



LCD MODULE SPECIFICATION FOR CUSTOMER'S APPROVAL

Product Model : TSG093-F-T

VERSION:1.0

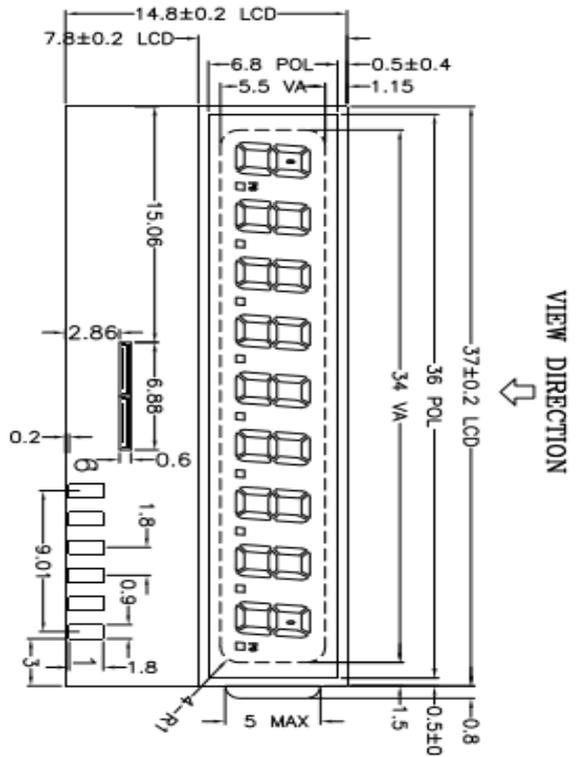
Customer
Approved by Customer
Approved Date:

Version	Revision Date	Contents	Editor
1.0	2017-12-20	New Release	KXH

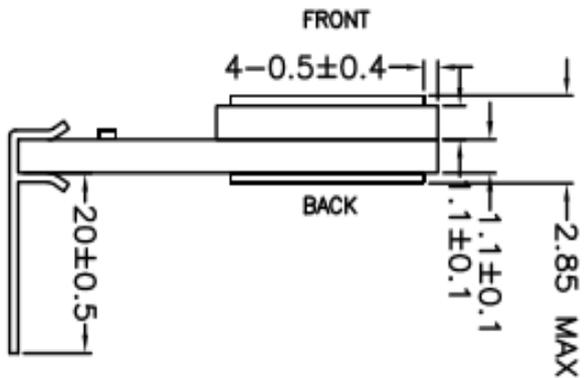
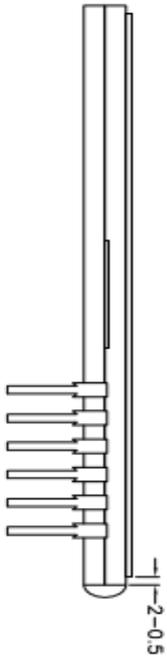
1. PHYSICAL DATA

Item	Contents	Unit
LCD type	TN, REFLECTIVE/POSITIVE	---
LCD duty	1/1DUTY	---
LCD bias	1/1BAIS	---
Viewing direction	12: 00	o'clock
Module size (W×H×T)	37*14.8	mm
Number of dots(W×H)	72segments 72logos	dots
Dot Size(W×H))		mm
Dot Pitch(W×H))		mm

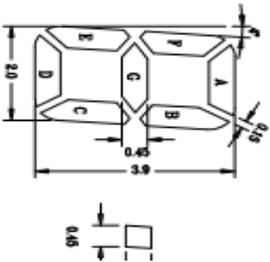
OPTIONAL SPECIFICATION		
LCD	<input type="checkbox"/> Normal Temperature (0~50℃) <input type="checkbox"/> Wide Temperature (-20~+70℃) <input type="checkbox"/> Super Wide Temperature (-30~+80℃)	
	<input type="checkbox"/> Yellow&Green <input type="checkbox"/> Blue <input type="checkbox"/> Gray <input type="checkbox"/> Black & White	
Backlight	LED Backlight	<input type="checkbox"/> White light <input type="checkbox"/> Green light <input type="checkbox"/> Yellow&Green light <input type="checkbox"/> Blue light
DC to DC Circuit	<input type="checkbox"/> Build-in <input type="checkbox"/> Not Build-in	
Controller	<input type="checkbox"/> Build-in <input type="checkbox"/> Not Build-in	



VIEW DIRECTION
↑



- NOTES:
- 1.DISPLAY TYPE: TN
 - 2.VIEWING DIRECTION: 12:00
 - 3.POLARIZER MODE: REFLECTIVE/POSITIVE
 - 4.IC: ML1001-2U
 - 5.OPERATING TEMP: -20°C-+70°C
 - 6.STORAGE TEMP: -30°C-+80°C
 - 7.Drive Method: STATIC
 - 8.OPERATING VOLTAGE: VDD=3V
 - 9.CONNECTOR: COG/PIN
 - 10.UNMARKED TOLERANCES: ±0.2mm
 - 11.REQUIREMENT ON ENVIRONMENTAL PROTECTION: RoHS



NO	SYMBOL
1	VDD
2	GND
3	LOAD
4	DIN
5	LCCLK
6	DCCLK

2. Pin define

PIN NO.	Symbol	Level	Description
1	VDD2	P	POWER supply(+3.0V)
2	VSS	P	POWER Ground
3	LOAD		Load data from the shift register to data register;
4	DIN		Display data input pin
5	LCLK	I	Input pin to the LCD display clock;
6	DCLK	I	Input pin for the clock of the display data;
7	NC		

Key:

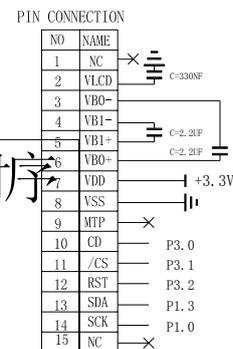
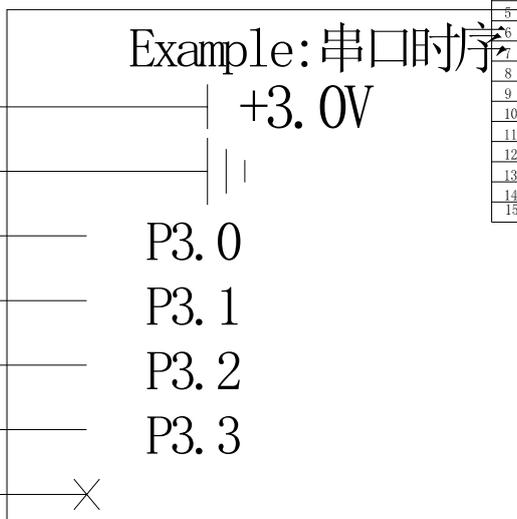
I = Input, O=OUTPUT,

IO = Bi - directional (input/output)

P = Power pin

H/L=High Level/Low Level/

PIN ASSIGNMENT:	
1	VDD
2	GND
3	LOAD
4	DIN
5	LCLK
6	DCLK
7	CHK



3. ABSOLUTE MAXIMUM RATINGS

(1)Electrical Absolute Ratings

Item	Symbol	Min.	Max.	Unit	Note
Power Supply for Logic	$V_{DD}-V_{SS}$	0	3.0	Volt	Note 1
Power Supply for LCD	V_{LCD}	0	3.0	Volt	
Input Voltage	V_I	0	V_{DD}	Volt	
Current for LED backlight	I_{LED}		---	mA	

Note 1 : Operator should be grounded during handling LCM

(2) Environmental Absolute Maximum Ratings

Item	Normal Temperature				Wide Temperature			
	Operating		Storage		Operating		Storage	
	Min.	Max,	Min.	Max,	Min.	Max,	Min.	Max,
Ambient Temperature	0°C	+50°C	-10°C	+60°C	-20°C	+70°C	-30°C	+80°C
Humidity(without condensation)	Note 2,4		Note 3,5		Note 4,5		Note 4,6	

Note 2 $T_a \leq 50^\circ\text{C}$: 80% RH max

$T_a > 50^\circ\text{C}$: Absolute humidity must be lower than the humidity of 85%RH at 50°C

Note 3 T_a at -20°C will be <48hrs at 70°C will be <120hrs when humidity is higher than 75%.

Note 4 Background color changes slightly depending on ambient temperature. This phenomenon

is reversible.

Note 5 $T_a \leq 70^\circ\text{C}$: 75RH max

$T_a > 70^\circ\text{C}$: absolute humidity must be lower than the humidity of 75%RH at 70°C

Note 6 T_a at -20°C will be <48hrs, at 80°C will be <120hrs when humidity is higher than 75%.

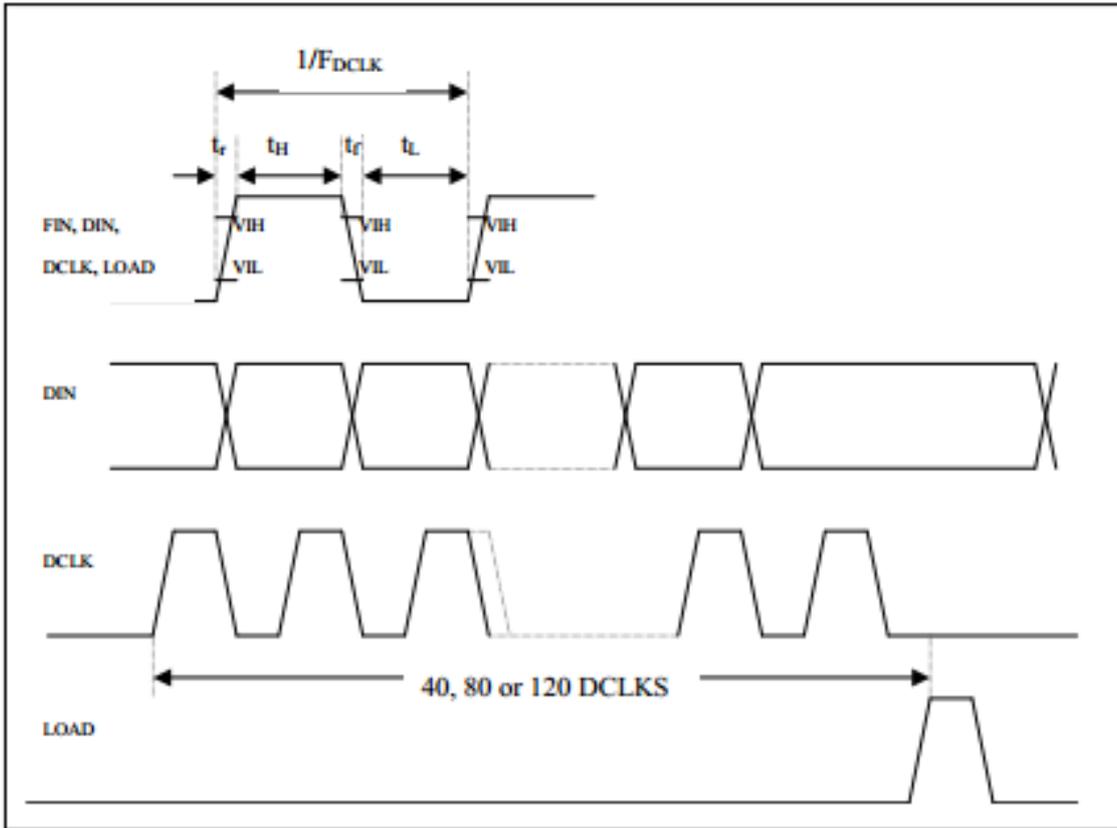
4. ELECTRICAL CHARACTERISTICS

DC Characteristics

($V_{DD}=3.0\text{V}; V_{SS}=0\text{V}; T_a=-20\sim 70^\circ\text{C}$)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Power Supply for Logic	$V_{DD}-V_{SS}$	---	---	3.0	3.2	Volt
Input Voltage	V_{IL}	---	V_{SS}	---	$0.3V_{DD}$	Volt
	V_{IH}	---	$0.7V_{DD}$	---	V_{DD}	Volt
Output Voltage	V_{OH}	$I_{OUT} = +1\text{mA}$	$0.8V_{DD}$	---	V_{DD}	Volt
	V_{OL}	$I_{OUT} = -1\text{mA}$	V_{SS}	---	$0.2V_{DD}$	Volt
LCM Recommend LCD Module Driving Voltage	V_{LCD}	$T_a = 0^\circ\text{C}$	---	---	---	Volt
		$T_a = 25^\circ\text{C}$		3.0	3.2	
		$T_a = 50^\circ\text{C}$	---	---	---	
Power Supply Current for LCM	$I_{DD}(\text{B/L OFF})$	---	---	---	---	mA
	$I_{LED}(\text{B/L ON})$	---	---	---	---	
Power Supply for LED Backlight	$V_{BLA}-V_{BLK}$	$T_a = 25^\circ\text{C}$	---	---	---	V

❖ *Timing Diagram*



Functional Description

The ML1001 is a static LCD COG (chip on glass) driver which can drive upto 40 segments or cascaded with two or three ML1001s to drive 80 & 120 segments. There is a shift register for serially shifting in the data and a data register to store the data that is going to be displayed. The display data is read into the shift register serially through the DIN pin at the rising edge of the DCLK signal. The display data will then be displayed at the rising edge of the LOAD signal. The display data in the shift register is output by the DOOUT pin after 40 rising edges of the DCLK signal. The display data should be input in the sequence of SEG40, SEG39... SEG2, SEG1 for proper display of data.

i) Power on reset

At Power on the ML1001 resets to a starting condition as follows:

1. The shift register outputs are set to GND.
2. The data register outputs are set to GND, hence all LCD segments off.

ii) Oscillator

a) Internal clock

The internal logic and the LCD driving signal of ML1001 are clocked either by the built-in oscillator or from an external clock. When the internal oscillator is used, OEN should be connected to GND and the OOUT should be connected to FIN. The oscillator will oscillate at 32 kHz and the frequency is independent in the range of $2.0V < V_{DD} < 6.0V$.

b) External clock

When using an external clock, the OEN is connected to VDD then connects the external clock to FIN.

iii) Timing

ML1001 have several frequencies of clock signal for the users to choose for the LCD display clock (ie. LCLK) and the blink clock (ie. BCLK). They include the following clock signals :

Frequency of Clock Signal at FIN = 32 kHz	Actual Divider of FIN	Target Input Pin
2 KHz	1/16	LCLK
1 KHz	1/32	
500 Hz	1/64	
256 Hz	1/128	
128 Hz	1/256	
4 Hz	1/8192	BCLK
2 Hz	1/16384	
1 Hz	1/32768	

iv) Segment outputs

ML1001 has 40 segment outputs which should be connected directly to the LCD. If less than 40 segments are required, the unused segments should be left open circuit. Users can disable the first 1 to 16 segments

and the last 17 to 40 segments by connecting the SEN1 and SEN2 to VDD, respectively. The segment outputs shall output GND level after disabling it.

v) Common outputs

ML1001 consists of 2 common signals (ie. COM1A & COM1B). These two common signals are the inversion of the LCLK. The common outputs should be left open-circuit if the outputs are unused.

Users

can disable the COM1A and COM1B by connecting the CEN1A and CEN1B to VDD, respectively.

The

common outputs will change to GND after disabling it.

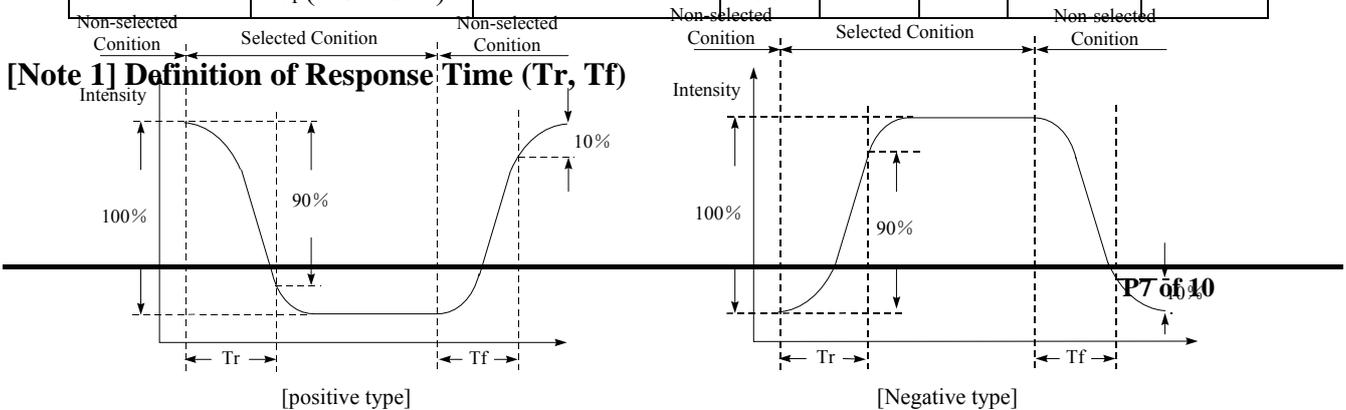
vi) Blink

ML1001 has a blink function that users shall connect the BEN to GND and input the blink clock (ie. BCLK) either by connecting ML1001 output clock signal from Frequency Divider or an external clock

signal. Users shall disable blink function by connecting BEN to VDD.

5. ELECTRO-OPTICAL CHARACTERISTICS

Item	Symbol	CS "H" pulse width	Min.	Typ.	Max.	Unit	note
			Viewing angle range	θ_f (12 o'clock)	Notes1: The input signal Notes2: All timing is specified When $Cr \geq 2$		
θ_b (6 o'clock)	55	---		---			
θ_l (9 o'clock)	55	---		---			
θ_r (3 o'clock)	55	---		---			



Conditions:

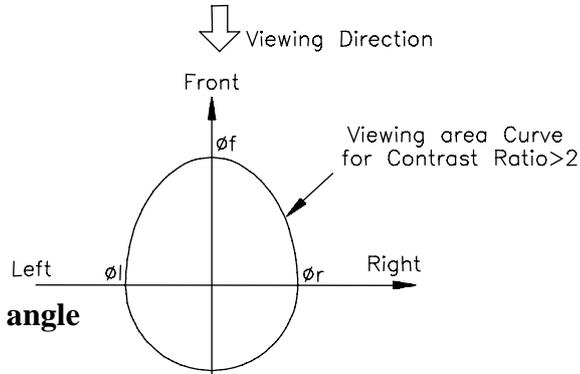
Operating Voltage : V_{op}

Frame Frequency : 64 Hz

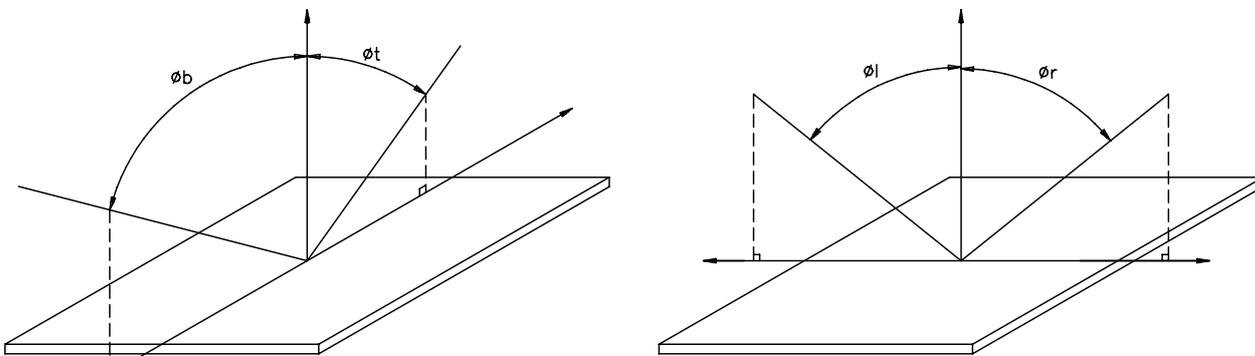
Viewing Angle(θ, φ): $0^\circ, 0^\circ$

Driving Wave form : 1/N duty, 1/a bias

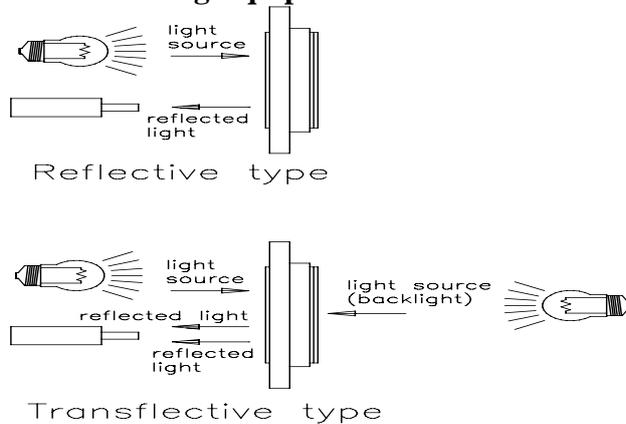
[Note 2] Definition of Viewing Direction



[Note 3] Definition of viewing angle



[Note 4] Description of Measuring Equipment



6. OPERATING PRINCIPLES & METHODS

7. RELIABILITY

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.	70 °C 200 hrs	-----
2	Low temperature storage	Endurance test applying the low storage temperature for a long time.	-20 °C 200 hrs	-----
3	High temperature	Endurance test applying the electric stress	60 °C	

	operation	(Voltage & Current) and the thermal stress to the element for a long time.	200 hrs	-----
4	Low temperature operation	Endurance test applying the electric stress under low temperature for a long time.	-10 °C 200 hrs	-----
5	High temperature / Humidity storage	Endurance test applying the high temperature and high humidity storage for a long time.	70 °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.	50 °C , 90 %RH 96 hrs	MIL-202E-103B JIS-C5023
7	Temperature cycle	Endurance test applying the low and high temperature cycle. $\begin{array}{ccccc} -10^{\circ}\text{C} & \rightleftharpoons & 25^{\circ}\text{C} & \rightleftharpoons & 60^{\circ}\text{C} \\ 30\text{min} & \longleftarrow & 5\text{min.} & \longrightarrow & 30\text{min} \\ & \longleftarrow & & \longrightarrow & \\ & & \text{1 cycle} & & \end{array}$	-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 msedc 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 10 time	MIL-883B-3015.1
<p>Inspection after test: Inspection after 2~4 hours storage at room temperature ,the sample shall be free from defects:</p> <ol style="list-style-type: none"> 1. Air bubble in the LCD. 2. Sealleak 3. Non-display. 4. Missing segments. 5. Glass crack. 6. Current Idd is twice higher than initial value. 				

8. QUALITY GUARANTEE

No	Item	Criteria
1	inclusions (black spot, white spot, dust)	(1)round type diameter mm(a*) no of defect* $a \leq 0.20$ neglect $0.20 < a \leq 0.35$ 5max $0.35 < a$ none (2)linear type length mm(l) width mm(W) no. of defect na $W \leq 0.03$ neglect $1 \leq 3$ $0.03 < W \leq 0.08$ 6 $3 < l$ $0.08 < W$ none
2	scratch	1. scratch on protective film is permitted. 2. scratch on polarizer shall be as follow: (1)round type diameter mm(a*) no of defect $a \leq 0.15$ neglect $0.15 < a \leq 0.20$ 2 max $0.20 < a$ none (2)linear type be judged bye 1.-(2) linear type
3	dent	diameter < 1.5mm
4	bubble	not exceeding 0.5mm average diameter is acceptable between glass and polarizing film
5	pin hole	$(a+b)/2 \leq 0.15\text{mm}$ maximum number: ignored $0.15 < (a+b)/2 \leq 0.20\text{mm}$ maximum number:10
6	dot width	design width $\pm 15\%$
7	dot defect	$(a+b)/2 \leq 0.20\text{mm}$ maximum number: ignored $0.20 < (a+b)/2 \leq 0.30\text{mm}$ maximum number:5 x=width
8	contrast irregularity(spot)	diameter spec no of defect $a \leq 0.50\text{mm}$ neglect $0.50 < a \leq 0.75$ 5 $0.75 < a \leq 1.00$ 3 $1.00 < a$ none
9	color tone and uniformity	obvious uneven color is not permitted