NEWHAVEN DISPLAY
INTERNATIONAL

Product Specification

NHD-0216K3Z-FL-GBW-V3

Serial Liquid Crystal Display Module

NHD-	Newhaven Display
0216-	2 Lines x 16 Characters
K3Z-	Model
F-	Transflective
L-	Yellow/Green LED Backlight
G-	STN (+) Gray
B-	6:00 Optimal View
W-	Wide Temperature
V3-	Firmware Version 3.00

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REACH Compliant

RoHS Compliant

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Table of Contents

Document Revision History 2
Mechanical Drawing 3
Pin Description 4
Jumper Selection 4
Electrical Characteristics 5
Optical Characteristics 5
Controller Information 5
Communication Information 6
Table of Commands 7
Built-in Font Table 14
Quality Information 15

Additional Resources

- **Support Forum:** https://support.newhavendisplay.com/hc/en-us/community/topics
- **GitHub:** https://github.com/newhavendisplay
- **Example Code:** https://support.newhavendisplay.com/hc/en-us/categories/4409527834135-Example-Code/
- **Knowledge Center:** https://www.newhavendisplay.com/knowledge_center.html
- **Quality Center:** https://www.newhavendisplay.com/quality_center.html
- **Precautions for using LCDs/LCMs:** https://www.newhavendisplay.com/specs/precautions.pdf
- **Warranty / Terms & Conditions:** https://www.newhavendisplay.com/terms.html

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Document Revision History

Revision	Date	Description	Changed By
0	05/16/2012	Initial Release	SB
1	10/01/2012	Character address code updated	AK
2	12/30/2015	Module Redesign	SB
3	12/29/2016	Backlight & PCB Redesign	SB
4	09/11/2018	Supply Voltage & I^2C Speed Updated	SB
5	06/10/2019	SPI & Self-Test Information Updated	SB
6	08/29/2019	I^2C Information, Custom Character note Added	AS
7	09/23/2019	Glass Supplier Changed, Supply Current Updated	SB
8	09/29/2021	Mechanical Drawing & Quality Information Updated	ZP
9	07/25/2023	Date Code Format Updated on Mechanical Drawing	KL

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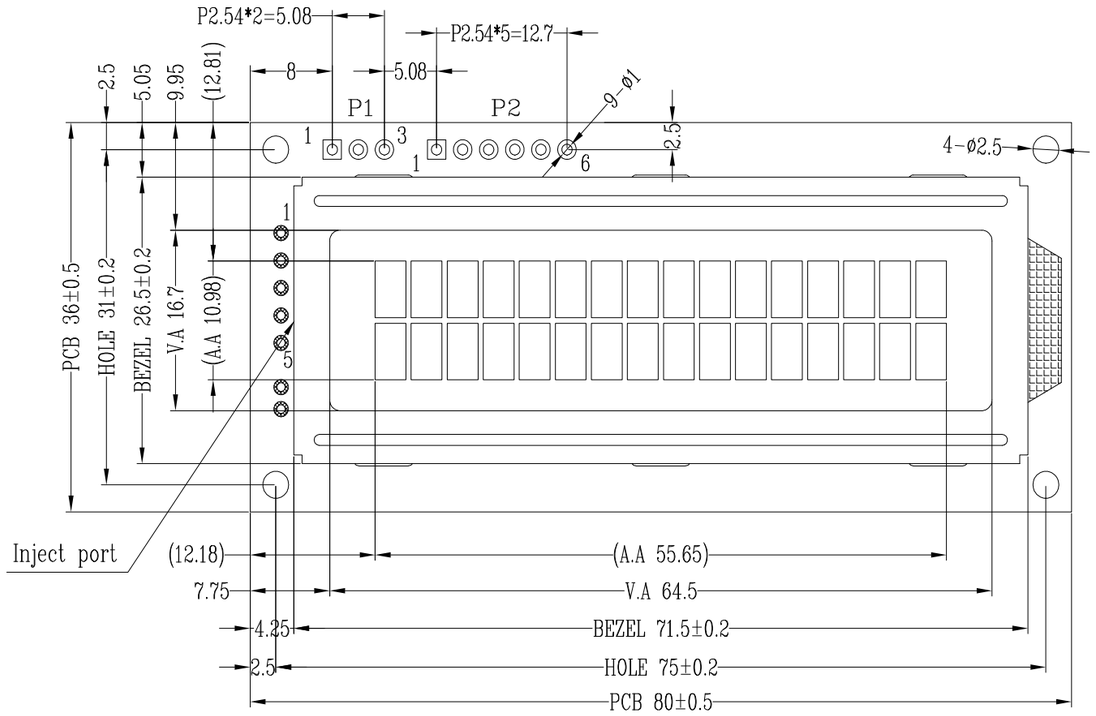
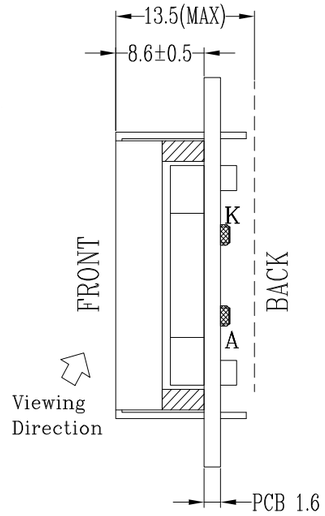
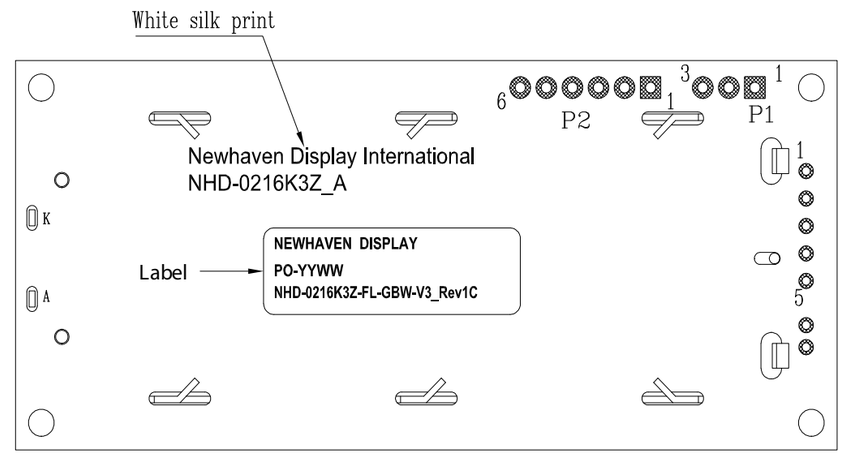
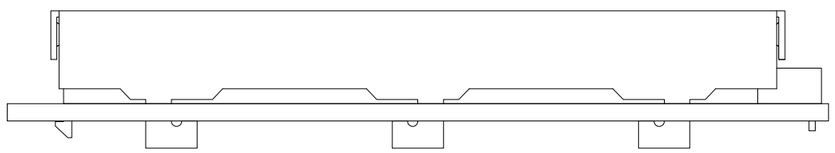
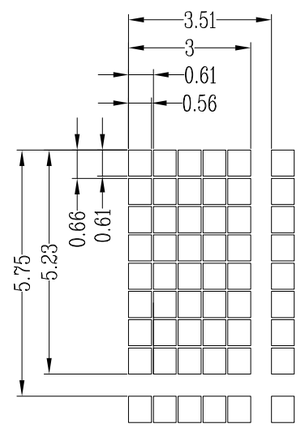
Mechanical Drawing











DOTS DETAIL
SCALE 4:1

P1	
NO.	Symbol
1	RX
2	VSS
3	VDD

P2	
NO.	Symbol
1	SPISS
2	SDO
3	SCK/SCL
4	SDI/SDA
5	VSS
6	VDD

Product Description: 2x16 Character LCD

1. Driver IC: PIC16F690
2. Driving Mode: 1/16 Duty, 1/5 Bias
3. Interface: RS323 (TTL), SPI, I²C
4. Power Requirement: 5.0V LCD
5. Optical Features: STN (+) Gray, Transflective, 6:00 View, Yellow/Green Backlight
6. Recommended Pin Header:
   - P1: 1x3pin 2.54mm pitch
   - P2: 1x6pin 2.54mm pitch

Standard Tolerance:
(Unless otherwise specified)
Linear: ±0.3mm

NEWHAVEN DISPLAY INTERNATIONAL

Drawing/Part Number: NHD-0216K3Z-FL-GBW-V3
Revision: 1C

Unless otherwise specified:
- Dimensions are in Millimeters
- Third Angle Projection

Drawn By: K. Lewis
Drawn Date: 07/25/2023
Approved By: K. Lewis
Approved Date: 07/25/2023

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Pin Description

P1:

Pin No.	Symbol	External Connection	Function Description
1	RX	MPU	RS-232 (TTL) Serial input port
2	V_{SS}	Power Supply	Ground
3	V_{DD}	Power Supply	Supply Voltage (+5.0V)

P2:

Pin No.	Symbol	External Connection	Function Description
1	SPISS	MPU	SPI Slave Select (NC in I^2C mode)
2	SDO	NC	No Connect
3	SCK/SCL	MPU	Serial Clock
4	SDI/SDA	MPU	Serial Data In (SPI) / Serial Data (I^2C)
5	V_{SS}	Power Supply	Ground
6	V_{DD}	Power Supply	Supply Voltage (+5.0V)

Recommended LCD connector: 2.54mm pitch pins on P1 or P2
Backlight connector: controlled by command **Mates with**: -

Jumper Selection

R1	R2	Protocol	Description
Short	Short	TEST	Self-test
Open	Short	SPI	100KHz max clock
Short	Open	I^2C	50KHz max clock
Open	Open	RS-232	5V, TTL signal

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Electrical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Operating Temperature Range	T_{OP}	-	-20	-	+70	°C
Storage Temperature Range	T_{ST}	-	-30	-	+80	°C
Supply Voltage	V_{DD}	-	4.7	5.0	5.5	V
Supply Current (LCD + Backlight)	I_{DD}	V_{DD} = 5.0V T_{OP} = 25°C	7	18	25	mA
Supply for LCD (contrast)	V_{LCD}		4.0	4.3	4.6	V
"H" Level input	V_{IH}	-	0.8 * V_{DD}	-	V_{DD}	V
"L" Level input	V_{IL}	-	V_{SS}	-	0.2 * V_{DD}	V

Optical Characteristics

Item		Symbol	Condition	Min.	Typ.	Max.	Unit
Optimal Viewing Angles	Top	φY+	CR ≥ 3	-	20	-	°
	Bottom	φY-		-	40	-	°
	Left	θX-		-	40	-	°
	Right	θX+		-	40	-	°
Contrast Ratio		Cr	-	2	4	-	-
Response Time	Rise	T_R	T_{OP} = 25°C	-	112	400	ms
	Fall	T_F		-	165	400	ms

Controller Information

Built-in PIC16F690 Controller: https://support.newhavendisplay.com/hc/en-us/articles/4414777456791-PIC-16F690

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Communication Information

This display uses a built-in PIC16F690 for serial communication.
100mS delay is required upon power-up for the built-in PIC to initialize the display controller.

I^2C protocol:

To enter the I^2C mode, place a jumper on R1.
SDA and SCL have pull-up resistors (10K Ohm) on R7 and R8.
The default I^2C address is 80 (50 hex) when counting the R/W bit, and 40 (28 hex) if not. The I^2C 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 I^2C address has been changed, it will be saved in the system memory, and it will revert back to the default address if either RS-232 or SPI protocol is selected.
The I^2C interface can receive data at up to 50KHz clock rate.

SPI protocol:

To enter the SPI mode, place a jumper on R2.
SPI mode has a normally high idle clock. When Slave Select is LOW, data is sampled on the rising edge of the Clock.
The SPI interface can receive data at up to 100KHz clock rate.
SPI Mode 3
CPOL = 1
CPHA = 1

RS-232 (TTL) protocol:

To enter the RS-232 mode, both R1 and R2 should be open.
The RS-232 signal must be 5V TTL compatible. Communication format is 8-bit data, 1 Stop bit, no parity, no handshaking. 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 to the default address if either I^2C or SPI protocol is selected.

Self-Test Mode

To enter self-test mode, both R1 and R2 should be populated with a 0Ω resistor.
In self-test mode the backlight will be turned on and set to high, the contrast will be set to nominal value. Then the display returns the following screens:
Screen 1:
- Newhaven Display

Screen 2:
- Firmware Version 3.0

Screen 3:
- Default baud rate: 9600
- Default I^2C Slave Address: 0x50

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 ST7066U controller. 0xFE is reserved.

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Table of Commands

Prefix	Command	Parameter	Description	Execution time
-	-	1 Byte	Display Character Write (0x00 ~ 0xFF) [1]	100uS
0xFE	0x41	None	Display on	100uS
0xFE	0x42	None	Display off	100uS
0xFE	0x45	1 Byte	Set cursor	100uS
0xFE	0x46	None	Cursor home	1.5mS
0xFE	0x47	None	Underline cursor on	1.5mS
0xFE	0x48	None	Underline cursor off	1.5mS
0xFE	0x49	None	Move cursor left one place	100uS
0xFE	0x4A	None	Move cursor right one place	100uS
0xFE	0x4B	None	Blinking cursor on	100uS
0xFE	0x4C	None	Blinking cursor off	100uS
0xFE	0x4E	None	Backspace	100uS
0xFE	0x51	None	Clear screen	1.5mS
0xFE	0x52	1 Byte	Set contrast	500uS
0xFE	0x53	1 Byte	Set backlight brightness	100uS
0xFE	0x54	9 Byte	Load custom character	200uS
0xFE	0x55	None	Move display one place to the left	100uS
0xFE	0x56	None	Move display one place to the right	100uS
0xFE	0x61	1 Byte	Change RS-232 BAUD rate	3mS
0xFE	0x62	1 Byte	Change I^2C address	3mS
0xFE	0x70	None	Display firmware version number	4mS
0xFE	0x71	None	Display RS-232 BAUD rate	10mS
0xFE	0x72	None	Display I^2C address	4mS

[1] **'Set Cursor' command must precede 'Display Character Write' command when calling Custom Characters.**

Changing the I^2C Slave Address

Syntax hexadecimal 0xFE 0x62 [addr]

Parameter

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

Description This command sets the I^2C address. The address must be an even number (LSB = 0). The address change requires 20 microseconds to take effect; therefore, the subsequent input must have an appropriate delay. The default I^2C address can be restored if SPI or RS-232 is selected as the communication mode.
Default: 0x50

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Changing BAUD Rate

Syntax hexadecimal 0xFE 0x61 [baud]

Parameter

Parameter	Length	Description
[BAUD]	1 byte	New RS-232 BAUD Rate, 1 - 8

Description This command sets the RS-232 BAUD rate. The single byte parameter selects the desired BAUD rate as in the table below. The new BAUD rate requires 20 microseconds to take effect; therefore, the subsequent input must have an appropriate delay. The default BAUD rate can be restored if I^2C or SPI is selected as the communication mode. Illegal parameter input will be discarded.

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

Default: 9600 BAUD

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

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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 2-line 16-character display is show below; a cursor position outside these ranges will not be viewable.

	Column 1	Column 16
Line 1	0x00	0x0F
Line 2	0x40	0x4F

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 moves 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.
Default: 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: Underline cursor is off

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Move Cursor Left One Space

Syntax hexadecimal 0xFE 0x49

Parameter

Parameter	Length	Description
None	None	Move cursor left 1 space

Description This command moves the cursor position left 1 space whether the cursor is turned on or not. The displayed character is not altered.
Default: None

Move Cursor Right One Space

Syntax hexadecimal 0xFE 0x4A

Parameter

Parameter	Length	Description
None	None	Move cursor right 1 space

Description This command moves the cursor position left 1 space whether the cursor is turned on or not. The displayed character is not altered.
Default: None

Turn On Blinking Cursor

Syntax hexadecimal 0xFE 0x4B

Parameter

Parameter	Length	Description
None	None	Turn on the blinking cursor

Description This command turns on the blinking cursor.
Default: The blinking cursor is off

Turn Off Blinking Cursor

Syntax hexadecimal 0xFE 0x4C

Parameter

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

Parameter	Length	Description
None	None	Move cursor back one space, delete last character.

Description This command is destructive backspace. The cursor is moved back one space and the character on the cursor is deleted.
Default: None

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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 and 50

Description This command sets the display contrast. The contrast setting can be between 1 and 50, where 50 is the highest contrast.
Default: 40

Set Backlight Brightness

Syntax hexadecimal 0xFE 0x53 [brightness]

Parameter

Parameter	Length	Description
[brightness]	1 byte	Set the backlight brightness level, value between 1 and 8

Description This command sets the backlight brightness level. Default: 8.
1 = Backlight OFF & 8 = Backlight ON (100%)

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 is space for eight user-defined custom characters. This command loads 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.

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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

Default: None

Note In order to display the custom character, user would first need to call '**Set Cursor Position**' command, then followed by the address of the custom character (0 to 8).

Shift Display to the Left

Syntax hexadecimal 0xFE 0x55

Parameter

Parameter	Length	Description
None	None	Shift the LCD screen to the left 1 space.

Description This command shifts the display to the left 1 space. 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 1 space.

Description This command shifts the display to the right 1 space. 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 firmware version.
Default: None

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Display RS-232 Baud Rate

Syntax hexadecimal 0xFE 0x71

Parameter

Parameter	Length	Description
None	None	Display Baud Rate

Description This command displays the RS-232 BAUD rate.
Default: None

Display I²C Address

Syntax hexadecimal 0xFE 0x72

Parameter

Parameter	Length	Description
None	None	Display I²C Address

Description This command displays the current I²C slave address.
Default: None

Example Initialization Program

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

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Built-in Font Table

b7-b4 / b3-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)															
0001	(2)															
0010	(3)															
0011	(4)															
0100	(5)															
0101	(6)															
0110	(7)															
0111	(8)															
1000	(1)															
1001	(2)															
1010	(3)															
1011	(4)															
1100	(5)															
1101	(6)															
1110	(7)															
1111	(8)															

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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, 96hrs	2
Low Temperature storage	Endurance test applying the low storage temperature for a long time.	-30°C, 96hrs	1,2
High Temperature Operation	Endurance test applying the electric stress (voltage & current) and the high thermal stress for a long time.	+70°C, 96hrs	2
Low Temperature Operation	Endurance test applying the electric stress (voltage & current) and the low thermal stress for a long time.	-20°C, 96hrs	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.	+50°C, 90% RH, 96hrs	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.

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