Technical Specification

Product:	Active Matrix Display Module (132x176)
Part No.:	LS020B8UD06

Table of Content

1. General Description

1.1. Display Module

This specification describes a display module with an intelligent graphic Liquid Crystal Display (LCD).
The specification comprises

- an Active Matrix Liquid Crystal Display Panel, transflective, 262k colours, positive mode
- a display controller mounted on the display glass (COG) which is connected to a FPC inside the module
- a light guide with 3 white LED's rank S,T (Nichia) "Colour Ranking 5,6"
- Illumination foil stack is implemented in the module to hint the specified brightness and homogeneity
- A PCB with all passive components
- A plastic frame
- Full adjusted display regard contrast , contrast settings and colour adjustment saved on display module
- An electrical interface that consists of land pattern designed for spring connector. The spring connector is mounted on the LCD PCB
- Serial interface with supports all colour modes up to 262k colours without hardware changes
- Mechanical design and delivery concept supports automatic display assembly at LCD production line

1.2. Mechanical Characteristics

Display Module:		
Outline dimensions	38.2 x 55.8 x 3.6 mm^3	(W x H x T)
Weight	10g	(complete module)
Display Panel:		
Display Resolution	132 x 176	pixel
Dot Pitch	horizontal:	0.237mm
	vertical:	0.237mm
Active Display Area	31.284 x 41.712 mm^2 (W x H)	
Blackmatrix area	34,2 x 44,9 mm^2	(W x H)
Outline Dimensions panel	35.9 x 52,0 mm^2	(W x H)
Design Viewing Direction	6 o'clock display	
Controller:	12 o'clock of the display module	

1.3. General Specification

1.3.1. Component Life Cycle

Storage Life	min. 1 Year
Operation Life *1	min. 40 x 10^3 h (22h per day x 7 days per week x 52 weeks / year x 5 years)
Backlight Operation Life *2	min. 5 x 10^3 h
MTBF, MTTF	as defined in QAA

Storage and Operation Life Times are defined for a temperature of +25℃

Notes:
*1. Operation life ends when one of the listed faults occurs:

- The on/off response-times reach 1.5 times of the max. value specified for a new display
- The contrast is reduced to 0.5 of the original contrast value
- Loss of function
- The number of cosmetic defects exceeds the maximum defined

*2. Backlight Operation Life ends when the backlight luminance is reduced to 0.7 of the original value

1.3.2. Temperature Ranges

Storage Temperature	-30... +80	℃
Operating Temperature	-10 ... +55	℃
Operating Temperature 2	-20…-10 and +55…+65℃ (reversible malfunction allowed)	

1.3.3. Relative Air Humidity/Temperature Under Operation

Temperature	40℃ ± 2℃
Relative Humidity	93% ± 2%
Time	500h

2. Optical Specification

2.1. Measurement Conditions

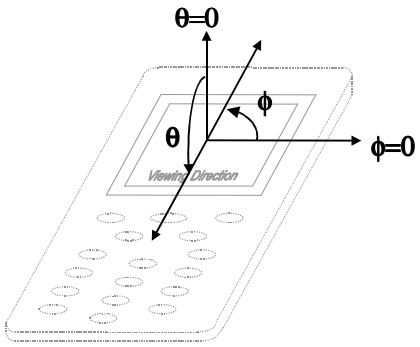
2.1.1. General Measurement Conditions

Unless specified, the following test conditions are valid:

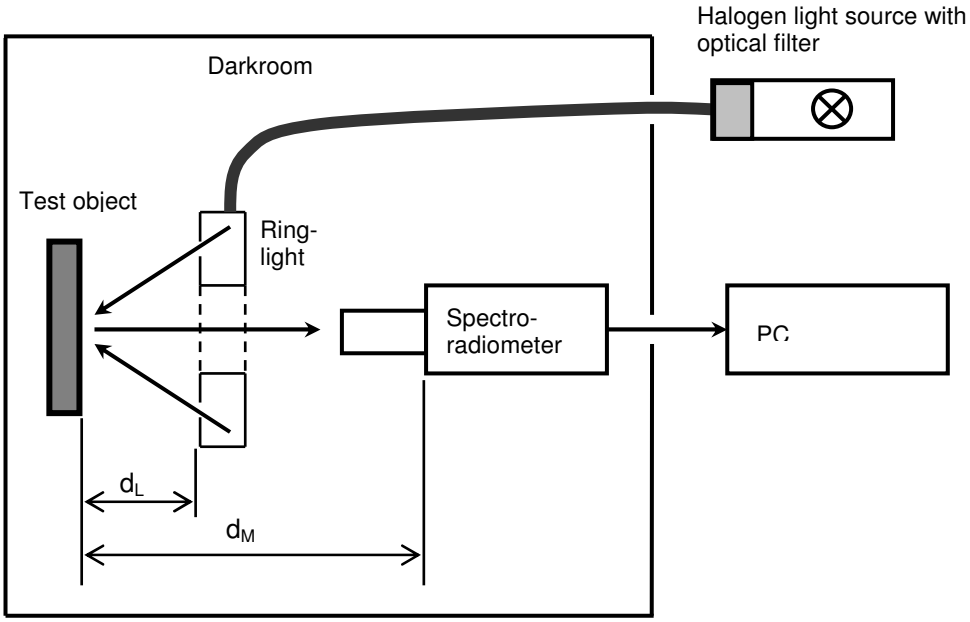
Room Temperature	23 (+/-4)	℃
Air Pressure	70 ... 110	kPa
Relative Humidity	10 ... 85	%RH
Hard- and Software-Settings	as specified in chapter 3.1	
Main Viewing Angle	Θ=Φ=0°	

2.1.2. Viewing Angles

Azimuth Angle : Φ
Tilt Angle : Θ



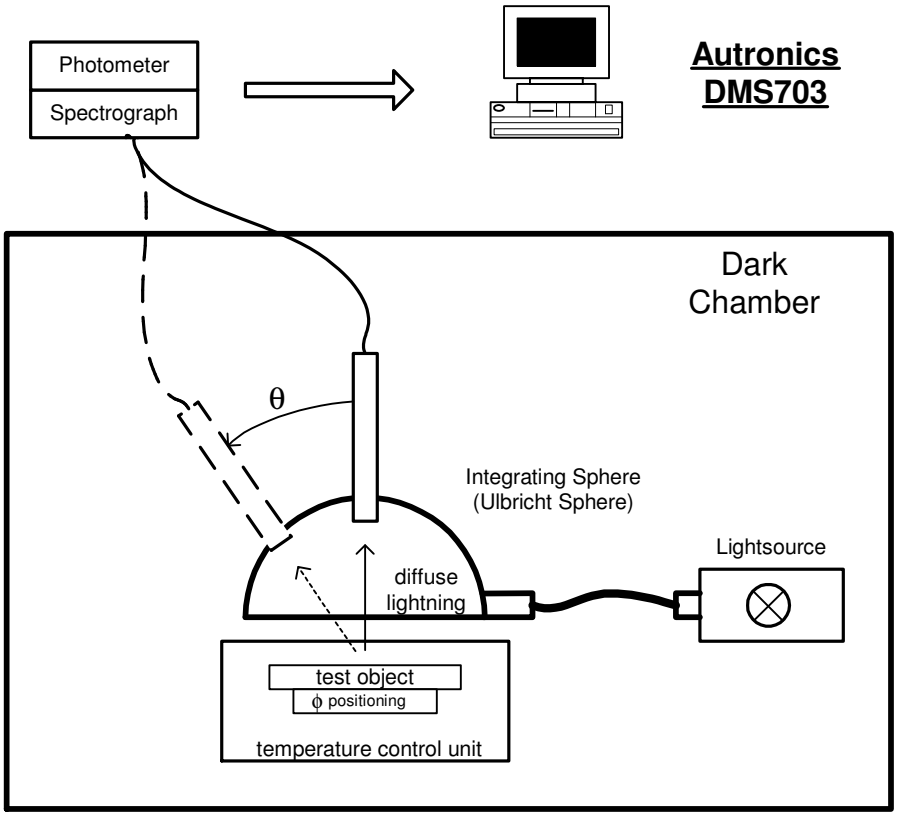
2.1.3. LCD Optical Measurement Equipment



Specification

Spectroradiometer	Minolta CS-1000
Objective	Standard (50mm, f:1.4), Macro (50mm, f:2.8)
Ring light optical diameter	80mm
Reflectance Standard	Gigaherz Optik BN-0201-01 (calibrated)
White light source	Halogen Ring Light with optical daylight filter. Diameter=80mm. Light source equivalent Type C (colour temperature=6774K)

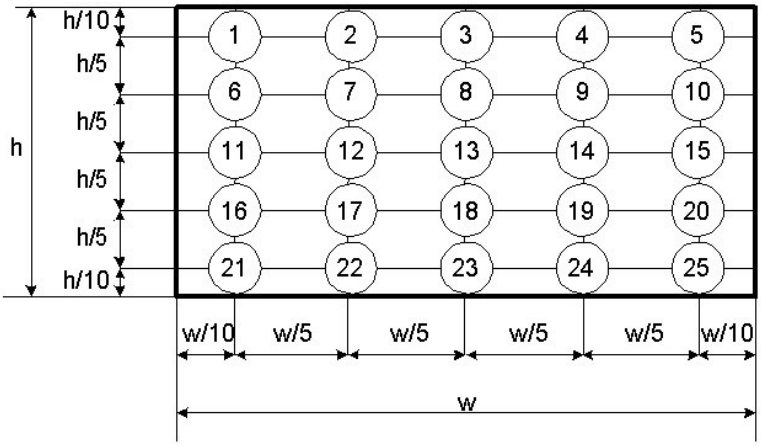
Measuring Distance d_M [mm]	155	225	450
Lighting Distance d_L [mm]	55	125	350
Objective type	Macro	Macro	Standard
Measuring point diameter [mm]	1.15	3	8



Specification Autronic DMS703:

Spectrograph	CCD Spect2
Photometer	PT100
Temperature Control	HSC-3 (air-forced temp. control, temp.range from -35°C to +85°C)
Reflectance Standard (Cal.plate)	Labsphere ID SRS-99-020
Lightsource	Halogen Lightsource with daylight filter Uniform Source Integrating Sphere (Ulbricht Sphere)

2.1.4. Measuring Points



h: height of active area
w: width of active area

2.2. Optical Characteristics

2.2.1. Contrast

Introduction

Contrast is measured under Design Viewing Direction (perpendicular to display surface) in reflective and transmissive mode.

Measurement conditions: MDS

Measuring Equipment	Autronic DMS703
Objective	
Measuring Distance d_M	
Measurement Point Diameter	3mm
Measurement Point Location	Active Area center point (No. 13)
Light Source	Reflective Mode: Integrating Sphere Transmissive Mode: Internal Module Light
Lighting Distance d_L	
Test pattern	A: All_px_white B: All_px_black
Contrast setting	Default values as stored in the display module

Definitions

Contrast ratio (according ISO/FDIS 13406-2)

$CR = L_A/L_B$

where

L_A: Luminance measured with test pattern A

L_B: Luminance measured with test pattern B

Characteristics

Item	Symbol	Condition	Rating		
			Min.	Typ.	Max
Contrast Ratio	CR	Reflective Mode	6	11	-
Contrast Ratio	CR	Transmissive Mode	40	70	-

2.2.2. Contrast Over Viewing Angle And Temperature

Measurement conditions:

Measuring Equipment	Autronic DMS703
Measuring Distance d_M	
Measurement Point Diameter	3 mm
Measurement Point Location	Active Area center point (No. 13)
Light Source	Reflective Mode: Integrating Sphere Transmissive Mode: Internal Module Light
Test pattern	A: All_px_white B: All_px_black

Definitions

Contrast ratio (according ISO/FDIS 13406-2)

$CR = L_A/L_B$

where

L_A: Luminance measured with test pattern A

L_B: Luminance measured with test pattern B

Characteristics

Contrast Ratio in reflective mode:

Θ	Φ	Contrast Ratio (reflective)					
		-20℃		25℃		55℃	
		Min.	Typ.	Min.	Typ.	Min.	Typ.
0°	0°	3	6	6	11	5	9
15°	270°	3	6	5	10	4	8
30°	0°	-	7	-	9	-	8
	90°	-	5	-	9	-	7
	180°	-	5	-	7	-	6
	270°	2	4	4	7	3	6

Contrast Ratio in transmissive mode:

Θ	Φ	Contrast Ratio (transmissive)					
		-20℃		25℃		55℃	
		Min.	Typ.	Min.	Typ.	Min.	Typ.
0°	0°	14	25	40	70	42	73
15°	270°	18	32	16	28	11	19
30°	0°	-	2	-	4	-	4
	90°	-	2	-	4	-	4
	180°	-	7	-	7	-	6
	270°	5	9	4	8	3	6

Viewing angle:

Item	Symbol	Condition	Rating		
			Min.	Typ.	Max
Viewing angle with max. contrast (Main Viewing Direction)	$\Theta_{CR\ max}$	Transmissive Mode	-5	5	15
Viewing angle with max. contrast (Main Viewing Direction)	Φ_{CRmac}	Transmissive Mode	265	270	275

2.2.3. Spatial Contrast Variation

Introduction

The Contrast Ratio variation inside the active area is defined as Spatial Contrast Variation

Measurement conditions:

Measuring Equipment	Autronic DMS703
Measurement point diameter	3 mm
Measurement Point Location	Number 1,3,5,11,13,15,21,23,25
Light Source	Internal Module Light
Lighting Distance d_L	
Test pattern	A: All_px_white B: All_px_black

Definitions

Spatial Contrast Variation ΔCRS

$\Delta CRS = ((CR_{max}-CR_{min})/CR_{max}*100\%)$

where

$CR_{max} = MAX\ (CR_i)$; $CR_{min} = MIN\ (CR_i)$;

CR_i is the Contrast Ratio at the defined measuring points.

Characteristics

Item	Symbol	Condition	Rating		
			Min.	Typ.	Max
Spatial Contrast Variation	ΔCRS	Reflective Mode	-	-	19%

2.2.4. Colour

Measurement conditions:

Measuring Equipment	Minolta
Objective	Macro
Measuring Distance d_M	225 mm
Measurement Point Diameter	3 mm
Measurement Point Location	No.: 13
Light Source	Reflective Mode Integrating Sphere Transmissive Mode: Internal Module Light
Lighting Distance d_L	
Test pattern	Red, Green, Blue, White: maximum colour saturation

Definitions

Panel colour coordinate according the CIE colour system (CIE 1976). In general, it is always requested to measure the X, Y and Z values.

Here u', v' and L* are according CIE 1976:

$$u' = \frac{4 \cdot X}{X + 15 \cdot Y + 3 \cdot Z}$$

$$v' = \frac{9 \cdot Y}{X + 15 \cdot Y + 3 \cdot Z}$$

$$L^* = 116 \cdot \left(\frac{Y}{Y_n} \right)^{1/3} - 16$$

Colour distance definition (maximum allowed colour distance to specified typical colour coordinate):

$$\Delta u'v' = \sqrt{\Delta u'^2 + \Delta v'^2}$$

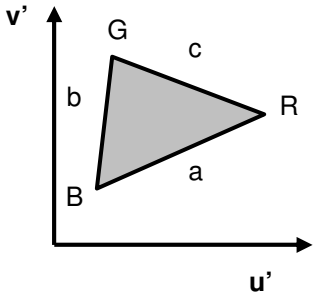
where:

$$\Delta u' = Max\left\{ \left| u'_{typ} - u'_{\max} \right|, \left| u'_{typ} - u'_{\min} \right| \right\}$$

$$\Delta v' = Max\left\{ \left| v'_{typ} - v'_{\max} \right|, \left| v'_{typ} - v'_{\min} \right| \right\}$$

Colour Gamut definition:

$$F = \sqrt{s(s-a)(s-b)(s-c)} * 1000$$



where

$$s = \frac{(a+b+c)}{2}$$

$$a = \sqrt{(u'_{blue} - u'_{red})^2 + (v'_{blue} - v'_{red})^2}$$

$$b = \sqrt{(u'_{blue} - u'_{green})^2 + (v'_{blue} - v'_{green})^2}$$

$$c = \sqrt{(u'_{red} - u'_{green})^2 + (v'_{red} - v'_{green})^2}$$

Colour Gamut Ratio related to NTSC:

CGR:=F(Display) / F(NTSC)

NTSC primaries:

	U'	v'
Red	0,4769	0,5285
Green	0,0757	0,5757
Blue	0,1522	0,1957

F(NTSC)=74,42

Distance White Point to the Red, Green, Blue Point:
Colour distance White-Red:

$$\Delta CWR = \sqrt{(u'_{white} - u'_{red})^2 + (v'_{white} - v'_{red})^2}$$

Colour distance White-Green:

$$\Delta CWG = \sqrt{(u'_{white} - u'_{green})^2 + (v'_{white} - v'_{green})^2}$$

Colour distance White-Blue:

$$\Delta CWB = \sqrt{(u'_{white} - u'_{blue})^2 + (v'_{white} - v'_{blue})^2}$$

Reflectance factor:
as defined in chapter 2.2.8 “Reflectance, Transmittance”

Characteristics

Mode	Item		Symbol	Min.	Typ.	Max.	Unit
Reflective	Colour coordinate	Red	u'	0.26	0.28	0.29	
			v'	0.44	0.47	0.50	
		Green	u'	0.15	0.16	0.18	
			v'	0.48	0.50	0.53	
		Blue	u'	0.11	0.13	0.15	
			v'	0.35	0.40	0.44	
		White	u'	0.17	0.19	0.20	
			v'	0.44	0.47	0.50	
	Colour Gamut Ratio related to NSTC		CGR	5	9	-	%
Transmissive	Colour coordinate	Red	u'	0.35	0.34	0.34	
			v'	0.45	0.50	0.54	
		Green	u'	0.13	0.15	0.17	
			v'	0.51	0.54	0.57	
		Blue	u'	0.08	0.12	0.15	
			v'	0.21	0.31	0.39	
		White	u'	0.16	0.18	0.19	
			v'	0.41	0.46	0.50	
	Colour Gamut Ratio related to NSTC		CGR	25	32	-	%

(*1) Refer to Colour Tolerance Table

Colour Luminance

Measurement conditions: Same as colour coordinates

Mode	Item		Symbol	Min.	Typ.	Max.	Unit
Transmissive	Luminance	Red	Lv	-	25	-	cd/m²
		Green	Lv	-	62	-	cd/m²
		Blue	Lv	-	18	-	cd/m²

2.2.5. Colour uniformity versus viewing angle

Introduction

The display colour uniformity of each primary colour (Red,Green Blue) should fulfil following requirements. The reference colour (u'_{Ref}, v'_{Ref}) coordinate for any primary colour is determined in the main viewing direction.

Measurement conditions:

Measuring Equipment	Autronic
Measurement Point Diameter	1mm
Measurement Point Location	Active Area Center Point
Light Source	Transmissive Mode: internal
Test pattern	Red, Green, Blue, White: maximum colour saturation
Contrast setting	Default values as stored in the display module

Definitions

Colour distance definition:

$$\Delta u'v' = \sqrt{\Delta u'^2 + \Delta v'^2}$$

where:

$$\Delta u' = \left| u'_{Ref}(0°,0°) - u'(\Theta,\Phi) \right|$$

$$\Delta v' = \left| v'_{Ref}(0°,0°) - v'(\Theta,\Phi) \right|$$

Reference sample1 represents the module design and determine typical performance of the LCD module. Variation is allowed within the limits of the individual components. Overall characteristics must not be affected.

Transmissive:

		Δu'v' Colour uniformity versus viewing direction
		(Transmissive Red)
		Room Temperature
Θ	**Φ**	**Typ.**
15	0	0.029
	90	0.040
	180	0.016
	270	0.012
30	0	0.075
	90	0.096
	180	0.048
	270	0.048

		Δu'v' Colour uniformity versus viewing direction
		(Transmissive Green)
		Room Temperature
Θ	**Φ**	**Typ.**
15	0	0.009
	90	0.013
	180	0.004
	270	0.002
30	0	0.031
	90	0.040
	180	0.019
	270	0.019

		Δu'v' Colour uniformity versus viewing direction
		(Transmissive Blue)
		Room Temperature
Θ	**Φ**	**Typ.**
15	0	0.035
	90	0.033
	180	0.015
	270	0.009
30	0	0.091
	90	0.076
	180	0.061
	270	0.061

2.2.6. Spatial Colour And Brightness Uniformity

Measurement conditions:

Measuring Equipment	Minolta
Objective	Macro
Measuring Distance d_M	
Measurement Point Diameter	3mm
Measurement Point Location	No.: 1,3,5,11,13,15,21,23,25
Light Source	Reflective Mode: Integrating Sphere (see 2.4.4.) Transmissive Mode: Internal module light
Lighting Distance d_L	
Test pattern	all_px_white
Contrast setting	Default setting as stored in the display module

Definitions

Spatial Colour Uniformity:
All spatial colour variation are defined relative to the colour coordinate values in the centre of the active area (Measurement Point No. 13)

$$\Delta u'_i = u'_i - u'_{13}$$
$$\Delta v'_i = v'_i - v'_{13}$$
$$\Delta SCU = Max\sqrt{(\Delta u'_i)^2 + (\Delta v'_i)^2}$$

where
u'_i ; v'_i are the colour coordinates at measuring points 1 ... 25

Luminance variation

$$\Delta Lv_{13} = Max\left|\frac{Lv_{13} - Lv_i}{Lv_{13}}\right| * 100\%$$

where
Lv_i is the luminance at measuring points 1 ... 25

Mean Luminance on panel surface
Lv_{mean} = AVG (Lv_1 ... Lv_{25})
where
Lv_1 ... Lv_{25} is luminance at measuring points 1 ... 25

Characteristics

Mode	Item	Symbol	Min.	Typ.	Max.	Unit
Reflective	Spatial Colour Uniformity	ΔSCU			0.008	
Transmissive	Spatial Colour Uniformity	ΔSCU			0.010	
	Luminance variation	ΔLv_{13}			25	%
	Mean Luminance	Lv_{mean}	70	110	-	cd/m²

2.2.7. Crosstalk

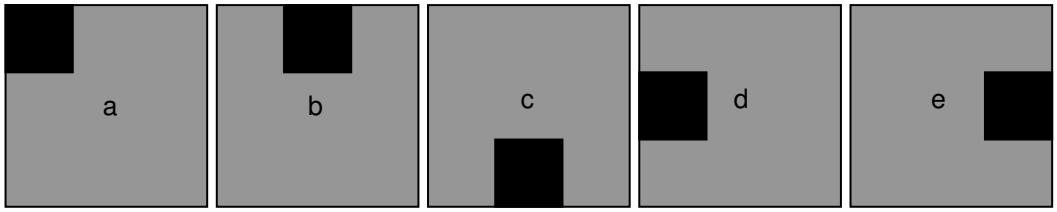
Introduction
The colour and luminance within a restricted display area can be influenced by the content of the remaining display area. Crosstalk and Image-Dependent Contrast Variation could cause this effect.

Measurement conditions:

Measuring Equipment	Minolta
Objective	Macro
Measurement Point Location	No.: 13
Light Source	Transmissive Mode: internal module light
Lighting Distance d_L	
Test pattern	See below
Contrast setting	Default setting as stored in the display module

Test Pattern:

The crosstalk of the display (XT) is evaluated by using midgrey (50% grey) picture with black box (1/3of height x 1/3 of width of display area). Measurements are done in the center of the display



Horizontal crosstalk (HXT): = 100% x { max|Yd-Ya|,|Ye-Ya| } / Ya

Vertical crosstalk (VXT): = 100% x { max|Yb-Ya|,|Yc-Ya| } / Ya

Crosstalk

Item	Symbol	Condition	Rating		
			Min.	Typ.	Max
Max Crosstalk (Max (HXT, VXT))	XT	Internal light	0	-	3%

OR:

Introduction
Crosstalk is an effect where the contrast of a display pixel is influenced by the state of the related pixels.

2.2.8. Reflectance, Transmittance

Introduction

Reflectance (diffuse reflection factor) of the LCD module is determined as factor to a standard white reference calibration plate. It is measured with the whole LCD module (including reflectance foils,…).

Transmittance (diffuse transmission factor) is a measure for the LCD panel transparency. The Light Source for this measurement is the accompanying LCD-module backlight system (LEDs, Lightguide).

Measurement conditions:

Measuring Equipment	Minolta // Autronic DMS703
Objective	Macro // Standard
Measuring Distance d_M	
Measurement Point Diameter	
Measurement Point Location	No.: 13
Light source	Reflectance: Integrating Sphere Transmittance: LCD internal light
Reflectance Plate	Reflectance Standard (Cal. plate)
Lighting Distance d_L	
Test pattern	All_Px_white
Contrast setting	Maximum

Measuring procedure:

Reflectance:

1. Measure the luminance of the Reflectance Plate
2. Replace the calibration plate with the LCD module.
   Backlight: OFF.
   Negative mode displays: Display ON, maximum contrast.
   Measure the luminance on the LCD panel surface.

Transmittance:

The light source is located at the backside of the panel.

1. Measure the light source
2. Place the LCD panel in front of the light source. Measure the luminance on the LCD panel surface

Definitions

$$R = \frac{Lv_{LCD-Module}}{Lv_{Rflec\,tan\,cePlate}} * 100\%$$

$$\tau = \frac{Lv_{LCD-Panel}}{Lv_{LightSource}} * 100\%$$

Characteristics

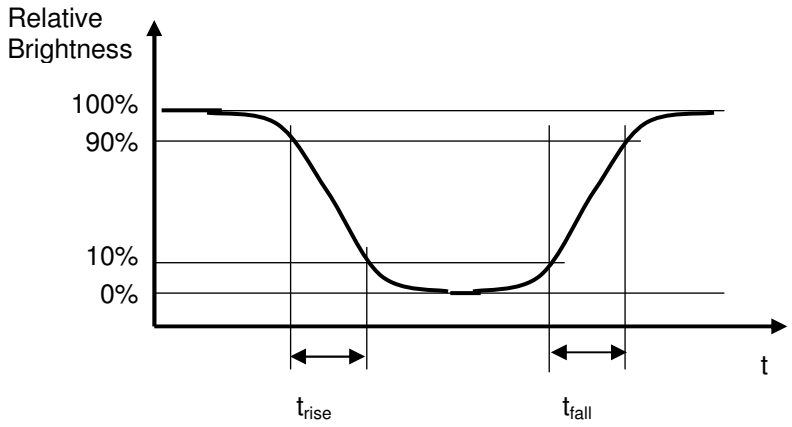
Item	Symbol	Condition	Rating		
			Min.	Typ.	Max
Reflectance factor integrating sphere	R		5%	7%	-

2.2.9. Response Times

Measurement conditions:

Measuring Equipment	Autronic DMS703
Objective	
Measuring Distance d_M	
Measurement Point Diameter	3mm
Measurement Point Location	No.: 13
Light Source	Internal module light
Lighting Distance d_L	
Test pattern	Black, White

Definitions

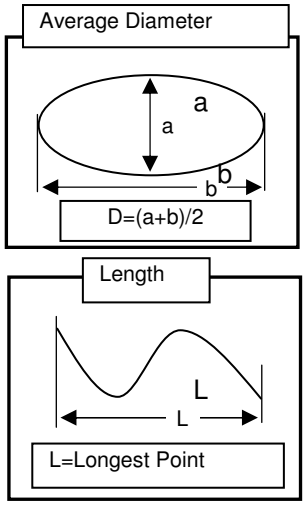


Characteristics

Item	Symbol	Temperature	Min	Typ.	Max	Units
Rise time	t_r	-20℃	-	240	450	ms
		0℃	-	60	100	ms
		+25℃	-	20	35	ms
		+55℃	-	10	20	ms
Fall time	t_f	-20℃	-	360	650	ms
		0℃	-	90	150	ms
		+25℃	-	30	55	ms
		+55℃	-	15	30	ms

2.2.10. Cosmetic Defects

Definitions: Cosmetic Defects



	Inspection standards				note
	No count	Count		NG	
Black or white spots	D < 0.15	0.15 <=D<= 0.25	N<=2	D>0.25	*1
Lint	L < 0.15	0.15 <=L<= 2.0 width < 0.03	N<=2	L>2.0	*1
Scratch	-	L< 2. 0 width < 0.05	N<=3	L>=2.0	*2
Polarizer Dent or Bubble	D<0.15	0.15<=D<=0.3	N<=3	D>0.30	*2

*1 Extraneous substances

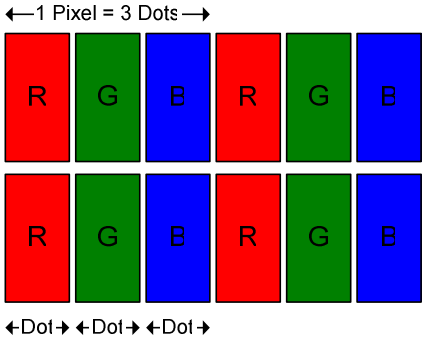
*2 Brightness on the surface of the panel must become 2500 ± 500 lx by using an external illumination.(Adjust the distance between inspector's eyes and LCD to 35±5cm.)

*Please refer to specifications for the inspection area of the externals inspection.

No cosmetic defects as defined above shall appear, when a cushion is placed upon the module (see drawing) and is pressed against the module with a force between 10N to 20N.

2.2.11. Pixel Fault

A pixel consists of 3 sub-pixel (red, green and blue).



Pixel defect definition
A pixel is defective, if a single sub-pixel cannot be controlled and therefore it stays permanent on or off. The pixel defect appears black or bright (red, green or blue)
Distance between more than one Pixel defect :
A maximum of 1 sub-pixel defect is allowed within a radius of 5mm

Visual inspection :

Item	**Max defect that count for a minor delivered quantity**	**dimension that do not count as defect**	**dimension that count as defect**
complete Pixel (3dot)	**0**	n.a.	n.a
bright adjacent Sub Pixel (2dot)	**0**	n.a.	n.a
black adjacent Sub Pixel (2dot)	**2 pair**	n.a.	1 pair with RG, GB, BR combination
bright dot defect	**1**	not visible through 5% transparency of filter Scratches on the color filter Visible under the half of a dot	green, red or blue dots when the Module lights, dots appear bright in display at black picture position visible through 5% transparency of filter Scratches on the color filter and Cr Mask Visible over the half of a dot
black dot defect	**4**	n.a.	green, red or blue dots when the Module lights, dots appear black in display at white picture position
max. of all dot defect	**4**	n.a.	all

3.

Electrical Characteristics

3.1. Display Controller

See also Display Controller Specification: LR38826 V1.32

3.1.1. Hardware-Settings

All colour settings and contrast settings are stored in the display module
Module identification, fixed by hardware coding on the display module (see also electrical interface).

3.1.2. Software-Settings

Refer to the "appendix" for all software settings.

Temperature Compensation:

No external Temperature Compensation necessary, implemented in the display module

3.1.2.1. Gradation Palette (Gamma Correction)

Integrated and adjusted in the display module.
(can be adjusted also by LCD Mobile Phone software)

Measurement conditions:

Measuring Equipment	Minolta
Objective	Macro
Measurement Point Location	middle of display, measured perpendicular
Light Source	Transmissive Mode: internal module light
Spot Diameter	3 mm
Test pattern	Grey scales 0 – 31 (i.e. black to white)

$$L = (L_{31}-L_0)\, x^{\gamma} + L_0$$

where:
L= luminance measured for grey scale x (has a value between 0 and 1)
x= normalized grey scale (x=0 for a black picture, x =1 for a white picture)
L_{31} = luminance measured for a white picture
L_0 = luminance measured for a black picture

step 1:
Measure Luminance for 32 grey scales (x ranges from 0 to 1) -> measured values (L)
step 2:
Subtract the luminance value for grey scale x=0 (i.e. black) from all measured values -> corrected measured values (i.e. $L - L_0$)
step 3:
Normalise all values that the maximum value is one-> Divide all Values by maximum corrected measured value -> normalised value (i.e. $(L - L_0)/(L_{31} - L_0)$ where L_{31} is luminance measured for x=1)
step 4:
Determine the gamma correction value of the display according formula above

Item	Symbol	Condition	Rating		
			Min.	Typ.	Max
Gamma correction value *)	γ	perpendicular measurement	1.9	2.2	2.5

*) Gamma values measured by LCD according to limit samples from Sharp

3.2. DC Characteristics

GND = 0V, Temp = 25°C unless noted otherwise

Item	Symbol	Condition	Rating			Unit
			Min.	Typ.	Max	
Logic Supply Voltage	V_{DD}	-	2.80	2.90	3.00	V
High-level Input Voltage	V_{ICH}	-	0.8xVdd		Vdd	V
Low-level Input Voltage	V_{IL}	-	0		0.15xVdd	V
Input Leakage Current	I_{IN}	-	-10	-	10	uA
Supply Voltage DC/DC	V_{EE}	-	2.80	2.90	3.00	
Supply Current Normal Mode [= 65k/full display]	I_{DD}	Normal Mode 1-pixel alternating chess pattern, maximum contrast ratio, (ULC-Mode)	-	1800 (310)	2600 (440)	µA
Supply Current	I_{DD}	Normal Mode Idle Bitmap (ULC-Mode)	-	1900 (330)	2700 (470)	µA
Supply Current	I_{DD}	Normal Mode Random Bitmap (ULC-Mode)	-	2070 (320)	2969 (460)	µA
Supply Current	I_{DD}	Partial Display Mode, 21lines, 65636 colours any Bitmap (ULC-Mode)	-	1350 (250)	1780 (330)	µA
Supply Current	I_{DD}	Partial Display Mode, 21lines, 8 colours any Bitmap (ULC-Mode)	-	1350 (250)	1780 (330)	µA
Supply Current	I_{DD}	full video mode 65636 colours (15fps) Random data transmission	-	2750	3620	µA
Backlight Voltage	V_f	3 LED serial	-	-	12	V
Backlight Current	I_f	TBD	-	-	15	mA

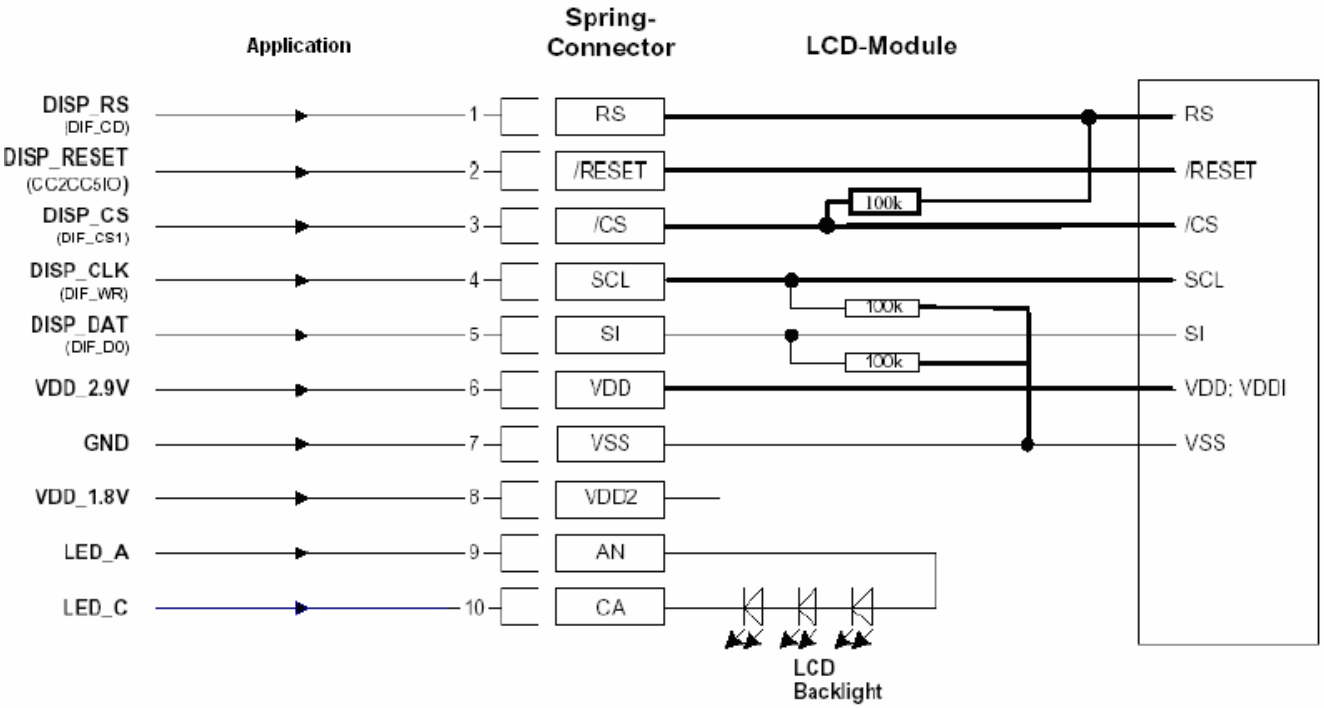
3.3. Interface

- synchronous serial interface (8-bit or 16-bit)
- Speed: 13 Mbit/s
- Connection: 10-pins incl. power supply (Spring connector on LCD PCB)
- Connection lines and pining:

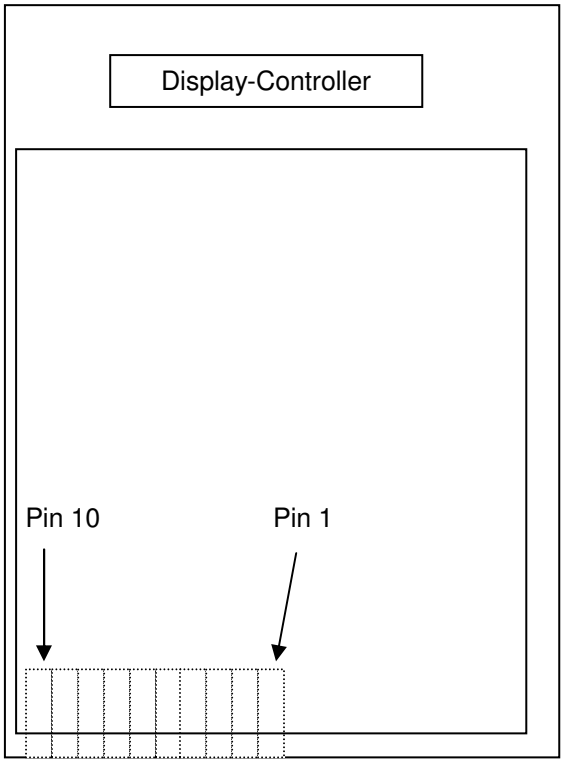
Pin description:

LCD Side			
Pin Number	**Pin Name**	**Description**	**I/O**
1	RS	Control / display data flag	O/I
2	RESET	Reset (low active)	O
3	CS	Chip select main display (low active)	O/I
4	SCL	Serial clock	O
5	SI	Serial data	O
6	VDD=2.9V	Power supply V_{DD1}	O
7	VSS	Power supply GND	O
8	n.c.	n.c	
9	AN	Anode LED	O
10	CA	Cathode LED	O

n.c: not connected



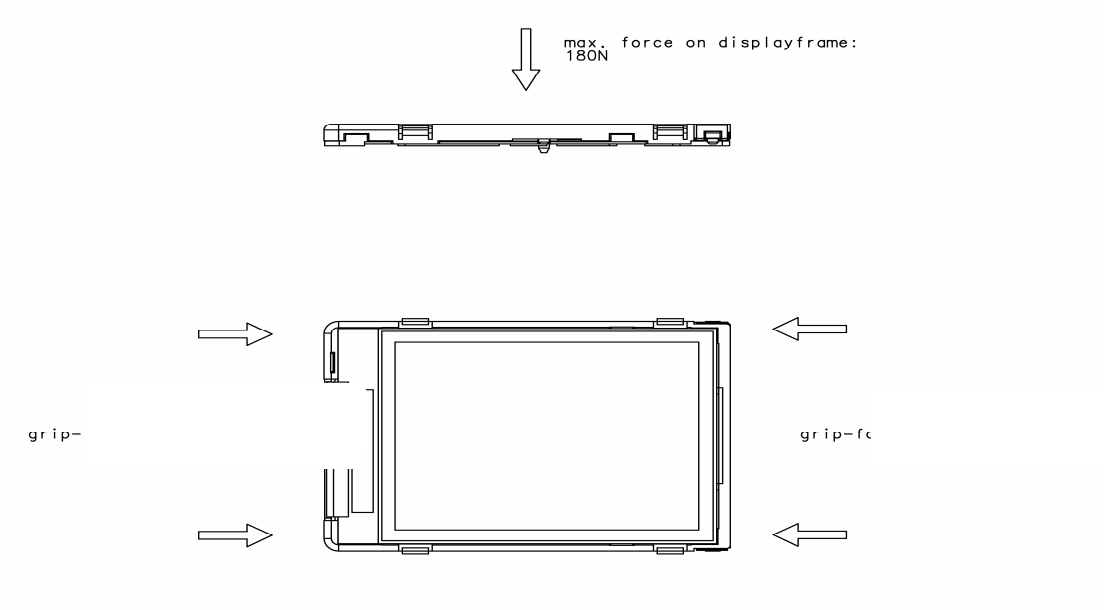
Schematic drawing of spring connector interface:
(Topview! (Look through the panel!!)



4. Mechanical Specification

For the mechanical dimensions see the according documents.

4.1. Module Assembly on LCD PCB



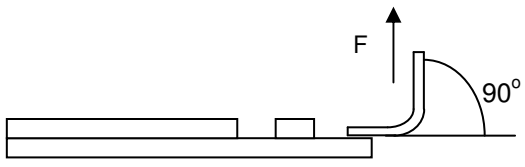
4.2. Interface Contact Pad

Gold plated for interconnection to spring connector.

Ni layer thickness: 1- 5µm
Gold thickness: 0.06 - 2 µm

4.3. FPC to Panel Interconnection Peel Off Profile Test

Measuring condition: perpendicular to the glass, velocity: 12 mm/min, 25°C



Peeling strength
Peel forces F ≥ 3 N/cm
For this value Sharp guarantee “long life-time” reliability

4.4. ITO Corrosion Protection

The ITO patterns are covered in order to avoid ITO corrosion.
No chemical reaction between the ITO-protection, the ACF and the cushion is allowed.

4.5. Dangerous Substances

The component must not contain any dangerous substances e.g.:

- Cadmium
- Chlorofluorocarbons
- Organic compounds that are harmful for handy and user
- Asbestos or asbestos materials
- Acid materials

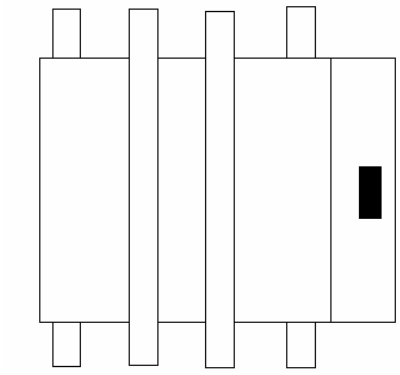
4.6. Tensile Strength (EN 843-1 or JIS for ceramic bending measurement)

Tensile Strength (EN 843-1 or JIS for ceramic bending measurement)
Test has to be done with a complete LCD-panel
This test is not subject for rejection of materials. The test results have to be reported to LCD monthly.

test conditions for 4-point-bending-test:

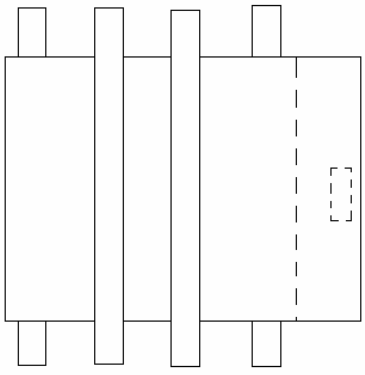
- notice temperature (20-30℃) and humidity (40-60 %),
- distance of the lower cylinders: 20 mm
- distance of the upper cylinders: 10 mm
- adjust sample centric like seen in PICTURE 1 below
- adjust sample centric like seen in PICTURE 2 below is optional test setup upon request
- pre load max. 2 N (for external displacement measurement),
- traverse speed (loading speed): 1.7 mm/min,
- fracture force: first drop (> 10 N) in the force-displacement-diagram,
- document fracture force and displacement at this point for each sample,
- Sample frequency (how many, and when test samples taken out from mass production): when in mass production 5 samples per shift
- The detailed test specification, as the test is conducted by supplier, should be provided upon request.

Test-cylinder diameter of LCD: 5 mm
Test-cylinder diameter: 4 mm



PICTURE 1

- **(smaller glass is facing up)**



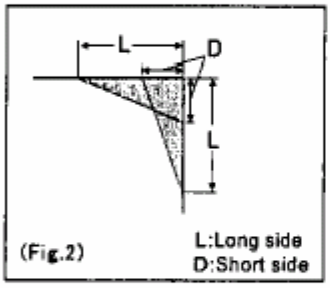
PICTURE 2

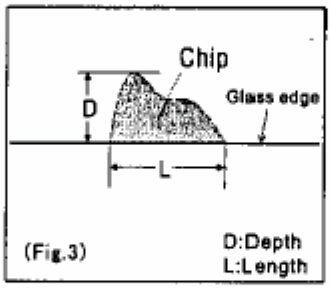
(lager glass is facing up)

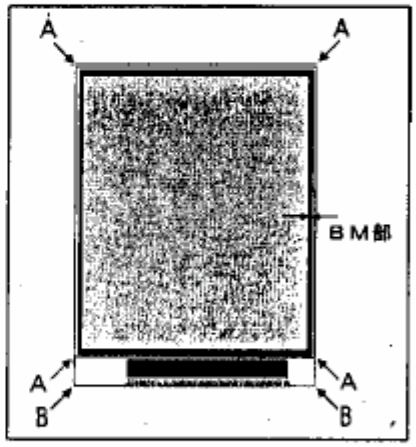
4.7. Chipped glass edges (of LCD-panel)

Definition: Chipped glass edge:

Items	Inspection criteria (Acceptable level)	note
Chip on glass corner (Part A)	L <= 5mm , D <= 1mm L + D <= 5mm *BM (black mask) is not affected.	Fig.1-A fig.2
Chip on the terminal glass (Part B)	L <= 3mm , D <= 3mm *FPC and patterns are not affected	fig.1-B fig.2
Chip on glass edge	L <= 10mm , D <= 1mm *BM (black mask) is not affected	fig.3





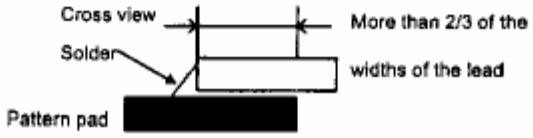


10-3 Parts assembly

10-3-1 Parts alignment

(a) Flat packaged LSI, IC

Locate 2/3 or more of the widths of the lead on the pattern pad.



Characteristics:

Type of defect	LCD glass cut to size	
Crack	Visibility	none

5. Climatic- And Environmental Tests As Performed by LCD

The following tests are made by LCD with complete assembled devices.

Test Standard Conditions
The following standard conditions apply unless the individual conditions specify otherwise:

Temperature	23 ± 5	℃
Air Pressure	860 to 1060	mbar
Rel. Humidity	45 to 75	%RH
Hard- and Software settings	as specified in chapter “Electrical Characteristic”	

5.1. Mechanical Stress Tests

5.1.1. Mechanical Test Series

The mechanical test sequence is an arrangement of single tests described below. The specimen has to go through all the tests in the given order.

Step 1: Vibration
Complete test procedure

Step 2: Vibration random
Complete test procedure

Step 3: Shock
Complete test procedure

Step 4: Shock (continuous shock test)
Complete test procedure

Product requirements
No mechanical damage to the device

Step 1: Vibration

Valid standard	DIN IEC 68-2-36	
Frequency range	10 to 20 Hz	20 to 500 Hz
Acceleration	3.1 mm amplitude	5 g
Duration	2 h for each position (axis) = 10 repetitions	
Test	all 3 axes (X, Y, Z)	
Phone	ON	

Step 2: Vibration random

Type	random vibration	
Frequency range	10 to 12 Hz	12 to 150 Hz
Acceleration	1.92 m^2/s^3 = 0.02g^2/Hz	-3 dB/oct.
Duration	3 x 30 minutes	
Test	all 3 axes (X,Y, Z)	
Phone	ON	

Step 3: Shock

Type	semi-sinusoidal current
Acceleration	500 g
Shock duration	1 ms
Number of shocks	1 shock / axis
Test	3 axes = 6 positions (± X, Y, Z)
Phone	ON

Step 4: Shock (continuous shock test)

Acceleration	25 g
Shock duration	6 ms
Number of shocks	1000 shocks per position
Test	3 axes = 6 positions (± X, Y, Z)
Phone	ON

5.1.2. Vibration With Temperature

Type	vibration	
Frequency range	10 to 20 Hz	20 to 500 Hz
Acceleration	3.1 mm amplitude	5 g
Temperature range	-25°C and +65°C	
Duration	2 h / axis and temperature	
Test	3 axes	
Phone	OFF	

5.2. Climatic Stress Tests

5.2.1. Climatic Test Sequence

The climatic test sequence is an arrangement of single tests described below. The specimen has to go through all the tests in the given order. The specimen has to be checked after each test.

Step 1: Dry heat
Complete test procedure

Step 2: Temperature shock
Complete test procedure

Step 3: Damp heat
Complete test procedure
exception:
Number of repetitions 1 of 6

Step 4: Constant cold
Complete test procedure

Step 5: Damp heat

Complete test procedure
exception:
Number of repetitions 5 of 6

Product requirements
No changes on the test sample

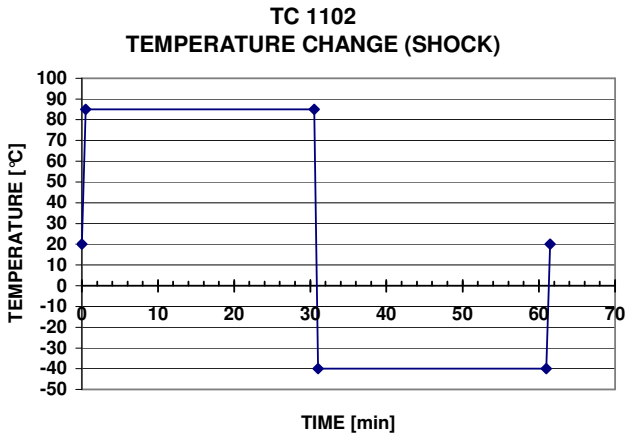
5.2.2. Dry Heat

Valid standards	EN 60068-2-2
Temperature	70°C ± 2°C
Humidity	< 50%
Test duration	16h
Phone	OFF

Product requirements
No changes on the test sample

5.2.3. Temperature Change (shock)

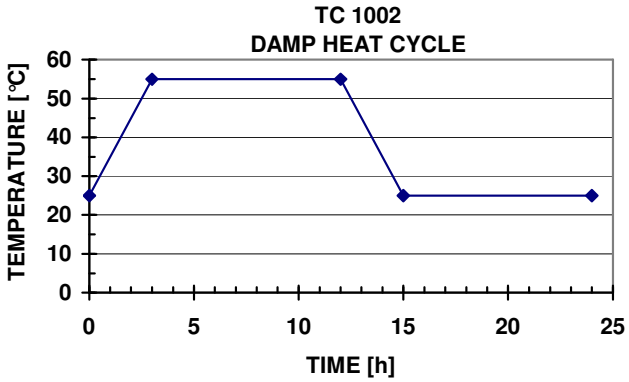
Valid standard	DIN IEC 68-2-14 nb
High temperature	+85°C ± 2°C
Low temperature	-40°C ± 2°C
Temp. changeover time (dual chamber system)	<30 sec.
Test duration	1h
Number of repetitions	100
Phone	OFF



Product requirements
No changes on the test sample

5.2.4. Damp Heat Cycle

Valid standards	DIN IEC 68-2-30 Db
High temperature	55°C ± 2°C
Low temperature	25°C ± 2°C
Humidity	93% ± 3%
Test duration	12h + 12h
Number of repetitions	6
Phone	ON



Product requirements
No changes on the test sample

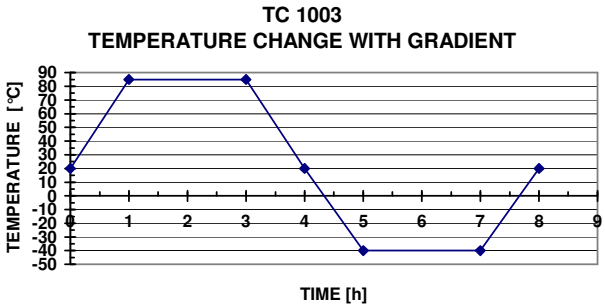
5.2.5. Constant Cold

Valid standard	DIN IEC 68-2-1
Temperature	-40°C ± 2°C
Test duration	16h
Phone	OFF

Product requirements
No changes on the test sample

5.2.6. Temperature Change With Gradient

Valid standard	DIN IEC 68-2-14 nb
High temperature	+85°C ± 2°C
Low temperature	-40°C ± 2°C
Temperature change	1°C ± 0,2°C / min
Test duration	8h
Number of cycles	10
Phone	OFF



Product Requirements
No changes on the device

5.2.7. Heat With Solar Radiation

Valid standard	DIN IEC 68-2-5
Ambient temperature	55°C ± 2°C
Irradiation level	1120 W/m²
Duration of irradiation	8h
Storage time in the dark	16h
Storage temperature in the dark	25° ± 3°C
Number of cycles	1
Phone	OFF

Product Requirements
No changes on the device
No aging

5.3. Aging

5.3.1. Mixed Gases And Vibration

Valid standard: DIN IEC 68-2-6
EN 60068-2-60

Step 1: Vibration

Frequency range	10 to 20 Hz	20 to 500 Hz
Acceleration	3.1 mm amplitude	5 g

Duration: 2 h for each position (axis) = 10 repetitions
Test: all 3 axes (X, Y, Z)
Phone: ON

Step 2: Mixed gas
Concentration of gases
Valid standards: EN 60068-2-60, Method 4
SO_2: 0.20 ppm
H_2S: 0.01 ppm
NO_2: 0.20 ppm
CL_2: 0.01 ppm
Temperature: 25°C ± 2°C
Humidity: 75% ± 3% (rel)
Test duration: 5 days
Phone: OFF

Step 3: vibration — See Step 1
Step 4: mixed gases

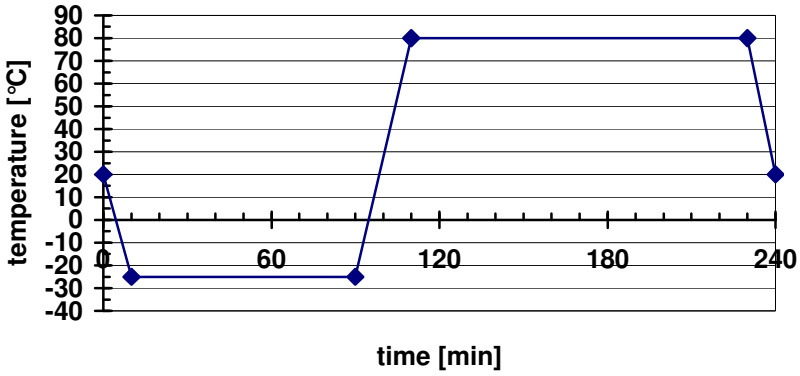
Product requirements
Corrosion is not allowed which may lead to a malfunction.
No material migration is accepted.

5.3.2. Vibration At Extreme Temperatures

Valid standard: ETS 300019-2-2
Type: random vibration
Frequency range: 10 - 20 Hz 20 - 500 Hz

Frequency range	10 to 20 Hz	20 to 500 Hz
Acceleration	0.96 m^2/s^3 = 0.01g^2/Hz	-3 db/oct.
Effective	0.9 g max. 3 sec.	2.6 g

Temperature range: -25°C to +80°C periodic exposure
Test duration: 8h / axis
Test: all 3 axes (X, Y, Z)
Phone: OFF



Product requirements
The function of the device may not be impaired or affected in any way.
The test device may not evidence any mechanical damage (no loose parts).

5.3.3. Aging By Temperature

Temperature	85°C
Test duration	1000 h
Phone	OFF

Half of the devices have to evaluated after the stress duration of 500 h.

Product Requirements
No damages on the test sample

5.3.4. Aging By Damp Heat Constant

Valid standard	DIN IEC 68-2-56 ETS 300019-2-7
Temperature	40°C ± 3°C
Humidity	93% ± 2%
Test duration	42 days
Phone	OFF

Half of the devices have to evaluated after the stress duration of 500 h.

Product requirements
The function of the test device may not be impaired or affected in any way.
The test device may not evidence any mechanical damage (no loose parts).

5.3.5. Mixed Gases And Damp Heat (Cyclic)

Step 1: Concentration of gases

Valid standards	EN 60068-2-60, Method 4
SO_2	0.20 ppm
H_2S	0.01 ppm
NO_2	0.20 ppm
	Cl_2 0.01 ppm
Temperature	25°C ± 2°C
Humidity	75% ± 3% (rel)
Test duration	10 days
Phone	OFF

Step 2: Damp heat cycle	See Chap. 5.2.4
Phone	OFF

Product requirements
Corrosion is not allowed
No changes on the device

5.4. Other Tests

5.4.1. ESD

1) Test of Device
Human Body Model
Contact discharge 1 kV

2) Test within Mobile Phone
The test is only applied to complete assembled devices.
Test according IEC 61000-4-2,
test level see a) and b)

a) Contact discharge 8 kV
Air discharge 15 kV
without ground connection

b) Contact discharge 6 kV
Air discharge 12 kV
with ground connection

For 2a) and 2b) no malfunction of the display is allowed up to 4kV contact discharge and 8 kV air discharge.
No permanent damages allowed above 4kV contact discharge and above 8kV air discharge

5.4.2. Ambient Light Sensitivity

Full functional under sunlight exposure with a luminance of 100.000 Lx
(Exposure to sunlight)
The test is only applied to complete assembled devices.

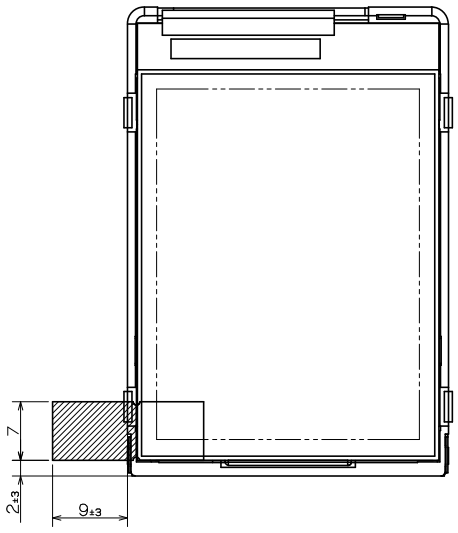
5.4.3. Resistance to EMI

The LCD module is functional under all GSM conditions. The module has to pass the LCD EMI test.
The test is only applied to complete assembled devices.

6. Packaging And Handling Items

6.1. Protection Foil Panel

All display panels are delivered with a protection foil on the panel. The protection foil is easy removable without remains of glue. During the proper removal the coloured pull tab must not be separated from the protection foil. The position of the pull tab is shown in the module drawing (see acc. documents).



GRIPPER POSITION

6.2. Package

The package must prevent damage to the components during transport and must be suitable for electrostatic-sensitive devices.
No poly vinyl chloride is allowed in the package.

Tray definition:

- Tray dimensions must be: 330 x 245 mm^2
- Gripping trough on long side, width: 20-25mm
- Surface resistance: $10^5 \leq Rs \leq 10^{10}\ \Omega$
  (Measurement according IEC 1340-5-1)
- All modules must be delivered with display panel side up (see also tray drawing)
- No alternating tray stack allowed (all modules in one direction)
- The tray pack must be wrapped with one tape to fix the tray stack
- The top tray of the tray pack should be covered always with an empty tray
- Max. dimension of tray pack is 260 x 360 x 90mm^3
- Number of modules per tray: 12
- Number of tray per cardboard box: 8 (+1 cover)
- Recommended box dimensions: 1200x800x H 970 mm^3

6.3. Module And Package Labelling

6.3.1. Module Labelling

Lot numbering and location are specified as follows.

LS020B8UD06 4 C 000001
1 2 3 4

1 model No.
2 product year (lower 1 digits)
4 : 2004
5 : 2005
3 product month
A : JANUARY
B : FEBRUARY
C : MARCH
:
:
L : DECEMBER
4 Serial number
000001 ~ 999999

6.3.2. Product Package Labelling

- LCD Part No. (LCD SNR, see page 1)
- Manufacturer Name
- Production-date
- Supplier module name