

LIQUID CRYSTAL DISPLAY MODULE

Standard Product Specification

PRODUCT NUMBER	LR2020/LR3020
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INTERNAL APPROVALS		
Product Manager	Engineering	Document Control
Date:	Date:	Date:

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	1 / 22
------	--------

TABLE OF CONTENTS

1	MAIN FEATURES	4
2	MECHANICAL SPECIFICATION.....	5
2.1	MECHANICAL CHARACTERISTICS	5
2.2	LABELLING & MARKING.....	5
2.3	MECHANICAL DRAWING	6
3	ELECTRICAL SPECIFICATION.....	7
3.1	ABSOLUTE MAXIMUM RATINGS	7
3.2	ELECTRICAL CHARACTERISTICS	7
3.3	RECOMMENDED LC DRIVE VOLTAGE (VDD-VO).....	7
3.4	INTERFACE PIN ASSIGNMENT	8
3.5	BLOCK DIAGRAM	9
3.6	POWER SUPPLY CIRCUIT	9
3.7	TIMING CHARACTERISTICS	9
3.8	AC CHARACTERISTICS	10
3.9	TIMING CHARACTERISTICS	11
3.10	CHARACTER FONT	12
4	OPTICAL SPECIFICATION.....	13
4.1	OPTICAL CHARACTERISTICS.....	13
5	BACKLIGHT SPECIFICATION	15
5.1	BACKLIGHT CHARACTERISTICS.....	15
6	QUALITY ASSURANCE SPECIFICATION.....	16
6.1	CONFORMITY	16
6.2	DELIVERY ASSURANCE	16
7	RELIABILITY SPECIFICATION	20
7.1	RELIABILITY TESTS	20
7.2	LIFE TIME.....	20
8	PART NUMBER DESCRIPTIONS FOR AVAILABLE OPTIONS.....	21
9	HANDLING PRECAUTIONS.....	22

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	2 / 22
------	--------

REVISION RECORD

Rev.	Date	Page	Chap.	Comment	ECN no.
A	08/24/06	--	--	New DCA Release	E2053
B	10/23/06	21	8	Item numbered 1. No backlight. please remove the text (reflective or transflective)	E3277

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	3 / 22
------	--------

1 MAIN FEATURES

Units : MM

ITEM	CONTENTS	REMARK
Display Format	1 Line 16 Characters	
Colour	Monochrome	
Overall Dimensions	80.0 (W) x 36.0 (H) x 10.5 (D) Max.	
Viewing Area	64.5 (W) x 13.8 (H)	
LCD Type	STN – Reflective – Positive	
	STN – Transflective – Positive	
Viewing Angle	6:00	
Duty Ratio	1/16	
Driver IC	Sitronix ST7066	
Backlight Type	EL	
Backlight Colour	Blue Green	
DC/DC Converter	Built-In	
Operating Temperature	-20°C ~ +70°C	Note 1
Storage Temperature	-30°C ~ +80°C	Note 2
ROHS Compliant	Yes	

Note 1: Background colour changes slightly depending on ambient temperature. This phenomenon is reversible. Ta≤70 °C: 75% RH max

Note 2: Ta≤80 °C: 75% RH max

Note 3: standard Temperature also available.

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	4 / 22
------	--------

2 MECHANICAL SPECIFICATION

2.1 MECHANICAL CHARACTERISTICS

ITEM	CHARACTERISTIC	UNIT
Display Format	1 Line 16 Characters	
Overall Dimensions	80.0 (W) x 36.0 (H) x 10.5 (D) Max.	mm
Viewing Area	64.5 (W) x 13.8 (H)	mm
Active Area	59.45 (W) x 5.95 (H)	mm
Character Size	3.20 (W) x 5.95 (H)	mm
Character Pitch	3.75 (W) x 5.95 (H)	mm
Dot Size	0.6 (W) x 0.7 (H)	mm
Dot Pitch	0.65 (W) x 0.75 (H)	mm
IC Controller/Driver	Sitronix ST7066	

2.2 LABELLING & MARKING

DENSITRON LR2020 TAIWAN YYMM

DENSITRON LR3020 TAIWAN YYMM

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	5 / 22
------	--------

3 ELECTRICAL SPECIFICATION

3.1 ABSOLUTE MAXIMUM RATINGS

VSS = 0 V, Ta = 25°C

Item	Symbol	Min	Max	Unit	Note
Power Supply Voltage	V _{DD}	0	7.0	V	
Power Supply for LCD	V _{DD} -V _O	0	10.0	V	Ta = 25°C
Static Electricity	Be sure that you are grounded when handling displays.				

3.2 ELECTRICAL CHARACTERISTICS

VSS = 0 V, Ta = 25 °C

Item	Symbol	Condition	Min	Typ	Max	Unit
Power Supply for Logic	V _{DD}	Ta = 25°C	4.75	--	5.25	V
Input Voltage	V _{IH}	Ta = 25°C	3.5	--	V _{DD}	V
	V _{IL}	Ta = 25°C	0	--	0.6	V
LCD Module Driving Voltage	V _{DD} -V _O	Ta = 25°C	3.9	4.1	4.3	V
Current Consumption	* I _{DD}	V _{DD} -V _{SS} = 5V	--	1.0	--	mA

- I_{DD} measurement condition is for all pattern ON

3.3 RECOMMENDED LC DRIVE VOLTAGE (VDD-VO)

Temperature	STN-H
Ta = -20°C	4.3
Ta = 0°C	4.2
Ta = 25°C	4.1
Ta = 50°C	4.0
Ta = 70°C	3.9

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	7 / 22
------	--------

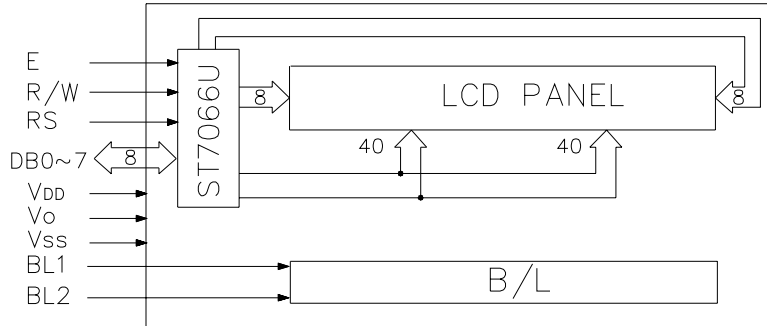
3.4 INTERFACE PIN ASSIGNMENT

Pin No.	Function	Level	Description
1	VSS	–	Ground (0V)
2	VDD	–	Logic Supply Voltage (+5V)
3	Vo	–	Voltage Level for LCD Control Adjustment
4	RS	I	Register Select 0: Instruction Register 1: Data Register
5	R/W	I	Read / Write 0: Data Write (Module-MPU) 1: Data Read (Module-MPU)
6	E	I	Enable Signal Active High (H – L)
7 ~ 14	DB0 ~ 7	I/O	Bi-directional data bus line 0 ~ 7
15	N/A		No connection
16	N/A		No connection
BL1	EL		EL B/L
BL2	EL		EL B/L

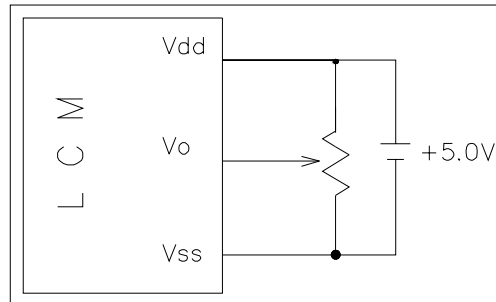
Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	8 / 22
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3.5 BLOCK DIAGRAM



3.6 POWER SUPPLY CIRCUIT



RECOMMENDED V_R : 10K ohm ~ 20K ohm

3.7 TIMING CHARACTERISTICS

Note: Please reference the manufacturer's datasheet for the Sitronix ST7066 controller.

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	9 / 22
------	--------

3.8 AC CHARACTERISTICS

ST7066U

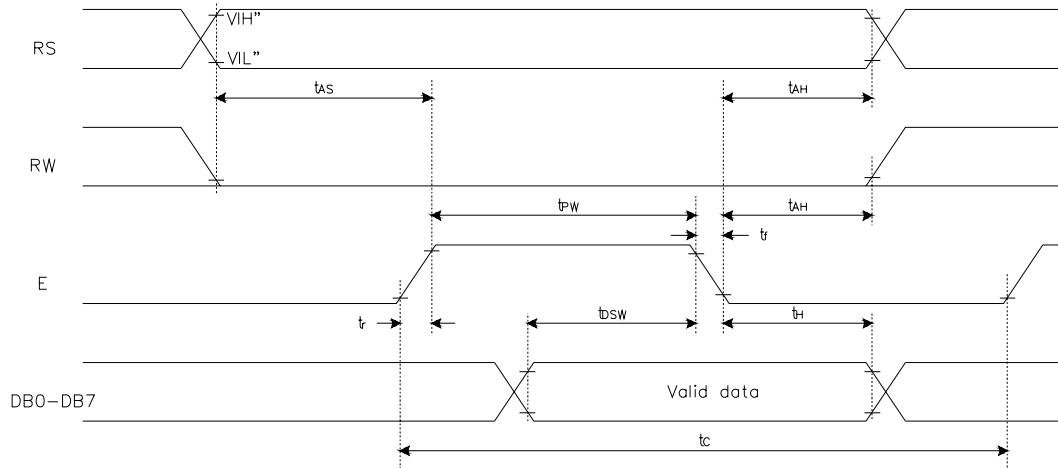
Symbol	Characteristics	Test Condition	Min.	Typ.	Max.	Unit
Internal Clock Operation						
f _{OSC}	OSC Frequency	R = 91K Ω	190	270	350	KHz
External Clock Operation						
f _{EX}	External Frequency	-	125	270	410	KHz
	Duty Cycle	-	45	50	55	%
T _R , T _F	Rise/Fall Time	-	-	-	0.2	μ s
Write Mode (Writing data from MPU to ST7066U)						
T _C	Enable Cycle Time	Pin E	1200	-	-	ns
T _{PW}	Enable Pulse Width	Pin E	140	-	-	ns
T _R , T _F	Enable Rise/Fall Time	Pin E	-	-	25	ns
T _{AS}	Address Setup Time	Pins: RS, RW, E	0	-	-	ns
T _{AH}	Address Hold Time	Pins: RS, RW, E	10	-	-	ns
T _{DSW}	Data Setup Time	Pins: DB0 - DB7	40	-	-	ns
T _H	Data Hold Time	Pins: DB0 - DB7	10	-	-	ns
Read Mode (Reading Data from ST7066U to MPU)						
T _C	Enable Cycle Time	Pin E	1200	-	-	ns
T _{PW}	Enable Pulse Width	Pin E	140	-	-	ns
T _R , T _F	Enable Rise/Fall Time	Pin E	-	-	25	ns
T _{AS}	Address Setup Time	Pins: RS, RW, E	0	-	-	ns
T _{AH}	Address Hold Time	Pins: RS, RW, E	10	-	-	ns
T _{DDR}	Data Setup Time	Pins: DB0 - DB7	-	-	100	ns
T _H	Data Hold Time	Pins: DB0 - DB7	10	-	-	ns
Interface Mode with LCD Driver(ST7065)						
T _{CWH}	Clock Pulse with High	Pins: CL1, CL2	800	-	-	ns
T _{CWL}	Clock Pulse with Low	Pins: CL1, CL2	800	-	-	ns
T _{CST}	Clock Setup Time	Pins: CL1, CL2	500	-	-	ns
T _{SU}	Data Setup Time	Pin: D	300	-	-	ns
T _{DH}	Data Hold Time	Pin: D	300	-	-	ns
T _{DM}	M Delay Time	Pin: M	0	-	2000	ns

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

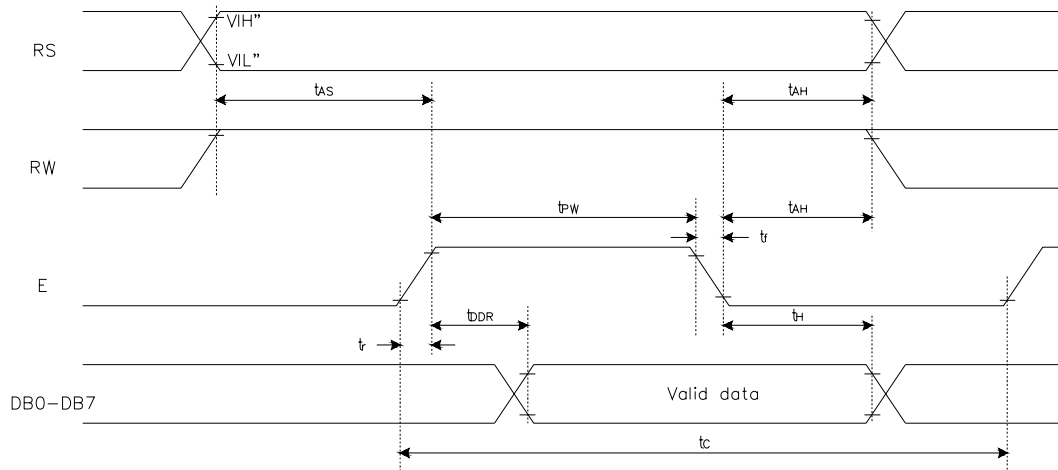
Page	10 / 22
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3.9 TIMING CHARACTERISTICS

● Writing data from MPU to ST7066U



● Reading data from ST7066U to MPU



Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	11 / 22
------	---------

3.10 CHARACTER FONT

NO.7066-0A

b7-b4 b3-b0	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111
0000	CG RAM (1)			0	Q	P	\	P				-	9	E	0	P
0001	(2)		!	1	A	Q	a	9			.	7	7	4	3	9
0010	(3)		"	2	B	R	b	r			"	Y	W	X	P	0
0011	(4)		#	3	C	S	c	s			!	7	T	E	S	*
0100	(5)		\$	4	D	T	d	t			\	I	t	t	P	Q
0101	(6)		%	5	E	U	e	u			.	7	7	I	0	0
0110	(7)		&	6	F	V	f	v			7	0	2	0	P	0
0111	(8)		'	7	G	W	g	w			7	7	7	7	g	π
1000	(1)		(8	H	X	h	x			Y	7	7	7	7	X
1001	(2))	9	I	Y	i	y			0	7	7	7	7	Y
1010	(3)		*	:	J	Z	j	z			E	0	0	7	7	7
1011	(4)		+	:	K	L	k	l			*	7	E	0	*	π
1100	(5)		*	<	L	*	I	I			0	7	7	7	7	π
1101	(6)		-	=	M	I	m	>			Y	7	7	7	7	7
1110	(7)		.	>	N	^	n	7			0	E	0	7	7	π
1111	(8)		/	?	0	_	o	e			7	7	7	7	0	■

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	12 / 22
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4 OPTICAL SPECIFICATION

4.1 OPTICAL CHARACTERISTICS

Ta = 25 °C

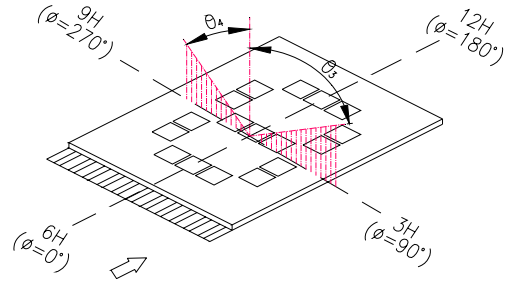
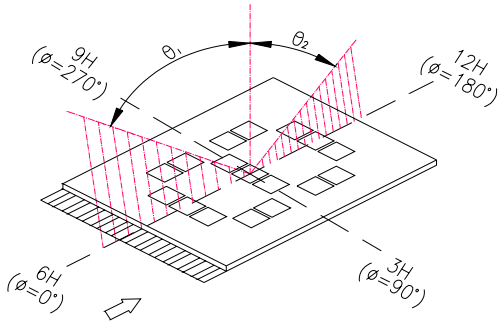
Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Viewing Angle	θ1 (down)	CR≥2	--	40	--	deg	1
	θ2 (up)	CR≥2	--	10	--	deg	1
	θ3 (right)	CR≥2	--	30	--	deg	2
	θ4 (left)	CR≥2	--	30	--	deg	2
Contrast Ratio	CR	Ta = 25 °C	--	5	--	-	3
Response Time	Tr	Ta = 25 °C	--	250	750	ms	4
	Tf	Ta = 25 °C	--	300	900		
Driving Method	Duty	1/16					
	Bias	1/4					
LCD Type	STN – (Positive)						
Viewing Direction	6:00						

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

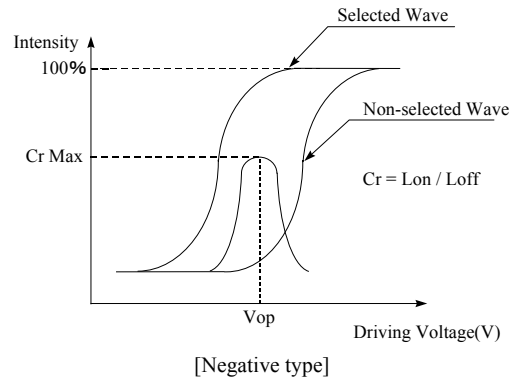
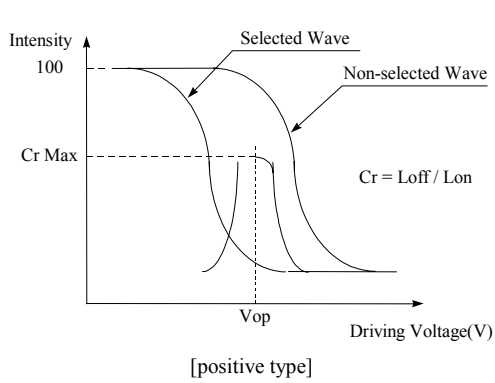
Page	13 / 22
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Note 1: definition of viewing angle θ_1 & θ_2

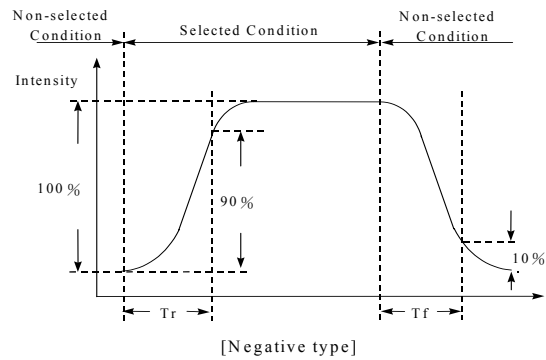
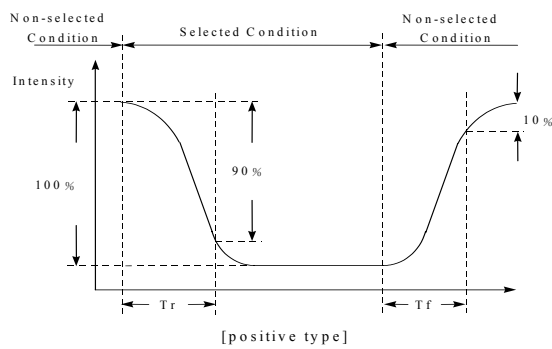
Note 2: definition of viewing angle θ_3 & θ_4



Note 3: definition of contrast ratio (CR)



Note 4: definition of response time



Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	14 / 22
------	---------

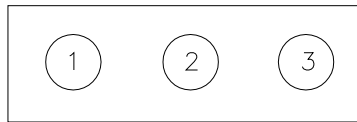
5 BACKLIGHT SPECIFICATION

5.1 BACKLIGHT CHARACTERISTICS

Item	Conditions	Standard			Unit
		Min.	Typ.	Max.	
Input voltage	Ta = 25 C , (400 ~ 800 Hz)	---	100	---	Vrms
Current consumption	Ta = 25 C		1.6		mA
Average brightness (B/L only) (Ta = 25 C, IL = 1.6 mA)	Test when connecting after 3 min. Ta = 25 C (max. contrast)				cd/m2 (Note 1)
	Blue-green B/L	---	50	---	
Brightness uniformity	Ta = 25 C , IL = 1.6 mA	80	---	---	% (Note 2)
Lamp life	Ta = 25 C , IL = 1.6 mA Humidity : 30%RH ~ 85%RH	---	3,000	---	Hrs (Note 3)
Operating Temp.	Humidity : 30%RH ~ 85%RH	-20	---	70	C
Storage Temp.	Humidity : 30%RH ~ 85%RH	-30	---	80	C

Note

- 1 : Average brightness of 3 points when B/L is used at the beginning.
- 2 : Brightness uniformity = (MIN / MAX) x 100 %
- 3 : Half of the original average brightness
- 4 : Recommended Backlight inverter: DAS5V4.



Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	15 / 22
------	---------

6 QUALITY ASSURANCE SPECIFICATION

6.1 CONFORMITY

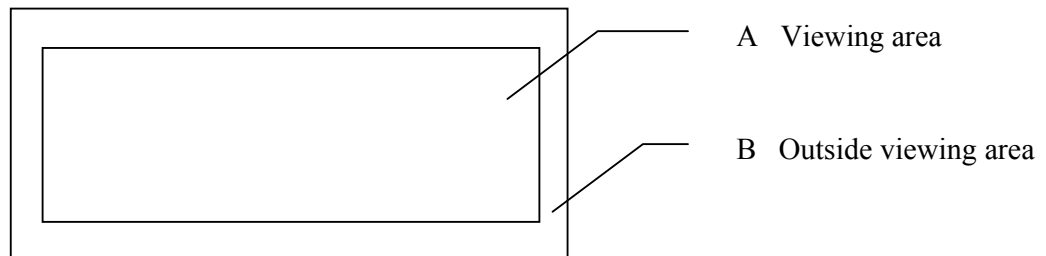
The performance, function and reliability of the shipped products conform to the Product Specification.

6.2 DELIVERY ASSURANCE

6.2.1 Delivery inspection standards

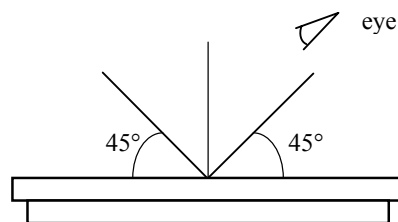
- IPC-AA610, class 2 electronic assemblies standard

6.2.2 Zone definition



6.2.3 Visual inspection

- Inspect under 2x20W or 40W fluorescent lamp (approximately 3000 lux) leaving 25 to 30 cm between the module and the lamp and 30 cm between the module and the eye (measuring position).
- Appearance is inspected at the best contrast voltage (best contrast is adjusted considering clearness and crosstalk on screen).
- Inspect the module at 45° right and left, top and bottom.
- Use the optimum-viewing angle during the contrast inspection.

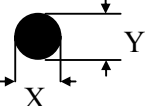
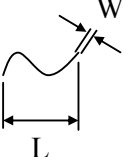
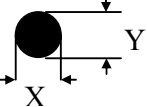


Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	16 / 22
------	---------

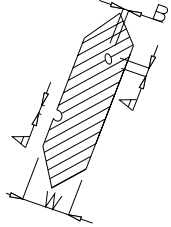
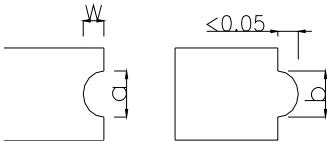
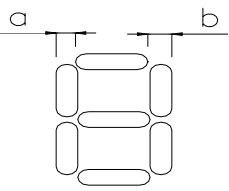
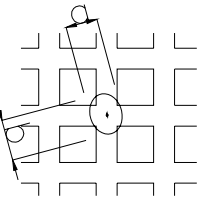
6.2.3.1 Standard of appearance inspection

Units: mm

Class	Item	Criteria																																			
Minor	Packing & Label	Outside & inside package Presence of product no., lot no., quantity																																			
Critical		Product must not be mixed with others and quantity must not be different from that indicated on the label																																			
Major	Dimension	Product dimensions must be according to specification and drawing																																			
Major	Electrical	Product electrical characteristics must be according to specification																																			
Critical	LCD Display	Missing lines or wrong patterns on LCD display are not allowed																																			
Minor	Black spot, white spot, dust	<p>Round type: as per following drawing $\varnothing = (X+Y)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="3">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th>Zone A</th> <th>Zone B</th> </tr> </thead> <tbody> <tr> <td>$\varnothing < 0.1$</td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td>$0.1 < \varnothing < 0.2$</td> <td>2</td> </tr> <tr> <td>$0.2 < \varnothing < 0.25$</td> <td>1</td> </tr> <tr> <td>$0.25 < \varnothing$</td> <td>0</td> </tr> </tbody> </table> <p>Line type: as per following drawing</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="4">Acceptable quantity</th> </tr> <tr> <th>Length</th> <th>Width</th> <th>Zone A</th> <th>Zone B</th> </tr> </thead> <tbody> <tr> <td>--</td> <td>$W \leq 0.02$</td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td>$L \leq 3.0$</td> <td>$0.02 < W \leq 0.03$</td> <td rowspan="2">2</td> </tr> <tr> <td>$L \leq 2.5$</td> <td>$0.03 < W \leq 0.05$</td> </tr> <tr> <td>--</td> <td>$0.05 < W$</td> <td>As round type</td> </tr> </tbody> </table> <p style="text-align: center;">Total acceptable quantity: 3</p>	Acceptable quantity			Size	Zone A	Zone B	$\varnothing < 0.1$	Any number	Any number	$0.1 < \varnothing < 0.2$	2	$0.2 < \varnothing < 0.25$	1	$0.25 < \varnothing$	0	Acceptable quantity				Length	Width	Zone A	Zone B	--	$W \leq 0.02$	Any number	Any number	$L \leq 3.0$	$0.02 < W \leq 0.03$	2	$L \leq 2.5$	$0.03 < W \leq 0.05$	--	$0.05 < W$	As round type
Acceptable quantity																																					
Size	Zone A	Zone B																																			
$\varnothing < 0.1$	Any number	Any number																																			
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$0.2 < \varnothing < 0.25$	1																																				
$0.25 < \varnothing$	0																																				
Acceptable quantity																																					
Length	Width	Zone A	Zone B																																		
--	$W \leq 0.02$	Any number	Any number																																		
$L \leq 3.0$	$0.02 < W \leq 0.03$	2																																			
$L \leq 2.5$	$0.03 < W \leq 0.05$																																				
--	$0.05 < W$	As round type																																			
Minor	Polariser scratch	Scratch on protective film is permitted Scratch on Polariser: same as No. 1																																			
Minor	Polariser bubble	<p>$\varnothing = (X+Y)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="3">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th>Zone A</th> <th>Zone B</th> </tr> </thead> <tbody> <tr> <td>$\varnothing < 0.2$</td> <td>Any number</td> <td rowspan="4">Any number</td> </tr> <tr> <td>$0.2 < \varnothing < 0.5$</td> <td>2</td> </tr> <tr> <td>$0.5 < \varnothing < 1.0$</td> <td>1</td> </tr> <tr> <td>$1.0 < \varnothing$</td> <td>0</td> </tr> </tbody> </table> <p style="text-align: center;">Total acceptable quantity: 3</p>	Acceptable quantity			Size	Zone A	Zone B	$\varnothing < 0.2$	Any number	Any number	$0.2 < \varnothing < 0.5$	2	$0.5 < \varnothing < 1.0$	1	$1.0 < \varnothing$	0																				
Acceptable quantity																																					
Size	Zone A	Zone B																																			
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$1.0 < \varnothing$	0																																				

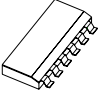
Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	17 / 22
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Class	Item	Criteria																												
Minor	Segment deformation	<p>1.a. Pin hole on segmented display</p> <p>W: segment width $\varnothing = (A+B)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Width</th> <th>\varnothing</th> </tr> </thead> <tbody> <tr> <td>$W \leq 0.4$</td> <td>$\varnothing \leq 0.2$ and $\varnothing \leq 1/2W$</td> </tr> <tr> <td>$W > 0.4$</td> <td>$\varnothing \leq 0.25$ and $\varnothing \leq 1/3W$</td> </tr> </tbody> </table> <p>Total acceptable quantity: 1 defect per segment Pin holes with \varnothing under 0.10 mm are acceptable</p>	Acceptable quantity		Width	\varnothing	$W \leq 0.4$	$\varnothing \leq 0.2$ and $\varnothing \leq 1/2W$	$W > 0.4$	$\varnothing \leq 0.25$ and $\varnothing \leq 1/3W$																				
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Minor	Segment deformation	<p>1b. Pin hole on dot matrix display</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th></th> </tr> </thead> <tbody> <tr> <td>$a, b < 0.1$</td> <td>Any number</td> </tr> <tr> <td>$(a+b)/2 \leq 0.1$</td> <td>Any number</td> </tr> <tr> <td>$0.5 < \varnothing < 1.0$</td> <td>3</td> </tr> </tbody> </table> <p>Total acceptable quantity: 7</p> <p>2. Segments / dots with different width</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable</th> </tr> <tr> <th>$a \geq b$</th> <th>$a/b \leq 4/3$</th> </tr> <tr> <th>$a < b$</th> <th>$a/b > 4/3$</th> </tr> </thead> </table> <p>3. Alignment layer defect</p> <p>$\varnothing = (a+b)/2$</p>  <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th colspan="2">Acceptable quantity</th> </tr> <tr> <th>Size</th> <th></th> </tr> </thead> <tbody> <tr> <td>$\varnothing \leq 0.4$</td> <td>Any number</td> </tr> <tr> <td>$0.4 < \varnothing \leq 1.0$</td> <td>5</td> </tr> <tr> <td>$1.0 < \varnothing \leq 1.5$</td> <td>3</td> </tr> <tr> <td>$1.5 < \varnothing \leq 2.0$</td> <td>2</td> </tr> </tbody> </table> <p>Total acceptable quantity: 7</p>	Acceptable quantity		Size		$a, b < 0.1$	Any number	$(a+b)/2 \leq 0.1$	Any number	$0.5 < \varnothing < 1.0$	3	Acceptable		$a \geq b$	$a/b \leq 4/3$	$a < b$	$a/b > 4/3$	Acceptable quantity		Size		$\varnothing \leq 0.4$	Any number	$0.4 < \varnothing \leq 1.0$	5	$1.0 < \varnothing \leq 1.5$	3	$1.5 < \varnothing \leq 2.0$	2
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Minor	Colour uniformity	Level of sample for approval set as limit sample																												
Critical	Backlight	The backlight colour should correspond to the product specification																												
Critical		Flashing and or unlit backlight is not allowed																												
Minor		Dust larger than 0.25 mm is not allowed																												
Major	COB	Exposed wire bond pad is not allowed																												
Major		Insufficient covering with resin is not allowed (wire bond line exposed)																												
Minor		Dust or bubble on the resin are not allowed																												

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	18 / 22
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Class	Item	Criteria													
Major	 PCB	No unmelted solder paste should be present on PCB													
Critical		Cold solder joints, missing solder connections, or oxidation are not allowed													
Minor		No residue or solder balls on PCB are allowed													
Critical		Short circuits on components are not allowed													
Minor	Tray particles	<table border="1"> <thead> <tr> <th></th> <th>Size</th> <th>Quantity</th> </tr> </thead> <tbody> <tr> <td rowspan="2">On tray</td> <td>$\varnothing < 0.2$</td> <td>Any number</td> </tr> <tr> <td>$\varnothing > 0.25$</td> <td>4</td> </tr> <tr> <td rowspan="2">On display</td> <td>$\varnothing \geq 0.25$</td> <td>2</td> </tr> <tr> <td>L = 3</td> <td>1</td> </tr> </tbody> </table>		Size	Quantity	On tray	$\varnothing < 0.2$	Any number	$\varnothing > 0.25$	4	On display	$\varnothing \geq 0.25$	2	L = 3	1
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Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	19 / 22
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7 RELIABILITY SPECIFICATION

7.1 RELIABILITY TESTS

Test Item	Test Condition	Evaluation and assessment
High Temperature Operation	70°C±2°C for 240 hours	No abnormalities in function* and appearance
Low Temperature Operation	-20°C±2°C for 240 hours	No abnormalities in function* and appearance
Thermal Shock Storage	-30°C (30 min.) ->25°C (5 min.) - >80°C (30 min.) ->25°C (5 min.) 5 cycles	No abnormalities in function* and appearance
Vibration	10 Hz ~ 55 Hz 0.3mm / 1 Octave 55 Hz ~500 Hz 3g / 1 Octave 20 cycles / per axis	No abnormalities in function* and appearance

* Current consumption < 2 times initial value

* Contrast > ½ initial value

7.2 LIFE TIME

Item	Description
1	Function, performance, appearance, etc. shall be free from remarkable deterioration within 50,000 hours under ordinary operating and storage conditions of room temperature (25±10 °C), normal humidity (45±20% RH), and in area not exposed to direct sunlight.
2	Function, performance, appearance, etc. shall be free from remarkable deterioration within 5,000 hours under ordinary operating and storage conditions of 70 °C temperature, normal humidity (45±20% RH), and in area not exposed to direct sunlight.

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	20 / 22
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8 PART NUMBER DESCRIPTIONS FOR AVAILABLE OPTIONS

LR①020②③1C16⑤⑥⑦
④

- ① 2 = No Backlight
3 = EL Backlight

② POLARIZER TYPE

A = Reflective
B = Transflective

③ BACKLIGHT COLOUR

Blank = No backlight
G = Blue-green

④ FORMAT: (1C16=1X16 module format)

⑤ FLUID TYPE AND TEMPERATURE RANGE

S = Standard temp with +5VDC operation
W = Extended temp with +5VDC operation

⑥ FLUID TYPE AND TEMPERATURE COMPENSATION

N = STN/NTN

⑦ TN TEMPERATURE RANGE OR STN/NTN BACKGROUND COLOUR

G = Grey mode STN/NTN (with A, B, F polarisers)
Y = Yellow mode STN/NTN

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	21 / 22
------	---------

9 HANDLING PRECAUTIONS

Safety

If the LCD panel breaks, be careful not to get the liquid crystal fluid in your mouth or in your eyes. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

Mounting and Design

Place a transparent plate (e.g. acrylic, polycarbonate or glass) on the display surface to protect the display from external pressure. Leave a small gap between the transparent plate and the display surface. When assembling with a zebra connector, clean the surface of the pads with alcohol and keep the surrounding air very clean. Design the system so that no input signal is given unless the power supply voltage is applied.

Caution during LCD cleaning

Lightly wipe the display surface with a soft cloth soaked with Isopropyl alcohol, Ethyl alcohol or Trichlorotrifluoroethane. Do not wipe the display surface with dry or hard materials that will damage the polarisers surface. Do not use aromatic solvents (toluene and xylene), or ketonic solvents (ketone and acetone).

Caution against static charge

As the display uses C-MOS LSI drivers, connect any unused input terminal to VDD or VSS. Do not input any signals before power is turned on.

Also, ground your body, work/assembly table and assembly equipment to protect against static electricity.

Packaging

Displays use LCD elements, and must be treated as such. Avoid strong shock and drop from a height. To prevent displays from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.

Caution during operation

It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life. Direct current causes an electrochemical reaction with remarkable deterioration of the display quality. Give careful consideration to prevent direct current during ON/OFF timing and during operation. Response time is extremely delayed at temperatures lower than the operating temperature range while, at high temperatures, displays become dark. However, this phenomenon is reversible and does not mean a malfunction or a display that has been permanently damaged. If the display area is pushed on hard during operation, some graphics will be abnormally displayed but returns to a normal condition after turning off the display once. Even a small amount of condensation on the contact pads (terminals) can cause an electro-chemical reaction which causes missing rows and columns. Give careful attention to avoid condensation.

Storage

Store the display in a dark place where the temperature is $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and the humidity below 50%RH. Store the display in a clean environment, free from dust, organic solvents and corrosive gases. Do not crash, shake or jolt the display (including accessories).

Product No.	LR2020/LR3020	REV. B
	LAF1616	REV. 1

Page	22 / 22
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