AZ DISPLAYS

SPECIFICATIONS FOR LIQUID CRYSTAL DISPLAY

CUSTOMER APPROVAL

※ **PART NO. :** ATM2412BS SERIES (AZ DISPLAYS) VER 1.3

APPROVAL		COMPANY CHOP	
CUSTOMER COMMENTS			

AZ DISPLAYS ENGINEERING APPROVAL		
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REVISION RECORD

REVISION	REVISION DATE	PAGE	CONTENTS
VER1.0	**2012-11-20**		**FIRST ISSUE**
VER1.1	**2013-04-17**	**5**	**REVISE VIEWING ANGLE**
VER1.2	**2019-06-26**	**7**	**MODIFY PIN DEFINITION**
VER1.3	**2020-05-10**	**ALL**	**CHANGE FORMAT AND ADD DETAILS**

※ CONTENTS

1.0 GENERAL SPECS

ATM2412BS series design is based on ZETTLER patented HC product ATM2412B/BA series. Besides all the features of ATM2412B/BA series, this product adopts SPI interface which can greatly save user's MCU resource. Traditional 240*128 mono products require 15 MCU GPIOs while ATM2412BS series require only 5 GPIOs. Furthermore, ATM2412BS integrates more functions into this SPI interface, now user can control font/column setting via SPI interface, and user can even change the font/background color and control the backlight brightness via this SPI interface without consuming extra hardware/software resource on their main board.

1.	Display Format	240*128 DOTS
2.	Power Supply LCM	5.0V/3.3V (Refer to P/N description in last page)
3.	Overall Module Size	144.0mm(W) x 104.0mm(H) x max 10.0mm(D) *
4.	Viewing Area(W*H)	113.5mm(W) x 64.0mm(H)
5.	Pixel Pitch (W*H)	0.462mm(W) x 0.462mm(H)
6.	Active Area(W*H)	110.88mm(W) x 59.136mm(H)
6.	Viewing Direction	Free viewing angle
7.	Driving Method	TFT
8.	Controller IC	SPI to parallel bridge chip + UCi6963 or compatible
9.	Interface	4-WIRE SPI, Write only
10.	Display Mode	4 color mode optional, controlled via SPI command
11.	Backlight Options	White LED/Side, integrated PWM dimming function
12.	Font Options	6*8 and 8*8 font optional, controlled via SPI command
13.	Column Options	32 and 40 columns optional, controlled via SPI command
14.	Operating temperature	-20ºC ~ 70ºC
15.	Storage temperature	-30ºC ~ 80ºC
16.	RoHS	RoHS compliant

* Doesn't contain connector height

2.0 ABSOLUTE MAXIMUM RATINGS

Item	Symbol	Min	Typ	Max	Unit
Operating temperature	Top	-20	--	70	ºC
Storage temperature	Tst	-30	--	80	ºC
Input voltage	Vin	Vss-0.3	--	Vdd+0.3	V
Supply voltage for logic	Vdd- Vss	-0.3	-	7.0	V

3.0 ELECTRICAL CHARACTERISTICS
3.1 Electrical Characteristics Of LCM

Item	Symbol	Condition	Min	Typ	Max	Unit
Power Supply Voltage	Vdd	25ºC	4.8	5.0	5.2	V
			3.0	3.3	3.6	
Power Supply Current	Idd	Vdd=5.0V	--	--	100	mA
		Vdd=3.3V	--	--	90	
Input voltage (high)	Vih	Pins:(SI / SCL / CSB / RS, RESET)	0.8Vdd	--	Vdd	V
Input voltage (low)	Vil		0	--	0.2Vdd	V

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3.2 The Characteristics Of LED Backlight

3.2.1 Electrical-Optical Characteristics Of LED Backlight (Ta=25°C)

Item	Symbol	Condition	Min	Typ	Max	Unit
Forward Voltage[1][5]	Vf	--	3	5	5.5	V
Forward Current[5]	If	Vf = 5V	--	206	--	mA
Luminance[3]	Lv	Vf = 5V	200	250	--	cd/㎡
Uniformity[2]	Δ	(Lvmin/Lvmax)%	70%	75%	--	-
Chroma coordinate	x	Vf = 5V	0.26	--	0.36	-
	y		0.28	--	0.38	-
Lifetime[4]	-	Vf = 5V	-	50000	-	Hours

NOTE:

(1) Forward voltage means voltage applied to Pin9 & Pin10
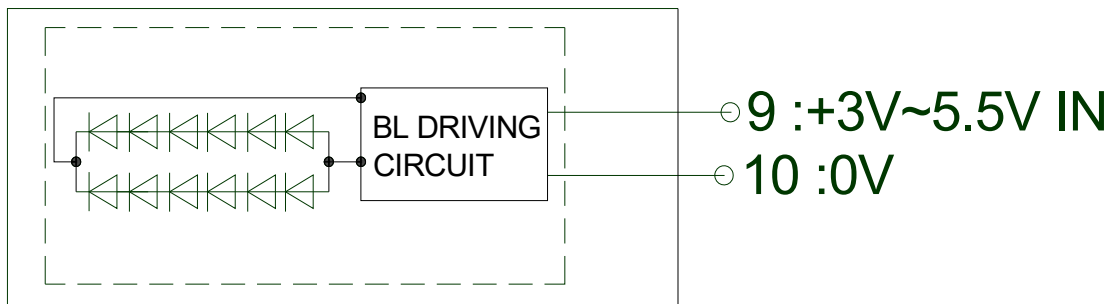
(2)The luminance is the average value of 5 points, The measurement instrument is BM-7 luminance colorimeter. The diameter of aperture is Φ5mm

(3) Luminance when LCM displaying white color.

(4) Backlight lifetime means luminance value larger than half of the original after 20000 hours' continuous working.
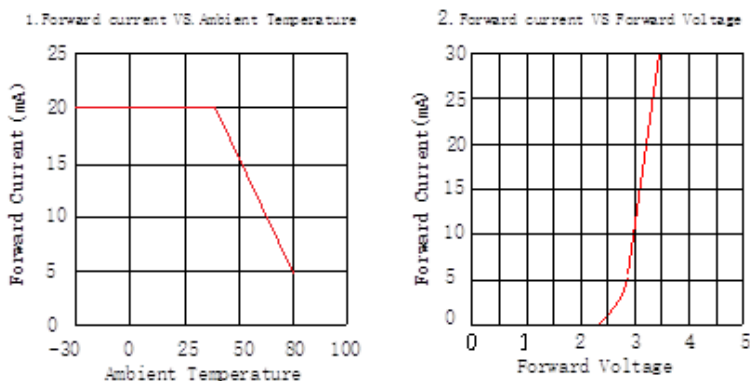
(5) Input current of Pin 9 might change because the voltage of PIN9 will affect the efficiency of backlight driving circuit, but current for LEDs will keep constant within the range of input voltage.

3.2.2 Backlight Control Circuit For LCM（2x6=12 pcs LED）
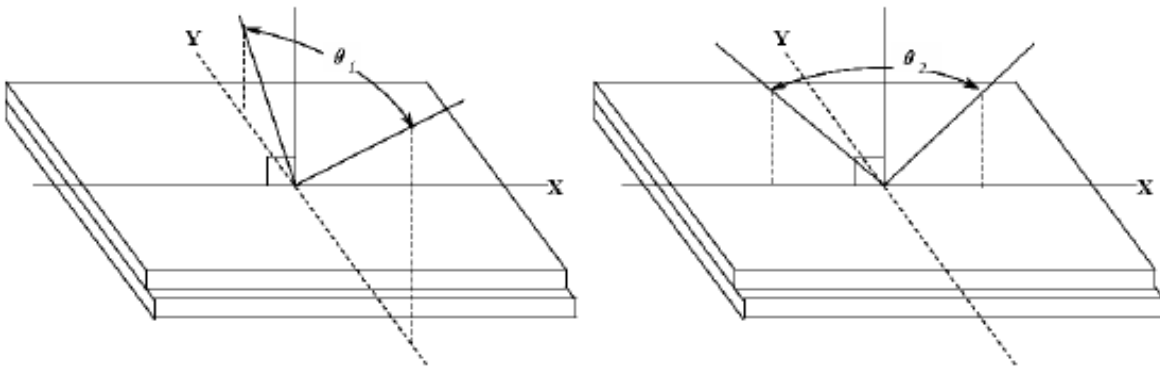

BL DRIVING CIRCUIT

9 :+3V~5.5V IN
10 :0V

PIN10 is connected to PIN2(VSS) internally

3.2.3 LED Characteristics Curves（for single led）

1. Forward current VS. Ambient Temperature

2. Forward current VS Forward Voltage

4.0 OPTICAL CHARACTERISTICS (Ta=25ºC)

Item	Symbol	Condition	Min	Typ	Max	Unit
Viewing angle (Left - right)	$\theta2$	$Cr \geq 2.0$	-80	-	80	deg
Viewing angle (Up-down)	$\theta1$	$Cr \geq 2.0$	-80	-	80	deg
Contrast Ratio ($\theta1=0°$, $\theta2=0°$)	Cr	FT:white,BG:black	400	500		-
		FT:black,BG:white	400	500		-
		FT:white,BG:blue	48	60		-
		FT:black,BG:Y-G	320	400	-	-
Response time (rise)	Tr	$\theta1=0°$, $\theta2=0°$	-	10	20	ms
Response time (fall)	Tf	$\theta1=0°$, $\theta2=0°$	-	15	30	ms

(1). Definition of Optical Response Time

[positive type]

[Negative type]

(2). Definition of Contrast Ratio

$$Cr= \frac{\text{Brightness of Non-selected Segment(B2)}}{\text{Brightness of selected Segment(B1)}}$$

(3). Definition of Viewing Angle θ2 and θ1

5.0 BLOCK DIAGRAM
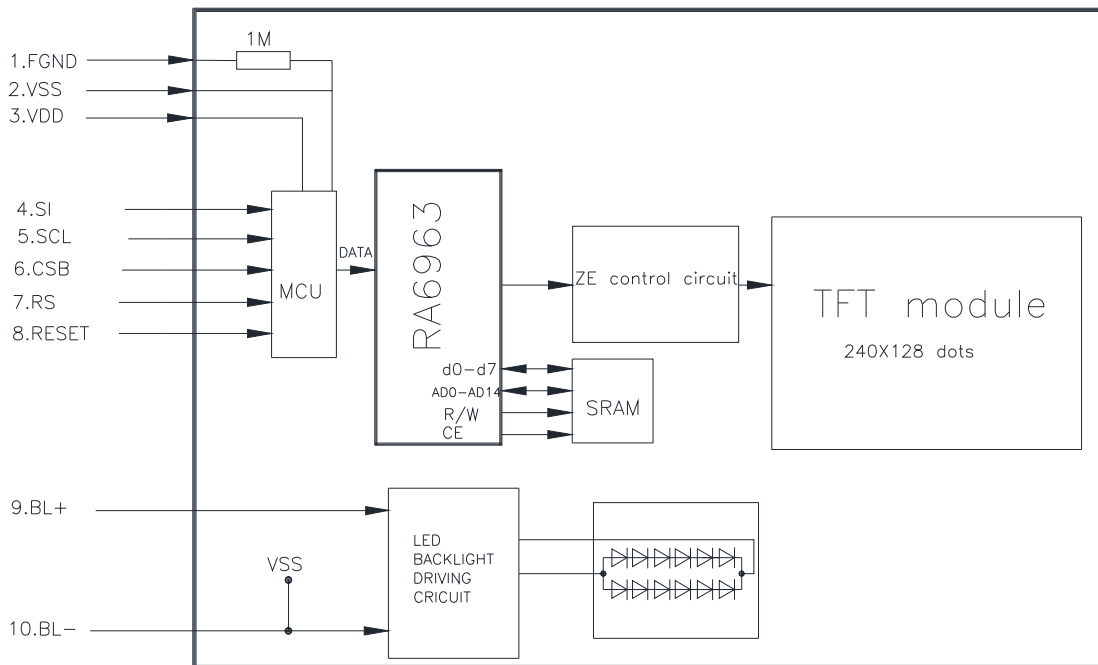
6.0 PIN ASSIGNMENT

Pin No.	Symbol	Function	I/O
1	FGND	Frame Ground, connected to VSS via a 1M ohms resistor internally	P
2	VSS	Power ground	P
3	VDD	5V/3.3V	P, Refer to P/N description
4	SI	SPI data, write only	I
5	SCL	SPI clock, latching at rising edge	I
6	CSB	Chip Enable, enabled "L"	I
7	RS	Command/Data RS = H, Command RS = L, Data	I
8	RESET	Reset, enabled "L"	I, refer to note for detailed information
9	BL+	Power supply for LED driving circuit, 5V typical	P
10	BL-	Power ground for LED driving circuit, internally connected to VSS	P

Note:

There're two methods to control the RESET signal:

1. Simply leave this pin open, the LCM has internal power on reset which can ensure reliable reset, please delay at least 100ms after power on before sending any command/data to LCM, or the command/data might be missed.
2. Connect this pin to a GPIO, after power on, pull the GPIO to LOW level for at least 1ms, after this, pull the GPIO to HIGH for at least 100ms, then you can start sending command/data to LCM.

7.0 TIMING CHARACTERISTICS
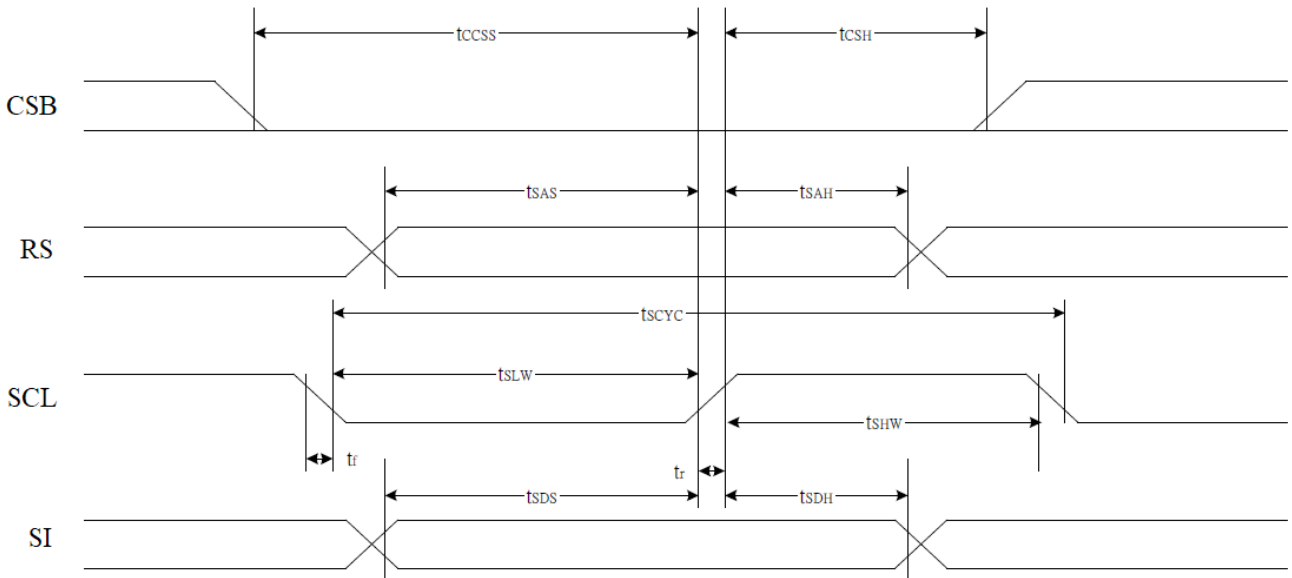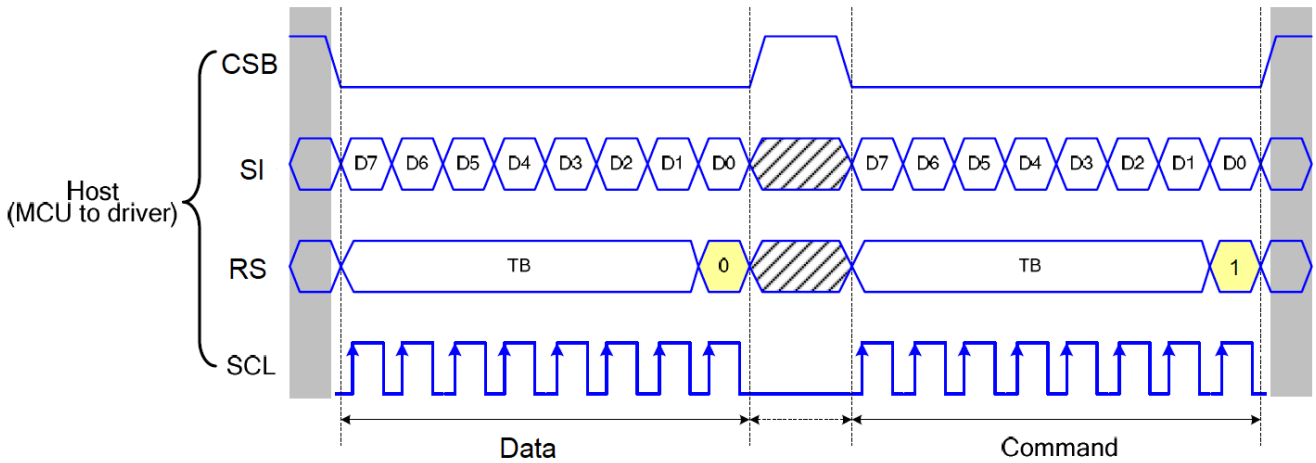
Item	Signal	Symbol	Rating		Units
			Min	Max	
Serial Clock Period	SCL	tSCYC	1000	--	ns
SCL "H" pulse width		tSHW	500	--	
SCL "L" pulse width		tSLW	500	--	
Address setup time	RS	tSAS	400	--	
Address hold time		tSAH	200	--	
Data setup time	SI	tSDS	400	--	
Data hold time		tSDH	200	--	
CS-SCL setup time	CSB	tCSS	400	--	
CS-SCL hold time		tCSH	800	--	

Note: SPI read is not supported
        Set RS to "H" when sending command and "L" when sending data

8.0 COMMAND LIST

ATM2412BS series' command list are fully compatible with RA6963, please refer to RA6963 to get the command list. Besides the RA6963 standard command list, ATM2412BS has an extra set of commands to control display color, display brightness, font/column setting. Please refer to below list for the standard and extension command lists.

Standard command list:

INSTRUCTION	D7	D6	D5	D4	D3	D2	D1	D0	DESCRIPTION
Register Set	0	0	1	0	0	0 0 1	0 1 0	1 0 0	Set Cursor Pointer Set Offset Register Set Address Pointer
Control Word Set	0	1	0	0	0	0	0 0 1 1	0 1 0 1	Set Text Home Address Set Text Area Set Graphic Home Address Set graphic Area
Mode Set	1	0	0	0	X X X X 0 1	0 0 0 1 X X	0 0 1 0 X X	0 1 1 0 X X	OR mode EXOR mode AND mode Text Attribute mode Internal CG ROM mode External CG RAM mode
Display Mode	1	0	0	1	0 X X 0 1 1	0 X X 1 0 1	0 1 1 X X X	0 0 1 X X X	Display Off Cursor on,blink off Cursor on,blink on Text on,graphic off Text off,graphic on Text on,graphic on
Cursor Pattern Select	1	1	0	0	0	N2	N1	N0	Cursor Set
Data Auto Read /Write	1	0	1	1	0	0	0 0 1	0 1 0	Set Data Auto Write Set Data Auto Read Auto Reset
Data Read Write	1	1	0	0	0	N2	N1	N0	Data Read/Write And ADP Increment/Decrement It should executed after setting Address using Set Address Pointer command.
Screen Peek	1	1	1	0	0	0	0	0	Screen Peek
Screen Copy	1	1	1	0	1	0	0	0	Screen Copy
Bit Set Reset	1	1	1	1	N3	N2	1	N0	Bit Set
Data Write	Write Data								Writes data DBO~DB7 from MPU to external display RAM.

Please refer to UCi6963/RA6963 datasheet for detailed information.

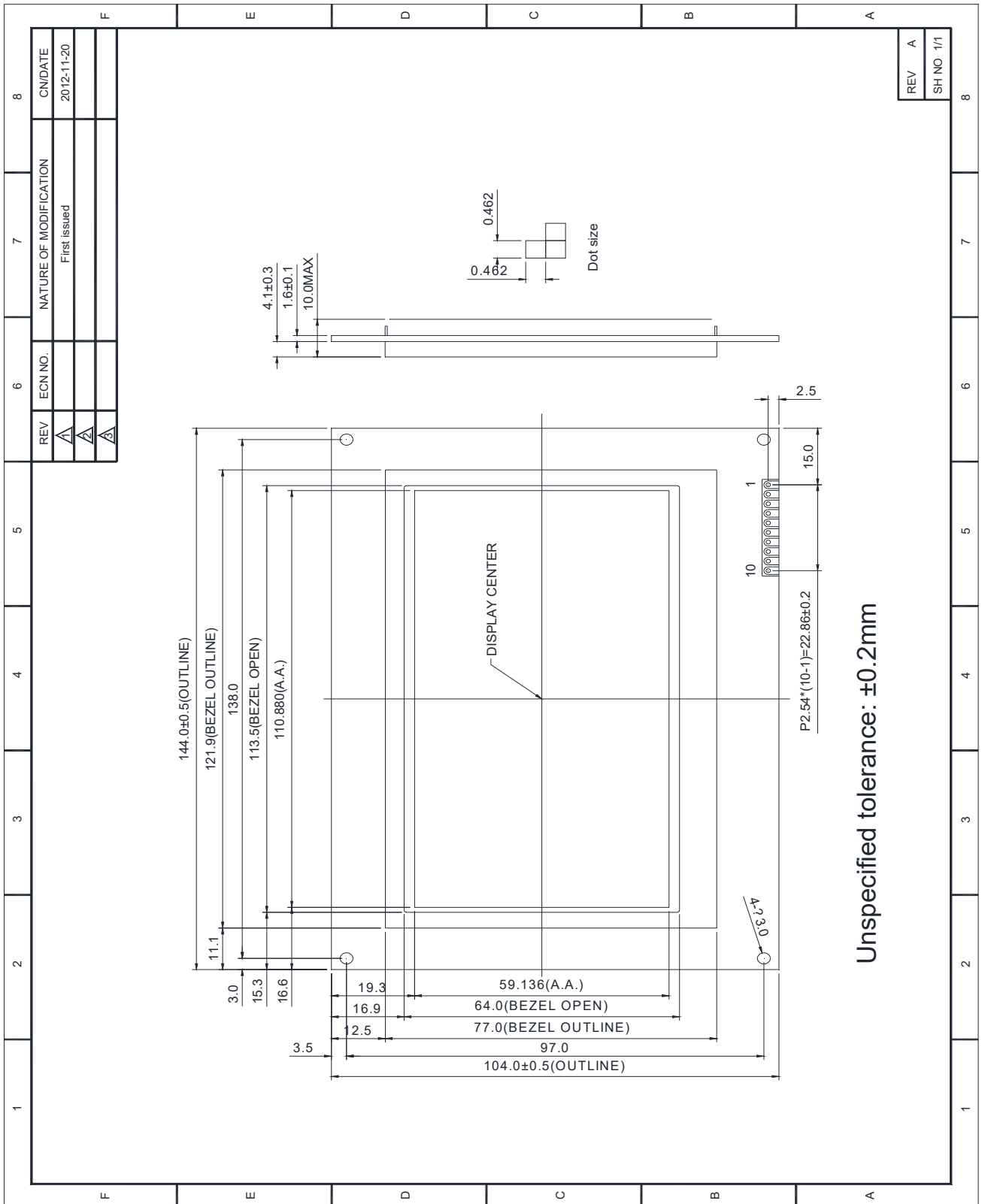**Extension command list:**
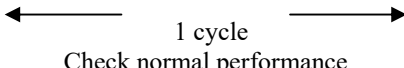
INSTRUCTION	D7	D6	D5	D4	D3	D2	D1	D0	DESCRIPTION
Font/Column Set	0	0	1	1	0	0 0 0	0 0 1	0 1 0	8x8 Font, 32 Column, Default Set 8x8 Font, 40 Column 6x8 Font, 40 Column
Display Color Set	0	0	1	1	1	0	0 0 1 1	0 1 0 1	Black Font, White Background, Default Set White Font, Black Background Black Font, Yellow-Green Background White Font, Black Background
Backlight Brightness Set (Total 16 levels from off(0x00) to brightest(0x1f))	0	0	0	1	0 0 0 - - 1 1 1	0 0 0 - - 1 1 1	0 0 1 - - 0 1 1	0 1 0 - - 1 0 1	Backlight off Backlight on, dimmest Backlight on, 2nd dimmest - - 3rd brightest 2nd brightest Backlight on, brightest

All are one byte command, set RS to "H" when using these commands.

9.0 MECHANICAL DIAGRAM

10.0 RELIABILITY TEST

NO	Test Item		Description	Test Condition	Remark
1	Environmental Test	High temperature storage	Applying the high storage temperature Under normal humidity for a long time Check normal performance	80 ºC 96hrs	
2		Low temperature storage	Applying the low storage temperature Under normal humidity for a long time Check normal performance	-30ºC 96hrs	
3		High temperature Operation	Apply the electric stress(Voltage and current) Under high temperature for a long time	70 ºC 96hrs	Note1
4		Low temperature Operation	Apply the electric stress Under low temperature for a long time	-20ºC 96hrs	Note1 Note2
5		High temperature/High Humidity Storage	Apply high temperature and high humidity storage for a long time	90% RH 40ºC 96hrs	Note2
6		Temperature Cycle	Apply the low and high temperature cycle -30ºC<>25ºC<>80ºC <>25ºC 30min 10min 30min 10min ←—————— ——————→ 1 cycle Check normal performance	-30ºC/80ºC 10 cycle	
7	Mechanical Test	Vibration test(Package state)	Applying vibration to product check normal performance	Freq:10~55~10Hz Amplitude:0.75mm 1cycle time:1min X.Y.Z every direction for 15 cycles	
8		Shock test(package state)	Applying shock to product check normal performance	Drop them through 70cm height to strike horizontal plane	
9	Other				

Remark

Note1: Normal operations condition (25ºC±5ºC).

Note2: Pay attention to keep dewdrops from the module during this test.

11.0 PRECAUTION FOR USING LCM

1. When design the product with this LCD Module, make sure the viewing angle matches to its purpose of usage.

2. As LCD panel is made of glass substrate, Dropping the LCD module or banging it against hard objects may cause cracking or fragmentation. Especially at corners and edges.

3. Although the polarizer of this LCD Module has the anti-glare coating, always be careful not to scratch its surface. Use of a plastic cover is recommended to protect the surface of polarizer.

4. If the LCD module is stored at below specified temperature, the LC material may freeze and be deteriorated. If it is stored at above specified temperature, the molecular orientation of the LC material may change to Liquid state and it may not revert to its original state. Excessive temperature and humidity could cause polarizer peel off or bubble. Therefore, the LCD module should always be stored within specified temperature range.

5. Saliva or water droplets must be wiped off immediately as those may leave stains or cause color changes if remained for a long time. Water vapor will cause corrosion of ITO electrodes.

6. If the surface of LCD panel needs to be cleaned, wipe it swiftly with cotton or other soft cloth. If it is not still clean enough, blow a breath on the surface and wipe again.

7. The module should be driven according to the specified ratings to avoid malfunction and permanent damage. Applying DC voltage cause a rapid deterioration of LC material. Make sure to apply alternating waveform by continuous application of the M signal. Especially the power ON/OFF sequence should be kept to avoid latch-up of driver LSIs and DC charge up to LCD panel.

8. Mechanical Considerations
   a) LCM are assembled and adjusted with a high degree of precision. Avoid excessive shocks and do not make any alterations or modifications. The following should be noted.
   b) Do not tamper in any way with the tabs on the metal frame.
   c) Do not modify the PCB by drilling extra holes, changing its outline, moving its components or modifying its pattern.
   d) Do not touch the elastomer connector; especially insert a backlight panel (for example, EL).
   e) When mounting a LCM makes sure that the PCB is not under any stress such as bending or twisting. Elastomer contacts are very delicate and missing pixels could result from slight dislocation of any of the elements.
   f) Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels.

9. Static Electricity
   a) Operator

Ware the electrostatics shielded clothes because human body may be statically charged if not ware shielded clothes. Never touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.

   b) Equipment

There is a possibility that the static electricity is charged to the equipment, which has a function of peeling or friction action (ex: conveyer, soldering iron, working table). Earth the equipment through proper resistance (electrostatic earth: 1×10^8 ohm).

Only properly grounded soldering irons should be used.

If an electric screwdriver is used, it should be well grounded and shielded from commutator sparks.

The normal static prevention measures should be observed for work clothes and working benches; for the latter conductive (rubber) mat is recommended.

   c) Floor

Floor is the important part to drain static electricity, which is generated by operators or equipment.

There is a possibility that charged static electricity is not properly drained in case of insulating floor. Set the electrostatic earth (electrostatic earth: 1×10^8 ohm).

   d) Humidity

Proper humidity helps in reducing the chance of generating electrostatic charges. Humidity should be kept over 50%RH.

   e) Transportation/storage

The storage materials also need to be anti-static treated because there is a possibility that the human body or storage materials such as containers may be statically charged by friction or peeling.

The modules should be kept in antistatic bags or other containers resistant to static for storage.

   f) Soldering

Solder only to the I/O terminals. Use only soldering irons with proper grounding and no leakage.

Soldering temperature : 280°C ± 10°C

Soldering time: 3 to 4 sec.

Use eutectic solder with resin flux fill.

If flux is used, the LCD surface should be covered to avoid flux spatters. Flux residue should be removed afterwards.

     g)   Others

The laminator (protective film) is attached on the surface of LCD panel to prevent it from scratches or stains. It should be peeled off slowly using static eliminator.

Static eliminator should also be installed to the workbench to prevent LCD module from static charge.

10. Operation
    a)   Driving voltage should be kept within specified range; excess voltage shortens display life.
    b)   Response time increases with decrease in temperature.
    c)   Display may turn black or dark blue at temperatures above its operational range; this is (however not pressing on the viewing area) may cause the segments to appear "fractured".
    d)   Mechanical disturbance during operation (such as pressing on the viewing area) may cause the segments to appear "fractured".

11. If any fluid leaks out of a damaged glass cell, wash off any human part that comes into contact with soap and water. The toxicity is extremely low but caution should be exercised at all the time.

12. Disassembling the LCD module can cause permanent damage and it should be strictly avoided.

13. LCD retains the display pattern when it is applied for long time (Image retention). To prevent image retention, do not apply the fixed pattern for a long time. Image retention is not a deterioration of LCD. It will be removed after display pattern is changed.

14. Do not use any materials, which emit gas from epoxy resin (hardener for amine) and silicone adhesive agent (dealcohol or deoxym) to prevent discoloration of polarizer due to gas.

15. Avoid the exposure of the module to the direct sunlight or strong ultraviolet light for a long time.

12.0 REFERENCE INITIAL CODE

//Power on and wait for power stable, then reset. If RESET pin is not connected, only 250ms delay is necessary.

```
GPIO_WriteBit(GPIO_RESET,0);      //set Reset to low level

Delay1ms();   //Delay at least 1ms

GPIO_WriteBit(GPIO_RESET,1);      //Set Reset to high level, normal working state

Delay100ms();        //Delay at least 100ms
```

//Set extension command according to the specification, these settings can be changed during normal working process

```
SPI_cmd(0x31);  //Set  8*8 font, 40 column, if it's 8*8 font, 32 column, this command can be omitted.

SPI_cmd(0x18);  //Set half brightness, if it's full brightness, this command can be omitted.

SPI_com(0x39); //Set white font on black background, if it's black on white, this command can be omitted.
```

//Set standard command according to UCi6963/RA6963 datasheet, user can change according to actual use.

```
SPI_cmd(0x80);//OR mode

SPI_dat(0x03);//CGRAM address

SPI_dat(0x00);

SPI_cmd(0x22);

SPI_cmd(0x98);//text off, graphic on, cursor off

SPI_dat(0x00);//graphic home address

SPI_dat(0x00);

SPI_cmd(0x42);

SPI_dat(30);//graphic columns, 30*8 = 240 columns

SPI_dat(0x00);

SPI_cmd(0x43);
```

Appendix: P/N description

No.	Module P/N	VDD	Remark
1	ATM2412BS-FLW-XFW	5V	5V version
2	ATM2412BS-FLW-XFW-M	3.3V	3.3V version