Integrated Serial LCD Module (ILM-216)

The ILM-216 combines a 2x16 supertwist LCD and PIC16F84 microcontroller into a compact module. It is normally sold with firmware installed for user-interface applications, but the PIC16F84 may be reprogrammed for custom applications that require an alphanumeric LCD, five I/O lines, and four switch/button inputs (multiplexed with LCD data bus).

This manual provides in-depth information for OEMs and advanced users of the ILM-216. It does not contain tutorial material on PIC microcontrollers, LCDs, or other fundamental technical issues. Scott Edwards Electronics, Inc. (S.E.E.) will provide tech support on this information *only* to bonafide developers.

Important Note: This manual describes reprogramming the ILM-216's microcontroller. Once this chip is reprogrammed, you will *not* be able to restore its original serial-LCD firmware. To restore the original firmware, contact S.E.E. and arrange to return the unit for reprogramming. The customer will bear the cost of reprogramming and full cost of shipping both ways.

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Scott Edwards Electronics, Inc. warrants this product against defects in materials and workmanship for a period of 90 days. If you discover a defect, we will, at our option, repair, replace, or refund the purchase price. Return the product with a description of the problem. We will return your product or its replacement via standard shipping. Expedited shipping is available at the customer's expense.

• Note: Physically abusing the module, or attempting to repair or modify it, voids this warranty.

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Detailed Memory Map of EEPROM Configuration Data

This information applies to the ILM-216 serial-LCD firmware, but may also be helpful to designers wishing to store the same kinds of configuration data in EEPROM. The PIC16F84 has 64 bytes of read/write EEPROM. The standard ILM-216 firmware allows the user to download bit patterns for six custom characters, various configuration settings, and a full-screen (32-character) display.

Figure 2 shows how the six custom symbols are stored in 30 bytes of EEPROM. Each custom symbol is a 5x8 grid. In the LCD's CG RAM, these bit patterns are normally stored as 8 bytes per symbol. The upper 3 bits of each byte are unused. To conserve space, the ILM-216 discards the unused bits and packs each symbol into 5 bytes as shown below. Each bit is labeled in the form *symbol.row.bit*. For example, 1.2.3 is bit 3 of row 2 of custom symbol 1.

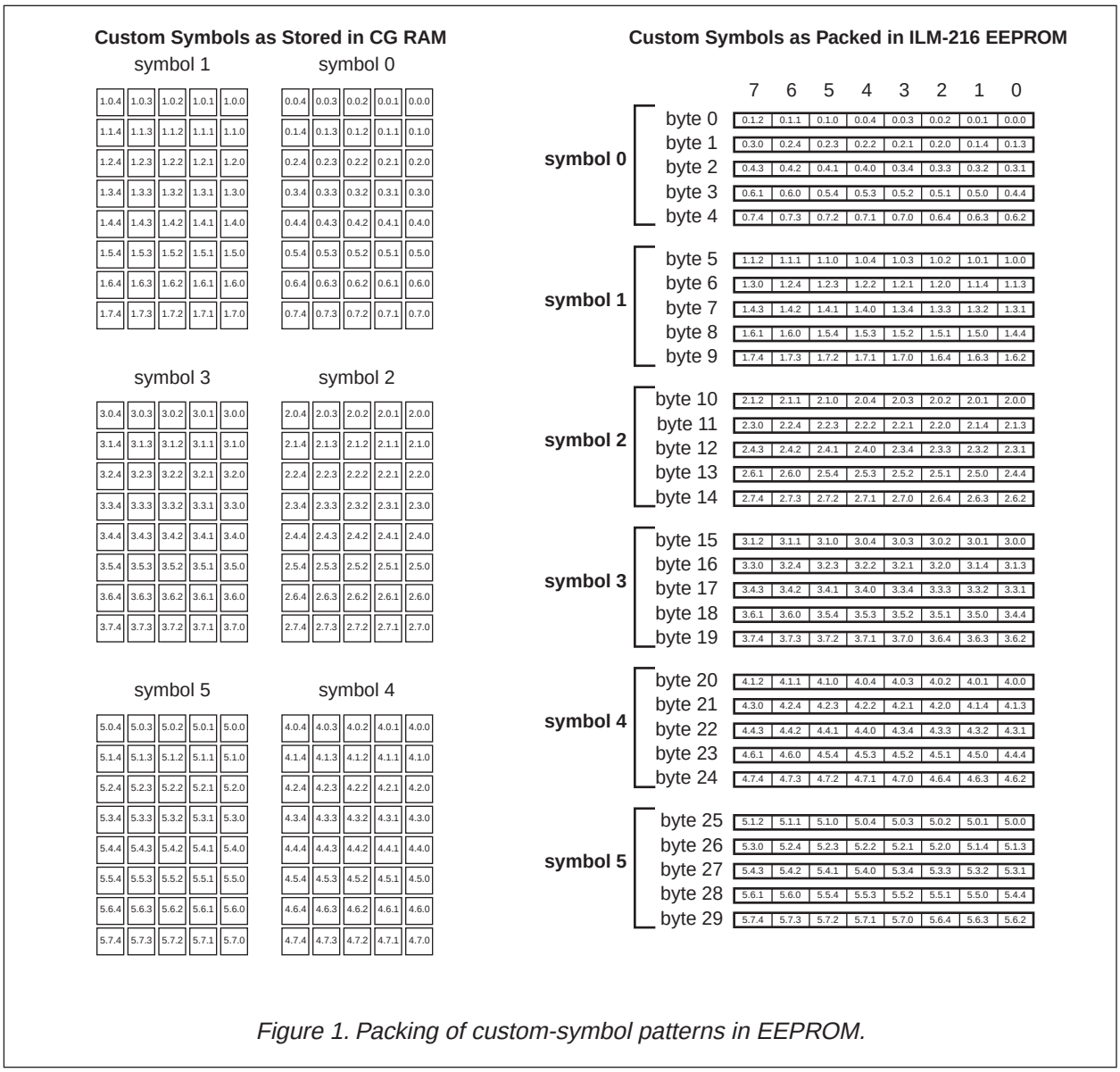


Figure 1. Packing of custom-symbol patterns in EEPROM.

Figure 3 shows how the text screen and display settings are stored in EEPROM. Bytes 30 and 31 hold the settings, while the remaining 32 bytes of EEPROM are literal ASCII values for each of the 2x16 screen's 32 characters.

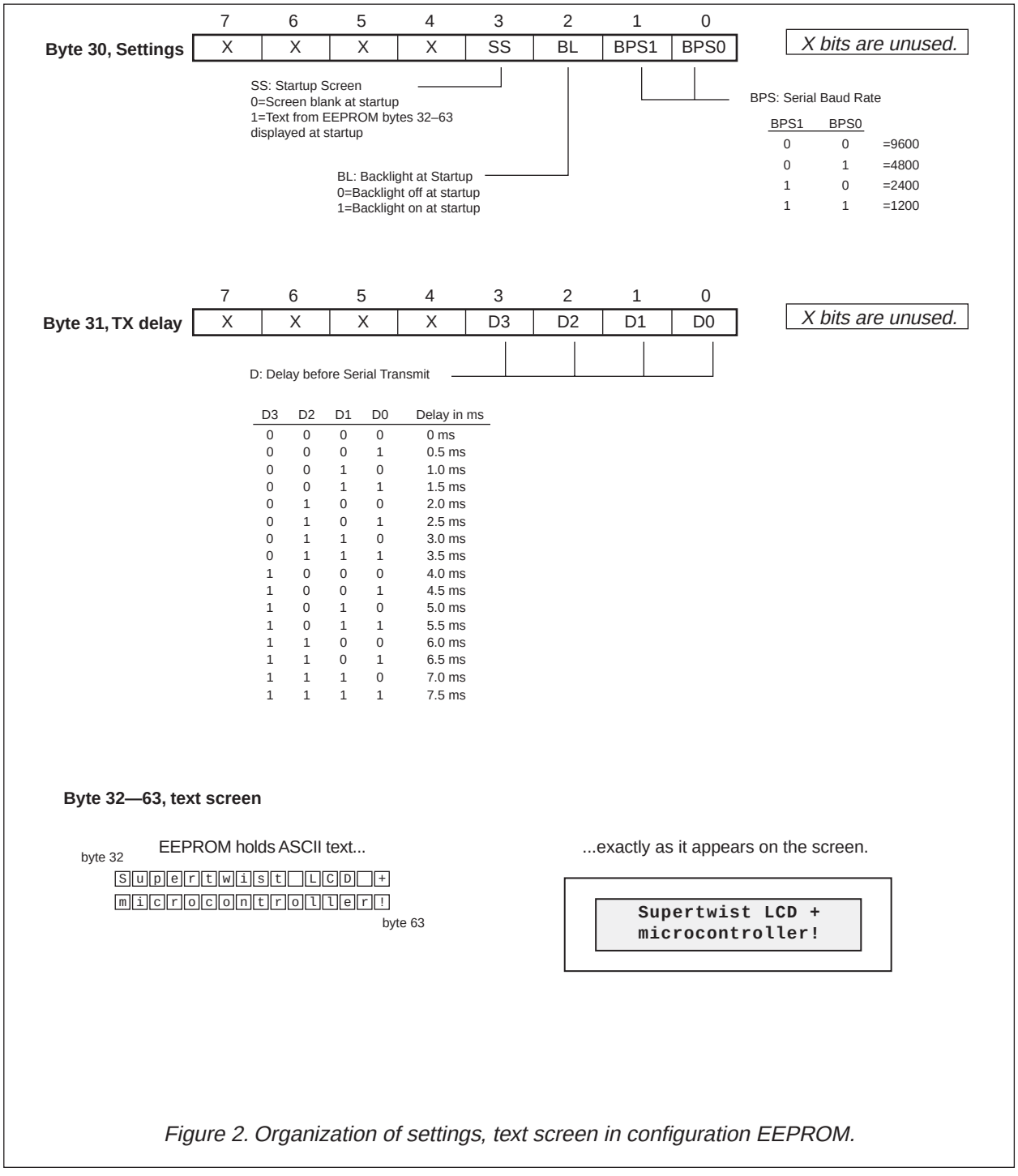


Figure 2. Organization of settings, text screen in configuration EEPROM.

Schematic Diagram of the ILM-216

Figure 1 is the schematic diagram of the ILM-216. The LCD uses a standard alphanumeric controller, the KS0066 (Samsung) in chip-on-board form. This chip is identical in operation to the common HD44780 LCD controller chip. Full documentation on these LCD controllers is available from many sources on the Internet. The manufacturer's specs are available in PDF form at:

`http://www.sec.samsung.com/Products/ldi/products/ks0066u.html`

Less authoritative but more friendly technical information on LCD interfacing is available from other LCD users. An LCD technical discussion group and LCD-related links are available from:

`http://www.eio.com`

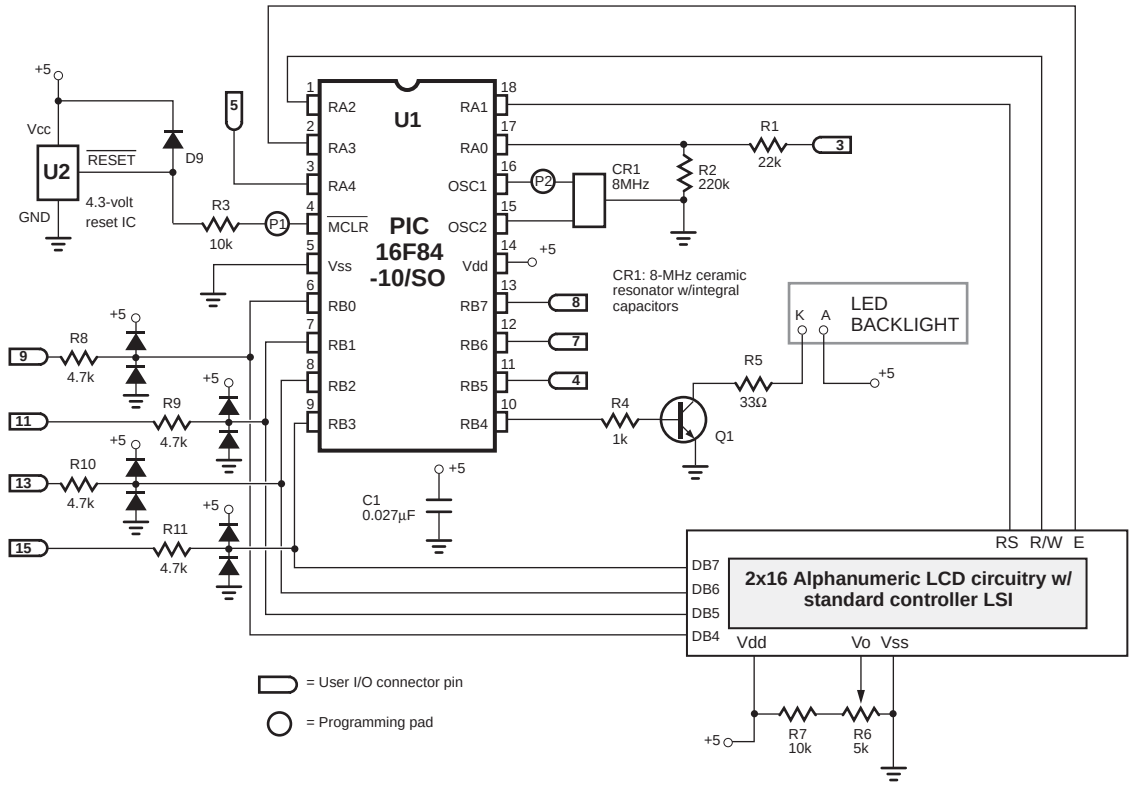


Figure 3. Schematic diagram of the ILM-216.

Reprogramming the PIC16F84

The 16F84 may be reprogrammed in circuit using the serial programming method described in Microchip's literature. You can obtain programming information from Microchip's web site at:

`http://www.microchip.com`

In-circuit programming requires access to several pins of the 16F84. These are accessible through the pins of the user interface connector, plus two marked pads (P1 and P2) to the left of pin 16 (as viewed from the component side of the ILM-216). The programming pins are listed below:

	Vss	Vdd	RB6	RB7	MCLR	OSC1*
ILM-216 pin	1	2	7	8	P1	P2
16F84 pin	5	14	12	13	4	16

**Some programmers may not use an OSC1 connection.*

As the schematic (figure 3) shows, the ILM-216 is designed to accommodate in-system programming. The reset IC on MCLR is diode-protected against the programming voltage (Vpp), and pins RB6 and RB7 are unconnected.

To program the 16F84, temporarily connect the ILM-216 pins listed above to the corresponding PIC16F84 pins of your programming hardware. For a more convenient arrangement, you can make an adapter that connects an 18-pin DIP header to a spring-loaded SOIC test clip. To program the 16F84, plug the DIP header into the programming socket of your PIC programmer and attach the test clip to the body of the 16F84 on the ILM-216 board. Figure 4 below shows the general idea.

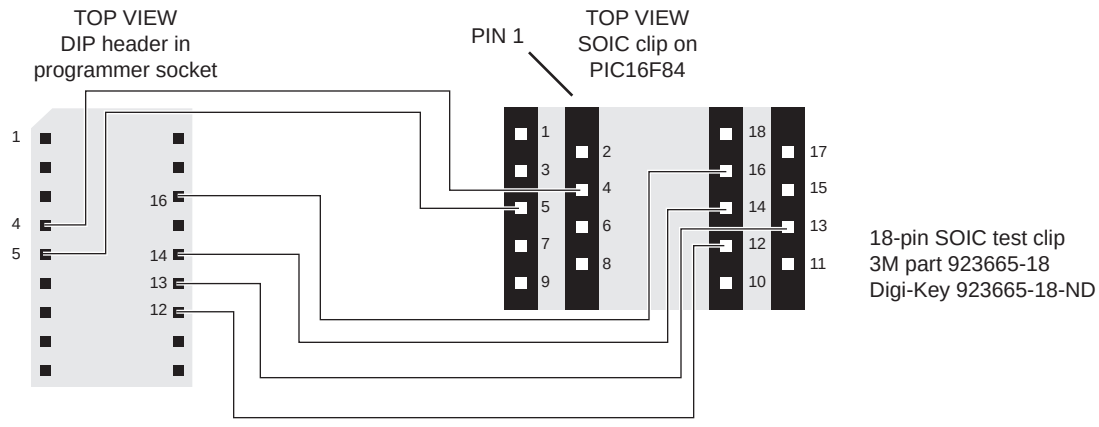


Figure 4. Programming adapter.

Initializing and Driving the 2x16 LCD

Program examples in Parallax and Microchip dialects of PIC assembly language are available from **www.seetron.com**.

Detailed LCD Specifications

The pages that follow contain the LCD manufacturer's detailed specifications on the display portion of the ILM-216.

1. SPECIFICATIONS

1.1 Features

- 16-characters, two-lines liquid crystal display of 5*7 dot matrix + cursor
- 1/16 Duty, 1/4 bias
- STN LCD, positive, yellow-green
- Transflective LCD
- 6 o'clock viewing angle
- 4 bits parallel data input
- LED backlight

1.2 Mechanical Specifications

- Outline dimension : 80.0mm(L)* 50.0mm(W)*14.5mm max.(H)
- Viewing area : 66.0mm *16.2mm
- Active area : 56.21mm *11.5mm
- Dot size : 0.56mm *0.66mm
- Dot pitch : 0.6mm *0.7mm
- Character Size : 2.96mm *5.56mm

1.3 Absolute Maximum Ratings

Item	Symbol	Conditions	Min.	Max.	Unit
Power supply Voltage	V_{DD}	-	-0.3	7.0	V
Input voltage	V_{IN}	-	-0.3	V_{DD}+0.3	V
Operating temperature	T_{OPR}	-	0	50	°C
Storage temperature	T_{STG}	-	-10	60	°C
Humidity*1	H_D	-	-	90	%RH

1.4 DC Electrical Characteristics

V_{DD}=+5V±10%,V_{SS}=0V,T_A=25°C

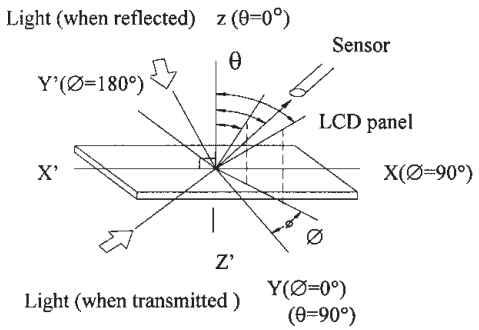
Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Logic Supply voltage	V_{DD}	-	4.5	5	5.5	V
"H" input voltage	V_{IH}	-	0.7V_{DD}	-	V_{DD}	V
"L" input voltage	V_{IL}	-	0	-	0.6	V
"H" output voltage	V_{OH}	-	V_{DD}-0.4	-	-	V
"L" output voltage	V_{OL}	-	-	-	0.4	V
Supply current	I_{OP}	V_{DD}=5V	-	3.3	-	mA
LCD driving voltage	V_{LCD}	-	-	4.4	-	V

1.5 Optical Characteristics

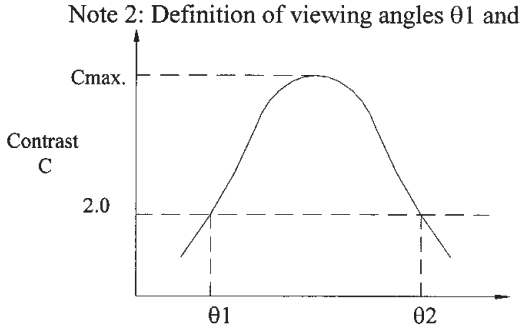
1/16 duty, 1/4 bias, Vopr=4.4V, Ta=25°C

Item	Symbol	Conditions	Min.	Typ.	Max	Reference
Viewing angle	θ	C≥2.0,∅=0°C	30°	-	-	Notes 1 & 2
Contrast	C	θ=5°, ∅=0°	-	3	-	Note 3
Response time(rise)	ton	θ=5°, ∅=0°	-	100ms	150ms	Note 4
Response time(fall)	toff	θ=5°, ∅=0°	-	300ms	500ms	Note 4

Note 1: Definition of angles θ and ∅



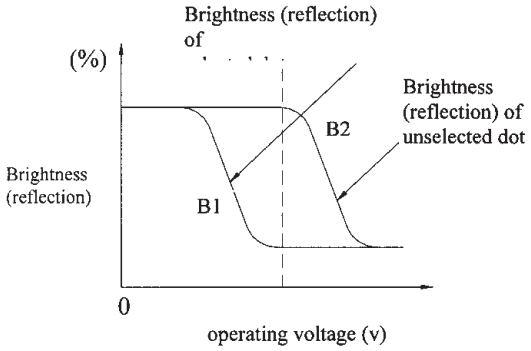
Note 2: Definition of viewing angles θ1 and θ2



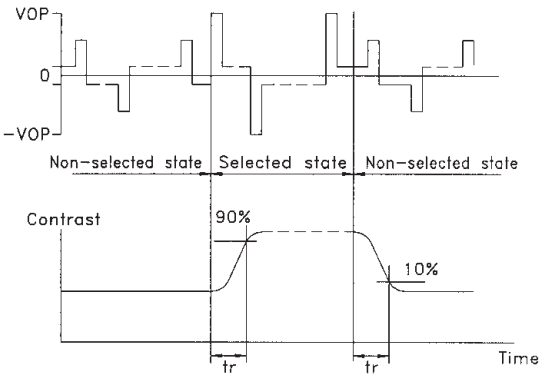
Note : Optimum viewing angle with the naked eye and viewing angle θ at Cmax. Above are not always the same

Note 3: Definition of contrast C

$$C = \frac{\text{Brightness (reflection) of unselected dot (B2)}}{\text{Brightness (reflection) of selected dot (B1)}}$$



Note 4: Definition of response time



Note: Measured with a transmissive LCD panel which is displayed 1 cm^2

Vopr : Operating voltgae
ton : Response time (rise)
fFRM : Frame frequency
toff : Response time (fall

1.6 Backlight Characteristic

The LCD Module is backlight using a array LED panel
•.Maximum Ratings

Item	Symbol	Conditions	Min.	Max.	Unit
Forward current	IF	TA=25°C	-	450	mA
Reverse voltage	VR	TA=25°C	-	8	V
Power dissipation	PO	TA=25°C	-	1.6	W
Operating Temperature	TOPR	-	-20	70	°C
Storage temperature	TSTG	-	-40	80	°C

•.Electrical Ratings

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Forward voltage	VF	IF=180mA	3.8	4.2	4.6	V
Reverse current	IR	VR=8V	-	-	0.2	mA
Luminous intensity	IV	IF=180mA	187	234	-	cd/m^2
Wavelength	λp	IF=180mA	571	-	576	nm
Color	Yellow Green					

2. MODULE STRUCTURE

2.1 Counter Drawing

*See Appendix

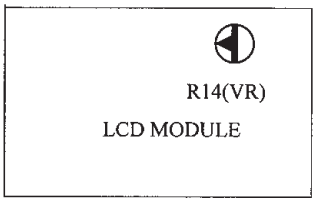
2.2 PIC single chip

*Reference MICROCHIP PIC 16F8X DATA SHEET

2.3 Interface Pin Description

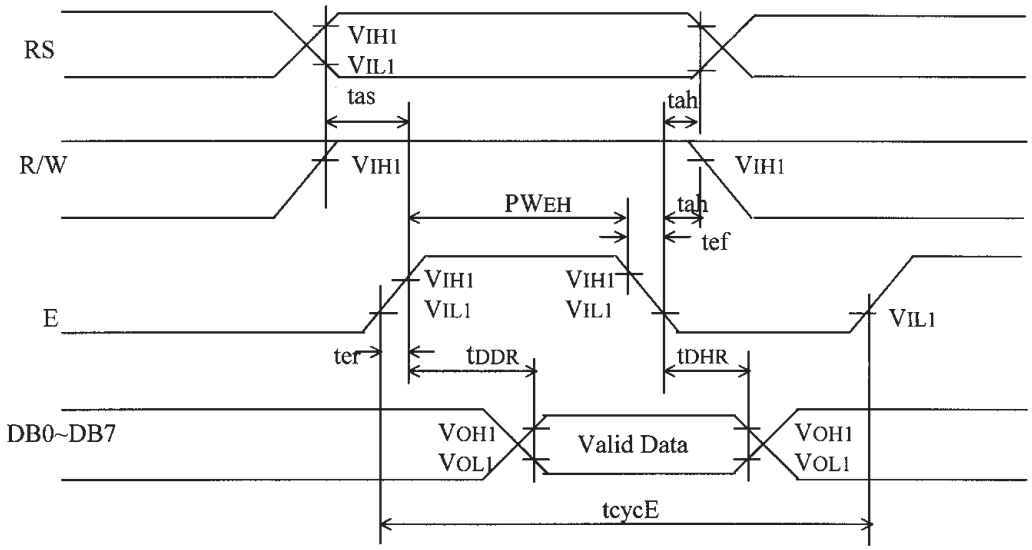
Pin No.	Symbol	Signal Description
1/6/10/12/ 14/16	GND	Signal ground
2	+5V	Power Supply
3	S(IN)	Input/Output pin. Internal software programmable weak pull-up.
4	S(OUT)	Input/Output pin. Internal software programmable weak pull-up.
5	PIEZO	Input/Output pin. Internal software programmable weak pull-up.
7	Config/Test	Input/Output pin. Internal software programmable weak pull-up.
8	Aux	Input/Output pin. Internal software programmable weak pull-up.
9	S1	External 4 bit parallel input data pin
11	S2	External 4 bit parallel input data pin
13	S3	External 4 bit parallel input data pin
15	S4	External 4 bit parallel input data pin
	P1	Programming voltage input
	P2	External clock source input

Contrast Adjust

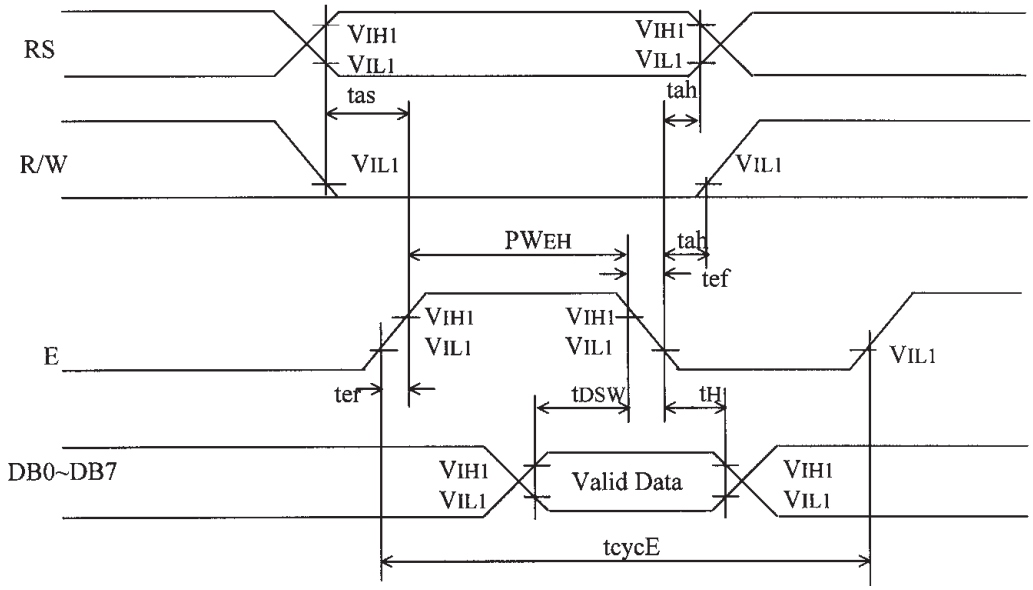


2.4 Timing Characteristics for LCD

• Read cycle



• Write cycle



• Read cycle

V_{DD}=+5V±10% ,V_{SS}=0V,Ta=25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Pin
Enable cycle time	tcycE	500	-	-	ns	E
Enable "H" level pulse width	PWEH	230	-	-	ns	E
Enable rise /fall time	ter,tef	-	-	20	ns	E
RS,R/W setup time	tas	40	-	-	ns	RS,R/W
RS,R/W address hold time	tah	10	-	-	ns	RS,R/W
Read data output delay time	TDDR	-	-	160	ns	DB0~DB7
Read data hold time	tDHR	5	-	-	ns	DB0~DB7

• Write cycle

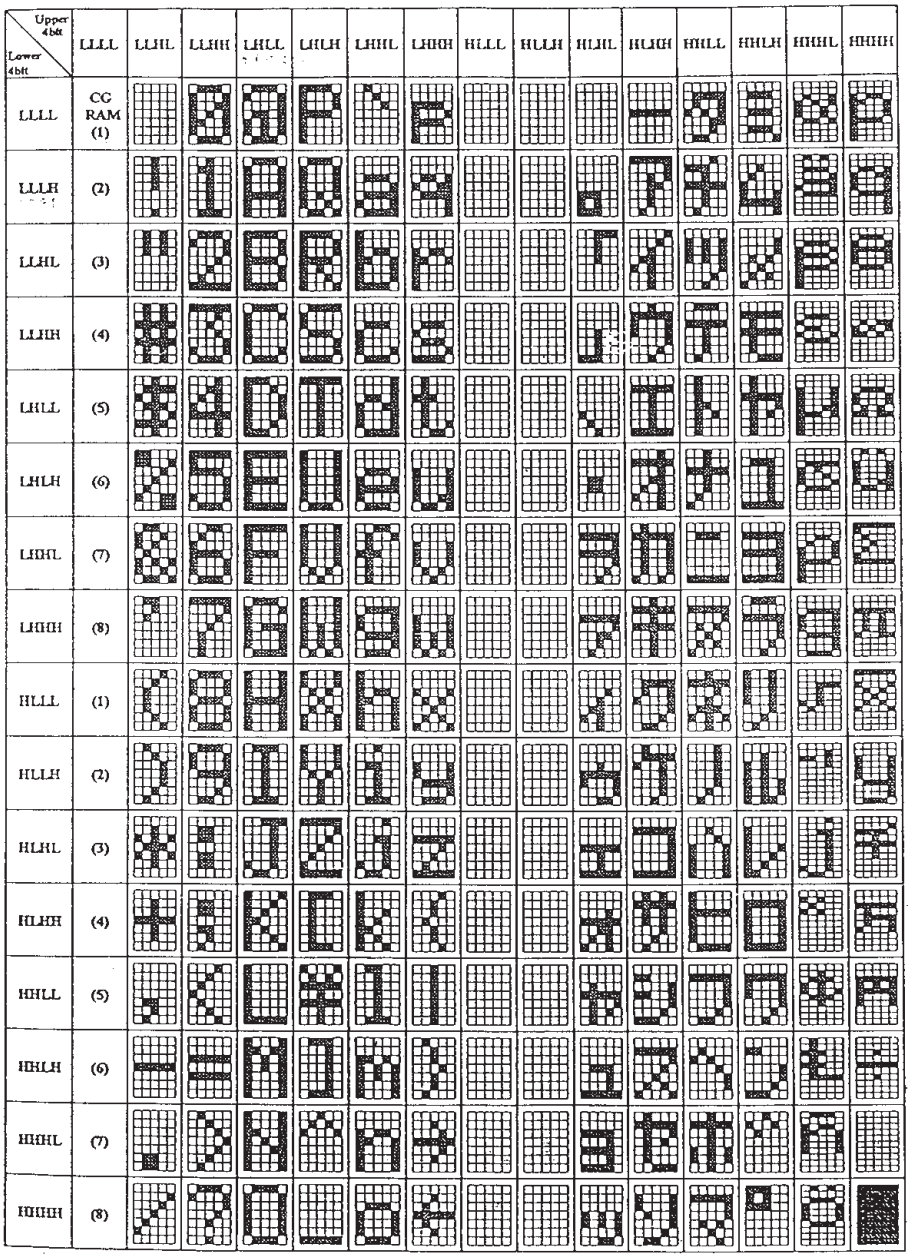
Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Pin
Enable cycle time	TcycE	500	-	-	ns	E
Enable "H" level pulse width	PWEH	230	-	-	ns	E
Enable rise /fall time	ter,tef	-	-	0	ns	E
RS,R/W setup time	tas	40	-	-	ns	RS,R/W
RS,R/W address hold time	tah	10	-	-	ns	RS,R/W
Read data output delay time	tDSW	80	-	-	ns	DB0~DB7
Read data hold time	tDHR	10	-	-	ns	DB0~DB7

2.5 Display Command for LCD

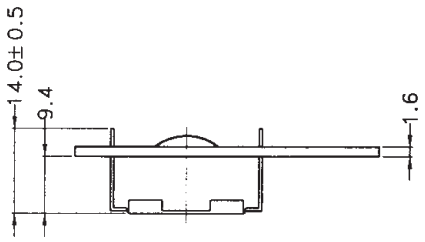
Instructions	Instruction Code										Description	Execution Time (fosc = 270KHZ)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write "20H" to DDRAM. and set DDRAM address to "00H" from AC.	1.52ms
Return Home	0	0	0	0	0	0	0	0	1	×	Set DDRAM address to "00H" from AC and return cursor to it's original position if shifted. The contents of DDRAM are not changed.	1.52ms
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and make shift of entire display enable.	37μs
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Sets display (D), cursor(C), and blinking of cursor(B) on/off control bit.	37μs
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	×	×	Set cursor moving and display shift control bit, and the direction, without changing of DDRAM data.	37μs
Function Set	0	0	0	0	1	DL	N	F	×	×	Set interface data length (DL:4 - bit/8-bit), numbers of display line (N: 1-line/2-line), display font type(F:5*8 dots/5*11 dots)	37μs
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	37μs
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	37μs
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Whether during internal operation or not can be known by reading BF. The contents of address counter can also be read.	0μs
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM).	37μs tADD=4us
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data from internal RAM (DDRAM/CGRAM).	37μs tADD=4us

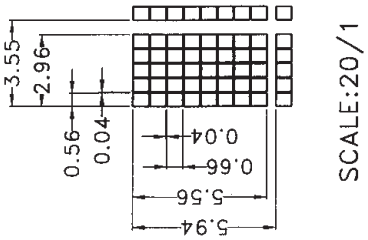
※ "×":don't care

2.6 Character Pattern



PIN NO.	SIGNAL
1	GND
2	+5V
3	S(IN)
4	S(OUT)
5	PIEZO
6	GND
7	Config/Test
8	Aux
9	S1
10	GND
11	S2
12	GND
13	S3
14	GND
15	S4
16	GND





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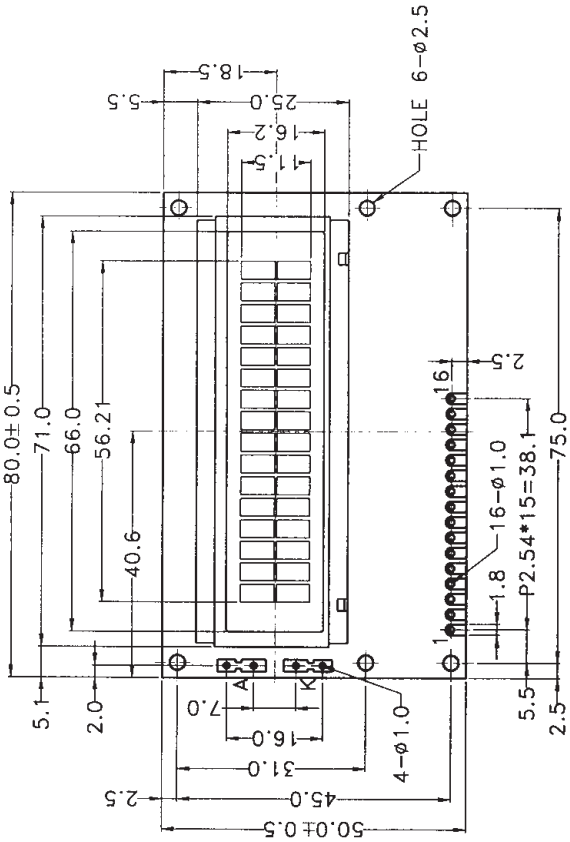

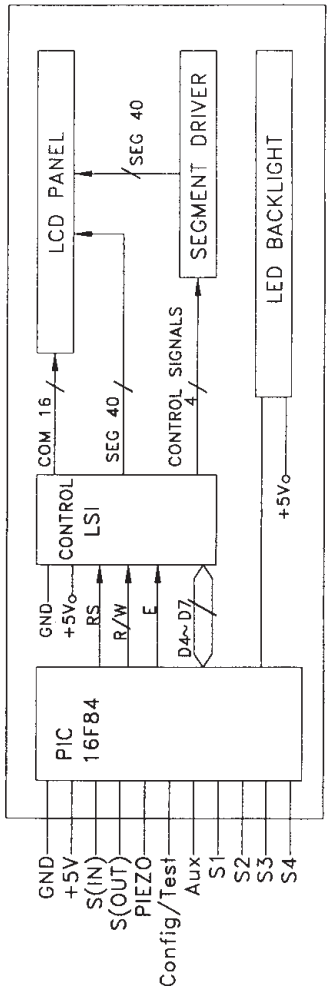

The tolerance unless classified ±0.3mm