APPLICATION		REVISIONS			
NEXT ASSY	FINAL ASSY	LTR	DESCRIPTION	DATE	APPROVED
		-	PRODUCTION RELEASE/E.O. 32324	11-12-96	D. Goodale
		A	E.O. 33085	9-19-97	D. Goodale
		B	E.O. 33754	5-27-98	D. Goodale

LIQUID CRYSTAL DISPLAY
4 X 40 CHARACTER
5x8 DOT MATRIX
SL330-X4X0

REV	B	-	-	-	-	B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	A			
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**
			LIQUID CRYSTAL DISPLAY 4 X 40 CHARACTER 5x8 DOT MATRIX
	DRAWN R. January 02/06/96 **CHECK** C. Rudolph 11/12/96		
	APPROVED **D. Goodale 11 - 12 - 96** APPROVED	**SIZE** **A**	**CODE IDENT NO.** **05464** SL330-X4X0
		SCALE	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) , 40 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
- Power and data on same connector
- 11-29 Volt Operation
- Low cost
- Shielded I/O Connector standard
- Wide operating temperatures (-20 to +70°)
- 4 User defined characters
- ASCII + 7 additional character sets
- EIA-232C data interface
- EIA-422A data interface
- Software selectable blink
- Software self test

1.4 Description

This LCD is a self-contained multiplexed unit 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 cell 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.

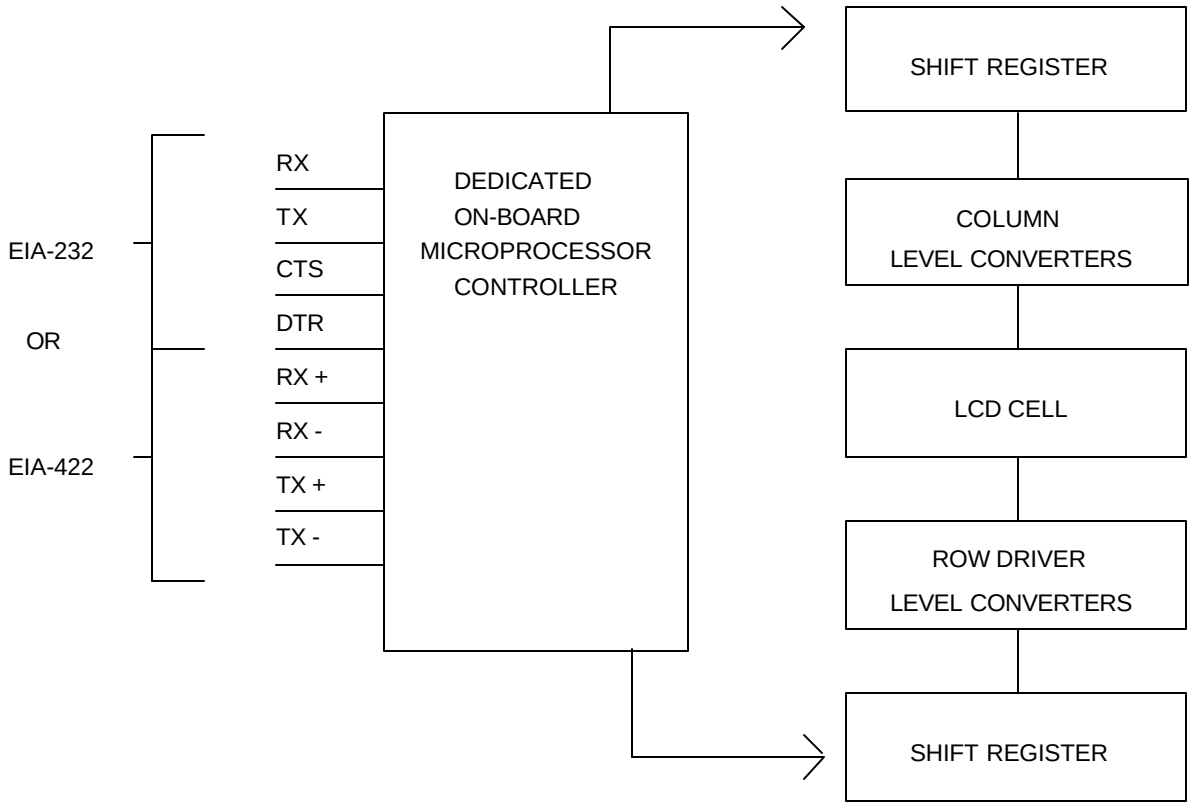
A single 11-29 volt power supply is required for operation. At +12VDC, total power is approximately .72 watts and current is about 60mA.

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.

2.0 BLOCK DIAGRAM



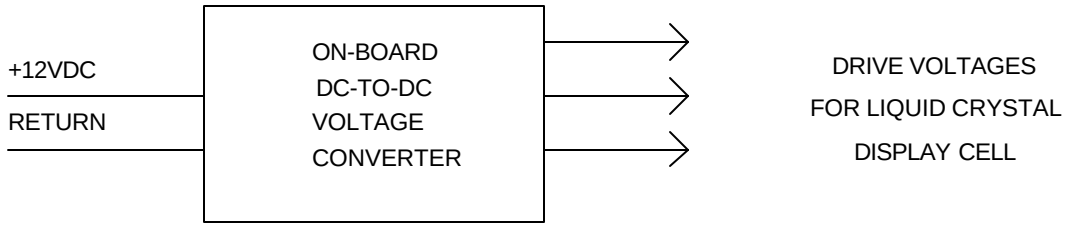


FIGURE 1

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 240 dots, to display four lines of characters. A matrix addressing technique provides individual control of the electric field applied to each dot used to create the character. A standard character is generated within a 5 x 8 dot matrix. A unselected dot passes the light which reflects back appearing as a yellow-green background. Selected dots block the light to create the lines of 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.

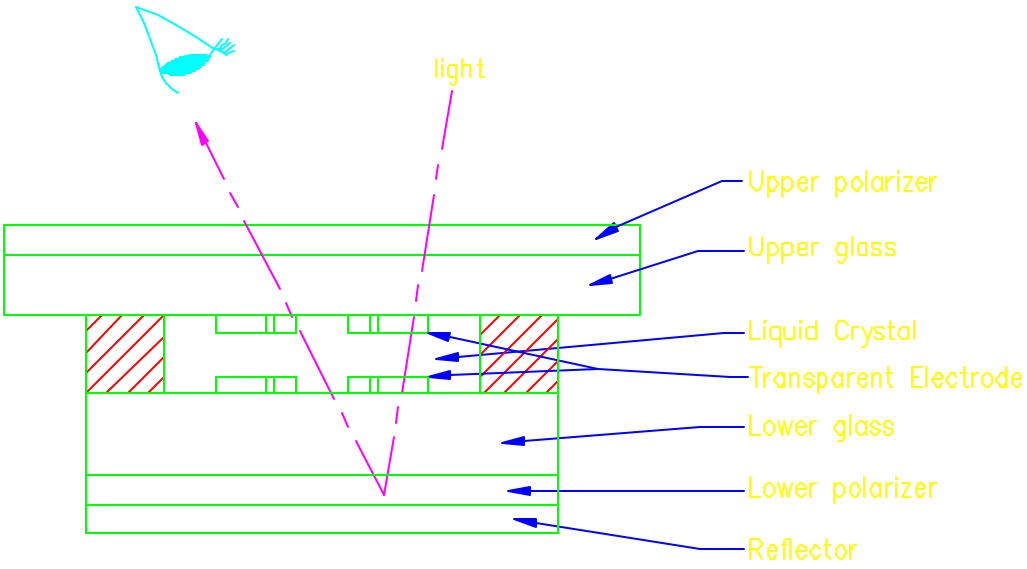


FIGURE 2

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 A0 (HEX))
02	DISPLAY SOFTWARE CHECKSUM AND SOFTWARE NUMBER
03	READ CURSOR LOCATION VALUE (DISPLAY RESPONDS WITH 1 BYTE) FOR 5 x 8 DOT CHARACTERS: 01-28 (HEX) FOR LINE 1; 41-68 (HEX) FOR LINE 2; 81-A8 (HEX) FOR LINE 3; C1-E8 (HEX) FOR LINE 4 FOR 10 x 14 DOT CHARACTERS: 01-14 (HEX) FOR LINE 1; 21-34 (HEX) FOR LINE 2
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 = 01-1E (HEX) (30 columns, each 8 pixels wide = 240 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
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, UNDER BAR
<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)

4.2.1 Instruction (Cont'd)

DATA (HEX)		DESCRIPTION
<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 (goes to system default settings and clears 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,36039,-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) (5x8 DOT CHARACTER ONLY)
	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=02, ASCII AND KATAKANA (fig. 6) N=03, ASCII AND CYRILLIC (fig. 5) 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.

4.2.1 Instruction (Cont'd)

DATA (HEX)		DESCRIPTION	
1F	1F-24-C-L	MOVE CURSOR TO COLUMN C LINE L	
		FOR 5x8 DOT CHARACTERS:	C=01-28 (HEX) L=01-04 (HEX)
		FOR 10x14 DOT CHARACTER:	C=01-14 (HEX) L=01-02 (HEX)
	1F-40	EXECUTE SELF TEST (Use 1B-40 to terminate self test)	
20 to 7F		MAIN CHARACTER SET	
80 to F7		ALTERNATE CHARACTER SET	

\+ Display automatically defaults to these conditions after power-up or reset.

< > These instructions are mutually exclusive

* These instructions are only for 10x14 DOT CHARACTER SET.

4.3 Character Set Charts

4.3.1 5x8 Dot Matrix Characters

The L330-X4X0 module offers six independently-selectable Character sets. Each consists 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 F2 as shown.

FIGURE 3 - ASCII CHARACTER SET

Note: N/A = Non-Applicable

FIGURE 4 - GENERAL EUROPEAN CHARACTER SET
(Default Setting)

Note: N/A = Non-Applicable

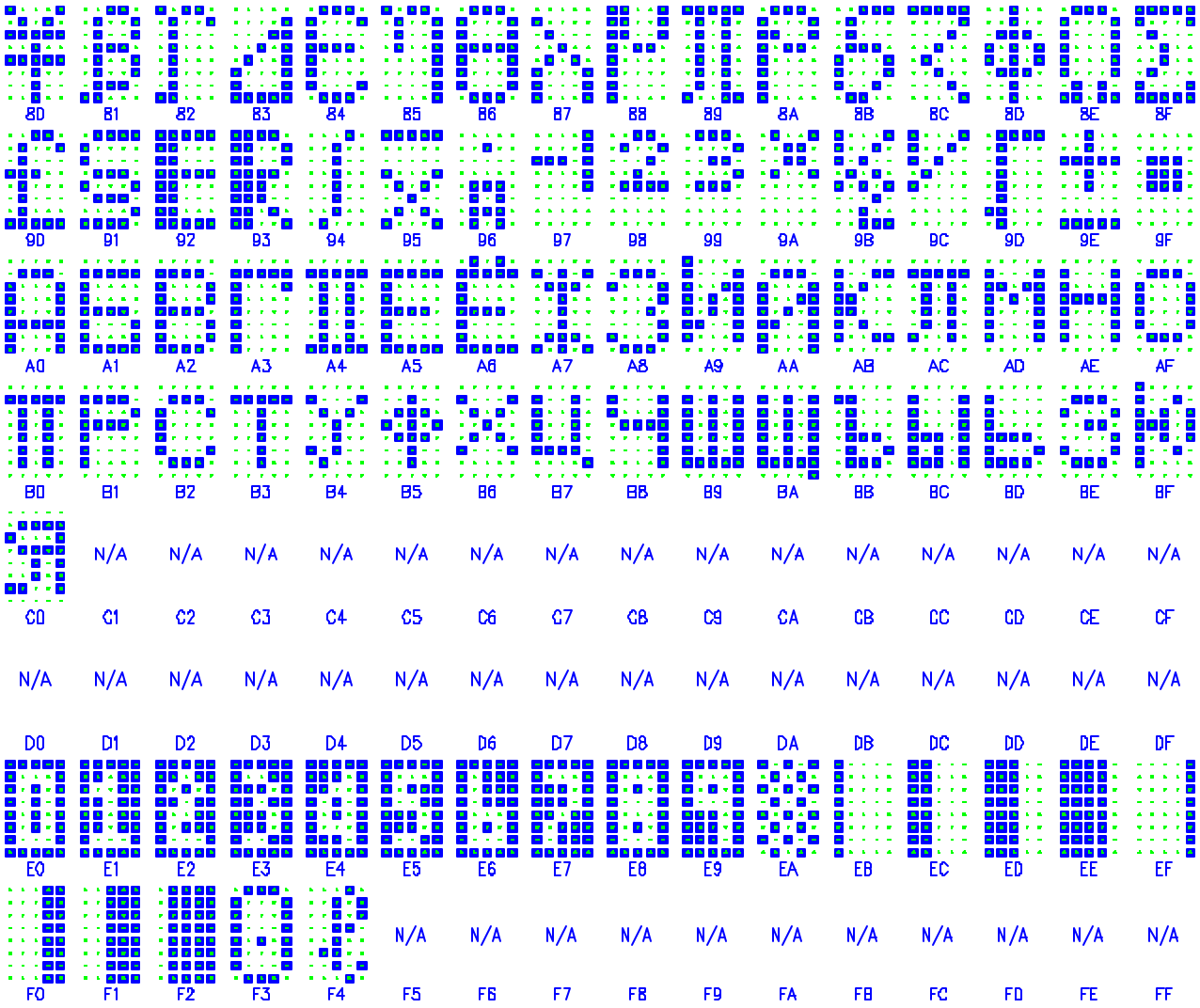


FIGURE 5 - CYRILLIC CHARACTER SET

Note: N/A = Non-Applicable

FIGURE 6 - KATAKANA CHARACTER SET

Note: N/A = Non-Applicable

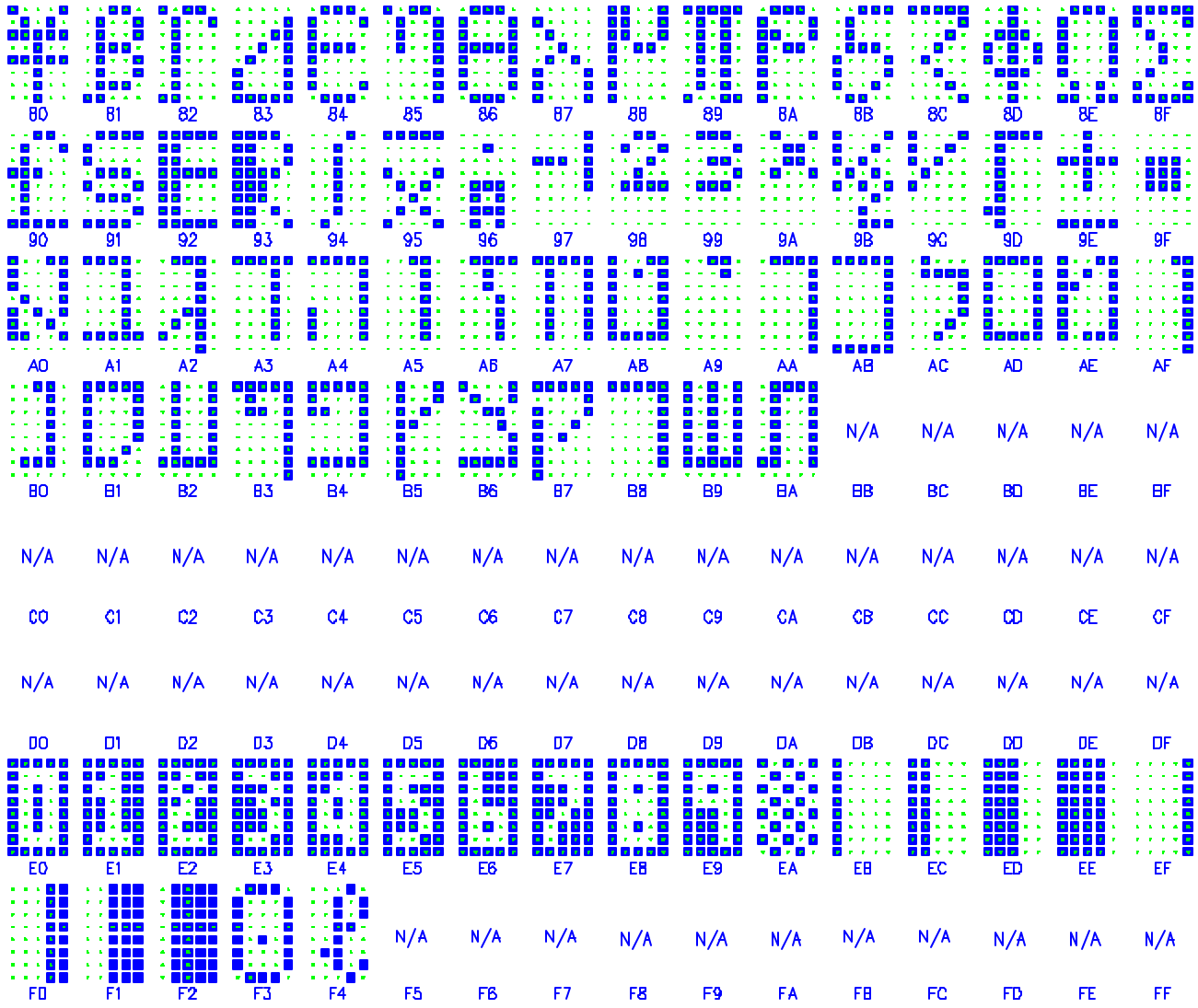


FIGURE 7 - HEBREW CHARACTER SET

Note: N/A = Non-Applicable

FIGURE 8 - GREEK CHARACTER SET

Note: N/A = Non-Applicable

FIGURE 9 - POLISH CHARACTER SET

Note: N/A = Non-Applicable

4.3.2 10 x 14 Dot Matrix Characters

The L330-XXXX offers a basic set of 64 upper case large, bold characters and symbols in a 10 x 14 dot matrix font (.582"; 14.9mm high characters). It displays two rows of 20 characters.

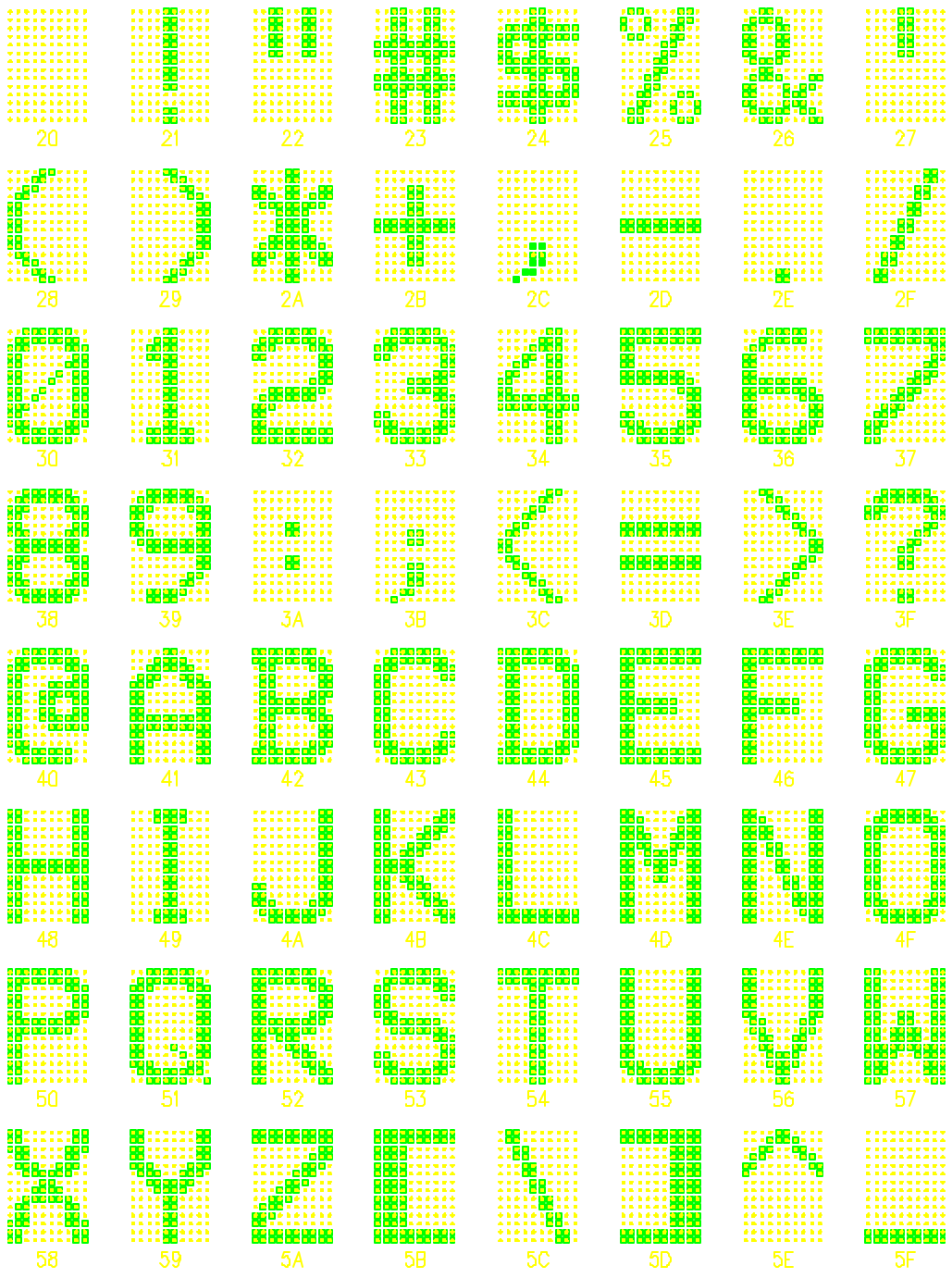


FIGURE 10 - 10 x 14 BOLD CHARACTER SET

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

A maximum of four 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:

BYTE	DESCRIPTION
1-3	Start load 1B-26-01 (HEX)
4	Location to begin download (20-FF hex)
5	Number of characters to download (01-04)
6-10	*Character dot data

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

CHARACTER DOT DATA

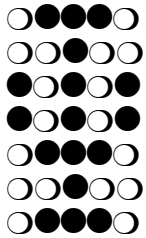
BYTE #	7	6	5	4	3	2	1	0
6	36	31	26	21	16	11	6	1
7	37	32	27	22	17	12	7	2
8	38	33	28	23	18	13	8	3
9	39	34	29	24	19	14	9	4
10	40	35	30	25	20	15	10	5

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

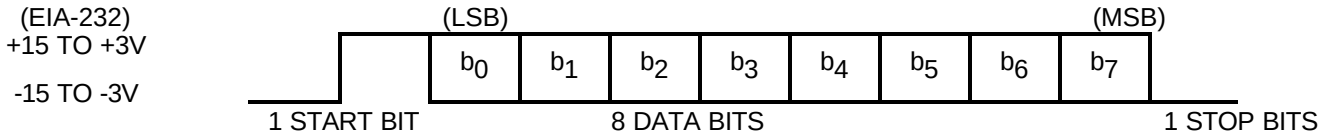


4.5 Dedicated Hardware Lines

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 F2 (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 TO +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 connector is standard.

EIA-422A

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

* Shielded connector is standard.

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: 0.72 WATTS

6.0 OPTICAL CHARACTERISTICS

Format:	4 lines of 40 characters
Character height:	.33 in. (8.5mm)
Character width:	.19 in. (4.8mm)
Character spacing:	.23 in. (5.8mm) center-to-center
Character design:	5 x 8 dot matrix
Type of cursor indicator:	UNDER BAR (10x14 DOT CHARACTER ONLY)
Character set:	ASCII, European, Cyrillic, Katakana, Hebrew, Greek, Polish
Color:	Dark blue characters on yellow-green background
Viewing angle:	100 degrees vertically, 90 degrees horizontally

6.1 Display Viewing/Contrast

This display has built-in temperature compensation circuitry and therefore should not require readjustment of the contrast once it is set at the factory. Potentiometer R4 (when used) is adjusted to obtain 10.70 VDC at 22°C when measured from +5V to TP1.

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

IEE has a large selection of cable lengths and connector combinations available. The display enclosure is available in several standard colors with multiple mounting methods and pole lengths. Contact IEE for specifics.

9.0 OUTLINE AND INSTALLATION DRAWING

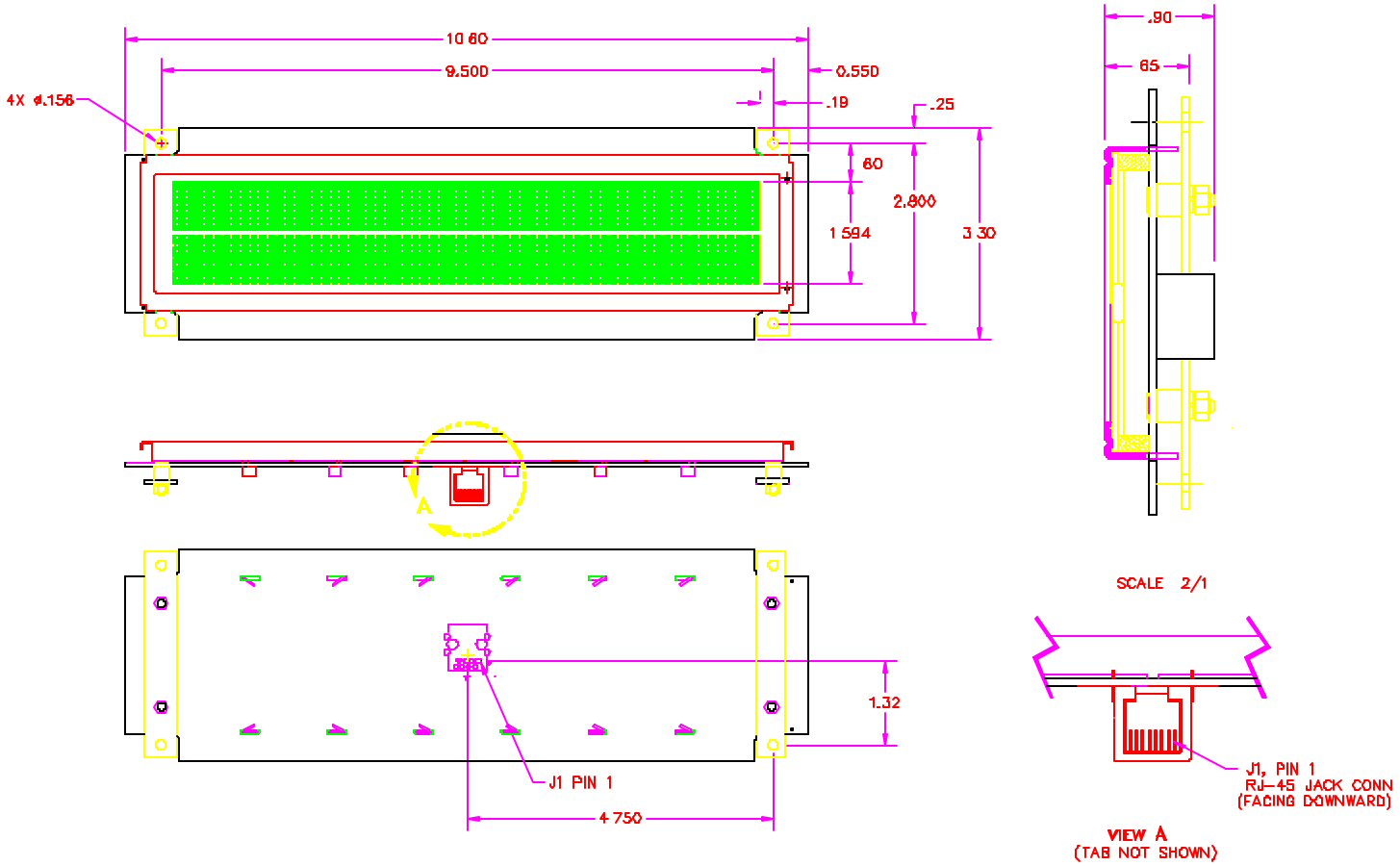


FIGURE 11

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

Industrial Electronic Engineers, Inc. Van Nuys, California	SIZE A	CODE IDENT NO. 05464	SL330-X4X0
	SCALE N/A	REV B	SHEET 21 of 21