REV:	PAGE:	REVISION DESCRIPTION	APPR:	DATE:
B	-	Released as a standard product.	GRW	11/05/96
B.1	5, 11 7	Removed reference to R5-C9 reset circuit in SYSTEM BLOCK DIAGRAM and RESET sections since components are not placed on the PCB. Average continuous current spec of 450mA previously in Note 2 now Icc Typ spec.		

***FUTABA* CORPORATION OF AMERICA SCHAUMBURG, IL.**		DRAWING TITLE: PRODUCT SPECIFICATION	
		PART NUMBER: US162SD03CB	
DESIGNED BY: R. B. Hipenbecker	ENGINEERING APPROVAL:	CUSTOMER NAME / PART NUMBER: STANDARD PRODUCT	
CHECKED BY:	MFG & MATERIALS APPROVAL:	DATE DRAWN: 06/13/97	FILE NAME: 162SD03C.DOC
CUSTOMER APPROVAL: N/A	QA APPROVAL:	DATE PRINTED: 01/05/98	SHEET: 1 OF 21

TABLE OF CONTENTS

Figures

Appendix

1.0 FEATURES

1. Synchronous Serial input
2. Continuous brightness level control
3. Full ASCII, European, and Katakana character set
4. Flexible display flashing capability
5. Next message buffer capability
6. Eight user definable characters
7. Single 5 volt power supply requirement
8. Bi-directional communication capability
9. Surface mount component reliability, quality, and long life
10. EMI specification to FCC Class B

2.0 SPECIFICATIONS

2.1 GENERAL SPECIFICATIONS

Item	Value
Number of Characters	2 row x 16 Characters
Character Configuration	5 x 7 Dot Matrix
Character Height	4.51 mm
Character Width	2.30 mm
Character Pitch	3.50 mm
Peak Wavelength of Illumination	Green (505 nm)
Luminance	102 fL min 204 fL typ.
Luminance difference between characters	2:1
Luminance difference adjacent characters	1.5:1
Life (Note 1)	50,000 Hours

Note 1: The life of a VFD is defined as the number of operating hours before the luminance level decreases to 50% of its initial luminance level.

2.1.1 MECHANICAL DRAWING

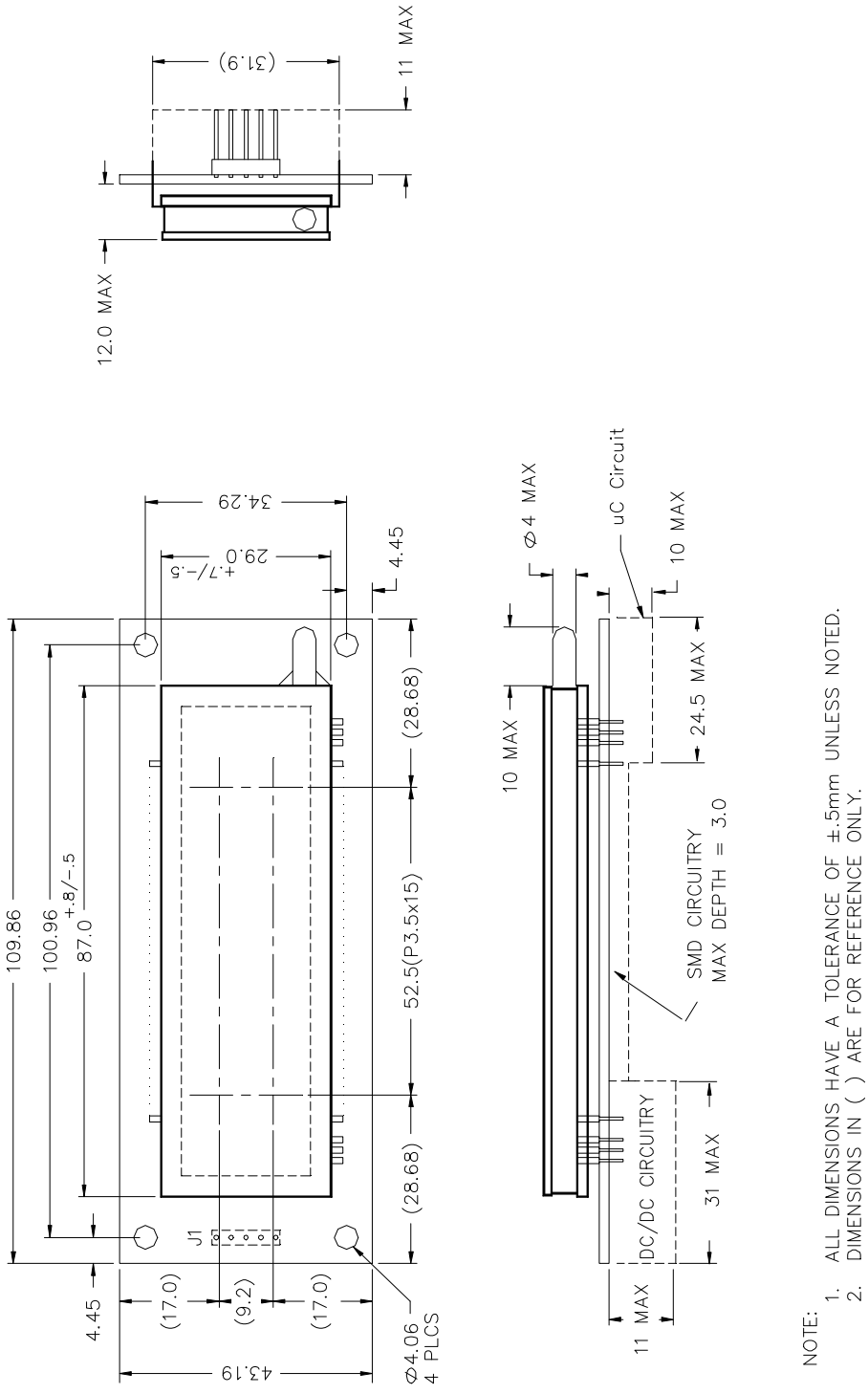


Figure 1. Mechanical Drawing

2.1.2 SYSTEM BLOCK DIAGRAM

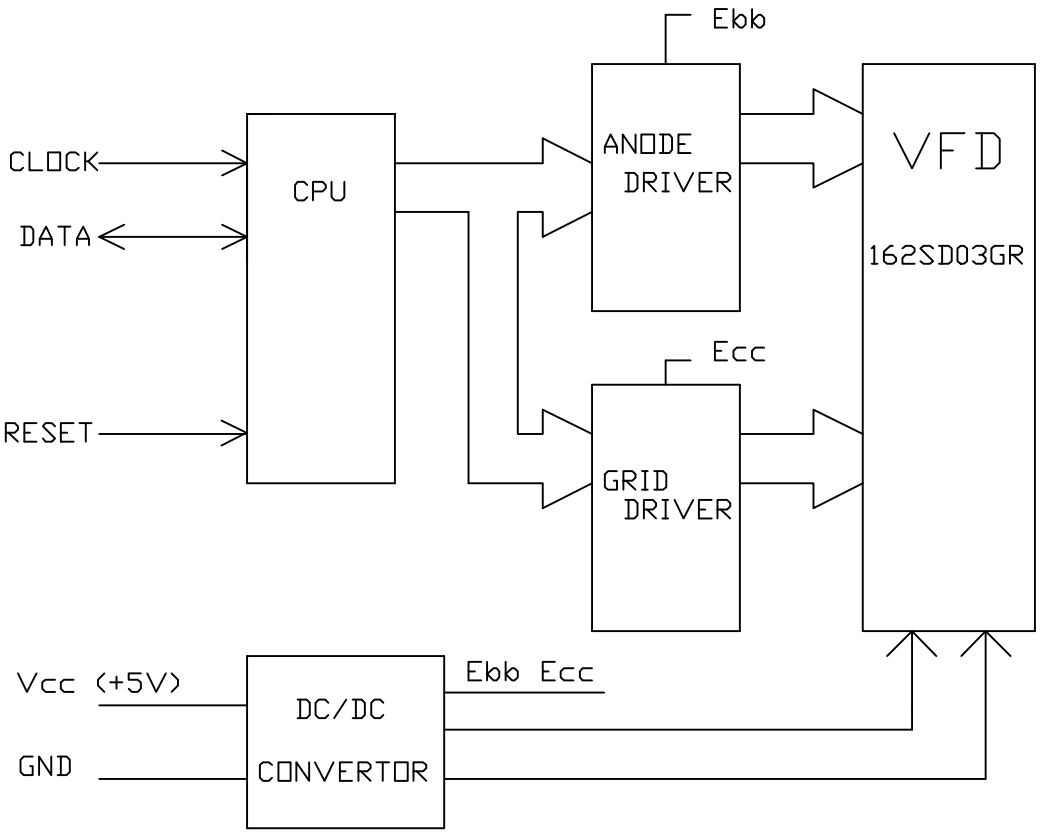


Figure 2. System Block Diagram

2.2 MECHANICAL

Item	Symbol	Value	Unit
Outside Dimensions	Length	109.9	mm
	Width	43.2	mm
	Depth	21.2	mm
Weight	-	70	g

2.3 ENVIRONMENTAL

Item	Operation		Storage		Comment
	Min	Max	Min	Max	
Ambient Temperature	0°C	70°C	-30°C	80°C	
Humidity	0%	95%	0%	95%	Without Condensation
Vibration	-	-	-	4 G	10 - 55 Hz
Shock (Acceleration)	-	-	-	40 G	11ms, x, y, z
EMI Radiated	FCC Class B, 15 J				

2.4 ABSOLUTE MAXIMUM ELECTRICAL RATINGS

Item	Symbol	Min	Max	Unit
Supply Voltage	V_{CC}	-0.3	7.0	V
Input Signal Voltage	V_{in}	-0.4	7.0	V

Note: Operation of the VFD module at or above these conditions for extended periods of time may cause reliability problems.

2.5 DC ELECTRICAL SPECIFICATIONS (V_{CC} = 5.0 V, Topr = 25°C)

Item	Symbol	Min	Typ	Max	Unit
Supply Current (See Note)	I_{CC}	-	450	600	mA
High Level Input Voltage	V_{IH}	2.0	-	V_{CC}+0.3	V
High Level Input Current (V_{in}=5.0)	I_{IH}	-	-	1	mA
Low Level Input Voltage	V_{IL}	-0.3	-	0.8	V
Low Level Input Current (V_{IL}=0.45V)	I_{IL}	-	-	-0.8	mA
Low Level Output Voltage (I_{OL}=1.6mA)	V_{OL}	-	-	0.45	V
High Level Output Voltage (I_{OH}=-80uA)	V_{OH}	2.4	-	-	V

Note: A surge current of up to 5 Amps for 1 mS can occur at Power-up. However, the exact peak surge current amplitude and duration are dependent on the characteristics of the host power supply.

2.6 AC ELECTRICAL CHARACTERISTICS (V_{CC} = 5.0, Topr = 25°C)

(See Figures 3,4,5,6)

Item	Symbol	Min	Max	Unit
Clock Period	T_{CLOCK}	40.0	-	µSec
Pulse Duration (Clock High)	t_{wCKH}	2.0	-	µSec
Pulse Duration (Clock Low)	t_{wCKL}	2.0	-	µSec
Data Set Up Time	t_{su}	-3.0	-	µSec
Data Hold Time	t_{hold}	15.0	-	µSec
Reset Pulse Width	t_{wRST}	30.0	-	µSec
Reset to Clock Wait Time	t_{wait}	2.0	-	mSec
Process Data Time	$t_{process}$	20.0	-	µSec
Data Response Time 1 (Mode 2)	t_{dr1}	15.0	25.0	µSec
Clock Response Time 1 (Mode 2)	t_{cr1}	2.0	-	µSec
Data Response Time 2 (Mode 2)	t_{dr2}	2.0	6.0	µSec
Clock Response Time 2 (Mode 2)	t_{cr2}	10.0	-	µSec
Data Response Time 3 (Mode 2)	t_{dr3}	15.0	25.0	µSec
Clock Response Time 3 (Mode 2)	t_{cr3}	2.0	-	µSec
Data Response Time 4 (Mode 2)	t_{dr4}	2.0	6.0	µSec

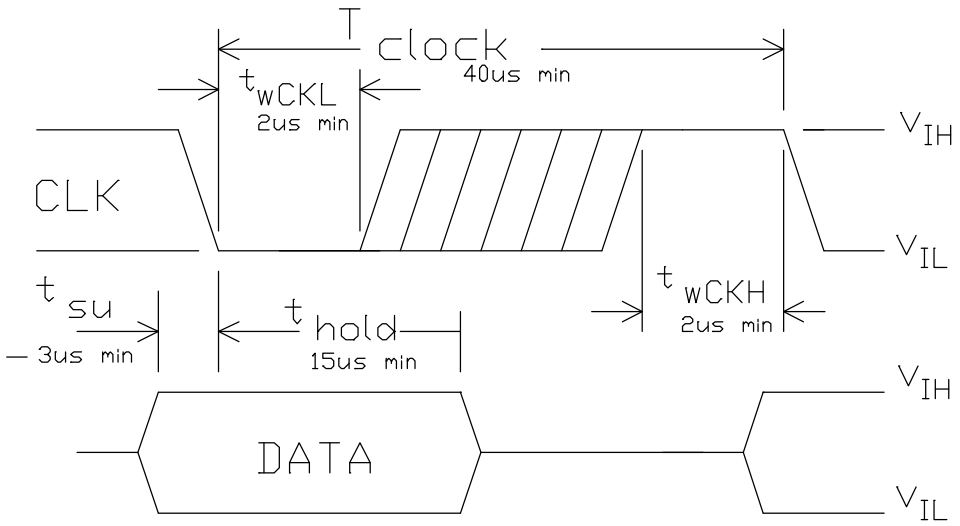


Figure 3. Data Bit Write Timing

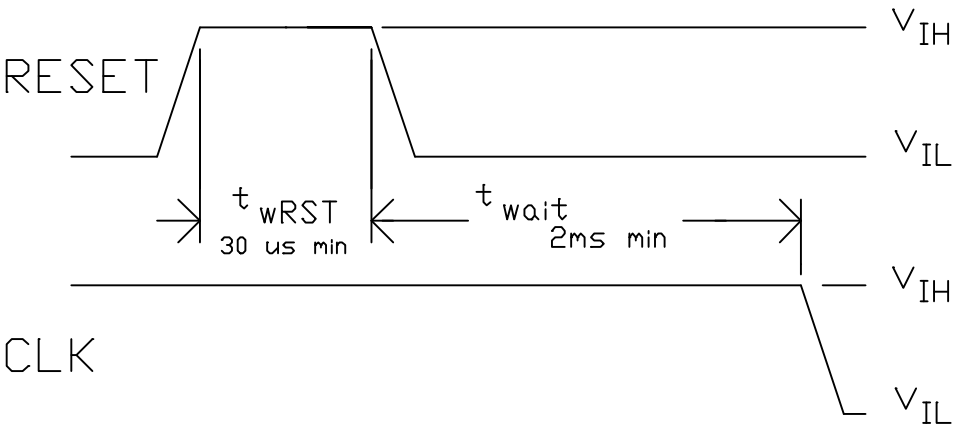


Figure 4. Reset Timing

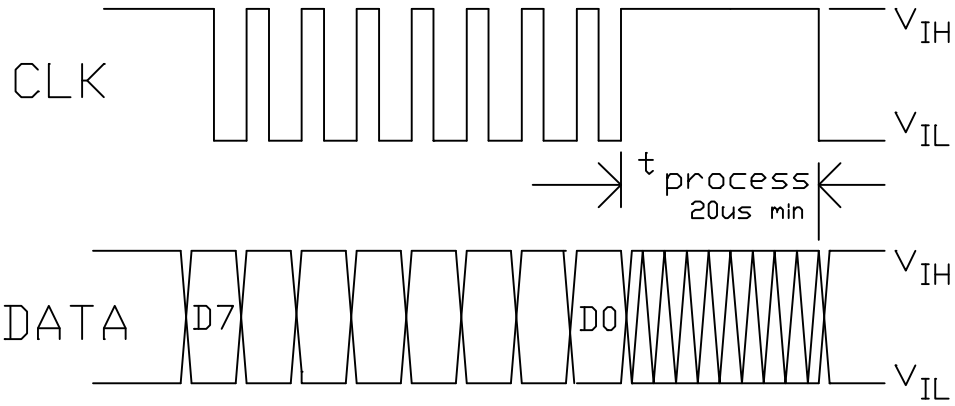


Figure 5. Mode 1 Data Write Timing

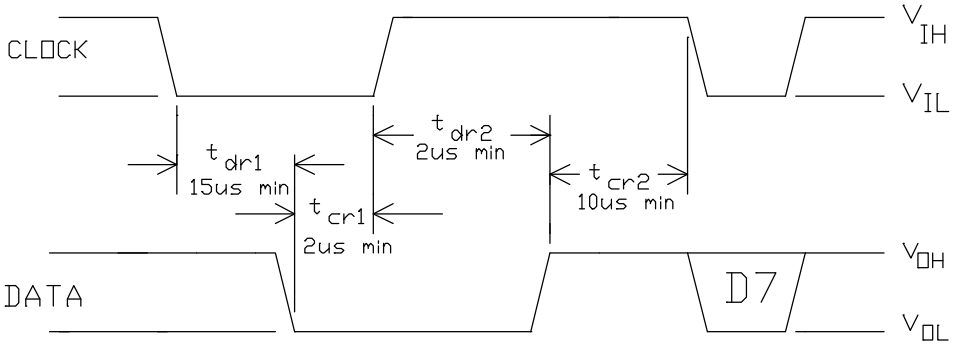


Figure 6. Mode 2 Handshake Timing Before Data Byte

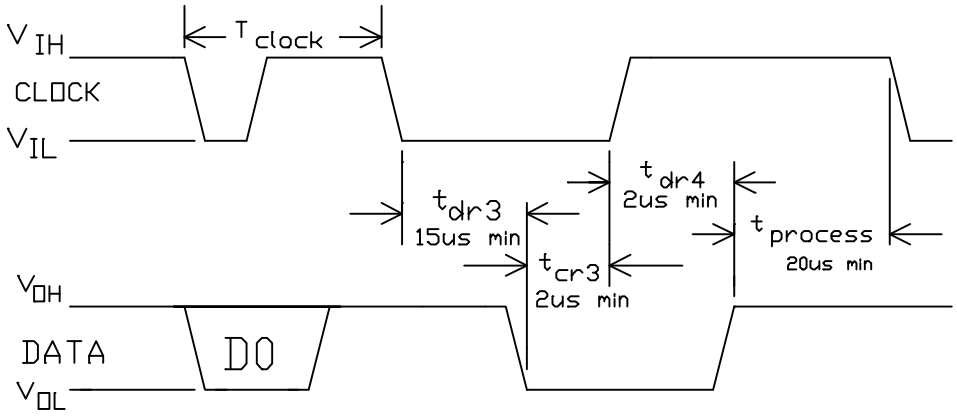


Figure 7. Mode 2 Handshake Timing After Data Byte

3.0 FUNCTIONAL DESCRIPTION

The module accepts character data and control codes, and has a host controlled reset function.

3.1 RESET

The reset input to the microcontroller is accessible at pin 5 of the connector. Module reset timing is shown in Figure 4. At reset, the following commands are performed:

Display buffer cleared
Message buffer cleared
Cursor position set to 1
Cursor mode set to auto-increment
Brightness set to full
I/O mode set to mode 1
Flashing off
Flash rate = 1 Hz
Character font 1
Default user definable characters
Buffered mode 1

3.2 DATA WRITE

Data is written to the module synchronously using the clock input and data signal. There are two modes of operation, Mode 1 and Mode 2. See Figure 3 for a detailed data bit write timing diagram.

3.2.1 MODE 1

In Mode 1, 8 bit data and control codes are written to the module with the MSB first on the high to low transition of the clock. After all 8 bits have been written, the clock must be returned to a high level for a minimum of 20 uS for the controller to process the received data. A detailed timing diagram is shown in Figure 5.

3.2.2 MODE 2

In Mode 2, data is written to the display as in Mode 1 with the exception that a handshake is performed before and after the data is sent to the module. The process is performed as follows. Before data is sent, the host must pull the clock line low. The module responds by pulling the data line low. The host then returns the clock line high and the module returns the data line high. Eight bits of data are then sent as in Mode 1. After the LSB is received, the host pulls the clock line low. The module responds by pulling the data line low. Finally the host sets the clock line high, and the module returns the data line high. Detailed timing diagrams are shown in figures 5, 6, and 7.

3.2.3 CHARACTER CODE

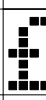
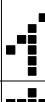
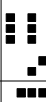
The character codes are shown in the following two tables. Font 1 shows the Western/European character codes. Font 2 shows Katakana. Either font table can be selected by using the select character font command, (See section 3.2.4 for a detailed description of command characters).

FONT 1 (Western / European)

Upper Nibble / Lower Nibble	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
××××0000														
××××0001														
××××0010														
××××0011														
××××0100														
××××0101														
××××0110														
××××0111														
××××1000														
××××1001														
××××1010														
××××1011														
××××1100														
××××1101														
××××1110														
××××1111														

FUTABA CORPORATION OF AMERICA SCHAUMBURG, IL.	PART NUMBER: US162SD03CB	REV: B.1	
	DATE PRINTED: 01/05/98	SHEET: 13 OF 21	

FONT 2 (Katakana)

Upper Nibble / Lower Nibble	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
××××0000														
××××0001														
××××0010														
××××0011														
××××0100														
××××0101														
××××0110														
××××0111														
××××1000														
××××1001														
××××1010														
××××1011														
××××1100														
××××1101														
××××1110														
××××1111														

FUTABA CORPORATION OF AMERICA SCHAUMBURG, IL.	PART NUMBER: US162SD03CB	REV: B.1	
	DATE PRINTED: 01/05/98	SHEET: 14 OF 21	

3.2.4 CONTROL CODE

The module control commands are used to control the display. The command characters are as follows. The details of each command are explained on the following pages. Column 1 represents the hexadecimal number which must be written to execute the command.

(00H) NP : No Operation
(01H) CD : Clear entire display
(02H) SC : Set Cursor Position
(03H) CM : Set Cursor Mode
(04H) SB : Set display brightness level
(05H) IO : Set Input/Output mode
(06H) FP : Set Flash positions
(07H) FM : Flash mode
(08H) FR : Set flash rate
(09H) FO : Select character font
(0AH) DC : Load user defined characters
(0BH) BM : Set buffered mode
(0CH) PB : Print message buffer
(0DH) R : Reserved
(0EH) R : Reserved
(0FH) R : Reserved
(10H) R : Reserved
(11H) R : Reserved
(12H) R : Reserved
(13H) R : Reserved
(14H) R : Reserved
(15H) R : Reserved
(16H) R : Reserved
(17H) R : Reserved
(18H) C1 : Print user definable character 1
(19H) C2 : Print user definable character 2
(1AH) C3 : Print user definable character 3
(1BH) C4 : Print user definable character 4
(1CH) C5 : Print user definable character 5
(1DH) C6 : Print user definable character 6
(1EH) C7 : Print user definable character 7
(1FH) C8 : Print user definable character 8

(00H) NP No operation

Reception of this character will result in a no operation. If the module is looking for a command parameter, the command is set to its default value.

(01H) CD Clear entire display

The display and message buffer are cleared of all characters and the cursor position is set to position 1. Also flashing mode and flashing positions are set to their respective default values.

(02H) SC Set cursor position

The cursor position is set to one of the 32 positions of the display. The position is chosen by sending a parameter byte within the following ranges:

Parameter	Character Position
01H	Top row left most character
10H	Top row right most character
11H	Bottom row left most character
20H	Bottom row right most character

(03H) CM Set cursor mode

The cursor mode determines the cursor position for the next character. Auto increment moves the cursor position to the right after each character write. Auto decrement moves the cursor left after each character write and non increment keeps the cursor position stationary. The cursor position wraps between the 1st and 32nd positions. The mode is chosen by one of the following parameter bytes:

(01H) auto-increment (default)
(02H) auto-decrement
(03H) non-increment

Note that the cursor position is represented by the space next to the last character entered. Changing between modes does not happen immediately. The next character will be written in the present cursor location before the new mode takes effect.

(04H) SB Set brightness

The set brightness command sets the brightness of the entire display to one of 255 levels. It is performed by sending the set brightness command and a parameter byte to determine the brightness level. Brightness ranges are shown below.

(01H) 10% Minimum
(FFH) 100% Maximum (default)

(05H) IO Set I/O mode

The input-output mode determines how the communication between the host and module is performed. Mode 1 is unidirectional from the host to the module. See section 3.21 for a detailed description of Mode 1. Mode 2 is bi-directional, (a handshake is performed before and after data is sent). See section 3.22 for a details on mode 2. The mode is chosen by a parameter byte sent after the command byte. The values are shown below.

(01H) I/O mode 1 (Default)
(02H) I/O mode 2

If the I/O mode is changed, the host must delay 1 ms before its next data write.

(06H) FP Set flash positions

The set flash positions command enables any range of characters to be flashed. The positions are chosen by sending two parameter bytes; a start flash character position and a end flash character position. Different ranges can be chosen and can overlap. Default is all flash positions cleared.

(07H) FM Flash mode

The flash mode is used to enable and disable display flashing. This is performed by sending the flash mode command followed by a parameter byte. The byte values are shown below.

(01H) Disable flashing (Default)
(02H) Enable flashing

(08H) FR Set flash rate

The rate of flash is determined by sending the set flash rate command followed by a parameter byte in the range of 01H to 0FFH. The range of flash rate is shown below.

(01H) 50 Hz
(30H) 1 Hz (Default)
(FFH) 1/10 Hz

(09H) FO Select font

The character font is chosen by sending the select font command followed by the parameter byte.

(01H) Font #1 West/Euro (Default)
(02H) Font #2 Katakana

(0AH) DC Load user definable characters
The user definable characters are loaded by sending the load user definable character command followed by 6 bytes of parameter data.

Byte 2:
Which character is to be loaded. (1 - 8)

Bytes 3-7:
5 bytes of character data where bit zero of each byte is set. See Appendix A for a detailed character map for loading user definable characters.

(0BH) BM (Module buffer mode)
The module has a 32 character input message buffer which can be enabled or disabled through the use of the buffered mode command. When the non-buffered mode is enabled, (Display buffer only), character data is transferred to the display as it is received. When the buffered mode is enabled, incoming characters are stored in a message buffer. The characters are moved to the display by overflowing the message buffer, or the host can perform the Print message buffer command. Note that Flash positions must be set for the message buffer before transferring to the display buffer. After the transfer from the message buffer to the display buffer the message buffer is cleared and the cursor position is set to 1.The modes are chosen by the parameter byte:

(01H) Non-buffered mode (Default)
(02H) Buffered mode

(0CH) PM Print message buffer
The print message buffer command transfers the data from the message buffer to the display buffer. The message buffer is cleared and the cursor is then placed at position 1.

(0DH - 17H) Reserved

(18H) C1 Print user defined character 1
User defined character 1 is printed at the present cursor position.

(19H) C2 Print user defined character 2
User defined character 2 is printed at the present cursor position.

(1AH) C3 Print user defined character 3
User defined character 3 is printed at the present cursor position.

(1BH) C4 Print user defined character 4
User defined character 4 is printed at the present cursor position.

(1CH) C5 Print user defined character 5
User defined character 5 is printed at the present cursor position.

(1DH) C6 Print user defined character 6
User defined character 6 is printed at the present cursor position.

(1EH) C7 Print user defined character 7
User defined character 7 is printed at the present cursor position.

(1FH) C8 Print user defined character 8
User defined character 8 is printed at the present cursor position.

4.0 CONNECTOR INTERFACE

Connector : AMP 104426-3

Pin Number	Function
1	V_{CC}
2	Clock
3	Ground
4	Data
5	Reset

APPENDIX A

UDF Character Bit Map

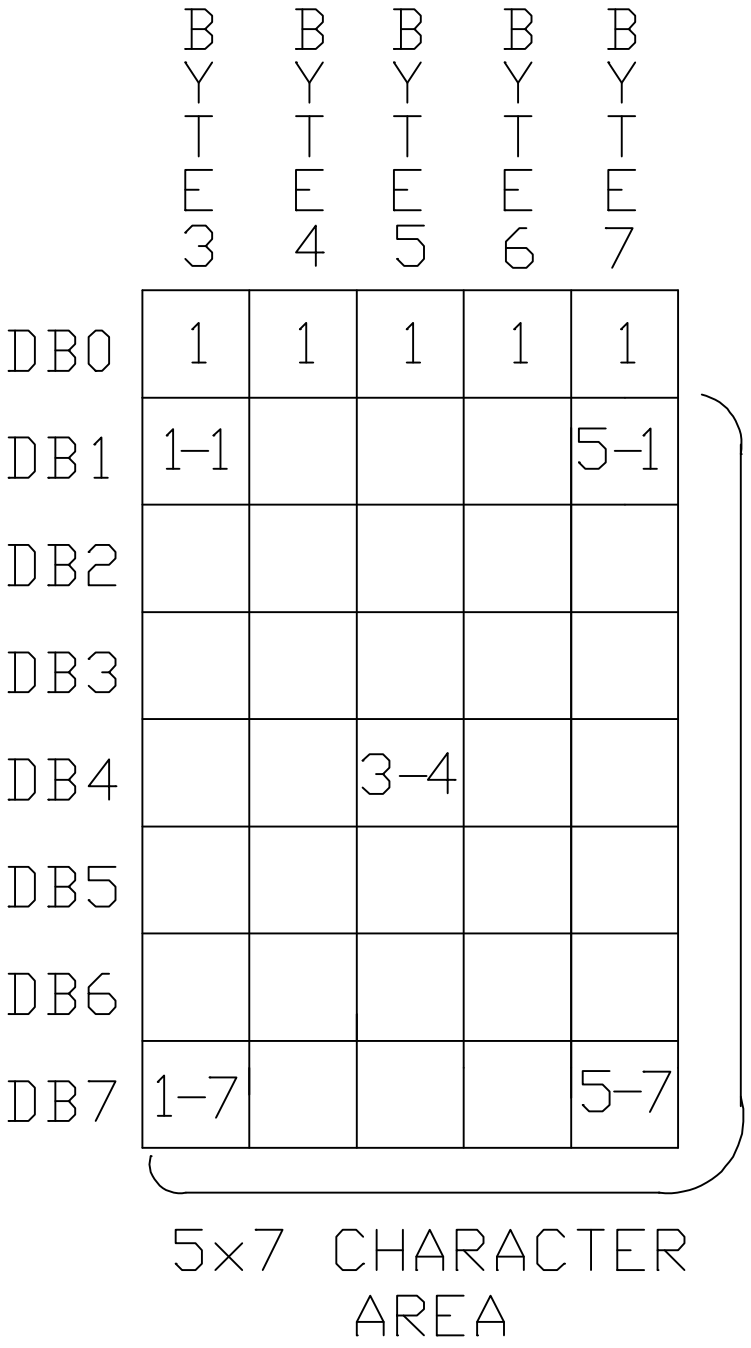


Figure 8. Bit map for user definable characters

***FUTABA* CORPORATION OF AMERICA SCHAUMBURG, IL.**	PART NUMBER: US162SD03CB	REV: B.1	
	DATE PRINTED: 01/05/98	SHEET: 21 OF 21	