| APPLICATION | | REVISIONS | | | |
|---|---|---|---|---|---|
| NEXT ASSY | FINAL ASSY | LTR | DESCRIPTION | DATE | APPROVED |
| | | A | PRODUCTION RELEASE/E.O. 40079 | 1-31-07 | |

# VACUUM FLUORESCENT DISPLAY
## 2 X 20 CHARACTER
## S03601-30-040R

| REV | A | A | A | A | 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. 246 | CONTRACT | | INDUSTRIAL ELECTRONIC ENGINEERS, INC.<br>VAN NUYS, CALIFORNIA |
| | DRAWN: R. Rabb 1/26/07 | | VACUUM FLUORESCENT DISPLAY<br>2 X 20 CHARACTER |
| | CHECK: 1/31/07 | | |
|  | APPROVED 1-31-07<br>APPROVED | SIZE: A<br>CODE IDENT NO.: 05464 | S03601-30-040R |
| | | SCALE | SHEET 1 OF 14 |

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PARAGRAPH NUMBER & TITLE

## 1.0 GENERAL DESCRIPTION

### 1.1 Introduction

This specification describes the interface requirements and features of a 2 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 footprint
Minimum depth
ECMA-7 character alternates
Serial interface at 1200 or 9600 baud
RS-232C with CTS and DTR
Bidirectional RS-422 Compatible
Hardware reset
Software dimming
Large characters – 11.3mm
RoHS Compliant

### 1.4 Description

The 2 x 20 Flip display is a self-contained multiplexed unit which provides a simple serial interface to a host system.

This unit consists of a vacuum fluorescent display tube with 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 700mA typical for brightest setting) is required for operation. Total power is thus about 3.5 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.

The Flip alphanumeric display uses vacuum fluorescent technology to display characters in a 5 X 7 dot matrix. All display characters and standard control codes are in 7-bit ASCII. An ASCII-coded English font employs a standard 96 character set.

Figure 3 depicts the standard ASCII and Greek character set as displayed by the 03601-30-040R module.

2.0 BLOCK DIAGRAM

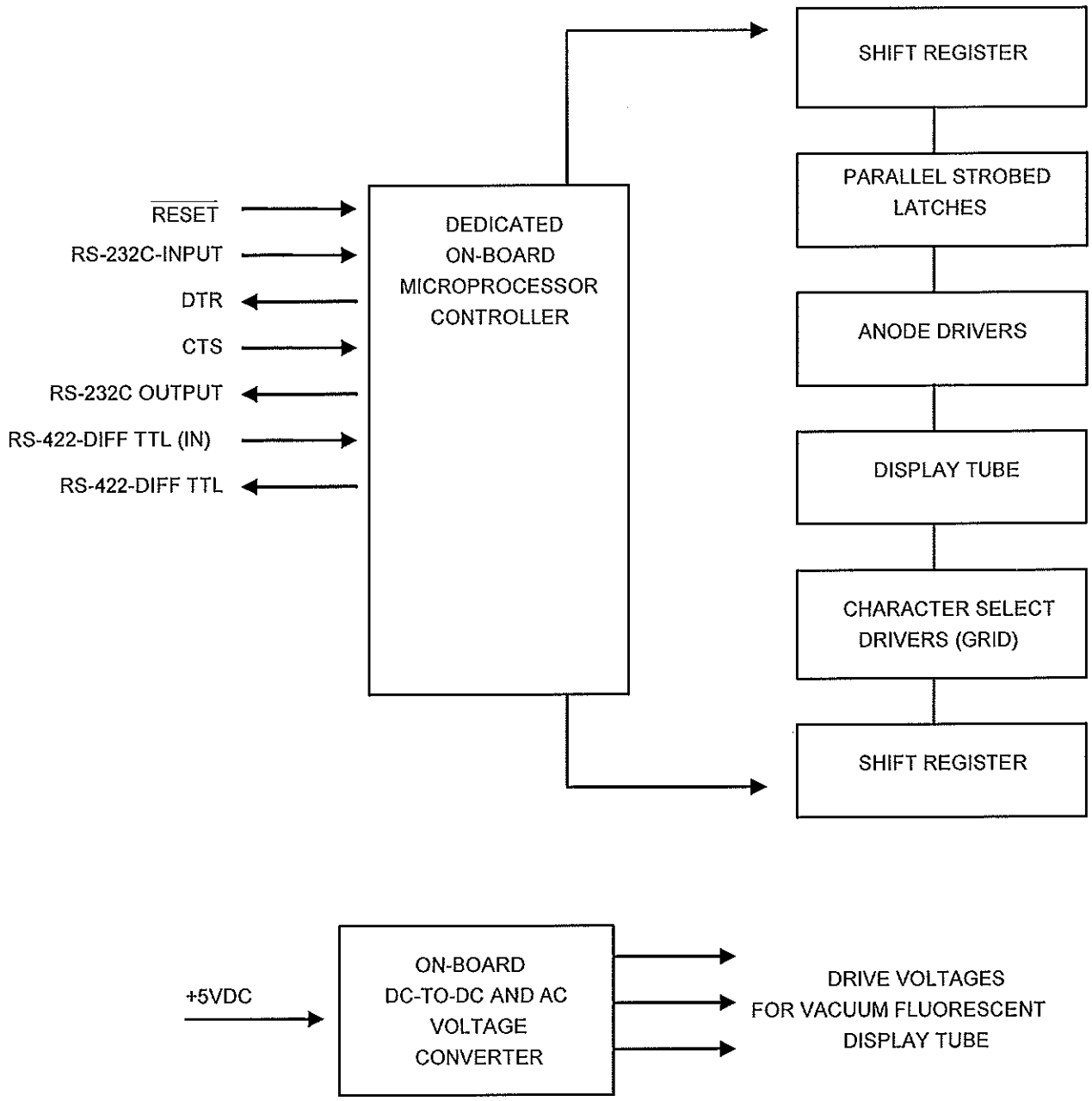



FIGURE 1

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.

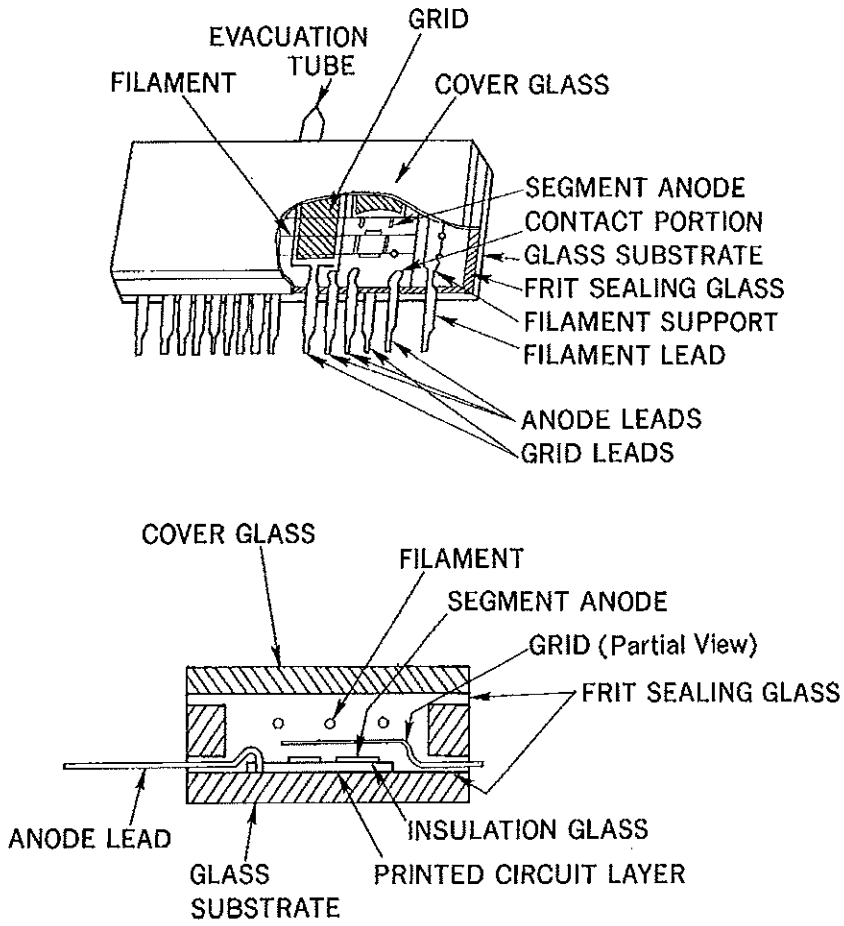



FIGURE 2

4.0 OPERATION

4.1 Loading ASCII Character Data

All printing characters are located in standard ASCII code locations from 20 (HEX) to 7F (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. WHEN USING HANDSHAKE, SEND CODES ONLY WHEN DTR IS HIGH. WHEN NOT USING HANDSHAKE, REFER TO EXECUTION TIMES IN SECTION 4.6.

| DATA (HEX) | | DESCRIPTION |
|---|---|---|
| 04 | * | PREPARE TO READ DATA AT PRESENT CURSOR LOCATION |
| 05 | * | PREPARE TO READ CURSOR LOCATION VALUE |
| 08 | | BACK SPACE CURSOR LOCATION ONE POSITION |
| 09 | | ADVANCE CURSOR LOCATION ONE POSITION |
| 0A | | LINE FEED |
| 0B | | BEGIN CHARACTER BLINK FIELD |
| 0C | | END CHARACTER BLINK FIELD |
| 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 (this is a blinking indicator of where the next character will be located) |
| <10> | | BOTTOM LINE DATA ENTRY WITH AUTOMATIC CARRIAGE RETURN & LINE FEED (data enters beginning at the left-most character position of the bottom row) |
| <11> | + | NORMAL DATA ENTRY WITH AUTOMATIC CARRIAGE RETURN AND LINE FEED |
| <12> | | OVERWRITE OF RIGHT-MOST CHARACTER / AUTOMATIC CARRIAGE RETURN OFF (right-most character on current line) |
| <13> | | HORIZONTAL SCROLL MODE (from right to left on bottom line only after line has been filled) |
| 14 | | RESET |

4.2 Control Codes (Cont'd)

| DATA (HEX) | | DESCRIPTION |
|---|---|---|
| 15 | + | DISPLAY CLEAR (puts cursor at left side bottom row in Mode 10 HEX, & home in Modes 11 HEX, 12 HEX and 13 HEX). |
| 16 | + | CURSOR HOME (returns cursor to upper left-most position) |
| 19 | | FIRST BYTE OF CERTAIN MULTIBYTE COMMANDS |
| [1A] | | SELECT SCIENTIFIC CHARACTER SET |
| [1C] | + | SELECT ENGLISH CHARACTER SET (U.S. ASCII-7) |
| [1D] | | SELECT GENERAL EUROPEAN CHARACTER SET (ECMA-7) |
| [1E] | | SELECT SCANDINAVIAN CHARACTER SET (ECMA-7) |
| [1F] | | SELECT GERMAN CHARACTER SET (ECMA-7) |
| 20-7F | | CHARACTER SET (see CHARACTER CHART) |

* "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.

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

< > These instructions are mutually exclusive

[ ] Character set control affects ASCII characters 5B, 5C, 5D, 5F, 23 & 60.

Additional commands may be written preceded by 19 HEX. They are as follows:

| **DATA (HEX)** | | **DESCRIPTION** |
|---|---|---|
| 00XX XXXX | | MOVE CURSOR TO LOCATION XX XXXX<br>(Location in binary – "0000 0000"<br>moves cursor to left-most position) |
| 40 | | RESET |
| 41 | * | PREPARE TO READ CURSOR LOCATION VALUE |
| 42 | * | PREPARE TO READ DATA AT PRESENT CURSOR LOCATION |
| 43 | * | PREPARE TO READ DATA AT PRESENT CURSOR LOCATION AND INCREMENT CURSOR |

4.2 Control Codes (Cont'd)

| DATA (HEX) | | DESCRIPTION |
|---|---|---|
| 4C | + | DISPLAY DIMMEST |
| 4D | | DISPLAY DIM |
| 4E | | DISPLAY BRIGHT |
| 4F | | DISPLAY BRIGHTEST |
| 50 | | NEXT CHARACTER WILL HAVE PERIOD ATTACHED |
| 51 | | NEXT CHARACTER WILL HAVE COMMA ATTACHED |

* When DTR is high send 19H to unit's RXD. When DTR is high send read code (04H, 05H, 41H, 42H, 43H) to unit's RXD. Set CTS high. Receive data via unit's TXD. Repeat as required.

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

NOTE: For interface configuration not using handshake (such as RS-422), connect CTS to VCC or high level voltage.

4.2.1 Cursor Positioning Instruction

| DATA (HEX) | DESCRIPTION |
|---|---|
| 1B HEX<br>(0001 1011) | MOVE CURSOR TO FOLLOWING POSITION<br>(2-byte instruction to locate the cursor) |
| XLXX XXXX | SECOND BYTE<br>(Location in binary – left most location is zero. L=0 upper line, L=1 lower line) |

4.4 Character Chart (5x7 Dot Matrix)

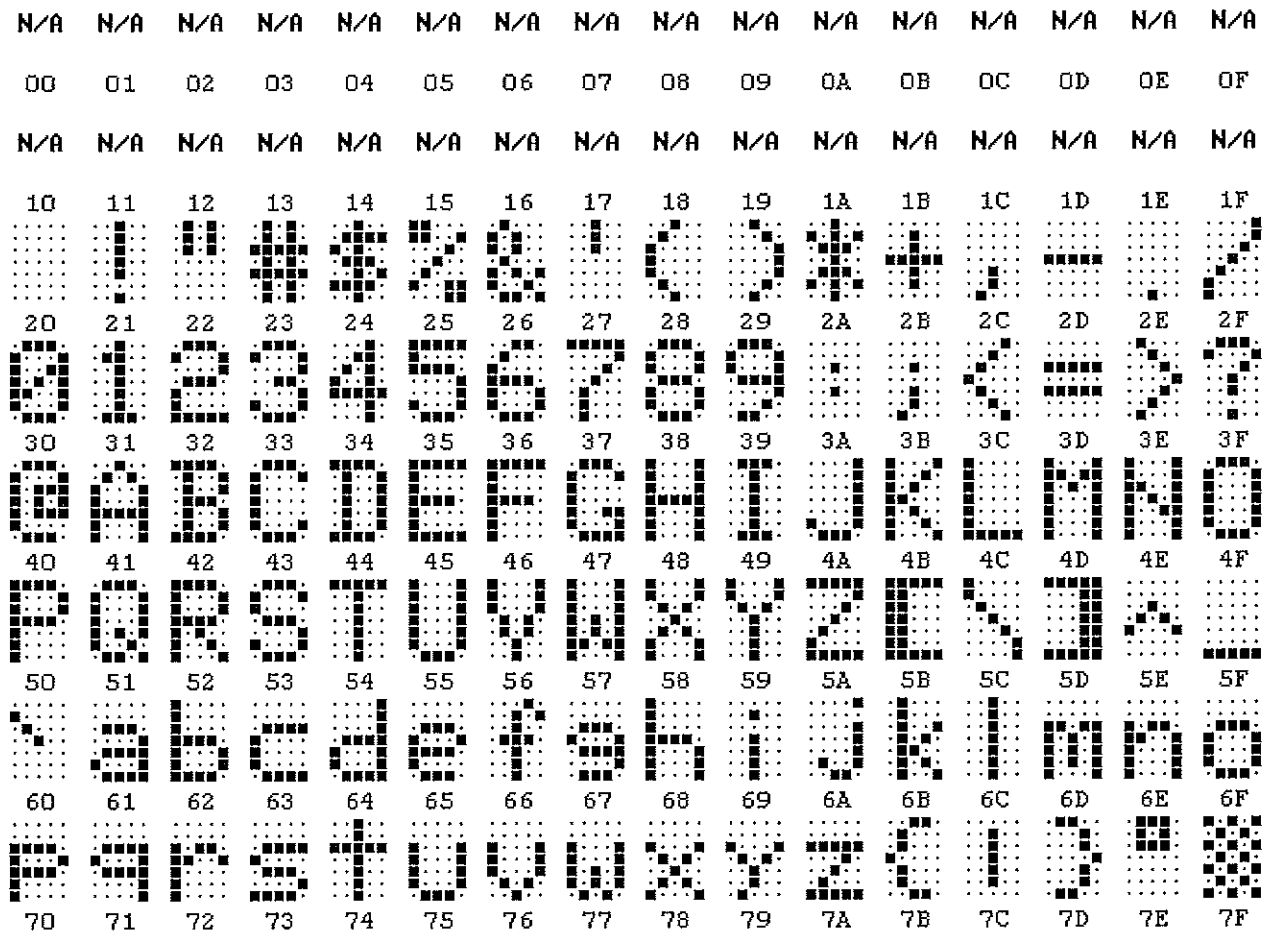
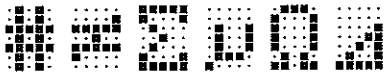
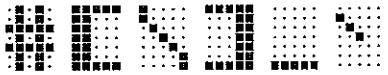
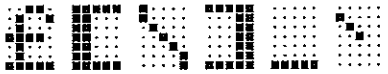
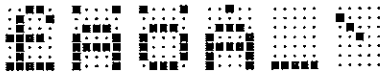
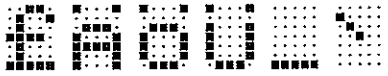



FIGURE 3

## 4.4 Alternate Character Codes

1A, 1C-1F are mutually exclusive latched functions. The following characters appear as a function of the last control code (1A, 1C-1F) and their ASCII location.

| CONTROL CODES | CHARACTER SET | ASCII LOCATION (HEX) CHARACTERS 23 5B 5C 5D 5F 60 |
|---|---|---|
| 1A | Scientific |  |
| 1C | English |  |
| 1D | General European |  |
| 1E | Scandinavian |  |
| 1F | German |  |

Default at power-up is 1C (English)

NOTE: Hardware or software reset restores any altered charcter to the 1C English character st.

## 4.5 Hardware Reset

### 4.5.1 $\overline{\text{RESET}}$

Hardware $\overline{\text{RESET}}$ is available on J1 (power), pin 6. Holding $\overline{\text{RESET}}$ low for at least 15mS, 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 1 second to complete. Sinking current must be able to sink a 10K resistor connected to Vcc internally.

### 4.5.2 Automatic Reset

The display module contains sophisticated power monitoring circuitry. The VCC is monitored and the microprocessor held in reset until VCC input exceeds 4.5VDC or 4.75VDC depending on jumper selection. If VCC drops below the selected level even briefly, or if the microprocessor program operation is not normal, the display module will automatically reset the microprocessor.

## 4.6 Execution Times (Maximum)

| | |
|---|---|
| Character (and Control Codes) Rate: | 1200 or 9600 Baud |
| Reset (Hardware): | 1 second |

4.7 Serial Data and Self-test

4.7.1 Serial Interface

The 2 X 20 Flip display has two interface options available:

| INPUT/OUTPUT | LINE RECEIVE/LINE DRIVER |
|---|---|
| 1) RS-232C | MAXIM MAX232 |
| 2) RS-422 | TEXAS INSTR. ALS180 |

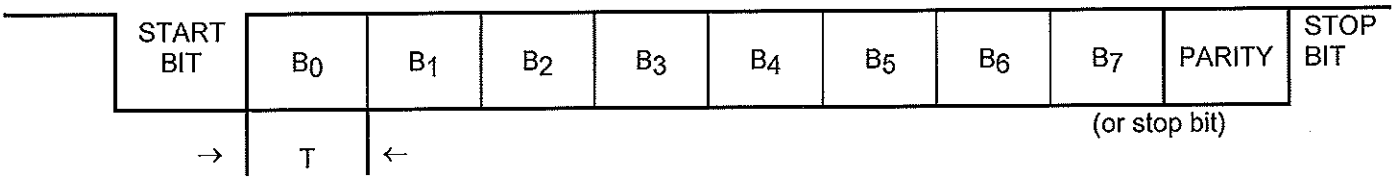
4.7.2 Transmit and Receive Data Configuration and Rate

A set of jumpers on the 2X20 display control board allows the user to select a data rate of 1200 or 9600 baud. Parity is also selectable for odd even, with one stop bit or no parity with two stop bits. Jumper selection for a desired data format is as follows:

| | | | |
|---|---|---|---|
| 4.37 ± 0.12 Volt Reset Tolerance | (E6 ) ( ) | (E12 ) | 4.62 ± 0.12 Volt Reset Tolerance |
| Normal Operation | (E5 ) ( ) | (E11) | Burn-In Test |
| Normal Operation | (E4 ) ( ) | (E10) | Self-test |
| Odd Parity | (E3 ) ( ) | (E9 ) | Even Parity |
| Enable Parity 1 Stop Bit | (E2 ) ( ) | (E8 ) | Disable Parity 2 Stop Bits |
| 9600 BAUD | (E1 ) ( ) | (E7 ) | 1200 BAUD |

Normally shipped from the factory in this configuration

Input and output word for the 2 x 20 Flip display is 7 data bits with, odd, even or no parity, and one stop bit (2 stop bits if no parity).




T = 833μS when baud rate equals1200 bits/sec.
T = 104.1μS when baud rate equals 9600 bits/sec.
(EACH CHARACTER IS 10 DATA BIT INTERVALS IN LENGTH)

4.7.3 Error Detection

The 2 x 20 Flip display is able to detect errors in data transmission. Each character received with an error is replaced with the error symbol "#". An error is detected if data rate is distorted by more than 5%, or if parity is incorrect.

4.7.4 Signal Definition

RXD (INPUT) – Receive Data: RS-232C, J2-3. Serial data signals from the host computer are sent to the receive data port of the Flip display.

DTR (OUTPUT) – Data Terminal Ready: RS-232C, J2-20. The display module will not accept data when DTR is low.

TXD (OUTPUT) – Transmit Data: RS-232C, J2-2. Serial data signals output from display to the receive data port of the host computer.

CTS (INPUT) – Clear To Send: RS-232C, J2-5. Flip display will output data on TXD only if CTS is high. If CTS is not used, jumper J2, pin 5 to J2, pin 9 on DB-25 so it will be high.

DIFFERENTIAL TTL (RECEIVE) +/-: J2-15, J2-17 (RS-422): Polarity sense for differential TTL operation.

DIFFERENTIAL TTL (TRANSMIT) +/-: J2-11, J2-18 (RS-422): Polarity sense for differential TTL operation.

NOTE: RS-232C and TTL reference ground must be connected to J2-7

4.7.5 Self-test

The 2 x 20 Flip Display may be evaluated on a stand-alone basis by moving the jumper on E4 to E10. Upon initiation of self-test, the display module will execute a "Display Test". The following sequence will be displayed when the display module enters the self-test mode. User can terminate self-test at any time during the test by reconnecting the jumper on E10 to E4.

"DISPLAY TEST"
"SOFTWARE #XXXXX-XX"
"XXXX BAUD"

Depending on jumper settings, one of the following messages will appear:

"7 DATA BITS, NO PARITY"
"7 DATA BITS, ODD PARITY"
"7 DATA BITS, EVEN PARITY"

At this time the display module will perform a "BRIGHTNESS TEST" to check for different stages of brightness (Dimmest, Dim, Bright, and Brightest).

After the above sequence has been completed, ASCII characters from 20 (HEX) to 7F (HEX) will be displayed advancing through the character field at approximately a 3 character per second rate. After the above procedures have been completed, the display will read "READY", after which the display will show incoming data in HEX format.

## 4.0 CONNECTOR PIN ASSIGNMENTS

J1 (POWER)

| PIN. NO. | FUNCTION |
|---|---|
| J1-1 | +5VDC @ 700mA (typ) + |
| J1-2 | NO CONNECTION |
| J1-3 | NO CONNECTION |
| J1-4 | COMMON |
| J1-5 | NO CONNECTION |
| J1-6 | $\overline{\text{RESET}}$ |

+FOR BRIGHTEST SETTING

J2 (DATA)

| PIN NO. | FUNCTION |
|---|---|
| J2-1 | CHASSIS GROUND |
| J2-2 | TRANSMIT DATA (RS-232C) |
| J2-3 | RECEIVE DATA (RS-232C) |
| J2-4 | NO CONNECTION |
| J2-5 | CLEAR TO SEND (RS-232C) |
| J2-6 | NO CONNECTION |
| J2-7 | SIGNAL GROUND |
| J2-8 | NO CONNECTION |
| J2-9 | +10V OUT (1K INT. SERIES RES.) |
| J2-10 | -10V OUT (1K INT. SERIES RES.) |
| J2-11 | TX- (RS-422) |
| J2-12 | NO CONNECTION |
| J2-13 | NO CONNECTION |
| J2-14 | NO CONNECTION |
| J2-15 | RX+ (RS-422) |
| J2-16 | NO CONNECTION |
| J2-17 | RX- (RS-422) |
| J2-18 | TX+ (RS-422) |
| J2-19 | NO CONNECTION |
| J2-20 | DATA TERMINAL READY (RS-232C) |
| J2-21 | NO CONNECTION |
| J2-22 | NO CONNECTION |
| J2-23 | NO CONNECTION |
| J2-24 | NO CONNECTION |
| J2-25 | NO CONNECTION |
| J2-26 | NO CONNECTION |

4.10 Connector Pin Assignments (Continued)

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 approximately 1 second.

### 5.2 Interface Signals

All logic signals abide by the following convention:

Logic "1" is a high, Logic "0" is a low.

| RS-422 Levels: | RS-232C Input Levels: | RS-232C Output Levels |
|---|---|---|
| | | |
| Logic 1> 2.4VDC @ 1uA | Logic 1 (MARK) < -3VDC | Logic 1 (MARK) < -6VDC |
| Logic 0 < 0.5VDC @ 0.5mA | Logic 0 (SPACE) > +3VDC | Logic 0 (SPACE) > +6VDC |

### 5.3 Absolute Maximum Ratings

| | |
|---|---|
| Primary voltage: | +5.5VDC |
| Logic range: | -0.5VDC thru +5.5VDC |
| RS-232C: | +25VDC to -25VDC |
| RS-422: | +15VDC to -15VDC |

### 5.4 Normal Operating Ratings

Primary voltage: +5.0 ± 0.25VDC

| | |
|---|---|
| Dimmest | |
| 580mA Min. | (Screen clear at 5.0V) |
| 590mA Typ. | (Screen filled with "A" character at 5.0V) |
| | |
| Brightest | |
| 660mA Min. | (Screen clear at 5.0V) |
| 700mA Typ. | (Screen filled with "A" character at 5.0V) |
| 750mA Max. | (Screen filled with "A" character at 5.25V) |

## 6.0 OPTICAL CHARACTERISTICS

| | |
|---|---|
| Format: | 2 lines of 20 characters |
| Character height: | 0.44 in. (11.3mm) |
| Character width: | 0.43 in. (7.25mm) |
| Character spacing: | 0.429 in. (10.9mm) center-to-center |
| Character design: | 5 x 7 dot matrix |
| Type of cursor indicator: | Flashing Block |
| Character set: | 96-character U.S. ASCII-7<br>General European ECMA-7<br>Scandinavian ECMA-7<br>German ECMA-7<br>Scientific Alternates |
| Color: | Blue-green, peak at 5000 Angstroms |
| Viewing angle: | 150 degrees |
| Brightness: (22°C) | 180 fL (min), 210fL (typ) – at brightest setting<br>30 fL (typ) – fully dim |
| 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: | -40 to +85 (°C) -40 to +185 (°F) |
| Relative humidity: | 0 to 95% (non-condensing) |
| Vibration: | 10 to 50 Hz 2mm peak-to-peak (3 axis) |
| Shock: | 20 G (3 axis) |
| Weight: | 14 ounces (397 grams) |

## 8.0 ACCESSORIES

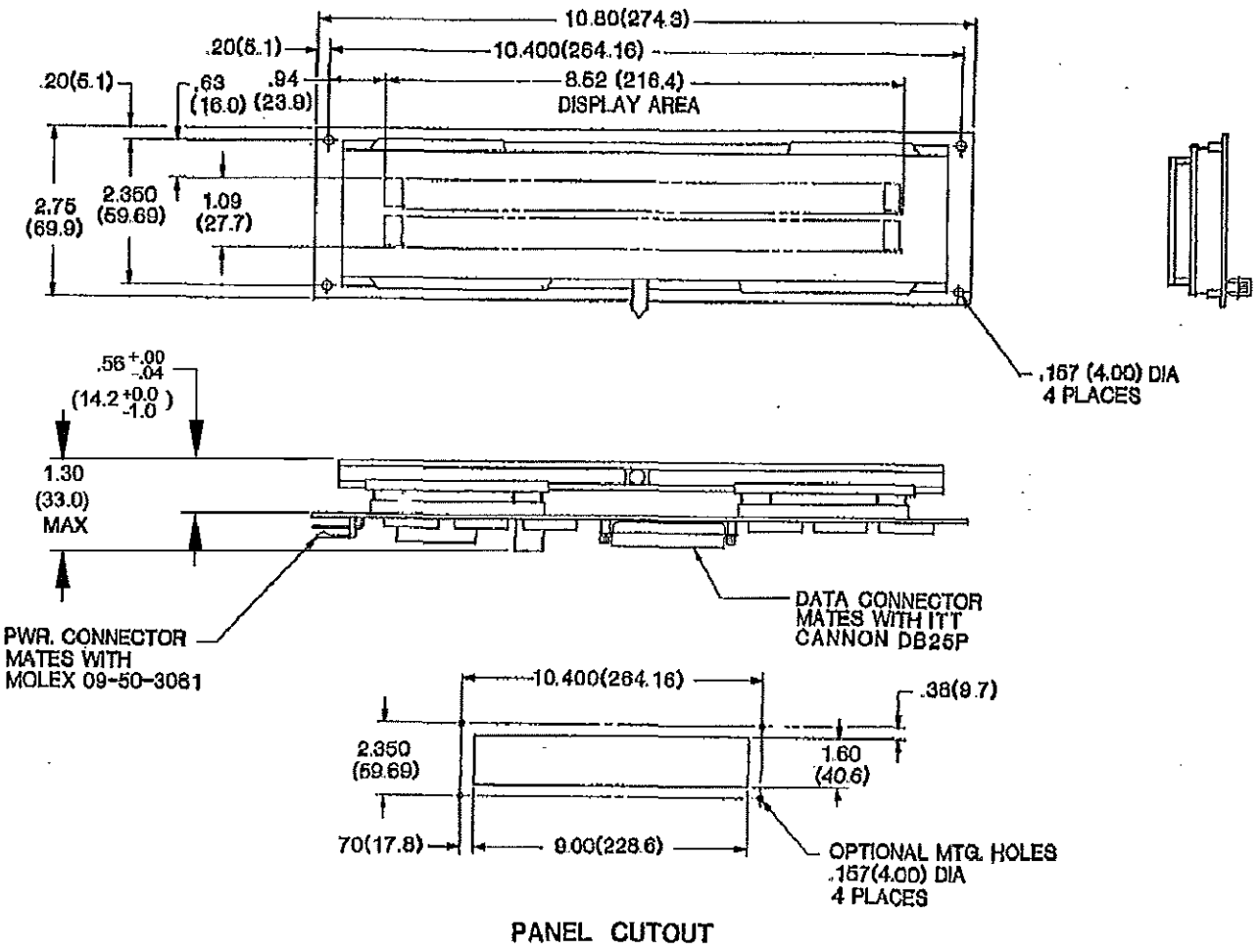
| **Cables** | **Part Number** | **Qty Required** |
|---|---|---|
| Power | 25387-XX* | 1 |
| Data (Connector only) | 26746-01 | 1 |

*XX = Length in inches: -99 omits cables

| **Filters** | **P/N 30442-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 | ITT Cannon DB25P |

9.0 OUTLINE AND INSTALLATION DRAWING




PANEL CUTOUT

FIGURE 4

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

| Industrial Electronic Engineers, Inc. | SIZE A | CODE IDENT NO. 05464 | S03601-30-040R |
|---|---|---|---|
| Van Nuys, California | SCALE N/A | REV A | SHEET 16 |