NHD-0216K3Z-FS(RGB)-FBW

Serial Liquid Crystal Display Module

NHD-	Newhaven Display
0216-	2 lines x 16 characters
K3Z-	Model
F-	Transflective
S(RGB)-	Side LED backlights (Red-Green-Blue)
F-	FSTN+
B-	6:00 view
W-	Wide Temperature (-20°C ~ +70°C)
	RoHS Compliant

Document Revision History

Revision	Date	Description	Changed by
0	7/11/2007	Initial Release	-
1	12/15/2009	User guide reformat	CL

Functions and Features

- **2 lines x 16 characters**
- **Red/Green/Blue LED backlights**
- **Serial Interface: I2C, SPI or RS232**
- **5V power supply**
- **1/16 duty, 1/5 bias**
- **5x8 pixels with cursor**
- **RoHS Compliant**

Mechanical Drawing
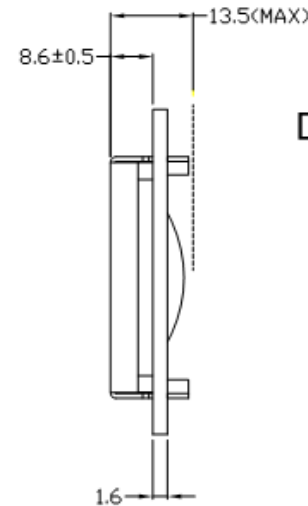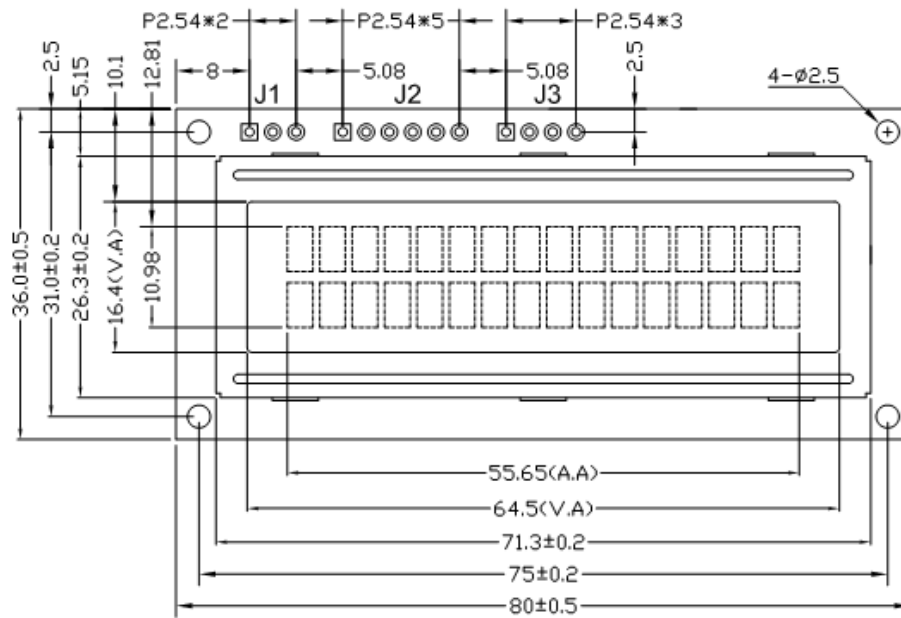
Display Pattern
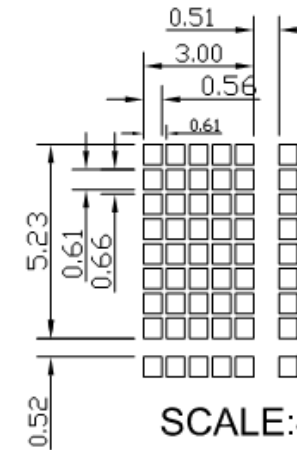
SCALE:4:1

Notes:
1). Drive Method: 1/16duty, 1/5bias, VDD5.0V VLCD4.5V
2). Display Type: FSTN/Positive/Transflective/6:00 Angle
3). Operating Temp: -20°C~70°C/Storage Temp: -30°C~80°C
4). Backlight Type: Edge/R,G,B
5). Driver: SPLC780D And PIC16F690 MPU
6). RoHS Compliant

NHD-0216K3Z-FS(RGB)-FBW

[3]

Pin Description

Pin No.	Symbol	External Connection	Function Description
1	RX	MPU	RS232 Serial input port
2	VSS	Power Supply	Ground
3	VDD	Power Supply	Power supply for logic (+5.0V)
1	SPISS	MPU	SPI Slave Select (NC in I2C mode)
2	SDO	NC	No Connect
3	SCK/SCL	MPU	Serial Clock
4	SDI/SDA	MPU	Serial Data In (SPI) / Serial Data (I2C)
5	VSS	Power Supply	Ground
6	VDD	Power Supply	Power Supply for logic (+5.0V)
1	K	Power Supply	Ground for LED backlights
2	A-RED	Power Supply	Power supply for Red LED (2.2V)
3	A-GREEN	Power Supply	Power supply for Green LED (3.3V)
4	A-BLUE	Power Supply	Power supply for Blue LED (3.3V)

Recommended LCD connector: 2.54mm pitch pins on J1 or J2
Backlight connector: 2.54mm pitch pins on J3

Jumper Communication Selection

R1	R2	Protocol	Description
Short	Short	TEST	Self-test
Open	Short	SPI	100KHz max clock
Short	Open	I2C	100KHz max clock
Open	Open	RS232	5V, TTL signal

Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Temperature Range	Top		-20	-	+70	ºC
Storage Temperature Range	Tst		-30	-	+80	ºC
Supply Voltage	VDD		4.7	5.0	5.5	V
Supply Current	IDD	Ta=25°C VDD=5.0V	-	18	-	mA
Supply for LCD (contrast)	V_{DD}-V_0	Ta=25°C	-	-	-	V
"H" Level input (Schmitt Trigger)	Vih		0.8VDD	-	VDD	V
"L" Level input (Schmitt Trigger)	Vil		VSS	-	0.2VDD	V
"H" Level output	Voh		-	-	-	V
"L" Level output	Vol		-	-	-	V
Backlight Supply Current – Red	Iled	Vled=2.2V	-	20	30	mA
Backlight Supply Voltage – Red	Vled	Ta=25°C	-	2.2	-	V
Backlight Supply Current – Green	Iled	Vled=3.3V	-	20	30	mA
Backlight Supply Voltage – Green	Vled	Ta=25°C	-	3.3	-	V
Backlight Supply Current – Blue	Iled	Vled=3.3V	-	20	30	mA
Backlight Supply Voltage – Blue	Vled	Ta=25°C	-	3.3	-	V

Optical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing Angle – Top	θ	Cr ≥ 2	-	35	-	º
Viewing Angle – Bottom	θ	Cr ≥ 2	-	60	-	º
Viewing Angle – Left	Φ	Cr ≥ 2	-	40	-	º
Viewing Angle – Right	Φ	Cr ≥ 2	-	40	-	º
Contrast Ratio	Cr		-	6	-	-
Response Time (rise)	Tr	-	-	150	250	ms
Response Time (fall)	Tf	-	-	150	250	ms

Built-in LCD Controller: PIC 16F690

http://www.newhavendisplay.com/app_notes/PIC16F690.pdf

Communication Information
This display uses a built-in PIC 16F690 for serial communication.

I2C protocol:
To enter the I2C mode, place a jumper on R1.
SDA and SDK have pull-up resistors (10K Ohm) on R7 and R8.
The default I2C address is 80 (50 hex). The I2C address can be changed to any 8-bit value by command function, with the exception that the LSB (least significant bit) must always be '0'. Once the I2C address has been changed, it will be saved in the system memory, and it will revert back to the default address if either RS232 or SPI protocol is selected. The I2C interface is capable of receiving data at up to 100KHz-clock rate.

SPI protocol:
To enter the SPI mode, place a jumper on R2.
SPI mode has a normally high level idle clock. When Slave Select is LOW, data is sampled on the rising edge of the Clock.
The SPI interface is capable of receiving data at up to 100KHz-clock rate.

RS232 protocol:
To enter the RS232 mode, both R1 and R2 should be open.
The RS232 signal must be 5V TTL compatible. Communication format is 8-bit data, 1 Stop bit, no parity, no hand-shaking. Default BAUD rate is 9600, and is changeable with a command function. Once the BAUD rate has been changed, it will be saved in the system memory, and it will revert back to the default address if either I2C or SPI protocol is selected.

ASCII TEXT
To display normal text, just enter its **ASCII** number. A number from **0x00 to 0x07** displays the user defined custom character**, 0x20 to 0x7F** displays the standard set of characters, **0xA0 to 0xFD** display characters and symbols that are factory-masked on the SPLC780D controller. 0xFE is reserved.

Table of Commands

Prefix	CMD	Param	Description
0xFE	0x41	None	Display on
0xFE	0x42	None	Display off
0xFE	0x45	1 Byte	Set cursor
0xFE	0x46	None	Cursor home
0xFE	0x47	None	Underline cursor on
0xFE	0x48	None	Underline cursor off
0xFE	0x49	None	Move cursor left one place
0xFE	0x4A	None	Move cursor right one place
0xFE	0x4B	None	Blinking cursor on
0xFE	0x4C	None	Blinking cursor off
0xFE	0x4E	None	Backspace
0xFE	0x51	None	Clear screen
0xFE	0x52	1 Byte	Set contrast
0xFE	0x53*	1 Byte	Set backlight brightness***Not used on RGB display***
0xFE	0x54	9 Byte	Load custom character
0xFE	0x55	None	Move display one place to the left
0xFE	0x56	None	Move display one place to the right
0xFE	0x61	1 Byte	Change RS232 BAUD rate 232
0xFE	0x62	1 Byte	Change I2C address
0xFE	0x70	None	Display firmware version number
0xFE	0x71	None	Display RS232 BAUD rate
0xFE	0x72	None	Display I2C address

Changing the I2C Slave Address

Syntax   hexadecimal   0xFE   0x62   [adr]

Parameter

Parameter	Length	Description
[adr]	1 byte	New I^{2}C address, 0x00 – 0xFE
		The LSB is always '0'.

Description   This command sets the I2C address, the address must be an even number, (LSB = 0). The address change requires 20 microsecond to take effect; therefore, the subsequent input must have an appropriate delay. The default I2C address can be restored if SPI or RS232 is selected as the communication mode.

Default   0x50

Changing BAUD Rate

Syntax	hexadecimal	0xFE	0x61	[baud]

Parameter	Parameter	Length	Description
	[baud]	1 byte	New RS232 BAUD Rate, 1 - 8

Description   This command sets the RS232 BAUD rate, the single byte parameter select the desired BAUD rate as in the table below. The new BAUD rate requires 20 microsecond to take effect, therefore, the subsequent input must have an appropriate delay. The default BAUD rate can be restored if I2C or SPI is selected as the communication mode. Illegal parameter input will be discarded.

Default   9600 BAUD

Parameter	BAUD
1	300
2	1200
3	2400
4	9600
5	14400
6	19.2K
7	57.6K
8	115.2K

Turn On Display

Syntax	hexadecimal	0xFE	0x41

Parameter	Parameter	Length	Description
	None	None	Turn on LCD screen

Description   This command turns on the LCD display screen, the display text is not altered.
Default   LCD screen is on

Turn Off Display

Syntax	hexadecimal	0xFE	0x42

Parameter	Parameter	Length	Description
	None	None	Turn off LCD screen

Description   This command turns off the LCD display screen, the display text is not altered.
Default   LCD screen is on

Set Cursor Position

Syntax   hexadecimal   0xFE   0x45 [pos]

Parameter

Parameter	Length	Description
[pos]	1 byte	Put cursor at location specified by [pos], 0x00 to 0x67

Description   This command moves the cursor to a specified location where the next character will be displayed. The typical cursor position for a 4-line display is show below; a cursor position outside these ranges will not be viewable.

.	Column1	Column20
Line1	0x00	0x13
Line 2	0x40	0x53
Line 3	0x14	0x27
Line 4	0x54	0x67

Default   After a reset, the cursor is on position 0x00.

Home Cursor

Syntax   hexadecimal   0xFE   0x46

Parameter

Parameter	Length	Description
None	None	Position cursor at line 1 column 1

Description   This command move the cursor to line 1, column 1 of the LCD screen, the display text is not altered.

Default   None

Turn On Underline Cursor

Syntax   hexadecimal   0xFE   0x47

Parameter

Parameter	Length	Description
None	None	Turn on underline cursor

Description   This command turns on the underline cursor, the cursor position is where the next character will appear.

Default   The underline cursor is off.

Turn Off Underline Cursor

Syntax   hexadecimal   0xFE   0x48

Parameter

Parameter	Length	Description
None	None	Turn off underline cursor

Description   This command turns off the underline cursor.

Default   The underline cursor is off.

Move Cursor Left One Space

Syntax	hexadecimal	0xFE 0x49

Parameter	Length	Description
None	None	Move cursor left 1 space

Description This command moves the cursor position left 1 space, regardless the cursor is displayed or not, and the displayed character is not altered

Default None

Move Cursor Right One Space

Syntax	hexadecimal	0xFE 0x4A

Parameter	Length	Description
None	None	Move cursor right 1 space

Description This command moves the cursor position right 1 space, regardless the cursor is displayed or not, and the displayed character is not altered

Default None

Turn On Blinking Cursor

Syntax	hexadecimal	0xFE 0x4B

Parameter	Length	Description
None	None	Turn on the blinking cursor

Description This command turns on the blinking cursor, both the cursor and the character on the cursor will blink.

Default The blinking cursor is off.

Turn Off Blinking Cursor

Syntax	hexadecimal	0xFE 0x4C

Parameter	Length	Description
None	None	Turn off the blinking cursor

Description This command turns off the blinking cursor.

Default The blinking cursor is off.

Back Space

Syntax	hexadecimal	0xFE 0x4E

Parameter	Length	Description
None	None	Move cursor back one space, deletes the character on the cursor.

Description This command is destructive backspace, the cursor is moved back one space and the character on the cursor is deleted.

Default None.

Clear Screen

Syntax   hexadecimal   0xFE   0x51

Parameter	Parameter	Length	Description
	None	None	Clear LCD and move cursor to line 1 column 1.
Description	This command clears the entire display and place the cursor at line 1 column 1.		
Default	None.		

Set Display Contrast

Syntax   hexadecimal   0xFE   0x52   [contrast]

Parameter	Parameter	Length	Description
	[contrast]	1 byte	Set the display contrast, value between 1 to 50
Description	This command sets the LCD character display contrast, the contrast setting is between 1 to 50, where 50 is the highest contrast.		
Default	Default contrast value is 40.		

Load Custom Characters

Syntax   hexadecimal   0xFE   0x54   [addr] [d0 …d7]

Parameter	Parameter	Length	Description
	[addr]	1 byte	Custom character address, 0 – 7
	[D0..D7]	8 bytes	Custom character pattern bit map
Description	There are space for eight user defined custom characters, this command load the custom character into one of the eight locations. The custom character pattern is bit mapped into 8 data bytes, the bit map for Spanish character '¿' is shown in table below, to display the custom character, user simply enter the address of the character (0 to 8).		
Default	None.		

Bit	7	6	5	4	3	2	1	0	Hex
Byte 1	0	0	0	0	0	1	0	0	0x04
Byte 2	0	0	0	0	0	0	0	0	0x00
Byte 3	0	0	0	0	0	1	0	0	0x04
Byte 4	0	0	0	0	1	0	0	0	0x08
Byte 5	0	0	0	1	0	0	0	0	0x10
Byte 6	0	0	0	1	0	0	0	1	0x11
Byte 7	0	0	0	0	1	1	1	0	0x0E
Byte 8	0	0	0	0	0	0	0	0	0x00

Shift Display to the Left

Syntax	hexadecimal	0xFE	0x55

Parameter	Parameter	Length	Description
	None	None	Shift the LCD screen to the left one Place.
Description	This command shifts the display one place to the left, the cursor position also moves with the display, and the display data is not altered.		
Default	None		

Shift Display to the Right

Syntax	hexadecimal	0xFE	0x56

Parameter	Parameter	Length	Description
	None	None	Shift the LCD screen to the right one Place.
Description	This command shifts the display one place to the right, the cursor position also moves with the display, and the display data is not altered.		
Default	None		

Display Firmware Version Number

Syntax	hexadecimal	0xFE	0x70

Parameter	Parameter	Length	Description
	None	None	Display the firmware version number.
Description	This command displays the micro-controller firmware version number.		
Default	None.		

Display RS232 Baud Rate

Syntax	hexadecimal	0xFE	0x71

Parameter	Parameter	Length	Description
	None	None	Display Baud Rate
Description	This command displays the current RS232 BAUD rate.		
Default	None.		

Display I^{2}C Address

Syntax	hexadecimal	0xFE	0x72

Parameter	Parameter	Length	Description
	None	None	Display I^{2}C Address
Description	This command displays the current I^{2}C slave address.		
Default	None.		

Built-in Font Table

Lower 4 Bits \ Upper 4 Bits	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)			0	@	P	`	p				─	9	ミ	α	p
xxxx0001	(2)		!	1	A	Q	a	q			。	ア	チ	ム	ä	q
xxxx0010	(3)		"	2	B	R	b	r			「	イ	ツ	メ	β	θ
xxxx0011	(4)		#	3	C	S	c	s			」	ウ	テ	モ	ε	∞
xxxx0100	(5)		$	4	D	T	d	t			、	エ	ト	ヤ	μ	Ω
xxxx0101	(6)		%	5	E	U	e	u			・	オ	ナ	ユ	σ	ü
xxxx0110	(7)		&	6	F	V	f	v			ヲ	カ	ニ	ヨ	ρ	Σ
xxxx0111	(8)		'	7	G	W	g	w			ア	キ	ヌ	ラ	g	π
xxxx1000	(1)		(	8	H	X	h	x			イ	ク	ネ	リ	√	x̄
xxxx1001	(2)		)	9	I	Y	i	y			ゥ	ケ	ノ	ル	⁻¹	y
xxxx1010	(3)		*	:	J	Z	j	z			エ	コ	ハ	レ	j	千
xxxx1011	(4)		+	;	K	[	k	{			オ	サ	ヒ	ロ	ˣ	万
xxxx1100	(5)		,	<	L	¥	l					ャ	シ	フ	ワ	¢	円
xxxx1101	(6)		─	=	M	]	m	}			ュ	ス	ヘ	ン	₺	÷
xxxx1110	(7)		.	>	N	^	n	→			ョ	セ	ホ	゛	ñ	
xxxx1111	(8)		/	?	O	_	o	←			ッ	ソ	マ	゜	ö	█

Example Initialization Program

See program code at http://www.newhavendisplay.com/app_notes/Serial_LCD.txt

Quality Information

Test Item	Content of Test	Test Condition	Note
High Temperature storage	Endurance test applying the high storage temperature for a long time.	+80°C , 48hrs	2
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-30°C , 48hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.	+70°C 48hrs	2
Low Temperature Operation	Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.	-20°C , 48hrs	1,2
High Temperature / Humidity Operation	Endurance test applying the electric stress (voltage & current) and the high thermal with high humidity stress for a long time.	+40°C , 90% RH , 48hrs	1,2
Thermal Shock resistance	Endurance test applying the electric stress (voltage & current) during a cycle of low and high thermal stress.	0°C,30min -> +25°C,5min -> +50°C,30min = 1 cycle 10 cycles	
Vibration test	Endurance test applying vibration to simulate transportation and use.	10-55Hz , 15mm amplitude. 60 sec in each of 3 directions X,Y,Z For 15 minutes	3
Static electricity test	Endurance test applying electric static discharge.	VS=800V, RS=1.5kΩ, CS=100pF One time	

Note 1: No condensation to be observed.
Note 2: Conducted after 4 hours of storage at 25°C, 0%RH.
Note 3: Test performed on product itself, not inside a container.

Precautions for using LCDs/LCMs

See Precautions at www.newhavendisplay.com/specs/precautions.pdf

Warranty Information and Terms & Conditions

http://www.newhavendisplay.com/index.php?main_page=terms