GenRad

Development Systems Division

EPROM PROGRAMMER USER'S MANUAL

2300-5035-00

MICROCOMPUTER
SYSTEMS

EPROM PROGRAMMER USER'S MANUAL

2300-5035-00

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GenRad/Development Systems Division
5730 Buckingham Parkway
Culver City, CA 90230

REVISION HISTORY

Title	Number	Date	Notes
EPROM Programmer User's Manual	PY-002-EPROG	2/81	Preliminary
EPROM Programmer User's Manual	2300-5035-00	6/81	First Edition

RELATED PUBLICATIONS

Installation and Maintenance Manual	2300-5003-01

WARRANTY

We warrant that this product is free from defects in material and workmanship and, when properly used, will perform in accordance with applicable GenRad specifications. If it is found not to meet this standard, it will be repaired or, at the option of GenRad, replaced as follows:

-- During the first three months after original installation, on-site at no charge unless such service is specifically excluded in the contract for sale.

-- After the third month following original installation, at our then prevailing schedule of charges for service either on-site or at a GenRad service facility.

Changes in the product not approved by GenRad shall void this warranty. GenRad shall not be liable for any indirect, special or consequential damages, even if notice has been given of the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

PREFACE

This manual documents the information and data that is necessary for users to program or verify EPROM modules using selected EPROM images from the Debugger memory in the GenRad/DSD 2300 ADS. The entire EPROM or only a portion of it may be programmed.

The GenRad/DSD module 2399-9009 EPROM Programmer is versatile and convenient to use.

Please note that a **Documentation Reply Card** is included in this manual. When you complete and return it, you help us produce better documentation for you.

A **User Registration Card** is included in the set of manuals you receive with your GenRad/DSD system. When you complete and return the User Registration Card, you ensure that you will receive all updates and new information for your configuration.

For your convenience, a list of **GenRad/DSD Service Locations** is appended to this manual.

CONTENTS

Chapter 1

INTRODUCTION

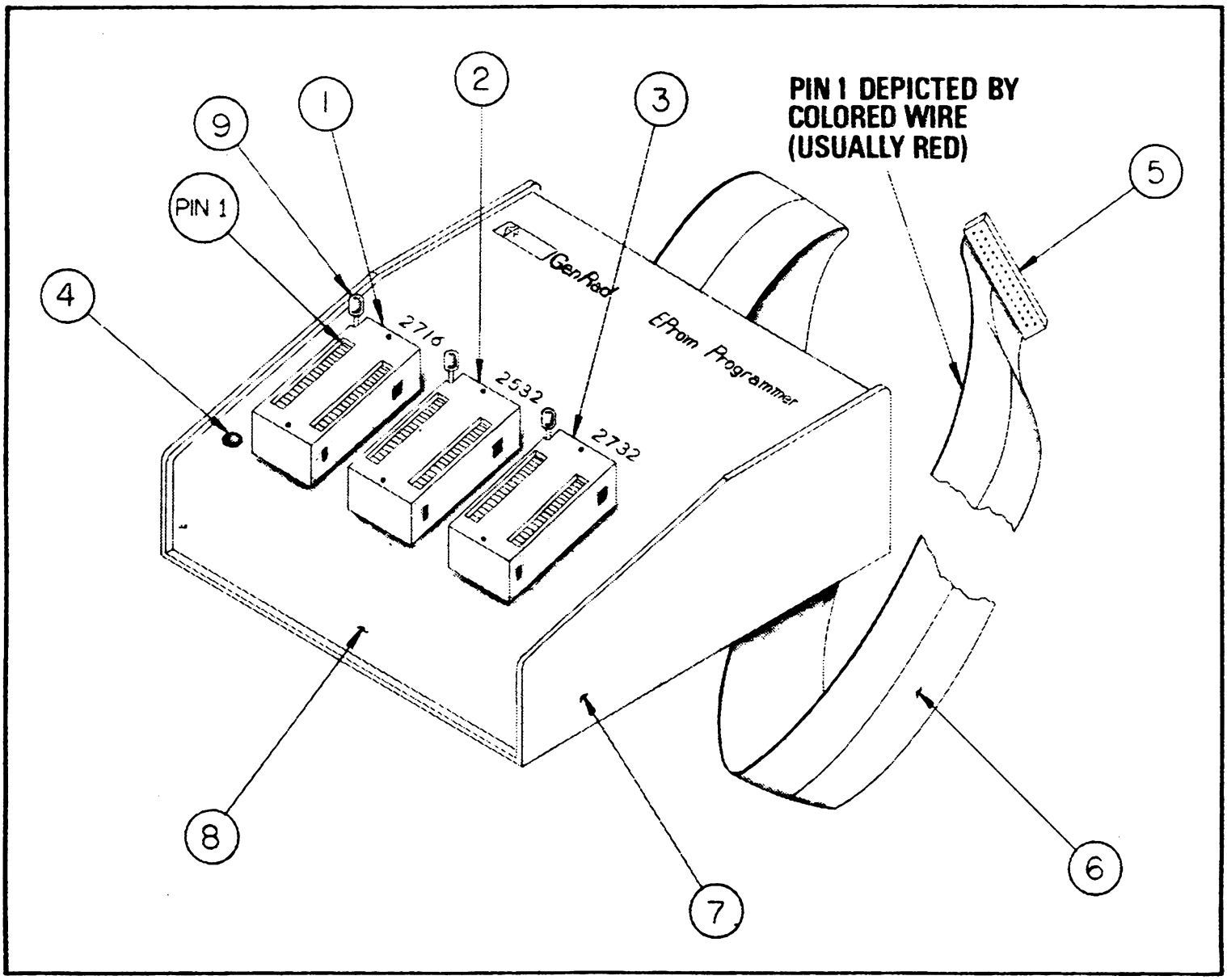
1.1 GENERAL DESCRIPTION

The EPROM Programmer hardware is a bench-mounted, sloping-face metal box with three 24-pin fixed IC sockets mounted side-by-side on the sloping face. Three ZIF (Zero Insertion Force) quick-disconnect IC sockets are plugged into each of the three fixed sockets. PROMs are then plugged into the ZIFs. The PROMs are locked in place by a locking shift lever mounted on each ZIF.

An LED indicator that guides and informs the operator is below the ZIF furthest to the left (when facing the box). When illuminated, the LED indicates that V_{pp} is applied to the PROM under program.

The EPROM Programmer is adapted to any GenRad/DSD model 2300 ADS by an attached 30-inch (75-cm.) ribbon cable and a 26-pin connector.

Figure 1-1 shows the EPROM Programmer controls and connectors.



1 PROM socket to 2716/2516 PROM
2 PROM socket to S/B 2532 PROM
3 PROM socket to 2732/2758
4 LED indicator for V_{pp}
5 Connector to ADS
6 Interconnecting ribbon cable
7 Chassis
8 Cover
9 PROM shift locks

Figure 1-1. EPROM Programmer Controls And Connectors

1.2 SPECIFICATIONS

Mechanical

Length: 5" (12.7 cm.)
Width: 5" (12.7 cm.)
Height: 2" (5.1 cm.)
Weight: 1.35 lbs (.613 Kg.)
Cable length: 30"(76.2 cm.)

Electrical

+5vdc, +26vdc

Environmental

Ambient air temperature: 0-40 C (32-104 F)
Relative humidity: 5-80% (non-condensing)

1.3 CONNECTOR AND CONTROL INDICATORS

The connectors and control indicator are shown in Figure 1-1, Items 1, 2, 3, and 4 respectively.

1.4 ACCESSORIES

None required--refer to Installation and Operation.

Chapter 2

INSTALLATION AND OPERATION

The following notes explain the prerequisites for EPROM operation, including complete installation and programming procedures. The notes discuss various processors and outline Debugger memory requirements. The notes end with a sample EPROM programming procedure.

2.1 INSTALLATION

2399-9010 AND 2399-9011 EPROM PROGRAMMING MODULES

Using the GenRad/DSD EPROM Programmer with the ADS requires the following equipment, software and documentation:

1. The version of the Debugger software which includes the EPROM programming software. The file name is of the form: DEBUGxxL, DEBUGxxP, DxxL or DxxP; in the place of xx will be a processor type. The L suffix denotes full Logic Analyzer support, while the P suffix denotes the standard Debugger with EPROM support and without the Logic Analyzer support.

2. The EPROM programming module for the intended EPROMs.

3. A copy of the 2300 Logic Analyzer/Debugger reference card (Part No. 2300-5012).

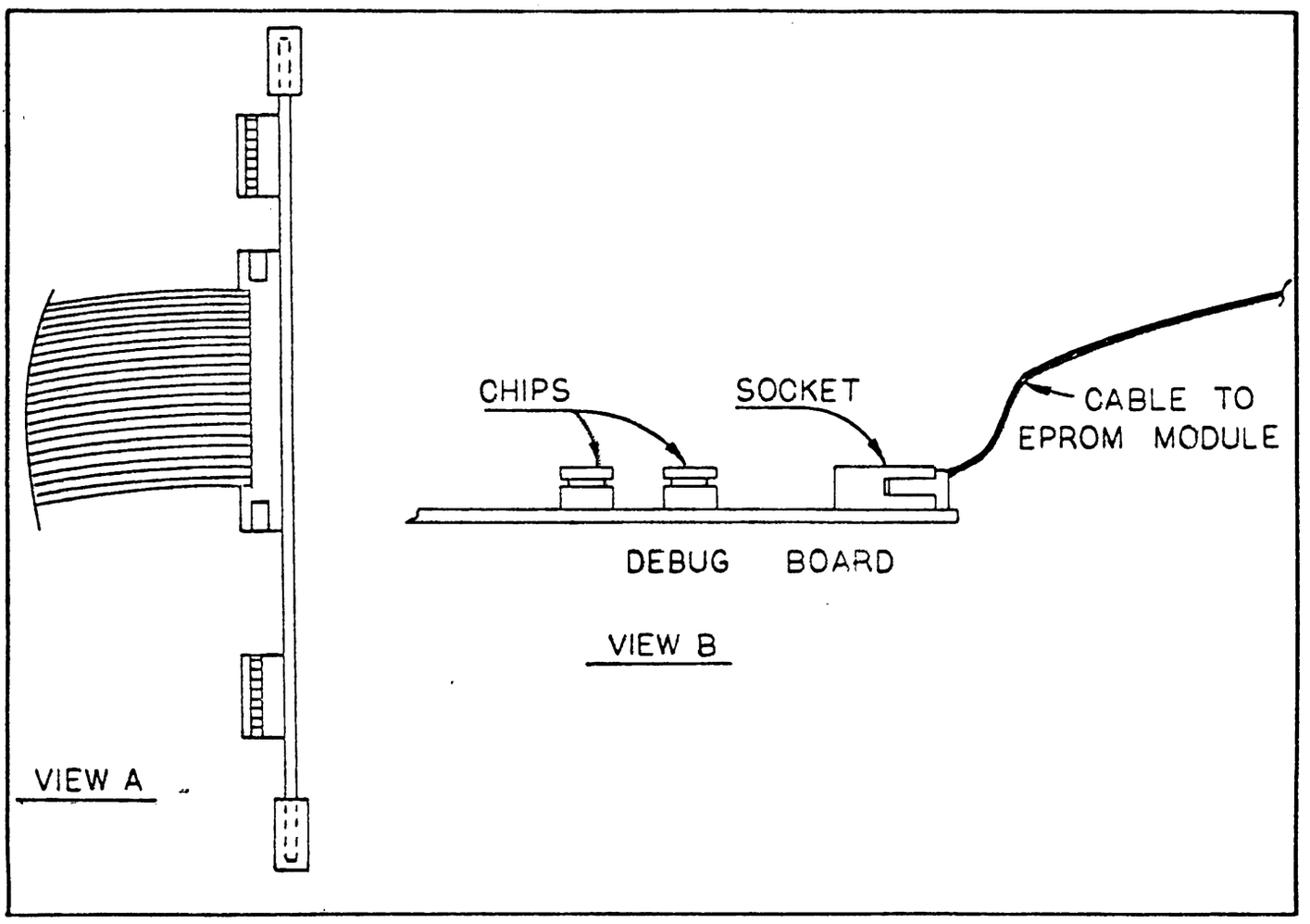
4. The Software Reference Manual (Part No. 2300-5000), and the Personality Supplement to the Software Reference Manual for the processor in your system.

HARDWARE SET-UP

WARNING

Inserting the cable backwards may result in damage to the Debugger board.

Insert the cable from the EPROM Programmer into the Debug board, Part No. 2300-4705. The cable should extend away from the Debugger board. The board will also be labeled in the top right corner of the component side of the board with DEBUG/EPROM PROGR. (See **Figures 2-1 and 2-2** for details.)



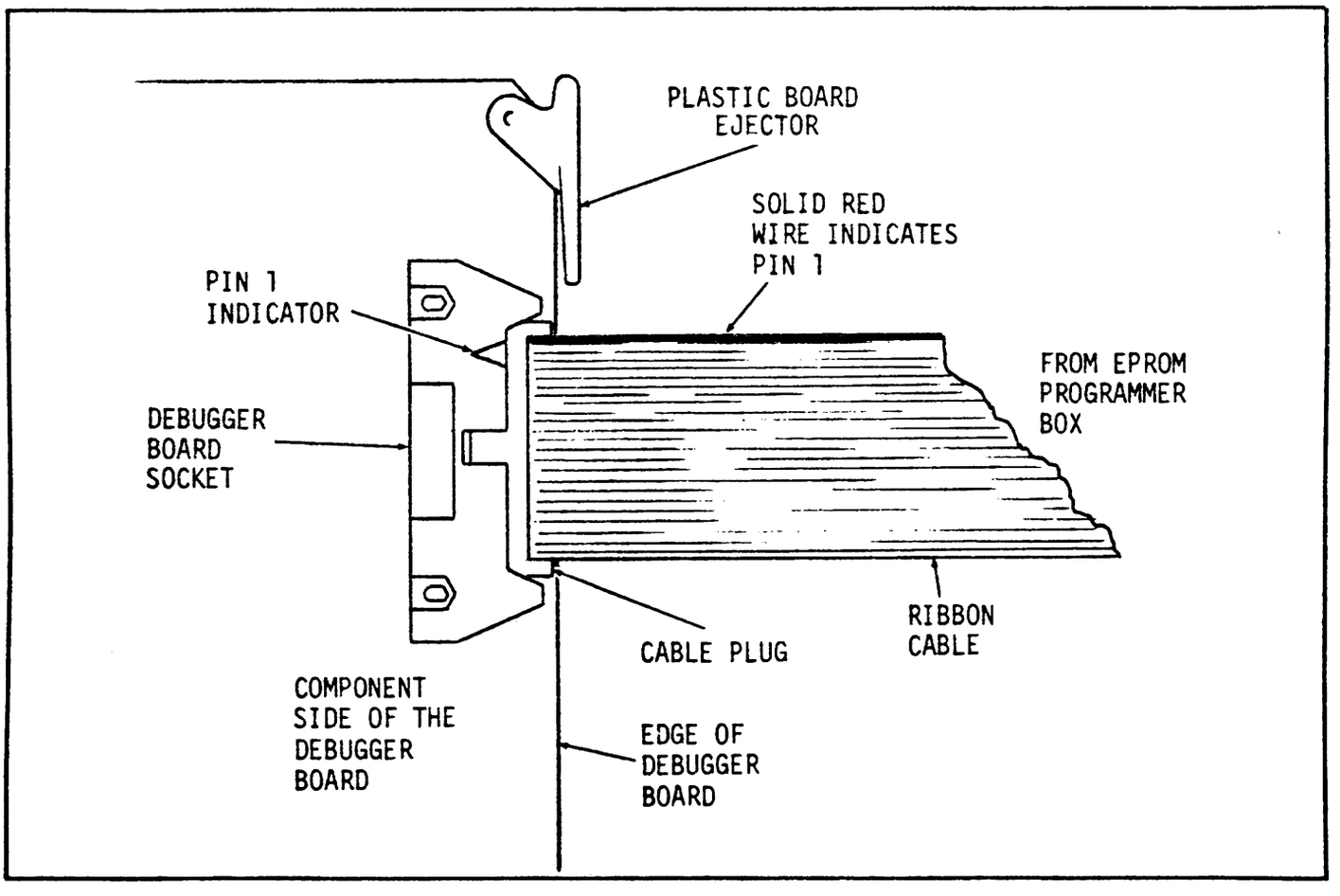


Figure 2-1 and 2-2. Cable Insertion In The Debug Board

2.2 PROGRAMMING CONSIDERATIONS

EPROM PROGRAMMING CONSIDERATIONS

The EPROM programming commands are resident under the Logic Analyzer/Debugger software. The file name is of the form: DEBUGxxL, DEBUGxxP, DxxL or DxxP; in the place of xx will be a processor type. The L suffix denotes full Logic Analyzer support, while the P suffix denotes the standard Debugger with EPROM support and without the Logic Analyzer support. The Debugger software is loaded into the ADS by typing JD<RETURN>. The Debugger file must be the only System file that starts with a D, where a System file is defined as a file with a Z attribute. (For further information refer to the **Manager section of the 2300 ADS Software Reference Manual, Part No. 2300-5000.**)

The EPROM image is defined as the data file which is to be programmed into a blank EPROM. It generally is an Object file resident on a floppy or hard disk. It must be loaded into the Debugger memory using the L command.

The L command in the Debugger has the general form:

L filename [,offset] [,symbol table address]<RETURN>

The L will load a file from the floppy or hard disk. The parameter, **filename** , is the name of the file to be loaded from the floppy or hard disk. The parameter, **[,offset]**, is an address offset that allows the EPROM image to be positioned to an unused portion of memory. The offset is combined with the absolute load address to form the offset load address. The Debugger assumes that the offset is a Hex value. The parameter, **[,symbol table address]**, is not normally needed for EPROM programming.

The EPROM image loaded into the ADS Debugger internal memory must not conflict with the Logic Analyzer/Debugger software and must reside in a valid portion of memory large enough to contain it. The reserved portions of memory are processor-dependent.

With the Standard Logic Analyzer/Debugger the available memory space can be determined from any one of the following files resident on the Debugger/Logic Analyzer configuration diskette: DBGxxL.DOC or DBGxxP.DOC shows the starting addresses for the link stream. The extent of the Logic Analyzer/Debugger memory allocation can be calculated from these starting addresses. This information is repeated in the Standard Configuration Link Command File specified in DBGxxL.LCF or DBGxxP.LCF. The actual memory allocation map is resident in the file **DBGxxL.MAP** or **DBGxxP.MAP**. If this file is not resident, it can be created by modifying the Link Command File **link stream**, with **N[:drive]:DBGxxL.MAP** or **DBGxxP.MAP** specified as the Listing File and no Object File specified, then executing the Link Command File. The **parameter, [:drive]** is the drive on which the file is to reside. This will generate a Link Map Disc File and no Object File. If the Debugger file has been previously modified a Link Map Listing File should have been generated at that time. **(For further information, refer to the Linker section of the 2300 ADS Software Reference Manual, Part No. 2300-5000.)**

Possible conflicts between the EPROM image and the interrupt vectors should be avoided. In the 8080, 8085 and Z80 processors, an offset of at least 100 Hex must be used if the EPROM image load address is 0. For the 6800-type processors, addresses FFF0 through FFFF hex should be avoided with use of an offset.

EPROM INSERTION

WARNING

Inserting the EPROM backwards may result in damage to the EPROM or EPROM programmer.

The EPROM to be programmed should be inserted into the ZIF (Zero-Insertion-Force) socket. To key the EPROM properly, observe the following procedure. Place the EPROM Programmer on a smooth surface with the cable leading away from you, and the EPROM socket facing you. Insert the EPROM in the socket with Pin 1 of the EPROM keyed to the top left corner of the socket. Figure 1 shows a correctly inserted EPROM.

Commands may now be entered to program the EPROM. For a discussion of commands and command parameters, refer to the COMMANDS section 2.3.

2.3 EPROM COMMANDS

INTRODUCTION

A detailed description of each EPROM programming command available to the ADS user is contained in this section. A command summary may be found on the Logic Analyzer/Debugger Reference Card (Part No. 2302-5002-01).

COMMAND COMPLETION AND SYNTAX

EPROM programming commands consist of single-letter entries which may be followed by operands. For example:

I2732,800,2

Syntax for EPROM programming commands is:

Command expr [,expr]...

C	keystroke to initiate the command.
{expr}	required entry, braces are not entered.
[,expr] or [:expr]	optional entry, brackets are not entered.
...	repeat previous entry.

Unless otherwise indicated, all commands must be followed by <RETURN>. Expressions allowed in EPROM commands are only numeric. Invalid entries will return a SYNTAX error Message.

COMMANDS

There are three parameters available for the EPROM programming commands.

PARAMETER TYPES

If a command is entered which changes the value of any one of the parameters, the new value becomes the default for the parameter until either another command is entered using a different value, or the Debugger is reloaded into system memory.

Type

The parameter, [,type] is the numeric entry of the EPROM to be accessed. The type default is a 2708. The currently supported range of EPROM consists of the following Intel or equivalent chips: 2704, 2708, 2516, 2716, 2532, 2732, 2758.

Length

The parameter, [,length] is the number of bytes to be programmed into the EPROM up to the maximum length of the specific EPROM. The length default is the maximum length of the EPROM. Changing the EPROM type may change the default previously set.

Interleaving Factor

The parameter, [,interleaving factor] may be a 1 or a 2 and determines how data is programmed into the EPROM from the Debugger memory. The interleaving factor default is 1 on entry to the Debugger. When a 1 is used, the contents of consecutive memory addresses will be programmed into the EPROM. A factor of 2 will cause the contents of alternate memory addresses to be programmed into the EPROM, starting with the odd or even address defined by the memory pointer on the active side of the Debugger display. This enables programming alternate bytes into two EPROMs to form a 16-bit word. Changing the EPROM type will not change the default previously set.

For example, if 2732 PROMs are to be programmed with alternate bytes to form a 16-bit word, the type of PROM, 2732, and the interleaving factor, 2, need only be specified in the first command **P2732,,2<RETURN>.** To program the second through nth PROMs, position the cursor to the appropriate odd or even address and enter P<RETURN>.

Table 2-1. EPROM COMMANDS

Command	Function	Page
C	Check for EPROM empty	2-6
I	Input data from EPROM	2-6
P	Program EPROM	2-7
V	Verify data in EPROM	2-7

CHECK FOR EPROM EMPTY

C[type][,length]<RETURN>

Entering a C<RETURN>. will cause a test of the EPROM for an unprogrammed condition. During command execution the cursor will stop flashing.

The flashing cursor and a message appearing again at the bottom of the display signify that the C command is complete The message EPROM EMPTY will be displayed in the bottom left corner of the screen if the condition is true. If false, the message NOT EMPTY AT xxxx will be displayed.

Where xxxx is the byte address

Messages: EPROM EMPTY
NOT EMPTY AT xxxx
SYNTAX

INPUT DATA FROM EPROM

I[type][,length][,interleaving factor]

Entering I<RETURN> will input program data to the Debugger memory from an EPROM. The memory pointer > on the active side of the debugger display defines the beginning address to which data will be loaded in Debugger memory from the EPROM. The active side is denoted by the flashing cursor at the bottom of the screen. During command execution the cursor will stop flashing.

The flashing cursor appearing again at the bottom of the display signifies that the I command is complete.

Messages: SYNTAX

PROGRAM EPROM

P[type][,length][,interleaving factor]

To program the EPROM, enter a P<RETURN>. The memory pointer > on the active side of the debugger display should be positioned at the first byte of code to be programmed. The active side is denoted by the flashing cursor at the bottom of the screen. During the actual programming, the cursor will stop flashing. When the programming module LED is illuminated, programming voltage V_{pp} is being applied to the EPROM.

Programming time is dependent on the size of the EPROM and the area to be programmed. Some types of EPROMs require that the entire EPROM be programmed. For further information refer to each EPROM manufacturer's data sheets.

After the programming pass is complete, the Debugger software will automatically verify that the EPROM matches the image in the Debugger memory. A mismatch will cause an error message of MISMATCH at xxxx to be displayed, where xxxx is the byte address, otherwise no message is displayed.

The flashing cursor appearing again at the bottom of the display signifies that the P command is complete.

Messages: MISMATCH AT xxxx
SYNTAX

VERIFY DATA IN EPROM

V[type][,length][,interleaving factor]

Entering a V<RETURN> command will compare the contents of the Debugger memory from the location defined by the memory pointer > on the active side of the Debugger Screen Display with the contents of an EPROM inserted in the Programming Module. A mismatch will cause an error message of MISMATCH at xxxx to be displayed, where xxxx is the byte address, otherwise no message is displayed.The active side is denoted by the flashing cursor at the bottom of the screen.

The flashing cursor appearing again at the bottom of the display signifies that the EPROM programming and verification are complete.

Messages: MISMATCH AT xxxx
SYNTAX

2.4 SAMPLE EPROM PROGRAMMING PROCEDURE

This is a sample procedure. It shows how a user would program an object file named TEST into two 2732 EPROMs. TEST is 1800 bytes in length, and is assembled to Z80 object code linked to address 0 hex.

Place a 2732 EPROM in a module built to program it.

Type:

JD<RETURN>.

Type:

C2732<RETURN>

and wait for the message EPROM EMPTY.

Position the memory pointer > to address 1000 hex, the area where the EPROM image is to be loaded, by typing:

D1000<RETURN>.

This a convenient address to avoid the restart vectors and the Debugger software while providing simple offset calculations. Then type:

I<RETURN>

to load the RAM from 1000 hex to 1FFF hex, with FF hex, the unprogrammed state of the 2732. Next position the memory pointer to 2000 hex by typing:

D2000<RETURN>.

Repeat the I command. Then return the memory pointer to 1000 hex. This will cause the sections of Debugger memory in the programming address range not overlayed by the EPROM image, to be loaded with FF hex.

Type:

LTEST,1000<RETURN>.

This will load the program into the area previously set to FF hex.

Type:

P<RETURN>.

The EPROM will now be programmed. As the maximum length of the EPROM is to be programmed and no interleave is desired, these two parameters were omitted. Wait for the cursor to return to the screen. If no message is returned, the programming was successful. Otherwise, repeat the P command. If a second failure occurs, repeat the procedure with another EPROM.

Type:

V<RETURN>

if an additional verify is desired. Remove the programmed 2732 EPROM.

Having completed the programming of the first 2732 EPROM, the rest of the EPROM image can now be programmed into another 2732 EPROM. Move the memory pointer to address 2000 hex. Insert the second EPROM and type:

C<RETURN>.

As the rest of the image is less than 1000 hex bytes long, enter **P,800<RETURN>.**

When the cursor returns to the screen, programming is complete.

Type:

V<RETURN>

if an additional verify is desired. Remove the programmed 2732 EPROM.

This completes the sample procedure.

Chapter 3

SERVICE AND MAINTENANCE

3.1 CUSTOMER SERVICE

Our warranty (at the front of this manual) refers to the materials and workmanship of our product. If malfunction occurs, our service engineers will assist in any way possible. Please write or phone the nearest GenRad/DSD service facility (see back page), giving full information on the trouble and on steps taken to remedy it. Describe the instrument by name, catalog number, serial number, and ID lot number if any. (Refer to front and rear panels).

3.2 INSTRUMENT RETURN

3.2.1 RETURNED MATERIAL NUMBER

Before returning an instrument to GenRad/DSD for service, please ask our nearest office for a "Returned Material" number. Use of this number in correspondence and on a tag tied to the instrument will insure proper handling and identification. After the initial warranty period, please avoid unnecessary delay by indicating how payment will be made. Please send a purchase order number.

3.2.2 PACKAGING

To safeguard your instrument during storage and shipment, please use packaging adequate to protect it, equivalent to the original packaging. Any GenRad/DSD field office can advise or provide packing material for this purpose. Contract packaging companies in many cities provide dependable custom packaging on short notice. Here are two recommended packaging methods:

Rubberized Hair. Cover painted surfaces of instrument with protective wrapping paper. Pack instrument securely in strong protective corrugated container (350 lb/sq. in., bursting test), with 2-inch rubberized hair pads placed along all surfaces of the instrument. Insert fillers between pads and container to ensure a snug fit. Mark the box "Delicate Instrument" and seal with strong tape or metal bands.

Excelsior. Cover painted surfaces of instrument with protective wrapping paper. Pack instrument in strong corrugated container (350 lb/sq. in., bursting test), with a layer of excelsior about six inches thick packed firmly against all surfaces of the instrument. Mark the box "Delicate Instrument" and seal with strong tape or metal bands.

Chapter 4

PARTS LIST AND DIAGRAMS

4.1 PARTS

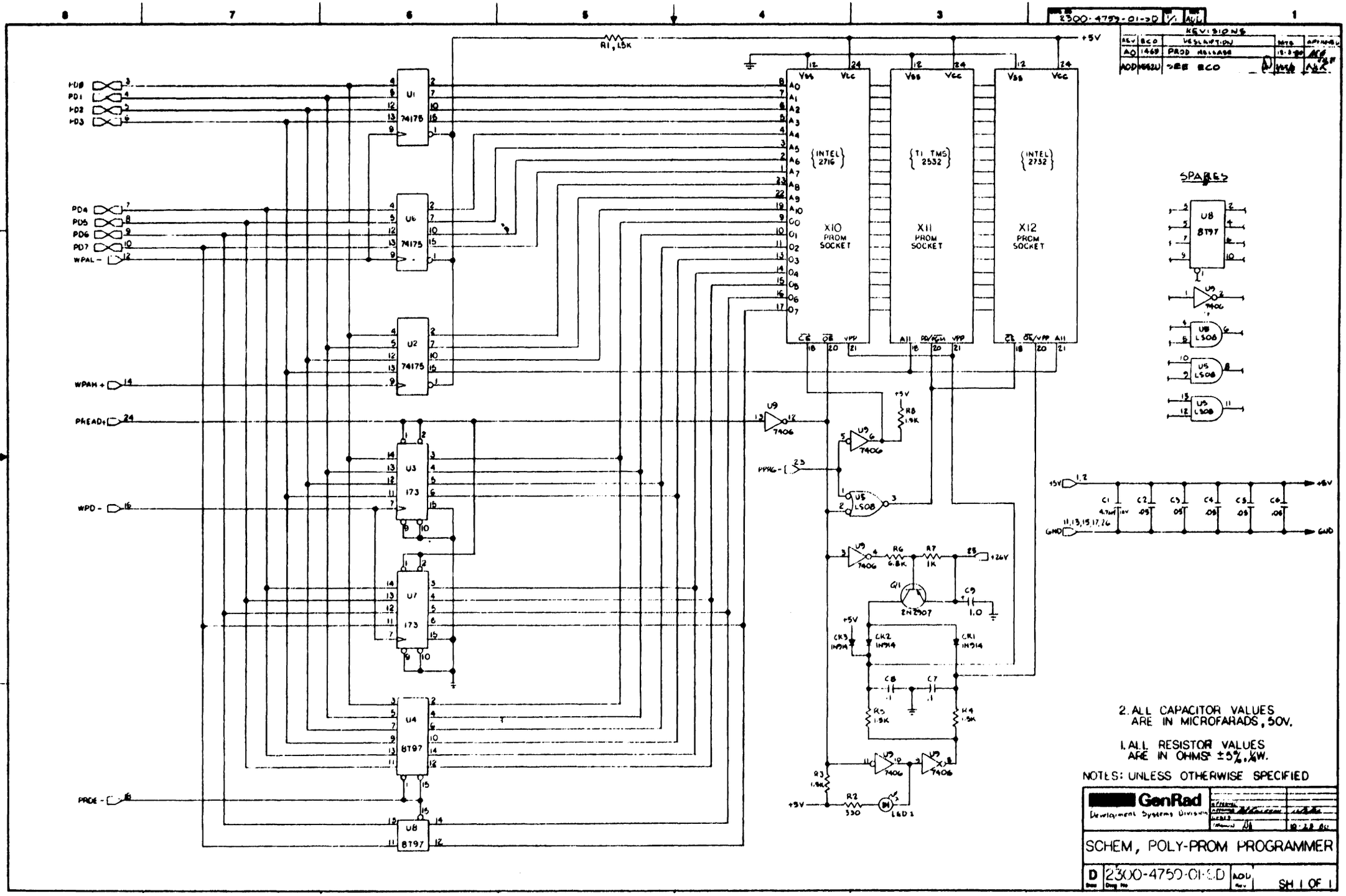
A complete parts list, logic diagram, and assembly drawing are given.

Schematic 2300-4759-01-SD (p.4-3) shows sockets and corresponding IC types.

SOCKET	IC Types
X10	2716/2516
X11	2532
X12	2732/2758

PARTS LIST
PWB POLY PROM PRGR
2300-4759

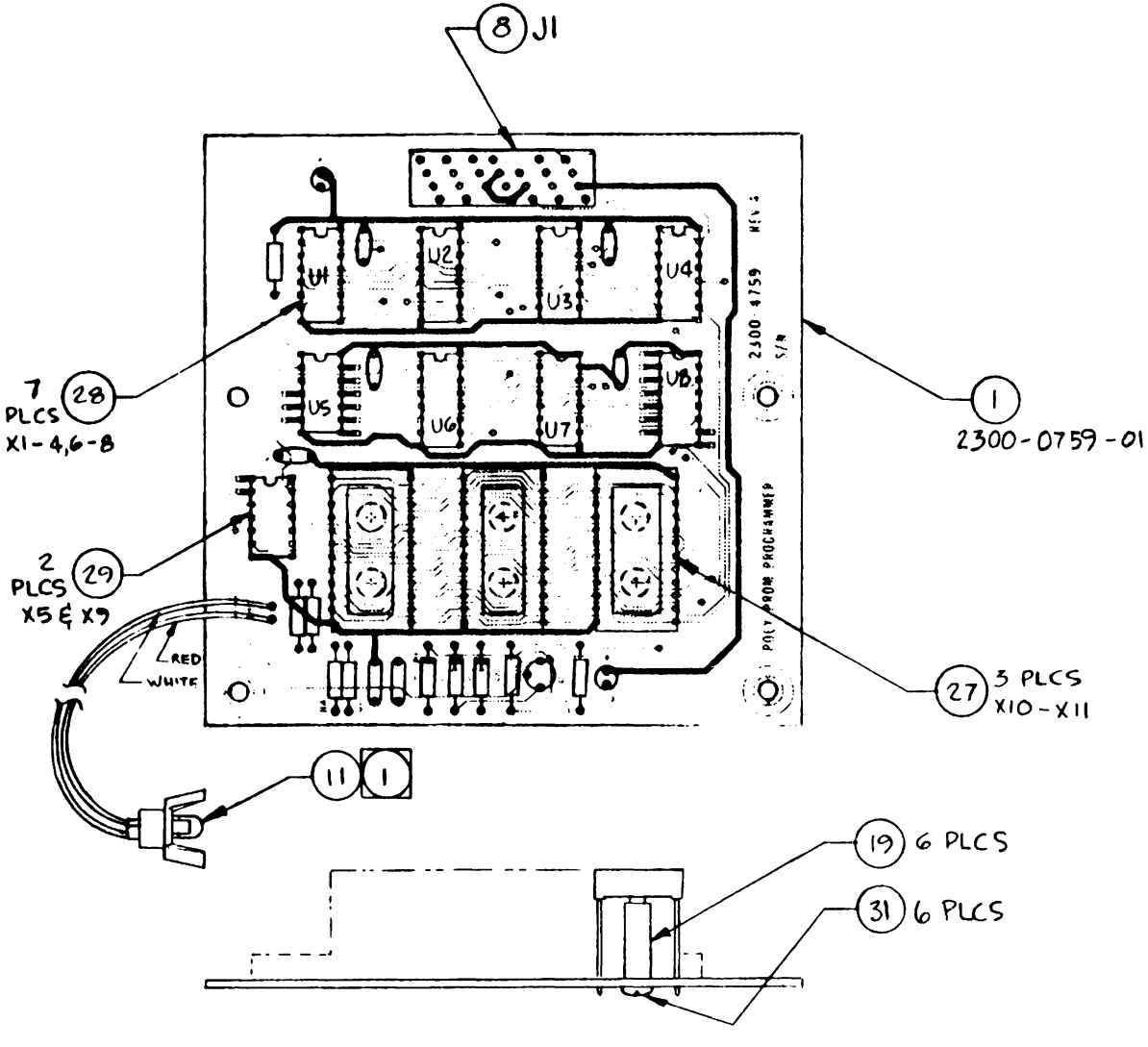
ITEM	QTY	PART	NAME	DESIGNATION
1	1	2300-0759	PWB, Poly PROM Programmer	
2				
3	1	4450-6261	CAP., 4.7uf 10V TANT	C1
4	5	4431-4102	CAP., .05uf CER DISK	C2-6
5	2	4860-6210	CAP., .1uf 100V FILM	C7, 8
6	1	4450-6265	CAP., 1uf 50V TANT	C9
7				
8	1	4230-9047	CONN., 26-PIN 3M	J1
9				
10	3	6082-1056	DIODE, 1N914B	CR1-3
11	1		INDICATOR, LED (IDI-5400)	LED 1
12				
13	5	6099-2155	RES., 1.5K	R1, 3, 4, 5, 8
14	1	6099-1335	RES., 330 OHM	R2
15	1	6099-2685	RES., 6.8K	R6
16	1	6099-2105	RES., 1K	R7
17				
18	1	8210-1336	TRANSISTOR, 2N2907	Q1
19	6	7700-2010	STAND-OFFS 1/2" #4 NYLON	
20	3	5431-8075	74175	U1, 2, 6
21	2	5431-8073	74173	U3, 7
22	2	5431-9702	8T97	U4, 8
23	1	5431-8608	74LS08	U5
24	1	5431-8106	7406	U9
25				
26				
27	3	7540-3620	SOCKET, 24-PIN, W/W	X10, 11, 12
28	7	7540-1816	SOCKET, 16-PIN	X1, 2, 3, 4, 6, 7, 8
29	2	7540-1815	SOCKET, 14-PIN	X5, 9
30				
31	6	7160-0410	SCREW, PAN-HEAD 4-40 x 5/8 PHILLIPS	
32				
33				
34				
35				
36				
37				
38				

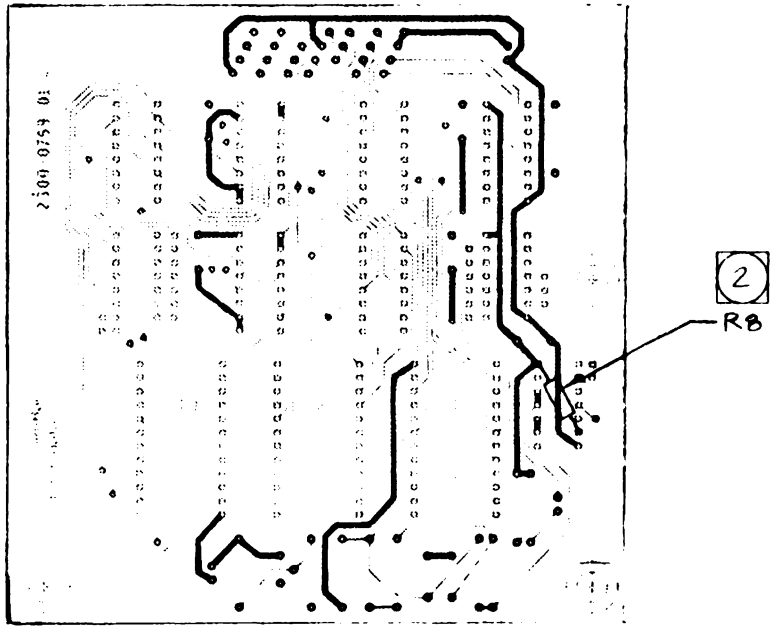

2300-4750-01-3D
REVISIONS
REV ECO DESCRIPTION DATE APPROVED
A0 1469 PROD RELEASE
ADD 1662U SEE ECO
R1, 1.5K
+5V
PD0
PD1
PD2
PD3
PD4
PD5
PD6
PD7
WPAL -
WPAH +
PREAD+
WPD -
PROG -
U1 74175
U6 74175
U2 74175
U3 I73
U7 I73
U4 8T97
U8 8T97
X10 PROM SOCKET (INTEL 2716)
X11 PROM SOCKET (TI TMS 2532)
X12 PROM SOCKET (INTEL 2732)
SPARES
U8 8T97
U9 7406
U5 LS08
U5 LS08
U5 LS08
U9 7406
R8 1.9K
U9 7406
U5 LS08
U9 7406
R6 6.8K
R7 1K
+12V
Q1 2N2907
C9 1.0
CR3 IN914
CR2 IN914
CR1 IN914
C8 .1
C7 .1
R5 1.9K
R4 1.9K
U9 7406
U9 7406
R3 1.9K
R2 330
LED1
C1 4.7mf 16V
C2 .05
C3 .05
C4 .05
C5 .05
C6 .05
GND
2. ALL CAPACITOR VALUES ARE IN MICROFARADS, 50V.
1. ALL RESISTOR VALUES ARE IN OHMS ±5%, ¼W.
NOTES: UNLESS OTHERWISE SPECIFIED
GenRad
Development Systems Division
SCHEM, POLY-PROM PROGRAMMER
D 2300-4750-01-3D ADD
SH 1 OF 1

DWG. NO. 2300-4759-01-AD | SH 1 | REV. AOD

Spec Sheet

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
AO	PROD RELEASE, ECO 1467	12-5-80	ACG
AOD	SEE ECO. 1552U	4/10/81	R&L





SEE SEP. P/L 2300-4759-01-PL

(2) INSTALL R8, 1.5K BETWEEN U9-6 & +5V.

(1.) INSTALL LED 1 AFTER FLOW SOLDER.

NOTES: UNLESS OTHERWISE SPECIFIED

REV	DESCRIPTION	DATE
	REVISIONS	

DRAWN	DS	11-80
CHECKED		
APPROVALS	DATE	
ACG R&L		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
1 TOLERANCES ON
FRACTIONS ±
DECIMALS XX ± .01
.XXX ±
2 BREAK ALL SHARP EDGES

GenRad futuredata

TITLE PWB ASSEMBLY POLY PROM PROGRAMMER

SIZE	REV	DRAWING NO
B	AOD	2300-4759-01-AD

SCALE | SHEET 1 OF 1

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GENRAD/DSD SERVICE LOCATIONS - USA & CANADA

CO	300 Baker Avenue Concord, MA 01742 617/369-4400 or 617/646-7400 TWX: 710-347-1051	Conn, Maine, Mass., N. H., R. I., Vt.
CHO	1083 East State Parkway Schaumburg, IL 60195 312/843-5580 TWX: 910-291-1209	Ill, Iowa, Minn, Ohio, Mo., N.D., S.D., Ky., Ind., Mich., W. Pa., Wis., Neb.
DEN	13132 St. Paul Drive Thornton, CO 80241 303/457-9147 (ans.serv.)	Colo., Mont., Wyoming, N.M., Utah
DSD	5730 Buckingham Parkway Culver City, CA 90230 (Factory) 213/641-7200; TWX: 910-328-7202	Factory Field Support
DTX	1121 Rockingham, Suite 100, Richardson, TX 75080 214/234-3357; TWX: 910-867-4771	Ark., Kan., La., Tex., Okla.
FLO	3751 Maguire Blvd Suite 170, Orlando, FL 32803 305/894-4303; TWX: 810-850-0270	Ala., Ga., Fla., N.C., S.C., Tenn, Miss.
LAO	17631 Armstrong Avenue P.O. Box 19500,Irvine, CA 92714 714/540-9830; TWX: 910-595-1762	So. Calif., Ariz., So. Nev.
NYO	380 Midland Avenue Saddlebrook, NJ 07662 201/791-8999 (NJ); 212/964-2722 (NY) TWX: 710-988-2205	Del., E. Pa., N.J., N.Y.
SFO	2855 Bowers Avenue, Santa Clara, CA 95051 408/727-4400; TWX: 910-338-0291	No. Calif., Idaho, No. Nev., Wash., Ore.
WO	1701 Research Blvd, Rockville, MD 20850 301/424-6224; TWX: 710-828-9783	Md., Va., W. Va., D.C.
GRC	307 Evans Avenue Toronto, Ontario, Canada M8Z 1K2 416/252-3395; TELEX: 06-967624	All Canada

GENRAD/DSD SERVICE LOCATIONS - EUROPE

GRU NORTHERN REGION GENRAD, LTD.
Norreys Drive, Maidenhead
Berkshire SL6 48P, England
Tele: (628) 39181 Tele: 851-848321

GRF SOUTHERN REGION GENRAD, INC.
96 Rue Orfila
75020 Paris, France
Tele: (01)7970739 Telex: 842-220991

GRG EASTERN REGION GENRAD, GmbH
Trausnitzstrasse 8
D-8 Munich 80, West Germany
Tele: (089) 402801 Telex: 841-529917

GRS EASTERN REGION GENRAD, (SCHWEIZ) AG
Helenastrasse 3
8034 Zurich, Switzerland
Tele: (01) 552420 Telex: 845-53638

GRB EASTERN REGION GENRAD/BENELUX B.V.I.O.
P.O. Box 210
5658 Aebest, Netherlands
Tele: (04) 9984240 Telex: 59535 GRBEN NL

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20141 Milano, Italy
Tele: (02) 8466541 Telex: 843-320373