APPLICATION		REVISIONS			
NEXT ASSY	FINAL ASSY	LTR	DESCRIPTION	DATE	APPROVED
		–	PRODUCTION RELEASE/E.O. 29204	3/9/93	D. Goodale
		A	E.O. 29436	6/3/93	D. Goodale
		B	E.O. 29541	6/28/93	D. Goodale
		C	E.O. 36743, Revised and Redrawn	2/13/02	D. Goodale

Specification

4 X 20 Daystar Nova LCD Module

with

Serial Data Input Option and EL Backlight

Model 03858–06–0205

REV	C	C																						
SHEET	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
REV	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
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. 411	**CONTRACT**		**INDUSTRIAL ELECTRONIC ENGINEERS, INC.** **VAN NUYS, CALIFORNIA**
	DRAWN	R. January	3–19–93
	CHECK		
			SERIAL DATA INPUT 4 X 20 LCD MODULE WITH EL BACKLIGHT
	APPROVED **D. Goodale 3 - 9 - 93**	**SIZE** **A**	**CODE IDENT NO.** **05464**	**S03858–06–0205**
	APPROVED	SCALE		SHEET 1 OF 26

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1.0 GENERAL INFORMATION

1.1 Introduction

This specification describes the serial interface Daystar Nova model 03858–06–0205, a 4–line supertwisted liquid crystal display (LCD) with 20 characters per line.

Model Number Designation System

03858	–	06	–	0	2	0	5
Transflective STN LCD w/EL Backlight		4x20 Format		Reserved	1 = Parallel Data Input * 2 = Serial Data Input	0 = External Backlight Power	0 = Aviation Green Color

* Parallel standard, Serial optional

1.2 Application

Daystar Nova modules provide alphanumeric information which is easily readable in high ambient light or in darkness with backlight activated. The low power requirements of the modules make them suitable for portable battery operated equipment. The wide operating temperature range (–30° to +80°C) is ideal for most outdoor applications. The choice of a preferential viewing hemisphere is not necessary because of the excellent wide angle viewing characteristics of the new Super Bi–refringent Effect (SBE) liquid crystal cell used in this display.

The serial data input model of the 03858–06 Daystar Nova display allows communication between a host processor and the display by means of a serial RS–232C interface. This provides the capability to communicate over a longer distance than is possible with the parallel model. The RS–232 interface is a two wire communication link.

1.3 Standard Features

- Serial data communication via RS–232C
- Multiple baud rates: 1200, 2400, 4800, and 9600
- Low power consumption
- Wide temperature range
- Built–in diagnostics
- Down–loadable special characters

1.4 Description

The serial input Daystar Nova module includes an on–board CMOS microprocessor which translates serial data into parallel data and provides other enhancements over the parallel model. The serial data may be set by a jumper to accommodate speeds of 1200, 2400, 4800, and 9600 baud. Parity may also be set by jumper for odd, even, or no parity. The electrical interface is RS–232C compatible.

A single +5 Volt nominal power supply is required for operation. The unit operates from 4.50 Volts to 5.50 Volts. The typical power requirement for the module is 120mW.

The module weighs 9.1 ounces (257.7 grams).

2.0 LOGICAL STRUCTURE AND FUNCTION

2.1 LCD Module

Figure 1 illustrates the major components of the serial option Daystar Nova module. The module provides means for an external viewing angle adjustment potentiometer (V_{BIAS} Adj.) at Pin 4, and connections for optional RESET and self–test switches at Pins 3 and 5. The external viewing angle adjustment potentiometer should be connected to the same +5 Volt supply as the display module. RESET and TEST pull down to ground to activate the function. All three inputs may be left open if not used. The V_{BIAS} test point is used at the factory to preset the viewing angle.

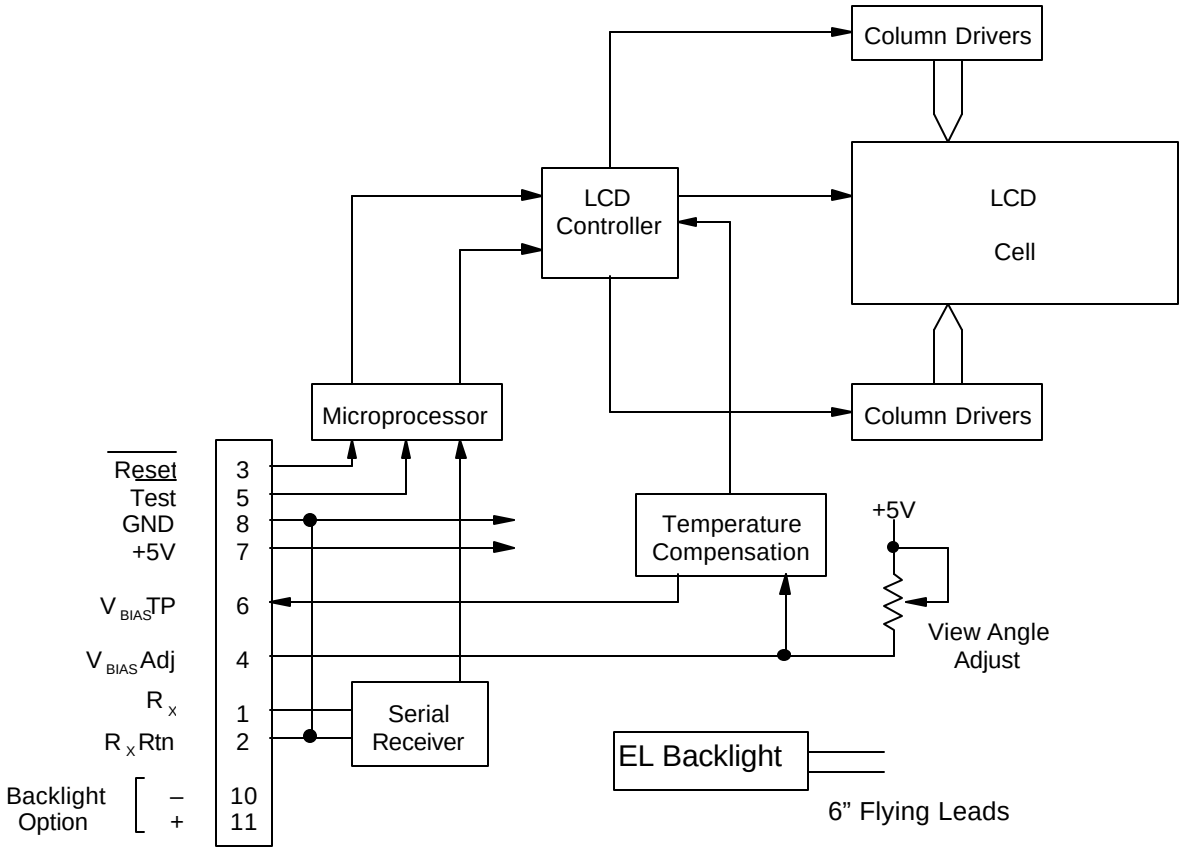


Figure 1 Module Block Diagram

2.1.1 Signal Description

Signal Name	Number Of Lines	Input/Output	Connected
RESET	1	I	MPU
TEST	1	I	MPU
V_{BIAS} TP	1	O	Temp. Comp. Ckt.
V_{BIAS} Adj.	1	I	Temp. Comp. Ckt.
RX	1	I	Serial Receiver
RX Rtn	1	I	Serial Receiver
V_{CC}	2	–	Power
GND	7	–	–

2.2 LCD Controller

The LCD Controller includes all of the circuitry necessary to take parallel input data and create the necessary control functions and characters. The block diagram of the controller is shown in Figure 2 below. The remaining subparagraphs of Section 2 describe the major function blocks.

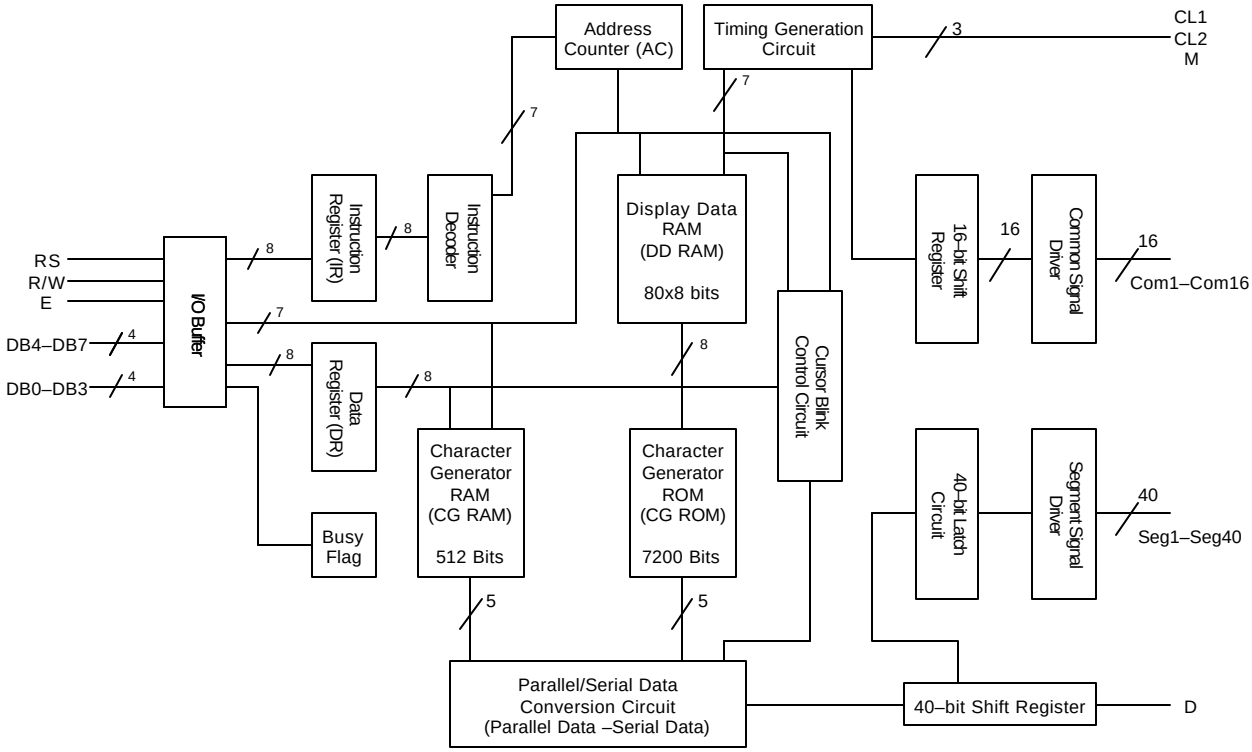


Figure 2 LCD Controller Block Diagram

2.2.1 Instruction Register (IR)

The IR stores instruction codes such as display clear and cursor shift, and address information of the display data RAM (DD RAM) and character generator RAM (CG RAM). The IR can be written from the MPU, but not read.

2.2.2 Data Register (DR)

The DR temporarily stores data to be written into or read from the DD RAM or the CG RAM.

2.2.3 Busy Flag

When the Busy Flag is a "1", the module is in an internal operating mode and ignores any additional instructions (Refer to Read Busy Flag and Address instruction).

2.2.4 Address Counter (AC)

The AC determines the address of the DD RAM or CG RAM in which new data is stored. After writing into (or reading from) the DD RAM or CG RAM, the AC is incremented or decremented as defined by the

Increment/Decrement bit (Refer to Entry Mode Set instruction).

2.2.5 Display Data RAM (DD RAM)

The DD RAM contains 80 X 8 bits and represents 80 characters. The relationship between the DD RAM address and position of the characters in the display can be controlled by the user (Refer to Entry Mode Set and Cursor or Display Shift instructions).

2.2.6 Character Generator ROM (CG ROM)

The CG ROM generates character patterns of 5 X 7 dots from 8 bit character codes. The 192 5 X 7 dot matrix characters are illustrated in Figure 3.

Figure 3 Correspondence Between Character Codes and Character Patterns

Note: Addresses 00h through 0Fh are reserved for CG RAM Addressing. Addresses 10h through 1Fh and 80h through 9Fh are not used.

2.2.7 Character Generator RAM (CG RAM)

The CG RAM allows the user to define 8 types of 5 X 7 character patterns. Figure 4 shows the relationship between CG RAM addresses and data patterns (Refer to Set CG RAM Address and Write to CG or DD RAM instructions).

Character Codes (DD RAM Data)									CG RAM Address							Character Patterns (CG RAM Data)								
7	6	5	4	3	2	1	0		5	4	3	2	1	0		7	6	5	4	3	2	1	0	
←Higher Order Bits Lower Order Bits→									←Higher Order Bits Lower Order Bits→							←Higher Order Bits Lower Order Bits→								
												0	0	0		*	*	*	1	1	1	1	0	
												0	0	1					1	0	0	0	1	
												0	1	0					1	0	0	0	1	Character
												0	1	1					1	1	1	1	0	Pattern
0	0	0	0	*	0	0	0		0	0	0	1	0	0					1	0	1	0	0	Example
												1	0	1					1	0	0	1	0	
												1	1	0					1	0	0	0	1	
												1	1	1		*	*	*	0	0	0	0	0	←Cursor

Figure 4 Relationship Between CG RAM Address, Character Codes (DD RAM) and Character Patterns (CG RAM Data)

NOTES:

1) The CG RAM consists of 64 bytes. Any bytes not used for character pattern information can be used for general purpose data RAM. The 5, 6 and 7 bits are never used for character pattern information and are always available for use.
2) The 0, 1 and 2 bits of character code correspond to the 3, 4 and 5 bits of the CG RAM address.
3) The 0, 1 and 2 bits of the CG RAM address specify the row of the character pattern.
4) The 8th row of the character pattern corresponds to the cursor character pattern. If any bit in the row is "1", then the corresponding cursor bit is a "1" regardless of cursor position. (For most applications, the data should be "0" in this row, which allows for normal cursor operation on the character.)
5) Since bit 3 is a "don't care", two character codes represent the same special character. For example, a character code of 07 (hexadecimal) selects the same character pattern as OF (hexadecimal).

2.2.8 Parallel/Serial Data Conversion Circuitry, Timing Generator Circuitry

These blocks control the interface to the LCD drivers.

3.0 THEORY OF OPERAT ION

The serial input option was designed to allow users to send data and control codes to the display module via the industry standard RS–232C serial interface. This follows the interface protocol of the parallel input Daystar Nova display modules with few exceptions.

3.1 Serial Interface

The serial input module is a receive only device. Consequently, it is impossible for the host to read data or status from the LCD controller. This precludes reading of data from the Data Display (DD) RAM, Character Generator (CG) RAM, or address counter (AC). It is not necessary to read the controller busy flag because a large serial data input buffer prevents overflow at 9600 baud.

The serial interface requires one start bit, and may be jumper selected to operate with (1) either 7 or 8 data bits per character and (2) either odd or even parity with one stop bit, or no parity and two stop bits.

Since two command characters and numerous data characters are 8 bits in length, it is recommended to operate in 8 bit mode if the host has this capability. Where this is not possible, 7 bit mode should be jumper selected (see section 4.2) and a special command character (19h) must be sent prior to each 8 bit command or data character; i.e., characters where $B_7 = 1$.

Figure 5 represents serial data formatted as one start bit, eight data bits, an odd or even parity with one stop bit, or 2 stop bits if no parity.

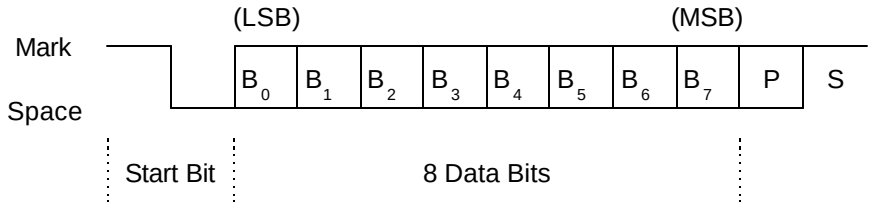


Figure 5 8–bit Serial Data Format

A logic "1" represents a "mark" condition and a logic "0" represents a "space" condition. For RS–232C the "mark" and "space" conditions are defined as –3.0 to –25.0 Volts and +3.0 to +25.0 Volts, respectively.

3.2 Error Detection and Reporting

During normal operation, the module will detect and display all parity and framing errors (see Section 3.8). Each character received in error is replaced with one of the following symbols:

Parity Error "&"
Framing Error "@"

If the display shows an "@" after power–up, the polarity of the serial interface may be reversed and should be checked.

3.3 Power–up Sequence

Upon power–up, the serial Daystar Nova display module is automatically initialized to the format defined by the jumper settings and default values shown in Figure 6. The power–up sequence takes about 0.5 second.

Baud rate:	Jumper defined (per section 4.2)
Parity bit present:	"
Parity checking enable:	"
Parity (Odd or Even):	"
7 or 8 data bits	"
Multiplex rate of LCD:	"
Display clear:	YES
Display ON/OFF:	ON
Cursor location:	Position 0
Cursor:	OFF
Entry mode set:	Shift cursor right after character entry
Controller:	1
Data/Instructions:	Data

Figure 6 Default Configuration at Power–up

3.4 Transmission Sequence for Instructions

Figures 7 and 8 depict the recommended sequence for each data or instruction transmission.

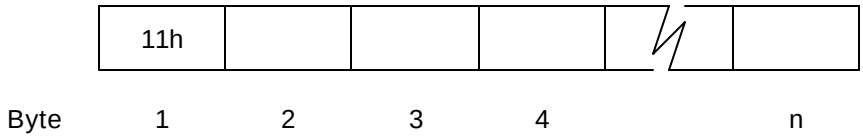


Figure 7 Instruction Sequence

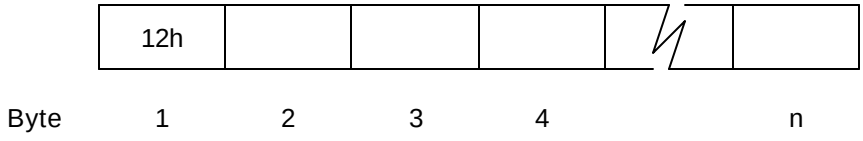


Figure 8 Data Sequence

3.5 Instruction Set

Instruction	Code								Description	Execution Time (Max)
	DB_7	DB_6	DB_5	DB_4	DB_3	DB_2	DB_1	DB_0		
Clear Display	0	0	0	0	0	0	0	1	Clears entire display and sets DD RAM to 0	1.64 ms
Return Home	0	0	0	0	0	0	1	*	Sets DD RAN counter to 0. If the display has been shifted, characters are returned to their initial positions. DD RAM contents remain unchanged.	1.64 ms
Entry Mode Set	0	0	0	0	0	1	I/D	S	Sets shift register direction and cursor movement direction which occur during data read and write operations	40µs
Display ON/OFF Control	0	0	0	0	1	D	C	B	Turns ON/OFF the entire display (D), cursor) and cursor blink attribute (B).	40µs
Cursor or Display Shift	0	0	0	1	S/C	R/L	*	*	Moves cursor or shifts entire display one position. DD RAM contents are unchanged.	40µs
Function Set	0	0	1	DL	1	0	*	*	Sets Interface Data Length.	40µs
Set CG RAM Address	0	1							Sets CG RAM address. CG RAM data is sent or received after this is set.	40µs
Set DD RAM Address	1								Sets DD RAM address. DD RAM data is sent or received after this is set.	40µs
Read Busy Flag and Address	BF								Reads Busy Flag (BF) and Address Counter	0µs
Write Data to CG or DD RAM									Writes data into CG RAM or DD RAM.	40µs
Read Data from CG or DD RAM									Reads data from CG RAM or DD RAM.	40µs
Controller 1 Instructions	0	0	0	1	0	0	0	1	Subsequent data is Display Module Instructions for controller 1.	
Controller 1 Data	0	0	0	1	0	0	1	0	Subsequent data is Display Module data for controller 1.	
Controller 2 Data	0	0	0	1	0	1	1	0	Subsequent data is Display Module data for controller 2.	
Controller 2 Instructions	0	0	0	1	0	1	0	1	Subsequent data is Display Module Instructions for controller 2.	
8 Bit Data Instructions	0	0	0	1	1	0	0	1	Causes microprocessor to add B_7=1 to the next character received.	
Down Load Special Character	0	0	0	1	0	1	1	1	Subsequent 2 characters define ROM address of characters, and its down load DD Ram address	

I/D=1:	Increment	DD RAM:	Display Data RAM
I/D=0:	Decrement	CG RAM:	Character Generator RAM
S=1:	Enable Shift Operation	A_{CG}	CG RAM Address
S/C=1:	Shift Display	A_{DD}	DD RAM Address
S/C=0:	Shift Cursor		(Corresponds to cursor address)
R/L=1:	Shift Right	AC	Address Counter
R/L=0:	Shift Left		(used for both CG and DD RAM)
DL=1:	8–bit operation	*	Don't Care

DL=0: 4–bit operation

BF=1: Operating internally

BF=0: Can accept instruction

Figure 9 Instruction Set

3.5.1 Instruction Summary

Hex Code	Command
01h	Clear Display
02h	Home Cursor
04h	Disable Shift And Decrement
05h	Enable Shift And Decrement
06h	Disable Shift And Increment
07h	Enable Shift And Increment
08h	Turn Display Off
0Ch	Turn Display On And Cursor Off
0Eh	Turn Display On And Cursor On
0Fh	Turn Display On And Blink Cursor
10h	Shift Cursor To The Left
14h	Shift Cursor To The Right
18h	Shift Display To The Left
1Ch	Shift Display To The Right
11h	Subsequent Data Is Controller 1 Instruction(S)
12h	Subsequent Data Is Controller 1 Display Data
15h	Subsequent Data Is Controller 2 Instruction(S)
16h	Subsequent Data Is Controller 2 Display Data
17h	Subsequent Data Down Loads Special Characters
19h	Subsequent Data Is 8 Bit Length Character

3.5.2 Sample Instructions In BASIC

The following instructions are provided as an example to illustrate the correct form and to assist the user to rapidly see his display operate.

```
10 CLOSE #1                                              'Close if open
20 OPEN "COM1:9600,N,8,2,CS,DS" AS #1                    'Setup serial port
30 PRINT #1, CHR$(&H4A); CHR$(&H61); CHR$(&H6E)          'Display date
40 PRINT #1, CHR$(&H2D); CHR$(&H32); CHR$(&H2D)
50 PRINT #1, CHR$(&H39); CHR$(&H36)
60 PRINT #1, CHR$(&H11); CHR$(&H0F)                      'Blink cursor
70 PRINT #1, CHR$(&H84)                                  'Move cursor to day
80 PRINT #1, CHR$(&H12)                                  'Prepare to change day
90 SYSTEM
```

The display should appear as follows:

Jan–2–96

3.6 Down–Loadable Special Characters

An added feature of the serial input module is the inclusion of a group of 206 special characters stored in its memory. These supplement the character library of the LCD module and may be easily down loaded (up to eight at a time) into the CG RAM of the display module for use in one display frame of the display. Thus, in addition to being able to input his own character designs as described in Paragraph 2.2.7, the user has these additional preformatted characters available. Note that all down loaded character data is lost and must be reloaded after power has been removed.

To facilitate the use of these characters, a "subsequent data" instruction (17h) is used to inform the microprocessor that the following two bytes of data identify (1) the location of the special character to be down loaded, and (2) the CG RAM location where it is to be loaded. This instruction sequence is as follows.

17h			
	(1) Character Locations 00h – E5h	(2) CG RAM Locations 00h – 07h	

Figure 10 defines the format of these special characters and their memory location used to select them. The eight CG RAM locations to which they may be sent are from 00h to 07h.

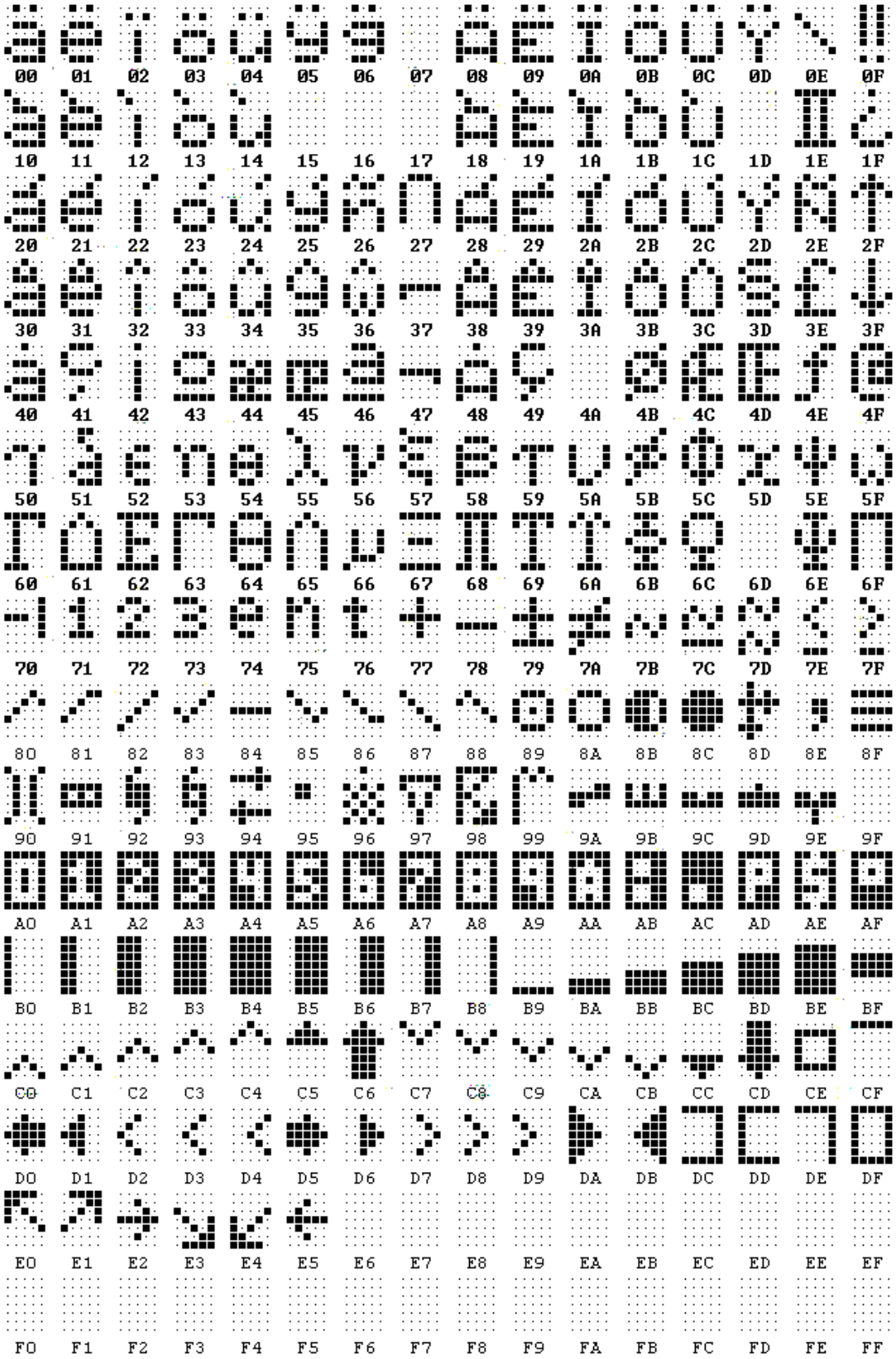


Figure 10 Down–loadable Special Characters

3.7 Self–test

The serial input display module can be operated independently from the host by using the "Self–test" option.

1. Check the multiplex jumper for proper setting (Section 4.2).
2. Connect a +5V power supply and potentiometer as discussed in Paragraph 2.1 and Figure 1.
3. Momentarily short the self–test line to GND (P2 pin 5 to pin 8).
4. All character positions should display the character "H".
5. The module can be stepped through the remaining test display frames by using the self–test line as in Step 3 (above). The display will advance from frame to frame each time the self–test line is momentarily shorted to ground. The remaining frames display: I, #, all pixels on, jumper settings in HEX (with jumper #8 being the LSB, see Section 4.2), firmware version number, and then resumption of normal operation.
6. Upon completion of "Self–test", the module is returned to the normal mode of operation with its previous controller and data/instruction (RS bit) settings.

3.8 Diagnostics

1. The display module can be operated by the host in a HEX dump mode. This diagnostic mode provides for the HEX display of all serial data received. While operating in this mode, the module will ignore the multiplex jumper setting and operate the display in a 1/8 multiplex mode.
2. Check the module jumpers for proper baud speed and parity settings (Section 4.2).
3. With power "OFF" short the self–test line to GND (P2 pin 5 to pin 8).
4. While the self–test line is shorted to ground, apply +5 Volts to the display module. The self–test line is now ineffective and may be allowed to float.
5. All serial data received will now be displayed in HEX. To return to the normal operating mode, remove power, allow the self–test line to float, and re–apply power.

If a parity or framing error should occur, the most significant nibble of the HEX code will be displayed as:

HEX Code	Parity Error	Framing Error
0X	GX	gX
1X	HX	hX
2X	IX	iX
3X	JX	jX
4X	KX	kX
5X	LX	lX
6X	MX	mX
7X	NX	nX
8X	OX	oX
9X	PX	pX
AX	QX	qX
BX	RX	rX
CX	SX	sX
DX	TX	tX
EX	UX	uX
FX	VX	vX

X = Least significant nibble

* Characters with parity and framing errors are displayed as framing errors only. Framing errors can occur due to loss of serial bit timing, improper baud rate and/or parity setting.

4.0 INTERFACE AND CONTROL

4.1 Connector Assignment (P2)

Pin No.	Function
P2–1	R_X Data
P2–2	R_X Data RTN (Signal Ground)
P2–3	RESET
P2–4	Adjust
P2–5	Self–Test
P2–6	V_{BIAS} (Factory Test Point)
P2–7	V_{CC} (+5 Volts)
P2–8	V_{SS} (Ground)
P2–9	No Connection
P2–10	Optional Backlight
P2–11	Optional Backlight

NOTE: The mating connector must be wired in a reverse pin sequence from its marking. (Pin 11 is Pin 1 etc.)

The mating connector is a Molex #22-01-2117 or equivalent. It uses crimp pins #08-50-0114.

4.2 Jumper Settings

Jumper No.	Pins	Jumper A = "0"	Jumper B = "1"
1	E1	4800 Baud	1200 Baud
2	E2	2 x Baud	1 x Baud
3	E3	Parity	No Parity♦
4	E4	Even Parity	Odd Parity
5	E5	7 Data Bits ***	8 Data Bits
6	E6	1/8 Mpx (N/A)	1/16 Mpx
7**	Not Used		
8**	Not Used		

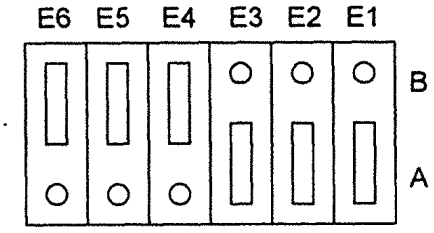
* Baud rate will default to "1" if no jumper is installed.

** Jumper options 7, and 8 are omitted and will indicate as logic "1" when in self–test mode.

*** 8 bit word preferred. When 7 bit word is selected see section 3.1.2 for use of instruction 19 Hex.

♦ Selection of NO PARITY requires use of two stop bits.

Example of jumpers installed for:
E1A 4800 Baud
E2A 2X = 9600 baud
E3A Parity
E4B Odd Parity
E5B 8 Data Bits
E6B 1/16 Multiplex



5.0 ELECTRICAL SPECIFICATIONS

5.1 Absolute Maximum Ratings

Power Supply Voltage (V_{CC}): –0.3 to +6.5 V_{DC}

Serial Input Voltage: –25.0 to +25.0 V_{DC}

5.2 Normal Operating Ratings

Power Supply Voltage (V_{CC}): +5.0 V_{DC} ±10%

Supply Current (+5 V_{DC}): 34 mA Max

EL Current (+5 Volt Inverter) 100 mA

5.2.1 Power–up Supply Requirements

Initialization may or may not be performed completely unless the rise time (t_{RCC}) of the power supply is correct at turn–on (1ms $\leq t_{RCC} \leq$ 10ms). Figure 11 represents the requirements of the power supply. Note that t_{OFF} stipulates the minimum time that power can be OFF ($t_{OFF} \geq$ 1ms) during a momentary dip or when the power supply cycles ON and OFF.

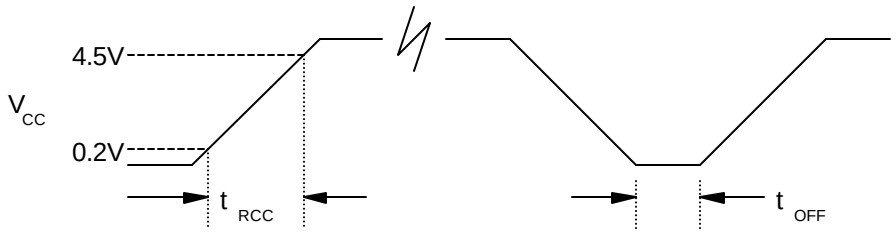


Figure 11 Power Supply Requirements

5.2.2 External Reset Requirements

To utilize the optional external reset, the RESET pin must be held at ground (<0.5 Volts) for at least 10 milliseconds after the power supply is within the voltage tolerance. Figure 12 shows the module Reset circuit.

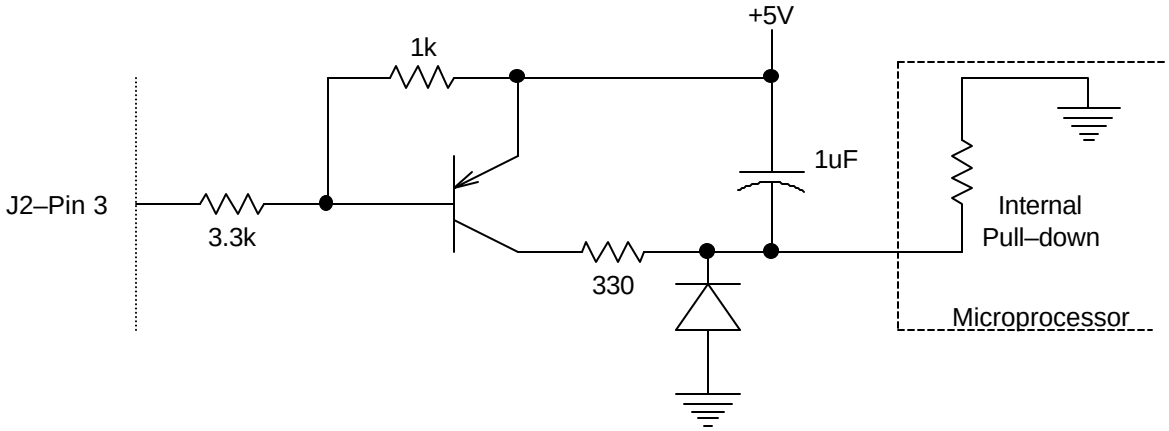


Figure 12 External Reset Circuit

5.3 Interface Signals

5.3.1 Serial Interface Signals

The display is designed to be operated by a standard RS–232 serial interface. The user can operate the module with any interface which meets the following requirements for a "mark" condition and a "space" condition. The user should observe generally accepted design rules when interfacing to the display.

Space Voltage
(V_{RX} Data – V_{RX} Data RTN) +3.0 to +25.0 Volts

Mark Voltage
(V_{RX} Data – V_{RX} Data RTN) –25.0 to +0.8 Volts

6.0 ENVIRONMENTAL CHARACTERISTICS

6.1 Operating

Temperature:	–30 to +80°C (Backlight Off)
	–30 to +40ºC (Backlight On, See Paragraph 8.3.5)
Humidity: (@ 40ºC)	95% RH (non–condensing)
Humidity (< 40°C):	Absolute humidity must be lower the humidity of 95% RH at 40°C
Vibration:	10g at 10 to 400Hz (3 axes)
Shock:	10g (all axes)

6.2 Non–Operating

Temperature: –40°C to +85°C

7.0 OPTICAL SPECIFICATIONS

7.1 Optical Characteristics

Format:	Four lines of 20 characters
Character Font:	5x7 dot matrix with cursor
Character Height w/ cursor:	0.48" (12.1mm)
Character Height w/o cursor:	0.39" (9.9mm)
Character Width:	0.24" (6.1mm)
Overall Active Area:	5.70" x 2.34" (144.9mm x 59.5mm)
Peak Vertical Viewing Angle:	20° below normal plane
Viewing Mode:	Transflective, light field

Item	Symbol	Condition	Min	Typ	Max	Unit
Viewing Angle–Vertical	$\phi 1–\phi 2$	CR=2.0, θ=0°	100	120	–	deg.
Viewing Angle–Horizontal*	T	CR=2.0	±45	±55	–	deg.
Contrast ratio (Peak)**	CR	25°C	10	18	–	–
Response time (ON)**	t_r	25°C	–	100	150	mS
		–30°C	–	2000	–	mS
Response time (OFF)**	t_f	25°C	–	150	200	mS
		–30°C	–	4000	–	mS

* Measured at peak vertical angle, ϕ = –20°

** Measured at peak viewing angles:

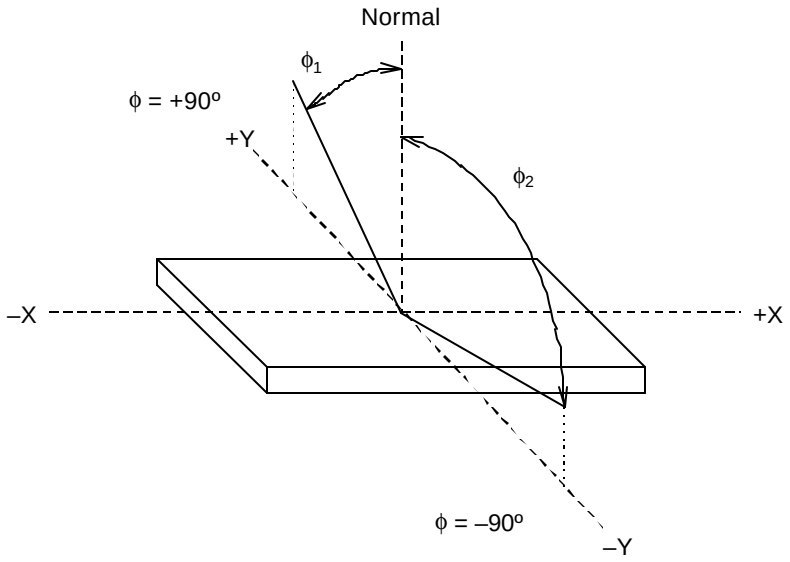


Figure 13 Definition of Vertical Viewing Angle

7.1 Optical Characteristics (Continued)

Definition of Horizontal Viewing Angle–top Viewing Display (for Bottom Viewing Displays ϕ = –20° Typically)

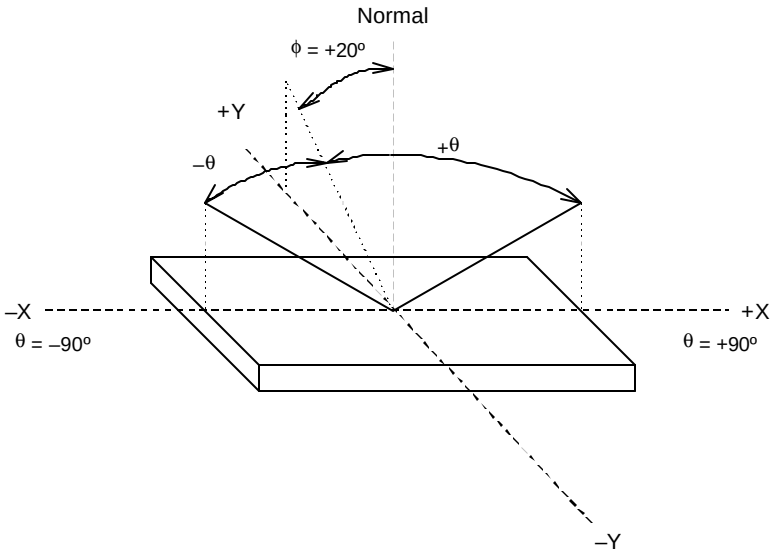


Figure 14 Definition of Horizontal Viewing Angle

Display contrast ratio is given by:

$$CR = \frac{B_2}{B_1}$$

Where: B_1 = Brightness of selected segment

B_2 = Brightness of non–selected segment

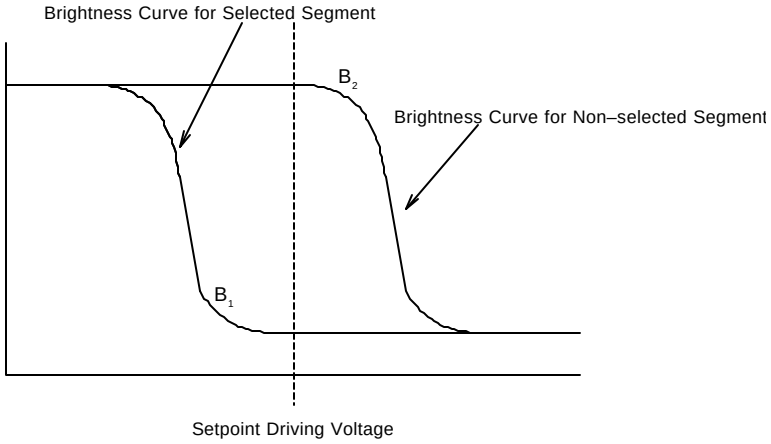


Figure 15 Definition of Contrast Ratio (CR)

7.1 Optical Characteristics (Continued)

Definition of optical response.

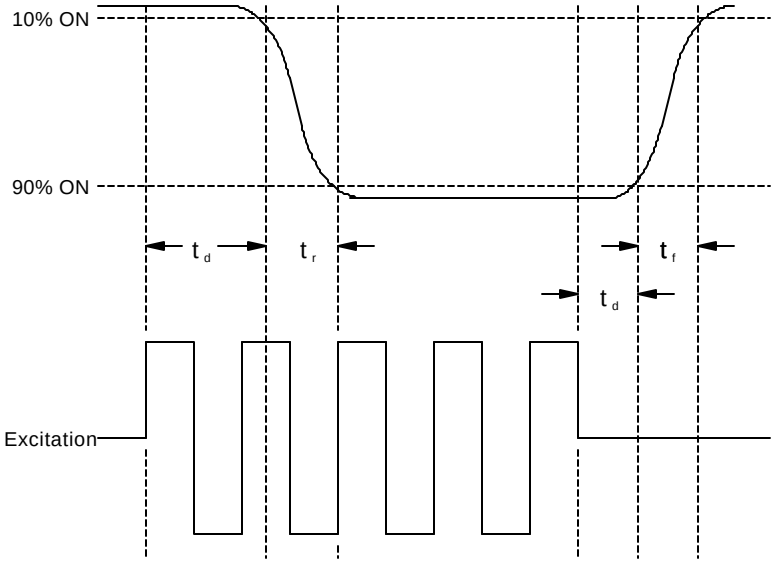


Figure 16 Definition of Optical Response

7.2 Viewing Angle Adjustment

The factory preadjusts the viewing angle of the display by setting the LCD bias voltage to 10.2 Volts using the on–board potentiometer. This is considered to be a nominal adjustment, but the user may prefer to vary this to optimize the viewing for a particular application. The bias voltage is measured between V_{CC} (pin #7) and V_{BIAS} (pin #6).

The viewing angle and contrast ratio may be externally controlled using an additional 10K ohm potentiometer. The potentiometer on the rear of the module must first be set to the maximum resistance by turning the adjustment fully counterclockwise. A 10K ohm potentiometer can then be connected between pin numbers 4 and 7 on the connector. Since the module has wide viewing angle characteristics and built–in temperature compensation of the viewing angle, the user may find that this external viewing control is unnecessary.

8.0 EL BACKLIGHTING

8.1 EL Backlight Description

The module contains an AC EL backlight which enables the LCD to read under low lighting conditions. The EL lamp provides uniform lighting across the entire display surface. Since the lamp is a cold light source, no heat is added to the module during operation.

8.2 Electrical Characteristics of EL Backlight

Typical measurements at 115VAC, 400Hz, unless otherwise noted.

Color:	Aviation Green
Radiance:	.051 Watts/ft^2
Spectral peak emission:	520mm
Chromaticity:	X = .230 ± .030, Y = .500 ± .030
Voltage Range:	41 to 130 Volts
Operating Frequency (max.):	600Hz
Power Requirements:	.035 Watts/inch^2

8.3 Operation

8.3.1 Normal Operation

The EL lamp is designed for typical operation at 90 Volts AC at 330 cycles. The light output of the lamp under these operating conditions is typically 12 ft–L. Since the LCD transmits approximately 8% of the light, the light output through the display is 1 ft–L.

8.3.2 Brightness, Voltage and Frequency Characteristics

Other voltages and frequencies can be applied to the lamp to increase or decrease the light output. Figure 17 illustrates the relationship between brightness and voltage. Figure 18 illustrates the relationship between brightness and frequency. A rough approximation of the initial brightness of an aviation green electroluminescent panel when driven by a sinusoidal waveform can be derived by the following equation.

$B = 0.27 \times V + 0.0455 \times f - 27.7$ where: B = brightness of lamp in ft–L, V = voltage applied to lamp in RMS Volts and f = frequency in Hertz

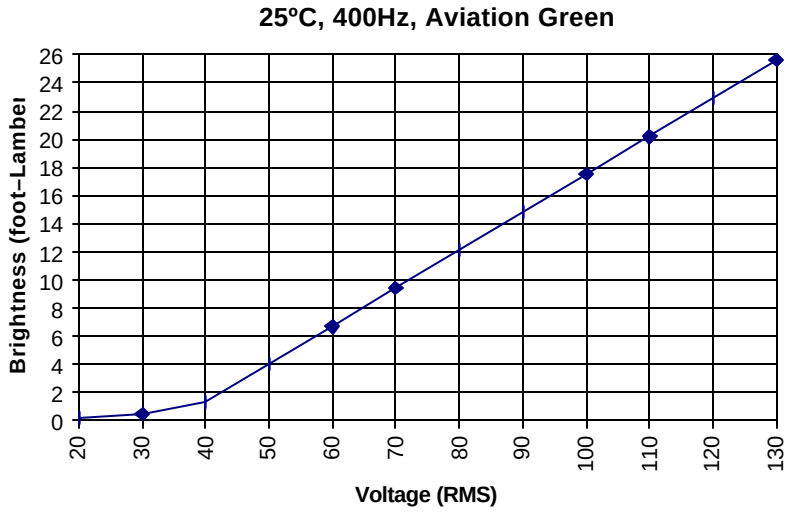


Figure 17 Initial Brightness vs. Voltage

8.3.2 Brightness, Voltage and Frequency Characteristics (Continued)

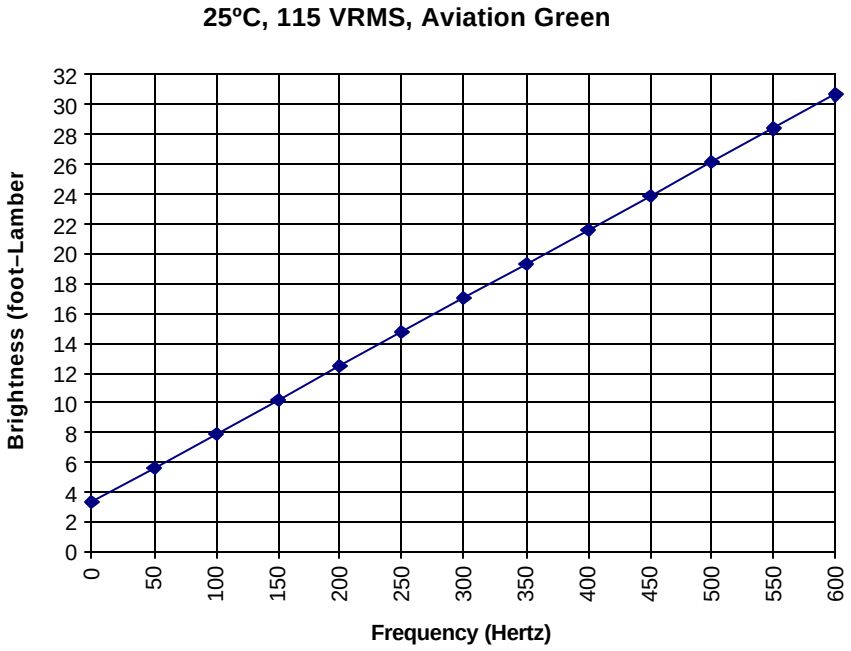


Figure 18 Initial Brightness vs. Frequency

8.3.3 Intermittent Operation

The EL backlight is intended for intermittent usage only. Continuous operation will result in greatly reduced life of the lamp. The user is cautioned to observe the notes in Section 8.3.5 and 8.3.6 to assure lifetime of the EL backlight.

8.3.4 Square Waveform Operation

Square wave operation is not recommended for EL lamps. First, square wave operation can result in a non–uniform light emission over the surface of the lamp. This non–uniformity is a result of the relatively high sheet resistivity of the front electrode causing an attenuation of the high frequency components in the square wave as distance from the bus bar increases. Consequently, the waveform is rounded at distances away from the bus bar. Second, the leading edge of a square wave contains high order harmonics which may cause radio interference (EMI).

8.3.5 Operating Temperature

The maximum continuous operating temperature for the EL backlight is specified at 40°C. Service may be extended to 70°C at a sacrifice in life. At temperatures above 70°C, aging is so rapid the prolonged operation is impractical. The specified non–operating temperature range –40°C to +85°C.

8.3.6 Operating Life

One of the prominent characteristics of EL lamps is the gradual decrease in light output, or aging, which occurs during operation. The useful life of the EL lamp depends on the ambient lighting conditions for a particular application. Typical lifetimes of 2000 to 10000 hours should be expected for most applications. The life of a lamp is affected by a number of factors, including the particular EL phosphor, the drive parameters (voltage and frequency) and the temperature during operation.

Figure 19 shows the gradual decrease in EL light output over time at 25°C with the inverter specified in Section

8.5. The brightness values are measures of the lamp surface brightness. The transmitted light through the LCD is approximately 8% of the lamp surface brightness.

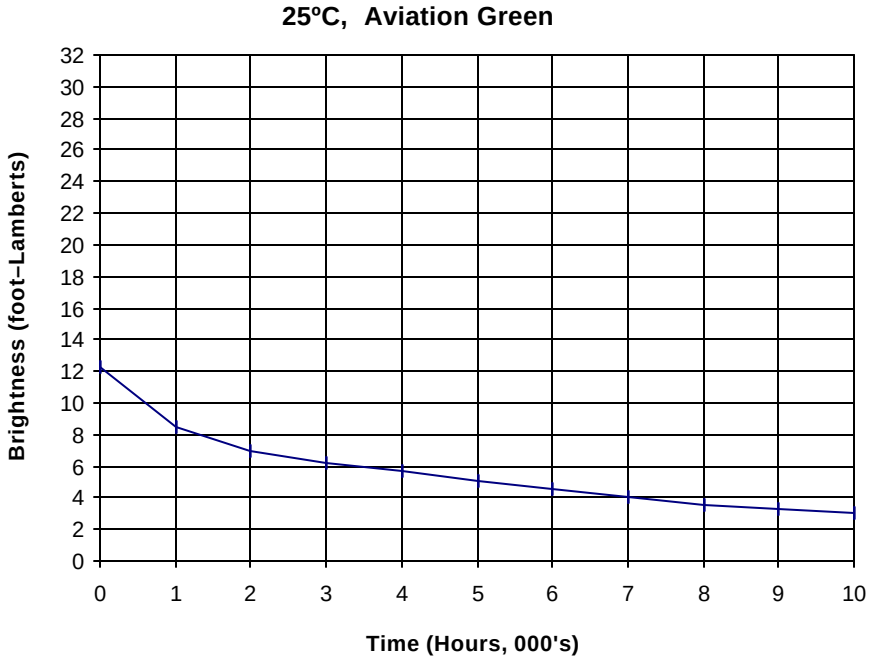


Figure 19 Brightness vs. Time

8.4 Electromagnetic Interference (EMI)

Electroluminescent lamps have been shown to radiate negligible interference through UHF when operated by quasi–sinusoidal waveforms.

8.5 DC–AC Inverter

Optimum performance and life can be achieved by using the inverter P/N 46013–01. The inverter extends; the useful life of the lamp by compensating for the aging characteristics of the lamp. The inverter operates in a constant power mode which provides for long lifetime at a relative constant light output. Because of the quasi–sinusoidal output, RFI is minimal and usually no shielding is required.

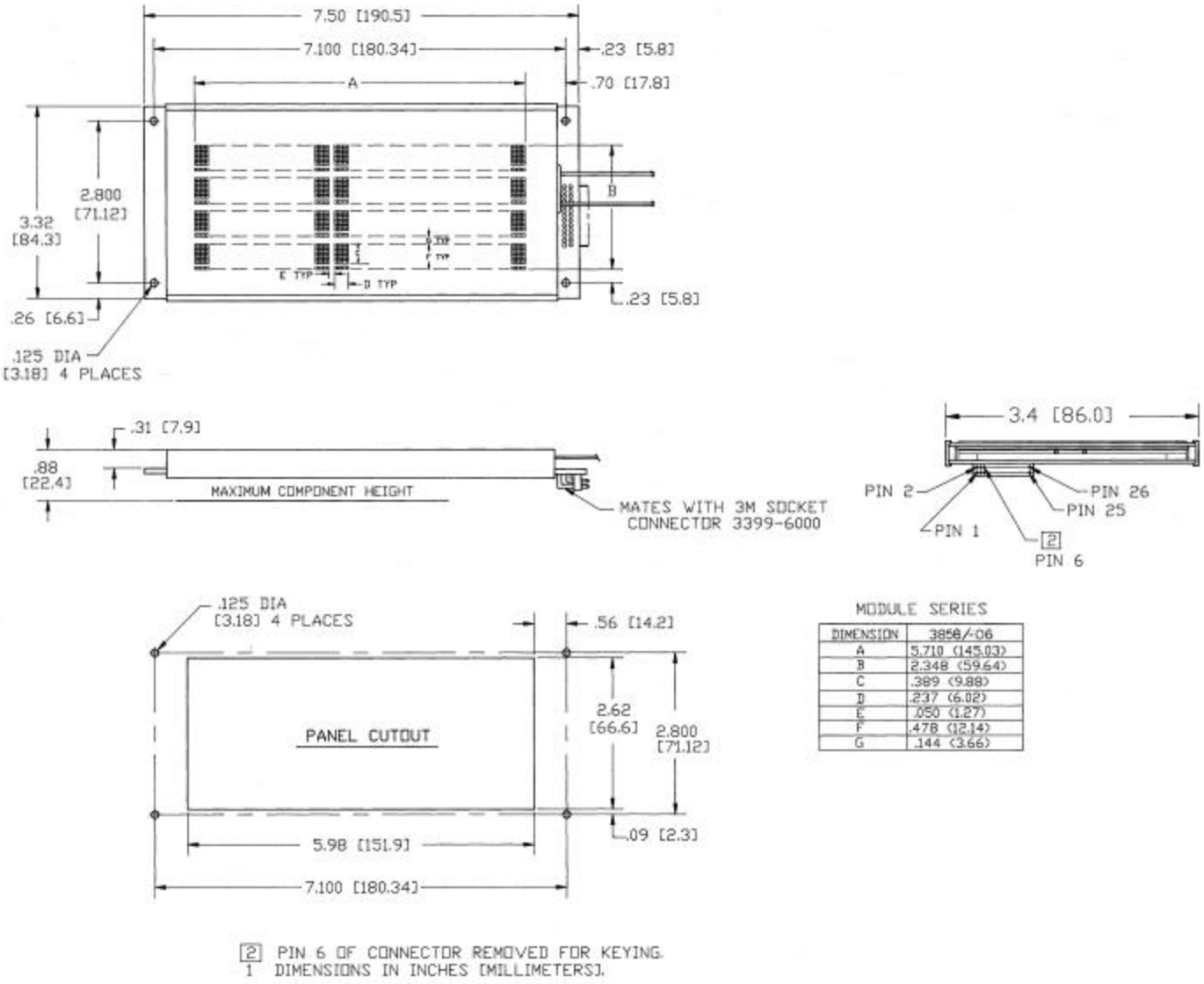
9.0 INSTALLATION NOTE

To protect the front polarizer from accidental damage it is highly recommended that the LCD be mounted behind a clear glass or polycarbonate window material. It is also recommended that an air gap of at least .030" to .050" minimum be provided between the window material and the surface of the LCD to prevent the transfer of static charges to the front surface of the LCD. Supertwist LCD's may activate un–driven elements in response to a surface static charge on the front polarizer. It may take several minutes for such a surface static charge to dissipate.

10.0 ACCESSORIES

Part	Mfr. Part No.	IEE Part No.
Power/Data Connector, 11 Pin (Molex):	22–01–2117	45125–11
Connector Pins, (Molex, 11 required)	08–50–0114	45126–01
5 Volt Input EL Backlight Inverter		46013–01

11.0 OUTLINE AND INSTALLATION CHARACTERISTICS



DIMENSION	3858/-06
A	5.710 (145.03)
B	2.348 (59.64)
C	.389 (9.88)
D	.237 (6.02)
E	.050 (1.27)
F	.478 (12.14)
G	.144 (3.66)

Figure 20 03858–06–0205 Outline Drawing