VALHALLA SCIENTIFIC, INC.

MODEL 2100/2101
DIGITAL POWER ANALYZER

OPERATION MANUAL

VALHALLA
SCIENTIFIC

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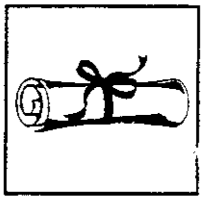
CERTIFICATION

Valhalla Scientific, Inc. certifies that this instrument was thoroughly tested and inspected and found to meet published specifications when shipped from the factory. Valhalla Scientific, Inc. further certifies that its calibration measurements are traceable to the National Institute of Standards and Technology to the extent allowed by NIST'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 repairs. No liability will be accepted if returned without such permission. Due to continuing product refinement and due to possible parts manufacturer changes, Valhalla Scientific reserves the right to change any or all specifications without notice.

This manual covers the following Valhalla Scientific products:

Models 2100, 2101, 2101L and 2101-20mA.

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SECTION I UNPACKING & INSTALLATION

1-1. Introduction

Valhalla Scientific Models 2100 and 2101 are accurate, reliable low-cost power measurement devices designed to aid engineering, production test, and quality assurance departments in determination of product power consumption from DC and AC power sources. The instruments feature dual independent digital displays. The left display provides a continuous indication of true power in watts. The right display is switch-selectable between amperes (true RMS) or volts (true RMS).

Models 2100 and 2101 provide a fast and convenient method of determining product efficiency, power factor, and true RMS current draw. Phase angle relationships may be calculated through manipulation of the displayed quantities.

Both models are nearly identical in function except for their voltage input capacity. The standard Model 2100 has voltage ranges of 150, 300, and 600 volts. The Model 2101 has voltage ranges of 30, 150, and 300 volts. The Model 2101 provides greater watts resolution when using low voltages, at the expense of a reduced maximum voltage capacity.

Variations on the basic instruments are available for specialized applications. The Model 2101L has reduced voltage ranges for greater accuracy when using low voltages. The Model 2101-20mA has reduced current ranges for greater accuracy when using low current levels. Please refer to Section 2 for details.

For convenience, in further discussions the various models of power analyzers will be referred to as a "2100", unless specific differences exist in which case they will be noted to the reader.

1-2. Inspection

If the shipping carton is damaged, request that the carrier's agent be present when the unit is unpacked. If the instrument appears damaged, the carrier's agent should authorize repairs before the unit is returned to the factory. Even if the instrument appears undamaged, it may have suffered internal damage in transit that may not be evident until the unit is operated or tested to verify conformance with its specifications. If the unit fails to operate, notify the carrier's agent and the nearest Valhalla Sales Office. Retain the shipping carton for the carrier's inspection. DO NOT return equipment to Valhalla Scientific or any of its sales offices prior to obtaining authorization to do so.

1-3. Line Voltage/Fuse Selection

The switch on the rear of the 2100 is used to configure the power analyzer for operation at different AC line voltages. The supply voltages and their corresponding fuses are listed below:

105 to 125 VAC, 50-400Hz = ¼ Amp Slo-Blo

210 to 250 VAC, 50-400Hz = .125 Amp Slo-Blo

Note that this switch is for the internal operating voltages required by the power analyzer, and should not be confused with the input voltage selectors on the front of the instrument.

☞ Ensure that the correct line voltage selection is made prior to applying power to the 2100!

1-4. Bench Use

The 2100 is delivered for operation in bench use and special instructions for use in this manner other than the procedures of Section 4 are not required.

1-5. Rack Mounting

An optional kit is available for mounting the 2100 in a standard 19" equipment rack. This is listed in Section 3 of this manual. Follow the installation diagram included with the kit. If the 2100 is to be transported while mounted in a rack then it must be supported so as to prevent upward and downward movement.

The user should note that the specifications for the 2100 become degraded at high temperatures thus it is required that sufficient room be allowed for airflow around the 2100. This may be achieved by placing a minimum 1.75" blank panel above and below the 2100 in the rack.

If a unit placed beneath the 2100 has an unusually hot exterior top surface and it is not possible to alter its location, it is recommended that an aluminum "reflector" plate be used between this unit and the 2100.

Under no circumstances should the ambient air temperature surrounding the 2100 be allowed to exceed 50°C while in operation or 70°C while in storage.

1-6. Safety Precautions

The power connector is a three-contact device and should be mated only with a three-contact connector where the third contact provides a continuous ground connection. A mating power cord has been provided. If the power is provided through an extension cable then the ground connection must be continuous throughout this cable. Failure to provide a continuous ground connection to the 2100 may render it unsafe for use!

Lethal voltages are routinely present on the rear terminals of the 2100! Always disable the power source before changing load or source connections.

SECTION II SPECIFICATIONS

2-1. General

This section contains accuracy, operating and environmental specifications for the Models 2100, 2101, 2101L and 2101-20mA.

2-2. Range and Resolution Tables

Model 2100

VOLTAGE	CURRENT RANGES		
	.2000 amps	**2.000 amps**	**20.00 amps**
150.00 volts	30.00 watts	300.0 watts	3000 watts
300.0 volts	60.00 watts	600.0 watts	6000 watts
600.0 volts	120.00 watts	1200.0 watts	12000 watts
	WATTS		

Model 2101

VOLTAGE	CURRENT RANGES		
	.2000 amps	**2.000 amps**	**20.00 amps**
30.00 volts	6.000 watts	60.00 watts	600.0 watts
150.0 volts	30.00 watts	300.0 watts	3000 watts
300.0 volts	60.00 watts	600.0 watts	6000 watts
	WATTS		

Model 2101-20mA

VOLTAGE	CURRENT RANGES		
	20.00 milliamps	**.2000 amps**	**2.000 amps**
30.00 volts	.6000 watts	6.000 watts	60.00 watts
150.0 volts	3.000 watts	30.00 watts	300.0 watts
300.0 volts	6.000 watts	60.00 watts	600.0 watts
	WATTS		

Model 2101L

		CURRENT RANGES		
VOLTAGE		**.2000 amps**	**2.000 amps**	**20.00 amps**
	1.5000 volts	.3000 watts	3.000 watts	30.00 watts
	15.000 volts	3.000 watts	30.00 watts	300.0 watts
	30.00 volts	6.000 watts	60.00 watts	600.0 watts
		WATTS		

2-3. Accuracies

Specified accuracies are valid for a period of 1 year from the date of calibration at 25°C ±5°C, following a 30 minute warm-up.

Voltage - AC+DC, DC Coupled

DC and 40Hz - 5 kHz:	±0.1% of reading ±6 digits
5 kHz - 10 kHz:	±0.5% of reading ±0.5% of range
10 kHz - 20 kHz:	±1% of reading ±1% of range

(Useable above 20 kHz to 50 kHz with typically an additional 1% error per 10 kHz)

Current - AC+DC, DC Coupled

DC and 40Hz - 5 kHz:	±0.1% of reading ±6 digits
5 kHz - 10 kHz:	±0.5% of reading ±0.5% of range (12 Amp maximum)
10 kHz - 20 kHz:	±1% of reading ±1% of range (2 Amp maximum)

(Useable above 20 kHz to 50 kHz with typically an additional 1% error per 10kHz)

Watts - True Power (EI A cosΦ)

DC and 40Hz - 5 kHz:	±0.25% of reading ±6 digits
5 kHz - 10 kHz:	±0.5% of reading ±0.5% of range (12 Amp maximum)
10 kHz - 20 kHz:	±1% of reading ±1% of range (2 Amp maximum)

(Useable above 20 kHz to 50 kHz with typically an additional 1% error per 10 kHz)

2-4. Operating Specifications

Crest Factor Response:	50:1 for minimum RMS input, linearly decreasing to 2.5:1 for full scale RMS input
Minimum Inputs:	5% of voltage and current ranges for specified accuracies
Maximum Voltage Input: (Without damage)	Models 2100, 2101, 2101-20mA = 600VDC or RMS, $\pm1500V_{PEAK}$ Model 2101L = 30VDC or AC_{RMS}, $\pm60V_{PEAK}$

Maximum Current Input: Models 2100, 2101, 2101L = ±35A_{PEAK}, 20ADC or RMS continuous; 100ADC or RMS for 16 milliseconds without damage

Model 2101-20mA = ±3.5A_{PEAK}, 2ADC or RMS continuous; 5ADC or RMS for 16 milliseconds without damage

Voltage Input Impedance: Models 2100, 2101, 2101-20mA = 600kΩ
Model 2101L = 45kΩ

Current Shunt Impedance: Models 2100, 2101, 2101L = .01Ω
Model 2101-20mA = 0.1Ω

Max Common Mode: ±1500V peak, neutral to earth

Peak Indicators: Illuminate at 2.5 x full scale for voltage and current

Overrange: 150% of full scale for DC, up to "maximum input" specification

2-5. Environmental and Physical Specifications

Temperature Range: 0°C to 50°C operating; -20°C to 70°C storage

Temperature Coefficient: ±0.025% of range per °C from 0°C-20°C and 30°C-50°C

Power Consumption: 105-125VAC or 210-250VAC, 50-400Hz; 25VA maximum

Dimensions: 25cm W x 27cm D x 8cm H (10" W x 10.5" D x 3" H)

Weights: 1.7kg (3.5 lbs) net; 3kg (6 lbs) shipping

Source/Load Connections: 4-terminal heavy-duty input jacks

SECTION III AVAILABLE OPTIONS

3-1. General

This section lists the options available for the 2100/2101 Digital Power Analyzer. Standard accessories include a detachable power cord and an operation manual.

3-2. Optional Accessories

Option I-75: Current Transformer

This "clamp-on" type current transformer extends the AC current measurement capability on the 2100 and 2101 to 75 amps RMS. The 100:1 output ratio is 2% accurate from 45Hz to 1000Hz. The device accommodates up to ½" diameter conductors.

Option I-150: Current Transformer

This "clamp-on" type current transformer extends the AC current measurement capability on the 2100 and 2101 to 150 amps RMS. The 1000:1 output ratio is 2% accurate from 50Hz to 60Hz, and 3% accurate at 60Hz to 10kHz. The device accommodates up to ½" diameter conductors.

Option I-1000: Current Transformer

This "clamp-on" type current transformer extends the AC current measurement capability on the 2100 and 2101 to 1000 amps RMS. The 1000:1 output ratio is 2% accurate from 50Hz to 1000Hz. The device accommodates up to 2" diameter conductors.

Option X21: Load Power Adaptor Cord

This cable is specifically designed for use with the 2100/2101 Power Analyzer. It allows for quick and easy connection and testing of loads that use a standard AC plug (i.e. televisions, toasters, microwaves, radios, hair dryers, etc.). The entire cable is 6 feet in length and accommodates supply currents up to 20 amperes.

Option CC4: Carrying Case

This item is a meter and accessory carrying case designed to protect the Power Analyzer when moved from one location to another. The case is made of black vinyl and includes a shoulder strap.

Option R4: Rack Mount Adaptor Kit

This item adapts the Power Analyzer for installation in a standard 19" equipment rack.

Option DMX: Multiplexed BCD Output

Option DMX provides raw, non-isolated data output for use by Valhalla Models 2190 or 2191 below. If desired, existing Power Analyzers may be retrofit with Option "DMX" at the factory. Please call for details.

Model 2190: D-to-A Converter

The Valhalla Model 2190 is an isolated digital to analog converter with outputs to ±5VDC. The outputs are directly proportional to the display indications. The outputs are ideal for driving a chart recorder, voltmeter or other device. The 2100 must be fitted with Option "DMX" to use this device.

Model 2191: Data Isolator/Demultiplexer

The Valhalla Model 2191 is an isolated demultiplexer that conditions the display data for ready use in a standard binary-coded-decimal (BCD) format. Model 2191 allows the Power Analyzer to be used with the Valhalla Model 1248 dual-limit comparator below, or with other types of data acquisition equipment. The Power Analyzer must be fitted with Option "DMX" to use this device.

Model 1248: Dual-Limit Comparator

The Valhalla Model 1248 is a dual-limit BCD comparator that compares the 2100 display readings to a tolerance that is set by the user. If the readings exceed either the high or low limits of the tolerance, the Model 1248 indicates the condition and closes a corresponding relay. The relay contacts may be used to trigger an alarm, counter, batch-sorter or other device. The Model 1248 connects to the outputs of Valhalla Model 2191 described previously. The mating cable is designated as Option "IDC-2".

Model 1020A: Digital Interface Module

The 1020A Isolated Remote Interface Module allows remote data acquisition of the Watts and Volts or Amps data via GPIB (IEEE-488.2), RS232C, and/or Centronics Parallel printer port(s). These three ports may be purchased in any combination. The Power Analyzer must be fitted with a special data output port denoted as Option "DMX-1020" in order to connect to the 1020A. The standard DMX port is incompatible.

Note that the 1020A is for remote data acquisition only, and does not allow range or function control of the Power Analyzer. Note also that only items present on the displays of the Power Analyzer may be retrieved. Volts and Amps data are not available simultaneously.

3-3. Special Versions of Model 2101

Two variations on the standard Model 2101 are available for special applications and are described below. The modifications are mutually exclusive (may not be installed simultaneously) and available on Model 2101 only. Retrofit for existing meters is available, please contact the factory.

2101-20mA: Reduced Current Ranges

This option reduces all current ranges by a factor of 10 for greater accuracy when working with low current levels. Watts resolution is also increased (see Section 2). Current ranges become 20mA, .2A and 2A. The maximum current input is 2 amps DC or RMS.

2101L: Reduced Voltage Ranges

This option provides reduced voltage ranges of 1.5, 15, and 30 volts for greater accuracy when working with low voltage levels. The maximum voltage input is 30 volts DC or RMS.

SECTION IV OPERATION

4-1. General

This section of the manual contains complete operating instructions for the Model 2100 and Model 2101 Digital Power Analyzers. Included are control functions, connection methods, and operational precautions. For convenience, all models of Power Analyzer are referred to as a "2100" unless specific differences exist in which case the reader will be informed of the necessary changes.

4-2. Front Panel Controls

The functions of all front panel controls and indicators are described in the following paragraphs.

4-2-1. Power Push-Button

Power is applied to the 2100 by pressing the POWER push-button. Application of power is indicated by lighting of the digital displays. The first depression locks the push-button in its ON position and applies power to the unit. When it is depressed a second time, it returns to its outer position and disconnects power from the unit.

4-2-2. DISPLAY Push-Buttons

These interlocked push-buttons control which measurement will be displayed in the AMPS TRMS - VOLTS TRMS window. These buttons do not affect the WATTS display.

4-2-3. CURRENT Push-Buttons

These interlocked push-buttons select the range of current that will be measured. For the greatest accuracy, select the range that provides the highest resolution without exceeding the value of the range.

If the amount of current is unknown, select the highest current range before applying power to the load. If the amount of current can be approximated, select the appropriate range.

4-2-4. VOLTAGE Push-Buttons

These interlocked push-buttons select the range of voltage that will be measured. For the greatest accuracy, select the range that provides the highest resolution without exceeding the value of the range.

If the level of voltage is unknown, select the highest voltage range before applying power to the load. If the level of voltage can be approximated, select the appropriate range.

4-2-5. Peak-Amp Overload Indicator

This indicator may be used to alert the user to the presence of spikes on the input signal. If the peak or steady-state current to the measured load is greater than 250% of the range selected with the CURRENT push-button, the "Amps O/L" indicator illuminates. Select a higher current range or reduce the current to the load to extinguish the indicator. Current and power displays may or may not be correct and should not be trusted if this indicator is lit.

4-2-6. Peak-Volt Overload Indicator

This indicator may be used to alert the user to the presence of spikes on the input signal. If the peak or steady-state voltage applied to the load is greater than 250% of the range selected with the VOLTAGE push-button, the "Volts O/L" indicator will be illuminated. Select a higher voltage range or reduce the supply voltage to extinguish the LED. Volts and power displays may or may not be correct and should not be trusted if this indicator is lit.

4-2-7. AMPS - VOLTS Display

When "Volts" is selected by the DISPLAY push-button, the right-hand digital display will show the True RMS (AC+DC) voltage applied to the rear panel connectors.

When "Amps" is selected, the True RMS (AC+DC) current passing through the internal shunt will be displayed in the right-hand display.

A flashing display in either mode indicates an overload condition. Reduce inputs or increase the ranges until a stable reading is observed.

4-2-8. WATTS - TRUE POWER Display

The power dissipated in the load (in watts) is indicated on the left-hand display. This reading is invalid if either the amps or volts overload indicator is illuminated. These peak indicators occur independently of whether "Amps" or "Volts" has been selected for the right-hand display. In either case, select a higher range or reduce the input signals. If the highest range has been selected and a peak O/L indicator is still on, the measurement may require the use of external dividers and/or current shunts.

This display includes a polarity (-) sign which indicates the general phase relationship between the voltage and current. A negative sign indicates that the voltage and current are out of phase. The lack of a negative sign means that the voltage and current are in phase. Note that a negative sign may also indicate that the voltage or current leads are reversed. The polarity sign may also be used to determine source or load power. *Load* power is that power which is consumed by a load. *Source* power (-) is that power which is supplied by a source.

If external dividers or shunts are used, the power display will be a fraction of the actual load power. Simple ratio calculations will then reveal the power actually delivered to the load. See Section 4-4-2.

Under certain conditions where complex waveforms are being applied to the load, it may be necessary to select a current and/or voltage range that is well above the true RMS value indicated on the display in order to extinguish the "O/L" indicator. This will reduce the resolution of the wattmeter reading, but is necessary for instrument accuracy. The display will blink if the load power is greater than that required for a display of 19999 (decimal omitted).

4-3. Rear Panel Controls

The locations of the rear panel controls are shown in Figure 4-1. The function of the 115V/230V switch and power cord receptacle were covered in section 1-3. It is important to connect the load in accordance with the L (line) and N (neutral) indications on the rear panel for maximum safety and accuracy. Refer to section 4-4.

The DMX Port houses the interface connector, if installed, for use by Valhalla Models 2190 and 2191. The ribbon cable supplied with the instrument is connected here.

4-4. Making Connections

The 2100 was designed to accommodate a multitude of connection methods allowing the user or test engineer to design custom harnesses according to the application. The basic guidelines for making connections are:

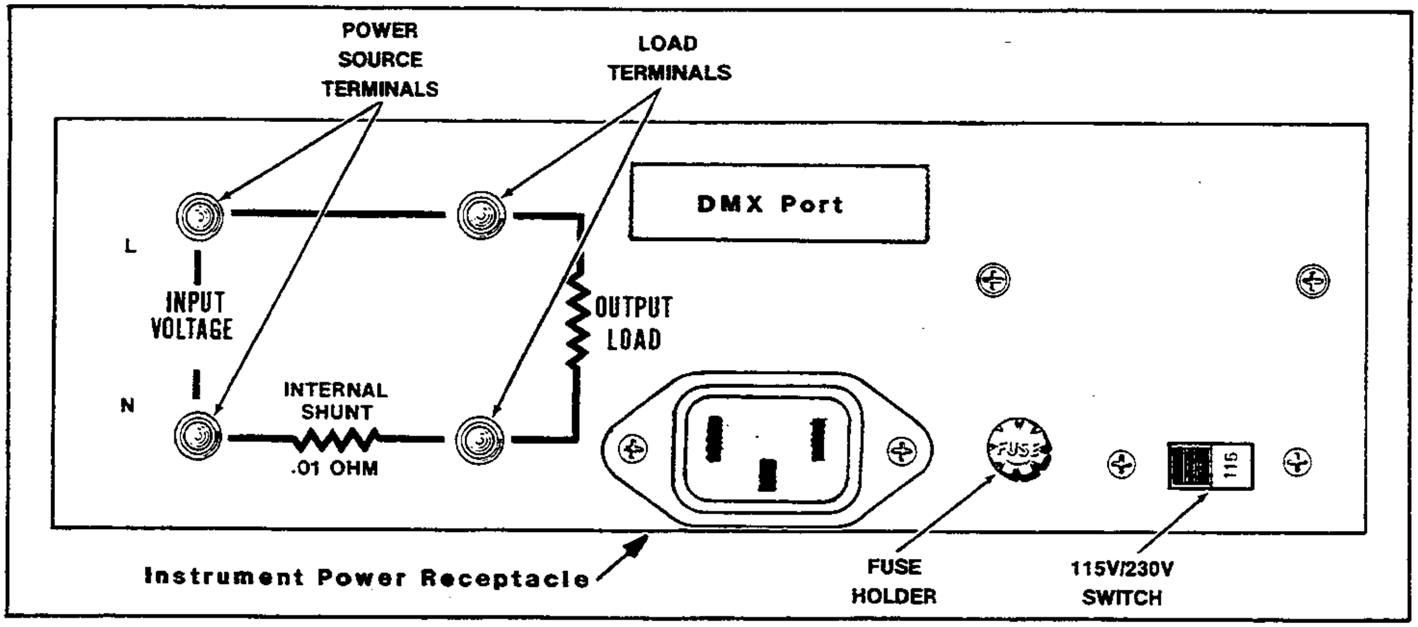

Figure 4-1. Power Analyzer Rear Panel

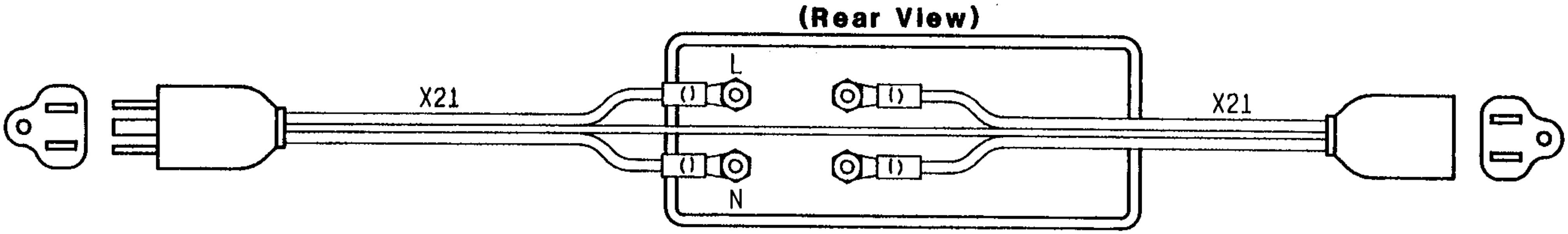

Figure 4-2. Power Analyzer Connections Using Option X21

1) The supply voltage is connected between the "L" and "N" terminals (line and neutral).

2) The current to the load passes through the internal shunt. The load is connected to the right-hand terminals.

In effect, the Power Analyzer is placed in series with the load to monitor the power drawn by it.

Some connection methods are more complex and require some explaining. These are described in the following paragraphs.

CAUTION!

Lethal voltages are routinely connected to the terminals of the 2100. Make sure that power sources are disabled before making or removing connections.

4-4-1. Using Option X21

Perhaps the easiest and most common method of making connections to the Power Analyzer is through the use of the Option X21 Load Power Cable. Option X21 allows for quick and easy connection of any device that uses a standard AC plug. Connections using Option X21 are shown in Figure 4-2.

4-4-2. Using CT's and PT's

Current and potential transformers (CT's and PT's) may be used with any Valhalla Digital Power Analyzer to increase its measurement range. Clamp-on CT's may also be used to simplify power analyzer connections.

4-4-2-1. Current Transformers

Current transformers (CT's) are used to extend the current measurement capabilities of Valhalla digital power analyzers. CT's are available in many ratios, maximum current ratings and isolation voltages.

There are two styles of CT's available, fixed and clamp-on. Fixed CT's are generally used for permanent test set-ups. The conductor being measured must be disconnected, passed through the center of the CT, and reconnected. Clamp-on CT's are easier to use because they are just clamped around the conductor. The conductor need not be disconnected when using a clamp-on CT.

CT's are also used for isolating the power analyzer from high voltage systems. Many high voltage systems operate at current levels directly measurable by the power analyzer, but with voltages beyond the power analyzer limits. The isolation voltage rating should be at least 1½ times the peak input voltage.

When selecting a CT, try to use decade ratios e.g. 10:1, 100:1, etc. Decade ratios make for easier power analyzer measurements. The user just mentally moves the current and power display decimal points to the right the appropriate number of places. Valhalla offers three types of CT's which are listed in Section 3 of this manual. Of course, non-decade ratios may also be used. The maximum current rating of the CT should be selected 1½ times the expected current to allow for high crest-factor waveforms.

The ratio accuracy of CT's is usually about 2%. This is quite a bit wider than the accuracy of a digital power analyzer. The easiest way to improve this accuracy is to measure the actual ratio and use this value when correcting measurements.

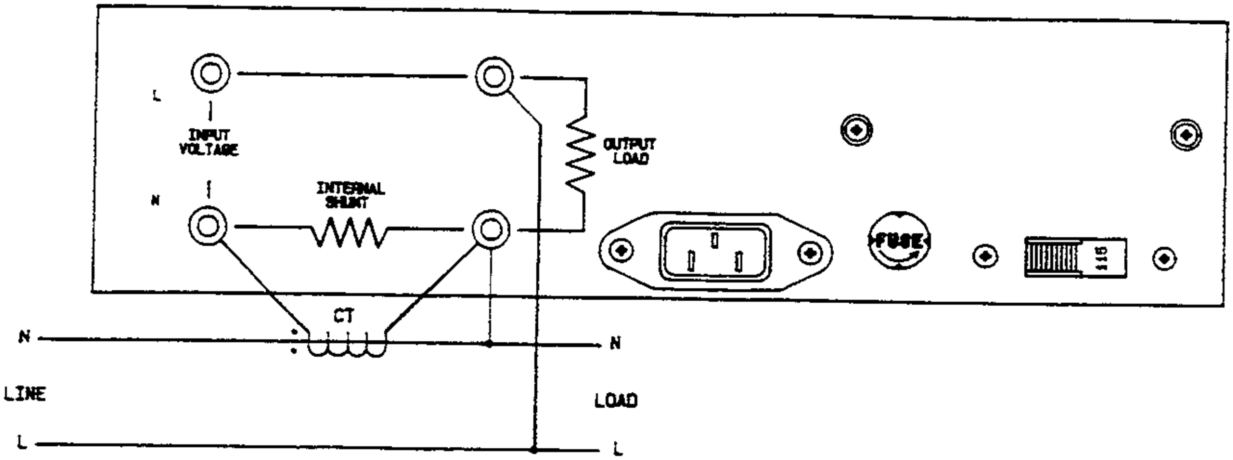

Figure 4-3. Power Analyzer Connections Using a CT

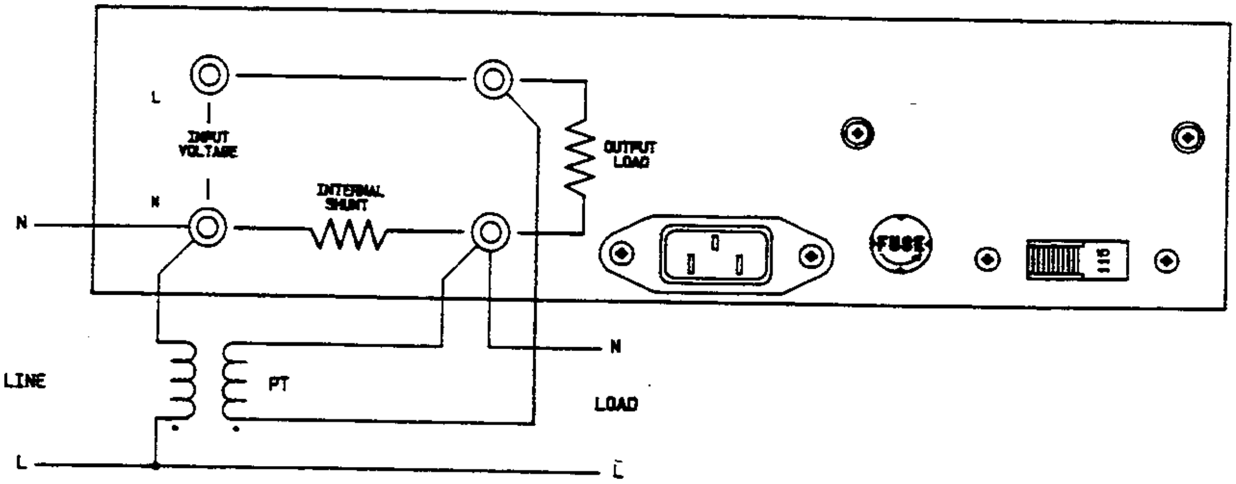

Figure 4-4. Power Analyzer Connections Using a PT

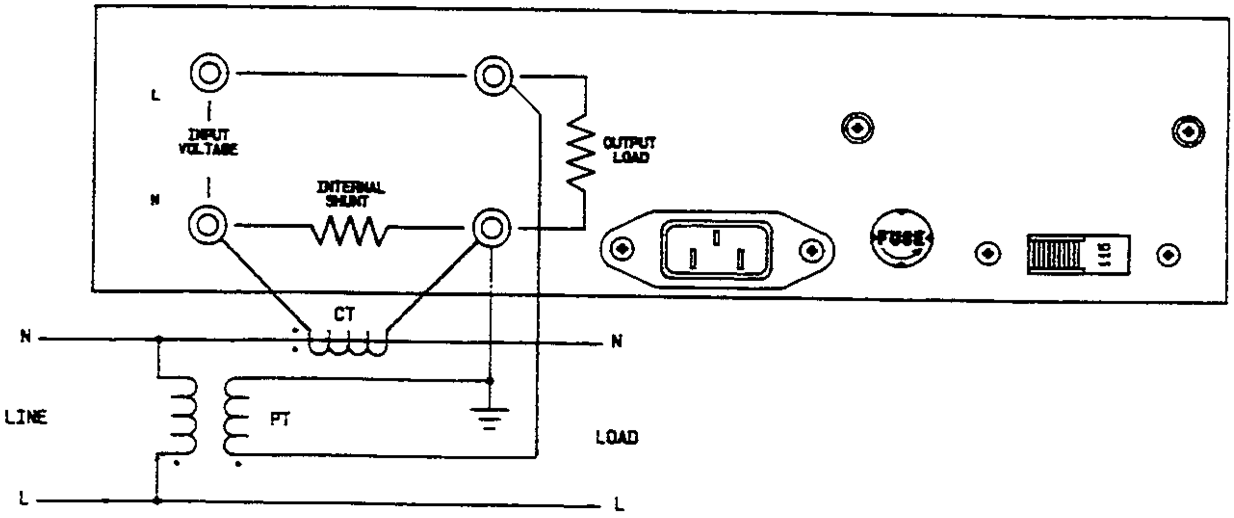

Figure 4-5. Power Analyzer Connections Using a CT and PT

CT's are low frequency devices, typically 50-400Hz. At high frequencies their phase shift will cause the power measurement to be in error.

CAUTION!

> **When using CT's, never open-circuit their secondaries while power is applied!! The CT will act like a step-up transformer and may produce lethal voltages which can damage the operator and/or the power analyzer.**

Figure 4-3 illustrates the basic method of connecting a CT to a digital power analyzer.

4-4-2-2. Potential Transformers

Potential transformers (PT's) are used to extend the voltage measurement capabilities of Valhalla digital power analyzers. PT's are available in many ratios, maximum voltage ratings and isolation voltages.

PT's can be used to isolate the digital power analyzer from high voltage systems. Some high voltage systems operate at voltage levels directly measurable by the power analyzer but at common-mode voltages beyond the power analyzer's limits. The isolation voltage rating should be at least 1½ times the common-mode voltage or peak input voltage.

When selecting a PT, try to use decade ratios, e.g. 10:1, 100:1, etc. Decade ratios make for easier power analyzer measurements. The user just mentally moves the voltage and power display decimal points to the right the appropriate number of places. Of course, non-decade ratios may also be used. The maximum voltage rating of the PT should be selected 1½ times the expected voltage level to allow for high crest factor waveforms.

The ratio accuracy of PT's is usually about 2%. This is quite a bit wider than the accuracy of a digital power analyzer. The easiest way to improve the accuracy is to measure the actual ratio and use this value when correcting measurements. PT's are low frequency devices, typically 50-400Hz. At high frequencies, their phase shift will cause the power measurement to be in error. Figure 4-4 illustrates the method of connecting a PT to a digital power analyzer.

4-4-2-3. Using Both CT's and PT's

Many applications using PT's will use CT's as well. In this case, the power measurement must be multiplied by both the CT and PT ratios. Figure 4-5 illustrates the method of connecting a CT and PT to a digital power analyzer.

4-5. Manipulating the Data

The 2100 directly measures the voltage, current and power used by a single-phase system. Volt-Amperes (VA), Reactive Volt-Amperes (VAR), power factor (PF), and phase angle (ϕ) are not displayed but can easily be calculated from the voltage, current and power measurements. The following paragraphs describe the methods for calculating VA, VAR, PF, and ϕ.

4-5-1. VA, VAR, PF and ϕ

The relationships between VA, Watts, VAR, PF and ϕ can best be described in a graphical manner. Figure 4-6 illustrates these relationships. VA is calculated by multiplying the true RMS voltage and true RMS current measurements of the digital power analyzer. PF is the cosine of the angle between VA and Watts and can be calculated using basic trigonometry. VAR is calculated from VA and Watts using Pythagorean's theorem. Phase angle (ϕ) may be calculated after the power factor has been determined. The relative phase (in degrees)

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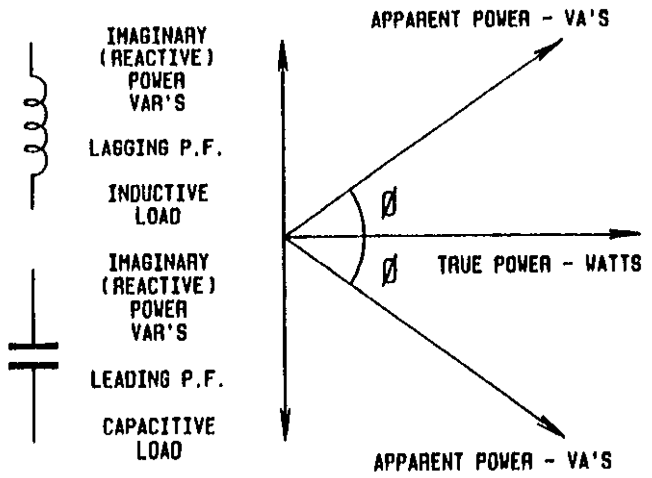
between the voltage and current waveforms is the anti-cosine (cos^{-1}) of the power factor.

4-5-2. PF, Leading or Lagging?

The terms leading and lagging power factor refer to the relative phase shift between the current and voltage waveforms. The current leads the voltage in a capacitive load while the current lags the voltage in an inductive load. When calculating power factor using a 2100, there is no way of determining whether the voltage waveform is leading or lagging the current. An oscilloscope must be used to determine leading or lagging. Fortunately, most every load has a lagging power factor. If the load has a transformer, fan, or motor, it is safe to assume lagging power factors and an oscilloscope is not required.

4-5-3. Accuracies

The accuracies of these calculations are the sums of the accuracies of the voltage, current and power measurements. For the 2100, the specified accuracies of section 2-3 should be summed to find the total uncertainty.



PF = COS Ø = $\frac{W}{VA}$, LAGGING

PF = COS Ø = $\frac{W}{VA}$, LEADING

VA'S = TRMS VOLTS X TRMS AMPS

VAR'S = $\sqrt{\text{VA'S}^2 - \text{W'S}^2}$

VA'S = $\sqrt{\text{VAR'S}^2 + \text{W'S}^2}$

W'S = $\sqrt{\text{VA'S}^2 - \text{VAR'S}^2}$

Figure 4-6. Watts, VA's, VAR's and PF

SECTION V CALIBRATION

5-1. General

The following procedures should be performed at routine intervals to ensure that the Power Analyzer remains within specified limits. In addition, calibration should be performed following repairs involving accuracy determining components.

Remove the top cover from the unit to gain access to the internal adjustments. The locations of the adjustments are listed on the circuit board and on drawing number 2100-600 at the back of this manual. Apply power to the 2100 and test equipment and allow approximately 30 minutes for stabilization.

Note that the instrument may also be returned to the factory for full calibration traceable to NIST.

5-2. Recommended Test Equipment

(1) Two DC Voltage Calibrators (Valhalla Scientific Model 2701C or equivalent)

(2) AC Voltage and Phase Standard (Valhalla Scientific Model 2703 and 2705 or equivalent)

(3) AC-DC Current Calibrator (Valhalla 2500EP or equivalent)

(4) DC Voltmeter, ±0.5% accuracy

5-3. Model 2100 Calibration Procedure

The following procedure applies only to the Model 2100. Refer to Section 5-4 for the Model 2101 procedure.

CAUTION!

The neutral input terminal (N) is connected to the internal common bus (ground). In normal use, the plastic case and other insulators isolate the operator from the high voltages on the input terminals. However, if the unit is opened for service and the N terminal is connected to a high potential, serious injury may result from contact with the internal circuitry.

5-3-1. Reference Adjustments

(1) Connect the positive terminal of the DVM to pin 7 of IC17 and the negative terminal to analog ground (E2). Adjust R100 if necessary for a DVM reading of +1.000 volts.

(2) Connect the positive terminal of the DVM to pin 7 of IC20 and the negative terminal to analog ground (E2). Adjust R107 if necessary for a DVM reading of +1.000 volts.

5-3-2. Voltage Adjustments

(1) Connect the 2100 to the DC Standards per Figure 5-1. Select the "Volts" display and perform the adjustments listed in Table 5-1. Connect the DVM between E2 (ground) and TP1 shown in Figure 5-2. These adjustments should be made in the order shown.

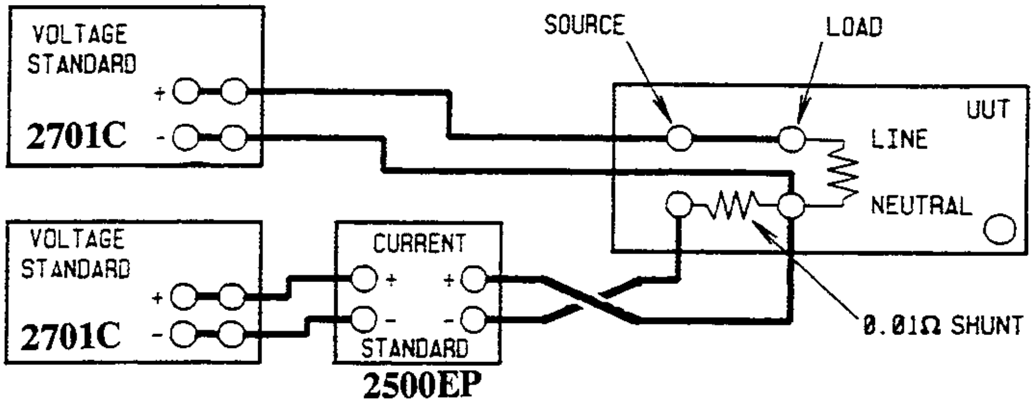


Figure 5-1. Calibration Equipment Connections

Table 5-1. Model 2100 Voltage Adjustments

Range	Input	Adjust	TP1	Adjust	2100 Display
150	10.00VDC	-	-	R8*	≈10.00
150	150.00VDC	R2	-5.000VDC	R45	150.00
150	10.00VDC	-	-	R117	10.00
300	300.0VDC	R4	-5.000VDC	R49	300.0
600	600.0VDC	R6	-5.000VDC	R47	600.0

* Alternate input polarity and adjust R8 for the same display reading at both polarities.

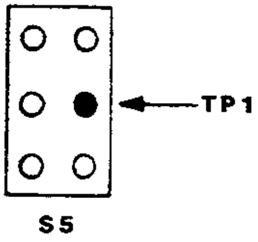


Figure 5-2. TP1 Location at Switch S5 (Amps)*

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* TP1 may also be obtained at the hook for IC6, pin 1 (if installed).

Table 5-2. **Model 2100/2101 Current Adjustments (located under shield)**

Range	Input	Adjust	2100/01 Current Display
20A	10.000ADC	R65	-2.500V @ TP1
20A	10.000ADC	R52	Adjust R52 for 10.00 on current display
2A	1.0000ADC	R71	Alternate polarity and balance for same reading on display
2A	1.0000ADC	R74	Adjust for 1.000 on display
.2A	.10000ADC	R83	Alternate polarity and balance for same reading on display
.2A	.10000ADC	R85	Adjust for .1000 on display

5-3-3. Current Adjustments

(1) Select the "Amps" display. Perform the adjustments in Table 5-2 in the order shown.

5-3-4. Watts Adjustments

(1) Monitor the "Watts" display. Select the 2 amp/600 volt (300V for 2101) ranges. Apply 1 amp and reduce the input voltage to zero. Alternate the input current polarity and adjust R29 for the same reading at both polarities. Adjust R43 for 000.0 on the watts display.

(2) Reduce the input current to zero. Apply 150 volts and alternate the input voltage polarity, adjusting R28 for the same reading at both polarities. The balanced reading should be ±1 digit from 000.0. If reading is not within the specified limits, adjust R43 for a reading of 000.0, then repeat step 1.

(3) Apply 1 amp and 600 volts to the 2100 (skip this step for 2101). Adjust R36 for a reading of 600.0 on the watts display. Reverse the current and volts polarity and adjust R36 for the same reading at both polarities.

(4) Select the 300 volt range and apply 300.0 volts. Adjust R34 for 300.0 on the watts display. Reverse the input voltage and current polarity, and adjust R34 for a balance between both polarities.

(5) Reduce the input voltage to 150.00 VDC and select the 150 volt range. Adjust R32 for 150.0 on the watts display. Reverse the input voltage and current polarity, and adjust R32 for a balance between both polarities.

(6) For 2101 only, select the 30V and 2A ranges. Apply 30.00 volts and 1 amp and check that the watts display indicates 30.00 (no adjustment).

5-3-5. AC Adjustments and Checks

(1) Replace the DC voltage standards illustrated in Figure 5-1 with the AC Wattmeter Calibration System (Valhalla 2703 Master, 2705 Slave). Select the 150 volt and the 20 amp ranges.

(2) Apply 150 volts AC and 10 amps AC (100 Hz) with a 0° phase difference. Adjust R69 for 10.00 on the current display.

(3) Verify that all volts, current, and watts ranges are within specifications. If the Valhalla 2703/2705 Wattmeter Calibration System is used, verify the power factor response at 90°, 120°, 180° and 240° phase shift.

5-4. Model 2101 Procedure Changes

The Model 2101 is calibrated the same as the Model 2100 with the following exceptions:

(1) Make the adjustments of Table 5-3 in the order shown instead of those of Table 5-1.

(2) Omit step 3 in Section 5-3-4.

(3) DO NOT apply 600 volts to the 2101.

(4) Current and watts adjustments are the same.

5-5. Model 2101-20mA Changes

The Model 2101-20mA uses the same procedure of Section 5-4 with the following exceptions:

1) The voltage adjustments are the same as for Model 2101.

2) The current adjustments of Table 5-2 shall be 10% of those indicated for the 2100/2101. For example, 10 milliamps instead of .1000 amps. DO NOT apply 10 amps to the 2101-20mA.

3) The watts adjustments will be 10% of those indicated for the 2101.

Table 5-3. Model 2101 Voltage Adjustments

Range	Input	Adjust	TP1	Adjust	2101 Display
150	10.00VDC	-	-	R8♦	≈10.00
150	10.00VDC	-	-	R117	10.00
30	30.00VDC	R2	-5.000VDC	♠	30.00
150	150.00VDC	R4	-5.000VDC	R45♦	150.00
300	300.0VDC	R6	-5.000VDC	R49♦	300.0

♦ Alternate input polarity and adjust for the same reading at both polarities.
♠ The 30V and 300V ranges share a common adjustment at R49.

SECTION VI THEORY OF OPERATION

6-1. General

The following paragraphs provide the information required to perform the required periodic maintenance and basic guidelines for troubleshooting the 2100.

6-2. Periodic Maintenance

The 2100 requires little periodic maintenance other than regular performance of the calibration procedure of Section 5. Maintenance which may be required is discussed in the following paragraphs.

6-2-1. Cleaning

It is recommended that the 2100 be operated in a clean environment. However, if the environment is dusty periodic cleaning of the unit will be necessary.

Loose dirt or dust which has collected on the exterior surfaces of the 2100 may be removed with a soft cloth or brush. Any remaining dirt may be removed with a soft cloth dampened in a mild soap and water solution. **Do not use abrasive cleaners.**

The front panel may be cleaned with a soft cloth and a "Windex" type cleaner. **Do not use petroleum based cleaners on the front panel.**

If required, the 2100 interior may be cleaned by blowing with dry compressed air.

If the 2100 has become heavily soiled with dirt or by other contaminants it is recommended that the unit be completely overhauled. Contact your local Valhalla Scientific Service Center for details.

6-2-2. Tightening

Tightness of connections to the input terminals is important for safety and reliability of measurements. Loose connections, especially when working with high current levels, may cause excessive temperatures to build up on the shunt input terminals. This contact resistance also requires the source to supply additional power in order to overcome it.

It is recommended that power be periodically removed and the integrity of connections checked as they may have become relaxed.

6-3. Troubleshooting

The following paragraphs give basic procedures for troubleshooting and component replacement in the 2100.

6-3-1. Component Replacement

The 2100 accuracy and reliability can only be maintained if the following precautions are taken when changing a component:

- Remove all power from the instrument and input terminals before attempting component replacement.
- Use only the specified component or its exact equivalent. Spare parts may be ordered from your nearest Valhalla Scientific Service Center by referring to the Valhalla part number listed in the Parts List section at the back of this manual. Please provide the type and serial number of the instrument with your order.

- Use only 63/37 rosin core electronic grade solder with a 50W (or lower) maximum power soldering iron.

- Many of the semiconductor devices used in the 2100 can be damaged by static discharges. Thus the user should follow strict static-free procedures to ensure that damage does not occur.

- When resoldering components the user must ensure that the highest possible quality soldering is used. A dry joint may cause the 2100 to drift outside of its specification limits.

- Minimize handling of components and assemblies. Transport and store components in the original containers.

- Discharge static build-up on the user and instrument prior to handling components or assemblies.

- Handle the components such that all (or as many as possible) of the leads are in contact with the user.

- Never slide a component over a surface.

- Use a grounded tip soldering iron and ensure that the assembly being (de)soldered is also grounded.

6-3-2. Finding the Faulty Component

WARNING
HAZARDOUS VOLTAGES
MAY BE
PRESENT INSIDE THE 2100

Experience has shown that apparent malfunctions are often the result of misinterpretation of the specifications or operating procedures of the unit. Check to be sure that the cables and other test equipment are in good order before attempting to repair the 2100.

Knowledge of circuit operation is a prerequisite for efficient fault finding in the 2100. This section is divided into two parts. The functional description gives basic descriptions as to the functions of various circuits in the Power Analyzer. The detailed descriptions explain circuit operation down to component level.

6-4. Functional Descriptions

A block diagram of the Model 2100 is shown in Figure 6-1. Power for the load under test is connected to one set of rear panel terminals and passes through the instrument to a second set of terminals where the external load under test is connected. A 0.01 ohm current shunt is installed between one input terminal and one output terminal. The inputs to the voltage amplifier are connected to both power line terminals. The inputs to the three-stage current amplifier are connected across the current shunt.

The voltage amplifier gain is controlled by the voltage range switch so that it has a full-scale 5-volt output at the selected range. The gains of the three stages of the current amplifier are 25, 10 and 10, respectively. The outputs of each current amplifier stage are individually selected by the current range switch for the .2, 2 and 20 ampere ranges.

The signal applied to the true RMS converter is determined by the position of the amps/volts selector switch. The 5-volt full-scale output of the voltage amplifier is the same for the three ranges and the output of the RMS converter will be passed through the scaler when the voltage amplifier output is selected. The scale factor is controlled by the voltage range switch which selects the correct voltage to be applied to the RMS converter.

If a current amplifier output is selected, scaling is not required.

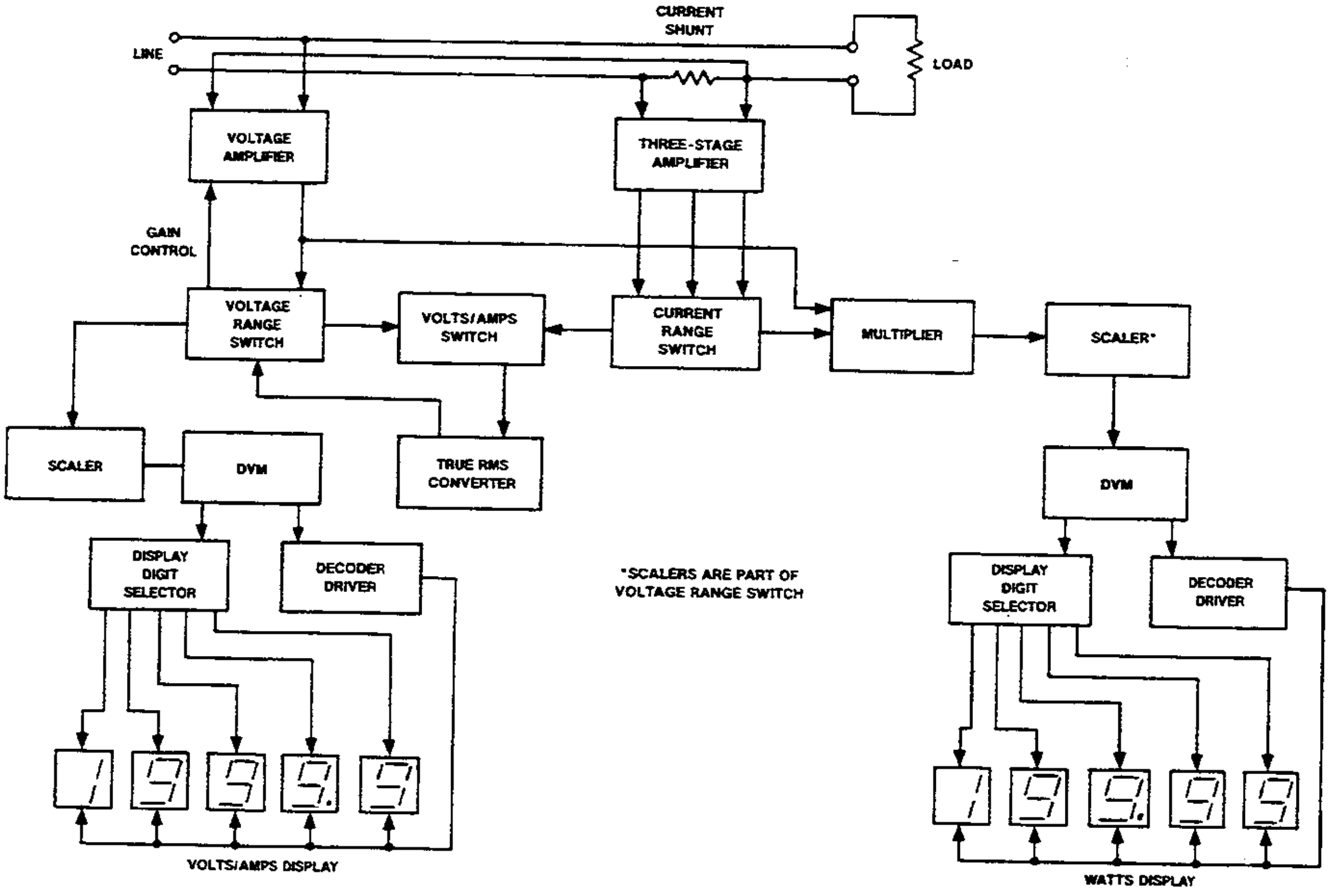


Figure 6-1. Digital Power Analyzer Block Diagram

However, the current range switch will place the decimal point of the display in the proper position for the selected range.

The DVM is a true dual-slope, integrating digital voltmeter. The full-scale voltage applied to its input is 0.2 volts in the current ranges and 1.5, 0.3 and 0.6 volts in the three voltage ranges of the Model 2100 and 0.3, 1.5 and 0.3 volts for the voltage ranges of the Model 2101. The voltage measured by the DVM is latched to its internal registers at the end of the measurement cycle. During the time of the next input measurement, each digit of the previously measured voltage is sequentially applied to the inputs of the decoder/driver. While the decoded data is present at the output of the decoder/driver, the display digit selector energizes the appropriate display digit. Thus, the display is multiplexed from a single BCD output of the DVM and at such a rate that it appears to be continuously illuminated.

The output of the voltage amplifier and the output of the current amplifier stage selected with the current range switch are applied to individual inputs of the power converter which is a multiplier circuit. The output of the power converter is passed through a scaler which is controlled by the voltage range switch. Again, scaling is necessary since the full-scale output of the voltage amplifier is the same on all ranges. The DVM which follows the scaler is identical to that used for the amps/volts display. However, its decimal point has only two positions and these are controlled by the voltage range switch.

6-5. Detailed Circuit Descriptions

To supplement the overview provided by the preceding functional description, this section describes the operation of each circuit. The reference designators used in this section are those of the schematic diagram of the Model 2100, 2100-070. The schematic of the Model 2101, drawing number 2101-070, is slightly different, but the principles are the same.

For convenience, the individual circuits of a multiple-circuit device are identified by the device designator followed by a suffix number corresponding to the output pin number. For example, the amplifier of IC7 that has its output connected to pin 1 is identified as IC7-1.

6-5-1. Power Supply

The power supply schematic is located in the lower left area of 2100-070. S1 is the front panel push button switch that connects one side of the power line to one end of the primary windings of transformer T1. The other end of the primary windings is permanently connected to the other side of the line. T1 has two primary windings that are connected in parallel by S10 for operation at 115 volts and in series for operation at 230 volts.

The voltage across one secondary winding of T1 is rectified by D1 and D3 and filtered by C18 to provide +5 volts to the display driver transistors TR1 through TR5 and TR8 through TR12, and to several IC's. The other secondary is rectified by D6 and D7 to provide a positive DC input to voltage regulator IC11 which develops +15 volts at its output. The same secondary is also rectified by D4 and D5 to provide the negative DC input to voltage regulator IC12 which develops -15 volts at its output. See the "Power Connections" table on the schematics for supply usage.

The neutral input terminal is connected to the internal common bus (ground). T1 provides isolation between the common bus and the power line. The plastic case and other insulators isolate the operator from the input terminals. However, when the unit is opened

for service, personnel should verify that the neutral terminal is at the same potential as the power line ground or serious injury could occur.

6-5-2. Voltage Amplifier and Scaling

The neutral line of the input (measured) voltage source is connected to the common internal bus (ground). The other line is connected to the input of the voltmeter amplifier circuit through a 600KΩ resistor, R1, on the rear panel assembly.

Refer to Figure 6-2. This is a simplified diagram of the operational amplifier circuit IC1 and RMS voltage converter IC6. The three switches connected to the input of IC1 are sections of the voltage range selector. The number adjacent to each switch indicates the selected range for which it is closed.

The gain of IC1 is determined by the closed section of the switch which selects the resistance value for the feedback loop of IC1. R2, R4 and R6 provide fine adjustments of gain in each range. The output of IC1 for full-scale input (150, 300 or 600 volts) is 5 volts. R8 provides the offset adjustment for IC1.

The output of IC1 passes through switch S5B, which selects the output of the voltage or current amplifiers as an input to IC6. When the "Volts" mode is selected, the output of IC6 is a DC voltage directly proportional to the RMS value of the input voltage and will be 5 volts full-scale. It appears across the voltage divider composed of R44 through R50.

The switches connected to the arms of the potentiometers in this voltage divider are other sections of the range switch that close simultaneously with those in the feedback circuit of IC1. The output of IC6 is scaled down through the divider to 0.6 volts for the 600 volt range, 0.3 volts for the 300 volt range and 1.5 volts for the 150 volt range, with the potentiometers providing the line calibration adjustments.

6-5-3. Current Amplifiers and Scaling

The source of the signal for the current meter is a 0.01 ohm shunt resistor, R61, through which the load current flows. The resistance of R61 is very low so there is minimal effect on the voltage applied to the load.

The signal developed across R61 must be amplified, especially in the lowest current range. The current signal amplifiers are shown in the schematic 2100-070. A simplified diagram of the input current amplifier is shown in Figure 6-3.

The minimal full-scale voltage developed across R61 is only 2 millivolts. Therefore, the input amplifier must remain stable at DC and from 40 Hz through the bandwidth of the instrument. Operational amplifier IC9-1 and chopper-stabilized amplifier IC8 operate in concert to achieve the required stability. Any offset appearing at the output of IC9-1 is reduced by a factor of 25 at the arm of R65 where it is applied to the non-inverting input of IC8. A differential exists between the two inputs of IC8. An offset is produced at the output of IC8 that places a charge on C17 with a polarity that drives the output of IC9-1 toward zero. The gain of IC8 is 200 and its output is integrated by R67 and C17 which eliminates any tendency toward oscillation. The system finds a point of equilibrium where the offset at IC9-1 has been reduced to a negligible level.

IC9-1 has a gain of 25 and the amplifiers that follow, IC9-7 and IC10-6, have a constant gain of 10 when properly adjusted with R74 and R85. The output of IC9-1, IC9-7 and IC10-6 are each connected to one contact of the "Current" switch. The other

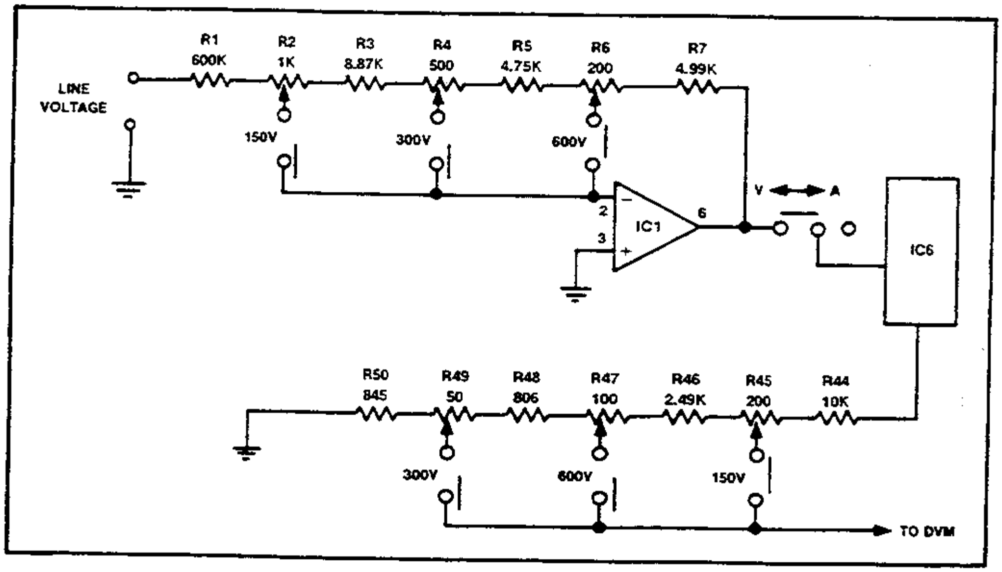


Figure 6-2. Simplified Voltage Scaler/Amplifier

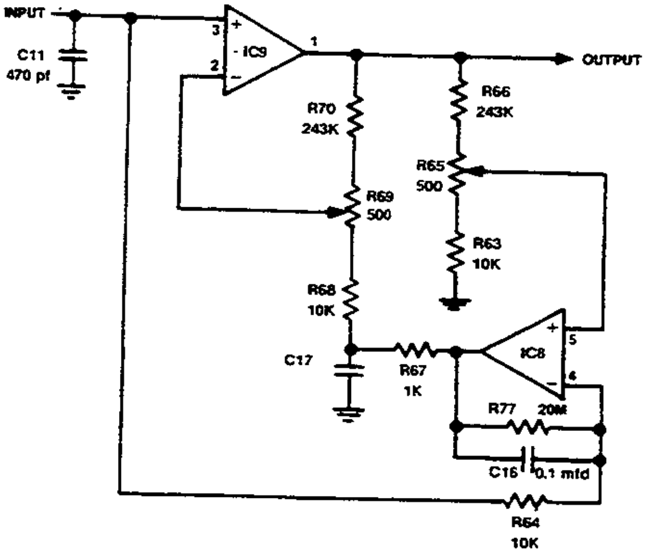


Figure 6-3. Simplified Current Amplifier

oscillator, IC21, which operates at 50 kHz. The first cycle is auto-zero which nulls out any offsets. The next integrates the input for a precise time (10,000 counts of the oscillator). In the process, it charges a capacitor to a level proportional to the input voltage. In the third cycle, a fixed level reference voltage of reverse polarity is applied to the integrator. The time required for the integrator to discharge its capacitor back to zero in this cycle is determined by counting the oscillator pulses. This count is an accurate measurement of the input voltage. The reference cycle count is displayed as the measured voltage.

6-5-5-1. Auto Zero

IC19 contains an integrator and a comparator. During the auto-zero cycle, an internal switch in IC20 which is connected between pins 16 and 17 connects the output of the comparator at pin 2 of IC19 to the input of the integrator at pin 12 of IC19. This charges auto-zero capacitor C33. The auto-zero cycle time is sufficient to completely charge the capacitor and zero the output of the integrator. The capacitor will hold its charge during the next two periods. The input reference capacitor, C34, is also charged to a reference level during this period.

6-5-5-2. Input Integration

The output of true RMS converter IC6 is connected to pin 10 of IC20 through a scaling voltage divider that is part of the voltage range switch. During the input integration period, an internal switch in IC20 connects pin 10 to pin 9 and to the input of the integrator of IC19. C32 is the integrator capacitor. At the end of the input integration period, C32 is charged to a level proportional to the input voltage. At the same time, the polarity of the input is latched in IC20.

6-5-5-3. Reference Integration

At the beginning of the second integration period, the switches in IC20 will select the 1.000 volt reference voltage at pin 7. This reference is obtained from pin 6 of IC16, in the watts DVM circuit, through R98, R99 and R107. R107 provides a fine adjustment of the reference input.

The reference is applied to the integrator to return its output to zero. During this integration period, the crystal oscillator drives a multi-stage counter. When the integrator output crosses zero, counting is terminated. The number of counts required to integrate the reference to zero, which is stored in the counter, is precisely proportional to the input voltage.

6-5-5-4. Amps/Volts Display

The reference integration counts, which are accumulated in an internal counter of IC20, are latched into a multiplexer, also internal to IC20, at the end of the count period. During the next series of auto-zero and integration periods, each digit of the count latched into the multiplexer is sequentially placed on the BCD outputs of IC20 and on the inputs of decoder/driver IC18.

While the most significant digit data is applied to IC18, transistor TR8 is turned on by IC20 to provide the anode voltage for DS8. When the next digit data is applied to IC18, TR8 is turned off and TR9 is turned on to provide the anode voltage for DS9. The sequence is continued for TR10/DS10, TR11/DS11 and TR12/DS12 and then repeated. The repetition rate is high enough that all digits appear to be continuously illuminated.

6-5-6. Decimal Point Positioning

The decimal points in the "Amps - Volts" display are positioned by

contact is connected to its counterparts so that the selected output is applied to the true RMS converter, IC6, when "Amps" is selected with the "Display" push-button.

A 200 millivolt input from IC9-1 produces 5 volts at the output of IC9-7 and 2 millivolts produces 5 volts at the output of IC10-6. The full-scale voltage applied to the true RMS converter in any range is 5 volts.

The output of the true RMS converter appears across the divider composed of R51, R52 and R53. The potential at the arm of R52 is 200 millivolts and is applied to the amps/volts DVM, IC20, through a section of the "Display" switch when "Amps" is selected.

6-5-4. Peak Detector/Indicators

When the voltage applied to the rear panel terminals exceeds 250% of the selected voltage range, the peak voltage indicator illuminates. This signals that the displayed voltage and power value may not be accurate and that spikes may be present on the input signal. An identical circuit provides a visual signal when the current to the load exceeds 250% of the selected current range. The peak detectors provide their visual signals irrespective of whether "Amps" or "Volts" has been selected for display.

The voltage peak detector is composed of comparators IC2-1, IC2-2 and IC2-13. Their circuit is shown in the upper area of drawing 2100-070. The reference voltage at the inverting input of IC2-6 is at -12 volts, which is derived from the divider composed of R11 and R12. The non-inverting input is connected to the output of the voltage amplifier, IC1-6. The non-inverting input IC2-5 is at +12 volts which is derived from the divider composed of R9 and R10. Its inverting input is also connected to the output of IC1-6.

When zero volts is applied to the input, the outputs of both comparators are high (+15 volts). Since the inverting input IC2-11 is at ground potential, its output will be high, back-biasing voltage peak indicator DS2 and holding it out of conduction.

When the input voltage (either peak or steady-state) exceeds +12 volts, the output of IC2-1 will transition to -15 volts, causing the output of IC2-13 to transition to -15 volts, turning on DS2. When the input voltage exceeds -12 volts, the output of IC2-2 and IC2-13 will transition to -15 volts to turn on DS2. An integrating capacitor C1 holds the output of IC2-13 at a low state between peaks so that DS2 is continuously illuminated until the input to IC2-13 is increased above its transition level.

An identical circuit for the current peak detector/indicator is composed of IC7-1, IC7-2, IC7-13 and associated components. The input to this detector is from the output of the selected current signal amplifier.

6-5-5. Digital Voltmeters

There are two nearly identical digital voltmeter (DVM) circuits. These are shown on the schematic 2100-070 sheet 2. As operation is very similar, only the DVM for the AMPS/VOLTS display is described below.

Most of the amps/volts DVM circuitry is contained in two special devices, IC19 and IC20, which form a dual-slope integrating voltmeter. The analog circuits are contained in IC19 and the digital circuits in IC20. The circuit of the watts DVM is composed of IC17 and IC16 and associated components.

A dual-slope integrating voltmeter has three cycles. Timing of these cycles is controlled by a crystal the "Voltage" switch when the "Volts" function is selected. Pin 6 of the display LED is the decimal input. In the 150 volt range, pin 6 of DS11 is grounded through contacts of the range switches so that the resolution is 0.01 volts. In the 300 and 600 volt ranges, pin 6 of DS12 is grounded and the resolution is 0.1 volts.

When the "Amps" function and the 0.2 range are selected, pin 6 of DS9 is grounded and the reading resolution is .0001 amperes. Pin 6 of DS10 is grounded in the 2 ampere range for a display resolution of 0.001 amperes. For the 20 ampere range, display resolution is 00.01 amperes, since pin 6 of DS11 is grounded. Note that the path to ground is through the switch and 100Ω resistor R54.

The decimal points of the watts display are controlled only by the "Current" range switch in the Model 2100. Pin 6 of DS6 is grounded in the .2 ampere range for a display resolution of 0.01 watts. In the 2 ampere range, pin 6 of DS7 is grounded for resolution of 0.1 watts. No decimal point is displayed in the 20 ampere range. The watts display decimal points are grounded through the current switch and 100Ω resistor R87.

The decimal points in the Model 2101 are controlled by NAND gates IC22 and IC23.

6-5-7. Analog Multiplier

Analog multiplier IC3 receives the output of voltage amplifier IC1-6 and the output of either IC9-1, IC9-7 or IC10-6, depending on the selected current range.

The output current from IC3 is proportional to the product of the signals at its two inputs. This output current is converted to a voltage by IC4.

The analog multiplier (IC3) is direct coupled and is therefore subject to DC shift at its output due to temperature changes. To correct for this shift, an auto-zero circuit is used. It consists of IC5, the switches of IC13 and IC14 and associated components. The switch drivers are shown in the upper right area of drawing 2100-070 (sheet 2). Each of the eight switch drivers is identified by an alpha character. The switch sections are shown in a manner that simplifies the diagram and facilitates the understanding of circuit operation. Each switch section in the main part of the diagram is identified with the same alpha character as its driver.

The circuit switches the two inputs to the multiplier to zero and measures the offset voltage output at IC4-6. IC5 amplifies the offset voltage and charges C4 to a voltage that will drive IC4-6 to zero. The inputs to the multiplier are switched back to the signal source. This sequence occurs during every auto-zero cycle.

6-6. Model 2101 Circuitry Changes

The Model 2100 and Model 2101 circuits are nearly identical and are assembled on identical circuit boards. The principle differences between them are:

- Some resistors installed in the Model 2100 are not installed in the 2101.
- The values of a number resistors are different. See parts list 2100-404 for a listing of these resistors.
- There are some minor switch wiring changes.
- NAND gates IC22 and IC23 are installed only in the Model 2101.

The purpose of IC22 and IC23, which are shown in drawing 2101-070 (sheet 2), is to control the display decimal points. The decimal point of DS5 is used in the Model 2101 to increase the resolution of the display in the lowest current and power ranges. This requires

that the decimal point illumination of the watts display be controlled by both the "Voltage" and "Amps" range switches. This is accomplished through the NAND gate logic of IC22 and IC23.

6-7. Model 2101-20mA Changes

The Model 2101-20mA uses the same circuitry as the Model 2101 with the following exceptions:

- The shunt (R61) is changed from a .01Ω value to a .1Ω value.
- The positioning of the display decimal points has been reconfigured.

6-8. Model 2101L Circuitry Changes

The Model 2101L uses the same circuitry as the Model 2101 with the following exceptions:

- The input voltage resistor (R1) is changed to 44.44kΩ.
- The values of the scaling resistors has been changed for R2-R7 and R44-R50.
- The positioning of the display decimal points has been reconfigured.

SECTION VII MANUAL CHANGES AND ADDENDUMS

This section contains any additional information regarding special modifications to the power analyzer or changes to the Operation Manual. If no addendums follow this page, your manual is complete as printed.

SECTION VIII PARTS LISTS

The following parts lists have been included in this manual:

PARTS LIST : 2100-400 2100/2101 Final Assy.

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA
		A	T	N		
1	2100-600	1			Main Board Assy.	Assembly 2100-600
2	01-20103	1			Shunt Assy.	ASSY 2100-401
5	04-10397	1			rear panel	DWG 2100-213
6	04-10130	1			Chassis	PAKTEK CH250-BEIGE ETC.
7	04-10309	1			Input Terminal Shield	DWG 2100-210
9	04-10285	1			shorting strap	DWG 2100-207
11	05-04010	1			0.25A,Slo Blo Fuse	Littlefuse,313-.250
13	05-10020	2			Binding post, black, 30 amp	Superior BP30B
15	05-10198	4			Spacer, 1/4 dia, 1/8 lg, #4, nylon	Smith 8880
16	05-10450	1			Solder lug, #10	Smith 1410-10
17	90-04608	8			#4 x 1/2" Self-Tap Phil Pan S.S. Type AB	
18	90-06006	6			#6-32 x 3/8" Phil Pan S.S.	
19	98-06001	5			#6 Split Lock Washer,STD,S.S.	
20	97-06001	6			#6-32 Hex Nut, SMALL PATTERN, S.S.	
21	05-10067			1	Cable, power cord	Electrocord 39806
23	05-10086	2			Solder lug, #6, internal star	Smith 1412-6
25	05-10085	1			Grommet, 11/32 od, 1/8 id, 1/4 panel dia	Smith 91114
26	05-10252	2			binding post cut off	DWG 2100-211 using 05-10020
27	05-10490	2			Washer, .562 od, .203 id, .04 thick, S.S.	Seastrom 5710-292-40
30	05-10218	1			Hole plug	Calmark 810-25 BLACK
33	05-10019	8			Cable tie, 4"x 1/8"	Panduit WRN-4
34	90-06012	3			#6-32 x 3/4" Phil Pan S.S.	
36	99-10000	1			#10 18-22awg Ring Lug (Red)	
37	80-01522	4			22awg Wire, Green PVC	M16878/1-BFE-5
40	80-02022	5			22Awg Wire, Black TFE	M16878/4-BFE-0
41	80-10174	24			RG174/U Coax Cable, 50 ohm	Belden 8216
42	80-02118	5			18awg wire, brown TFE	M16878/4-BHE/1
43	70-00002	2			1/8" Black Shrink Tubing FP301	3M 3000125BK
44	04-10812	1			Adhesive Insulating Material	Jesco .020" Polycarb & 3M465-12 Adhesive
F1	05-10018	1			Fuseholder, panel mount	Littlefuse 345061
J5	05-10166	1			Receptical, AC, filter	Corcom 6EF1
R1	01-10089	1			600K 1% 80ppm/C 1W Metal Film	Caddock MG714-600K-1%
S2	05-03017	1			Slide Switch,115/230V,2Pole	Switchcraft,4625LFR
T1	04-20038	1			power transformer	DWG 2100-010

PARTS LIST : 2100-403 REV G 2100 Final Assy.

REF.DES.	STOCK #	QUANTITY			---------------- DESCRIPTION ----------------	------- MANUFACTURING/PURCHASING DAT
		A	T	N		
8	04-10490		1		Front Panel (screened)	DWG 2100-100 using 04-10307
R2	01-50013	1			1K Top Adjust	Beckman 68WR1K
R3	01-10141	1			8.87K 1% 50ppm/C 1/4W Metal Film	RN60C8871F
R4	01-50029	1			500 Top Adjust	Beckman 68WR500ohm
R5	01-10142	1			4.75K 1% 50ppm/C 1/4W Metal Film	RN60C4751F
R6	01-50037	1			200 Top Adjust	Beckman 68WR200ohm
R7	01-10061	1			4.99K 1% 50ppm/C 1/4W Metal Film	RN60C4991F
R36	01-50014	1			100 Top Adjust	Beckman 68WR100ohm
R47	01-50014	1			100 Top Adjust	Beckman 68WR100ohm

PARTS LIST : 2100-404 REV F 2101 Final Assy.

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA
		A	T	N		
8	04-10491		1		2101 front panel (screened)	DWG 2101-100 using 04-10307
IC22	03-30161	1			Quad 2 Input NAND Open Collector	7438N
IC23	03-30161	1			Quad 2 Input NAND Open Collector	7438N
R2	01-50040	1			5K Top Adjust	Beckman 68WR5K
R3	01-10154	1			73.2K 1% 50ppm/C 1/4W Metal Film	RN60C7322F
R4	01-50013	1			1K Top Adjust	Beckman 68WR1K
R5	01-10099	1			10.2K 1% 1/4W	
R6	01-50029	1			500 Top Adjust	Beckman 68WR500ohm
R7	01-10156	1			11.3K 1% 50ppm/C 1/4W Metal Film	RN60C1132F
R109	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J
R110	01-01025	1			200 5% 1/4W Carbon Film	RC07GF201J
R111	01-01025	1			200 5% 1/4W Carbon Film	RC07GF201J
R112	01-01025	1			200 5% 1/4W Carbon Film	RC07GF201J
R113	01-01025	1			200 5% 1/4W Carbon Film	RC07GF201J
R114	01-01021	1			100 5% 1/4W Carbon Film	RC07GF101J
R115	01-01021	1			100 5% 1/4W Carbon Film	RC07GF101J
R116	01-01021	1			100 5% 1/4W Carbon Film	RC07GF101J

PARTS LIST : 2100-600 REV Y 2100/2101 Main PCB Assembly 11/9/1995 Page : 1

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
		A	T	N			
192	05-10007	1			Terminal, turret, swage	Useco 1300B-1	
200	05-10657			16	Connector Spcr,.047ID,.125OD,.030-1.250LG	BIVAR 939-065	
A1	04-30070	1			Main Board	DWG 2100-700	
A2	2100-601	1			2100/2110A Series Display Board Assembly	Assembly 2100-601	
C1	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C2	02-60019	1			2200pF 100V Mylar	WIMA FKS2-2200P	
C3	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C4	02-10002	1			500pF 100V Ceramic Disc	SPRAGUE 56AT50	
C5	02-30000	1			4.7uF 16V Tantalum Bead	TAP475K016SP	
C6	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C7	02-60002	1			0.1uF 250V Mylar	Illinois 104MSR250K	
C8	02-60002	1			0.1uF 250V Mylar	Illinois 104MSR250K	
C9	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C10	02-60019	1			2200pF 100V Mylar	WIMA FKS2-2200P	
C11	02-10002	1			500pF 100V Ceramic Disc	SPRAGUE 56AT50	
C12	02-10014	1			0.1uF 50V Ceramic Disc	AVX SR205E104MAA00	
C13	02-10014	1			0.1uF 50V Ceramic Disc	AVX SR205E104MAA00	
C14	02-10006	1			0.01uF 50V Ceramic disc	Illinois 103GR050-Z	
C15	02-10006	1			0.01uF 50V Ceramic disc	Illinois 103GR050-Z	
C16	02-10009	1			0.001uF 50V Ceramic Disc	NIC NCD102K1VX5P	
C17	02-40031	1			470u 10V Alum. Radial	ILL. 477RMR010M	
C18	02-40000	1			4700uF 16V Aluminum Axial	Illinois 478TTA016	
C19	02-40013	1			470uF 50V Aluminum	Illinois 477TTA050	
C20	02-40013	1			470uF 50V Aluminum	Illinois 477TTA050	
C21	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C22	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C23	02-10013	1			1u 50V Ceramic disc	8131-050-651-105M	
C24	02-10006	1			0.01uF 50V Ceramic disc	Illinois 103GR050-Z	
C25	02-90003	1			5u 5% 50V Polycarbonate	IMB RA7A505J	
C26	02-50000	1			0.22uF 10% 50V Polystyrene	IMB PA2A224K	
C27	02-30000	1			4.7uF 16V Tantalum Bead	TAP475K016SP	
C28	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C29	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C30	02-10007	1			330p 1000V Ceramic disc	SPRAGUE 56AT33	
C31	02-60002	1			0.1uF 250V Mylar	Illinois 104MSR250K	
C32	02-50000	1			0.22uF 10% 50V Polystyrene	IMB PA2A224K	
C33	02-30000	1			4.7uF 16V Tantalum Bead	TAP475K016SP	
C34	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C35	02-30001	1			10uF 25V Tantalum Bead	AVX TAP106K025SP	
C36	02-10006	1			0.01uF 50V Ceramic disc	Illinois 103GR050-Z	
C37	02-20012	1			10p 500V Mica	CM05FD100J03	
C38	02-20013	1			100pF 500V Mica	CM05FD101J03	
D1	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D2	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D3	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D4	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D5	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D6	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D7	03-20002	1			Diode, rectifier, 1A, 50V	1N4001-1N4007	
D8	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D9	03-20000	1			Diode, general purpose	1N4148 or 1N914	

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
		A	T	N			
D10	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D11	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D12	03-20000	1			Diode, general purpose	1N4148 or 1N914	
D13	03-20000	1			Diode, general purpose	1N4148 or 1N914	
IC1	03-30090	1			General Purpose JFET Op-Amp	LF356N or H	03-30074
IC2	03-30133	1			Quad general purpose comparator	LM339N	
IC3	03-30091	1			Analog Multiplier	Raytheon RC4200ANB	
IC4	03-30090	1			General Purpose JFET Op-Amp	LF356N or H	03-30074
IC5	03-30090	1			General Purpose JFET Op-Amp	LF356N or H	03-30074
IC6	03-30045	1			RMS-to-DC Converter	Analog Devices AD536AJH	
IC7	03-30133	1			Quad general purpose comparator	LM339N	
IC8	03-30111	1			Precision chopper amplifier	Intersil ICL7650CPD or equiv.	03-30336
IC9	03-30134	1			Dual very low noise Op-amp	NE5532N	
IC10	03-30090	1			General Purpose JFET Op-Amp	LF356N or H	03-30074
IC11	03-30036	1			Regulator,+15V,0.5A,TO202 or TO220	78M15CP or LM340T-15	
IC12	03-30037	1			Regulator,-15V,0.5A,TO202 or TO220	79M15CP or LM320T-15	
IC13	03-30144	1			Quad JFET switch	National LF13333N	
IC14	03-30144	1			Quad JFET switch	National LF13333N	
IC15	03-30106	1			BCD to 7-Segment decoder/driver	74LS47N	
IC16	03-30113	1			A to D Convertor (analog portion)	Intersil ICL8068ACPD or equiv.	
IC17	03-30114	1			A to D convertor (digital portion)	Intersil ICL71C03ACPI or equiv.	
IC18	03-30106	1			BCD to 7-Segment decoder/driver	74LS47N	
IC19	03-30113	1			A to D Convertor (analog portion)	Intersil ICL8068ACPD or equiv.	
IC20	03-30114	1			A to D convertor (digital portion)	Intersil ICL71C03ACPI or equiv.	
IC21	05-02007	1			Programmable Osc.,8.3Hz-1MHz	Statek,PX01000KHzA	
R8	01-50028	1			50K Top Adjust	Beckman 68WR50K	
R9	01-01047	1			2.4K 5% 1/4W Carbon Film	RC07GF242J	
R10	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R11	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R12	01-01047	1			2.4K 5% 1/4W Carbon Film	RC07GF242J	
R13	01-01085	1			200K 5% 1/4W Carbon Film	RC07GF204J	
R14	01-01054	1			5.1K 5% 1/4W Carbon Film	RC07GF512J	
R15	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R16	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R17	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R18	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R19	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R20	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R21	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R22	01-01073	1			47K 5% 1/4W Carbon Film	RC07GF473J	
R23	01-01073	1			47K 5% 1/4W Carbon Film	RC07GF473J	
R24	01-01083	1			150K 5% 1/4W Carbon Film	RC07GF154J	
R25	01-01083	1			150K 5% 1/4W Carbon Film	RC07GF154J	
R26	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R27	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R28	01-50028	1			50K Top Adjust	Beckman 68WR50K	
R29	01-50028	1			50K Top Adjust	Beckman 68WR50K	
R30	01-10049	1			100K 0.1% 50ppm/C 1/4W Metal Film	RN60C1003B	
R31	01-10140	1			768 1% 50ppm/C 1/4W Metal Film	RN60C7680F	
R32	01-50033	1			50 Top Adjust	Beckman 68WR50ohm	
R33	01-10131	1			750 1% 50ppm/C 1/4W Metal Film	RN60C7500F	

REF.DES.	STOCK #	QUANTITY			------------- DESCRIPTION -------------	------- MANUFACTURING/PURCHASING DATA -------	ALTERNATE
		A	T	N			
R34	01-50033	1			50 Top Adjust	Beckman 68WR50ohm	
R35	01-10066	1			1.5K 1% 50ppm/C 1/4 Metal Film	RN60C1501F	
R38	01-10150	1			68.1K 1% 50ppm/C 1/4W Metal Film	RN60C6812F	
R39	01-50012	1			10K Top Adjust	Beckman 68WR10K	
R40	01-01100	1			1M 5% 1/4W Carbon Film	RC07GF105J	
R41	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R42	01-01081	1			100K 5% 1/4W Carbon Film	RC07GF104J	
R43	01-50028	1			50K Top Adjust	Beckman 68WR50K	
R44	01-10099	1			10.2K 1% 50ppm/C 1/4W Metal Film	RN60C1022F	
R45	01-50037	1			200 Top Adjust	Beckman 68WR200ohm	
R46	01-10083	1			2.49K 1% 50ppm/C 1/4W Metal Film	RN60C2491F	
R48	01-10127	1			806 1% 50ppm/C 1/4W Metal Film	RN60C8060F	
R49	01-50033	1			50 Top Adjust	Beckman 68WR50ohm	
R50	01-10133	1			845 1% 50ppm/C 1/4W Metal Film	RN60C8450F	
R51	01-10028	1			24.9K 1% 50ppm/C 1/4W Metal Film	RN60C2492F	
R52	01-50033	1			50 Top Adjust	Beckman 68WR50ohm	
R53	01-10001	1			1.0K 1% 50ppm/C 1/4W Metal Film	RN60C1001F	
R54	01-01021	1			100 5% 1/4W Carbon Film	RC07GF101J	
R55	01-01047	1			2.4K 5% 1/4W Carbon Film	RC07GF242J	
R56	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R57	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R58	01-01047	1			2.4K 5% 1/4W Carbon Film	RC07GF242J	
R59	01-01085	1			200K 5% 1/4W Carbon Film	RC07GF204J	
R60	01-01054	1			5.1K 5% 1/4W Carbon Film	RC07GF512J	
R62	01-50033	1			50 Top Adjust	Beckman 68WR50ohm	
R63	01-10008	1			10K 1% 50ppm/C 1/4W Metal Film	RN60C1002F	
R64	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R65	01-50029	1			500 Top Adjust	Beckman 68WR500ohm	
R66	01-10015	1			243K 1% 50ppm/C 1/4W Metal Film	RN60C2433F	
R67	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R68	01-10008	1			10K 1% 50ppm/C 1/4W Metal Film	RN60C1002F	
R69	01-50029	1			500 Top Adjust	Beckman 68WR500ohm	
R70	01-10015	1			243K 1% 50ppm/C 1/4W Metal Film	RN60C2433F	
R71	01-50028	1			50K Top Adjust	Beckman 68WR50K	
R72	01-01040	1			910 5% 1/4W Carbon Film	RC07GF911J	
R73	01-01102	1			1.5M 5% 1/4W Carbon Film	RC07GF155J	
R74	01-50033	1			50 Top Adjust	Beckman 68WR50ohm	
R75	01-10001	1			1.0K 1% 50ppm/C 1/4W Metal Film	RN60C1001F	
R76	01-10017	1			9.09K 1% 50ppm/C 1/4W Metal Film	RN60C9091F	
R77	01-01123	1			20M 5% 1/4W Carbon Film	RC07GF206J	
R78	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R79	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R80	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R81	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R82	01-01040	1			910 5% 1/4W Carbon Film	RC07GF911J	
R83	01-50028	1			50K Top Adjust	Beckman 68WR50K	
R84	01-10001	1			1.0K 1% 50ppm/C 1/4W Metal Film	RN60C1001F	
R85	01-50033	1			50 Top Adjust	Beckman 68WR50ohm	
R86	01-10017	1			9.09K 1% 50ppm/C 1/4W Metal Film	RN60C9091F	
R87	01-01021	1			100 5% 1/4W Carbon Film	RC07GF101J	
R88	01-01086	1			220K 5% 1/4W Carbon Film	RC07GF224J	

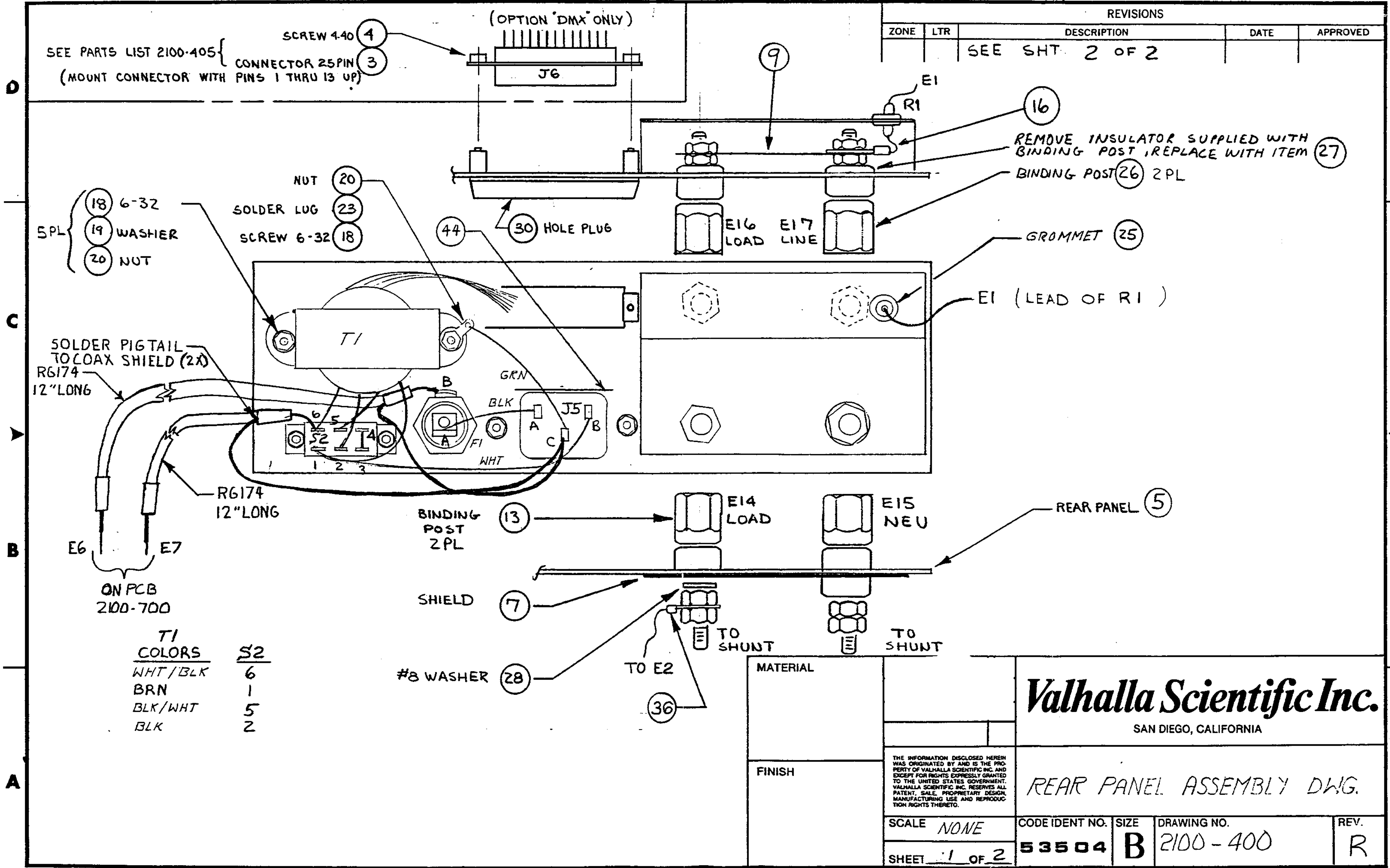
REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA	ALTERNATE
		A	T	N			
R89	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R90	01-01041	1			1K 5% 1/4W Carbon Film	RC07GF102J	
R91	01-01021	1			100 5% 1/4W Carbon Film	RC07GF101J	
R92	01-01053	1			4.7K 5% 1/4W Carbon Film	RC07GF472J	
R93	01-01073	1			47K 5% 1/4W Carbon Film	RC07GF473J	
R94	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R95	01-01085	1			200K 5% 1/4W Carbon Film	RC07GF204J	
R96	01-01070	1			33K 5% 1/4W Carbon Film	RC07GF333J	
R97	01-01086	1			220K 5% 1/4W Carbon Film	RC07GF224J	
R98	01-10143	1			453 1% 50ppm/C 1/4W Metal Film	RN60C4530F	
R99	01-10085	1			249 1% 50ppm/C 1/4W Metal Film	RN60C2490F	
RN1	01-40002	1			8 x 100 Network	A-B 316B-101	
RN2	01-40002	1			8 x 100 Network	A-B 316B-101	
R100	01-50014	1			100 Top Adjust	Beckman 68WR100ohm	
R101	01-10078	1			2K 1% 50ppm/C 1/4W Metal Film	RN60C2001F	
R102	01-01073	1			47K 5% 1/4W Carbon Film	RC07GF473J	
R103	01-01061	1			10K 5% 1/4W Carbon Film	RC07GF103J	
R104	01-01085	1			200K 5% 1/4W Carbon Film	RC07GF204J	
R105	01-01070	1			33K 5% 1/4W Carbon Film	RC07GF333J	
R106	01-01086	1			220K 5% 1/4W Carbon Film	RC07GF224J	
R107	01-50014	1			100 Top Adjust	Beckman 68WR100ohm	
R108	01-10078	1			2K 1% 50ppm/C 1/4W Metal Film	RN60C2001F	
R117	01-50028	1			50K Top Adjust	Beckman 68WR50K	
R118	01-01093	1			470K 5% 1/4W Carbon Film	RC07GF474J	
R119	01-10085	1			249 1% 50ppm/C 1/4W Metal Film	RN60C2490F	
S1	05-03003	1			Switch, DPDT, Push-Push	Centralab 004184	
S2	05-03058	1			Switch,8Sta.,Interlocked	Centralab	
TP1	05-10290	1			Test Hook, PCB	Vector K32-2	
TR1	03-10013	1			NPN Transistor (TO92)	2N4401	
TR2	03-10013	1			NPN Transistor (TO92)	2N4401	
TR3	03-10013	1			NPN Transistor (TO92)	2N4401	
TR4	03-10013	1			NPN Transistor (TO92)	2N4401	
TR5	03-10013	1			NPN Transistor (TO92)	2N4401	
TR6	03-10010	1			PNP Transistor (TO92)	2N4402	
TR7	03-10013	1			NPN Transistor (TO92)	2N4401	
TR8	03-10013	1			NPN Transistor (TO92)	2N4401	
TR9	03-10013	1			NPN Transistor (TO92)	2N4401	
TR10	03-10013	1			NPN Transistor (TO92)	2N4401	
TR11	03-10013	1			NPN Transistor (TO92)	2N4401	
TR12	03-10013	1			NPN Transistor (TO92)	2N4401	
TR13	03-10013	1			NPN Transistor (TO92)	2N4401	
XIC15	05-10008	1			Socket, dil, 16 pin	Burndy C8516-01	
XIC16	05-10041	1			Socket, dil, 14 pin	Burndy 8514-01	
XIC17	05-10295	1			Socket, dil, 28 pin	Burndy DILB28P-108	
XIC18	05-10008	1			Socket, dil, 16 pin	Burndy C8516-01	
XIC19	05-10041	1			Socket, dil, 14 pin	Burndy 8514-01	
XIC20	05-10295	1			Socket, dil, 28 pin	Burndy DILB28P-108	

PARTS LIST : 2100-601 REV B Display Board Assy.

REF.DES.	STOCK #	QUANTITY			DESCRIPTION	MANUFACTURING/PURCHASING DATA
		A	T	N		
2	04-30071	1			Display Board	DWG 2100-701
DS1	05-01028	1			LED,Red,Panel Mount	Hewlett Packard,HLMP3301
DS2	05-01028	1			LED,Red,Panel Mount	Hewlett Packard,HLMP3301
DS3	05-01020	1			Display,LED,Red,+/-1	Hewlett Packard,QDSP-3789 Bin B
DS4	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02
DS5	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02
DS6	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02
DS7	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02
DS8	05-01020	1			Display,LED,Red,+/-1	Hewlett Packard,QDSP-3789 Bin B
DS9	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02
DS10	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02
DS11	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02
DS12	05-01010	1			Display,LED,Red,0-9	Hewlett Packard,5082-7650-S02

SECTION IX DRAWINGS AND SCHEMATICS

The following drawings have been included in this manual:



T1 COLORS	S2
WHT/BLK	6
BRN	1
BLK/WHT	5
BLK	2

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
		SEE SHT 2 OF 2		

MATERIAL

FINISH

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Valhalla Scientific Inc.
SAN DIEGO, CALIFORNIA

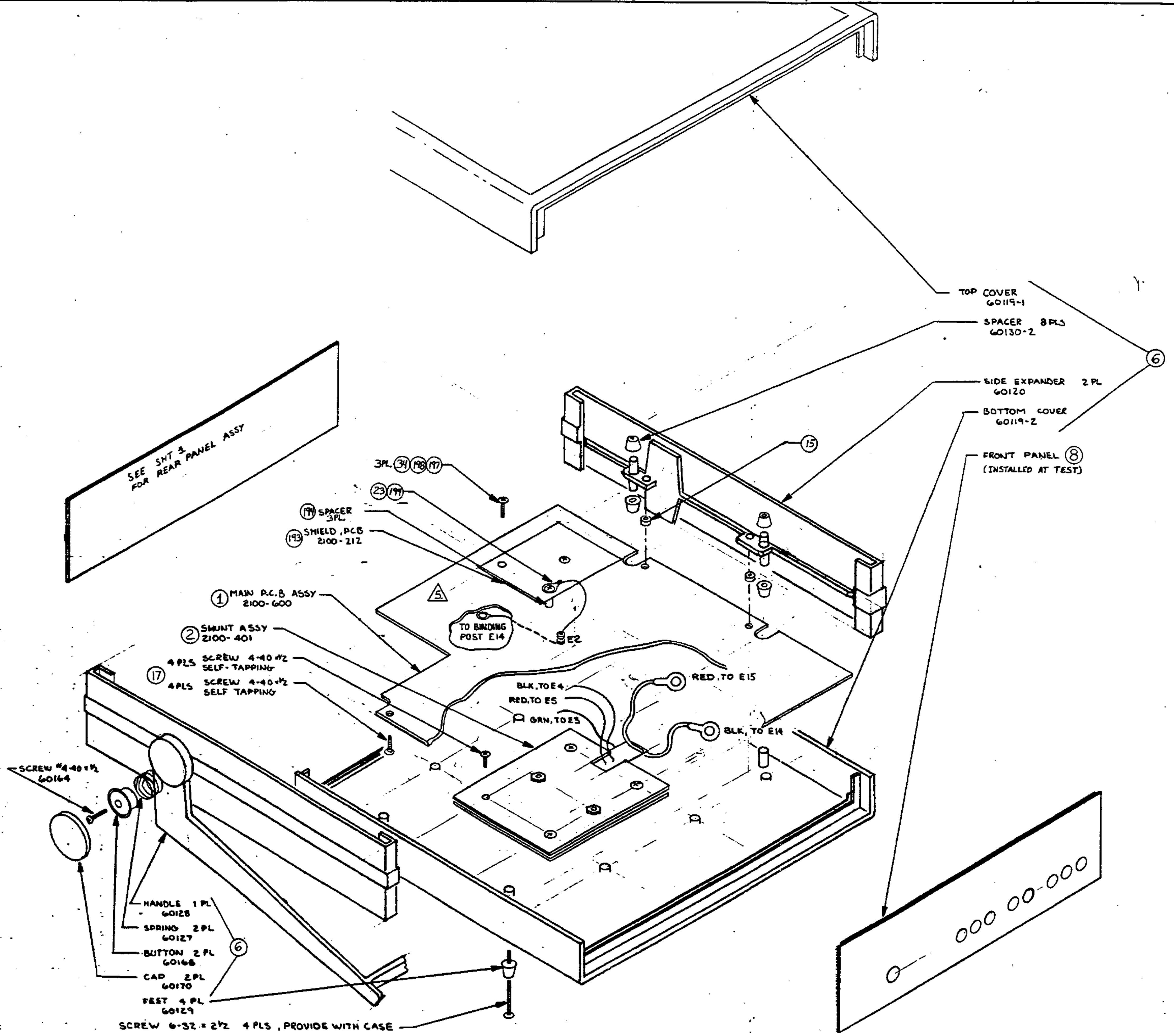
REAR PANEL ASSEMBLY DWG.

SCALE NONE

SHEET 1 OF 2

CODE IDENT NO.	SIZE	DRAWING NO.	REV.
53504	B	2100 - 400	R

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED



NOTES:

1. FOR SCHEMATIC SEE 2100-070 SHTS 1 AND 2.
2. FOR PARTS LIST SEE 2100-400.
3. FOR FINAL PARTS PLACEMENT ON 2100 SEE 2100-403.
4. FOR FINAL PARTS PLACEMENT ON 2101 SEE 2100-404.

△5 TRIM LEADS FLUSH UNDER AC RECEPTACLE.

MATERIAL

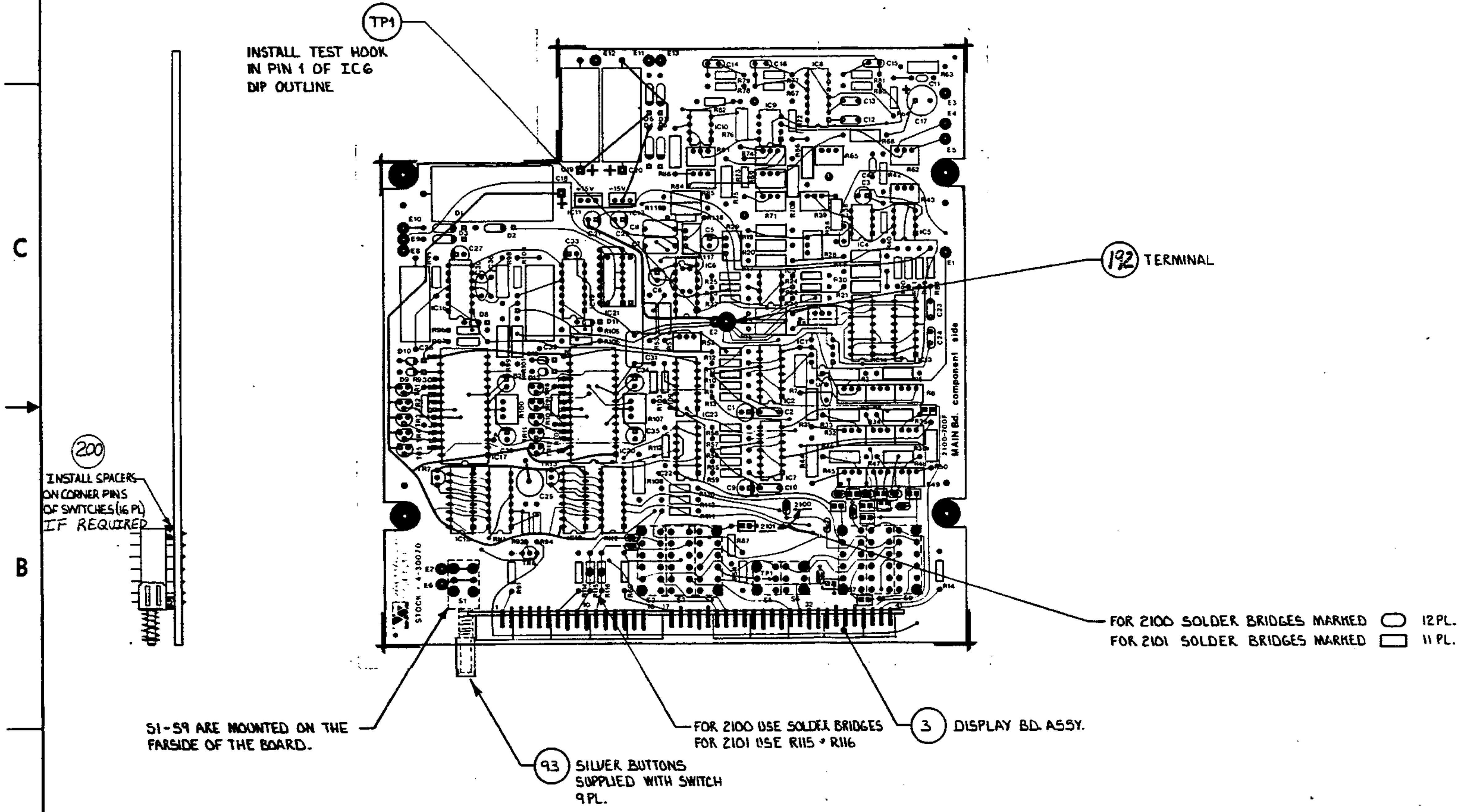
FINISH

Valhalla Scientific Inc.
SAN DIEGO, CALIFORNIA

ASSEMBLY -
MODEL 2100/2101

SCALE NONE
SHEET 2 OF 2

CODE IDENT NO	SIZE	DRAWING NO	REV
53504	D	2100-400	R



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

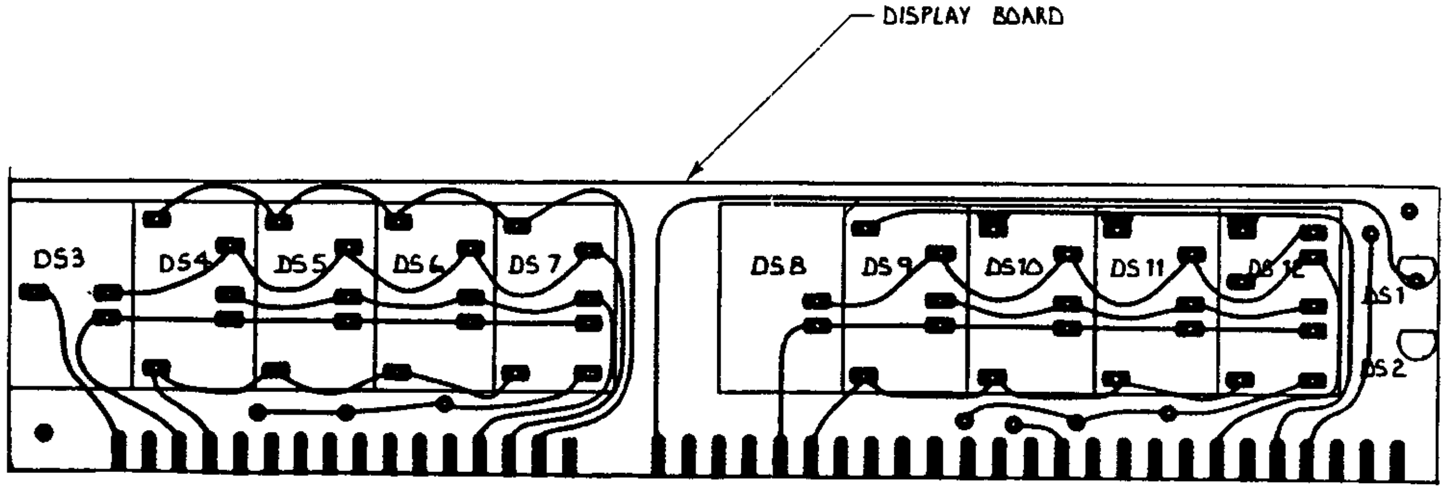
FINISH

Valhalla Scientific Inc.
SAN DIEGO, CA

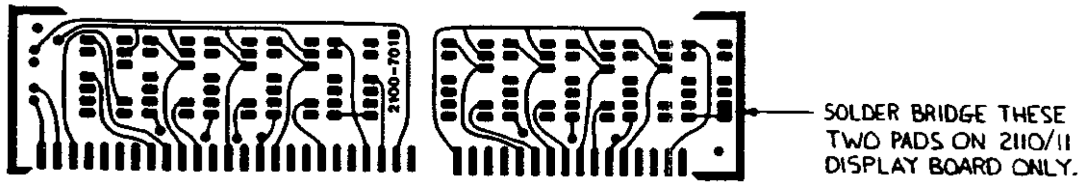
2100 + 2101 MAIN BD. ASSY.

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
1:1	53504	C	2100-600	W

SHEET 1 OF 1



CLAD SHOWN IS NEARSIDE



SOLDER SIDE IS SHOWN

(SCALE = 1 : 1)

THIS MODIFICATION IS FOR 2110/2111 ONLY.

2100-601 A

DASH NO	QTY REQD	NEXT ASSEMBLY	USED ON
	1	2100-600	2101
	1	2100-600	2100

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

BREAK ALL SHARP CORNERS AND EDGES. MACH SURFACES 64 ✓

MATERIAL

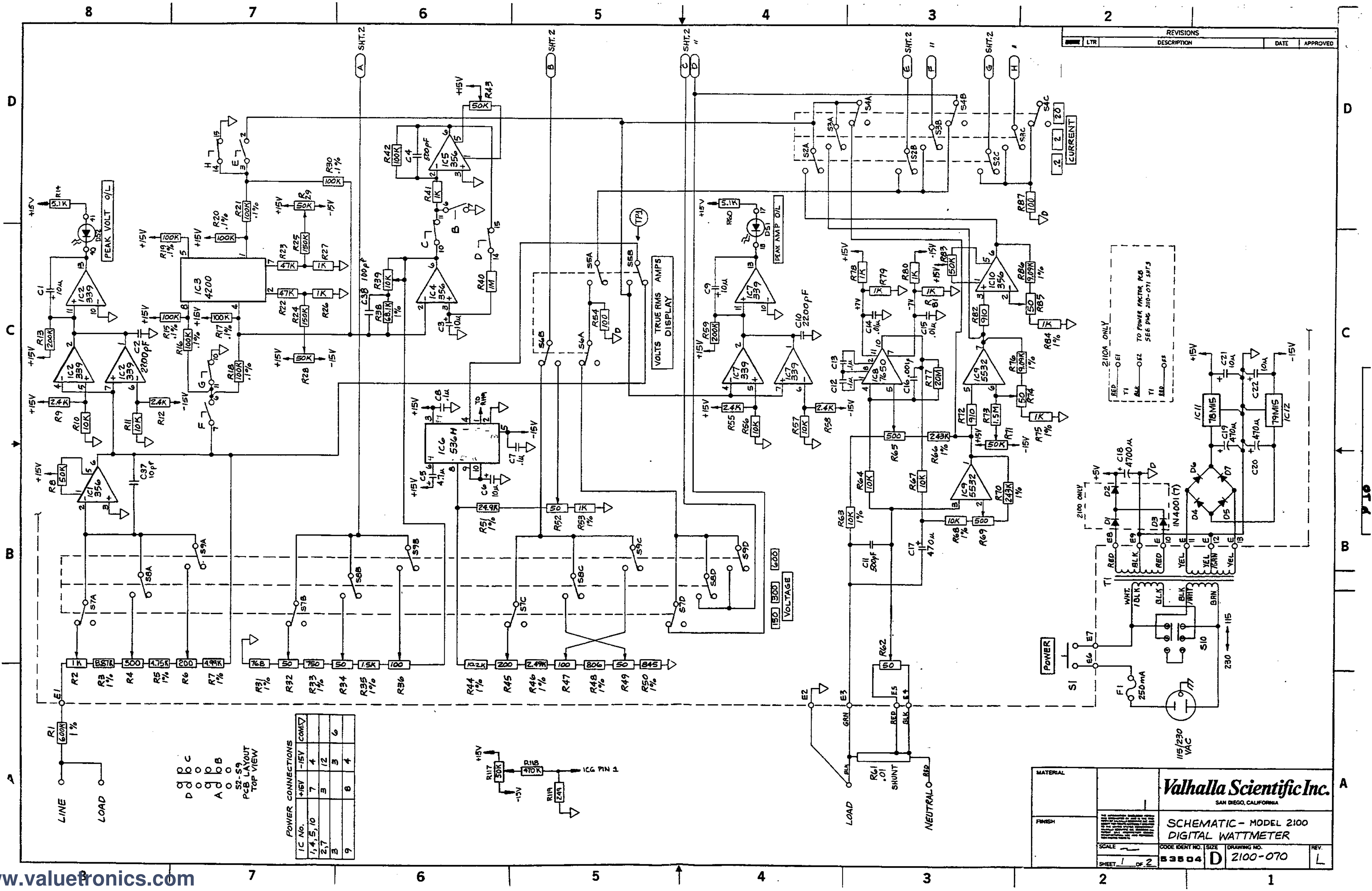
FINISH

Valhalla Scientific Inc.
SAN DIEGO, CA

DISPLAY BOARD ASSY. 2100/2101

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
2:1	53504	C	2100-601	C

SHEET 2 OF 2



POWER CONNECTIONS

IC No.	+16V	-15V	COM▽
1,4,5,10	7	4	
2,7	3	12	
3		3	6
9	8	4	

MATERIAL

FINISH

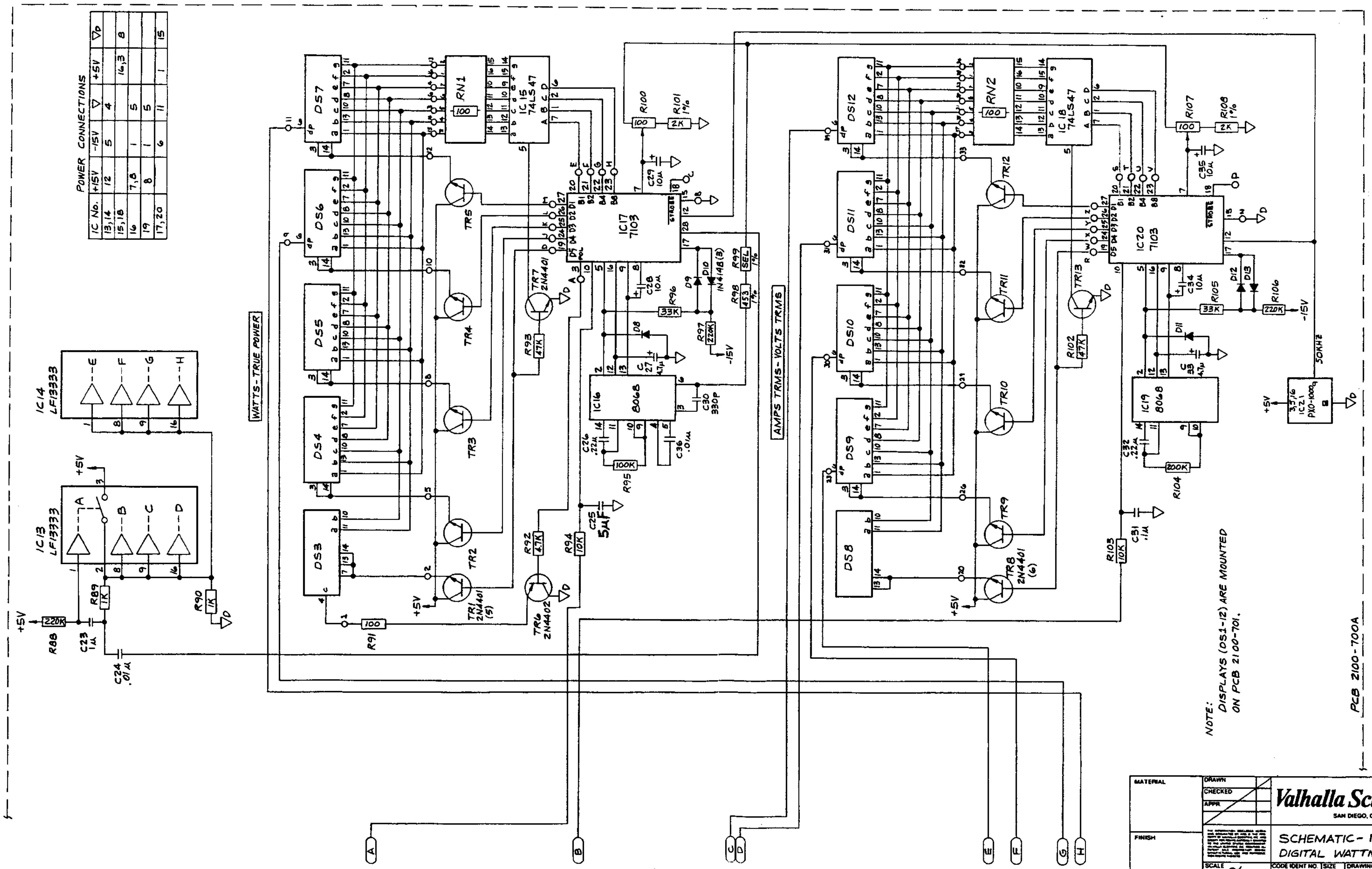
Valhalla Scientific Inc.
SAN DIEGO, CALIFORNIA

SCHEMATIC - MODEL 2100
DIGITAL WATTMETER

SCALE —
SHEET 1 OF 2

CODE IDENT NO.	SIZE	DRAWING NO.	REV.
53504	D	2100-070	L

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
		SEE SHT. 1		



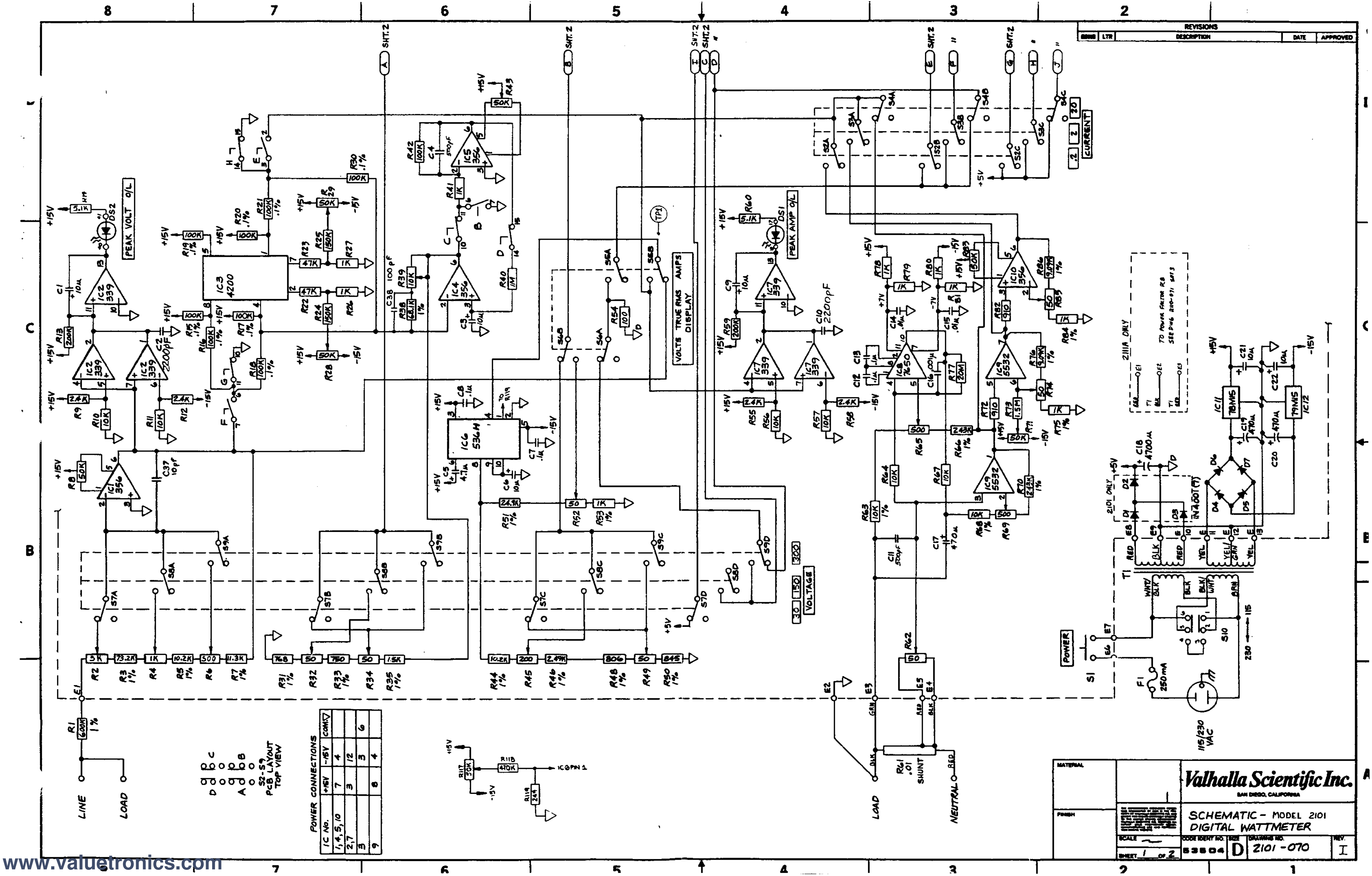
POWER CONNECTIONS					
IC No.	+15V	-15V	▽	+5V	▽D
13,14	12	5	4		
15,18				16,3	8
16	7,8	1	5		
19	8	1	5		
17,20		6	11	1	15

NOTE:
DISPLAYS (DS1-12) ARE MOUNTED
ON PCB 2100-701.

PCB 2100-700A

MATERIAL	DRAWN		**Valhalla Scientific Inc.** SAN DIEGO, CALIFORNIA			
	CHECKED					
	APPR					
FINISH			SCHEMATIC- MODEL 2100 DIGITAL WATTMETER			
	SCALE ~		CODE IDENT NO. 53504	SIZE D	DRAWING NO. 2100-070	REV. L
	SHEET 2 OF 2					

)



POWER CONNECTIONS

IC No.	+15V	-15V	COM ▽
1,4,5,10	7	4	
2,7	3	12	
3		3	6
9	8	4	

MATERIAL

FINISH

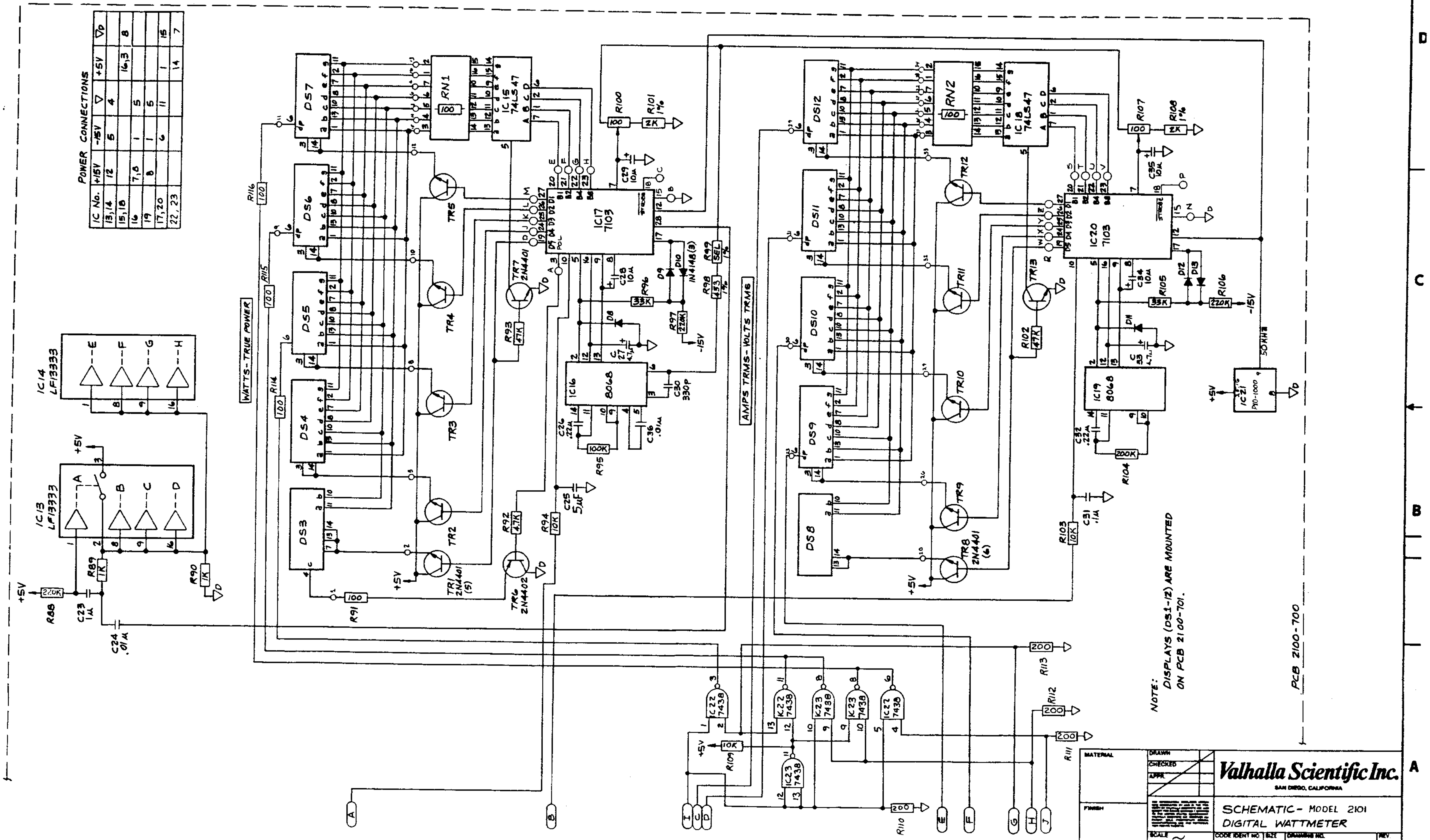
Valhalla Scientific Inc.
SAN DIEGO, CALIFORNIA

SCHEMATIC - MODEL 2101
DIGITAL WATTMETER

SCALE	CODE IDENT NO.	SIZE	DRAWING NO.	REV.
~	53604	D	2101 -070	I

SHEET 1 OF 2

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
		SEE SHT. 1		



POWER CONNECTIONS

IC No.	+15V	-15V	▽	+5V	▽D
13,14	12	5	4		
15,18				16,3	8
16	7,8	1	5		
19	8	1	5		
17,20		6	11	1	15
22,23				14	7

NOTE:
DISPLAYS (DS1-12) ARE MOUNTED ON PCB 2100-701.

PCB 2100-700

MATERIAL	DRAWN	**Valhalla Scientific Inc.** SAN DIEGO, CALIFORNIA
	CHECKED	
	APPR.	
FINISH		SCHEMATIC- MODEL 2101 DIGITAL WATTMETER
	SCALE ~	CODE IDENT NO. 53504 · SIZE D · DRAWING NO. 2101-070 · REV. I
	SHEET 2 OF 2	