REVISION	PAGE	REVISION DESCRIPTION	APPROVAL	DATE
A1.0	All	Created	CEV	21May02
A1.1	7	Deleted section 3.8; external reset timing	CEV	11Jun09
A	All	Released to Production Part Number was NA204SD01CA1 (ECO 10-007)	CEV	17Nov10
B1.0	7 11 All	Section 4.1 GENERAL: Deleted "…or software initialization command (see section 4.4.6)…" Section 4.4.6 INITIALIZATION: Was "The initialization command resets the module as upon power up (see section 4.1)." Part Number was NA204SD01CA (ECO 11-006)	CEV	27Apr11
B	All	Released to Production Part Number was NA204SD01CB1 (ECO 11-008)	CEV	25May11
C	All	Part Number was NA204SD01CB (ECO 13-001)	CEV	12Mar13

Futaba®

Futaba Corporation of America
Schaumburg, IL

DRAWING TITLE:
PRODUCT SPECIFICATION

PART NUMBER:
NA204SD01CC

DESIGNED BY:	QUALITY ASSURANCE APPROVAL:	CUSTOMER NAME / PART NUMBER:	
John Kan	Dean Sharpe	STANDARD PRODUCT	
CHECKED BY:	SYSTEMS ENGINEERING APPROVAL:	FILE NAME:	
John Hohmeier	Charles Voegeli	NA204SD01CC_revC_12Mar2013.doc	
CUSTOMER APPROVAL:	DIRECTOR OF ENGINEERING APPROVAL:	DATE PRINTED:	SHEET:
N / A	Gary R. Wires	03/12/13	1 OF 14

1.0 INTRODUCTION

This module consists of an 80-character VFD (4 rows of 20 characters), driver circuitry, bus interface, DC/DC-AC converter and character generator. Communication with the module is via an 8-bit parallel data bus with chip-select, write, and busy control lines, or via asynchronous serial communications (19200BPS, 8 data bits, even parity, one stop bit) with a busy handshake.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this product specification:

Futaba America Engineering Standard FAES 801, Printed Circuit Board Markings

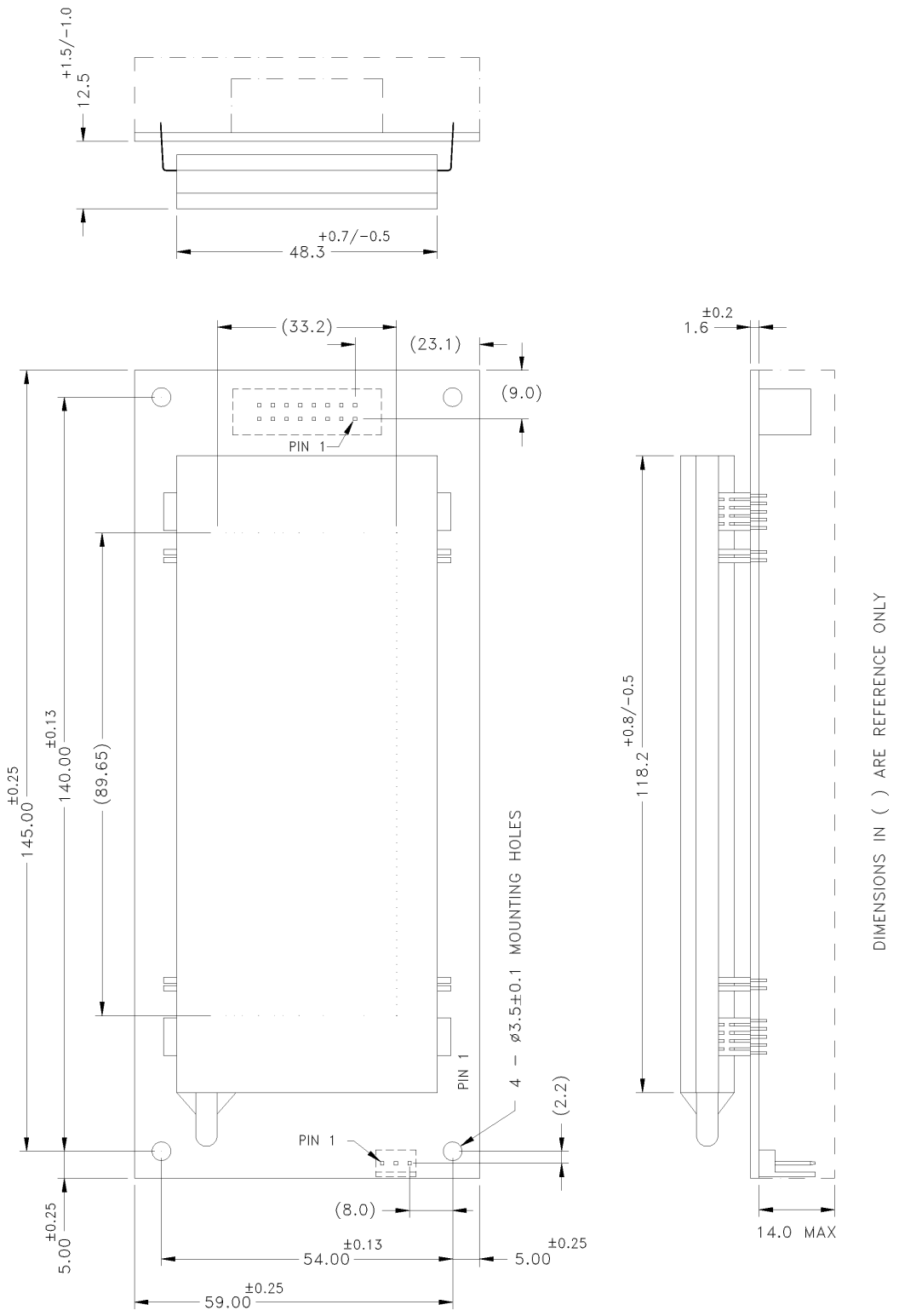
Futaba Vacuum Fluorescent Display Specification Number 204-SD-01GY

3.0 SPECIFICATIONS

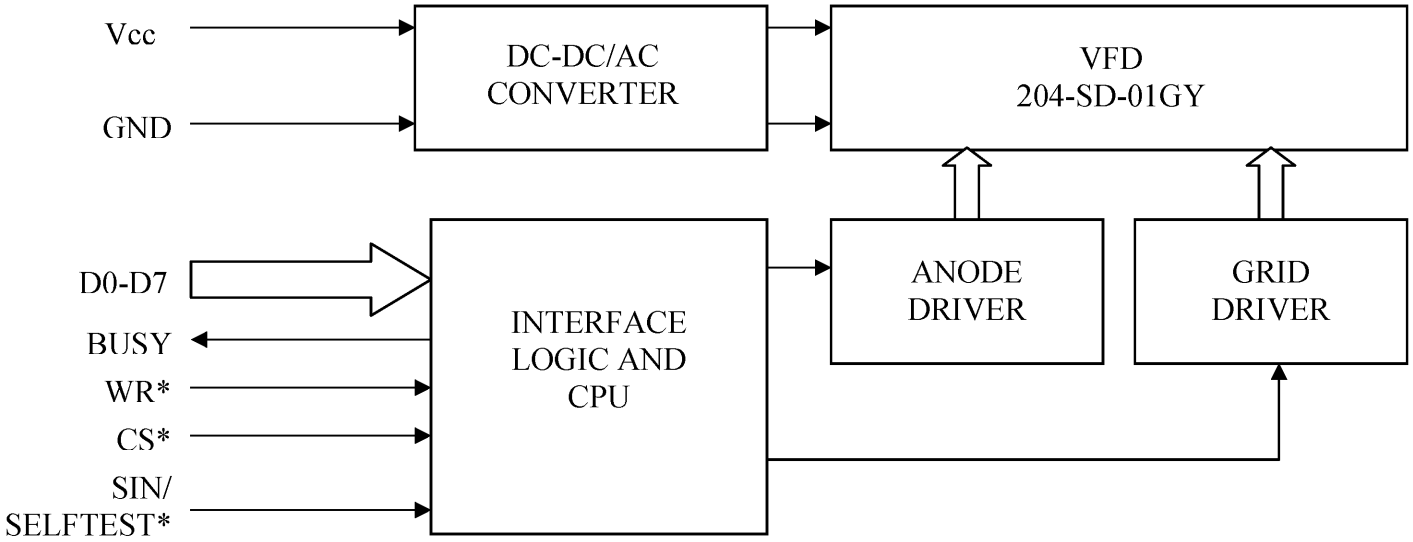
3.1 GENERAL SPECIFICATIONS

Item	Value
Number of Characters	4 Rows x 20 Characters
Character Configuration	5x7 Dot Matrix w/Cursor
Character Height	5.0 mm
Character Width	3.2 mm
Character Pitch	4.55 mm
Peak Wavelength of Illumination	Green (505 nm)
Luminance	204 fL typ.

3.2 MECHANICAL DRAWING



3.3 SYSTEM BLOCK DIAGRAM



3.4 ENVIRONMENTAL SPECIFICATIONS

Item	Symbol	Min	Max	Unit
Operating Temperature	T_{opr}	-40	+85	°C
Storage Temperature	T_{stg}	-40	+85	°C
Relative Humidity (operating) (note 3)	H_{opr}	10	90	%
Vibration (note 1)	-	-	4	G
Shock (note 2)	-	-	40	G

Notes:
1. Amplitude: 1.5mm; Frequency: 10 - 55 Hz; Sweep time: 1 min/cycle; Time: 2 hours/axis (x,y,z).
2. Duration: 11ms; half sine wave; 3 times each (x,y,z).
3. Without condensation.

3.5 ABSOLUTE MAXIMUM ELECTRICAL RATINGS

Item	Symbol	Min	Max	Unit
Power Supply Voltage	V_{CC}	0.0	6.5	V
Output Signal Voltage	V_{out}	0.0	V_{CC}	V
Input Signal Voltage	V_{in}	0.0	5.5	V

3.6 RECOMMENDED OPERATING CONDITIONS

Item	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V_{CC}	4.75	5.0	5.25	V
Power Supply Current (note 1)	I_{CC}	-	0.65	1.0	A
High Level Input Voltage	V_{IH}	2.0	-	-	V
Input Current	I_{IN}	-	-	±10.0	uA
Low Level Input Voltage	V_{IL}	-	-	0.8	V
Low Level Input Current (V_{IL}=0.2V, note 2)	I_{IL}	-	-	-0.54	mA
Low Level Output Voltage (I_{OL}=4mA)	V_{OL}	-	-	0.33	V
High Level Output voltage (I_{OH}=-4mA)	V_{OH}	3.84	-	-	V

Notes:

1. A surge current of up to 2 times maximum input current can occur upon power up. The peak surge current amplitude and duration are dependent on the host power supply characteristics.
2. Each input has a pull-up resistor to V_{CC} of 10kΩ.

3.7 COMMUNICATION INTERFACE SPECIFICATIONS

(See figures 1 & 2)

Item	Symbol	Min	Max	Unit
DATA set up time	t_{suDATA}	37	-	ns
DATA hold time	t_{hDATA}	60	-	ns
CS* set up time	t_{suCS}	0	-	ns
CS* hold time	t_{hCS}	0	-	ns
WR* pulse width time	t_{wWR}	30	-	ns
BUSY TO CS* delay	$t_{wBUSY-CS}$	0	-	ns
WR* to BUSY delay	$t_{wWR-BUSY}$	-	135	ns
Stop Bit to BUSY delay	t_d	0	900	us

The BUSY pulse width (t_{wBUSY}) is dependent upon the data written to the module. The following table lists the BUSY time during the quick write mode. BUSY time during the flickerless mode of operation will be from 2 to 15 times that of the quick write mode.

DATA		t_{wBUSY} (MAX)	
		DC1 MODE	DC2 MODE
Character data, HT, and LF		200us	1000us
BS, FF, CR, CT0, CT1, DC1, DC2, DC4, DC5, DC6, and DC7		200us	
CLR		900us	
ESC	1st BYTE	200us	
	2nd BYTE (except 'I')	200us	
	2nd BYTE = 'I'	1400us	
	3rd - 8th BYTES	200us / BYTE	

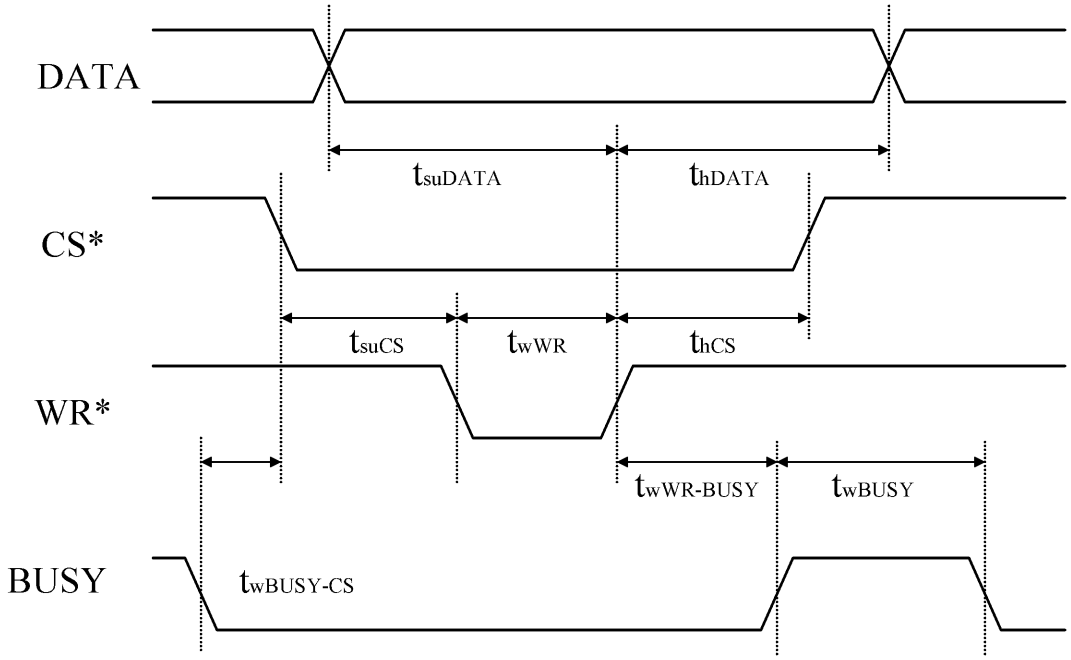


Figure 1. Parallel Interface

The serial interface supports asynchronous serial communication comprised of one start bit, 8 data bits, even parity, and one stop bit at 19200 bits per second (see figure 4). Data is transmitted least significant bit first.

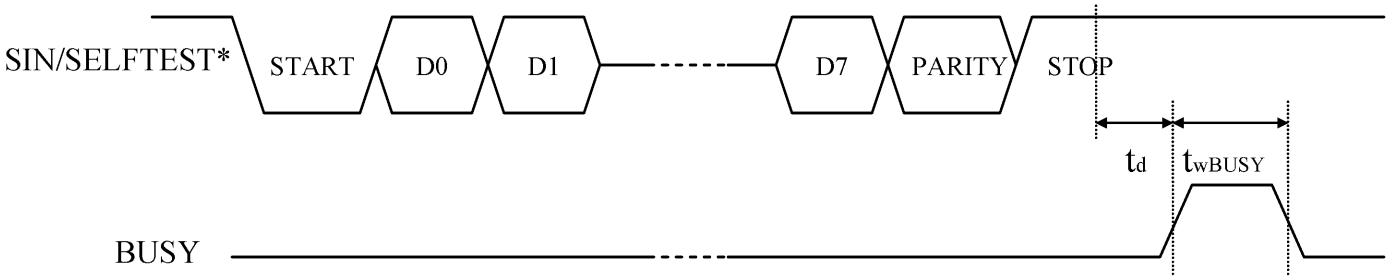


Figure 2. Serial Interface

4.0 FUNCTIONAL DESCRIPTION

4.1 GENERAL

Upon power up, the module resets to the following state:

Display cleared
Cursor set to position 1 (left most character) of row 1
Display mode set to character overwrite (DC1) and invisible cursor (DC4)
Brightness set to 100%
Blink speed set to 14H
Character table 0 selected (CT0)
Quick write mode selected.

Data is written to the module in either parallel or serial format. Data should only be sent to the module while the BUSY signal is low. In parallel format, data is written to the module on the rising edge of the WR* pulse while CS* is low. The module sets the BUSY line after data is latched and clears the line after the data is processed. In serial format, data is written to the module least significant bit (LSB) first. The module sets the BUSY line after the stop bit is sent and clears the line after the data is processed. The length of time that the busy line is set depends upon the data that is sent. Refer to section 3.7 for specific bus timing.

Since the module is in quick write mode upon power up there may be times when the display flickers during high-speed data transmission. This is because in the quick write mode the communications have the highest priority resulting in a minimum busy signal. This flicker can be avoided by selecting the flickerless mode of operation (see section 4.4.4).

4.2 CHARACTER DATA

Standard character data is from 20H to FFH (see section 7.0). User defined characters can exist at any location from 00H to FFH. Writing data from 20H to FFH or a user-defined character will result in the corresponding character being displayed at the current cursor position. The horizontal tab command (see section 4.3.2) is then executed.

4.3 COMMAND DATA

Command data is in the range of 00H to 1FH.

4.3.1 BS: BACKSPACE (08H)

The cursor position is moved one position to the left. At the left most character position of rows 2 - 4 the cursor will move to the right most character position of the row above it. At the left most character position of row 1 the cursor will not move.

4.3.2 HT: HORIZONTAL TAB (09H)

The cursor position is shifted to the right one position. At the right end of a row the cursor moves to the left end of the next lower row. At the right end of the bottom row the cursor movement depends upon DC1 and DC2 modes as follows:

DC1 Mode:
The cursor moves from the right end of the bottom row to the left end of the top row.

DC2 Mode:
The contents of the each row are shifted up one row. Data in the first row is lost. The bottom row is cleared and the cursor is placed at the left most position of the bottom row.

4.3.3 LF: LINE FEED (0AH)

The cursor is shifted to the same column position of the next lower row. At the bottom row movement depends upon DC1 or DC2 modes.

DC1 Mode:
The cursor moves to the same column position of the top row.

DC2 Mode:
The contents of the each row are shifted up one row. Data in the first row is lost. The bottom row is cleared and the cursor remains at the same position.

4.3.4 FF: FORM FEED (0CH)

The cursor moves to the left end of the top row.

4.3.5 CR: CARRIAGE RETURN (0DH)

The cursor position is placed at the left most position of the same row.

4.3.6 CLR: CLEAR (0EH)

All characters are cleared. The cursor does not move.

4.3.7 DC1: DEVICE CONTROL 1 (11H) (DEFAULT)

Character overwrite mode for character data, horizontal tab (HT) or line feed (LF) commands.

4.3.8 DC2: DEVICE CONTROL 2 (12H)

Display scroll mode for character data, horizontal tab (HT) or line feed (LF) commands.

4.3.9 DC4: DEVICE CONTROL 4 (14H) (DEFAULT)

Invisible cursor.

4.3.10 DC5: DEVICE CONTROL 5 (15H)

Blinking cursor. The blink rate is controlled by the blink speed control command (see section 4.4.5)

4.3.11 DC6: DEVICE CONTROL 6 (16H)

Invisible cursor.

4.3.12 DC7: DEVICE CONTROL 7 (17H)

Invisible cursor.

4.3.13 CT0: CHARACTER TABLE 0 (18H) (DEFAULT)

Selects English/International character table.

4.3.14 CT1: CHARACTER TABLE 1 (19H)

Selects the English/Katakana character table.

4.4 ESCAPE COMMANDS

The following commands are executed by first writing the escape character (1BH) followed by one or more bytes.

4.4.1 USER DEFINABLE CHARACTER (1BH + 43H + CHR + B4 + B5 + B6 + B7 + B8)

Two user definable characters (UDC) are available. Any 5x7 pattern of pixels can be stored at the character location identified by CHR, which can be any value from 00H to FFH. Assignment of a UDC to a specific character code will cause that character or function to be replaced with the UDC. Only two UDCs can be defined at one time. Defining additional UDCs will cause the oldest UDC to revert back to its original character or function. If the escape command (1BH) is redefined power must be removed to restore the function. Bytes 4 through 8 (B4 ... B8) specify the specific UDC according to figure 4. Setting a bit = 1 turns on the pixel while setting the bit = 0 leaves it off (* = do not care).

UDC Example: Define a UDC at location A2H, the UDC is a dash (-). The pixels that need to be turned on are P16 - P20. The command sequence is:

1BH + 43H + A2H + 00H + 80H + 0FH + 00H + 00H.

COMMAND BYTES 4 - 8								
BYTES	BIT POSITION							
	7	6	5	4	3	2	1	0
4th	P8	P7	P6	P5	P4	P3	P2	P1
5th	P16	P15	P14	P13	P12	P11	P10	P9
6th	P24	P23	P22	P21	P20	P19	P18	P17
7th	P32	P31	P30	P29	P28	P27	P26	P25
8th	X	X	X	X	X	P35	P34	P33

5X7 PIXEL MAP				
P1	P2	P3	P4	P5
P6	P7	P8	P9	P10
P11	P12	P13	P14	P15
P16	P17	P18	P19	P20
P21	P22	P23	P24	P25
P26	P27	P28	P29	P30
P31	P32	P33	P34	P35

Figure 4. User Definable Character Map

4.4.2 MOVE CURSOR (1BH + 48H + DATA)

The cursor position can be set to any display position by sending escape (1BH), move cursor command (48H), and then a parameter byte identifying a specific cursor location according to the following chart:

Col. / Row	1	2	3	4	- - -	20
1	00H	01H	02H	03H	- - -	13H
2	14H	15H	16H	17H	- - -	27H
3	28H	29H	2AH	2BH	- - -	3BH
4	3CH	3DH	3EH	3FH	- - -	4FH

DATA values of 50H to FFH are invalid and do not cause the cursor to move.

4.4.3 LUMINANCE CONTROL (1BH + 4CH + DATA)

Display luminance can be set to one of the following four levels by sending escape (1BH), luminance control command (4CH), and then a luminance byte.

DATA	LUMINANCE
00H to 3FH	25%
40H to 7FH	50%
80H to BFH	75%
C0H to FFH	100% (Default)

4.4.4 FLICKERLESS MODE (1BH + 53H)

Flickerless mode is selected by sending 1BH + 53H. Flickerless mode makes updating the display the highest priority of the module and as such will extend the busy time for many commands. Serial communication cannot be used in the flickerless mode. Once flickerless mode is selected, the module must be powered down or sent a software initialization command (see section 4.4.6) to reenter the quick write mode.

4.4.5 BLINK SPEED CONTROL (1BH + 54H + DATA)

The blinking speed of the cursor (an all on character) can be controlled in 30ms increments. The period of the blinking cursor equals the multiplying value (represented by DATA) times 30ms.

DATA	Multiplying value
00H	256
01H	1
02H	2
…	…
FFH	255

The power up default blink speed value (DATA) is 14H.

4.4.6 INITIALIZATION (1BH + 49H)

The initialization command performs the following:

Clears Display and UDC Memory
Sets Cursor to position 1 (left most character) of row 1
Sets Display Modes to character overwrite (DC1) and invisible cursor (DC4)
Sets Brightness to 100%
Stops Blinking and sets Blink Speed to 14H
Selects Character table 0 (CT0)

5.0 TEST MODE

The test mode can be entered by holding the SIN/SELFTEST* pin low for more than 100ms at power up or during software initialization. See section 3.8 for more information about the power up reset timing. During the test mode all characters of character table 0 are sequentially displayed and no communication data will be accepted. The mode is exited by disconnecting power from the module.

6.0 CONNECTOR INTERFACES

6.1 J1 CONNECTOR INTERFACE

(3M P/N: 2516-6002UB)

PIN	SYMBOL	PIN	SYMBOL
1	D7	2	D6
3	D5	4	D4
5	D3	6	D2
7	D1	8	D0
9	WR*	10	CS*
11	SIN/SELFTEST*	12	BUSY
13	GND	14	GND
15	VCC	16	VCC

6.2 J2 CONNECTOR INTERFACE

(AMP P/N: 171825-3)

PIN	SYMBOL
1	VCC
2	SIN/SELFTEST*
3	GND

7.0 JUMPER CONFIGURATION

The bus mode selection jumpers are located on the component side of the PCB. Solder a jumper at JP1 for single module mode or at JP2 to select multiple module mode. The module is initially configured for single module bus mode operation. Contact Futaba for initial setup of multiple bus mode.

8.0 CHARACTER TABLES

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

8.1 CHARACTER TABLE 0

LSB: D3-D0 \ MSB: D7-D4	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000																
0001		DC1														
0010		DC2														
0011																
0100		DC4														
0101		DC5														
0110		DC6														
0111		DC7														
1000	BS	CT0														
1001	HT	CT1														
1010	LF															
1011		ESC														
1100	FF															
1101	CR															
1110	CLR															
1111																

8.2 CHARACTER TABLE 1

MSB: D7-D4 / LSB: D3-D0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000																
0001		DC1															
0010		DC2															
0011																	
0100		DC4															
0101		DC5															
0110		DC6															
0111		DC7															
1000	BS	CT0														
1001	HT	CT1														
1010	LF															
1011		ESC														
1100	FF															
1101	CR															
1110	CLR															
1111																