



# Wizards Workshop

\*\*\*\*\*  
\*\* ALL SERVICE QUESTIONS FROM EUROPE, MIDDLE EAST, \*\*  
\*\* AND AFRICA SHOULD BE ADDRESSED TO THE EUROPEAN \*\*  
\*\* MARKETING CENTER SERVICE GROUP IN THE NETHERLANDS. \*\*  
\*\*\*\*\*

TEKTRONIX INTERNAL USE ONLY

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## LABORATORY INSTRUMENT DIVISION

### SEMICONDUCTOR TEST SYSTEMS

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## PERSONNEL CHANGES

Ron Morris has announced that the IDD Field Service Supervisor position in Santa Clara has been accepted by Frank Spina. Frank comes to his new position as a transfer from the in-house service operation. His previous position was Service Center Supervisor in Santa Clara.

Frank's area of responsibility will be IDD Service for the city of San Francisco and the Southern Bay Area.

We all join Ron in welcoming Frank to his new position and wish him continued success.

\*\*\*\*\*

Please join the Albuquerque Service Center in congratulating Dick Dodrill on his promotion to Electronic Technician III. Dick started with TEK as an ET I in 1976.

Congratulations Dick!

\*\*\*\*\*

Please join Rockville in congratulating the following people on their recent promotions:

Dwight Ball, ET-I  
Bobby Edwards, ET-II  
Rick Gigliotti, ET-II  
Jerry Harrington, ET-II

Jim Mauck, ET-II  
Jeremy Parsons, ET-II  
Tom Zullinger, ET-II

Congratulations One and All!

\*\*\*\*\*

Also, please join Irvine T&M Service in welcoming three new hires to Tek.

Chris Winfrey is a new Jr. Electronic Technician. She is in her second year of technical studies and plans on pursuing an engineering career.

Kevin Ruhl is a new Electronic Technician I. Kevin will be graduating from Long Beach State in June with a BS Degree in Industrial Technology. He has prior electronics experience with Cal Comp.

Ken Worley is a new Electronic Technician II. He comes to Tek with seven years experience in repair and calibration of all technical equipment at Harvey Mudd College. Prior to that Ken spent 20 years in the U.S. Air Force.

Welcome and we all wish you much success in your career with Tektronix!

\*\*\*\*\*

--Editor



GENERAL

ANNOUNCEMENT OF CALIBRATION FIXTURES CATALOG

Tektronix 1980 edition of the Calibration Fixtures Catalog is off the press. This 8½ x 11", 3 hole punched, 24 page publication describes the calibration fixtures not found in the Tektronix Instruments Catalog. Part numbers and descriptions of each item are contained in the catalog and photographs of many fixtures and alignment tools are included. For your copy of this publication please write to Beaverton, attention Jerry Hogan, at 76-260. Ask for the 1980 Calibration Fixtures Catalog, AX 4400.

Submitted by--  
Tom Jones

Inserted by--  
Editor

P/N 285-0938-00: DEFECTIVE DATE CODES

Manufacturing Engineering Component Support has discovered that "Capco Brand" capacitors, P/N 285-0938-00, with Date Codes 7935 through 7951 inclusive have not had oil impregnation. Please purge all "Capco Brand" capacitors, with the noted date codes, from all stock areas and kits. Reorder as necessary.

--Rich Andrusco  
94-816, Ext. 1582

OPTO COUPLER/ISOLATORS - DEFECTIVE DATE CODES

Date Codes 7952 through 8013 of the below listed subject part numbers have a high percentage of defective parts (Motorola Brand):

Part Numbers

156-0399-00	156-0907-00
156-0885-00	156-0885-01

Please purge all Date Codes listed for the above part numbers from all stock areas and reorder as necessary.

--Rich Andrusco  
94-816, Ext. 1582

## TROUBLESHOOTING YOUR OSCILLOSCOPE - REVISION

This article is a revision to TROUBLESHOOTING YOUR OSCILLOSCOPE (Article 4 - High Voltage Supplies) concerning a double peaking CRT in the CRT conditions section is in order:

Normal relationship between gas and double peaking in a CRT is difficult to judge because almost all double peaking is a transient low temperature symptom during cathode warm-up. Many cathode designs take 15 to 20 minutes to reach temperature equilibrium. During this time interval, double peaking will be the visual indication; however, double peaking is not necessarily a sign of early failure to the CRT. In fact, double peaking before warm-up completion indicates, for that particular CRT, the normal operating temperature is on the low side of normal temperature distributions and almost always indicates that a cathode will have better than normal life expectancy. It is possible for gassy CRT's to double peak but double peaking doesn't necessarily mean a gassy CRT.

Glass helix type CRT's can exhibit static charge, however, as most glass CRT's are obsolete, this phenomenon is more likely to be noticed on older instruments. Rod charge and static charge are increasingly rare as we build and design newer CRT's using better methods and materials.

How should a technician determine whether or not to reject a CRT for double peaking? Use these suggested guidelines:

1. Allow 15 to 20 minutes warm-up time.
2. Be certain CRT filament voltage is correct. Typically  $6.3\text{ V} \pm 3\%$ .
3. Do not reject for double peaking if the concern is premature cathode failure.

If you are interested in a complete package with all eight articles, please contact Maintenance Training ext. 7212 or MS 74-740.

Submitted by--  
Dick Hornicak

Inserted by--  
Editor

## ADMINISTRATIVE SUPPORT

### SERVICE RECORD REPORTING - MODULE EXCHANGE COPY

The Module Repair Center uses information on the service record in the module repair process. The Module Exchange Information Copy accompanying exchanged modules is used for this purpose.

Modules are repaired on an individual basis and are treated as individual jobs. Consequently, if three modules are exchanged and returned to the Module Repair Center, each module might be assigned to a different technician for repair.

In order to ensure each of the modules received have the service record information required for repair, copies are made of the Module Exchange Information Copy and attached to the individual modules.

A good, readable Module Exchange Information Copy is essential to ensure further "xeroxed" copies are readable.

Please use a ball point pen and press hard when making hand-written entries onto the service record.

--Bill Duerden  
53-027, Ext. 8938 Merlo



LABORATORY INSTRUMENT DIVISION

TM500

AM502 DIFFICULTY MEETING 1 MHZ BANDPASS

Manufacturing has experienced bandpass problems when using specific date codes of Teledyne parts for Q162A,B. (P/N 151-1029-00). If Teledyne parts with Date Codes 79-10 through 79-32 are used, your instrument will not meet 1 MHz Bandpass.

--Submitted by  
Dwain Gross

--Inserted by  
Rich Andrusco  
94-816, Ext. 1582

DC505A ERRONEOUS COUNTING AT 10Hz

If you are experiencing erroneous counting at 10Hz with a low input signal ( $\approx 150\text{mv}$  P-P) you should try using a Signetics Brand I.C. for U-780, PN 156-0128-00. Dressing of cables to the display board may also help.

--Rich Andrusco  
94-816, Ext. 1582

DC505A Manual Error

Reference: P/N 070-1984-01, Performance Check

On page 2-12, Step 11-d, the expected readings on the display are incorrect. Instead of between .008 to .112 (kHz) you should look for between .008 to .012 (kHz).

Manual Maintenance has been notified and a manual correction has been submitted.

--Rich Andrusco  
94-816, Ext. 1582

SC503 MAINTENANCE NOTES

Intermittent Triggering (After Warm-up)

Suspect a cold solder joint on A50 R2015, "DC Balance" adjustment, on Trigger Switch Board. Resoldering will usually cure.

Unable to Meet Pre-shoot Spec. of <2%

Suspect A60 C1021 (CH.1) or A61 C1021 (CH.2)

Capacitor may need selecting because of variations in tolerance of part being used. A mod is under evaluation to change the part used to a part with tighter specifications.

--Rich Andrusco  
94-816, Ext. 1582



## 5000 SERIES

### 5000, FLEXIBLE EXTENDER

Tektronix offers a flexible extender to facilitate testing and adjustment of 5000 series plug-ins on the bench. This extender is useful for troubleshooting plug-ins. TM500 has a similar extender, but it is totally incompatible with the 5000 series, and will short out the +5 volt supply and other connections. The part number for the 5000 series Flexible Extender is 067-0645-03 and can be used on all 5100 and 5400 series.

--John Eaton  
58/511, Ext. 6902

### 5400 SERIES READOUT

Reference: 5440 Service Manual P/N 070-2139-01

7 Readout System

5441 Service Manual P/N 070-2140-00

3 Readout System

5444 Service Manual P/N 070-2141-00

3 Readout System

Mod Change #M38269

To increase reliability the transistor socket, P/N 136-0220-00, for Q1052 is being removed, and the transistor being soldered directly into the board. To perform the readout calibration, Q1040 is now being removed to set CRT readout to all "zeros." Q1040 is the metal cased, dual transistor, located above Q1052 on the readout board.

--John Eaton  
58/511, Ext. 6902

## 7000 SERIES

### 7603, H.F. ADJUSTMENT

Reference: 7603/R7603 Service Manual P/N 070-1429-00  
Section 3, Calibration

The Tektronix Calibration Fixtures part numbers 067-0587-00 and 067-0587-01 are no longer available. They have been replaced by P/N 067-0587-02. To make the calibration procedure conform to the new calibration fixture, the following changes should be made to the 7603/R7603 Service Manual.

- Step 11. Adjust Bias Adjustment  
Part C. Set the calibration fixture rep rate switch to 100kHz.
- Step 14B Adjust Thermal Compensation  
Part A. Set the calibration fixture rep rate switch to 10kHz.  
Part B. Set the time-base unit sweep rate for 20 $\mu$ s/div  
Part E. Set the calibration fixture rep rate switch to 100kHz, and set the time-base unit sweep rate for 2 $\mu$ s/div.  
Part G. Set the calibration fixture rep rate switch to 1mHz, and set the time-base unit sweep rate for 1 $\mu$ s/div.
- Step 15. Adjust Vertical High-Frequency Compensation  
Part A. Set the calibration fixture rep rate switch to 1mHz.

The above procedure changes can only be used with the 067-0587-01 and 067-0587-02 calibration fixtures.

--John Eaton  
58/511, Ext. 6902

### 7904, H.F. ABERRATION SPECIFICATION CORRECTION

Reference: 7904 Instruction Manual P/N 070-2390-00  
Section D Performance Check and Adjustment  
B260000 & Up  
WIZARD'S WORKSHOP Issue 10-6

The aberration specification in the newer manuals, B260000 and up, are incomplete, and were stated wrong in WIZARD'S WORKSHOP Issue 10-6. From the step to 50 nanoseconds, the specification should read 5% or less, not 2% as stated.

--John Eaton  
58/511, Ext. 6902

COMMUNICATIONS DIVISION

TELEVISION PRODUCTS

520A, CALIBRATION PROCEDURE CHANGE

Reference: 520A Manual P/N 070-1709-00

Step 14, Page 2-11 of 520A calibration procedure calls for Q570 and Q571 to be removed from their respective sockets. Q570 and Q571 are no longer being put in sockets but soldered in. To adjust the Luminance Calibrator without removing Q570 and Q571 use the following procedure:

INSTALL: 7A13, 7B53A\* into mainframe  
SET: 7A13--Both inputs to DC coupling, sensitivity to 5 millivolts.  
7B53A--To 0.1 milliseconds  
520A--Depress A CAL, Full field, A Ø, and Y Pushbuttons.  
PG506--Standard Amplitude, 1 Volt.  
CONNECT: X1 Probe from 7A13 Channel A input to TP583 in the 520A. Connect 1 volt square wave from PG506 to B input of 7A13.  
ADJUST: R583, Luminance Cal to null the display on scope.

\*Or equivalent.

This procedure will work for units with sockets as well. A manual correction has been implemented. Thanks to Bob Anderson, Santa Clara Service Center, for bringing this to our attention.

--Steve Schmelzer  
58/511, Ext. 6507

## 520A/R520A, PART NUMBER CHANGE FOR PUSH BUTTON KNOBS

Reference: 520A Manual P/N 070-1709-00  
Modification M39283

Four push button knobs on the 520A/R520A have red lettering on them. These knobs are being received with various shades of red causing a quality problem. It has been decided that the red lettering is unnecessary. New part numbers are as follows:

<u>OLD NOMENCLATURE</u>	<u>OLD NUMBER</u>	<u>NEW NOMENCLATURE</u>	<u>NEW NUMBER</u>
VECTOR/SET VIRS to IØ	366-1448-00	VECTOR	366-0480-00
Y/VIDEO LEVEL	366-1449-00	Y	366-0474-00
I/CHROMA GAIN	366-1450-00	I	366-0476-00
Q/BURST Ø	366-1451-00	Q	366-0463-00

These parts are also used in 520/R520 instruments.

--Steve Schmelzer  
58/511, Ext. 6507

## 528, SYNC SWITCH AND DC RESTORER SWITCH CHANGED TO CORRECT INTERMITTENT MALFUNCTION

Sync switch, SW85 (260-0816-00), and DC Restorer switch, SW120 (260-0816-00), have been changed to part number 260-1833-00. Use this number when replacing SW85 or SW120. This switch is a direct replacement.

--Steve Schmelzer  
58/511, Ext. 6507

## 529/RM529, UPDATE FOR CRT REPLACEMENT KIT

The 050-0365-10 parts replacement kit has been updated. It contains parts and instructions to modify older 529 monitors to accept the 154-0514-10 CRT.

Effective Serial Numbers: 529 100-2929  
RM529 100-6109

Serial numbers above those listed or if this kit is already installed, may use the 154-0514-10 as a direct replacement.

--Steve Schmelzer  
58/511, Ext. 6507

## 1480 SERIES, CORRECTION FOR INCOMPLETE D.C. RESTORER TURN-OFF

Reference: 1480 Series Manual P/N 070-2338-00  
Modification 39711

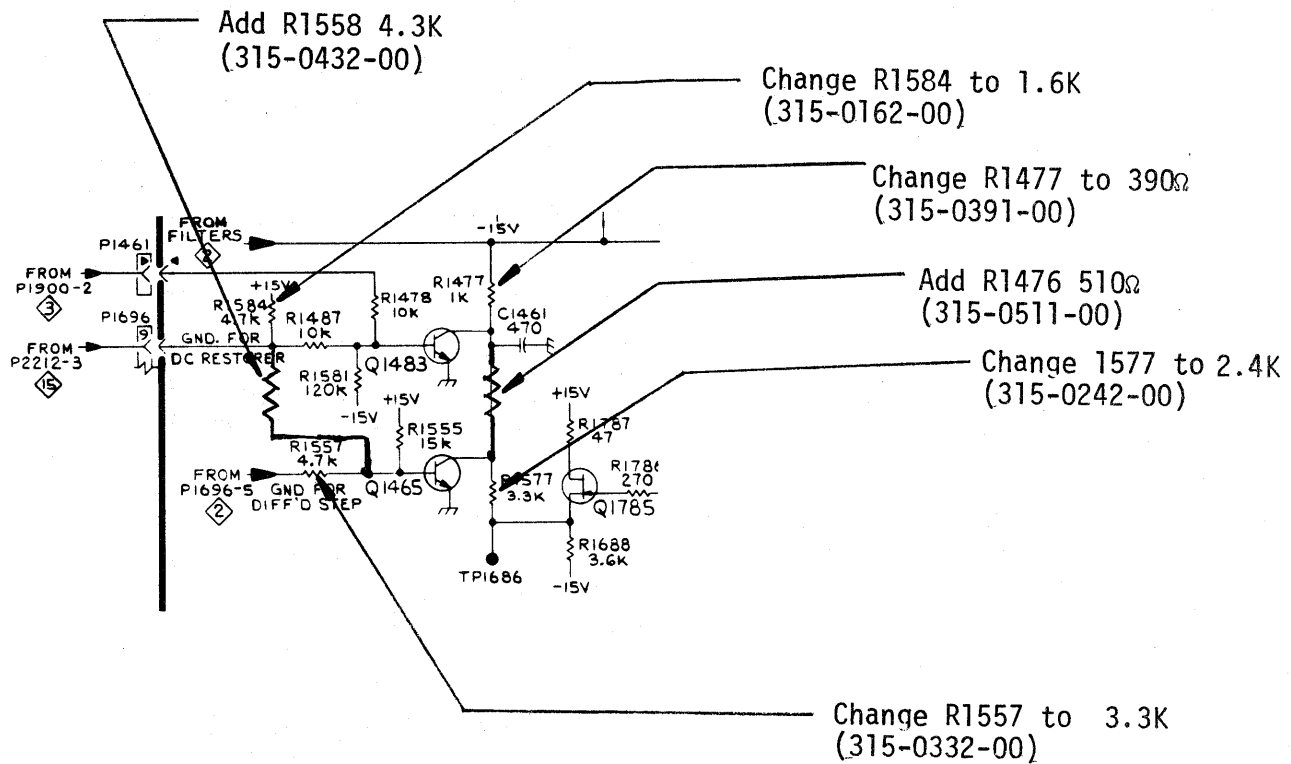
In the 1480C/1480R series waveform monitors, when the D.C. Restorer off button is pushed the restorer circuitry is not completely disabled. To check for this malfunction a slow ramp (period greater than 5 seconds) from an FG501 or equivalent is used. Set the controls to: Channel A or A-B, DC coupling, DC restorer off, and the field sweep. Center the trace on screen. Apply the ramp signal to channel A and adjust for a signal that will move the trace up and down approximately full screen. If the unit has the problem the trace will move up close to mid-screen, stop momentarily, and then jump up to correct level and continue moving to top screen.

To correct this malfunction:

1. Change R1557 from 4.7K to 3.3K (315-0332-00)
2. Change R1584 from 4.7K to 1.6K (315-0162-00)
3. Add R1558, 4.3K (315-0432-00) between the junction of R1557 - R1555 and the junction of R1584 - R1487.
4. Change R1477 from 1K to 390 ohms (315-0391-00)  
When changing R1477, leave the end of R1477 that was connected to R1577 lifted.
5. Lift the collector lead of Q1483 out of the socket and solder it to the lifted end of R1477.
6. Change R1577 from 3.3K to 2.4K (315-0242-00).
7. Add R1476, 510 ohms (315-0511-00) from the junction of R1577 - C1461 - Q1465 to the junction of R1477 - Q1483 that was soldered in Step 5.

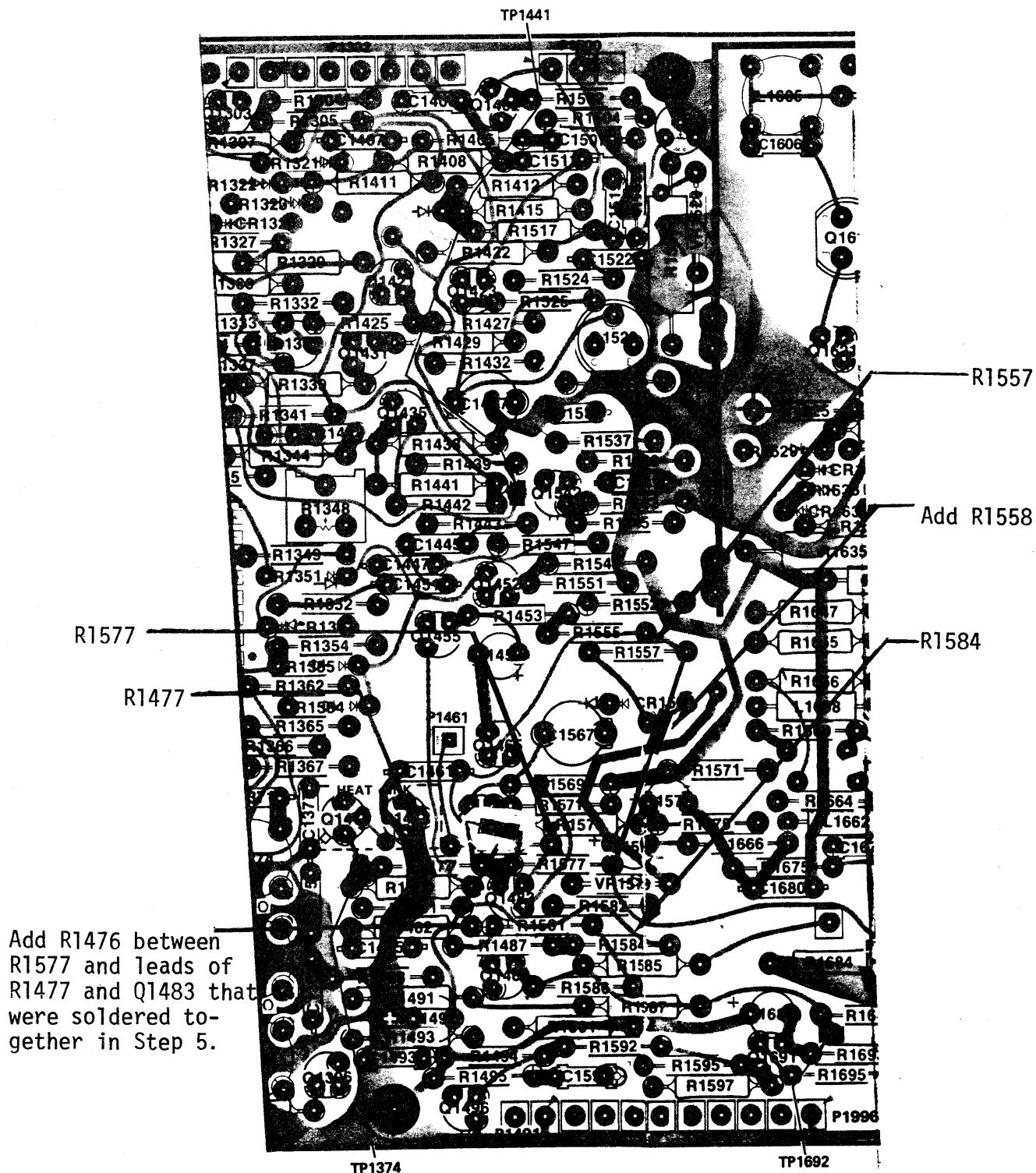
See the following drawing and schematic for location of changes.

1480 SERIES, CORRECTION FOR INCOMPLETE D.C. RESTORER TURN-OFF (CONTINUED)



DC RESTORATION AND GAIN CONTROL  
SCHEMATIC 3

(continued on the following page)



# VERTICAL AMPLIFIER BOARD

--Steve Schmelzer  
58/511, Ext. 6507





## SERVICE INSTRUMENT DIVISION

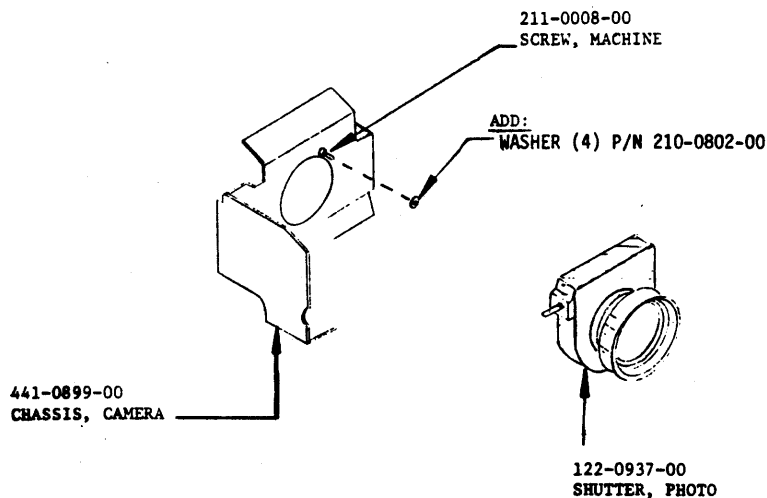
### ACCESSORIES

#### C-51 CAMERA

The C-51 camera focuses at or near the end of adjustment. To allow focusing at the center of adjustment, add \*4 flat washers, P/N 210-0802-00, between the photo shutter and camera chassis. The washers move the shutter forward, increasing the adjustment range.

<u>Quantity</u>	<u>Part Number</u>	<u>Description</u>
* 4 Each	210-0802-00	Washer, Flat, STL (.15ID X .032THK, .3120D)

FIG. 2 CHASSIS, C-51 SERIES  
PARTIAL VIEW



--Dave McKinney  
58/511, Ext. 7072

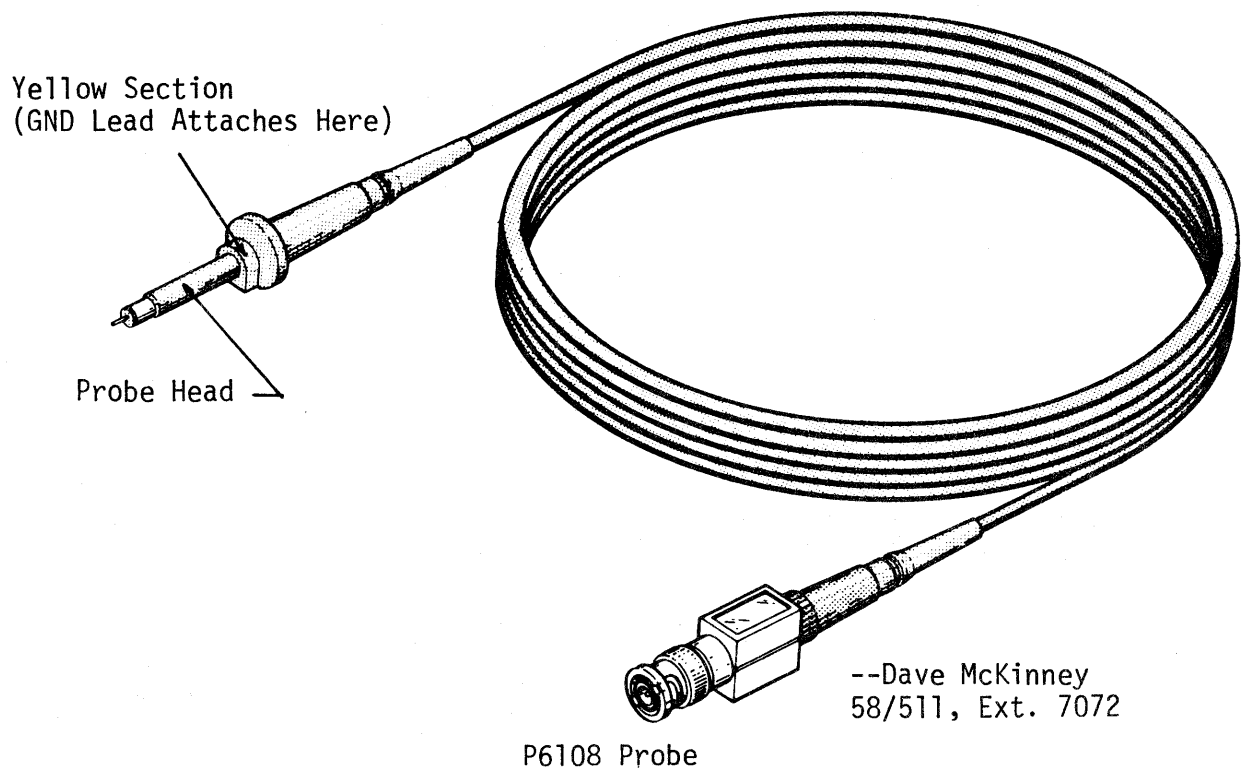
## P6108 PROBE

Reference: Data Sheet P/N 062-1853-00

The P6108 probe is a miniature, 10X, passive probe for use with DC to 100 MHZ oscilloscopes. During the time frame of Week 30, 1979 until Week 12, 1980, approximately 1,000, 2 meter P6108 probes were shipped with a special hybrid circuit in the probe tip.

The difference between a standard P6108 and the hybrid version is on the probe head assembly. \*The ground lead for the probe, snaps into a yellow section on the probe head. There are letters on the top side of this yellow section. The standard version P6108 has white letters and the hybrid version has black. This is the only nonevasive visible difference. When a Service Center replaces a defective probe head assembly P/N 206-0225-00, PLEASE SEND ALL HYBRID VERSIONS TO ME FOR FURTHER EVALUATION.

\*See the following picture for location of parts.



## INFORMATION DISPLAY DIVISION

### 4024/25/27 OPTION 2 AND 11: BAD LOT DATES ON OPTO ISOLATORS

Opto Isolators P/N 156-0907-00 and P/N 156-0399-00 with lot dates 7953 through 8013 have been found to be defective. These parts are used in the Current Loop Interface (Option 2) for the 4024/25/27 and the Polling Interface (Option 11).

Symptoms of these bad lot dates are:

- 1) Communication to a host computer has stopped (4024/25/27 is configured with a Current Loop Interface).
- 2) When the 4024/25/27 is configured with a Polling Controller Interface (Option 11)(Option 11 also includes Option 2) the message "CRC CHECK OK" will not appear on the display. In this case the bad lot dates may either be found on the Current Loop Interface Board (670-5257-0X) or the Polling Controller Interface Board (670-5377-0X).

Please return defective parts to Beaverton at delivery station 70/899. Mark parts "return to vendor, reference MQR #H-129.

--Marty DeVall  
63/503, ext. 3927

### 4027 BATTERY CIRCUIT MOD ON PROCESSOR BOARD AND OPTION 11 PROCESSOR BOARD

Reference: 4027 Service Manual Vol. 1 070-2832-00  
Mod #40083  
4027 Processor Board 670-5720-00  
Option 11 Polling Controller Processor Board 670-5376-03

The 4027 and (or) the Polling Controller Interface Option 11 may lock up upon power up when the battery for the C-MOS RAM is not fully charged. A locked up condition will produce a horizontal line at the top of the display area and a row of cursors down the left side if the battery connected to the 4027 Processor Board is discharged. If Option 11 is installed the message "CRC CHECK OK" will not be displayed if the battery connected to the Polling Controller Processor Board is discharged.

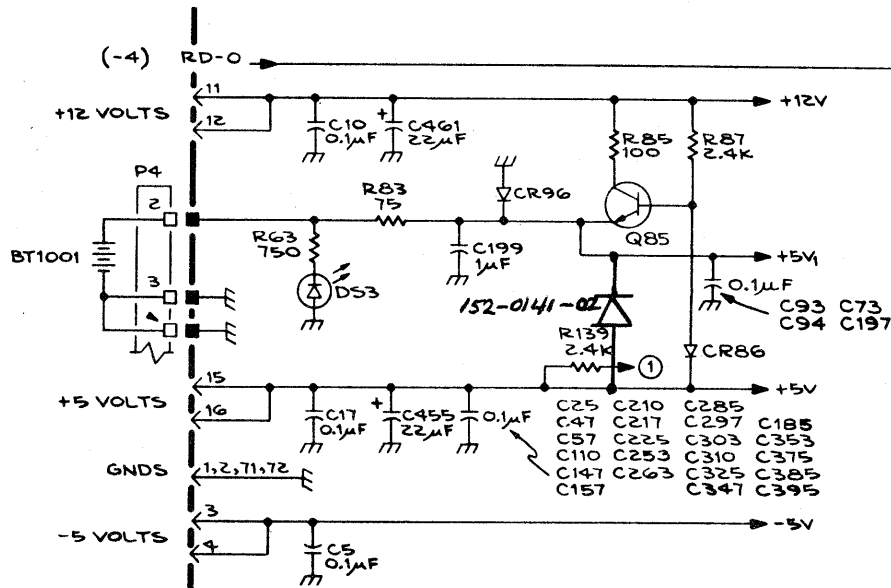
The discharged battery will cause the 5V supply to the C-MOS RAM to drop below 4 volts on power up during the 30 msec delay it takes the +12V supply to come up after the 5V supply. The lowered Vcc voltage to the C-MOS RAM will cause the terminal to lock up. The battery circuit Mod will clamp the Vcc pin (+5 V1) for the C-MOS RAM so it will not drop below 4.4V during power up.

(continued on the following page)

# 4027 BATTERY CIRCUIT MOD ON PROCESSOR BOARD AND OPTION 11 PROCESSOR BOARD (CONTINUED)

## Processor Board Mod:

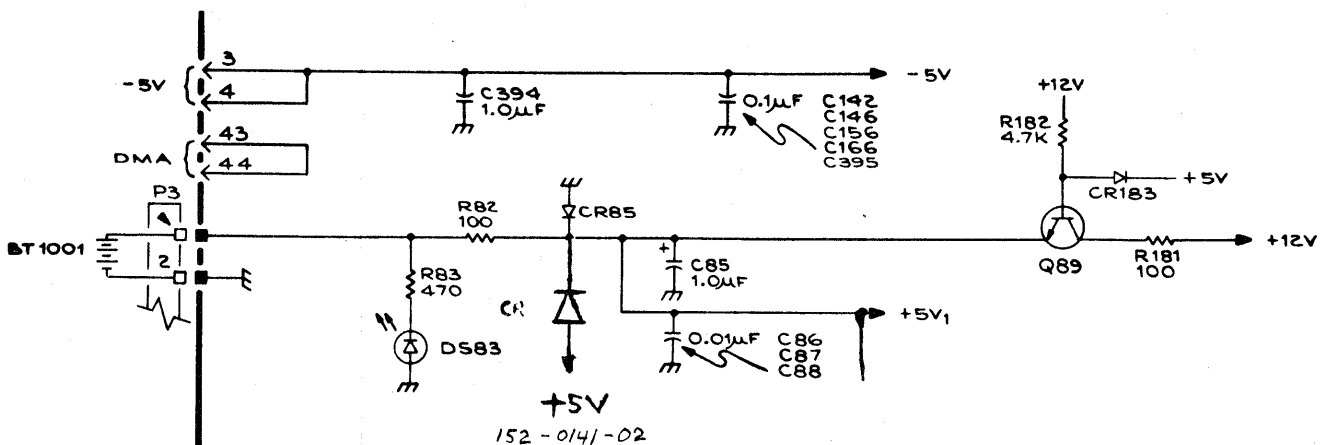
1. Connect the cathode side of diode 152-0141-02 to the pad which connects R88, R90, R92, C93, C94, R95 and CR96 together.
2. Connect the anode side of diode 152-0141-02 to the cathode side of CR86. The side closest to the edge of the circuit board.



4025/27 Processor Board Battery Circuit

## Polling Controller Processor Board Mod:

1. Connect the anode side of diode 152-0141-02 to the anode of CR185.
2. Connect the cathode side of diode 152-0141-02 to the top of R186. Face edge connector towards the left and components facing up.



## Option 11 Battery Circuit

4027 BATTERY CIRCUIT MOD ON PROCESSOR BOARD AND OPTION 11 PROCESSOR BOARD (CONTINUED)

TEKTRONIX INTERNAL USE ONLY

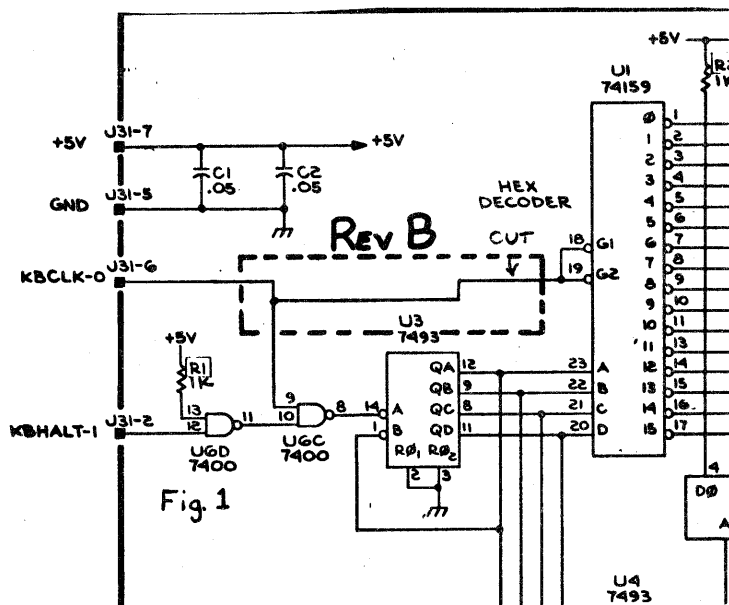
Manufacturing is installing this Mod in the 4025 also because both Processor Boards 670-5055-XX and 670-5376-XX are used in both the 4025 and 4027 instruments. Because the 4027's power supply comes up differently than the 4025 at power up, the problem only exists in the 4027's. Field Service should only install this Mod in 4027 instruments. Factory Service should install the Mod in all Polling Controller Processor Boards and all 4027 Processor Boards.

## 4051/52/54 KEYBOARD LEVEL B

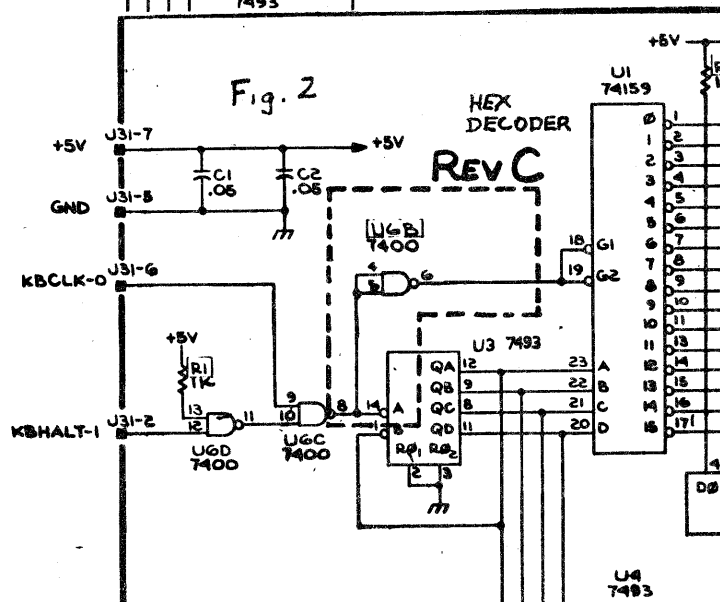
There are a few REV B level (Figure 1) keyboards installed in the 4051/52/54 Graphic Systems, which are incorrect. They should be REV C (Figure 2) keyboards. The problem that occurs is if two keys are pressed at once a string of characters will write across the screen with the REV B level keyboards. If this happens check the level of the keyboard. The location of this label is on the upper right hand corner of the keyboard under the label CHERRY.

The mod #31903 uses the NAND gate of U6B. The mod is as follows. Refer to Figure 1 and Figure 2.

1. Cut the run on top of the REV B keyboard that comes off of pin 18 and 19 of U1. (Figure 1)
2. Strap pin 18 and 19 of U1 to pin 6 of U6. (Figure 2)
3. Strap pins 4, 5 and 8 of U6 together. (Figure 2)



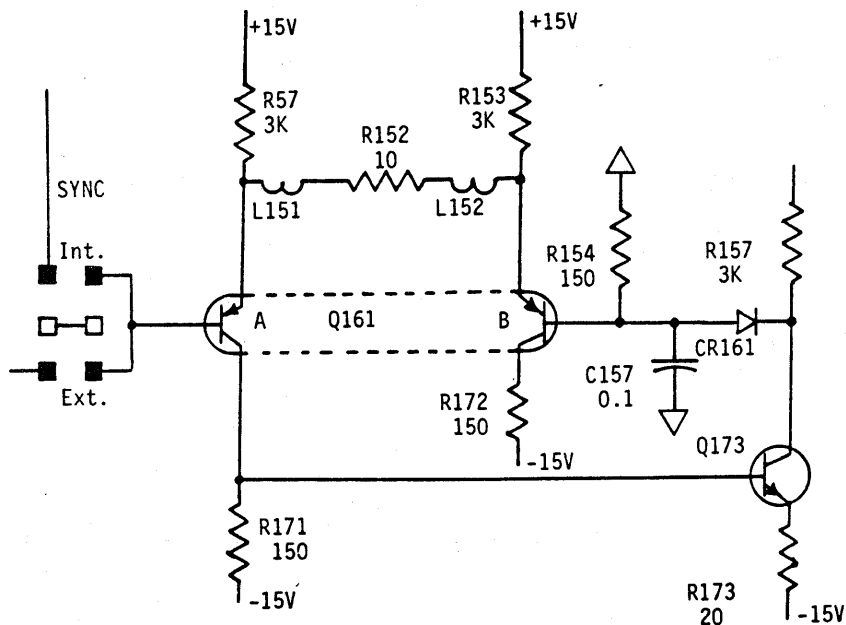
--Darrell McGiverin  
63/503, ext. 3786



#### 4632 OPTION 6: VIDEO INTERFACE MODIFICATION #39499

A herringbone pattern has sometimes been noted on copies produced by the 4632 Option 6 instrument. This effect is especially evident with a five to ten megahertz resolution signal such as that available from the 067-0690-00 and -01 test fixtures. The cause for the pattern is an oscillation of about 750 megahertz in the vicinity of Q161. The oscillation may diminish or disappear when an oscilloscope lead is connected to either end of R152.

To correct this, Mod #39499 calls for two toriodal ferrite beads to surround the leads of R152 and suppress high frequencies. These beads, L151 and L152, are part number 276-0507-00. A partial schematic illustrating their location is given below.



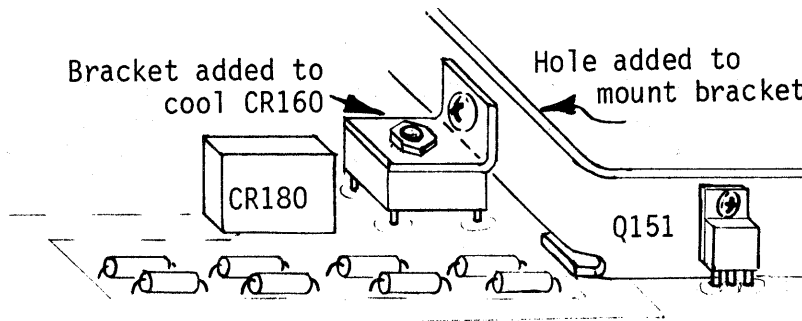
Addition of the two beads changes the part number of the Option 6 video interface assembly from 672-0565-00 to 672-0565-01.

There is no need to modify existing Option 6 assemblies unless the effects of a high frequency oscillation appear evident after replacement of Q161.

--George Kusiowski  
63/503, ext. 3928

#### 4633A MOD JE: MAINBOARD MODIFICATION

To assist the cooling of CR160, a bracket has been added as shown in the figure below. A mounting hole has also been added to the mainboard bracket.



Part number changes accompanying this modification are as follows:

<u>PART</u>	<u>OLD NUMBER</u>	<u>NEW NUMBER</u>
Heatsink Bracket	-----	CM 407-2620-00
Diode Mounting Screw	-----	211-0014-00
Bracket Mounting Screw	-----	211-0097-00
Mounting Nuts	-----	210-0586-00
Mainboard Bracket	CM 407-2563-00	CM 407-2563-01
Mainboard	CM 670-6394-02	CM 670-6394-03

No update of instruments in the field is intended. This article is for your information only.

#### TEKTRONIX INTERNAL USE ONLY

CM part numbers must be ordered as instructed on Parts Notice No. 176.

--George Kusiowski  
63-503, Ext. 3928



## 4663 VERSION 2 FIRMWARE

Version 2 firmware allows Option 32 installation (math character set and downloadable characters) and corrects Option 31 problems. Version 2 firmware is not a Service Update Program, and should be ordered or installed only if a 4663 is exhibiting a symptom Version 2 is known to correct.

Any existing Option 31's which were shipped with the V1 firmware will not function correctly with Version 2 firmware.

There are four major areas where Version 2 firmware has changed part numbers and in Option 32's case, is now firmware compatible.

### 1. ROM Patch B (Patch Board)

<u>V1</u>	<u>V2</u>
670-6114-01	670-6114-02

### 2. ROM Patch Board Firmware

<u>Device #</u>	<u>V1 P/N</u>	<u>V2 P/N</u>
U315	Not Used	160-0273-01
U325	160-0273-00	160-0274-00
U335	160-0281-00	160-0281-01
U345	160-0282-00	160-0282-01

NOTE: Part number 160-0273-00 was mis-labeled for Version 1. In Version 2 firmware U315 is the correct location for 160-0273-01.

### 3. Option 31 (Installed on Processor Board)

<u>Device #</u>	<u>V1 P/N</u>	<u>V2 P/N</u>
U481	160-0185-01	160-0185-02
U475	160-0395-01	160-0395-02

### 4. Option 32 (Installed on Processor Board)

<u>Device #</u>	<u>V1 P/N</u>	<u>V2 P/N</u>
U591	Not used	160-0182-00
U581	Not used	160-0183-00
U575	Not used	160-0184-00
U571	Not used	160-0724-00

(continued on the following page)

There are three (3) 050 Kits that are currently being implemented that will cover these firmware changes.

1. 050-1345-00 will replace the entire ROM Patch B (Board), and old (V1) Option 31 firmware IC's.
2. 050-1335-00 will replace the four (4) old V1 firmware IC's found on the ROM Patch B (Board).
3. 050-1334-00 will replace the four (4) old V1 firmware IC's found on the ROM Patch B (Board) and the old Option 31 firmware IC's.

SUMMARY:

1. Option 32 requires V2 firmware.
2. If the V2 Patch Board firmware is installed in a 4663, the most current level of Option 31 must also be installed.
3. Most of the corrections accomplished by V2 firmware are oriented towards Option 31 and allows Option 32 installation.
4. Order V2 firmware only if required.

--Larry North  
63/503, ext. 3926

## LABORATORY INSTRUMENT DIVISION

### LDP (MDL) SYSTEMS

#### MICROPROCESSOR REFERENCE LIST

The intent of this article is to provide a list of current publications relating to microprocessors used in conjunction with the 800X MDL systems. The publications listed does not constitute a list of all the publications available. Its intent is to provide at least one source of information for each microprocessor currently supported by the 800X MDL systems. The information provided will be sufficient for the publication to be obtained from the publisher.

First, a series a publications by Adam Osborne and Associates, Inc. follows. An Introduction to Microcomputers Volume 1: Basic Concepts is a book that discusses both the basic hardware and software operations performed by a microprocessor. Volume 2 - Some Real Microprocessors discusses the hardware and software specifics of a number of microprocessors. The microprocessors currently used in the 800X MDL system are covered in this volume. Volume 3 - Some Real Support Devices discusses memory devices, parallel and serial input/output devices and a number of other support devices used with microporcessors. These books from the Osborne series can provide a comprehensive source of reference material. Note: A list of foreign distributors is available from Osborne.

Osborne/McGraw-Hill  
630 Bancroft Way, Dept. UB  
Berkeley, California 94710

Volume 1: Basic Concepts, Second Edition  
by Adam Osborne, Book #34-9, price \$12.50  
Order Number ISBN 0-931988-34-9, 320 pp., softbound

Volume 2: Some Real Microprocessors  
by Adam Osborne and Jerry Kane, Book #15-2,  
price \$25.00, 1400 pp., looseleaf unbound,  
Order Number 0-931988-15-2  
Binder #16-0, price \$5.00  
Six Updates #97, price \$25.00, looseleaf unbound  
Order Number ISSN 0190-5783

Volume 3: Some Real Support Devices  
by Jerry Kane and Adam Osborne, Book #18-7  
price \$15.00, 700 pp., looseleaf unbound  
Order Number ISSN 0-931988-18-7  
Binder #19-5, price \$5.00  
Six Updates #98, price \$25.00, looseleaf unbound  
Order Number ISSN 0190-5775

Combined update subscription for both Volumes, 12 issues, price \$40.00,  
Book #99.

(continued on the following page)

## MICROPROCESSOR REFERENCE LIST (CONTINUED)

The list of books by Osborne is only one possible source of information. It is the one source, however, that covers the processors that we currently support.

Another source of information is the manufacturer of the microprocessor. In the following list the manufacturer and the title of the publication will be presented. The prices will also be included when available.

Signetics Corporation  
P.O. Box 9052  
811 East Arques Avenue  
Sunnyvale, California 94086

Signetics 2650 Microprocessor, price N.A.  
(discusses hardware and software)

Intel Corporation  
Literature Department  
3065 Bowers Avenue  
Santa Clara, California 95051

MCS-80/85 Family Users' Manual, \$7.50  
(discusses hardware and software)  
Order No. 121506-001

8080/8085 Assembly Language Programming Manual, \$10.00  
Order No. 9800301

MCS-48 Users' Manual, \$7.50  
(discusses hardware and software)  
Order No. 9800270

UPI-41 Users' Manual, \$5.00  
(discusses hardware and software)  
Order No. 9800504

MCS-48 and UPI-41, \$10.00  
Assembly Language Manual  
(software covered in detail)  
Order No. 9800255

Note: Intel's software documentation in the Users' Manual  
if sufficient for most applications.

Motorola Semiconductor Products, Inc.  
P.O. Box 20924  
Phoenix, Arizona 85036

The Complete Motorola Microcomputer Data Library, \$6.00  
(discusses hardware and little software. Covers  
6800, 6802 and many others).

M6800 Programming Reference Manual, \$3.00  
(discusses software)

(continued on the following page)

MICROPROCESSOR REFERENCE LIST (CONTINUED)

Zilog  
10460 Bubb Road  
Cupertino, California 95014

Z80 CPU Technical Manual, \$7.50  
(discusses hardware)

Z80 Assembly Language Programming Manual, \$15.00  
(discusses software)

Z80 PIO Technical Manual, \$7.50

Z80 CTC Technical Manual, \$7.50

Z80 SIO Technical Manual, \$7.50  
(peripherals)

Texas Instruments Incorporated  
P.O. Box 1444  
M/S 769  
Houston, Texas 77001

TMS 9900 Microprocessor Data Book, Price N.A.  
(discusses abbreviated hardware and software)

9900 Family Systems Design and Data Book, Price N.A.  
(discusses hardware and software)

Mostek  
1215 W. Crosby Road  
Carrollton, Texas 75006

Microcomputer Data Book, Price N.A.  
Publication Number MK79707  
(discusses Z80 Family, 3870 Family and F8 Family  
hardware and some software)

F8 Programming Manual, \$5.00  
Publication Number MK79504  
(discusses software)

Z80 Programming Manual V2.0, \$7.50  
Publication Number MK78515  
(discusses software)

RCA Solid State Division  
Box 3200  
Somerville, New Jersey 08876

COS/MOS Memories, Microprocessors and Support Systems,  
Price N. A. (discusses hardware)

(continued on the following page)

## MICROPROCESSOR REFERENCE LIST (CONTINUED)

User Manual for the CDP 1802 COSMAC Microprocessor, \$5.00  
(discusses software)

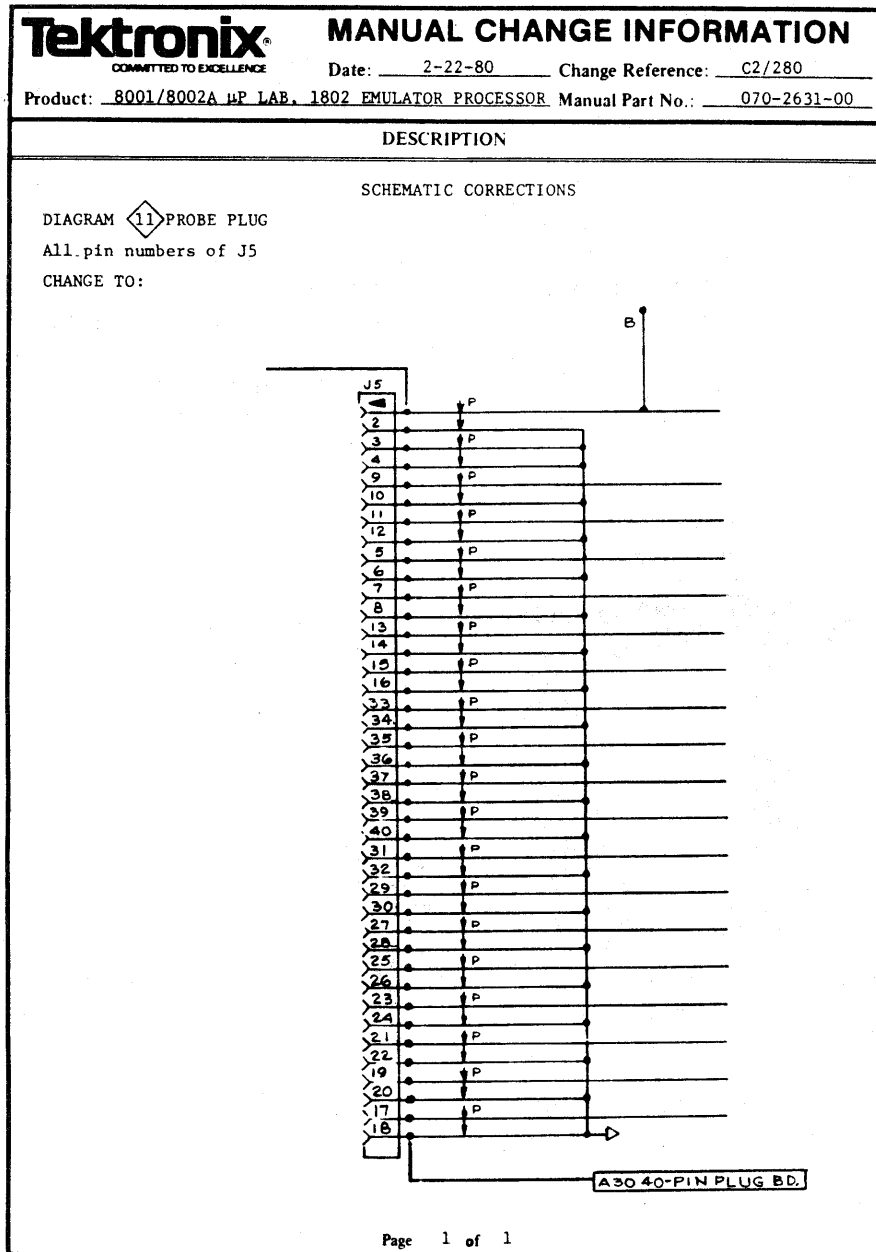
In most cases the manufacturer's publication listed may be obtained from a local distributor. However, specific ordering information may be obtained from the manufacturer. The method of obtaining the publications is up to the individual.

This article was generated due to requests for sources of additional information on the microprocessors supported by the 800X MDL systems. The prices listed are subject to change.

--Kevin King, Brad Griffin  
94-816, Ext. 1636, 1608

## 1802-J5 NUMBERING CORRECTIONS

In the 1802 Emulator Processor Service Manual part number 070-2631-00 an error was found on Diagram 11, Probe Plug. The numbering on the connector J5 was found to be in error. A copy of the corrected Diagram is shown below.



--Kevin King/Brad Griffin  
94-816, Ext. 1636, 1608

## SAMPLING

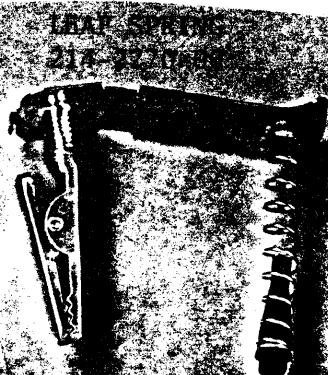
### 1502 SAMPLING BRIDGE INSTALLATION AID

When constructed, this little jig looks to be straight out of a five-year-old's Tinker Toy box, but it works; and it saves a lot of aggravation and heat damaged sampling bridges (CR1732).

This is a "hold-down" device, and the clip mounts right at the corner of the plated brass shield near the bridge. The bridge is set into place and held there with the corner of a screwdriver tip or a scribe as the jig is placed over it. The jig will hold the bridge in place while it is being soldered; the bridge is so small and light that the steel leads are attracted to a magnetic soldering iron tip, making it nearly impossible to work with without this "third hand." In fact, even the surface tension of the solder has sufficient grip to move an unanchored bridge along with the iron.

SCREW  
211-0504-00

CLIP  
344-0046-00



COIL SPRING  
214-1779-00

BUMPER  
348-0089-00

Cut bumper here after screwing into spring.

Attach clip to leaf spring with screw and solder all three parts to each other. Solder coil spring to leaf spring at rounded portion. Screw onto bumper, cut head off bumper and stretch spring to provide slight tension on sampling bridge when jig is mounted in place on the 1502.

(continued on the following page)





## SEMICONDUCTOR TEST SYSTEMS

### S-3455 FORMAT:REC

There are a few items that should be added to the S-3455 recal Format:REC procedure. Before running the format program you should adjust drivers using Driver:REC. In the set up of the scope, be sure that you trigger the scope on the rising edge of Phase 6. It's also important that when using two scope probes that they and the two channels are matched. Any difference should be noted so that when adjusting other signals to Y0 you can compensate.

Sometimes there is confusion on adjustment of the wave forms called out in the Format:REC Program. In the following, it's important to remember that the first cross over is T0, second cross over is leading edge, third cross over is trailing edge. In Step 1 and 2, the adjustment is the rise and fall of the leading edge. In Step 3 you may have to increase the intensity to see Return to Complement. Up to this point all adjustments have been to the rise and fall of the leading edge. In Step 4 this adjustment is to the leading and trailing edges. In Step 5, when performing portion B, C161 is the leading edge and C162 is the trailing edge adjustment. Step 5C R252 is 0 (zero) rising and R258 is 0 (zero) falling of the leading edge.

In Step 6 a clarification. The adjustment being made is to the rise and fall edges of the leading edge, second cross over. The reference to start edge is the second cross over.

In Step 8 if major adjustments were made to drivers you may find that the clock format will not adjust to the 50% cross over. In those cases when 50% cross over is not possible you can add or subtract capacitance. These capacitors are C560, C552, C582 and C580. Once cross over is correct the 50% adjustment is to the leading and trailing edges, not the rise and fall of the leading edge. There is one error in the manual and the BOARDC.EDT:REC Program. Adjustments BT and BL are reversed. Correction to the BOARDC Program can be made at line 8.21 (becomes a Print "BT") and Line 8.11 (becomes Print "BL").

Adjust Y0 to match the furthest clock format signal. Adjust Y0 with a little extra so that the clock format adjustment won't have to be at its max. A fair rule is about 1 ns more than would be needed to match signals. Now you must go through a complete recal of format. It's not a bad practice to make a rough adjustment of clock format after adjusting Y0. It could save you a lot of rework.

--Joe Lipska  
94-816, Ext. 1634

S3200: 1803, 4K PRAM LIMITATIONS

Caution must be exercised when considering a 4K PRAM update for S3260's. (See Marketing Sales Release #947 dated December 14, 1979.) Any old 1803 with serial number beginning with B01 or B02 will not accept the 4K PRAM. The reason is heat. There is insufficient airflow in these older tables for proper reliable operation of the 4K PRAM. These old tables cannot be modified to improve the airflow as we originally thought when the MSR was written.

If a customer has a 4K PRAM requirement and an old 1803, it is best to recommend a complete system update with the S3260 to S3270 conversion package. Moving the guts of his old table into a new table chassis is not an option.

Submitted by Bob Rosenoff, STS Marketing.

--Inserted by  
Ron Lang  
94-816, Ext. 1015

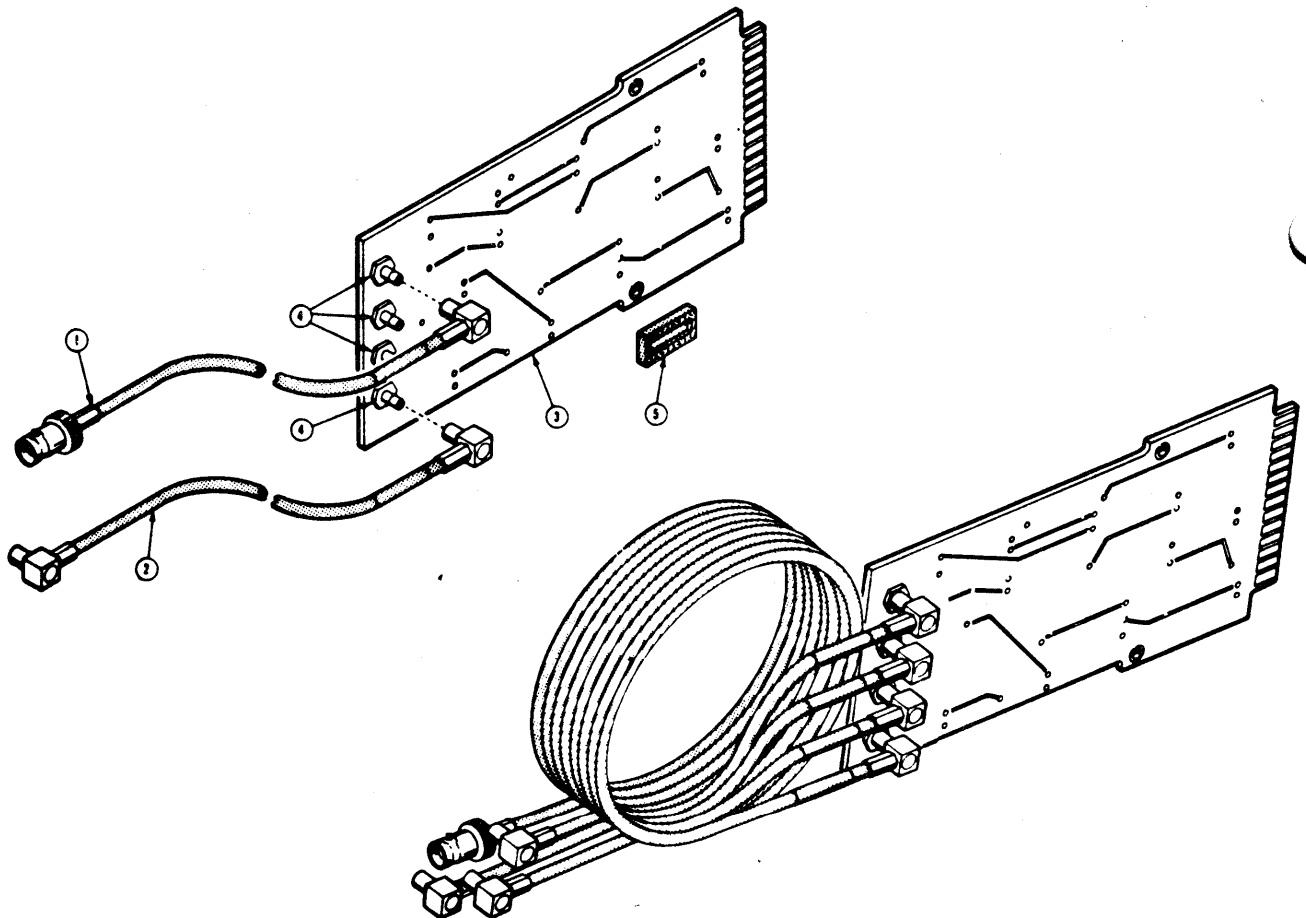
### S3200: 067-0777-00 DELTA-T RECAL FIXTURE

The 067-0777-00 is no longer necessary with DELCAL.EDT Version 1.02 or higher. Reference 062-3368-03 Recal III Calibration Manual, Page 39, equipment required #1.

This fixture will be removed from the 067-0778-00 Calibration Fixture. The 067-0777-00 will be available as an end item only.

1- 067-0777-00  
-1 012-0634-02  
-2 012-0656-00  
012-0657-00  
012-0657-01  
-3 -----  
-4 131-0391-00  
-5 136-0260-02

1 FIXTURE,CAL:DELTA-T RECAL  
1 . CABLE,INTCON:PHASE 1,50 OHM,72" L,W/CONN  
1 . CABLE,INTCON:PROG CYCLE,50 OHM,36" L,W/CONN  
1 . CABLE,INTCON:START,50 OHM,13.5NS,9' L,W/CONN  
1 . CABLE,INTCON:STOP,50 OHM,13.5NS,9' L,W/CONN  
1 . CKT BOARD ASSY:DELTA-T RECAL(SEE PN EPL)  
4 . . CONNECTOR,RCPT:50 OHM,COAX,SNAP-ON MALE  
4 . . SOCKET,PLUG-IN:16 CONTACT,LOW CLEARANCE



Submitted by--  
Larry Edwards  
STS Production Eng.

Inserted by--  
Ron Lang  
94-816, Ext. 1015

April 18, 1980  
Issue 10-8

## SIGNAL PROCESSING SYSTEMS

### 7A16P: GPIB INTERFERENCE WITH TWO 7A16P's IN 7612D

References: Service Manual 070-2308-00  
Schematic (6) and Figure 8-7.  
All Serial Numbers before B020286  
Modification # M37285

SYMPTOM: If a 7A16P (before Serial Number B020286) is used in a 7612D it will cause interference with GPIB bus functions. A bad 7A16P will make a good one look and act bad. (Will not respond to queries).

It is suggested to update 7A16P's that will be in the same area as 7612D's to eliminate the problem.

SOLUTION: On the 670-4916-XX (Programming Logic Board) of the 7A16P, replace C1518 (.001 $\mu$ f Cap) with a 650pf capacitor, part number 283-0150-00.

--Randy Newton  
94-816, Ext. 1635

### 7A16P and 7B90P: AN 050 KIT FOR THE 155-0164-00 HYBRID

References: 7A16P Service Manual 070-2308-00  
Schematic Diagram (6) and Figure 8-7.  
7B90P Service Manual (070-2309-00)  
Schematic Diagram (7) and Figure 8-8  
Modification # M38692

#### SYMPTOM:

It is difficult to troubleshoot and/or remove the 155-0164-00 hybrid chip. The new chip has been designed to be put into a socket.

#### SOLUTION:

When not already socketed in the 7A16P, U1500 (on the Programming Logic Board 670-4916-XX) when removed should be replaced with the 050-1357-00 kit.

7B90P, U1500 (on the Programming Logic Board 670-5039-XX) when removed, should also be replaced with the 050-1357-00 kit.

The part number 155-0164-00 has not been changed.

--Randy Newton  
94-816, Ext. 1635

## 7612D

There is a conflict of part numbers for the Universal Load Unit Program Module to support the 7612D Power Supply between the Service Introduction Program dated September 4, 1979 and the Service Implementation Notice dated November 14, 1979. The SIN is correct: 067-0921-99. Please correct any SIP's being held. Thanks to Jos Willemse, EMC, for bringing this to our attention.

--Dean Hager  
94-816, Ext. 1284

## 7912AD: A PLUG-IN INTERFACE EXTENDER CARD

There is now an extender for the Plug-In Interface Assembly 672-0688-XX. This will provide you with the capabilities for ease of troubleshooting and calibration. The part number for this extender is 670-6466-00. It will be added to the 067-0854-00 test kit also.

--Randy Newton  
94-816, Ext. 1635

## 7912AD, R7912, R7912R: IMPROVED FOCUS CONTROL AND RELIABILITY

References: 7912AD Service Manual 070-2385-00  
R7912 Service Manual 070-1590-00  
R7912R Service Manual 070-2124-00  
Modification #M38042

### SYMPTOMS:

1. Insufficient focus control adjustment range may cause rejection of good CRT's.
- 2a. 7912AD: There has been a high failure rate of Q906 of the Scan Amp and Read Gun supply (Board #670-2486-00).
- 2b. R7912, R7912R: There has been a high failure rate of Q1821 of the Scan Amp and Read Gun supply (Board 670-2486-00).

(continued on the following page)

7912AD, R7912, R7912R: IMPROVED FOCUS CONTROL AND RELIABILITY (CONTINUED)

SOLUTION:

Replace Q906 (of the 7912AD) and Q1821 (of the R7912 and R7912R) with a 2N3495 Transistor (Part #151-0270-00). On the 7912AD also add a heat sync (Part #214-1254-00) to Q906. This improves the reliability of this circuit.

Replace R806 (of the 7912AD) and R1811 (of the R7912 and R7912R) with a 4.1 Kohm resistor (Part # 321-0815-07). This will improve the focus control adjustment range.

This mod applies to:

R7912	B251095 and earlier
R7912R	All
7912AD	B030488 and earlier.

--Randy Newton  
94-816, Ext. 1634





REFERENCE PULL-OUT

LABORATORY INSTRUMENT DIVISION

SEMICONDUCTOR TEST SYSTEMS

SOFTWARE CHANGES AND PROBLEMS SOLVED FOR AP009

The following list of software changes and problems solved is intended to aid field service technicians in identifying new and updated versions of software for S-3200 Series Systems. Also, to inform service technicians of solutions for common field problems. We will attempt to forward this information on a monthly basis.

Internal Use Only:  
If you have any questions, please call.

--Craig Wasson  
94-816, Ext. 1564

(continued on the following page)

TITLE: SOFTWARE CHANGES AND PROBLEMS SOLVED FOR AP009

<u>Program Name</u>	<u>Hardware Supported</u>	<u>Old Version</u>	<u>New Version</u>	<u>Problem Description</u>	<u>Problem Solution or Changes</u>
DDUM.FNC	3200	V02.10	V02.11	Autorange does not return proper value for DAMADVM. Also, when measuring an open, the ohms routine returns a hard error if the measurement was overrange.	The autorange starts at 100mv and increments uprange. Overrange in ohms or millivolts now returns the overrange value.
PRMSUB.FNC	3200	V03.00	V03.01	Using E.C.O. (Extended Core Option) running a program with more than one RLOADCORE statement, the 2nd statement hangs the computer.  After running certain sub-routines in PRMSUB, TCM's status command would read back garbage.	Problem is reproducible in V02.27 PRMSUB but not in V03.01.  PRMSUB used R4 to contain the address of the data distributor. When executing an NPT, R4 is modified and now points to some tables in IP. Any later data sent to the data distributor would go to the IP tables instead. The solution is to save R4 before executing an NPT and then restore it.
STATUS.FNC	3200	V02.26	V02.27	With PRAM TRAP-ON-ERROR mod, SPY can't trace move in RSTOP(1) or RSTOP(2). At line where TRAP-ON-ERROR occurs, SPY repeats indefinitely.  When using mag tape ANALYZ responds with "NO DATA" when "VALUE" is the first command given. This is caused because STATUS is used before the file is read and information needed is incomplete at this point on mag tape.	There is no practical way to solve this problem. The only way to stop the indefinite loop is to type a Control S. The PRAM manual rewrite will point out this problem.  If the status information is incomplete RESTOR changes the status IARRAY to essentially reset the file.

# SOFTWARE CHANGES AND PROBLEMS

VED FOR AP009 CONTINUED

<u>Program Name</u>	<u>Hardware Supported</u>	<u>Old Version</u>	<u>New Version</u>	<u>Problem Description</u>	<u>Problem Solution or Changes</u>
IP3260.RUN TC3260.RUN	S-3260	V03.08	V03.09	Translator no longer functions properly after memory has allocated in LOG.  The statement "MOVE CORE...WITH FICM" aborted with a C2 error.	The move code used R3 to indicate C.P. mode. The 2941 clock program routine in the formatter modified R3. The cure is to save and re-store R3.
BACKUP.RUN	S-3200	V02.20	V02.21	When backing up a file which already exists on the target mag tape with the verify switch, the BACK UP program asks for the new file name twice. If the same name is not given to each of the two prompts then BACKUP aborts with a mag tape error.	Removed code which required the second entry of Filename upon discovery that the file already existed on mag tape.
HP0COM.EDT	3200/70	V03.33	V03.34		Test will now run with D70 pin cards
ALTER.EDT	3270	428100	428101		Repaired 'Loop on Test' switch register option
TRAN.RUN	3200	V03.07	V03.08		Modified to not call the formatter for US1 and US2 when Bit 8 of the SID is set.
TCM.RUN	3200	V03.06	V03.07		Same as above
EDIT.RUN	3200	V02.26	V02.27		Fixed to check if PRINT loaded before running TCM. Allocated the disk so as to not cause an illegal abort.
STATUS.FNC	3200	V02.26	V02.27		Changes in "RESTOR" to tell if a proper status was taken.
HP8660.FNC	3200	V02.14	V03.00		New Checkout software



REFERENCE PULL-OUT

LABORATORY INSTRUMENT DIVISION

SEMICONDUCTOR TEST SYSTEMS

S-3200 POWER SUPPLY SUMMARY

The following list summarizes all the major O.E.M. power supplies used in the S-3200 systems. This is intended to assist when ordering, since many times the correct supply part can be difficult to find.

If you have questions call me.

--Craig Wasson  
94-816, Ext. 1564

# S-3200 POWER SUPPLIES

<u>PART NUMBER</u>	<u>INPUT REQUIREMENTS</u>	<u>LOCATION</u>	<u>OUTPUT</u>	<u>SOURCE</u>	<u>MODEL #</u>
119-0224-01	115V & 230V, Internal Strap, Strapped for 115V	1140	40V, .5A	Kepco	Model OPS 40-0.5B (C)
119-0225-01	115V & 230V, Internal Strap, Strapped for 115V	1140	100V, .2A	Kepco	Model OPS 100-0.2B
119-0225-02	Strapped for 230V	1140	100V, .2A	Kepco	Model OPS 100-0.2B
119-0428-01	115V Only	2941	5V, 20A	Trio Labs	Model 601
119-0439-01	AC to DC	DCSS	±15V	Intronics	SM200/15
119-0440-01	AC to DC	DCSS	±5V	Intronics	SM500/5
119-0453-02	115V Only	1803/S3455	±5V, 70A	P.M.C.	HV-EE-5-0V-P2454A
119-0453-03	230V Only	1803	±5V, 70A	P.M.C.	HV-EE-5-0V-P2328
119-0454-02	115V Only	1803	-15V, 7.5A	P.M.C.	OEM-15E-0V-P2372A
119-0454-03	230V Only	1803	-15V, 7.5A	P.M.C.	OEM-15E-0V-LL-P2372A
119-0455-02	115V Only	1803/1805	+15V, 16A	P.M.C.	OEM-15G-0V-P2370A
119-0455-03	230V Only	1803/1805	+15V, 16A	P.M.C.	OEM-15G-0V-LL-P2370A
119-0456-02	115V Only	1803/1804	-36V, 9.4A	P.M.C.	OEM-36G-0V-P2371A
119-0457-02	115V Only	1803/1804	+36V, 12A	P.M.C.	OEM-36H-0V-P2372A
119-0457-03	230V Only	1803/1804	+36V, 12A	P.M.C.	OEM-36H-0V-LL-P2372A
119-0628-01	115V & 230V, Internal Strap, Strapped for 115V	1140	7V, 2A	Kepco	Model OPS 7-2B (C)
119-0629-01	115V & 230V, Internal Strap, Strapped for 115	1140	15V, 1.5A	Kepco	Model OPS 15-1.5B

S-3200 POWER SUPPLIES CONT'D

<u>PART NUMBER</u>	<u>INPUT REQUIREMENTS</u>	<u>LOCATION</u>	<u>OUTPUT</u>	<u>SOURCE</u>	<u>MODEL #</u>
119-0674-00	DC to 5V	CF1	130V		
119-0682-01	115V Only	2942	5V, 3A	Electrostatics	Model 30
119-0694-01	115V & 230V, Internal Strap, Strapped for 115V	1140	21V, 1A	Kepco	Model OPS 21-1B (C)
119-0695-01	115V Only	2942	5V, 24A	Sorenson	STM 5-24
119-0696-01	115V, 230V, Internal Strap, Strapped for 115V	1843	15V, 3.5A	Sorenson	PTM 15-3.5
119-0696-02	Strapped for 230V	1843	15V, 3.5A	Sorenson	PTM 15-3.5
119-0715-01	115V & 230V, Internal Strap, Strapped for 115V	1140	72V, .3A	Kepco	Model OPS 72-0.3B
119-0734-01	115V & 230V, Internal Strap, Strapped for 115V	1882	5V, 11A	Sorenson	PTM 5-11
119-0873-01	115V & 230V, Internal Strap, Strapped for 115V	PRAM	2V, 6A	Power One	HC2-6
119-0916-01	115V & 230V, External Strap, Strapped for 115V	PRAM/1843/ 2942	5V, 30A	Sorenson	SSD-5-30
119-1005-00	115V & 230V. No Strap. With Mounting Plate	1803/04/05	±5V, 120A	P.M.C.	SW-5K P2795
119-1005-01	115V, 230V, With Shield & Mounting Bar. No Strap	S-3455 Export	±5V, 120A	P.M.C.	SW-5K P2795
119-1051-00	115V & 230V, Internal Strap	1140	10V, 440MA	Kepco	Model OPS 40-0.5B (C) Tektronix modified for S-3280

S-3200 POWER SUPPLIES CONT'D

<u>PART NUMBER</u>	<u>INPUT REQUIREMENTS</u>	<u>LOCATION</u>	<u>OUTPUT</u>	<u>SOURCE</u>	<u>MODEL #</u>
119-1052-00	115V & 230V, Internal Strap	1140	8V, 1.4A	Kepco	Model OPS 15-1.5B Tektronix Modified for S-3280
119-1082-00	115V Only	2943/44	5V, 36A	Kepco	RMK-05B
119-1085-00	Checked, 115V, 230V No Strapping	1804	±15V, 12A	P.M.C.	SW-15G
119-1123-00	Checked, 115V, 230V No Strapping	1805	-36V, 20A	P.M.C.	SWA-36K

COMBINATION WIZARDS  
MICHAEL A. MICHALIK

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