

MOSAIC INDUSTRIES, INC.
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Serial Liquid Crystal Display Module
2 Lines by 16 Characters Per Line
Part# LCDS-216

Getting Started with the Serial Display Module

Connect the Display Module

The serial liquid crystal display (LCD) module connects via a custom cable to the Mosaic controller board. The connecting cable can be purchased from Mosaic Industries. Three wires provide the interface to the LCD: the logic-level serial receive signal Rx, ground, and +5V power. On the LCD module, the three relevant wires are brought to positions 1 through 3 of a single in-line 10-position header. The extra 7 pins are not wired, and are designed to prevent backward installation of the header on the display. On the display module, Rx is the signal nearest to the corner, ground is the next pin, and +5V is the 3rd pin from the corner. On the Mosaic controller board, ground is pin 1 and +5V is pin 2 on the digital field header. Using a QCard or QScreen controller, the logic-level serial signal originates at pin PA4 (serial2 transmit on the QCard), which is pin 12 on the QCard field header. Using a PDQ Board or PDQScreen, the logic-level serial signal originates at pin XCV2+ which is pin 4 on the Comm header.

NOTE for PDQ users:

If you are using a PDQ Board or PDQScreen, the Serial2 RS485 must be enabled by installing a jumper on the Mosaic controller board. On the PDQ Board, install the 7th jumper below the reset button, labeled “485En” in the “2” section of the jumper pack. On the PDQScreen, install the 10th jumper to the right of the reset button, labeled “485-2.”

Writing Characters to the Display

The LCD module is configured by Mosaic to run at 1200 baud, and this value is stored in nonvolatile memory in the LCD module. (If the display baud rate is not at the default for any reason, a downloadable program is available from Mosaic to set the display baud rate to 1200.) After a power-up, the display comes on with the cursor homed to the upper left corner, and the backlight is on. After initializing the controller serial channel as described below, the Emit2 function can be used to write characters to the display as shown in the code examples below. Another way to write to the display is to set up a task and invoke UseSerial2 in the task activation routine. Then standard print routines like printf can be used to write to the LCD module from within the task.

Using the Display with the QCard or QScreen Controller

After initializing the serial2 port, setting the serial2 baud rate, and enabling interrupts using StartTimeslicer or ENABLE_INTERRUPTS, characters can be written to the display by invoking Emit2 to send the ASCII values to the LCD module. For example, the following C instructions print “Hi!” to the display:

```
InitSerial2();           // initialize serial2 port
Baud2(1200);            // set 1200 baud on serial2
StartTimeslicer();      // enable interrupts
Emit2('H'); Emit2('i'); Emit2('!'); // write Hi! to the display
```

Using the Display with the PDQ Board or PDQScreen Controller

The PDQ controllers use the serial2 RS485 XCV2+ output to write to the display. After initializing the serial2 RS485 channel, characters can be written to the display by invoking Emit2 to send the ASCII values to the LCD module. For example, the following C instructions print “Hi!” to the display:

```
RS485Init();           // initialize RS485
RS485Transmit(2);     // serial2 RS485 is in transmit mode
Baud( 12, 2 );        // set 1200 baud on serial2
Emit2('H'); Emit2('i'); Emit2('!'); // write Hi! to the display
```

Command Sequences

The display module can be turned on or off, the display can be cleared, the backlight intensity can be set, and the contrast can be controlled via software commands. These command sequences are described later in this document. For example, the backlight defaults to an intensity level of 5 on a scale of 1 to 8 (a backlight intensity of zero is not allowed). While a higher backlight intensity may enhance display visibility, the transfective display is visible in a variety of ambient light conditions even without the backlight. To minimize power drain, the backlight could be set to its minimal level of 1 using these commands:

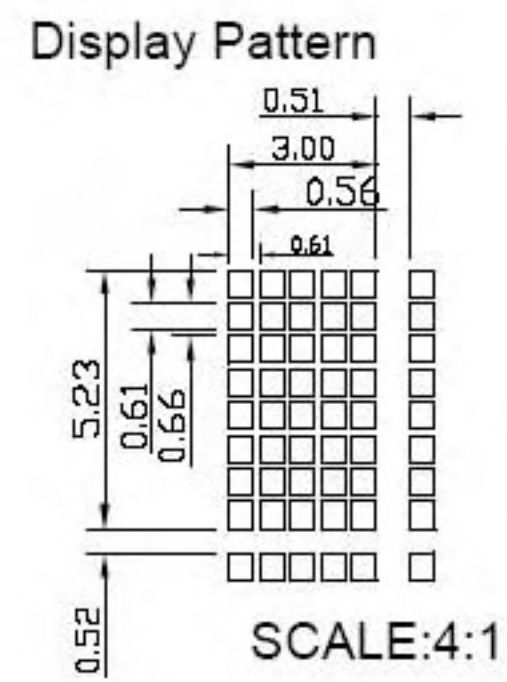
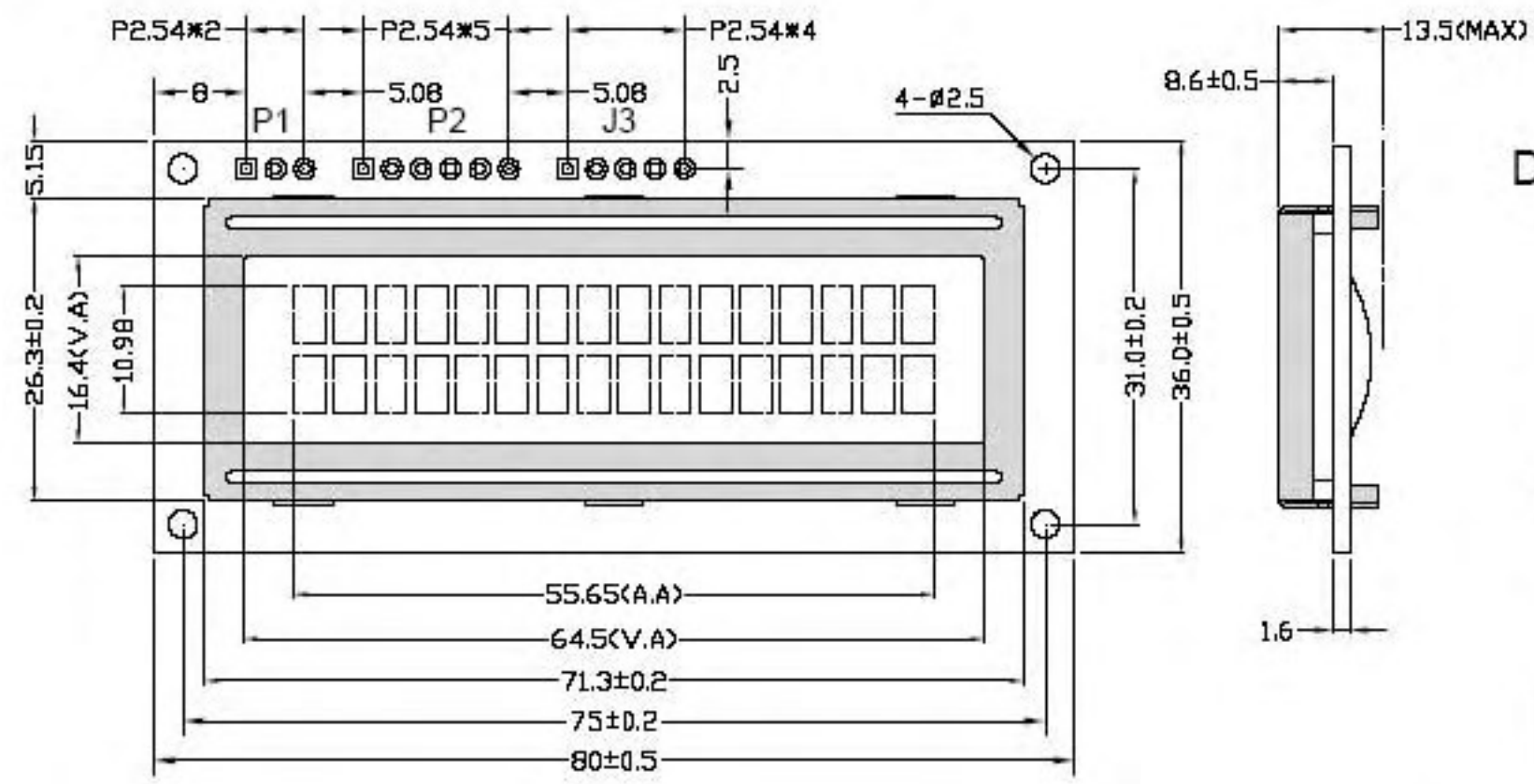
```
Emit2(0xFE); Emit2(0x53); Emit2(1); // set backlight intensity to 1
```

The display contrast can be changed under software control to any level between 1 and 50, with a default value of 40. This allows an application program to provide a way for the user to change the contrast.

Technical Support

Please call Mosaic Industries at 510-790-8222 if you have any questions about this product.

REV	DESCRIPTION:	DATE



PIN ASSIGNMENT

1	RX
2	VSS
3	VDD

1	SPISS
2	SDO
3	SCK/SCL
4	SDI/SDA
5	VSS
6	VDD

1	VPP
2	VDD
3	VSS
4	PA0
5	PA1

Specification:

- 1). Driving: Duty:1/16, Bias:1/5, VLCD:4.5V, VDD:5.0V
- 2). Viewing Direction: 6 O'clock
- 3). Display mode: STN/Gray/Positive/Transflective
- 4). Operating temp.: -20°C~+70°C
Storage temp.: -30°C~+80°C
- 5). Driver : SPLC780D And PIC16F690 MPU
- 6). Backlight: Yellow-green

Part No. LCDS-216

Pin Description

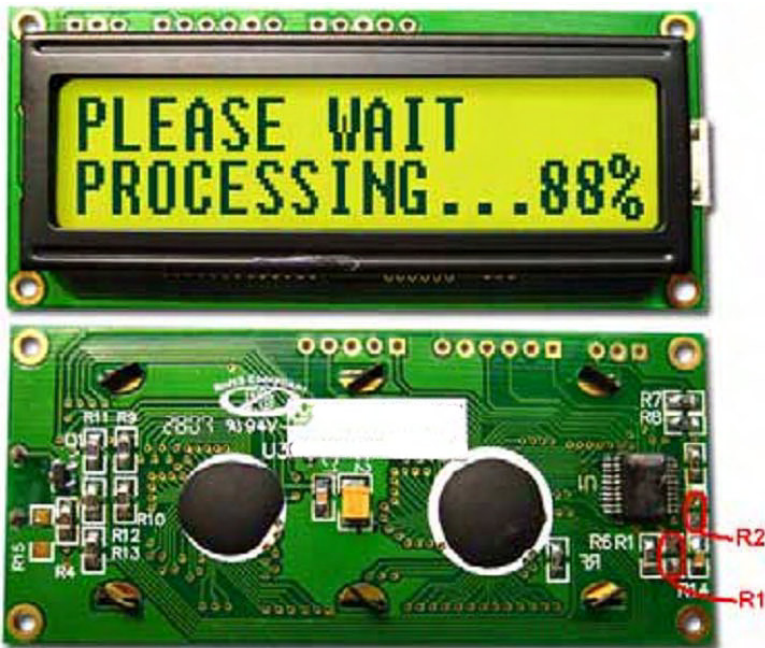
Pin No.	Symbol	External Connection	Function Description
1	RX	MPU	RS232 Serial input port
2	VSS	Power Supply	Ground
3	VDD	Power Supply	Power supply for logic (+5.0V)
1	SPISS	MPU	SPI Slave Select (NC in I2C mode)
2	SDO	NC	No Connect
3	SCK/SCL	MPU	Serial Clock
4	SDI/SDA	MPU	Serial Data In (SPI) / Serial Data (I2C)
5	VSS	Power Supply	Ground
6	VDD	Power Supply	Power Supply for logic (+5.0V)
1	VPP	NC	No Connect
2	VDD	NC	No Connect
3	Vss	NC	No Connect
4	PA0	NC	No Connect
5	PA1	NC	No Connect

Recommended LCD connector: 2.54mm pitch pins on P1 or P2

Backlight connector: controlled by command **Mates with:** -

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	°C
Storage Temperature Range	Tst		-30	-	+80	°C
Supply Voltage	VDD		4.7	5.0	5.5	V
Supply Current	IDD	Ta=25°C VDD=5.0V	-	125	-	mA
Supply for LCD (contrast)	VDD-V0	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	Iled		-	100	-	mA

Optical Characteristics

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Viewing Angle – Top	θ	Cr ≥ 2	-	10	-	°
Viewing Angle – Bottom	θ	Cr ≥ 2	-	60	-	°
Viewing Angle – Left	Φ	Cr ≥ 2	-	45	-	°
Viewing Angle – Right	Φ	Cr ≥ 2	-	45	-	°
Contrast Ratio	Cr		-	3	-	-
Response Time (rise)	Tr	-	-	100	150	ms
Response Time (fall)	Tf	-	-	150	200	ms

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 handshaking. Default BAUD rate is 1200, 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
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 1200 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	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	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	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	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, 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.

Set Backlight Brightness

Syntax hexadecimal 0xFE 0x53 [brightness]

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

Description This command set the LCD display backlight brightness level, the value is between 1 to 8.
Default Default brightness value is 5.

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 I²C Address

Syntax hexadecimal 0xFE 0x72

Parameter	Parameter	Length	Description
-----------	-----------	--------	-------------

	None	None	Display I ² C Address
--	------	------	----------------------------------

Description This command displays the current I²C 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	a	P	`	P				-	夕	三	&	P
xxxx0001	(2)		!	1	A	Q	a	q			。	ア	チ	△	△	q
xxxx0010	(3)		"	2	B	R	b	r			「	イ	ツ	×	⊗	⊗
xxxx0011	(4)		#	3	C	S	c	s			」	ウ	テ	モ	ε	ε
xxxx0100	(5)		\$	4	D	T	d	t			、	エ	ト	⊂	⊂	Ω
xxxx0101	(6)		%	5	E	U	e	u			・	オ	ナ	⊂	ε	ü
xxxx0110	(7)		&	6	F	V	f	v			ヲ	カ	ニ	ヨ	ρ	Σ
xxxx0111	(8)		'	7	G	W	g	w			フ	キ	ヌ	ラ	g	π
xxxx1000	(1)		(	8	H	X	h	x			ィ	ク	ネ	リ	√	×
xxxx1001	(2)		)	9	I	Y	i	y			ウ	ケ	ル	ル	√	√
xxxx1010	(3)		*	:	J	Z	j	z			エ	コ	ハ	レ	J	キ
xxxx1011	(4)		+	;	K	[	k	[			オ	サ	ヒ	ロ	×	⊗
xxxx1100	(5)		,	<	L	¥	l	l			カ	シ	フ	ワ	⊗	⊗
xxxx1101	(6)		-	=	M	]	m	)			ユ	ス	ハ	シ	⊗	÷
xxxx1110	(7)		.	>	N	^	n	→			ヨ	セ	ホ	△	△	
xxxx1111	(8)		/	?	O	_	o	€			ッ	リ	マ	□	ö	■

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	