SAMSUNG

ELECTRONICS

Approval

LEAD-FREE

SAMSUNG TFT-LCD
MODEL NO : LTN156AT22-N01

NOTE : Extension code [N01]
  → LTN156AT22-**N01**
  Surface type [**Glare**]

The information described in this SPEC is approved and can not be changed without prior notice.

APPROVED BY :   *S. S. Seomun*

PREPARED BY : **LCD Application Engineering, Sales & Marketing Team**

SAMSUNG ELECTRONICS CO., LTD.

wise view™

Samsung Secret

Approval

CONTENTS

Samsung Secret

REVISION HISTORY

Approval

Date	Revision No.	Page	Summary
Oct. 12. 2010	P00	All	LTN156AT22-N01 model spec was issued first.
Oct. 29. 2010	P01	p. 7	R,G,B color chromaticity was updated.
		p. 8	Figure of note 4 was changed from 5points to 1point.
		p. 10	Current of power supply was updated.
		p. 12	LED driver characteristic was updated as RT8510 LED driver.
		p. 14	Pin 5 (WPN) was updated with on, off levels.
Nov. 12. 2010	P02	p. 14	Pin5 (WPN) was updated as NC.
		p. 23	Thickness on the outline dimension was corrected from 5.65mm max to 5.5mm max.
Dec. 14. 2010	P03	p. 7	Contrast was changed from 'Min 300, Typ. 500' to 'Min. 500, Typ. 600'
		p. 10, 11	Max pattern was updated as 1 dot inversion.
		p. 13	No.8 LED was updated as clean.
		p. 23	Bigger 8-M2 direction
			Weight was changed from 490g max to 450g max.
		p. 25	Packing was updated as paper box.
		p. 26	Pallet was updated as paper box.
Jan. 17. 2011	P04	p. 27	To classify use, Characteristic changing on Model Label (From C to D / The Mean of 'D' is DID用)
Apr. 29.2011	P05	p. 29	Small box attached label was changed (Qunatiry value is changed from 20pcs to 22pcs)
Jun. 15. 2011	A00	All	The Approval Specification of LTN156AT22-N01 is issued.

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	3 / 34

REVISION HISTORY

Approval

Date	Revision No.	Page	Summary

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	4 / 34

Approval

GENERAL DESCRIPTION

DESCRIPTION

LTN156AT22-N01 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a backlight system. The resolution of a 15.6" contains 1366 x 768 pixels and can display up to 262,144 colors. 6 O'clock direction is the Optimum viewing angle.

FEATURES

- Thin and light weight
- High contrast ratio, high aperture structure
- 1366 x 768 pixels resolution (16:9)
- Fast Response Time
- Low power consumption
- LED BLU Structure
- DE (Data enable) only mode
- 3.3V LVDS Interface
- On board EDID chip
- Pb-free product
- RoHS comply product
- Flicker should be optimized with 2 by 1 half gray green pattern before shipping MP.

APPLICATIONS

- Notebook PC
- If the usage of this product is not for PC application, but for others, please contact SEC

GENERAL INFORMATION

Item	Specification	Unit	Note
Display area	344.232 (H) x 193.536 (V) (15.6"diagonal)	mm	
Driver element	a-Si TFT active matrix		
Display colors	262,144		
Number of pixel	1366 x 768	pixel	16 : 9
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.252 (H) x 0.252 (V) (TYP.)	mm	
Display Mode	Normally white		
Surface treatment	Haze 0, Hardness 3H (Reflection ratio 4~5%)		Glare

Samsung Secret

Approval

Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	358.8	359.3	359.8	mm	
	Vertical (V)	209.0	209.5	210	mm	
	Depth (D)	-	-	5.5	mm	(1)
Weight		-	405	450	g	

Note (1) Measurement condition of outline dimension
. Equipment : Vernier Calipers
. Push Force : 500g ·f (minimum)

# 1. ABSOLUTE MAXIMUM RATINGS

1.1 ENVIRONMENTAL ABSOLUTE RATINGS

Item	Symbol	Min.	Max.	Unit	Note
Storage temperate	T_{STG}	-20	60	°C	(1)
Operating temperate (Temperature of glass surface)	T_{OPR}	0	40	°C	(1)
Shock (non-operating)	Snop	-	210	G	(2),(5)
			50		(3),(5)
Vibration (non-operating)	Vnop	-	2.41	G	(4),(5)
Altitude (operation)	-	-	15,000	feet	
Altitude (storage)	-	-	40,000	feet	

Note (1) Temperature and relative humidity range are shown in the figure below.
95 % RH Max. (40 °C $\geq$ Ta)
Maximum wet - bulb temperature at 39 °C or less. (Ta > 40 °C) No condensation.
(2) 2ms, half sine wave, one time for $\pm X, \pm Y, \pm Z$.
(3) 11ms, Trapezoidal wave, one time for $\pm X, \pm Y, \pm Z$.
(4) 5~500 Hz, Random vibration, 30 min for X,Y,Z.
(5) At testing Vibration and Shock, the fixture in holding the Module to be tested have to be hard and rigid enough so that the Module would not be twisted or bent by the fixture.

Relative Humidity (%RH)

Operating Range

Storage Range

Temperature (°C)

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	6 / 34
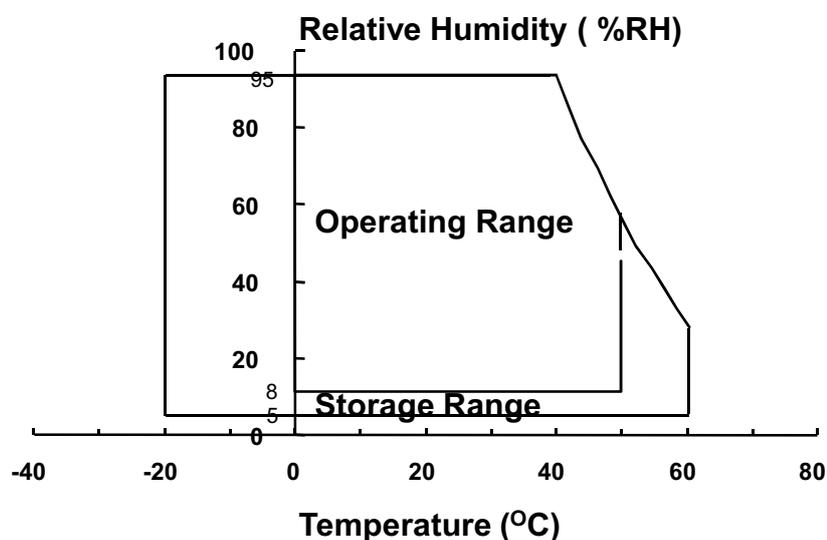
Approval

1.2 ELECTRICAL ABSOLUTE RATINGS

(1) TFT LCD MODULE

V_{DD} =3.3V, V_{SS} = GND = 0V

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	$V_{DD} - 0.3$	$V_{DD} + 0.3$	V	(1)
Logic Input Voltage	V_{DD}	$V_{DD} - 0.3$	$V_{DD} + 0.3$	V	(1)

Note (1) Within Ta (25 ± 2 ℃)

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	7 / 34

Approval

2. OPTICAL CHARACTERISTICS

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (5). Measuring equipment ： TOPCON SR-3

* Ta = 25 $\pm$ 2 ℃, V$_{DD}$=3.3V,   fv= 60Hz, fDCLK = **72.33** MHz, PWM duty = 100%

Item		Symbol	Condition	Min.	Typ.	Max	Unit	Note
Contrast Ratio		CR	1 center point	500	600	-	-	(1), (2), (5)
Response Time at Ta (Rising + Falling)		T$_{RT}$		-	16 (6.75 + 9.25)	25	msec	(1), (3)
Average Luminance of White		Y$_{L,AVE}$	1 center point	190	220	-	cd/m^2	PWM duty = 100% (1), (4)
Color Chromaticity (CIE)	Red	R$_X$	Normal Viewing Angle ϕ = 0 θ = 0	0.585	0.615	0.645	-	
		R$_Y$		0.325	0.355	0.385		
	Green	G$_X$		0.305	0.335	0.365		
		G$_Y$		0.580	0.610	0.640		
	Blue	B$_X$		0.120	0.150	0.180		
		B$_Y$		0.070	0.100	0.130		
	White	W$_X$		0.283	0.313	0.343		
		W$_Y$		0.299	0.329	0.359		
Viewing Angle	Hor.	θ_L	CR $\geq$ 10	40	45	-	Degrees	(1), (5) SR-3
		θ_R		40	45	-		
	Ver.	ϕ_H		10	15	-		
		ϕ_L		30	35	-		
Color Gamut				-	60	-	%	
13 Points White Variation		δ_L		-	1.6	1.7	-	(6)

Samsung Secret

Note 1) Definition of Viewing Angle : Viewing angle range($10 \leq$ C/R)
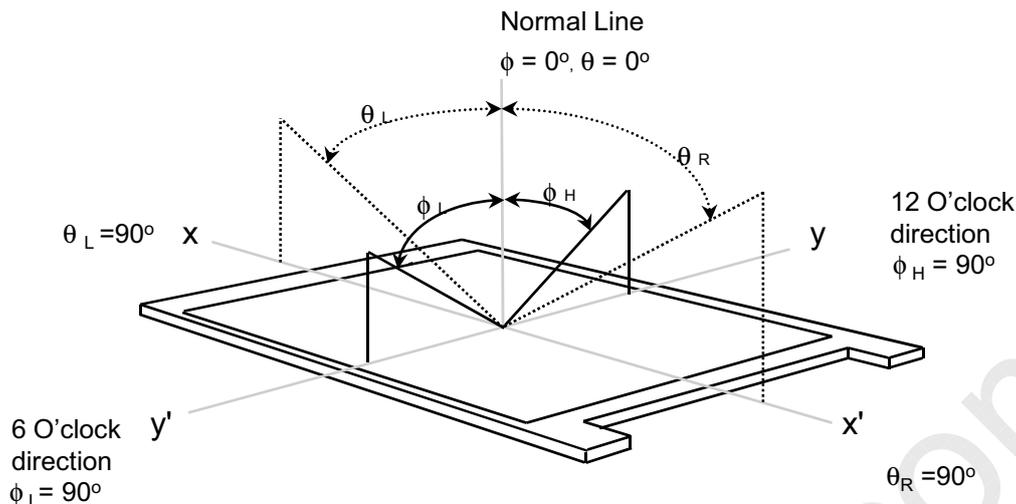
Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax) ,gray min (Gmin) at 5 points(4, 5, 7, 9, 10)

$$CR = \frac{CR(4) + CR(5) + CR(7) + CR(9) + CR(10)}{5}$$

Points : ④ , ⑤ , ⑦ , ⑨ , ⑩ at the figure of Note (6).

Note 3) Definition of Response time :
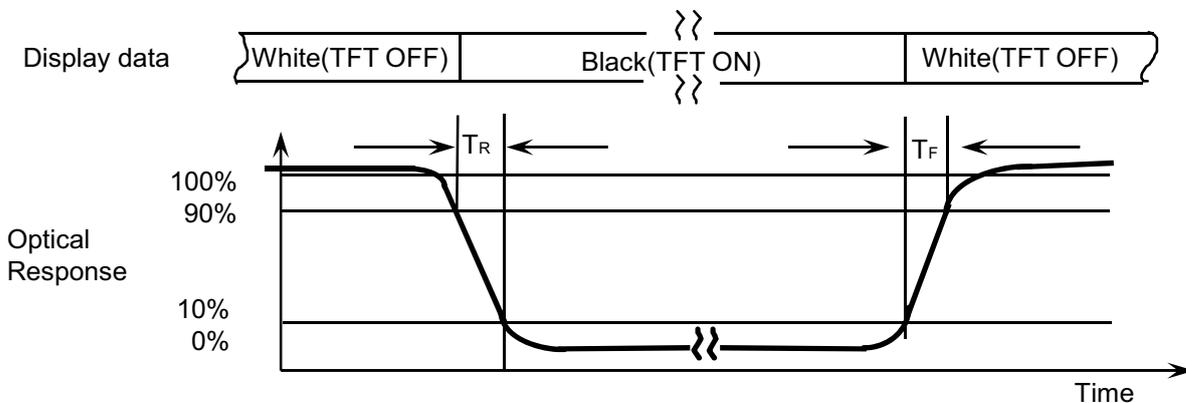
Note 4) Definition of Average Luminance of White : measure the luminance of white at 1 point.

. Center 1point of White ($Y_{L,AVE}$)

$Y_{,CENTER} = Y_{L7}$

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	9 / 34
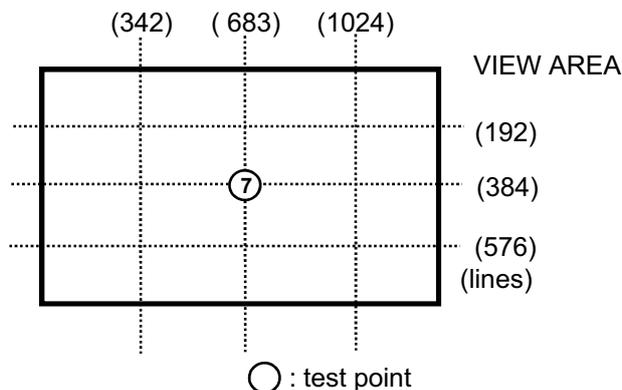
Approval

Note 5) After stabilizing and leaVBLg the panel alone at a given temperature for 30 min , the measurement
should be executed. Measurement should be executed in a stable, windless,and dark room.
30 min after lighting the backlight. This should be measured in the center of screen.
LED current : 25.5 mA
Environment condition : Ta = 25 ± 2 °C

Photo-detector
(TOPCON SR-3)

Field = 2°

50 cm

TFT-LCD module

LCD panel

Center of the screen

[Optical characteristics measurement setup]
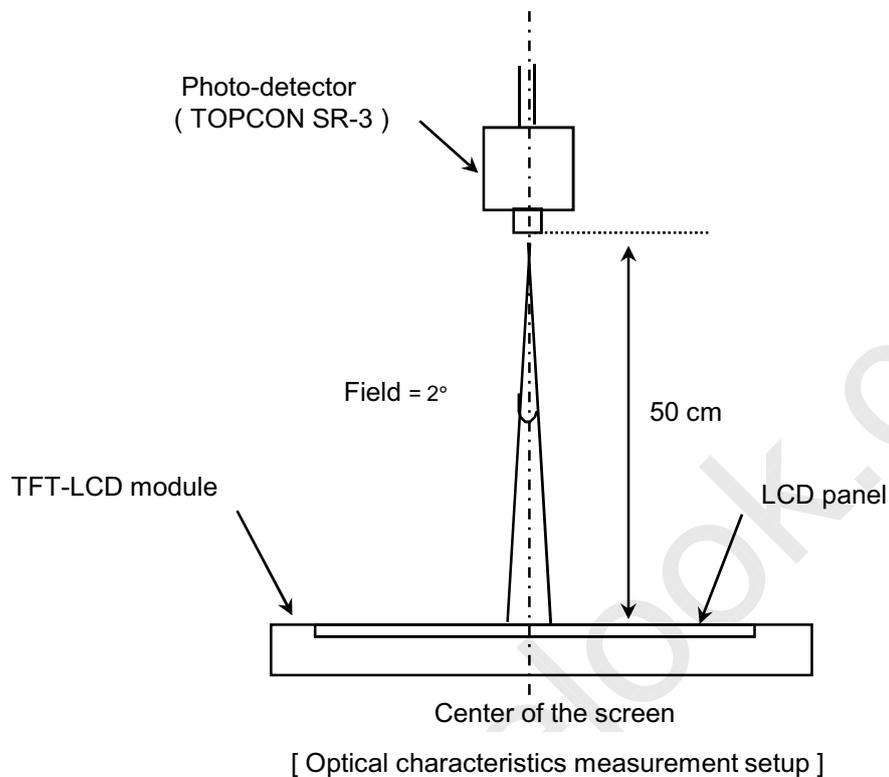
Note 6) Definition of 13 points white variation (δ L), [(1) ~ (13)]

$$\delta_L = \frac{\text{Maximum luminance of 13 points}}{\text{Minimum luminance of 13 points}}$$

10mm   10mm

10mm   342   683   1024

10mm

13   12   11

10   9   192

8   7   6   384   ◯   : test point

5   4   576

3   2   1   (lines)

10mm

| Doc.No. | LTN156AT22-N01 | Rev.No | 04-A00-S-110615 | Page | 10 / 34 |
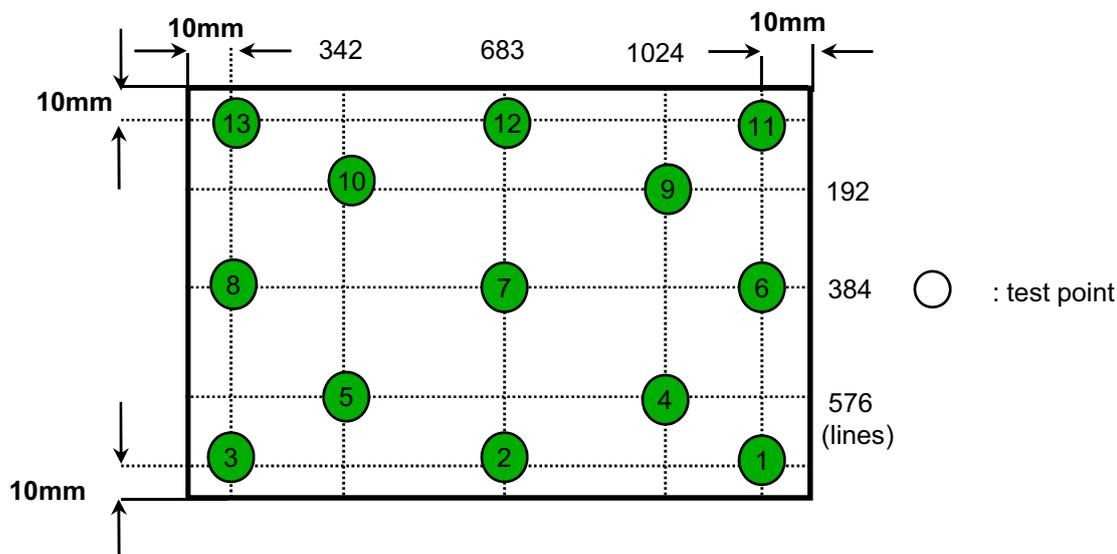
3. ELECTRICAL CHARACTERISTICS

Approval

3.1 TFT LCD MODULE

Ta= 25 ± 2℃

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	3.0	3.3	3.6	V	
Differential Input Voltage for LVDS Receiver Threshold	High	V_{IH}	-	-	+100	mV	V_{CM} = +1.2V (+/- 10%)
	Low	V_{IL}	-100	-	-	mV	
Vsync Frequency		fv	-	60	-	Hz	
Hsync Frequency		f_H	-	47.4	-	KHz	
Main Frequency		f_{DCLK}	67.5	72.33	80	MHz	
EDID Input Voltage		V_{EDID}	2.5	3.3	5.0	V	
EDID Input Current		I_{EDID}	-	0.8	1.0	mA	
Skew		PS	-500	-	+500	ps	f_{DCLK} =72.33Mhz
Rush Current		I_{RUSH}	-	-	1.5	A	(4)
Current of Power Supply	White	I_{DD}	-	200	-	mA	(2),(3)*a
	Mosaic		-	220	-	mA	(2),(3)*b
	V. Stripe		-	350	-	mA	(2),(3)*c
	Black		-	200	-	mA	(2),(3)*d
	1 dot		-	400	450	mA	(2),(3),(4)*e

Note (1) Display data pins and timing signal pins should be connected.(GND = 0V)

(2) fv = 60Hz, f_{DCLK} = 72.33 MHZ, V_{DD} = 3.3V , DC Current.

(3) Power dissipation pattern

(4) Max. 450mA is fixed with the margin from the maximum current in the SEC's test by even.

*a) White Pattern
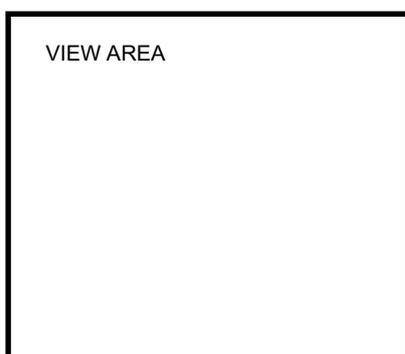
VIEW AREA

*b) Mosaic Pattern

Display Brightest Gray Level

Display Darkest Gray Level
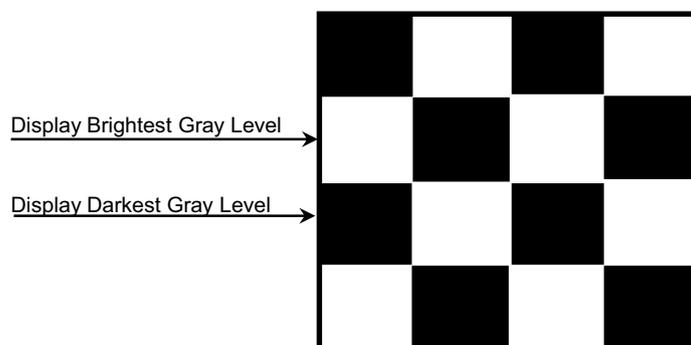
Samsung Secret

Approval

*c) 1dot Vertical stripe pattern
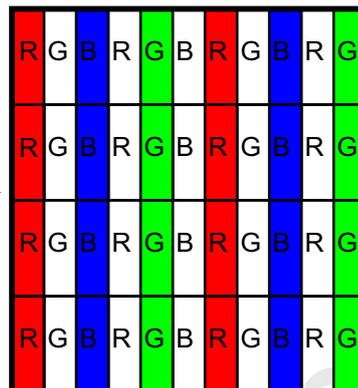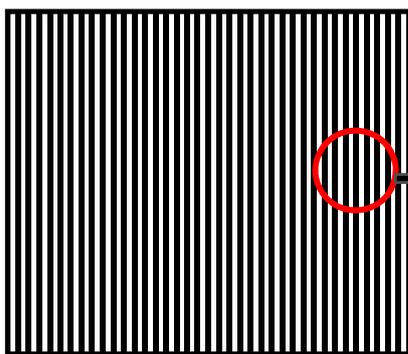
*d) Black
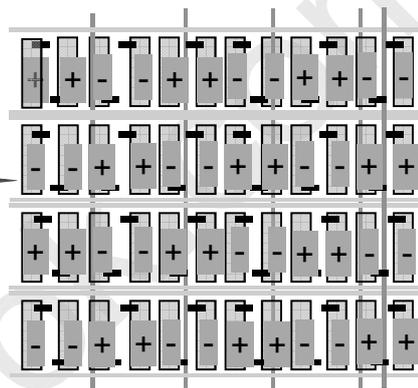
*e) Max pattern : 1dot inversion
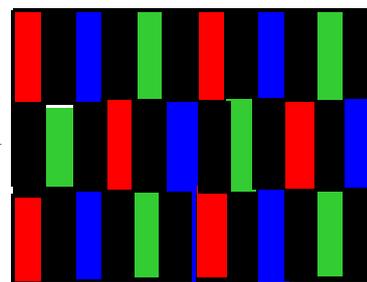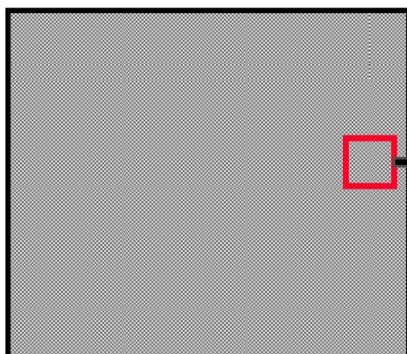
4) Rush current measurement condition

3.3V

M1
2SK1059

R1
47K

FUSE

C1
1uF

V_{DD} (LCD INPUT)

CONTROL SIGNAL
(HIGH to LOW)

R2
1K

M2
2SK1399

12V

R3

47K

C2

10000pF

C3
1uF

V_{DD} rising time is 470us

0.9V_{DD}

3.3V

0.1V_{DD}

GND

470us

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	12 / 34
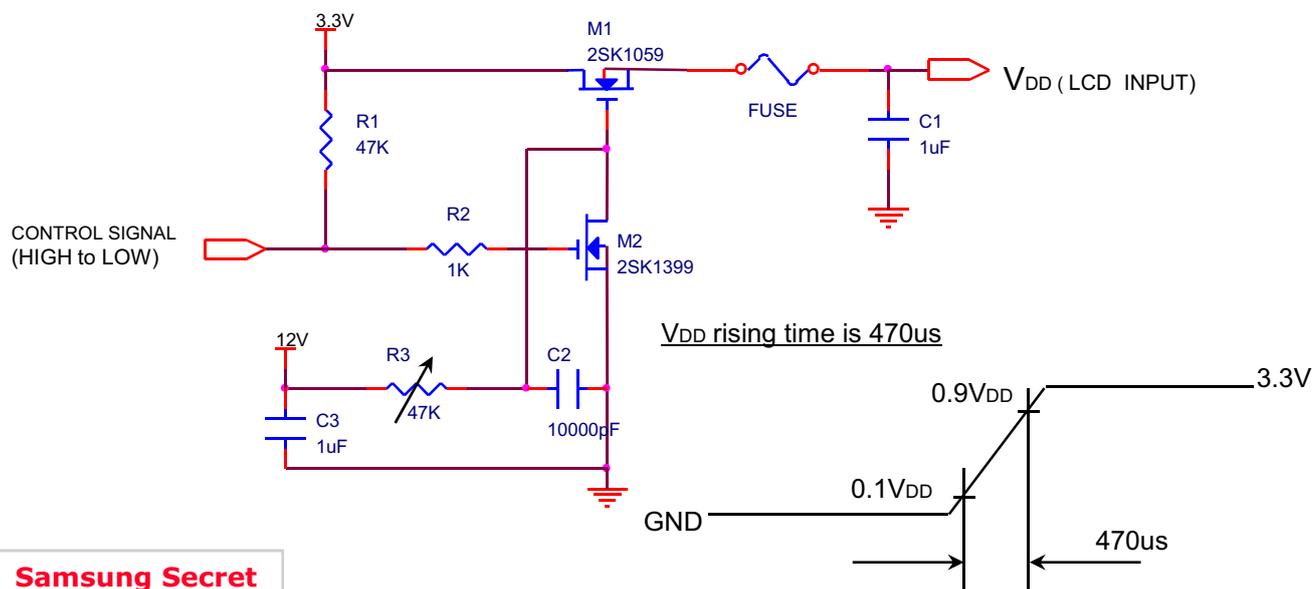
Approval

3.2 BACK-LIGHT UNIT

Ta= 25 ± 2 ℃

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Operating Life Time	Hr	10,000	-	-	Hr	(1)

Note (1) Life time (Hr) of LEDs can be defined as the time in which it continues to operate under the
condition Ta= 25 ± 2 ℃ and PWM duty = 100% until one of the following event occurs.
- When the brightness becomes 50% or lower than the original.

3.3 LED Driver

- LED Driver Manufacturer : Richtek (RT8510)

Ta= 25 ± 2 ℃

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Input Voltage	V_{BL}	7	12	21	V	
V_{LED} on level voltage	V_{LED_on}	7	-	21	V	
V_{LED} off level voltage	V_{LED_off}	0	-	2	V	
Input Current	I	-	320	340	mA	
Input Power	Pin	-	3.84	4.08	W	Pin = VBL x I
PWM duty ratio	-	6	-	100	%	(1)
PWM Frequency	F_{PWM}	0.1	-	30	KHz	(1)
PWM Impedance	Z_{PWM}	2.4	-	-	Mohm	
PWM high level vol.	V_{PWM_H}	2.0	-	5.0	V	
PWM low level vol.	V_{PWM_L}	0	-	0.5	V	
LED_EN Impedance	Z_{PWM}	50	-	-	Mohm	
LED_EN high vol.	$V_{LED\_EN\_H}$	2.0	-	5.0	V	
LED_EN low vol.	$V_{LED\_EN\_L}$	0	-	0.8	V	
LED rush current	$I_{LED\ RUSH}$	-	-	1.5	A	

Note -(1) PWM can be guaranteed under the same condition as operation temperate T_{OPR} 0 ~ 50 ℃.

4. BLOCK DIAGRAM

Approval

4.1 TFT LCD Module

I²C bus → EDID EEPROM

Input Connector
I-PEX 20455-040E-12

LVDS → LVDS Input/LCDS Output Timing Controller → *mLVDS* → Source Driver IC

DC-DC Converter VCOM Generator → Gamma Generator

15.6" HD TFT-LCD Panel

TFT on Glass

Legend:
- → Video Signal
- → Control Signal
- → VCOM
- → Gamma
- → DVDD
- → AVDD
- → Von/Voff

SOURCE PCB
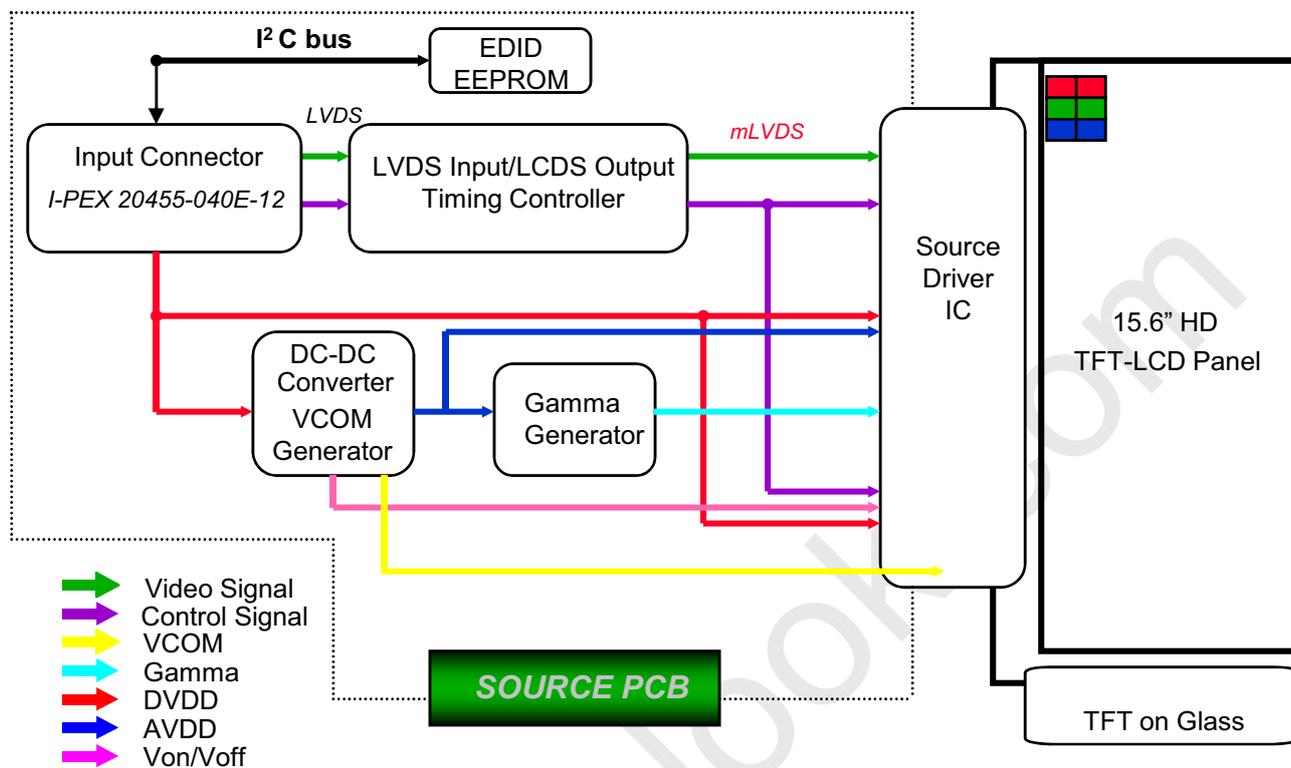
4.2 LED connection and placement
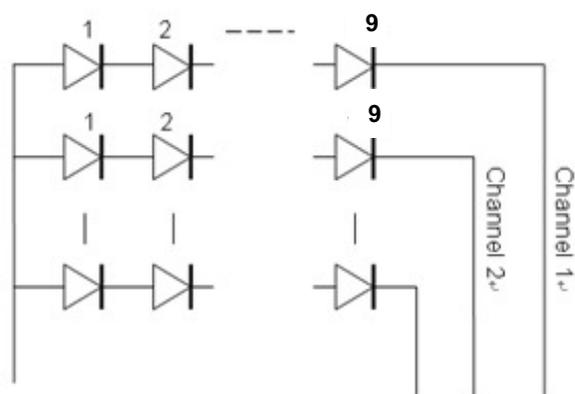
9 LEDs x 4 channels = Total 36 LEDs

LED Wiring

LED 36, Channel 4-9
·
·
·
LED 5, Channel 1-2
LED 4, Channel 4-1
LED 3, Channel 3-1
LED 2, Channel 2-1
LED 1, Channel 1-1

LED Placement

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	14 / 34
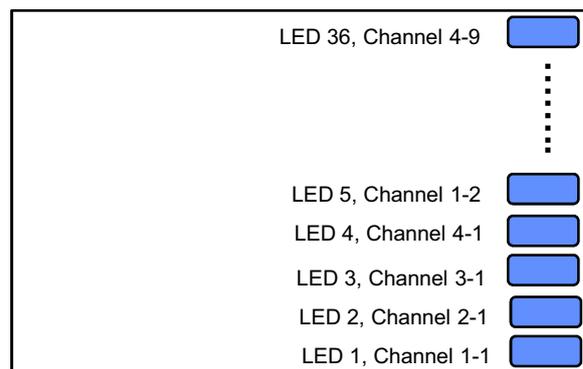
5. INPUT TERMINAL PIN ASSIGNMENT

Approval

5.1. Input Signal & Power   LVDS, Connector : I-PEX 20455-040E-02R
Mating Connector: I-PEX 20454-040T-01 or 02

Pin	Symbol	Function
1	NC	No Connection (Reserved for supplier)
2	VCC	Power Supply, 3.3V (typical)
3	VCC	Power Supply, 3.3V (typical)
4	VCC_EDID	DDC 3.3V power, Current 0.8mA (typical)
5	NC	No Connection (Reserved for supplier)
6	CLK_EDID	DDC Clock
7	DATA_EDID	DDC Data
8	RXin0-	- LVDS differential data (R0-R5, G0)
9	RXin0+	+ LVDS differential data (R0-R5, G0)
10	GND	Ground
11	RXin1-	- LVDS differential data (G1-G5, B0-B1)
12	RXn1+	+ LVDS differential data (G1-G5, B0-B1)
13	GND	Ground
14	RXin2-	- LVDS differential data (B2-B5,HS,VS, DE)
15	RXn2+	+ LVDS differential data (B2-B5,HS,VS, DE)
16	GND	Ground
17	ClkIN-	- LVDS differential clock input
18	ClkIN+	+ LVDS differential clock input
19	GND	Ground
20~21	NC	No Connection
22	GND	Ground
23~24	NC	No Connection
25	GND	Ground
26~27	NC	No Connection
28	GND	Ground
29~30	NC	No Connection
31~33	GND	LED Ground
34	NC	No Connection
35	PWM	PWM for luminance control
36	LED_EN	BL On/Off (On: 2.0~5.0V, Off: 0~0.8V)
37	NC	No Connection
38~40	$V_{BL}(7{\sim}21)$	*LED Power Supply 7V-21V

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	15 / 34

Approval

5.2 LVDS Interface : Transmitter DS90CF363 or Compatible

Pin No.	Name	RGB Signal	Pin No.	Name	RGB Signal
51	TxIN0	R0	14	TxIN14	G5
52	TxIN1	R1	15	TxIN15	B0
54	TxIN2	R2	19	TxIN18	B1
55	TxIN3	R3	20	TxIN19	B2
56	TxIN4	R4	22	TxIN20	B3
3	TxIN6	R5	23	TxIN21	B4
4	TxIN7	G0	24	TxIN22	B5
6	TxIN8	G1	27	TxIN24	Hsync
7	TxIN9	G2	28	TxIN25	Vsync
11	TxIN12	G3	30	TxIN26	DE
12	TxIN13	G4	31	TxCLKIN	Clock

LVDS INTERFACE
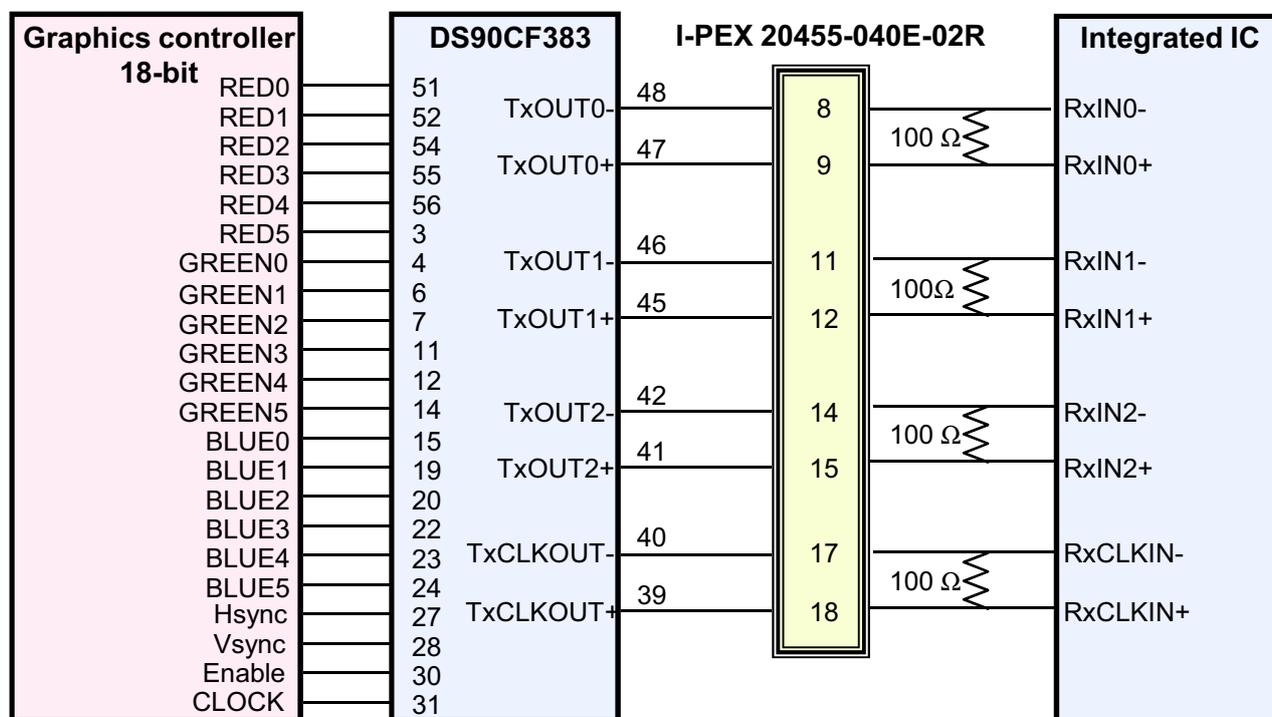
Note : The LCD Module uses a 100ohm resistor between positive and negative lines of each receiver input.

Samsung Secret

| Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	16 / 34

Approval

5.3 LVDS characteristics

LVDS DC Specifications

Characteristics	Symbol	Conditions	Min	Typ	Max	Unit
Differential input high threshold voltage	|VTH|	Vcm = 1.2V	100			mV
Differential input low threshold voltage	|VTL|		100			mV
Differential input voltage	|Vid|		100		600	mV
Common mode voltage	Vcm	|Vid| = 100mV, AVDD33I = 3.3V	0.4	1.2	2.9	V

LVDS AC Specifications

Characteristics	Symbol	Min	Typ	Max	Unit	Remarks
ROUTCLK frequency	fRCP	30	72.33	105	MHz	–
TTL data set-up to ROUTCLK	tRS	0.3/fRCP			ns	
TTL data hold from ROUTCLK	tRH	0.3/fRCP			ns	
Skew (Strobe) right margin	TRSRM			500	ps	
Skew (Strobe) left margin	TRSLM			500	ps	
LVDS clock to clock skew margin (Even to odd)	Tskew_eo	-1/7		+1/7	Tclk	–
Unit delay width in skew control block	Δ		100		ps	@NN,55°C,2.5/1.2V

Characteristics	Symbol	Min	Typ	Max	Unit	Remarks
Modulation Rate	Fmr	-3		3	%	@ MAINCLK = 72.33MHz
Modulation Frequency	Fmf	30		300	Khz	

Center Spreading
Triangular Modulation
Modulation Rate = -3~+3%
Modulation Freq = 30~100Khz
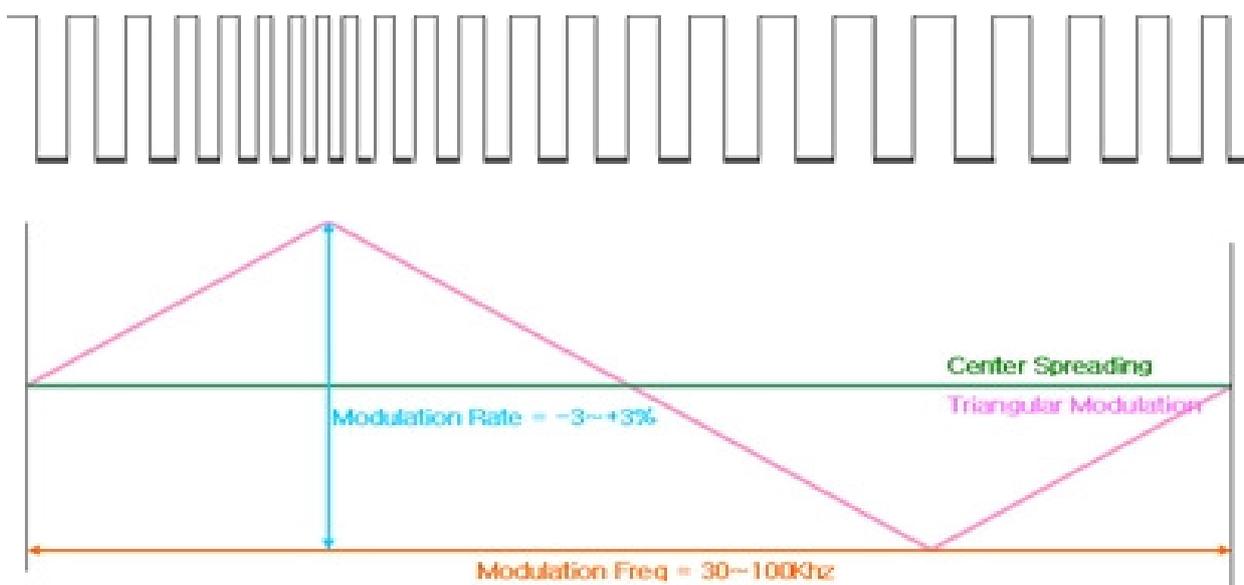
Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	17 / 34

Approval
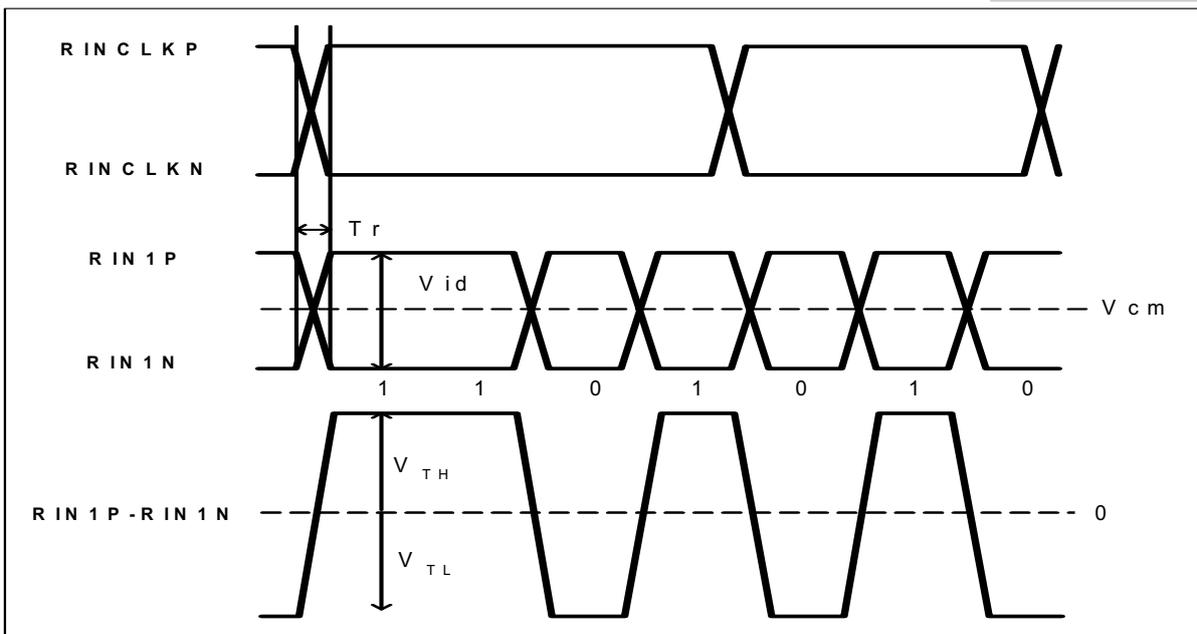
< Definition of LVDS DC characteristics >
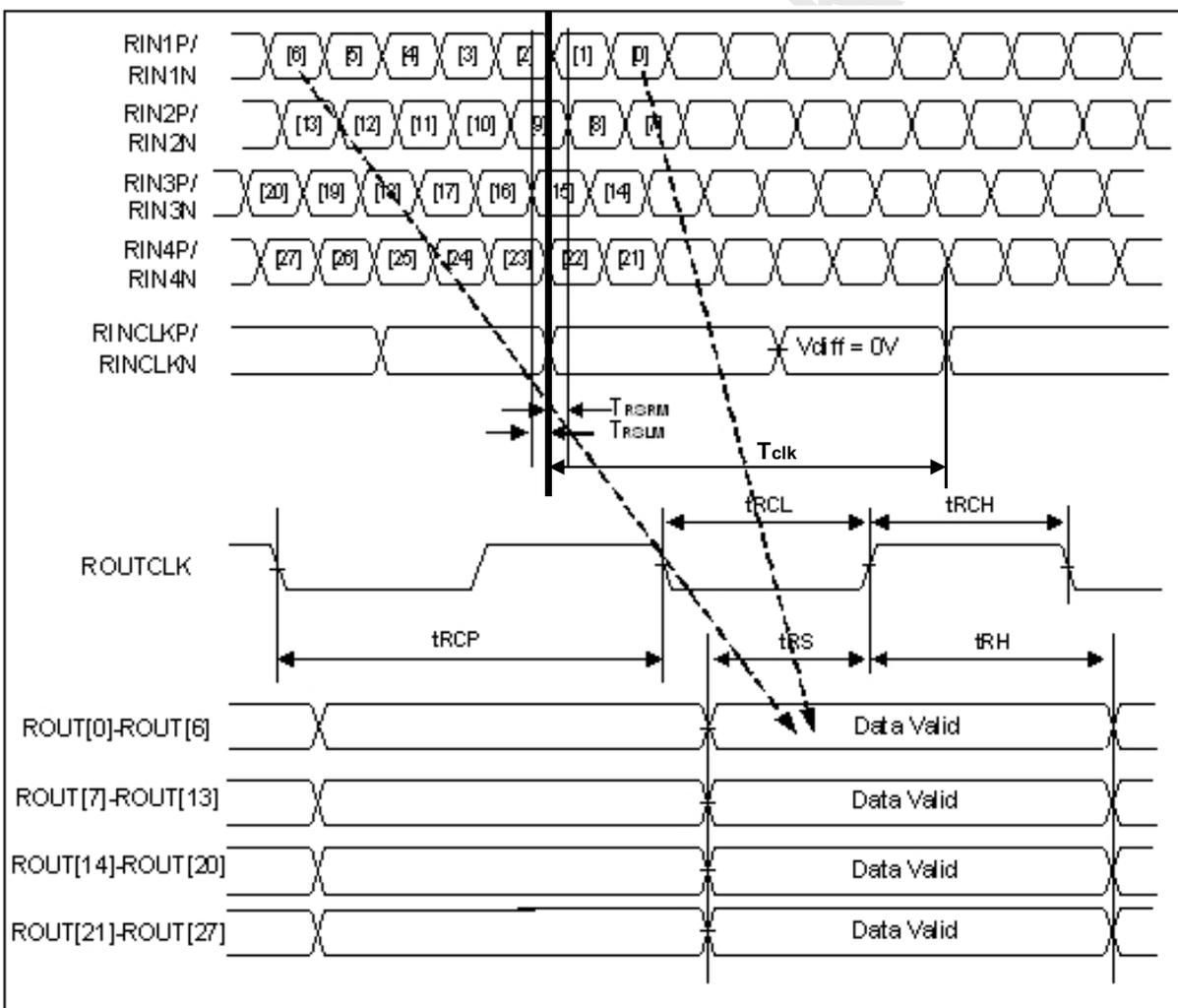
< Definition of LVDS AC characteristics >

Samsung Secret

| Doc.No. | LTN156AT22-N01 | Rev.No | 04-A00-S-110615 | Page | 18 / 34 |

Approval

5.4 Input Signals, Basic Display Colors and Gray Scale of Each Color

Color	Display	Data Signal																		Gray Scale Level
		Red						Green						Blue						
		R0	R1	R2	R3	R4	R5	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3	45	B5	
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	-
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	-
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	-
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	-
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	-
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	-
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-
Gray Scale Of Red	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R0
	Dark	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R1
	↑	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R61
	Light	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R62
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R63
Gray Scale Of Green	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G0
	Dark	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	G1
	↑	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	G2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	G61
	Light	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	G62
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	G63
Gray Scale Of Blue	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B0
	Dark	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	B1
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	B2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	B61
	Light	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	B62
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	B63

Note 1) Definition of gray :
   Rn: Red gray, Gn: Green gray, Bn: Blue gray (n=gray level)
Note 2)Input signal: 0 =Low level voltage, 1=High level voltage

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	19 / 34

Approval

5.5 Pixel Format in the display

Pixel 1   Pixel 1366

Line 1   R G B R G B   R G B R G B

LTN156AT22-N01

Line 768   R G B R G B   R G B R G B
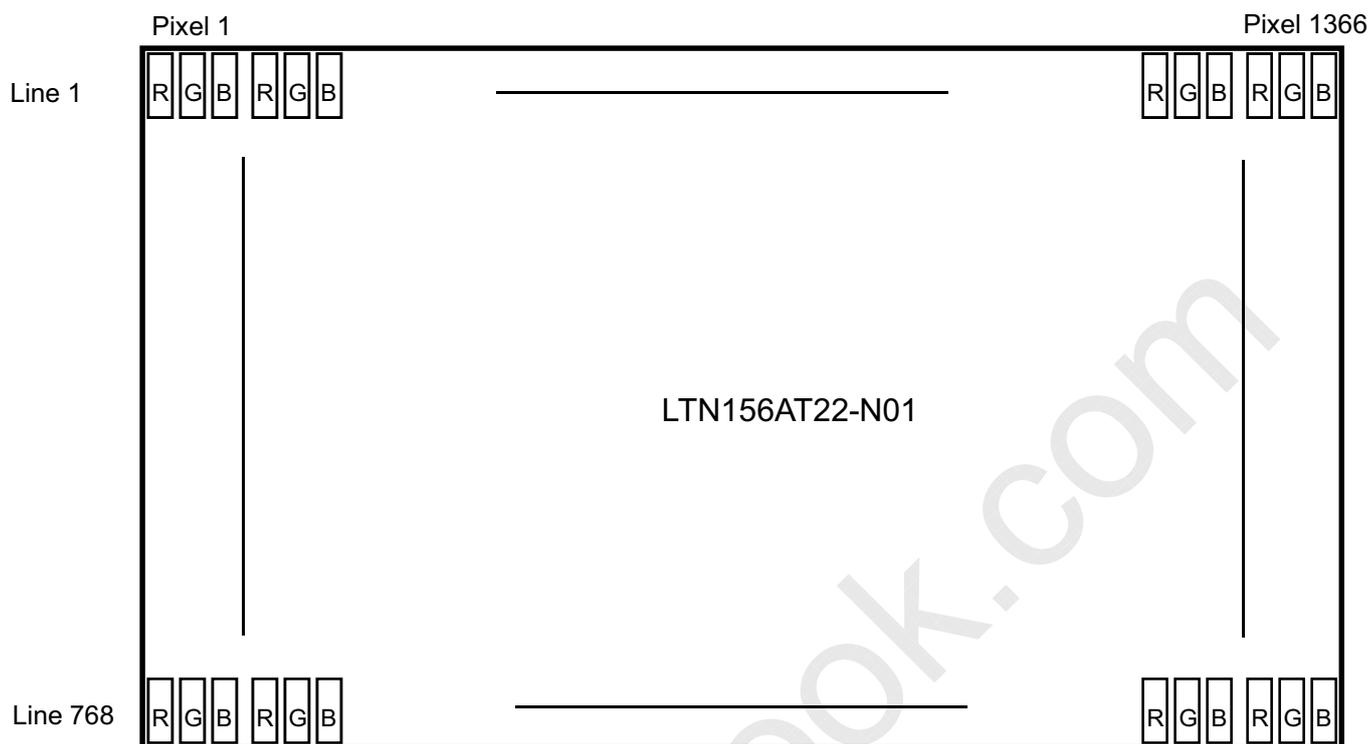
Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	20 / 34

Approval

6. INTERFACE TIMING

6.1 Timing Parameters

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Frame Frequency	Cycle	TV	780	790	807	Lines	-
Vertical Active Display Term	Display Period	TVD	-	768	-	Lines	-
One Line Scanning Time	Cycle	TH	1430	1526	1620	Clocks	-
Horizontal Active Display Term	Display Period	THD	-	1366	-	Clocks	-

6.2 Timing diagrams of interface signal
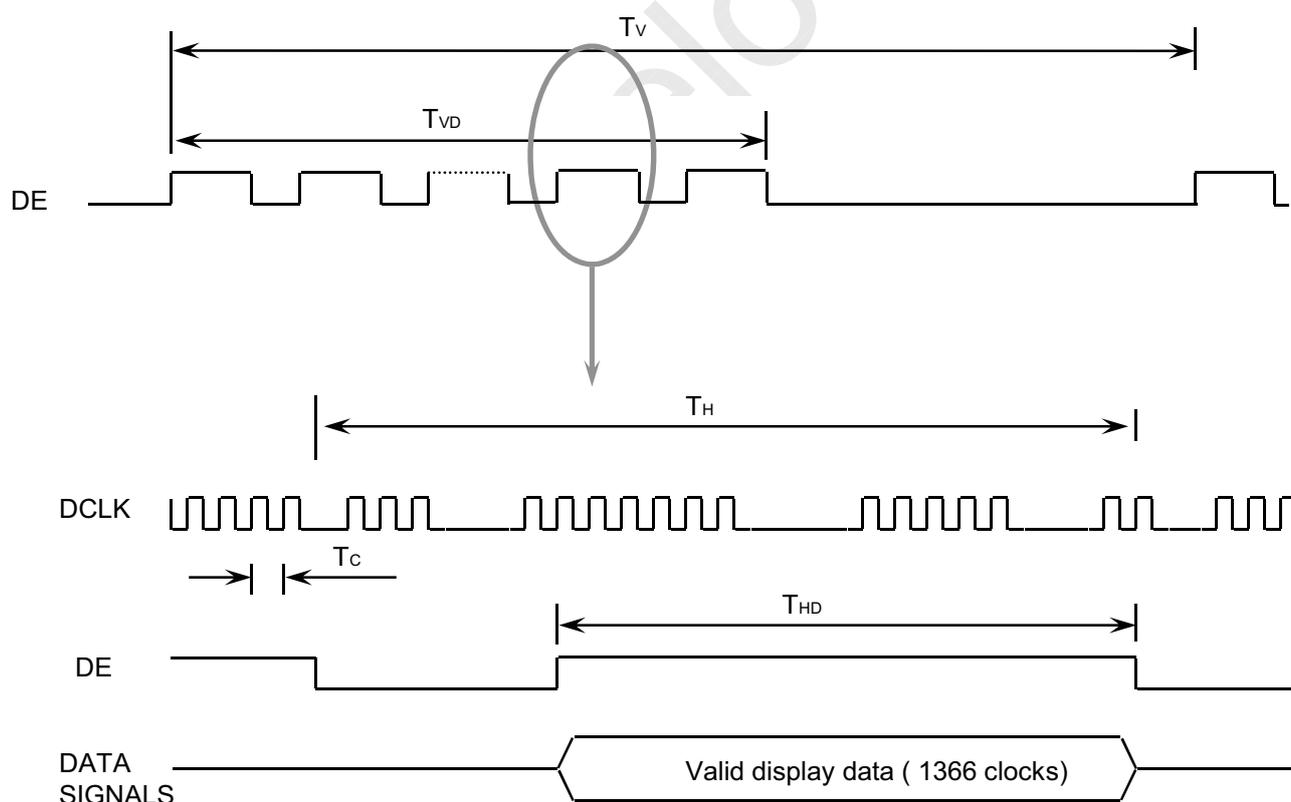
T_V

T_{VD}

DE

T_H

DCLK

T_C

T_{HD}

DE

DATA SIGNALS

Valid display data (1366 clocks)

Samsung Secret

Approval

6.3 Power ON/OFF Sequence

: To prevent a latch-up or DC operation of the LCD module, the power on/off sequence should be as the diagram below.

Power ON/OFF Sequence
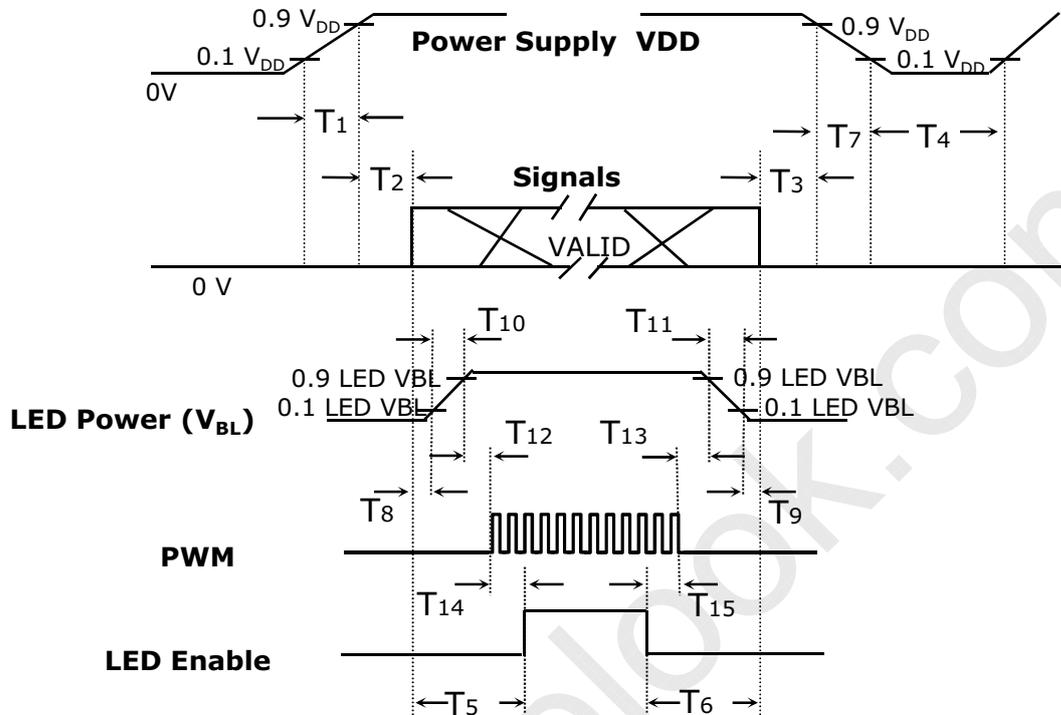
| Timing (ms)	Remarks
$0 < T_1 \leq 10$	V_{DD} rising time from 10% to 90%
$0 < T_2 \leq 50$	Delay from V_{DD} to valid data at power ON
$0 < T_3 \leq 50$	Delay from valid data OFF to V_{DD} OFF at power Off
$400 \leq T_4$	V_{DD} OFF time for Windows restart
$200 \leq T_5$	Delay from valid data to LED enable at power ON
$200 \leq T_6$	Delay from valid data off to LED disable at power Off
$0 < T_7 \leq 10$	V_{DD} falling time from 90% to 10%
$0 < T_{10} < 10$	LED VBL rising time from 10% to 90%
$0 < T_{11} < 10$	LED VBL falling time from 90% to 10%
$10 < T_{12}$	Delay from LED driver VBL rising time 90% to PWM ON
$10 < T_{13}$	Delay from PWM Off to LED driver VBL falling time 10%
$0 < T_{14}$	Delay from PWM ON to LED Enable ON
$0 < T_{15}$	Delay from B/L Enable Off to PWM Off

Timing Parameters and definition

Note (1)   Regarding the timing of T8 and T9, the following one are recommended

　　　　10 < T8 : Delay from valid data on to LED driver VBL rising time 10%

　　　　10 < T9 : Delay from LED driver VBL falling time 10% to valid data Off

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	22 / 34

7. MECHANICAL OUTLINE DIMENSION

Approval

[Refer to the next page]

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	23 / 34

NO	PART NAME	CODE NO	SPECIFICATION	Q'TY	WEIGHT		UNFOLDED DIM. OF. MATERIAL	REMARK
					FINISH	MATERIAL		

5.5 MAX [MODULE THICKNESS]

4-3.1±0.3

11.9±0.3

8-M2.0, P0.4 TAPPING
DP=2.5MAX SCREW PENETRATION

185.7±0.3

118.8±0.3

66.9±0.3

7.982

1.782

2.284

7.534

ACTIVE CENTER

(104.75)

193.536[ACTIVE AREA]

197.1[BEZEL OPENING AREA]

209.5±0.5[OUTLINE]

7.982

1.782

2.284

7.534

(179.65)

344.232[ACTIVE AREA]

348.8[BEZEL OPENING AREA]

359.3±0.5[OUTLINE]

5.65 MAX

3.1

SCREW HOLE DEPTH 2.5 Min

BM SHIFT SPEC.

|A-B| < 1.0 (mm)
|C-D| < 1.0 (mm)
|BM| > 1.0 (mm)

C

A   BM   B
ACTIVE AREA

D
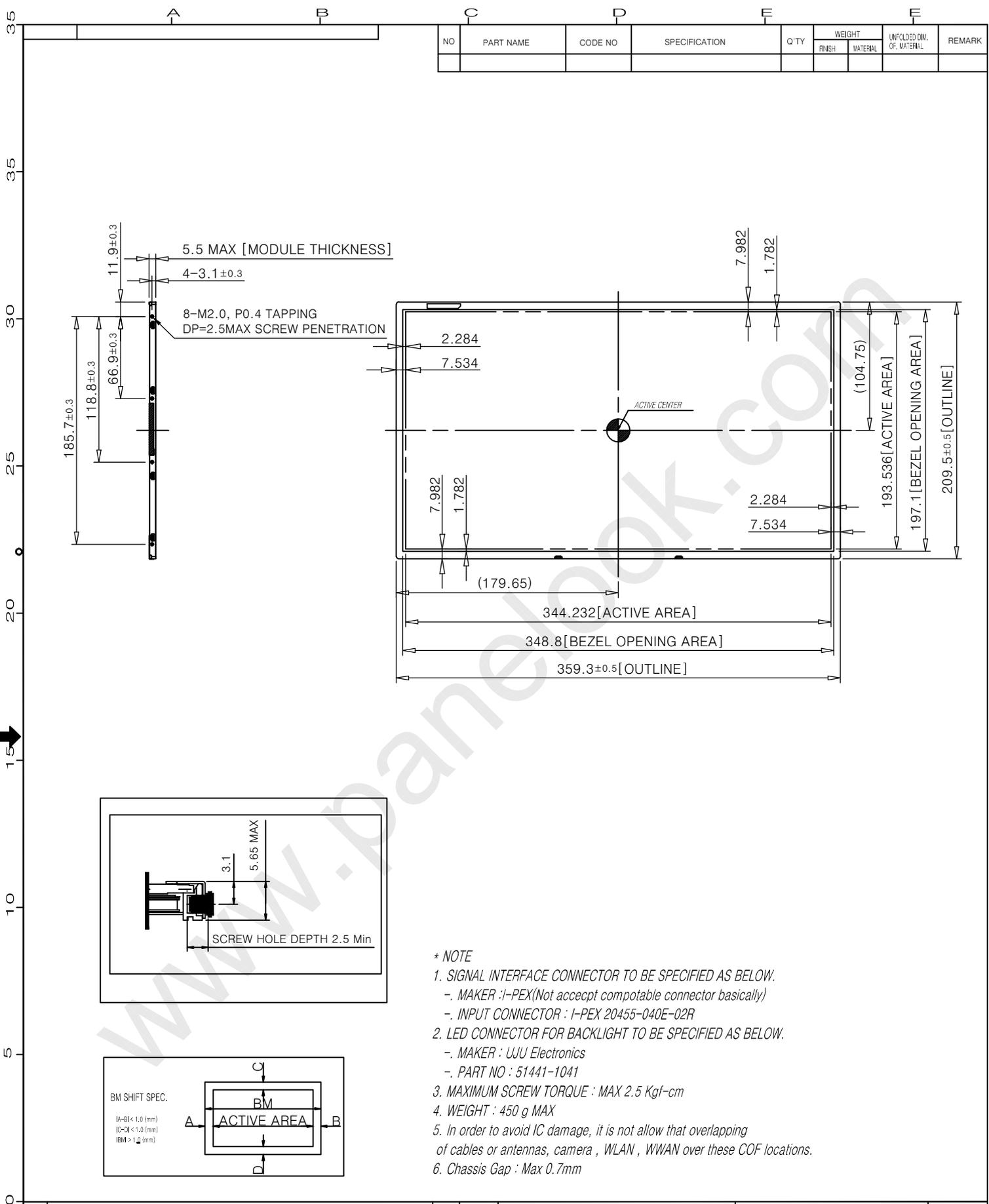
* NOTE
1. SIGNAL INTERFACE CONNECTOR TO BE SPECIFIED AS BELOW.
  -. MAKER : I-PEX(Not accecpt compotable connector basically)
  -. INPUT CONNECTOR : I-PEX 20455-040E-02R
2. LED CONNECTOR FOR BACKLIGHT TO BE SPECIFIED AS BELOW.
  -. MAKER : UJU Electronics
  -. PART NO : 51441-1041
3. MAXIMUM SCREW TORQUE : MAX 2.5 Kgf-cm
4. WEIGHT : 450 g MAX
5. In order to avoid IC damage, it is not allow that overlapping
  of cables or antennas, camera , WLAN , WWAN over these COF locations.
6. Chassis Gap : Max 0.7mm

REV	DATE	DESCRIPTION OF REVISION	REASON	CHG'D BY		
UNIT	mm	DRA'N BY	DES'D BY	CHK'D BY	APP'D BY	MODEL NAME
SCALE	0.3		H.H.KIM	M.K.HYUN		
TOLERANCE						PART/SHEET NAME
±0.5	. .		2010.10.29	2010.10.29		
					SPEC. NO	

SAMSUNG ELECTRONICS

MODEL NAME   LTN156AT22-001

PART/SHEET NAME   OUTLINE DIMENSION   SHEET 1 / 1

CODE NO.   VER. 000

NO	PART NAME	CODE NO	SPECIFICATION	Q'TY	WEIGHT		UNFOLDED DIM. OF. MATERIAL	REMARK
					FINISH	MATERIAL		

359.3±0.5

209.5±0.5

I-PEX 20455-040E-02R

35±1

128±1

LTN156AT22

REV	DATE	DESCRIPTION OF REVISION		REASON		CHG'D BY			
UNIT	mm	DRA'N BY	DES'D BY	CHK'D BY	APP'D BY	MODEL NAME	LTN156AT22-001		
SCALE	0.5		H.H.KIM	M.K.HYUN		PART/SHEET NAME	OUTLINE DIMENSION	SHEET	1 /1
TOLERANCE		. .	2011.03.25	2011.03.25					
±0.5						SPEC. NO			
SAMSUNG ELECTRONICS						CODE NO.		VER.	

8. PACKING

Approval

1. CARTON(Internal Package)

(1) Packing Form
   Corrugated Cardboard box form as shock absorber

(2) Packing Method
   All 22pcs panels have each "Static electric protective sack" (22pcs)
   (Two panels are in 1 partition.)

PANEL

BAG-SHILDING

PACKING CASE

CUSHION PAD

Note 1) Total Weight : Approximately 12.0 kg

2) Acceptance number of piling : 22 sets

3) Carton size : 283(W) x 263(D) x 401 (H)

Samsung Secret

| Doc.No. | LTN156AT22-N01 | Rev.No | 04-A00-S-110615 | Page | 26 / 34 |

Approval

(3)Packing Material

No	Part name	Quantity
1	Static electric protective sack	20
2	Packing case (Inner box) included shock absorber	1 set
3	Pictorial marking	2 pcs
4	Carton	1 set

(4)Pallet Form

850mm

1150mm

120mm

Hoof 5mm

401mm   283mm

263mm
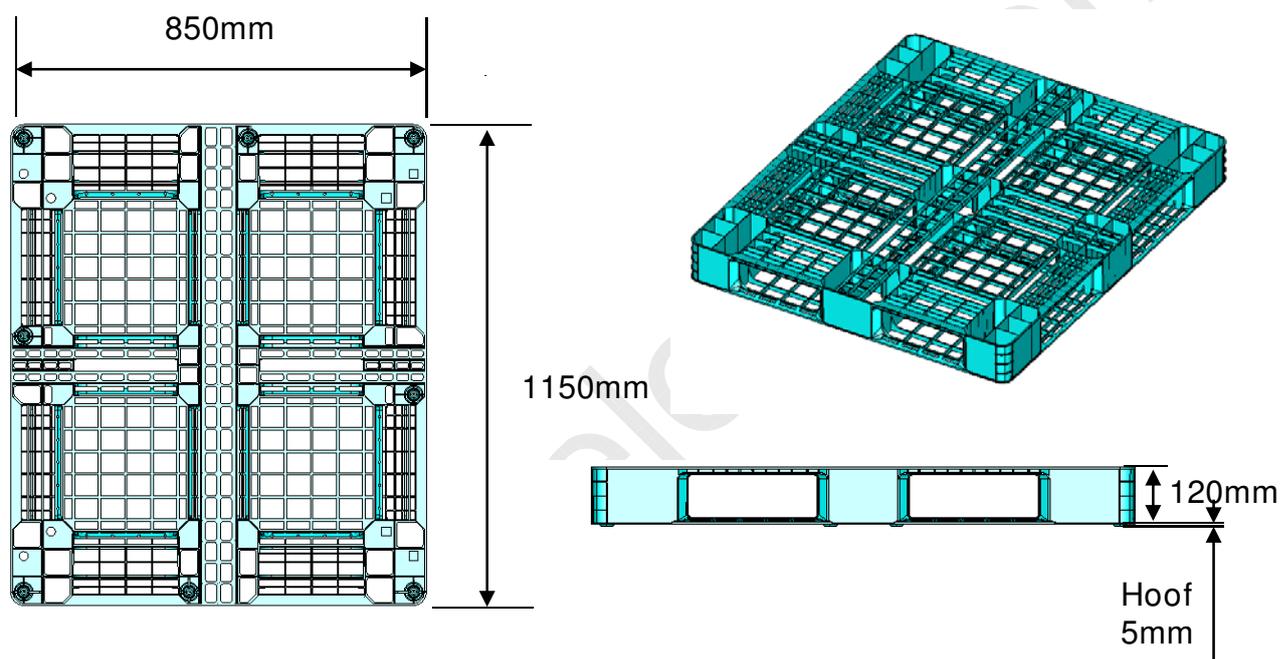
Note 1) Total : 24 boxes
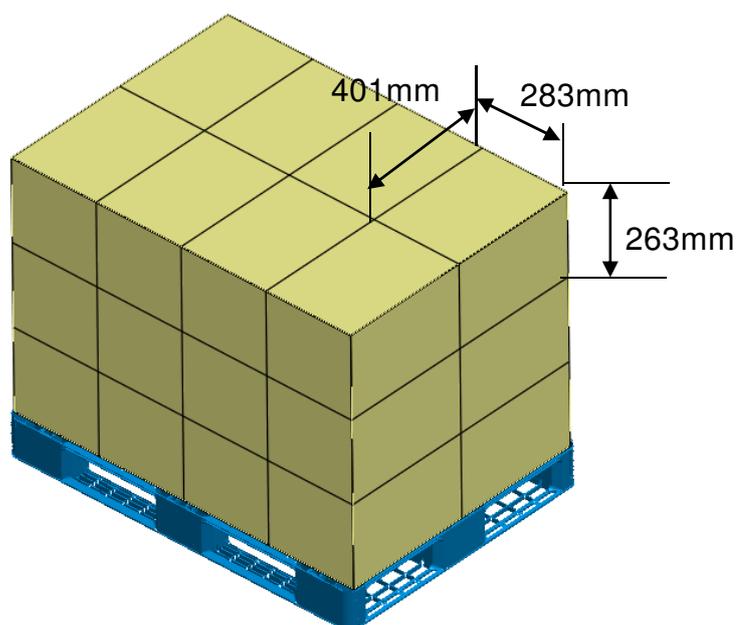
Samsung Secret

| Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	27 / 34

Approval

9. MARKINGS & OTHERS

A nameplate bearing followed by is affixed to a shipped product at the specified location on each product.

(1)Parts number : LTN156AT22
(2)Revision code : 3 letters
(3)Lot number   : X X X X   XX XX XX   N01

SEC Revision Code
Panel number
Cell ID
Lot ID
Month
Year
Product Code
Line

(4) Nameplate Indication

LTN156AT22

1140

XXXXXXXXXX   N01

USP6639589 / USP5280371

MADE IN CHINA

40 mm

80 mm
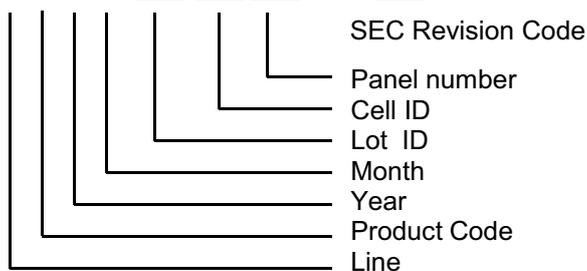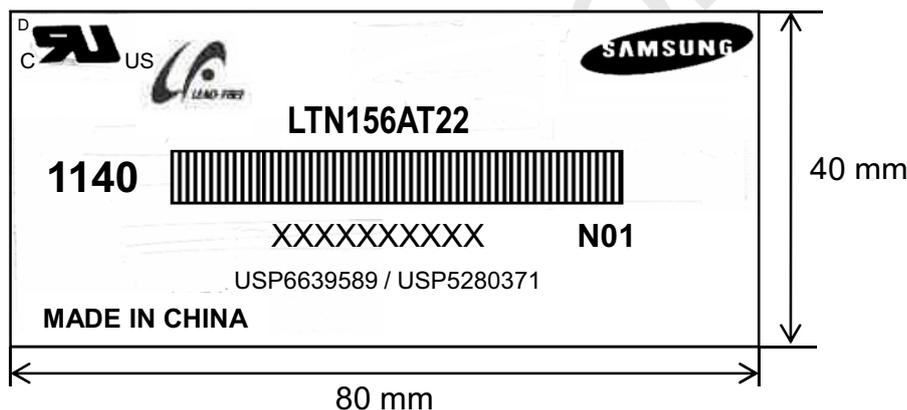
Parts name   : LTN156AT22
Lot number   : XXXXXXXXXX
Inspected work week   : 1140 (2011 year 40th week)
Product Revision Code : N01

High voltage caution label

HIGH VOLTAGE CAUTION
RISK OF ELECTRIC SHOCK DISCONNECT THE ELECTRIC POWER BEFORE SERVICE

THIS COVER CONTAINS FLUORESCENT LAMP. PLEASE FOLLOW LOCAL ORDINANCES OR REGULATIONS FOR ITS DISPOSAL

10mm High voltage caution

70mm

Samsung Secret

| Doc.No. | LTN156AT22-N01 | Rev.No | 04-A00-S-110615 | Page | 28 / 34 |
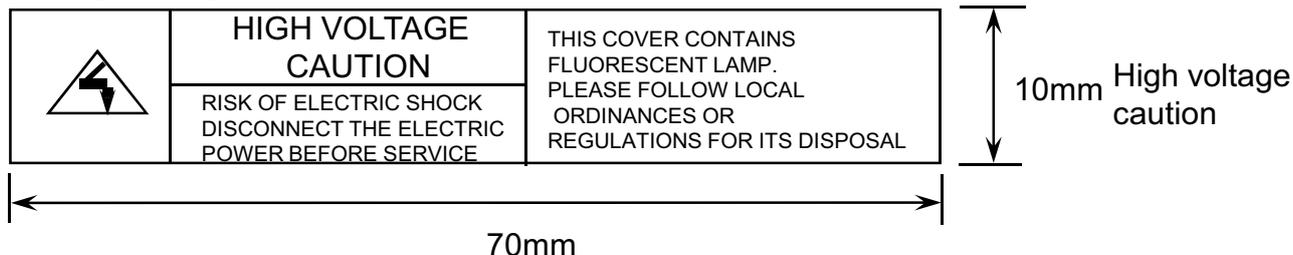
Approval

(5) Packing small box attach

SAMSUNG
ELECTRONICS

DEVICE   : LTN156AT22
TYPE   : N01
QUANTITY   : 22 PCS

CO6040001
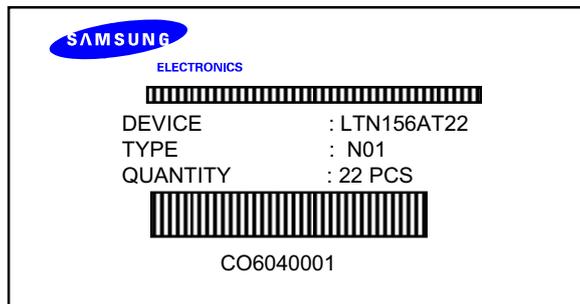
Samsung Secret

Doc.No.	LTN156AT22-N01	**Rev.No**	04-A00-S-110615	**Page**	29 / 34

10. GENERAL PRECAUTIONS

Approval

1. Handling

(a) When the module is assembled, It should be attached to the system firmly
    using every mounting holes. Be careful not to twist and bend the modules.

(b) Refrain from strong mechanical shock and / or any force to the module. In addition to
    damage, this may cause improper operation or damage to the module and CCFT back-light.

(c) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch
    the surface harder than a HB pencil lead.

(d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time,
    Staining and discoloration may occur.

(e) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.

(f) The desirable cleaners are water, IPA (Isoprophyl Alcohol) or Hexane.
    Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl
    chloride. It might permanent damage to the polarizer due to chemical reaction.

(g) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or
    mouth . In case of contact with hands, legs or clothes, it must be washed away thoroughly
    with soap.

(h) Protect the module from static , it may cause damage to the C-MOS Gate Array IC.

(i) Use fingerstalls with soft gloves in order to keep display clean during the incoming
    inspection and assembly process.

(j) Do not disassemble the module.

(k) Do not pull or fold the lamp wire.

(l) Do not adjust the variable resistor which is located on the back side.

(m) Protection film for polarizer on the module shall be slowly peeled off just before use so
     that the electrostatic charge can be minimized.

(n) Pins of I/F connector shall not be touched directly with bare hands.

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	30 / 34

2. STORAGE

Approval

(a) Do not leave the module in high temperature, and high humidity for a long time.
It is highly recommended to store the module with temperature from 5 to 40 °C and relative humidity of less than 70%.

(b) Do not store the TFT-LCD module in direct sunlight.

(c) The module shall be stored in a dark place. It is prohibited to apply sunlight or fluorescent light during the store.

(d) Storage period is recommended not to exceed 1 year.

3. OPERATION

(a) Do not connect,disconnect the module in the " Power On" condition.

(b) Power supply should always be turned on/off by following item 6.3 " Power on/off sequence ".

(c) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.

(d) The cable between the back-light connector and its inverter power supply shall be a minimized length and be connected directly . The longer cable between the back-light and the inverter may cause lower luminance of lamp(CCFT) and may require higher startup voltage (Vs).

(e) The standard limited warranty is only applicable when the module is used for general notebook applications. If used for purposes other than as specified, SEC is not to be held reliable for the defective operations. It is strongly recommended to contact SEC to find out fitness for a particular purpose.

(f) When you connect a signal cable to LCD, remove an AC adapter by all means. In addition, to connect with keep the correct sequence, not to occur the short by left voltage.

4. OTHERS

(a) Ultra-violet ray filter is necessary for outdoor operation.

(b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.

(c) Do not exceed the absolute maximum rating value. (the supply voltage variation, input voltage variation, variation in part contents and environmental temperature, so on) Otherwise the module may be damaged.

(d) If the module displays the same pattern continuously for a long period of time,it can be the situation when the image "sticks" to the screen.

(e) This module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	31 / 34

11. EDID

Approval

Address (HEX)	FUNCTION	Value HEX	BIN	DEC	ASCII or Data	Notes	Comments
00	Header	00	00000000	0		EDID Header	
01		FF	11111111	255			
02		FF	11111111	255			
03		FF	11111111	255			
04		FF	11111111	255			
05		FF	11111111	255			
06		FF	11111111	255			
07		00	00000000	0			
08	ID Manufacturer Name	4C	01001100	76	S E C	3 character ID	These Characters represent Vendor ID which is assigned
09		A3	10100011	163		"SEC"	by Microsoft.
0A	ID Product Code	32	00110010	50	[2]		
0B		4E	01001110	78	[N]		
0C	32-bit serial no.	00	00000000	0			
0D		00	00000000	0			
0E		00	00000000	0			
0F		00	00000000	0			
10	Week of manufacture	00	00000000	0			
11	Year of manufacture	13	00010011	19	2009	2009	value=year-1990
12	EDID Structure Ver.	01	00000001	1	1	EDID Ver. 1.0	Version no.
13	EDID revision #	03	00000011	3	3	EDID Rev. 3	Revision no.
14	Video input definition	80	10000000	128			
15	Max H image size	22	00100010	34	34	34 cm(approx)	horizontal size (cm)
16	Max V image size	13	00010011	19	19	19 cm(approx)	vertical size (cm)
17	Display Gamma	78	01111000	120	2.2	Gamma 2.2	gamma value=(1.00~3.54) / value stored=(gamma x 100)-100
18	Feature support	0A	00001010	10			
19	Red/green low bits	8D	10001101	141		10000111	
1A	Blue/white low bits	A5	10100101	165		11111110	
1B	Red x/ high bits	9D	10011101	157	0.615	Red x 0.615= 10011101	
1C	Red y	5B	01011011	91	0.355	Red y 0.355= 01011000	
1D	Green x	55	01010101	85	0.335	Green x 0.335= 01010101	
1E	Green y	9C	10011100	156	0.610	Green y 0.610= 10011100	Color coordinates Data
1F	Blue x	26	00100110	38	0.150	Blue x 0.150= 00100110	
20	Blue y	19	00011001	25	0.100	Blue y 0.100= 00011001	
21	White x	50	01010000	80	0.313	White x 0.313= 01010000	
22	White y	54	01010100	84	0.329	White y 0.329= 01010100	
23	Established timing 1	00	00000000	0			
24	Established timing 2	00	00000000	0			
25	Established timing 3	00	00000000	0			
26	Standard timing #1	01	00000001	1		not used	Unused field in this section shall be set to 01H.
27		01	00000001	1			
28	Standard timing #2	01	00000001	1		not used	Unused field in this section shall be set to 01H.
29		01	00000001	1			
2A	Standard timing #3	01	00000001	1		not used	Unused field in this section shall be set to 01H.
2B		01	00000001	1			
2C	Standard timing #4	01	00000001	1		not used	Unused field in this section shall be set to 01H.
2D		01	00000001	1			
2E	Standard timing #5	01	00000001	1		not used	Unused field in this section shall be set to 01H.
2F		01	00000001	1			
30	Standard timing #6	01	00000001	1		not used	Unused field in this section shall be set to 01H.
31		01	00000001	1			
32	Standard timing #7	01	00000001	1		not used	Unused field in this section shall be set to 01H.
33		01	00000001	1			
34	Standard timing #8	01	00000001	1		not used	Unused field in this section shall be set to 01H.
35		01	00000001	1			

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	32 / 34

Approval

Addr	Descriptor	Hex	Binary	Dec	Value	Description	Description
36		41	01000001	65	72.33	Main clock= 72.33 MHz	Pixel clock / 10000 (Stored LSB first)
37		1C	00011100	28			
38		56	01010110	86	1366	Hor active=1366 pixels	Horizontal Active
39		A0	10100000	160	160	Hor blanking=160 pixels	Horizontal Blanking
3A		50	01010000	80		4bit : 4bit	Horizontal Active : Horizontal Blanking (upper 4bit)
3B		00	00000000	0	768	Vertcal active=768 lines	Vertical Active
3C		16	00010110	22	22	Vertical blanking=22 lines	Vertical Blanking (DE Blanking min for DE only mode panel)
3D		30	00110000	48		4bit : 4bit	Vertical Active : Vertical Blanking (upper 4bit)
3E		30	00110000	48	48		Horizontal Sync. Offset
3F	Detailed timing/monitor	20	00100000	32	32	H sync. Width=32 pixels	Horizontal Sync. Pulse Width
40	descriptor #1	25	00100101	37	2 / 5	V sync. Offset=2 lines / V sync. Width=5 lines	Vertical Sync. Offset : Vertical Sync. Pulse Width
41		00	00000000	0		2bit : 2bit :2bit :2bit	Horizontal Sync. Offset (upper 2bit) / Horizontal Sync Pulse Width (upper 2bit) / Vertical Sync. Offset (upper 2bit) / Vertical Sync. Pulse Width (upper 2bit)
42		58	01011000	88	344	H image size= 344 mm(approx)	Horizontal Image Size
43		C1	11000001	193	193	V image size = 193 mm(approx)	Vertical Image Size
44		10	00010000	16			Horizontal & Vertical Image Size (upper 4bit)
45		00	00000000	0		No Horizontal Border	Horizontal Border
46		00	00000000	0		No Vertical Border	Vertical Border
47		19	00011001	25			Flag
48		00	00000000	0			
49		00	00000000	0			
4A		00	00000000	0		Manufacturer Specified (Timing)	Data type Tag
4B		0F	00001111	15			
4C		00	00000000	0			
4D		00	00000000	0		Value=HSPWmin / 2	
4E		00	00000000	0		Value=HSPWmax / 2	
4F	Detailed timing/monitor	00	00000000	0		Value=Thbpmin /2	
50	descriptor #2	00	00000000	0		Value=Thbpmax/2	DE only mode
51		00	00000000	0		Value=VSPWmin /2	
52		00	00000000	0		Value=VSPWmax /2	
53		00	00000000	0		Value=Tvbpmin / 2	
54		00	00000000	0		Value=Tvbpmax / 2	
55		1E	00011110	30		Thpmin=value*2 + HA pixelclks	
56		B4	10110100	180		Thpmax=value*2 + HA pixelclks	
57		02	00000010	2		Tvpmin=value*2 + VA lines	
58		74	01110100	116		Tvpmax=value*2 + VA lines	
59		00	00000000	0		Module revision	
5A		00	00000000	0			
5B		00	00000000	0			
5C		00	00000000	0		ASCII Data String Tag	Data type Tag
5D		FE	11111110	254			
5E		00	00000000	0			
5F		53	01010011	83	[S]		Supplier Name
60		41	01000001	65	[A]		
61	Detailed timing/monitor	4D	01001101	77	[M]		
62	descriptor #3	53	01010011	83	[S]		
63		55	01010101	85	[U]		
64		4E	01001110	78	[N]		
65		47	01000111	71	[G]		
66		0A	00001010	10	[^]		
67		20	00100000	32	[ ]		
68		20	00100000	32	[ ]		
69		20	00100000	32	[ ]		
6A		20	00100000	32	[ ]		
6B		20	00100000	32	[ ]		

Samsung Secret

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	33 / 34

Approval

6C		00	00000000	0		Monitor Name Tag (ASCII)	Data type Tag
6D		00	00000000	0			
6E		00	00000000	0			
6F		FE	11111110	254			
70		00	00000000	0			
71		31	00110001	49	[1]		Supplier Product Name
72		35	00110101	53	[5]		
73	Detailed timing/monitor	36	00110110	54	[6]		
74	descriptor #4	41	01000001	65	[A]		
75		54	01010100	84	[T]		
76		32	00110010	50	[2]		
77		32	00110010	50	[2]		
78		2D	00101101	45	[-]		
79		4E	01001110	78	[N]		
7A		30	00110000	48	[0]		
7B		31	00110001	49	[1]		
7C		0A	00001010	10	[^]		
7D		20	00100000	32	[ ]		
7E	Extension Flag	00	00000000	0			
7F	Checksum	E5	11100101	229			

Doc.No.	LTN156AT22-N01	Rev.No	04-A00-S-110615	Page	34 / 34