



TCL23B-1602-2 Series

Character Module

User Manual



Attention:

- A. Some specifications of IC are not listed in this manual. Please refer to the IC manual for more details.
- B. The schematic drawing and demo code are available as separate documents from our web site.
- C. Please pay close attention to "INSPECTION CRITERIA" in this manual. Placement of an order with TVI Electronics indicates Buyer's agreement with these criterions.

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1. ORDERING INFORMATION

No.	Part Number	LCD Type	Backlight Color	Graphic & Font Color	Background Color
1	TCL23B-1602BW-2	STN, Negative Blue	White	White	Blue
2	TCL23B-1602WW-2	FSTN, Positive	White	Black	White
3	TCL23B-1602YY-2	STN, Positive Yellow Green	Yellow-Green	Dark Blue	Yellow Green

* Some of the products above may not sell in our online store. Please contact us by email sales@tvelectronics.com for more information.

2. GENERAL SPECIFICATIONS

2.1. Display Specifications

ITEM	STANDARD VALUE	UNIT
Resolution	16 Characters x 2 Lines	-
Display Connector	Pin Header, 16 pins	-
Operating Temperature	-20 ~ +70	°C
Storage Temperature	-30 ~ +80	°C
Touch Panel (Optional)	N/A	-
Font Chip (Optional)	N/A	-
Sunlight Readable*	No.2, No.3	-

* Refer to [Section 1. Ordering Information](#).

2.2. Mechanical Specifications

ITEM	STANDARD VALUE	UNIT
Outline Dimensions (Max)	84.00 (W) x 44.00 (H) x 13.30 (D)	mm
Viewing Area	60.80 (W) x 16.90 (H)	mm
Active Area	56.20 (W) x 11.50 (H)	mm
Character Size	2.95 (W) x 5.55 (H)	mm
Dot Size	0.55 x 0.65	mm
Dot Pitch	0.60 x 0.70	mm
Net Weight (Typical)	51.0 ± 15%	grams

2.3. Electrical Specifications

ITEM	STANDARD VALUE	UNIT
IC Package	COB	-
Controller	HD44780 or Equivalent KS0066 or SPLC780	-
Interface	4-bit Parallel, 8-bit Parallel	-

2.4. Optical Specifications

ITEM	STANDARD VALUE	UNIT
LCD Type	Refer to Section 1. Ordering Information	-
Backlight Color	Refer to Section 1. Ordering Information	-
Viewing Direction	6:00	Clock
LCD Duty	1/16	Duty
LCD Bias	1/5	Bias

3. ELECTRICAL SPECIFICATIONS

3.1. Absolute Maximum Ratings

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Supply Voltage (Logic)	VDD-VSS	-0.3	-	+7.0	V
Supply Voltage (LCD)	VLCD	VDD-15	-	VDD+0.3	V
Input Voltage	VIN	-0.3	-	VDD+0.3	V
Backlight Current	ILED	-	-	25	mA

3.2. DC Characteristics

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Voltage (LCM)	VDD-VSS	VDD=5V	4.8	5.0	5.2	V
		VDD=3.3V	3.0	3.3	3.6	
Input Voltage	VIL	"Low" Level	-0.2	-	1	V
	VIH	"High" Level	VDD-1.0	-	VDD	V
LCD Driving Voltage	VDD-V0	-	4.8	5.0	5.2	V
Current Consumption (LCM)	IDD	VDD=5.0V	-	-	1500	uA
Current Consumption (Backlight)	ILED	-	-	15	-	mA

4. I/O TERMINAL

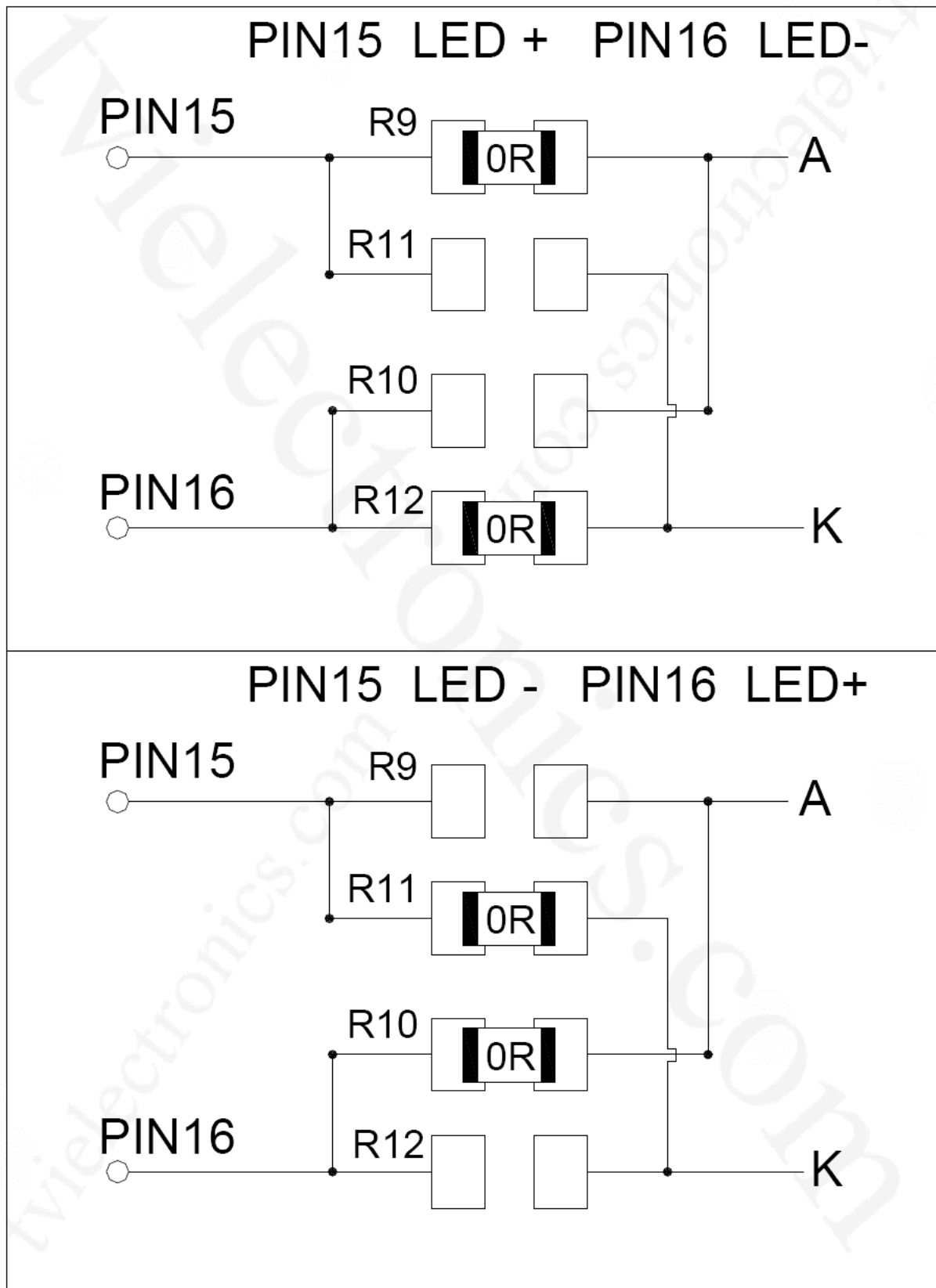
4.1. Pin Assignment

No.	Symbol	Function
1	VSS	Ground, 0V
2	VDD	Logic Power Supply, +5V
3	V0	Operating voltage for LCD
4	RS	Data / Instruction Register Select (H: Data Signal, L: Instruction Signal)
5	R/W	Read / Write (H: Read Mode, L: Write Mode)
6	E	Enable Signal
7	DB0	Data Bit 0
8	DB1	Data Bit 1
9	DB2	Data Bit 2
10	DB3	Data Bit 3
11	DB4	Data Bit 4
12	DB5	Data Bit 5
13	DB6	Data Bit 6
14	DB7	Data Bit 7
15	LED_A	Backlight Anode
16	LED_K	Backlight Cathode

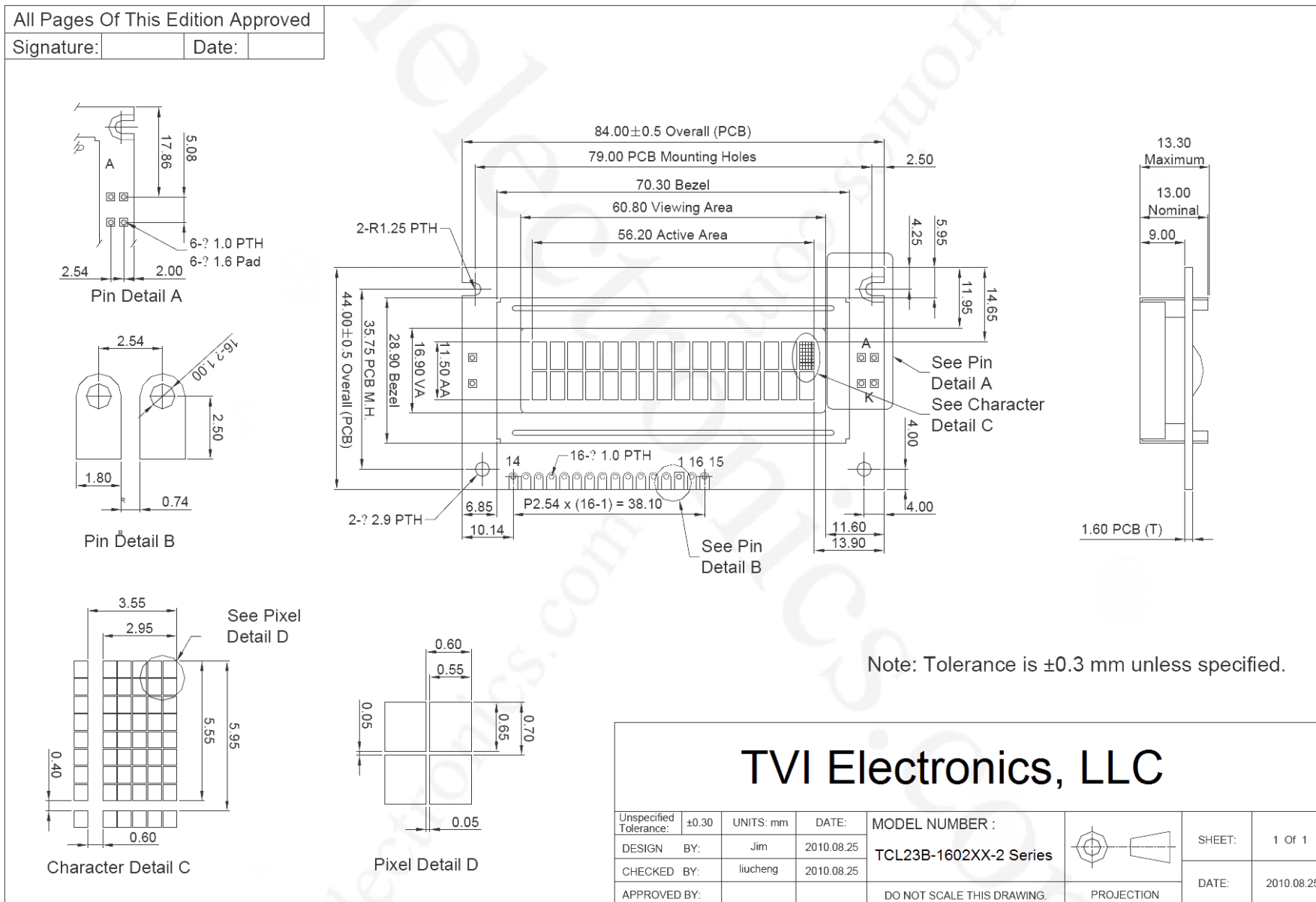
Please refer to [4.2 Jumper Drawing](#) for the Pin Function below.

15	LED_K	Backlight Cathode
16	LED_A	Backlight Anode

4.2. Jumper Drawing



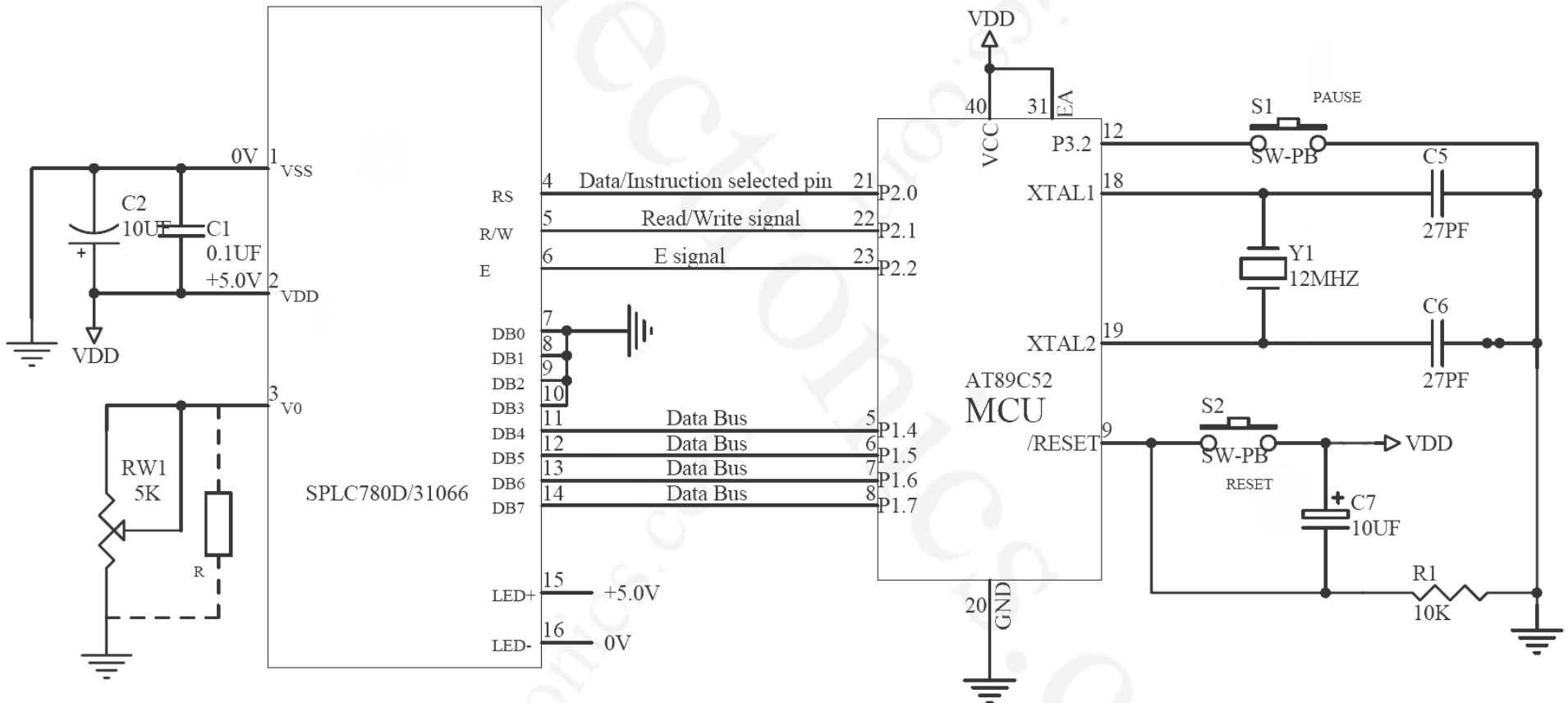
5. OUTLINE DRAWING



6. INTERFACING TO AT89C52 MCU

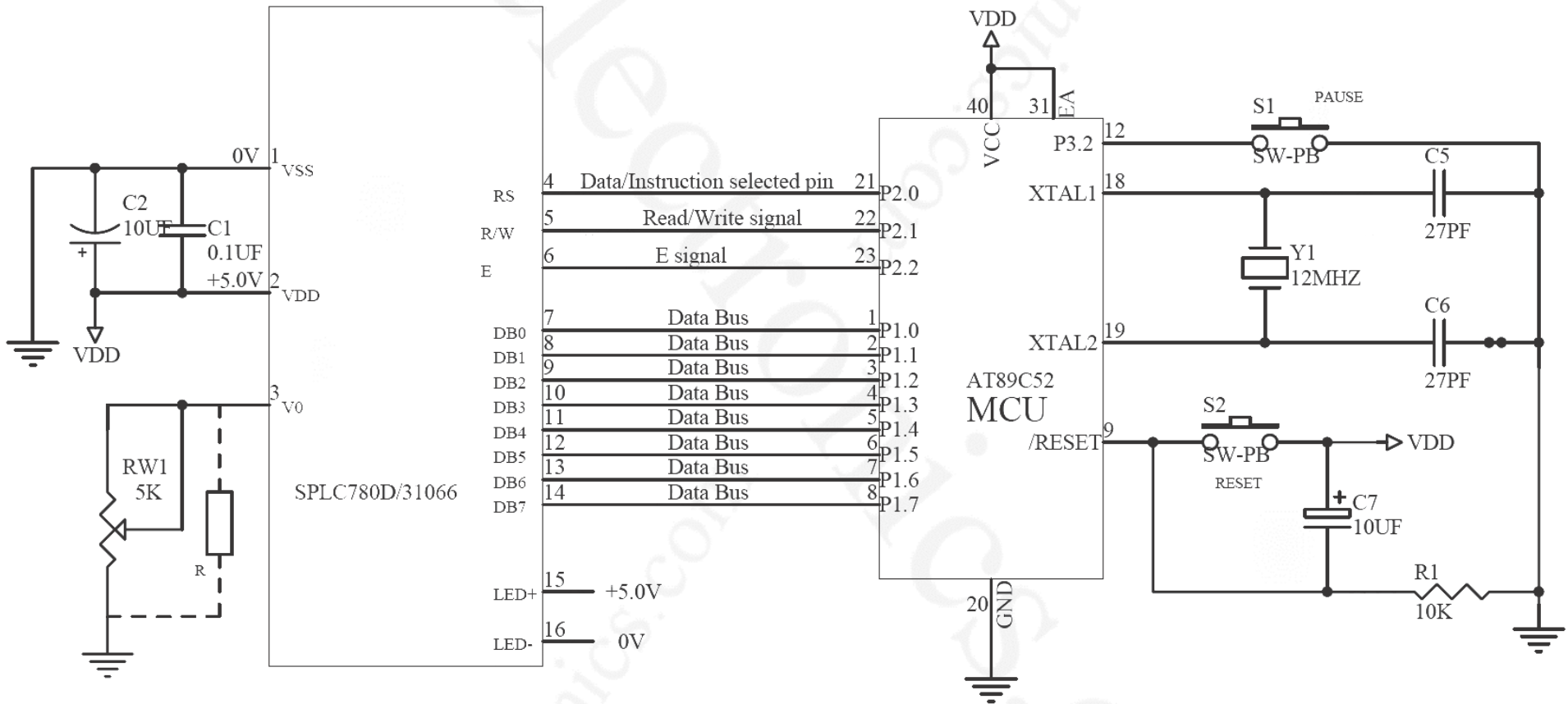
6.1. The Parallel 4Bit (6800 Series MCU) Reference Example

The Parallel 4Bit(6800 Series MCU)Reference Example



6.2. The Parallel 8Bit (6800 Series MCU) Reference Example

The Parallel 8Bit(6800 Series MCU)Reference Example



7. INSPECTION CRITERIA

7.1. Acceptable Quality Level (AQL)

Each lot should satisfy the quality level as defined below:

PARTITION	AQL	DEFINITION
A. Major	0.4%	Functional defective as product.
B. Minor	1.5%	Satisfy all functions as product but not satisfy cosmetic standard.

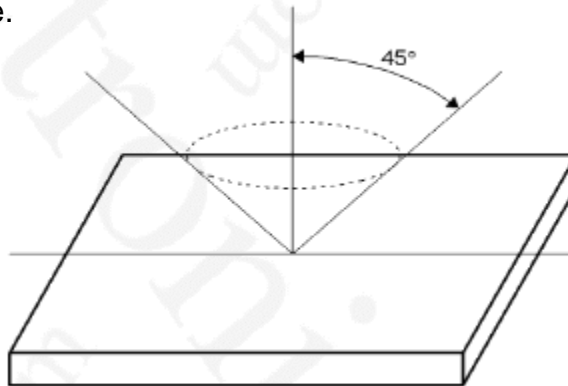
7.2. Definition of Lot

One lot means the quantity delivered to a customer at one time.

7.3. Appearance Standards

7.3.1. Inspection Conditions

- The LCD shall be inspected under 20W white fluorescent lamp.
- The distance between the eyes and the sample shall be 100mm.
- All directions for inspecting the sample should be within 45 degrees against perpendicular line.



7.3.2. AQL Inspection Level

- Sampling Method: MIL-STD-105D
- Sampling Plan: Single
- Major Defect: 0.4% (Major)
- Minor Defect: 1.5% (Minor)
- General Level: II/Normal

7.4. Module Cosmetic Criteria

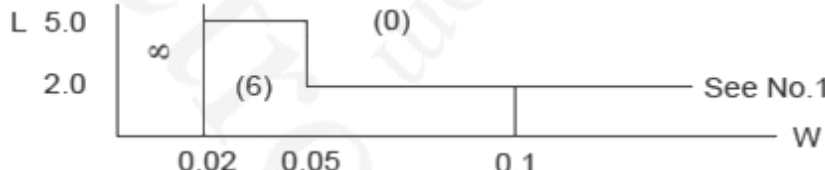
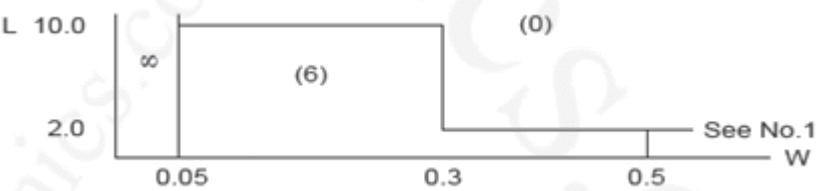
No.	Item	Judgment Criterion	Partition
1	Difference in Spec.	Not allowed	Major
2	Pattern Peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing	Major
		No soldering bridge	Major
		No cold soldering	Minor
4	Resist flaw on substrate	Invisible copper foil (\varnothing 0.5mm or more) on substrate pattern.	Minor
5	Accretion of metallic foreign matter	No soldering dust	Minor
		No accretion of metallic foreign matters (not to exceed \varnothing 0.2mm).	Minor
6	Stain	No stain to spoil cosmetic	Minor
7	Plate discoloring	No plate fading, rusting and discoloring	Minor
8	Solder amount	a. Soldering side of PCB Solder to form a 'Filet' all around the lead. Solder should not hide the leads.	Minor
	1. Leaded parts	b. Components side (In case of 'Through Hole PCB'). Solder to reach the Components side of PCB.	
	2. Flat packages	Either 'toe' (A) or 'heel' (B) of the lead to be covered by 'Filet'. Lead form to be assumed over Solder.	Minor
	3. Chips	$(1/2) H \leq h \leq (3/4) H$	Minor
9	Backlight defects	1. Light fails or flickers. (Major) 2. Color and luminance do not correspond to specifications. (Major) 3. Exceeds standards for display's blemishes, foreign matter, dark lines or scratches. (Minor)	See List ←
10	PCB defects	1. Oxidation or contamination on connectors.* 2. Wrong parts, missing parts, or parts not in specification.* 3. Jumpers set incorrectly. (Minor) 4. Solder (if any) on bezel, LED pad, zebra pad, or screw hole pad is not smooth. (Minor) * Minor if display functions correctly. Major if display fails.	See List ←

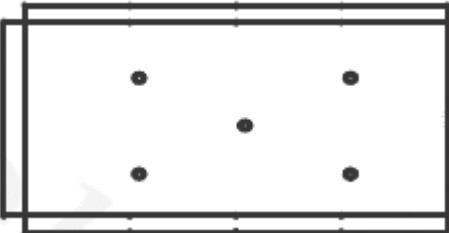
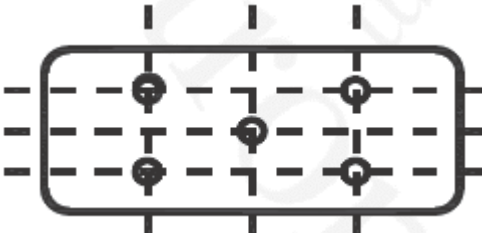
11	Soldering defects	<ol style="list-style-type: none"> 1. Unmelted solder paste. 2. Cold solder joints, missing solder connections, or oxidation.* 3. Solder bridges causing short circuits.* 4. Residue or solder balls. 5. Solder flux is black or brown. <p>* Minor if display functions correctly. Major if display fails.</p>	Minor
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7.5. Screen Cosmetic Criteria (Non-Operating)

No.	Defect	Judgment Criterion		Partition
1	Spots	In accordance with Screen Cosmetic Criteria (Operating) No.1.		Minor
2	Lines	In accordance with Screen Cosmetic Criteria (Operating) No. 2.		Minor
3	Air Bubbles (between glass & polarizer)	Size: D (mm)	Acceptable Qty in active area	Minor
		$D \leq 0.3$	Disregard	
		$0.3 < D \leq 1.0$	3	
		$1.0 < D \leq 1.5$	1	
		$1.5 < D$	0	
4	Scratch	In accordance with spots and lines operating cosmetic criteria. When the light reflects on the panel surface, the scratches are not to be remarkable.		Minor
5	Allowable Density	Above defects should be separated more than 30mm each other.		Minor
6	Color Variation	Not to be noticeable coloration in the viewing area of the LCD panels. Back-light type should be judged with back-light ON only.		Minor
7	Contamination	Not to be noticeable.		Minor

7.6. Screen Cosmetic Criteria (Operating)

No.	Defect	Judgment Criterion	Partition	
1	Spots	A. Clear (The shade and size are not changed by Vo.)	Minor	
		Size: D (mm)		Acceptable Qty in active area
		D ≤ 0.10		Disregard
		0.10 < D ≤ 0.20		6
		0.20 < D ≤ 0.30		2
0.30 < D	0			
		Note: Including pin holes and defective dots which must be within one pixel size.		
		B. Unclear (The shade and size are changed by Vo.)		
		Size: D (mm)	Acceptable Qty in active area	
		D ≤ 0.2	Disregard	
		0.2 < D ≤ 0.5	6	
		0.5 < D ≤ 0.7	2	
		0.7 < D	0	
2	Lines	A. Clear (The shade and size are not changed by Vo.)	Minor	
				
		Note: () – Acceptable Qty in active area L - Length (mm) W -Width(mm) ∞-Disregard		
		B) Unclear (The shade and size are changed by Vo.)		
				
3	Rubbing line	Not to be noticeable.	Minor	
4	Allowable density	Above defects should be separated more than 10mm each other.	Minor	
5	Rainbow	Not to be noticeable.	Minor	
6	Dot size	To be 95%~105% of the dot size (Typ.) in drawing. Partial defects of each dot (ex. pin-hole) should be treated as 'spot'. (see Screen Cosmetic Criteria (Operating) No.1)	Minor	

7	Brightness (only back-light modules)	<p>Brightness Uniformity must be $B (MAX) / B (MIN) \leq 2$</p> <ul style="list-style-type: none"> - B (MAX): Max. value measure is 5 points - B (MIN): Min. value measure is 5 points <p>Divide active area into 4 quadrants vertically and horizontally. Measure 5 points shown in the following figure.</p> 	Minor
8	Contrast Uniformity	<p>Contrast Uniformity must be $B (MAX) / B (MIN) \leq 2$. Measure 5 points shown in the following figure. Dashed lines divide active area into 4 quadrants vertically and horizontally. Measuring points are located at the inner-sections of dashed line.</p>  <p>Note: B (MAX) – Max. value measure is 5 points. B (MIN) – Min. value measure is 5 points. O – Measuring points in $\phi 10mm$.</p>	Minor

Notes:

- 1) Size: $D = (Long\ Length + Short\ Length) / 2$
- 2) The limit samples for each item have priority.
- 3) The total number of defined complex defects should not exceed 10.
- 4) In case of 'concentration', even the spots or the lines of 'disregarded' size should not be allowed. Following three situations should be treated as 'concentration':
 - 7 or more defects in circle of $\phi 5mm$
 - 10 or more defects in circle of $\phi 10mm$
 - 20 or more defects in circle of $\phi 20mm$



8. PRECAUTIONS RELATING PRODUCT USAGE

8.1. Handling Precautions

8.1.1. Liquid Crystal Display Devices

- 1) The liquid crystal display panel used in liquid crystal display module is made of plate glass. Avoid any strong mechanical shock on LCD or touch screen (if available). Should the glass break, handle it with care.
- 2) The polarizer adhering to the surface of the LCD is made of a soft material and can be easily scratched. Protect against scratching it.
- 3) Do not ingest the LCD fluid should the liquid crystal display panel break and fluid leak out. Should hands or clothing come in contact with LCD fluid, wash it off immediately with soap and water.
- 4) Do not stack up LCD modules, since they can be damaged by components on neighboring modules.
- 5) Do not place heavy objects on top of the product. This could cause glass breakage.
- 6) Avoid any bending, pulling, or other excessive force on flexible cables, which can result in broken connections.

8.1.2. Avoid Static Electricity!

- 1) To prevent destruction of the elements by static electricity, be careful to maintain an optimum working environment.
- 2) Be sure to ground your body when handling the LCD module.
- 3) Tools required for assembling, such as soldering irons, must be properly grounded.
- 4) To reduce the amount of static electricity generated, do not conduct assembling and other work under dry conditions. A relative humidity of 50%-60% is recommended.
- 5) The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film, since this operation can generate static electricity.

8.2. Power Supply Precautions

- 1) Identify and observe absolute maximum ratings for both logic and LC drivers at all times. Note that there is some variation between models.
- 2) Prevent the application of reverse polarity to VDD and VSS.
- 3) Use the LCD module with a power supply that is equipped with an overcurrent protector circuit, since the module is not provided with this protective feature.
- 4) The VDD power of LCD module should also supply power to all devices that may access the display. Don't allow the data bus to be driven when the logic supply to the module is turned off.

8.3. Operating Precautions

- 1) DO NOT plug or unplug the LCD module when the system is powered up.
- 2) Minimize the cable length between LCD module and host MPU.

- 3) For models with backlights, do not disable the backlight by interrupting the HV line. Unload inverters produce voltage extremes that may arc within a cable or at the display.
- 4) Operate LCD module within the limits of the modules temperature specifications.
- 5) NC terminal should be open. Do not connect anything.
- 6) If the logic circuit power is off, do not apply the input signals.
- 7) Viewing angle varies with the change of liquid crystal driving voltage (VO). Adjust VO to show the best contrast.
- 8) Driving the LCD in the voltage above the limit will significantly shorten its service life.
- 9) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of order. It will recover when it returns to the specified temperature range.
- 10) If LCD module's area is pushed hard during the operation, it will become abnormal. However, it will return to normal if it is turned off and then back on.
- 11) Condensation on terminals can cause an electrochemical reaction disrupting the terminal circuit. Therefore, it must be used under the relative condition of 40°C, 50% RH.
- 12) When turning the power on, input each signal after the positive/negative voltage becomes stable.

8.4. Mechanical/Environmental Precautions

- 1) Improper soldering is the major cause of module difficulty. Use of flux cleaner is not recommended, as it may seep under the electrometric connection and cause display failure.
- 2) Mount the LCD module, so that it is free from torque and mechanical stress.
- 3) Surface of the LCD panel should not be touched or scratched. Avoid contact and clean only when necessary with soft, absorbent cotton dampened with petroleum benzene.
- 4) Always employ anti-static procedure while handling the LCD module.
- 5) Prevent moisture build-up upon the module and observe the environmental constraints for storage temperature.

8.5. Storage Precautions

When the LCD module alone must be stored for long periods of time:

- 1) Protect the modules from high/low temperatures and humidity, whenever possible.
- 2) Keep the modules out of direct sunlight or direct exposure to ultraviolet rays.
- 3) Protect the modules from excessive external forces.
- 4) Exercise care to minimize corrosion of the electrodes. Corrosion of the electrodes is accelerated by water droplets, moisture condensation, or a current flow in a high-humidity environment.

8.6. Other Precautions

- 1) Liquid crystals solidify under low temperatures (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white).

- 2) If LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.
- 3) To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., exercise care to avoid holding the following sections when handling the modules:
 - Exposed area of the printed circuit board.
 - Terminal electrode sections.

8.7. Using LCD Modules

Liquid Crystal Display Modules are composed of glass and polarizer. Pay attention to the following items when handling:

- 1) Keep the temperature within specified range for use and storage. Polarization degradation, bubble generation, or polarizer peel-off may occur with high temperatures and high humidity.
- 2) Do not touch, push or rub the exposed polarizers with anything harder than an HB pencil lead (glass, tweezers, etc.).
- 3) N-hexane is recommended for cleaning the adhesives used to attach front/rear polarizers and reflectors made of organic substances, which will be damaged by chemicals such as acetone, toluene, ethanol and isopropyl alcohol.
- 4) When LCD surface becomes dusty wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzene. Do not scrub hard to avoid damaging the display surface.
- 5) Wipe off saliva or water drops immediately. Contact with water over a long period of time may cause deformation or color fading.
- 6) Avoid contact with oil and fats.
- 7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizers.
- 8) After products were tested at low temperatures, they must be warmed up in a container before being introduced to a room temperature air.
- 9) Do not put or attach anything to the display area to avoid leaving marks on it.
- 10) Do not touch the display with bare hands. This will stain the display area and degrade insulation between terminals (some cosmetics are determinate to the polarizers).
- 11) If liquid crystal display surface becomes contaminated, breathe on it and gently wipe it off with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following: Isopropyl or alcohol.
 - Solvents other than those mentioned above may damage the polarizer.
 - Especially, do not use water.
- 12) As glass is fragile, it tends to become chipped during handling, especially on the edges. Please avoid dropping or jarring.

8.8. Installing LCD Modules

- 1) Cover the surface with a transparent protective plate to protect the polarizer and LC cell.
- 2) When assembling the LCM into other equipment, the spacer between the LCM and the fitting plate should have enough height to avoid causing stress to the module surface, refer to the individual specifications for measurements. The measurement tolerance should be $\pm 0.1\text{mm}$.
- 3) Install the LCD module by using the mounting holes.
- 4) When mounting the LCD module make sure it is free of twisting, warping, and distortion. In particular, do not forcibly pull or bend the cable or the backlight cable.
- 5) Since the LCD module has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.
 - Do not alter, modify or change the shape of the tab on the metal frame.
 - Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
 - Do not damage or modify the pattern writing on the printed circuit board.
 - Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
 - Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
 - Do not drop, bend or twist the LCM.
 - Do not attempt to disassemble or process LCD module.
- 6) NC terminal should be open. Do not connect anything.
- 7) If the logic circuit power is off, do not apply the input signals.

8.9. Soldering LCD Modules

- 1) Observe the following precautions when soldering lead wire, connector cable, etc. to the LCM:
 - Soldering iron temperature: $280^{\circ}\text{C} \pm 10^{\circ}\text{C}$.
 - Soldering time: 3-4 sec.
 - Solder: eutectic solder.
- 2) If soldering flux is used, be sure to remove any remaining flux after finishing the soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage due to flux spatters.
- 3) When soldering the electroluminescent panel and PC board, the panel and board should not be detached more than three times. This maximum number is determined by the temperature and time conditions mentioned above, though there may be some variance depending on the temperature of the soldering iron.
- 4) When remove the electroluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.



9. LIMITED WARRANTY

TVI Electronics warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TVI Electronics' standard warranty. All TVI Electronics products have been manufactured to your company's or your own specifications as a part for use in your company's or own general electronic products. It is guaranteed to perform according to delivery specifications.

We cannot take responsibility for any other use apart from general electronic equipment, if the product is used in medical devices, nuclear power control equipment, aerospace equipment, fire and security systems, or any other applications in which there is a direct risk to human life and where extremely high levels of reliability are required.

Customers are responsible for their products and applications using TVI Electronics components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

Following conditions are not covered by the warranty and are subject to change.

- 1) Any malfunctions and damages during transportation and transfer by user.
- 2) Any malfunctions and damages caused by static electricity, electrostatic discharge (ESD) or application of incorrect voltage after the product has passed your company's acceptance inspection procedures.
- 3) Any malfunctions and damages caused by a natural disaster or a fire.
- 4) Any malfunctions and damages caused by the failure of the associated equipment.
- 5) Any malfunctions and damages caused by an application of strong external force or mechanical stress to the product.
- 6) Any malfunctions and damages caused by an additional manufacturing of the product (including disassembly and reassembly), remodeling or repairing by the user or unauthorized personnel after product delivery.
- 7) If the product is glued onto the equipment and then uninstalled.
- 8) Any malfunctions and damages caused by an improper installation (including an incidental or consequential damages), usage and handling against the specifications and notes.
- 9) Custom products are not eligible for Warranty Replacement.

10. RETURN POLICY

Unless agreed between TVI Electronics and the customer, TVI Electronics will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with TVI Electronics LCD acceptance standards (copies available upon request) for a period of one year from date of shipment. Cosmetic/visual defects must be returned to TVI Electronics within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of TVI Electronics



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limited to repair and/or replacement on the terms set forth above. TVI Electronics will not be responsible for any subsequent or consequential events.

No warranty can be granted if the precautions stated above have been disregarded. The typical examples of violations are:

- 1) Broken LCD glass
- 2) PCB eyelet damaged or modified
- 3) PCB conductors damaged
- 4) Circuit modified in any way, including addition of components
- 5) PCB tampered by grinding, engraving or painting varnish
- 6) Soldering to or modifying the bezel in any manner

Module repairs will be invoiced to the customer upon mutual agreement. Modules must be returned with sufficient description of the failure or defect. Any connectors or cables installed by the customer must be removed completely without damaging the PCB eyelets, conductors and terminals.