

APPLICATION		REVISIONS			
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		D	E.O. 36176	6-8-01	B. Lo

LIQUID CRYSTAL DISPLAY
4 X 20 CHARACTER
5x8 DOT MATRIX
SLB324-X4X0

REV	D	-	-	-	-	C	-	-	-	D	D	D	D	A	D	-	-	-	-	-	B			
SHEET	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

REVISION STATUS

PROJ. NO. 368	CONTRACT			INDUSTRIAL ELECTRONIC ENGINEERS, INC. VAN NUYS, CALIFORNIA	
	LQUID CRYSTAL DISPLAY 4 X 20 CHARACTER 5x8 DOT MATRIX				
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	CHECK	M. Mayberry	9/16/96		
	APPROVED <i>D. Goodale 9-25-96</i>			SLB324-X4X0	
APPROVED			SCALE N/A	SHEET 1 OF 21	

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1.0 GENERAL DESCRIPTION

1.1 Introduction

This specification describes the interface requirements and features of a 4 line Liquid Crystal Display (LCD) , 20 characters wide. The characters are formed using a 5x8 dot matrix.

1.2 Application

This unit may be used as a console display which provides alphanumeric information that is easily readable in high ambient light. It is ideal for point-of-sale terminals, office computers, and a wide range of business and industrial equipment.

1.3 Special Features

Minimum depth	8 User defined characters
Power and data on same connector	ASCII + 6 additional character sets
11-29VDC	EIA-232C data interface
Low cost	EIA-422A data interface
Shielded I/O and Connector	Software selectable blink
Wide operating temperatures (-20 to +70°)	Software self test

1.4 Description

This LCD is a self-contained multiplexed display which provides a simple interface to a microprocessor system.

The display is available with one I/O connector and a choice of EIA-232C/EIA-422A interfacing.

This unit consists of a liquid crystal display tube and a minimal amount of electronic hardware. All display characters and control codes can be accessed in a 8-bit format. Primary complexity is contained within the microprocessor software, which controls all display functions.

A single 11-29VDC power supply is required for operation. At 12.0VDC, total power is approximately .67 watts and current is about 56mA.

Data is entered serially at 9600 Baud at rates determined by execution times.

The large characters are easily readable, even in direct sunlight and provide comfortable short or long-term viewing.

Figures 3 through 10 depict character sets used in this module.

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2.0 BLOCK DIAGRAM

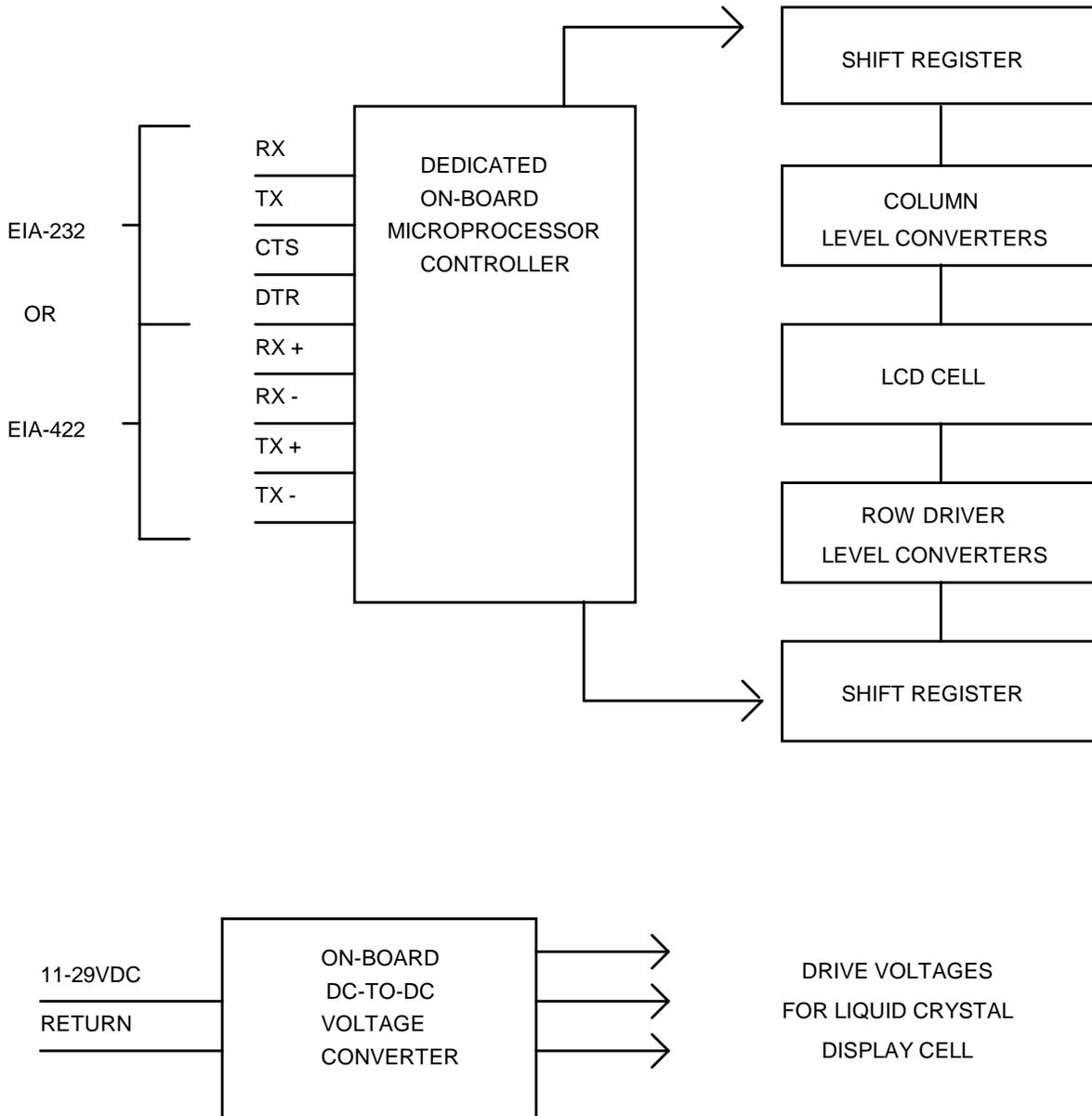


FIGURE 1

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3.0 THEORY OF OPERATION

Liquid Crystal Displays utilize ambient light falling on the display to reflect the image to the observer. The LCD cell is constructed by sandwiching a liquid crystal mixture between two glass plates that are coated with a polarizer, and lined with transparent electrodes. A selectively applied electric field aligns the nematic molecules (crystals) so that they either transmit or block the polarized light from being reflected back out of the cell to the viewer.

This display consists of two display areas, each comprising a matrix of 18 x 120 dots, to display two lines of characters. A matrix addressing technique provides individual control of the electric field applied to each dot used to create the character. The reflected light appears as a yellow-green background, and the light is blocked to create the dark blue characters. The 18 high dot columns allow for creation of special characters and fonts. Liquid crystal displays have several advantages over other display technologies. LCDs operate from low voltage and power, are viewable in direct sunlight, have long life, and are more economical to manufacture.

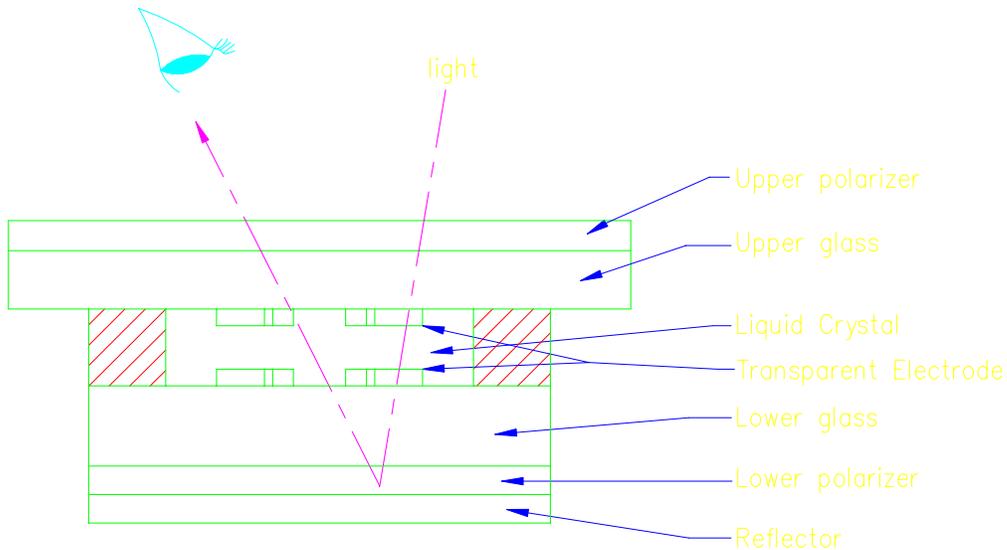


FIGURE 2

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4.0 OPERATION

4.1 Loading ASCII Character Data

All printing characters are located in standard ASCII code locations from 20 (HEX) to FF (HEX). Control character assignments are as follows.

4.2 Control Codes

NOTE: CARE SHOULD BE TAKEN NOT TO SEND UNDEFINED CONTROL OR COMMAND CODES TO THE DISPLAY MODULE AS THIS MAY CAUSE A SOFTWARE MALFUNCTION OF THE MODULE.

4.2.1 Instruction

DATA (HEX)	DESCRIPTION										
01	READING THE CHARACTER CAPACITY OF THE DISPLAY (DISPLAY RESPONDS SENDING 50 (HEX))										
02	DISPLAY SOFTWARE CHECKSUM AND SOFTWARE NUMBER										
03	READ CURSOR LOCATION VALUE (DISPLAY RESPONDS WITH 1 BYTE) <table border="0" style="margin-left: 40px;"> <tr> <td style="padding-right: 40px;">FOR 5X8 DOT CHARACTERS</td> <td>FOR 10X14 DOT CHARACTERS</td> </tr> <tr> <td>01-14 (HEX) FOR LINE 1</td> <td>01-0A (HEX) FOR LINE 1</td> </tr> <tr> <td>21-34 (HEX) FOR LINE 2</td> <td>21-2A (HEX) FOR LINE 2</td> </tr> <tr> <td>41-54 (HEX) FOR LINE 3</td> <td></td> </tr> <tr> <td>61-74 (HEX) FOR LINE 4</td> <td></td> </tr> </table>	FOR 5X8 DOT CHARACTERS	FOR 10X14 DOT CHARACTERS	01-14 (HEX) FOR LINE 1	01-0A (HEX) FOR LINE 1	21-34 (HEX) FOR LINE 2	21-2A (HEX) FOR LINE 2	41-54 (HEX) FOR LINE 3		61-74 (HEX) FOR LINE 4	
FOR 5X8 DOT CHARACTERS	FOR 10X14 DOT CHARACTERS										
01-14 (HEX) FOR LINE 1	01-0A (HEX) FOR LINE 1										
21-34 (HEX) FOR LINE 2	21-2A (HEX) FOR LINE 2										
41-54 (HEX) FOR LINE 3											
61-74 (HEX) FOR LINE 4											
04	READ DATA AT PRESENT CURSOR LOCATION										
05	05-C-L-D GRAPH MODE: DISPLAY 8 PIXEL DATA D ON LINE L COLUMN C C = 01-0F (HEX) (15 columns, each 8 pixels wide = 120 pixels) L = 01-24 (HEX) (36 pixel lines) D = 8 PIXEL DATA example: 05-01-01-A3: turn on 1st, 3rd, 7th and 8th pixel from upper left corner										
06	BEGIN BLINK FIELD AT CURRENT CURSOR LOCATION										
07	END BLINK FIELD AT CURRENT CURSOR LOCATION										
08	BACKSPACE CURSOR LOCATION ONE POSITION (cursor stays when at HOME location)										
09	ADVANCE CURSOR LOCATION ONE POSITION (cursor wraps around after bottom right character location)										
0A	LINE FEED (vertical scroll from bottom line; cursor position does not change)										
0C	CLEAR THE DISPLAY (cursor stays)										
0D	CARRIAGE RETURN (returns cursor to left-most character position of the same line; does not clear display)										
0E	MAKE CURSOR INDICATOR INVISIBLE (the cursor location counter continues to function but there is no visible indicator of next character location)										
0F	+ MAKE CURSOR INDICATOR VISIBLE, FLASHING BLOCK.										

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4.2.1 Instruction (Cont'd)

DATA (HEX)	DESCRIPTION
<10>	BOTTOM LINE DATA ENTRY WITH AUTOMATIC CARRIAGE RETURN & LINE FEED (puts cursor a left side bottom row and data enters beginning at the left-most character position of the bottom row, vertical scroll from bottom line after line has been filled)
<11>	+ NORMAL DATA ENTRY WITH AUTOMATIC CARRIAGE RETURN AND LINE FEED (data enters beginning at the home position, vertical scroll from bottom line after line has been filled)
<12>	OVERWRITE OF RIGHT-MOST CHARACTER ON THE PRESENT LINE/AUTOMATIC CARRIAGE RETURN OFF
<13>	HORIZONTAL SCROLL MODE (from right to left on bottom line only, after line has been filled)
14	RESET (go to system default settings and clear all DOWN LOAD CHARACTERS)
15	+ DISPLAY CLEAR (puts cursor at left side bottom row in Mode 10 HEX, & home in Modes 11 HEX, 12 HEX, 13 HEX and 1A HEX)
16	+ CURSOR HOME (returns cursor to upper left-most position)
19	SET BIT 7 HIGH FOR NEXT BYTE ONLY: 19-00 TO 19-7F: Same as ASCII 80-FF
<1A>	WRAP AROUND DATA ENTRY: (After bottom right character enters, cursor moves to home position)
1B	1B-05-49 IEE SPECIFIC RESPONSE CODE (Sent without regard for flow control) D,2,IEE,35964,-01 (CR) (18 BYTES)
	1B-26-01-M-N DEFINE DOWN LOAD CHARACTERS (5x8 DOT CHARACTER ONLY) M=BYTE LOCATION TO BEGIN DOWNLOAD (20 to FF) N=NUMBER OF CHARACTERS TO BE DOWNLOADED EACH CHARACTER PATTERN IS 5 BYTES (See 4.4)
	1B-3F-N DELETE DOWNLOAD CHARACTER LOCATION N (N=20-FF)
	1B-40 TERMINATE SELF TEST (all configurations go to default setting and clear all DOWN LOAD CHARACTERS)
	1B-74-N SELECT CHARACTER SET + N=01, ASCII AND GENERAL EUROPEAN (fig. 3 & 4) N=03, ASCII AND CYRILLIC (fig. 5) N=02, ASCII AND KATAKANA (fig. 6) N=04, ASCII AND HEBREW (fig. 7) N=05, ASCII AND GREEK (fig. 8) N=06, ASCII AND POLISH (fig. 9) N=07, BOLD FONT (fig. 10)
1D-05	EPSON SPECIFIC RESPONSE CODE DISPLAY RESPONDS SENDING 05 TO HOST.

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4.3 Character Chart (5x8 Dot Matrix)

The LB324-X4X0 module offers seven independently-selectable Character sets. Six sets consist of the ASCII set shown below in Fig 3 occupying hex 20 through hex 7F, plus either General European (fig 4), Cyrillic (fig 5), Katakana (fig 6), Hebrew (fig 7), Greek (fig 8), or Polish (fig 9). These “special” portions of the character field occupy all or portions of hex 80 through hex F4 as shown. The seventh set consists of Bold characters (fig 10) occupying hex 20 through hex 5F.



FIGURE 3 - ASCII CHARACTER SET

Note: N/A = Non-Applicable

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	SCALE	N/A	REV D

4.3 Character Chart (5x8 Dot Matrix) (Continued)



FIGURE 4 - GENERAL EUROPEAN CHARACTER SET
(Default Setting)

Note: N/A = Non-Applicable

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	SLB324-X4X0
	SCALE	N/A	REV D

4.3 Character Chart (5x8 Dot Matrix) (Continued)

FIGURE 5 - CYRILLIC CHARACTER SET

Note: N/A = Non-Applicable

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4.3 Character Chart (5x8 Dot Matrix) (Continued)



FIGURE 6 - KATAKANA CHARACTER SET

Note: N/A = Non-Applicable

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	SCALE	N/A	REV D

4.3 Character Chart (5x8 Dot Matrix) (Continued)



FIGURE 7 - HEBREW CHARACTER SET

Note: N/A = Non-Applicable

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4.3 Character Chart (5x8 Dot Matrix) (Continued)



FIGURE 8 - GREEK CHARACTER SET

Note: N/A = Non-Applicable

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	SCALE	N/A	REV	D	SHEET

4.3 Character Chart (5x8 Dot Matrix) (Continued)



FIGURE 9 - POLISH CHARACTER SET

Note: N/A = Non-Applicable

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4.3 Character Chart (5x8 Dot Matrix) (Continued)

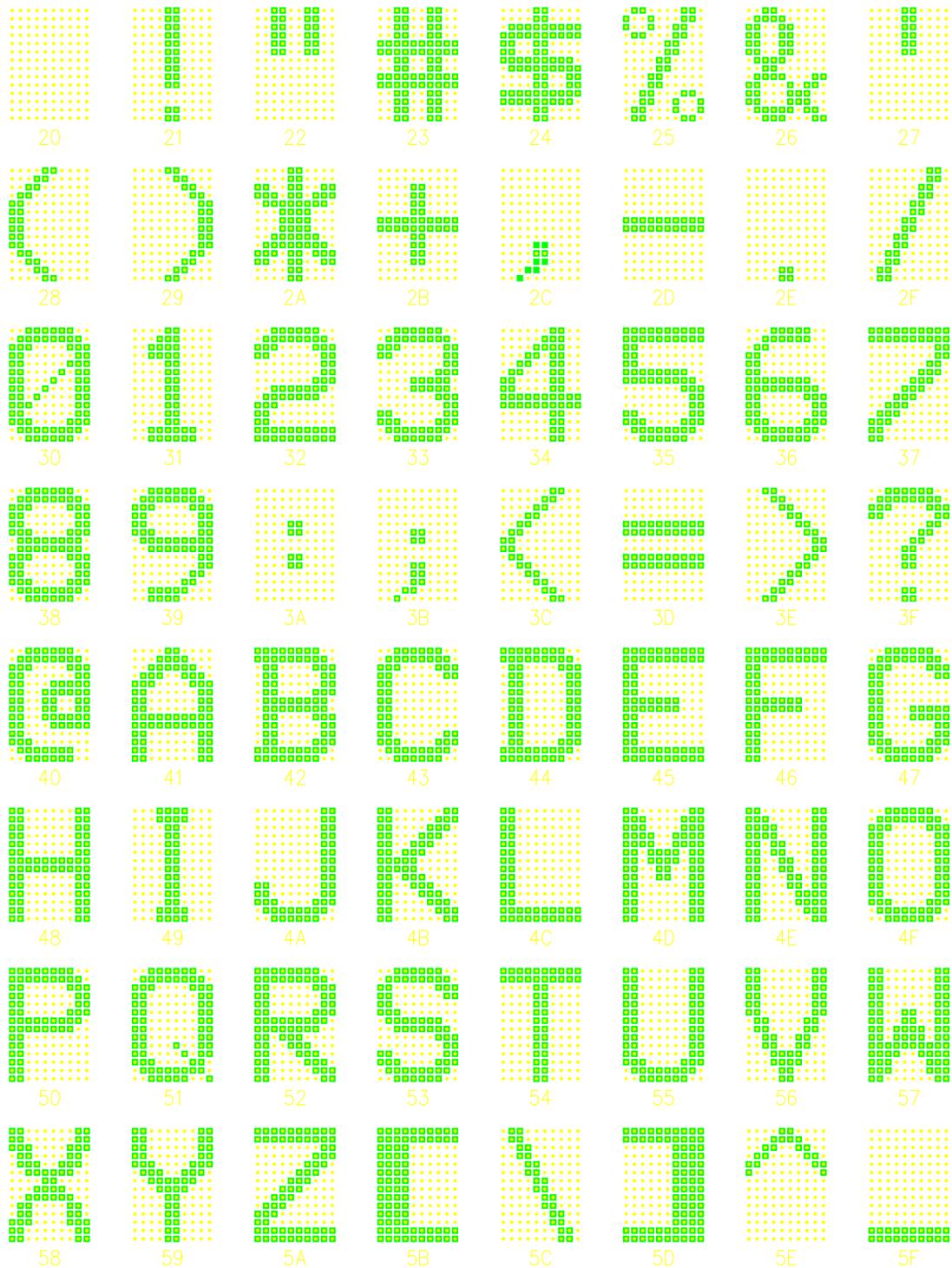


FIGURE 10 - 10 x 14 BOLD CHARACTER SET

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	SCALE	N/A	REV D

4.4 User Defined Character Loading (5 x 8 Dot Matrix)

A maximum of eight characters may be created temporarily (until power-off or reset) by a user-defined down-loaded character pattern. To do so, enter the following sequence of commands and data:

<u>BYTE</u>	<u>DESCRIPTION</u>
1-3	Start load 1B-26-01 (HEX)
4	Location to begin download (20-FF hex)
5	Number of characters to download (01-08)
6-10	*Character dot data

*Repeat bytes 6-10 for the number of characters to be downloaded.

CHARACTER DOT DATA

BYTE #	7	6	5	4	3	2	1	0
6	36	31	26	21	16	11	6	1
7	37	32	27	22	17	12	7	2
8	38	33	28	23	18	13	8	3
9	39	34	29	24	19	14	9	4
10	40	35	30	25	20	15	10	5

CHARACTER MATRIX

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15
16	17	18	19	20
21	22	23	24	25
26	27	28	29	30
31	32	33	34	35
36	37	38	39	40

Example: To download 1 Greek letter Psi for character F8.

1Bh	BYTE 1, start load
26h	BYTE 2, start load
01h	BYTE 3, start load
F8h	BYTE 4, location to begin download
01h	BYTE 5, download 1 character
0Ch	BYTE 6, Dots 16, 11 ON
91h	BYTE 7, Dots 37, 22, 2 ON
FFh	BYTE 8, Dots 38, 33, 28, 23, 18, 13, 8, 3 ON
91h	BYTE 9, Dots 39, 24, 4 ON
0Ch	BYTE 10, Dots 20, 15 ON

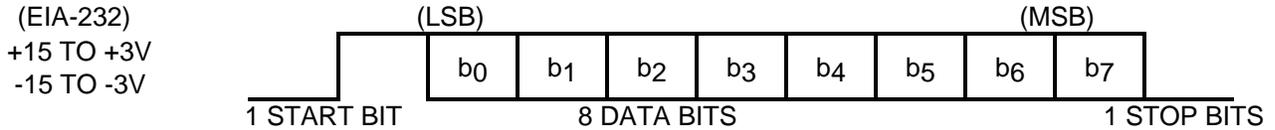
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4.5 Dedicated Hardware Lines

Not available.

4.6 Serial Data and Self-test

Serial characters are received with data formatted as a 10-bit word. The command set is structured to allow transmission of 8 data bits. The data rate is fixed at 9600 baud. The level is EIA-232C.



Self-test is a very useful feature and can be activated by sending 1F-40 (HEX). The test may be terminated by sending 1B-40 (HEX). Characters from 20 (HEX) to F4 (HEX) will be displayed advancing through the characters at approximately 2.0 characters per second. This self-test capability can be used to speed up both in-field fault isolation and incoming receiving inspection.

4.7 Connector Pin Assignment

EIA-232C

J1 (RJ-45) PIN NO.	FUNCTION
*1	SIGNAL GROUND
2,7	11-29 VOLTS DC
3	TRANSMIT DATA (OUTPUT)
4	DATA SET READY (INPUT)
5	DATA TERMINAL READY (OUTPUT)
6	RECEIVE DATA (INPUT)
*8	POWER RETURN

* Shielded cable and/or connector are optional.

EIA-422A

J1 (RJ-45) PIN NO.	FUNCTION
*1	SIGNAL GROUND
2,7	11-29 VOLTS DC
3	TRANSMIT DATA (A+)
4	TRANSMIT DATA (A-)
5	RECEIVE DATA (A-)
6	RECEIVE DATA (A+)
8	POWER RETURN

* Shielded cable and/or connector are optional.

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5.0 ELECTRICAL CHARACTERISTICS

5.1 Power ON / OFF Sequence

There are no deleterious effects associated with power ON and OFF of this display; however, rapid ON/OFF sequencing is not recommended. Neither data nor power connectors should be connected/disconnected while power is applied.

Because of the power-up cycle within the microprocessor, rise time of the power supply should be less than 100mS. The display module is not ready to accept data for 850mS (typ) - 1.2 sec (max).

5.2 Interface Signals

All logic signals abide by the following convention: logic "1" is a high, logic "0" is a low.

5.3 Absolute Maximum Ratings

EIA-232C: +15VDC to -15VDC
EIA-422A: +15VDC to -10VDC

5.4 Normal Operating Ratings

Primary voltage: 11-29 VOLTS DC

Power dissipation: $P(\text{watts}) = .056 (\text{operating voltage})$

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6.0 OPTICAL CHARACTERISTICS

Format: 4 lines of 20 characters
 Character height: .39 in. (10mm)
 Character width: .24 in. (6.2mm)
 Character spacing: .30 in. (7.5mm) center-to-center
 Character design: 5 x 8 dot matrix
 Type of cursor indicator: FLASHING BLOCK
 Character set: ASCII, European, Cyrillic, Katakana, Hebrew, Greek, Polish, Bold
 Color: Dark blue characters on yellow-green background
 Viewing angle: 100 degrees vertically, 90 degrees horizontally

7.0 ENVIRONMENTAL CHARACTERISTICS

Operating temperature: -20 to +70 (°C) -4 to 158 (°F)
 Storage temperature: -40 to +70 (°C) -40 to +158 (°F)
 Relative humidity: (≤ 40°C) 0 to 95% (non-condensing)
 (≥ 40°C) Absolute humidity must be lower than the humidity of 95% RH at 40°C
 Vibration: 10 to 50 Hz 2mm peak-to-peak (3 axis)
 Shock: 10 G (3 axis)

8.0 ACCESSORIES

Cables

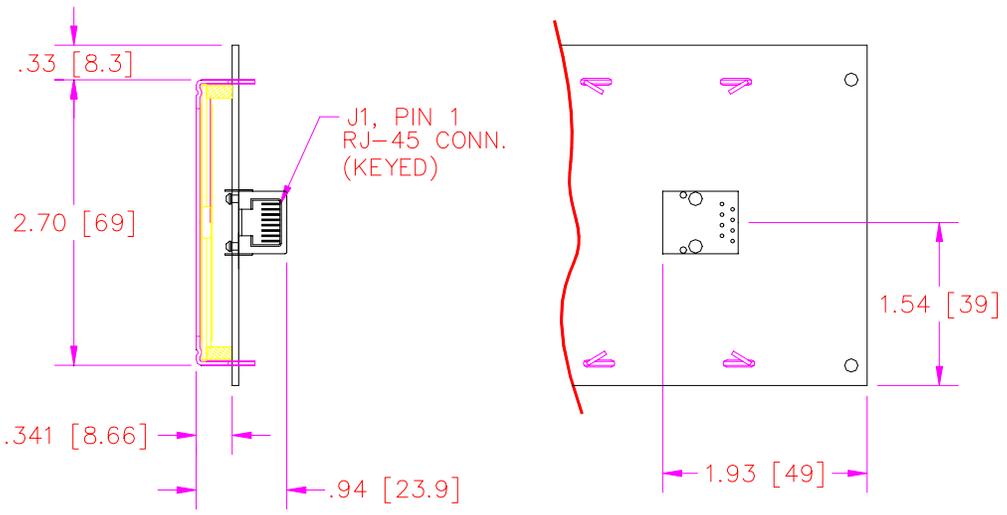
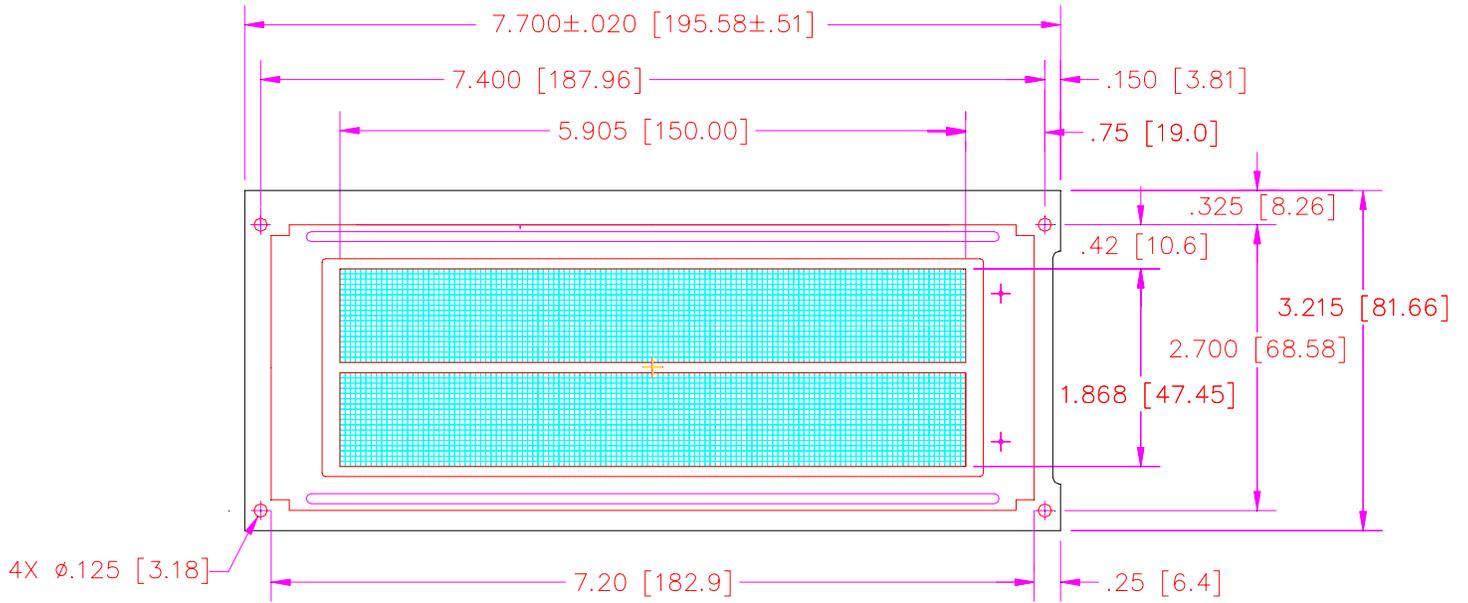
Part Number

RJ-45 to DIN-8 male & DIN-8 female to DB-9 female (UNSHIELDED)	35754-XX & 35802-XX
RJ-45 to DIN-8 male & DIN-8 female to DB-9 female (SHIELDED)	35753-XX & 35801-XX
RJ-45 to RJ-45 (UNSHIELDED)	35804-XX
RJ-45 to RJ-45 (SHIELDED)	35803-XX

XX=length in inches

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9.0 OUTLINE DRAWING



TOLERANCE:

.XX = ±.03 (0.8)
 .XXX = ±.010(0.25)
 Dim. in inches (mm)

FIGURE 11

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