Model 2703/2705

AC Voltage / Phase Standard

Operation Manual

VALHALLA SCIENTIFIC

Need Help? Call 800-548-9806.
www.valhallascientific.com

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.

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

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
Centrelab 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

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
Bell Industries Elect.
Burbank, California

99392
STM
Oakland, California

99515
ITT Jennings Monrovia Plant
Monrovia, California

99779
Use 29587
Bunker-Ramo Corp.
Landsdowne, Pennsylvania

99942
Centrelab Semiconductor
El Monte, California

TABLE OF CONTENTS

TABLE OF CONTENTS
(CONTINUED)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I - UNPACKING AND INSTALLATION

1.1 UNPACKING AND 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 when unpacked, 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 or fails to meet the performance specifications of Section II, 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.

1.2 INITIAL ADJUSTMENTS

The only adjustments required before placing the unit in operation are to set the rear panel switch to the local power voltage and verify that the proper fuse is installed as listed in Table 1-1.

1.3 INSTRUCTIONS FOR BENCH USE

The unit is delivered with all required hardware for bench use installed and special instructions for use in that manner are not necessary. However, before connecting the unit to the local power source, verify that the power cord is equipped with a three-terminal connector (see the Safety Precautions of paragraph 1.5).

1.4 INSTRUCTIONS FOR RACK MOUNTING

Optional brackets are available for mounting the Model 2703 in an equipment rack. These are listed in Section VII. The size of the unit and the location of its center of gravity dictate that it should be supported on both sides along its entire length through the use of "trays" or slides. If it is to be transported while mounted in a rack, it should be supported so as to prevent upward or downward movement.

Note that the specifications listed in Section II indicate that accuracy of the unit is degraded at abnormally high temperatures. Therefore, it is recommended that blank panels at least 1.75 inches high be installed between this and any other units in the rack to insure freedom of air flow. Under no circumstances should the ambient air temperature around the unit exceed 50°C while the unit is in operation or 70°C when power is removed.

1.5 SAFETY PRECAUTIONS

The power plug should be a three-contact device and should be inserted only into a three-contact mating socket where the third contact provides a ground connection. If power is provided through an extension cable, the ground connection must be continuous. Any discontinuity in the ground lead may render the unit unsafe for use.

Table 1-1. Voltage Switch Settings and Fuse Ratings.

SUPPLY VOLTAGE	SWITCH SETTING	FUSE RATING
100 - 130 Volts	115	3.0 Amp Slo Blo
200 - 260 Volts	230	1.5 Amp Slo Blo

SECTION II - SPECIFICATIONS

2.1 GENERAL

Operating specifications are listed in Tables 2-1 and 2-2. Power and environmental requirements are listed in Table 2-3. Accuracy may be degraded if environmental conditions are not within specified limits.

Table 2-1. Operating Specifications.

AMPLITUDE SETABILITY AND RESOLUTION:

RANGE	SETABILITY	RESOLUTION
0.12V	0.122221	1uV
1.2V	1.22221	10uV
12.V	12.2221	100uV
120.V	122.221	1mV
1200.V	1222.21	10mV

AMPLITUDE ACCURACY*:

RANGE	10 Hz	1 KHz	10 KHz	30 KHz	100 KHz
0.12	0.02 + 0.01		0.03 + 0.02		0.05 + 0.05
1.2					0.03 + 0.03
12.					0.03 + 0.03
120.					0.05 + 0.03
1200.	0.03 + 0.03				

*Amplitude accuracy is for ninety days at 22°C to 28°C following a thirty-minute warm-up time. The percentages in the table are of ±% of setting and ±% of range ±20 uV and are relative to NSB traceable standards. The specifications are valid above 1% of range for the full range of supply voltages and frequencies.

AMPLITUDE STABILITY: 1/20th of specification per month.

AMPLITUDE TEMPERATURE COEFFICIENT: 1/20th of specification per °C.

OUTPUT CURRENT CAPABILITY: 100 mA RMS except 0.12V range is 0.4 mA; 1200V range is 7mA.

LOAD CAPACITANCE: Minimum Load Impedance 50 ohms
Maximum load capacitance is 500 pf within output current limitations.

LOAD REGULATION: Less than 0.01% change from no load to full load.

(Continued)

Table 2-1. Operating Specifications (Continued).

FOUR-TERMINAL OPERATION: Reduces the effect of lead impedance by at least 100:1 in Remote Sense mode.

FREQUENCY SETABILITY AND RESOLUTION:

RANGE	SETABILITY	INCREMENT
100 Hz	100.00 Hz	0.01 Hz
1000 Hz	1000.0 Hz	0.1 Hz
10 KHz	10.000 KHz	1 Hz
100 KHz	100.00 KHz	1 KHz (10 KHz above 50 KHz)

FREQUENCY ACCURACY: ±0.01% of setting for 1 year over entire temperature range.

FREQUENCY STABILITY: ±0.0005% of setting per month
±0.0001% of setting per °C.

EXTERNAL PHASE LOCK CAPABILITY: Output frequency may be locked to an external signal over a range of ±40% of the frequency selected on the front panel. A front panel LED indicates out of lock condition.

2703 DISTORTION AND NOISE

Frequency	THD + N (Typical)	THD + N (Maximum)
	10Hz - 400KHz MBW	10Hz - 5MHz MBW
10Hz - 4KHz	0.015% + 0.01% range + 80uV	0.04% + 0.03% range + 250uV
4KHz - 10KHz	0.045% + 0.01% range + 80uV	0.09% + 0.03% range + 250uV
10KHz - 50 KHz	0.2% + 0.02% range + 80uV	0.4%+ 0.05% range + 250uV
50KHz - 100KHz	0.4% + 0.03% range + 150uV	0.75% +0.07% range + 500uV

Add 0.05% of range on 1200V range below 30Hz

Notes on measurement techniques:

The 2703 (as all microprocessor controlled calibration equipment) exhibits common mode interference in the 1 to 50MHz range. This means that for low level signals to be adequately measured, this noise must b grounded at the 2703. Even if the distortion analyzer is grounded, the output low (black terminal) of the 2703 must be grounded for these signals not to be converted into series mode high frequency signals. This is especially true if Hewlett-Packard distortion analyzers are used, since these products have very high measurement bandwidth (in excess of 10 MHz) but have a very poor common mode rejection at these frequencies.

Revised 10/5/85

2705 AC VOLTAGE/PHASE STANDARD

Phase Accuracy -	10 Hz - 1000 Hz ± .25° 1 KHz - 10 KHz ± 1.5°
Phase Noise -	10 Hz - 1000 Hz ± .14° 1 KHz - 10 KHz ± .7°
Phase Settability -	10 Hz - 1000 Hz ± .1° (0-360° Lag). 1 KHz - 10 KHz ± 1° (0-360° Lag).
Harmonic Distortion & Noise -	10 Hz - 1000 Hz - AS 2703 1 KHz - 10 KHz - Dominated by Phase Noise

VOLTAGE OUTPUT SPECIFICATIONS - As 2703 + 0.02% of setting below 30 Hz and above 4KHz. Minimum output of both master and slave 5% of range or 10 mV, whichever greater.

Master-Slave Common Mode Voltage - 100V peak - A maximum of two slaves can be driven from one master.

Note: When operating a slave unit eg 2705 via another slave unit, phase errors are cumulative from Master eg. 2703 to final slave unit.

FRONT PANEL CONTROLS:

Voltage, Standby/Operate, Local, Remove Sense - As 2703

Phase - Rotary Switches - Continuous Phase Adjustment

Push Buttons - Five Preset Phase Settings - 0°, 90°, 120°, 180°, 240°

ALL OTHER SPECS SAME AS 2703

Table 2-3. Environmental, Power and Physical Requirements

ENVIRONMENTAL

Working Temperature Range:	0 to 50°C
Storage Temperature Range:	-30 to 70°C
Maximum Relative Humidity:	70% to 40°C

POWER REQUIREMENTS

Power Supply Voltage:	100-130 or 200-260 volts
Power Supply Frequency:	50, 60 or 400 Hz (±5%)
Power Consumption:	180 Watts maximum

SECTION III - MANUAL OPERATION - 2703

3.1 GENERAL

A complete description of major functions of the front panel controls and indicators is provided in the following paragraphs.

Each time power is applied, all bars and all LEDs on the front panel will be illuminated. Approximately one second later, both displays will greet the operator with "HELLO". After another second, the instrument will commence operation in the Standby mode in the 100 millivolt range, set to 100 millivolts at a frequency of 1000 Hz.

3.2 CONNECTIONS

The Model 2703 is a four-wire instrument. It is equipped with separate terminals for connection of the output voltage and remote sensing leads of the instrument. However, it may be used as a two-wire instrument as well. Directions for use in both modes are included in following paragraphs.

CAUTION

> The 2703 has rear panel terminals wired in parallel with those on the front panel. The user should be careful when making connections that other leads are not already connected to the other terminal cluster.

3.2.1 FOUR-WIRE CONNECTIONS

When the Model 2703 is used as a four-wire instrument, the voltage leads and the sense leads of the instrument should be connected together at the load. Care should be exercised to insure that the leads connected together at the load are of the same polarity. The REMOTE SENSE pushbutton should be used to select Remote Sense (four-wire), as indicated by the LED on the pushbutton being illuminated. It should be noted that should the voltage at the SENSE terminals be more than 20% of range from that expected, then the unit automatically selects STANDBY.

3.2.2 TWO-WIRE CONNECTIONS

When the instrument is used with only two wires, the REMOTE SENSE pushbutton should be used to deselect Remote Sense, as indicated by the LED on the pushbutton being extinguished. Sensing is then done internally, and the SENSE terminals are open-circuited.

3.3 STANDBY/OPERATE PUSHBUTTON

The STANDBY/OPERATE pushbutton is an alternate action pushbutton switch. The output in Standby is zero, in Operate it is the voltage and frequency indicated in the front panel display.

3.4 SETTING OUTPUT VOLTAGE AND FREQUENCY

To set the voltage output of the Model 2703, select the desired full-scale voltage range using the range pushbuttons. The LED on the key for the chosen range will remain illuminated. Set the desired voltage using the five rotary switches below the VOLTAGE display. As the numbers are entered, they appear in the display. Note that selecting a range other than 1200V, does not change the Standby/Operate mode. The 1200V pushbutton places the instrument in Standby.

To set the frequency of the Model 2703 output, select the full-scale frequency range using the frequency range pushbuttons. The LED on the key for the chosen range will remain illuminated. Set the desired frequency using the four rotary switches below the frequency display. As the numbers are entered, they appear in the display.

3.5 LIGHTNING BOLT

To the left of the output terminals is a display that looks like a bolt of lightning. When it is illuminated, it indicates that the instrument output voltage is 30 volts or greater, or that the 1200-volt range is selected.

3.6 PHASE LOCK PUSHBUTTON

This button alternately selects and deselects the Phase Lock mode of operation. When the PHASE LOCK mode is active, the LED in the key is illuminated. In this mode, the desired frequency must be connected to the EXT connector on the rear panel, and the frequency and frequency range selected should be close to the external frequency. If the difference between the external frequency and the frequency selected on the front panel is excessive, the LED marked UNLOCKED will be illuminated.

3.7 REMOTE SENSE PUSHBUTTON

This pushbutton alternately selects and deselects the Remote Sense (four-wire) mode. The LED indicator in the key is illuminated when the mode is active. When it is inactive, sensing is done internally and the sense terminals are open-circuited.

3.8 LOCAL PUSHBUTTON

This button allows the operator to take control of the instrument if it is in IEEE Remote and If Local Lockout has not been selected (see Section IV).

SECTION IV - IEEE-488 INTERFACE OPERATION

4.1 IEEE-488, AN EXPLANATION OF THE BUS

The reader that is not familiar with the requirements of IEEE Standard 488 (1978) (IEEE-488) will want to review the following paragraphs which provide explanations of terms, commands and some examples of commands. For a complete explanation of the requirements, refer to the IEEE-488 Standard.

In the text of this section, to provide clarity, Ø is used for zero and O is used for the letter 'O'.

4.2 DEFINITIONS

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

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

Bi-Directional Bus: A 'highway' used for two-way communication, with input and output data being carried on the same lines.

Bit Parallel: A data transmission method in which all of the bits comprising an item of data are present simultaneously on a group of wires in a bus.

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

Byte Serial: A data transmission method in which information, in bit-parallel bytes, is transferred sequentially between devices.

Device Dependent Message: A message containing commands/data intended for a specific device.

Handshake: An exchange of signals between two devices which is used to control the transfer of data between them.

Interface: The part of an instrument or system which enables it to be connected to another via a bus.

Interface Message: A message intended for interface management.

Local Operation: Operation of a device by its front panel controls (also referred to as Manual Control).

Remote Operation: Operation of device under the control of another via a bus.

4.3 BUS DESCRIPTION

The IEEE-488 Interfacing Standard (also known as IEC DTC66(WG3), ANSI MC1-1, GP-IB, HP-IB, etc.), defines a bi-directional bus for interconnecting programmable instrumentation in a bit-parallel, byte serial fashion. It defines 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 m, whichever is the 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 listener. The other devices may be listeners (only able to receive data) or talkers (only able to transmit data) or both. The model 2703 is capable of talking and listening. The controller may address other devices and command them to listen or talk. Only one device may talk at any one time.

The interconnecting cable consists of sixteen signal wires and eight ground returns linking devices into a complete system. Each cable connector is a plug/socket combination to permit "daisy-chaining" of units. The sixteen signal wires are:

Eight data wires (DIO-0 through DIO-7)

Five management wires (ATN, EDI, SRO, IFC and REN)

Three "handshake" wires (DAV, NRFD and NADC)

It should be noted that these wires use "inverse logic". That is to say that a low level indicates the true (asserted) state and a high level indicates a false (non-asserted) state.

4.4 DETAILED DESCRIPTION

The five management wires are described as follows:

ATN - Asserted by the controller whenever an address or a command is present on the bus.

EOI - May be asserted by the controller or any talker. With ATN true, EOI indicates that the controller is polling devices. With ATN false, EOI is asserted by the talker to indicate the end of data.

SRQ - May be asserted by any device. This indicates that the device requires attention (e.g., a fault has occurred). Normally, the controller will respond by polling to determine which device requires service.

IFC - May be asserted only by the controller. This line initializes the bus to a reset state.

REN - May be asserted only by the controller. This signal, when asserted, places the addressed device into the remote mode.

The three handshake wires are described as follows:

DAV - May be asserted by any talker. Indicates that a valid data byte is present on the data wires.

NRFD - May be asserted by any listener. Indicates that the listener is not ready to receive data.

NDAC - May be asserted by any listener. Indicates that the listener has not yet finished reading the data byte.

The transfer of data on the bus is controlled by these three handshake wires. It is important to note that the drivers for the handshake wires are all connected for wired-or operation. That is, as long as any of the devices on the bus asserts a handshake line, it will remain true. Thus, there must be complete consensus among the devices for any handshake wire to be high (false).

The talker first waits for all devices to be ready to accept data (checks that NRFD is false) then puts one byte of data on the bus and asserts DAV. It then waits for all devices to indicate that the data has been accepted (that is for NDAC to become false) before starting to transfer the next byte of data. This handshake protocol assures that data on the bus is transferred at the speed of the slowest device on the bus.

Data is sent in 8-bit bytes on the DIO wires, usually (as in the 2703) using the ISO-7 standard ASCII characters. Table 4-1 lists each ASCII character and the bus messages applicable to each. Note that the table is divided into two main groups; the primary command group and the secondary command group. The secondary command group is not utilized in the 2703.

The primary command group is further divided into four sub-groups as follows:

1. Addressed Command Group - applied only to addressed devices.
2. The Universal Command Group - applied to all devices.
3. The Listen Address Group - set of device listen addresses.
4. The Talk Address Group - set of device talk addresses.

Data in the above command groups is sent with ATN true. When data is sent with ATN false, then it is "device dependent".

4.5 GENERAL

All IEEE-488 device dependent activity with the 2703 takes place via input and output buffers.

Input Buffer - Incoming data is placed in the input buffer as it is received. It is not acted upon until any one of the valid input delimiters is received. Then the commands are decoded and the input buffer contents erased. Input data is held off until the previous data is decoded and actioned. Should an invalid character be found in the input buffer, then the buffer is only decoded up to the error, the rest being discarded. An SRQ can be asserted, is required, should this occur.

The valid input delimiters are:

CR (Carriage Return) or
EOI with the last character.

Output Buffer - With every receipt of the command "E", the output buffer is filled with the current status of the unit. This data may be read by the controller any number of times.

The address of the 2703 is set by means of a five pole switch on the rear of the unit.

At power-up, the 2703 will be in the local mode (i.e., the unit will respond to commands entered with the front panel keyboard). In order for the 2703 to enter the remote mode, the following sequence, stipulated by IEEE-488 1978, must occur:

1. The remote enable, REN, wire on the bus must be true (pulled low).

2. The 2703 must receive its listen address.

With an HP 85 computer, this is accomplished by the statement REMOTE 710, assuming that the 2703 address is 10. In all future examples, an HP 85 computer is assumed as is the 2703 address of 10.

When the 2703 is in remote, the REMOTE-IEEE 488 indicator on the front panel will be illuminated and all front panel keys (except POWER and LOCAL) are inhibited. The LOCAL key, if pressed, will return control to the front panel. If the LOCAL control is also to be inhibited, then LOCAL LOCKOUT must be sent over the bus. This is achieved with the HP 85 by LOCAL LOCKOUT 7.

The computer may reset the 2703 to the local state any time by the command LOCAL 7 (or LOCAL 710 if only the 2703 is to be returned to the local mode). Note also that a device clear command will return the unit to local control.

4.6 SIMPLE COMMANDS AND EXAMPLES

Six simple commands, with examples, are shown in the following paragraphs.

1. **Setting a Voltage Value** -- To set the 2703 to a numeric voltage level, all that is required is to send the letter "V" followed by the numeric value in volts. A maximum of seven digits are accepted, digits in excess of seven are ignored.

   The overall delimiter is any invalid character within numeric entry.

   The following is an example of such a program using the HP 85:

```
1Ø REMOTE 71Ø
2Ø INPUT A
3Ø OUTPUT 71Ø ; "V" & VAL$(A)
4Ø GO TO 2Ø
```

This program will prompt the user for an input of the desired voltage value on the HP 85 and send this value to the 2703. (It is assumed that the 2703 is turned on and that the calibrate switch is OFF). It should be noted that the unit automatically selects OPERATE upon the receipt of an output voltage command. If the user requires no output, one should send "VØ.Ø".

2. **Setting a Frequency Value** -- To set the frequency of the 2703, all that is required is to send an "F" followed by the numeric value in Hertz.

   The following is an example of such a program using the HP 85:

```
1Ø REMOTE 71Ø
2Ø INPUT A
3Ø OUTPUT 71Ø ; "F"&VAL$(A)
4Ø GO TO 2Ø
```

3. **Remote/Local Sense Control** -- To set the 2703 to Remote Sense, send S1. To select local sensing send S0.

4. **Phase-Lock Control** -- To select the Phase-Lock mode of operation, send P1. To select normal frequency control, send PØ.

5. **Device-Dependent Return to Local** -- Some controllers do not have the capability of returning a single unit to local control. In the 2703, this is accomplished by sending L.

6. **Output Buffer Update** -- The output data from the 2703 may be updated to present conditions by sending E (either alone or followed by another command).

4.7 ADVANCED COMMANDS AND EXAMPLES

Output Delimiters -- As mentioned earlier, the 2703 updates its output buffer with the display data. The format of this data is as follows:

"nnnnnnn fffff uoc"

followed by the required output delimiter, where:

n is the output voltage (6 digits plus decimal point).
f is the output frequency (5 digits plus decimal point).
u is a space if not in unlocked, U if it is.
o is a space if not in overload, O if it is.
c is a space if not in Calibration mode, C if it is.

The required output delimiter is set by sending an "E" followed by the required code (see controller manual for details regarding the required delimiter). The list of available codes is given below:

EØ - Carriage return line feed at end of data.
E1 - Carriage return line feed (with EOI asserted) at end of data.
E2 - Carriage return only at end of data.
E3 - Carriage return (with EOI asserted) at end of data.
E4 - EOI asserted with last character.

Note that most controllers use EØ. However, the Commodore PET should use E3.

4.8 SRQ, SERIAL AND PARALLEL POLL

1. **Parallel Poll Response** -- The 2703 may have its parallel poll response bit set by means of the "PP" command. The user must send "PPn" to the unit in order to configure the response, where "n" defines the DIO line that is to be asserted by the 2703. Sending "PPO" selects that no response shall be made to a parallel poll.

2. **SRQ Definition** -- The 2703 may assert the SRQ wire for one (or more) of several reasons. This is defined by the user sending "Qn", where n is the numeric code for the required reasons.

   QØ - Disables the 2703 from asserting SRQ
   Q1 - Enables the 2703 to assert SRQ on overload
   Q2 - Enable to assert SRQ on input data errors
   Q3 - Enable to assert SRQ on all reasons given in Q1 and Q2

3. **Serial Poll Response Byte** -- When the controller in the system conducts a serial poll, the 2703 responds with a byte of data informing the controller of the reasons for the SRQ. If the 2703 did not generate the SRQ, a 0 byte is used as the response. The bit pattern used by the 2703 is shown in Table 4-2 below.

Table 4-1. ASCII Character Codes.

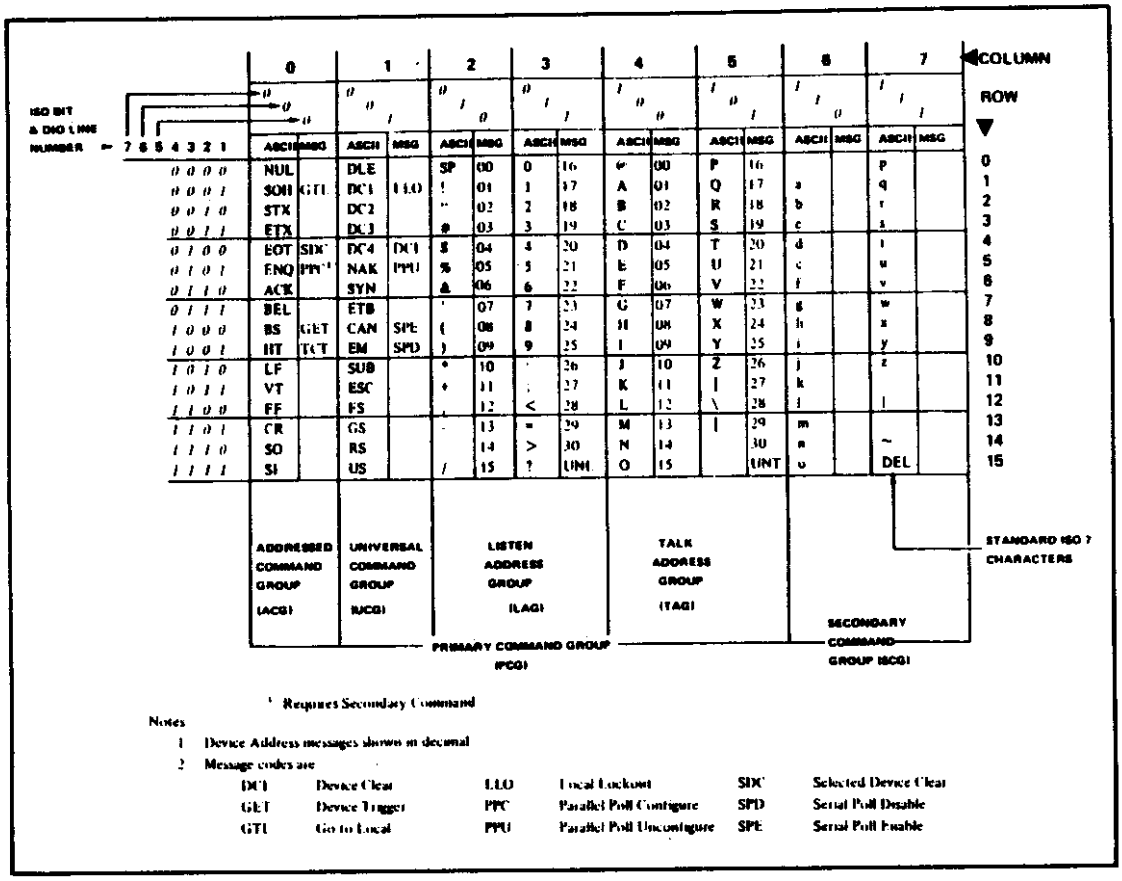


Table 4-2. SRQ Bit Patterns.

IN RESPONSE	BIT PATTERN REASON
Overload	0100 0001
Error in input data	0100 0010

Note that the most significant bit is set if the 2703 is in Remote.

SECTION V - THEORY OF OPERATION 2703

5.1 GENERAL

This section of the manual describes operation of the circuits of the Model 2703 AC Voltage Standard. The functional description of paragraph 5.2 is intended to assist the user in gaining a general understanding of instrument operation. It refers to the block diagram of Figure 5-1. Following the functional description are detailed circuit descriptions which refer to the schematic diagrams of Section X. The circuit descriptions are intended to provide the user with sufficient information on circuit operation to permit efficient troubleshooting. The information contained in this section, together with that of Section VI, will provide the background necessary for maintaining the instrument.

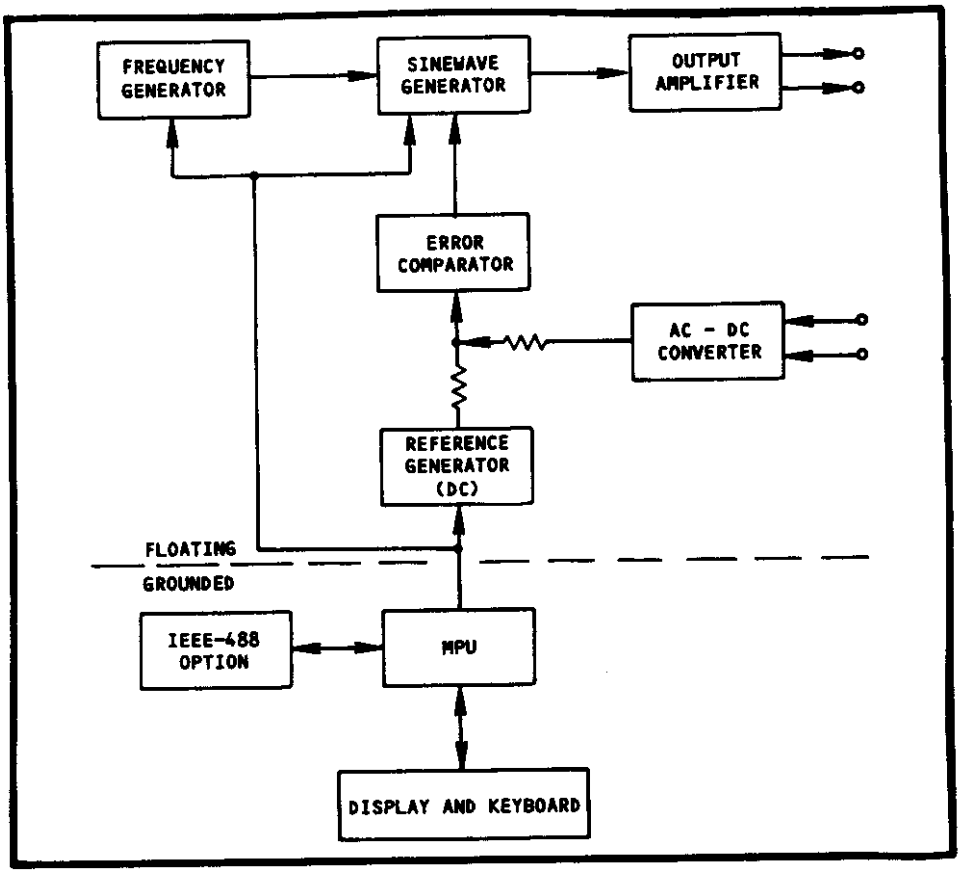


Figure 5-1. Block Diagram, Model 2703.

5.2 FUNCTIONAL DESCRIPTION

The operator can select any frequency or amplitude of AC sinewave within the range of the instrument. The selection may be made using either the front panel keyboard or from a remote location through the IEEE-488 interface (if provided). The microprocessor continuously monitors commands from both sources, and sends the current values of frequency and voltage to the front panel display. The frequency data from the microprocessor also drives the frequency generator, and the voltage data is also sent to the AC sinewave generator and to the reference generator.

The frequency generator is capable of producing any frequency within a wide range with quartz crystal accuracy. The microprocessor directs the frequency generator to produce the frequency displayed on the front panel. The output of the frequency generator is the 8-bit output of a counter chain, which drives the AC sinewave generator. The AC sinewave generator in turn synthesizes a sinewave whose amplitude is controlled approximately by the microprocessor, and very accurately by the error comparator. The sinewave generator's output is amplified by the output amplifier, which drives the voltage output terminals of the instrument.

The output voltage is held to a very high degree of accuracy by an analog feedback system consisting of the AC-DC converter, the reference standard and the error comparator. The output voltage is connected to the input of the AC-DC converter through the sense input terminals. The AC-DC converter precisely rectifies the sinewave and sends the resulting DC to the error comparator. There it is compared to the DC output of the reference generator, whose very accurate DC voltage has been set by the microprocessor to a value proportional to the front panel display. The output of the error comparator is used to adjust the output amplitude of the sinewave generator so that the voltage at the output terminals equals the value displayed on the front panel.

In order for the output of the instrument to be isolated from ground, it is necessary for the power supplied to part of the circuitry to be isolated from ground, while the portions of the circuitry connected to the front panel and the remote control connector must be referenced to ground for safety reasons.

5.3 DETAILED CIRCUIT DESCRIPTIONS

This section describes the operation of each circuit of the Model 2703 AC Voltage Standard. The reference designators used in the following paragraphs are those of the schematic diagrams shown in Section X.

5.3.1 POWER SUPPLY

There are three separate power supplies, using two separate transformers. One provides +5 volts for the circuits which must operate at or near chassis ground. The second has electrostatic shielding between primary and secondary transformer windings, and provides multiple low voltages for the floating circuits. The third supplies ±250 volts for the 250-volt output amplifier, used for the 100V and 1000V ranges of the instrument. The two low voltage power supplies are shown in Figure 9-5. Switch SX, the voltage selector switch on the rear panel, connects the two primary windings on each transformer in parallel for 115-volt operation and in series for 230-volt operation.

5.3.2 DISPLAY AND KEYBOARD

Refer to Figures 9-7 and 9-8, the Display and Keyboard schematics. Each switch on the front panel is associated with a display. Each rotary switch is paired with a seven-segment digital display; each keyboard switch has an integral status indicator LED. All status LEDs and segments are driven using a multiplexing technique from a common 8-bit bus marked "Bar Data" at the lower left of Figure 9-7. The digital data from all front panel switches is multiplexed onto a 6-bit bus marked "Switch Data" at the right of Figure 9-8.

5.3.2.1 DISPLAY AND KEYBOARD MULTIPLEXING

The multiplexing system operates as follows. Each switch, with its accompanying display, is assigned a separate time slot by the window drive circuit, IC1, IC15 and IC16. A 1.5 MHz clock from the microprocessor drives IC15-13. IC15, a 74LS393 dual 4-bit counter, divides the input frequency by 256. Its output, IC15-6, drives IC16-1, the first counter of a second 74LS393. Its first three stages further divide by eight at IC16-5. At this point, the frequency is approximately 730 Hz. The first counter's divide-by-sixteen output, IC16-6, drives the second counter, IC16-13.

IC16-5, IC16-6, IC16-10 and IC16-11 are the 4-bit output of IC16, changing states at the 730 Hz rate. This output drives IC1, a 74154 4-line to 16-line demultiplexer. If the enable inputs, IC1-18 and IC1-19 are low, the sixteen output pins of IC1 are driven low one at a time, enabling each of fifteen sampling circuits in turn for a brief interval. (The sixteenth is used for synchronization.) Meanwhile, each time the 4-bit output changes state, IC16-4 outputs a falling edge. This edge is inverted by IC14 and triggers pin 3, the clock input of IC17, a 74LS74 positive edge-triggered flip-flop, which sets IC17.

When IC17 is set, IC17-6 swings low, initiating a microprocessor interrupt request on the line marked **FIRQ**. Simultaneously, IC17-5 swings high, raising IC1-18 and IC1-19, which blanks the currently selected display. In response to the interrupt request, the microprocessor executes an interrupt service routine in which it first loads the information for the next display in the sequence into IC12, a 74LS374 octal flip-flop, which in turn places the data on the bar data bus. Next, the microprocessor resets IC17, unblanking the newly selected display, and reads the data from the newly selected switch (or a synchronization flag from IC1-17) into IC11, a 74LS541 8-bit latch, whose output is connected to the display data bus.

The remaining elements of the display and keyboard multiplexing system are the driver transistors, TR1 through TR14, which enable the individual seven-segment (plus decimal point) displays or groups of status LEDs. Similarly, the individual rotary switches and pushbutton groups are enabled by low levels directly from the respective outputs of IC1. The individual segments and LEDs are driven from the bar data bus through IC3 and IC4, two 7438 quad open-collector buffers, and RN2, a 47 ohm 8-resistor array.

5.3.2.2 ROTARY SWITCH OPERATION

The rotary switches on the front panel operate in an unconventional manner, in that the position of a switch has no absolute meaning. No matter how the switches are set at power up, the microprocessor interprets them as being set at zero. From that point until the instrument is turned off, the microprocessor keeps track only of changes in switch position, calculating the change in voltage or frequency each time a switch is moved. When a switch is moved outside its range, the microprocessor automatically performs the required carry or borrow to provide the correct display and output.

5.3.2.3 LIGHTNING BOLT

DS12 is an 8-LED indicator which, when illuminated, displays a lightning bolt. It is illuminated whenever the microprocessor detects any of several hazardous conditions. The microprocessor loads IC13, a 74LS374 octal flip-flop, with all zeroes. IC13 in turn drives the eight LEDs through RN1, a 100 ohm 8-resistor array.

5.3.3 MICROPROCESSOR

As stated in Section I, the Model 2703 is microprocessor controlled. Its operating program is contained in read-only memory (ROM). Random access memory (RAM) is used to store data obtained during operation that is required for later use. When the instrument is calibrated, the calibration data is stored in non-volatile, random access memory (NOVRAM). The schematic of the microprocessor board is shown in Figure 9-10.

A complete description of the microprocessor system operation would require an explanation of the software stored in ROM, including a complete listing of the program. Such a dissertation is beyond the scope of this manual. Therefore, the following discussion is limited to a description of the bus structure and of the registers that acquire and store data from the data bus and peripheral circuits shown in Figure 9-10.

The 6809 microprocessor, IC4, has a 16-bit address bus and an 8-bit bi-directional data bus. Read and write operations are controlled by a Read/Write line, designated "R", at IC4-32. A 6809 microprocessor's I/O can occupy any memory address; to distinguish between memory and I/O operations, IC8 and IC9, two 74LS138 3-to-8 line decoders, decode address lines A10 through A15. IC8 and IC9 are enabled by the system clock, designated "E", from IC4-34. The outputs of these decoders are used to enable the desired I/O or memory devices. By this means, ROM, RAM NOVRAM and various I/O functions share the memory space as follows.

5.3.3.1 MICROPROCESSOR MEMORY AND I/O SECTION

The ROM, IC3, is 8K by 8. It is a 2764. IC3 is enabled by IC8-7 when an address between EØØØ and FFFF hexadecimal is selected.

The RAM, IC2, is a 4016 2K by 8 static device. It is enabled by IC8-13 when an address between AØØØ and BFFF hexadecimal is selected. The Read/Write line is gated by the system clock via IC1 to IC2-21.

The NOVRAM, IC24 and IC25, consists of two 2212 256 by 4 devices, connected as 256 by 8. Its read and write operations are more complex than those of an ordinary RAM, and are performed at separate addresses. A NOVRAM consists of a RAM, with normal read and write capability, and a second, non-volatile memory which can be written to and read from only by copying to or from the RAM portion.

In ordinary use, any information to be permanently saved must first be written to the RAM, then copied (written) to the non-volatile memory. Then, each time the device is powered up, the contents of the non-volatile memory must be copied (read) to the RAM. IC24 and IC25 use pin 7 for Read/Write, pin 10 for copy (read), and pin 9 for copy (write).

In its normal read/write operation, the NOVRAM is enabled by IC8-12 when an address between 8000 and 9FFF hexadecimal is selected. Copying (reading) from non-volatile to RAM is enabled by IC8-11 when an address between 6000 and 7FFF hexadecimal is selected. Copying (writing) from RAM to non-volatile is enabled by IC8-9 when an address between 4ØØØ and 5FFF is selected and the Calibrate switch on the rear panel is in the CAL position.

5.3.3.2 BUFFERED DATA BUS FUNCTIONS

The microprocessor data bus can drive MOS devices, such as those just described, but because of load impedance and voltage level differences, it cannot reliably drive TTL devices. The buffered data bus is the channel through which the microprocessor data bus communicates with all of the TTL devices it services, and through them, with the rest of the instrument. It consists of eight data lines and eight select lines. Data is transferred in both directions between the microprocessor data bus and the buffered data bus by IC410, a 74LS245 octal transceiver. The signal direction through IC10 is governed by the state of the Read/Write line, which is connected to IC10-1. The tri-state outputs of the device are enabled by IC8-10 when any address below 2ØØØ hexadecimal is selected.

The eight select lines are driven from the eight outputs of IC9, a 74LS138 3-line to 8-line decoder. Note that IC9 is enabled only when data is being transferred to or from the buffered data bus through IC10. Three of the select lines, marked AD0-AD2, are used to enable IC14, IC15 and IC16. These devices are used to transfer data between the buffered data bus and the floating bus. The remaining five select lines are connected to connector pins 51-55. They perform the functions shown in Table 5-1.

The eight data lines of the buffered data bus appear at connector pins 49-54, from which they are connected to the display and keyboard, and to the IEEE-488 interface.

5.3.3.3 ISOLATION CIRCUITS

The circuitry shown below the buffered data bus in Figure 9-10 is the interface between the grounded and the floating parts of the instrument. IC14 and IC15 are 74LS374 octal flip-flops which serve as output data latches. IC14 is enabled by IC9-13, via AD2, when an address between 8ØØ and 8ØF hexadecimal is selected. IC15 is enabled by IC9-14, via AD1, when an address between 4ØØ and 4ØF hexadecimal is selected.

The latches drive quad optical isolators IC18, IC19 and IC20 through current limiting resistor arrays RN1 and RN2. Resistor array RN3 provides collector loads for the phototransistors. The floating data from IC14 drives IC22, a 74LS541 octal bus driver. IC22 is continuously enabled.

The floating data from IC15 drives IC21, a 74LS138 3-line to 8-line decoder. IC21 provides eight select lines for the floating bus. It is enabled only when bit DØ is a one.

The floating bus data lines, FDØ-FD7, are routed to the DC reference generator, Figure 9-11, the frequency generator, Figure 9-13, and the output amplifier, Figure 9-15. Of select lines FAØ-FA7, FAØ-FA2 go to the DC reference generator, Figure 9-11, FA3-FA5 to the frequency generator, Figure 9-13, and FA6-FA7 to the output amplifier, Figure 9-15.

To avoid data instability due to differences in settling times of the optical isolators, transfers of data from the buffered data bus to the floating data bus are done in the five-step sequence of Table 5-2.

IC16, a 74LS541 octal bus driver, serves as an input data latch to the buffered data bus. Of its eight lines, three bring data from the floating part of the instrument through isolator IC17. DØ is high whenever the output amplifier is overloaded. D1 indicates whether the phase locked loop in the frequency generator is locked. D2 carries out of range information from the error comparator.

Table 5-1. Buffered Data Bus Functions.

LINE	FUNCTION
AD3 AD4	Two control lines for the IEEE-488 interface, Figure 9-12
AD5	Enables lightning bolt latch, Figure 9-1
AD6	Enables switch latch, Figure 9-1
AD7	Enables display latch, Figure 9-1

Table 5-2. Transfers of Data.

STEP	COMMENT
1. Disable IC21	Send any address with a 0 LSB.
2. Enable IC14	Latches data into IC14.
3. Enable IC15	Latches address of desired device into IC15. Bit 0 must be 1, which enables IC21.
4. Enable IC21	Address desired device.
5. Disable IC21	Rising edge of enable pulse latches data into addressed device.

Of the remaining five lines, D3 is connected to the CAL switch on the rear panel. When it is low, the microprocessor enters the Calibrate mode. D4-D7 are connected to DIP switch SW2. SW2 selects various optional calibration procedures. Its functions are described in Section VI.

5.3.3.4 POWER-ON RESET

The microprocessor is reset each time power is applied by R2, C3 and D1. When power is first applied, C3 is fully discharged. It holds IC4-37 low for the time it takes for C3 to charge through R2, about one-half second. D1 rapidly discharges C3 when power is removed.

5.3.4 DC REFERENCE GENERATOR

Refer to Figure 9-11. The DC reference generator consists of an 8-bit and a 12-bit digital-to-analog converter (DAC). The outputs of the two DACs are added together. The 8-bit DAC is weighted more heavily; it is the most significant DAC. The 12-bit converter is eight bits less significant than the 8-bit DAC. Therefore, it is weighted so that its contribution to the output voltage is one 1/256 that of the most significant DAC.

5.3.4.1 8-BIT DIGITAL-TO-ANALOG CONVERTER

Both DACs function identically. The 8-bit DAC is described in detail. It consists of IC102, a 74LS374 octal flip-flop, and IC106 and IC107, both 74LS85 4-bit magnitude comparators. A clock, IC113, counters IC108 and IC109 provide a continuously cycling 8-bit number to the "A" inputs of IC106 and IC107. This constantly changing number is compared to the binary number which has been placed in IC102 by the microprocessor.

The magnitude comparators will indicate that the cycling number is greater than the fixed number part of the time, and less the rest of the time. In fact, the output of the comparator will be a stream of pulses whose duty cycle will exactly reflect the percentage relationship between the number in IC102 and a full-scale value of 11111111. For example, if the number in IC102 is 1000000, which is half of full-scale, the output at IC107-7 will have a 50% duty cycle. If the number in IC102 is 0100000, which is one quarter of full scale, the output at IC107-7 will have a 25% duty cycle.

The stream of pulses from the 8-bit DAC, if simply filtered to remove the clock frequency, would yield a DC voltage accurately divisible into 256 equal increments. While the increments are quite accurate, further steps must be taken to assure that the absolute magnitude of the DC voltage is accurate.

5.3.4.2 12-BIT DIGITAL-TO-ANALOG CONVERTER

The 12-bit DAC consists of IC100, IC101, IC3, IC4 and IC5. It uses the same clock and counter as the 8-bit DAC, but requires all 12 of the counter outputs. Its theory of operation is identical to that of the 8-bit DAC.

5.4.3.3 DC SWITCHING AND SUMMING

The pulse outputs of the DACs are resynchronized to the clock in IC110. This removes any jitter caused by ripple in the counters. The resynchronized pulses are used to drive IC111, a DG303A MOSFET switch with two independent sections, wired in a single pole double throw configuration. Each section switches between the output of IC112, a 6.95 volt reference, and ground. The outputs of the switches are summed in a weighted summing network consisting of R101, R102, R103, R104 and RV102.

NOTE

> The voltage at this point will be approximately zero, because it is connected to the input of operational amplifier IC115. Instead of a voltage, the reference is now a current flowing into a low impedance.

5.3.4.4 LOW PASS FILTER

IC114 and its associated components form a three-pole low-pass filter. It eliminates the pulses entirely, leaving only the average DC. The output of the DC reference is connected to the error detector, where it is summed with the output of the AC-DC converter.

5.3.5 ERROR COMPARATOR

The error comparator is shown in Figure 9-11 at the bottom left. Its purpose is to match the voltage from IC202-6 and the instrument output voltage, as represented by the output of the AC-DC converter, to the reference voltage from the DC reference generator. It consists of IC115, IC212, IC213 and IC215 and their associated components. IC115 is a non-inverting amplifier with a gain of 40. Its input is the Dc from the DC reference generator less the 'feedback' from the AC-DC convertor. RV101 is used to adjust IC115 for zero offset.

5.3.5.1 SUMMING SAMPLE AND HOLD

The remaining components of the error comparator comprise the summing sample and hold. The amplified 'error' from IC115 is connected to the inverting input of IC214, a unity-gain instrumentation amplifier. The output of IC214 goes through the normally open section of IC213, a DG303A MOSFET switch, to C218 and the input of IC212.

IC212 is connected as a unity-gain voltage follower. Its output is sent through the normally closed section of IC213 to the non-inverting input of IC214, and to C219. The output of IC212 is the error output of the error comparator. It is connected to the AC sinewave generator, and through D206 and D207 to the microprocessor's error flag input, IC17-6 in Figure 9-10.

To analyze this circuit, assume that R212 is disconnected from the output of IC212. IC215, a 555 timer, is running with a period of approximately 300 milliseconds, switching IC213 at that rate. The correction voltage (IC212 output) minus the amplified error voltage (IC115 output) appears at the output of IC214. When IC213 is enabled, this voltage charges C218. That same voltage will appear at the output of IC212. Thus, the output of IC212 is modified every 300 milliseconds until there is no error between the DC reference generator and the AC-DC convertor.

Now assume that the loop is closed by connecting R212 to the output of IC212. R212 is connected to IC201, a DAC whose output is a current. Any voltage present at the output of IC212 will add to or subtract from the DAC output current, providing an adequate range of adjustment. The overall result is that the error comparator adjusts the approximate voltage from IC201 to precisely the value produced by the DC reference generator.

One additional consideration is the timing of corrections to the error voltage. Any adjustment which takes place will take time to make its way to the output of the instrument. For this reason, the error comparator has unique timing characteristics. The initial error charges C218, then, 300 milliseconds later, C219. After the next switch cycle of IC213, if the error has not yet been corrected, it remains on C218, and the new error is added to it. Thus, C218 accumulates errors until they are corrected.

5.3.6 AC SINE WAVE GENERATOR

The AC sinewave generator is shown at the right side of Figure 9-11. It consists of IC201 through IC211 and their associated components. IC201 is a type 1408-6 low precision, 8-bit DAC. Its input is the most significant eight bits from the microprocessor. It uses the 6.95 volt reference, adjusted by RV201, for its reference input. RV201 is adjusted to closely approximate the correct voltage, so as to minimize the amount of correction required of the error comparator.

The output of IC201 is a current, so output amplifier IC202 is required to produce a voltage. The output of IC202 is connected to the reference input of precision DAC IC206. Note that through the combined effects of IC201 and the error comparator, the voltage at IC202-6 has been set precisely to the voltage required to generate the AC voltage displayed on the front panel.

IC206 is a type AD566 12-bit DAC. Since its output is a current, it requires output amplifier IC207. Its 12-bit inputs are driven by IC203, IC204 and IC205, which are 7621 ROMs. Phase data from the frequency generator, Figure 9-13, comes into the phase bus, where it selects a sequence of addresses in the ROMs. Programmed into those addresses are 12-bit values for each selected phase of a sinewave.

The output of IC207 is a stair-step approximation of a sinewave whose amplitude depends on the DC voltage applied to IC206-5 and -7, whose shape depends on the values in the ROMs for each phase, and whose frequency depends on the rate at which phase data is being supplied to the phase bus by the frequency generator. In order to avoid generating spurious values while the phase data is changing, the tristate outputs of the ROMs are disabled by TR201 during data transitions.

IC208, IC209 and IC210 comprise a tunable 2-pole low-pass filter. Its purpose is to eliminate high order harmonics which are present in a sinewave generated as a stair-step. The values of capacitors in the filter are selected by the frequency range data, FR0 and FR1, from the display and keyboard section. The values of the resistors are selected by data from the most significant digit of the frequency display.

5.3.7 FREQUENCY GENERATOR

The frequency generator is shown on Figure 9-13. IC4b is one half a 74LS629 dual voltage-controlled oscillator. It is connected as a 12.8 MHz crystal-controlled oscillator. Its output drives IC9-10, a NAND gate, whose output drives pin 9 of IC11, IC12 and IC13. IC9-9, the other input of the NAND gate, is driven by another oscillator, IC4a. Pins 6 and 11 of IC4 enable the individual sections. They are connected so that only one section is enabled at any time. When disabled, the outputs of IC4 go to a high state.

IC3, an MC4044 phase comparator, is driven by the external frequency input on the rear panel via amplifier IC1 and optical isolator IC2. The external frequency, on pin 1, is compared with the instrument output frequency taken from the most significant bit of the phase data, on pin 3. IC4a is a free-running oscillator whose control voltage input, pin 2, is driven by IC3, through filter C6, R10 and C12.

IC11, IC12 and IC13 are 74167 decade rate multipliers. Their 4-bit inputs are driven from the buffered data bus through latches IC7 and IC8. The rate multipliers divide the incoming 12.8 MHz by an amount determined by the frequency data placed on the buffered data bus by the microprocessor. If the most significant decade is set to 10, IC9-1 and -2 decode the selection code and the frequency is switched by IC15 directly to 12.8 MHz instead of the rate multipliers.

IC19 and IC20 perform further frequency division. IC19, a 74LS90 decade counter, divides the frequency by five. IC20 is a dual decade counter. The output of IC19, IC20a or IC20b is selected by IC18, a 74LS138 3-line to 8-line decoder/demultiplexer. The selector inputs of

IC18 are driven from the frequency range data from the display and keyboard section. In the 100 KHz range, IC18-6 is selected; for 10 KHz, IC18-5; for 1000 Hz, IC18-4; for 100 Hz, IC18-3.

The output of IC18 is normally 256 times the desired frequency. It drives the clock inputs of IC16 and IC17, a pair of 74LS163A synchronous binary counters. Their 8-bit output constitutes the phase data bus which drives the ROMs in the AC sinewave generator. The output of IC18 also drives IC22 pins 1 and 9 to supply sync to other parts of the instrument. IC22-8 drives TR201 in the AC sinewave generator; IC22-6 drives the rear panel connector.

At frequencies above 50 KHz, the output of IC18 is 128 times the desired frequency. Only seven bits of counter output are used, and the line marked "HF" is set high. The HF line has two functions. On the frequency board, it switches the source of instrument output frequency, used by the phase lock circuit, IC3, from bit 7 to bit 6. On the AC sinewave generator, it appears as an extra address line. When it is high, the generator uses a different sinewave table.

5.3.8 OUTPUT AMPLIFIERS

The output amplifiers are shown in Figures 9-15, 9-4 and 9-17. At the top of Figure 9-15 is a block diagram of the entire output amplifier system. Details of the 10-volt and 100-volt amplifiers are shown at the bottom of Figure 9-15. The 100-volt amplifier requires another detail, shown at the left of Figure 9-4. The 10-volt and 100-volt amplifiers are both high-gain amplifiers whose gains in the circuit are determined entirely by the external resistors shown in the block diagram.

The incoming sinewave at C1 is 10 volts peak-to-peak at full scale. The 90.9k resistor, R1, reduces the signal to one-third of this value. The 10-volt amplifier directly drives the output on the 0.12V, 1.2V, and 12V ranges. It is composed of IC1, an operational amplifier, which has high open-loop gain, TR1, a level shifter, and power FETs TR2 and TR3, which together form a class A output stage. Its gain is either 1 or 10, depending on the state of relay RLA. R9 and R10 are an output attenuator, providing a gain of 0.1 as well. The gain of 0.1 is used for the 0.12-volt range; the gain of 1, for the 1.2-volt range; and the gain of 10, for the 12-volt range. The output of the instrument is switched between amplifiers and the gains are set by relays RLA, RLB, RLC and RLD.

The 100-volt amplifier is shown at the lower right of Figure 9-15. IC2 is an operational amplifier with high open-loop gain, with DC offset adjustable by RV2. The output stage of the 100-volt amplifier is shown in Figure 9-4. It is similar in design to that of the 10-volt amplifier, with extra FETs sharing the voltage swing. TR4 serves as a level translator. The gain of the output stage is 28, set by R28 and R29. The overall gain of the 100-volt amplifier is 10, set by R20 and R22.

The 100-volt amplifier drives the output terminals on the 120-volt range, connected by RLB and RLC. On the 1200-volt range, the 100-volt amplifier drives T1, a 1-to-10 step-up transformer, which in turn drives the output terminals.

IC3 is connected as a rectifier, monitoring the virtual grounds at the inputs of the 10-volt and 100-volt amplifiers through R2 and R21. These points remain at zero potential unless the gain of one of the amplifiers falls below the value set by the feedbakc loop. This can occur only if the output swing is greater than the amplifier can deliver, due either to excessive output voltage, or an undervoltage power supply. If a voltage appears at IC21-2, it is rectified and presented as a DC to IC4, which outputs a high level through D9 to the overload input on the microprocessor board.

The relays which switch the output amplifier configuration for various output ranges and which set the gain within the AC-DC converter are shown in Figure 9-17. They are driven by IC201 and IC202, both 74LS374 octal flip-flops, which in turn are driven by the microprocessor through the floating data bus.

5.3.9 AC-DC CONVERTER

The AC-DC converter is shown in Figure 9-16, which is labeled Feedback. Its purpose is to convert an AC input from the sense terminals (or directly from the output in Local Sense) to DC for use in the error comparator. It consists of a variable-gain prescaler, IC101 and IC102 and their associated components, and converter circuits, consisting of the rest of the circuit.

RLK selects internal or external sensing. In both cases, the AC-DC converter is measuring the difference between the high level input and the low level input. The high level input passes through an attenuator comprising R100, R103, R104 and R106, with high frequency compensation capacitors C100 and C105, to the inverting input of IC101.

The low level input passes through a second attenuator consisting of R101, R105 and R107 to the inverting input of IC102. Its output is summed through R110 with the high level input at IC101-2. Frequency compensation is provided by C121. The gain of IC102 is set by R106 alone or in parallel with R108, as selected by RLH. The combination of relay positions required for each of the output ranges is shown in Table 5-3.

For a switch setting of 1 in the most significant digit, followed by all zeroes, these attenuation settings result in an output at IC101-6 of 1.0 volt on all ranges except on the 0.12-volt range, where it is 0.1 volt.

The remaining circuitry has switch selectable gains of 3.2 and 32, as determined by RLJ. RLJ2 sets the gain by selecting feedback resisters R133 or R129 and 133 in series. In order to preserve high frequency response at a gain of 32, the open-loop gain of the amplifier is increased by RLJ1.

TR100 is an FET source follower input stage. Its output drives IC104, which in turn drives the current output stage, TR102-TR105. Feedforward through C108 provides high frequency drive to the output stage which is independent of the characteristics of IC104. The output of the current stage is fed back through R120 to TR100, holding the DC output voltage at approximately zero volts.

Table 5-3. Relay Positions Versus Range.

RANGE	RLE&RLL	RLF&RLG	RLH	RLJ
0.12	X	X		X
1.2	X	X		
12.	X	X	X	
120.	X		X	
1200.			X	

Schottky diodes D100 and D101 rectify the AC signal, providing separate positive and negative outputs. These are filtered at R130-C119 and R131-C120 and fed to the inputs of dual amplifier IC104, which serves as a unity-gain buffer. The outputs of IC104 drive IC103, a unity-gain instrument amplifier. The voltage at the output of IC103 is approximately 3.2 volts for an output of 1.0 volt at IC101-6 (or 0.1 volt at IC101-6 in the 0.12-volt range of the instrument).

The output voltage of IC103 is fed through R132 to a summing point in the error comparator, where it opposes the current from the DC reference generator.

The AC-DC converter also drives a comparator circuit comprised of IC106 and its associated components. The comparator provides a square wave output coincident to the output sinewave waveform. The square wave is sent to the frequency generator to provide phase shift correction information to a 2705 phase generator.

5.3.10 IEEE-488 INTERFACE

The IEEE-488 interface enables a remote controller to enter commands into the Model 2703 when both are interconnected to a general purpose interface bus (GPIB) meeting the requirements of IEEE Standard 488 (1978). Programming for control of the Model 2703 in such a system is completely covered in Section IV. The schematic of the IEEE-488 interface is shown in Figure 9-5.

Commands and data from the remote controller are processed internally by the interface device, IC2. IC3 and IC4 are bi-directional transceivers. The direction of data flow through IC3 and IC4 is controlled by IC2. IC1 is also a bi-directional transceiver. However, it is a tri-state device that is controlled by the microprocessor. A byte of data received from the controller is processed by IC2 which

then generates an interrupt (IRQ) to the microprocessor. The microprocessor responds by enabling IC1, addressing IC2 and causing it to write the data to the internal data bus through IC1.

When the 2703 has data for the controller, principally SRQ messages, it addresses IC2, enables IC1 and writes the data into IC2. IC2 then processes the data and transmits it to the controller.

The processes are almost entirely internal to IC2 and the microprocessor system. The microprocessor operations are under software control which is not detailed in this manual. Insight into operation of IC2 can be obtained by perusal of the device manufacturer's publications.

SECTION VI - CALIBRATION AND MAINTENANCE - 2703

6.1 MANUAL CALIBRATION

6.1.1 GENERAL

It is recommended that calibration be performed with the 2703 fully assembled (i.e., with covers in place) and after power has been applied for a minimum of one hour to achieve temperature stabilization. Calibration may be accomplished manually, using the front panel controls, or automatically through the IEEE-488 interface. Whether calibration is to be accomplished manually or automatically, the keyswitch on the rear panel should be set to CALIBRATE to initiate the auto-calibration cycle.

6.1.2 INTERNAL CALIBRATION SELECTION SWITCH

The internal calibration switch is found on the MPU and Reference board on the left side of the instrument, viewed from the front. The functions of the five switches, listing from the top, are as follows:

1. Leave OFF for 2703, ON for 2705.

2. ON for short calibration. OFF for long calibration.

3. Leave OFF at all times.

4. Leave OFF, ON to select 1V on .12V range.

5. Leave OFF at all times.

6.1.3 RANGE OFFSET ADJUSTMENT

Adjustment of the offset in voltage value between ranges requires the following equipment:

5 1/2 digit AC DVM with linearity better than 0.01% on the 1-volt range at 1 KHz (e.g., Guideline 9676A)

NOTE: Most RMS DVMs do not have sufficient linearity.

1. Connect the input of the DVM to the output of the 2703. Select Internal Sense on the 2703. Select the 1.2-volt range and set the output to 1.0 volt. Measure the voltage on the 1-volt range of the DVM, and note the value.

2. Keeping the 2703 on the 1.2-volt range, set the voltage to 0.01 volt on the display. Without changing ranges on the DVM, note the reading.

3. Adjust RV101, at the left rear of the 2703, so the DVM reads 1/100th of the initial reading $\pm$0.00002 volt.

4. Repeat steps 1 through 3 until correct.

CAUTION

UNLESS ONE OR MORE COMPONENTS HAVE BEEN CHANGED, NO OTHER INTERNAL ADJUSTMENTS SHOULD BE MADE.

6.1.4 LOCAL AUTOMATIC CALIBRATION

The following equipment is required for the automatic calibration procedure:

DC Voltage Standard, 1-1000 volts at better than 0.005% accuracy with four-terminal capability (Valhalla 2701B or equivalent).

Thermal-transfer standard with better than 0.01% accuracy to 10 KHz, and better than 0.03% accuracy to 100 KHz, to 100 volts (Fluke 540B or equivalent).

1. To enter the calibration mode, turn the key in the rear panel switch to the CALIBRATE position. The 2703 will now display CAL in the voltage display for approximately one second, then commences the automatic calibration sequence.

2. The 2703 will automatically select the required voltage and frequency ranges to be calibrated. At each change of voltage range, the 2703 will select STANDBY and it will be necessary to select OPERATE to obtain an output. Adjust the voltage using the Voltage Selector switches to the exact value required, then press the STANDBY/OPERATE switch. The next step will now be selected. Repeat the process of adjusting the voltage, then pressing the STANDBY/OPERATE button, until the sequence is completed. The short and extended calibration sequences are shown in Tables 6-1 and 6-2.

NOTE

The short calibration sequence is sufficient for most purposes. The extended sequence should be used every two years or when required.

6.2 IEEE-488 CALIBRATION

6.2.1 PERIODIC CALIBRATION

Calibration via the IEEE-488 interface follows a simular procedure to manual calibration. The major difference is the method by which the next calibration point is selected by sending "C" over the bus to the unit.

Thus, the sequence is as follows:

1. First point, following a range change.

a. Unit is in standby. Send unit a voltage (e.g., 1.0 for 1 volt calibration).

b. Send voltages until output is correct.

c. Send "C". Unit automatically steps onto the next step.

2. Frequency response calibration.

   As step 1, but unit starts in OPERATE, thus step C is unnecessary.

Table 6-1. Short Calibration Sequence.

RANGE	VOLTAGE	FREQUENCY
1.2V	1.00000	1000 Hz
0.12V	0.100000 or 1.00000	1000 Hz
12V	10.0000	1000 Hz
120V	100.000	1000 Hz
1200V	1000.00	10 Hz

Table 6-2. Extended Calibration Sequence.

RANGE	VOLTAGE	FREQUENCY
0.12V	0.100000 or 1.00000	10,20,30,40,50,60,70,80,90,100 KHz,10 Hz
1.2V	1.00000	10,20,30,40,50,60,70,80,90,100 KHz,10 Hz
12V	10.0000	10,20,30,40,50,60,70,80,90,100 KHz,10 Hz
120V	100.000	10,20,30,40,50,60,70,80,90,100 KHz,10 Hz
1200V	1000.00	100,200,300,400,500,600,700,800,900,1000 Hz

The user should also note that voltages should be sent as though the output was 0.1 volt even though the output is 1.0 volt.

6.3 CALIBRATION FOLLOWING COMPONENT REPLACEMENT

Following replacement of any component, or removal of the voltage output PCB, the full automatic calibration routine must be peformed. If the component replaced was in the AC-DC converter section, the

following adjustments should be made before the automatic calibration is performed.

1. Adjust C101 on the voltage output PCB for a 1 KHz to 100 KHz difference of <0.5% at 1 volt output on the 1.2-volt range.

2. Adjust C102 on the voltage output PCB for a 1 KHz to 100 KHz difference of <0.5% at 10 volts output on the 12-volt range.

3. Adjust C100 on the voltage output PCB for a 1 KHz to 100 KHz difference of <0.5% at 100 volts output on the 120-volt range.

4. Repeat steps 1 through 3 until no further adjustments are required.

6.4 TROUBLESHOOTING

It is not possible to anticipate all failure modes of the integrated circuit devices and other components of the Model 2703. Therefore, the servicing technician should be familiar with the contents of Section V -- Theory of Operation. Knowledge of circuit operation is a requisite for efficient servicing of the 2703. As a servicing aid the troubleshooting chart, Table 6-3, lists a number of fault symptoms and possible sources. If the exhibited symptom is not listed or a check of the sources listed does not locate the defective component, it will be necessary to employ normal troubleshooting procedures.

Table 6-3. Troubleshooting Chart.

SYMPTOM	POSSIBLE TROUBLE SOURCE
No display	Check fuse, Power Supply Board and Microprocessor.
No output	Check 10-volt amplifier, frequency board and DC reference amplifier. Check sinewave generator.
Highly distorted output	Check 100-volt amplifier. Check 10-volt amplifier output stage. Check sinewave generator ROM's.
Output ramps to above required output, then unit selects standby	If in Remote Sense, check wiring to SENSE terminals or check AC-DC converter and ERROR amplifier.
Output inaccurate	Check Error amplifier and AC-DC converter.

SECTION VII - AVAILABLE OPTIONS

7.1 GENERAL

This section describes several options available from Valhalla Scientific to increase the utility of the Model 2703.

7.2 OPTION TL-2

This is the Talk/Listen interface described in Section IV.

7.3 OPTION R6

This is required to rack mount the 2703.

7.4 OPTION BBC

Option BBC is a dual shielded cable equipped with banana plugs. It is 48 inches long with dual banana plugs on each end.

7.5 OPTION C

Option C is a pair of cables terminated with alligator clips at one end and a dual banana plug at the other end.

7.6 OPTION R03

This is supplied as standard.

7.7 OPTIONS GP-1 AND GP-2

Options GP-1 and GP-2 are IEEE-488 (GPIB) cables of one meter and two meters in length, respectively.

7.8 OPTION 2704

This precision 100:1 divider attaches to the front-panel terminals to provide very low noise low-level (0-1 volt) output voltages. Provides 1 mV, 10 mV and 1 volt ranges from 10 Hz to 10 KHz with an overall specification of $\pm$0.07% of output $\pm$0.01% of full-scale $\pm$1 uV.

SECTION VIII - 2705 OPERATION

8.1 GENERAL

The basic operation of the Model 2705 is similar to that of the Model 2703. The operation of the Model 2703 should be reviewed to aid the operator in the use of the Model 2705.

8.2 MANUAL OPERATION

8.2.1 GENERAL

A description of major functions of the front panel controls and indicators is provided in the following paragraphs.

Each time power is applied, all bars and LEDs on the front panel are illuminated. Approximately one second later both displays will greet the operator with "HELLO". After another second, the instrument will commence operation in the STANDBY mode in the 120 millivolt range set to 100 millivolts at a phase of zero degrees.

8.2.2 CONNECTIONS

The Model 2705 is connected to the Model 2703 via a 15 conductor ribbon cable provided with the 2705. The cable is plugged into mating connectors on the back of the 2703 and 2705. The 2703 connector is labeled "TO SLAVE UNIT". The 2705 has two connectors. The cable from the 2703 should be plugged into the connector labeled "TO MASTER UNIT". When multiple 2705s are connected, e.g., 3 phase calibration; the second slave unit is connected to the first slave unit. The first slave unit functioning as a master unit to the second slave unit. Figure 8.1 illustrates these connections. Note: When multiple slave units are connected in this manner the phase specifications are cumulative. To avoid the additive phase specifications alternate connections may be used. Special cabling is required which is not supplied with the 2705. Please consult the customer service department for availability and pricing for this cable.

CAUTION

> The 2705 has rear panel terminals wired in parallel with those on the front panel. The user should be careful when making connections that other leads are not already connected to the other terminal cluster.

8.2.2.1 FOUR WIRE CONNECTIONS

When the Model 2705 is used as a four wire instrument, the voltage leads and the sense leads of the instrument should be connected together at the load. Care should be taken to insure that the leads

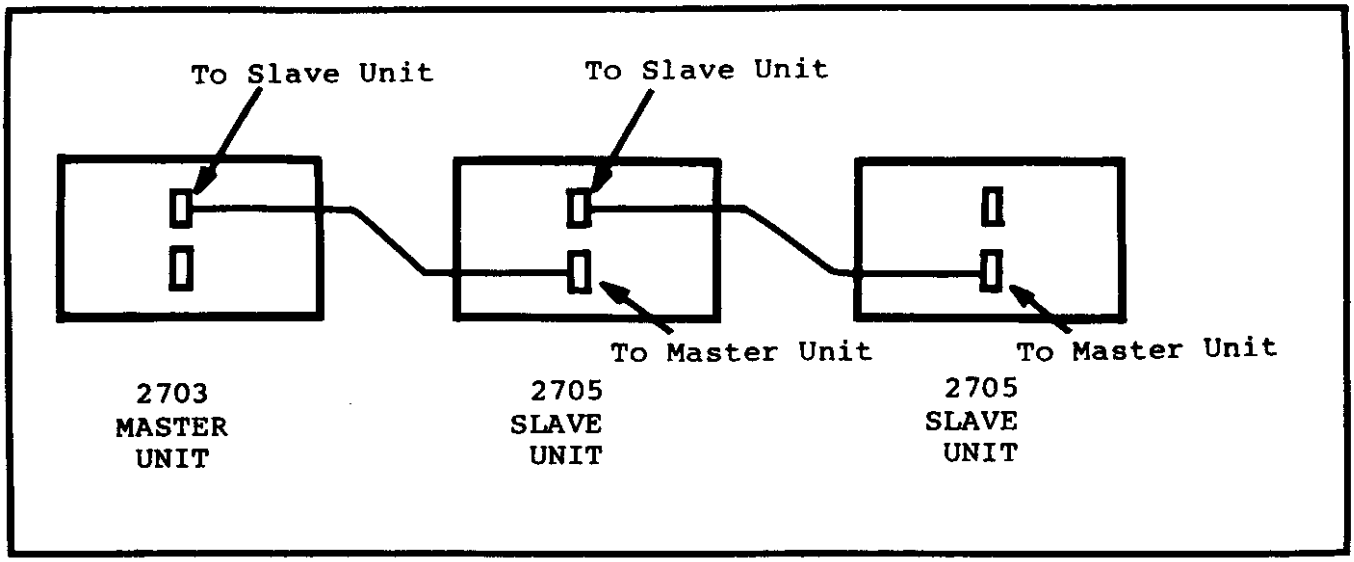


Figure 8.1 2703/2705 INTERCONNECTIONS

connected together at the load are of the same polarity. The REMOTE SENSE pushbutton should be used to select Remote Sense as indicated by the LED on the pushbutton being illuminated. It should be noted that should the voltage at the sense terminals be more than 20% of range from that expected, the unit automatically selects STANDBY.

8.2.2.2 TWO WIRE CONNECTIONS

When the instrument is used with only two wires, the REMOTE SENSE pushbutton should be used to deselect Remote Sense, as indicated by the LED on the pushbutton being extinguished. Sensing is then done internally, and the sense terminals are open-circuited.

8.2.3 STANDBY/OPERATE PUSHBUTTON

The STANDBY/OPERATE pushbutton is an alternate action pushbutton switch. The output in standby is zero, in operate it is the voltage and phase indicated in the front panel display.

8.2.4 SETTING OUTPUT VOLTAGE AND PHASE

To set the voltage output of the Model 2705, select the desired full-scale voltage range using the range pushbuttons. A LED on the key for the chosen range will remain illuminated. Set the desired voltage using the five rotary switches below the VOLTAGE DISPLAY. To output a voltage at a specific frequency and phase, the 2705 must have correct information from the Model 2703. The only way the 2703 can send this information to the 2705 is when the 2703 is in the OPERATE mode and has at least 1/10 of full scale output dialed up. The 2705 output amplitude is also limited to a minimum of 1/10 of full scale.

The desired PHASE of the 2705 output is set using the four rotary switches below the PHASE LEAD display. As the numbers are entered, they appear in the display. The PHASE ANGLE PRESET pushbuttons allow the operator to rapidly select 0°, 90°, 120°, 180°, or 240° for cardinal point phase checks. The 2705 has some frequency limitations. The maximum operating frequency of the 2705 is 10KHz. Any time the 100 KHz frequency range is selected on the 2703 the 2705 automatically selects the standby. Caution: Do not select the 1200 volt range of the 2705 when the 2703 frequency is above 1 KHz.

8.2.5 LIGHTNING BOLT

To the left of the output terminals is a display that looks like a lightning bolt. When it is illumiated, it indicates that the instrument output voltage is 30 volts or greater, or that the 1200 volt range has been selected.

8.2.6 REMOTE SENSE PUSHBUTTON

This pushbutton alternately selects and deselects the Remote Sense (four-wire) mode. The LED indicator in the key is illuminated when Remote Sensing is selected. When the LED is extinguished, sensing is done internally and the sense terminals are open-circuited.

8.2.7 LOCAL PUSHBUTTON

This pushbutton allows the operator to take control of the instrument if it is in IEEE Remote and if Local Lockout has not been selected. (see Section IV of the manual).

8.2.8 EXTERNAL SYNC FAULT LED

This LED indicates that a fault has occurred in the interconnecting cable between the Model 2703 and the Model 2705.

8.3 IEEE-488 INTERFACE OPERATION

The complete IEEE operation is not described here. Please refer to Section IV of the manual for a detailed explanation of IEEE operation.

8.3.1 SIMPLE COMMANDS AND EXAMPLES

The Phase command; relevant to the model 2705 is described in the following paragraph. Only commands regarding phase will be described here. All other commands for amplitude and mode are the same as for the 2703.

8.3.1.1 Setting a Phase Value -- To set the 2705 to a numeric phase value, all that is required is to send the letter "P" followed by the numeric value in degrees. The overall delimiter is any invalid character within numeric entry. The following is an example of such a program using the HP 85:

```
1Ø REMOTE 71Ø
2Ø INPUT A
3Ø OUTPUT 71Ø; "P" & VAL $[A]
4Ø GO TO 2Ø
```

This program will prompt the user for an input of the desired phase value on the HP85 and send this value to the 2705 (it is assumed that the 2705 is turned on, connected to a 2703, and operate selected).

8.4 CALIBRATION

8.4.1 GENERAL

It is recommended that calibration be performed with the 2705 fully assembled (e.g., covers in place) and after power has been applied for a minimum of one hour to achieve temperature stabilization. The keyswitch on the rear panel must be set to the CALIBRATE position to initiate the calibation procedure.

8.4.2 CALIBRATION

To calibrate the 2705 the following steps must be performed in order:

1. Connect the 2705 to the 2703 with the 15 conductor ribbon cable.

2. Select the 2703 1 volt range, 100 Hz frequency range, OPERATE mode with 1 volt output at 100 Hz.

3. Turn the 2705 keyswitch to the CALIBRATE position and follow the calibration sequence as it is displayed. Adjust the voltage, using the Voltage Selector switches, to the exact value required, then press the STANDBY/OPERATE switch. The next step will then be selected. Repeat the process of adjusting the voltage then press the STANDBY/OPERATE switch until the five calibration steps have been completed.

4. Return the keyswitch to the OPERATE position.

5. Verify the high frequency calibration of the 2705. Select 10 KHz on the 2703 and check the frequency response of the .1V, 1V, 10V, and 100V ranges. Select 1 KHz on the 2703 and verify the frequency response of the 1000V range.

8.4.3 CALIBRATION FOLLOWING COMPONENT REPLACEMENT

Following replacement of any component, or removal of the voltage output PCB the following calibration must be performed.

A. RANGE OFFSET ADJUSTMENT

Note, the following equipment is required to perform the Range Offset Adjustment: 5 1/2 digit AC DVM with linearity better than 0.01% on the 1V range at 1 KHz (e.g., GUILDLINE 9576A).

1. Connect the DVM to the output of the 2705. Set the 2703 to 1 KHz and select the 1.2 volt range and set the output to 1.0 volt. Measure the voltage, using the 1 volt range of the DVM, and note the value.

2. Keeping the 2705 on the 1.2 volt range, set the voltage to 0.01 volt on the display. Without changing ranges on the DVM, note the reading.

3. Adjust RV101 (at the left rear of the 2705) so the DVM reads 1/100th of the initial reading $\pm$0.00002 volt.

4. Repeat steps 1 to 3 until correct.

B. FREQUENCY RESPONSE ADJUSTMENT

These adjustments should be made prior to the automatic calibration sequence.

1. Adjust C101, on the voltage output PCB, for minimal difference in output at 1 volt on the 1.2 volt range between 100 Hz and 10 KHz.

2. Adjust C102, on the voltage output PCB, for minimal difference in output at 10 volts output on the 12 volt range between 100 HZ and 10 KHz.

3. Adjust C100, on the voltage output PCB, for minimal difference in output at 100 volts output on the 120 volt range between 100 Hz and 10 KHz.

4. Repeat steps 1-3 until no further adjustments are required.

8.5 THEORY OF OPERATION

8.5.1 GENERAL

This section of the manual describes the theory of operation of the Model 2705. The 2705 is identical in operation to the 2703 with the exception of the Phase Generator PCB. This PCB replaces the Frequency Generator PCB of the 2703.

The Model 2703 and 2705 generate their sinewave outputs digitally. An eight bit counter provides phase data to the sinewave generator in the 2703. Clocking and synchronization signals from the 2703 frequency generator PCB are sent to the 2705 via the 15 way cable. An eight bit counter on the phase generator PCB provides phase data to the sinewave generator in the 2705. Because the counter on the phase generator is synchronized with the counter on the frequency generator the sinewave output of the 2705 will be synchronized with the sinewave output of the 2703.

If the counter in the Phase Generator is delayed, in time, from the frequency generator counter the 2705 sinewave output will be phase shifted from the 2703 output. Generating this time delay is what the Phase Generator does. At this point, the sinewave outputs of the 2703 and 2705 are synchronized by their digital generation. The sinewaves are phase shifted by the analog amplifiers in their signal paths. The phase shifts are defined by the analog circuit design and are variable by component values. To minimize these analog phase shift errors, correction circuits in the Phase Generator correct the phase shift to a minimum and constant error.

8.5.2 DETAILED CIRCUIT DESCRIPTION

The synchronizing signals from the master unit are isolated from the 2705 by opto-couplers IC1-IC4. The MS FREQ 1,2,4,8, FR0 DC and FR1 signals are buffered by IC8 and sent to the active filter in the 2705 sinewave generator. These signals also go to the 2705 output connector "TO SLAVE UNIT" to drive another 2705. These six signal lines tell the 2705 what frequency range to use. The CABLE line is an interlock signal that is normally low. If the interconnect cable is disconnected the CABLE signal goes low informing the microprocessor that the cable is faulty. The eight bit data bus from the microprocessor is latched by IC20 and IC21 to provide phase data to the phase generator. The phase data is loaded into the first phase correction counter chain IC22-24 by the LOAD SLAVE signal. The phase data is modified by the counter chain. The counter chain subtracts the amount of 2705 analog signal path phase shift from the phase data. At the end of this calculation the LATCH SLAVE signal stores the result in latches IC28

and IC29. The phase data is then loaded into the second counter chain IC30-32 by the LOAD MASTER signal. This counter chain adds the amount of 2703 analog signal path phase shift to the phase data. At the end of this calculation the LATCH MASTER signal stores the phase shift data in latches IC33 and 34. The data is then loaded into the output counter chain IC36-38. IC36 and IC37 generate the phase data that is applied to the 2705 sinewave generator. The two phase correction counter chains' function is to hold the phase shift error between the master and slave units constant. The LOAD SLAVE, LATCH SLAVE, LOAD MASTER, and the LATCH MASTER signals are derived from the STNC and CLOCK signals from the 2703. The SLAVE ENABLE signal is generated from the phase comparator IC35. The comparator provides a pulse width output proportional to the phase shift between the Ø7 signal, synchronized with the digital sinewave, and the phase signal which is a square-wave coincident with the analog sinewave. This signal is generated by a comparator in the 2705 feedback system. A similar phase comparator in the 2703 provides the PHASE signal which is used to generate the MASTER ENABLE signal in a similar fashion.

SECTION IX - USEFUL HINTS

9.1 GENERAL

This section contains a number of useful hints that will assist the user in obtaining maximum utility from the Model 2703. As experience with the Model 2703 in the field is accumulated, this section will be expanded in later issues of this manual.

9.1.1 OPERATION AT LOW OUTPUT LEVELS

It may be noticed that there is some high frequency noise present on the output wave form at very low-levels. Whilst the effect when used with either average or RMS sensing DVM's are covered in the specification, when the 2703 is used with wide-band AC voltmeters it is recommended that the 2703 be operated with its output LO grounded. In extreme cases (voltmeters with <20 MHz bandwidth) a 50 ohm termination at the voltmeter should be used.

For very low-level applications the 2704 precision 100:1 divider should be used (remembering the 50 ohm output impedance).

SECTION X - DIAGRAMS

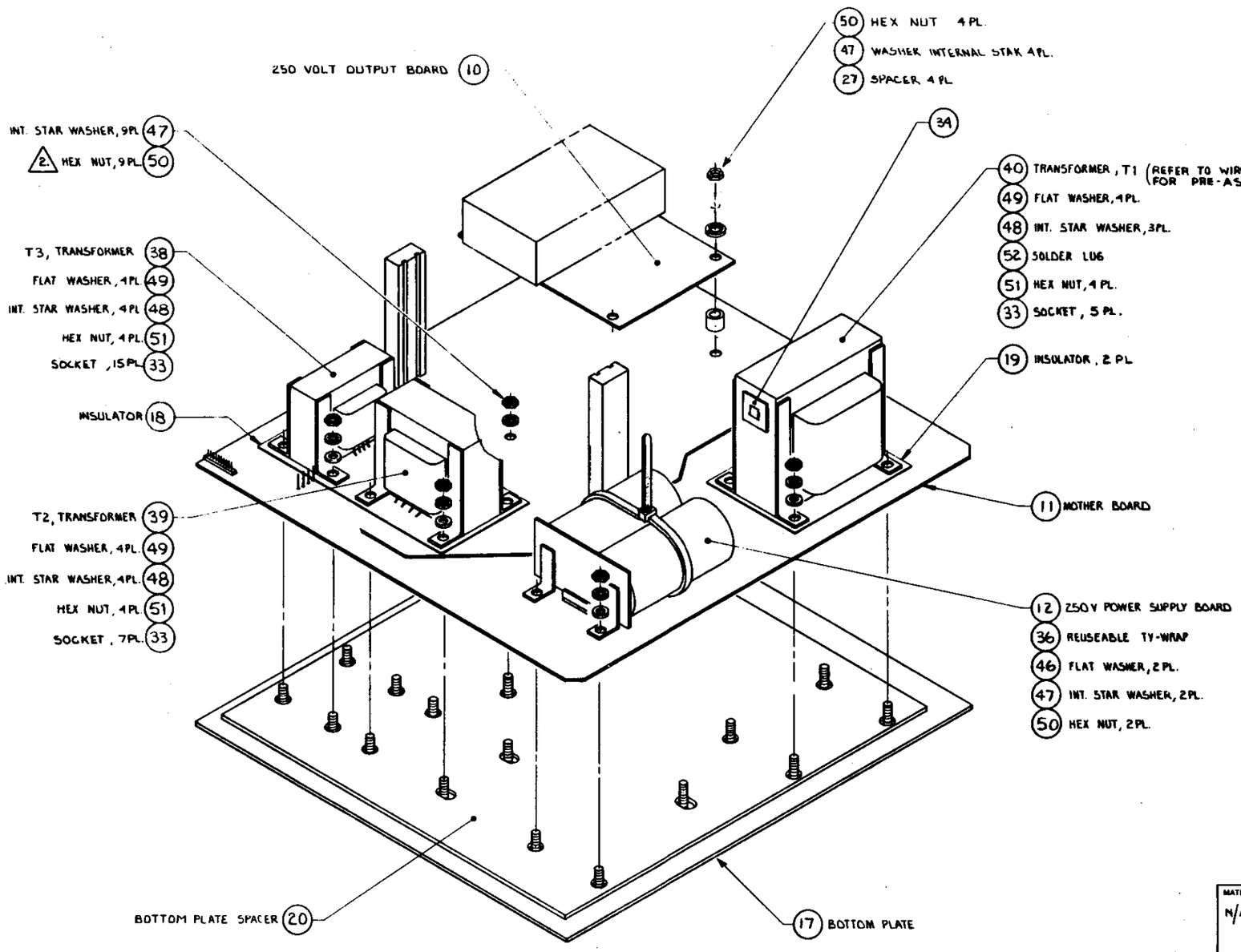
10.1 GENERAL

The illustrations of this section are the schematic, logic and assembly diagrams of the Model 2703. To the extent practical, an assembly diagram faces the appropriate schematic or logic diagram. All diagrams are reductions of factory engineering drawings. Title blocks, and other information not required may have been removed.

NOTES:

1. VISUALLY INSPECT ALL SOLDER CONNECTIONS ON MOTHER BOARD BEFORE ASSEMBLING IT TO THE BOTTOM PLATE.
2. DO NOT TIGHTEN DOWN THE NUTS ON THE TWO STUDS MARKED "GND" (REFER TO THE MOTHER BOARD SILKSCREEN).
3. INSTALL REUSABLE TY-WRAP (ITEM 36) BEFORE MOUNTING MOTHER P.C.B. TO BOTTOM PLATE.
4. ADD C1 (ITEM 25) FROM GND LUG ON T1 TO PIN E13. SEE SHT 5.
5. FOR WIRING INFO ON TRANSFORMERS SEE WTT. 2703-051.

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED



MATERIAL N/A	DRAWN C.R.L. 4/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
	CHECKED RM 4/82		
	APPR.		
FINISH N/A		ASSEMBLY, CHASSIS 2703 / 2705	
	SCALE 1:2	CODE IDENT NO. 83504	SIZE D
	SHEET 4 OF 5	DRAWING NO. 2703-400	REV G

REVISIONS					
ZONE	LTR	DESCRIPTION		DATE	APPROVED
0078	D	SEE ECR	WPW	12-12-83	[illegible]
0251	E	ADDED STAND OFFS (29)	[illegible]	1-9-84	[illegible]
0429	F	CHANGED P/L	[illegible]	4-30-84	[illegible]
628	G	ADDED MODIFIED STANDOFFS	DPM	3-28-85	[illegible]

OPTIONAL RACK EARS 5-10277 4 PLS

SCREW, FLAT-PHIL. 8 PL 832 x 5/8

PLACE TIE BLOCKS IN THE EXTREME CORNERS OF SIDE RAIL.

(15)

(16)

4 PL (22) 5 PL (34)

8 PL (45)

16 PL (41)

(26) 3 PL

(6)

OPTIONAL IEEE CABLE

A2 MPU AND REF. PCB. 2703-602

A3 POWER SUPPLY 2705-603

A3 FPEG GENERATOR 2703-603

(9)

(7) 2703 OR 2705 USE 2705-604

(42) 2 PL

(47) 2 PL

(4) REAR PANEL ASSY

A8 IEEE OPTION 2703-608

AIR FLOW

A10 230 VOLT 2703-610

FROM REAR PANEL

(50)

(8)

A5 VOLTAGE OUTPUT PCB 2703-605

6 PL (30)

(16)

(15)

FRONT PANEL ASSY.

(3)

2 PL (43)

A1 DISPLAY PCB 2703-601

4 PL (14)

12 PL (45)

4 PL (42)

4 PL (29)

A4 MOTHER PCB 2703-611

CHASSIS ASSEMBLY 2703

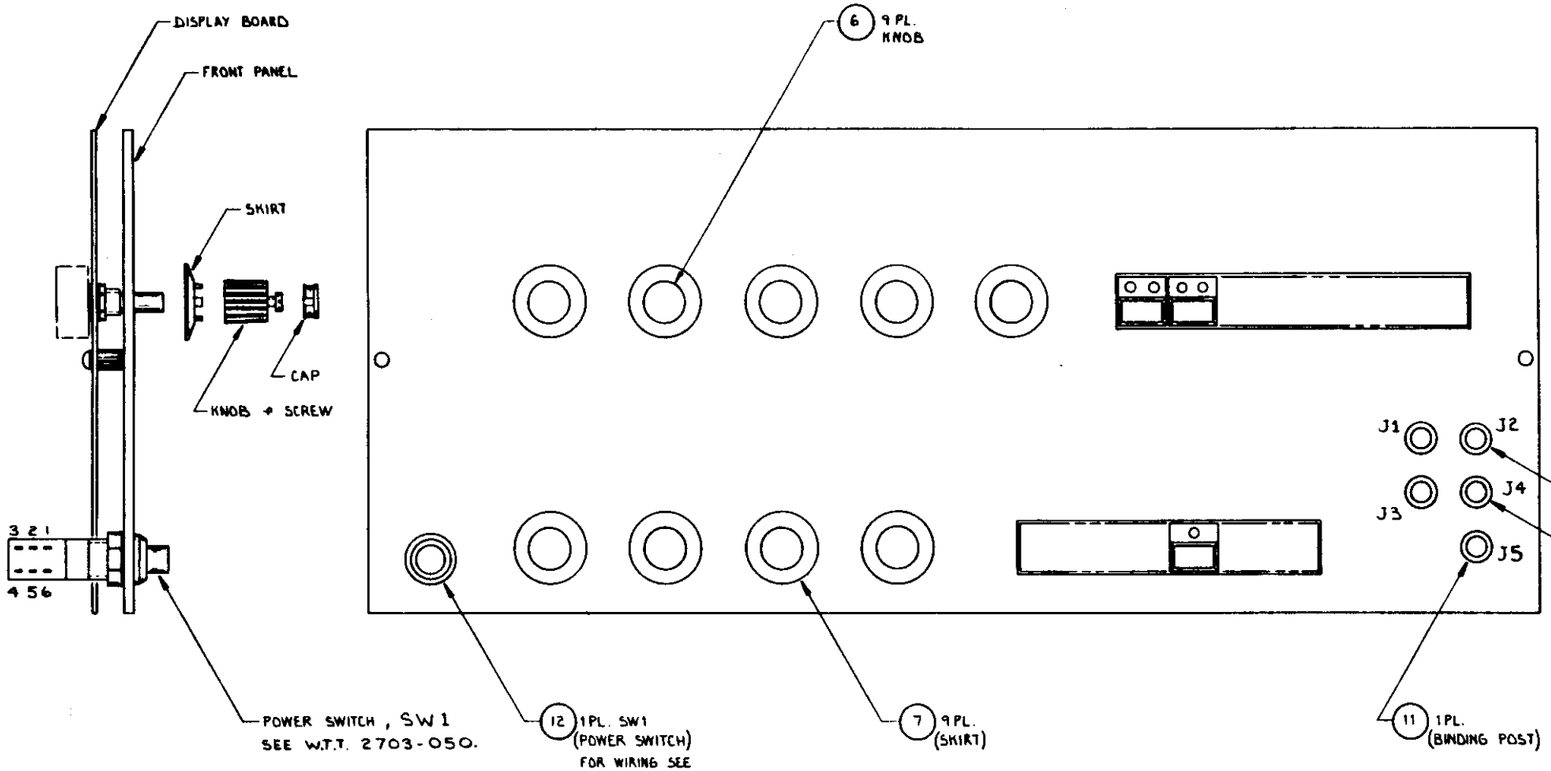
TOP BEZELS, TRANSFORMERS AND COVER OMITTED FOR CLARITY

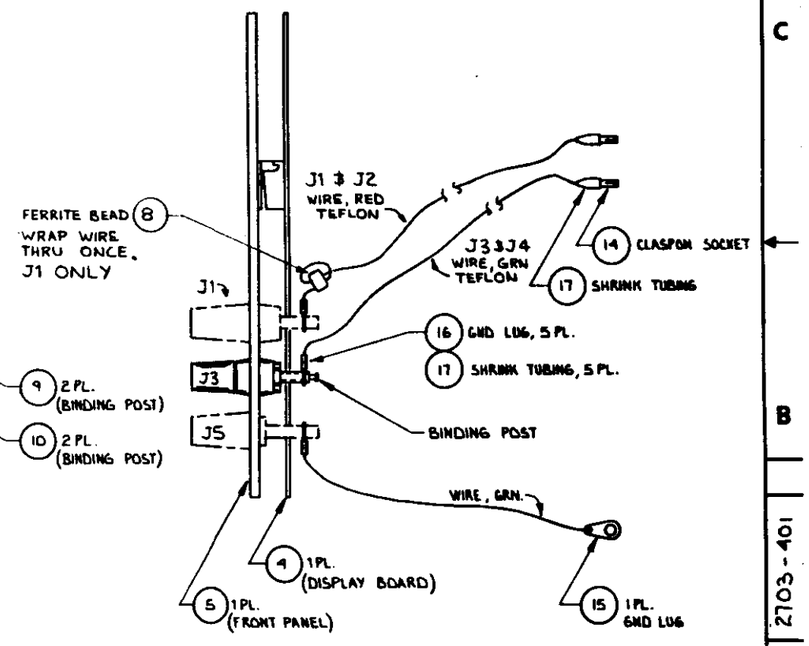
MATERIAL	DRAWN R M	12/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
	CHECKED [illegible]	[illegible]		
	APPR. [illegible]	[illegible]		
FINISH	[boilerplate]		ASSEMBLY, CHASSIS 2703	
SCALE NONE	SHEET 5 OF 6	CODE IDENT NO. 83504	SIZE D	DRAWING NO. 2703-400 REV G

NOTES:

1. FOR PARTS LIST SEE SHT. 1
2. FOR W.T.T. SEE 2703-052.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED C.R.E. 1-7-83		
	B	ECO 50 RM 2-7-83		
	C	P/L CHANGE	4/30/84	RL



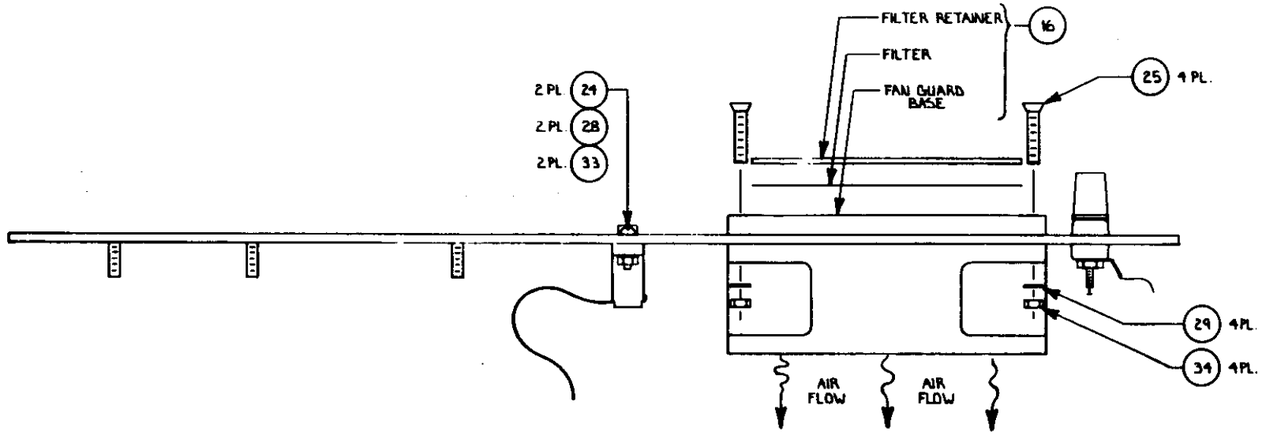


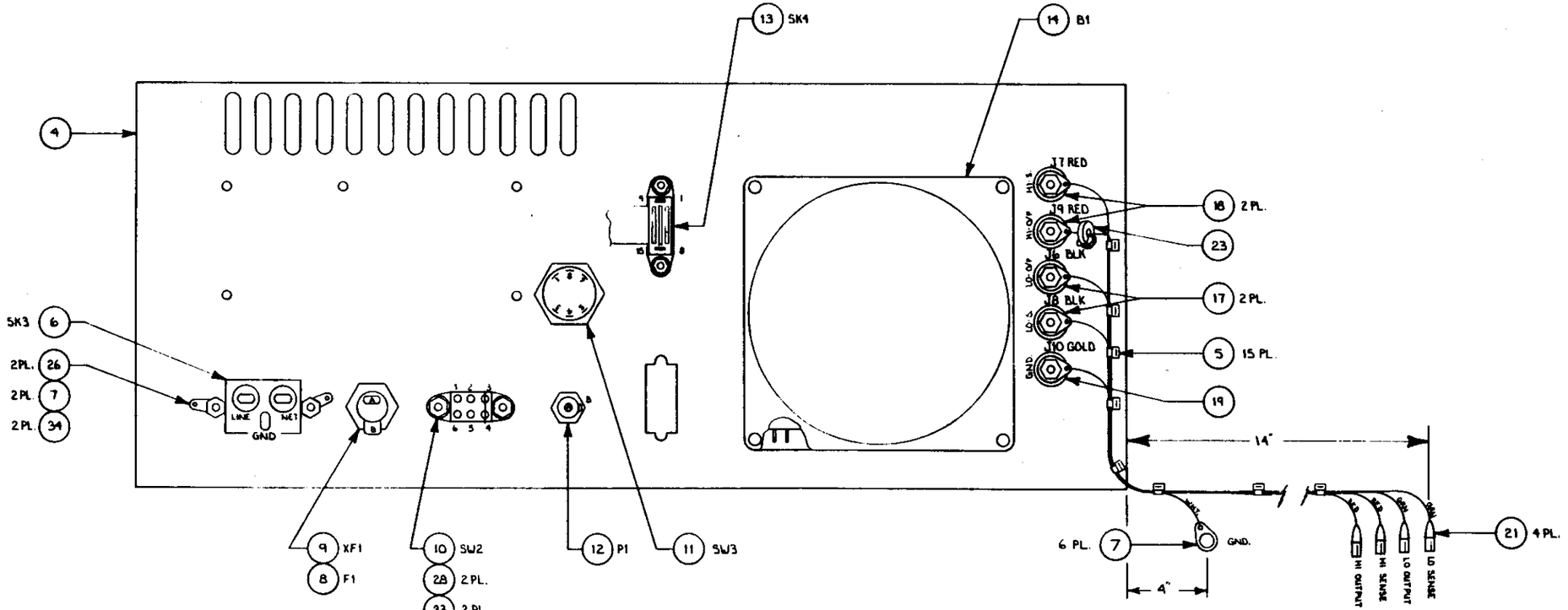
MATERIAL N/A	DRAWN C.R.E. 1/7/83	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA		
	CHECKED			
	APPR.			
FINISH N/A		FRONT PANEL ASSEMBLY		
	SCALE 1:1 SHEET 2 OF 2	CODE IDENT NO. 83504	SIZE D	DRAWING NO. 2703-401 REV C

2703-401

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
628	G	REDRAWN INCORPORATED ECR 1994	3-24-85	PBO





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

DRAWN DPM	3-26-85
CHECKED CBS	3-29-85
APPR PBO	4/2/85
STK NO —	

Valhalla Scientific Inc.
SAN DIEGO, CA

2703 REAR PANEL ASSEMBLY

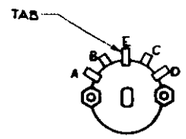
SCALE	CODE IDENT	SIZE	DRAWING NO	REV
1:1	53504	D	2703-402	G

SHEET 3 OF 3

NOTES

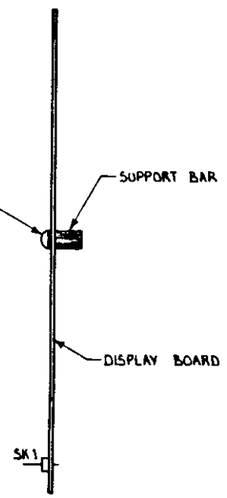
1. FOR PARTS LIST SEE SHTS 1 & 2.
2. FOR SCHEMATIC SEE DWG. NO. 2703-071.

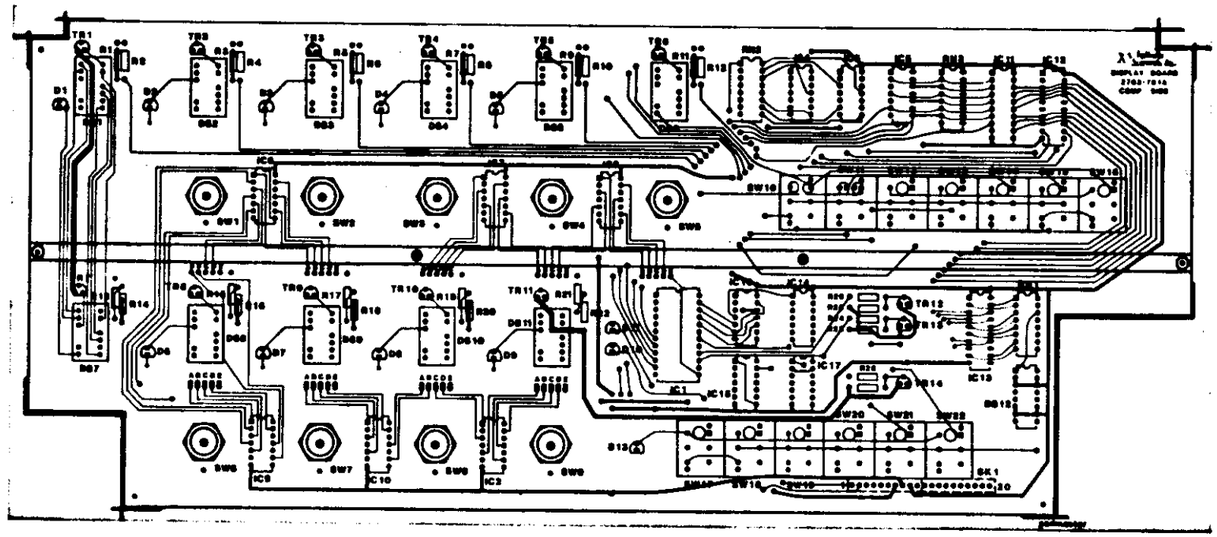
REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
—	A	RELEASED 12-15-82		
0265	E	CHANGE SWITCH WIRING	2-27-84	



WIRE TABS A-E TO CORRESPONDING LETTERS ON DISPLAY BOARD. USING 22 AWG 4 IN. LONG.

SHOWN IS REAR VIEW OF SW1-SW9

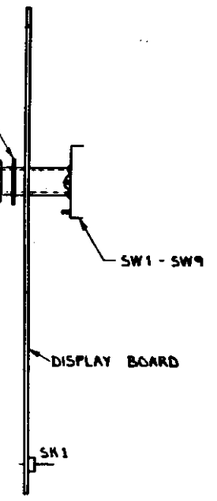




CLAD SHOWN IS FARSIDE

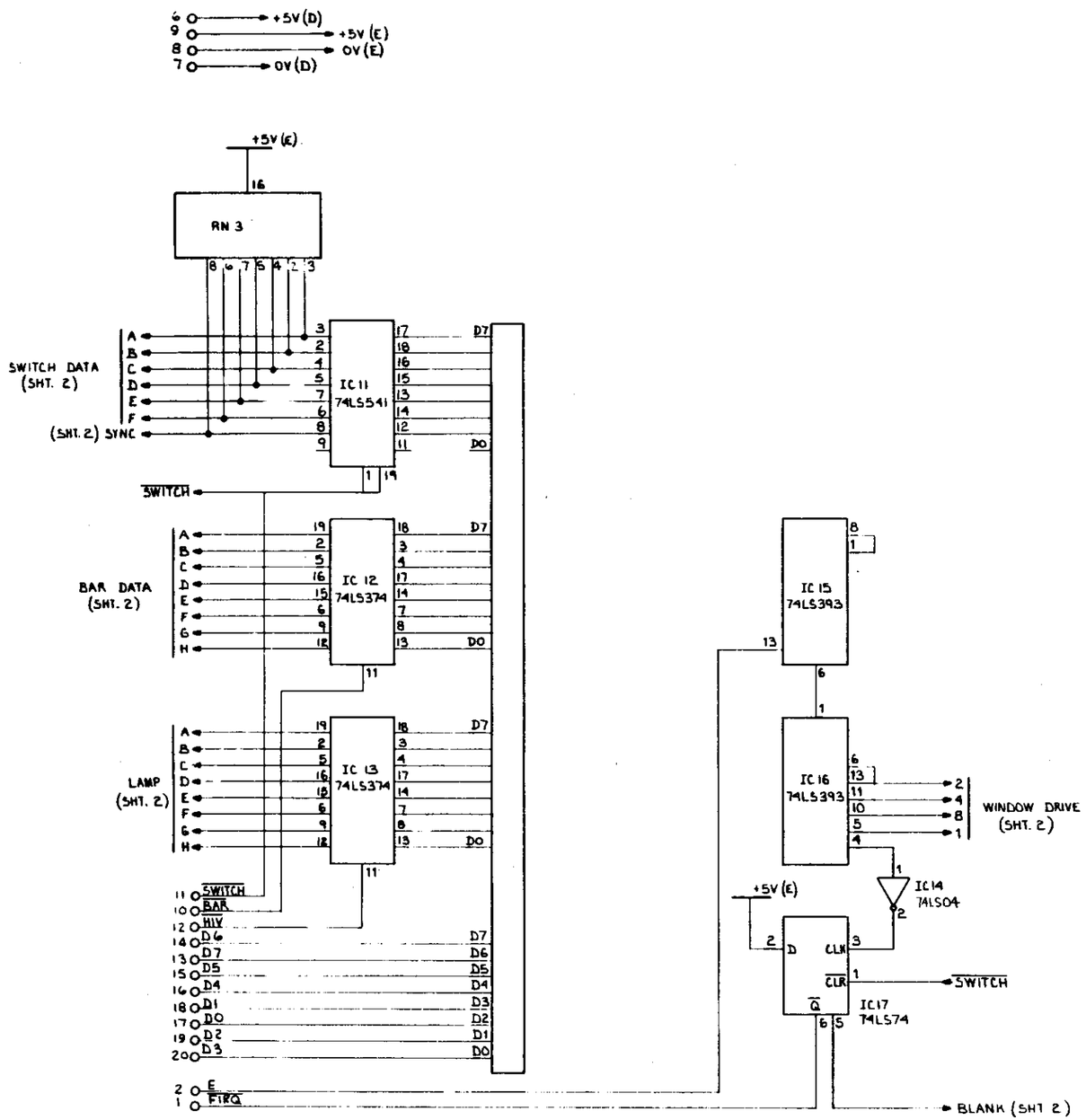
MOUNTING OF SW1-SW9

ASSEMBLE SW1-SW9 TO THE DISPLAY BOARD AS SHOWN.



MATERIAL N/A	DRAWN CRE 12/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
	CHECKED 12/14/82		
	APPR. 12/15/82		
FINISH N/A		ASSY. DWG. DISPLAY BOARD	
	SCALE 1:1	CODE IDENT NO 83504	SIZE D
	SHEET 3 OF 3	DRAWING NO. 2703-601	REV E

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



POWER CONNECTIONS

DEVICE	IC #	0V(D)	0V(E)	+5V(E)
SN74145	1		12	24
SN7438	3 4	7		14
SN7407	2,5,6,7,8,10		7	14
74LS541	11		10	20
74LS374	12,13		1,10	20
	14		7	14
74LS393	15 16		2,7,12	14
74LS74	17		7	4,10-14

NOTES:

1. FOR P.C. BOARD SEE 2703-601.
2. ALL TRANSISTORS ARE MPS-D54.
3. ALL RESISTORS ARE 4.7 K Ω.
4. COMPONENTS MARKED * ARE NOT FITTED IN 2705.
5. " " + " " " " 2709 OR 2711.
6. " " • " " " " 2711.

MATERIAL	DRAWN C.R.C.		Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA
	CHECKED		
	APPR.		
FINISH			2703 SERIES SCHEMATIC - DISPLAY + KEYBOARD
SCALE	CODE IDENT NO. 53504	SIZE D	DRAWING NO. 2703-071 REV A
SHEET 1 OF 2			

2703-071 A

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

(SHT. 1) SYNC

(SHT. 1) BLANK

WINDOW DRIVE (SHT. 1) 1 2 4 8

IC1 74154

+5V (D)

TR1 TR2 TR3 TR4 TR5 TR6

R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11 R12

DS1 DS2 DS3 DS4 DS5 DS6 5082-7650

D1 D2 D3 D4 D5

VOLTAGE (2703/5/11) OR CURRENT SELECTION

+5V (D)

R25 R26 R23 R24 TR12 TR13

KHz Hz Range D10 D11 D12

SWITCH DATA (SHT. 1)

IC5 7407

SW10 SW11 SW12 SW13 SW14 SW15 SW16

LOCAL STANDBY 1mA/0.1V 10mA/1V 100mA/10V 1A/100V 10A/1000V

+5V (D) R27 R28 TR14

D13 UNLOCKED

SW17 SW18 SW19 SW20 SW21 SW22

PHASE LOCK 100Hz 1000Hz 10KHz 100KHz (AC-2703) REMOTE SENSE

LAMP (SHT. 1)

+5V (D)

100Ω RN1

DS12 NLMP-2685

IC9 IC6 IC7 IC8 7407

SW1 SW2 SW3 SW4 SW5

+5V (D)

TR7 TR8 TR9 TR10 TR11

R13 R14 R15 R16 R17 R18 R19 R20 R21 R22

DS7 DS8 DS9 DS10 DS11 5082-7650

D6 D7 D8 D9

7438

IC3 IC4

BAR DATA (SHT 1)

RN2 47Ω

FREQUENCY (2703/7) OR PHASE SHIFT (2705) OR POWER FACTOR (2709/11) SELECTION

IC9 IC10 IC2 7407

SW6 SW7 SW8 SW9

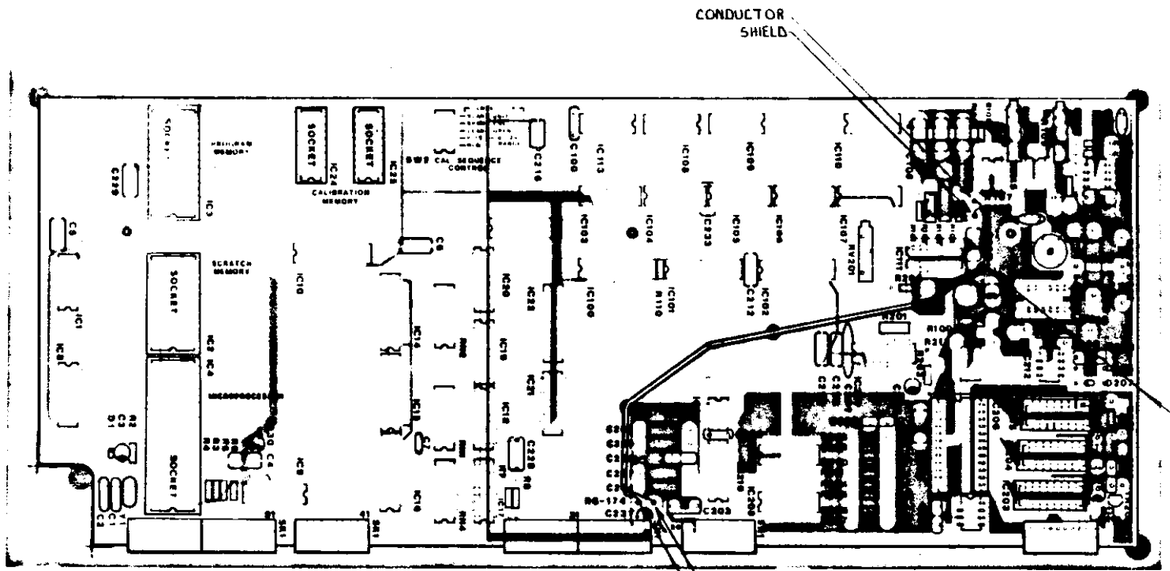
MATERIAL	DRAWN	Valhalla Scientific Inc.	
	CHECKED	SAN DIEGO, CALIFORNIA	
	APPR.	2703 SERIES	
FINISH		SCHEMATIC - DISPLAY + KEYBOARD	
	SCALE —	CODE IDENT NO 83804	SIZE D
	SHEET 2 OF 2	DRAWING NO 2703-071	REV A

2703-071 A

NOTES:

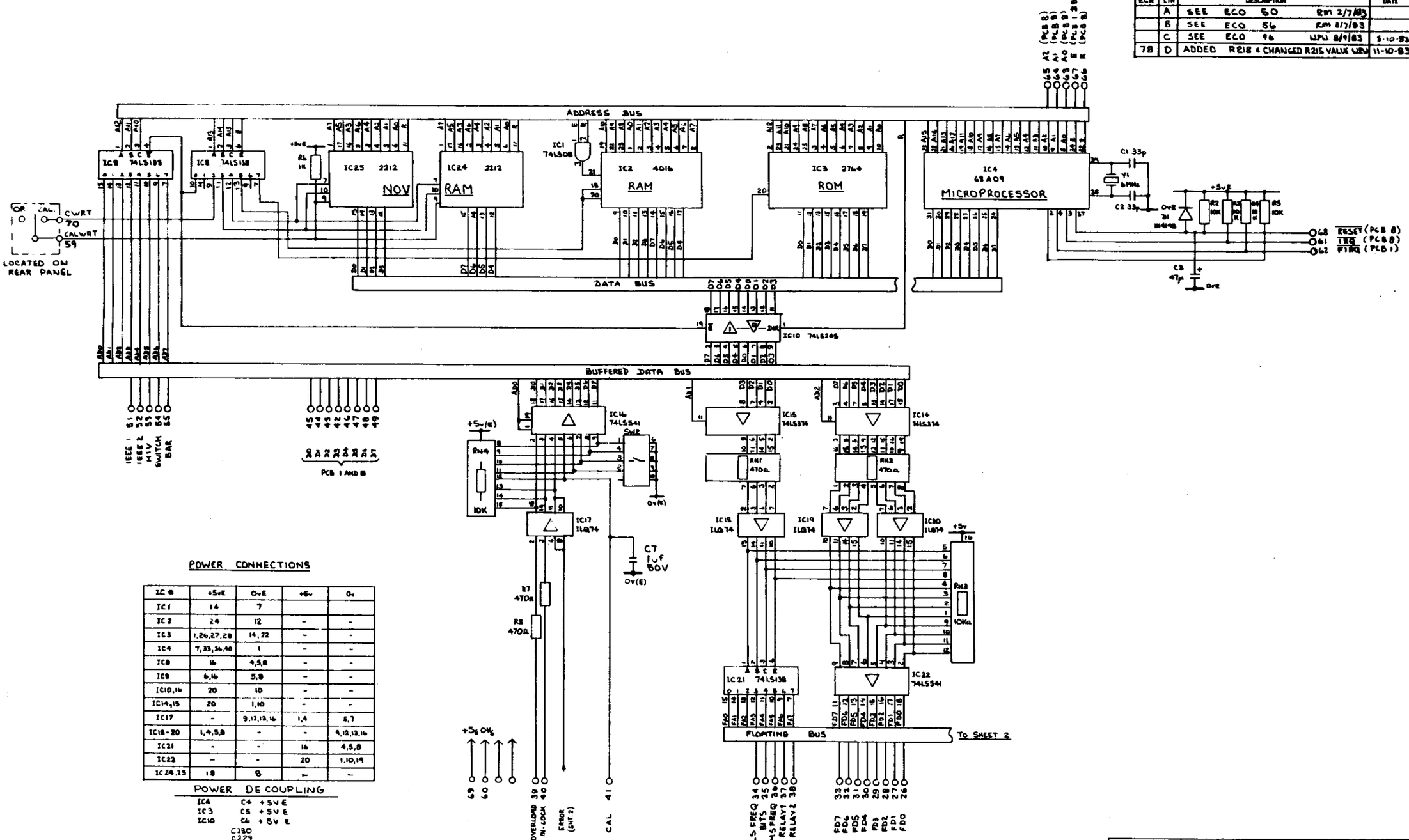
1. FOR PARTS LIST SEE SHT.S 1-5.
2. FOR SCHEMATIC SEE DWG. NO. 2703-072.

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASE 12-16-82		
	B	ECO 56 BM 3-7-83		
0078	C	MODIFIED PARTS LIST WPW	12-7-83	WPW
248	D	CHG. P/L ERROR WPW	12-22-83	RL
0152	E	CHG. P/L ERROR RL	1-3-84	RL
724	F	CORRECT P/L ERROR DPM	6-26-85	WPW



MATERIAL N/A	DRAWN CRE 5/80	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
	CHECKED		
	APPR. WPW 0184		
FINISH N/A		ASSY. DWG. MICROPROCESSOR	
	SCALE 1:1	CODE IDENT NO 53604	SIZE D
	SHEET 6 OF 6	DRAWING NO 2703-602	REV F

REVISIONS				
ECR	LTR	DESCRIPTION	DATE	APPROVED
	A	SEE ECO 60 RM 2/7/83		
	B	SEE ECO 56 RM 8/7/83		
	C	SEE ECO 96 WPJ 8/9/83	8-10-83	RMS
78	D	ADDED R218 & CHANGED R215 VALUE WPJ	11-10-83	RL



POWER CONNECTIONS

	+5vE	OvE	+5v	Ov
IC 9	16	8	–	–
IC 8	16	8	–	–
IC 1	14	7		
IC 2	24	12	–	–
IC 3	1,26,27,28	14, 22	–	–
IC 4	7,33,36,40	1	–	–
IC 8	16	4,5,8	–	–
IC 9	6,16	5,8	–	–
IC 10,16	20	10	–	–
IC 14,15	20	1,10	–	–
IC 17	–	9,12,13,16	1,4	8,7
IC 18-20	1,4,5,8	–	–	9,12,13,16
IC 21	–	–	16	4,5,8
IC 22	–	–	20	1,10,19
IC 24,25	18	8	–	–

POWER DE COUPLING

IC4 C4 +5V E
IC3 C5 +5V E
IC10 C6 +5V E
C230
C229
C233 +5v Ov

MATERIAL	DRAWN PW	8/83	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA		
	CHECKED PW	8/83			
	APPR				
FINISH			MICRO PROCESSOR 2703		
	SCALE		CODE IDENT NO. 53504	SIZE D	DRAWING NO. 2703-072 REV. D
	SHEET 1 OF 2				

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED

FROM SHT. 1

FLOATING BUS

IC100 74LS374 · IC101 74LS374 · IC102 74LS374

IC103 74LS85 · IC104 74LS85 · IC105 74LS85 · IC106 74LS85 · IC107 74LS85

IC108 74LS393 · IC109 74LS393

R110 330 · +5V

C100 1200p · IC113 74LS624

IC110 7474

IC201 1408-6 · R201 2.4K · R202 2.7K · Rv201 1K · SET NOMINAL · C201 +1µ · -15V

C217 10µ · R203 4.99KΩ · R212 39K · IC202 LF356 · 0V(S16)

TR201 2N4401 · C211 300p · D208 IN4148 · R214 100Ω · R213 200Ω · +5V · 1 CLOCK

IC206 AD566 · IC203 7621 LSB · IC204 7621 MID · IC205 7621 MSB · PHASE BUS

C210 47p · IC207 LF356

8 Ø0 · 9 Ø1 · 10 Ø2 · 7 Ø3 · 6 Ø4 · 5 Ø5 · 4 Ø6 · 3 HF · 2 Ø7

0V (S16) 19 · 0V (S16) 23 · FEEDBACK 20 · RG-174 · 0V (S16)

24 → +15V · 22 → +5V · 21 → 0V · 25 → -15V

C102 22µ · C101 22µ · IC114 LF356 · C108 22µ · R104 900K · R103 1M · R101 390K · R102 2K · Rv102 500Ω LINEARITY · IC111 DG303A · R100 2K · IC112 LM399H · C105 47p · 0V(S16) · 0V

R104 220K · R105 220K

IC203 LF13202 · IC209 LF13202 · IC210 LF13509 · IC211 LF356

R208 3.3K · R209 7.8K · R210 18K · R211 20K

C203 1000p · C204 .01µ · C205 1µ · C208 500p · C207 .005µ · C206 .05µ · C202 100p · C209 50p

15 FR0 · 16 FR1 · 14 8 · 13 4 · 12 2 · 11 1 | MS FREQUENCY

17 OUTPUT

OFFSET · Rv101 50K · +15V · -15V · +5V · R109 2MΩ · IC115 OPA105CM · R108 39K · C104 1µ · R107 1K · 0V(S16)

IC214 INA101 BM · C219 1µ · 0V(S16) · IC213 DG303A · C218 1µ · 0V(S16)

D205 FD300 · D208 IN4148 · IC212 LF356 · D206 IN5238 · D207 IN5239 · ERROR (SHT. 1)

R216 390K · R217 100K · C220 1µ · 0V · IC215 555 · R218 330 · D202 IN4148 · D203 IN4148 · C221 .01µ · R215 10K · 0V

POWER CONNECTIONS

IC #	+15V	+5V	0V	-15V
100 - 102	-	20	1,10	-
103, 106	-	3,16	2,1,8	-
104, 105 107	-	16	8	-
108	-	14	2,7,13	-
110	-	1,4,10 13,14	7	-
113	-	9,15,16	1,2,5 7	-
109	-	14	3,7,12	-

IC #	+15V	+5V	0V	-15V
201	-	13	2	3
202, 207, 211 212, 114, 115	7	-	-	4
203 - 205	-	16	8	-
206	-	-	12	6
208, 209	13	-	5	4
210	14	2	15	3
213, 111	14	-	7	8
214	9	-	-	6
215	-	4,8	1	-

POWER DECOUPLING

CAP #	VOLT.	CAP#	VOLT.
C212	+5V 0V	225	+5V 0V
213	+5V 0V	226	+15V 0V(S16)
214	-15V 0V	227	-15V 0V(S16)
215	-15V 0V(S16)	228	+5V 0V
216	+5V		
231	0V +5V	232	+5V 0V

MATERIAL · FINISH · DRAWN · CHECKED · APPR.

Valhalla Scientific Inc.
SAN DIEGO, CALIFORNIA

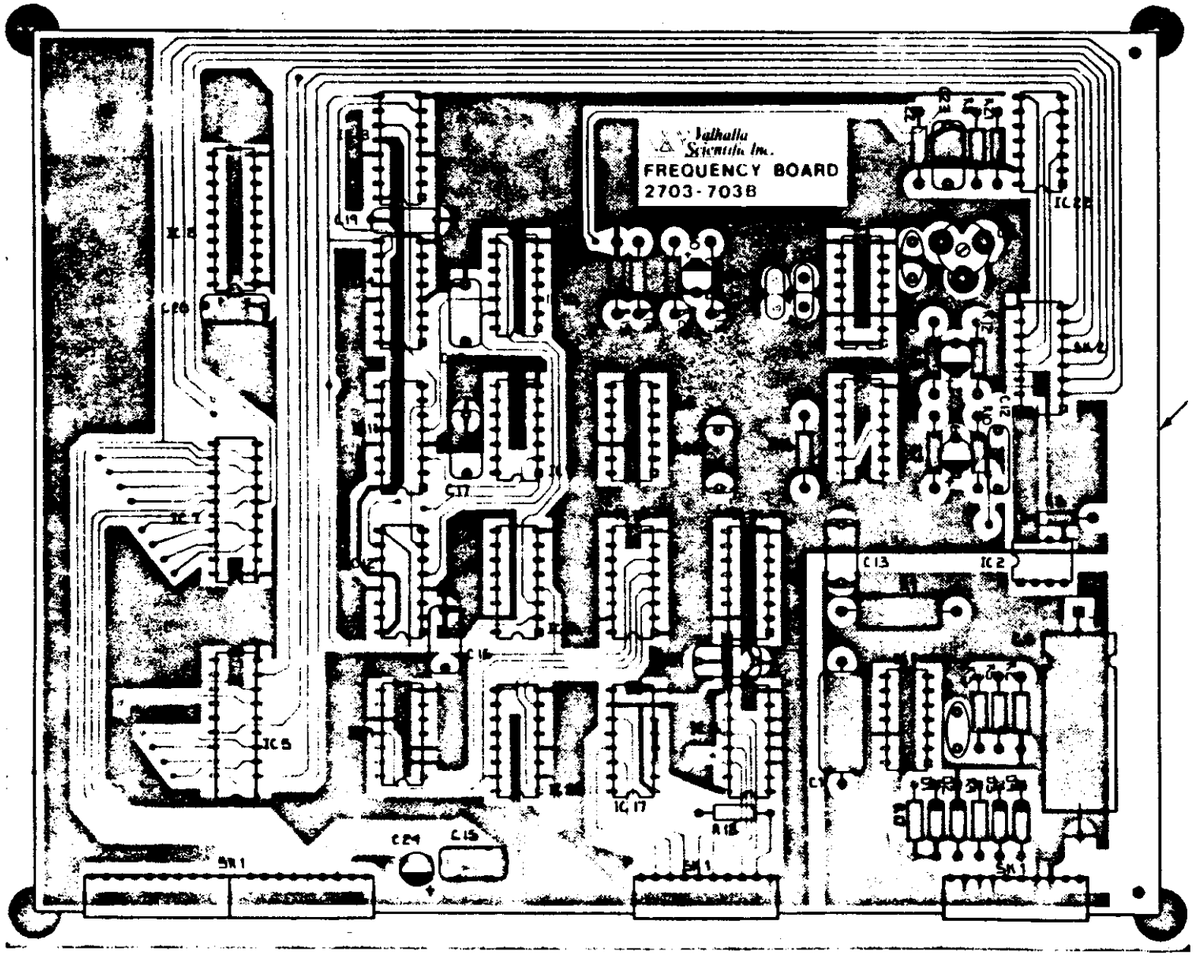
REFERENCE GENERATOR

SCALE · SHEET 2 OF 2 · CODE IDENT NO. 53604 · SIZE D · DRAWING NO. 2703-072 · REV. D

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. FOR PARTS LISTS SEE SHTS 1 + 2.
2. FOR SCHEMATIC SEE DWG. 2703-073.

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED		
56	B	ECO 56 3-8-83		
78	C	ADDED C14 W.P.W.	11-11-83	
189	D	CHANGED VALUE OF Y1 R.	12-13-83	
634	E	CHG. VALUE OF R12 DPM	3-25-85	



P.C. BOARD 2703-703

CLAD SHOWN IS COMPONENT SIDE

DASH NO	QTY REQD	NEXT ASSEMBLY	USED ON
	1	2703-400	2703

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

BREAK ALL SHARP CORNERS AND EDGES. MACH SURFACES 64

MATERIAL

FINISH

DRAWN	C.R.C.	4/27/83
CHECKED	R.M.	4-29-83
APPR	(illegible)	12/12/83
STK NO		

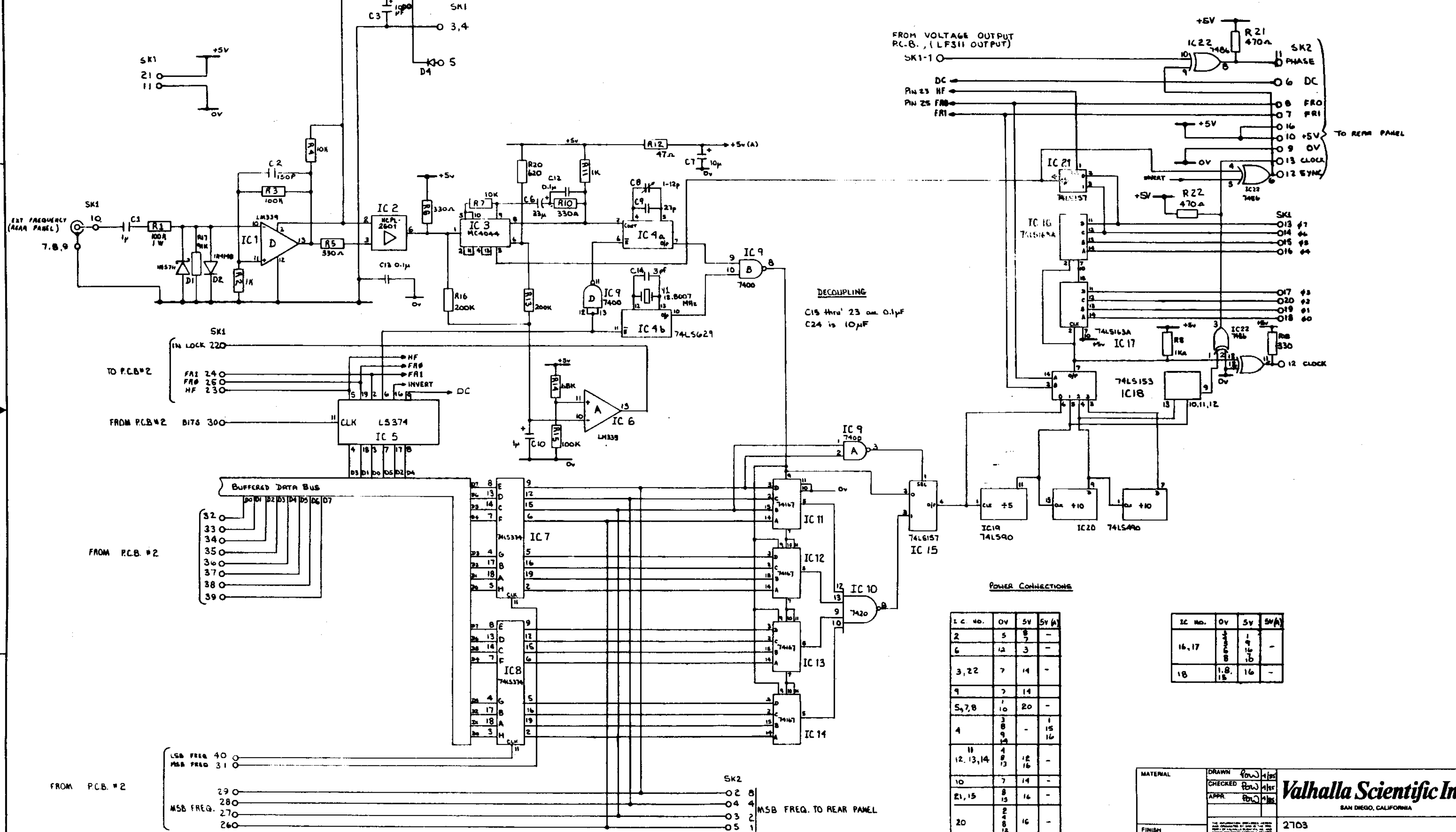
Valhalla Scientific Inc.
SAN DIEGO, CA

ASSY. DWG. FREQUENCY BOARD

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
2:1	53504	D	2703-603	E

SHEET 3 OF 3

REVISIONS				
ECR	LTR	DESCRIPTION	DATE	APPROVED
	B	ECO 56 3/7/83		
78	C	ADDED C14 WPW	11-10-83	
634	D	CHG. R12 TO 47Ω DPM	3-25-85	



POWER CONNECTIONS

I.C. NO.	0V	5V	5V (A)
2	5	8 7	–
6	12	3	–
3, 22	7	14	–
9	7	14	
5, 7, 8	1 10	20	–
4	3 8 9 14	–	1 15 16
11 12, 13, 14	4 8 13	12 16	–
10	7	14	–
21, 15	8 15	16	–
20	2 4 8 13 14	16	–
19	2 3 7 10	5	–

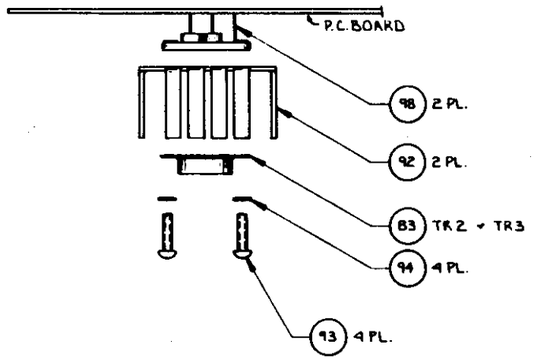
IC NO.	0V	5V	5V(A)
16, 17	2 3 4 6 8	1 9 16 7 10	–
18	1, 8, 15	16	–

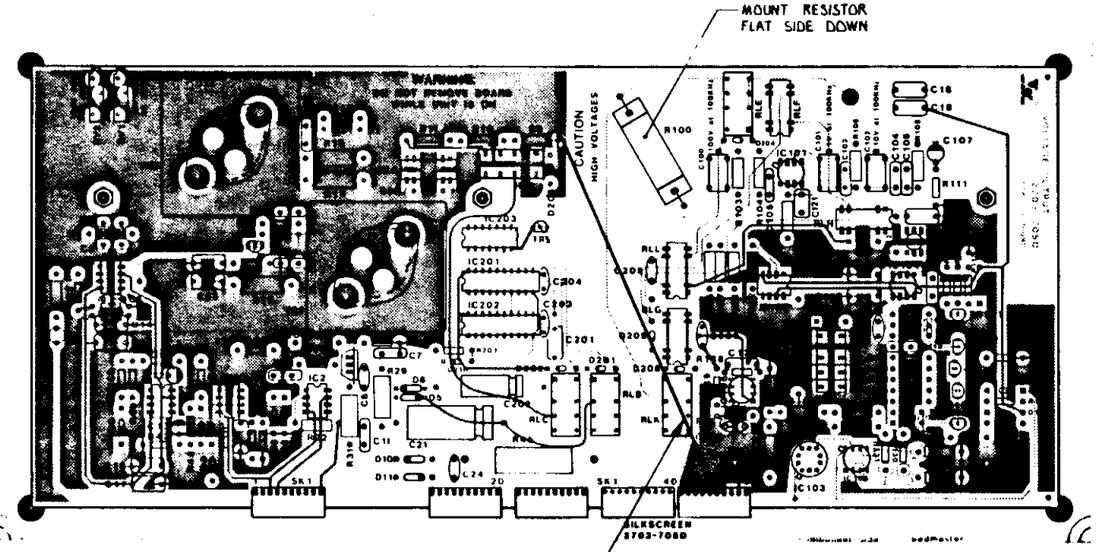
MATERIAL	DRAWN 4/85	**Valhalla Scientific Inc.** SAN DIEGO, CALIFORNIA
	CHECKED 4/85	
	APPR. 4/85	
FINISH		2703 FREQUENCY GENERATOR
	SCALE	CODE IDENT NO. 53504 / SIZE D / DRAWING NO. 2703-073 / REV. D
	SHEET 1 OF 1	

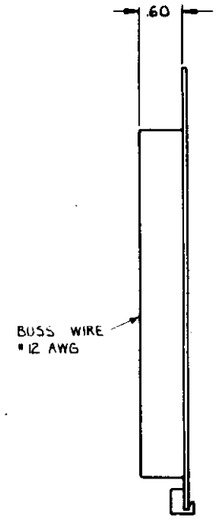
2703-073 B

REVISIONS				
	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED		
	B	SEE ECO 56 RM 3/7/83		
78	C	FIXED PARTS LIST CALL OUT WPW.	11-16-83	
248	D	ADDED STK NO. TO P/L. WPW	12-22-83	
411	E	CHANGED R104 .10Ω TO 33Ω WPW	4-9-84	
413	F	DELETED C80 ROB	4-10-84	
526	G	P/L CHANGE ONLY	8-7-84	
666	H	ADDED C21, D5+D6 DPM	3-29-85	

SHOWN IS MOUNTING OF TR2 + TR3



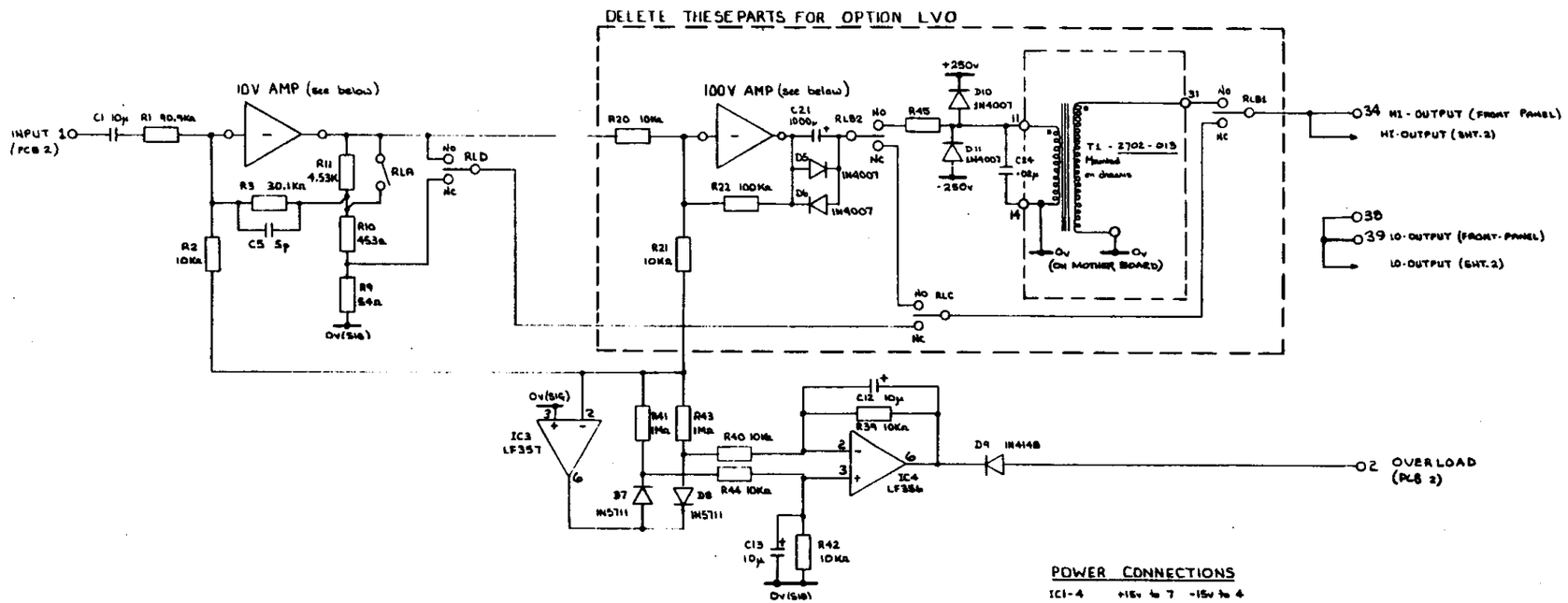




NOTES:
1. FOR SCHEMATIC SEE DWG. #2703-075.
2. FOR PARTS LIST SEE SHTS 1 THRU 5.

MATERIAL N/A	DRAWN CRE	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
FINISH N/A	CHECKED	ASSY. DWG. VOLTAGE OUTPUT BD.	
	SCALE 1:1	CODE IDENT NO 83504	SIZE D
	SHEET 6 OF 6	DRAWING NO. 2703-605	REV. H

REVISIONS				
ECR	LTR	DESCRIPTION	DATE	APPROVED
		REDRAWN	9-26-83	[illegible]
	A	SEE ECO 060 RM 3/7/83		
	B	SEE ECO 056 RM 3/7/83		
78	C	CHANGED C122, C123, R136, R137 VALUES. W.P.W	11-10-83	
	D	REDRAWN RL	1-4-84	RL
666	D1	ADDED D5, D6, C21 C.R.C	3-27-85	[illegible]

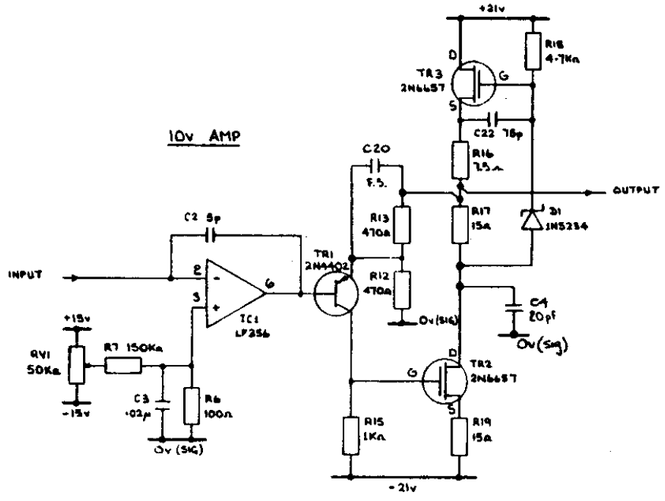


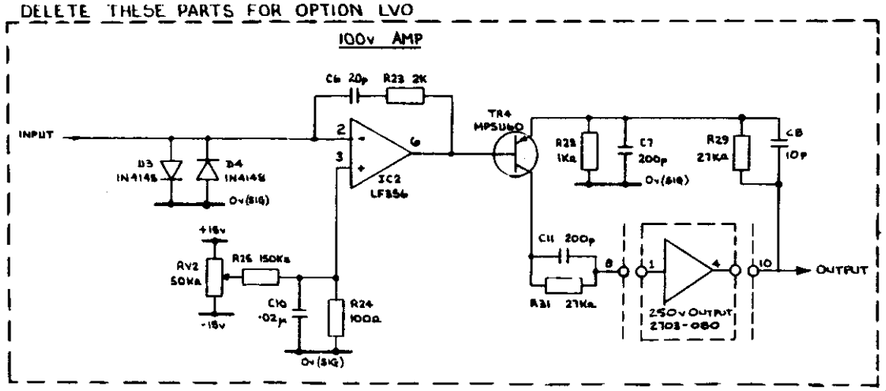
POWER CONNECTIONS

IC1-4 +15v to 7 -15v to 4

POWER DECOUPLING

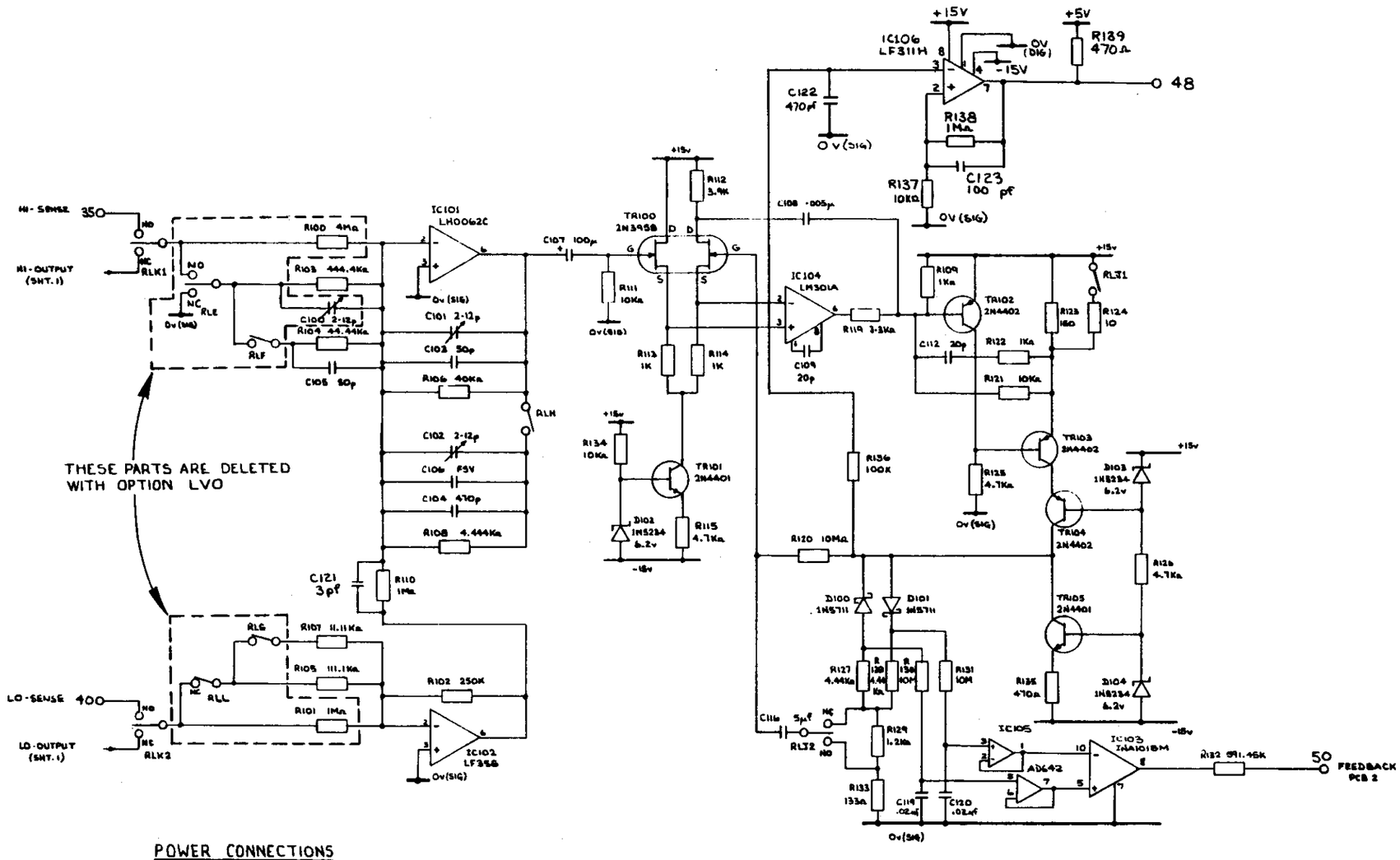
IC1	C14 (+15v)	C15 (-15v)
IC4	C16 (+15v)	C17 (-15v)
TR3	C26 (+21v)	
R19	C26 (-21v)	





MATERIAL	DRAWN PMJ 9/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA			
	CHECKED				
	APPR.				
FINISH		VOLTAGE OUTPUT - 2703			
	SCALE	CODE IDENT NO. 83504	SIZE D	DRAWING NO 2703 - 075	REV. D1
	SHEET 1 OF 3				

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



POWER CONNECTIONS

IC #	+15v	-15v
101,102,104	7	4
103	9	6
105	8	4

POWER DECOUPLING

POSITION	+15	-15
TR100	C114	—
IC101	C118	C119
IC104	C117	C116

ALL DECOUPLING IS TO 0v(SIG) USING .02μF.

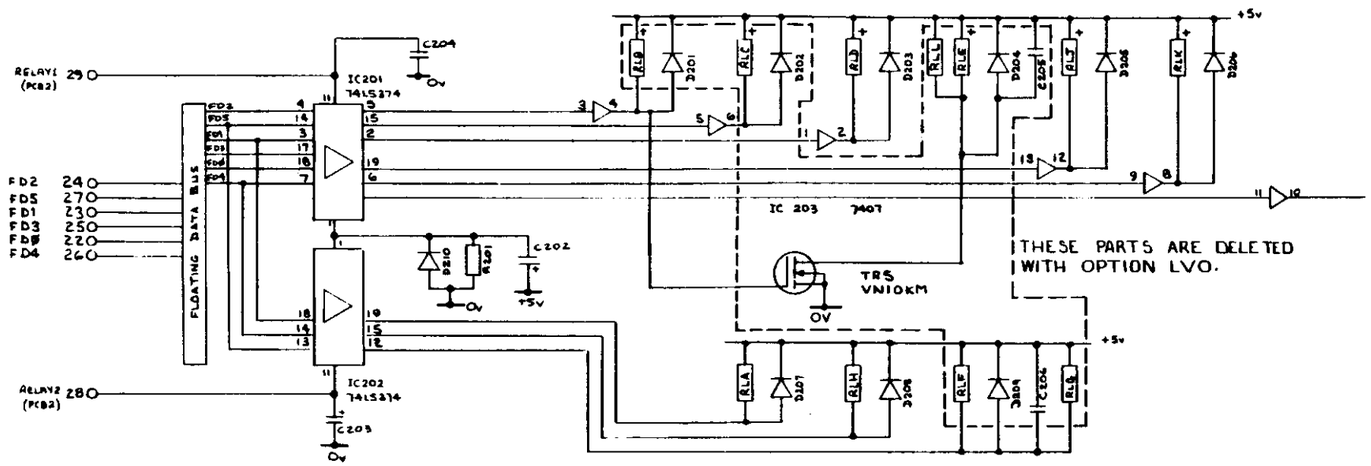
ADJUSTMENTS

C100 - 100v , 100KHz.
C101 - 1v , 100KHz.
C106, C102 - 10v , 100KHz.
RV100 - 0v @ TR104 collector.

NOTE - C100 C101 and C102 are interactive. Adjustment order is C101, 102, 100.

MATERIAL	DRAWN [illegible]	P/B2	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA
	CHECKED		
FINISH	APPR.		FEEDBACK - 2703
	SCALE —	CODE IDENT NO. 53504	SIZE D
	SHEET 2 OF 3	DRAWING NO. 2703 - 075	REV D_1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



4 ⟶ +15v (SHTS. 1 and 2)

47 & 49 ⟶ 0v (BIG) (SHTS 1 and 2)

3 ⟶ -15v (SHTS. 1 and 2)

5 ⟶ +21v (SHT 1)

6 ⟶ -21v (SHT 1)

20 ⟶ +250v (SHT 1)

17 ⟶ -250v (SHT 1)

21 ⟶ +5v (SHT 3)

30 ⟶ 0v (1) (SHT 3)

(20) .02μ

POWER CONNECTIONS

IC #	+5v	0v(1)
IC201, 202	20	10
IC203	14	7

ALL DIODES ARE 1N4148

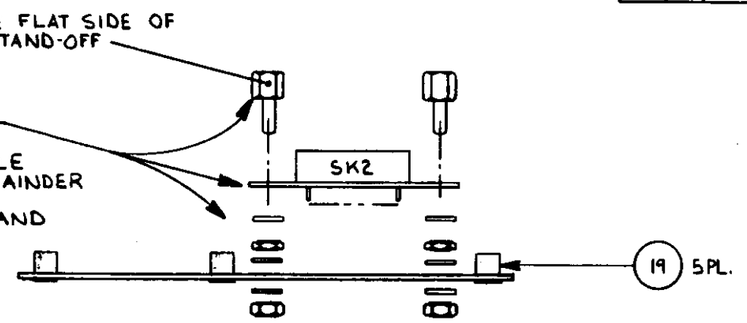
MATERIAL	DRAWN P(BL) 9/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA		
	CHECKED			
FINISH	APPR	2703 - RELAY DRIVES		
	SCALE — SHEET 3 OF 3	CODE IDENT NO 53804	SIZE D	DRAWING NO 2703-075 REV D1

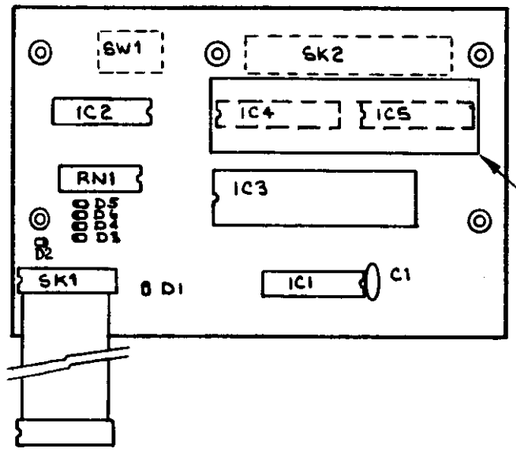
REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED		
33	B	ADDED EXPANSION BOARD WPW 8-3-83	8-8-83	
471	C	DELETED SCREWS (5) RDN	6-6-84	
591	D	CHANGED IN4148s to IN5711s CRL	12-3-84	
628	E	ADDED SWAGE-IN SPACERS DPM	3-25-85	

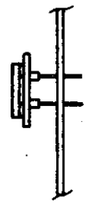
IEEE STANDOFF	18	
SK2	16	
WASHER, SPLIT LOCK	20	
NUT, HEX	21	
WASHER, FLAT	22	
PCB	3	
WASHER & NUT PROVIDED WITH STANDOFF	18	

ASSEMBLY PROCEDURE

ASSEMBLE ITEMS 18, 16, 20, 21 TIGHTEN HEX NUTS. THEN ASSEMBLE ITEM 22, 14 AND THE REMAINDER OF 18. TIGHTEN ALL HEX NUTS AND THEN SOLDER PINS OF ITEM 16 TO P.C.B..







INSTALL EXPANSION BD. ASSY (2724-604) IN PLACE OF IC 4 & IC 5. MAKE SURE PIN 1'S ON IEEE BD. AND PIN 1'S ON EXPANSION BD. LINE UP (ONLY IF IC 4 & IC 5 ARE NOT MOUNTED ON IEEE BOARD.)

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 /

DRAWN RM	3/19/83
CHECKED	6/7/84
APPR	8/8/83
STK NO	

Valhalla Scientific Inc.
SAN DIEGO, CA

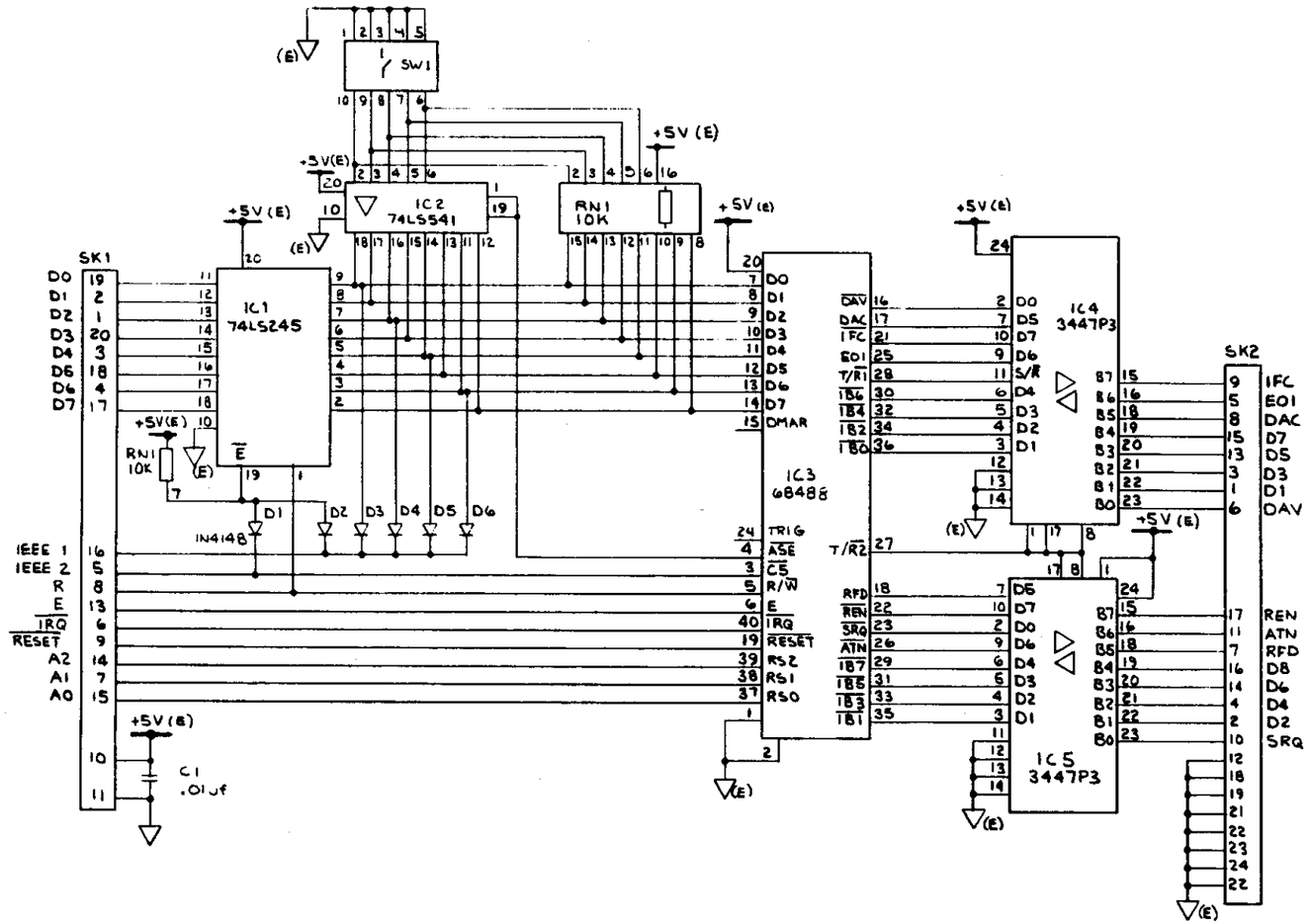
ASSEMBLY - IEEE

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
1/1	53504	C	2703-608	E

SHEET 2 OF 2

NOTES:
1. FOR P.C.B ASSY SEE 2703-608

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



MATERIAL	DRAWN R M	12/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA			
	CHECKED					
	APPR.					
FINISH			SCHEMATIC, IEEE-488 INTERFACE BOARD			
	SCALE —	SHEET 1 OF 1	CODE IDENT NO. 53804	SIZE D	DRAWING NO 2703-078	REV A

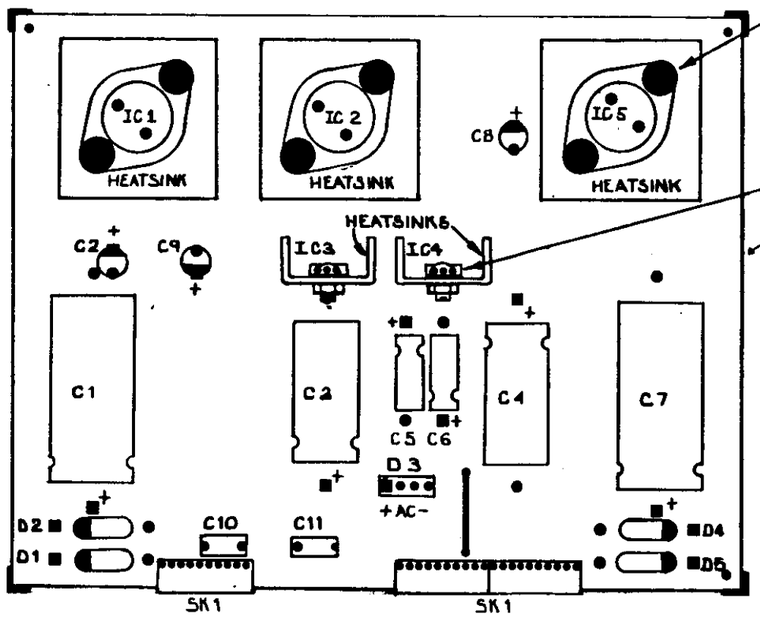
2703-078 4

NOTES:

1. FOR PARTS LIST SEE SHT.S 1 AND 2.
2. FOR SCHEMATIC SEE DWG. NO. 2703-079.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED 11-23-82		
472	B	UPDATE DRAWING RDN	6-11-84	PWJ
553	C	P/L CHANGE	8-16-83	RL

SHOWN IS COMP. SIDE OF 2703-709



(27) 6 PL , SCREW #6
(18) 3 PL , IC1, 2.5
(25) 3 PL , HEAT SINK
(28) 6 PL , WASHER , STAR
(29) 6 PL , NUT #6

(27) 2 PL , SCREW #6
(19) OR (20) , IC3 OR IC4
(26) 2 PL , HEAT SINK
(28) 2 PL , WASHER , STAR
(29) 2 PL , NUT #6

2703-609

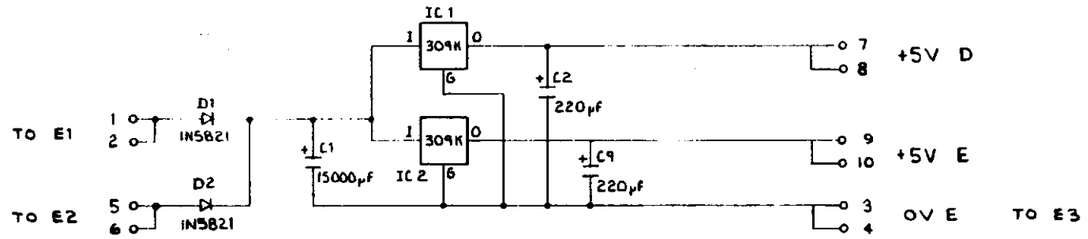
MATERIAL N/A	DRAWN CRE 6/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA
FINISH N/A	CHECKED PWJ	
	APPR. PWJ 6/84	ASSY. DWG. (P.C.B 2703-709)
	SCALE 1:1	CODE IDENT NO. 53504 / SIZE C / DRAWING NO. 2703-609 / REV. C
	SHEET 3 OF 3	

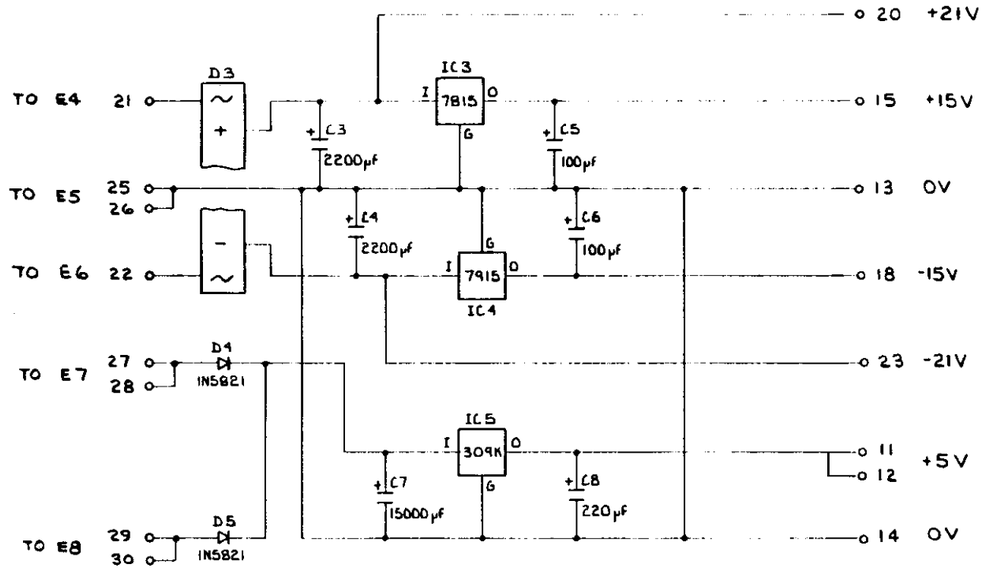
Optico 279-0151

NOTES:

1. IC'S 1-5 ARE MOUNTED ON HEATSINKS
2. FOR ASSY SEE DWG. NO. 2703-609.
3. FOR P/L SEE SHT.'S 1+2 OF 2703-609.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED C.R.C. 9-23-82		

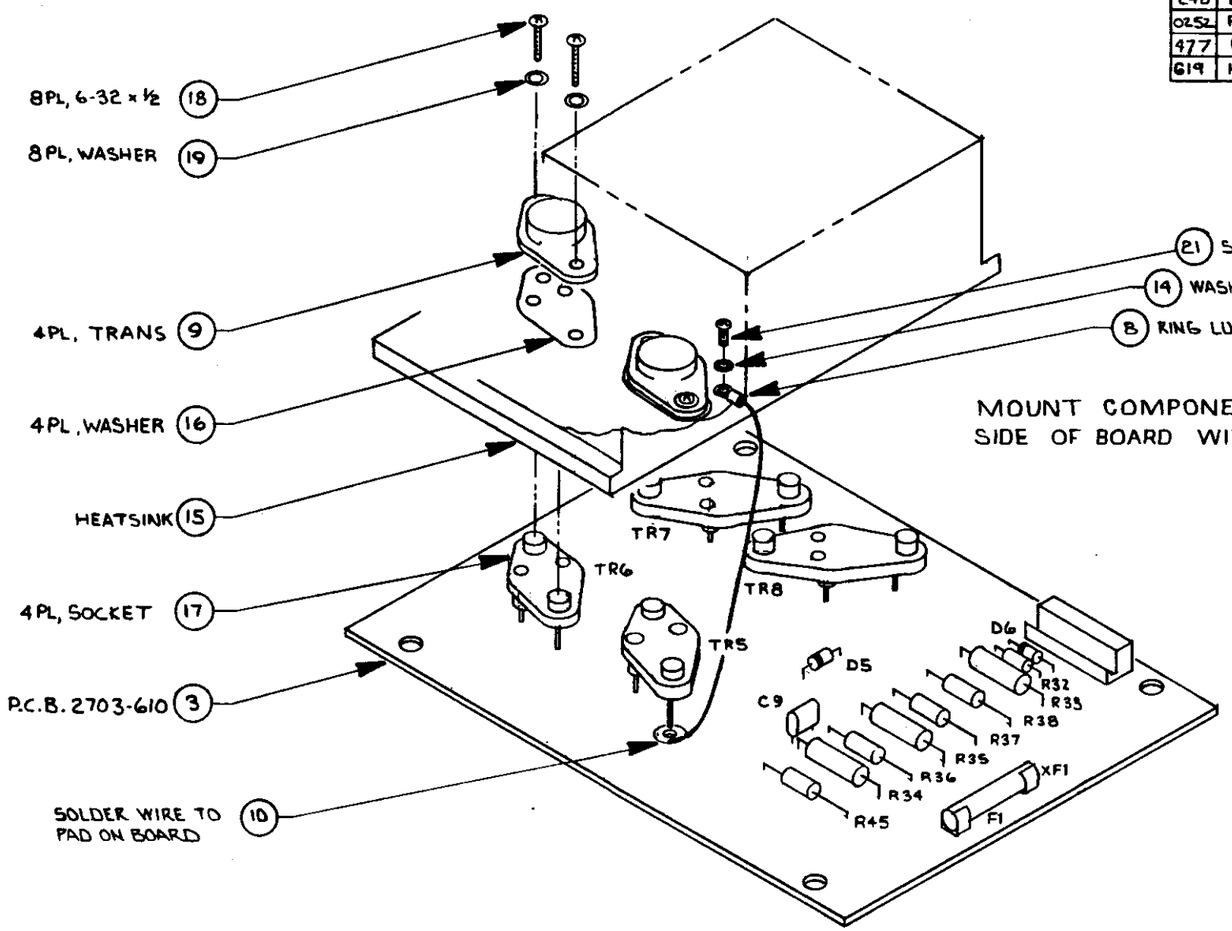




MATERIAL	DRAWN C.R.C. 9-23-82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA			
FINISH	CHECKED	SCHEMATIC - POWER SUPPLY BD.			
	APPR.				
	SCALE	CODE IDENT NO. 83504	SIZE D	DRAWING NO. 2703-079	REV A
	SHEET 1 OF 1				

2703-079 A

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED RM 2-27-83		
	B	ECO 56 RM 3-18-83		
0150	C	HEAT SINK STOCK NO. CORRECTED	11-11-83	RDN
0078	D	CHANGED VALUE OF C9 W.RW	11-16-83	RDN
248	E	CHG. VALUES OF D5 & D6. WPW	12-21-83	RL
0252	F	CHG. P/L ERROR RL	1-3-84	RL
477	G	ADD MOUNTING NOTE. RDN	6-11-84	RDN
619	H	CHANGE PARTS LIST ITEM #9. RDN	11-28-84	RDN



MOUNT COMPONENTS ON SIDE OF BOARD WITH NO TRACKS.

DASH NO	QTY REQD	NEXT ASSEMBLY	USED ON
	1	2703-400	2703

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

BREAK ALL SHARP CORNERS AND EDGES. MACH SURFACES 64

MATERIAL

FINISH

DRAWN RM 2-27-83
CHECKED RDN
APPR RDN 6-11-84
STK NO

Valhalla Scientific Inc.
SAN DIEGO, CA

250VOLT OUTPUT
P.C.B. ASSEMBLY

SCALE 1/1
SHEET 2 OF 2

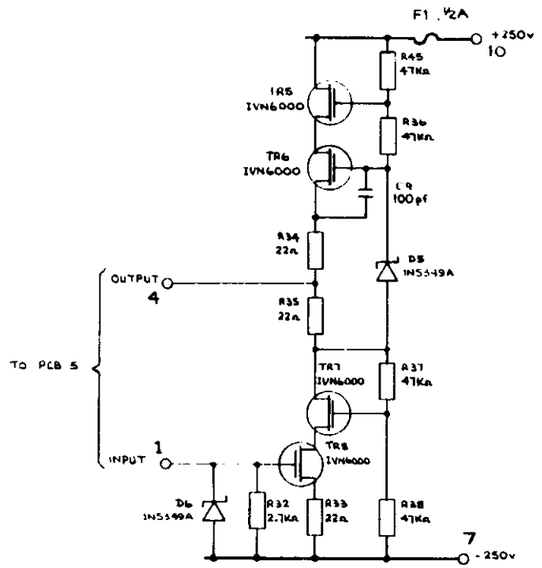
CODE IDENT	SIZE	DRAWING NO	REV
53504	C	2703-610	H

2703-610

NOTES:

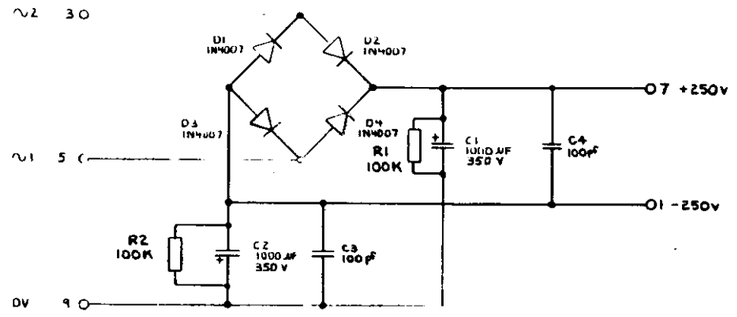
1. WITH OPTION LVO, BOTH OF THESE ASSEMBLYS ARE DELETED.

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED
		REDRAWN	9-27-82	RMJ
	A	RELEASED RM 3/18/83		
78	B	CHANGED VALUE OF C9 W.P.W.	11-16-83	PBO



250 VOLT OUTPUT

FOR P.C. BOARD ASSY SEE DWD 2703-610



250 VOLT POWER SUPPLY

FOR P.C. BOARD ASSY. SEE DWD 2703-612

2703-080

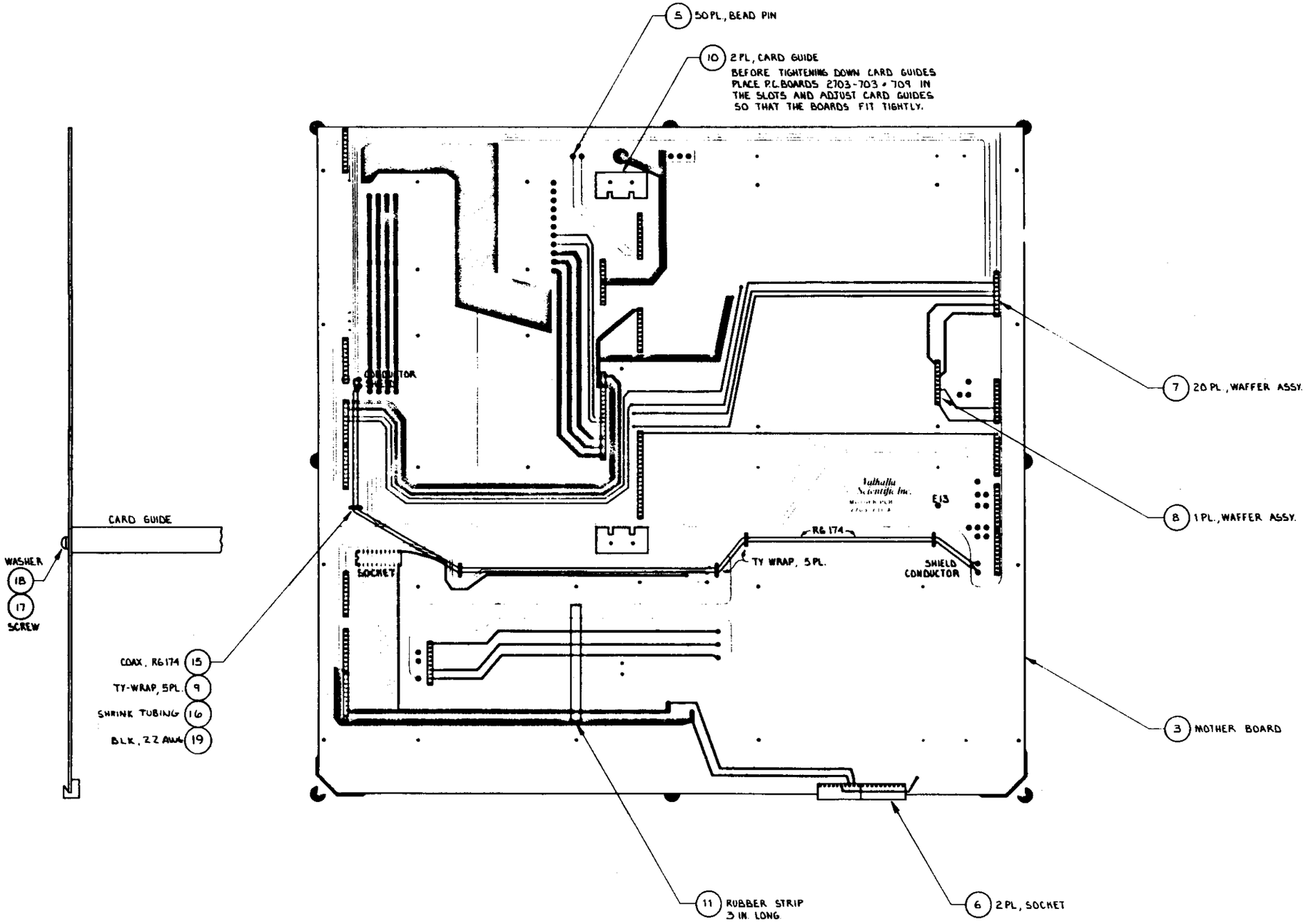
MATERIAL	DRAWN PMJ 9/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
	CHECKED		
	APPR		
FINISH		250 VOLT OUTPUT/ 250 VOLT POWER SUPPLY	
	SCALE —	CODE IDENT NO 53804 / SIZE D / DRAWING NO 2703-080 / REV B	
	SHEET 1 OF 1		

NOTES.

1. FOR PARTS LIST SEE SHT. 1.
2. FOR SCHEMATIC SEE DWG. NO. 2703-081.

REVISIONS

ECR	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED		
0078	B	DELETED SPACERS W.P.W.	11-15-83	PWD



Valhalla Scientific Inc.		
SCALE: NONE	APPROVED BY:	DRAWN BY C.R.C.
DATE: 1-6-83		REVISED
ASSY. DWG. MOTHER P.C. BOARD		
SHT. 2 OF 2	REV. B	DRAWING NUMBER 2703-611

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED RM		

MPU/REF PCB
A2, 2703-602

FROM LINE POWER

TO CAL SWITCH

A9 POWER SUPPLY
2703-609

TO REAR PANEL 15 PIN CONN.

A3 2703-603
FREQ GEN.

A5 2703-605
FEEDBACK-OUTPUT

A10 2703-610

A8, IEEE INT.
2703 608

A12 2703 612
250V OUTPUT

A1, 2703-601
DISPLAY

MATERIAL	DRAWN
FINISH	CHECKED
	APPR
	SCALE NONE
	SHEET 1 OF 1

Valhalla Scientific Inc.
SAN DIEGO, CALIFORNIA

SCHEMATIC -
MAIN P.C.B.

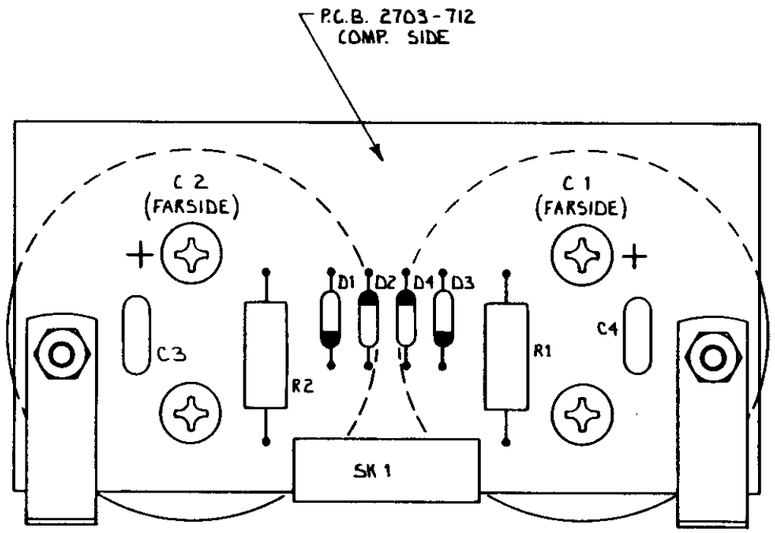
CODE IDENT NO	SIZE	DRAWING NO	REV
53604	D	2703-081	A

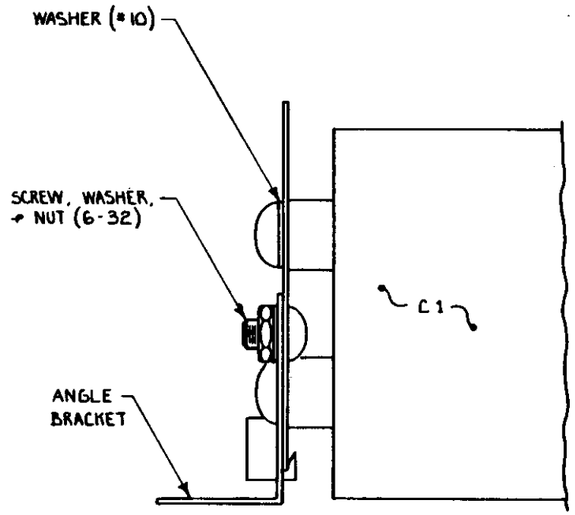
2703-081

NOTES:

1. FOR PARTS LIST SEE SHT. 1.
2. FOR SCHEMATIC SEE DWG. # 2703-080.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED 11-29-82		
199	B	ADDED C3 & C4 C.R.E.	12-20-83	





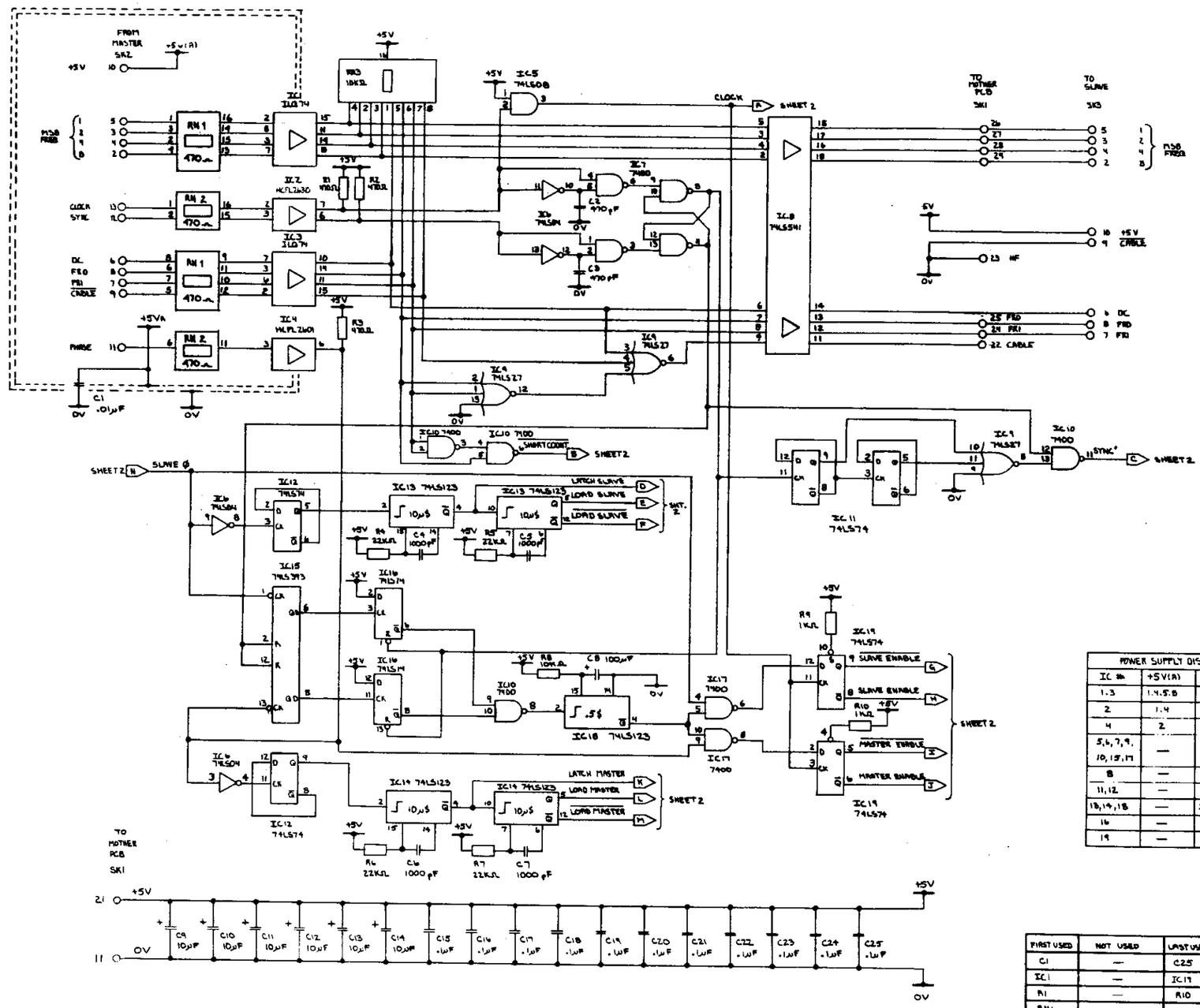
SHOWN IS COMP. SIDE OF 2703-712

MATERIAL N/A	DRAWN C.R.E. 11/82	Valhalla Scientific Inc. SAN DIEGO, CALIFORNIA	
	CHECKED		
	APPR.		
FINISH N/A	THE INFORMATION DISCLOSED HEREIN WAS ORIGINATED BY AND IS THE PROPERTY OF VALHALLA SCIENTIFIC, INC. AND SHOULD NOT BE DISCLOSED TO OTHERS OR USED FOR REPRODUCTION, MANUFACTURING OR SALE WITHOUT ITS WRITTEN PERMISSION.	ASSY. DWG. (P.C.B. 2703-712)	
	SCALE 2:1	CODE IDENT NO. 53504	SIZE C	DRAWING NO. 2703-612	REV. B
	SHEET 2 OF 2				

Optico 279-0151

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED



POWER SUPPLY DISTRIBUTION			
IC #	+5V(A)	+5V	0V
1,3	1,4,5,8	—	7,12,13,16
2	1,4	8	5
4	2	8,7	5
5,6,7,9, 10,15,17	—	14	7
8	—	20	1,10,19
11,12	—	1,4,10,13,14	7
13,14,18	—	3,11,16	1,8,9
16	—	4,10,14	7
19	—	1,13,14	7

FIRST USED	NOT USED	LAST USED
C1	—	C25
IC1	—	IC19
R1	—	R10
RN1	—	RN3
SK1	—	SK3
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

DRAWN		3-83
CHECKED	PW	6-28-83
APPR	PW	6-28-83
STK NO		

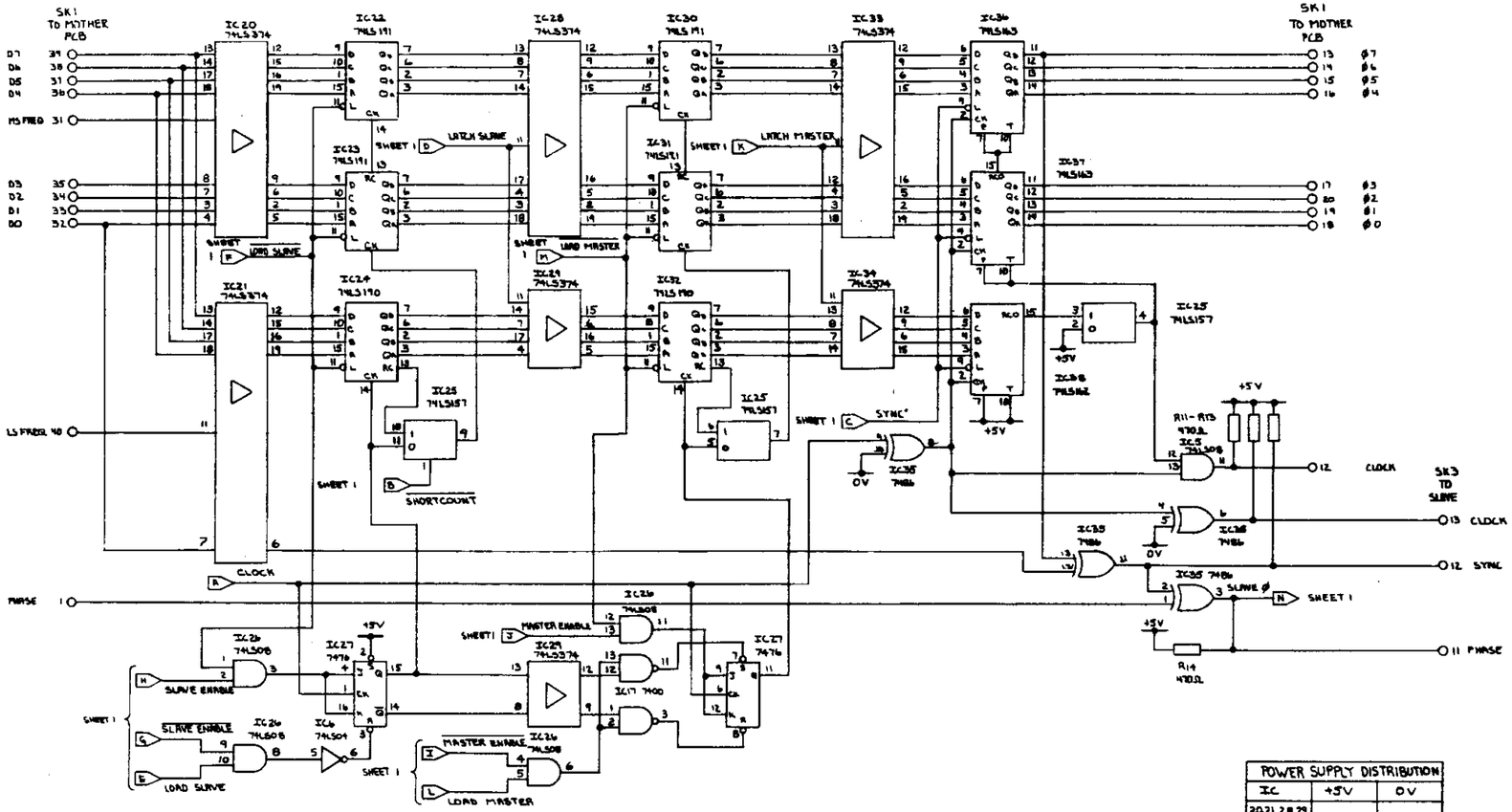
Valhalla Scientific Inc. SAN DIEGO, CA

2705/09/13
PHASE GENERATOR

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
SHEET 1 OF 2	53504	D	2705-074	D

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS				
ECO	LTR	DESCRIPTION	DATE	APPROVED



POWER SUPPLY DISTRIBUTION		
IC	+5V	0V
20,21,28,29 33,34	20	1,10
22,23,24	16	5,8,4
25	16	8,15
26,35	14	7
27	5	13
30,31,32	5,16	8,4
36,37,38	1,16	8

FIRST USED	NOT USED	LAST USED
IC5	IC7-IC16, IC18, IC19	IC35
R11		R14
SK1	SK2	SK3
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

DRAWN	JM	3-83
CHECKED	PJ	4-28-83
APPR	PW	4-28-83
STK NO		

Valhalla Scientific Inc. SAN DIEGO, CA

2705/09/13
PHASE GENERATOR

SCALE	CODE IDENT	SIZE	DRAWING NO	REV
SHEET 2 OF 2	53504	D	2705-074	D

Valhalla Scientific Inc.	PARTS LIST	CHASSIS ASSEMBLY	MODEL 2703	DWG NO 2703-400	REV G

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
1											
2											
3			Front Panel Assy.	53504	2703-401	1					
4			Rear Panel Assy.	53504	2703-402	1					
5											
6	A2		MPU/REF PCB Assy.	53504	2703-602	1					
7	A3		Freq. Gen. PCB Assy.	53504	2703-603	1					
8	A5		Voltage Out. PCB Assy.	53504	2703-605	1					
9	A9		Power Supply PCB Assy.	53504	2703-609	1					
10	A10		250V Output PCB Assy.	53504	2703-610	1					
11	A11		Mother PCB Assy.	53504	2703-611	1					
12	A12		250V Power Sup. PCB Assy.	53504	2703-612	1					
13											
14		4-10333	Bezel	53504	2724-205	4					
15		4-10457	Side Rail	53504	2703-224	2					
16		4-10456	Side Rail	53504	2703-223	2					
17		4-10361	Bottom Plate	53504	2703-202	1					
18		4-10392	Insulator Trans.	53504	2703-218	1					
19		4-10393	Insulator Tran.	53504	2703-219	1					
20		4-10412	Bottom Plate Spacer	53504	2703-220	1					
21											
22		4-10370	Chassis Support Bar	53504	2703-212	4					
23		4-10371	Top Cover	53504	2703-213	1					

NOTES: For Assy. Dwg. See Shts. 4 & 5

Valhalla Scientific Inc.

PARTS LIST

CHASSIS ASSEMBLY | MODEL 2703 | DWG NO 2703-400 | REV G

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
24	R136	1-10001	Res. 1K 1%	81349	RN60C1001F	1					
25	C1	2-60002	Cap .1uf Mylar	81349	225P10491	1					
26		5-10318	Standoff, Snap-in	83330	3922	3					
27		5-10276	Spacer, Plastic, 1/2"lg.	Smith	4016	4					
28		5-10067	Power Cord	70903	17250	1					
29		5-10361	Rubber Feet	Accurate	2093W-475Grey	4					
30		5-10496	Standoff, Modified 8-32	Valhalla	2720-226	6					
31		5-10086	Washer "GND Lug"	83330	1412-6	3					
32											
33		5-10331	Claspcon Socket	27264	02-06-1103	27					
34		5-10261	TY Blocks	06383	ABM25-A	6					
35		5-10019	Ty-Wrap 3 1/2 x 1/8		WRN 3.5	25					
36		5-10325	Ty-Wrap 14 x 1/4	06383	PRT4S	1					
37											
38	T3	4-20041	Transformer	53504	2703-010	1					
39	T2	4-20042	Transformer	53504	2703-011	1					
40	T1	4-20031	Trnasformer	53504	2702-013	1					
41			Screw Phil. Flat SS		6-32 X 9/16	16					
42			Screw Phil Pan SS	81349	6-32 x 9/16	6					
43			Screw Phil Pan Blk	81349	6-32 x 3/4	2					
44											
45			Screw Phil Flat SS	81349	6-32 x 3/8	20					
46			Washer Flat	81349	#6	2					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	CHASSIS ASSEMBLY	MODEL 2703	DWG NO 2703 - 400	REV G

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
47			Washer Int. Star	81349	#6	35					
48			Washer Int. Star	81349	#8	12					
49			Washer Flat	81349	#8	12					
50			Nut, Radio Hex	81349	6-32	16					
51			Nut, Radio Hex	81349	8-32	12					
52		5-10354	Washer, Gnd Lug.	83330	1412-8	1					
53											
54			Tubing Shrink		1/16 dia.	A/R					
55			Tubing Shrink		1/8 dia	A/R					
56											
57											
58											
59											
60											
61											
62											
63											
64											
65											
66											
67											
68											
69											

NOTES:

Valhalla Scientific Inc.	PARTS LIST	FRONT PANEL ASSEMBLY	MODEL 2703	DWG NO 2703-401	REV C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
1											
2											
3											
4	A1		Display PCB Assy.	53504	2703-601	1					
5		4-10455	Screened Front Panel	53504	2703-100	1					Made From 2703-200
6		5-10202	Knob. Collect Blk.	Alco	AS1-352-W3-302	9					
7		5-10346	Knob, Skirt, Clear	Alco	Aw5-300	9					
8	XJ1	4-20043	Ferrite Bead	Amidon	FB-43-2401	1					
9	J1, J2	5-10003	Binding Post, Blk.	Superior	BP21BC	2					
10	J3, J4	5-10001	Binding Post, Red	Superior	BP21RC	2					
11	J5	5-10137	Binding Post, Gold	83330	1518	1					
12	SW1	5-03061	Switch, Power, 4A	Schadow	ZFNE15/F2U	1					
13					103EE-11010106B						
14		5-10331	Claspon Socket	27264	02-06-1103	4					
15		5-10086	Washer, Gnd. Lug	83330	1412-6	1					
16		5-10354	Washer, Gnd. Lug	83330	1412-8	5					
17			Shrink Tubing 12"		Blk	1					
18			Wire:								
19			Red, 30" Teflon		20 AWG.	1					
20			Grn., 36" Teflon		20 AWG.	1					
21											
22											
23											

NOTES: See sht 2 for Assembly Drawing

Valhalla Scientific Inc.	PARTS LIST	REAR PANEL ASSEMBLY	MODEL 2703	DWG NO 2703-402	REV G

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
1											
2											
3											
4		4-10360	Rear Panel	53504	2703-201	1					
5		5-10019	Cable Tie 4" x 1/8"	Panduit	WRN-4	15					
6	SK3	5-10166	Line Filter	14655	APF600CEE	1					
7	E12, E11	5-10086	Washer Gnd. Lug	83330	1412-6	8					
8	F1	5-04011	Fuse 3A slo-blo	75915	313 003	1					For 120V Operation
9	XF1	5-10018	Fuse holder	75915	342004A	1					
10	SW2	5-03017	115/230 Slide switch	82389	46256LFR	1					
11	SW3	5=03062	Switch, key	C&K	Y201-13-0-A1-01-Q4	1					
12	P1	5-10064	Conn. BNC., Male	02660	31-010	1					
13	SK4	5-10333	Cable 15 pin "D"	53504	2703-055	1					
14	B1	5-10059	Fan, 4 1/2	82877	MU2A1	1					
15											
16		5-10493	Filter, Fan guard, 4 1/2		AFP,FF450 A/30 45PPI or	1					
17	J6, J8	5-10003	Binding Post Blk.	Superior	BP21-BC	2					
18	J7, J9	5-10001	Binding Post Red	Superior	BP21-RC	2					
19	J10	5-10137	Binding Post Gold	83330	1518	1					
20	F1	5-04013	Fuse 1.5A Slo-Blo	75915	313-01.5	1					For 250V Operation
21		5-10331	Clasp-on Socket	27264	02-06-1103	12					
22											
23		4-20043	Ferrite Bead	Amidon	FB-43-2401	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	REAR PANEL ASSEMBLY	MODEL 2703	DWG NO 2703-402	REV G

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
24			Screw Phil Pan SS		4-40 x 9/16"	2					
25			Screw, Phil,flat, SS		6-32 x 3/4"	4					
26			Screw Phil Pan Blk.		6-32 X 3/8"	2					
27											
28			Washer Split lock		#4	4					
29			Washer, flat		#6	4					
30											
31											
32											
33			Nut, Radio Hex		#4-40	4					
34			Nut, Radio Hex		#6-32	6					
35			Tubing, Shrink		3/16" Dia.	AR					
36			Wire:								
37			Grn, Teflon		20 AWG.	34"					
38			Red, Teflon		20 AWG	34"					
39			Blk.		20 AWG.	82"					
40			Grn.		20 AWG.	80"					
41			Wht.		20 AWG.	38"					
42			Red,		20 AWG	79"					
43											
44											
45											
46											

NOTES: For Wiring information, see W. T. T. 2703-050

For Assembly Drawing see 2703-402 Sht. 3

Valhalla Scientific Inc.	PARTS LIST	DISPLAY P.C.B ASSY A1	MODEL 2703	DWG NO 2703-601	REV E

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
1			DISPLAY BOARD ASSY.		2703-601	X					
2											
3		4-30086	P.C.BOARD MECH	53504	2703-701 B	1					
4											
5	R1-R28	1-01053	RES. 4.7K 1/4W 5%	81349	RC07GF472J	28					
6											
7	TR1-TR14	3-10022	TRANSISTOR, PNP	04713	MPS-D54	14					
8											
9	D1-5, 7-11, 13	5-01011	LED RED	28480	5082-4655	11					
10											
11	SW1-9	5-03073	SWITCH, BCD ROTARY	71590	2APA0160	9					
12	SW11, 10	5-03077	SWITCH, PUSH BUTTON	SCHADOW	SEAU0A0106RG	2					
13	SW12-22	5-03052	SWITCH, PUSH BUTTON	SCHADOW	SEAU0A0105R	11					
14											
15											
16	DS1-11	5-01010	DISPLAY 0-9	28480	5082-7650-B	11					
17	DS12	5-01023	LED, LIGHT BAR, RED	28480	HLMP 2685	1					
18	RN1	1-40002	RES NET. 100Ω	01121	316B-101	1					
19	RN2	1-40005	RES NET. 22Ω	01121	316B-220	1					
20	RN3	1-40003	RES NET. 10K	01121	316A-103	1					
21											
22											
23											

NOTES:

Valhalla Scientific Inc.	PARTS LIST	DISPLAY P.C.B. ASSY, A1	MODEL 2703	DWG NO 2703-601	REV E

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
24	IC1	3-30182	4 to 16 DECODER	01295	SN74154N	1					
25	IC3, 4	3-30161	QUAD NAND GATE	01295	SN7438N	2					
26	IC2, 5 - 10	3-30164	HEX BUFFER	01295	SN7407N	7					
27	IC11	3-30156	OCTAL 3 STATE BUFFER	01295	SN74LS541N	1					
28	IC12, 13	3-30177	OCTAL LATCH	01295	SN74LS374N	2					
29	IC14	3-30184	HEX INVERTER	01295	SN74LS04N	1					
30	IC15, 16	3-30176	DUAL COUNTER	01295	SN74LS393N	2					
31	IC17	3-30095	DUAL D TYPE	01295	SN74LS74N	1					
32											
33											
34	PL.1	5-10332	WAFER, ASSY	C.A.	CAS-10SP-230T-1.23	2					
35											
36											
37		4-10363	P.C.B. SUPPORT	53504	2703-204	1					
38			SCREW, PAN PHIL CAD		6-32 X 3/8	2					
39			WASHER, STAR		#6	2					
40											
41			NUT, PANEL 3/8 HEX		3/8-32	9					
42											
43			WIRE, BLACK, 90 INCHES.		22 AWG	1					
44											
45											
46											

NOTES: FOR ASSY DWG., SEE SHT. #3.

Valhalla Scientific Inc.	PARTS LIST	MICROPROCESSOR AND REFERENCE P. C. B. ASSY.	MODEL 2703	DWG NO 2703-602	REV F

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
1			MPU/REF PCB Assy.	53504	2703-602	X					
2											
3		4-30087	PCB Mech. MPU	53504	2703-702	1					
4											
5	C101, 102, 103	2-60001	Cap Mylar .22uf	14752	225P22491	3					
6	C1, 2	2-20018	Cap MICA, 33pf	56289	CM05ED330J03	2					
7	C3,105	2-30003	Cap Tan., 47uf	05397	T390D476M010AS	2					
8	C4-6, 212-216	2-60002	Cap Mylar .1uf	56289	225P22491	14					
	225-229, 233										
10	C203	2-20011	Cap MICA, 1000pf	56289	CM06F0102J03	1					
11	C218, 219	2-90006	Cap Poly C, 1uf	14752	625B1A105J	2					
12											
13	C221	2-10011	Cap Cerm, .01uf	56289	5GAS10	1					
14	C201	2-10014	Cap Cerm, .1uf, 50V		8121-050-651-104M	1					
15	C202	2-20013	Cap MICA, 100pf	56289	CM05FD101J03	1					
16	C204	2-90004	Cap Poly.C, .01uf	14752	625B1A103J	1					
17	C205	2-90005	Cap Poly.C, .1uf	14752	625B1A104J	1					
18	C206	2-90001	Cap Poly.C, .05uf	14752	625B1A503J	1					
19	C207	2-90000	Cap Poly.C, .005uf	14752	625B1A502J	1					
20	C208	2-20016	Cap MICA, 500pf	56289	CM05FD501J03	1					
21	C209, 210	2-20002	Cap MICA, 47pf	56289	CM05FD470J03	2					
22	C100	2-20017	Cap MICA, 1200pf	56289	CM06FD122J03	1					
23	C211	2-20020	Cap MICA, 300pf	56289	CM05FD301J03	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	MICROPROCESSOR AND REFERENCE P. C. B. ASSY.	MODEL 2703	DWG NO 2703-602	REV F

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
24	C217,230-232	2-30001	Cap. Tan, 10uf	05397	T390C106M025AS	4					
25	C104, 220, 7	2-10013	Cap Cerm 1 uf 50V		8131-050-651-105M	3					
26											
27	D1,201-204,208	3-20000	Diode	04713	1N4148	6					
28	D206, 207	3-20017	Diode, Zener	04713	1N5239	2					
29	D205	3-20006	Diode	04713	FD300	1					
30	IC2	3-30213	2K x8 RAM	01295	TMS4016	1					
31	IC3	3-50010	8K x 8 PROM	53504	3-30198	1					
32	IC4	3-30187	MIcroprocessor - 1.5MHz.	04713	Mc68A09P	1					
33	IC108, 109	3-30176	Dual 4 BIT counter	27014	SN74LS393N	2					
34	IC110	3-30095	Dual "D" Type	27014	SN74LS74N	1					
35	IC8, 9, 21	3-30155	3 to 8 Decoder	27014	SN74LS138N	3					
36	IC10	3-30162	Octal 2 way buffer	27014	SN74LS245N	1					
37	IC14, 15, 100-102	3-30177	Octal Latch	27014	SN74LS374N	5					
38	IC22, 16	3-30156	Octal Buffer	27014	SN74LS541N	2					
39	IC17-20	3-30185	Quad Opto-Isolator	Litronix	ILQ-74	4					
40	IC1	3-30061	Quad 2 Input AND	27014	SN74LS08N	1					
41	IC24,25	3-30189	256 x 4 NOV RAM	Xicor	XC2212	2					
42	IC103-107	3-30212	4 Bit Mag. Comparator	27014	SN74LS85N	5					
43	IC111, 213	3-30314	Dual C/O FET Switch	Harrris	HI3-303-5	2					
44	IC112	3-30122	6.9v Reference	27014	LM399H	1					
45	IC113	3-30199	Oscillator	27014	SN74LS624N	1					
46	IC114, 202, 207	3-30090	Op Amp	27014	LF356N	5					

NOTES: 211, 212

Valhalla Scientific Inc.	PARTS LIST	MICROPROCESSOR AND REFERENCE P. C. B. ASSY.	MODEL 2703	DWG NO 2703-602	REV F

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
47	IC115	3-30315	Op Amp	13919	OPA103CM	1					
48	IC201	3-30317	8 Bit MDAC	04713	MC1408-L6	1					
49	IC203	3-50011	512 x 4 PROM (7621A)	Harris	3-30316	1					
50	IC206	3-30123	12 Bit DAC	AD	AD566A	1					
51	IC208, 209	3-30318	Quad FET Switch	27014	LF13202N	2					
52	IC210	3-30319	Dual 4 I/P MUX	27014	LF13509D	1					
53	IC214	3-30211	Instru. Amp	13919	INA101BM	1					
54	IC215	3-30009	Timer	27014	555	1					
55	IC204	3-50012	512 x4 PROM (7621A)	Harris	3-30316	1					
56	IC205	3-50013	512 x 4 PROM (7621A)	Harris	3-30316	1					
57											
58											
59	R204, 208	1-01051	Res 3.9K 1/4W 5%	81349	RC07GF392J	2					
60	R107,6	1-01041	Res 1K 1/4W 5%	81349	RC07GF102J	2					
61	R2-5, 215	1-01061	Res 10K 1/4W 5%	81349	RC07GF103J	5					
62											
63	R7, 8	1-01033	Res 470 Ohm 1/4W 5%	81349	RC07GF471J	2					
64	R102	1-01045	Res 2K 1/4W 5%	81349	RC07GF202J	1					
65	R202	1-01048	Res 2.7K 1/4W 5%	81349	RC07GF272J	1					
66	R109	1-01104	Res 2M ohm 1/4W 5%	81349	RC07GF205F	1					
67	R101, 216	1-01091	Res 390K 1/4W 5%	81349	RC07GF394J	2					
68	R110, 218	1-01030	Res 330 ohm 1/4W 5%	81349	RC07GF331J	2					
69	R103	1-01100	Res 1 M ohm 1/4W 5%	81349	RC07GF105J	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	MICROPROCESSOR AND REFERENCE P. C. B. ASSY.	MODEL 2703	DWG NO 2703-602	REV F

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
70	R104	1-20007	Res 900K 1%	Elliot	E48 5PPM	1					
71	R105, 106	1-01086	Res 220K 1/4W 5%	81349	RC07GF224J	2					
72											
73	R203	1-10061	Res 4.99K 1%	81349	RN60C4991F	1					
74	R207, 211	1-01065	Res 20K 1/4W 5%	81349	RC07GF203J	2					
75	R108, 212	1-01071	Res 39K 1/4W 5%	81349	RC07GF393J	2					
76	R205, 209	1-01058	Res 7.5K 1/4W 5%	81349	RC07GF752J	2					
77	R213	1-01025	Res 200 ohm 1/4W 5%	81349	RC07GF201J	1					
78	R217	1-01081	Res 100K 1/4W 5%	81349	RC07GF104J	1					
79	R214	1-01021	Res 100 ohm 1/4W 5%	81349	RC07GF101J	1					
80	R100	1-10001	Res 1K 1%	81349	RN60C1001B	1					
81	R206, R210	1-01062	Res 12K 1/4W 5%	81349	RC07GF123J	2					
82	R201	1-01047	Res 2.4K 1/4W 5%	81349	RC07GF242J	1					
83	RN1, 2	1-40001	Res Net 470 ohm	01121	316B-471	2					
84	RN 3, 4	1-40003	Res Net 10K	01121	316A-103	2					
85	RV201	1-50022	Res Var 1K	73138	89PR-1K	1					
86	RV101	1-50035	Res Var 50K	73138	89PR-50K	1					
87	RV102	1-50034	Res Var 500 ohm	73138	89PR-500 Ohm	1					
88											
89	SW2	5-03037	Switch DIL 5 Pos.	Alco	DB-5	1					
90											
91											
92											

NOTES:

Valhalla Scientific Inc.	PARTS LIST	MICROPROCESSOR AND REFERENCE P. C. B. ASSY.	MODEL 2703	DWG NO 2703-602	REV F

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
93											
94	TR201	3-10013	Transistor NPN	04713	2N4401	1					
95											
96	Y1	5-02006	Crystal, MPU 6MHz.	Nel	HC18	1					
97	XIC24, 25	5-10293	Socket Dil 18 pin	Burndy	DILB18P-108	2					
98	XIC4	5-10246	Socket Dil 40 pin	Burndy	DILB40P-11	1					
99	XIC3	5-10295	Socket Dil 28 pin	Burndy	DILB20P-108	1					
100	XIC2, XIC206	5-10042	Socket DIL 24 Pin	01295	C8525-01	2					
101	XIC203-205	5-10008	Socket DIl 16 Pin	Burndy	DILB16P-117	3					
102											
103	SK1	5-10310	Socket, 10-way	Molex	22-15-2106	7					
104											
105		5-10016	Coax, 10"	81349	RG174	1					
106											
107											
108											
109											
110											
111											
112											
113											
114											
115											

NOTES:

Valhalla Scientific Inc.	PARTS LIST	FREQUENCY GENERATOR P. C. B. ASSY.	MODEL 2703	DWG NO 2703-603	REV E

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
1	A3		P. C. B. Assy.	53504	2703-603	X					
2											
3		4-30088	P. C. Board	53504	2703-703	1					
4											
5	C1	2-60003	Cap, Mylar, 1uf 100V	56283	225P10591	1					
6	C2	2-20007	Cap, Mica, 150 pf	56283	CM05FD151J03	1					
7	C3	2-40010	Cap, Elec., 1000uf	56283	TVA-1211	1					
8	C6	2-30002	Cap, Tan, 33uf 10V	05397	T390D336M010AS	1					
9	C7, 24	2-30010	Cap, Tan 10uf 10V	05397	T390B106M010AS	2					
10	C8	2-70001	Cap, Var., 2-12pf	Mouser	24AA061	1					
11	C9	2-20021	Cap, Mica, 27pf	56289	CM05FD270J03	1					
12	C10	2-30004	Cap, Tan 1uf 25V	05397	T390A105M010AS	1					
13	C12, 13, 15, 16-23	2-60002	Cap, Mylar, .1uf	56289	225P10491	11					
14	C14	2-20006	Cap, Mica, 3pf		CM05CD030J03	1					
15	D1	3-20028	Schottky Diode	28480	1N5711	1					
16	D2, 3, 4	3-20000	Diode	04713	1N4148	3					
17											
18	IC 1, 6	3-30133	Quad Comparator	27014	LM339N	2					
19	IC 2	3-30093	Opto Coupler	28480	MCPL2601	1					
20	IC3	3-30196	Phase Comparator	04713	MC4044	1					
21	IC4	3-30191	Dual Oscillator	01295	SN74LS629N	1					
22	IC5, 7, 8	3-30177	Octal Latch	01295	SN74LS374N	3					
23	IC9	3-30002	Quad Nand	01295	SN7400N	1					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	FREQUENCY GENERATOR P. C. B. ASSY.	MODEL 2703	DWG NO 2703-603	REV E

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
24	IC10	3-30192	Dual 4 I/P Nand	01295	SN7420N	1					
25	IC11, 12, 13, 14	3-30130	Decade Multiplier	01295	SN74167N	4					
26	IC15, 21	3-30193	Data Selector	01295	SN74LS157N	2					
27	IC16, 17	3-30194	Synchronous Counter	01295	SN74LS163AN	2					
28	IC18	3-30195	Data Selector	01295	SN74LS153N	1					
29	IC19	3-30179	BCD Counter	01295	SN74LS90N	1					
30	IC20	3-30181	Dual BCD Counter	01295	SN74LS490N	1					
31	IC22	3-30010	Quad Excl	01295	SN7486N	1					
32	R20	1-01036	Res 620 ohm 1/4W 5%	81349	RC07GF621J	1					
33											
34	R21, 22	1-01033	Res 470 ohm 1/4W 5%	81349	RC07GF471J	2					
35	R1	1-30019	Res 100K, 1W 5%	81349	RC32GF104J	1					
36	R2, 8, 11	1-01041	Res 1K, 1/4W 5%	81349	RC07GF102J	3					
37	R3, 15	1-01081	Res 100K, 1/4W 5%	81349	RC07GF104J	2					
38	R4, 7	1-01061	Res 10K, 1/4W 5%	81349	RC07GF103J	2					
39	R6, 5, 10, 18	1-01030	Res 330 ohm, 1/4W 5%	81349	RC07GF331J	4					
40	R12	1-01015	Res 47 ohm, 1/4W 5%	81349	RC07GF470J	1					
41	R13, 16	1-01085	Res. 200K, 1/4W 5%	81349	RC07GF204J	2					
42	R14	1-01077	Res. 68K, 1/4W 5%	81349	RC07GF683J	1					
43	R17	1-01080	Res 91K, 1/4W 5%	81349	RC07GF913J	1					
44	Y1	5-02002	Crystal, 12.8007MHz.	Nel	HC18-12.8007MHZ	1					
45	SK2	5-10008	Socket Dil 16-way		DILB-16P-11	1					
46	SK1	5-10310	Socket 10-way	Molex	22-15-2106	4					

NOTES: See sheet 3 for assy. drawing

Valhalla Scientific Inc.	PARTS LIST	VOLTAGE OUTPUT AND FEEDBACK P. C. B. ASSY.	MODEL 2703	DWG NO 2703-605	REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
1											
2	A5	4-30090	P. C. Board, Voltage out	53504	2703-705	1					
3	C11	2-20005	Cap, Mica., 39pf	81349	CM05ED390J03	1					
4	C1, 12, 13	2-30001	Cap, Tant., 10uf	81349	T390C106M025AS	3					
5	C2, 5	2-20003	Cap, Mica, 5pf	81349	CM05CD05D03	2					
6	C3, 206, 24, 205	2-10004	Cap, Cerm, .02uf	56289	5GAS-S20	4					
7	C10, 14-19, 25, 26 110, 201, 114, 117, 118	2-60002	Cap, Mylar, .1uf	14752	225P10491	14					
8	C109, 103, 105, 122	2-20002	Cap, Mica, 50pf	81349	CM05ED470J03	4					
9	C6, 4, 112	2-20014	Cap, Mica, 20pf	81349	CM05FD200J03	3					
10	C7	2-20019	Cap, Mica, 200pf	81349	CM05FD201J03	1					
11	C8	2-20012	Cap, MIca, 10pf	81349	CM05FD100J03	1					
12	C123	2-20013	Cap, Mica, 100pf	81349	CM05FD101J03	1					
13	C100-102	2-70000	Cap, Var, 1-12pf	JFD	VC58G	3					
14	C104	2-20009	Cap, Mica, 470pf	81349	CM05FD471J03	1					
15	C106, 20		Factory Selected								
16	C107	2-30014	Cap, Tant, 100uf	81349	T390E107M010AS	1					
17	C108, 203, 204	2-10000	Cap, Cerm, .005uf	56289	5GAD50	3					
18	C116	2-90003	Cap, PolyC, 5uf	14752	625B1A505J	1					
19	C119, 120	2-90008	Cap, PolyC, .02uf	14752	625B1A203J	2					
20	C22	2-20015	Cap, Mica 75pf	81349	CM05FD750J03	1					
21	C202, 21	2-40010	Cap. 1000uf 25v Alum	Sprage	TVA-1211	2					
22	C121	2-20006	Cap mica 3pf	81349	CM05CD030J03	1					
23											

NOTES: Sheet 6 of 6 is assy. drawing

Valhalla Scientific Inc.	PARTS LIST	VOLTAGE OUTPUT AND FEEDBACK P. C. B. ASSY.	MODEL 2703	DWG NO 2703-605	REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
24	D1, 102-104	3-20005	Diode	04713	1N5234	4					
25	D3,4,9, 201-210	3-20000	Diode	04713	1N4148	15					
	105, 106										
26	D100,101, 7, 8	3-20028	Diode, Schottky	28480	1N5711	4					
27											
28	D11, 10, 5. 6	3-20015	Diode Rectifier 1A	--	1N4007	4					
29	IC3	3-30104	Op Amp Bifet uncompensated	27014	LF357H	1					
30	IC1, 2, 4, 102	3-30090	Op. Amp	27014	LF356N	4					
31	IC101	3-30125	Op. Amp	27014	LH0062CH	1					
32	IC103	3-30211	Intrut Amp	13919	INA101BM	1					
33	IC201, 202	3-30177	Octal Latch	27014	SN74LS374N	2					
34	IC203	3-30164	HEX Buffer	27014	7407	1					
35	IC104	3-30013	Op. Amp	27014	LM301N	1					
36	IC105	3-30321	Dual Fet Op-Amp	AD	AD642JH	1					
37	IC106	3-30073	Comparator	27014	LF311H	1					
38	R22	1-10006	Res., 100K, 1%		RN60C1003F	1					
39	R42, 44, 111,	1-01061	Res., 10K, 1/4W, 5%		RC07GH103F	10					
	121,2,21,39,40,134,137										
40	R1	1-10079	Res., 30.1K, 1/4W, 5%		RN60C3012F	1					
41	R119	1-01050	Res., 3.3K, 1/4W, 5%		RC07GF332F	1					
42	R6, 24, 123	1-01021	Res., 100 ohm 1/4W, 5%		RC07GF101J	3					
43	R7, 25	1-01083	Res. 150K, 1/4W, 5%		RC07GF154J	2					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	VOLTAGE OUTPUT AND FEEDBACK P. C. B. ASSY.	MODEL 2703	DWG NO 2703-605	REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
44	R16	1-30038	Res 7.5 ohm 1W 5%	--	RC32GF7R5J	1					
45	R9	1-10179	Res., 54.9 ohm 1%	81349	RN60D540F	1					
46	R10	1-10143	Res., 453 ohm 1%	81349	RN60C453OF	1					
47	R11	1-10084	Res., 4.53K, 1%	81349	RN60C4531F	1					
48	R13, 135, 139	1-01033	REs. 470 ohm 1/4W, 5%	81349	RC07GF471J	3					
49	R15,28,109,113 114,122,201	1-01041	Res. 1K, 1/4W, 5%	81349	RC07GF102J	7					
50	R19, 17	1-30017	Res. 15 ohm, 1W, 5%	81349	RC32GF150F	2					
51	R18,115,125,126	1-01053	Res., 4.7K, 1/4W, 5%	81349	RC07GF472J	4					
52	R20, R3	1-10008	Res., 10K, 1%	81349	RN60C1002F	2					
53	R23	1-01045	Res., 2K, 1/4W, 5%	81349	RC07GF202J	1					
54	R29, 31	1-30015	Res., 27K, 1W	81349	RC32GF2702F	2					
55	R41, 43,138	1-01100	Res., 1Mohm, 1/4W, 5%	81349	RC07GF105J	3					
56	R45	1-30021	Res., 22 ohm, 2W	81349	RC42GF220J	1					
57	R100	1-30020	Res., 4Mohm, .1%	caddock	TF050N-4M 5PPM-.1%	1					
58	R101, 110	1-10048	Res., 1Mohm, .1%	81349	RN65C1004B	2					
59	R102	1-10180	Res., 250K, .1%	80031	UPR5063ZA	1					
60	R103	1-10181	Res., 444.4K, 1%	80031	UPR5063ZB	1					
61	R104	1-10182	Res., 44.44K, 1%	80031	UPR5063ZA	1					
62	R105	1-10183	Res., 111.1K, .1%	80031	UPR5063ZA	1					
63	R106	1-10184	Res., 40K, 1%	80031	UPR5063ZA	1					
64	R107	1-10185	Res., 11.11K, .1%	80031	UPR5063ZA	1					
65	R108, 127, 128	1-10186	Res., 4.444K, 1%	80031	UPR5063ZA	3					

NOTES:

Valhalla Scientific Inc.	PARTS LIST	VOLTAGE OUTPUT AND FEEDBACK P. C. B. ASSY.	MODEL 2703	DWG NO 2703-605	REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
66	R112	1-01051	Res. 3.9K, 1/4W, 5%	81349	RC07GH392J	1					
67	R120, 130, 131	1-01119	Res. 10M ohm 1/4W 5%	81349	RC07GF106J	3					
68	R136	1-01081	Res. 100K ohm 1/4W 5%	81349	RC07GF104J	1					
69	R124	1-01013	Res. 33 ohm 1/4W 5%	81349	RC07GF330J	1					
70	R129	1-10187	Res 1.2K .1%	80031	UPR5063ZA	1					
71											
72	R132	1-20015	Res. 591.45K .05%	Elliot	E1 27	1					
73	R133	1-10188	Res. 133ohm 1%	80031	UPP5063ZA	1					
74	R12	1-01026	Res. 220 ohm 1/4W 5%	81349	RC07GF221J	1					
75											
76											
77	RLH, RLL, RLA	5-03012	Relay, 1 pole, 5V, Reed	Sigma	191TE1A-55	5					
	RLF, RLG										
78	RLB, RLC, RLD	5-03072	Relay, 2 pole, C/O, 5V	Aromat	DS2E-DC5V	6					
	RLE, RLK										
79											
80											
81	RV 1, 2	1-50035	Res. Variable 50K	73138	89PR-50K	2					
82											
83	TR2, 3	3-10012	Transistor VMOS	17856	2N6657	2					
84	TR4	3-10019	Transistor PNP	04713	MPS-U60	1					
85	TR5	3-10026	Transistor	17856	VN10KM	1					
86											

NOTES:

Valhalla Scientific Inc.	PARTS LIST	VOLTAGE OUTPUT AND FEEDBACK P. C. B. ASSY.	MODEL 2703	DWG NO 2703-605	REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
87	TR100	3-10023	Dual N Channel FET	27014	2N3958	1					
88	TR101, 105	3-10013	Transistor NPN	27014	2N4401	2					
89	TR102-104, 1	3-10010	Transistor PNP	27014	2N4402	4					
90											
91											
92		5-10025	Heatsink to -3	13103	6003-B-2	2					
93			Screw, Phil, pan CAD		6-32 X 1/2	4					
94			Washer, split lock		#6	4					
95											
96											
97		5-10310	Socket, 10-way	Molex	22-15-2106	5					
98		5-10315	Socket, to -3	83330	6243	2					
99											
100		4-10389	Shield Front	53504	2703-216A	1					
101		5-10216	Standoff		2323	3					
102			Screw, Phil, pan, CAD		6-32 x 3/8	6					
103			Washer, Int., Star		#6	6					
104											
105											
106											
107											
108											
109											

NOTES: Sht. 6 is assy. drawing

Valhalla Scientific Inc.

PARTS LIST

2703 IEEE P. C. B. ASSEMBLY

MODEL 2703

DWG NO 2703-608

REV E

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
1											
2											
3		4-30091	P. C. Board	53504	2703-708	1					
4	D1-6	3-20028	Diode Signla Schottky		1N5711	6					
5	C1	2-10006	Cap., .01uf, 50V, Cer.		8121-050-651-103M	1					
6	IC1	3-30162	Octal Bus Transceiver	01259	74LS245N	1					
7	IC3	3-30158	GPIA	04713	MC68488P	1					
8	IC4, 5	3-30157	Octal Bus Tranceiver	04713	MC3447P3	2					
9		or	P. C. B. Assy.	53504	2724-604	1					
10	RN1	1-40003	Res. Net 10K	Allen	316A-103	1					
11	IC2	3-30156	Octal Buffer	04713	74LS541N	1					
12	SW1	5-03037	Switch, Dil, 5 Pos.	Alco	DBS-5	1					
13											
14	SK1	5-10345	Cable , Ribbon 20 pin	53504	2703-053	1					
15											
16	SK2	5-10268	Receptacle	Amph.	57-20240-14	1					
17											
18		5-10244	Connector, Hardware	Amp.	552633-3	1					
19		5-10487	Spacer,1/4dia.1/4lg.swage#6	RAF	1533-B-6-A-O	5					
20			Washer, split lock		#8	2					
21			Nut, Hex		4-40	2					
22			Washer Flat		#4	2					
23											

NOTES: Sheet 2 is assy. drawing

Valhalla Scientific Inc.	PARTS LIST	POWER SUPPLY P. C. B. ASSEMBLY	MODEL 2703	DWG NO 2703-609	REV C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
1			P. C. B. Assy. Power Sup.	53504	2703-609	X					
2											
3	A9	4-30092	P. C. Board	53504	2703-709	1					
4											
5											
6	C1, 7	2-40012	Cap. Elec. 15000uf, 10V	Illinois	159TTA0108	2					
7	C2, 8, 9	2-40030	Cap, Alum., 220uf, 16V			3					
8	C3, 4	2-40017	Cap., Elec., 2200uf, 35V	Illinois	228TT035B	2					
9	C5, 6	2-40014	Cap, Elec., 100uf, 25V	Illinois	107TTA025B	2					
10	C10, 11	2-60002	Cap, Mylar, .1uf	Illinois	225P10491	2					
11											
12	D1, 2, 4, 5	3-20021	Diode, Rect., 20V	04713	1N5821	4					
13	D3	3-20027	Diode, Bridge, 100V	04713	3N247	1					
14											
15											
16											
17											
18	IC1, 2, 5	3-30042	Reg., 5V, Pos.	83781	MC7805CK	3					
19	IC3	3-30036	Reg. 15V, Pos.	83781	7815	1					
20	IC4	3-30037	Reg., 15V, Neg.	83781	7915	1					
21											
22	SK1	5-10310	Socket 10-way	Molex	22-15-2106	3					
23											

NOTES:

Valhalla Scientific Inc.

PARTS LIST

POWER SUPPLY
P. C. B. ASSEMBLY

MODEL: 2703

DWG NO: 2703-609

REV: C

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
24											
25		5-10025	Heatsink to -3	13103	6003B-2	3					
26		5-10211	Heatsink to -220	13103	6106B-14	2					
27			Screw, Phil, Pan, CAD		6-32 x 3/8	8					
28			Washer, Inter. Star		#6	8					
29			Nut, Hex, Std.		6-32	8					
30											
31											
32											
33											
34											

NOTES: Sheet 3 is assembly drawing

Valhalla Scientific Inc.	PARTS LIST	250 VOLT OUTPUT P. C. B. ASSEMBLY	MODEL 2703	DWG NO 2703-610	REV H

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY. I	QTY. N	I	N		REMARKS
1	A10		P. C. B. Assy, 250V	53504	2703-610	X					
2											
3		4-30093	P. C. B. Mech. 250V	53504	2703-710	1					
4											
5	C9	2-20013	Cap., Mica 100pf	81349	CM05FD101J03	1					
6											
7	D5, 6	3-20017	Diode, Zener, 9.1V	04713	1N5239	2					
8			Ring lug #4 22 AWG		Ring lug solderless	1					
9	TR5-8	3-10020	Transistor VMOS	IR	IRF432 or 431	4					
10			Wire Blue 22AWG		22AWG Blue	4"					
11	R32	1-01048	Res. 2.7K ohms	81349	RC07GF272J	1					
12	R33, 34, 35	1-30021	Res. 22 ohm W	81349	RC42GF220J	3					
13	R36, 37, 38, 45	1-30014	Res. 47K 1W	81349	RC32	4					
14			Washer Internal Star		#4	1					
15		4-10369	Heatsink	53504	2703-211	1					
16		5-10232	Washer to -3	Berquist	7403-09FR-06	4					
17		5-10315	Socket, to -3	83330	6243	4					
18			Screw, Phil, pan CAD		6-32 x 1/2	8					
19			Washer, star		#6	8					
20		5-10321	Socket, 10-way	Molex	22-14-2101	1					
21			Screw phil pan SS		4-40 x 1/4	1					
22	XF1	5-10269	Fuse Clip	Zierick	926	2					
23	F1	5-04007	Fuse 1/2A		.5A slo-blo	1					

NOTES: Sheet two is assembly drawing

Valhalla Scientific Inc.

PARTS LIST

MOTHER BOARD ASSY.

MODEL 2703

DWG NO 2703-611

REV B

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
1	A11		MOTHER P.C.B. ASSY.	53504	2703-611	X					
2											
3		4-30102	MOTHER P.C.BOARD	53504	2703-711	1					
4											
5		5-10330	BEAD PIN	27264	R62-3	50					
6		5-10310	SOCKET 10 WAY	MOLEX	22-15-2101	2					
7		5-10313	WAFER ASSY 10 PIN	27264	22-03-2101	20					
8		5-10332	WAFER ASSY 10 PIN	CA	CA-S105P-230T-1.23	1					
9		5-10019	TY WRAP 3 1/2"	DENNISON	WRN 3.5	5					
10		4-10372	DUAL CARD GUIDE	53504	2703-214	2					
11		5-10266	STRIP RUBBER ADHES.	ACCURATE	1/2 X 3/16 NEOPRENE	1					3 INCHES LG.
12											
13		5-10294	SOCKET IC. 20 PIN	BURNDY	DILB20P-108	1					
14		5-10331	CLASPON SOCKET	27264	02-06-1103	4					
15		5-10016	WIRE, COAX 20IN.	81349	RG174	1					
16			TUBING, SHRINK		1/16 DIA	AR					
17			SCREW PHIL PAN CAD	81349	6-32 X 1/2	4					
18			WASHER, INT. STAR	81349	#6	4					
19			WIRE, BLK 3IN		22 AWG	1					
20											
21											
22											
23											

NOTES: SEE SHT. 2 FOR ASSY. DWG.

Valhalla Scientific Inc.	PARTS LIST	250V POWER SUPPLY PCB ASSY	MODEL 2703	DWG NO 2703-612	REV B

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	QTY I	QTY N	I	N		REMARKS
1											
2											
3		4-30094	P.C.B. PWR. SUP	53504	2703-712	1					
4											
5	C1, C2	2-40006	CAP. 1000µf 350V	90201	CGS102T350V4C	2					
6	C3, C4	2-20013	CAP. 100pf 500V	81349	CM05FD101J03	2					
7	D1, 2, 3, 4	3-20015	DIODE	04713	1N4007	4					
8											
9											
10	SK1	5-10310	CONN. RIGHT ANGLE	MOLEX	22-15-2101						
11	R1, 2	1-30019	RES, 100K, 1W		RC32GF104J	2					
12											
13		5-10328	BRACKET, ANGLE	ZIERICK	251	2					
14			SCREW, PHIL, PAN, CAD		6-32 X 1/4	2					
15			WASHER, STAR		#6	2					
16			NUT, HEX		6-32	2					
17											
18			WASHER, STAR		#10	2					
19											
20											
21											
22											
23											

NOTES:

Valhalla Scientific Inc.

PARTS LIST

CONVERT 2703 INTO into 2705

MODEL 2705

DWG NO 2705-400

REV E

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
1			Complete 2703	53504	2703-400	1					
	Delete	2703-603	Frequency Gen. P. C. B. Assy	53504	2703-603	1					Chassis Assy. Parts List
2	Add	2705-604	Phase Gen. PCB Assy	53504	2705-604	1					2703-400
	Delete	4-10455	2703 Front Panel	53504	2703-100	1					Front panel Assy. Parts List
3	Add	4-10468	2705 Front Panel	53504	2705-100	1					2703-401
4	Add	5-10349	Interconnect cable	53504	2705-050	1					
5	Add	5-10333	Cable, 15 pin D	53504	2703-055	1					
6			Screw Phil pan SS		4-40 1/2"	2					
7			Nut Radio Hex		4-40	2					
8			Washer split lock		#4	2					
9											
10	Delete P1	5-10064	Conn, BNC Male		31-010	1					

NOTES: This parts list is used to convert a Model 2703 into a Model 2705

SHT 1 OF 1

Valhalla Scientific Inc.	PARTS LIST	P. C. B. ASSEMBLY PHASE GENERATOR	MODEL 2705/09/13	DWG NO 2705-604	REV F

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	qty. I	qty. N	I	N		REMARKS
			P. C. B. Assembly			X					
1		4-30089	P. C. Board		2705-704	1					
2	C1	2-60004	Cap, paper .01uf		418P10396KD3	1					
3	C2, 3	2-20009	Cap, Mica 470pf		CM05FD471J03	2					
4	C4-7	2-20011	Cap, Mica 1000pf		CM06FD102J03	4					
5	C8	2-30014	Cap, Tan 100 uf		T390E107M010AS	1					
6	C9-14	2-30001	Cap, Tan 10uf		T390C106M025AS	6					
7	C15-25	2-60002	Cap, paper, .1uf		225P10491	11					
8											
9											
10	IC1, 3	3-30185	Quad Opto-Coupler		ILQ-74	2					
11	IC2	3-30186	Dual Opto-Coupler		HCPL-2630	1					
12	IC4	3-30093	Opto Coupler		HCPL-2601	1					
13	IC5, IC 26	3-30061	Quad and Gate		74LS08N	2					
14	IC6	3-30184	Hex Inverter		74LS04N	1					
15	IC7, IC10, IC17	3-30002	Quad Nand Gate		7400N	3					
16	IC8	3-30156	Octal Bus Driver		74LS541N	1					
17	IC9	3-30324	Triple 3-in nor gate		74LS27N	1					
18	IC11, 12 16, 19	3-30095	Dual D type Flip-flop		74LS74N	4					
19	IC13, 14, 18	3-30175	Dual one shot		74LS123N	3					

NOTES: Sheet four is assembly drawing

Valhalla Scientific Inc.	PARTS LIST	P. C. B. ASSEMBLY PHASE GENERATOR	MODEL 2705/09/13	DWG NO 2705-604	REV F

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
20	IC15	3-30176	Dual Binary counter		74LS393N	1					
21	IC20, 21, 28	3-30177	Octal Latch		74LS374N	6					
	29, 33, 34										
22	IC22, 23, 30, 31	3-30109	Binary counter		74LS191N	4					
23	IC24, 32	3-30047	Decade Counter		74LS190N	2					
24	IC25	3-30193	Quad Data Selector		74LS157N	1					
25	IC27	3-30331	Dual J-K Flip-flop		7476N	1					
26	IC35	3-30010	Quad XOR gate		7486N	1					
27	IC36, 37	3-30194	Binary Counter		74LS163N	2					
28	IC38	3-30323	Decade counter		74LS162N	1					
29											
30											
31	R1-3, R11-14	1-01033	Res., Fxd. 470 ohm 1/4W		RC07GF471F	7					
32	R4-7	1-01066	Res., Fxd. 22 K ohm 1/4W		RC07GF223F	4					
33	R8	1-01061	Res., Fxd 10K ohm 1/4W		RC07GF103F	1					
34	R9, 10	1-01041	Res., Fxd. 1K ohm 1/4W		RC07GF102F	2					
35											
36											
37	RN1, RN2	1-40001	Res., net 470 ohm		316B-471	2					
38	RN3	1-40003	Res., Net 10K ohm		316A-103	1					
39											
40											

NOTES: Sheet four is assembly drawing

Valhalla Scientific Inc.	PARTS LIST	P. C. B. ASSEMBLY PHASE GENERATOR	MODEL 2705/09/13	DWG NO 2705-604	REV F

#	REF DES	VALHALLA PART NO	DESCRIPTION	CODE IDENT	MFG PART NO	Qty. I	Qty. N	I	N		REMARKS
41	SK1	5-10310	Socket - 10 way		22-15-2101	4					
42	SK2, SK3	5-10008	Socket 16 pin DIL		C8416-01	2					

NOTES:

Sheet 4 is assembly drawing