REV:	PAGE:	REVISION DESCRIPTION	APPR:	DATE:
A1.0	ALL	Created	CEV	08/07/98
A1.1	8	Modified Line Feed DC2 or DC3 Mode command: was "...and the cursor remains at the same position."	CEV	08/19/98
A2.0	All 3 5	Part number was NA202SD08FA1 (ECO 98-045) Added "φ6.35 (4 PLCS) PLATED COPPER RING VFD SIDE ONLY" I_{CC} was 400mA (Typ), 450mA (Max) Deleted Input current I_I Added I_{IH} and I_{IL} for D0-D7 and WR V_{OL} was 0.1V @ I_{OL} = 20uA	CEV	10/21/98
A3.0	All 7	Part number was NA202SD08FA2 (ECO 98-051) Removed Test Mode command (01H)	CEV	11/06/98
A3.1	5 7	I_{CC} was 440mA (Typ), 500mA (Max) Added Test Mode command (01H)	CEV	01/04/99
A4.0	All 2 3 5 6 7 12	Part number was NA202SD08FA3 (ECO 99-015) Removed Busy line from Figure 1 Removed Pin 1 of connector; added Note 2 to Figure 2 Removed V_{OUT} from Section 2.3 Removed V_{OH} and V_{OL} from Section 2.4 Removed $t_{WR-Busy}$, t_{wBUSY}, $t_{Busy-WR}$; added t_{wCYCLE} to Section 2.5 Removed references to the Busy line in Section 3.2 Added "with Pin 1 void" to the J1 part number Symbol for Pin1 was Busy	CEV	06/22/99
A	All	Released to production Part number was NA202SD08FA4 (ECO 00-017)		

DRAWING TITLE:	PRODUCT SPECIFICATION
PART NUMBER:	NA202SD08FA

DESIGNED BY: Robert Parker	ENGINEERING APPROVAL:	CUSTOMER NAME / PART NUMBER: 02S-93490-VFD	
CHECKED BY:	MFG & MATERIALS APPROVAL:	DATE DRAWN: 08/21/00	FILE NAME: 202SD08F.DOC
CUSTOMER APPROVAL:	QA APPROVAL:	DATE PRINTED: 11/08/16	SHEET: 1 OF 12

1.0 GENERAL DESCRIPTION

This vacuum fluorescent display (VFD) module consists of a 20 character by 2 line 5x7 dot matrix display, DC-DC/AC converter, character generator with 224 5x7 characters, controller/driver circuitry, and an 8-bit parallel data communication interface.

1.1 APPLICABLE DOCUMENTS

Futaba vacuum fluorescent display specification 202-SD-08GLYK
Futaba America Engineering Standard FAES 801, Printed Circuit Board Markings
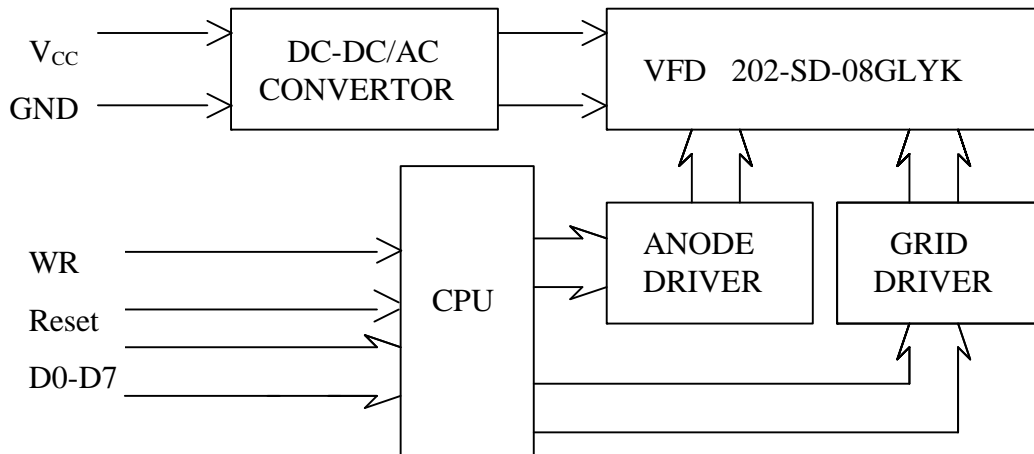
1.2 SYSTEM BLOCK DIAGRAM

Figure 1. System Block Diagram

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1.3 MECHANICAL DRAWING

Figure 2. Mechanical Drawing

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NOTES:
1. DIMENSIONS IN ( ) ARE FOR REFERENCE ONLY.
2. PIN 1 VOID.

2.0 SPECIFICATIONS

2.1 GENERAL SPECIFICATIONS

Item	Value	
Number of characters	20 characters x 2 lines	
Character configuration	5x7 dot matrix w/cursor	
Character height	5.0 mm	
Character width	3.5 mm	
Character pitch	5.2 mm	
Line pitch	11.1 mm	
Dot size	0.5 x 0.5 mm	
Dot pitch	0.75 x 0.75 mm	
Peak wavelength of illumination	Green (505 nm) x=0.235, y=0.405	
Luminance	Minimum 350 cd/m^2, 102 fL	Typical 700 cd/m^2, 204 fL

2.2 ENVIRONMENTAL SPECIFICATIONS

Item	Symbol	Min	Max	Unit	Comment
Operating temperature	T_{opr}	0	+70	^{o}C	
Storage temperature	T_{stg}	-55	+80	^{o}C	
Operating humidity	H_{opr}	20	85	%RH	Without condensation
Storage humidity	H_{stg}	20	90	%RH	Without condensation
Vibration	-	-	4.0	G	Total amplitude: 1.5mm Frequency: 10-55Hz sine wave Sweep time: 1 min./cycle Duration: 2hrs/axis(X,Y,Z)
Shock	-	-	40	G	Duration: 11ms Waveform: half sine wave 3 times/axis (X,Y,Z,-X,-Y,-Z)

2.3 ABSOLUTE MAXIMUM ELECTRICAL RATINGS

Item	Symbol	Min	Max	Unit
Supply voltage	V_{CC}	-0.3	6.5	V
Input signal voltage	V_{IN}	-0.5	$V_{CC}+0.5$	V

2.4 DC ELECTRICAL SPECIFICATIONS

Item		Symbol	Min	Typ	Max	Unit
Supply voltage		V_{CC}	4.75	5	5.25	V
Supply current (Note 1)		I_{CC}	-	425	515	mA
High level input voltage	D0-D7, WR	V_{IH}	2.0	-	-	V
	Reset		$0.7V_{CC}$	-	$V_{CC}+0.5$	V
Low level input voltage	D0-D7, WR	V_{IL}	-	-	0.8	V
	Reset		-0.5	-	$0.2V_{CC}-0.1$	V
High level input current	D0-D7 ($V_I = 2.7V$)	I_{IH}	-	-	20	uA
	WR ($V_I = 3.84V$)		-	-	5.9	mA
Low level input current (D0-D7, WR) ($V_I = 0.4V$)		I_{IL}	-	-	-0.4	mA

Note 1: A surge current of up to 3 Amps for 1mS can occur at power-up. However, the exact peak of surge current amplitude and duration are dependent on the characteristics of the host power supply.

2.5 AC ELECTRICAL SPECIFICATIONS

(See Figure 3, Figure 4)

Item	Symbol	Min	Max	Unit
D0-D7 set up time	t_{su}	50	-	ns
D0-D7 hold time	t_h	50	-	ns
WR pulse width time, high or low	t_{wWR}	50	-	ns
WR cycle time	t_{wCYCLE}	325	-	us
Reset pulse width	t_{wRST}	2	-	ms
Reset to WR wait time	t_{wait}	2	-	ms
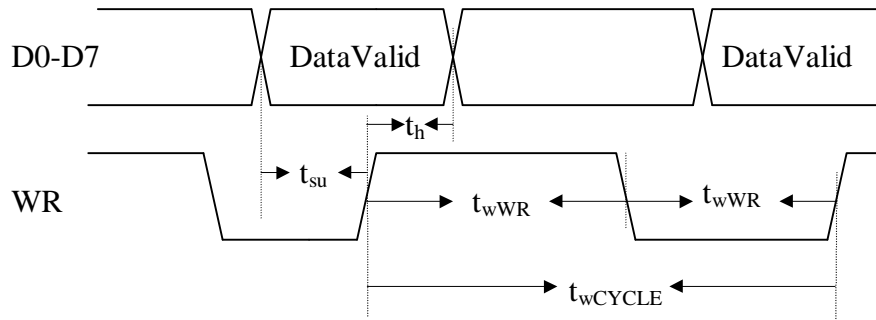
Figure 3. Input Data Timing
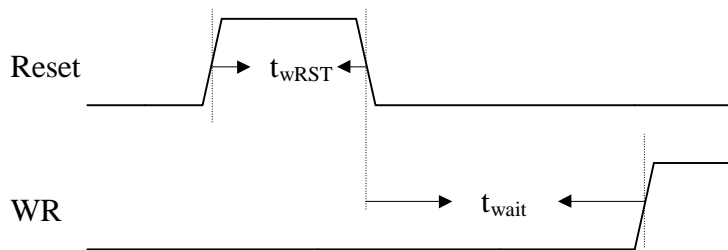
Figure 4. Reset Timing

3.0 FUNCTIONAL DESCRIPTION

3.1 RESET

The module is reset automatically at power-up, or by pulsing the reset line according to Figure 4. The module can also be reset after receiving a reset command (software reset). At reset, the following functions are performed: display is cleared, cursor position set to the top row leftmost position, display mode set to DC2, luminance set to 100%, and cursor is enabled. Note that after power up, the host must wait a minimum of 2ms before sending data. Any data sent before this time may be ignored.

3.2 DATA WRITE

Data is written to the module on the rising edge of the WR pulse (see Figure 3).

3.2.1 COMMAND CODES

Command codes fall into the range of 00H to 1FH. The following are the only valid command codes.

1) **Test Mode**   (01H) (02H) (05H) (03H) (00H)

This function is used during the manufacture of the module for testing purposes. The Test Mode is only entered into after the module receives the 5-byte sequence: 01H 02H 05H 03H 00H. If this 5-byte sequence is not followed, the module does not enter in the Test Mode, and the byte that caused the break in the 5-byte sequence is processed. On the other hand, if the Test Mode is entered, it can be exited by the reception of a non-Test Mode byte (any byte except 01H); this non-Test Mode byte will be processed.

2) **Luminance Control**   (04H)   (xxH)

Display luminance can be set to one of the following 4 levels by sending the Luminance Control command followed by a succeeding parameter byte with the following format:
        FFH   Maximum luminance   (Default)
        60H   60% of maximum luminance
        40H   40% of maximum luminance
        20H   20% of maximum luminance
Sending an invalid parameter byte will cause the command to be canceled.

3) **Blink Cursor** (07H)

The cursor position is displayed as a blinking underline.

4) **Backspace** (08H)

The cursor position is shifted to the left one position and the character at that position cleared. The cursor will auto-wrap from the top row leftmost position to the bottom row rightmost position or the from bottom row leftmost position to the top row rightmost position.

5) **Horizontal Tab** (09H)

DC1 Mode:
The cursor position is shifted to the right one position. The cursor will auto-wrap from the top row rightmost position to the bottom row leftmost position and from the bottom row rightmost position to the top row leftmost position.

DC2 or DC3 Mode:
The cursor position is shifted to the right one position. The cursor will auto-wrap from the top row rightmost position to the bottom row leftmost position. If the cursor is at the bottom row rightmost position, the contents of the bottom row are transferred to the top row, the bottom row is cleared, and the cursor is placed at the bottom row leftmost position.

6) **Line Feed** (0AH)

DC1 Mode:
The cursor position is shifted to the same column position of the other row.

DC2 or DC3 Mode:
When the cursor is on the bottom row, the contents of the bottom row are shifted to the top row, the bottom row is cleared, and the cursor moves to the leftmost position of the bottom row. When the cursor is on the top row, the command is executed the same as the DC1 mode.

7) **Start Blink Field** (0BH)

All characters received after this command will blink. Note that multiple blink fields can be set.

8) **End Blink Field** (0CH)

All characters received after this command will not blink.

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9) **Carriage Return**   (0DH)

The cursor position is placed at the leftmost position of the same row.

10) **Cursor Off Mode**   (0EH)

The cursor position is not displayed.

11) **Cursor On Mode**   (0FH)   (Default)

The cursor position is displayed as an underline.

12) **Set Cursor**   (1BH)   (xxH)

The cursor position can be set to any display position by sending this command followed by a parameter byte with the following format:

        00H   Top leftmost position of display
        13H   Top rightmost position of display
        14H   Bottom leftmost position of display
        27H   Bottom rightmost position of display

Sending a parameter byte greater than 27H will cause the command to be canceled.

13) **DC1   Normal Mode**   (11H)

In this mode, after a character is written, the cursor position is automatically shifted to the right one position. The cursor will auto-wrap from the top row rightmost position to the bottom row leftmost position and from the bottom row rightmost position to the top row leftmost position.

14) **DC2   Auto Carriage Return Off** (12H)   (Default)

In this mode, after a character is written, the cursor position is automatically shifted to the right one position. The cursor will auto-wrap from the top row rightmost position to the bottom row leftmost position. The cursor position does not change if it is at the bottom row rightmost position.

15) **DC3   Horizontal Scroll**   (13H)

In this mode, after a character is written, the cursor position is automatically shifted to the right one position. The cursor will auto-wrap from the top row rightmost position to the bottom row leftmost position. If the cursor is at the bottom row rightmost position, the contents of the bottom row are shifted left one position, and the cursor position does not change.

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16) **Reset** (14H)

The module is reset. (The conditions are the same as a power-on reset, see section 3.1).

17) **Display Clear** (15H)

The display is cleared and the cursor is placed at the top row leftmost position.

18) **Cursor Home** (16H)

The cursor is placed at the top row leftmost position.

19) **Underline Mode** (17H) (xxH)

The underline of any character can be set to "ON" or "BLINK" by sending the Underline Mode command followed by a succeeding parameter byte with the following format:
      44H   Begin Underline On field
      46H   Begin Underline Blink field
      45H   End Underline On or Blink field
Note that after sending the command sequence 17H,44H all characters following will be displayed with an underline until the End Underline command sequence is executed. Multiple underline fields can be set.

Sending an invalid parameter byte will cause the command to be canceled.

20) **Mask MSB** (19H)

The most significant bit of the next byte received is masked "HIGH". (Example: sending 19H,00H is the same as sending 80H.)

21) **High Brightness** (1FH)

Sets the luminance of the display to 100%.

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3.2.2 CHARACTER CODES

Character codes fall into the range of 20H to FFH.

Figure 5. General European Character Set

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4.0 CONNECTOR INTERFACE

J1 pinout (Molex #22-23-2141 with Pin 1 void)

Pin	Symbol	Pin	Symbol
1	Void	8	D2
2	WR	9	D1
3	D7	10	D0
4	D6	11	V_{CC}
5	D5	12	GND
6	D4	13	NC
7	D3	14	Reset