1.0 GENERAL DESCRIPTION

This series of graphical 140 x 32 dot matrix Vacuum Fluorescent Display (VFD) modules are capable of displaying both graphics and text. The modules contain the VFD driver circuitry, microcontroller with built-in font tables, DC-DC converter, and serial and/or parallel interfaces.

1.1 INTERFACE OPTIONS

NAGP1250AB/BB-0: parallel and/or RS-232 level asynchronous serial communicationNAGP1250AB/BB-2: parallel and/or synchronous or asynchronous CMOS level serial communicationNAGP1250AB/BB-3: synchronous or asynchronous CMOS level serial communication

1.2 FEATURES

- 5VDC operation
- -40°C to +85°C operation
- 1000 cd/m² luminance and wide viewing angles
- Display both graphics and text simultaneously
- Fixed and proportional fonts for smoother character spacing
- 14 international font sets
- 8 levels of luminance control from 12.5% to 100%
- Screen saver modes to reduce power consumption and to reduce image burn-in
- 4 User Windows in addition to the Base Window for quicker image updates
- Variable speed scrolling
- Choice of serial and/or parallel interfaces (input buffer shared when using 2 interfaces at once)

1.2.1 NEW FEATURES ADDED

- Increased size of Extended Memory from 116 to 140 columns allowing page swapping
- Increased number of user defined characters from 16 to 224 allowing an entire font table to be defined
- Increased user defined characters size from 5x7 to 5x8 allowing descenders (g, j, p, q, y)
- Added 3X and 4X vertical font magnification allowing up to 4X x 4X characters
- Added a 255 byte input buffer for increased communication speeds

2.0 APPLICABLE DOCUMENTS

- Futaba Vacuum Fluorescent Display Specification GP1250AI
- Futaba America Engineering Standard FAES 801, Printed Circuit Board Markings

	PART NUMBER:	REVISION:			
Futaba®	NAGP1250AB-x/BB-x	B.1			
	DATE PRINTED:	SHEET:			
Futaba Corporation of America Schaumburg, IL	17Oct12	1 OF 45			

3.0 GENERAL SPECIFICATIONS

Item	Value	Unit
Number of dots	140 columns x 32 rows	-
Dot height	0.57	mm
Dot width	0.4	mm
Dot pitch vertical	0.67	mm
Dot pitch horizontal	0.5	mm
Pattern width	69.9	mm
Pattern height	21.34	mm
Peak wavelength of illumination	x = 0.24, y = 0.41 (green)	-
Luminance	500 (min.) – 1000 (typ.)	Cd/m ²

4.0 SYSTEM BLOCK DIAGRAM





5.1 NAGP1250BB-X MECHANICAL DRAWING



6.0 SPECIFICATIONS

6.1 ENVIRONMENTAL SPECIFICATIONS

Item	Symbol	Min.	Max.	Unit	Comment
Operating temperature	Topr	-40	+85	°C	
Storage temperature	Tstg	-40	+85	°C	
Operating humidity	Hopr	_	85	%RH	without condensation
Storage humidity	Hstg	_	90	%RH	without condensation
Vibration (non-operating)	_	_	4	G	total amplitude: 1.5mm freq: 10 ~ 55 Hz sine wave sweep time: 1 min / cycle duration: 2 hrs / axis (X, Y, Z)
Shock (non-operating)	_	_	40	G	duration: 11ms waveform: half sine wave 3 times / axis (X, Y, Z, -X, -Y, -Z)

6.2 MISCELLANEOUS SPECIFICATIONS

6.2.1 MTBF SPECIFICATIONS

Design target of greater than 425,000 hours.

6.2.2 ROHS COMPLIANCE SPECIFICATIONS

RoHS 6 of 6 compliant.

6.3 ABSOLUTE MAXIMUM ELECTRICAL SPECIFICATIONS

Item	Symbol	Min.	Max.	Unit
Supply voltage	V _{CC}	-0.3	6.0	V
Input signal voltage D0-D7, /WR, /RD, /RESET, SIN _{-2,3} , SCK _{-2,3}	V _{IS}	-0.3	V _{CC} +.03	V
Input signal voltage SIN ₋₀	V _{IS}	-20	+20	V

Futaba Corporation of America Schaumburg, ILNAGP1250AB-x/BB-xB.1Date PRINTED:SHEET: 5 OF 45		PART NUMBER:	REVISION:
Futaba Corporation of AmericaDate PRINTED:SHEET:Schaumburg, IL17Oct125 OF 45	Futada ®	NAGP1250AB-x/BB-x	B.1
Schaumburg, IL 170ct12 5 OF 45	Eutobe Componetion of Imenias	DATE PRINTED:	SHEET:
	Schaumburg, IL	170ct12	5 OF 45

6.4 NORMAL ELECTRICAL SPECIFICATIONS

$V_{CC} =$	5.0	V4	10 to	+85	°C
, UU	~··	• •		100	\sim

Item	Symbol	Min.	Тур.	Max.	Unit
Supply voltage	V _{CC}	4.75	5.0	5.25	V
Supply current (all dots on)	I _{CC}	_	400	520	mA
Supply current (all dots off)	I _{CC}	_	330	430	mA
Supply current (screen saver – power supply off)	I _{CC}	_	35	45	mA
High level input signal voltage: D0-D7, /WR, /RD, /RESET, SIN _{-2,3} ,	V _{IH}	0.7 * V _{CC}	_	V _{CC}	V
Low level input signal voltage: D0-D7, /WR, /RD, /RESET, SIN _{-2,3}	V _{IL}	0.0	_	0.3 * V _{CC}	V
High level input signal voltage: SCK _{-2,3}		$0.8 * V_{CC}$	_	V _{CC}	V
Low level input signal voltage: SCK _{-2,3}		0.0	_	$0.2 * V_{CC}$	V
High level input signal voltage: SIN ₋₀	V _{IH}	3.0	_	15.0	V
Low level input signal voltage: SIN ₋₀	V _{IL}	-15.0	_	0.5	V
High level output signal voltage: PBUSY		$V_{CC}-0.1$	_	_	
Low level output signal voltage: PBUSY		_	_	0.1	
High level output signal voltage: SBUSY _{-2,3} (Note 2)	V _{OH}	4.0	_	5.0	V
Low level output signal voltage: SBUSY _{-2,3} (Note 2)	V _{OL}	0.0	_	0.6	V

Notes:

1) A 50uS surge current of up to 10X I_{CC} can occur at power-up on V_{CC} . However, the exact peak amplitude and duration of surge current is dependent on the characteristics of the host power supply.

2) $R_{LOAD} = 3K\Omega$ to GND

6.5 RESET TIMING SPECIFICATIONS

The module is reset automatically at power-up or by an external /RESET pulse. The module initializes to the same conditions as after the Initialize Display command, plus the input buffer is cleared.

Item	Symbol	Min.	Тур.	Max.	Unit
Delay from power-up or reset to DC/DC on	t _{DC/DC}	-	25	-	ms
Delay from power-up or reset to filament on	t _{FIL}	-	25	-	ms
Delay from power-up or reset to busy	t _{DELAY}	-	-	2	μs
/RESET low time	t _{REL}	2.5	-	-	μs
Busy time during initialization	t _{BUSY}	-	-	50	ms
Wait time before command byte	t _{WAIT}	0	-	S	ms

Notes:

1) All timing is specified using 20% and 80% of V_{CC} as the reference points.

6.6 SERIAL INTERFACE SPECIFICATIONS

Three serial interface options are available in the NAGP1250xx-x module series; CMOS level synchronous, CMOS level asynchronous and RS-232 level asynchronous. The options and baud rates are selected by module part number and jumper settings.

A 255 byte input buffer allows data to be sent to the module without monitoring the SBUSY output. However, the buffer may overflow if too many commands with long execution times are sent without waiting for them to execute. The SBUSY outputs an ACK pulse after each byte is received and remains active if the buffer is almost full indicating a busy condition. SBUSY remains active when the buffer can hold 16 or less additional bytes, this allows a host's 16 byte transmit buffer to be flushed without overflowing the input buffer.

Item	Symbol	Min.	Тур.	Max.	Unit		
SCK frequency	1 / t _{SCK}	-	-	2.45	MHz		
SCK low time	t _{SCKL}	163	-	-	ns		
SCK high time	t _{SCKH}	163	-	-	ns		
SIN setup time	t _{DS}	50	-	-	ns		
SIN hold time	t _{DH}	50	-	-	ns		
Delay time before SBUSY ACK pulse (Note 2)	t _{DELAY}	-	-	60	μs		
SBUSY ACK pulse width	t _{ACK}	2.5	4.0	10.5	μs		
Command execution time	t _{EXEC.} .	See Command and Characters Section					
Wait time before next command byte (Note 2)	t _{WAIT}	0		-	S		

Notes:

- 1) All timing is specified using 20% and 80% of V_{CC} as the reference points.
- 2) Up to 20Khz data rate can be achieved by monitoring SBUSY in synchronous mode, data rate is limited by the baud rate in asynchronous mode.

RS-232 level asynchronous serial interface NAGP1250xx-0 (J2 open)

Asynchronous Parameter	Value
Baud rate	9600, 19200, 38400, 115200
Parity	no parity
Format	start $(1 \text{ bit}) + \text{data} (8 \text{ bits}) + \text{stop} (1 \text{ bit})$
Handshake	SBUSY

6.7 PARALLEL INTERFACE SPECIFICATIONS

The parallel interface option is available on NAGP1250xx-0 and NAGP1250xx-2 modules. The parallel interface consists of an 8-bit data bus and /WR and /RD control inputs. Only bit D7 is bi-directional and is used to monitor the PBUSY output. PBUSY can also be read directly from a separate pin when jumper JB is shorted.

A 255 byte input buffer allows data to be sent to the module without monitoring the PBUSY output. However, the buffer may overflow if too many commands with long execution times are sent without waiting for them to execute. The PBUSY output goes high when data is latched in hardware by the rising edge of /WR, and goes low when data is read from the latch by the module software unless the buffer is almost full. PBUSY remains active when the buffer can only hold 16 or less additional bytes, indicating a busy condition, this allows a host's 16 byte transmit buffer to be flushed without overflowing the input buffer.

Item	Symbol	Min.	Max.	Unit
/WR low time	t _{/WRL}	5	-	ns
/WR high time	t _{/WRH}	5	-	ns
Data setup time	t _{DS}	3	-	ns
Data hold time	t _{DH}	2	-	ns
Delay time before PBUSY high (Note 2)	t _{DELAY}	-	15	ns
D7 tri-state setup time	t _{TRIS}	0		S
Delay time after /RD low to PBUSY on D7	t _{D7H}		5.8	ns
Delay time after /RD high to D7 an input	t _{D7T}		5.0	ns
ACK pulse width	t _{ACK}	2.5	60	μs
Command execution time	t _{EXEC.} .	See Comma	and and Charac	ters Section
Wait time before next command byte (Note 2)	t _{WAIT}	0	-	S

Notes:

1) All timing is specified using 20% and 80% of V_{CC} as the reference points.

2) Up to 20Khz data rate can be achieved by monitoring SBUSY in synchronous mode, data rate is limited by the baud rate in asynchronous mode.

6.8 DISPLAY MEMORY

The Display Memory consists of 280x4 vertical bytes (280x32 bits) with each byte addressed by an X and Y pointer. The Display Memory is divided into 2 areas, the Standard Memory area (0,0 to 139,3) and the Extended Memory area (140,0 to 279,3).

Display Memory is 280x4 bytes (280x32 bits)

Pixel data stored in the Standard Memory area is displayed on the VFD. Pixel data stored in the Extended Memory area can be displayed by scrolling it into Standard Memory area using the Display Memory Scroll command. For example, scrolling Display Memory data by 140 columns (560 bytes) would instantly change the displayed image to the pixel data that was in the Extended Memory area, i.e. "page swap". When scrolling pixel data from the Extended Memory area into the Standard Memory area, Standard Memory area data is scrolled back into the other end of the Extended Memory area (no data is lost).

6.9 WINDOWS

In addition to the Base Window, four User Windows can be defined anywhere in the Display Memory area (this includes the Extended Memory) and can overlap one another. Each window supports independent control and can be selected anytime.

6.9.1 BASE WINDOW

The Base Window (Window 0) is located either in the entire Standard Memory area between X,Y location 0,0 (upper left corner) and 139,3 (lower right corner), in the entire Extended Memory area between 140,0 and 279,3, or in the entire Display Memory area between 0,0 and 279,3.

6.9.2 USER WINDOWS

Each User Window (Window 1 to 4) is defined separately with an upper left corner and size anywhere within the Display Memory. User Windows can be re-defined anytime without affecting data stored in the Display Memory.

6.10 COMMANDS AND CHARACTERS

Commands are sent to the module in single-byte or multi-byte command packets and characters are sent to the module as single-byte packets. Command codes range from 00h to 1Fh and character codes from 20h to FFh.

Command Packet Byte 1 Comma									Command Packet Byte 2							Command Packet Byte N															
8-bit 8-bit									bit				8-bit						8-bit												
	Command Comma								nd Data				Command Data					Command Data													
C7	C6	C5	C4	C3	C2	C1	C0	D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0	D7	D6	D5	D4	D3	D2	D1	D0

8-bit Command:

CMD Code	Description	Execution Time
08h	Backspace	n/a (execution time is less than 50us)
09h	Horizontal Tab	n/a to 6.2ms depending on size, mode, and cursor position
0Ah	Line Feed	n/a (MD1 and MD3), n/a to 5.9ms (MD2)
0Bh	Home Position	n/a
0Ch	Clear Window	2.6ms (base), 96us to 4.4ms (user), 1.75ms (all memory)
0Dh	Carriage Return	n/a
10h	Select Window 0	n/a
11h	Select Window 1	n/a
12h	Select Window 2	n/a
13h	Select Window 3	n/a
14h	Select Window 4	n/a
1Bh + 25h	Select UDF Character Set	n/a
1Bh + 26h	Define UDF Character Set Characters	135us (End Character Code Byte), all others n/a
1Bh + 3Fh	Delete UDF Character Set Character	128us (single UDF character), 356us (all UDF characters)
1Bh + 40h	Initialize Display	2.11ms (when power supply is on), 256ms (when PS is off)
1Bh + 52h	Select Font Set (20h through 7Fh)	n/a
1Bh + 74h	Select Font Set (80h through FFh)	n/a
1Fh + 01h	Select Overwrite Mode (MD1)	n/a
1Fh + 02h	Select Vertical Scroll Mode (MD2)	n/a
1Fh + 03h	Select Horizontal Scroll Mode (MD3)	n/a
1Fh + 24h	Set Cursor Position	n/a
1Fh + 28h + 61h + 01h	Wait	0 to 127.5 seconds
1Fh + 28h + 61h + 10h	Display Memory Scroll	0 to 65 hours
1Fh + 28h + 61h + 11h	Display Blink	28ms to 30 minutes
1Fh + 28h + 61h + 40h	Screen Saver	n/a
1Fh + 28h + 66h + 11h	Graphic Image	n/a
1Fh + 28h + 67h + 03h	Select Character Width / Character Spacing	n/a
1Fh + 28h + 67h + 40h	Font Magnification	n/a
1Fh + 28h + 77h + 01h	Select Window	n/a
1Fh + 28h + 77h + 02h	Define User Window (Windows 1 to 4)	n/a
1Fh + 28h + 77h + 10h	Define Base Window (Window 0)	n/a
1Fh + 43h	Cursor On / Off	n/a
1Fh + 58h	Select Luminance Level	n/a
1Fh + 72h	Reverse Video Write Mode Enable / Disable	n/a
1Fh + 73h	Set Horizontal Scroll Speed	n/a
1Fh + 77h	Select Write Logic Mode	n/a
20h to FFh	Write Character	170us to 6.2ms depending on size, mode, and cursor position

Note: The module's 255 byte input buffer coupled with the maximum byte input rate of 20KHz (50us) in parallel and synchronous serial modes or 115,200 baud (87us) in asynchronous serial mode allow most commands to be sent without monitoring the Busy output. The Busy output may need to be monitored depending on how many commands with long execution times are sent at once to avoid overflowing the input buffer. The Busy output toggles when room for 16 bytes remains in the input buffer allowing a host's 16 byte transmission buffer to be flushed after a Busy is detected.

	PART NUMBER:	REVISION:
Futaba	NAGP1250AB-x/BB-x	B.1
Eutaba Corporation of Amorida	DATE PRINTED:	SHEET:
Schaumburg, IL	17Oct12	12 OF 45

6.10.1 BACKSPACE

This single-byte command packet backspaces the cursor one character position within the current window based on the current Cursor Mode (MD1, MD2, or MD3), the current Character Spacing and the current Font Magnification. This command only moves the cursor it does not erase any data.

Command Packet Byte 1							
	8-bit						
	Command						
08h							
0	0	0	0	1	0	0	0

Width of the Backspace:

Character Spacing	Font Magnification X	Width of the Backspace (columns)
	1	6
0	2	12
(space after each character)	3	18
	4	24
	1	7
1	2	14
(space before and after each character)	3	21
	4	28

Backspace operation when Cursor Mode = Overwrite (MD1) or Vertical Scroll (MD2):

Font Magnification Y	X Direction	Y Direction	Backspace Operation
	Space is available on the current row for the Backspace.		1) The cursor moves to the left the Width of the Backspace.
1, 2, 3 or 4 rows	Space is not available on the current row for the Backspace.	Space is available for 1, 2, 3 or 4 rows above the current row. + Current window is wide enough for the Backspace.	1) The cursor moves to the column, the Width of the Backspace from the right end of the row 1, 2, 3 or 4 rows above the current row.
		Space is available for 1, 2, 3 or 4 rows above the current row. + Current window is not wide enough for the Backspace.	1) The cursor moves to the left end of the row 1, 2, 3 or 4 rows above the current row.
		Space is not available for 1, 2, 3 or 4 rows above the current row.	1) The cursor does not move.

Backspace operation when Cursor Mode = Horizontal Scroll (MD3):

Font Magnification Y	X Direction	Y Direction	Backspace Operation
1.2.3 or 4 roug	Space is available on the current row for the Backspace.		1) The cursor moves to the left the Width of the Backspace.
1, 2, 3 01 4 10ws	Space is not available on the current row for the Backspace.		1) The cursor does not move.

	PART NUMBER:	REVISION:
FUtaDa ®	NAGP1250AB-x/BB-x	B.1
Eutaba Corporation of Amorida	DATE PRINTED:	SHEET:
Schaumburg, IL	170ct12	13 OF 45

6.10.2 HORIZONTAL TAB

This single-byte command packet tabs the cursor one character position within the current window based on the current Cursor Mode (MD1, MD2, or MD3), the current Character Spacing and the current Font Magnification.

Command Packet Byte 1							
	8-bit						
	Command						
09h							
0	0	0	0	1	0	0	1

Width of the Horizontal Tab:

Character Spacing	Font Magnification X	Width of the Tab (columns)
	1	6
0	2	12
(space after each character)	3	18
	4	24
	1	7
1	2	14
(space before and after each character)	3	21
	4	28

Horizontal Tab operation when Cursor Mode = Overwrite (MD1):

Font Magnification Y	X Direction	X Direction Y Direction	
1, 2, 3 or 4 rows	Space is available on the current row for the Horizontal Tab.		 The cursor moves to the right the Width of the Horizontal Tab.
	Space is not available on the current	Space is available for 1, 2, 3 or 4 rows below the current row.	1) The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the current row.
	Tow for the Horizontal Tao.	Space is not available for 1, 2, 3 or 4 rows below the current row.	1) The cursor moves to the left end of the top row.

Horizontal Tab operation when Cursor Mode = Vertical Scroll (MD2):

Font Magnification Y	X Direction	Y Direction	Horizontal Tab Operation
	Space is available on the current row for the Horizontal Tab.		1) The cursor moves to the right the Width of the Horizontal Tab.
	Space is not available on the current row for the Horizontal Tab.	Space is available for 1, 2, 3 or 4 rows below the current row.	1) The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the current row.
1, 2, 3 01 4 10ws		Space is not available for 1, 2, 3 or 4 rows below the current row.	 The displayed pattern is scrolled up 2, 3 or 4 rows while clearing the bottom 1, 2, 3 or 4 rows. The cursor moves to the left end of the current row.

Horizontal Tab operation when Cursor Mode = Horizontal Scroll (MD3):

Font Magnification Y	X Direction	Y Direction	Horizontal Tab Operation
	Space is available on the current row for the Horizontal Tab.		1) The cursor moves to the right the Width of the Horizontal Tab.
1, 2, 3 or 4 rows	Space is not available on the current row for the Horizontal Tab.		 The displayed pattern on the cursor row and the 1, 2 or 3 rows below are scrolled left, clearing the rightmost columns, to make room for the Horizontal Tab. The cursor moves to the right end of the current row.

6.10.3 LINE FEED

This single-byte command packet performs a Line Feed. The cursor moves to a new row within the current window based on the current Cursor Mode (MD1, MD2, or MD3) and the current Font Magnification.

Command Packet Byte 1										
8-bit										
	Command									
0Ah										
0	0	0	0	1	0	1	0			

Line Feed operation when Cursor Mode = Overwrite (MD1):

Font Magnification Y	X Direction	Y Direction	Line Feed Operation
1, 2, 3 or 4 rows		Space is available for 1, 2, 3 or 4 rows below the current row.	1) The cursor moves down 1, 2, 3 or 4 rows and remains in the same column.
		Space is not available for 1, 2, 3 or 4 rows below the current row.	1) The cursor moves to the top row and remains in the same column.

Line Feed operation when Cursor Mode = Vertical Scroll (MD2):

Font Magnification Y	X Direction	Y Direction	Line Feed Operation
		Space is available for 1, 2, 3 or 4 rows below the current row.	1) The cursor moves down 1, 2, 3 or 4 rows and remains in the same column.
1, 2, 3 or 4 rows		Space is not available for 1, 2, 3 or 4 rows below the current row.	 The displayed pattern is scrolled up 2, 3 or 4 rows while clearing the bottom 1, 2, 3 or 4 rows. The cursor does not move.

Line Feed operation when Cursor Mode = Horizontal Scroll (MD3):

Font Magnification Y	X Direction	Y Direction	Line Feed Operation
1, 2, 3 or 4 rows			1) The cursor does not move.

6.10.4 HOME POSITION

This single-byte command packet sets the Cursor Position to the upper left hand corner of the currently selected Window.

	Command Packet Byte 1									
8-bit										
	Command									
			OI	3h						
0	0	0	0	1	0	1	1			

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Rutaba Componention of Amonica DATE PRINTED: SHEET:	
Schaumburg, IL 170ct12	15 OF 45

6.10.5 CLEAR WINDOW

This single-byte command packet clears the Display Memory of the currently selected Window and sets the Cursor Position to the upper left hand corner.

Command Packet Byte 1									
8-bit									
Command									
0Ch									
0	0	0	0	1	1	0	0		

6.10.6 CARRIAGE RETURN

This single-byte command packet sets the Cursor Position to the leftmost column of the current row of the currently selected Window.

Command Packet Byte 1										
8-bit										
Command										
0Dh										
0	0	0	0	1	1	0	1			

6.10.7 SELECT WINDOW 0

This single-byte command packet selects Window 0 as the current Window.

	Command Packet Byte 1									
8-bit										
Command										
	10h									
0	0	0	1	0	0	0	0			

6.10.8 SELECT WINDOW 1

This single-byte command packet selects Window 1, if defined, as the current Window.

	Command Packet Byte 1										
8-bit											
Command											
11h											
0	0	0	1	0	0	0	1				

	PART NUMBER:	REVISION:
Futaba	NAGP1250AB-x/BB-x	B.1
Rutche Commenties of America	DATE PRINTED:	SHEET:
Futaba Corporation of America Schaumburg, IL	17Oct12	16 OF 45

6.10.9 SELECT WINDOW 2

This single-byte command packet selects Window 2, if defined, as the current Window.

Command Packet Byte 1										
8-bit										
Command										
12h										
0										

6.10.10 SELECT WINDOW 3

This single-byte command packet selects Window 3, if defined, as the current Window.

	Co	mma	und P	acket	Byte	e 1								
8-bit														
Command														
			13	3h										
0	0 0 0 1 0 0 1 1													

6.10.11 SELECT WINDOW 4

This single-byte command packet selects Window 4, if defined, as the current Window.

	Co	mma	und P	acket	Byte	e 1							
8-bit													
Command													
			14	4h									
0	0	0	1	0	1	0	0						

6.10.12 SELECT UDF CHARACTER SET

This three-byte command packet selects the UDF Character Set to be used when writing a character to Display Memory. An entire font table, 20h through FFh, can be defined by using all 16 UDF characters of all 14 UDF Character Sets. To disable writing UDF characters, select UDF Character Set 0.

	Co	mma	und P	acke	t Byte	e 1			Co	mma	and P	acke	Byt	e 2			Co	omma	and P	acke	t Byt	e 3	
			8-	bit							8-	bit						8	bit				
		Com	manc	1						Com	mand	l					-o Cha	racta	r Sat				
			11	3h				25h										UDI	Cha	Tacie	1 500		
0	0 0 0 1 1 0 1								0 0 1 0 0 1 0 1							CS7	CS6	CS5	CS4	CS3	CS2	CS1	CS0

8-bit UDF Character Set (CS7:CS0):

0 UDF characters are disabled

1 to 14 UDF characters, if defined, are written to the display from this UDF Character Set

All UDF characters, defined or not, are combined into a single font table, 20h through FFh $0 \le CS$ value ≤ 14 or CS value = 224

6.10.13 DEFINE UDF CHARACTER SET CHARACTERS

This multi-byte command packet defines up to 16 UDF characters in a UDF Character Set. The UDF characters are stored in volatile RAM and are undefined at power-up. The command terminates after all bytes are received or an error is detected.

Up to 16 UDF characters can be defined at once if the Character Codes for the UDF characters are numerically continuous. If not continuous, then a separate command needs to be used for each individual Character Code and/or group of Character Codes. Each of the UDF characters can be defined in either the 5x8 (which allows characters with descenders) or the 7x8 format.

After 16 UDF characters are defined in a UDF Character Set, any additional UDF characters must replace those already defined or some existing UDF characters must be deleted first.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4					
8-bit Command 1Bh	8-bit Command 26h	8-bit UDF Character Set	8-bit Start Character Code					
0 0 0 1 1 0 1 1	0 0 1 0 0 1 1 0	CS7 CS6 CS5 CS4 CS3 CS2 CS1 CS0	S7 S6 S5 S4 S3 S2 S1 S0					

Command Packet Byte 5	Command Packet Byte 6	Command Packet Byte 7						
8-bit End Character Code	8-bit 1 ST UDF Character	8-bit 1 ST UDF Character Bivel Dete	8-bit 1 ST UDF Character Biral Data					
E6 E5 E4 E3 E2 E1 E0	77 76 75 74 73 72 71 70	D7 D6 D5 D4 D3 D2 D1 D0	D7 D6 D5 D4 D3 D2 D1 D0					

(Comm	and	Pack	et By	te 11	l or 1	3	0	Comn	nand	Pack	et By	te 12	or 1	4	C	Comn	nand	Pack	et By	te 13	or 1	5								
			8-	bit				8-bit											8-	bit							8-	bit			
		1^{ST} U	JDF	Char	acter				2 ND UDF Character								2 ND UDF Character									UI	OF C	harac	ter		
]	Pixel	Data	ı				Size									J	Pixel	Data							Pixel	Data	ı		
D7	D6	D5	D4	D3	D2	D1	D0	27 Z6 Z5 Z4 Z3 Z2 Z1 Z0						Z0	D7	D6	D5	D4	D3	D2	D1	D0	D0 D7 D6 D5 D4 D3 D2 D1				D0				

Command Packet Byte N (up to 133) 8-bit Last UDF Character Pixel Data D7 D6 D5 D4 D3 D2 D1 D0

8-bit UDF Character Set (CS7:CS0):

1 <= CS value <= 14

8-bit Start Character Code (S7:S0):

 $20h \le S$ value $\le FFh$

8-bit End Character Code (E7:E0):

S value $\leq E$ value $\leq FFh$

8-bit UDF Character Size (Z7:Z0):

5 = Z value Selects 5x8 format 7 = Z value Selects 7x8 format

	PART NUMBER:	REVISION:
Futada®	NAGP1250AB-x/BB-x	B.1
Rutche Componstion of Imoniae	DATE PRINTED:	SHEET:
Schaumburg, IL	17Oct12	18 OF 45

8-bit UDF Character Pixel Data:

Note: An invalid value terminates the command packet at that byte. Subsequent bytes are considered part of the next command packet.

6.10.14 DELETE UDF CHARACTER SET CHARACTER

This four-byte command packet deletes a UDF character from a UDF Character Set.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4
8-bit Command 1Bh	8-bit Command 3Fh	8-bit UDF Character Set	8-bit Character Code
0 0 0 1 1 0 1 1	0 0 1 1 1 1 1 1	CS7 CS6 CS5 CS4 CS3 CS2 CS1 CS0	C7 C6 C5 C4 C3 C2 C1 C0

8-bit UDF Character Set (CS7:CS0):

0 Deletes all UDF Character Set characters (This also terminates the command)

1 to 14 Selects UDF Character Set to delete Character Code from

 $0 \le CS$ value ≤ 14

8-bit Character Code (C7:C0):

20h <= C value <= FFh

Note: An invalid value terminates the command packet at that byte. Subsequent bytes are considered part of the next command packet.

	PART NUMBER:	REVISION:
Futada®	NAGP1250AB-x/BB-x	B.1
Rutche Componstion of Imanias	DATE PRINTED:	SHEET:
Schaumburg, IL	17Oct12	19 OF 45

6.10.15 INITIALIZE DISPLAY

This two-byte command packet resets the module to the conditions listed below which are the same as at power-up. This command does not clear the 255 byte input buffer.

	Co	mma	und P	acket	Byte	e 1			Co	mma	und P	acket	Byte	e 2	
			8-	bit							8-	bit			
			Com	mand	l			Command							
			1I	3h							40)h			
0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	1

Reset Conditions:

Entire Display Memory cleared (Standard and Extended) Base Window selected and defined from 0,0 to 139,3 with cursor at position 0,0 All User Windows deleted Overwrite Mode (MD1) selected for all Windows Write Logic Mode set to normal Reverse Video Write Mode disabled Font Magnification set to 1x1 Character Width / Spacing set to fixed width with left and right spaces Font Set 0 selected for both 20h through 7Fh and 80h through FFh characters All UDF characters deleted and UDF Character Set 0 selected (UDF's disabled) Luminance set to 100% Cursor off Horizontal Scroll Speed set to 0 Display Blink canceled Switching power supply turned on

Futaba Corporation of America Schaumburg, IL

NAGP1250AB-x/BB-x		B.1
DATE PRINTED:	SHEET:	
17Oct12		20 OF

REVISION:

PART NUMBER:

6.10.16 SELECT FONT SET (20H THROUGH 7FH)

This three-byte command packet selects the International Font Set characters that replace a few of the Common Font Set characters between 20h and 7Fh.

	Сс	mma	und P	acke	t Byt	e 1			Сс	omma	and P	acke	Byte	e 2			Co	omma	and P	acke	t Byt	e 3	
			8-	bit	1						8- Com	bit							8-	bit			
			11 11	manc 3h	1						Com 52	manc 2h							Fon	t Set			
0	0	0	1	1	0	1	1	0 1 0 1 0 0 1 1									n6	n5	n4	n3	n2	n1	n0

8-bit Font Set (n7:n0):

n value	Font Set
00h	America
01h	France
02h	Germany
03h	England
04h	Denmark 1
05h	Sweden
06h	Italy

n value	Font Set
07h	Spain 1
08h	Japan
09h	Norway
0Ah	Denmark 2
0Bh	Spain 2
0Ch	Latin America
0Dh	Korea

Note: Invalid values are ignored.

6.10.16.1 INTERNATIONAL FONT SET

	PART NUMBER:	REVISION:	
Futada®	NAGP1250AB-x/BB-x	B.1	
Eutoba Componstion of Imaniaa	DATE PRINTED:	SHEET:	
Schaumburg, IL	17Oct12	21 OF 45	

6.10.16.2 COMMON FONT SET

		Commor	n Font Set	t (20H - 7F	Ή)	
	2xH	3xH	4xH	5xH	6xH	7xH
x0H					•••	 -
x1H						
x2H						 -
xЗH						• • • •
x4H						
x5H						!!
x6H		.				I.,I
x7H	•					
x8H						
x9H						•••••
XAH	:			 	•••••	
хBH		₩ ₽.				
хСН				••••		
XDH						
хEН				••*••	 -''	•*** [*]
xFH						

B.1

22 OF 45

6.10.17 SELECT FONT SET (80H THROUGH FFH)

This three-byte command packet selects the Font Set for characters between 80h and FFh.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3
8-bit Command	8-bit Command 74b	8-bit Font Set
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	n7 n6 n5 n4 n3 n2 n1 n0

8-bit Font Set (n7:n0):

n value	Font Set
00h	PC437 (US – European)
01h	Katakana – Japanese
02h	PC850 (Multilingual)
03h	PC860 (Portuguese)
04h	PC863 (Canadian – French)
05h	PC865 Nordic
10h	WPC1252
11h	PC866 (Cyrillic #2)
12h	PC852 (Latin #2)
13h	PC858

Note: Invalid values are ignored.

Futaba Corporation of America Schaumburg, IL

NAGP1250AB-x/BB-x
DATE PRINTED:

PART NUMBER:

REVISION:

170ct12

SHEET:

23 OF 45

B.1

6.10.17.1 PC437 (US – EUROPEAN) AND KATAKANA – JAPANESE FONT SETS

		PC	:437 (US	- Europea	an) (80H ·	FFH)		
n=0	8xH	9xH	AxH	BxH	СхН	DxH	ExH	FxH
хон							O	
x1H								
x2H								2
хзн						₩.		
x4H		\sim						
x5H								
x6H							.	
x7H								-**-* -***-*
x8H								••
x9H					₽			÷
хАН								==
хвн								
хСН								
xDH								
xEH								
xFH			<u>></u>					

	Katakana - Japanese (80H - FFH)							
n=1	8xH	9xH	AxH	BxH	СхН	DxH	ExH	FxH
x0H					-	 		
x1H						""		
x2H								
x3H								
x4H			-		.			
x5H			==		-		\Leftrightarrow	
x6H							-	
x7H			 _=-				•≣•	
x8H		-=] -	
x9H			:- ³ -:				-	
хАН		-					-===-	
хBН								
хСН							-83	
xDH					•*• •		<u></u>	
хЕН								
xFH			•••					

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Futaba Corporation of America Schaumburg, IL

PART NUMBER:	REVISION:
NAGP1250AB-x/BB-x	B.1
DATE PRINTED:	SHEET:
17Oct12	24 OF 45

6.10.17.2 PC850 (MULTILINGUAL) AND PC860 (PORTUGUESE) FONT SETS

PC850 (Multilingual) (80H - FFH)								
n=2	8xH	9xH	AxH	BxH	СхН	DxH	ExH	FxH
x0H					.		Ó	
x1H								
x2H								
x3H								
x4H								
x5H								
x6H							 .	
x7H	•		•					
x8H		•••						••
x9H								
хАН							Ô	==
хвн								-
хСН								
xDH								
хEН		24						
xFH							•*	

PC860 (Portuguese) (80H - FFH)													
n=3	8xH	9xH	AxH	BxH	CxH	DxH	ExH	FxH					
x0H													
x1H			ייין יי										
x2H			`										
x3H													
x4H													
x5H		•. ••											
x6H							ļ ^j .						
x7H	•							-****					
x8H								- :: -					
x9H								÷					
xAH													
хBН													
хСН													
xDH								•••• •••					
xEH													
xFH			*										

B .1

25 OF 45

6.10.17.3 PC863 (CANADIAN – FRENCH) AND PC865 (NORDIC) FONT SETS

		PC8	63 (Cana	dian - Fre	ench) (80H	H - FFH)		
n=4	8xH	9xH	AxH	BxH	CxH	DxH	ExH	FxH
хон								
x1H			•*					
x2H								2
хзн								
x4H								
x5H								
x6H						!! "	.	
x7H								-**-* -****
x8H				•				••
x9H								÷
хАН								==
хвн								
хСН								
xDH								
хEH								
xFH			*					

PC865 (Nordic) (80H - FFH)													
n=5	8xH	9xH	AxH	BxH	СхН	DxH	ExH	FxH					
x0H													
x1H			' • ;••]										
x2H								2					
x3H													
x4H													
x5H		•. ••											
x6H							 .						
x7H	=		::					-*#- -*#-					
x8H								••					
x9H								•:•					
хАН								==					
хBН													
хСН													
xDH					====								
хЕН													
xFH													

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Futaba Corporation of America Schaumburg, IL
 PART NUMBER:
 REVISION:

 NAGP1250AB-x/BB-x
 B.1

 DATE PRINTED:
 SHEET:

 17Oct12
 26 OF 45

6.10.17.4 WP1252 AND PC866 (CYRILLIC #2) FONT SETS

			WPC	1252 (80	H - FFH)			
n=16	8xH	9xH	AxH	BxH	CxH	DxH	ExH	FxH
x0H				••				
x1H			I			 [`•.]		
x2H								
x3H						Ó	-::: -:::	
x4H	:= :=	33		•*				$\ddot{\Box}$
x5H				 .				
x6H								•
x7H				==		34	= 	
x8H		⁸	••					
x9H				•				
хАН								
хBH	•••	• • •		<u></u>				-*-
хСН								
xDH								
хЕН								
xFH				<u>.</u>		ß		

			PC866 (C	yrillic #2) (80H - F	FH)		
n=17	8xH	9xH	AxH	BxH	СхН	DxH	ExH	Fx
x0H								
x1H								
x2H								
x3H							=	
x4H								
x5H							34	
x6H								
x7H		••••					=	
x8H	. -1		. -1					
x9H			•• •*					-
хАН			K				-	
хBH								
хСН							= =	
xDH								
хEН							₽0	
xFH								

	PART NUMBER:	REVISION:		
Futaba®	NAGP1250AB-x/BB-x	B.1		
Eutobe Componenties of America	DATE PRINTED:	SHEET:		
Schaumburg, IL	17Oct12	27 OF 45		

6.10.17.5 PC852 (LATIN #2) AND PC858 FONT SETS

			PC852 (Latin #2)	(80H - FF	H)		
n=18	8xH	9xH	AxH	BxH	CxH	DxH	ExH	FxH
x0H							۲ 4	
x1H							ß	
x2H								
x3H								
x4H								
x5H			•					
x6H								
x7H	•							
x8H								
x9H								-
хАН								
хвн			-* 					
хСН	·							
xDH		-	•					
хEH		24						
xFH	Ć		*				•*	

			PC	858 (80H	- FFH)			
n=19	8xH	9xH	AxH	BxH	СхН	DxH	ExH	FxH
x0H			'u					
x1H			" • ;••					
x2H			`					
x3H								
x4H		: :::						
x5H		•. ••						
x6H					-::: -:::		ļ ¹ .	
x7H	•					Î		
x8H		•••	<u>.</u>					••
x9H								-
хАН							Ô	==
хBН								-
хСН								
xDH								
xEH		24						
xFH			<u>*</u>				•*	

	PART NUMBER:	REVISION:		
Futada®	NAGP1250AB-x/BB-x	B.1		
Tutoha Componetion of Imaniaa	DATE PRINTED:	SHEET:		
Schaumburg, IL	17Oct12	28 OF 45		

6.10.18 SELECT OVERWRITE MODE (MD1)

This two-byte command packet selects the Overwrite Mode (MD1) for the currently selected Window.

	Command Packet Byte 1						Command Packet Byte 2								
8-bit						8-bit									
Command						Command									
		1Fh					01h								
0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	1

6.10.19 SELECT VERTICAL SCROLL MODE (MD2)

This two-byte command packet selects the Vertical Scroll Mode (MD2) for the currently selected Window.

	Co	mma	und P	acket	Byte	e 1			Co	mma	and P	acket	t Byte	e 2			
	8-bit									8-bit							
Command									Command								
1Fh											02	2h					
0 0 0 1 1 1 1 1						1	0 0 0 0 0 0 1 0							0			

6.10.20 SELECT HORIZONTAL SCROLL MODE (MD3)

This two-byte command packet selects the Horizontal Scroll Mode (MD3) for the currently selected Window.

	Co	mma	und P	acket	Byte	e 1			Co	mma	und P	acket	Byte	e 2	
			8-	bit			8-bit								
			Com	mand	l		Command								
			11	Fh							03	3h			
0 0 0 1 1 1 1 1						1	0 0 0 0 0 0 1 1							1	

	PART NUMBER:	REVISION:
Futaba	NAGP1250AB-x/BB-x	B.1
	DATE PRINTED:	SHEET:
Futaba Corporation of America Schaumburg, IL	17Oct12	29 OF 45

6.10.21 SET CURSOR POSITION

This six-byte command packet sets the Cursor Position within the currently selected Window. The address of a Window's upper left corner is 0,0 for Windows 1 through 4 and either 0,0 or 140,0 for Window 0 depending on how it is defined.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4					
8-bit Command 1Fh	8-bit Command 24h	8-bit X Cursor Position – Low Byte	8-bit X Cursor Position – High Byte					
0 0 0 1 1 1 1 1	0 0 1 0 0 1 0 0	X7 X6 X5 X4 X3 X2 X1 X0	X15 X14 X13 X12 X11 X10 X9 X8					

	Com	mand I	Packet	Byte	e 5	Command Packet Byte 6								
Y	Curso		Y Cu	rsor I	8-1 Positi	bit on –	High	Byte	e					
Y7]	Y6 Y	5 Y4	Y3	Y2	Y1	Y0	Y15	Y14	Y13	Y12	Y11	Y10	Y9	Y8

16-bit X Cursor Position (X15:X0):

Valid X Cursor Positions are based on the size of the currently selected window.

16-bit Y Cursor Position (Y15:Y0):

Valid Y Cursor Positions are based on the size of the currently selected window.

Note: After all command packet bytes are received, invalid values cause entire command packet to be ignored.

6.10.22 WAIT

This five-byte command packet is a waste of time. Command execution halts until the Wait Time elapses.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4						
8-bit	8-bit	8-bit	8-bit						
Command	Command	Command	Command						
1Fh	28h	61h	01h						
0 0 0 1 1 1 1 1	0 0 1 0 1 0 0 0	0 1 1 0 0 0 1	0 0 0 0 0 0 0 1						

Command Packet Byte 5
8-bit
Wait Time
W7 W6 W5 W4 W3 W2 W1 W0

8-bit Wait Time (W7:W0):

Wait Time is approximately 0.5s * W. $0 \le W$ value ≤ 255

	PART NUMBER:	REVISION:
Futaba®	NAGP1250AB-x/BB-x	B.1
Eutaba Corporation of Amorida	DATE PRINTED:	SHEET:
Schaumburg, IL	170ct12	30 OF 45

6.10.23 DISPLAY MEMORY SCROLL

This nine-byte command packet sets the display scrolling parameters. The Display Memory will scroll, any number of columns, repeatedly, at the Scroll Speed. Command execution halts while scrolling.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4				
8-bit	8-bit	8-bit	8-bit				
Command	Command	Command	Command				
1Fh	28h	61h	10h				
0 0 0 1 1 1 1 1	0 0 1 0 1 0 0 0	0 1 1 0 0 0 1	0 0 0 1 0 0 0 0				

Command Packet Byte 5							Command Packet Byte 6					Command Packet Byte 7							Command Packet Byte 8												
8-bit							8-bit					8-bit							8-bit												
Number of Column Bytes to Scroll						oll	Number of Column Bytes to Scroll				Number of Repetitions							Number of Repetitions													
Low Byte					High Byte							Low	Byte				High Byte														
C7	C6	C5	C4	C3	C2	C1	C0	C15	C14	C13	C12	C11	C10	C9	C8	R7	R6	R5	R4	R3	R2	R1	R0	R15	R14	R13	R12	R11	R10	R9	R8

	Command Packet Byte 9											
	5-bit											
	Scroll Speed											
S 7	S6	S5	S4	S 3	S2	S1	S0					

16-bit Number of Column Bytes to Scroll (C15:C0):

This number specifies how many Column Bytes to scroll Display Memory for each repetition. This number should be a multiple of 4 since there are 4 bytes of Display Memory per display column. $0 \le C$ value ≤ 1119

16-bit Number of Repetitions (R15:R0):

This number specifies how many times to repeat the scroll. $1 \le R$ value ≤ 65535

8-bit Scroll Speed (S7:S0):

Scroll Speed is approximately 14ms * S per repetition. $0 \le S$ value ≤ 255

Note: An invalid value terminates the command packet at that byte. Subsequent bytes are considered part of the next command packet.

Futaba Corporation of America PART NUMBER: REVISION: Schaumburg, TL Date PRINTED: SHEET:			
Futaba Corporation of America Schaumburg, TLNAGP1250AB-x/BB-xB.1Date PRINTED:SHEET:17Oct1231 OF 45		PART NUMBER:	REVISION:
Futaba Corporation of AmericaDate PRINTED:SHEET:Schaumburg, TL17Oct1231 OF 45	Futaba	NAGP1250AB-x/BB-x	B.1
Schaumburg, TL 170ct12 31 OF 45	Butche Companytion of Imanias	DATE PRINTED:	SHEET:
2011aanna - 37,	Schaumburg, IL	17Oct12	31 OF 45

6.10.24 DISPLAY BLINK

This eight-byte command packet sets the display blinking parameters. The display will repeat the Normal / Blink Pattern cycle at the blink rate set by T_1 and T_2 indefinitely, or by the Number of Repetitions specified.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4				
8-bit	8-bit	8-bit	8-bit				
Command	Command	Command	Command				
1Fh	28h	61h	11h				
0 0 0 1 1 1 1 1	0 0 1 0 1 0 0 0	0 1 1 0 0 0 1	0 0 0 1 0 0 1				

Command Packet Byte 5	Command Packet Byte 6	Command Packet Byte 7	Command Packet Byte 8
8-bit Blink Pattern	8-bit $T_1 = Time of Normal Pattern$	$\begin{array}{l} \text{8-bit} \\ T_2 = \text{Time of Blink Pattern} \end{array}$	8-bit Number of Repetitions
P7 P6 P5 P4 P3 P2 P1 P0	T_17 T_16 T_15 T_14 T_13 T_12 T_11 T_10	$ T_27 \ \ T_26 \ \ T_25 \ \ T_24 \ \ T_23 \ \ T_22 \ \ T_21 \ \ T_20 $	R7 R6 R5 R4 R3 R2 R1 R0

8-bit Blink Pattern (P7:P0):

- 0 Normal display pattern during period T₂
- 1 Blank display pattern during period T₂
- 2 Reverse Video display pattern during period T₂

 $0 \le P$ value ≤ 2

8-bit Time of Normal Pattern (T₁7:T₁0):

Normal Pattern is displayed approximately $14ms * T_1$ per cycle. $1 \le T_1$ value ≤ 255

8-bit Time of Blink Pattern (T₂7:T₂0):

Blink Pattern is displayed approximately $14ms * T_2$ per cycle. $1 \le T_2$ value ≤ 255

8-bit Number of Repetitions (R7:R0):

This number specifies how many times to repeat the Normal / Blink Pattern cycle.

- 0 Command execution continues and the cycle repeats until the Number of Repetitions is changed by another Display Blink command or the Initialize command. Command execution is not interrupted.
- >0 Command execution halts until the Number of Repetitions is reached.
- 0 <= R value <= 255

Note: An invalid value terminates the command packet at that byte. Subsequent bytes are considered part of the next command packet.

	PART NUMBER:	REVISION:
Futada ®	NAGP1250AB-x/BB-x	B.1
Tutaha Gamanatian of Imanian	DATE PRINTED:	SHEET:
Futaba Corporation of America Schaumburg, IL	17Oct12	32 OF 45

6.10.25 SCREEN SAVER

This five-byte command packet sets the Screen Saver parameters.

Command Packet Byte 4			e 3	Byte	icket	nd P	mma	Co			e 2	Byte	acket	and Pa	mma	Co			e 1	Byte	cket	d Pa	imai	Coi	
8-bit					it	8-1							oit	8-ł							t	8-b			
Command					nand	Com							nanc	Com							and	omn	C		
40h					h	61							h	28							ı	1F			
1 0 0 0 0 0 0	1	1	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	1	1	1	1	1	0	0	0
	1	1	0	0	0	0	1	1	0	0	0	0	1	0	1	0	0	1	1	1	1	1	0	0	0

8-bit Blink Pattern (SS7:SS0):

- 0 Turns off module's internal switching power supply.
- 1 Turns on module's internal switching power supply.
- 2 Turns all display dots off (Display Memory is not affected).
- 3 Turns on all display dots (Display Memory is not affected).
- 4 Alternates between all dots on and reverse video display patterns every 2 seconds.

 $0 \le SS$ value ≤ 4

Note: Invalid values are ignored.

6.10.26 GRAPHIC IMAGE

This multi-byte command packet writes a Graphic Image to Display Memory within the currently selected Window starting from the current cursor location. Only the portion of the Graphic Image that fits within the currently selected Window is written to Display Memory.

	Co	omma	and P	acket	Byte	e 1			Co	mma	and P	acke	Byte	e 2			Co	mma	und P	acket	Byte	e 3			Co	omma	und P	acke	t Byt	e 4	
			8-	bit							8-	bit							8-1	bit							8-	bit			
			Com	mand							Com	mand	l						Com	mand							Com	manc	1		
			11	Fh							28	3h							66	5h							11	lh			
0	0	0	1	1	1	1	1	0	0	1	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	1	0	0	0	1

Command Packet Byte 5	Command Packet Byte 6	Command Packet Byte 7	Command Packet Byte 8
8-bit	8-bit	8-bit	8-bit
Image Size X	Image Size X	Image Size Y	Image Size Y
Low Byte	High Byte	Low Byte	High Byte
X7 X6 X7 X6 X7 X6 X7 X6	X15 X14 X13 X12 X11 X10 X9 X8	Y7 Y6 Y5 Y4 Y3 Y2 Y1 Y0	Y15 Y14 Y13 Y12 Y11 Y10 Y9 Y8

Command Packet Byte 9	Command Packet Byte 10		Command Packet Byte N
8-bit Image Mode	8-bit Image Data	8-bit Image Data	8-bit Image Data
IM7 IM6 IM5 IM4 IM3 IM2 IM1 IM0	D7 D6 D5 D4 D3 D2 D1 D0	D7 D6 D5 D4 D3 D2 D1 D0	D7 D6 D5 D4 D3 D2 D1 D0

16-bit Image Size X (X15:X0):

This is the number of columns in the Graphic Image. 1 <= X value <= 280

16-bit Image Size Y (Y15:Y0):

This is the number of rows in the Graphic Image. 1 <= Y value <= 4

8-bit Image Mode (IM7:IM0):

1 Fixed Mode

1 <= IM value <= 1

8-bit Image Data (D7:D0):

The Graphic Image is written to Display Memory as the Image Data bytes are received starting from the current cursor location filling each row of a column of the Graphic Image from top to bottom, from the left to the right column. The MSB of Image data represents the upper pixel of each byte in a column.

0 <= D value <= 255

Note: An invalid value terminates the command packet at that byte. Subsequent bytes are considered part of the next command packet.

6.10.27 SELECT CHARACTER WIDTH / CHARACTER SPACING

This five-byte command packet selects the Character Width and Charter Spacing to be used when writing characters to Display Memory.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4
8-bit	8-bit	8-bit	8-bit
Command	Command	Command	Command
1Fh	28h	67h	03h
0 0 0 1 1 1 1 1	0 0 1 0 1 0 0 0	0 1 1 0 0 1 1 1	0 0 0 0 0 0 1 1

	Co	mma	und P	acket	Byte	e 5	
		Wi	8- dth /	bit Spac	ing		
D7	D6	D5	D4	D3	D2	D1	D

8-bit Width / Spacing (D7:D0):

- 0 Fixed Character Width and a space on the right side of each character.
- 1 Fixed Character Width and a space on the left and right sides of each character.
- 2 Proportional Character Width and a space on the right side of each character.
- 3 Proportional Character Width and a space on the left and right sides of each character.
- $0 \le D$ value ≤ 3

6.10.27.1 CHARACTER WIDTH / CHARACTER SPACING EXAMPLES

Fixed 5x7 character width with left and right spaces

Г							Γ					Ι					Т											
Γ											Τ	Ι	Τ			Τ	Т											
Г												Ι					Т											
Г							Γ					Ι					Т											
Г												Ι					Т											
Г												Ι					Т											
Г					Γ	Γ	Г		Τ		Т	Τ				Т	Т	Τ		Τ		Τ						

Fixed 5x7 character width with right space

																				_
																				٦
																				٦
																				٦
																				٦
																				٦

Proportional 5x7 character width with left and right spaces

Proportional 5x7 character width with right space

Note:

1) The descender of the lower case "g" requires a 5x8 UDF charcter.

5x8 UDF	Fixed Width with	Fixed Width with	Proportional with	Proportional with
	F with left and right s	space spacing w	with right space sp	acing
	╈			

Notes:

Only the left most 6 columns of a 7x8 UDF are displayed with right space spacing.
 Fixed / Proportional Width setting is ignored by 7x8 UDF characters.

	PART NUMBER:	REVISION:
Futaba	NAGP1250AB-x/BB-x	B.1
Tubaha Gaunanahian af Imaniaa	DATE PRINTED:	SHEET:
Futaba Corporation of America Schaumburg, IL	17Oct12	35 OF 45

6.10.28 FONT MAGNIFICATION

This six-byte command packet selects the Font Magnification X and Y values to be used when writing characters to Display Memory.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4			
8-bit	8-bit	8-bit	8-bit			
Command	Command	Command	Command			
1Fh	28h	67h	40h			
0 0 0 1 1 1 1 1	0 0 1 0 1 0 0 0	0 1 1 0 0 1 1 1	0 1 0 0 0 0 0 0			

		Co	mma	and P	acke	t Byte	e 5			Co	mma	and P	acket	t Byte	e 6	
P hit											0	h.i.t				
	8-bit Font Magnification X								F	Font I	o-I Magn	ificat	tion `	Y		
	X7	X6	X5	X4	X3	X2	X1	X0	Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0

8-bit Font Magnification X (X7:X0):

 $1 \le X$ value ≤ 4

8-bit Font Magnification Y (Y7:Y0):

 $1 \le Y$ value ≤ 4

Note: After all command packet bytes are received, invalid values are ignored.

6.10.29 SELECT WINDOW

This five-byte command packet selects a Window, if defined, as the current Window. Window 0 is always defined.

	C	omma	and P	acket	t Byte	e 1		Command Packet Byte 2				Co	omma	und P	acket	Byte	e 3		Command Packet Byte 4												
			8-	bit					8-bit				8-bit					8-bit													
			Com	mand	l				Command				Command					Command													
			11	Fh					28h				77h				01h														
0	0	0	1	1	1	1	1	0	0	1	0	1	0	0	0	0	1	1	1	0	1	1	1	0	0	0	0	0	0	0	1

	Command Packet Byte 5									
		Wir	8- ndow	bit Nun	ıber					
W7	W6	W5	W4	W3	W2	W1	W(

8-bit Window Number (W7:W0):

 $0 \le W$ value ≤ 4

	PART NUMBER:	REVISION:
Futaba	NAGP1250AB-x/BB-x	B.1
Eutaba Corporation of America	DATE PRINTED:	SHEET:
Schaumburg, IL	170ct12	36 OF 45

6.10.30 DEFINE USER WINDOW (WINDOWS 1 TO 4)

This fourteen-byte command packet defines a User Window. The Cursor Position of the new Window is automatically set to 0,0. The Cursor Control Mode, MD1, MD2, MD3 of the Window is not affected.

Command Packet Byte 1	Command Packet Byte 2	Command Packet Byte 3	Command Packet Byte 4				
8-bit	8-bit	8-bit	8-bit				
Command	Command	Command	Command				
1Fh	28h	77h	02h				
0 0 0 1 1 1 1 1	0 0 1 0 1 0 0 0	0 1 1 1 0 1 1 1	0 0 0 0 0 0 1 0				

Command Packet Byte 5	Command Packet Byte 6	Command Packet Byte 7	Command Packet Byte 8				
8 hit	8 bit	8-bit	8-bit				
Window Number	Define / Delete	Upper Left Corner X Position	Upper Left Corner X Position				
window Number	Define / Defete	Low Byte	High Byte				
W7 W6 W5 W4 W3 W2 W1 W0	D7 D6 D5 D4 D3 D2 D1 D0	X7 X6 X5 X4 X3 X2 X1 X0	X15 X14 X13 X12 X11 X10 X9 X8				

Command Packet Byte 9	Command Packet Byte 10	Command Packet Byte 11	Command Packet Byte 12
8-bit	8-bit	8-bit	8-bit
Upper Left Corner Y Position	Upper Left Corner Y Position	Window Size X	Window Size X
Low Byte	High Byte	Low Byte	High Byte
Y7 Y6 Y5 Y4 Y3 Y2 Y1 Y0	Y15 Y14 Y13 Y12 Y11 Y10 Y9 Y8	X7 X6 X5 X4 X3 X2 X1 X0	X15 X14 X13 X12 X11 X10 X9 X8

	Command Packet Byte 13								Co	mma	nd Pa	acket	Byte	14	
	8-bit							8-bit							
		Wi	ndov	v Size	eΥ			Window Size Y							
	Low Byte									High	Byte	•			
Y7	Y6	Y5	Y4	Y3	Y2	Y1	Y0	Y15	Y14	Y13	Y12	Y11	Y10	Y9	Y8

8-bit Window Number (W7:W0):

1 <= W value <= 4 (Invalid values terminate the command.)

8-bit Define / Delete (D7:D0):

- 0 Delete Window (If current Window is deleted, Window 0 becomes the current Window. This also terminates the command. Invalid values terminate the command.)
- 1 Define Window
- $0 \le D$ value ≤ 1

16-bit Upper Left Corner X Position (X15:X0):

0 <= X value <= 279

16-bit Upper Left Corner Y Position (Y15:Y0):

 $0 \le Y$ value ≤ 3

16-bit Window Size X (X15:X0):

1 <= X value <= 280

16-bit Window Size Y (Y15:Y0):

 $1 \le Y$ value ≤ 4

Note: After all command packet bytes are received, invalid values or if the Window does not fit in Display Memory cause entire command packet to be ignored.

	PART NUMBER:	REVISION:
Futada®	NAGP1250AB-x/BB-x	B.1
Eutaba Corporation of Amorida	DATE PRINTED:	SHEET:
Schaumburg, IL	17Oct12	37 OF 45

6.10.31 DEFINE BASE WINDOW (WINDOW 0)

This five-byte command packet defines Window 0's size, either 140x32 or 280x32.

Command Fuence Dyte F	at Dyte 2	Con	nmand Pac	кет Вут	e 3		C	omma	and Pa	acket	t Byte	e 4
8-bit 8-bit			8-bit						8-l	bit		
Command Command	d		Comma	ind					Com	mand	l	
1Fh 28h			77h						10)h		
0 0 0 1 1 1 1 1 0 0 1 0 1	0 0 0	0 1	1 1 () 1	1	0	0	0	1	0	0	0

8-bit Window 0 Size (Z7:Z0):

0 Use either the Standard Memory area or the Extended Memory area for Window 0. Whichever area Window 0's cursor is in becomes the defined area for Window 0, even when using the Set Cursor Position command to move the cursor to the opposite area.

1 Use both the Standard Memory and Extended Memory areas for Window 0.

 $0 \le Z$ value ≤ 1

Note: Invalid values are ignored.

6.10.32 CURSOR ON / OFF

This three-byte command packet turns the cursor on or off. When the cursor is on, it blinks at about 1Hz.

		Co	omma	and P	acke	t Byte	e 1			Co	omma	and P	acket	Byte	e 2			Сс	mma	and P	acke	t Byte	e 3	
				-8 Com 11	bit mand Fh	l						8-1 Comi 43	bit mand 3h	l					Cu	8-1 rsor (bit On / (Off		
(0	0	0	1	1	1	1	1	0	1	0	0	0	0	1	1	C7	C6	C5	C4	C3	C2	C1	C0

8-bit UDF Cursor On / Off (C7:C0):

- 0 Cursor off.
- 1 Cursor on.

0 <= C value <= 1

6.10.33 SELECT LUMINANCE LEVEL

This three-byte command packet sets the display luminance to one of eight levels.

Γ		Сс	omma	and P	acke	t Byt	e 1			Сс	mma	und P	acket	t Byt	e 2			Co	mma	and P	acket	t Byte	e 3	
				-8 Com 11	bit manc Fh	l						8-1 Comi 58	bit manc 3h	l					Lun	8- ninar	bit ice L	evel		
	0	0	0	1	1	1	1	1	0	1	0	1	1	0	0	0	L7	L6	L5	L4	L3	L2	L1	L0

8-bit Luminance Level (L7:L0):

- 1 12.5%
- 2 25%
- 3 37.5%
- 4 50%
- 5 62.5%
- 6 75%
- 7 87.5%
- 8 100%

 $1 \le L$ value ≤ 8

Note: Invalid values are ignored.

6.10.34 REVERSE VIDEO WRITE MODE ENABLE / DISABLE

This three-byte command packet enables / disables the Reverse Video Write Mode. When enabled, all data written to Display Memory is logically inverted.

	Co	omma	and P	acke	t Byt	e 1			Co	omma	und P	acke	t Byt	e 2			Co	omma	and P	acke	t Byt	e 3	
			8- Com	bit manc	1						8-l Com	bit manc	1				Pau	arca	8- Vide	bit o Wr	ite M	[ode	
			11	Fh							72	2h					Kev	erse	viue	0 11	ne w	loue	
0	0	0	1	1	1	1	1	0	1	1	1	0	0	1	0	R7	R6	R5	R4	R3	R2	R1	R0

8-bit Reverse Video Write Mode (R7:R0):

- 0 Disabled
- 1 Enabled
- $0 \le R$ value ≤ 1

	PART NUMBER:	REVISION:
Futada ®	NAGP1250AB-x/BB-x	B.1
Eutoba Corneration of America	DATE PRINTED:	SHEET:
Schaumburg, IL	17Oct12	39 OF 45

6.10.35 SET HORIZONTAL SCROLL SPEED

This three-byte command packet sets the Horizontal Scroll Speed for the MD3 mode.

	Co	omma	und P	acke	t Byt	e 1			Co	omma	und P	acket	Byte	e 2			Сс	omma	und P	acke	t Byte	e 3	
			-8 Com 11	bit mand Fh	1						8- Com 73	bit mand 3h	l				H	orizo	8-1 ntal S	bit Scrol	l Spe	ed	
0	0	0	1	1	1	1	1	0	1	1	1	0	0	1	1	S 7	S6	S5	S4	S 3	S2	S1	S0

8-bit Horizontal Scroll Speed (S7:S0):

Horizontal Scroll Speed is approximately S * 14ms per column. $0 \le S$ value ≤ 31

Note: Invalid values are ignored.

6.10.36 SELECT WRITE LOGIC MODE

This three-byte command packet selects the Write Logic Mode. As character data or graphic data is written it is logically combined with the data already in the Display Memory.

	Co	mma	and P	acke	t Byt	e 1			Co	omma	and P	acke	t Byte	e 2			Co	omma	and P	acke	t Byt	e 3	
			8-	bit							8-	bit							8-	bit			
			Com 11	manc Fh	1						Com 7	manc 7h	l					Wri	te Lo	gic N	lode		
0	0	0	1	1	1	1	1	0	1	1	1	0	1	1	1	L7	L6	L5	L4	L3	L2	L1	L0

8-bit Write Logic Mode (L7:L0):

0 Normal (overwrites existing data)

- 1 OR (combines new and existing data)
- 2 AND (masks existing data)
- 3 XOR (inverts existing data when new data is 0xFF)
- $0 \le L$ value ≤ 3

	PART NUMBER:	REVISION:
Futada®	NAGP1250AB-x/BB-x	B.1
Eutoba Corneration of America	DATE PRINTED:	SHEET:
Schaumburg, IL	17Oct12	40 OF 45

6.10.37 WRITE CHARACTER

This single-byte command packet writes the specified character to Display Memory at the Cursor Position in the currently selected Window based on the current Cursor Mode (MD1, MD2, or MD3), the current Character Width and Spacing and the current Font Magnification. The character is taken from selected Font Set unless it is redefined and enabled as a UDF.

	Co	omma	and P	acket	Byte	e 1	
			8-	bit			
		Cha	racte	r Nur	nber		
		2	20h te	o FFł	ı		
C7	C6	C5	C4	C3	C2	C1	C0

Write Character operation when Cursor Mode = Overwrite (MD1):

Font Magnification Y	X Direction	Y Direction	Write Character Operation
	Space is available on the current row for the character and the cursor.		 The character is written at the current cursor position. The cursor moves to the right of the new character.
	Space is available on the current row for the character but not the	Space is available for 1, 2, 3 or 4 rows below the current row.	 The character is written at the current cursor position. The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the current row.
	cursor.	Space is not available for 1, 2, 3 or 4 rows below the current row.	 The character is written at the current cursor position. The cursor moves to the left end of the top row.
	Space is available at the left end of a	Space is available for 1, 2, 3 or 4 rows below the current row.	 The character is written at the left end of the row 1, 2, 3 or 4 rows below the current row. The cursor moves to the right of the new character.
	row for the character and the cursor.	Space is not available for 1, 2, 3 or 4 rows below the current row.	 The character is written at the left end of the top row. The cursor moves to the right of the new character.
1, 2, 3 or 4 rows		Space is available for 1, 2, 3 or 4 rows below the current row and space is available for 1, 2, 3 or 4 rows below that.	 The character is written at the left end of the row 1, 2, 3 or 4 rows below the current row. The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the new character.
	Space is available at the left end of a row for the character but not the	Space is available for 1, 2, 3 or 4 rows below the current row but space is not available for 1, 2, 3 or 4 rows below that.	 The character is written at the left end of the row 1, 2, 3 or 4 rows below the current row. The cursor moves to the left end of the top row.
	cursor.	Space is not available for 1, 2, 3 or 4 rows below the current row but space is available for 1, 2, 3 or 4 rows below the top 1, 2, 3 or 4 rows.	 The character is written at the left end of the top row. The cursor moves to the left end of the row 1, 2, 3 or 4 rows the new character.
		Space is not available for 1, 2, 3 or 4 rows below the current row and space is not available for 1, 2, 3 or 4 rows below the top 1, 2, 3 or 4 rows.	 The character is written at the left end of the top row. The cursor moves to the left end of the top row.
	Space is not available for the	Space is available for 1, 2, 3 or 4 rows below the current row.	1) The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the current row.
		Space is not available for 1, 2, 3 or 4 rows below the current row.	1) The cursor moves to the right of the top row.

Futaba Corporation of America Schaumburg, IL

PART NUMBER:	REVISION:
NAGP1250AB-x/BB-x	B.1
DATE PRINTED:	SHEET:
17Oct12	41 OF 45

Font Magnification Y	X Direction	Y Direction	Write Character Operation
	Space is available on the current row for the character and the cursor.		 The character is written at the current cursor position. The cursor moves to the right of the new character.
	Space is queilable on the surrant	Space is available for 1, 2, 3 or 4 rows below the current row.	 The character is written at the current cursor position. The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the current row.
	row for the character but not the cursor.	Space is not available for 1, 2, 3 or 4 rows below the current row.	 The character is written at the current cursor position. The displayed pattern is scrolled up 1, 2, 3 or 4 rows while clearing the bottom 1, 2, 3 or 4 rows. The cursor moves to the left end of the current row.
		Space is available for 1, 2, 3 or 4 rows below the current row.	 The character is written at the left end of the row 1, 2, 3 or 4 rows below the current row. The cursor moves to the right of the new character.
	Space is available at the left end of a row for the character and the cursor.	Space is not available for 1, 2, 3 or 4 rows below the current row.	 The displayed pattern is scrolled up 2, 3 or 4 rows while clearing the bottom 1, 2, 3 or 4 rows. The character is written at the left end of the current row. The cursor moves to the right of the new character.
1, 2, 3 or 4 rows		Space is available for 1, 2, 3 or 4 rows below the current row and space is available for 1, 2, 3 or 4 rows below that.	 The character is written at the left end of the row 1, 2, 3 or 4 rows below the current row. The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the new character.
	Space is available at the left end of a row for the character but not the cursor.	Space is available for 1, 2, 3 or 4 rows below the current row but space is not available for 1, 2, 3 or 4 rows below that.	 The character is written at the left end of the row 1, 2, 3 or 4 rows below the current row. The displayed pattern is scrolled up 1, 2, 3 or 4 rows while clearing the bottom 1, 2, 3 or 4 rows. The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the new character.
		Space is not available for 1, 2, 3 or 4 rows below the current row.	 The displayed pattern is scrolled up 2, 3 or 4 rows while clearing the bottom 1, 2, 3 or 4 rows. The character is written at the left end of the current row. The displayed pattern is again scrolled up 1, 2, 3 or 4 rows while clearing the bottom 1, 2, 3 or 4 rows. The current row
		Space is available for 1, 2, 3 or 4 rows below the current row.	 The cursor moves to the left end of the row 1, 2, 3 or 4 rows below the current row.
	Space is not available for the character.	Space is not available for 1, 2, 3 or 4 rows below the current row.	 The displayed pattern is scrolled up 2, 3 or 4 rows while clearing the bottom 1, 2, 3 or 4 rows. The cursor moves to the left end of the current row.

Futaba Corporation of America Schaumburg, IL PART NUMBER: REVISION: NAGP1250AB-x/BB-x B.1 DATE PRINTED: SHEET: 17Oct12 42 OF 45

Write Character operation when Cursor Mode = Horizontal Scroll (MD3):

Font Magnification Y	nt Magnification Y X Direction Y Direction		Write Character Operation
	Space is available on the current row for the character and the cursor.		 The character is written at the current cursor position. The cursor moves to the right of the new character.
	Space is available on the current row for the character but not the cursor.		 The character is written at the current cursor position. The cursor moves to the right end of the current row.
1, 2, 3 or 4 rows	Space is available on current row for some of the character.		 As much of the character that fits on the current row is written at the current cursor position. The displayed pattern on the current row and the 1, 2 or 3 rows below are scrolled left, filling the rightmost column with the rest of the character data. The cursor moves to the right end of the current row.
	The cursor is at the right end of the current row.		 The displayed pattern on the current row and the 1, 2 or 3 rows below are scrolled left, filling the rightmost column with character data. The cursor moves to the right end of the current row.

	PART NUMBER:	REVISION:
Futaba®	NAGP1250AB-x/BB-x	B.1
Tutoha Componstion of Imanias	DATE PRINTED:	SHEET:
Schaumburg, IL	17Oct12	43 OF 45

7.0 CONNECTORS AND JUMPERS

Contact Futaba for customer specified connector and/or cable options and factory preconfigured jumper settings.

7.1 CN1 – PARALLEL INTERFACE

The parallel interface, CN1, consists of 14 plated through holes in the PCB, in a 1x14 or 2x7 array depending on the module version.

Pin	Signal	Pin	Signal
1	GND	8	D1
2	V _{CC}	9	D2
3	/RESET or PBUSY	10	D3
4	no internal connection	11	D4
5	/WR	12	D5
6	/RD	13	D6
7	D0	14	D7 and PBUSY

7.2 CN2 – SERIAL INTERFACE

The serial interface, CN2, consists of 6 plated through holes in the PCB, in a 1x6 array.

Pin	Signal
1	V _{CC}
2	SIN
3	GND
4	SBUSY
5	SCK
6	/RESET

	PART NUMBER:	REVISION:
Futaba ®	NAGP1250AB-x/BB-x	B.1
Eutobe Componetion of Imenias	DATE PRINTED:	SHEET:
Futaba Corporation of America Schaumburg, IL	170ct12	44 OF 45

7.3 JRB – SIGNAL SELECT FOR CN1 PIN 3

The signal select, JRB, consists of 3 plated through holes in the PCB, in a 1x3 array. Connecting pin 1 to pin 2 routes the /RESET signal to CN1 pin 3, likewise connecting pin 3 to pin 2 routes the PBUSY signal to CN1 pin 3. Similarly, either jumper JR or JB can be placed to route a signal to CN1 pin 3.

Pin	Signal
1	/RESET
2	CN1 pin 3
3	PBUSY

Note: Do not route both signals to CN1 pin 3 at once or connect them together.

7.4 JUMPERS J0 THROUGH J3

These jumpers are used to select module options.

JO	J1	J2	J3	Function		
open	open		Х	Asynchronous serial at 38400 baud		
shorted	open	open x x x		Asynchronous serial at 19200 baud		
open	shorted			open	Х	Asynchronous serial at 9600 baud
shorted	shorted			Asynchronous serial at 115200 baud		
Х	Х	shorted	Х	Synchronous serial		
				Self-test image displayed at power-up and after a reset for about 4		
Х	Х	Х	shorted	seconds before the all dots on screen saver is displayed.		
				(image includes software revision)		

	PART NUMBER:	REVISION:
Futada	NAGP1250AB-x/BB-x	B.1
Butche Componetion of America	DATE PRINTED:	SHEET:
Futaba Corporation of America Schaumburg, IL	17Oct12	45 OF 45

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