DISPLAY Elektronik GmbH

DATA SHEET

LCD MODULE

DEM 160080A SYH-LY

Product specification ***Version :2***

19/04/2004

GENERAL SPECIFICATION

MODULE NO. :

DEM 160080A SYH-LY

CUSTOMER P/N

VERSION NO.	CHANGE DESCRIPTION	**DATE**
0	ORIGINAL VERSION	2003/06/19
1	CHANGE PCB DRAWING	2003/07/15
2	CHANGED EXTERNAL DIMENSIONS&PCB DRAWING AND DESCRIPTION	2004/03/16

PREPARED BY: CHJ DATE: 16/03/2004

APPROVED BY: MH DATE: 19/04/2004

CONTENTS

1.FUNCTIONS & FEATURES

- DEM 160080A SYH-LY :

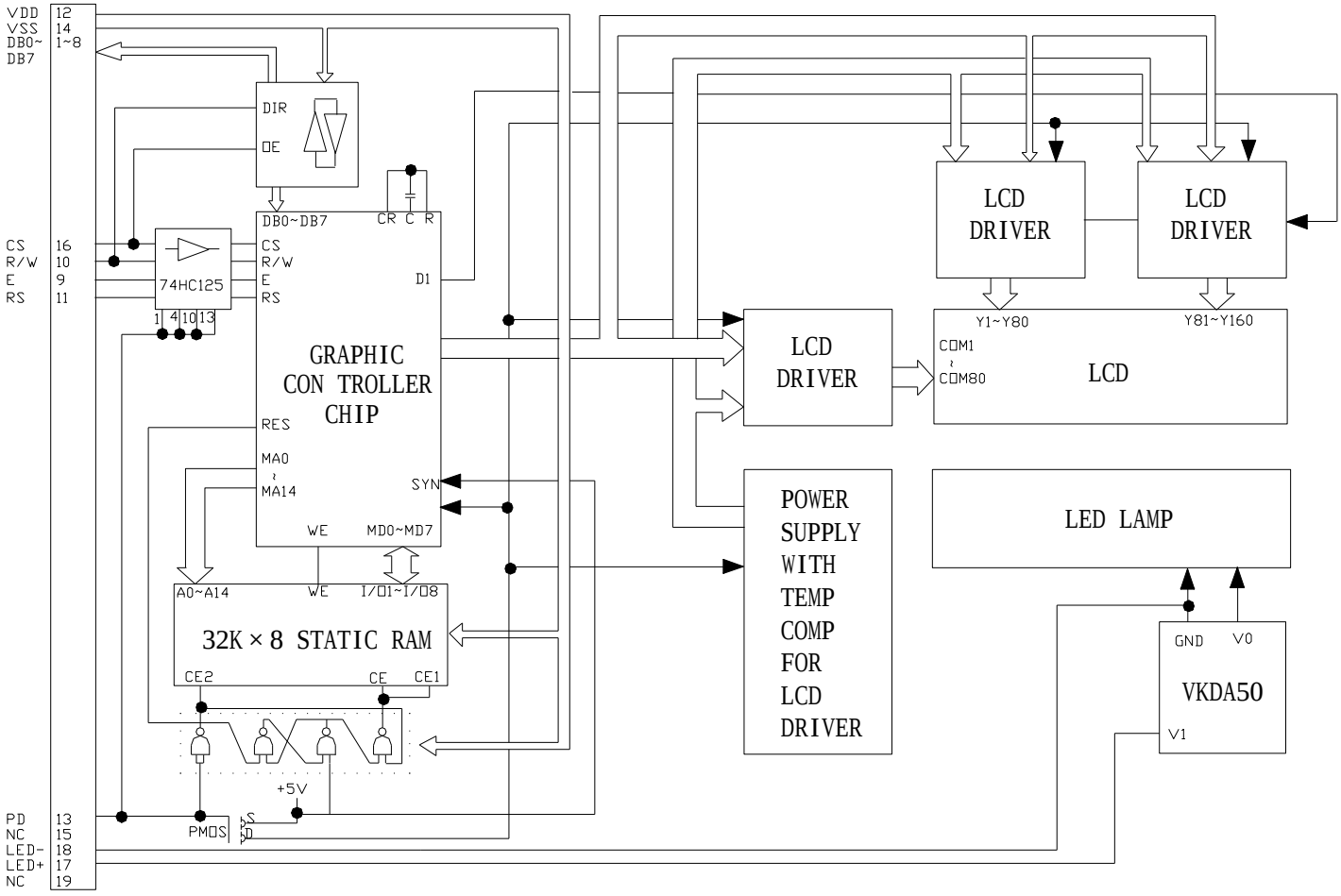
Module	LCD Technology	LCD Mode
DEM 160080A SYH-LY	STN Yellow Green	Transflective Positive Mode

- Viewing Direction : 6 o'clock
- Driving Scheme : 1/80 Duty Cycle, 1/9 Bias
- Power Supply Voltage : 5.0 Volt
- V_{LCD} Adjustable For Best Contrast : 11.2 Volt
- Operating Temperature : -20°C ... +70°C
- Storage Temperature : -25°C ... +75°C
- Backlight : LED-Lightbox (Yellow/Green)
- Display Contents : 160 x 80 Dots
- RAM Size : 32K x 8 bits
- Interface : 8 bit parallel display data from MPU

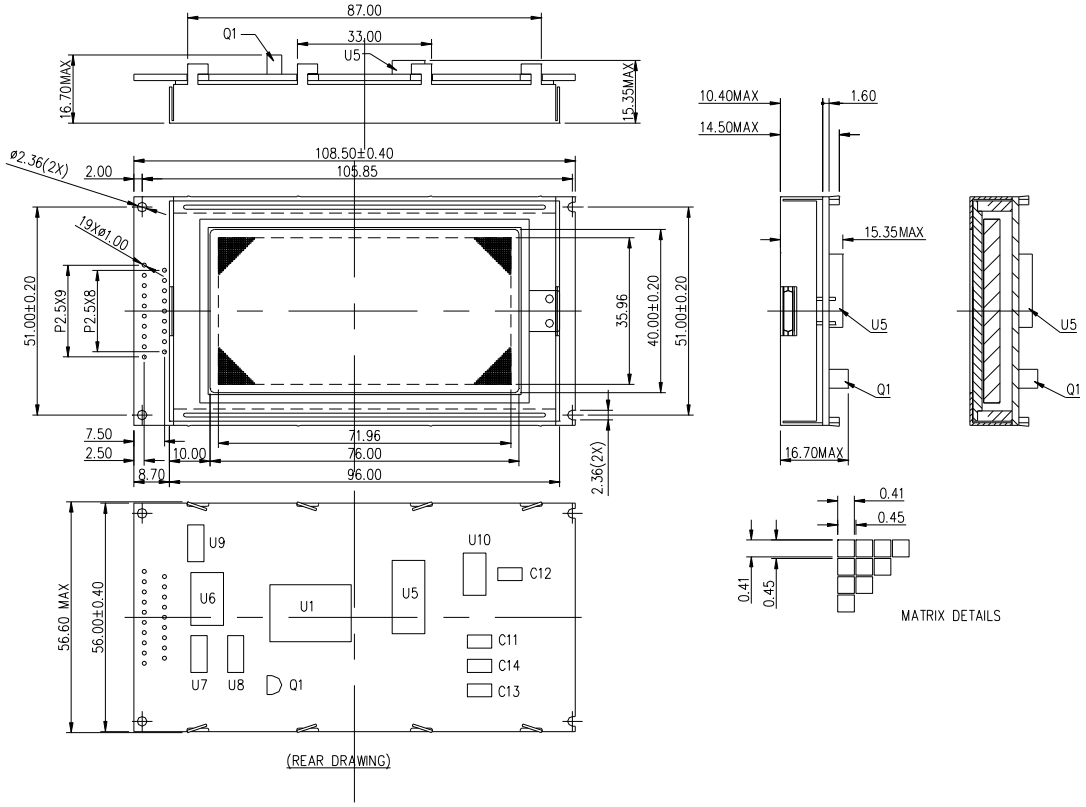
2. MECHANICAL SPECIFICATIONS

- Dot Size : 0.41 (W) x 0.41 (H) mm
- Dot Pitch : 0.45 (W) x 0.45 (H) mm

3. BLOCK DIAGRAM



4. EXTERNAL DIMENSIONS



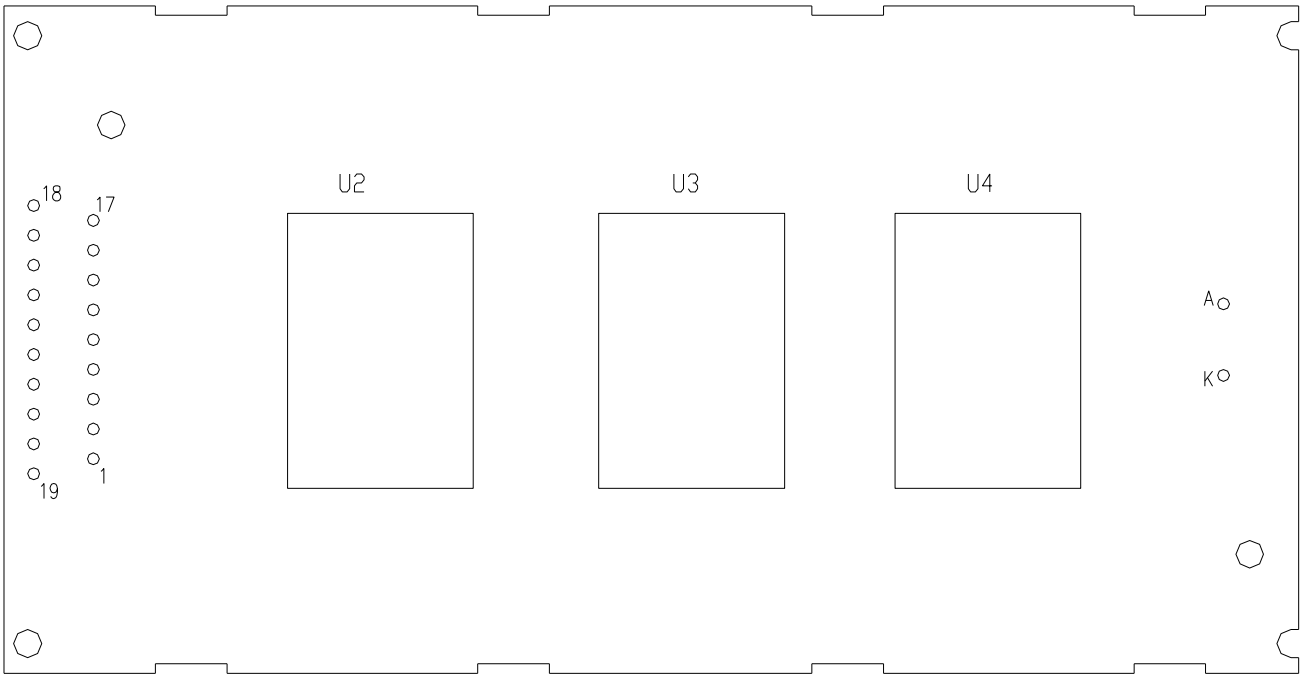
5. PIN ASSIGNMENT

Pin No.	Symbol	Function
1	DB7	8-bit data bus
2	DB6	
3	DB5	
4	DB4	
5	DB3	
6	DB2	
7	DB1	
8	DB0	
9	E	Enable E=H: data can be read. E=H→L: data can be written
10	R/W	Read/Write R/W=1: read R/W=0: write
11	RS	Register select RS=1: instruction RS=0: data
12	VDD	Power supply terminal of module +5V DC
13	PD	Power down input PD=1: Power down mode PD=0: normal mode
14	VSS	Terminal of module ground
15	NC	No connection
16	CS	Chip select
17	LED+	LED-backlight, please refer to 6.2.
18	LED-	

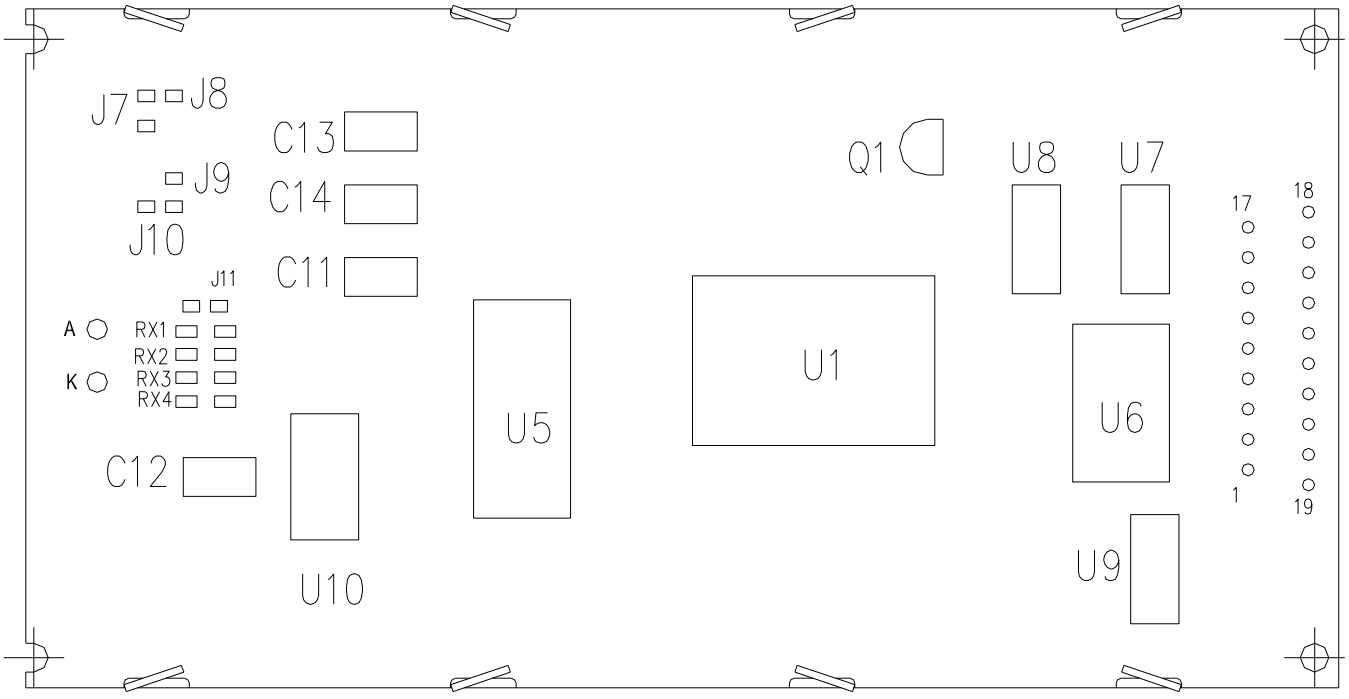
6. PCB DRAWING AND DESCRIPTION

6-1. PCB DRAWING

Top Layer



Bottom Layer



NOTE:RX1 = RX2 = RX3 = 10Ohm,RX4 = OPEN **J7 = J9 = J11 = OPEN,J8 = J10 = CLOSED**

6-2. DESCRIPTION:

6-2-1.The polarity of the pin 17 and the pin 18:

symbol / state		J7, J9	J8, J10	LED Polarity	
				17 Pin	18 Pin
J8, J10	Each solder-bridge	Each open	Each Close	Anode	Cathode
J7, J9	Each solder-bridge	Each Close	Each open	Cathode	Anode

6-2-2.The LED resistor can be bridged when the J11 is closed.

6-2-3.The R_{X1}, R_{X2}, R_{X3} and the R_{X4} are the LED resistor.

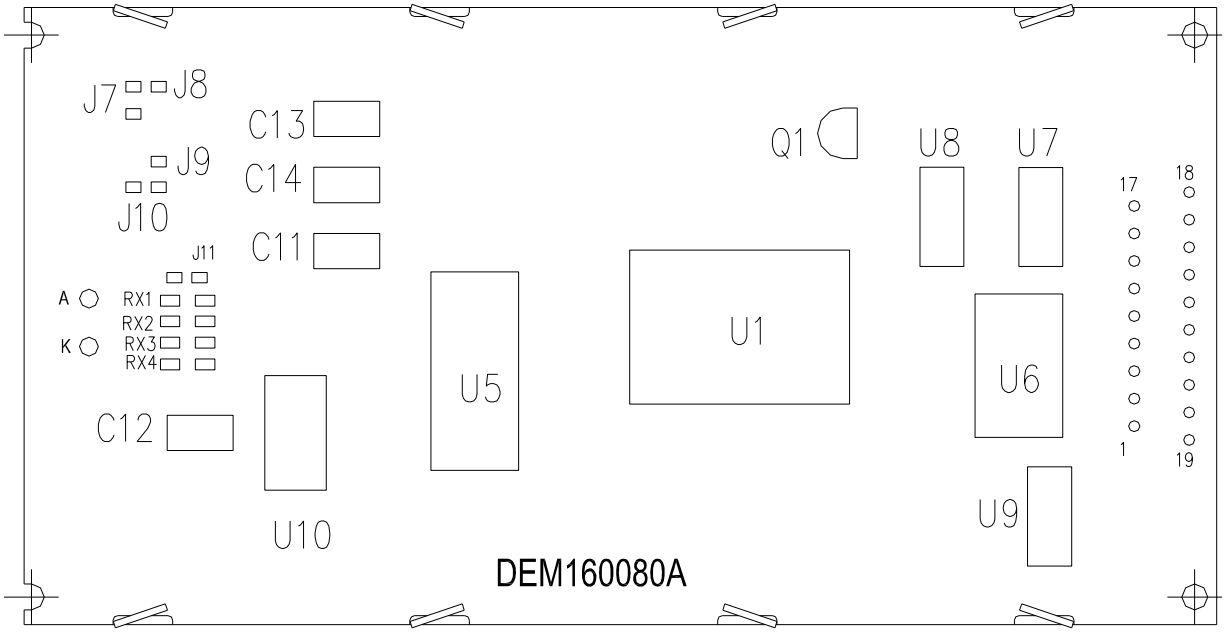
Note: $R_{X1} = R_{X2} = R_{X3} = 10\ \Omega$, R_{X4} = Open.

6.3 Example application

6-3-1. The 17 pin is the anode and the 18 pin is the cathode as following.

6-3-2.The 17 pin is the cathode and the 18 pin is the anode as following.

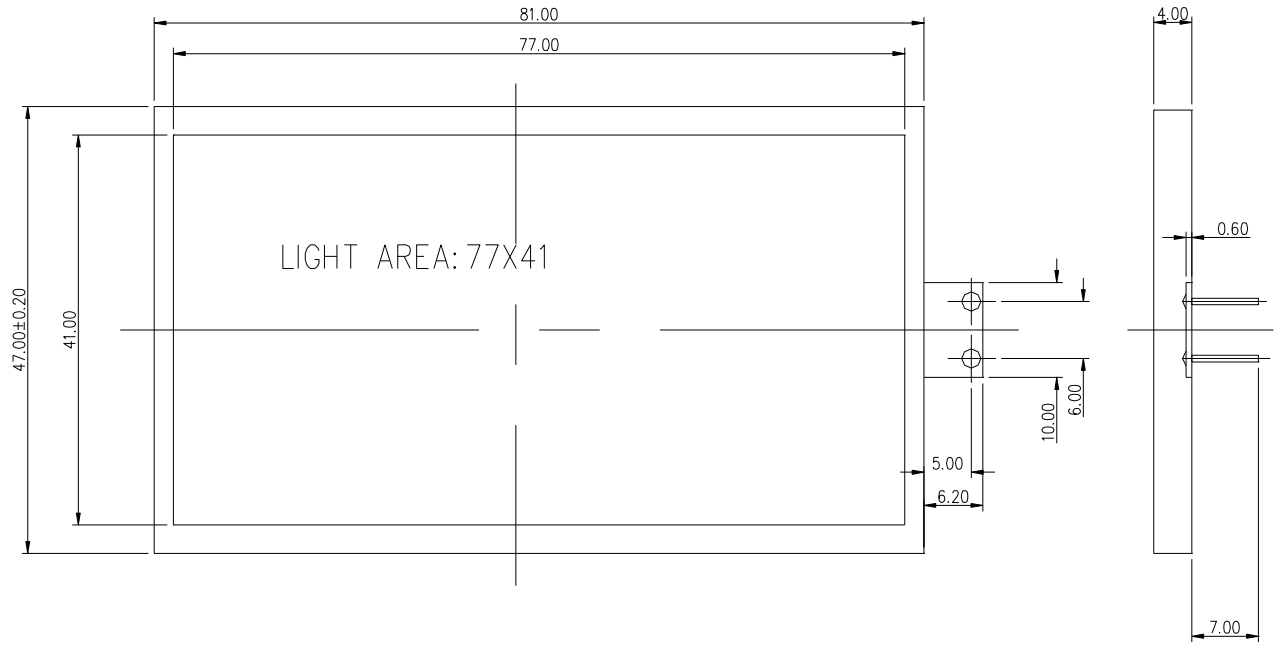
6-3-3. The Module number DEM160080A is printed on the PCB.

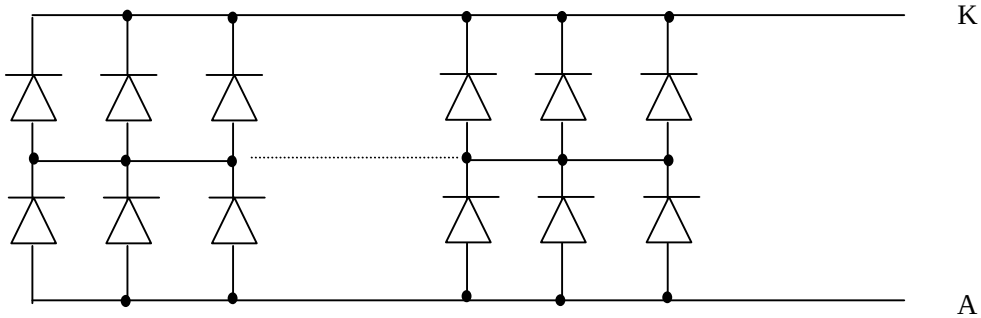


7. BACKLIGHT & SWITCH (Ta= -20 ~ +70°C)

7.1 Backlight Color : Yellow green Lightbox

Item	Symbol	Standard Value	Unit	Applicable Terminal
Backlight Voltage	V	5.0	V	LED+ / LED-
Backlight Current	I	~ 230	mA	





49 × 2 = 98 dices

8. MAXIMUM ABSOLUTE POWER RATINGS (Ta=25°C)

Item	Symbol	Min.	Max.	Unit
Supply voltage for logic	V_{DD}-V_{SS}	0	7.0	V
Supply voltage	V_1	V_{SS}	V_{DD}	V
Operating temperature	Topr	-20	70	℃
Storage temperature	Tstg	-25	75	℃

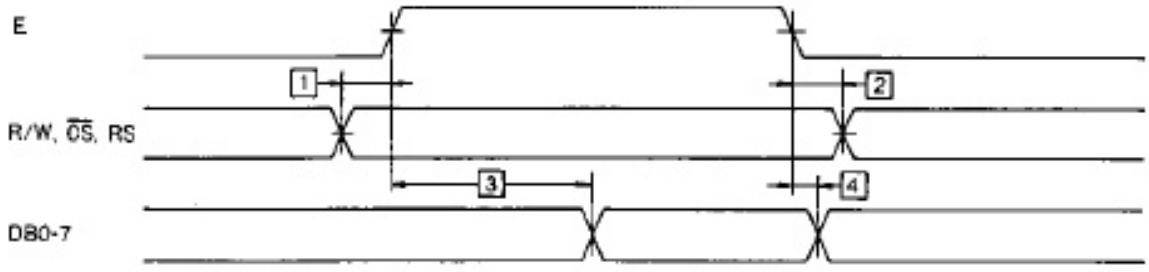
9. ELECTRICAL CHARACTERISTICS (Ta=+25°C)

Item	Symbol	Standard Value			Condition	Unit
		MIN	TYP	MAX		
Supply voltage	V_{DD}	4.75	5.0	5.25	-------	V
Supply module current – Normal mode	I_{DD}	----	15	20	V_{DD} = 5.0V	mA
Module standby current	I_{DDSBY}	----	1.0	----	P_D = 5.0V	mA
Input high voltage for logic	V_{IH}	3.15	----	----	V_{DD} = 4.5V	V
Input low voltage for logic	V_{IL}	0	----	1.0	V_{DD} = 4.5V	V
Output high voltage for logic	V_{OH}	4.4	----	----	I_{OH} = -0.02mA	V
Output low voltage for logic	V_{OL}	----	----	1.0	I_{OL} = 0.02mA	V
PD (Power down) input voltage	V_{IH} V_{IL}	4.5V	---- ----	---- 0.1	V_{DD} = 5.0 V	V

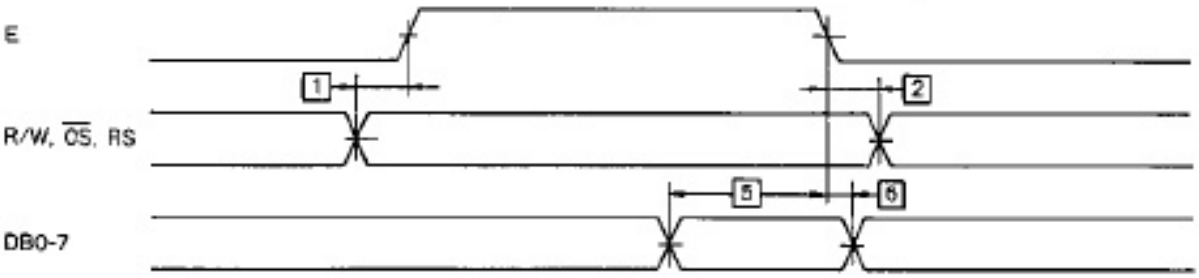
10. TIMING CHARACTERISTICS

- **Bus read/write operation 1**

Read cycle



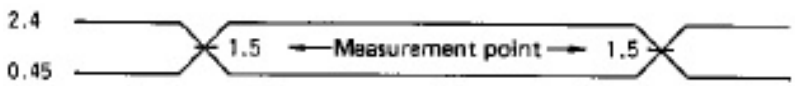
Write cycle



Ta= -20 to +75°C, V_{DD}= 5V ± 5%, GND= 0V

No.	Item	Symbol	Min.	Typ.	Max.	Unit	Conditions
1	Address set-up time	t_{AS}	90			ns	
2	Address hold time	t_{AH}	10			ns	
3	Data delay time (read)	t_{DDR}			140	ns	CL = 50 pF
4	Data hold time (read)	t_{DHR}	10			ns	
5	Data set-up time (write)	t_{DSE}	220			ns	
6	Data hold time (write)	t_{DHW}	20			ns	

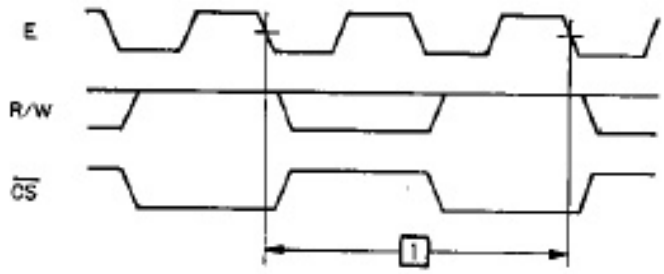
Note: Definition of the test waveform



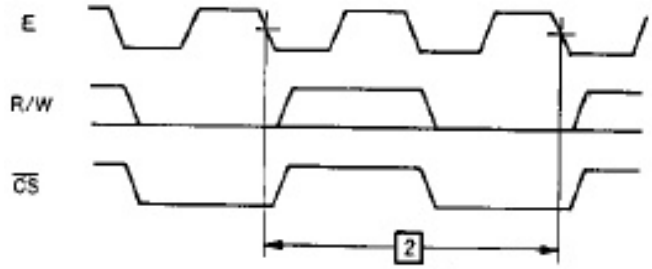
The input terminals are driven at 2.4V and 0.45V. Timing is measured at 1.5V.

- **Bus read/ write operation 2**

Data read cycle



Data write cycle

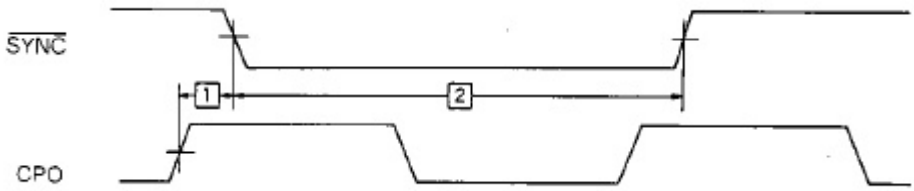


Ta= -20 to + 75°C, V_{DD}= 5V ± 5%, GND= 0V

No.	Item	Symbol	Min.	Typ.	Max.	Unit	Instruction register value
1	Read cycle time	t_{RCY}			$\frac{(Hp + 2) \times 10^3}{F_{OSC}}$ +200	ns	0DH
2	Write cycle time	t_{WCY1}			$\frac{(2Hp + 2) \times 10^3}{F_{OSC}}$ +200	ns	0EH, 0FH
2	Write cycle time	t_{WCY2}			$\frac{(Hp + 2) \times 10^3}{F_{OSC}}$ +200	ns	0CH
2	Write cycle time	t_{WCY3}			$\frac{2000}{F_{OSC}}$ +200	ns	00H, 01H, 02H, 03H, 04H, 08H, 09H, 0AH, 0BH

Notes: (1) In the character mode, Hp is the number of horizontal dots per character in a character display. In the graphic mode, Hp indicates how many bits from RAM appear in a 1-byte display.
(2) Fosc is the oscillating frequency, expressed in MHz.
(3) All measurement points are at 1.5V.

- Parallel operation (at master mode)



Ta= -20 to +75°C, V_{DD}= 5V ± 5%, GND= 0V

No.	Item	Symbol	Min.	Typ.	Max.	Unit	Conditions
1	SYNC delay time	t_{DSY}			100	ns	
2	SYNC pulse width	t_{WSY}	250			ns	

Notes: (1) All output terminals are under no load.
(2) All measurement points are at 0.5 V_{DD}

11. FUNCTION OF EACH BLOCK

- **Registers**
  The LC7981 has the five types of registers: instruction register, data input register, data output register, dot registers, and mode control register.
  The input register stores such instruction codes as the start address, cursor address specification, etc. It consists of 4 bits, and the lower order 4 bits of the bus, DB0 to DB3, are written into it.
  The data input register is temporarily store data to be written into the external RAM, dot registers, and mode control register. It consists of 8 bit.
  The data output register temporarily store data to be read from the external RAM, and consists of 8 bits. When the cursor address is written into the cursor address counter via the data input register and the memory read instruction is set in the instruction register, data in external RAM is read into the data output register by internal operation. With the next instruction, the MPU read the data output register, and completes data transfer to the MPU.
  The dot registers stores dot information such as character pitch, the number of vertical dots, etc. Data sent from the MPU is written into the dot registers via the data input register.
  The mode control register stores LCD status information such as display on/off and cursor on/off/blink. It consists of 6 bits. Data sent from the MPU is written into this register via the data input register.

- **Busy Flag**
  When the busy flag = 1 indicates the LC7981 is operating internally. At this time, the next instruction cannot be accepted. The busy flag is output to DB7 when RS=1, RW=1. The next instruction must be written after ensuring that the busy flag=0. When the maximum vale of the read cycle time or write cycle time has been passed after the execution of the preceding data read instruction or data write instruction, the next instruction can be executed without checking the busy flag.

- **Dot Counters**
  The dot counters generate LC display timing according to the contents of the dot registers.

- **Refresh Address Counters**
  The refresh address counters addresses of external RAM, character generator ROM, extended ROM and is available in two types – refresh address counters(1) and refresh address counters(2). The former is for the upper screen, and the latter for the lower screen. In the graphic mode, 16-bit data is data is output and used as the address signal for the external RAM. In the character mode, the high-order 4 bits are ignored and 4 bits of the row address counter are output instead. The 4 bits are used address of the extended ROM.

- **Character Generator ROM**
  The character generator ROM has a 7360 bits and stores data on 192 kinds of character. Character codes from the external RAM and row codes from the row address counter are added to address signals, and ROM outputs 5-bit dot data. There are 192 kinds of character fonts, of which 160 are 5 × 7 and 32 are 5 × 11. with extended Rom, character fonts can be increased to 256 kinds sized 8 × 16.

- **Cursor Address Counter**
  The cursor address counter is a 16-bit counter can be preset by instruction. When data is read from or written into external RAM (i.e., read/write of display dot data or character codes), the counter retains the address. The value indicated on the cursor address counter is automatically incremented by 1 when instructions to read/write display data and to perform bit set/clear are issued.

- **Cursor Signal Generator**
  In the character mode, the cursor can be displayed by means of instructions. The cursor is generated automatically when the cursor address counter and the row address counter reach the specified value.

- **Parallel/Serial Conversion**
  The two parallel-serial conversion circuits simultaneously transfer parallel data from the external RAM, character generator, and extended ROM to the upper and lower LC screen drive circuits as serial data.

12. DISPLAY CONTROL INSTRUCTIONS

Display is controlled by writing data into the instruction register and 13 data registers. The instruction register and the data registers are distinguished by the RS signal. First, write 4-bit data in the data in the instruction register when RS=1, then specify the code of the data register. Next, with RS=0, rite 8-bit data in the data register, which executes the specified instruction.

A new instruction cannot be accepted while an old instruction is being executer. As the busy flag is set under this condition, write an instruction only after reading the busy flag and making sure that it is 0.

However, the next instruction can be executed without checking the busy flag when maximum read cycle time or the write cycle time has been exceeded after execution of the previous data read instruction or the data write instruction. The busy flag does not change when data is written in to the instruction register (RS=1). Therefore, the busy flag need not be checked immediately after writing data into the instruction register.

12-1. Mode control

Write code “00H” (in hexadecimal notation) in the instruction register and specify the mode control register.

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	0	0	0	0
Mode control register	0	0	0	0	Mode data					

DB5	DB4	DB3	DB2	DB1	DB0	Cursor/blink	CG	Graphic/character display
1 / 0	1 / 0	0	0	0	0	Cursor OFF	Built-in CG	Character display
		0	1			Cursor ON		
		1	0			Cursor OFF character blink		
		1	1			Cursor blink		
		0	0		1	Cursor OFF	External CG	
		0	1			Cursor ON		
		1	0			Cursor OFF character blink		
		1	1			Cursor blink		
		0	0	1	0			Graphic mode
Display ON/OFF	Master/slave	Blink	Cursor	mode	External/ Built-in CG			

1: master mode
0: slave mode

1: display ON
0: display OFF

12-2. Set character pitch

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	0	0	0	1
Character pitch register	0	0	(V_P - 1) binary				0	(H_P - 1) binary		

V_P is the number of vertical dots per character. Determine V_P with the pitch between two vertically placed characters taken into consideration. This value is meaningful only in the character display mode: it is invalid in the graphic mode.
In character mode, H_P indicates the number of horizontal dots per character, from the leftmost part of one character to the leftmost part of the next. In the graphic mode, H_P indicates how many bits (or dots) from RAM appear in a 1-byte display.
H_P must take one of the following three values.

HP	DB2	DB1	DB0	Horizontal character pitch
6	1	0	1	6
7	1	1	0	7
8	1	1	1	8

12-3. Set number of characters

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	0	0	1	0
Character number register	0	0	(H_N – 1) binary							

In the character display mode, H_N indicates of characters in the horizontal direction. In the graphic mode, it indicates the number of bytes in the horizontal direction. The total number of dots positioned horizontally on the screen n is given by the formula: $N = H_P \times H_N$
Even numbers in the range 2 to 256 (decimal) can be set as H_N.

12-4. Setting the time division number (display duty)

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	0	0	1	1
Time division register	0	0	(H_X – 1) binary							

Consequently, $1/N_X$ is the display duty.
Decimal numbers within the range 1 to 256 can be set as N_X.

12-5. Setting the cursor position

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	0	1	0	0
Cursor position register	0	0					(C_P – 1) binary			

In the character display mode, P_C indicates the position in a character where the cursor is displayed in the character mode. For example, when C_P=8 (decimal) is specified, the cursor is displayed beneath the character of the 5 × 7 dot-font. The horizontal length of the cursor equals H_P (the horizontal character pitch). Decimal values in the range 1 to 16 can be assigned to C_P. When the value is less than the vertical character pitch VP ($C_P \leq V_P$), display priority is given the cursor (provided the cursor display is ON). The cursor is not displayed when $C_P < V_P$. The horizontal length of the cursor equals H_P.

12-6. Setting the display start lower address

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	1	0	0	0
Display start address register (lower byte)	0	0	(start address lower byte) binary							

12-7. Setting the display start upper address

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	1	0	0	1
Display start address register (upper byte)	0	0	(start address upper byte) binary							

This instruction writes the display start address value in the display start address register. The display start address is the ARM address at which data to be displayed at the leftmost position of top line of the screen is stored. The start address consists of 16 bits (upper and lower).

12-8. Setting the cursor (lower) address (ARM read/write lower address)

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	1	0	1	0
Cursor address register (lower byte)	0	0	(cursor address lower byte) binary							

12-9. Setting the cursor (upper) address (ARM read/write lower address)

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	1	0	1	1
Cursor address register (upper byte)	0	0	(cursor address upper byte) binary							

This instruction writes the cursor address value in the cursor address counter. The cursor address indicates the address for exchanging display data and character codes with RAM. In other words, data the address specified by the cursor address is read from or written into RAM. In character display, the cursor is displayed at the position specified by the cursor address. The cursor address is divided into a lower address (8 bits) and an upper address (8 bits). It should be set in accordance with the following rules.

1	To rewrite (set) both lower and upper address:	First set the lower address, then the upper.
2	To rewrite the lower address:	Always reset the upper address after setting the lower address.
3	To rewrite the upper address only:	Set the upper address. It is necessary to reset the lower address.

The cursor address counter is a 16-bit up-counter with set/reset functions: when the nth bit goes from 1 to 0, the count of the (N + 1)th bit increments by one. Accordingly, when the lower address is set so that the lower MSB (8th bit) changes from 1 to 0, the LSB (1st bit) of the upper counter must increment by one. When setting the cursor address, set the lower and upper addresses as a 2-byte continuous instruction.

12-10. Writing display data

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	1	1	0	0
RAM	0	0	MSB (pattern data, character code) LSB							

Write code “0CH” in the instruction register. Then, write 8-bit data with RS=0, and the data is written into RAM as display data or character codes at the address specified by the cursor. After writing, the count of the cursor address counter increments by 1.

12-11. Reading display data

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	1	1	0	1
RAM	1	0	MSB (pattern data, character code) LSB							

Write “0DH” in the instruction register. Then, establish the read status with RS=0, and data in the RAM can be read. The procedure for reading data is as follows:

This instruction outputs the contents of the data output register to DB0 to 7, then transfers the RAM data indicated by the cursor address to the data output register. It then increments the cursor address by 1, which means that correct data cannot by read in the first read operation. The specified value is output in the second read operation. Accordingly, a dummy read operation must be performed once when reading data after setting the cursor address.

12-12. Bit clear

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	1	1	1	0
Bit clear	0	0	0	0	0	0	0	(B_N – 1) binary		

12-13. Bit set

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Instruction register	0	1	0	0	0	0	1	1	1	0
Bit clear	0	0	0	0	0	0	0	(N_B – 1) binary		

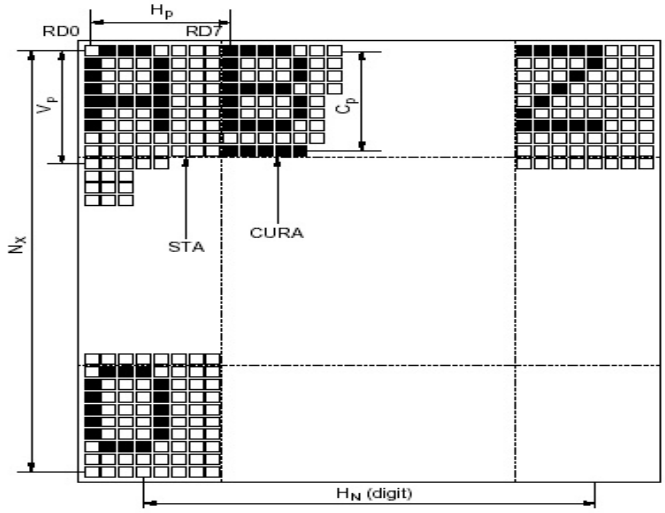
As the bit-clear or bit-set instruction, 1 bit of a 1 byte of data in display RAM is set to 0 or 1. The bit specified by N_B is set to 0 for the bit-clear instruction and 1 for the bit-set instruction. The RAM address is specified by the cursor address, which is automatically incremented by 1 at the completion of the instruction. N_B is a value in the range from 1 to 8. The LSB is indicated by N_B=1, and the MSB by N_B=8.

12-14. Reading the busy flag

Register	R/W	RS	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
Busy flag	1	1	1/0	*						

The busy flag is output to DB7 when read mode is established with RS =1. The busy flag is set to 1 while any of the instructions12-1 through 12-13 is being executed. It is set to 0 at the completion, allowing the next instruction to be accepted. No other instruction can be accepted when busy flag is 1. Accordingly, before writing an instruction and data, it is necessary to ensure that the busy flag is 0. However, the next instruction can be executed without checking the busy flag when the maximum read cycle time or the cycle time has been exceeded after execution of the previous data read instruction or the data write instruction. The busy flag does not change when data is writing into the instruction register (RS=1). Therefore, the busy flag need not be checked immediately after writing data into the instruction register. Specification of the instruction register is unnecessary to read the busy flag.

The relation between the LCD panel display and H_P, H_N, C_P, and N_X.



Symbol	Description	Contents	Value
H_P	Horizontal character pitch	Character pitch in the horizontal direction	6 to 8 dots
H_N	Number of characters in the horizontal direction	Number of character (digits) per horizontal line or the number of words per line (graphic)	Even digits in the range 2 to 256
V_P	Vertical character pitch	Character pitch in the vertical direction	1 to 16 dots
C_P	Cursor position	The line number at which the cursor is to be displayed	1 to 16 lines
N_X	Number of lines in the vertical direction	Display duty	1 to 256 lines

Note: when the number of vertical dots on the is m and that of horizontal dots is n,

$1/m = 1/N_X$ = display duty

$n = H_P \times H_N$

m/V_P = number of display lines

$C_P \leq V_P$

13. LCD MODULES HANDLING PRECAUTIONS

- Please remove the protection foil of polarizer before using.
- The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
- If the display panel is damaged and the liquid crystal substance inside it leaks out, do not get any in your mouth. If the substance come into contact with your skin or clothes promptly wash it off using soap and water.
- Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarize carefully.
- To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
  -Be sure to ground the body when handling the LCD module.
  -Tools required for assembly, such as soldering irons, must be properly grounded.
  -To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
  -The LCD module is coated with a film to protect the display surface. Exercise care when peeling off this protective film since static electricity may be generated.
- Storage precautions
  When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps. Keep the modules in bags designed to prevent static electricity charging under low temperature / normal humidity conditions (avoid high temperature / high humidity and low temperatures below 0°C).Whenever possible, the LCD modules should be stored in the same conditions in which they were shipped from our company.

14. Others

- Liquid crystals solidify at low temperature (below the storage temperature range) leading to defective orientation of liquid crystal or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subjected to a strong shock at a low temperature.
- If the LCD modules have been operating for a long time showing the same display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. Abnormal operating status can be resumed to be normal condition by suspending use for some time. It should be noted that this phenomena does not adversely affect performance reliability.
- To minimize the performance degradation of the LCD modules resulting from 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