MULTI-INNO TECHNOLOGY CO., LTD.

LCD MODULE SPECIFICATION

Model : MI320240C-G

Revision	
Engineering	
Date	
Our Reference	

REVISION RECORD

Version	Page	Revision Items	Name	Date
0.0		First release	Skymond	2008.05.11

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1 Description

The MI320240C-G , a Dot-Matrix Graphic LCM unit, consists of 320(segment) x 240(common) FSTN LCD panel, LCD drivers, a LED backlight unit, and a PCB with controller, DC/DC and bias circuits on it. We can display characters very easily, using a controller with a ROM which has the font of English and simple Chinese code.

- Built-in controller, DC/DC and bias circuits
- Built-in ROM with English and simple Chinese code
- Wide viewing direction
- Wide Operating temperature
- Requirements on environmental protection: RoHS

2 Features

Item	Contents
LCD Type	FSTN
	Negative
LCD Duty	240
LCD Bias	1/14
Polarizer	Transmissive
LCD Background Color	Black
Display Segment Color	White
Backlight Type	LED(White, Edge)
Backlight Driving Condition	10V, 60mA
View Direction	6:00
Operating temperature	-20℃~70℃
Storage Temperature	-30℃~80℃
Controller	RA8806
Frame	SUS430
Technology	COG+SMT
Power supply	5.0V(Typical)
Data Transfer	8 Bit Parallel

Notes:

- Color tone can slightly change with temperature and driving voltage.
- Color tone will be changed by backlight.

3 Absolute maximum ratings

Parameter	Symbol	Min	Max	Unit	Remark
Logic supply voltage	VDD	-0.3	+6.0	V	
Logic circuit supply negative voltage	VEE	0	+25	V	
LCD driving voltage	VOP	-0.3	+24	V	
Operating temperature	Top	-20	+70	℃	No Condensation
Storage temperature	Tst	-30	+80	℃	

Note:

- LCD operating voltage VOP = V0 –GND. We can get VOP between the test pad TEST2 and GND.
- If the module is above these absolute maximum ratings. It may become permanently damaged.
- VEE>VDD >GND must be maintained.

4 Mechanical Characteristics

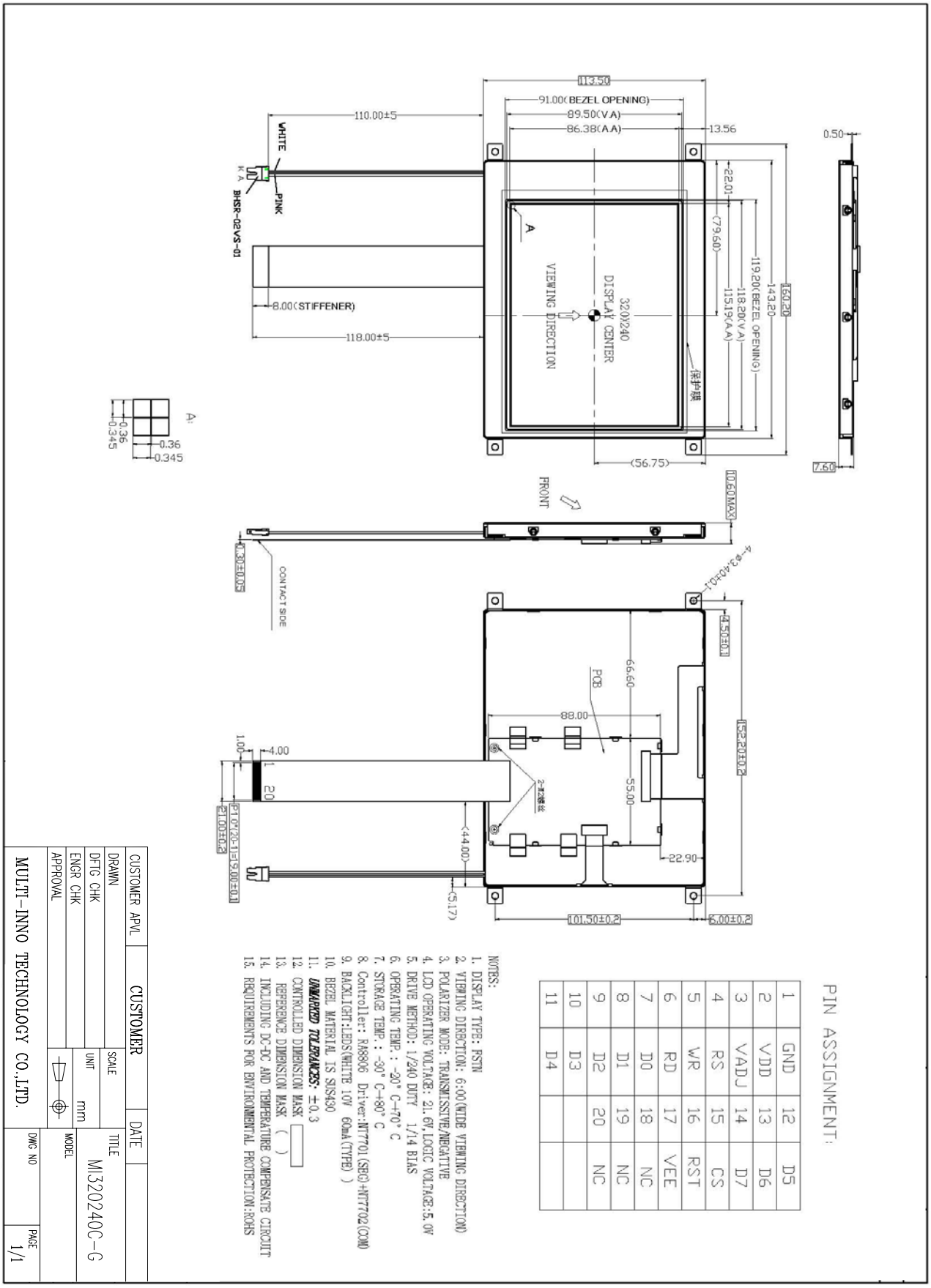
4.1 Mechanical features

Parameter	Standard Value	Unit
Display Type	Dot-Matrix Graphic LCM	---
Character Size(H×V)	Refer to RA8806's Datasheet	Pixel
Number of Pixels(H×V)	320 x 240	---
View Area (H×V)	118.2 x 89.5	mm
Active Area (H×V)	115.19 x 86.38	mm
Pixel Size (H×V)	0.345 x 0.345	mm
Pixel Pitch (H×V)	0.36 x 0.36	mm
Module Size(H×V×T)	160.2 x 113.5 x 10.6(MAX)	mm
Module Total Weight (approx)	(TBD)	g
Module Outline Dimensions	Refer to page 5-"Mechanical Drawing"	--

Note:

- H×V×T, here H indicates Horizontal, V indicates Vertical, and T indicates Thickness.

4.2 Mechanical drawing



PIN ASSIGNMENT:

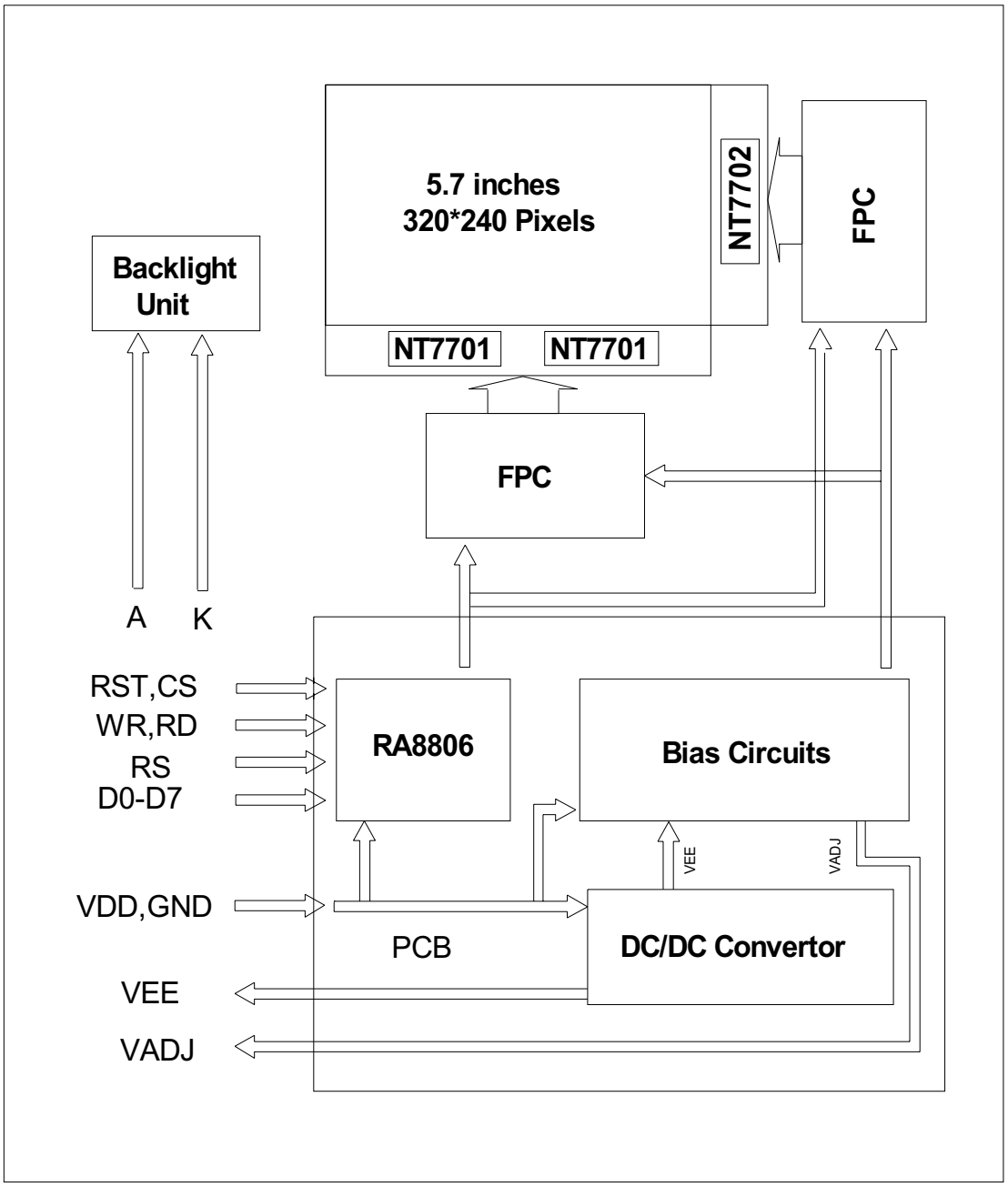
1	GND	12	D5	
2	VDD	13	D6	
3	VADJ	14	D7	
4	RS	15	CS	
5	WR	16	RST	
6	RD	17	VEE	
7	D0	18	NC	
8	D1	19	NC	
9	D2	20	NC	
10	D3			
11	D4			

NOTES:
1. DISPLAY TYPE: FSTN
2. VIEWING DIRECTION: 6:00(WIDE VIEWING DIRECTION)
3. POLARIZER MODE: TRANSMISSIVE/NEGATIVE
4. LCD OPERATING VOLTAGE: 21.6V, LOGIC VOLTAGE:5.0V
5. DRIVE METHOD: 1/240 DUTY 1/14 BIAS
6. OPERATING TEMP.: -20° C~+70° C
7. STORAGE TEMP.: -30° C~+80° C
8. Controller: R88806 Driver:NT7701(SEG)+NT7702(COM)
9. BACKLIGHT:LEDS(WHITE 10V 60mA(TYPE))
10. BEZEL MATERIAL IS SUS430
11. UNMARKED TOLERANCES: ±0.3
12. CONTROLLED DIMENSION MASK ( )
13. REFERENCE DIMENSION MASK ( )
14. INCLUDING DC-DC AND TEMPERATURE COMPENSATE CIRCUIT
15. REQUIREMENTS FOR ENVIRONMENTAL PROTECTION:ROHS

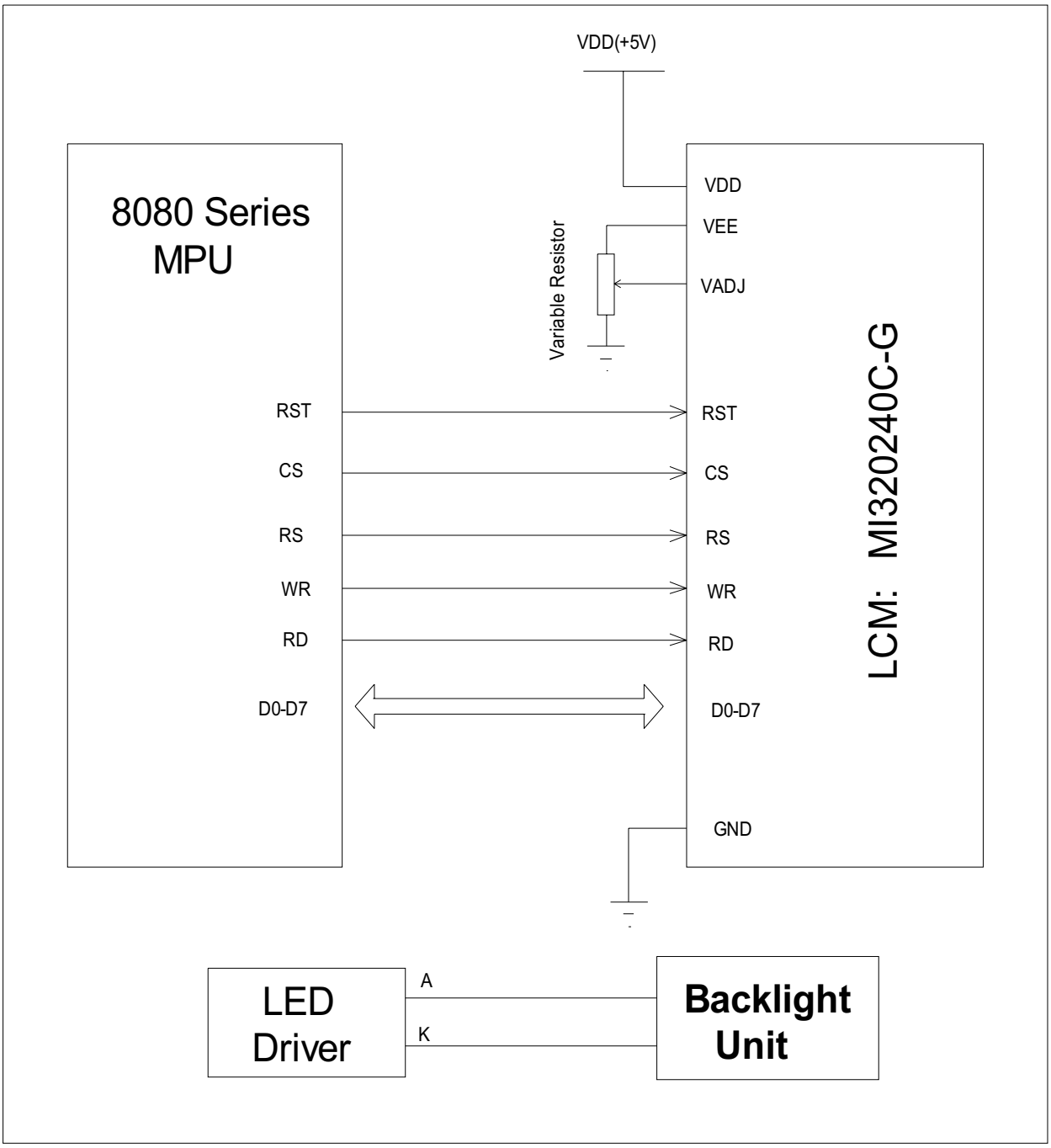
CUSTOMER APVL	CUSTOMER	DATE	
DRAWN		SCALE	TITLE: MI320240C-G
DFTG CHK		UNIT: mm	
ENGR CHK			MODEL
APPROVAL			DWG NO
MULTI-INNO TECHNOLOGY CO.,LTD.			PAGE 1/1

5 Circuit

5.1 Block Diagram



5.2 Recommend interface circuit



Note:

- The VEE is generated by the DC-DC block circuits, if we do not want to control the contrast of module outside, please don't add the Variable Resistor. If we want to control the contrast outside, you can add a resistor just like the picture shown above, and connect the JP1 and JP2 on PCB..
- The default interface is for 8080 Series MPU. When we use a MPU of 6800 Series, we have to remove the resister R6 and add a resistor R5 (0 ohm) on PCB. Both R5 and R6 are near the controller RA8806.
- It is recommended to use a LED Driver to driver the backlight unit.

6 Interface Description

Pin No.	Symbol	I/O	Description
1	GND	P	Power Ground
2	VDD	P	Power supply voltage(Typical +5V)
3	VADJ	P	VOP adjust control pin
4	RS	I	H : D0~D7 are Display Data; L : D0~D7 are Instructions
5	WR	I	Selects read or write
6	RD	I	Read execution input signal
7	D0	I/O	8-bit parallel Databus--bit0(Low)
8	D1	I/O	8-bit parallel Databus—bit1
9	D2	I/O	8-bit parallel Databus—bit2
10	D3	I/O	8-bit parallel Databus—bit3
11	D4	I/O	8-bit parallel Databus—bit4
12	D5	I/O	8-bit parallel Databus—bit5
13	D6	I/O	8-bit parallel Databus—bit6
14	D7	I/O	8-bit parallel Databus—bit7
15	CS	I	Chip Enable Signal (Low active)
16	RST	I	Reset Execution inut Signal (Low active)
17	VEE	P	Positive voltage supply for LCD(Typical 21.6V),
18	NC	---	No connection
19	NC	---	No connection
20	NC	---	No connection

7 Instruction Code & Timing characteristics

7.1 Instruction Table

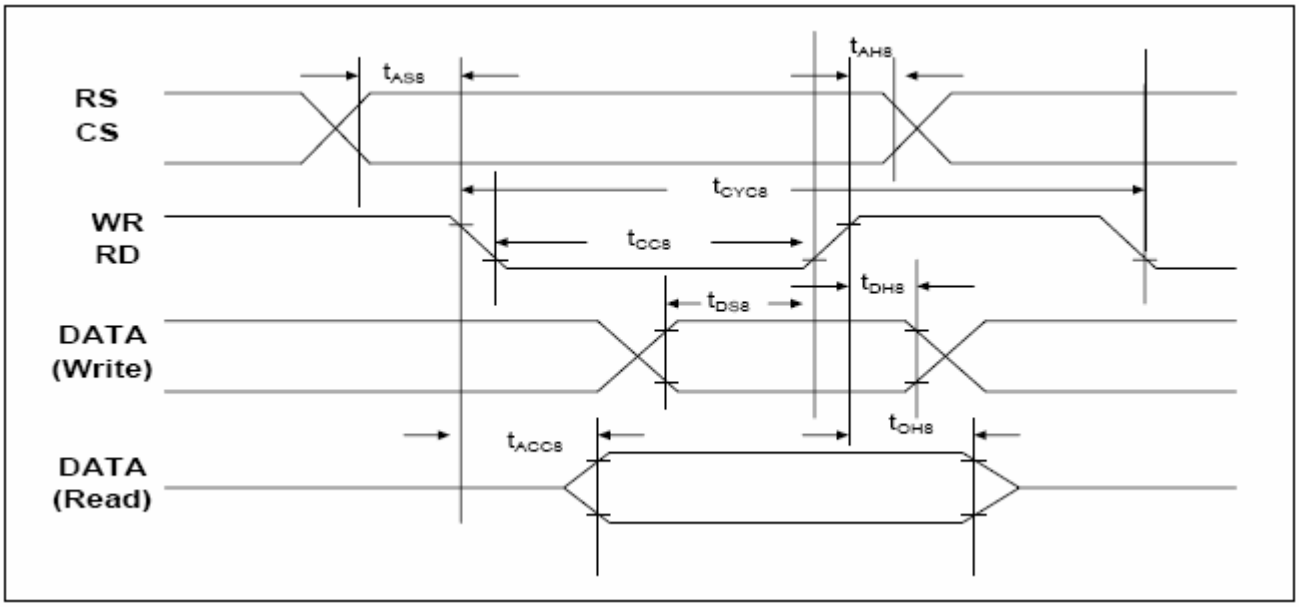
This module, MI320240C-G , with a controller of RA8806, needs to be set up some registers after reset execution. The registers and its function are listed in the table below. More details please refer to the datasheet of RA8806.

REG#	Name	D7	D6	D5	D4	D3	D2	D1	D0	Default
--	STATUS	MBUSY	SBUSY	SLEEP			WAKE_STS	KS_STS	TP_STS	--
00h	WLCR	PWR	LINEAR	SRST	--	TEXT_MD	ZDOFF	GBLK	GINV	00h
01h	MISC	NO_ FLICKER	CLKO_SEL	BUSY_ LEV	INT_LEV	XCK_SEL1	XCK_SEL0	SDIR	CDIR	04h
03h	ADSR	SCR_PEND	--	--	--	BIT_INV	SCR_DIR	SCR_HV	SCR_EN	00h
0Fh	INTR	--	WAKI_EN	KEYI_EN	TPI_EN	TP_ACT	WAK_STS	KEY_STS	TP_STS	00h
10h	WCCR	CUR_INC	FULL_OFS	BIT_REV	BOLD	T90DEG	CUR_EN	CUR_BLK	---	00h
11h	CHWI	CURH3	CURH2	CURH1	CURH0	ROWH3	ROWH 2	ROWH 1	ROWH 0	00h
12h	MAMR	CUR_HV	DISPMD2	DISPMD1	DISPMD0	L_MIX1	L_MIX 0	MW_MD1	MW_MD0	11h
20h	AWRR	--	--	AWR5	AWR4	AWR3	AWR2	AWR1	AWR0	27h
21h	DWWR	--	--	DWW5	DWW 4	DWW 3	DWW 2	DWW 1	DWW 0	27h
30h	AWBR	AWB7	AWB6	AWB5	AWB4	AWB3	AWB2	AWB1	AWB0	EFh
31h	DWHR	DWH7	DWH6	DWH5	DWH4	DWH3	DWH2	DWH1	DWH0	EFh
40h	AWLR	--	--	AWL5	AWL4	AWL3	AWL2	AWL1	AWL0	00h
50h	AWTR	AWT7	AWT6	AWT5	AWT4	AWT3	AWT2	AWT1	AWT0	00h
60h	CURX	--	--	CURX5	CURX4	CURX3	CURX2	CURX1	CURX0	00h
61h	BGSG	--	--	BGSG5	BGSG4	BGSG3	BGSG2	BGSG1	BGSG0	00h
62h	EDSG	EDSG7	EDSG6	EDSG5	EDSG4	EDSG3	EDSG2	EDSG1	EDSG0	00h
70h	CURY	CURY7	CURY6	CURY5	CURY4	CURY3	CURY2	CURY1	CURY0	00h
71h	BGCM	BGCM7	BGCM6	BGCM5	BGCM4	BGCM3	BGCM2	BGCM1	BGCM0	00h
72h	EDCM	EDCM7	EDCM6	EDCM5	EDCM4	EDCM3	EDCM2	EDCM1	EDCM0	00h
80h	BTMR	BLKT7	BLKT6	BLKT5	BLKT4	BLKT3	BLKT2	BLKT1	BLKT0	00h
90h	ITCR	ITC7	ITC6	ITC5	ITC4	ITC3	ITC2	ITC1	ITC0	00h
A0h	KSCR1	KEY_EN	KEY4X8	KSAMP1	KSAMP0	LKEY_EN	KF2	KF1	KF0	00h
A1h	KSCR2	KWAK_EN	--	--	--	LKEY_T1	LKEY_T0	KEYNO1	KEYNO0	00h
A2h	KSDR0	KSD07	KSD06	KSD05	KSD04	KSD03	KSD02	KSD01	KSD00	00h
A3h	KSDR1	KSD17	KSD16	KSD15	KSD14	KSD13	KSD12	KSD11	KSD10	00h
A4h	KSDR2	KSD27	KSD26	KSD25	KSD24	KSD23	KSD22	KSD21	KSD20	00h
B0h	MWCR	MWD7	MWD6	MWD5	MWD4	MWD3	MWD2	MWD1	MWD0	--
B1h	MRCR	MRD7	MRD6	MRD5	MRD4	MRD3	MRD2	MRD1	MRD0	--

REG#	Name	D7	D6	D5	D4	D3	D2	D1	D0	Default
C0h	TPCR1	TP_EN	TP_SMP2	TP_SMP1	TP_SMP0	TPWAK _EN	ACLK2	ACLK1	ACLK0	00h
C1h	TPXR	TPX9	TPX8	TPX7	TPX6	TPX5	TPX4	TPX3	TPX2	00h
C2h	TPYR	TPY9	TPY8	TPY7	TPY6	TPY5	TPY4	TPY3	TPY2	00h
C3h	TPZR	TPX1	TPX0	--	--	TPY1	TPY0	--	--	00h
C4h	TPCR2	MTP_MD	--	--	--	--	--	MTP_PH1	MTP_PH2	00h
D0h	PCR	PWM_EN	PWM_DIS_ LEV	--	--	PCLK_R3	PCLK_R2	PCLK_R1	PCLK_R0	00h
D1h	PDCR	PDUTY7	PDUTY6	PDUTY5	PDUTY4	PDUTY3	PDUTY2	PDUTY1	PDUTY0	00h
E0h	PNTR	PND7	PND6	PND5	PND4	PND3	PND2	PND1	PND0	00h
F0h	FNCR	ISO8859_E N	--	--	--	MCLR	ASC	ASC_SEL1	ASC_SEL0	00h
F1h	FVHT	FH1	FH0	FV1	FV0	--	--	--	--	00h

7.2 Interface Timing characteristics

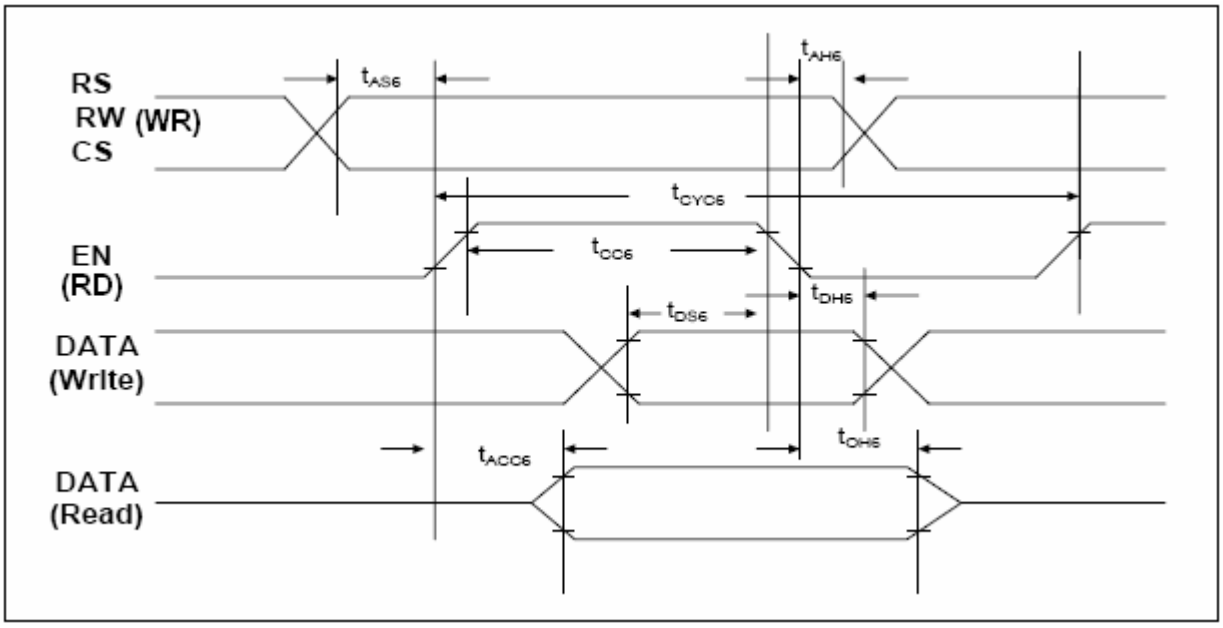
Note: More details please refer to the datasheet of RA8806.



8080 MPU Interface Waveform

Symbol	Description	Rating		Unit	Condition
		Min.	Max.		
t_{CYC8}	Cycle time	2*tc	--	ns	tc = one system clock period
t_{CC8}	Strobe Pulse width	50	--	ns	
t_{AS8}	Address setup time	0	--	ns	
t_{AH8}	Address hold time	20	--	ns	
t_{DS8}	Data setup time	30	--	ns	
t_{DH8}	Data hold time	20	--	ns	
t_{ACC8}	Data output access time	0	20	ns	
t_{OH8}	Data output hold time	0	10	ns	

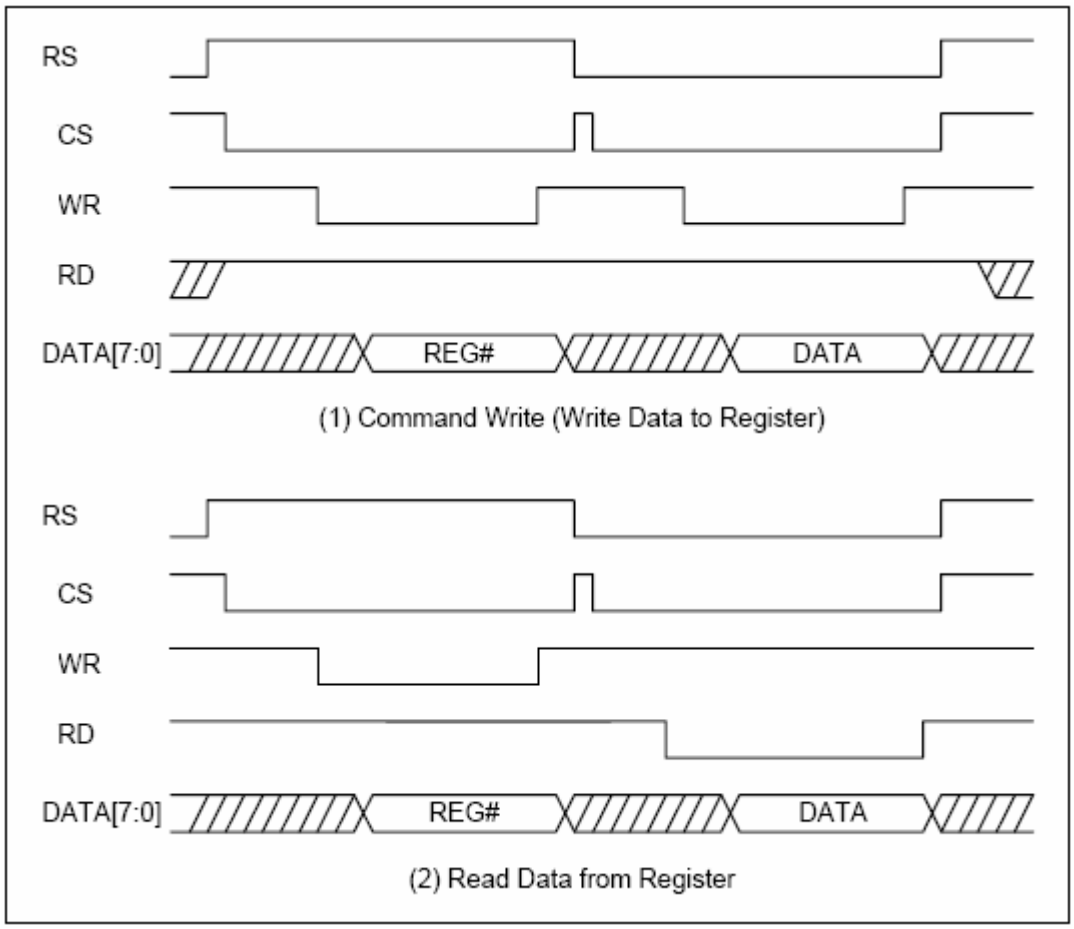
8080 MPU Interface Timing



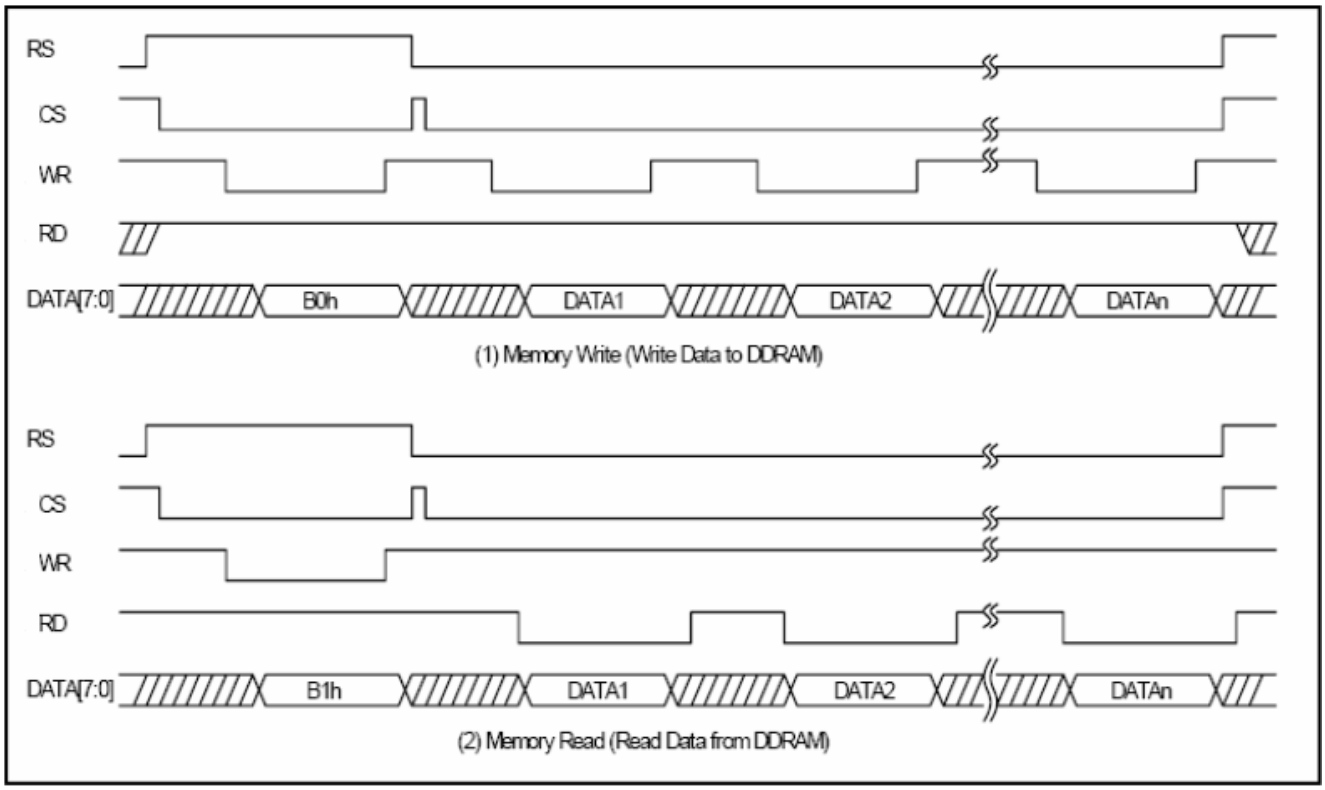
6800 MPU Interface Waveform

Symbol	Description	Rating		Unit	Condition
		Min.	Max.		
t_{CYC6}	Cycle time	2*tc	--	ns	tc = one system clock period
t_{CC6}	Strobe Pulse width	50	--	ns	
t_{AS6}	Address setup time	0	--	ns	
t_{AH6}	Address hold time	20	--	ns	
t_{DS6}	Data setup time	30	--	ns	
t_{DH6}	Data hold time	20	--	ns	
t_{ACC6}	Data output access time	0	20	ns	
t_{OH6}	Data output hold time	0	10	ns	

6800 MPU Interface Timing

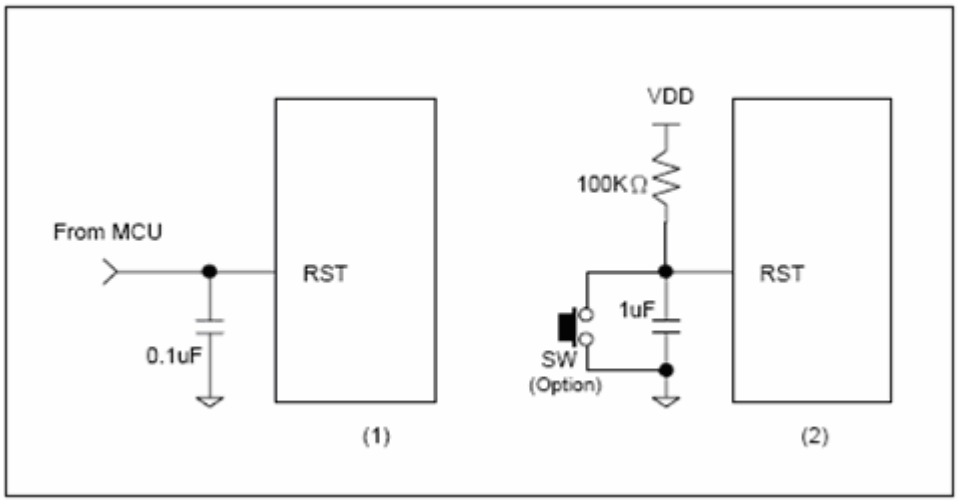


Command Write and Register Read Cycle

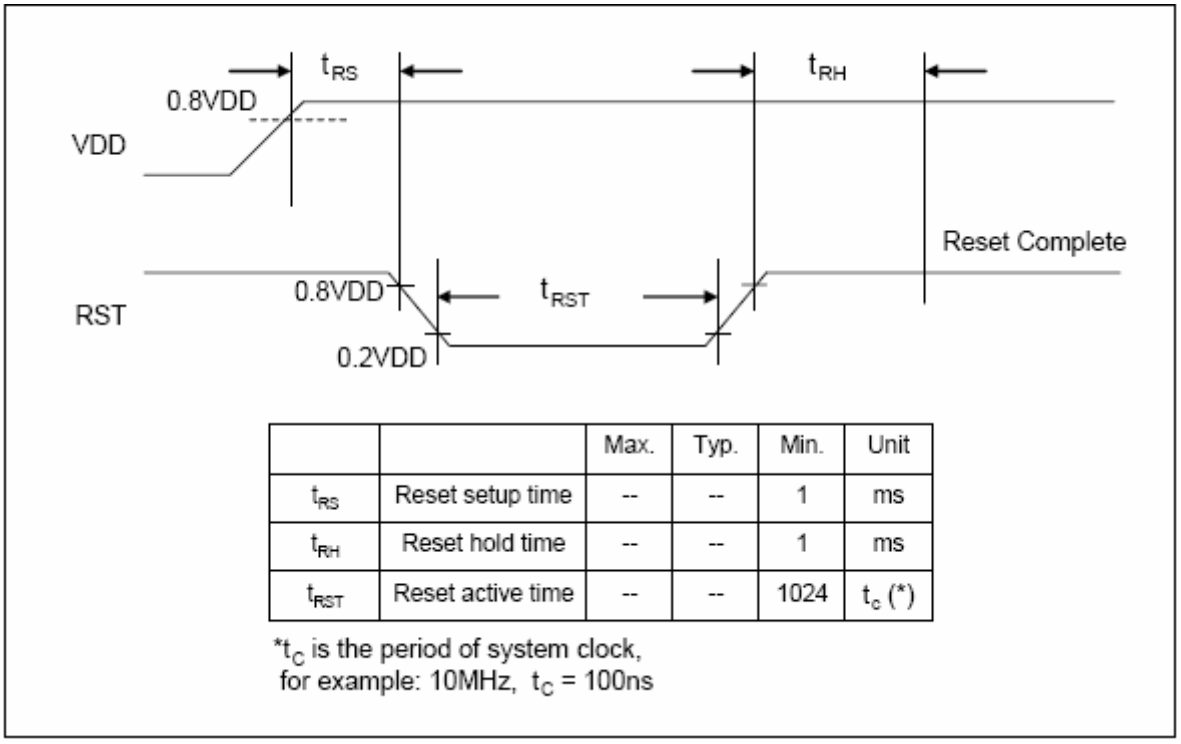


Memory Write and Read Cycle

7.3 Reset Timing



Examples of RST PIN



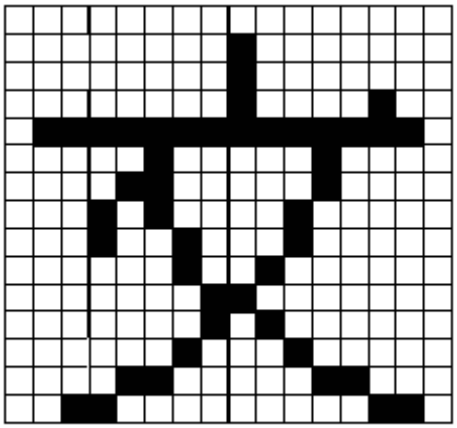
		Max.	Typ.	Min.	Unit
t_{RS}	Reset setup time	--	--	1	ms
t_{RH}	Reset hold time	--	--	1	ms
t_{RST}	Reset active time	--	--	1024	t_c (*)

*t_C is the period of system clock,
for example: 10MHz, t_C = 100ns

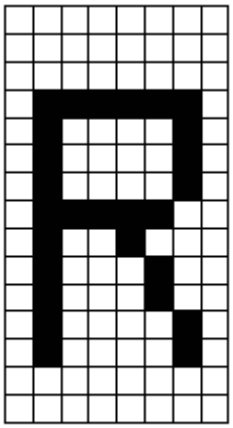
Reset Timing

7.4 Display Font

There are two modes for MPU to write data to this module, character mode and graphic mode. In graphic mode, data is directly written to DDRAM in bit-map format. In character mode, data is written in code format, the font bit-map in the CGROM will be written to DDRAM by this way. The controller RA8806 stores two different sizes of characters in its font ROM: Half size font(8×16pixels) and full size font(16×16), as shown below.



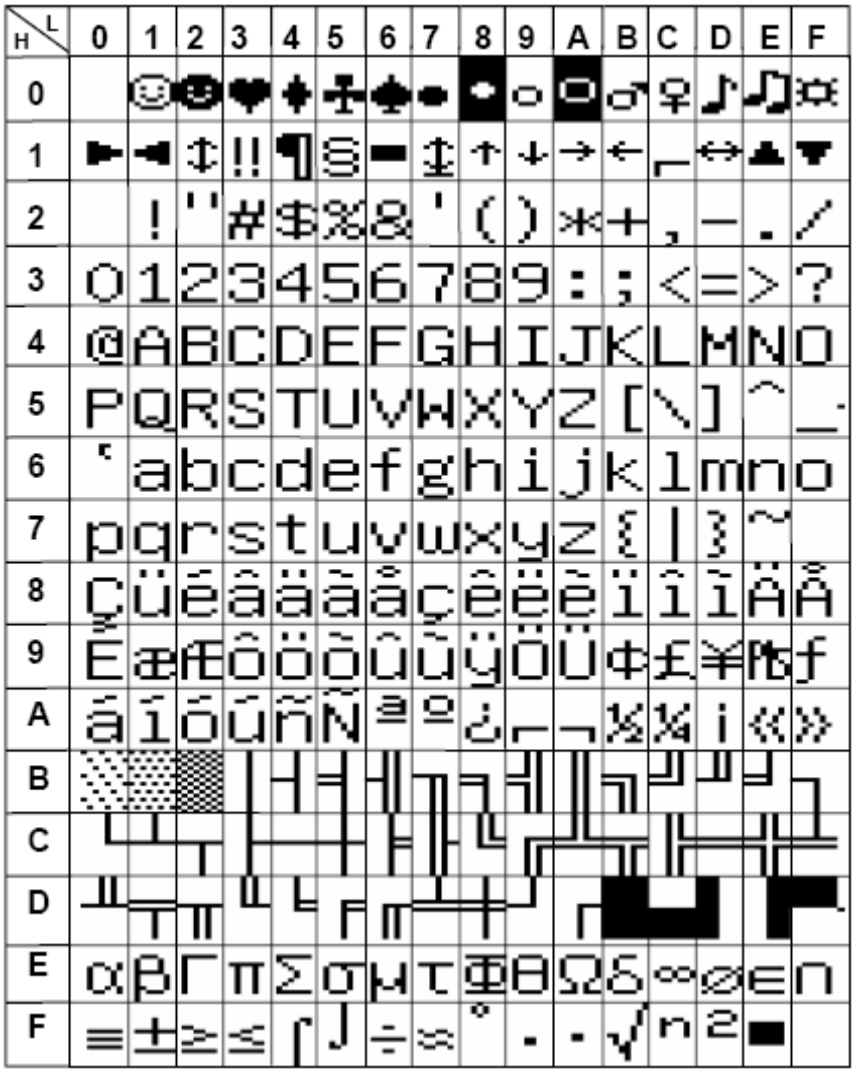
16X16 font



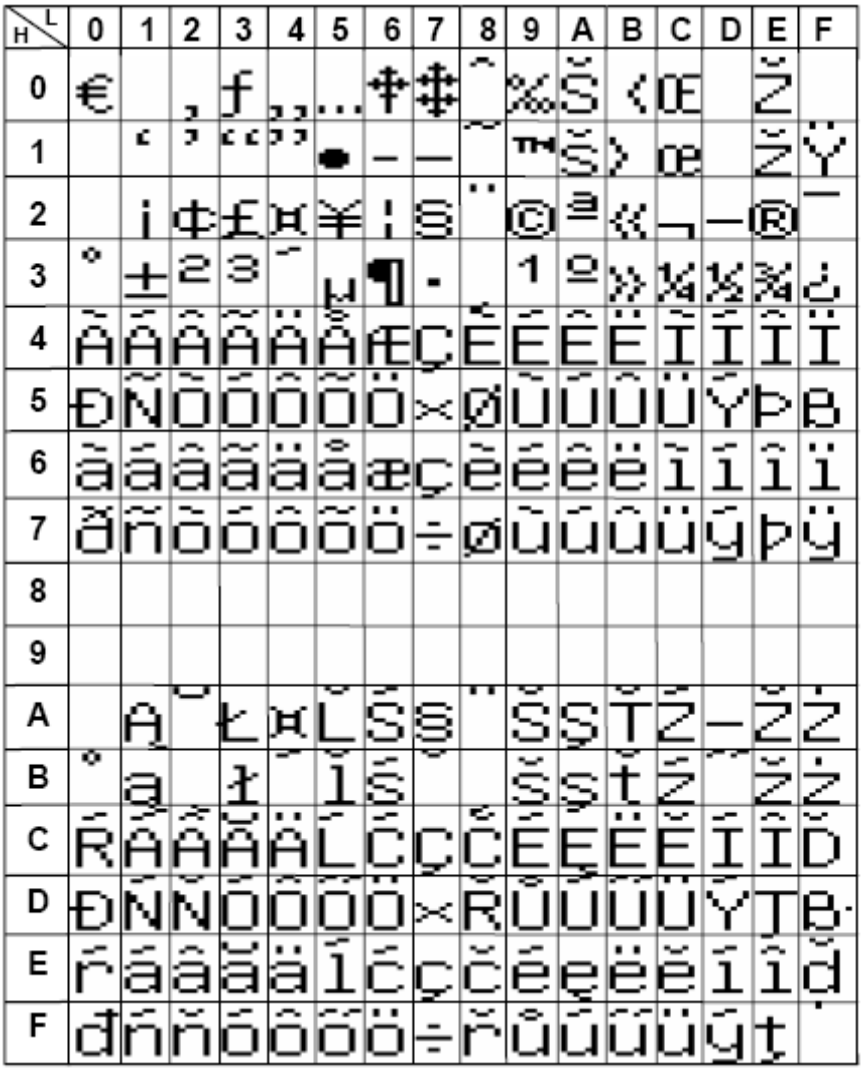
8X16 font

Full Size and Half Size Font

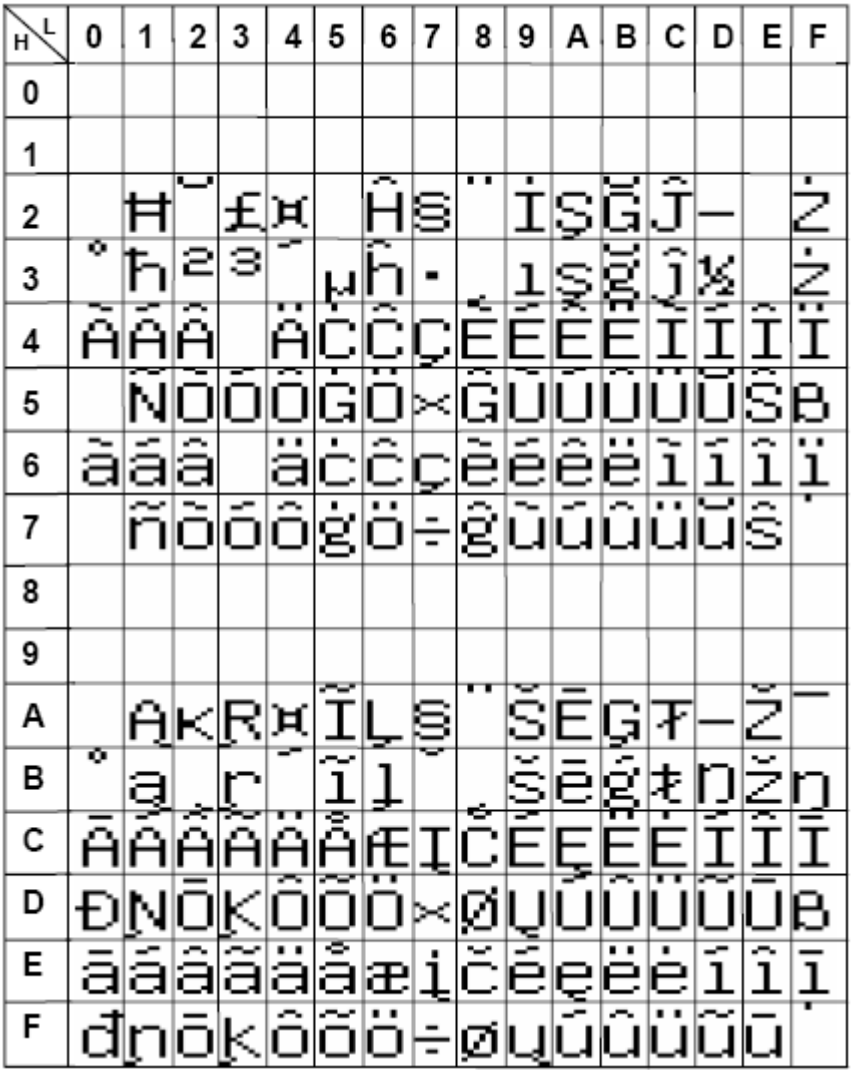
It has 8 selectable ASCII Font Tables and a GB Code, The ASCII Font Tables is shown below. When we want to display the simple Chinese character, we can look for it in the appendix of the datasheet of RA8806.



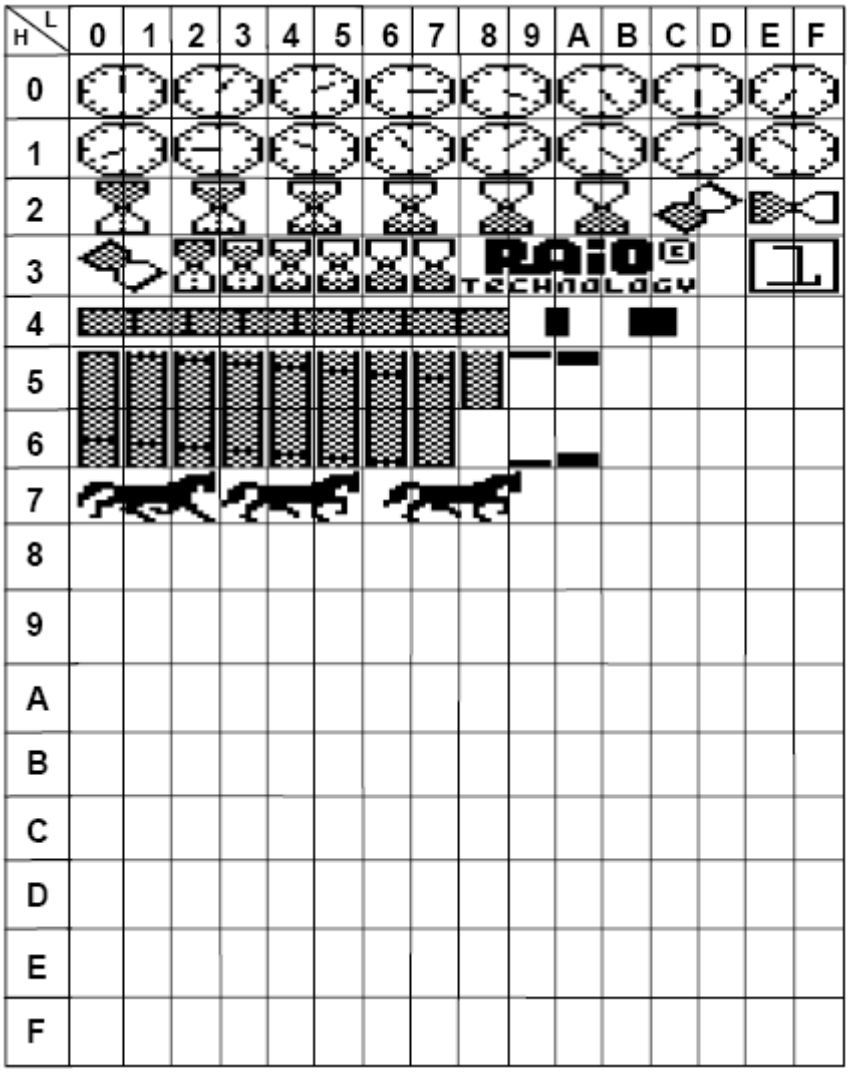
ASCII Font Table 1



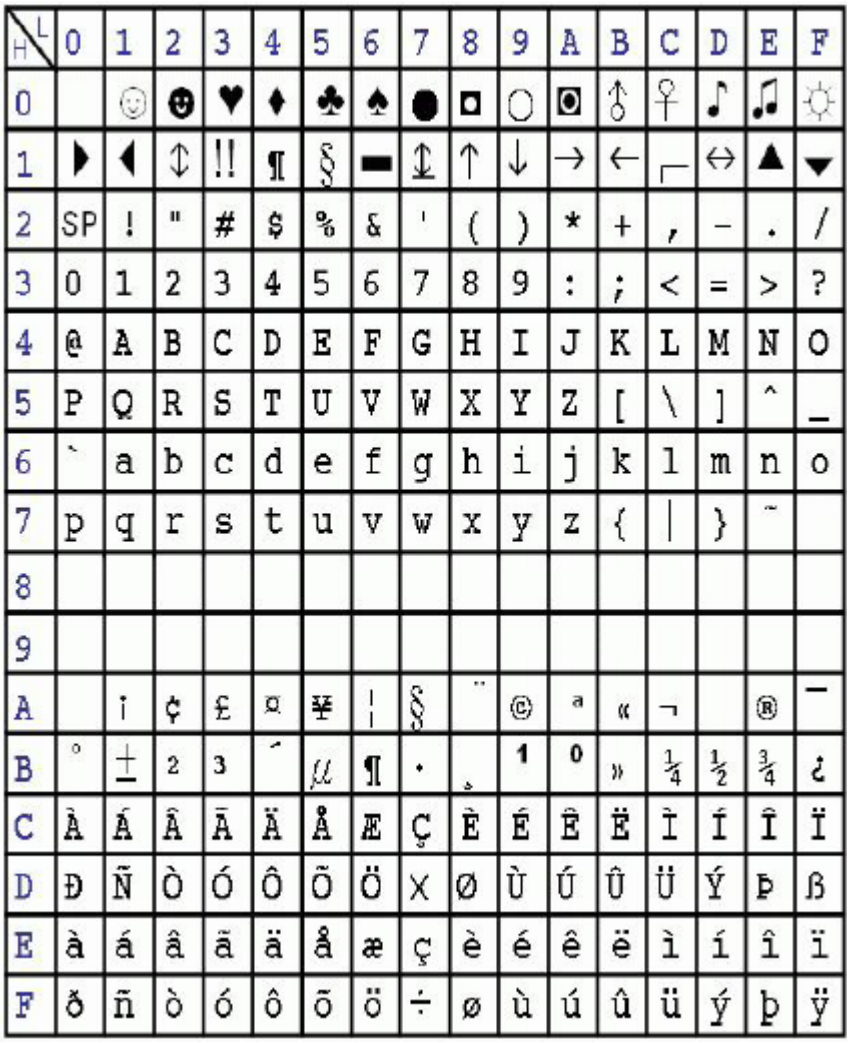
ASCII Font Table 2



ASCII Font Table 3

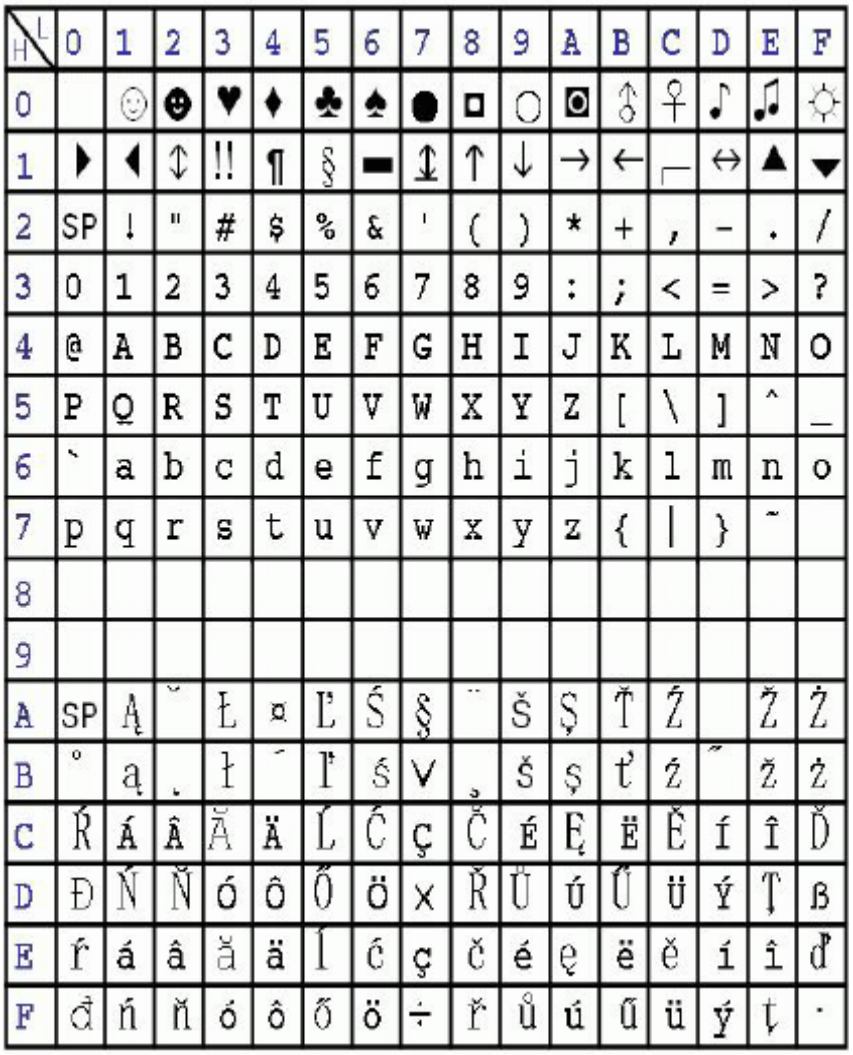


ASCII Font Table 4



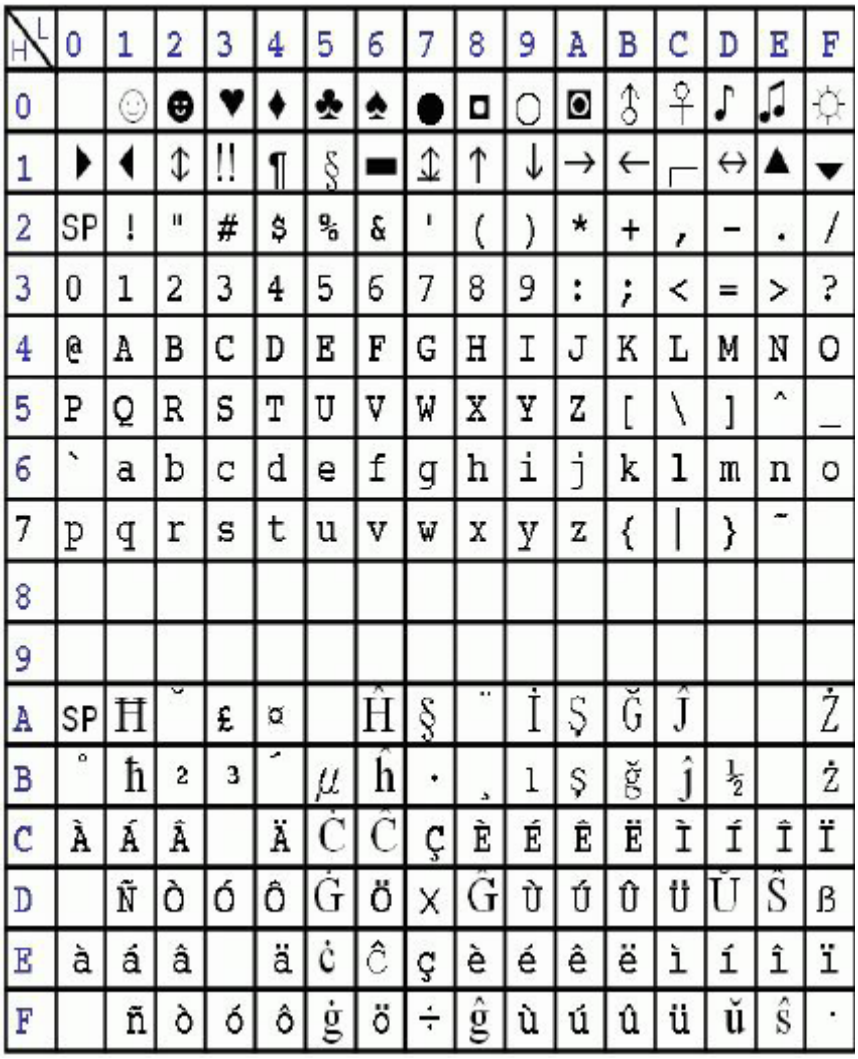
H \ L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		☺	☻	♥	♦	♣	♠	●	◘	○	◙	♂	♀	♪	♫	☼
1	►	◄	↕	!!	¶	§	▬	↨	↑	↓	→	←	∟	↔	▲	▼
2	SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	
8																
9																
A		¡	¢	£	¤	¥	¦	§	¨	©	ª	«	¬		®	¯
B	°	±	²	³	´	µ	¶	·	¸	¹	º	»	¼	½	¾	¿
C	À	Á	Â	Ã	Ä	Å	Æ	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
D	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß
E	à	á	â	ã	ä	å	æ	ç	è	é	ê	ë	ì	í	î	ï
F	ð	ñ	ò	ó	ô	õ	ö	÷	ø	ù	ú	û	ü	ý	þ	ÿ

ASCII Font Table 5



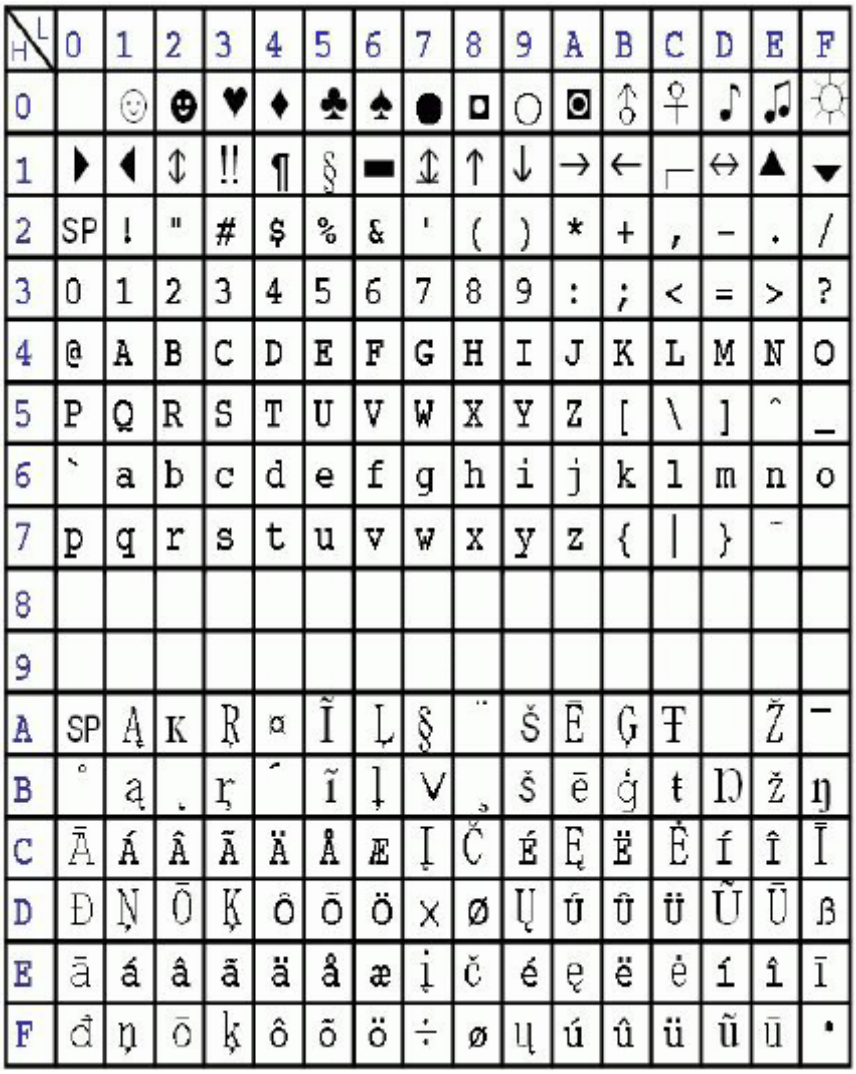
H \ L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		☺	☻	♥	♦	♣	♠	●	◘	○	◙	♂	♀	♪	♫	☼
1	►	◄	↕	‼	¶	§	▬	↨	↑	↓	→	←	∟	↔	▲	▼
2	SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	
8																
9																
A	SP	Ą	˘	Ł	¤	Ľ	Ś	§	¨	Š	Ş	Ť	Ź		Ž	Ż
B	°	ą	˛	ł	´	ľ	ś	ˇ	¸	š	ş	ť	ź	˝	ž	ż
C	Ŕ	Á	Â	Ă	Ä	Ĺ	Ć	Ç	Č	É	Ę	Ë	Ě	Í	Î	Ď
D	Đ	Ń	Ň	Ó	Ô	Ő	Ö	×	Ř	Ů	Ú	Ű	Ü	Ý	Ţ	ß
E	ŕ	á	â	ă	ä	ĺ	ć	ç	č	é	ę	ë	ě	í	î	ď
F	đ	ń	ň	ó	ô	ő	ö	÷	ř	ů	ú	ű	ü	ý	ţ	˙

ASCII Font Table 6



H\L	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		☺	☻	♥	♦	♣	♠	●	◘	○	◙	♂	♀	♪	♫	☼
1	►	◄	↕	‼	¶	§	▬	↨	↑	↓	→	←	∟	↔	▲	▼
2	SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	
8																
9																
A	SP	Ħ	˘	£	¤		Ĥ	Ş	¨	İ	Ş	Ğ	Ĵ			Ż
B	°	ħ	2	3	´	μ	ĥ	·	¸	1	ş	ğ	ĵ	½		ż
C	À	Á	Â		Ä	Ċ	Ć	Ç	È	É	Ê	Ë	Ì	Í	Î	Ï
D		Ñ	Ò	Ó	Ô	Ġ	Ö	×	Ğ	Ù	Ú	Û	Ü	Ŭ	Ş	ß
E	à	á	â		ä	ċ	ĉ	ç	è	é	ê	ë	ì	í	î	ï
F		ñ	ò	ó	ô	ġ	ö	÷	ĝ	ù	ú	û	ü	ŭ	ş	˙

ASCII Font Table 7



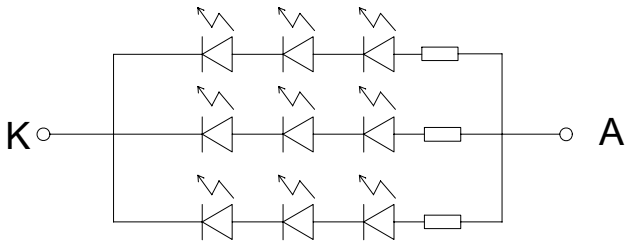
ASCII Font Table 8

8 Electrical characteristics

（GND=0V, Ta=25℃）

Parameter		Symbol	Condition	MIN	TYP	MAX	UNIT
Logic Circuit Supply Voltage		VDD	---	4.5	5.0	5.5	V
Power Supply LCD(+)		VEE	---	---	+21.6	---	
Input Voltage for Logic Circuit	“H” level	V_{IH}	VDD=5.0V	0.8VDD	VDD	VDD+0.5	
	“L” level	V_{IL}		---	GND	0.2VDD	
Output Voltage for Logic Circuit	“H” level	V_{OH}		0.8VDD	VDD	VDD+0.5	
	“L” level	V_{OL}		---	GND	0.2VDD	
Logic Power Supply Current (Without Backlighting)		I_{CC}		---	(TBD)	---	mA
Controller and Driver		RA8806(Controller)+NT7701(Driver)+NT7702(Driver)					

9 LED backlight characteristics



CIRCUIT DIAGRAM

（Ta=25℃）

Item	Symbol	Condition	MIN.	TYP.	MAX.	Unit
Forward voltage	V_F	I_F =60mA	9.3	10	10.5	V
Forward current	I_F	V_F = 10V	---	60	---	mA
Reverse voltage	V_r	---	---	---	10	V
Reverse Current	I_r	---	---	---	---	uA
Luminous intensity*	Bp	I_f =60mA	600	900	---	cd/m^2
Luminous Uniformity*	△Bp		70	---	---	%
Color coordinate*	X		0.27	---	0.32	---
	Y		0.27	---	0.32	---

Note:

- Measured at the bare LED backlight unit.
- If the backlight is above these maximum ratings for long time, the service life of the LED backlight will reduce or it will cause poor reliability.

10 Optical Characteristics

10.1 Optical Characteristics

Parameter		Symbol	Ratings			Unit	Measuring Temp.	Reference
			Min	Type	Max.			
Operating voltage		V_{OP}		(TBD)		V	0℃	〔Note10-1〕
				21.6			25℃	
				(TBD)			50℃	
Frame frequency		f		(TBD)		Hz		〔Note10-2〕
Contrast ratio		Cr(θ=20°, Φ=90° or 270°)	---	(TBD)	---	---	25℃	〔Note10-3〕
Response time	Turn on	t_{on}	---	(TBD)	---	ms	25℃	〔Note10-4〕
			---	(TBD)	---		0℃	
	Turn off	t_{off}	---	(TBD)	---	ms	25℃	
			---	(TBD)	---		0℃	
Viewing angle (Cr≥2)	Up-down	θ1 (Φ=90° or	---	(TBD)	---	deg	25℃	〔Note10-5〕
	Left-right	θ2 (Φ=0° or 180°)	---	(TBD)	---	deg	25℃	

〔Note10-1〕The maximum and minimum ratings don't mean the LCD works well in the whole range of V_{OP}. V_{OP} must be adjusted to optimize the viewing angle and contrast. Refer to definition of drive voltage, refer to 10.2.

〔Note10-2〕The frequency shouldn't be too low to avoid flicker. Refer to definition of drive voltage, refer to 10.2.

〔Note10-3〕Refer to 10.2/10.3/10.4/10.5.

〔Note10-4〕The selected state is dark and non-selected state is white(or bright) with positive type, reversely the selected state is white (or bright) and non-selected state is dark with negative type. Refer to 10.6 definition of response time.

〔Note10-5〕Generally the viewing direction is 6:00 or12:00, sometimes 3:00 or 9:00. The range of left to right and up to down based on Cr=2 show the viewing angle. Viewing angle range isn't the range of defects inspection. Refer to 10.4.

10.2 Definition of drive voltage

(1) Definition of drive voltage and waveform

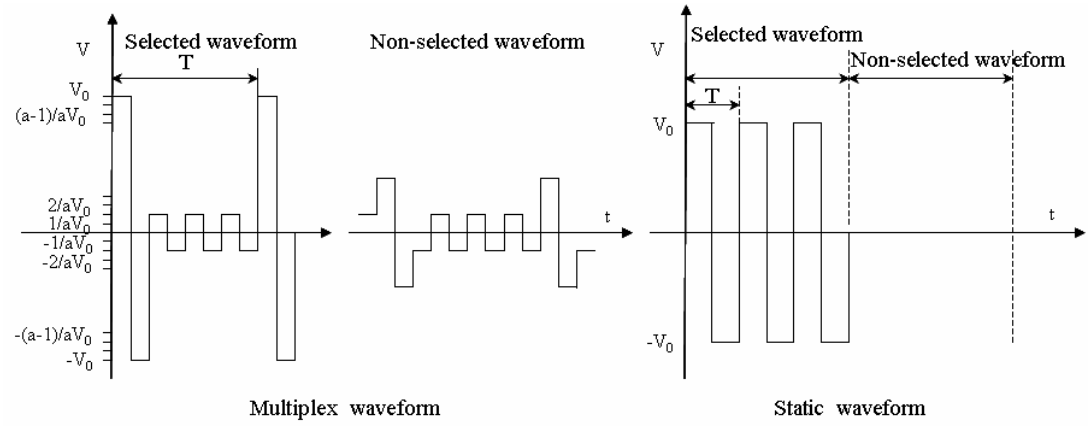


Fig.1 Definition of drive voltage and waveform

Operating voltage: V_o Frame frequency: f=1/T

Duty: 1/N Bias: 1/a

(2) Operating voltage: $V_{OP}(V_O)$

MULTI-INNO can evaluate whether the LCD can be redesigned to obtain customer preferable performance if customer's LCD drive voltage isn't adjustable.

10.3 Optical characteristics measurement equipment and method

The setup and test method are showed in fig.2. Test methods are different according to different illumination mode.

Transmissive mode: light resource is placed at the back of LCD.

Reflective mode and transflective mode: light resource is placed at the front side of LCD.

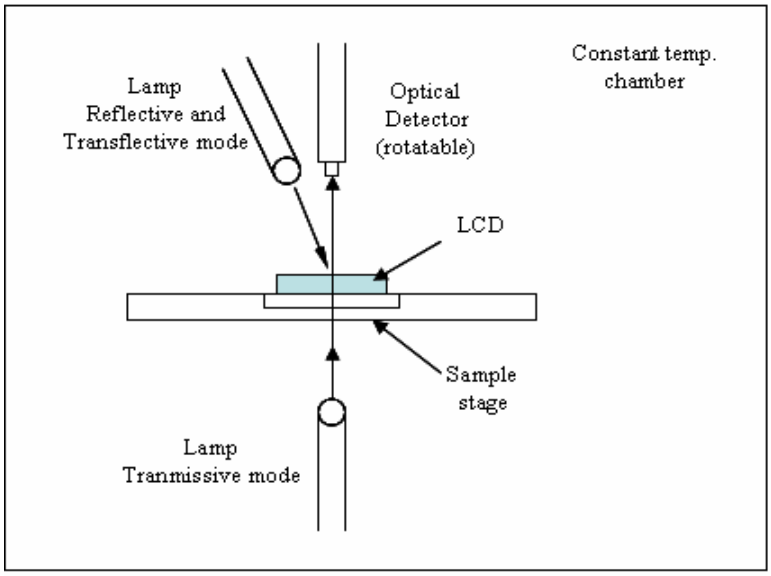


Fig.2 Optical characteristics measurement equipment

The chamber temperature, light resource and driving signal should be stable before testing. If test the characteristics under high or low temperature, the test system should be stable for more than 10 minutes

before testing.

10.4 Definition of viewing direction

Refer to the graph below marked by θ and Φ

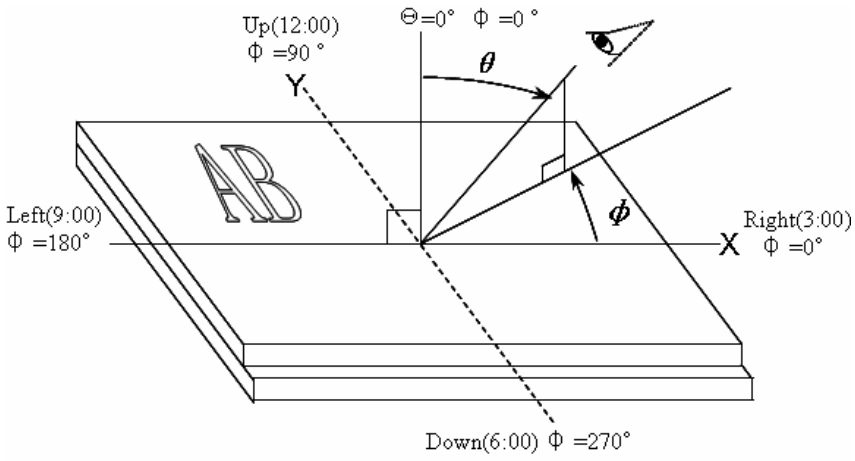


Fig.3 Definition of viewing direction

10.5 Definition of contrast ratio

Contrast ratio can be calculated by the formula (10-1) below for positive type. If the LCD is negative type, Cr (θ, Φ) is equal to luminance (θ, Φ, non-selected state) divided by luminance (θ, Φ, selected state). Note3-4 shows the relationship between selected state, non-selected state and bright state, dark state.

$$Cr(\theta,\phi)=\frac{L_2}{L_1}=\frac{\text{Luminance}(\theta,\phi)\ (\text{Bright state})}{\text{Luminance}(\theta,\phi)\ (\text{Dark state})} \qquad (10\text{-}1)$$

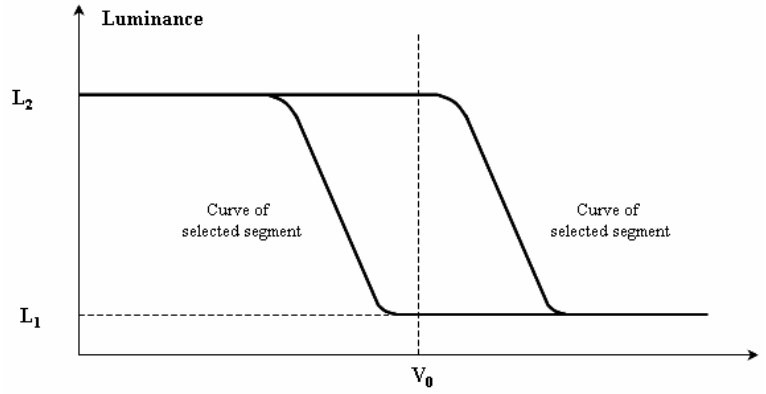


Fig.4 Electro-optical characteristic (EOC) graph (positive type)

10.6 Definition of response time

Turn on time (rise time): $t_{on}= t_d + t_r$ (from non-selected state to selected state)

Turn off time (fall time): $t_{off}=t_D + t_R$ (from selected state to non-selected state)

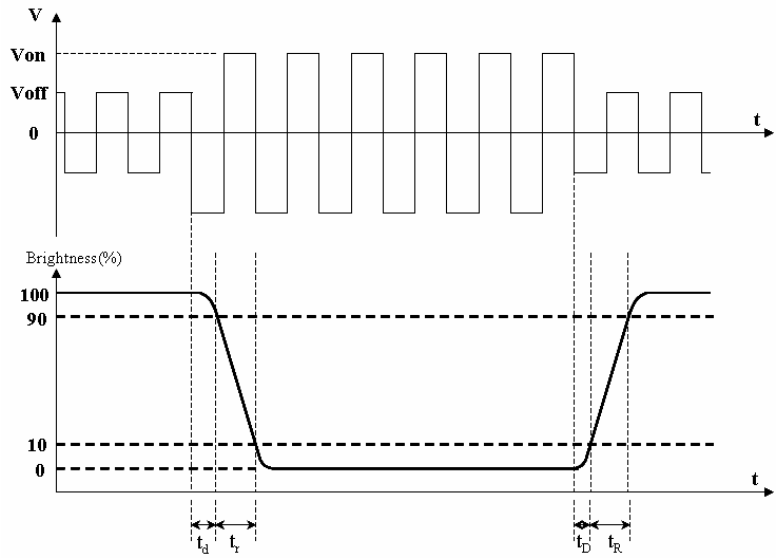


Fig.5 Definition of response time (positive type)

3.7 Definition of viewing angle

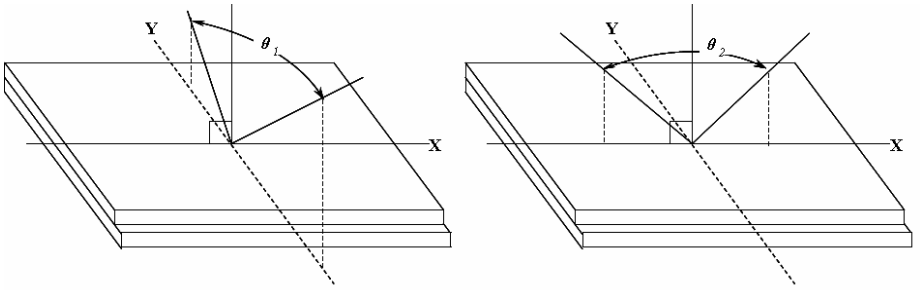


Fig 6 Definition of viewing angle

θ_1 ——range of viewing angle from up to down

θ_2 ——range of viewing angle from left to right.

11 Reliability

11.1 Content of Reliability Test

Ta=25℃

No	Test Item	Test condition	Criterion
1	High Temperature Storage	80℃±2℃ 120H Restore 2H at 25℃ Power off	After testing, cosmetic and electrical defects should not happen.
2	Low Temperature Storage	-30℃±2℃ 120H Restore 2H at 25℃ Power off	
3	High Temperature Operation	70℃±2℃ 120H Restore 2H at 25℃ Power on	
4	Low Temperature Operation	-20℃±2℃ 120H Restore 4H at 25℃ Power on	
5	High Temperature & Humidity Operation	60℃±2℃ 90%RH 120H Power on	
6	Temperature Cycle	−30℃←→25℃←→80℃ 30min 5min 30min after 10cycle, Restore 2H at 25℃ Power off	
7	Vibration Test	10Hz~150Hz, 100m/s^2, 120min/X、Y、Z	
8	Shock Test	Half-sine wave,300m/s^2,18ms	
9	Drop Test(package state)	800mm, concrete floor,1corner, 3edges, 6 sides each time	1.After testing, cosmetic and electrical defects should not happen. 2.the product should remain at initial place 3.Product uncovered or package broken is not permitted.

Notes:

1. Each test item applies for a test sample only once, The test sample can not be used again in any other test item.
2. The test sample is inspected after 2 hours or more storing at room temperature and room humidity after each test item is finished.
3. The criteria refer to 11.2.

11.2 Inspection of criteria

Remark NO.	Content
1	Functional test is OK. Missing Segment, shorts, unclear segment, nondisplay, display abnormally, liquid crystal leak are unallowable.
2	After testing, cosmetic defects should not happen, no low temperature bubbles, seal loose and fall, frame rainbow, ACF bubble growing are unallowable in the appearance test.
3	Total current consumption should not be over 10% of initial value.
4	After tests being executed, Contrast must be larger than 70% of its initial value prior to the tests.
5	No glass crack, chipped glass, end seal loose frame crack and so on.
6	No structure loose and fall.

12 Package

(TBD)

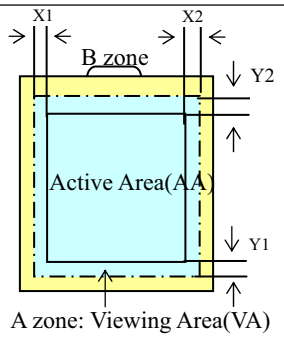
13 Quality level

13.1 Classification of defects

Major defects (MA): A major defect refers to a defect that may substantially degrade usability for product applications, including all functional defects (such as no display, abnormal display, open or missing segment, short circuit, missing component), outline dimension beyond the drawing, progressive defects and those affecting reliability.

Minor defects (MI): A minor defect refers to a defect which is not considered to be able to substantially degrade the product application or a defect that deviates from existing standards almost unrelated to the effective use of the product or its operation, such as black spot, white spot, bright spot, pinhole, black line, white line, contrast variation, glass defect, polarizer defect, etc.

13.2 Definition of inspection range

For LCD defects, dividing two areas to make a judgment (according figure 1). A zone : Inside Viewing area B zone : Outside Viewing area X1(A.A~V.A): 1.5mm X2(A.A~V.A): 1.5mm Y1(A.A~V.A): 1.5mm Y2(A.A~V.A): 1.5mm	 Figure 1

13.3 Inspection items and general notes

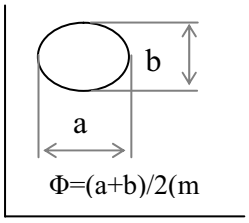
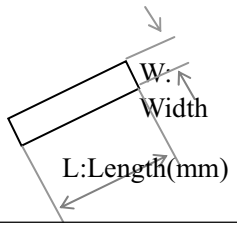
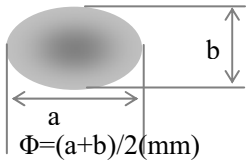
General notes	①Should any defects which are not specified in this standard happen, additional standard shall be determined by mutual agreement between customer and Multi-inno. ②Viewing area should be the area which Multi-inno guarantees. ③Limit sample should be prior to this Inspection standard. ④Viewing judgment should be under static pattern. ⑤Inspection conditions Inspection distance: 250 mm (from the sample) Temperature : 25±5 ºC Inspection angle : 45 degrees in 6 o'clock direction (all defects in viewing area should be inspected from this direction)	
Inspection items	Pinhole, Bright spot, Black spot, White spot, Black line, White Line, Foreign particle, Bubble	The color of a small area is different from the remainder. The phenomenon doesn't change with voltage
	Contrast variation	The color of a small area is different from the remainder. The phenomenon changes with voltage
	Polarizer defect	Scratch, Dirt, Particle, Bubble on polarizer or between polarizer and glass
	Functional defect	no display, display abnormally, open or missing segment, short circuit, False viewing direction
	Glass defect	Glass crack, Shaved corner of glass, Surplus glass

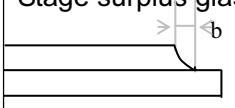
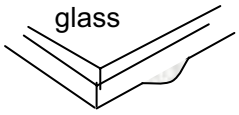
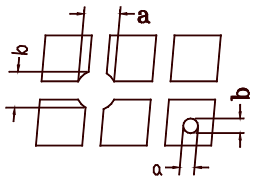
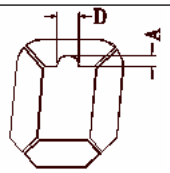
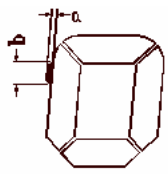
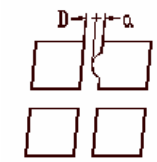
	Segment defect	Pin holes or cracks in segment, Transformation of segment
	PCB defect	Components assembly defect

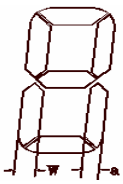
13.4 Outgoing Inspection level

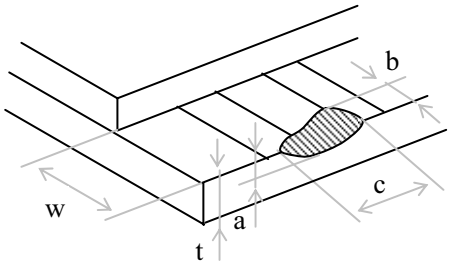
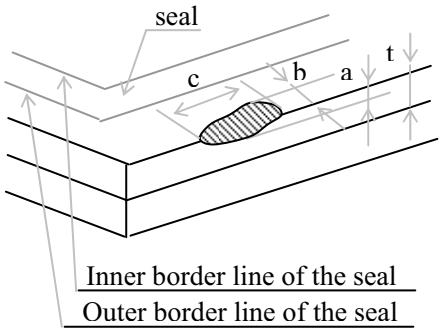
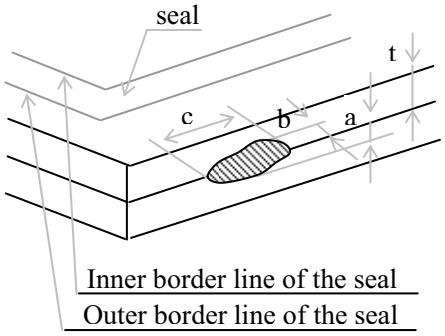
Outgoing Inspection standard	Inspection conditions	Inspection				
		Min.	Max.	Unit	IL	AQL
Major Defects	See 13.3 general notes	See 13.5			II	0.65
Minor Defects	See 13.3 general notes	See 13.5			II	1.5
Note：Sampling standard conforms to GB2828						

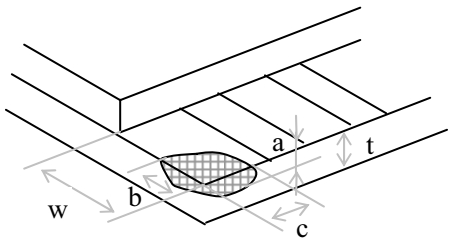
13.5 Inspection Items and Criteria

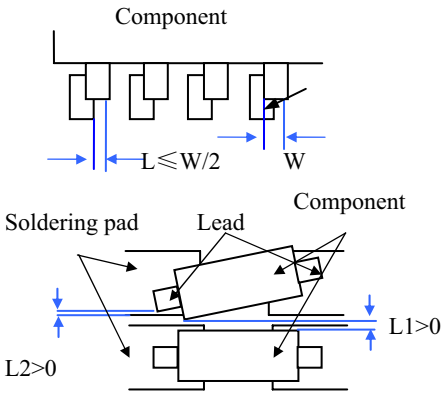
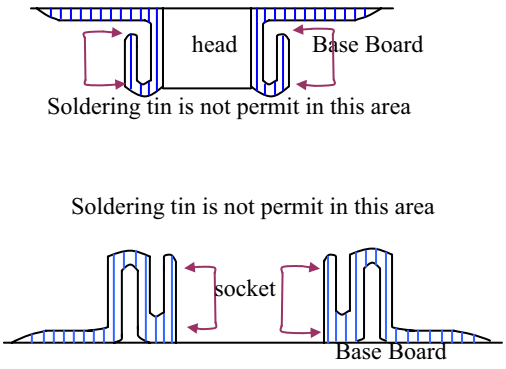
Inspection items			Judgment standard			
			Category		Acceptable number	
					A zone	B zone
1	Black spot,White spot, Bright Spot, Pinhole, Foreign Particle, Particle in or on glass, Scratch on glass		A	Φ≦0.10	Neglected	Neglected
			B	0.10<Φ≦0.20	3	
			C	0.20<Φ	0	
2	Black line, White line, Particle Between Polarizer and glass, Scratch on glass		A	W≦0.02	Neglected	Neglected
			B	0.02<W≦0.05 L≦3.0	3	
			C	W＞0.05 or L＞3.0	0	
3	Contrast variation		A	Φ≦0.2	Neglected	Neglected
			B	0.2<Φ≦0.3	2	
			C	0.3<Φ≦0.4	1	
			D	0.4<Φ	0	
			Total defective point(B,C)		3	
4	Bubble inside cell		any size		none	none
5	Polarizer defect (if Polarizer is used)	Scratch ,damage on polarizer, Particle on polarizer or between polarizer and glass.	Refer to item 1 and item 2.			
		Bubble, dent and	A	Φ≦0.3	Neglected	Neglected

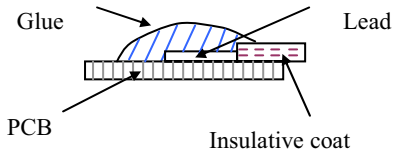
		convex	B	0.3<Φ≦0.7	2	d
			C	0.7<Φ	0	
6	Surplus glass	Stage surplus glass 	b≦0.3mm			
		Surrounding surplus glass 	Should not influence outline dimension and assembling.			
7	Open segment or open common		Not permitted			
8	Short circuit		Not permitted			
9	False viewing direction		Not permitted			
10	Contrast ratio uneven		According to the limit specimen			
11	Crosstalk		According to the limit specimen			
12	Black /White spot(display)		Refer to item 1			
13	Black /White line(display)		Refer to item 2			
14	Pin holes and cracks in segment		not counted	Max.3 dots allowed		Max.3 dots allowed
			x<0.1mm	0.1mm≤x≤0.2mm		
			x=(a+b)/2			
			not counted	Max.2 dots allowed each segment		
			A<0.1mm	0.1mm≤A≤0.2mm D<0.25mm		
15	Transformation of segment		not counted	Max.1 defect allowed each segment		Max.3 defects allowed
			x<0.1mm	0.1mm≤x≤0.2mm		
			x=(a+b)/2			
			not counted	Max.1 defect allowed each segment		
			a<0.1mm	0.1mm≤a≤0.2mm D>0		

			0.8W≤a≤1.2W a=measured value of width W=nominal value of width	Max.2 defects allowed

Inspection items			Judgment standard		
			Category(application: B zone)		Acceptable number
17	Glass defect crack	①The front of lead terminals 	A	a≤ t, b≤1/5W, c≤3mm	Max.3 defects allowed
			B	Crack at two sides of lead terminals should not cover patterns and alignment mark	
		②Surrounding crack—non-contact side 	b < Inner borderline of the seal		
		③ Surrounding crack— contact side 	b < Outer borderline of the seal		

		④Corner 	A	a ≦ t, b ≦ 3.0, c ≦ 3.0	
			B	Glass crack should not cover patterns u and alignment mark and patterns.	

Inspection items			Judgment standard Category(application: B zone)
18	PCB defect	Component soldering: No cold soldering、short、open circuit、burr、tin ball The flat encapsulation component position deviation must be less than 1/3 width of the pin (Pic.1); the sheet component deviation: Pin deviates from the pad and contact with the near components is not permitted（Pic.2）	
		lead defect: The lead lack must be less than 1/3 of its width; The lead burr must be less than 1/3 of the seam; Impurities connect with the near leads is not permitted	
		Connector soldering: Soldering tin is at contact position of the plug and socket is not permitted No foundation is scald Serious cave distortion on plug and socket contact pin is not permitted	

		Glue on root of the speaker receiver and motor lead: The insulative coat of the lead must join into the PCB; the protected glue must envelop to the insulative coat.	

14 Precautions for Use of LCD Modules

14.1 Handling Precautions

14.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.

14.1.2 Liquid in LCD is hazardous substance, if the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, thoroughly and promptly wash it off using soap and water.

14.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.

14.1.4 Don't touch, push or rub the exposed polarizer covering the display surface of the LCD module with anything harder than an HB pencil lead, the polarizer is soft and easily scratched, handle it carefully.

14.1.5 Don't put or attach anything on the display area to avoid leaving any marks on.

14.1.6 If the display surface is contaminated or becomes dusty, breathe on the surface and gently wipe it with a soft dry cloth. do not scrub hard to avoid damage the surface. If still not completely clear, moisten cloth with one of the following solvents:

— Isopropyl alcohol
— Ethyl alcohol

Solvents other than those mentioned above may damage the polarizer. Especially, do not use the following:

— Water
— Ketone
— Aromatic solvents

14.1.7 Do not attempt to disassemble the LCD Module.

14.1.8 If the logic circuit power is off, do not apply the input signals.

14.1.9 Avoid using the same display pattern long time (continous ON segment).Software must be prepared so that the pattern will be changed

14.1.10 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.

a. Be sure to ground the body and electric appliances when handling the LCD Modules. It is preferable to use conductive mat on table and wear cotton clothes or conductive processed fibre. Synthetic fibre is not recommended.

b. Tools required for assembly, such as soldering irons, must be properly ground.

c. To reduce the amount of static electricity generated, do not conduct assembly and other work under

dry conditions.

d. The LCD Module is coated with a film to protect the display surface. Be careful and slow when peeling off this protective film since static electricity may be generated. It is recommended to use ionic fan or machine when operating. It is recommended to remove the protection foil slowly (> 3 sec.).

e. It is preferable to wear gloves etc, to avoid damaging the LCD. Please do not touch electrodes with bare hands or avoid any other contamination.

14.2 Storage precautions

14.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.

14.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:

Temperature : 5℃ ～ 40℃

Relatively humidity: ≤80%

14.2.3 The LCD modules should be stored in a clean environment or room, free from acid, alkali and harmful gas.

14.2.4 Store the module in anti-static electricity container and without any physical load.

14.3 Transportation precautions

The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.

14.4 Soldering

14.4.1 Use the high quality solders, only solder the I/O terminals.

14.4.2 No higher than 280℃ and time less than 3-4 second during soldering.

14.4.3 Rewiring: no more than 3 times.

14.4.4 when you remove connector or cable soldered to I/O terminals, please confirm that solder is fully melted. If you remove by force, electrodes at I/O terminals may be damaged (or stripped off). It is recommended to use solder suction machine.

15. LCD Module Part Numbering System