72-121 R67,68,71,154	1-01033	RES FXD 470Ω 1/4W 5%	81349	RC07GF471J	54					
21	R138, R139	1-01030	RES FXD 330Ω 1/4W 5%	81349	RC07GF331J	2					
22											

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Valhalla Scientific Inc.	PARTS LIST	DISPLAY PCB ASSEMBLY	MODEL 2701	DWG NO 2701-600	REV G

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
23	S 1-6	5-03033	BCD ROTARY SWITCH	53330	2701-050	6					
24	S 7	5-03031	2 POLE 3 POSITION ROTARY	71590	SA-203-3F-000	1					
25			NUT HEX		3/8 x 32	7					
26											
27		4-30052	P.C. BOARD DISPLAY	53504	2701-700	1					
28		5-10008	16 PIN SOCKET	01295	CS2016B	7					
29											
30											
31	S 8, S 9	5-03086	SWITCH PUSH-BUTTON	SCHADOW	SEAUOA0102R	2					BLK
			HEX NUT		3/8 X 56	7					

NOTES: See SHT 3 for ASSY. DWG.

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Valhalla Scientific Inc.	PARTS LIST	OPTION L488	MODEL 2701B	DWG NO 2701-604	REV A

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
1											
2			IEEE BD ASSY	53504	1000-600	1					
3											
4											
5		5-10019	CABLE TIE 4" x 1/8"		PANDUIT WRN-4	25					
6		5-10261	BLOCK, ADHESIVE		PANDUIT ABM25-A	3					
7		5-50030	2701B	53504		1					
8											
9											
10											
11			WIRES:								
12			BRN, 22AWG		252"	1					
13			RED, 22AWG		144"	1					
14			ORN, 22AWG		144"	1					
15			YEL, 22AWG		108"	1					
16			GRN, 22AWG		108"	1					
17			BLU, 22AWG		108"	1					
18			VIO, 22AWG		72"	1					
19			GRAY, 22AWG		72"	1					
20			WHT, 22AWG		72"	1					
21			BLK, 22AWG		72"	1					
22											
23											

NOTES SHT 3 OF 3 IS ASSY. DWG.

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Valhalla Scientific Inc.	PARTS LIST	OPTION L488	MODEL 2701B	DWG NO 2701-604	REV A

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
24											
25											
26	DELETE FROM 1000-600 BOARD										
27											
28	5K1-4	5-10294	IC SOCKET 20 PIN	BURNDY	D1LB20P-108	4					
29	IC13	3-30034	VOLTAGE REGULATOR	01295	LM340T-5.0	1					
30											
31											
32											
33											
34											
35	DELETE FROM 2701B UNIT										
36											
37		4-10293	BUTCH PLATE, IEEE	53504	4300-213	1					
38		-	WASHER, SPLIT LOCK	-	#6	2					
39			NUT, RADIO HEX		#6	2					
40											
41											
42											
43											
44											
45											
46											

NOTES:

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Valhalla Scientific Inc.	PARTS LIST	IEEE-488 INTERFACE	MODEL MULIT	DWG NO 1000-600	REV E

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	-1		-2			REMARKS
						I	N	I	N		
1	C1	2-30014	CAP, TANT, 100µ, 10V	05397	T390E107M010AS	1		1			
2	C2, 3	2-20018	CAP, MICA, 33p	56289	CM05ED330J03	2		2			
3	C4-7	2-10006	CAP, CER, .01µ, 50V	72982	8121-050-651-103M	4		4			
4	C8, C9	2-30002	CAP, TANT 33µ , 10V	05397	T390D336M010AS	2					
5	D1	3-20000	DIODE	04713	IN4148	1		1			
6	IC13		VOLTAGE REGULATOR	01295	LM340T-5.0	1					
7	IC1	3-30156	OCTAL BUFFER	01295	74LS541N	1		1			
8											
9	IC4	3-30158	GP1A, 1.0 MHz	04713	MC68488P	1		1			
10	IC5	3-30160	MICROPROCESSOR	04713	MC680ZP	1		1			
11	IC6 or	3-30154	EPROM, 4Kx8	01295	TMS2532JL	1		1		OR	(USE ONLY 1)
12	IC6		EPROM, 4Kx8	34649	2732	1		1			UNPROGRAMMED
13	IC7	3-30155	3 TO 8 DECODER	01295	74LS138N	1		1			
14	IC8-11	3-30159	PIA, 1.0MHz	04713	MC6821P	4		4			
15	IC12	3-30184	HEX BUFFER	04713	74LS04N	1		1			
16											
17	SK5	5-10243	CONNECTOR, GP1B	00779	552791-1	1		1			
18		5-10244	CONN. HARDWARE	00779	552633-3	1		1			
19											
20	TR1-4	3-10013	TRANSISTOR, NPN	04713	2N4401	4		4			
21											
22	R1-11	1-01061	RESISTOR, 1/4W,5%,10K	81349	RC076GF103J	11		11			

NOTES

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Valhalla Scientific Inc.	PARTS LIST	IEEE- 488 INTERFACE	MODEL MULIT	DWG NO 1000-600	REV E

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	I	N	I	N		REMARKS
23	S1	5-03037	ROCKER SW., 5 POS.	95146	DBS-5	1		1			
24		5-10170	SOCKET - 90°	52072	CA-14SE-10RAC3-01	1		1		FOR	ROCKER SW.
25											
26	Y1	5-02004	4MHz MICROPROCESSOR	M-TRON	HC-18/U	1		1			
			CRYSTAL								
27											
28		4-30084	PC BOARD	53504	1000-700B	1		1			
29		4-10296	PCB MTG. BRACKET	53504	2300-216	2		2			
30		5-10156	NUT-TINNERMAN	78553	C8094-632-24	2		2			
31			SCREW, PHIL. PAN. CAP.		6-32x3/8	4		4			
32			WASHER, SPLIT LOCK		6	4		4			
33			NUT, HEX		6-32	4		4			
34											
35											
36		5-10246	IC SOCKET, 40 PIN	BURNDY	DILB40P-11	6		6		FOR IC	4,5,8-11
37		5-10042	IC SOCKET, 24 PIN	BURNDY	DILB24P-11	1		1			FOR IC6
38											
39											
40			SCREW, PHIL PAN LAD		2-56x3/8	2		2			
41			WASHER SPLIT LOCK		#2	2		2			
42			NUT, NEX RADIO		2-56	2		2			
43	IC2 & 3	3-30157	OCTAL BUS TRANCEIVER	04713	MC3447P3	2		2			
44		OR	P.C.B. ASSEMBLY	53504	1000-601A	1		1			

NOTES:

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Valhalla Scientific Inc.	PARTS LIST	OPT. IRP	MODEL 2701B	DWG NO 2701B-602	REV B

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
1	IC-1	3-30108	IC BCD TO DEC.	86684	CD4028B	1					
2	Q1-6	3-10013	TRANSISTOR NPN	04713	2N4401	6					
3		4-30057	P.C. BD, IRP	53504	2701-702	1					
4		5-10089	14 PIN. CONN. PANEL	02660	57-40140	1					
5		5-10090	14 PIN. CONN. CABLE	02660	57-30140	1					
6	R1-R4	1-01061	RES. 10K, 1/4W, 5%		RC07GF103J	4					
7	WIRE:										
8			WIRE, BLUE, 18"		24 AWG	1					
9			WIRE, GREEN, 18"		24 AWG	1					
10			WIRE, BROWN, 18"		24 AWG	1					
11			WIRE, YELLOW, 18"		24 AWG	1					
12			WIRE, RED, 18"		24 AWG	1					
13			WIRE, BLACK, 18"		24 AWG	1					
14											
15			SCREW, PHIL PAN HD CAD		2-56 x 1/4 LG	2					
16			WASHER, SPLIT LOCK		#2	2					
17			NUT, HEX		2-56	2					

NOTES : ASSY DWG see SHT 3 of 2701-604

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Valhalla Scientific Inc.

PARTS LIST

POLARITY CONTROL BOARD

MODEL 2701B

DWG NO 2701-603

REV B

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N				REMARKS
1	CR 1, 2	3-20000	DIODE	04713	IN4148	2					
2	Q 1,2	3-10016	TRANSISTOR FET	SILICON	IX VN66AK	2					
3	K 1	5-03019	RELAY, CRADLE, 4 FROM C	POTTER-BRUM	R10-EZ-24-J1.0K	1					
4	R 1,2	1-01061	RES FXD 10K 1/4W 5%	81349	RC07GF103J	2					
5		4-30069	P.C. BOARD, PRM	53504	2701-703	1					
6		5-10177	NYLON STANDOFF	SMITH	4060	4					
7			SCREW, NYLON, PAN, BLK		6-32-1/2	4					
8			WIRE, BLK, 46 INCH		24 AWG	1					
9			WIRE, RED, 46 INCH		24 AWG	1					
10			WIRE, YEL 15 INCH		24 AWG	1					
11			WIRE, GRN 10 INCH		24 AWG	1					
12			WIRE, WHT 8 INCH		24 AWG	1					
13											
14			RING LUG, SOLDERLESS TERMINAL	06383	PV 24-6R	4					
15		5-10123	#6 STUD 24 AWG								
16											
17		5-10221	CABLE, NYLON TIE 7"x3/16"	PANDUIT	WRN-7						
18		5-10019	CABLE, NYLON TIE 4"x1/8"	PANDUIT	WRN-4						

NOTES: For ASSY DWG See SHT 2

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SECTION VIII - DIAGRAMS

8.1 GENERAL

The illustrations of this section are the schematic, logic and assembly diagrams of the Model 2300/2301. To the extent practical, an assembly diagram is adjacent to the appropriate schematic or logic diagram. All diagrams are reductions of factory engineering drawings. Title blocks, and other information not required for the maintenance of the unit, have been removed.

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8 7 6 5

D

Q8 3439 Q10 3439 Q12 3439 Q14 3439 Q16 3439

Q7 3439 Q9 3439 Q11 3439 Q13 3439 Q15 3439

R2 1K R4 1K R6 1K R8 1K R10 1K

HI VOLTAGE

R1 100K R3 100K R5 100K R7 100K R9 100K R13 100K

HI VOLTAGE

R33 240K R34 240K R35 240K R36 240K

C

+15 IC6 4N45

IC3 356H

R43 10K

R37 150K CR7 IN 5234 R38 1K

R42 15K

R44 4.7K CR8 IN 4148

-15

E9 CR11 IN 4148

E8 CR12 IN 4148

R52 100K IC5 356H

+15

R62 15K

R60 10K R61 100pf

+15 R150 1K

B

+15 IC47 199AH

C21 10μf

Q1 VN66AK Q2 VN66AK

1K W.W.

R17 R16 F.S. R19 F.S. R21 F.S. R23 50Ω R24 49.75K R25 5K

R20 1.25M MF R18 100K

Q3 VN66AK Q4 VN66AK

C7 .22μf C3 .22μf

R161 33K R22 33K C41 .22μf

IC1 LF356H

R185 5K

R49 1K

R47 4.7K

R48 2.4K

R148 10K R50 3.0K

TO IC8-6 TO IC9-6 TO IC11-6 TO IC10-6

A

8 7 6 5

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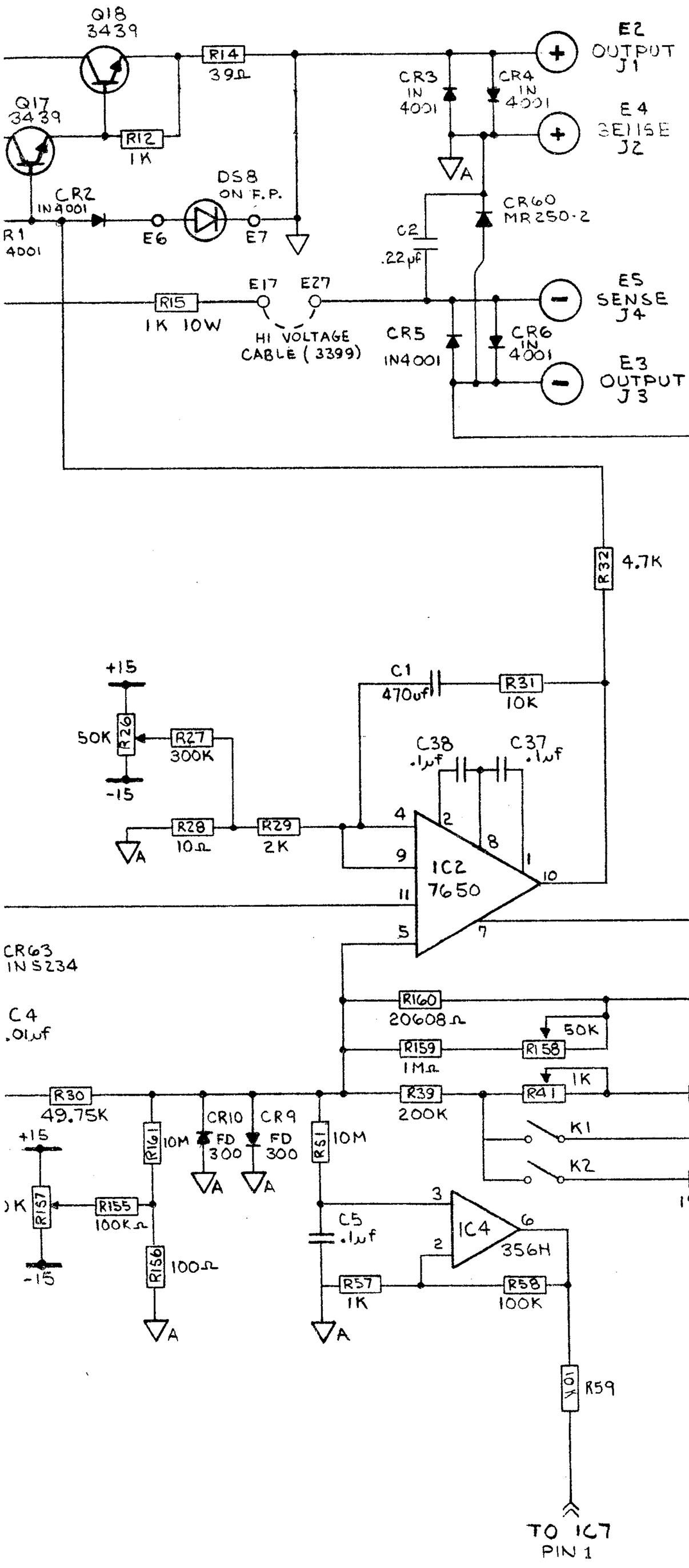
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	C	SEE ECO 25		



IC NO.	-15V	+15V
IC1	4	7
IC3	4	7
IC4	4	7
IC5	4	7
IC47		3

2. FOR P.L. SEE SHT 1-6 OF 2701-601.
1 FOR ASSY SEE SHT 7 OF 2701-601.

NOTES :

MATERIAL	DRAWN RM	3/82	Valhalla Scientific Inc.
	CHECKED		SAN DIEGO, CALIFORNIA
	APPR. TBD	4/82	
FINISH .	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT VALHALLA SCIENTIFIC INC RESERVES ALL PATENT, SALE, PROPRIETARY, DESIGN MANUFACTURING, USE AND REPRODUCTION RIGHTS THERETO		SCHEMATIC 2701 MAIN P.C.B.
	SCALE NONE	CODE IDENT NO. 53504	SIZE D — DRAWING NO. 2701-071 — REV. C
	SHEET 1 OF 3		

2701-071 C

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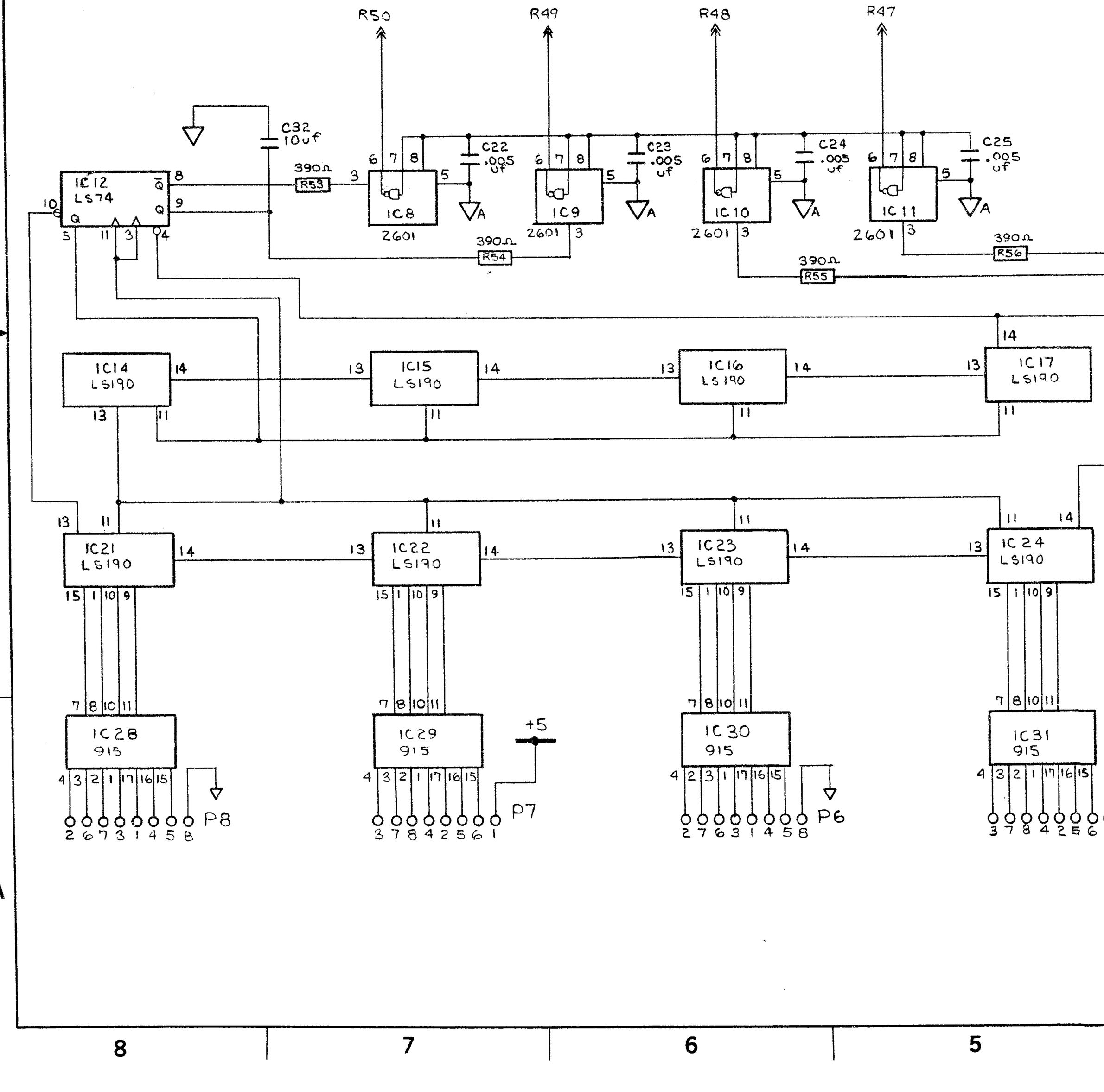
IC NO.	0V	+5V
IC7	4	
IC8		2
IC9		2
IC10		2
IC11		2
IC12	2,7,12	1,13,14
IC13	2,7	1,13,14,10
IC14	1,10,9	5,15,16
IC15	15,10,9,4,8	5,1,16
IC16	1,10,4,8	5,9,15,16
IC17	1,10,4,8	5,9,15,16
IC18	4,8	5,11,16
IC19	4,8	5,11,16
IC20	4,8	5,11,16
IC21	4,8	5,16
IC22	4,8	5,16

IC NO.	0V	+5V
IC23	4,8	5,16
IC24	4,8	5,16
IC25	4,8	5,16
IC26	4,8	5,16
IC27	4,8	5,16
IC28	6,9,12	14,18
IC29	6,9,12	14,18
IC30	6,9,12	14,18
IC31	6,9,12	14,18
IC32	6,9,12	14,18
IC33	6,9,12	14,18
IC34	6,9,12	14,18
IC42	7	14
IC43	7,9,11	14
IC44	7	14

NOTES:

1. S8 & S9 ARE LOCATED ON THE DISPLAY P.C.B. (2701-600).



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REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

TO R59

P1-2 E76

P1-6

P1-3 E77

IC7 4N45 — 1, 2, 4 OV, 5 — ▽A

C31 1uf

S8 STBY. LOCATED ON DISPLAY P.C.B — P1-5

S9 OPER. LOCATED ON DISPLAY P.C.B — P1-4

IC44 4001 — R64 10K — R66 10K — R69

IC43 4013

GND

+5

R63 10K

IC42 LS OON

C6 .005uf

R146 10K

Y1 1MHz

IC42 LSOON

IC42 LSOON — IC42 LSOON

IC13 LS74 — IC18 LS190 — IC19 LS190 — IC20 LS190

IC25 LS190 — IC26 LS190 — IC27 LS190

IC32 915 — P4 (2 7 6 3 1 4 5 8)

IC33 915 — P3 (3 7 8 4 2 5 6 1)

IC34 915 — P2 (2 7 6 3 1 4 5 8)

+5

MATERIAL	DRAWN RM 3/82	Valhalla Scientific Inc.	
	CHECKED	SAN DIEGO, CALIFORNIA	
	APPR. 6/82		
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT VALHALLA SCIENTIFIC INC RESERVES ALL PATENT, SALE, PROPRIETARY, DESIGN MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO	SCHEMATIC : 2701 MAIN P.C.B.	
	SCALE NONE	CODE IDENT NO. 53504 / SIZE D / DRAWING NO. 2701-071	REV. C
	SHEET 2 OF 3		

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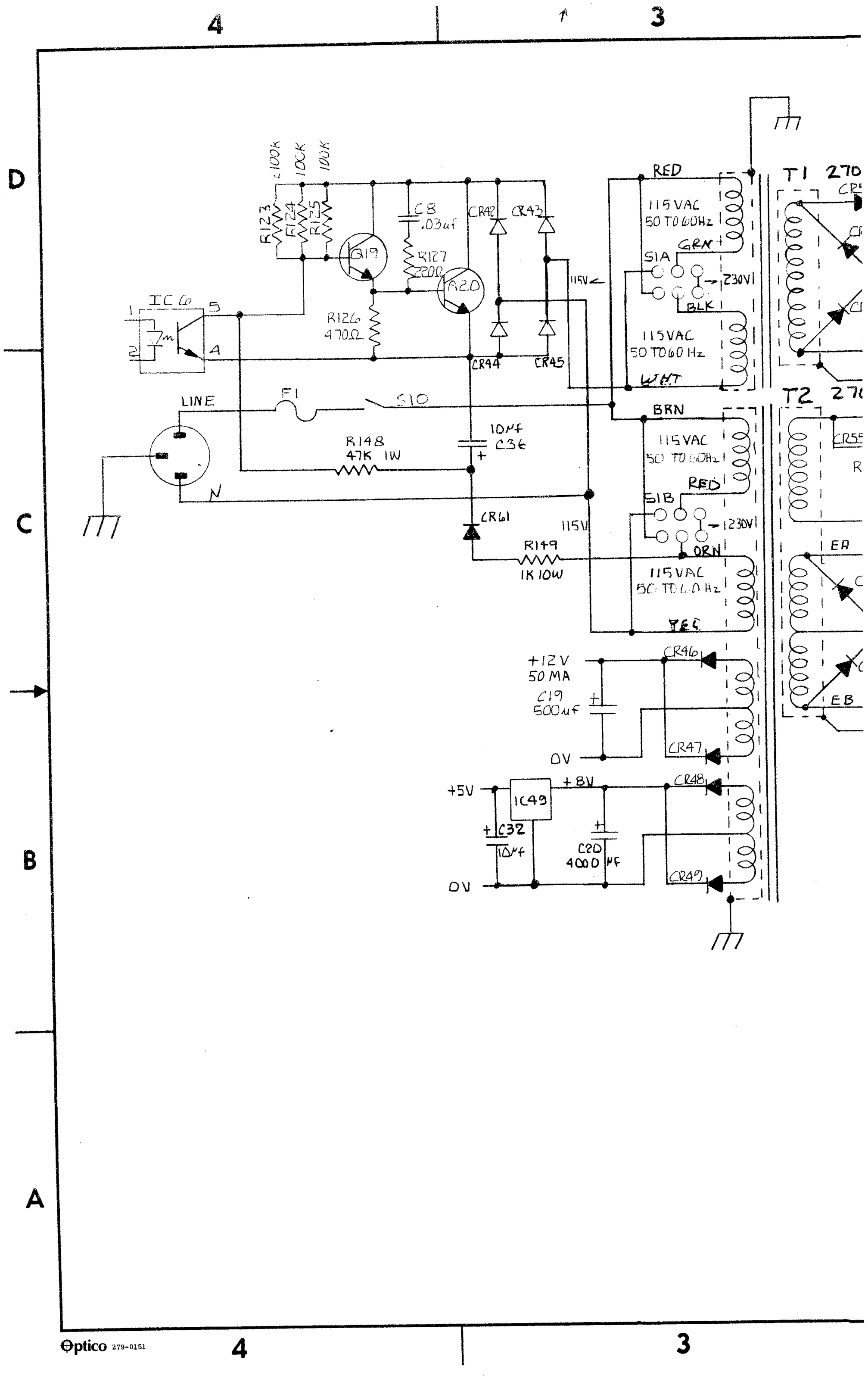

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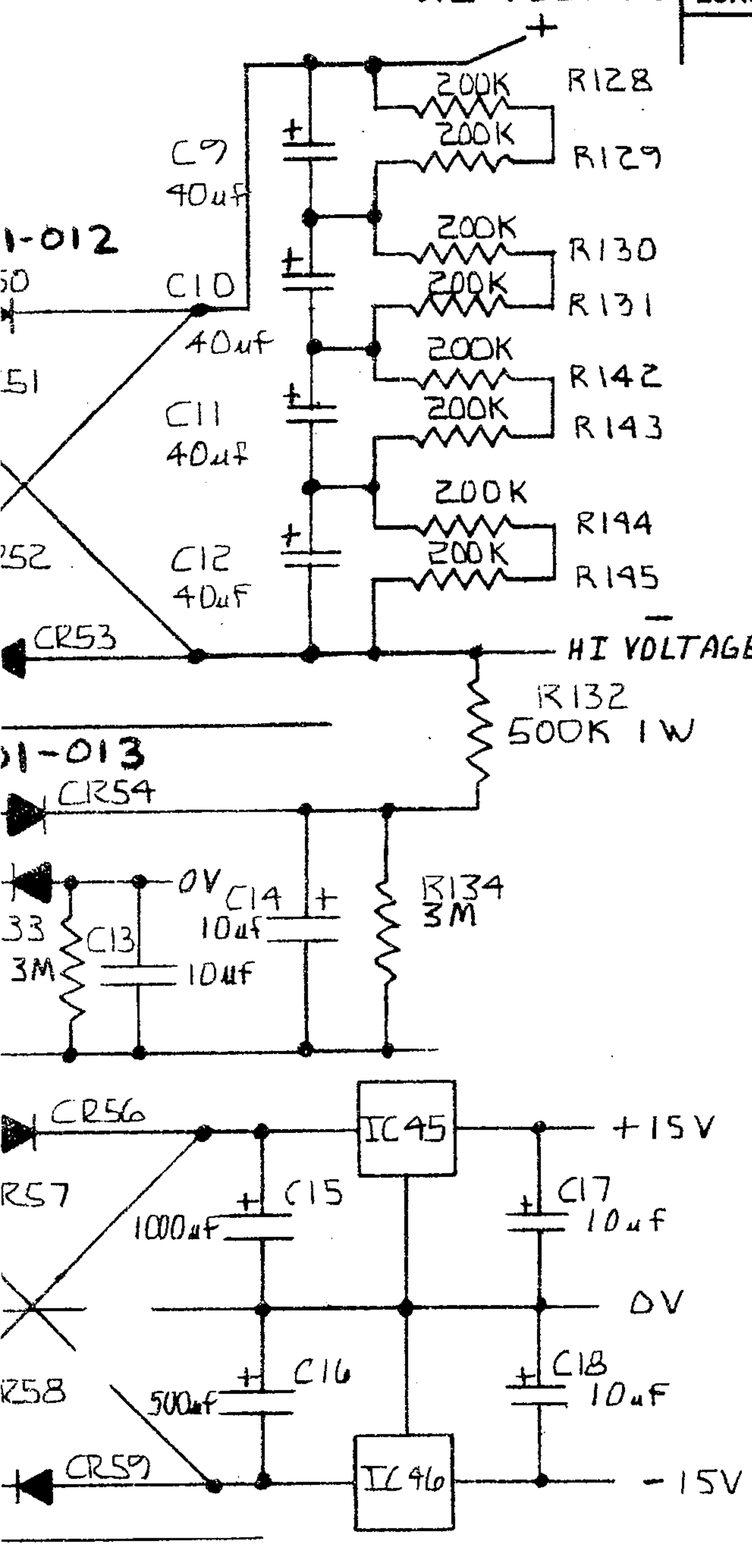
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



100 TO 1500 VDC

D

C

B

A

MATERIAL	DRAWN RWF 7/79	**Valhalla Scientific Inc.** SAN DIEGO, CALIFORNIA			
	CHECKED				
	APPR.				
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC. AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT, VALHALLA SCIENTIFIC INC. RESERVES ALL PATENT, SALE, PROPRIETARY DESIGN, MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO.	2701 POWER SUPPLY DIAGRAM			
	SCALE NONE	CODE IDENT NO. 53504	SIZE C	DRAWING NO. 2701-071	REV.
	SHEET 3 OF 3				

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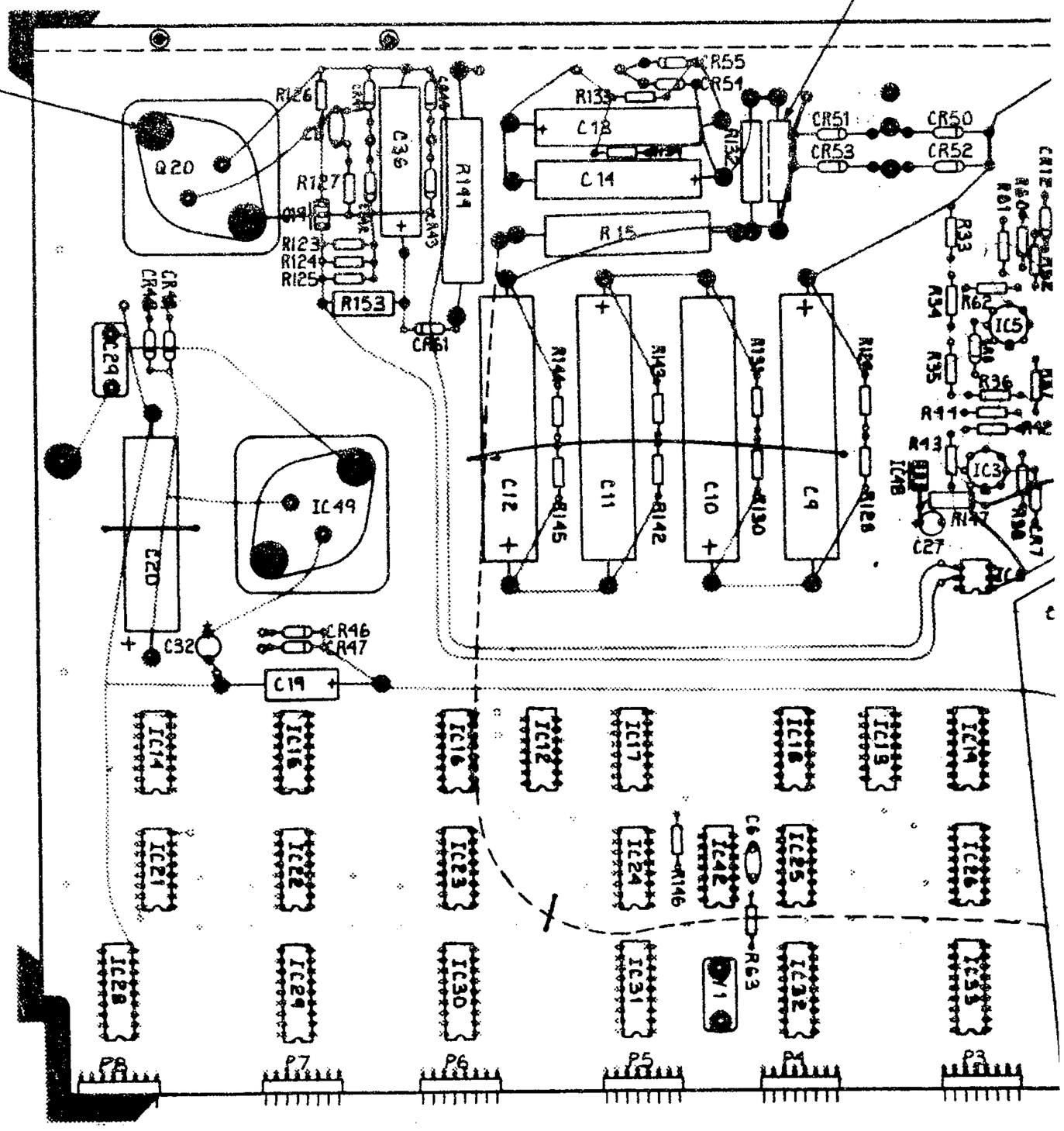
NOTES:

1. FOR UNIT ASSY. SEE 2701-400.
2. FOR SCHEMATIC SEE 2701-070.

SCREW, 4 PL (109)
HEATSINK, 2 PL (100)
P.C.B. (99)
WASHER, 4 PL (110)
NUT, 4 PL (111)



SHOWN IS P.C.B. ASSY. 2701-601
CLAD SHOWN IS FARSIDE

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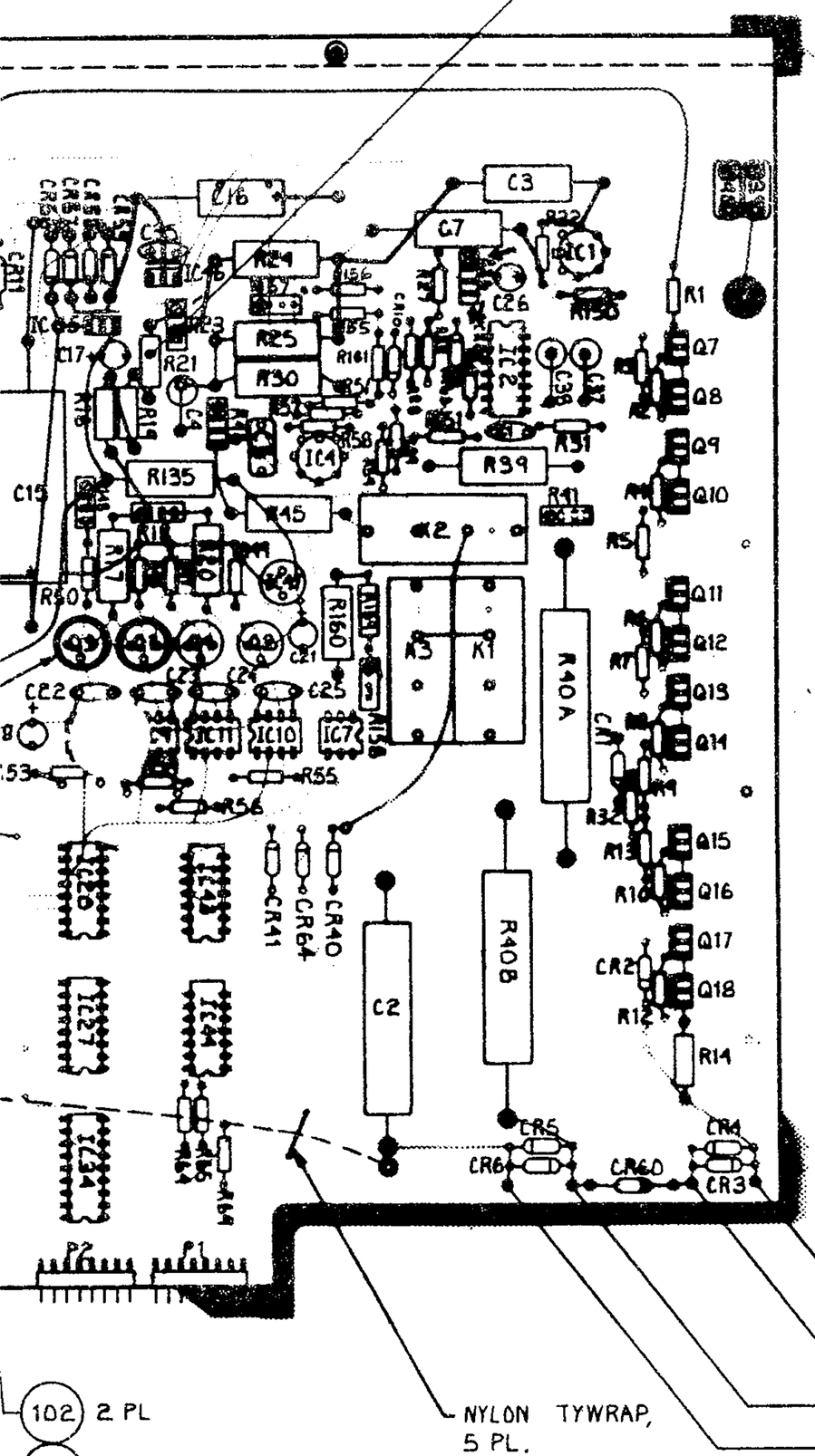
REVISIONS				
	LTR	DESCRIPTION	DATE	APPROVED
	E	ECO 21 2111 -135		
296	J	P/L CHANGE	2-28-84	RL
479	K	P/L CHANGE	6-12-84	RL

NGE ADD EXTRA RES.
W) AND CHANGE FUSE TO .5A

INSTALL 22 AWG BUS WIRE
FOR R16, R19 & R21.



*4 SPLIT LOCK WASHER,
3 PL.

P.C.B. SUPPORT

4-40 X 1/4
CAD., PHIL., PAN HD.,
3 PL.

P.C.B.

TO J1, RED
TO J2, GRN.
TO J3, WHT.
TO J5, BLK.

20 AWG, 4" LG.

NYLON TYWRAP,
5 PL.

(102) 2 PL

(101) BETWEEN WASHER
AND TRANS. CAN A/R.

MATERIAL	DRAWN C.R.E.	11/30	Valhalla Scientific Inc.
	CHECKED R M	3/82	SAN DIEGO, CALIFORNIA
	APPR.		
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT, VALHALLA SCIENTIFIC INC RESERVES ALL PATENT SALE PROPRIETARY DESIGN MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO		ASSEMBLY, MAIN P.C.B., MODEL 2701
	SCALE NONE		CODE IDENT NO. 53504 / SIZE D / DRAWING NO. 2701 – 601 / REV. K
	SHEET 7 OF 7		

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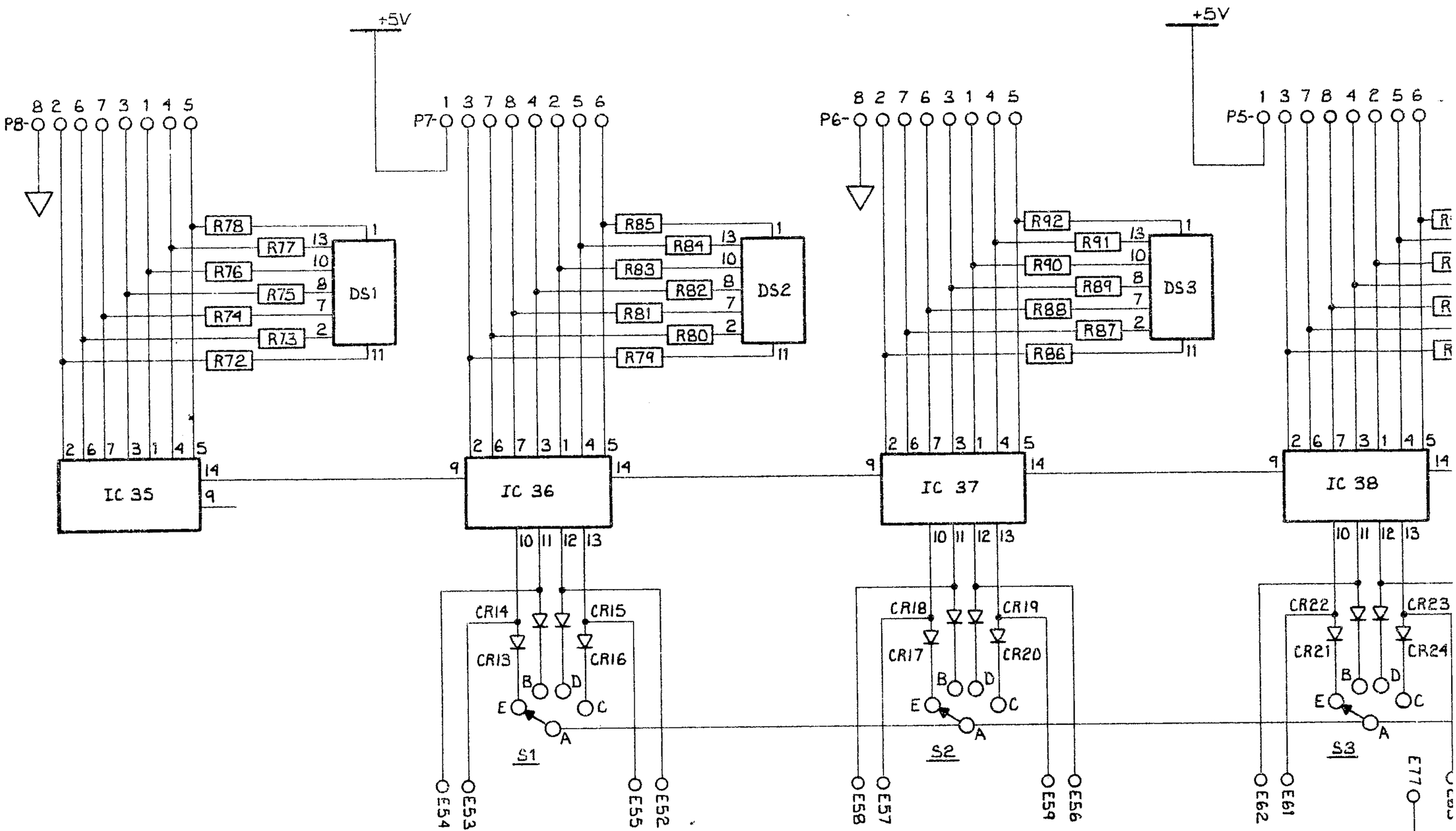
NOTES:

1. FOR P/L AND ASSY. SEE DWG. NO. 2701-600.
2. RESISTORS R72 THRU R120 ARE 470Ω.



POWER CONNECTIONS

IC NO.	0V	+5V
35	8,15	10,11,12,13,16
36	8,15	16
37	8,15	16
38	8,15	16
39	8,15	16
40	8,15	16
41	8,14,15	16

DS NO.	0V	+5V
1		3,14
2		3,14
3		3,14
4		3,14
5		3,14
6		3,14
7		3,14

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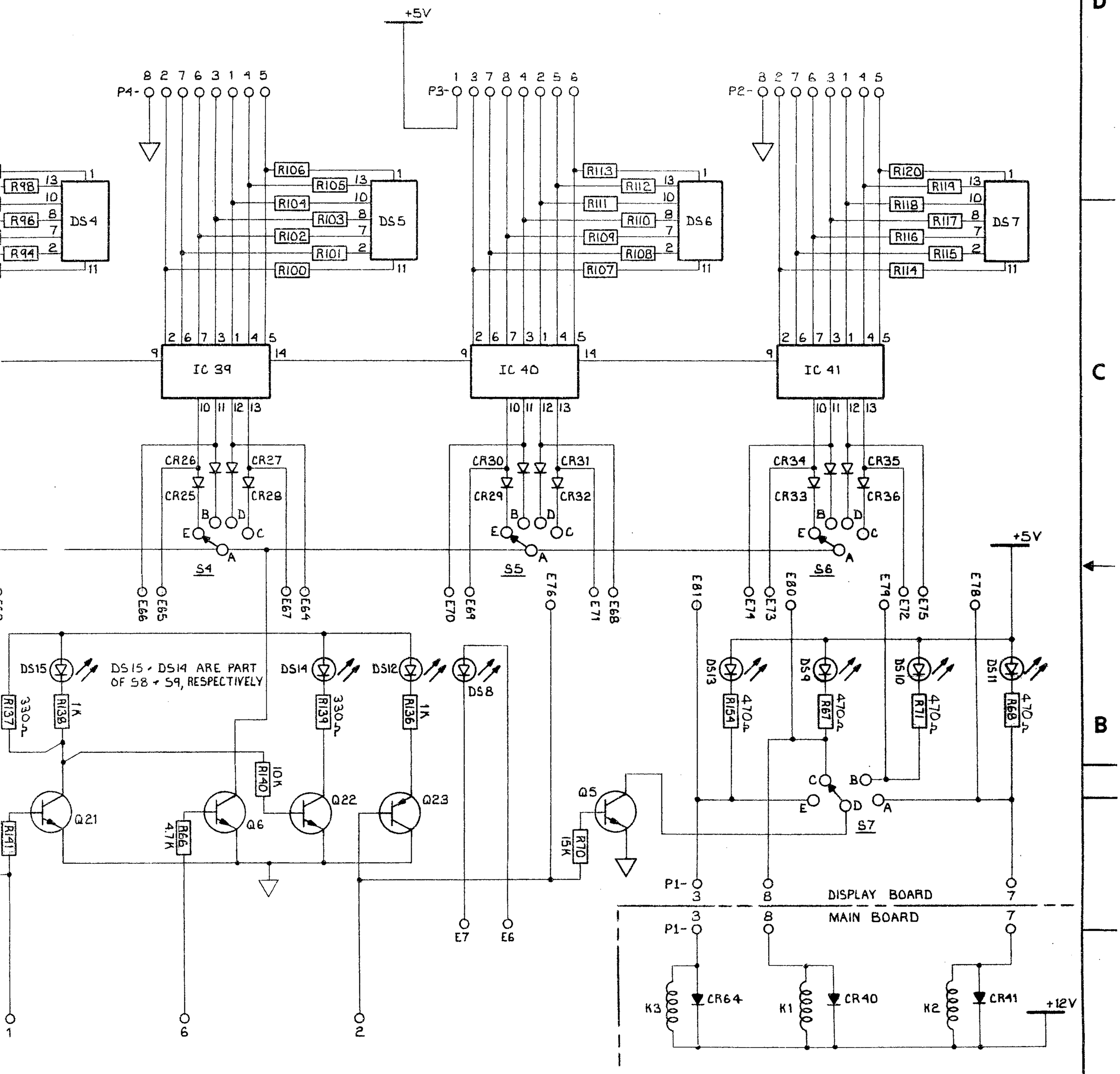
REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	B	REDRAWN. MAIN BOARD SCHEMATIC IS NOW ON DWG. NO. 2701-071. C.R.E. 2-1-82		
	C	R68 [illegible] USED 1.5K		



MATERIAL N/A	DRAWN C.R.E. 2/82	**Valhalla Scientific Inc.** SAN DIEGO, CALIFORNIA	
	CHECKED		
	APPR. Pete 4/82		
FINISH N/A	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC. AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT VALHALLA SCIENTIFIC INC. RESERVES ALL PATENT SALE PROPRIETARY DESIGN MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO	SCHEMATIC: 2701 DISPLAY BOARD	A1
	SCALE NONE	CODE IDENT NO. 53504 / SIZE D / DRAWING NO. 2701-070	REV. C
	SHEET 1 OF 1		

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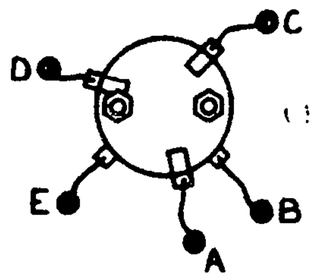
D

C

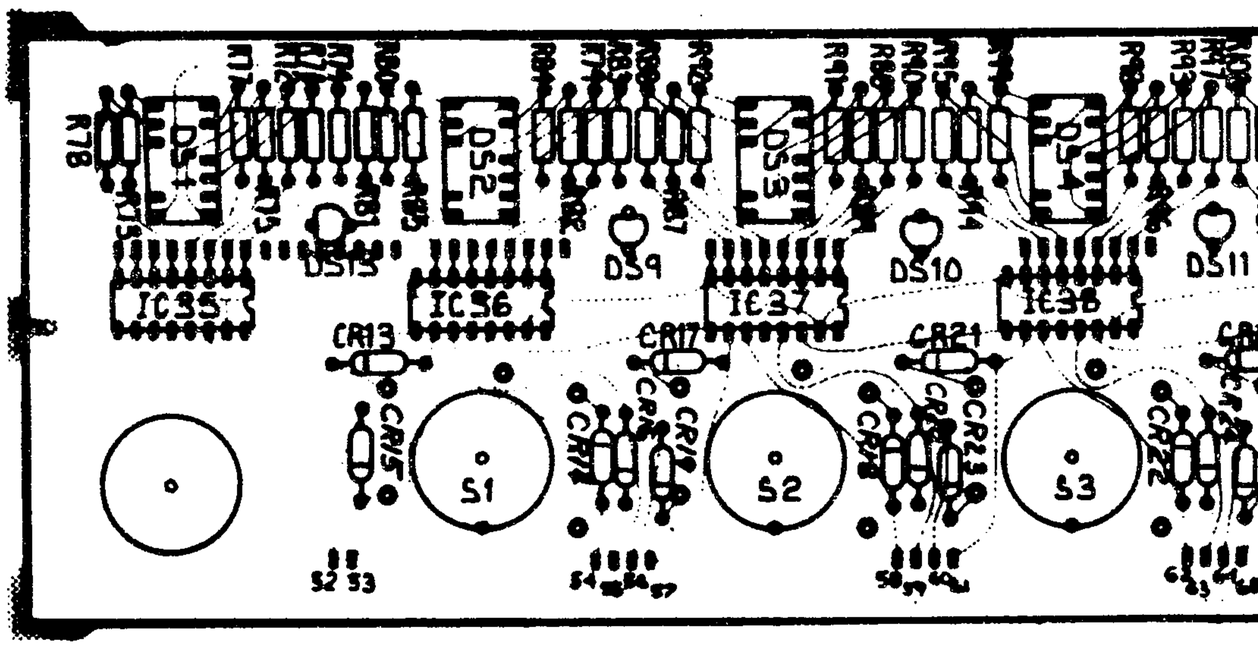
B

A

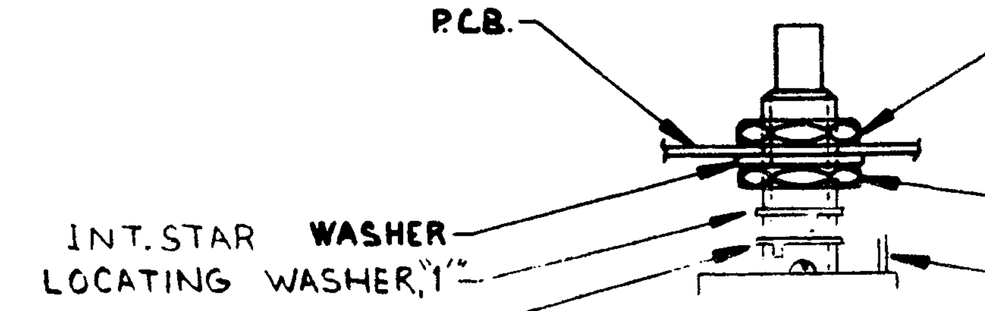
(WIRING DIAGRAM)



REAR VIEW OF
S1 - S6



SHOWN IS FRON
C_AL SHOW



MOUNTING OF SWITCHES
S1 - S7

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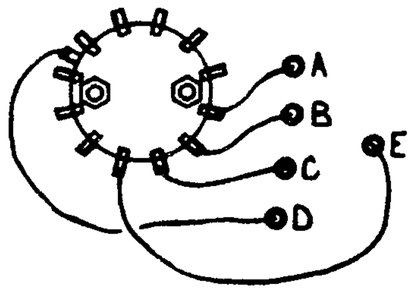
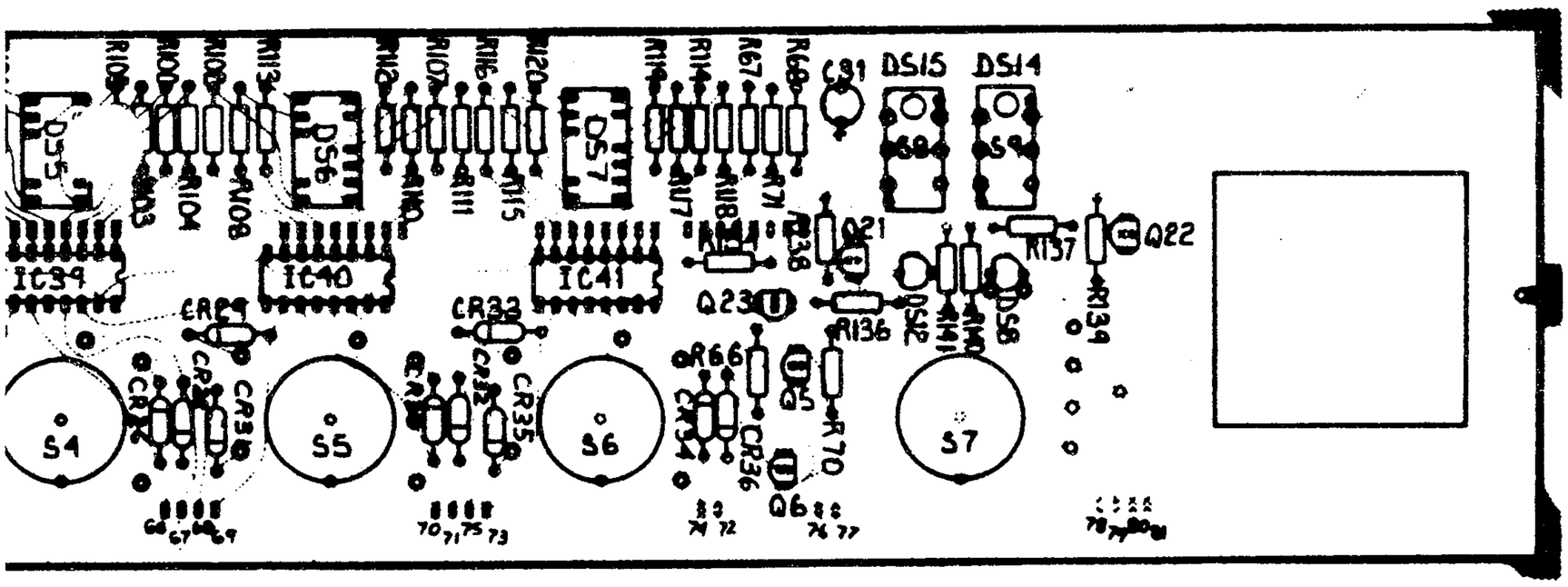
REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	C	INCORP ECO 1 AND 7	12-[illegible]-81	RM
273	F	PARTS LIST CHANGE WPW	1-18-84	RE
296	G	P/L CHANGE	2-28-84	RE

(WIRING DIAGRAM)



REAR VIEW OF S7

USE BLK LEAD

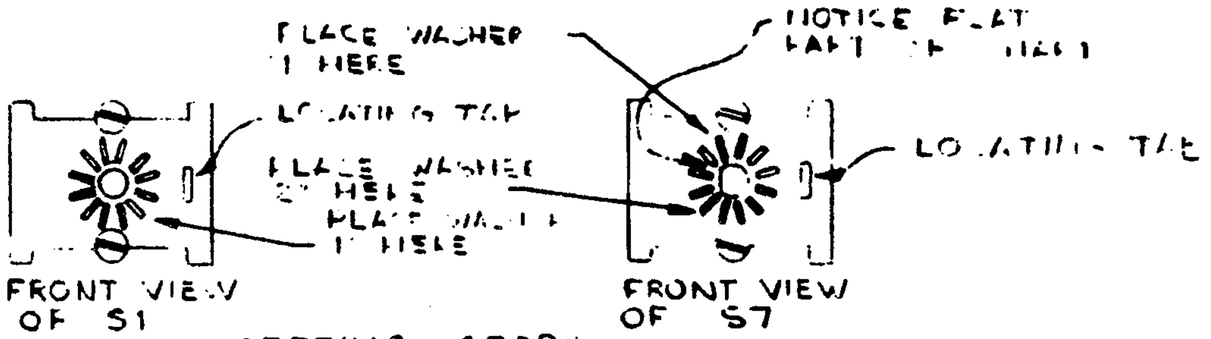


VIEW OF 2701-600 IS FARSIDE

NUT, 3/8-32

NUT, PROVIDED W/SWITCH

LOCATING TAB



FRONT VIEW OF S1

FRONT VIEW OF S7

SETTING STOPS ON SWITCHS S1 AND S7
S2-S6 USE NO LOCATING WASHER

MATERIAL	DRAWN C.R.E.	12/1	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA
	CHECKED RM	12/2	
	APPR.		
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT VALHALLA SCIENTIFIC INC RESERVES ALL PATENT SALE PROPRIETARY DESIGN MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO		ASSEMBLY, DISPLAY P.C.B. MODEL 2701
	SCALE NONE		CODE IDENT NO. 53504 / SIZE C / DRAWING NO. 2701-600 / REV. G
	SHEET 3 OF 3		

D C B A

2701-600

2 1

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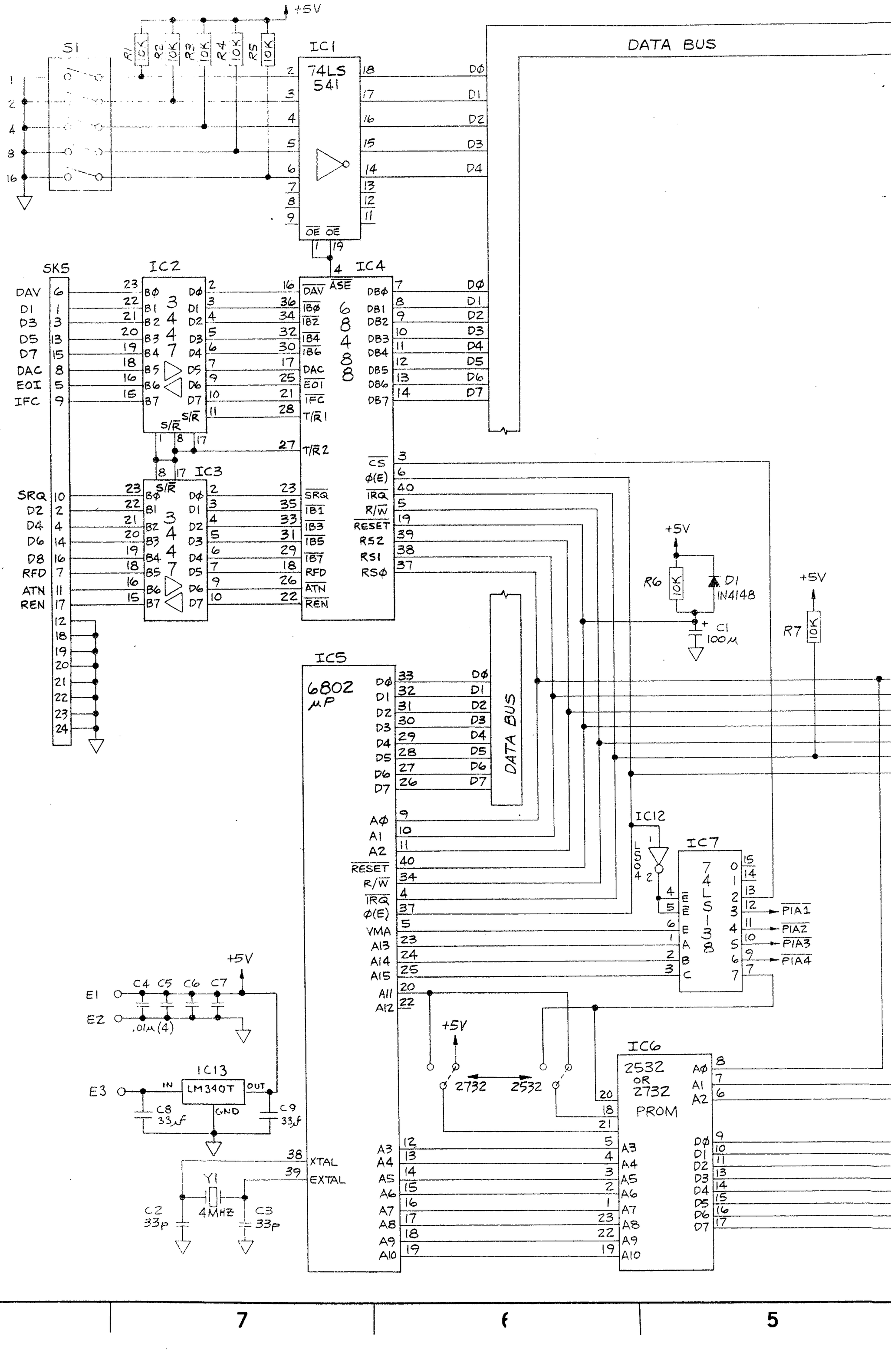

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REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASE	1-12-82	[illegible]
	B	ADDED IC 12 DM 5/82		

I.C. No.	+5V	GND ▽
1	20	10
2	24	12,13,14
3	1,24	11,12,13,14
4	20	1,2
5	2,3,6,8, 35,36	1,21
6	24	12
7	16	8
8-11	20,22,24	1
12	14	7

NOTES:
1. ALL RESISTORS ARE 1/4W, 5%.
2. FOR ASSEMBLY SEE 1000-600.

MATERIAL	DRAWN RICK	1/82	Valhalla Scientific Inc.
	CHECKED		SAN DIEGO, CALIFORNIA
FINISH	APPR. [illegible]	1/82	SCHEMATIC- IEEE-488 INTERFACE
	SCALE		CODE IDENT NO. 53504 / SIZE D / DRAWING NO. 1000-070 / REV. B
	SHEET 1 OF 1		

THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT, VALHALLA SCIENTIFIC INC RESERVES ALL PATENT SALE PROPRIETARY DESIGN MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO

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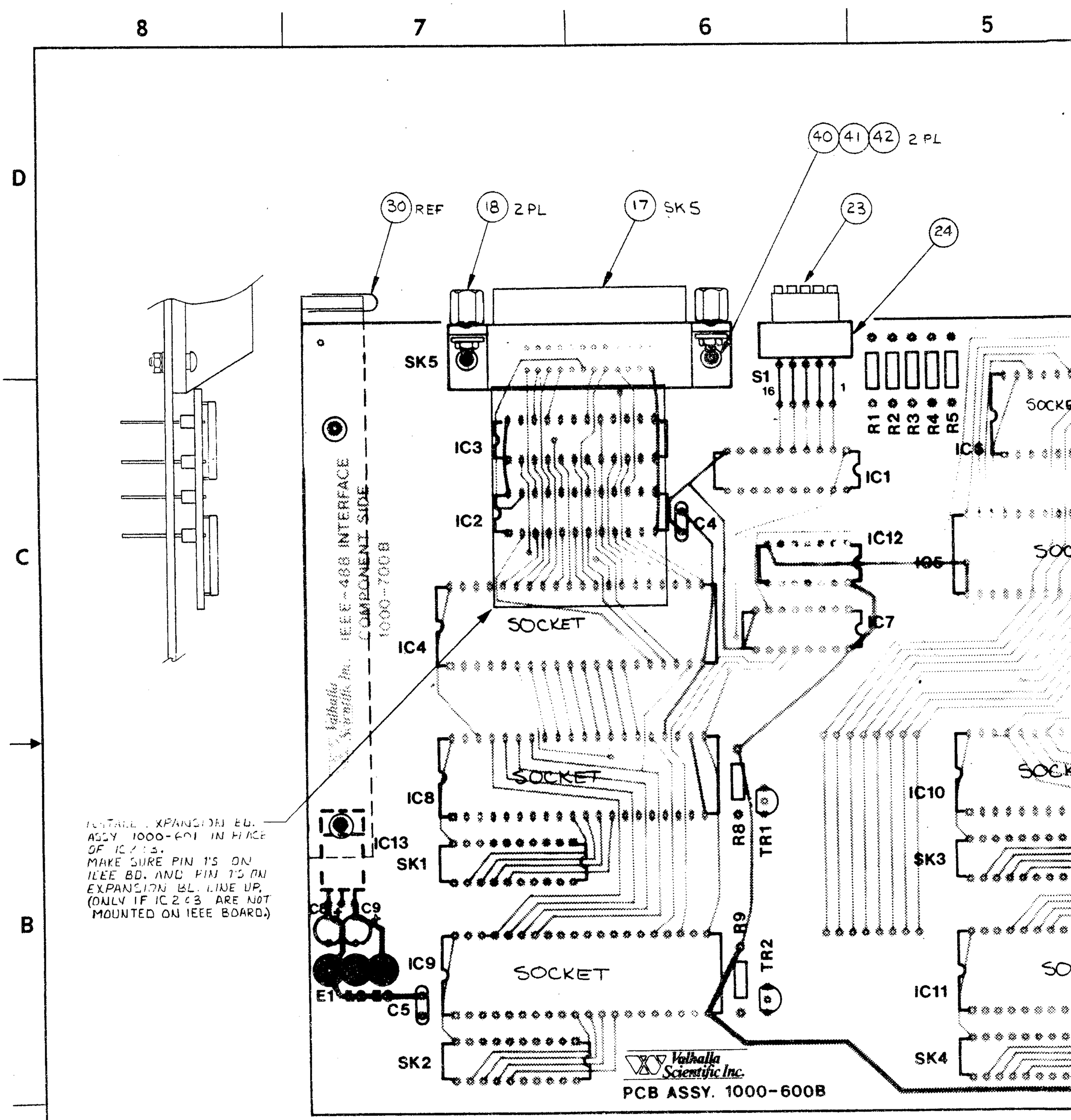
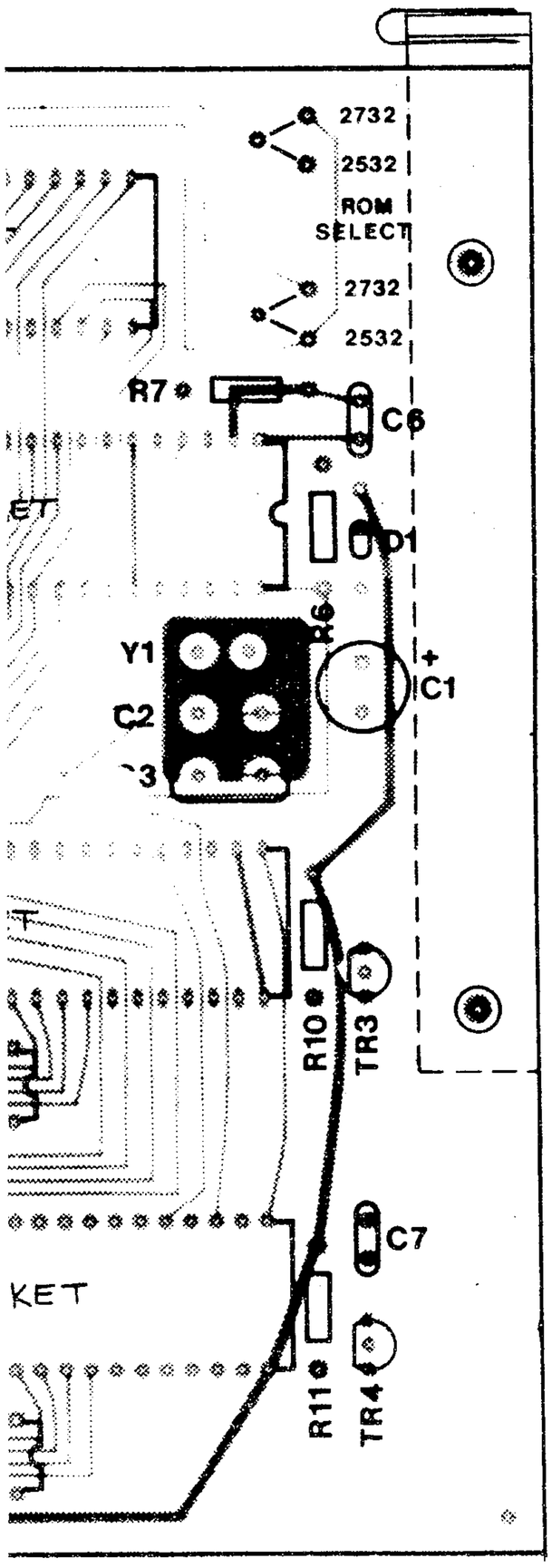
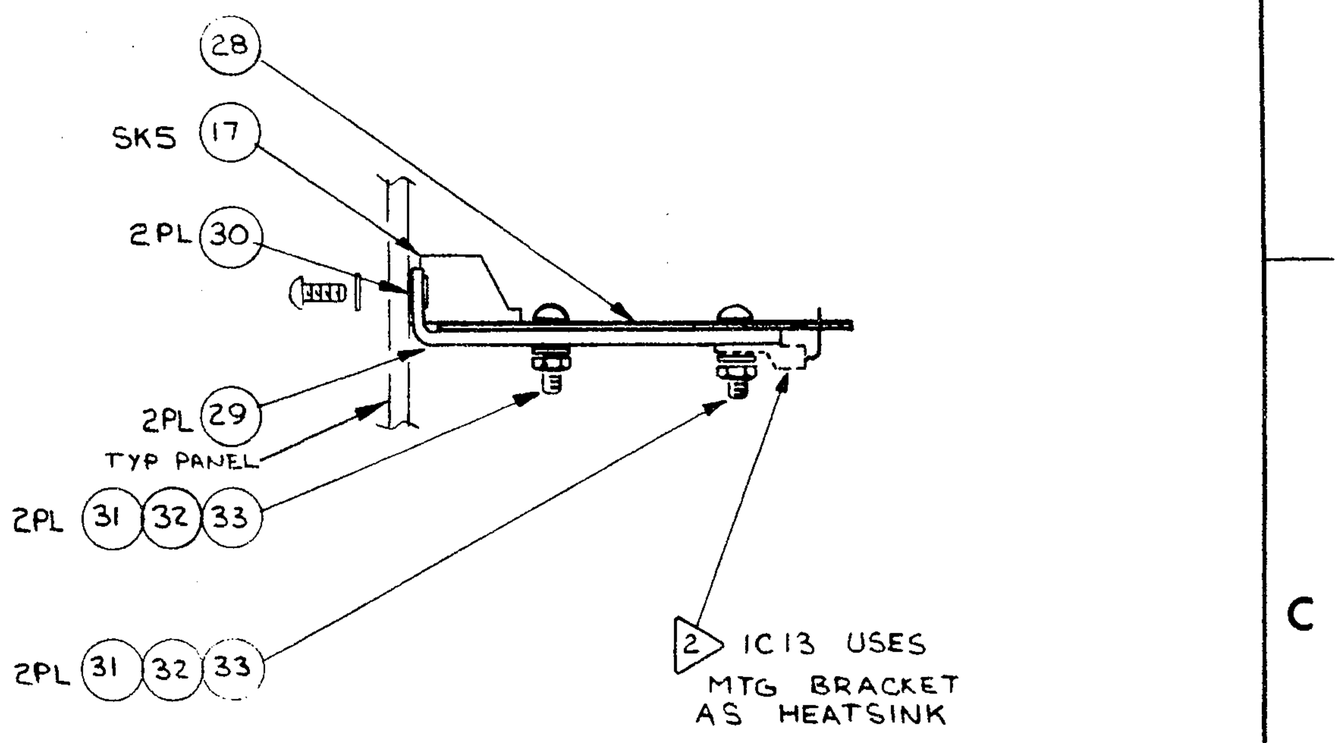


SHOWN IS P.C.B. ASSY
1000-600-1

ManualsPlus.com

REVISIONS				
	LTR	DESCRIPTION	DATE	APPROVED
	B	ADDED IC 12 RM 5/82		
	C	ADDED EXPANSION BD. W.P.W. 9 483	8-8-83	PWJ
0216	D	CHG SOCKETS TO S-10294 FROM S-10245	1-23-84	
493	E	DELETED SK1-4 SOCKETS WPW	6-28-84	





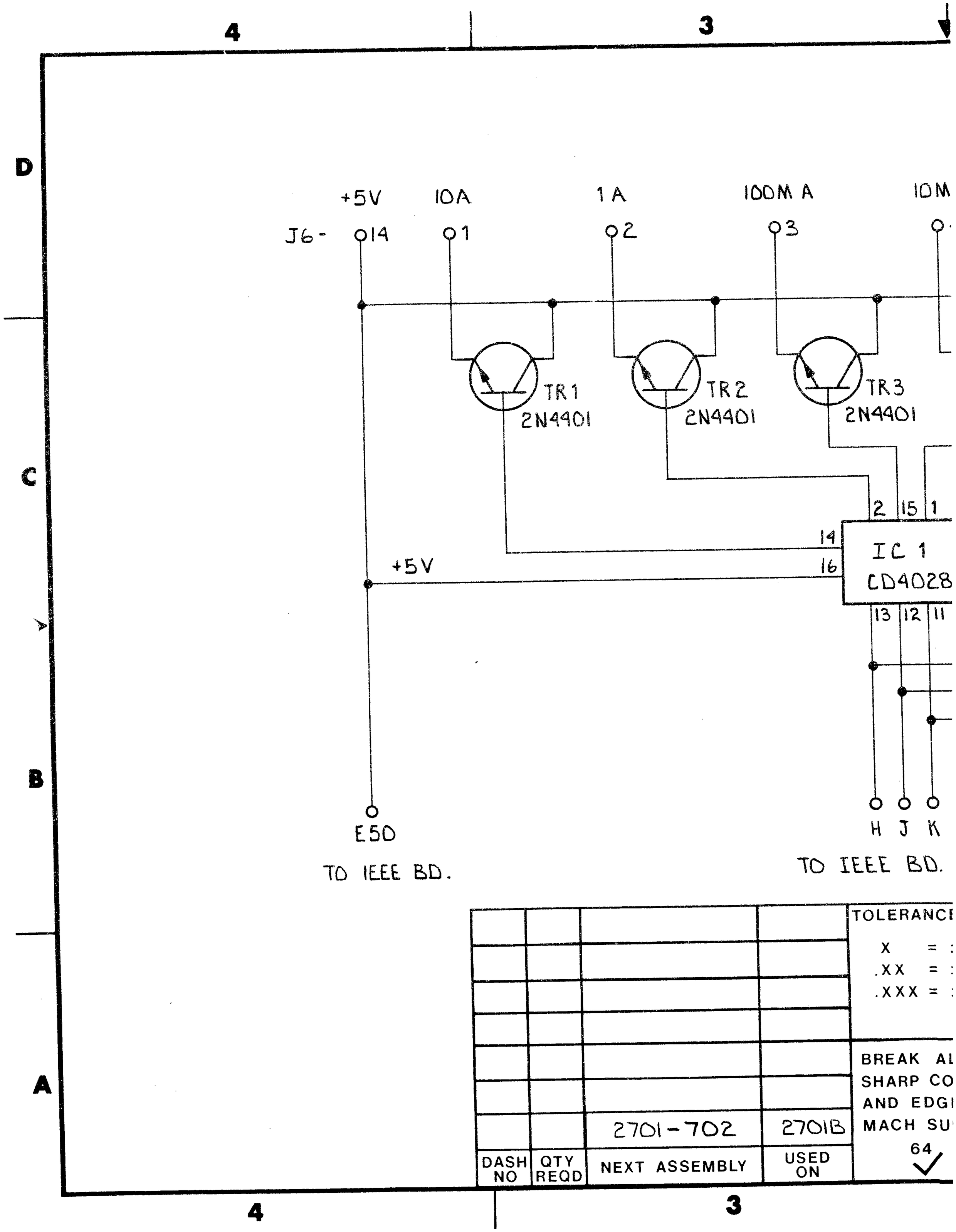
NOTES :

1. P.C.B IS DESIGNED TO ACCEPT EITHER ROM 2532 OR 2732 IN POSITION I.C. 6. AFTER ROM IS POSITIONED SOLDER APPROPRIATE JUMPERS FROM "ROM SELECT"
2. COMPONENTS C8, C9 AND I.C. 13 ARE ONLY USED IN UNITS HAVING LESS THAN 5V @ 1 AMP OF AVAILABLE POWER FOR THE IEEE P.C.B. CHECK PARTS LIST 1000-600-1 .
3. FOR SCHEMATIC SEE DWG. 1000-070.
4. FOR WIRING INFO. SEE : 4300 → 4300-051.
   2300 → 2300-052.
5. 20 PIN SOCKETS ARE NOT USED EXCEPT ON 2500/01.

MATERIAL	DRAWN RM 5/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA		
	CHECKED			
	APPR. PWJ 8/83			
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT VALHALLA SCIENTIFIC INC RESERVES ALL PATENT SALE PROPRIETARY DESIGN MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO	ASSEMBLY- IEEE INTERFACE P.C.B		
	SCALE 2/1	CODE IDENT NO 53504	SIZE D	DRAWING NO. 1000-600 REV. E
	SHEET 3 OF 3			

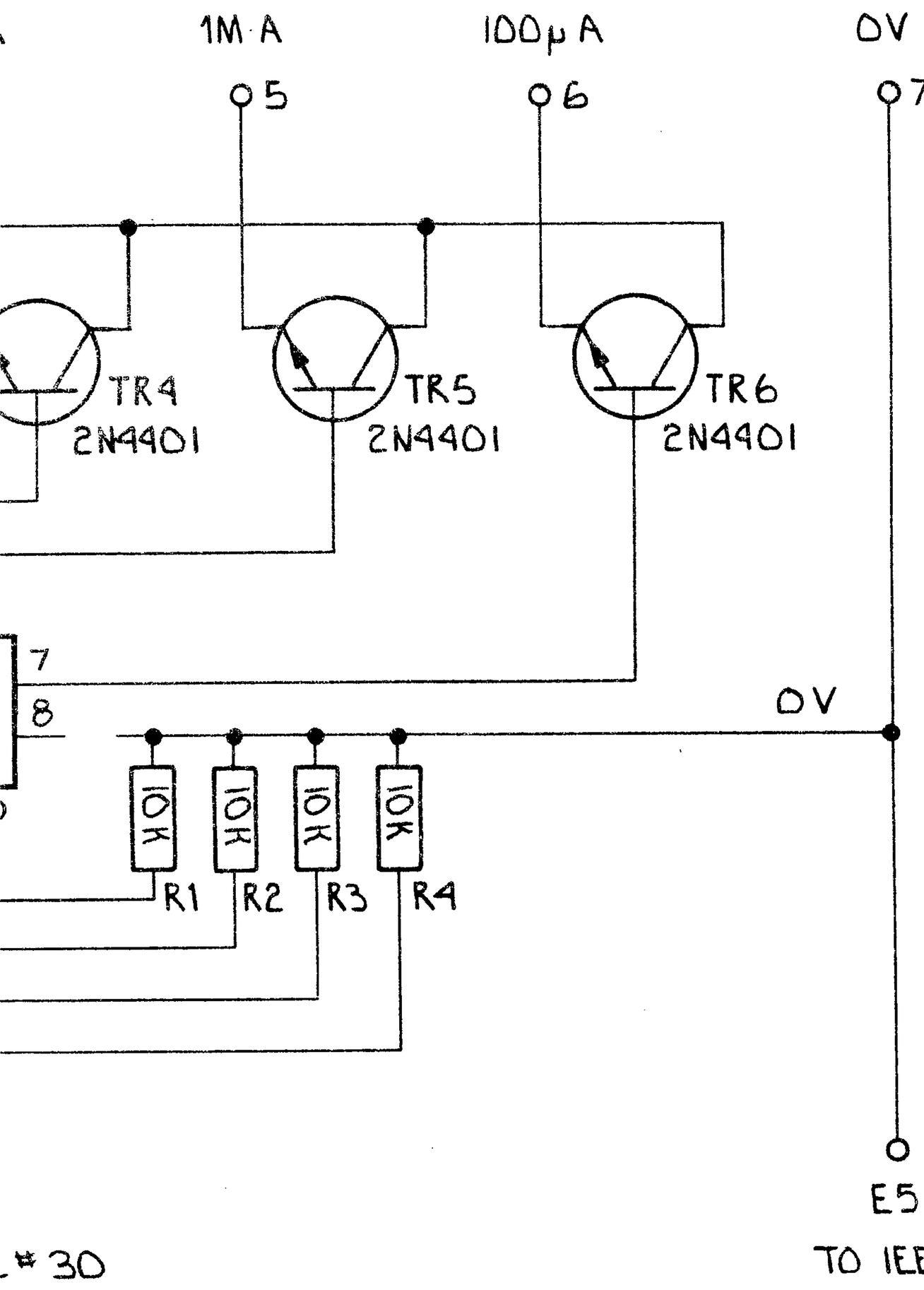
1000-600

ManualsPlus.com



ManualsPlus.com

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	C	REDRAWN SEE ECO 67 FOR MOD.5 TO BOARD C.R.E. 4-12-83		



MATERIAL	DRAWN CRE	4-12-83	Valhalla Scientific Inc. SAN DIEGO, CA		
	CHECKED RM	5-12-83			
	APPR				
	STK NO				
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT VALHALLA SCIENTIFIC INC RESERVES ALL PATENT, SALE, PROPRIETARY DESIGN, MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO	OPTION "IRP" SCHEMATIC			
	SCALE —	CODE IDENT 53504	SIZE B	DRAWING NO 2701-072	REV C
	SHEET 1 OF 1				

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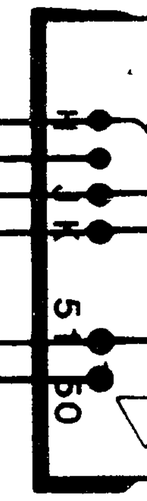
4 3

D C B A

(488-600) TO IEEE BD. { TO IC 30 PIN #4 YEL; TO IC 30 PIN #3 BRN; TO IC 30 PIN #5 GRN; TO IC 30 PIN #6 BLUE

(488-600) TO IEEE BD. { TO E 51 BLK; TO E 50 RED



ALL WIRES 24 AWG, 18" LG.

4 3

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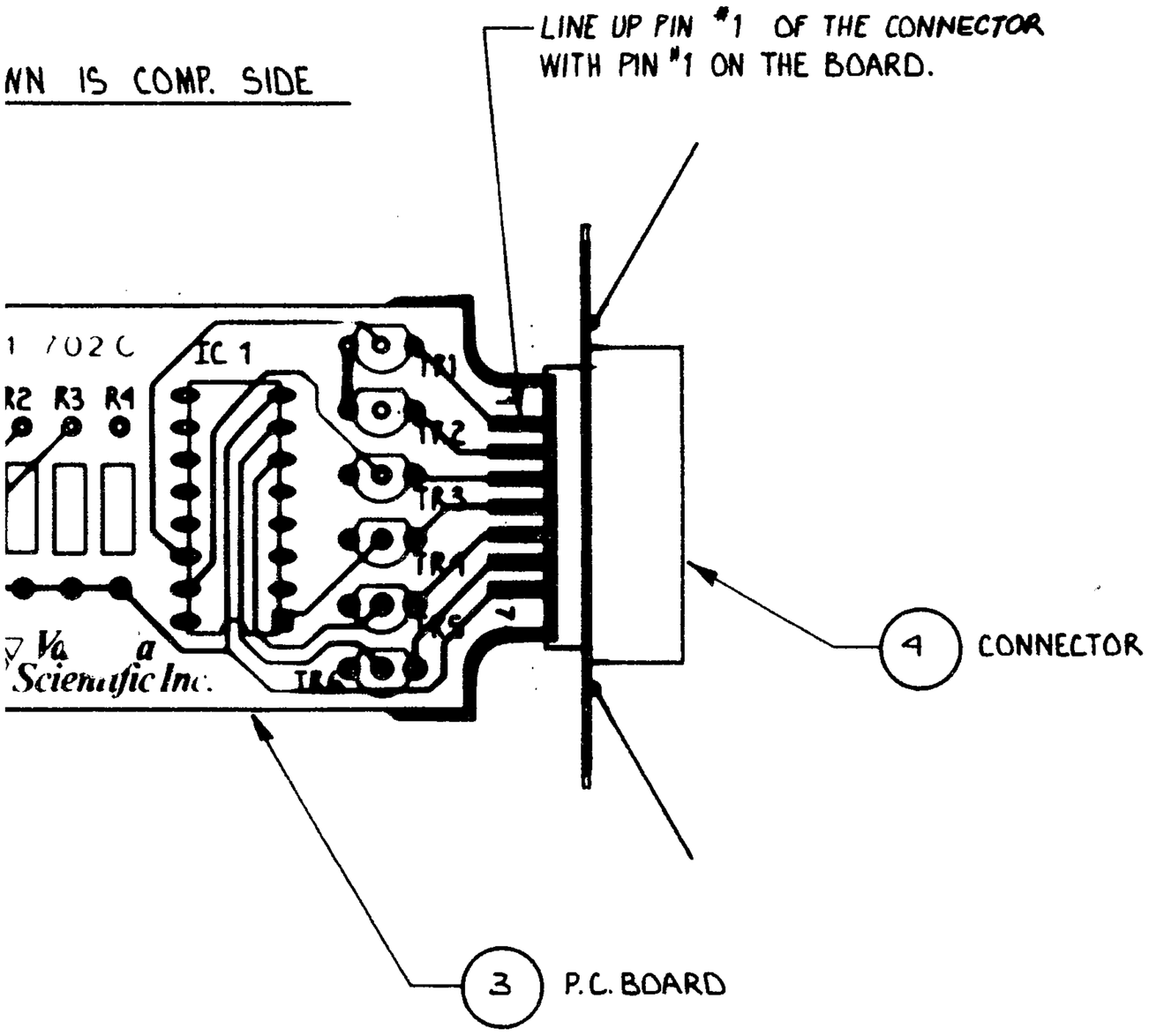
REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	C	REDESIGNED SEE E.C.O. 67 C.R.E 4-15-83	2-28-84	
296	D	CHG. TO P/L	2-28-84	

NN IS COMP. SIDE



ASH NO	QTY REQD	NEXT ASSEMBLY	USED ON

TOLERANCES
X° = ± 30'
.XX = ± .03
.XXX = ± .010

MATERIAL

BREAK ALL SHARP CORNERS AND EDGES. MACH SURFACES 64

FINISH

DRAWN CRE 4-14-83
CHECKED 2/23/84
APPR 2/23/84
STK NO

THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC. AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT VALHALLA SCIENTIFIC INC. RESERVES ALL PATENT, SALE, PROPRIETARY, DESIGN MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO

Valhalla Scientific Inc.
SAN DIEGO, CA

OPTION "IRP" BOARD ASSEMBLY

SCALE 2:1
SHEET 2 OF 2

CODE IDENT	SIZE	DRAWING NO	REV
53504	C	2701 - 602	D

2701 - 602 C

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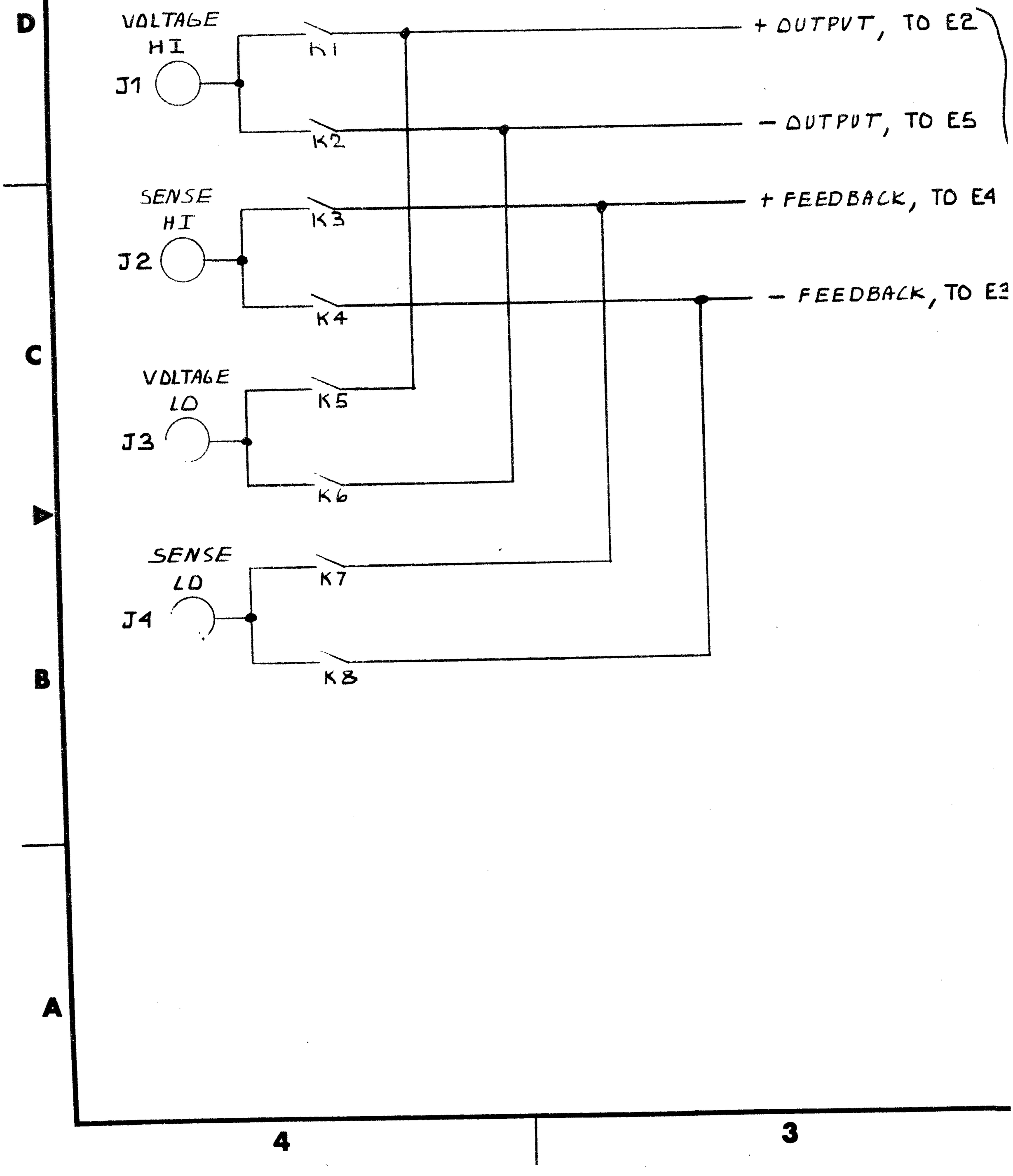
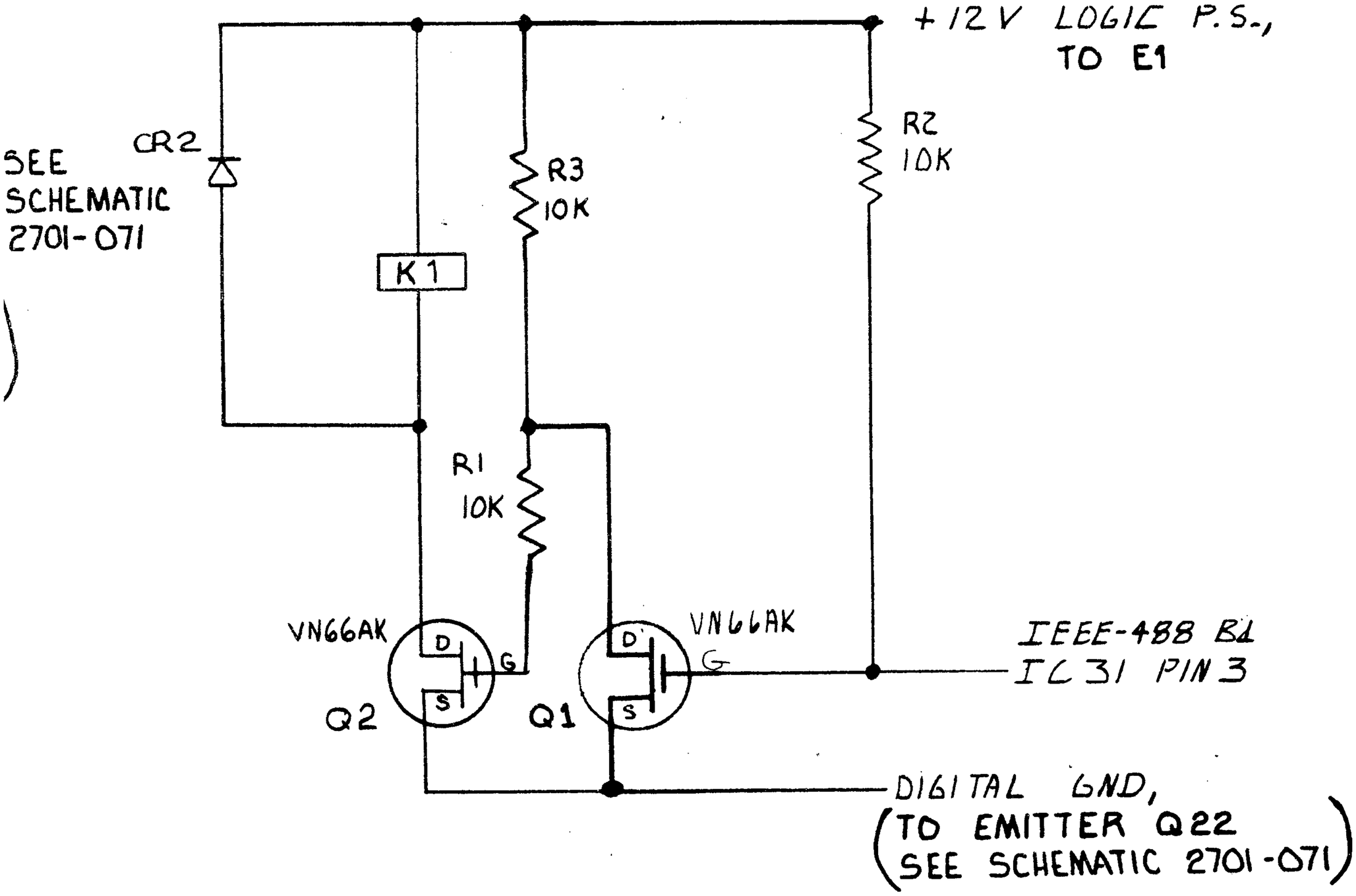


ManualsPlus.com

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
342	B	TOOK OUT RELAY RDN	3-2-84	PE



MATERIAL / FINISH	DRAWN		Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA		
	CHECKED				
	APPR.				
	3-11-81		2701 POLARITY CONTROL		
	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC. AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT. VALHALLA SCIENTIFIC INC. RESERVES ALL PATENT, SALE, PROPRIETARY DESIGN, MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO.				
	SCALE NONE	CODE IDENT NO. 53504	SIZE B	DRAWING NO. 2701-073	REV. B
	SHEET 1 OF 1				

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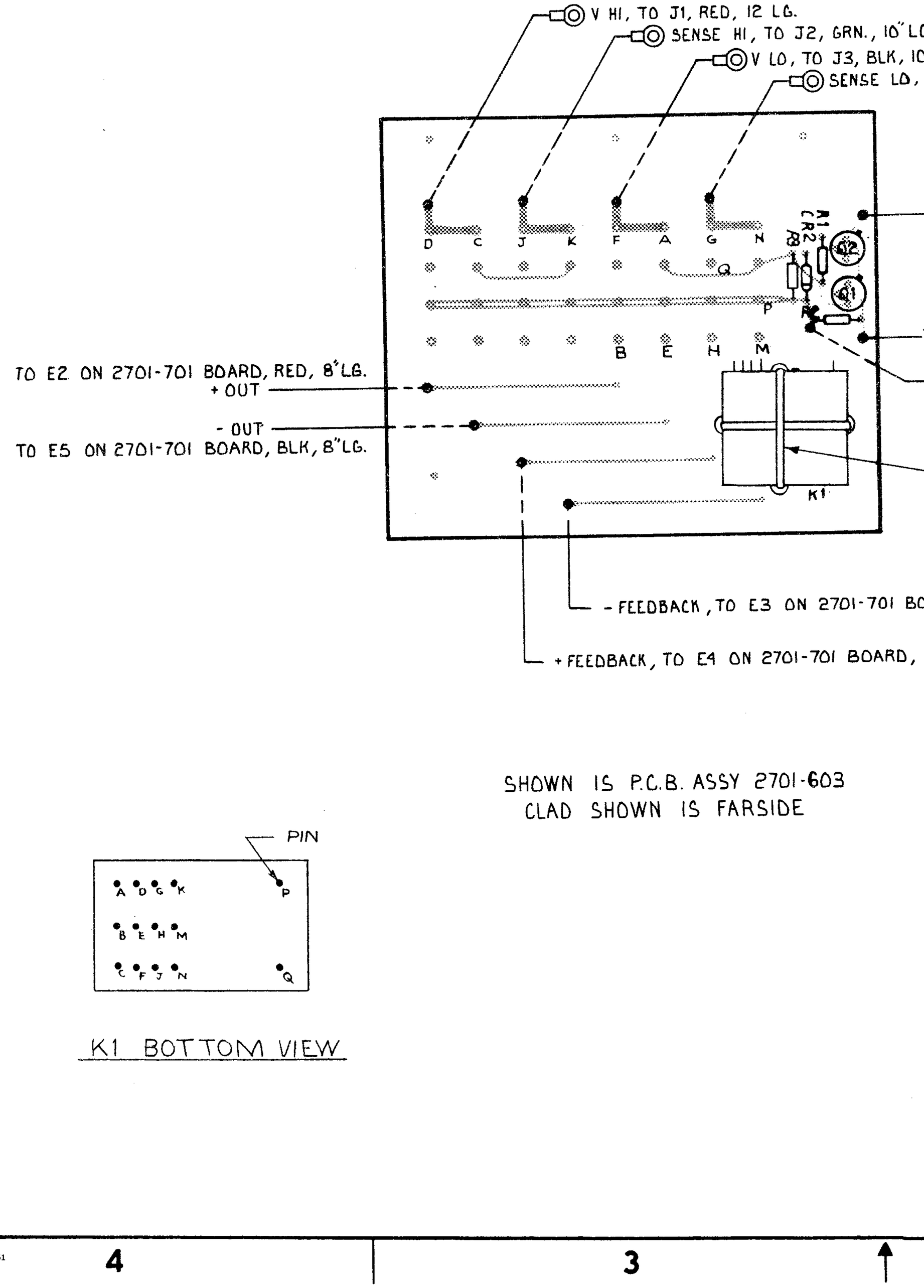
NOTES

1. FOR SCHEMATIC SEE 2701-073.
2. ALL WIRE IS TO BE 24 AWG. AND SOLDER FROM FAR SIDE.



SHOWN IS P.C.B. ASSY 2701-603
CLAD SHOWN IS FARSIDE

K1 BOTTOM VIEW

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REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED		
342	B	CHANGED RELAY RDN	3-2-84	

5.

J4, WHT., 8 LG.

) V, TO EMITTER Q22 ON 2701-700 BOARD, BLK., 8 LG.

[C31, PIN 3, ON IEEE-488 BOARD, YELLOW, 15" LG.

-12 V, TO E1 ON 2701-701 BOARD, RED, 8" LG.

(17)

D, BLK., 8" LG.

), 8" LG.

MATERIAL	DRAWN C.R.E.	11/24	Valhalla Scientific Inc.			
	CHECKED		SAN DIEGO, CALIFORNIA			
	APPR.					
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC. AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT, VALHALLA SCIENTIFIC INC. RESERVES ALL PATENT, SALE, PROPRIETARY, DESIGN, MANUFACTURING USE AND REPRODUCTION RIGHTS THERETO.		ASSEMBLY P.C.B 2701-703			
	SCALE NONE		CODE IDENT NO.	SIZE	DRAWING NO.	REV.
	SHEET 2 OF 2		53504	C	2701-603	B

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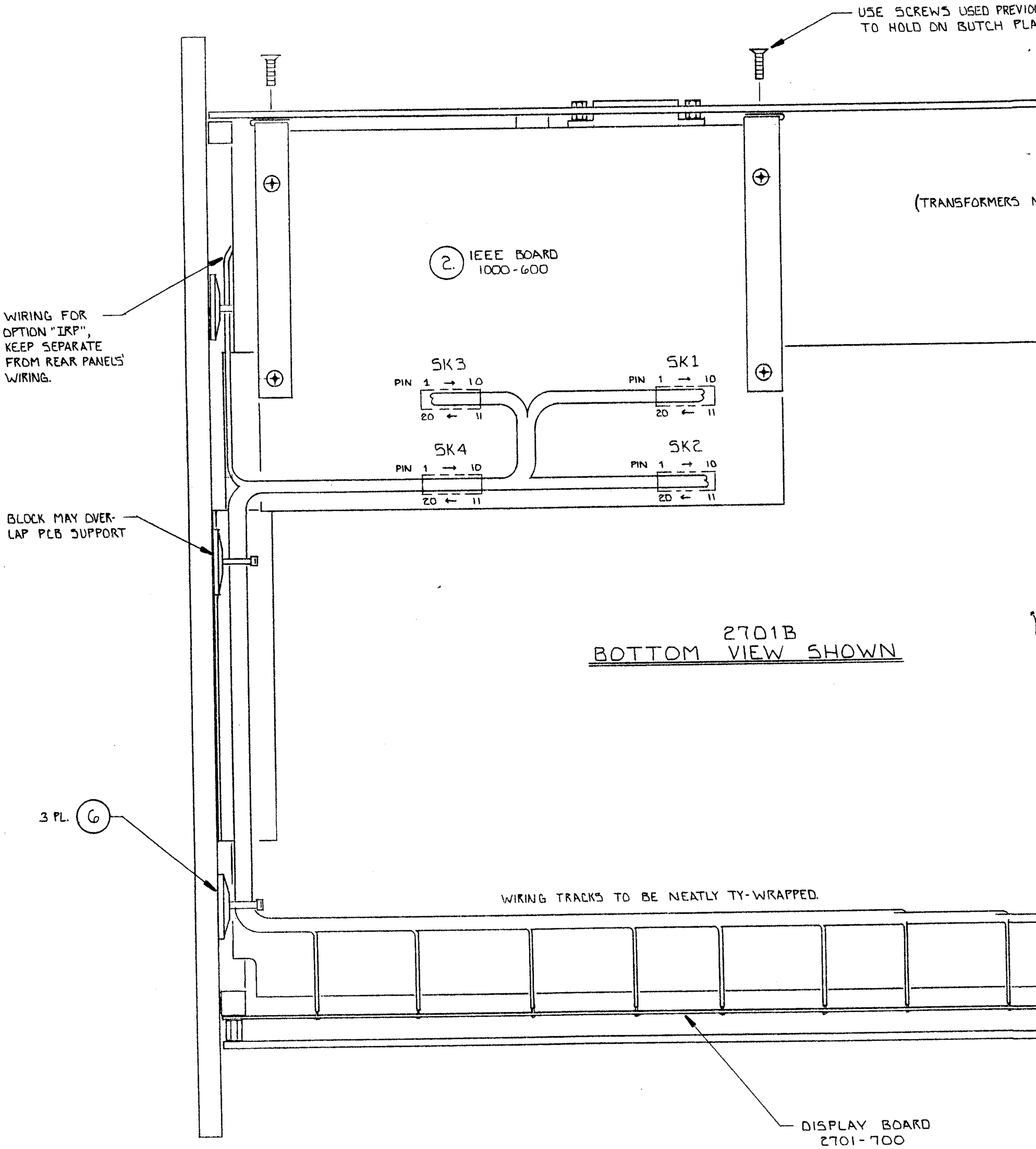
NOTES: (UNLESS OTHERWISE SPECIFIED)



2701B
BOTTOM VIEW SHOWN

22X34

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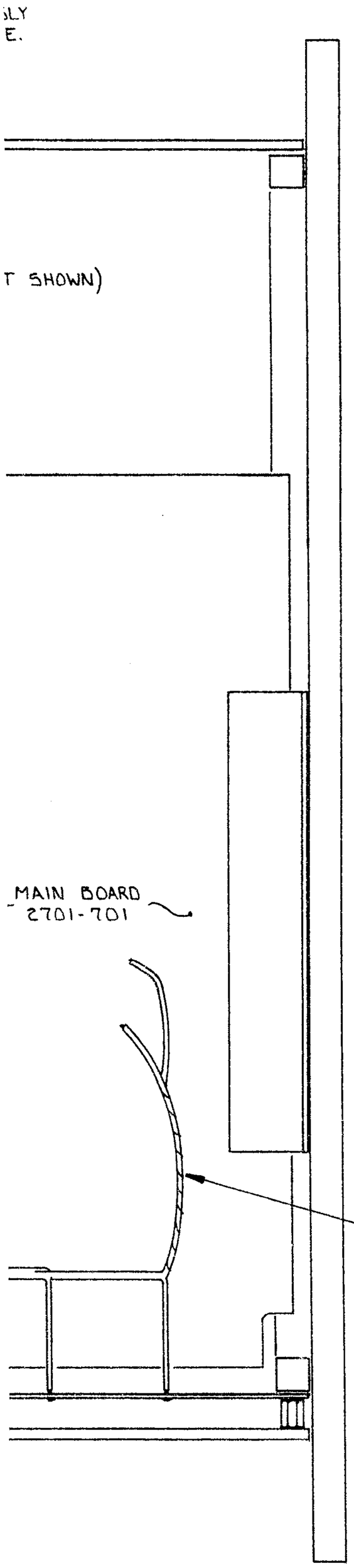
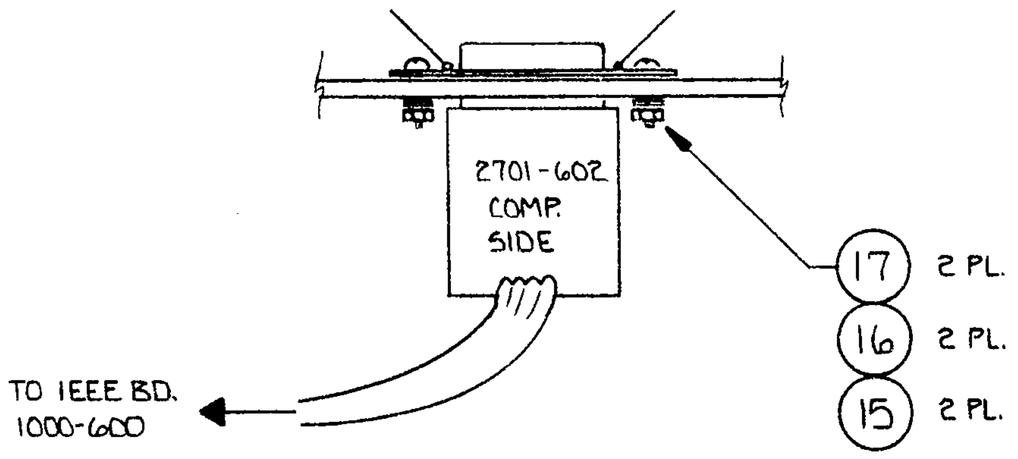
REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
41[illegible]	B	DWG. RELEASED WPW	7-16-84	[illegible]



OPTION "IRP" DETAIL
TOP VIEW SHOWN



GENERAL NOTES:
1. FOR EXACT WIRING INSTRUCTIONS SEE WIRE TAB # 2701-051.

DASH NO	QTY REQD	NEXT ASSEMBLY	USED ON

TOLERANCES
X° = ± 30'
.XX = ± .03
.XXX = ± .010

BREAK ALL SHARP CORNERS AND EDGES, MACH SURFACES 64 ✓

MATERIAL: SEE PARTS LIST

FINISH: ~

DRAWN WPW	7-16-84	
CHECKED JH	7/16/84	
APPR H.	7/16/84	
STK NO ~		

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Valhalla Scientific Inc.
SAN DIEGO, CA

OPTION "TL-3"
(ASSY. DWG.)

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
NONE	53504	D	2701-604	B

SHEET 3 OF 3

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NOTES:

1. FOR SCHEMATIC SEE 2701-070 + 2701-071.
2. FOR WIRING INFO. SEE 2701-050.
3. MOUNTING EARS 2714-206 (4-10277) NOT SHOWN.

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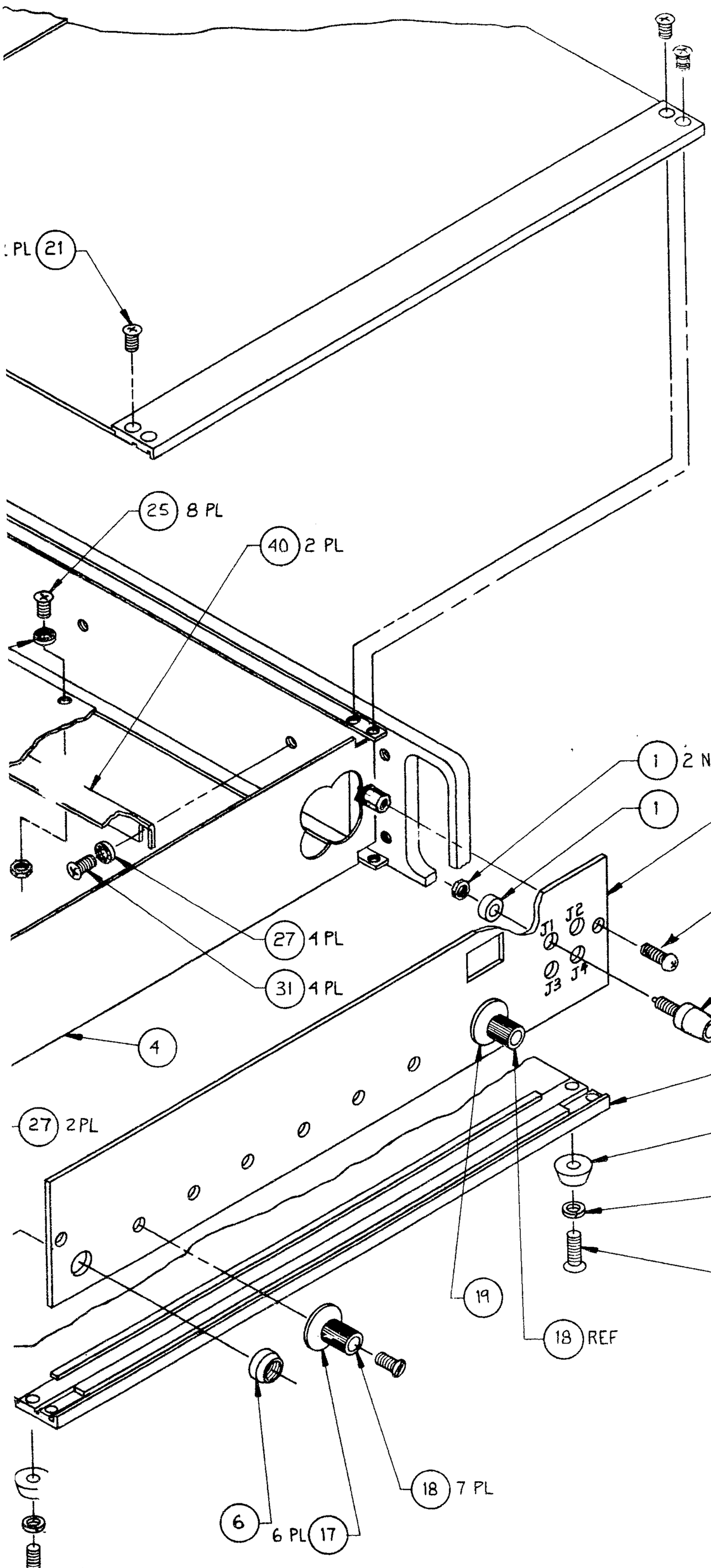
REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED C.R.E. 11-24		
	B	ECO 21 PWW 4-82		
	C	REDESIGNED CASE C.R.E. 5-28-82		PoW
151	D	NEW SIDE RAIL WPW	11-22-83	PoW
0204	E	DELETED ITEM 27 (BPL). R	12-13-83	R
239	F	MOD. FRONT PANEL MOUNTING WPW	1-16-84	R
296	G	P/L CHANGE	2-29-84	R
394	H	CHG'D IEEE BD. WPW	3-23-84	R



SEE SEPARATE PARTS LIST

MATERIAL	DRAWN C.R.E. 11/24	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
	CHECKED RM 1/2		
	APPR. PoW 6/3		
FINISH	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC INC AND EXCEPT FOR RIGHTS EXPRESSLY GRANTED TO THE UNITED STATES GOVERNMENT VALHALLA SCIENTIFIC INC. RESERVES ALL PATENT, SALE, PROPRIETARY, DESIGN MANUFACTURING, USE AND REPRODUCTION RIGHTS THERETO	ASSEMBLY - UNIT MODEL 2701	
	SCALE NONE	CODE IDENT NO. 53504 / SIZE D / DRAWING NO. 2701-400	REV. H
	SHEET 4 OF 4		

2701-400

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Federal Supply Codes for Manufacturers (cont.)

18612
Vishay Intertechnology Inc.
Malvern, Pennsylvania

18722
R C A
Mountaintop, Pennsylvania

18927
GTE Sylvania Inc.
Titusville, Pennsylvania

21604
Bucheye Stamping Co.
Columbus, Ohio

21845
Solitron Devices Inc.
Riveria Beach, Florida

22767
ITT Semiconductors
Palo Alto, California

23936
Pamotor Div.
Burlingham, California

24355
Analog Devices Inc.
Norwood, Massachusetts

24655
General Radio
Concord, Massachusetts

25088
Siemen Corp.
Isilen, New Jersey

25403
Amperex Electronic Corp.
Slatersville, Rhode Island

25684
Victoreen Instrument Co., Inc.
Oak Lawn, Illinois

27014
National Semiconductor Corp.
Santa Clara, California

27556
IMB Electronic Products
Santa Fe Springs, California

27264
Molex Products
Downers Grove, Illinois

28213
Minnesota Mining & Mfg. Co.
St. Paul, Minnesota

28480
Hewlett Packard Co.
Palo Alto, California

29083
Monsanto Co., Inc.
Santa Clara, California

29604
Stackpole Components Co.
Raleigh, North Carolina

30323
Illinois Tool Works, Inc.
Chicago, Illinois

30983
Electra/Midland
San Diego, California

32539
Mura Corp.
Great Neck, New York

32897
Erie Technological Products, Inc.
Carlisle, Pennsylvania

32997
Bourns Inc.
Riverside, California

33173
General Electric Co.
Owensboro, Kentucky

34333
Silicon General
Westminister, California

34335
Advanced Micro Devices
Sunnyvale, California

34802
Electromotive Inc.
Kenilworth, New Jersey

37942
P.R. Mallory & Co., Inc.
Indianapolis, Indiana

43543
Nytronics Inc.
Geneva, New York

44655
Ohmite Mfg. Co.
Skokie, Illinois

49671
RCA Corp.
New York, New York

49956
Raytheon Company
Lexington, Massachusetts

50088
Mostek Corp.
Carrollton, Texas

50579
Litronix Inc.
Cupertino, California

51605
Scientific Components Inc.
Linden, New Jersey

53021
Sangamo Electric Co.
Springfield, Illinois

53504
Valhalla Scientific, Inc.
San Diego, California

54294
Cutler-Hammer Inc.
Selma, North Carolina

55026
Simpson Electric Co.
Elgin, Illinois

56289
Sprague Electric Co.
North Adams, Massachusetts

58474
Superior Electric Co.
Bristol, Connecticut

63743
Ward Leonard Electric Co., Inc.
Mount Vernon, New York

65092
Weston Instruments Inc.
Newark, New Jersey

70563
Amperite Company
Union City, New Jersey

70903
Belden Corp.
Geneva, Illinois

71279
Cambridge Thermionic Corp.
Cambridge, Massachusetts

71400
Bussmann Mfg.
Saint Louis, Missouri

71450
CTS Corp.
Elkhart, Indiana

71468
ITT Cannon Electric Inc.
Santa Ana, California

71482
Clare, C.P. & Co.
Chicago, Illinois

71590
Centralab Electronics
Milwaukee, Wisconsin

71707
Coto Coil Co., Inc.
Providence, Rhode Island

71744
Chicago Miniature Lamp Works
Chicago, Illinois

71785
TRW Electronics Components
Chicago, Illinois

72005
Wilber B. Driver Co.
Newark, New Jersey

72259
Nytronics Inc.
Pelham Manor, New Jersey

72619
Dialight Div.
Brooklyn, New York

72982
Erie Tech. Products Inc.
Erie, Pennsylvania

73138
Bechman Instrument Inc.
Helipot Division
Fullerton, California

73445
Amperex Electronic Corp.
Hicksville, New York

73734
Federal Screw Products, Inc.
Chicago, Illinois

73899
JFD Electronics Co.
Brooklyn, New York

73949
Guardian Electric Mfg. Co.
Chicago, Illinois

74276
General Instrument Corp.
Neptune, New Jersey

74306
Piezo Crystal Co.
Carlisle, Pennsylvania

74970
Johnson E.F., Co.
Waseca, Minnesota

75042
TRW Electronics Components
IRC Fixed Resistors
Philadelphia, Pennsylvania

75378
CTS Knights Inc.
Sandwich, Illinois

75382
Kulka Electric Corp.
Mount Vernon, New York

75915
Littlefuse Inc.
Des Plaines, Illinois

76055
Mallory Controls
Frankfort, Indiana

76493
J.W. Miller Company
Los Angeles, California

76854
Oak Industries Inc.
Crystal Lake, Illinois

77342
Potter & Brumfield Div.
Princeton, Indiana

77638
General Instrument Corp.
Rectifier Division
Brooklyn, New York

78488
Stackpole Carbon Co.
Saint Marys, Pennsylvania

78553
Eaton Corp.
Cleveland, Ohio

80031
Electro-Midland Corp.
Mepco Div.
Norristown, New Jersey

56289
Sprague Products
North Adams, Massachusetts

80294
Bourns Inc., Instrument Div.
Riverside, California

81073
Grayhill, Inc.
La Grange, Illinois

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Federal Supply Codes for Manufacturers

00656
Aerovox Corp.
New Bedford, Massachusetts

00686
Film Capacitors, Inc.
Passaic, New Jersey

00779
AMP Inc.
Harrisburg, Pennsylvania

00853
Sangamo Electric Company
Pickens, South Carolina

01121
Allen-Bradley Co.
Milwaukee, Wisconsin

01255
Litton Industries, Inc.
Beverly Hills, California

01281
TRW Electronic Comp.
Semiconductor Operations
Lawndale, California

01295
Texas Instruments, Inc.
Dallas, Texas

01686
RCL Electronics Inc.
Manchester, New Hampshire

02114
Ferroxcube Corp.
Saugerties, New York

02131
General Instrument Corp.
Westwood, Maine

02799
Areo Capacitors, Inc.
Chatsworth, California

03508
General Electric Co.
Syracuse, New York

03797
Genisco Technology Corp.
Compton, California

03877
Transistron Electronic Corp.
Wakefield, Massachusetts

03911
Clairex Corp.
Mt. Vernon, New York

04009
Arrow Hart Inc.
Hartford, Connecticut

04217
Essex International Inc.
Anaheim, California

04222
AVX Corp.
Myrtle Beach, Florida

04423
Telonic Industries
Laguna Beach, California

04713
Motorola Inc.
Phoenix, Arizona

04946
Standard Wire & Cable
Los Angeles, California

05276
Pomona Electronics Co., Inc.
Pomona, California

05277
Westinghouse Electric Corp.
Youngwood, Pennsylvania

05397
Kemet, Union Carbide Corp.
New York, New York

05574
Viking Industries
Chatsworth, California

05820
Wakefield Engineering Inc.
Wakefield, Massachusetts

06001
General Electric Co.
Columbia, South Carolina

06383
Panduit Corp.
Tinley Park, Illinois

06473
Bunker Ramo Corp.
Chatsworth, California

06555
Beede Electrical Instrument Co.
Penacook, New Hampshire

06743
Clevite Corp.
Cleveland, Ohio

07088
Kelvin Electric Company
Van Nuys, California

07256
Silicon Transistor Corp.
Chelmsford, Massachusetts

07263
Fairchild Semiconductor
Mountain View, California

07344
Bircher Co., Inc.
Rochester, New York

07597
Burndy Corp.
Rochester, New York

07716
I R C Incorporated
Burlington, Iowa

07910
Teledyne Semiconductor
Hawthorne, California

08065
Accurate Rubber and Plastics Co.
San Diego, California

08261
Spectra Strip Corp.
Garden Grove, California

08530
Reliance Mica Corp.
Brooklyn, New York

08806
General Electric Co.
Cleveland, Ohio

09026
Babcock Electronics Corp.
Costa Mesa, California

09214
G. E. Co. Semi-Conductor
Auburn, New York

09353
C and K Components
Watertown, Massachusetts

09922
Burndy Corp.
Norwalk, Connecticut

09969
Dale Electronics Inc.
Yankton, S. Dakota

11236
CTS of Berne
Berne, Indiana

11403
Best Products Co.
Chicago, Illinois

11503
Keystone Columbia Inc.
Warren, Michigan

11532
Teledyne Relays
Hawthorne, California

11711
General Instrument Corp.
Hicksville, New York

12014
Chicago Rivet & Machine Co.
Bellwood, Illinois

12060
Diodes, Inc.
Chatsworth, California

12136
Philadelphia Handle Co.
Camden, New Jersey

12405
Hysol Corporation
El Monte, California

12406
Elpac, Incorporated
Fullerton, California

12615
U.S. Terminals Inc.
Cincinnati, Ohio

12617
Hamlin Inc.
Lake Mills, Wisconsin

12697
Clarostat Mfg. Co.
Dover, New Hampshire

12969
Unitrode Corp.
Watertown, Massachusetts

13103
Thermalloy Co., Inc.
Dallas, Texas

13327
Solitron Devices Inc.
Tappan, New York

13454
Texas Crystals
River Grove, Illinois

13511
Amphenol Cadre Div.
Los Gatos, California

13606
Use 56289
Sprague Electric Co.
Concord, New Hampshire

14099
Semtech Corp.
Newbury Park, California

14655
Cornell-Dublier Electronics
Newark, New Jersey

14752
Electro Cube Inc.
San Gabriel, California

14936
General Instrument Corp.
Hicksville, New York

15801
Fenwal Electronics Inc.
Framingham, Massachusetts

15818
Teledyne Semiconductors
Mountain View, California

15849
Useco Inc.
Van Nuys, California

15898
International Business
Machines Corp.
Essex Junction, Vermont

16332
Replaced by 28478

16473
Cambridge Scientific Ind.
Cambridge, Maryland

16758
Delco Electronics
Kokomo, Indiana

17856
Siliconix, Inc.
Santa Clara, California

18324
Signetics Corp.
Sunnyvale, California

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Federal Supply Codes for Manufacturers (cont.)

81095
Triad Transformer Corp.
Venice, California

81312
Winchester Electronics
Div. of Litton Industries Inc.
Oakville, Connecticut

81483
International Rectifier Corp.
Los Angeles, California

81741
Chicago Lock Co.
Chicago, Illinois

82389
Switchcraft Inc.
Chicago, Illinois

82877
Rotron Inc.
Woodstock, New York

82879
ITT Royal Electric Div.
Pawtucket, Rhode Island

83003
Varo Inc.
Garland, Texas

83298
Bendix Corp.
Eatontown, New Jersey

83330
Herman H. Smith, Inc.
Brooklyn, New York

83594
Burroughs Corp.
Plainfield, New Jersey

83740
Union Carbide Corp.
New York, New York

84171
Arco Electronics
Great Neck, New York

84411
TRW Electronic Components
Ogallala, Nebraska

84613
Fuse Indicator Corp.
Rockville, Maryland

84682
Essex International Inc.
Peabody, Massachusetts

86684
Radio Corp. of America
Harrison, New Jersey

88219
Gould Inc.
Trenton, New Jersey

88245
Litton Systems Inc.
Useco Div.
Van Nuys, California

88419
Cornell-Dubilier Electronic Div.
Fuquay-Varian, North Carolina

89730
G.E. Co.
Newark, New Jersey

90201
Mallory Capacitor Co.
Indianapolis, Indiana

56365
Square D Co.
Chicago, Illinois

90303
Mallory Battery Co.
Tarrytown, New York

91094
Essex International Inc.
Newmarket, New Hampshire

91293
Johanson Mfg. Co.
Boonton, New Jersey

91506
Augat Inc.
Attleboro, Massachusetts

91637
Dale Electronics Inc.
Columbus, Nebraska

91662
Elco Corp.
Willow Grove, Pennsylvania

71468
Gremar Mfg. Co., Inc.
ITT Cannon/Gremar
Santa Ana, California

91802
Industrial Devices, Inc.
Edgewater, New Jersey

91833
Keystone Electronics Corp.
New York, New York

91929
Honeywell Inc.
Micro Switch Div.
Freeport, Illinois

92194
Alpha Wire Corp.
Elizabeth, New Jersey

93332
Sylvania Electric Products
Woburn, Massachusetts

94988
Wagner Electric Corp.
Tung-Sol Div.
Newark, New Jersey

95146
Alco Electronic Products Inc.
Lawrence, Massachusetts

95275
Vitramon Inc.
Bridgeport, Connecticut

95303
RCA Corp.
Receiving Tube Div.
Cincinnati, Ohio

95348
Gordo's Corp.
Bloomfield, New Jersey

95712
Bendix Corp.
Franklin, Indiana

97913
Industrial Electronic
Hardware Corp.
New York, New York

97945
Penwalt Corp.
SS White Industrial Products Div.
Piscataway, New Jersey

98278
Malco A. Microdot Co., Inc.
Connector & Cable Div.
Pasadena, California

98291
Sealectro Corp.
Mamaroneck, New York

98388
Royal Industries
Products Div.
San Diego, California

98978
IERC
Burbank, California

99120
Plastic Capacitors, Inc.
Chicago, Illinois

99217
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Burbank, California

99392
STM
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99515
ITT Jennings Monrovia Plant
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