

SPEC. NO.	TQ3C-8EAC0-E1AAYE22-01
DATE	December 6, 1997

S P E C

FOR :

TYPE : KCS077VG2EA-A03
(KCS6448ESTT-X5)

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KYOCERA CORPORATION
KAGOSHIMA HAYATO PLANT
LCD DIVISION

Original	Designed by :Engineering Dept.			Confirmed by :QA Dept.	
Issue Data	Prepared	Checked	Approved	Checked	Approved
October.7, 1996	S. Kojima	S. Matsuo	A. Ichino	D. Hayashi	Y. Yoshida

Revision Record

Date	Designed by :Engineering Dept.			Confirmed by :QA Dept.	
	Prepared	Checked	Approved	Checked	Approved
December 6, 1997	S. Kojima	S. Matsuo	A. Hoshino	S. Hayashi	Y. Yoshida
Rev. No.	Date	Page	Descriptions		
01	Dec 6, 1997	-	Cover page ~Change type name. "KCS6448ESTT-X5" → "KCS077VG2EA-A03" ~Delete dumping code and comment.		
		1	2. Construction and Outline ~Change recommended Inverter. "KCI-04(HITACHI MEDIA ELECTRONICS)" ↓ "KCI-13(MINEBEA ELECTRONICS)"		
		2	3. Mechanical Specifications Weight ~Delete "()".		
		3	4-2. Environmental absolute maximum ratings ~Change max operating humidity. "85" → "*3" ~Add comment *6		
		4	5. Electrical Characteristics ~Delete "()". ~Change power consumption value.		
		5	6. Optical Characteristics ~Change symbol "φ" → "φ". ~Delete "()"		
		9	7-1. Power Supply ~Change type name. "KCS6448E" → "KCS077VG"		
		17	13-1. CFL ratings ~Change measuring Inverter. "KCI-04(HITACHI MEDIA ELECTRONICS)" ↓ KCI-13(MINEBEA ELECTRONICS) 13-2. Surface Brightness of LCD ~Change starting discharge voltage, discharging tube voltage, operating life, operating frequency. ~Delete ()		
		18	14. Lot Number Identification ~Change type name. "KCS6448ESTT-X5" → "KCS077VG2EA-A03"		
			18. Outline Drawing ~Change outline drawing		

1. Application

This data sheet defines the specification for a $(640 \times 3) \times 480$ dot, STN color dot matrix type Liquid Crystal Display with CFL backlight.

2. Construction and Outline

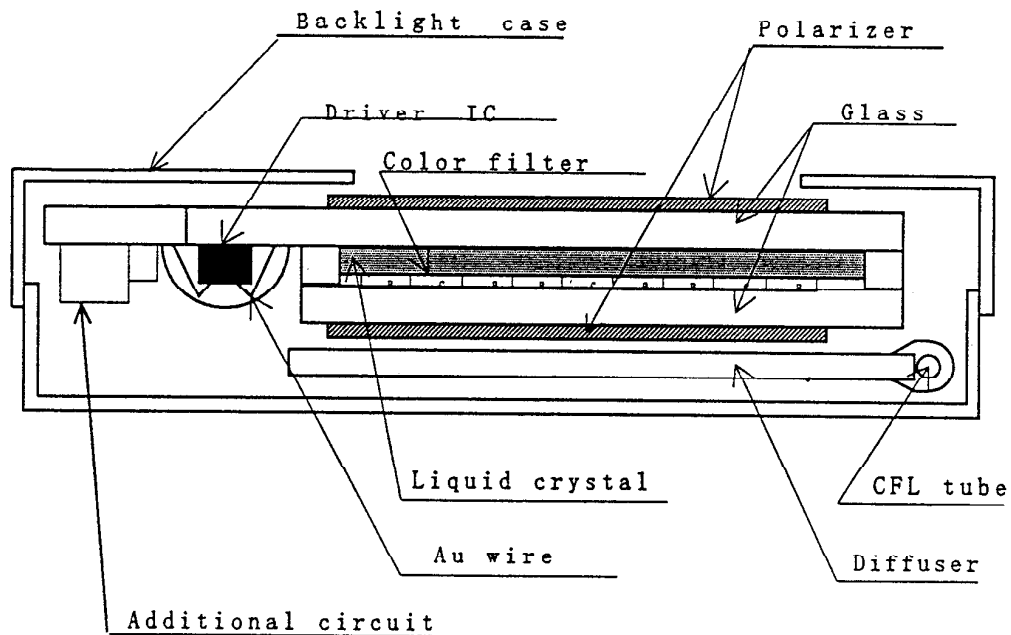
$(640 \times 3) \times 480$ dots, COB type LCD with CFL backlight.

Backlight system : Side-edge type CFL. (2 tubes)

Inverter : Option
Recommended Inverter: KCI-13 (MINEBEA ELECTRONICS)
or equivalent.

Polarizer : Non-Glare treatment.

Additional circuit : Bias voltage circuit, Randomizing circuit.



3. Mechanical Specifications

ITEM	SPECIFICATION	UNIT
Outline dimensions	199.0(W) × 147.0(H) × 10.0(D)	mm
Effective viewing area	160.42(W) × 121.06(H)	mm
Dot number	(640×3)(W) × 480(H)	Dots
Dot size	0.062 (W) × 0.226 (H)	mm
Dot pitch	0.082 (W) × 0.246 (H)	mm
Display color *1	White *2	—
Base color *1	Black *2	—
Weight	330	g

*1 Due to the characteristics of the LC material, the color vary with environmental temperature.

*2 Negative-type display

Display data "H" :R,G,B Dots ON : White

Display data "L" :R,G,B Dots OFF : Black

4. Absolute Maximum Ratings

4-1 Electrical absolute maximum ratings

Temp. = 25 °C

ITEM	SYMBOL	MIN.	MAX.	UNIT
Supply voltage for logic	VDD	0	7.0	V
Supply voltage for LCD driving	VEE	0	44.0	V
Input voltage	Vin	0	VDD	V

4-2. Environmental absolute maximum ratings

ITEM	SYMBOL	MIN	MAX	UNIT
Operating temperature *6	Top	0	50	℃
Storage temperature *1	T _{STO}	-20	60	℃
Operating humidity *2	H _{OP}	10	*3	% RH
Storage humidity *2	H _{STO}	10	*3	% RH
Vibration	—	*4	*4	—
Shock	—	*5	*5	—

*1 Temp. = -20℃ < 24Hr. , Temp = 60℃ < 24Hr.
No vibration and shock.

*2 Non-condensation.

*3 Temp. ≤ 40℃, 85% RH Max.
Temp. > 40℃, Absolute Humidity shall be less than 85%RH at 40℃.

*4

Frequency	10~55 Hz	Converted to acceleration value : (0.03~0.91G)
Vibration width	0.15 mm	
Interval	10-55-10 Hz 1 minute	

2 hours in each direction X/Y/Z (6 hours as total)
EIAJ ED-2531,

*5 Acceleration: 50 G
Pulse width : 11 msec
3 times in each direction : ±X/±Y/±Z.
EIAJ ED-2531, method 05, condition A.

*6 LCD's display quality shall not be guaranteed at the temperature
range of :below 0℃ and upper 40℃

5. Electrical Characteristics

Temp. = 25°C, VDD = 5V $\pm$ 5%

ITEM	SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT
Supply voltage for logic	VDD	—	4.75	5.00	5.25	V
Supply voltage for LCD driving	VEE		32.0	34.0	36.0	V
LCD driving voltage *1	Vop=	0 °C	27.1	28.1	29.1	V
	VCONT	25 °C	26.6	27.6	28.6	V
		40 °C	26.1	27.1	28.1	V
Input signalvoltage	Vin	"H" level	0.8VDD	—	VDD	V
		"L" level	0	—	0.2VDD	V
Clock frequency	f _{cp}		4.03	4.32	12.0	MHz
Frame frequency *2	f _{FRM}		70	75	80	Hz
Current consumption for logic	IDD	*3	—	2.0	3.0	mA
Current consumption for LCD driving	IEE		—	15.0	22.5	mA
Power consumption	Pdisp		—	424	636	mW

*1 Maximum contrast ratio is obtained by adjusting the LCD driving voltage
($V_{op} = V_{CONT}$) FOR driving LCD.

*2 In consideration of display quality, it is recommended that frame frequency is set in the range of 70~80Hz. When you have to use higher frame and clock frequencies, confirm the LCD's performance and quality prior to finalizing the frequency values: Generally, as frame and clock frequencies become higher, current consumption will get bigger and display quality will be degraded.

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*3 Display high frequency pattern, ( see below ).
VDD = 5V      Vop= VCONT , FRM= 75 Hz , fcp = 4.32 MHz
Pattern:
```

[illegible]

6. Optical Characteristics

Temp. = 25°C Measuring spot = ϕ 12 mm

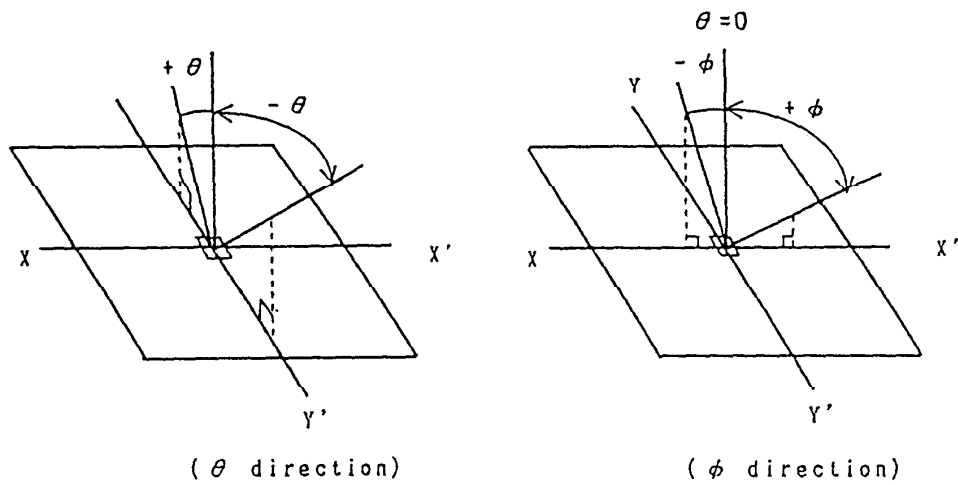
ITEM		SYMBOL	CONDITION		MIN.	TYP.	MAX.	UNIT
Response time	Rise	Tr	$\theta = \phi = 0^\circ$		—	160	260	ms
	Down	Td	$\theta = \phi = 0^\circ$		—	80	180	ms
Viewing angle range		θ	$CR \geq 2$	$\phi = 0^\circ$	-30	—	40	deg.
		ϕ		$\theta = 0^\circ$	-50	—	50	deg.
Contrast ratio		CR	$\theta = \phi = 0^\circ$		10.0	20.0	—	—
Chromaticity coordinates	Red	x	$\theta = \phi = 0^\circ$		0.49	0.54	0.59	—
		y			0.29	0.34	0.39	
	Green	x	$\theta = \phi = 0^\circ$		0.24	0.29	0.34	
		y			0.50	0.55	0.60	
	Blue	x	$\theta = \phi = 0^\circ$		0.11	0.16	0.21	
		y			0.09	0.14	0.19	
	White	x	$\theta = \phi = 0^\circ$		0.25	0.30	0.35	
		y			0.28	0.33	0.38	
	Black	x	$\theta = \phi = 0^\circ$		0.24	0.29	0.34	
		y			0.25	0.30	0.35	

Optimum contrast is obtained by adjusting the LCD driving voltage (Vop) while at the viewing angle of $\theta = \phi = 0^\circ$

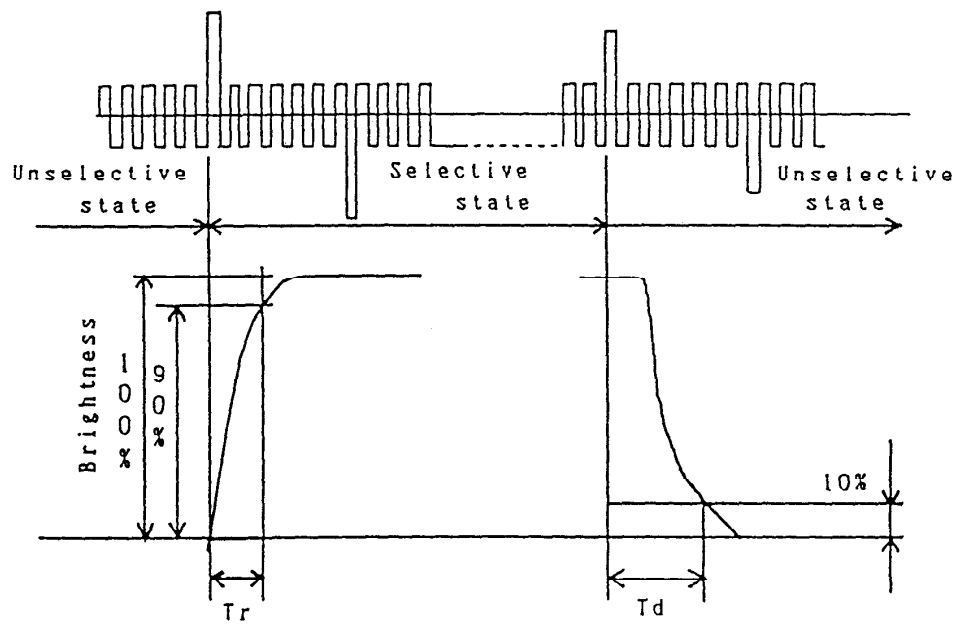
6-1. Contrast ratio is defined as follows:

$$CR = \frac{\text{Brightness all pixels "White"}}{\text{Brightness all pixels "Black"}}$$

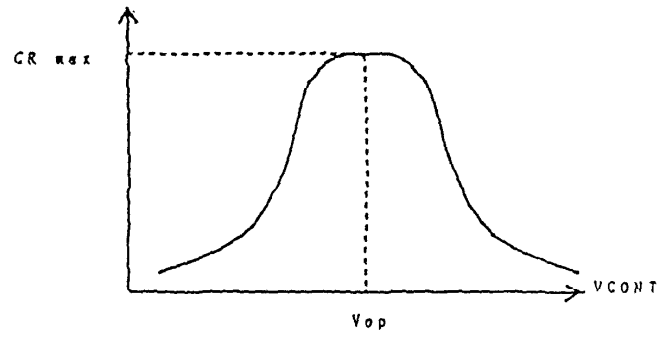
6-2. Definition of viewing angle



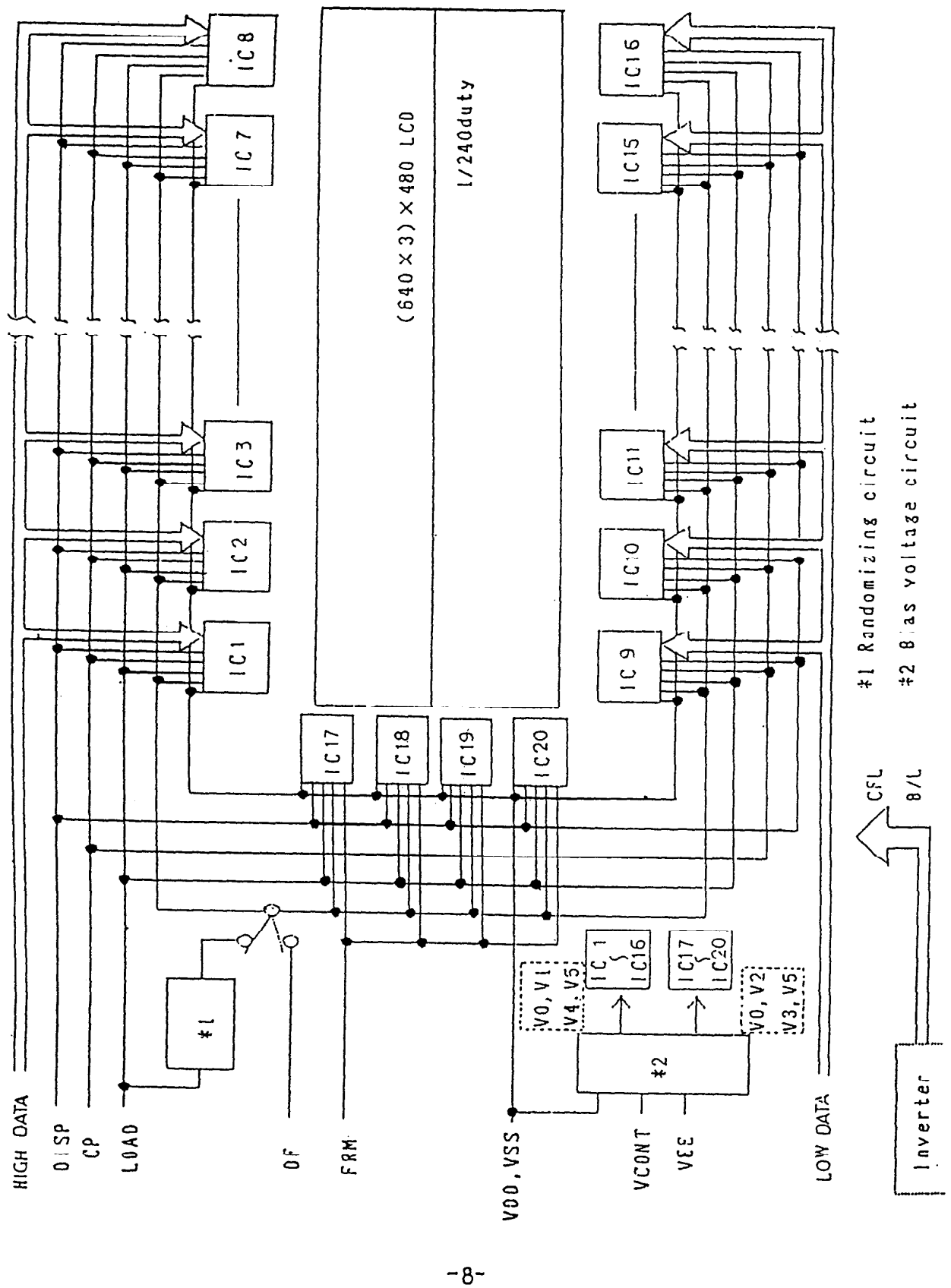
6-3. Definition of response time



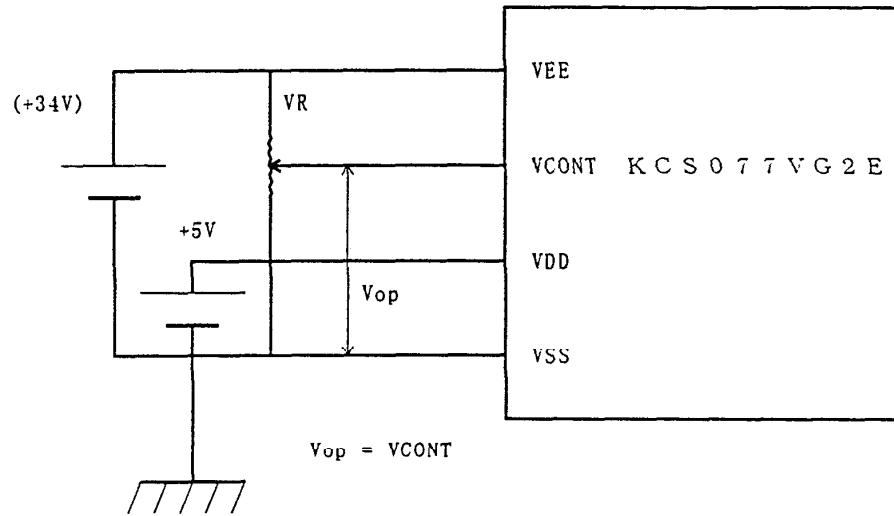
6-4. Definition of V_{op}



7. Circuit Block Diagram



7-1. Power supply



8. Interface Signals

8-1. LCD

CN1:53261-1510(Molex)

PIN NO.	SYMBOL	DESCRIPTION	LEVEL
1	FRM	Synchronous signal for driving scanning line	H
2	NC	No connect	—
3	DISP	Display control signal	H(ON),L(OFF)
4	LOAD	Data signal latch clock	H → L
5	VSS	GND	—
6	CP	Data signal shift clock	H → L
7	VSS	GND	—
8	HD0	Display data (Upper column)	H(ON),L(OFF)
9	HD1		
10	HD2		
11	HD3		
12	HD4		
13	HD5		
14	HD6		
15	HD7		

Recommended matching connector:51021-1500(Molex)

CN2:53261-1410(Molex)

PIN NO.	SYMBOL	DESCRIPTION	LEVEL
1	LD0	Display data (Lower column)	H(ON),L(OFF)
2	LD1		
3	LD2		
4	LD3		
5	LD4		
6	LD5		
7	LD6		
8	LD7		
9	VDD	Power supply for logic	—
10	VSS	GND	—
11	NC	No connect	—
12	VEE	Power supply for LCD	—
13	VEE	Power supply for LCD	—
14	VCONT	LCD adjust voltage	—

Recommended matching connector:51021-1400(Molex)

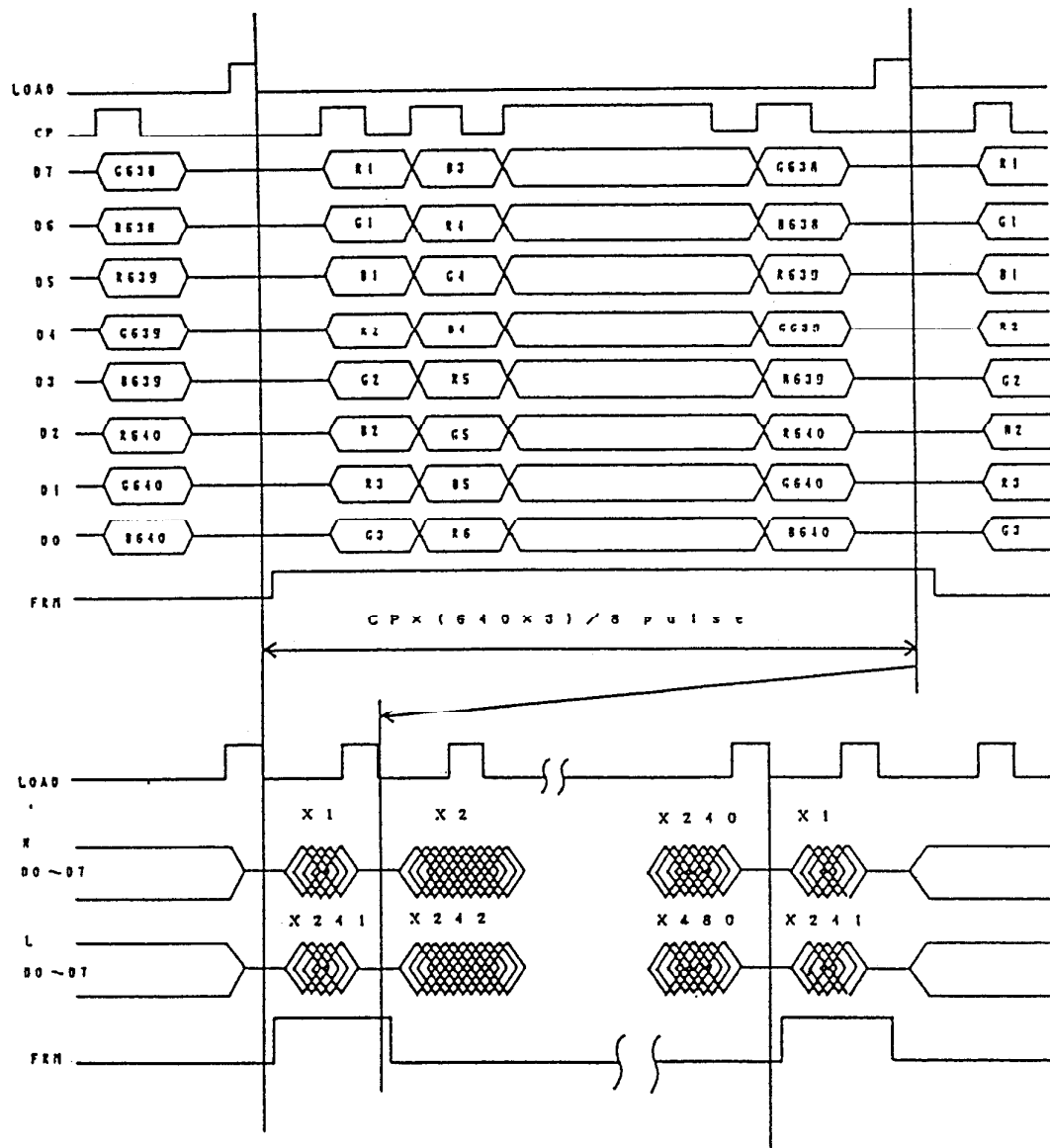
8-2.CFL

CN3:QZ-19-3F01(HONDA)×2

PIN NO.	SYMBOL	DESCRIPTION	LEVEL
1	GND	Ground line(from inverter)	—
2	NC	—	—
3	HV	Power supply for CFL	AC

Recommended matching connector:QZ-19-A3MYL(HONDA)×2

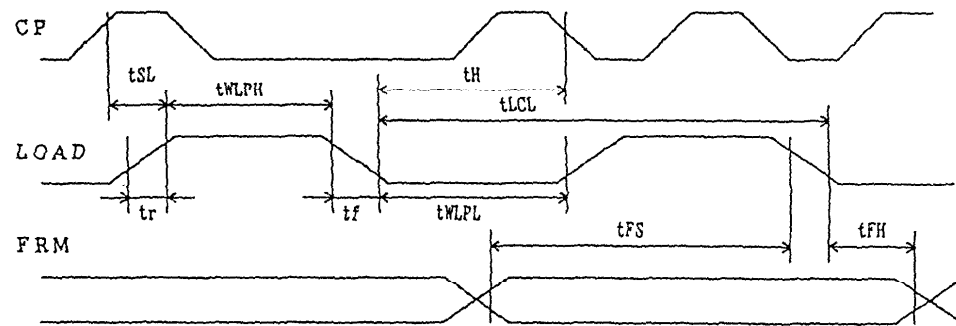
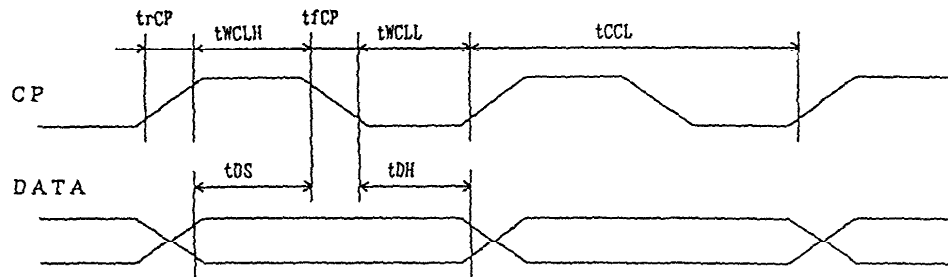
9. Interface Timing Chart



10. Data and Screen

CHIP AREA														
C H I P A R E A	X1	Y1			Y2			Y3				Y640		
	.	HD7	HD6	HD5	HD4	HD3	HD2	HD1	HD0	HD7		HD2	HD1	HD0
	.	R1	G1	B1	R2	G2	B2	R3	G3	B3		R640	G640	B640
	X240													
	X241	LD7	LD6	LD5	LD4	LD3	LD2	LD1	LD0	LD7		LD2	LD1	LD0
.	R1	G1	B1	R2	G2	B2	R3	G3	B3		R640	G640	B640	
.	X480													
CHIP AREA														

11. Input Timing Characteristics



11-1. Switching characteristics

Input characteristics ; VDD = +5V $\pm$ 5%

Temp. = 25°C

ITEM	SYMBOL	MIN.	MAX.	UNIT
CP Cycle *1	tCCL	82	—	ns
CP "H" Pulse Width	tWCLH	28	—	ns
CP "L" Pulse Width	tWCLL	28	—	ns
CP Rise Up Time. *2	trCP	—	13	ns
CP Fall Down Time *2	tfCP	—	13	ns
Data Set up Time	tDS	28	—	ns
Data Hold Time	tDH	20	—	ns
Load "H" Pulse Width	tWLPH	55	—	ns
Load "L" Pulse Width	tWLPL	330	—	ns
LOAD Cycle	tLCL	400	—	ns
Data Strobe Set Up Time	tSL	-5	—	ns
Data Strobe Hold Time	tH	40	—	ns
Input Signal Rise Up Time	tr	—	30	ns
Input Signal Falll Down Time	tf	—	30	ns
FRM Data Set Up Time	tFS	100	—	ns
FRM Data Hold Time	tFH	30	—	ns

*1 CP Cycle is adjust.so that FRM signal is 75Hz.

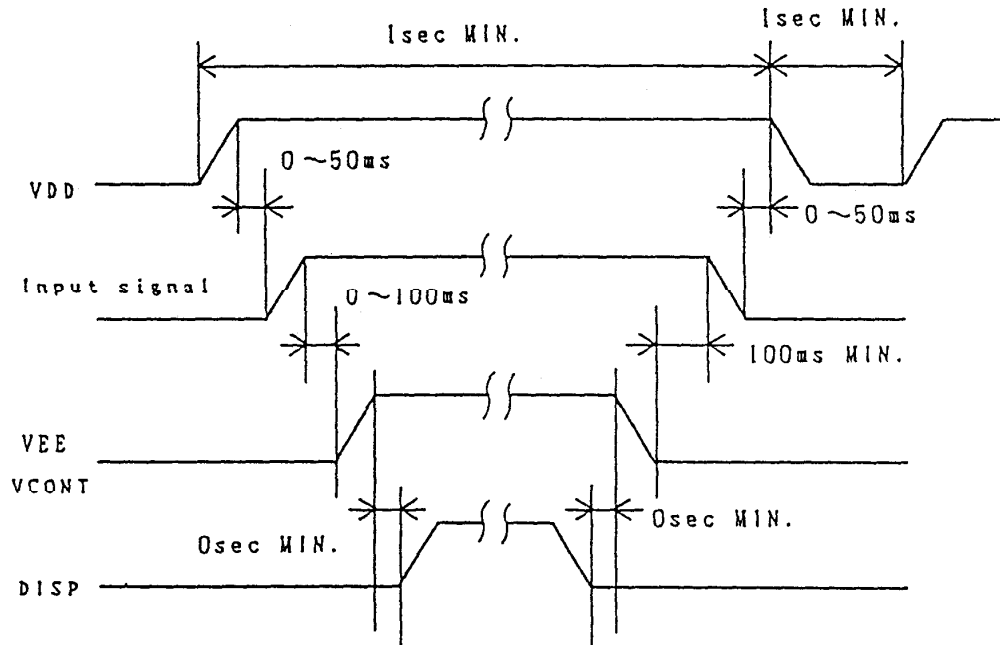
*2 The formura of condition

$$\textcircled{1} \quad trCP, tfCP < \{tCCL - (tWCLH + tWCLL)\} / 2$$

Please use on condition that $\textcircled{1}$ is filled.

1 2 . Supply Voltage Sequence Condition

DO NOT apply DC voltage to the LCD panel. DC voltage induce irreversible electrochemical reactions and reduce LCD life. Always follow the power supply ON/OFF sequence of VDD first, input signal second, VCONT third and finally DISP. This will prevent DC driving of the LCD or CMOS LSI latch-up as shown below.



1.3 . Backlight Characteristics

13-1 CFL ratings (For one lamp)

Inverter: KCI-13 (MINEBEA ELECTRONICS)

Temp. = 25°C

ITEM	SYMBOL	MIN.	TYP.	MAX.	NOTE
Starting discharge Voltage *1	VS	—	—	980 Vrms.	0 °C
		—	—	650 Vrms.	25 °C
Discharging tube current	IL	2.0 mArms.	5.0 mArms.	6.0 mArms.	—
Discharging tube voltage	VL	—	400 Vrms.	—	—
Operating life *2 (IL=5.0mArms.)	T	—	25,000 Hr.	—	—
Operating frequency	F	40 kHz	—	100 kHz	—

*1 The Non-load output voltage (VS) of the inverter should be designed to have some margin, because VS may increase due to the leak current which may be caused by wiring of CFL cables. (Reference value: 1,274 Vrms. MIN.)

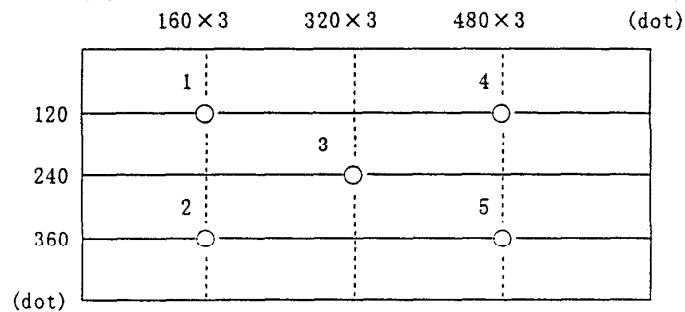
*2 When the illuminance or quantity of light has decreased to 50 % of the initial value.

13-2. Surface Brightness of LCD (IL = 5.0 mArms. × 2)

Temp. = 25°C

ITEM	MIN.	TYP.	MAX.	UNIT
Brightness	110	150	—	cd/m ²

(Measuring points)

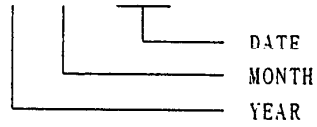


- 1) Rating is defined as the average brightness inside the viewing area.
- 2) 30 minutes after CFL is turned on. (Ambient Temp. = 25°C)
- 3) The inverter should meet the eccentric conditions;
-Sine, symmetric waveform without spike in positive and negative.

1 4 . Lot Number Identification

The lot number shall be indicated on the back of the backlight case of each LCD.

K C S 0 7 7 V G 2 E A - A 0 3 - ☐ ☐ - ☐ ☐



YEAR	1997	1998	1999	2000
CODE	7	8	9	0

MONTH	JAN.	FEB.	MAR.	APR.	MAY	JUN
CODE	1	2	3	4	5	6

MONTH	JUL.	AUG.	SEP.	OCT.	NOC.	DEC.
CODE	7	8	9	X	Y	Z

1 5 . Warranty

15-1. Incoming inspection

Please inspect the LCD within one month after your receipt.

15-2. Production Warrnaty

Kyocera warrants its LCDs for a period of 12 months after receipt by the purchaser, and within the limits specified. Kyocera shall, by mutual agreement, replace or rework defective LCDs that are shown to be Kyocera's responsibility.

16.Precautions for use

16-1.Installation of the LCD

- 1.Please ground either of the mounting(screw) holes located at each corner of an LCD module,in order to stabilize brightness and display quality.
- 2.The LCD shall be installed so that there is no pressure on the LSI chips.
- 3.The LCD shall be installed flat,without twisting or bending.
- 4.The display window size should be the same as the effective viewing area.
- 5.In case you use outside frame of effective viewing area as outward appearance of your product,unevenness of its outward appearance is out of guarantee.

16-2.Static Electricity

- 1.Since CMOS ICs are mounted directly onto the LCD glass,protection from static electricity is required.Operation should wear ground straps.

16-3.LCD Operation

- 1.The LCD shall be operated within the limits specified.Operation at values outside of these limits shorten life,and/or harm display images.
- 2.Vop must be adjusted to optimize viewing angle and contrast.
- 3.Operation of the LCD at temperature below the limit specified may cause image degradation and/or bubbles. It may also change the characteristics of the liquid crystal. This phenomenon may not recover. The LCD shall be operated within the temperature limits specified.

16-4.Storage

- 1.The LCD shall be stored within the temperature and humidity limits specified. Store in a dark area, and protected the LCD from direct sunlight or fluorescent light.
- 2.The LCD should be packaged to prevent damage.

16-5. Screen Surface

1. DO NOT store in a high humidity environment for extended periods. Image degradation, bubbles, and/or peeling off of polarizer may result.
2. The front polarizer is easily scratched or damaged. Prevent touching it with any hard material, and from being pushed or rubbed.
3. The LCD screen may be cleaned with a soft cloth or cotton pad. Methanol, or Isopropyl Alcohol may be used, but insure that all solvent residue is removed.
4. Water may cause damage or discoloration of the polarizer. Clean any condensation or moisture from any source immediately.
5. Always keep the LCD free from condensation during testing. Condensation may permanently spot or stain the polarizers.

17. Reliability Data / Environmental Test

TEST ITEM	TEST CONDITION	TEST TIME	RESULT
High Temp. Atmosphere	70°C	240hr.	Display Quality : No defect Display Function : No defect Current Consumption: No defect
Low Temp. Atmosphere	-20°C	240hr.	Low Temp.Bubble : None Solid Crystallization of Liquid Crystal : None Display Quality : No defect Display Function : No defect Current Consumption: No defect
High Temp. Humidity Atmosphere	40°C 90%RH	240hr.	Display Quality : No defect Display Function : No defect Peel-off of Organic Sealing : None Current Consumption: No defect
Temp.Cycle	-20°C 0.5hr. R.T. 0.5hr. 70°C 0.5hr.	10 cycles	Display Quality : No defect Display Function : No defect Peel-off of Organic Sealing : None Bubble on Cell : None
High Temp. Operation	50°C Vop	500hr.	Display Quality : No defect Current Consumption: No defect

*Each test item uses a test LCD only once.The tested LCD is not used in any other tests.

*The LCD is tested in circumstances in which there is no condensation.

*The tested LCD is inspected after 24 hours of storage at room temperature and room humidity after each test is finished.

*The reliability test is not an out-going inspection.

*The results of the reliability test are for your reference purpose only.The reliability test is conducted only to examine the LCD's capability.

Document. No.

TQ3C-8EAC0-E2AAYE22-01

DATE

December 6, 1997

FOR : _____

KYOCERA INSPECTION STANDARDTYPE : KCS077VG2EA-A03

(KCS6448ESTT-X5)

KYOCERA CORPORATION
KAGOSHIMA HAYATO PLANT
LCD DIVISION

Original	Designed by : Engineering Dept.			Confirmed by : QA Dept.	
Issue Date	Prepared	Checked	Approved	Checked	Approved
Oct. 7, 1997	S. Kojima	S. Matsuo	A. Ishino	S. Hayashin	Y. Yoshida

Revision Record

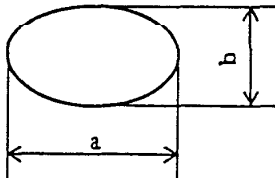
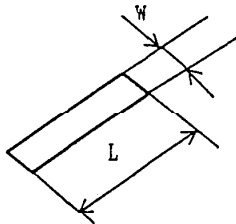
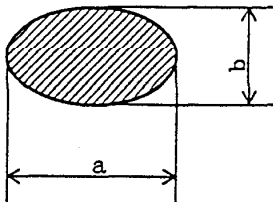
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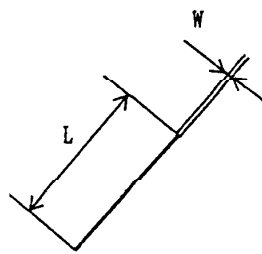
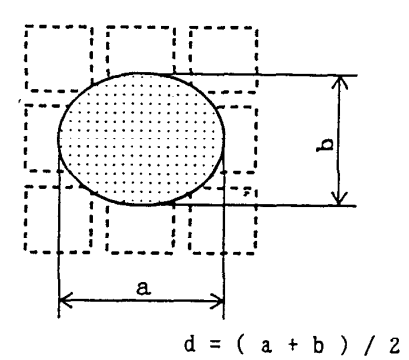
Visuals specification

1)Note

Item	Note						
General	1.When defects specified in this Inspection Standards are inspected,operating voltage(Vop) shall be set at the level where optimized contrast is available. Display quality is applied up to effective viewing area. (Bi-Level INSPECTION) 2.This inspection standard about the image quality shall be applied to any defect within the effective viewing area and shall not be applicable to outside of the area. 3.Should any defects which are not specified in this standard happen,additional standard shall be determined by mutual agreement between customer and Kyocera. 4.Inspection conditions Luminance : 500 Lux minimum Inspection distance : 300 mm (from the sample) Temperature : 25 ± 5 °C Direction : right above						
Definition of Inspection item	<table><tr><td>Pinhole, Bright spot Black spot,Scratch Foreign particle</td><td>The color of a small area is different from the remainder. The phenomenon does not change with voltage.</td></tr><tr><td>Contrast variation</td><td>The color of a small area is different from the remainder. The phenomenon changes with voltage.</td></tr><tr><td>Polarizer (Scratch, Bubble,Dent)</td><td>Scratch,Bubble and Dent in the polarizer which can be observed in on / off state.</td></tr></table>	Pinhole, Bright spot Black spot,Scratch Foreign particle	The color of a small area is different from the remainder. The phenomenon does not change with voltage.	Contrast variation	The color of a small area is different from the remainder. The phenomenon changes with voltage.	Polarizer (Scratch, Bubble,Dent)	Scratch,Bubble and Dent in the polarizer which can be observed in on / off state.
Pinhole, Bright spot Black spot,Scratch Foreign particle	The color of a small area is different from the remainder. The phenomenon does not change with voltage.						
Contrast variation	The color of a small area is different from the remainder. The phenomenon changes with voltage.						
Polarizer (Scratch, Bubble,Dent)	Scratch,Bubble and Dent in the polarizer which can be observed in on / off state.						

2)Standard

Inspection item	Judgement standard																						
Pinhole, Bright spot Black spot, Foreign particle	 $d = (a + b) / 2$ <table><tr><th>Category</th><th>Size (mm)</th><th>Acceptable number</th></tr><tr><td>A</td><td>$d \leq 0.2$</td><td>neglected</td></tr><tr><td>B</td><td>$0.2 < d \leq 0.3$</td><td>5</td></tr><tr><td>C</td><td>$0.3 < d \leq 0.5$</td><td>3</td></tr><tr><td>D</td><td>$0.5 < d$</td><td>0</td></tr></table>	Category	Size (mm)	Acceptable number	A	$d \leq 0.2$	neglected	B	$0.2 < d \leq 0.3$	5	C	$0.3 < d \leq 0.5$	3	D	$0.5 < d$	0							
Category	Size (mm)	Acceptable number																					
A	$d \leq 0.2$	neglected																					
B	$0.2 < d \leq 0.3$	5																					
C	$0.3 < d \leq 0.5$	3																					
D	$0.5 < d$	0																					
Scratch,Foreign particle	 <table><tr><th></th><th>Width (mm)</th><th>Length (mm)</th><th>Acceptable No.</th></tr><tr><td>A</td><td>$W \leq 0.03$</td><td>—</td><td>neglected</td></tr><tr><td>B</td><td rowspan="3">$0.03 < W \leq 0.1$</td><td>$L \leq 2.0$</td><td>neglected</td></tr><tr><td>C</td><td>$2.0 < L \leq 4.0$</td><td>3</td></tr><tr><td>D</td><td>$4.0 < L$</td><td>0</td></tr><tr><td>E</td><td>$0.1 < W$</td><td>—</td><td>According to Circular</td></tr></table>		Width (mm)	Length (mm)	Acceptable No.	A	$W \leq 0.03$	—	neglected	B	$0.03 < W \leq 0.1$	$L \leq 2.0$	neglected	C	$2.0 < L \leq 4.0$	3	D	$4.0 < L$	0	E	$0.1 < W$	—	According to Circular
	Width (mm)	Length (mm)	Acceptable No.																				
A	$W \leq 0.03$	—	neglected																				
B	$0.03 < W \leq 0.1$	$L \leq 2.0$	neglected																				
C		$2.0 < L \leq 4.0$	3																				
D		$4.0 < L$	0																				
E	$0.1 < W$	—	According to Circular																				
Contrast variation	 $d = (a + b) / 2$ <table><tr><th>Category</th><th>Size (mm)</th><th>Acceptable number</th></tr><tr><td>A</td><td>$d \leq 0.5$</td><td>neglected</td></tr><tr><td>B</td><td>$0.5 < d \leq 0.7$</td><td>3</td></tr><tr><td>C</td><td>$0.7 < d$</td><td>0</td></tr></table>	Category	Size (mm)	Acceptable number	A	$d \leq 0.5$	neglected	B	$0.5 < d \leq 0.7$	3	C	$0.7 < d$	0										
Category	Size (mm)	Acceptable number																					
A	$d \leq 0.5$	neglected																					
B	$0.5 < d \leq 0.7$	3																					
C	$0.7 < d$	0																					

Inspection item	Judgement standard																		
Polarizer (Scratch, Bubble,Dent)	(1) Scratch 																		
	<table><tr><th></th><th>Width (mm)</th><th>Length (mm)</th><th>Acceptable No.</th></tr><tr><td>A</td><td>$W \leq 0.1$</td><td>—</td><td>neglected</td></tr><tr><td>B</td><td rowspan="2">$0.1 < W \leq 0.3$</td><td>$L \leq 5.0$</td><td>neglected</td></tr><tr><td>C</td><td>$5.0 < L$</td><td>0</td></tr><tr><td>D</td><td>$0.3 < W$</td><td>—</td><td>0</td></tr></table>		Width (mm)	Length (mm)	Acceptable No.	A	$W \leq 0.1$	—	neglected	B	$0.1 < W \leq 0.3$	$L \leq 5.0$	neglected	C	$5.0 < L$	0	D	$0.3 < W$	—
	Width (mm)	Length (mm)	Acceptable No.																
A	$W \leq 0.1$	—	neglected																
B	$0.1 < W \leq 0.3$	$L \leq 5.0$	neglected																
C		$5.0 < L$	0																
D	$0.3 < W$	—	0																
	(2)Bubble (dent)  $d = (a + b) / 2$																		
	<table><tr><th>Category</th><th>Size (mm)</th><th>Acceptable number</th></tr><tr><td>A</td><td>$d \leq 0.2$</td><td>neglected</td></tr><tr><td>B</td><td>$0.2 < d \leq 0.3$</td><td>5</td></tr><tr><td>C</td><td>$0.3 < d \leq 0.5$</td><td>3</td></tr><tr><td>D</td><td>$0.5 < d$</td><td>0</td></tr></table>	Category	Size (mm)	Acceptable number	A	$d \leq 0.2$	neglected	B	$0.2 < d \leq 0.3$	5	C	$0.3 < d \leq 0.5$	3	D	$0.5 < d$	0			
Category	Size (mm)	Acceptable number																	
A	$d \leq 0.2$	neglected																	
B	$0.2 < d \leq 0.3$	5																	
C	$0.3 < d \leq 0.5$	3																	
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