APPLICATION		REVISIONS			
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VACUUM FLUORESCENT DISPLAY
2 X 20 CHARACTER
S03601-95B-40

REV	A	A	A	A	-	A	-	-	A	A	A	A	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. 418	**CONTRACT**		**INDUSTRIAL ELECTRONIC ENGINEERS, INC.** **VAN NUYS, CALIFORNIA**
	DRAWN C. Lewis 4-25-91 **CHECK**		VACUUM FLUORESCENT DISPLAY 2 X 20 CHARACTER
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		SCALE		SHEET 1 OF 14

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1.0 GENERAL DESCRIPTION

1.1 Introduction

This specification describes the interface requirements and features of a two-line Vacuum Fluorescent Display, 20 characters wide. The characters are formed using a 5x7 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"	Hardware reset
Low cost	Software dimming
Hardware interrupt	Extended/European character set
10 User defined characters	Superset of 03601-951

1.4 Description

This Vacuum Fluorescent Display is a self-contained multiplexed unit which provides a simple interface to a microprocessor system.

This unit consists of a vacuum fluorescent display tube and a minimal amount of electronic hardware. All display characters and standard control codes are in a 8-bit format. All inputs are TTL compatible. Primary complexity is contained within the microprocessor software, which controls all display functions.

Timing is not critical for data communication except which is shown in Section 5.5. Data is entered in parallel at rates determined by execution times.

A single +5VDC power supply (approximately 370mA typical for brightest setting) is required for operation. Total power is about 1.8 watts.

A wide spectrum of color filters is available to fit all applications. The characters are bright, but soft, providing comfortable short or long-term viewing.

An ASCII-coded English font employs a 96 character set with an extended European character set and 10 user defined characters.

Figure 3 depicts the character sets as displayed by the 03601-95B-40 module.

2.0 BLOCK DIAGRAM

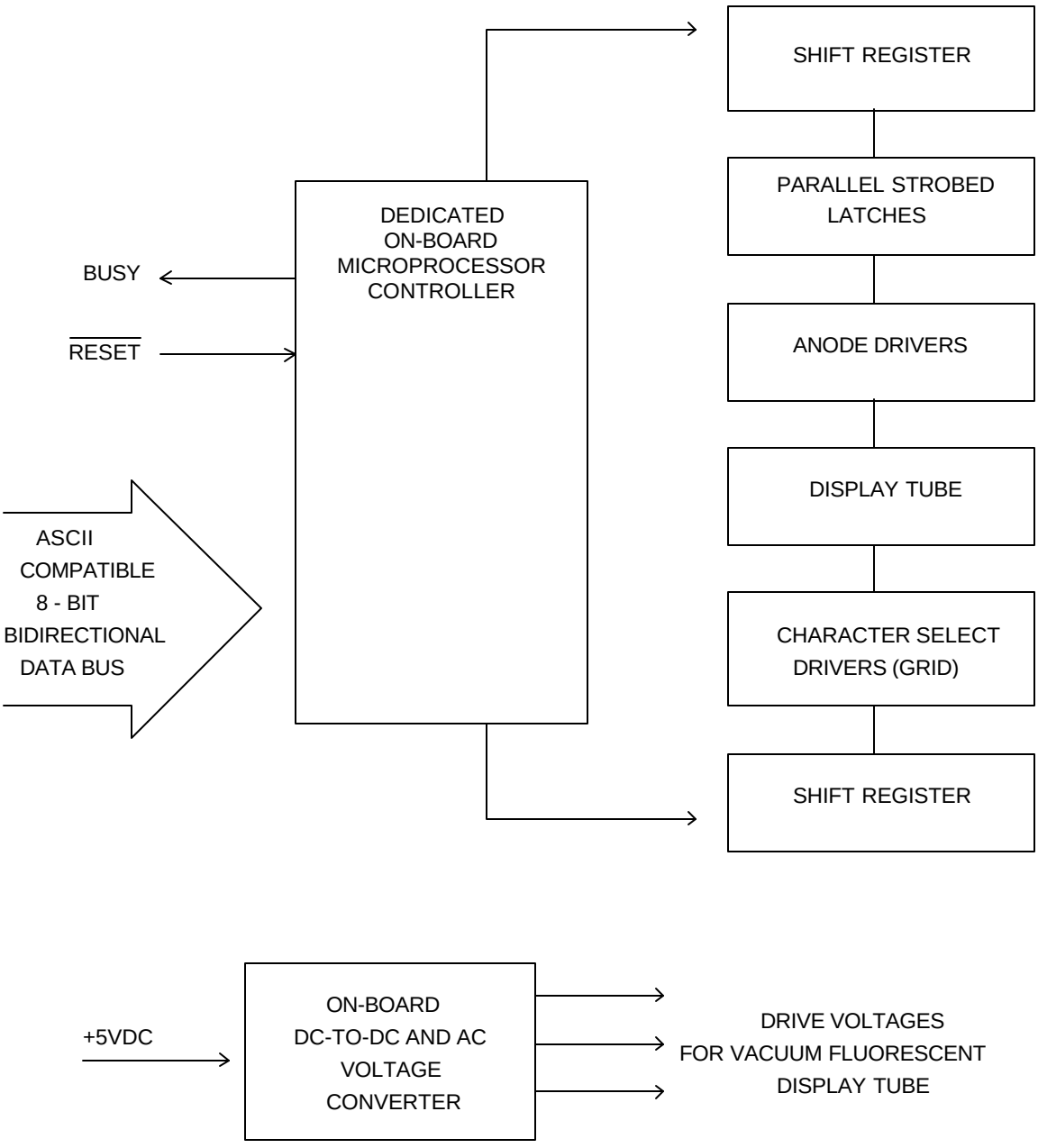


FIGURE 1

3.0 THEORY OF OPERATION (Dot Matrix Displays)

The Vacuum Fluorescent Display array consists of three basic electrodes which are enclosed in an evacuated glass chamber. The first electrode is the filament, which spans the entire length of the display, and is made from a small diameter oxide coated tungsten wire. This element is common to all characters and supplies the electron emission needed for operation. Individual grid electrodes are provided, one for each character, to control current passing to the anodes. Each grid is a fine mesh metal screen which provides digit-select electrical control with no visual interference. When the grid is positive with respect to the filament, electrons are allowed to pass on to the third electrode, the anode dots, causing the fluorescent phosphor coating on each positively charged dot to glow. Selectively energizing these fluorescent dots causes the desired character to be displayed.

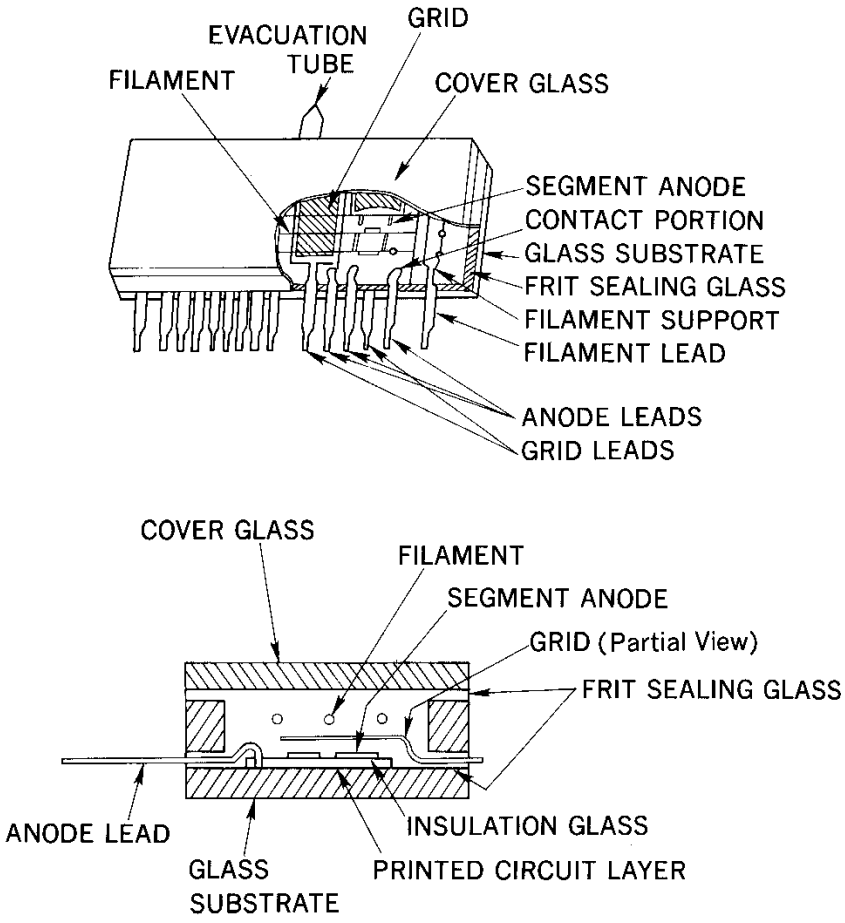


FIGURE 2

4.0 OPERATION

4.1 Loading ASCII Character Data

All printing characters are in locations from 20 (HEX) to 7F (HEX), and from A0 (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 FLIP DISPLAY MODULE AS THIS MAY CAUSE A SOFTWARE MALFUNCTION OF THE MODULE.

DATA (HEX)		DESCRIPTION
08		BACK SPACE CURSOR LOCATION ONE POSITION
09		ADVANCE CURSOR LOCATION ONE POSITION
0A		LINE FEED (vertical scroll from bottom line; cursor positions to the left-most grid).
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 location)
0F		MAKE CURSOR INDICATOR VISIBLE (Flashing “reverse rubout character”)
<11>	+	NORMAL DATA ENTRY WITH WRAPAROUND TO HOME POSITION (data enters beginning at the home position)
<12>		OVERWRITE OF RIGHT-MOST CHARACTER ON THE BOTTOM LINE ONLY/ AUTOMATIC CARRIAGE RETURN OFF
<13>		HORIZONTAL SCROLL MODE (from right to left on bottom line only, after line has been filled)
14		RESET
15	+	DISPLAY CLEAR (returns cursor to upper left-most position of multi-line displays)
16	+	CURSOR HOME (returns cursor to upper left-most position)
18		BEGIN USER DEFINED CHARACTER LOADING (Para. 4.6)
19		BIT 7 HIGH FOR NEXT BYTE ONLY

4.2 Control Codes (Continued)

DATA (HEX)	DESCRIPTION
1C	DIMMEST (12%)
1D	DIM LEVEL (25%)
1E	BRIGHT LEVEL (50%)
+1F	BRIGHTEST LEVEL (100%)

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

4.2.1 Cursor Positioning Instruction

DATA (b_7-b_0)		DESCRIPTION
1B HEX (0001 1011)		MOVE CURSOR TO FOLLOWING POSITION (2 byte instruction to locate cursor)
XXLL LLLL	*	SECOND BYTE (LLLL location in binary - upper left-most location is zero, 00 0000 moves cursor to home position)

* For numbers greater than 27 Hex cursor location will remain unchanged.

4.3 Reading Data and Status Information

Busy status is available on J1-1. This signal may be used as a hardware interrupt for the host processor when the display is busy. High busy signal indicates that the display is busy.

4.4 Character Chart (5x7 Dot Matrix)

FIGURE 3
US ASCII & EUROPEAN CHARACTER SET
(default)

Note: 30H & AFH are the same character.
N/A = Non-Applicable
UDC = User defined character

4.5 Alternate Character Codes

Not available at this time.

4.6 External Font Loading (5 X 7 Dot Matrix)

One or more characters may be replaced temporarily (until power-off or reset) by user-defined down-loaded character patterns. To do so, enter the following sequence of commands and data:

BYTE	DESCRIPTION
1	Start load 18 (HEX)
2	Location
3-7	Character dot data
8	Last byte with end bit
End bit E:	0 = end of external font load
End bit E:	1 = continue to next ASCII character position

Location byte:

00 → F6 (Hex) location	05 → FB (Hex) location
01 → F7 (Hex) location	06 → FC (Hex) location
02 → F8 (Hex) location	07 → FD (Hex) location
03 → F9 (Hex) location	08 → FE (Hex) location
04 → FA (Hex) location	09 → FF (Hex) location

CHARACTER DOT DATA

BYTE #	DATA BIT 7	6	5	4	3	2	1	0
3	X	03	17	34	X	X	X	X
4	X	07	13	30	23	04	14	33
5	X	11	09	26	27	08	10	29
6	X	15	05	22	31	12	06	25
7	X	19	01	18	35	16	02	21
8	X	E	X	X	32	28	24	20

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

NOTE 1: ADDRESSING EVERY DOT FOR EVERY GRID IS NOT RECOMMENDED.

4.7 Execution Times (Maximum)

Character rate:	220µS
Line feed:	230µS
Control codes:	230µS
Display clear:	350µS
Horizontal scroll:	530µS
Software (Reset):	710µS
Hardware (Reset):	500mS

4.8 Dedicated Hardware Lines

4.8.1 $\overline{\text{RESET}}$

Hardware $\overline{\text{RESET}}$ is available on J1-14. Setting $\overline{\text{RESET}}$ low for greater than 50µS will clear the display and set the cursor to the upper left character (power-up condition). Sinking current must be able to discharge a 1µF capacitor connected internally.

4.8. $\overline{\text{INTERRUPT}}$ (BUSY)

A busy signal is available on J1-1 and may be used to interrupt the host signaling a READY condition.

4.9 Self-Test

The display will go into self-test mode, if E2 is connected to the ground. In the self-test mode, the display will display every printable character from 20 (HEX) to FF (HEX) until E2 is disconnected from ground.

4.10 Connector Pin Assignments

J1 (POWER/DATA)

PIN NO.	FUNCTION
J1-1	BUSY
J1-2	WRITE STROBE
J1-3	D7 (MSB)
J1-4	D6
J1-5	D5
J1-6	D4
J1-7	D3
J1-8	D2
J1-9	D1
J1-10	D0 (LSB)
J1-11	+5V @ 370mA (TYP) *
J1-12	GROUND (COMMON)
J1-13	NOT USED
J1-14	$\overline{\text{RESET}}$

* For brightest software setting.

CMOS Note: Care must be taken to insure that input signals do not exceed the supply voltage or ground levels. Data cables must be as short as possible to reduce signal overshoots.

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. The power/data connector should not be connected/disconnected while power is applied.

CAUTION: Do not apply data or strobe signals unless logic power is also applied; otherwise, the input circuits may be damaged.

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 500mS.

5.2 Interface Signals

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

Input Levels:

Logic 1 > 2.4VDC @ 1µA.
Logic 0 < 0.5VDC @ 1.6mA.

Output Levels:

Logic 1 > 3.5VDC @ 150µA.
Logic 0 < 0.5VDC @ 4mA.

All parallel interface lines are internally pulled up using 10K resistors connected to the +5V supply.

5.3 Absolute Maximum Ratings

Primary voltage: +5.5VDC
Logic range: -0.5VDC thru +5.5VDC

5.4 Normal Operating Ratings

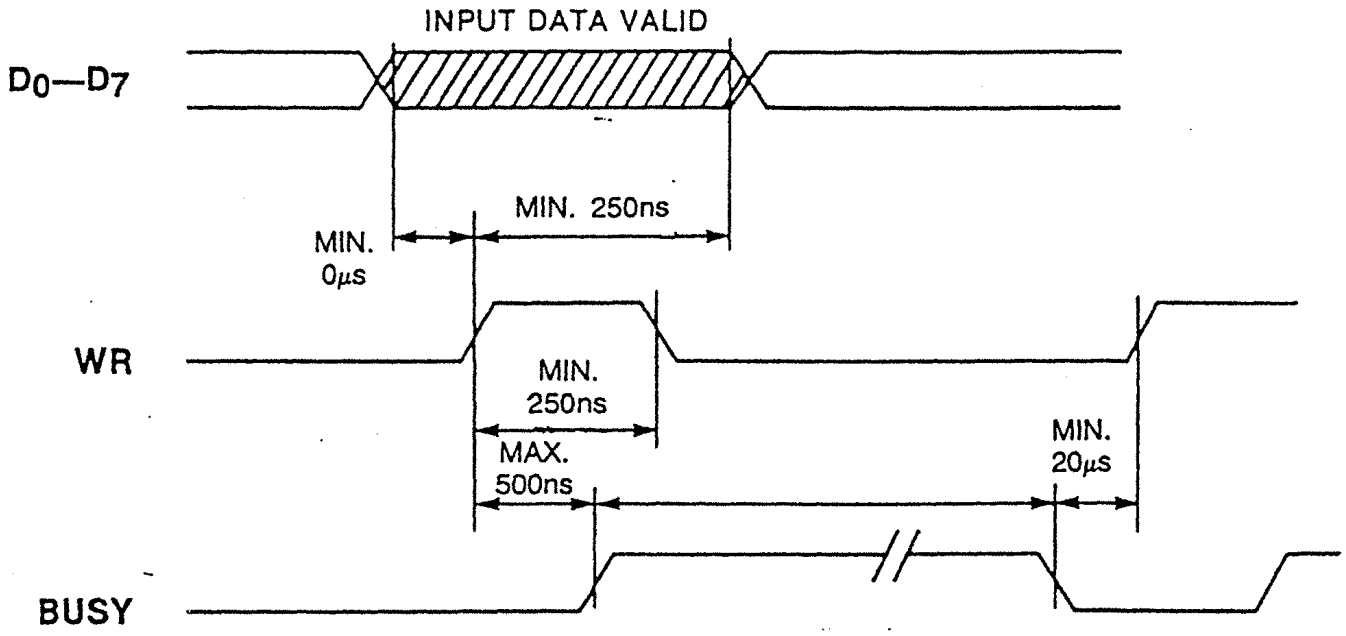
Primary voltage**:** +5.0 ± 0.25VDC

PRODUCTION

Dimmest	
260mA Min.	(Screen clear at 5.0V)
290mA Typ.	(Screen filled with "A" character at 5.0V)
Brightest	
280mA Min.	(Screen clear at 5.0V)
370mA Typ.	(Screen filled with "A" character at 5.0V)
460mA Max.	(Screen filled with "A" character at 5.25V)

5.5 Timing Characteristics And Timing Diagram

DATA WRITE TIMING



6.0 OPTICAL CHARACTERISTICS

Format:	2 line of 20 characters
Character height:	0.20 in. (5.05mm)
Character width:	0.14 in. (3.55mm)
Character spacing:	0.19 in. (4.75mm) center-to-center
Character design:	5 x 7 dot matrix
Type of cursor indicator:	Block
Character set:	96-character U.S. ASCII-7 Extended European character set and 10 user defined characters
Color:	Blue-green, peak at 5000 Angstroms
Viewing angle:	150 degrees
Brightness: (22^{O}C)	100fL (min), 200fL (typ)
Projected life at rated operating conditions:	40,000 to 100,000 hours*

*Note: End of useful life is defined as the point when the display tube light output has decreased to half its initial minimum rated brightness. This life rating is based on use with random text messages. To obtain maximum life, users are encouraged to avoid fixed messages and to blank or clear the display when it is not in use.

7.0 ENVIRONMENTAL CHARACTERISTICS

Operating temperature:	0 to +55 (°C) +32 to 131 (°F)
Storage temperature:	-20 to +70 (°C) -4 to +158 (°F)
Relative humidity:	0 to 95% (non-condensing)
Vibration:	10 to 50 Hz 2mm peak-to-peak (3 axis, random)
Shock:	20 G (3 axis)
Weight:	6.3 ounces (177 grams)

8.0 ACCESSORIES

Cables	**Part Number**		**Qty Required**
Data and Power	33375-XX*	Single-ended	1
	33374-XX*	Double-ended	1
Serial Converter	31785-22/-23		1

*XX = Length in inches: -99 omits cables

Filters	**31110-XX**
Gray	-01
Blue	-02
Aqua	-04
Neon Yellow-Orange	-05
Green	-07
Neutral Gray CP	-09
Yellow CP	-10

Connectors	**Mates With: Molex 6373-14**
Data & Power	Molex 2695-14 (Crimp) Molex 7720-14 (IDC)

9.0 OUTLINE AND INSTALLATION DRAWING

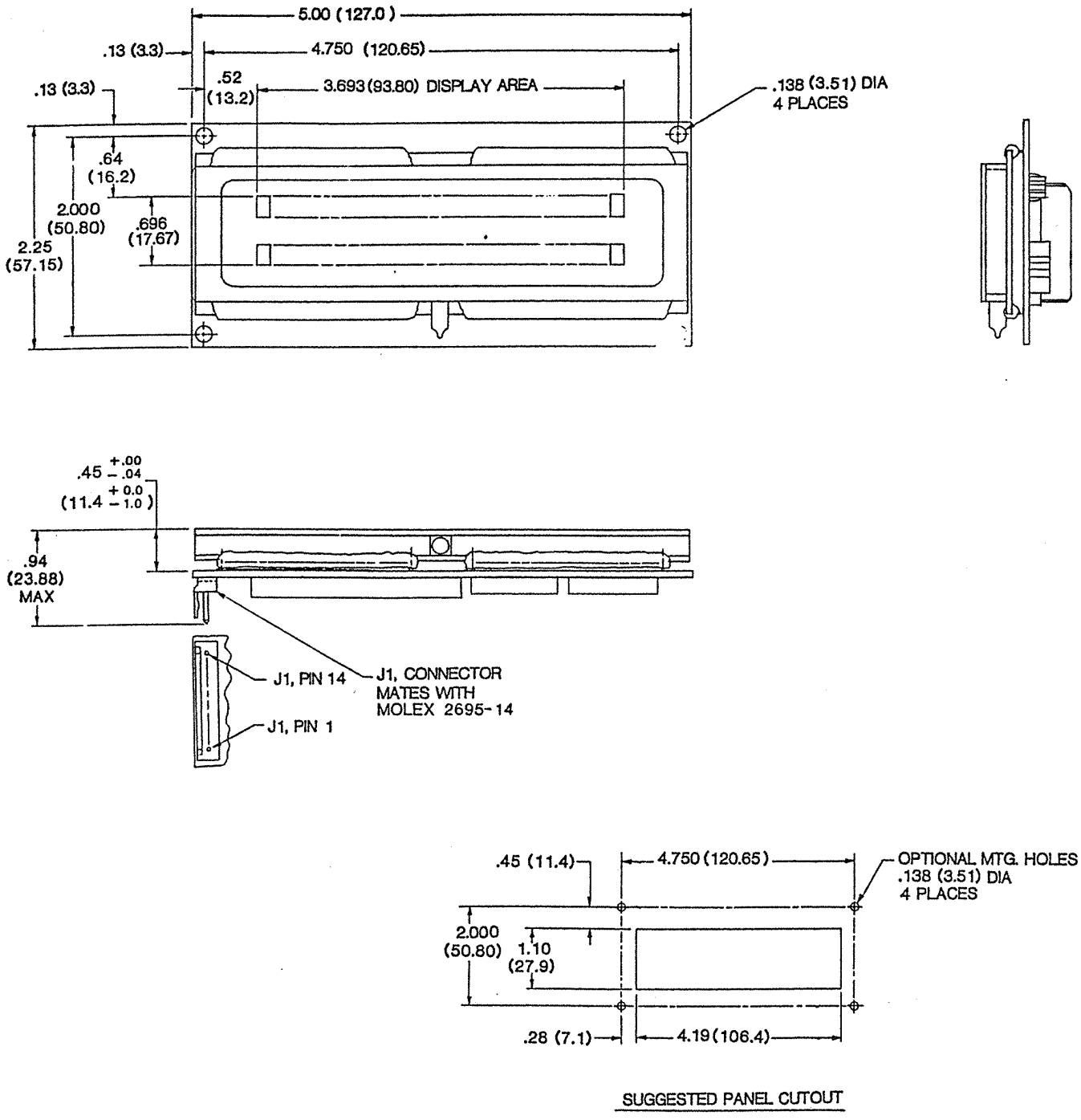


FIGURE 5

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

Industrial Electronic Engineers, Inc.	SIZE **A**	CODE IDENT NO. **05464**	**S03601-95B-40**
Van Nuys, California	SCALE N/A	REV **A**	SHEET 14 of 14

08/26/02