POWERTIP TECH. CORP.

DISPLAY DEVICES FOR BETTER ELECTRONIC DESIGN

Specification For Approval

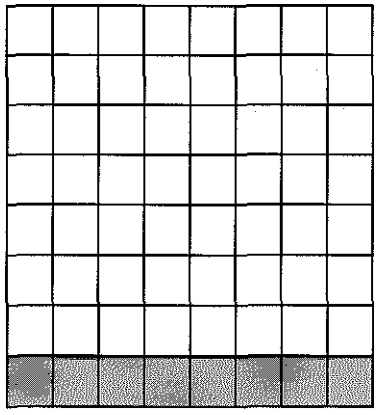
Customer		ELATEC
Model Type	:	LCD MODULE
Sample Code	:	
Mass Production Code	:	PG240128LRU-ATA-H
Revision	:	0

Customer Sign	Sales Sign	Checked By	Prepared By
		6/17-07	6/17-07

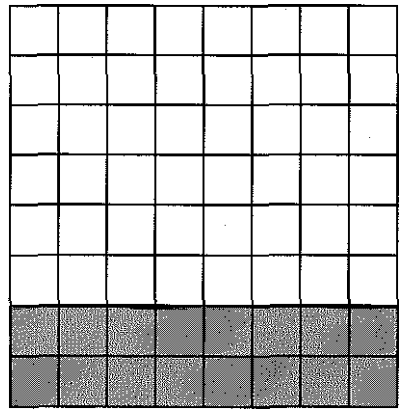
5.Cursor pattern select

Code	Function	Operand
10100000	1 line cursor	-
10100001	2 lines cursor	-
10100010	3 lines cursor	-
10100011	4 lines cursor	-
10100100	5 lines cursor	-
10100101	6 lines cursor	-
10100110	7 lines cursor	-
10100111	8 lines cursor	-

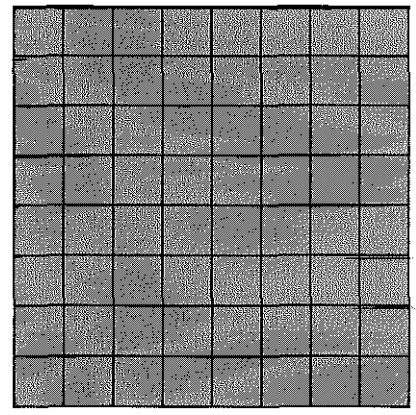
When cursor display is ON, this command selects the cursor pattern from 1 line to 8 lines. The cursor address is defined by cursor pointer set command.



1 line cursor



2 lines cursor



8 lines cursor

6.Data auto read/write

Code	Hex.	Function	Operand
10110000	BOH	Data auto write set	-
10110001	B1H	Data auto read set	-
10110010	B2H	Auto reset	-

This command is convenient to send full screen data from external display RAM.
After setting auto mode, "Data write (or read)" command is not necessary between each data "Data write (or read)" command should follow the "Address pointer set" and address pointer is automatically increment by + 1 after each data. After sending (or receiving) all data "Auto reset" is necessary to return normal operation because all data is regarded "Display data" and no command can be accepted in the auto mode.

Note : Status check for auto mode (STA2, STA should be checked between each data.
Auto reset should be performed after checking STA3=1 (STA2=1).
Please refer following flow chart.

Attribute function

"Reverse display" **,** "Character blink" and "Inhibit" are called "Attribute". The attribute data is written in the graphic area defined by Control word set command.

The mode set command selects text display only and graphic display cannot be displayed.

The attribute data of the 1st character in text area is written at the 1st lbyte in graphic area, and attribute data **of** n-th character is written at the n-th lbyte in graphic area. Attribute function is

Attribute RAM 1byte	**X**	X	**X**	X	d3	d2	d1	d0

d3	d2	d1	d0	Function
0	0	0	0	Normal display
0	1	0	1	Reverse display
0	0	1	1	Inhibit display
1	0	0	0	Blink of normal display
1	1	0	1	Blink of reverse display
1	0	1	1	Blink of inhibit display

4.Display mode

Code	Function	Operand
10010000	Display off	-
1001xx10	Cursor on , blink off	-
1001xx11	Cursor on , blink on	-
100101xx	Text on, graphic off	-
100110xx	Text off, graphic on	-
100111xx	Text on , graphic on	-

1	0	0	1	d3	d2	d1	d0

d0 — Cursor blink — on: 1, **off** 0

d1 — Cursor display — on: 1, oft 0

d2 — Text display — on: 1, off *0*

d3 — Graphic display — on: **1,** oft 0

Note: It is necessary to turn on "Text display" and " Graphic display" in following case.

(1) Combination **of** text/graphic display

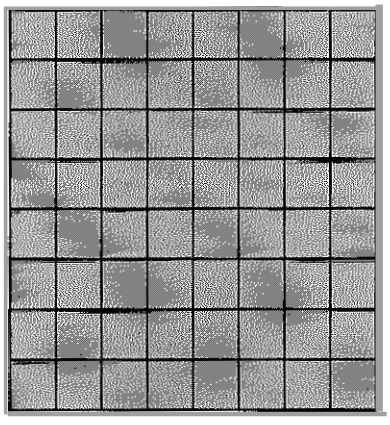
(2) Attribute function

3.Mode set

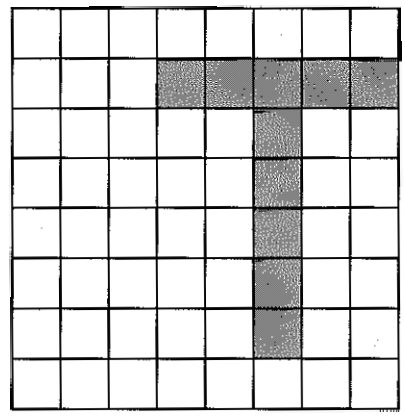
Code	Function	Operand
1000x000	"OR" Mode	-
1000x001	"EXOR" Mode	-
1000x011	"AND" Mode	-
1000x 100	"TEXT ATTRIBUTE" Mode	-
10000xxx	Internal Character Generator Mode	-
10001xxx	External Character Generator Mode	-

When internal character generator mode is selected, character code OOH–7FH are selected from built-in character generator ROM. The character code 80H~FFH are automatically selected external character generator RAM.

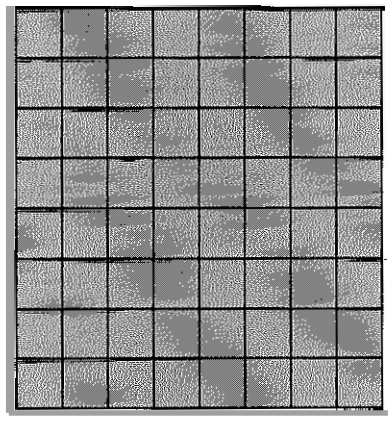
(Example)



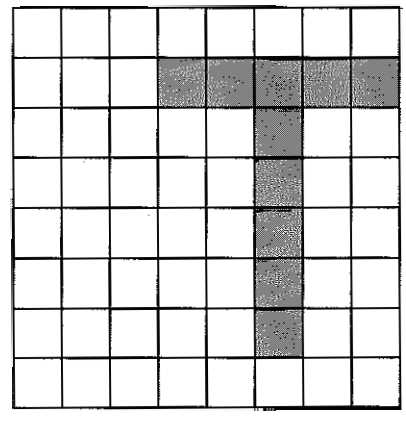
Graphic



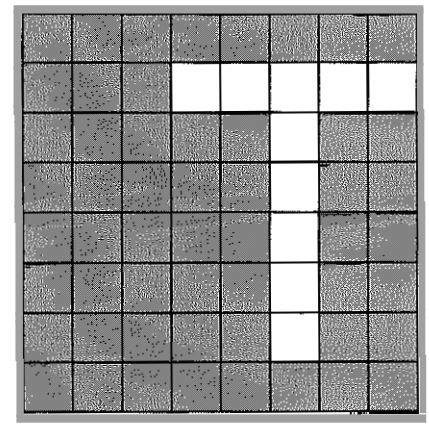
Text



"OR'



"AND"



"EXOR'

Note: Only text display is attributed, because attribute data is located in graphic RAM area

(4)Graphic area set

The columns of display are defined by the hardware setting. This command can be used to adjust columns of graphic display.

(Example)

LCD size : 20 columns, 2 lines
Text home address : 0000H
Text area : 0014H
MD2=H, MD3=H : 32 columns
DUAL=H, MDS=L, MDD=H, MD1=H : 2 lines

0000	0001	.....	0013	0014	.....	001F
0014	0015	.....	0027	0028	.....	0033
0028	0029	.....	003B	003C	.....	0047
003C	003D	.....	004F	0050	.....	005B
0050	0051	.....	0063	0064	.....	006F
0064	0065	.....	0077	0078	.....	0083
0078	0079	.....	008B	008C	.....	0097
008C	008D	.....	009F	00A0	.....	00AB
00A0	00A1	.....	00B3	00B4	.....	00BF
00B4	00B5	.....	00C7	00C8	.....	00D3
00C8	00C9	.....	00DB	00DC	.....	00E7
00DC	00DD	.....	00EF	00F0	.....	00FD
00F0	00F1	.....	0103	0104	.....	011F
0104	0105	.....	0127	0128	.....	0123
0128	0129	.....	013B	013C	.....	0147
013C	013D	.....	014F	0150	.....	0158

LCD

The address in graphic area can be continuous and RAM area can be used without ineffective area, if graphic area is defined the same number as the actual column number of LCD display.

(Example)

Graphic home address : 0000H

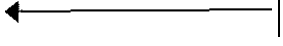
Graphic area : 0020H

MD2=H, MD3=H : 32 columns

$\overline{\text{DUAL}}$ =H, MDS=L, MD0=H, MD1=H : 2 lines

0000H	0001H		001EH	001FH
0020H	0021H		003EH	003FH
0040H	0041H		005EH	005FH
0060H	0061H		007EH	007FH
0080H	0081H		009EH	009FH
00A0H	00A1H		00BEH	00BFH
00C0H	00C1H		00DEH	00DFH
00E0H	00E1H		00FEH	00FFH
0100H	0101H		011EH	011FH
0120H	0121H		013EH	013FH
0140H	0141H		015EH	015FH
0160H	0161H		017EH	017FH
0180H	0181H		019EH	019FH
01A0H	01A1H		01BEH	01BFH
01C0H	01C1H		01DEH	01DFH
01E0H	01E1H		01FEH	01FFH

0000	0001	……	0013	0014	……	001F
0014	0015	……	0027	0028	……	0033
0028	0029	……	003B	003C	……	0047
003C	003D	……	004F	0050	……	005B



TH		TH+CL
TH+TA		TH+TA+CL
(TH+TA)+TA		TH+2TA+CL
(TH+2TA)+TA		TH+3TA+CL

OOOOH	0001H		001EH	001FH
0020H	0021H		003EH	003FH
0040H	0041H		OOSEH	005FH
0060H	0061H		007EH	007FH

(2)Graphic home address set

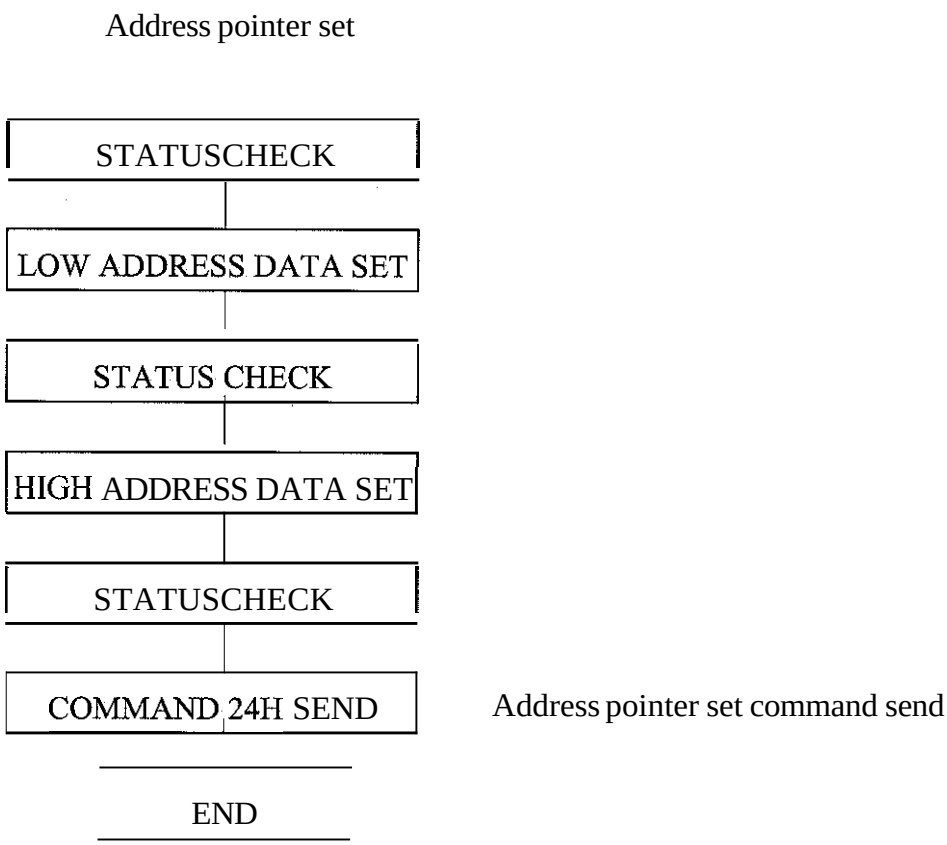
The starting address of external display RAM for Graphic display is defined by this command.The Graphic home address show the left end most upper line.

GH		GH+CL
GH+GA		GH+GA+CL
(GH+GA)+GA		GH+2GA+CL
(GH+2GA)+GA		GH+3GA+CL
GH+(n-1)GA		GH+(n-1)GA+CL

(3)Address pointer set

The address pointer set command is used to indicate the start address for writing (or reading) to external RAM.

The flow chart address pointer set command



2.Control word set

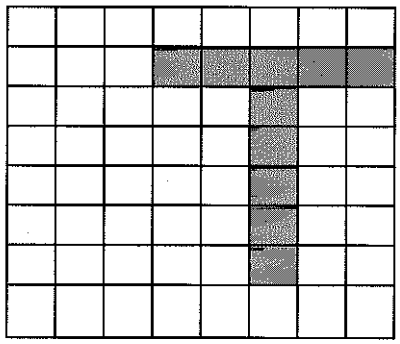
Code	Hex.	Function	D1	D2
01000000	40H	Text home address set	Low address	High address
01000001	41H	Text area set	Columns	00H
01000010	42H	Graphic home address set	Low address	High address
01000011	43H	Graphic area set	Columns	00H

The relationship of display RAM address and offset register

Data of offset register	CG RAM HEX. Address (start-end)
00000	0000-07FFH
00001	0800-OFFFH
00010	1000-17FFH
11100	E000-E7FFH
11101	E800-EFFFH
11110	F000-F7FFH
11111	F800-FFFFH

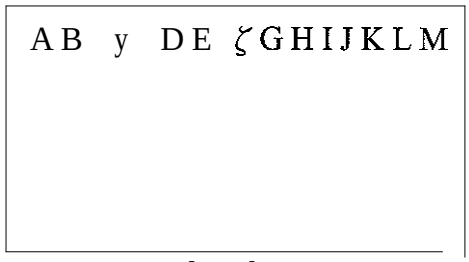
(Example 1)

Offset register 02H
Character code 80H
Character generator RAM start address 0001 0100 0000 0000
1 4 0 0 H



(Address)	(Data)
1400H	OOH
1401H	1FH
1402H	04H
1403H	04H
1404H	04H
1405H	04H
1406H	04H
1407H	OOH

(Example 2) The relationship of display RAM data and display character



Display character

(RAM DATA)	(Character)
21H	A
22H	B
83H	γ
24H	D
25H	E
86H	ζ

y and ζ are displayed by character generator RAM

2.4 Display command

Code	Hex.	Function	D1	D2
00100001	21H	Cursor pointer set	X ADRS	Y ADRS
00100010	22H	Offset register set	Data	00H
00100100	24H	Address pointer set	Low ADRS	High ADRS

(1) Cursor pointer set

The position of cursor is specified by X ADRS, Y ADRS. The cursor position is moved only by this command. The cursor pointer doesn't have the function of increment and decrement. The shift of cursor are set by this command. X ADRS, Y ADRS are specified following.

X ADRS 00H–4FH (Lower 7bits are valid)

Y ADRS 00H~1FH (Lower 5 bits are valid)

1. 1 screen drive

X ADRS 00–4FH

Y ADRS 00H-0FH

2. 2 screens drive

X ADRS 00–4FH

Y ADRS 00H-0FH
Upper screen

Y ADRS 10H~1FH
Lower screen

(2) Offset register set

The offset register is used to determine external character generator RAM area.

T693C has 16 bit address lines as follow.

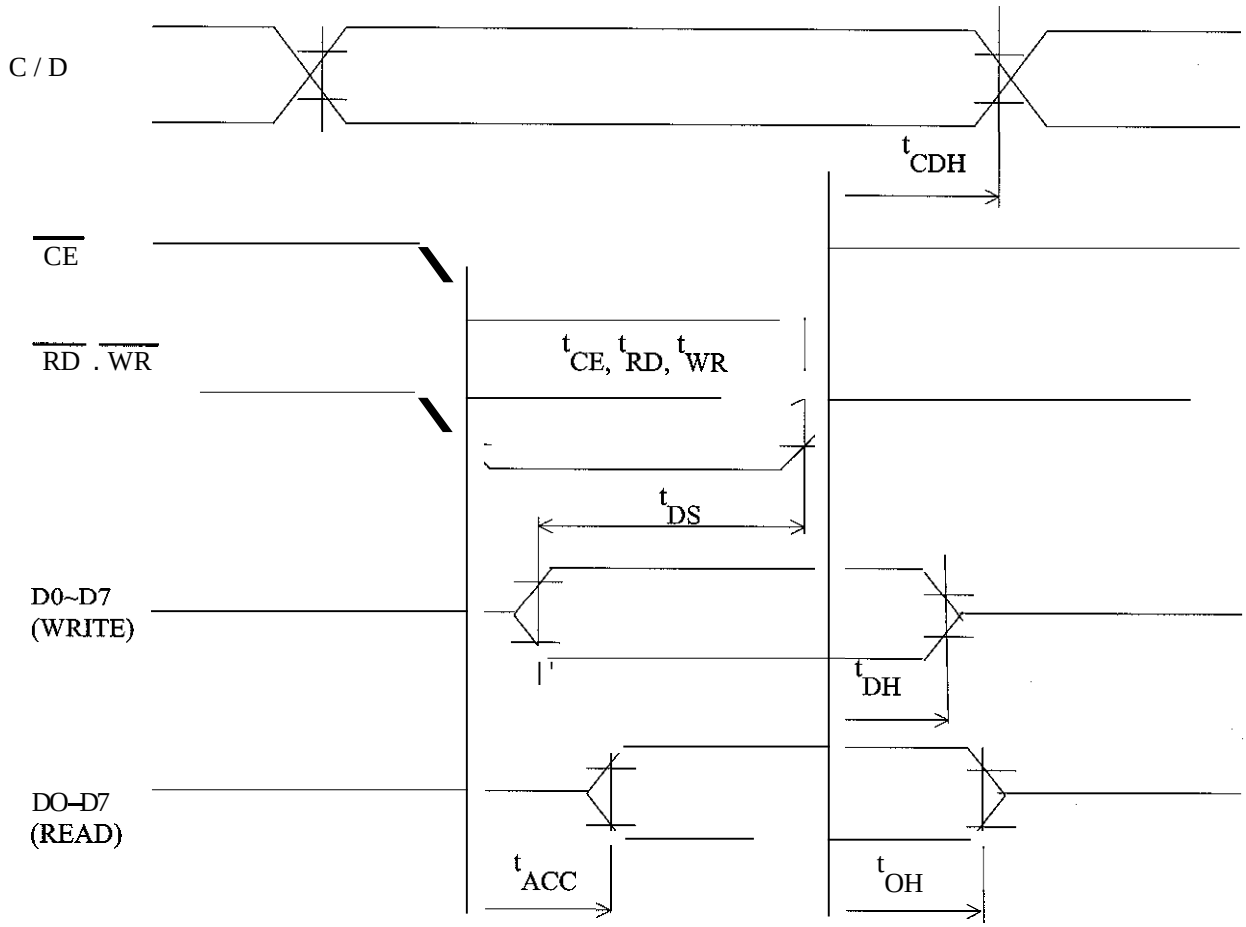
MSB															LSB
ad15	ad14	ad13	ad12	ad11	ad10	ad9	ad8	ad7	ad6	ad5	ad4	ad3	ad2	ad1	ad0

The upper 5 bit (ad15~ad11) are determined by offset register. The middle 8 bit (ad10~ad3) are determined by character code. The lower 3 bit (ad2~ad0) are determined by vertical counter. The lower 5 bit of D1 (data) are valid.

The data format of external character generator RAM.

2.3 Timing Characteristics

Bus Timing

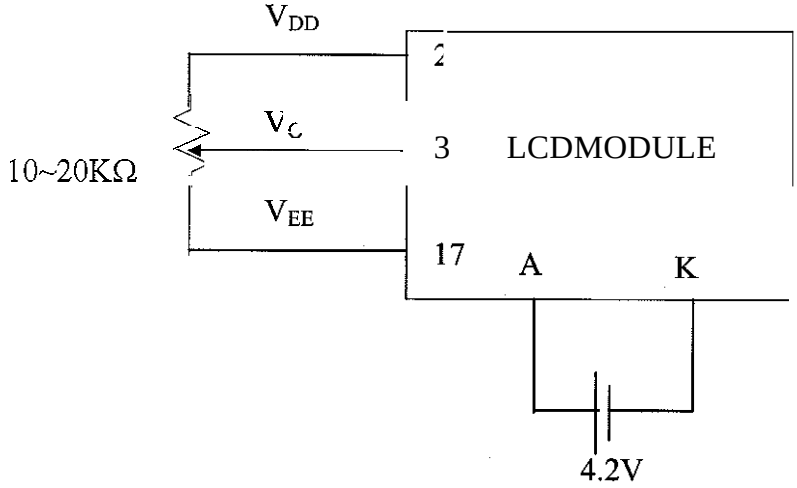


Unless otherwise noted, V_{DD}=5.0V±10%, V_{SS}=0V, Ta=25℃

ITEM	SYMBOL	TEST CONDITION	MIN.	MAX.	UNIT
C/D Set Up Time	t_{CDS}	-	100	-	ns
C/D Hold Time	t_{CDH}	-	10	-	ns
$\overline{CE}$, $\overline{RD}$, $\overline{WR}$ Pulse Width	t_{CE},t_{RD},t_{WR}	-	80	-	ns
Data Set Up Time	t_{DS}	-	80	-	ns
Data Hold Time	t_{DH}	-	40	-	ns
Access Time	t_{ACC}	-	-	150	ns
Output Hold Time	t_{OH}	-	10	50	ns

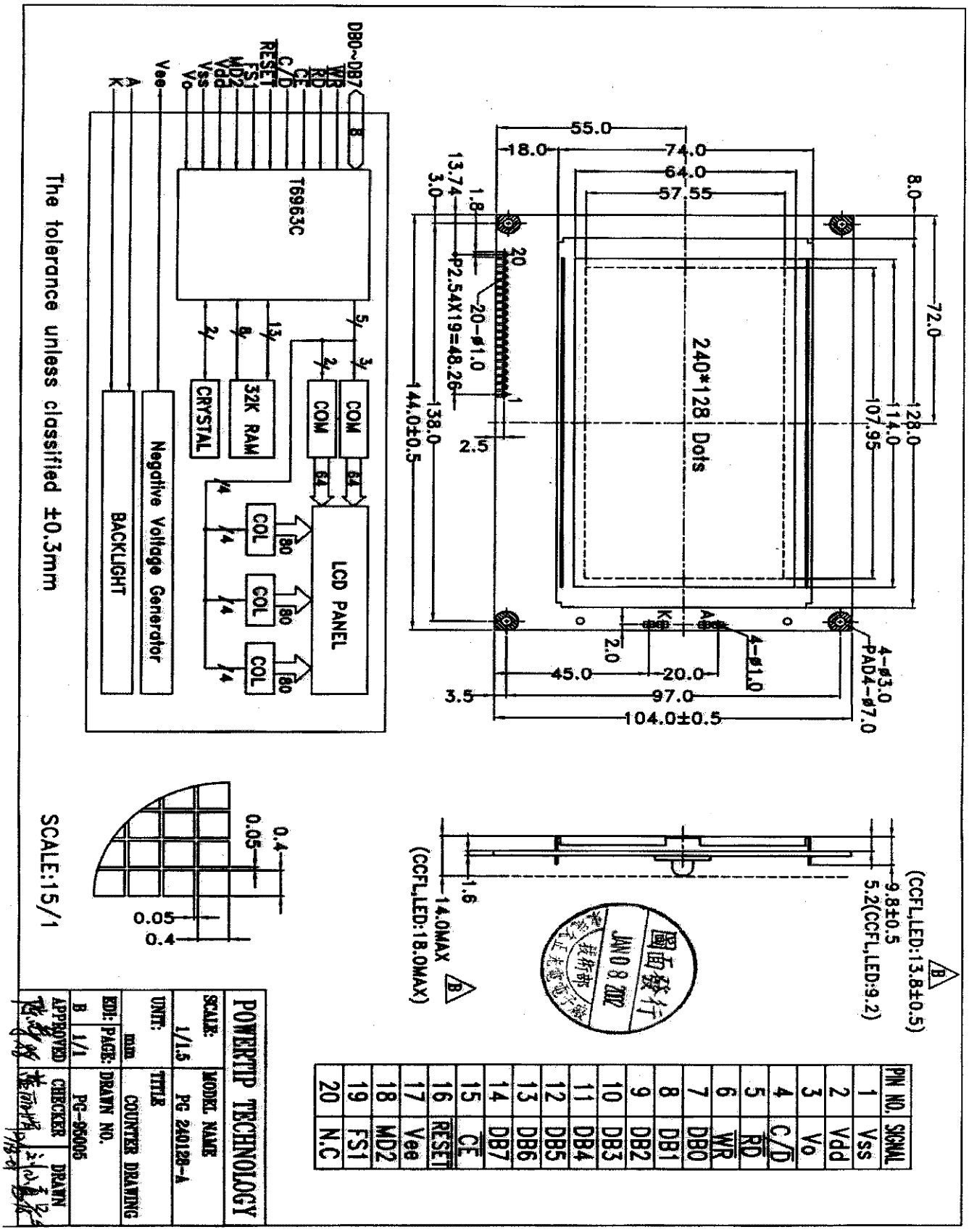
2.2 Interface Pin Description

Pin No.	Symbol	Function
1	V_{SS}	Power Supply (Vss=0)
2	V_{DD}	Power Supply (V_{DD}>V_{SS})
3	V_0	Operating voltage (LCD Driver)
4	C/$\overline{D}$	$\overline{WR}$ ="L";C/$\overline{D}$ = "H" :command write, C/$\overline{D}$ ="L":data write $\overline{RD}$ ="L";C/$\overline{D}$ = " H :command read, C/$\overline{D}$ ="L":data read
5	$\overline{RD}$	Data read (read data from the module at "L")
6	$\overline{WR}$	Data write (write data to the module at "L")
7–14	D0–D7	Data bus (D0=MSB, D7=LSB)
15	$\overline{CE}$	Chip enable for the module (active at "L")
16	$\overline{RESET}$	Controller reset (module reset)
17	V_{EE}	Power supply for LCD drive (build in)
18	MD2	Columns select ; connect to V_{DD} :32 columns connect to V_{SS} :40 columns
19	FS1	Font select :open **or** connect to V_{DD} : 6*8 Dots font connect to V_{SS} : 8*8 Dots font
20	NC	Not connection



2. MODULE STRUCTURE

2.1 Counter Drawing



1.6 Backlight Characteristics

LCD **Module with** LED Backlight

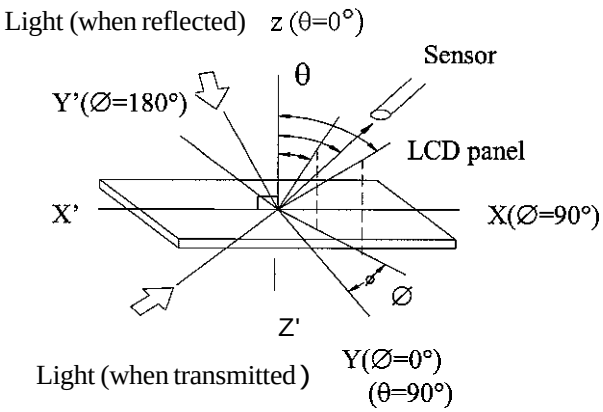
Maximum Ratings

Item	Symbol	Conditions	Min.	Max.	Unit
Forward current	IF	TA=25°C	-	2250	mA
Reverse voltage	VR	TA=25°C	-	8	V
Power dissipation	PO	TA=25°C	-	10.35	W
Operating Temperature	TOPR	-	-20	70	°C
Storage temperature	TSTG	-	-40	80	°C

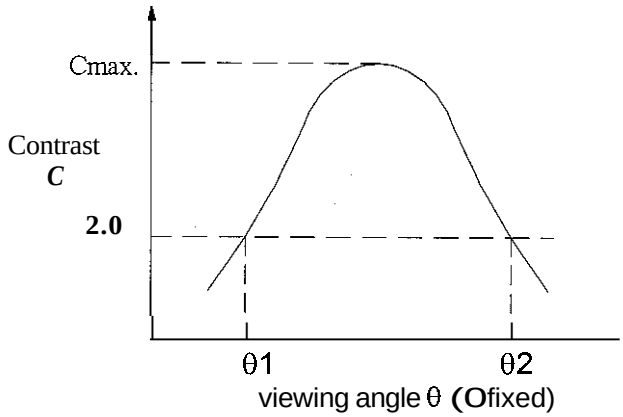
.Electrical Ratings

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Forward voltage	VF	IF=900mA	-	4.2	4.6	V
Reverse current	IR	VR=8V	-	-	0.2	mA
Luminous intensity	IV	IF=900mA	160	200	-	cd/m^2
Wavelength	HUE	IF=900mA	571	-	576	nm
Color	Yellow Green					

Note 1: Definition of angles θ and **O**

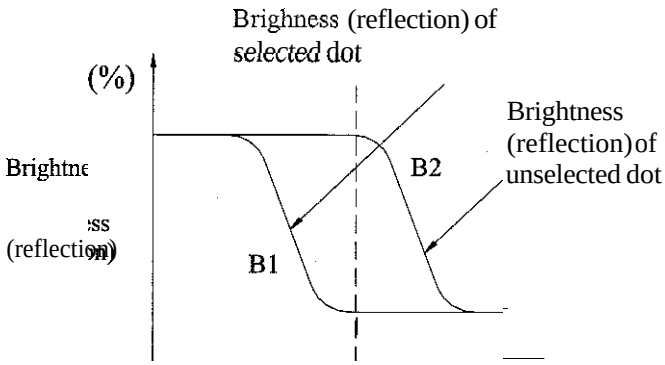


Note 2: Definition of viewing angles θ1 and *02*

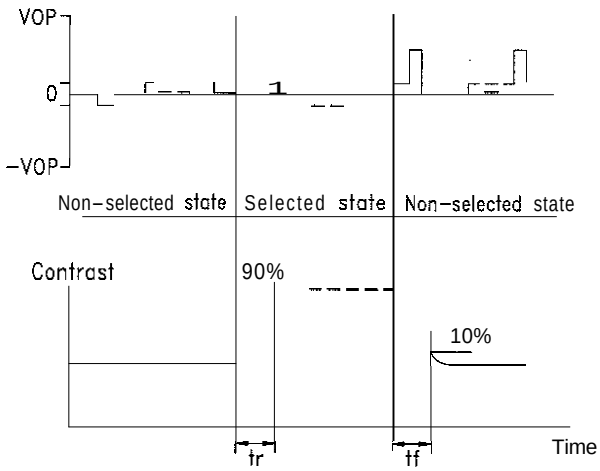


Note : Optimum viewing angle with the naked eye and viewing angle θ at Cmax. Above are not always the same

Note 3: Definition of contrast C



Note **4:** Definition of response time



V_{OPR} : Operating voltage
t_r : Response time (rise)

f_{FRM} : Frame frequency
t_f : Response time (fall)

1.4 DC Electrical Characteristics

V_{DD} = 5.0 V ± 5%, V_{SS} = 0V, Ta = 25°C

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Logic Supply Voltage	V_{DD}	—	4.5	5.0	5.5	V
"H" Input Voltage	V_{IH}	—	V_{DD}-0.2	-	V_{DD}	V
"L" Input Voltage	V_{IL}	—	0	-	0.8	V
"H" Output Voltage	V_{OH}	—	V_{DD}-0.3	-	V_{DD}	V
"L" Output Voltage	V_{OL}	—	0	-	0.3	V
Operating Frequency	fosc	—	0.4	-	5.5	
Supply Current	I_{DD}	V_{DD} = 5.0 V f_{OSC}=3.0MHz	-	55	-	mA
LCD Driver Voltage	V_{OP}	V_{DD} - V_O (-20°C)			-	V
		V_{DD} - Vo (25°C)		.5	-	
		V_{DD} - V_O (70°C)		-	-	

1.5 Optical Characteristics

1/128Duty, 1/12Bias, VOP = 17.5V, Ta = 25°C

Item	Symbol	Conditions	Min.	Typ.	Max.	Reference
View Angle	θ	C>2.0,∅= 0°	35"	-	-	Notes 1 & 2
Contrast Ratio	C	θ=5°, ∅= 0°	-	2.7	-	Note 3
Response Time(rise)	Tr	θ= 5°, ∅= 0°	-	150 ms	300 ms	Note 4
Response Time(fall)	Tf	θ= 5°, ∅= 0°	-	200 ms	300 ms	Note 4

Item	Standard Value
Display Type	240 * 128 dots
LCD Type	STN, YG, Transflective, Positive, Extended Temp.
Driver Type	11128 Duty, 1/12 Bias
Viewing Direction	6 O'clock
Backlight	Yellow-Green LED B/L
Weight	—
Other	—

Item	Standard Value	Unit
Outline Dimension	144.0mm(L) * 104.0mm(w) * 14.3mm(H)(Max)	mm
Viewing Area	114.0mm(L) * 64.0mm(w)	mm
Active Area	107.95mm(L) * 57.55mm(w)	mm
Dot Size	0.40mm(L) * 0.40mm(w)	mm
Dot Pitch	0.45mm(L) * 0.45mm(w)	mm

1.3 Absolute Maximum Ratings

Item	Symbol	Condition	Min.	Max.	Unit
Power Supply Voltage	V_{DD}	—	-0.3	7.0	V
LCD drive Supply voltage	V_{DD}-V_{EE}	—	3.0	19.0	V
Input Voltage	V_{IN}	—	-0.3	V_{DD}+0.3	V
Operating Temperature	T_{OP}	—	-20	70	°C
Storage Temperature.	T_{ST}	—	-30	80	°C
Humidity	H_D	—		90	%RH

Contents

Revision Record

Date(y/m/d)	Rev.	Description	Note	Page
2002/06/16	0	Revised Contents		

Total Page : 32