APPLICATION		REVISIONS			
NEXT ASSY	FINAL ASSY	LTR	DESCRIPTION	DATE	APPROVED
		A	PRODUCTION RELEASE/E.O. 33511	2-6-98	E.S.
		B	E.O. 35927	04-05-01	

VACUUM FLUORESCENT DISPLAY
1 X 16 CHARACTER
S03701-13-016

REV	B	A	A	A	A	A	A	A	A	A	A	A	B	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

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	APPROVED	SCALE	SHEET 1 OF 16

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PARAGRAPH NUMBER & TITLE

1.0 GENERAL DESCRIPTION

1.1 Introduction

This specification describes the interface requirements and features of a 1 line Vacuum Fluorescent Display, 16 characters wide. The characters are formed using 14 bar segments.

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 footprint" - 2-board model
Hardware reset

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 control codes are in 7-bit ASCII. All inputs are TTL compatible. Primary complexity is contained within the mircroprocessor software which controls all display functions.

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

This unit consists of a vacuum fluorescent display tube, and a minimal amount of electronic hardware. Primary complexity is contained within the microprocessor software which controls all display functions.

A single +5VDC power supply (approximately 440mA typical) is required for operation. Total power is thus about 2.2 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 standard 64 character set, plus additional symbols.

Figure 3 depicts the standard ASCII character set as displayed by the 03701-13-016 module.

2.0 BLOCK DIAGRAM

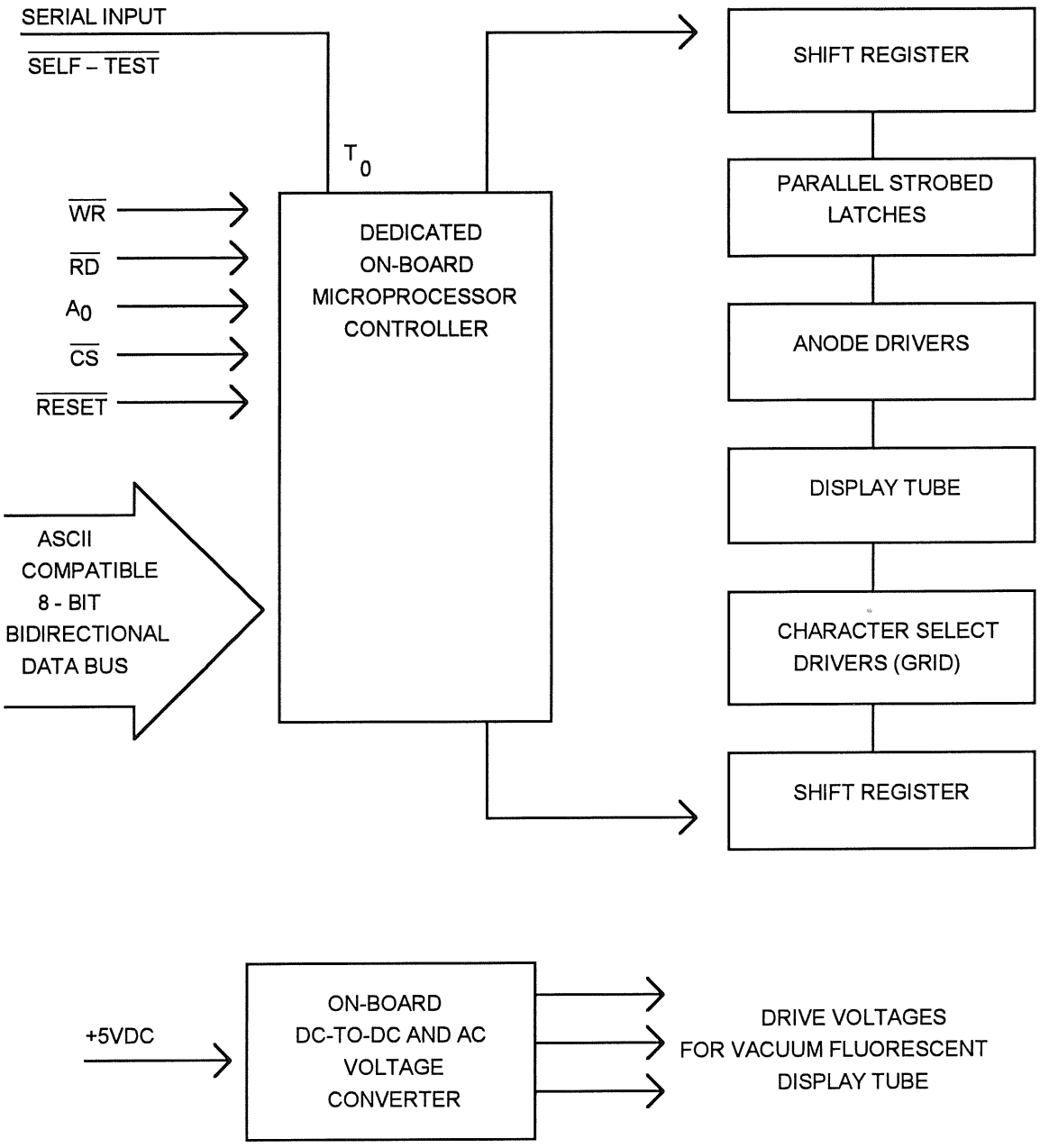


FIGURE 1

3.0 THEORY OF OPERATION (segmented 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 segments, causing the fluorescent phosphor coating on each positively charged dot to glow. Selectively energizing these fluorescent segments causes the desired character to be displayed.

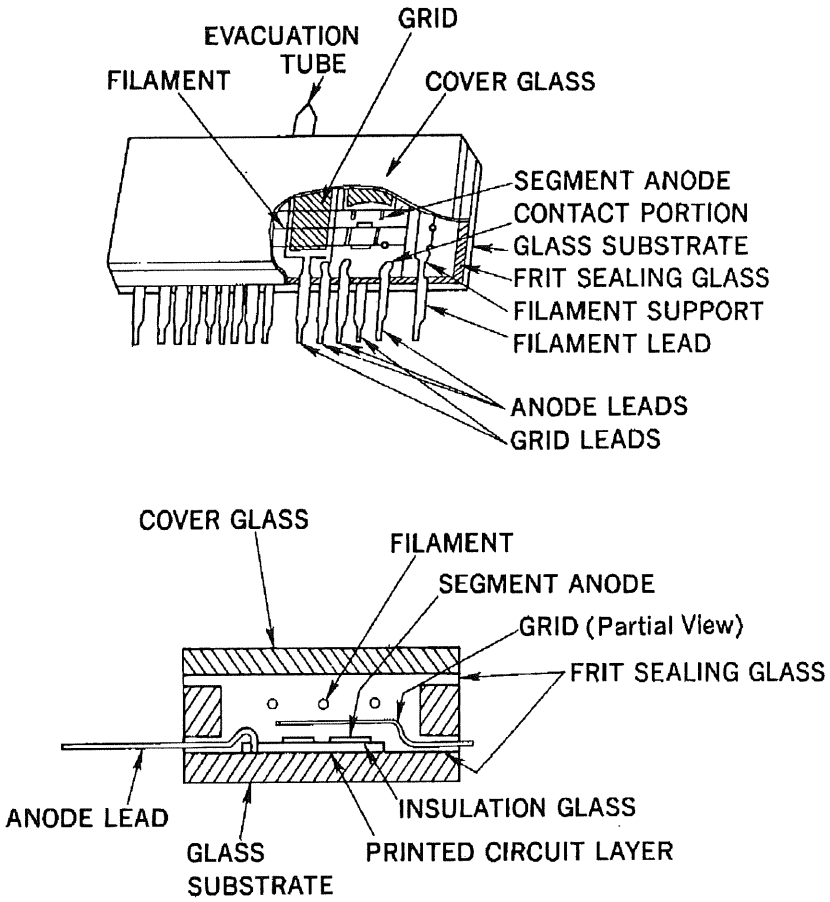


FIGURE 2

4.0 OPERATION

4.1 Loading ASCII Character Data

All printing characters are located in standard ASCII code locations from 20 (HEX) to 7F (HEX), and can be written with $\overline{CS}=A_0=0$ by pulsing $\overline{WR}$ low. 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.

4.2.1 Instruction For $A_0=0$ (Pulse $\overline{WR}$ Low, $\overline{CS}$ =0, Input Buffer Empty)

DATA (HEX)		DESCRIPTION	FUNCTION AVAILABLE IN SERIAL MODE
08		BACK SPACE CURSOR LOCATION ONE POSITION	YES
09		ADVANCE CURSOR LOCATION ONE POSITION	YES
0A		LINE FEED (clears one-line displays; cursor position does not change.)	YES
0B		BEGIN CHARACTER BLINK FIELD	YES
0C		END CHARACTER BLINK FIELD	
0D		CARRIAGE RETURN (returns cursor to left-most character position does not clear display)	YES
0E	+	MAKE CURSOR INDICATOR INVISIBLE (the cursor location counter continues to function but there is no visible indicator of next character location)	YES
0F		MAKE CURSOR INDICATOR VISIBLE (this is a blinking indicator of where the next character will be located)	YES
<11>	+	NORMAL DATA ENTRY WITH AUTOMATIC CARRIAGE RETURN	YES
<12>		OVERWRITE OF RIGHT-MOST CHARACTER/AUTOMATIC CARRIAGE RETURN OFF	YES
<13>		HORIZONTAL SCROLL MODE (from right to left after line has been filled)	YES

4.2.1 **Instructions for A_0=0 (Pulse $\overline{WR}$ Low, $\overline{CS}$ =0 Input Buffer Empty) Cont'd**

The inclusion of an inter-character decimal point/comma feature allows the user to display either of these two characters without using an additional character location on the display. An eighth bit is used in conjunction with the seven ASCII bits to derive a code which selects the decimal point or comma function. Thus, the display responds to an 8-bit code in the following manner:

DATE HEX	DESCRIPTION	FUNCTION AVAILABLE IN SERIAL MODE
20-5F	64-character ASCII subset of upper-case alphabet, numerals and punctuation.	YES
60-7F	ASCII lower-case alphabet locations are displayed as upper-case. Six supplemental punctuation marks at locations 60, 7B, 7C, 7D, 7E, 7F, (HEX)	YES
80-9F	ASCII 20-3F (HEX) with comma	YES
A0-BF	ASCII 20-3F (HEX) with decimal point	YES
C0-DF	ASCII 40-5F (HEX) with decimal point	YES
E0-FF	ASCII 40-5F (HEX) with comma	YES

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

< > These instructions are mutually exclusive.

4.2.2 **Cursor Positioning Instruction (Pulse $\overline{WR}$ Low, $\overline{CS}$ =0, Input Buffer Empty))**

DATA (b_7-b_0)	DESCRIPTION	A_0	FUNCTION AVAILABLE IN SERIAL MODE
00XX XXXX	MOVE CURSOR TO LOCATION XX XXXX (Location in binary - "0000 0000" moves cursor to left-most position)	1	NO
1B HEX (0001 1011)	MOVE CURSOR TO FOLLOWING POSITION (2 byte instruction to locate cursor in serial (or parallel) mode)	0	YES
00XX XXXX	SECOND BYTE (Location in binary - left most location is zero)	0	YES

4.2.3 Instruction for A_0=1 (Pulse $\overline{WR}$ Low, $\overline{CS}$ =0, Input Buffer Empty)

DATE HEX		DESCRIPTION	FUNCTION AVAILABLE IN SERIAL MODE
40		RESET	NO
41	*	PREPARE TO READ CURSOR LOCATION VALUE	NO
42	*	PREPARE TO READ DATA AT PRESENT CURSOR LOCATION	NO
43	*	PREPARE TO READ DATA AT PRESENT CURSOR LOCATION AND INCREMENT CURSOR	NO

DATA (b_7-b_0)	DESCRIPTION	FUNCTION AVAILABLE IN SERIAL MODE
10XX XXXX	* PREPARE TO READ DATA AT POSITION XX XXXX (Location in binary - "1000 0000" reads data at left-most position)	NO

* "PREPARE TO READ. . ." commands should be followed with a "READ DATA FROM DISPLAY MODULE" operation, which is accomplished by pulsing $\overline{RD}$ low when A_0=0 and $\overline{CS}$=0. See Section 4.3.

4.3 Reading Data and Status Information ($\overline{CS}$ =0 and A_0=1)

Status may be read from the display by pulsing $\overline{RD}$ low. Instructions are as follows:

DATA (b_7-b_0)	DESCRIPTION	FUNCTION AVAILABLE IN SERIAL MODE
	READ OUTPUT BUFFER STATUS (Data may be read from the display module when the output buffer is full)	NO
XXXX XXX1 OR XXXX XXX0	DATA BIT 0 = 1: OUTPUT BUFFER FULL DATA BIT 0 = 0: OUTPUT BUFFER EMPTY	
	READ INPUT BUFFER STATUS (Data may be written to the display module when the input buffer is empty)	NO
XXXX XX1X OR XXXX XX0X	DATA BIT 1 = 1: INPUT BUFFER FULL DATA BIT 1 = 0: INPUT BUFFER EMPTY	
Bits 2-7	Not defined.	

4.4 Character Chart (segmented)

Data Bits				b7 b6 b5 b4	0 0 0 0	0 0 0 1	0 0 1 0	0 0 1 1	0 1 0 0	0 1 0 1	0 1 1 0	0 1 1 1
b3	b2	b1	b0	HEX	0	1	2	3	4	5	6	7
0	0	0	0	0			SP					
0	0	0	1	1								
0	0	1	0	2								
0	0	1	1	3								
0	1	0	0	4								
0	1	0	1	5								
0	1	1	0	6								
0	1	1	1	7								
1	0	0	0	8								
1	0	0	1	9								
1	0	1	0	A								
1	0	1	1	B								
1	1	0	0	C								
1	1	0	1	D								
1	1	1	0	E								
1	1	1	1	F								

FIGURE 3

4.5 Alternate Character Codes

Not available at this time

4.6 External Font Loading

Not available at this time.

4.7 Execution Times (Maximum)

Character rate:	120μS
Line feed:	350μS
Horizontal scroll:	350μS
Control codes:	350μS
Reset (Software):	350μS
Reset (Hardware):	500mS

4.8 Dedicated Hardware Lines

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

Hardware reset is available on J1 (power), pin 6. Holding $\overline{\text{RESET}}$ low for at least 5μS, and then returning it to high, will clear the display and set the cursor to the home position (power-up condition); this sequence requires approximately 500mS to complete. Sinking current must be able to discharge a 1μF capacitor connected internally.

4.8.2 $\overline{\text{INTERRUPT}}$ ($\overline{\text{INT}}$)

Not available at this time.

4.9 Serial Data and Self-test

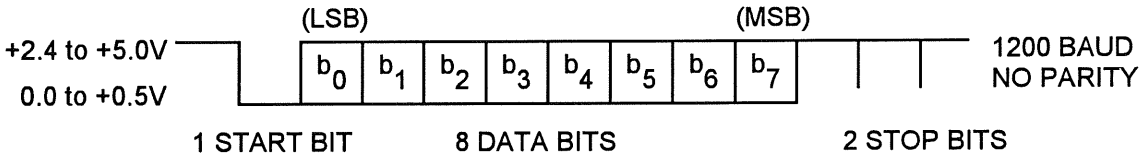
Included as a standard feature is a serial asynchronous receiver with a TTL compatible input (T_0) which is unidirectional. A logic high represents a "mark" and a logic low represents a "space", with data formatted as an 11-bit word of one start bit, eight data bits and two stop bits. Jumper-selectable data rates of 110, 300, 600, or 1200 baud are available. When the display is shipped from the factory, it is set for a 1200 baud data rate. Since data is TTL level, it is not electrically compatible with RS-232 communications code levels. In the serial mode, device select ($\overline{CS}$) has no effect.

Serial mode baud rate select:

Jumpers

A	B	Baud
0	0	110
0	1	300
1	0	600
1	1	1200

0 = Installed
1 = Open (no jumper)



STANDARD TTL SERIAL INPUT

Self-Test is a very useful feature and can be activated by maintaining a logic low on the serial input (T_0) for a period longer than 4 seconds. ASCII characters from 20 (HEX) to 7F (HEX) will be displayed advancing through the character field at approximately a 3-character per second rate. This self-test capability can be used to speed up both in-field fault isolation, and incoming receiving inspection.

4.10 Connector Pin Assignment

J1 (POWER)

PIN. NO.	FUNCTION
J1-1	+5VDC @ 440mA (typ)
J1-2	NO CONNECTION
J1-3	NO CONNECTION
J1-4	COMMON
J1-5	NO CONNECTION
J1-6	$\overline{\text{RESET}}$

J2 (DATA)

PIN NO.	FUNCTION
J2-1	SERIAL IN/SELF-TEST (T_0)
J2-2	COMMON
J2-3	$\overline{\text{DEVICE SELECT}}$ ($\overline{\text{CS}}$)
J2-4	INTERNAL CONNECTION
J2-5	$\overline{\text{READ}}$ ($\overline{\text{RD}}$)
J2-6	COMMON
J2-7	ADDRESS ZERO BIT (A_0)
J2-8	COMMON
J2-9	$\overline{\text{WRITE}}$ ($\overline{\text{WR}}$)
J2-10	COMMON
J2-11	DATA B0 (LSB)
J2-12	COMMON
J2-13	DATA B1
J2-14	COMMON
J2-15	DATA B2
J2-16	COMMON
J2-17	DATA B3
J2-18	COMMON
J2-19	DATA B4
J2-20	COMMON
J2-21	DATA B5
J2-22	COMMON
J2-23	DATA B6
J2-24	COMMON
J2-25	DATA B7 (MSB)
J2-26	COMMON

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. Neither data nor power connectors should 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:	Output Levels:
Logic 1 > 2.4VDC @ 1μA	Logic 1 > 3.5VDC @ 150μA
Logic 0 < 0.5VDC @ 0.5mA	Logic 0 < 0.5VDC @ 0.5mA

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

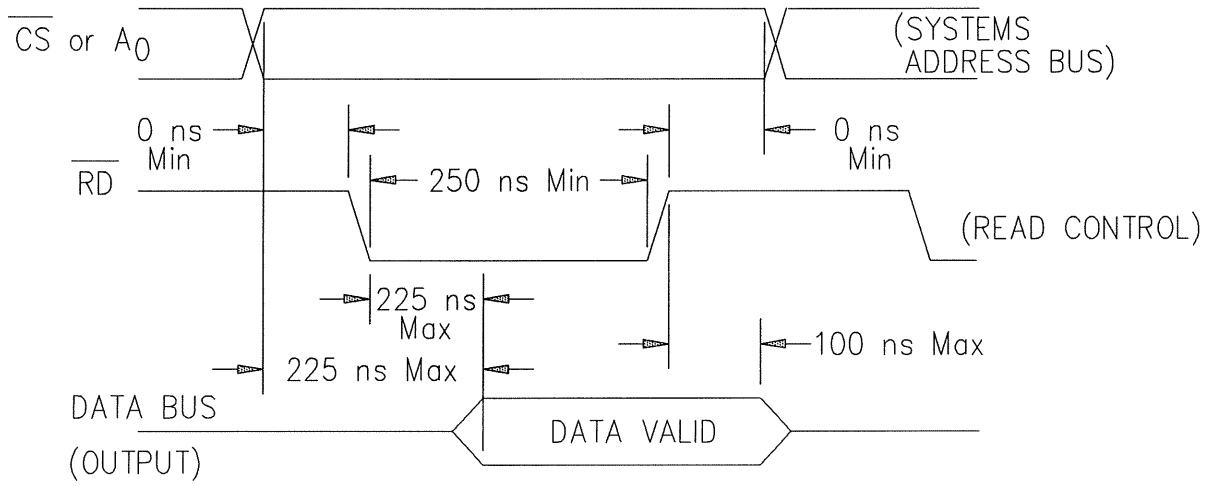
Primary voltage: +5.0 ± 0.25VDC

PRODUCTION

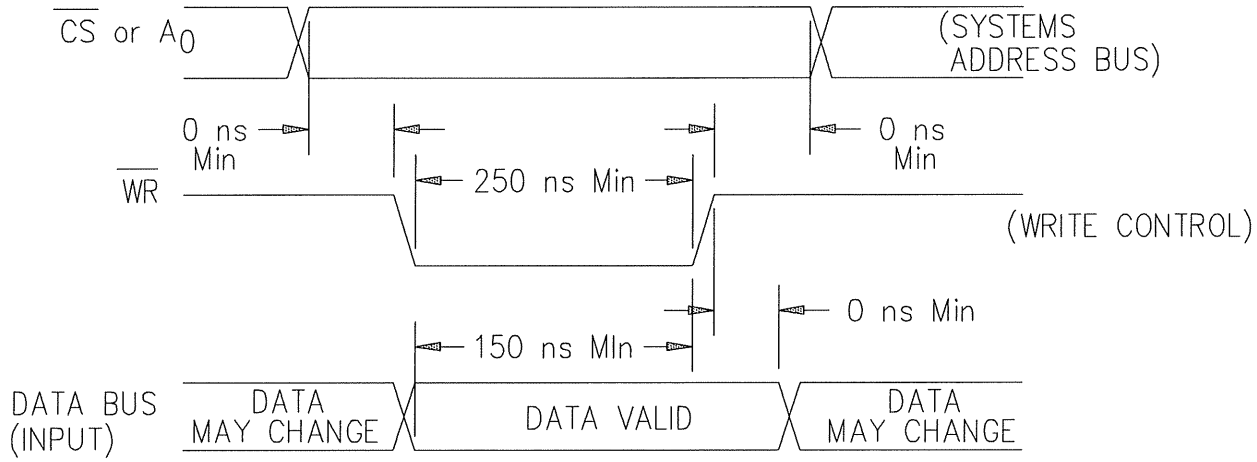
305mA Min.	(Screen clear at 5.0V)
440mA Typ.	(Screen filled with "A" character at 5.0V)
460mA Max.	(Screen filled with "A" character at 5.25V)

5.5 Timing Characteristics And Timing Diagrams

READ OPERATION



WRITE OPERATION



6.0 OPTICAL CHARACTERISTICS

Format:	1 line of 16 characters
Character height:	0.24 in. (6.0mm)
Character spacing:	0.24 in. (6.0mm) center-to-center
Character design:	14 bar segments/with comma and decimal point
Type of cursor indicator:	Block
Character set:	64-character U.S. ASCII + additional symbols
Color:	Blue-green, peak at 5000 Angstroms
Viewing angle:	150 degrees
Brightness: (22°C)	100 fL (min), 175 fL (typ)
Projected life at rated operating conditions:	40,000 hours 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:	-50 to +85 (°C) -58 to +185 (°F)
Relative humidity:	0 to 95% (noncondensing)
Vibration:	10 to 50 Hz 2mm peak-to-peak (3 axis)
Shock:	20 G (3 axis)
Weight:	4 ounces (113 grams)

8.0 ACCESSORIES

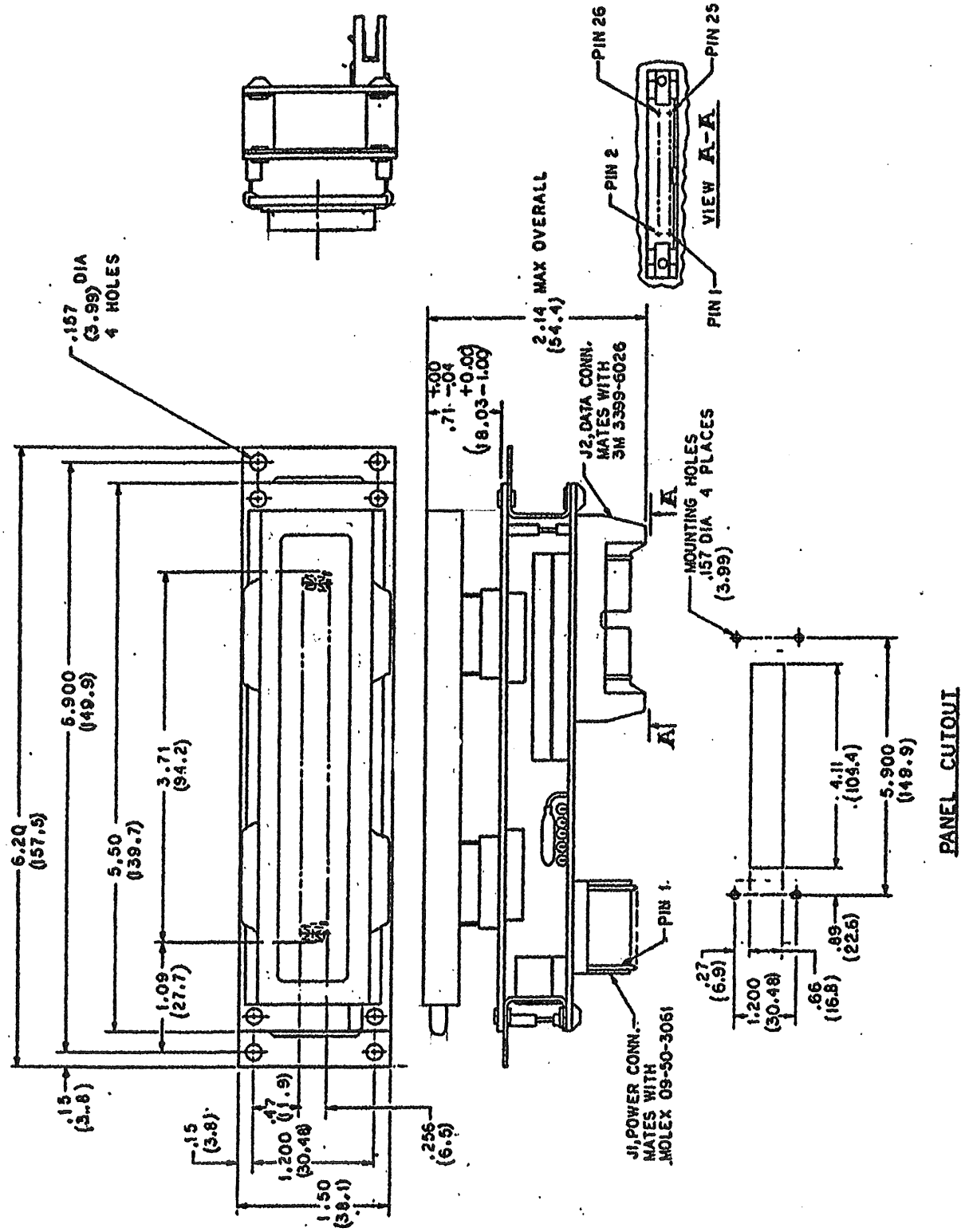
Cables	**Part Number**	**Qty Required**
Power	25387-XX*	1
Data	26160-XX*	1

* XX=length in inches: -99 omits cables

Filters	**P/N 26542-XX**
Gray	-01
Blue	-02
Aqua	-04
Neon Yellow-Orange	-05
Green	-07
Neutral Gray CP	-09
Yellow CP	-10

Connectors	**Mates With:**
Power	Molex 09-50-3061
Data	3M3399-6026

9.0 OUTLINE AND INSTALLATION DRAWING



TOLERANCES:
.XX = ±.03 (0.8)
.XXX = ±.010(0.25)

FIGURE 4

Industrial Electronic Engineers, Inc.	SIZE A	CODE IDENT NO. 05464	S03701-13-016
Van Nuys, California	SCALE N/A	REV A	SHEET 16 of 16