

<b>Technikerarbeit 2005</b>	
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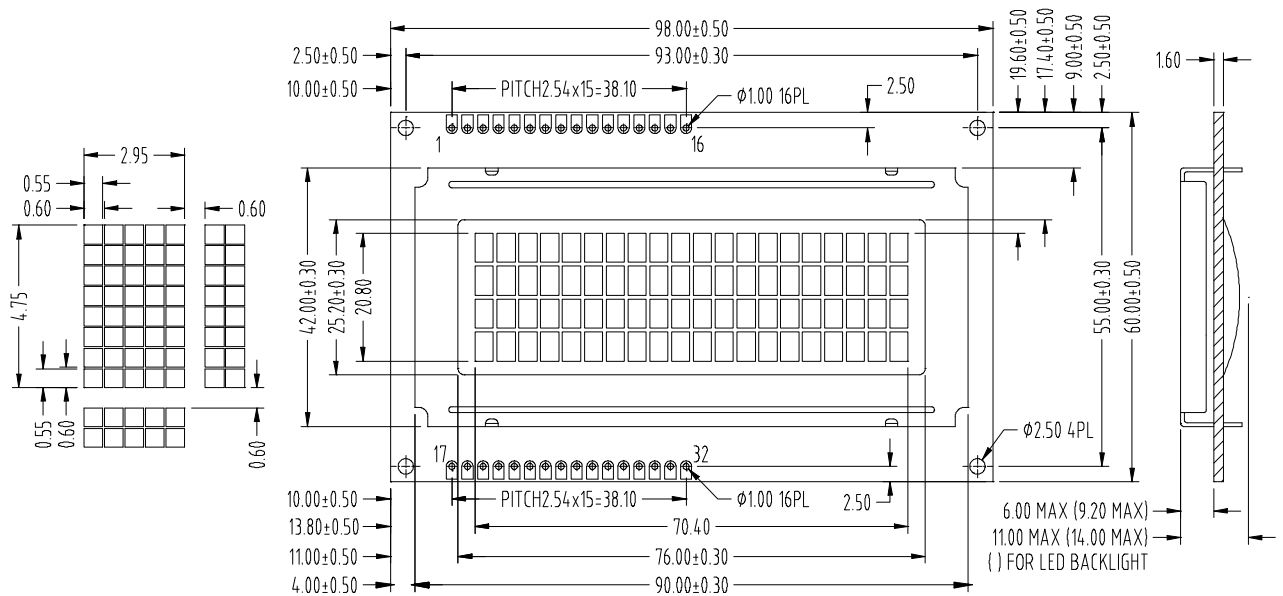
# **PRODUCT SPECIFICATIONS**

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- EXTERNAL DIMENSIONS
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- ABSOLUTE MAXIMUM RATINGS
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- OPERATING PRINCIPLES & METHODS
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- USING LCD MODULES

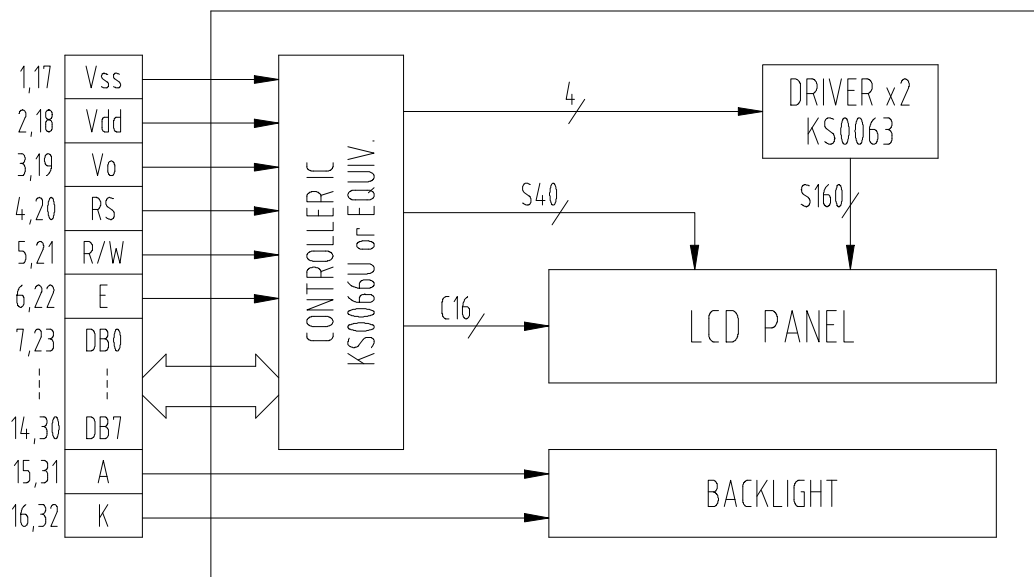
■ PHYSICAL DATA

Item	Contents	Unit
LCD type	TN / STN / FSTN	---
LCD duty	1/16	---
LCD bias	1/5	---
Viewing direction	6 / 12	o'clock
Module size (W×H×T)	98 × 60 × 11.0 MAX (14.0 MAX W/LED BACKLIGHT)	mm
Viewing area (W×H)	76 × 25.2	mm
Number of characters (characters×lines)	20 × 4	---
Character matrix (W×H)	5 × 8	dots
Character size (W×H)	3.55 × 5.35	mm
Dot size (W×H)	0.55 × 0.55	mm
Dot pitch (W×H)	0.60 × 0.60	mm

■ EXTERNAL DIMENSIONS



■ BLOCK DIAGRAM



■ **ABSOLUTE MAXIMUM RATINGS** ( Ta = 25°C )

Parameter	Symbol	Min	Max	Unit
Supply voltage for logic	VDD	-0.3	7.0	V
Supply voltage for LCD	VDD - VO	-0.3	VDD+0.3	V
Input voltage	VI	-0.3	VDD+0.3	V
Normal operating temperature	TOP	0	50	°C
Normal storage temperature	TST	-10	60	°C
Wide operating / storage temperature (except FSTN)	TOP / TST	-30	80	°C
Wide operating / storage temperature (FSTN)	TOP / TST	-30	70	°C

■ **ELECTRICAL CHARACTERISTICS** ( VDD = +5V±10% , VSS = 0V, Ta = 25°C )

◆ **DC Characteristics**

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage for logic	VDD	---	4.5	5.0	5.5	V
Supply current for logic	IDD	---	---	1.44	4	mA
Operating voltage for LCD	VDD - VO	25°C	4.5	4.8	5.1	V
Input voltage ' H ' level	VIH	---	VDD - 2.2	---	VDD	V
Input voltage ' L ' level	VIL	---	0	---	0.8	V

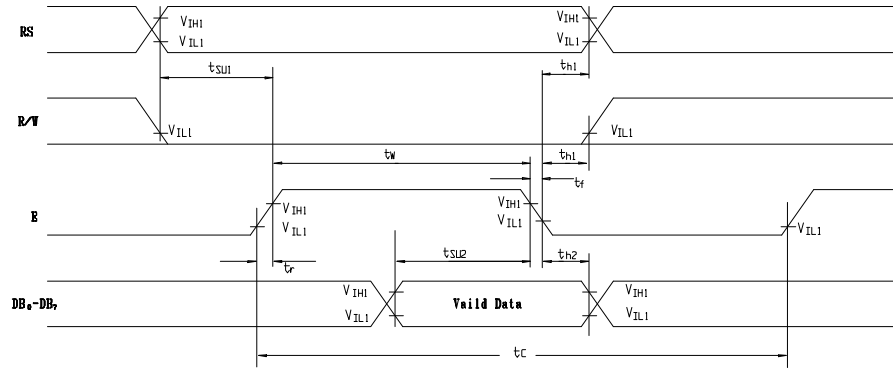
- Backlight operating information (Ta = 25°C )

LED Backlight	Supply voltage VF (V)			Supply current IF (mA)		
	Min	Typ	Max	Min	Typ	Max
Light box Y/G (-2)	---	4.2	4.6	---	280	480
EL Backlight	EL Enable voltage EON (VAC)			EL frequency LF (Hz)		
	Min	Typ	Max	Min	Typ	Max
EL (B)	---	100	150	---	400	1000

◆ **AC Characteristics**

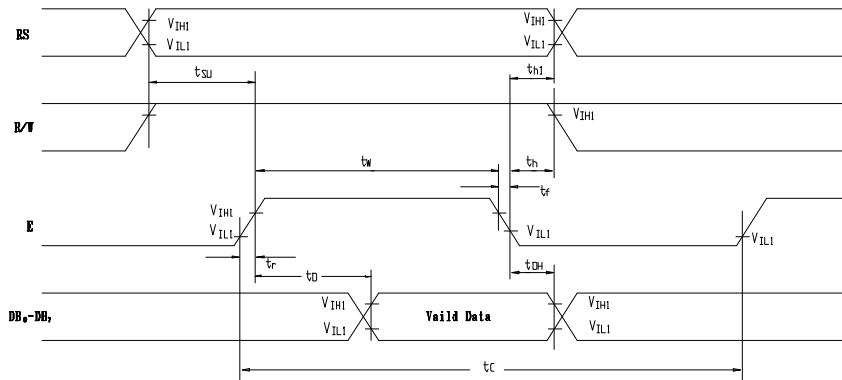
- Write mode

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Test pin
E cycle time	t <sub>C</sub>	500	---	---	ns	E
E rise time	t <sub>r</sub>	---	---	25	ns	E
E fall time	t <sub>f</sub>	---	---	25	ns	E
E pulse width (High, Low)	t <sub>w</sub>	220	---	---	ns	E
R/W and RS set-up time	t <sub>SU1</sub>	40	---	---	ns	R/W, RS
R/W and RS hold time	t <sub>h1</sub>	10	---	---	ns	R/W, RS
Data set-up time	t <sub>SU2</sub>	60	---	---	ns	DB <sub>0</sub> ~ DB <sub>7</sub>
Data hold time	t <sub>h2</sub>	10	---	---	ns	DB <sub>0</sub> ~ DB <sub>7</sub>



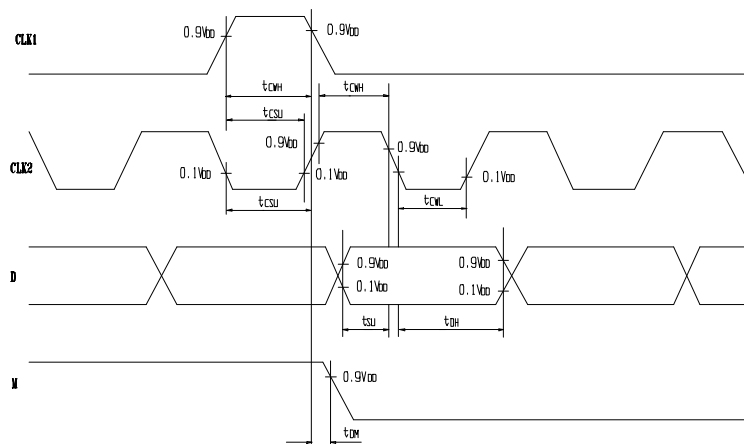
● Read mode

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Test pin
E cycle time	$t_C$	500	---	---	ns	E
E rise time	$t_r$	---	---	25	ns	E
E fall time	$t_f$	---	---	25	ns	E
E pulse width	$t_w$	220	---	---	ns	E
R/W and RS set-up time	$t_{SU}$	40	---	---	ns	R/W, RS
R/W and RS hold time	$t_h$	10	---	---	ns	R/W, RS
Data output delay time	$t_D$	---	---	120	ns	DB <sub>0</sub> ~ DB <sub>7</sub>
Data hold time	$t_{DH}$	20	---	---	ns	DB <sub>0</sub> ~ DB <sub>7</sub>



● Interface mode with ,KS0063B

Characteristic	Symbol	Min.	Typ.	Max.	Unit	Test pin
Clock pulse width High	$t_{CWH}$	800	---	---	ns	CLK
Clock pulse width Low	$t_{CWL}$	800	---	---	ns	CLK
Data set-up time	$t_{SU}$	300	---	---	ns	DB <sub>0</sub> ~ DB <sub>7</sub>
Data hold time	$t_{DH}$	300	---	---	ns	DB <sub>0</sub> ~ DB <sub>7</sub>
Clock set-up time	$t_{CSU}$	500	---	---	ns	CLK
M Delay time	$t_{DM}$	-1000	---	1000	ns	M



■ OPERATING PRINCIPLES & METHODS

◆ Control and Display Command

Command	RS	R/W	DB <sub>7</sub>	DB <sub>6</sub>	DB <sub>5</sub>	DB <sub>4</sub>	DB <sub>3</sub>	DB <sub>2</sub>	DB <sub>1</sub>	DB <sub>0</sub>	Execution Time (f <sub>osc</sub> = 250kHz)	Remark																		
DISPLAY CLEAR	L	L	L	L	L	L	L	L	L	H	1.64ms																			
RETURN HOME	L	L	L	L	L	L	L	L	H	X	1.64ms	Cursor move to first digit																		
ENTRY MODE SET	L	L	L	L	L	L	L	H	I/D	SH	42μs	<ul style="list-style-type: none"> <li>I/D : Set cursor move direction                             <table border="1"> <tr><td>I/D</td><td>H</td><td>Increase</td></tr> <tr><td>I/D</td><td>L</td><td>Decrease</td></tr> </table> </li> <li>SH : Specifies shift of display                             <table border="1"> <tr><td>SH</td><td>H</td><td>Display is shifted</td></tr> <tr><td>SH</td><td>L</td><td>Display is not shifted</td></tr> </table> </li> </ul>	I/D	H	Increase	I/D	L	Decrease	SH	H	Display is shifted	SH	L	Display is not shifted						
I/D	H	Increase																												
I/D	L	Decrease																												
SH	H	Display is shifted																												
SH	L	Display is not shifted																												
DISPLAY ON/OFF	L	L	L	L	L	L	H	D	C	B	42μs	<ul style="list-style-type: none"> <li>Display                             <table border="1"> <tr><td>D</td><td>H</td><td>Display on</td></tr> <tr><td>D</td><td>L</td><td>Display off</td></tr> </table> </li> <li>Cursor                             <table border="1"> <tr><td>C</td><td>H</td><td>Cursor on</td></tr> <tr><td>C</td><td>L</td><td>Cursor off</td></tr> </table> </li> <li>Blinking                             <table border="1"> <tr><td>B</td><td>H</td><td>Blinking on</td></tr> <tr><td>B</td><td>L</td><td>Blinking off</td></tr> </table> </li> </ul>	D	H	Display on	D	L	Display off	C	H	Cursor on	C	L	Cursor off	B	H	Blinking on	B	L	Blinking off
D	H	Display on																												
D	L	Display off																												
C	H	Cursor on																												
C	L	Cursor off																												
B	H	Blinking on																												
B	L	Blinking off																												
SHIFT	L	L	L	L	L	H	S/C	R/L	X	X	42μs	<table border="1"> <tr><td>S/C</td><td>H</td><td>Display shift</td></tr> <tr><td>S/C</td><td>L</td><td>Cursor move</td></tr> </table> <table border="1"> <tr><td>R/L</td><td>H</td><td>Right shift</td></tr> <tr><td>R/L</td><td>L</td><td>Left shift</td></tr> </table>	S/C	H	Display shift	S/C	L	Cursor move	R/L	H	Right shift	R/L	L	Left shift						
S/C	H	Display shift																												
S/C	L	Cursor move																												
R/L	H	Right shift																												
R/L	L	Left shift																												
SET FUNCTION	L	L	L	L	H	DL	N	F	X	X	42μs	<table border="1"> <tr><td>DL</td><td>H</td><td>8 bits interface</td></tr> <tr><td>DL</td><td>L</td><td>4 bits interface</td></tr> </table> <table border="1"> <tr><td>N</td><td>H</td><td>2 line display</td></tr> <tr><td>N</td><td>L</td><td>1 line display</td></tr> </table> <table border="1"> <tr><td>F</td><td>H</td><td>5 X 10 dots</td></tr> <tr><td>F</td><td>L</td><td>5 X 7 dots</td></tr> </table>	DL	H	8 bits interface	DL	L	4 bits interface	N	H	2 line display	N	L	1 line display	F	H	5 X 10 dots	F	L	5 X 7 dots
DL	H	8 bits interface																												
DL	L	4 bits interface																												
N	H	2 line display																												
N	L	1 line display																												
F	H	5 X 10 dots																												
F	L	5 X 7 dots																												
SET CG RAM ADDRESS	L	L	L	H	CG RAM address (corresponds to cursor address)					42μs	CG RAM Data is sent and received after this setting																			
SET DD RAM ADDRESS	L	L	H	DD RAM address					42μs	DD RAM Data is sent and received after this setting																				
READ BUSY FLAG & ADDRESS	L	H	BF	Address Counter used for both DD & CG RAM address					0μs	<table border="1"> <tr><td>BF</td><td>H</td><td>Busy</td></tr> <tr><td>BF</td><td>L</td><td>Ready</td></tr> </table> <ul style="list-style-type: none"> <li>– Reads BF indication internal operating is being performed</li> <li>– Reads address counter contents</li> </ul>	BF	H	Busy	BF	L	Ready														
BF	H	Busy																												
BF	L	Ready																												
WRITE DATA	H	L	Write Data					46μs	Write data into DD or CG RAM																					
READ DATA	H	H	Read Data					46μs	Read data from DD or CG RAM																					

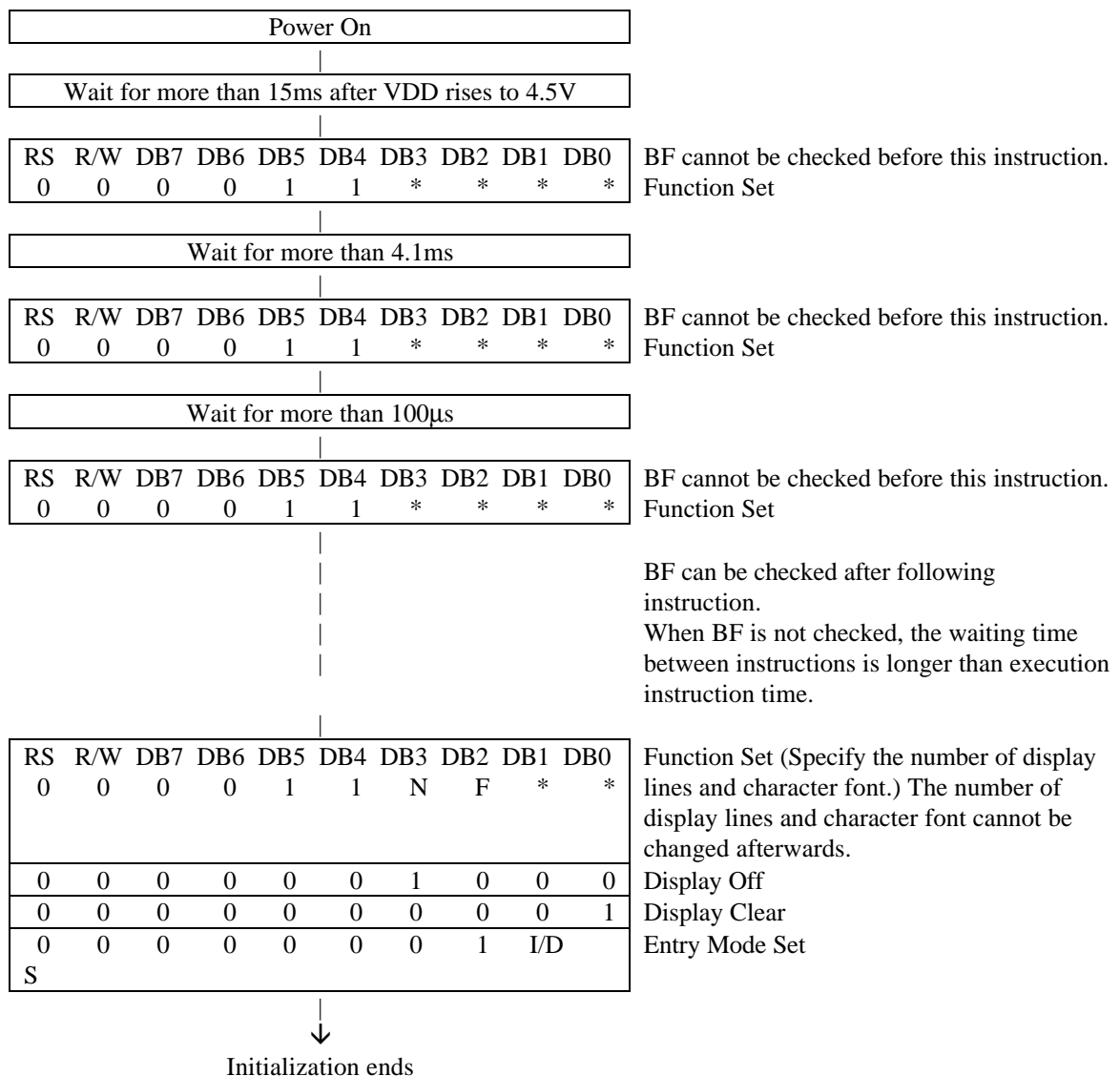
X : Don't care

**◆ Initializing by Internal Reset Circuit**

The KS0076B automatically initializes (resets) when the power is on using the internal reset circuit. The following instruction are executed in initialization. The busy flag is kept in busy state (BF=1) until initialization ends. The busy state is 10ms after VDD rises to 4.5V.

- (1) Display Clear
- (2) Function Set
  - DL = 1 : 8-bit interface data
  - N = 0 : 1-line display
  - F = 0 : 5x7-dot character font
- (3) Display On/Off Control
  - D = 0 : Display Off
  - C = 0 : Cursor Off
  - B = 0 : Blink Off
- (4) Entry Mode Set
  - I/D = 1 : +1 (Increment)
  - S = 0 : No Shift

**◆ Initializing by Instruction**





◆ Standard Character Pattern

upper 4 bit lower 4 bit	0000	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)														
0001	(2)														
0010	(3)														
0011	(4)														
0100	(5)														
0101	(6)														
0110	(7)														
0111	(8)														
1000	(1)														
1001	(2)														
1010	(3)														
1011	(4)														
1100	(5)														
1101	(6)														
1110	(7)														
1111	(8)														

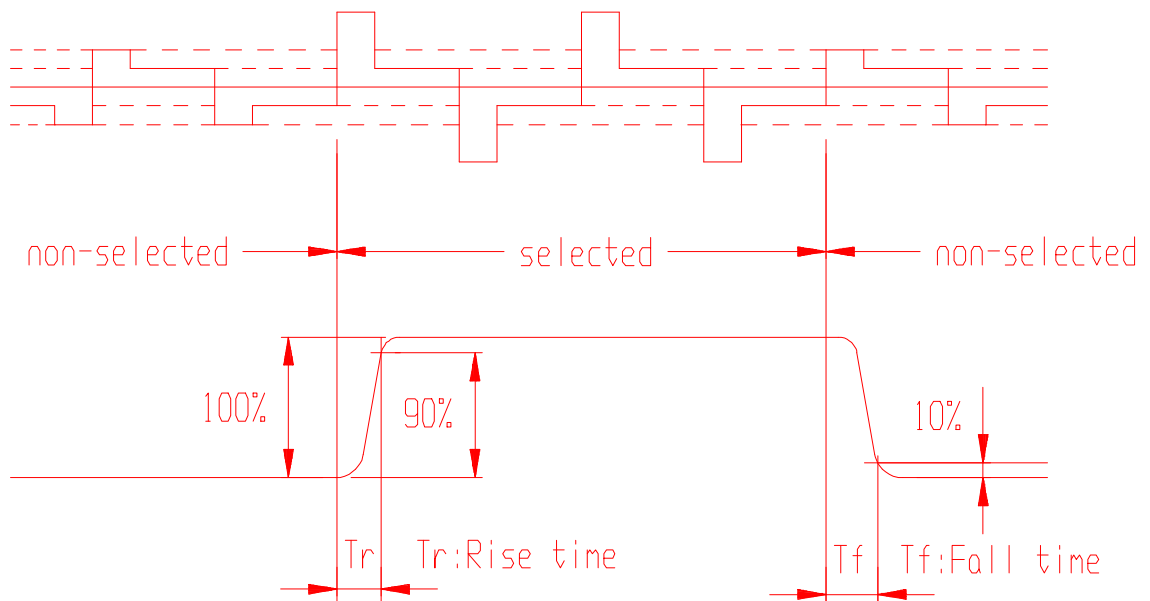
■ DISPLAY DATA RAM ADDRESS MAP

Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
First line (H)	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F	10	11	12	13
Second line (H)	40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F	50	51	52	53
Third line (H)	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F	20	21	22	23	24	25	26	27
Fourth line (H)	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F	60	61	62	63	64	65	66	67

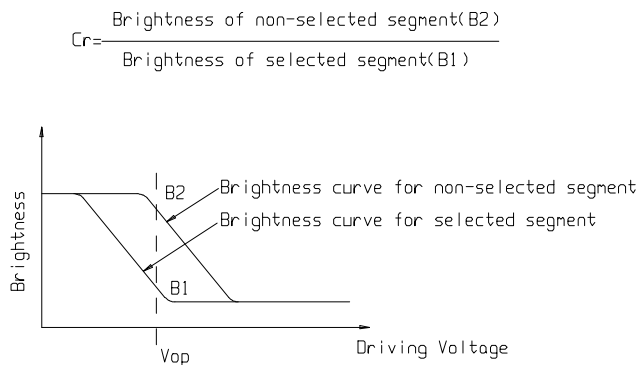
■ ELECTRO-OPTICAL CHARACTERISTICS (  $V_{OP} = 5.0V$ ,  $T_a = 25^{\circ}C$ , Transflective version)

LCD mode	Typ response time Tr (ms)		Typ response time Tf (ms)		Typ contrast ratio Cr	Typ viewing angle q (deg)			
	Normal temp	Wide temp	Normal temp	Wide temp		$\theta = 0^{\circ}$	$\theta = 90^{\circ}$	$\theta = 180^{\circ}$	$\theta = 270^{\circ}$
TN (A)	275	147	61	57	28	20	40	5	40
STN Y/G (B)					30	60	48	57	47
STN Blue (C)					6	52	25	33	33
STN Grey (D)					12	60	37	55	38
FSTN (F)					38	65	49	58	48
FSTN Negative (G)					18	53	25	34	33

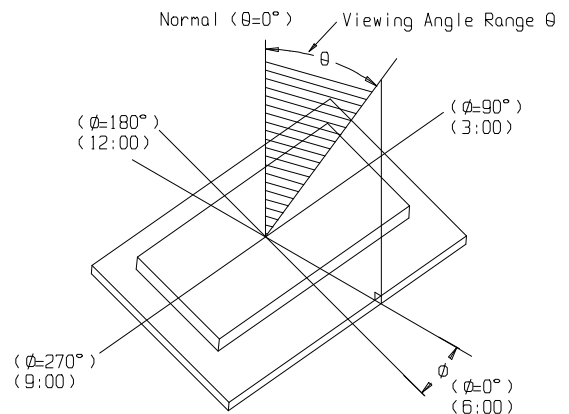
Note1: Definition of response time.



Note2: Definition of contrast ratio 'Cr' .



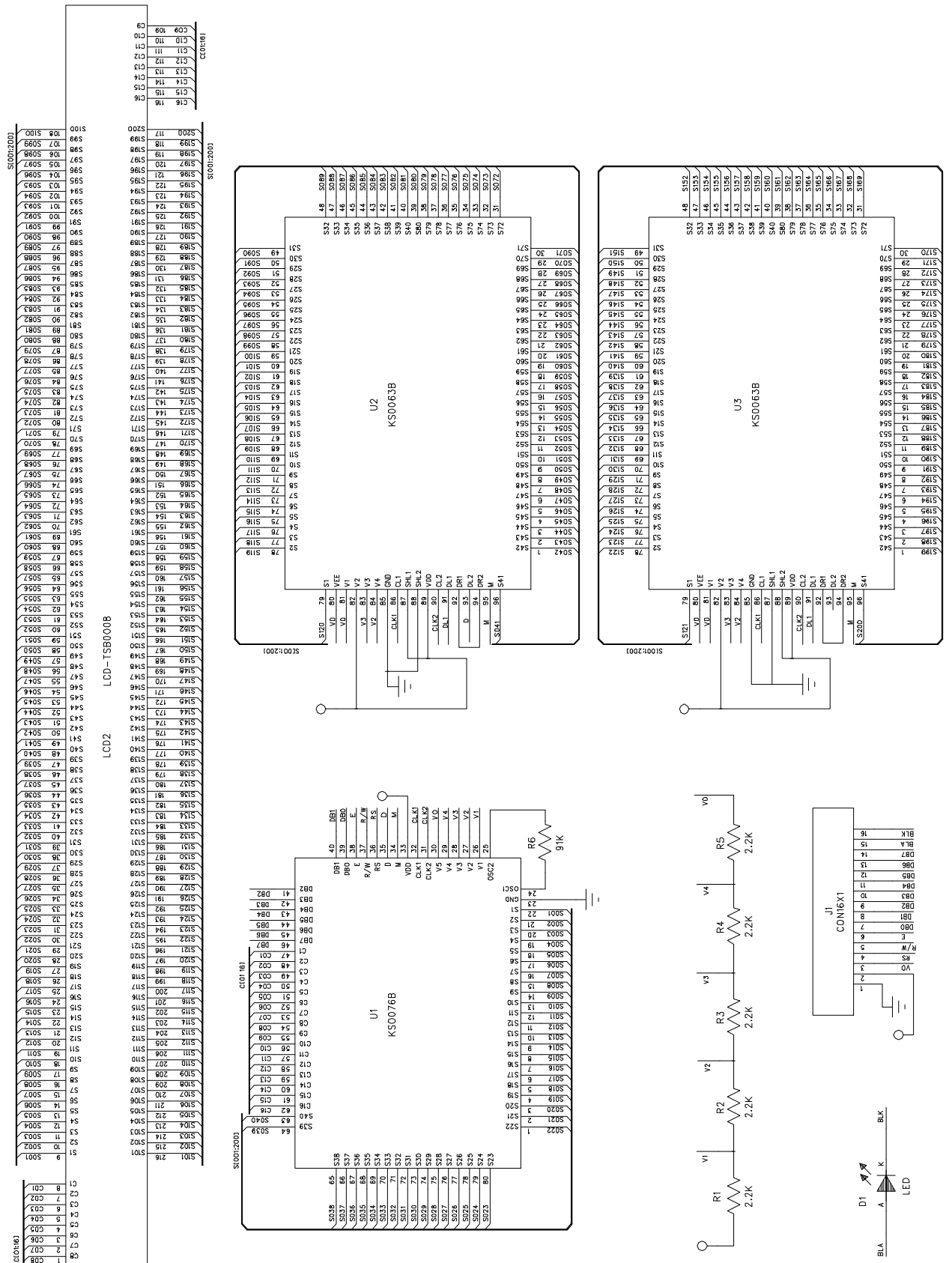
Note3: Definition of viewing angle range 'θ'.



**■ INTERFACE PIN CONNECTIONS**

Pin NO.	Symbol	Level	Description
1, 17	VSS	0V	Ground
2, 18	VDD	5.0V	Supply voltage for logic
3, 19	VO	---	Input voltage for LCD
4, 20	RS	H/L	H : Data signal, L : Instruction signal
5, 21	R/W	H/L	H : Read mode, L : Write mode
6, 22	E	H, H → L	Enable signal for KS0076
7, 23	DB0	H/L	Data bit 0
8, 24	DB1	H/L	Data bit 1
9, 25	DB2	H/L	Data bit 2
10, 26	DB3	H/L	Data bit 3
11, 27	DB4	H/L	Data bit 4
12, 28	DB5	H/L	Data bit 5
13, 29	DB6	H/L	Data bit 6
14, 30	DB7	H/L	Data bit 7
15, 31	A	---	Back light anode
16, 32	K	---	Back light cathode

### ■ CIRCUIT DIAGRAM



Pin	Signal	Pin	Signal
1	C08	31	S10
2	C07	32	S09
3	C06	33	S08
4	C05	34	S07
5	C04	35	S06
6	C03	36	S05
7	C02	37	S04
8	C01	38	S03
9	S01	39	S02
10	S02	40	S01
11	S03	41	S00
12	S04	42	S00
13	S05	43	S00
14	S06	44	S00
15	S07	45	S00
16	S08	46	S00
17	S09	47	S00
18	S10	48	S00
19	S11	49	S00
20	S12	50	S00
21	S13	51	S00
22	S14	52	S00
23	S15	53	S00
24	S16	54	S00
25	S17	55	S00
26	S18	56	S00
27	S19	57	S00
28	S20	58	S00
29	S21	59	S00
30	S22	60	S00
31	S23	61	S00
32	S24	62	S00
33	S25	63	S00
34	S26	64	S00
35	S27	65	S00
36	S28	66	S00
37	S29	67	S00
38	S30	68	S00
39	S31	69	S00
40	S32	70	S00
41	S33	71	S00
42	S34	72	S00
43	S35	73	S00
44	S36	74	S00
45	S37	75	S00
46	S38	76	S00
47	S39	77	S00
48	S40	78	S00
49	S41	79	S00
50	S42	80	S00
51	S43	81	S00
52	S44	82	S00
53	S45	83	S00
54	S46	84	S00
55	S47	85	S00
56	S48	86	S00
57	S49	87	S00
58	S50	88	S00
59	S51	89	S00
60	S52	90	S00
61	S53	91	S00
62	S54	92	S00
63	S55	93	S00
64	S56	94	S00
65	S57	95	S00
66	S58	96	S00
67	S59	97	S00
68	S60	98	S00
69	S61	99	S00
70	S62	100	S00
71	S63	101	S00
72	S64	102	S00
73	S65	103	S00
74	S66	104	S00
75	S67	105	S00
76	S68	106	S00
77	S69	107	S00
78	S70	108	S00
79	S71	109	S00
80	S72	110	S00
81	S73	111	S00
82	S74	112	S00
83	S75	113	S00
84	S76	114	S00
85	S77	115	S00
86	S78	116	S00
87	S79	117	S00
88	S80	118	S00
89	S81	119	S00
90	S82	120	S00
91	S83	121	S00
92	S84	122	S00
93	S85	123	S00
94	S86	124	S00
95	S87	125	S00
96	S88	126	S00
97	S89	127	S00
98	S90	128	S00
99	S91	129	S00
100	S92	130	S00
101	S93	131	S00
102	S94	132	S00
103	S95	133	S00
104	S96	134	S00
105	S97	135	S00
106	S98	136	S00
107	S99	137	S00
108	S100	138	S00
109	S101	139	S00
110	S102	140	S00
111	S103	141	S00
112	S104	142	S00
113	S105	143	S00
114	S106	144	S00
115	S107	145	S00
116	S108	146	S00
117	S109	147	S00
118	S110	148	S00
119	S111	149	S00
120	S112	150	S00
121	S113	151	S00
122	S114	152	S00
123	S115	153	S00
124	S116	154	S00
125	S117	155	S00
126	S118	156	S00
127	S119	157	S00
128	S120	158	S00
129	S121	159	S00
130	S122	160	S00
131	S123	161	S00
132	S124	162	S00
133	S125	163	S00
134	S126	164	S00
135	S127	165	S00
136	S128	166	S00
137	S129	167	S00
138	S130	168	S00
139	S131	169	S00
140	S132	170	S00
141	S133	171	S00
142	S134	172	S00
143	S135	173	S00
144	S136	174	S00
145	S137	175	S00
146	S138	176	S00
147	S139	177	S00
148	S140	178	S00
149	S141	179	S00
150	S142	180	S00
151	S143	181	S00
152	S144	182	S00
153	S145	183	S00
154	S146	184	S00
155	S147	185	S00
156	S148	186	S00
157	S149	187	S00
158	S150	188	S00
159	S151	189	S00
160	S152	190	S00
161	S153	191	S00
162	S154	192	S00
163	S155	193	S00
164	S156	194	S00
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201	S193	231	S00
202	S194	232	S00
203	S195	233	S00
204	S196	234	S00
205	S197	235	S00
206	S198	236	S00
207	S199	237	S00
208	S200	238	S00
209	S201	239	S00
210	S202	240	S00
211	S203	241	S00
212	S204	242	S00
213	S205	243	S00
214	S206	244	S00
215	S207	245	S00
216	S208	246	S00
217	S209	247	S00
218	S210	248	S00
219	S211	249	S00
220	S212	250	S00
221	S213	251	S00
222	S214	252	S00
223	S215	253	S00
224	S216	254	S00
225	S217	255	S00
226	S218	256	S00
227	S219	257	S00
228	S220	258	S00
229	S221	259	S00
230	S222	260	S00
231	S223	261	S00
232	S224	262	S00
233	S225	263	S00
234	S226	264	S00
235	S227	265	S00
236	S228	266	S00
237	S229	267	S00
238	S230	268	S00
239	S231	269	S00
240	S232	270	S00
241	S233	271	S00
242	S234	272	S00
243	S235	273	S00
244	S236	274	S00
245	S237	275	S00
246	S238	276	S00
247	S239	277	S00
248	S240	278	S00
249	S241	279	S00
250	S242	280	S00
251	S243	281	S00
252	S244	282	S00
253	S245	283	S00
254	S246	284	S00
255	S247	285	S00
256	S248	286	S00
257	S249	287	S00
258	S250	288	S00
259	S251	289	S00
260	S252	290	S00
261	S253	291	S00
262	S254	292	S00
263	S255	293	S00
264	S256	294	S00
265	S257	295	S00
266	S258	296	S00
267	S259	297	S00
268	S260	298	S00
269	S261	299	S00
270	S262	300	S00
271	S263	301	S00
272	S264	302	S00
273	S265	303	S00
274	S266	304	S00
275	S267	305	S00
276	S268	306	S00
277	S269	307	S00
278	S270	308	S00
279	S271	309	S00
280	S272	310	S00
281	S273	311	S00
282	S274	312	S00
283	S275	313	S00
284	S276	314	S00
285	S277	315	S00
286	S278	316	S00
287	S279	317	S00
288	S280	318	S00
289	S281	319	S00
290	S282	320	S00
291	S283	321	S00
292	S284	322	S00
293	S285	323	S00
294	S286	324	S00
295	S287	325	S00
296	S288	326	S00
297	S289	327	S00
298	S290	328	S00
299	S291	329	S00
300	S292	330	S00
301	S293	331	S00
302	S294	332	S00
303	S295	333	S00
304	S296	334	S00
305	S297	335	S00
306	S298	336	S00
307	S299	337	S00
308	S300	338	S00
309	S301	339	S00
310	S302	340	S00
311	S303	341	S00
312	S304	342	S00
313	S305	343	S00
314	S306	344	S00
315	S307	345	S00
316	S308	346	S00
317	S309	347	S00
318	S310	348	S00
319	S311	349	S00
320	S312	350	S00
321	S313	351	S00
322	S314	352	S00
323	S315	353	S00
324	S316	354	S00
325	S317	355	S00
326	S318	356	S00
327	S319	357	S00
328	S320	358	S00
329	S321	359	S00
330	S322	360	S00
3			

**■ RELIABILITY**

**◆ Content of Reliability Test**

Environmental Test				
No.	Test Item	Content of Test	Test Condition	Applicable Standard
1	High temperature storage	Endurance test applying the high storage temperature for a long time.	60 °C 200 hrs	-----
2	Low temperature storage	Endurance test applying the low storage temperature for a long time.	-10 °C 200 hrs	-----
3	High temperature operation	Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.	50 °C 200 hrs	-----
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	0 °C 200 hrs	-----
5	High temperature / Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time.	60 °C , 90 %RH 96 hrs	MIL-202E-103B JIS-C5023
6	High temperature / Humidity operation	Endurance test applying the electric stress (Voltage & Current) and temperature / humidity stress to the element for a long time.	40 °C , 90 %RH 96 hrs	MIL-202E-103B JIS-C5023
7	Temperature cycle	Endurance test applying the low and high temperature cycle. $  \begin{array}{ccccc}  -10^{\circ}\text{C} & \rightleftharpoons & 25^{\circ}\text{C} & \rightleftharpoons & 60^{\circ}\text{C} \\  30\text{min} & & 5\text{min.} & & 30\text{min} \\  \leftarrow & & & & \rightarrow \\  & & \text{1 cycle} & &   \end{array}  $	-10°C / 60°C 10 cycles  -----	
Mechanical Test				
8	Vibration test	Endurance test applying the vibration during transportation and using.	10~22Hz → 1.5mmp-p 22~500Hz → 1.5G Total 0.5hrs	MIL-202E-201A JIS-C5025 JIS-C7022-A-10
9	Shock test	Constructional and mechanical endurance test applying the shock during transportation.	50G half sign wave 11 msdc 3 times of each direction	MIL-202E-213B
10	Atmospheric pressure test	Endurance test applying the atmospheric pressure during transportation by air.	115 mbar 40 hrs	MIL-202E-105C
Others				
11	Static electricity test	Endurance test applying the electric stress to the terminal.	VS=800V , RS=1.5 kΩ CS=100 pF 1 time	MIL-883B-3015.1

\*\*\* Supply voltage for logic system = 5V. Supply voltage for LCD system = Operating voltage at 25°C.

**◆ Failure Judgement Criterion**

Criterion Item	Test Item No.											Failure Judgment Criterion	
	1	2	3	4	5	6	7	8	9	10	11		
Basic specification													Out of the Basic Specification
Electrical characteristic													Out of the DC and AC Characterstic
Mechanical characteristic													Out of the Mechanical Specification Color change : Out of Limit Apperance Specification
Optical characteristic													Out of the Apperance Standard

**■ QUALITY GUARANTEE**

**◆ Acceptable Quality Level**

Each lot should satisfy the quality level defined as follows.

- Inspection method : MIL-STD-105E LEVEL II Normal one time sampling
- AQL

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

**◆ Definition of ‘LOT’**

One lot means the delivery quantity to customer at one time.

**◆ Conditions of Cosmetic Inspection**

- Environmental condition

The inspection should be performed at the 1m of height from the LCD module under 2 pieces of 40W white fluorescent lamps (Normal temperature 20~25°C and normal humidity 60±15%RH).

- Inspection method

The visual check should be performed vertically at more than 30cm distance from the LCD panel.

- Driving voltage

The  $V_o$  value which the most optimal contrast can be obtained near the specified  $V_o$  in the specification. (Within ±0.5V of the typical value at 25°C.).

**■ INSPECTION CRITERIA**

**◆ Module Cosmetic Criteria**

No.	Item	Judgement Criterion	Partition
1	Difference in Spec.	None allowed	Major
2	Pattern peeling	No substrate pattern peeling and floating	Major
3	Soldering defects	No soldering missing No soldering bridge No cold soldering	Major Major Minor
4	Resist flaw on substrate	Invisible copper foil (∅0.5mm or more) on substrate pattern	Minor
5	Accretion of metallic Foreign matter	No soldering dust No accretion of metallic foreign matters (Not exceed ∅0.2mm)	Minor Minor
6	Stain	No stain to spoil cosmetic badly	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 lead form perfectly. (too much)	Minor
	1. Lead 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 assume over solder.	
	3. Chips	$(3/2) H \geq h \geq (1/2) H$	Minor

**◆ Screen Cosmetic Criteria (Non-Operating)**

No.	Defect	Judgement Criterion	Partition										
1	Spots	In accordance with <i>Screen Cosmetic Criteria (Operating) No.1.</i>	Minor										
2	Lines	In accordance with <i>Screen Cosmetic Criteria (Operating) No.2.</i>	Minor										
3	Bubbles in polarizer	<table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td><math>d \leq 0.3</math></td> <td>Disregard</td> </tr> <tr> <td><math>0.3 &lt; d \leq 1.0</math></td> <td>3</td> </tr> <tr> <td><math>1.0 &lt; d \leq 1.5</math></td> <td>1</td> </tr> <tr> <td><math>1.5 &lt; d</math></td> <td>0</td> </tr> </tbody> </table>	Size : d mm	Acceptable Qty in active area	$d \leq 0.3$	Disregard	$0.3 < d \leq 1.0$	3	$1.0 < d \leq 1.5$	1	$1.5 < d$	0	Minor
Size : d mm	Acceptable Qty in active area												
$d \leq 0.3$	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	Coloration	Not to be noticeable coloration in the viewing area of the LCD panels. Back-lit type should be judged with back-lit on state only.	Minor										
7	Contamination	Not to be noticeable.	Minor										

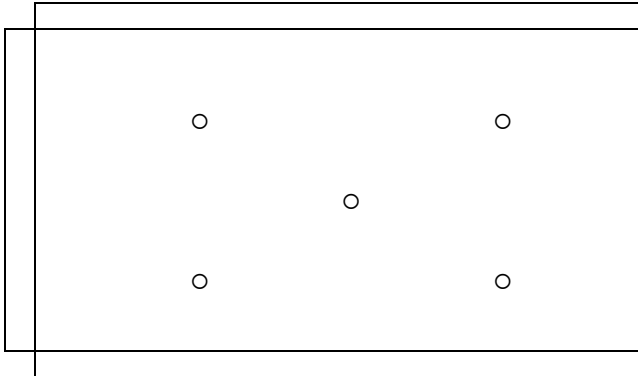
**◆ Screen Cosmetic Criteria (Operating)**

No.	Defect	Judgement Criterion	Partition																				
1	Spots	<p>A) Clear</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td><math>d \leq 0.1</math></td> <td>Disregard</td> </tr> <tr> <td><math>0.1 &lt; d \leq 0.2</math></td> <td>6</td> </tr> <tr> <td><math>0.2 &lt; d \leq 0.3</math></td> <td>2</td> </tr> <tr> <td><math>0.3 &lt; d</math></td> <td>0</td> </tr> </tbody> </table> <p>Note : Including pin holes and defective dots which must be within one pixel size.</p> <p>B) Unclear</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Size : d mm</th> <th>Acceptable Qty in active area</th> </tr> </thead> <tbody> <tr> <td><math>d \leq 0.2</math></td> <td>Disregard</td> </tr> <tr> <td><math>0.2 &lt; d \leq 0.5</math></td> <td>6</td> </tr> <tr> <td><math>0.5 &lt; d \leq 0.7</math></td> <td>2</td> </tr> <tr> <td><math>0.7 &lt; d</math></td> <td>0</td> </tr> </tbody> </table>	Size : d mm	Acceptable Qty in active area	$d \leq 0.1$	Disregard	$0.1 < d \leq 0.2$	6	$0.2 < d \leq 0.3$	2	$0.3 < d$	0	Size : d mm	Acceptable Qty in active area	$d \leq 0.2$	Disregard	$0.2 < d \leq 0.5$	6	$0.5 < d \leq 0.7$	2	$0.7 < d$	0	Minor
Size : d mm	Acceptable Qty in active area																						
$d \leq 0.1$	Disregard																						
$0.1 < d \leq 0.2$	6																						
$0.2 < d \leq 0.3$	2																						
$0.3 < d$	0																						
Size : d mm	Acceptable Qty in active area																						
$d \leq 0.2$	Disregard																						
$0.2 < d \leq 0.5$	6																						
$0.5 < d \leq 0.7$	2																						
$0.7 < d$	0																						
2	Lines	<p>A) Clear</p> <p>Note : ( ) - Acceptable Qty in active area L - Length (mm) W - Width (mm) <math>\infty</math> - Disregard</p> <p>B) Unclear</p>	Minor																				

'Clear' = The shade and size are not changed by  $V_o$ .

'Unclear' = The shade and size are changed by  $V_o$ .

**◆ Screen Cosmetic Criteria (Operating) (Continued)**

No.	Defect	Judgement Criterion	Partition
3	Rubbing line	Not to be noticeable.	
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 <i>Screen Cosmetic Criteria (Operating) No.1</i> )	Minor
7	Uneven brightness (only back-lit type module)	Uneven brightness must be $B_{MAX} / B_{MIN} \leq 2$ - $B_{MAX}$ : Max. value by measure in 5 points - $B_{MIN}$ : Min. value by measure in 5 points Divide active area into 4 vertically and horizontally. Measure 5 points shown in the following figure.  ○ : Measuring points	Minor

Note :

- (1) Size :  $d = (\text{long length} + \text{short length}) / 2$
- (2) The limit samples for each item have priority.
- (3) Complexed defects are defined item by item, but if the number of defects are defined in above table, the total number should not exceed 10.
- (4) In case of 'concentration', even the spots or the lines of 'disregarded' size should not allowed. Following three situations should be treated as 'concentration'.
  - 7 or over defects in circle of  $\varnothing 5\text{mm}$ .
  - 10 or over defects in circle of  $\varnothing 10\text{mm}$ .
  - 20 or over defects in circle of  $\varnothing 20\text{mm}$ .

**■ PRECAUTIONS FOR USING LCD MODULES**

**◆ Handing Precautions**

- (1) The display panel is made of glass. Do not subject it to a mechanical shock by dropping it or impact.
- (2) If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.
- (3) Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- (4) The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
- (5) If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten cloth with one of the following solvents :
  - Isopropyl alcohol
  - Ethyl alcohol
- (6) Solvents other than those above-mentioned may damage the polarizer. Especially, do not use the following.
  - Water
  - Ketone
  - Aromatic solvents
- (7) Exercise care to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or a current flow in a high-humidity environment.



(8) Install the LCD Module by using the mounting holes. When mounting the LCD module make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.

(9) Do not attempt to disassemble or process the LCD module.

(10) NC terminal should be open. Do not connect anything.

(11) If the logic circuit power is off, do not apply the input signals.

(12) 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 modules.

- Tools required for assembling, such as soldering irons, must be properly grounded.

- To reduce the amount of static electricity generated, do not conduct assembling 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 (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.

### ◆ **Others**

Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subject to a low temperature.

If the 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.

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.

## ■ **USING LCD MODULES**

### ◆ **Liquid Crystal Display Modules**

LCD is composed of glass and polarizer. Pay attention to the following items when handling.

(1) Please keep the temperature within specified range for use and storage. Polarization degradation, bubble generation or polarizer peel-off may occur with high temperature 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 isopropylalcohol.

(4) When the display surface becomes dusty, wipe gently with absorbent cotton or other soft material like chamois soaked in petroleum benzin. 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 contacting oil and fats.

(7) Condensation on the surface and contact with terminals due to cold will damage, stain or dirty the polarizers. After products are tested at low temperature they must be warmed up in a container before coming in contact with room temperature air.

(8) Do not put or attach anything on the display area to avoid leaving marks on.

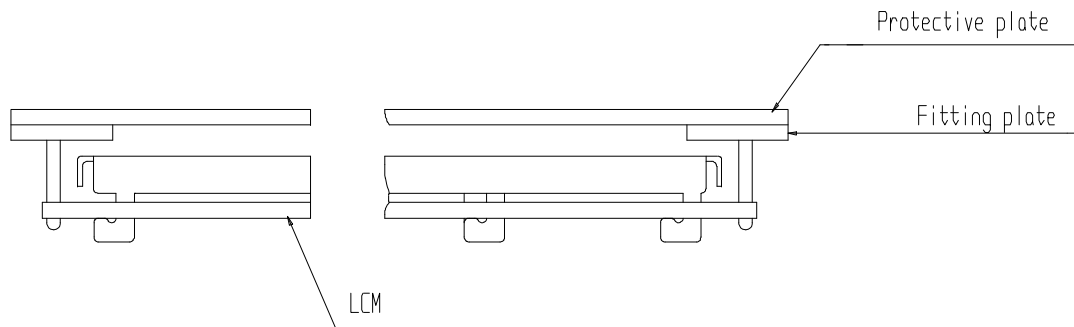
(9) Do not touch the display with bare hands. This will stain the display area and degrade insulation between terminals (some cosmetics are determined to the polarizers).

(10) As glass is fragile. It tends to become or chipped during handling especially on the edges. Please avoid dropping or jarring.

### ◆ Installing LCD Modules

The hole in the printed circuit board is used to fix LCM as shown in the picture below. Attend to the following items when installing the LCM.

- (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 to the bit 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  $\pm 0.1\text{mm}$ .

### ◆ Precaution for Handling LCD Modules

Since LCM 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.

- (1) Do not alter, modify or change the the shape of the tab on the metal frame.
- (2) Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
- (3) Do not damage or modify the pattern writing on the printed circuit board.
- (4) Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
- (5) Except for soldering the interface, do not make any alterations or modifications with a soldering iron.
- (6) Do not drop, bend or twist LCM.

### ◆ Electro-Static Discharge Control

Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC.

- (1) Make certain that you are grounded when handling LCM.
- (2) Before remove LCM from its packing case or incorporating it into a set, be sure the module and your body have the same electric potential.
- (3) When soldering the terminal of LCM, make certain the AC power source for the soldering iron does not leak.
- (4) When using an electric screwdriver to attach LCM, the screwdriver should be of ground potentiality to minimize as much as possible any transmission of electromagnetic waves produced sparks coming from the commutator of the motor.
- (5) As far as possible make the electric potential of your work clothes and that of the work bench the ground potential.
- (6) To reduce the generation of static electricity be careful that the air in the work is not too dried. A relative humidity of 50%-60% is recommended.

### ◆ Precaution for soldering to the LCM

- (1) Observe the following when soldering lead wire, connector cable and etc. to the LCM.
  - Soldering iron temperature :  $280^{\circ}\text{C} \pm 10^{\circ}\text{C}$ .
  - Soldering time : 3-4 sec.
  - Solder : eutectic solder.

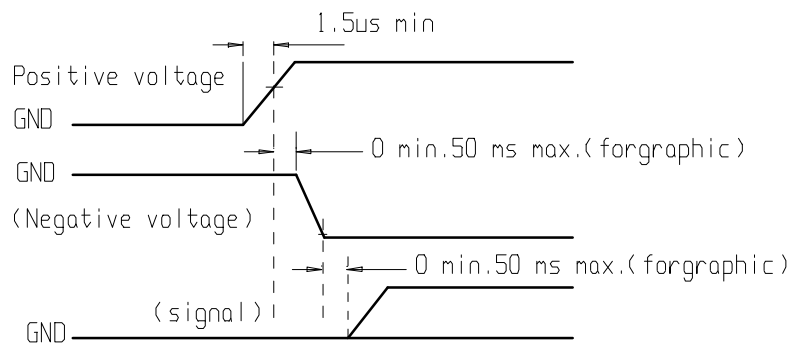
If soldering flux is used, be sure to remove any remaining flux after finishing to soldering operation. (This does not apply in the case of a non-halogen type of flux.) It is recommended that you protect the LCD surface with a cover during soldering to prevent any damage dur to flux spatters.

- (2) 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.

- (3) When remove the electoluminescent panel from the PC board, be sure the solder has completely melted, the soldered pad on the PC board could be damaged.

**◆ Precautions for Operation**

- (1) Viewing angle varies with the change of liquid crystal driving voltage ( $V_0$ ). Adjust  $V_0$  to show the best contrast.
- (2) Driving the LCD in the voltage above the limit shortens its life.
- (3) Response time is greatly delayed at temperature below the operating temperature range. However, this does not mean the LCD will be out of the order. It will recover when it returns to the specified temperature range.
- (4) If the display area is pushed hard during operation, the display will become abnormal. However, it will return to normal if it is turned off and then back on.
- (5) 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.
- (6) When turning the power on, input each signal after the positive/negative voltage becomes stable.

**◆ Storage**

When storing LCDs as spares for some years, the following precaution are necessary.

- (1) Store them in a sealed polyethylene bag. If properly sealed, there is no need for dessicant.
- (2) Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0°C and 35°C.
- (3) The polarizer surface should not come in contact with any other objects. (We advise you to store them in the container in which they were shipped.)
- (4) Environmental conditions :
  - Do not leave them for more than 168hrs. at 60°C.
  - Should not be left for more than 48hrs. at -20°C.

**◆ Safety**

- (1) It is recommended to crush damaged or unnecessary LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.
- (2) If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

**◆ Limited Warranty**

Unless agreed between DISPLAYTECH and customer, DISPLAYTECH will replace or repair any of its LCD modules which are found to be functionally defective when inspected in accordance with DISPLAYTECH LCD acceptance standards (copies available upon request) for a period of one year from date of shipments. Cosmetic/visual defects must be returned to DISPLAYTECH within 90 days of shipment. Confirmation of such date shall be based on freight documents. The warranty liability of DISPLAYTECH limited to repair and/or replacement on the terms set forth above. DISPLAYTECH will not be responsible for any subsequent or consequential events.

**◆ Return LCM under warranty**

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

- Broken LCD glass.
- PCB eyelet's damaged or modified.
- PCB conductors damaged.
- Circuit modified in any way, including addition of components.
- PCB tampered with by grinding, engraving or painting varnish.
- 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 failures or defects. Any connectors or cable installed by the customer must be removed completely without damaging the PCB eyelet's, conductors and terminals.