

**SPECIFICATION FOR LCD MODULE**

<b>Customer Name</b>	
<b>Customer Model</b>	
<b>Project Name</b>	<u>BG2002-02</u>
<b>Date</b>	<u>2023.8.2</u>
<b>Version</b>	<u>1.0</u>

Preliminary Specification

Final Specification

**Customer's Acceptance** : This module uses RoHS material.

<b>Comment</b>	<b>Approved by</b>
Rio	Shawn

<b>Developer</b>	<b>Reviewer</b>	<b>Approver</b>
<b>R&amp;D</b>	<b>R&amp;D</b>	<b>R&amp;D</b>
Shawn	William	Rio

# Bocen Display Technology Co., Ltd.

Tel: +86-0755-23145782 E-mail: info@bocentech.com Website: www.bocentech.com  
Address: 603 Esun Tech Building, No.22 Jia'an South Road, Bao'an District, 518101 Shenzhen, China.

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## RECORDS OF REVISION

Date	Rev.	Description	Page	Design by
2023.8.2	1.0	First Issue	-	-

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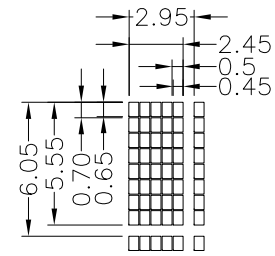
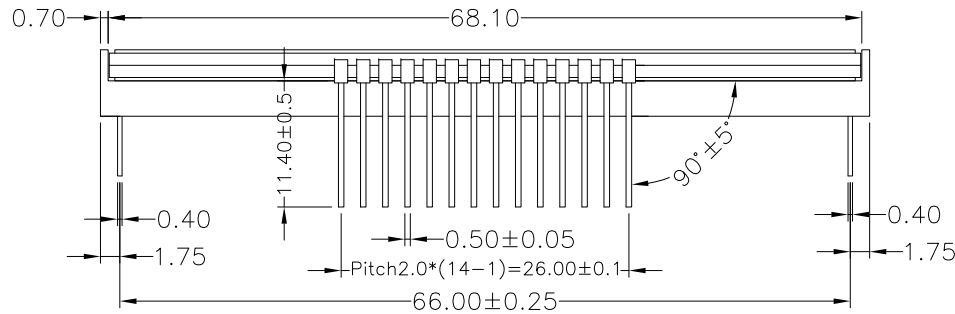
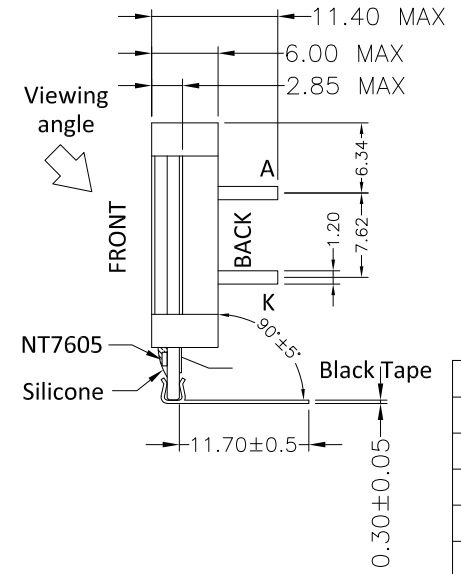
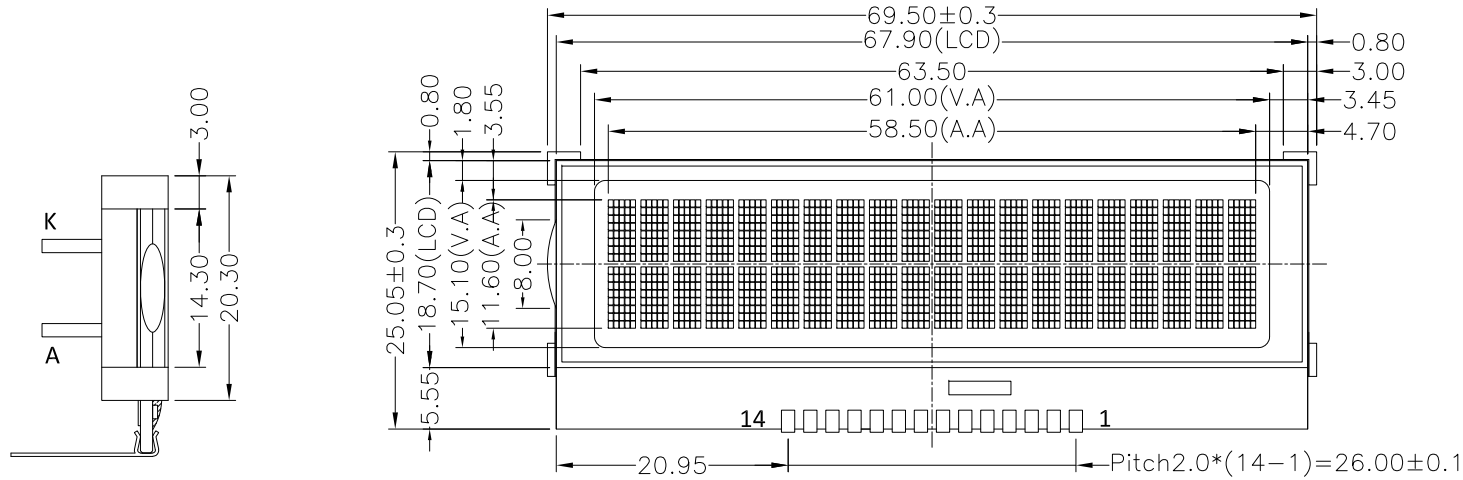
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## 1. GENERAL SPECIFICATIONS

ITEM	DESCRIPTION	UNIT
Outline Size	69.5(L) × 25.0(W) × 6.0(T)	mm
LCD Type	STN,Blue, Transmissive / Negative, 1/16Duty, 1/5Bias	---
Display type	20×2 Character	---
View Area	61.00×15.10	mm
Display Area	58.5×11.6	mm
Dots size	0.45×0.65	mm
Dots pitch	0.5.0×0.70	mm
Controller & driver	NT7605	---
View Direction	12 O'Clock	---
Interface mode	8 bit 6800	---
VDD&VOP(Type)	5.0V & 5.0 V	V
Backlight(Type)	White, 2.9V, 60MA	---
Operation Temp.	-20~+60	°C
Storage Temp.	-30~+65	°C

Revised Record

1.0 2023-07-22 New Issue



PIN	SYMBOL
1	GND
2	V5
3	VDD
4	RS
5	R/W
6	E
7	DB0
8	DB1
9	DB2
10	DB3
11	DB4
12	DB5
13	DB6
14	DB7

SCALE(2:1)

**SPECIFICATIONS:**

- 1. DISPLAY TYPE: STN / BLUE / NEGATIVE / TRANSMISSIVE
- 2. DRIVE IC: NT7605
- 3. OPERATING VOLTAGE: Vlcd=5.0V; Vdd=5.0V
- 4. OPERATING TEMPERATURE: -20°C ~ +60°C
- 5. STORAGE TEMPERATURE: -30°C ~+ 65°C
- 6. DRIVE MODE: 1/16DUTY, 1/5 BIAS
- 7. BACKLIGHT: White LED, IF=60mA, VF=2.9V
- 8. VIEWING ANGLE: 12 O'CLOCK
- 9. CUSTOMER PART NO.: BOCEN STANDARD PRODUCT

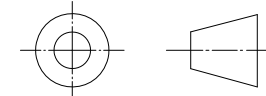
**BOCEN DISPLAY TECHNOLOGY CO., LTD.**

DESIGNED BY: Shawn

**BG2002-02**

VERSION: 1.0

CHECKED BY: William



NO.: 1 OF 1

APPROVED BY: Rio

UNIT: mm

Website: <http://www.bocentech.com>

DATE: 2023-07-22

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## 3. PIN CONNECTIONS

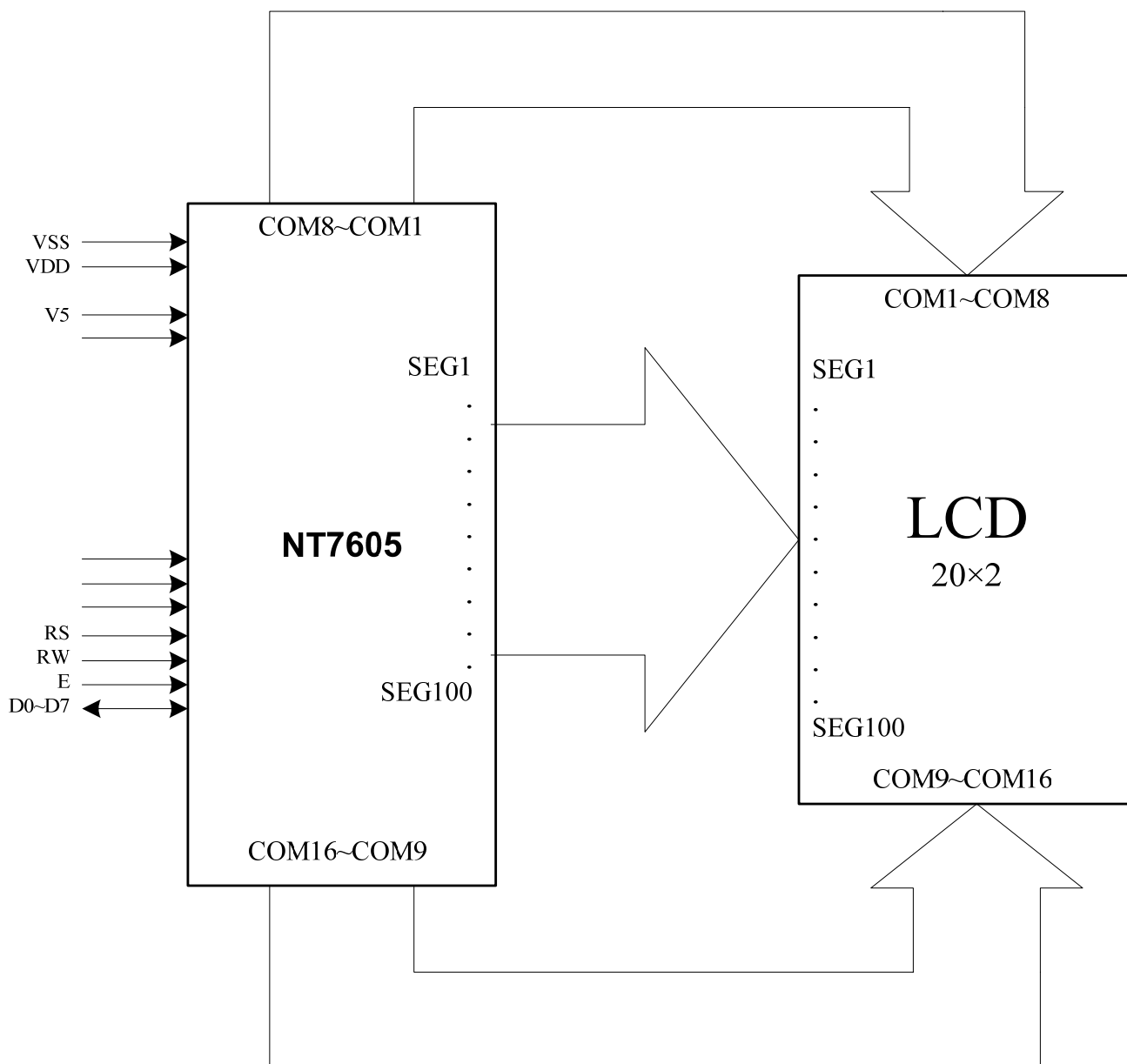
### NT7605

Pin No.	Pin Out	Description
1	GND	Ground.
2	V5	Power supply for LCD drive, Connected to GND through a resistor.
3	VDD	Power supply for circuit.
4	RS	Select registers. 0: Instruction register (for write) Busy flag & address counter (for read) 1: Data register (for write and read)
5	R/W	Select read or write (In parallel mode). 0: Write 1: Read
6	E	Starts data read/write. ("E" must connect to "VDD" when serial interface is selected.)
7	DB0	Four high order bi-directional data bus pins.
8	DB1	
9	DB2	
10	DB3	
11	DB4	
12	DB5	
13	DB6	
14	DB7	

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## 4. BLOCK DIAGRAM

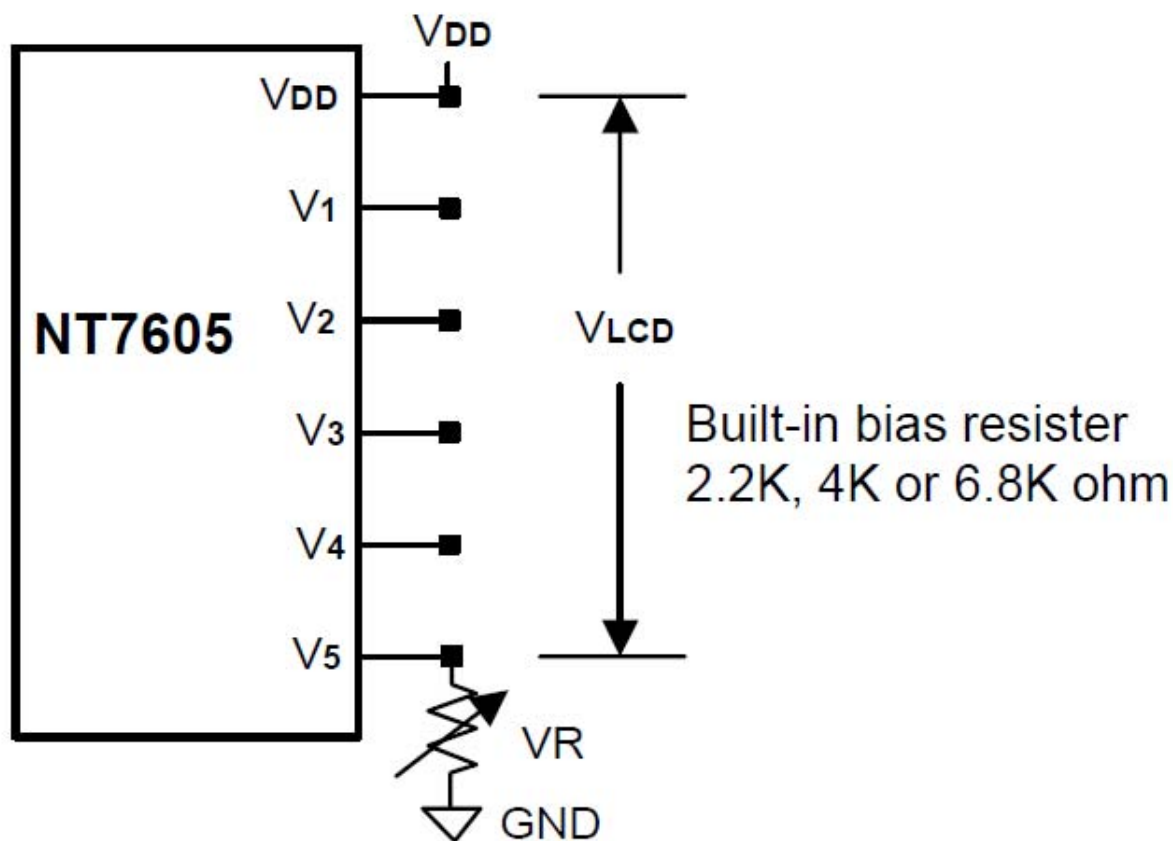


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## 5. APPLICATION CIRCUIT EXAMPLE





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## 6. ABSOLUTE MAXIMUM RATING

### ELECTRICAL ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN	MAX	UNIT
POWER SUPPLY FOR LOGIC	VDD-VSS	-0.3	5.5	V
POWER SUPPLY FOR LCD DRIVE	VLCD	-0.3	7.0	V
INPUT VOLTAGE	VIN	-0.3	VDD+0.3	V
POWER SUPPLY FOR LED	VA-VK	-0.3	3.3	V

### ENVIRONMENTAL ABSOLUTE MAXIMUM RATINGS

ITEM	OPERATING		STORAGE		UNIT	COMMENT
	MIN	MAX	MIN	MAX		
AMBIENT TEMPERATURE	-20	+60	-30	+65	°C	
HUMIDITY	NOTE(1)		NOTE(1)		--	WITHOUT CONDENSATION
VIBRATION (M/S <sup>2</sup> )	/	/	/	/	--	SEE "ITEMS OF RELIABILITY"
TEMPERATURE CYCLING TEST	/	/	/	/	--	SEE "ITEMS OF RELIABILITY"
CORROSIVE GAS	NOT ACCEPTABLE		NOT ACCEPTABLE		--	

## 7. ELECTRICAL CHARACTERISTICS (V<sub>SS</sub>=0V)

Item	Symbol	Condition	Min.	Typ	Max.	Unit	note
Power Supply for Logic	V <sub>DD</sub> -V <sub>SS</sub>	T <sub>a</sub> =25°C	4.8	5.0	5.2	Volt	
Power Supply for LED	A-K	T <sub>a</sub> =25°C	--	--	--	Volt	
Input Voltage	V <sub>IL</sub>	V <sub>DD</sub> =5V±5%	V <sub>SS</sub>		0.2 V <sub>DD</sub>	Volt	
	V <sub>IH</sub>		0.8 V <sub>DD</sub>	-	V <sub>DD</sub>	Volt	
Output Voltage	V <sub>OL</sub>	V <sub>DD</sub> =5V±5%	V <sub>SS</sub>	-	0.2 V <sub>DD</sub>	Volt	
	V <sub>OH</sub>		0.8 V <sub>DD</sub>	-	V <sub>DD</sub>	Volt	
LCD drive Voltage (recommended Voltage)	V <sub>0</sub> -V <sub>SS</sub>	T <sub>a</sub> =0°C	--	--	--	Volt	
		T <sub>a</sub> =25°C	4.8	5.0	5.2		
		T <sub>a</sub> =50°C	--	--	--		
Power Supply Current for LCM	I <sub>DD</sub>	V <sub>DD</sub> =5.0V	-	1.5	2.0	mA	-
	I <sub>LED</sub>	V <sub>LED</sub> =2.9 V	--	60	80	mA	None 1

Note 1: Backlight Electrical-Optical Characteristics

Item	Symbol	Min.	Typ.	Max.	Unit	Condition
Luminance	L <sub>v</sub>	200	300	--	CD/m <sup>2</sup>	If=60 mA
Range	x	0.26	--	0.31	-	
	y	0.26	--	0.31	-	
Brightness uniformity	△%	70	--	--	%	min / max * 100%

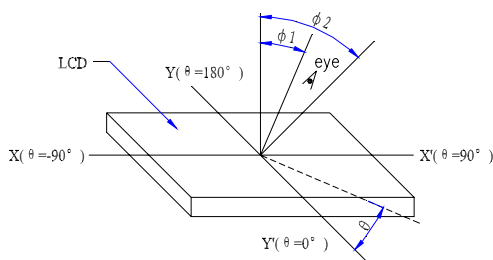
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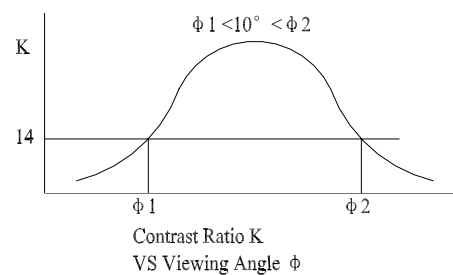
## 8. ELECTRO-OPTICAL CHARACTERISTICS

Item	Symbol	Condition	Min.	Typ	Max.	Unit	note
Viewing angle range	$\Theta 2 - \Theta 1$	$T_a = 25^\circ\text{C}$	20	-	-	Deg	K=1.4 A,B
	$\Phi$		-	-	-		
Rise Time	$T_r$	$T_a = 25^\circ\text{C}$	-	200	300	ms	$\Phi = 10$ $\Theta = 0$ C
		$T_a = 0^\circ\text{C}$	-	-	-		
Fall Time	$T_f$	$T_a = 25^\circ\text{C}$	-	230	350	ms	$\Phi = 10$ $\Theta = 0$ C
		$T_a = 0^\circ\text{C}$	-	-	-		
Contrast	Cr	$T_a = 25^\circ\text{C}$	-	5	-	-	$\Phi = 10$ $\Theta = 0$ D

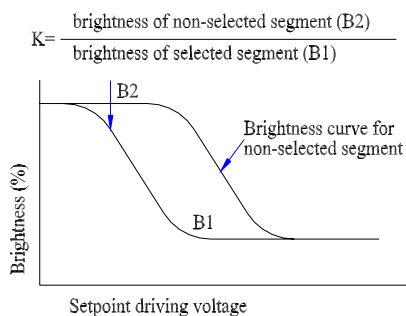
### 8.1 Definition of angle $\theta$ and $\phi$



### 8.2 Definition of viewing angle $\phi 1$ and $\phi 2$

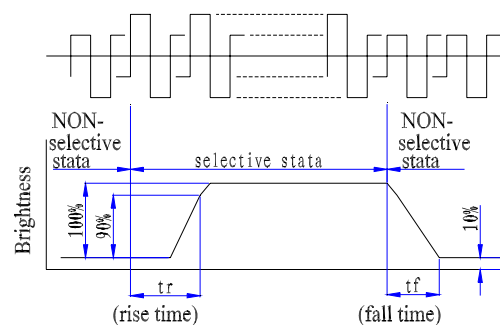


### 8.3 Definition of contrast "K"



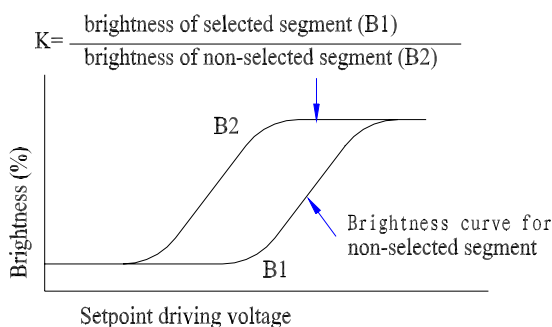
POSITIVE TYPE

### 8.4 Definition of optical response



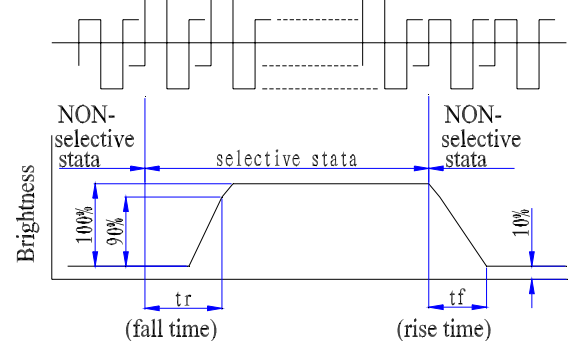
POSITIVE TYPE

### 8.5 Definition of contrast "K"



NEGATIVE TYPE

### 8.6 Definition of optical response



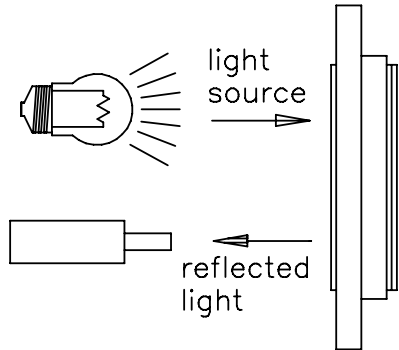
NEGATIVE TYPE

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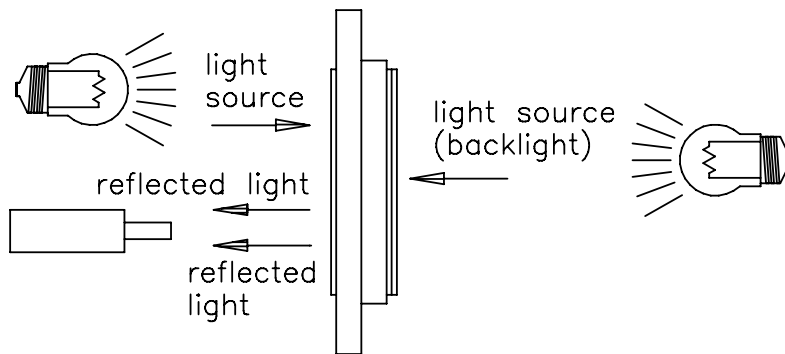
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## 8.7 DESCRIPTION OF MEASURING EQUIPMENT



Reflective type



Transflective type

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## 9. CONTROLLER ELECTRICAL CHARACTERISTICS

DC Electrical Characteristics ( $V_{DD} = 4.5V \sim 5.5V$ ,  $GND = 0V$ ,  $T_A = 25^\circ C$ )

Symbol	Parameter	Min.	Typ.	Max.	Unit	Conditions	Applicable Pin
V <sub>DD</sub>	Operating Voltage	4.5	5.0	5.5	V		
V <sub>IH1</sub>	"H" Level Input Voltage	0.8 V <sub>DD</sub>	-	V <sub>DD</sub>	V		DB0 - DB7, RS, R/W, E, OSC1
V <sub>IL1</sub>	"L" Level Input Voltage	-0.3	-	0.2 V <sub>DD</sub>	V		
V <sub>OH1</sub>	"H" Level Output Voltage	V <sub>DD</sub> - 0.6	-	-	V	I <sub>OH</sub> = -1.2mA	DB0 - DB7 (CMOS)
V <sub>OL1</sub>	"L" Level Output Voltage	-	-	GND + 0.6	V	I <sub>OL</sub> = 1.2mA	
V <sub>COMD</sub>	Driver Voltage Descending (COM)	-	-	0.3	V	I <sub>D</sub> = 5μA	COM1 - 16
V <sub>SEGD</sub>	Driver Voltage Descending (SEG)	-	-	0.3	V	I <sub>D</sub> = 5μA	SEG1 - 100
I <sub>IL</sub>	Input Leakage Current	-1	-	1	μA	V <sub>IN</sub> = 0 to V <sub>DD</sub>	
-I <sub>P</sub>	Pull-up MOS Current	50	125	250	μA	V <sub>DD</sub> = 5V	RS, R/W, DB0 - DB7
I <sub>OP</sub>	Power Supply Current	-	1	1.5	mA	Rf oscillation, from external clock V <sub>DD</sub> = 5V, f <sub>osc</sub> = f <sub>CP</sub> = 540KHz, include LCD bias current	V <sub>DD</sub>
External Clock Operation							
f <sub>CP</sub>	External Clock Operating Frequency	380	540	750	KHz		
t <sub>DUTY</sub>	External Clock Duty Cycle	45	50	55	%		
t <sub>RCP</sub>	External Clock Rise Time	0.1	-	0.5	μs		
t <sub>FCP</sub>	External Clock Fall Time	0.1	-	0.5	μs		
Internal Clock Operation (Built-in RC Oscillator)							
f <sub>osc</sub>	Oscillator Frequency	380	540	750	KHz	Rf = 50KΩ (reference only) V <sub>DD</sub> = 2.8V ~ 5.5V	
V <sub>LCD</sub>	LCD Driving Voltage	3.0	-	V <sub>DD</sub>	V	V <sub>DD</sub> - V <sub>5</sub>	

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## 10. TIMING CHARACTERISTICS

### Read Operation

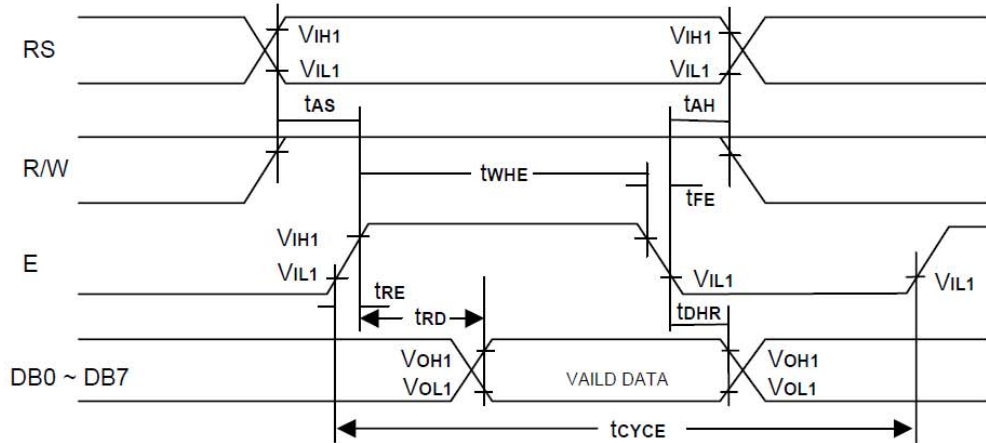


Figure 1. Bus Read Operation Sequence  
 (Reading out data from NT7605 to MPU)

### Write Operation

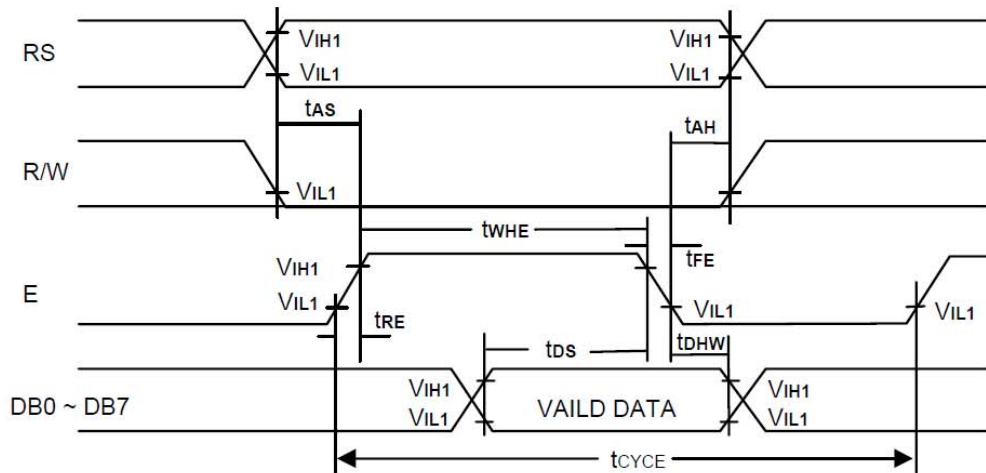


Figure 2. Bus Write Operation Sequence  
 (Writing data from MPU to NT7605)

### Interface Signals with Segment Driver LSI

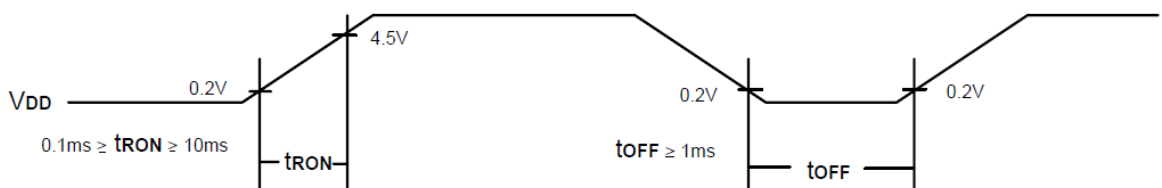


Figure 3. toff stipulates the time of power off for instantaneous Power supply to or when power supply repeats ON and OFF.

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## 11. DISPLAY COMMANDS

Instruction	Code										Function	Execution time (max) (fosc = 540KHz)		
	RS	RW	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0				
Display Clear	0	0	0	0	0	0	0	0	0	0	1	Clear entire display area, Restore display from shift, and load address counter with DD RAM address 00H	1.64ms	
Display/ Cursor Home	0	0	0	0	0	0	0	0	0	1	*	Restore display from shift and load address counter with DD RAM address 00H	1.64ms	
Entry Mode Set	0	0	0	0	0	0	0	0	1	I/D	S	Specify direction of cursor movement and display shift mode. This operation takes place after each data transfer (read/write)	40μs	
Display ON/OFF	0	0	0	0	0	0	0	1	D	C	B	Specify activation of display (D) cursor (C) and blinking of character at cursor position (B)	40μs	
Display/ Cursor Shift	0	0	0	0	0	0	1	S/C	R/L	*	*	Shift display or move cursor	40μs	
Function Set	0	0	0	0	1	DL	N	F	*	*		Set interface data length (DL), number of the display line (N), and character font (F)	40μs	
RAM Address Set	0	0	0	1	ACG							Load the address counter with a CG RAM address Subsequent data access is for CG RAM data	40μs	
DD RAM Address Set	0	0	1	ADD							Load the address counter with a DD RAM address Subsequent data access is for DD RAM data	40μs		
Busy Flag/ Address Counter Read	0	1	BF	AC							Read Busy Flag (BF) and contents of Address Counter (AC)	1μs		
CG RAM/ DD RAM Data Write	1	0	Write data									Write data to CG RAM or DD RAM	40μs	
CG RAM/ DD RAM Data Read	1	1	Read data									Read data from CG RAM or DD RAM	40μs	
	I/D = 1 : Increment S = 1 : Display Shift On D = 1 : Display On C = 1 : Cursor Display On B = 1 : Cursor Blink On S/C = 1 : Shift Display R/L = 1 : Shift Right DL = 1 : 8-Bit N = 1 : Dual Line F = 1 : 5x10 dots BF = 1 : Internal Operation BF = 0 : Ready for Instruction										I/D = 0 : Decrement S/C = 0 : Move Cursor R/L = 0 : Shift Left DL = 0 : 4-Bit N = 0 : Signal Line F = 0 : 5x8 dots		DD RAM : Display Data RAM CG RAM : Character Generator RAM ACG : Character Generator RAM Address ADD : Display Data RAM Address AC : Address Counter	

Note 1: Symbol " \* " signifies an insignificant bit (disregard).

Note 2: Correct input value for "N" is predetermined for each model.

Note 3: The variation of execution time depends on the change of oscillator frequency; for example:

$$\text{if } f_{OSC} = 380\text{KHz, then execution time} = 40\mu\text{s} \times (540\text{KHz} / 380\text{KHz}) = 57\mu\text{s}$$

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## 12. QUALITY LEVEL

### Inspection conditions

#### *Environmental conditions*

The environmental conditions for inspection shall be as follows: Room temperature:  $22 \pm 3$  °C; Humidity:  $50 \pm 10\%$  RH

#### *The external visual inspection*

The inspection shall be performed by using a single 2W fluorescent lamp for illumination and the distance from LCD to eyes of the inspector should be 3cm or more.

### Classification of defects

#### *A major defect*

A major defect refers to A defect which may substantially degrade usability for product applications.

#### *Minor defect*

A Minor defect refers to A defect which is not considered to substantially degrade product application or A defect which deviates from existing standards almost unrelated to the effective use of the product or its operation

Sampling procedures for each items acceptance level table

Defect type	Sampling procedures	AQL
Major defect	MIL-STD-105D Inspection level1 normal inspection Single sample inspection	1.0
Minor defect	MIL-STD-105D Inspection level1 normal inspection Single sample inspection	2.5

### *Life time*

50,000Hrs(25°C in the room without ray of sun)

### *Items of reliability*

ITEM	CONDITIONS	CRITERION
High temperature operation test	+60°C \ 120 hours	1. It judged at room temperature after 1 hours to be good as appearance and electrical test is normal after the experiment. 2. Current consumption should within the specification of Approval sheet Electro-optical characteristics
Low temperature operation test	-20°C \ 120 hours	5-10pcs
High temperature/humidity storage test	+65°C, 80%±10%RH \ 120 hours	
High temperature storage test	+65°C \ 120 hours	
Low temperature storage test	-30°C \ 120 hours	

Temperature cycling test	<p style="text-align: center;">-20°C (30 min) ↓     ↑ 25°C (5 min) ↓     ↑ 60°C (30 min)</p> <p style="text-align: center;"><b>CYCLES: 10</b></p>	
Vibration	Random Wave: 10 ~ 50 Hz Each Direction (x, y, z): 30 Min.	

**Cosmetic criteria of LCD screen**

DEFECT	JUDGEMENT CRITERION	
Spots	<b>Size d (mm)</b>	<b>Acceptable quantity in active area</b>
	d ≤ 0.1	Disregard
	0.1 < d ≤ 0.2	6
	0.2 < d ≤ 0.3	2
	d > 0.3	0
	Note: d = (Length + Width)/2	
Polarizer Bubbles	<b>Size d (mm)</b>	<b>Acceptable quantity in active area</b>
	d ≤ 0.3	Disregard
	0.3 < d ≤ 1.0	3
	1.0 < d ≤ 1.5	1
	d > 1.5	0
	Note: d = (Length + Width)/2	
Lines	<b>Width W (mm)</b> <b>Length L (mm)</b>	<b>Acceptable quantity in active area</b>
	W ≤ 0.02	Disregard
	0.02 < W ≤ 0.05	L ≤ 5.0
		L > 5.0
	0.05 < W ≤ 0.1	L ≤ 2.0
		L > 2.0
	W > 0.1	See criteria for spots
Testing conditions: 20W fluorescent lamp at 30 cm distance at normal viewing angle		



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## 13. PRECAUTIONS

### **Static charge**

Since this LCD module contains CMOS LSI that are sensitive to static charge, care must be taken when handling it.

### **Power on sequence**

1. Input signals should not be applied to the LCD module before the logic system voltage has reached the specified voltage. If the above sequence is not kept, the LCD module might be permanently damaged.
2. When connecting the power supply, connect the LCD bias voltage after connecting the logic system voltage.
3. When disconnecting the power supply, disconnect the logic system voltage after the LCD bias voltage.
4. It is recommended to connect a serial resistor or fuse to the LCD bias power supply of the system as a current limiter. The value of the resistor depends on the kind of LCD used, but is typically 50~100 $\Omega$

### **Operation**

1. It is essential to drive the LCD within the specified voltage limits, since a higher driving voltage than allowed causes a shorter LCD lifetime. Under these circumstances, electrochemical reactions will result in undesirable deterioration of the LCD.
2. The response time of the LC fluid is considerably longer at low temperature than in the normal operating temperature range. On the other hand, the LCD will show a dark blue color at high temperatures. Those phenomena do not indicate a malfunction or defect of the LCD. Back at normal temperatures, the LCD will return to its original behavior.
3. If the display area is pressed hard during operation, some abnormal display patterns might appear. However, the display will resume normal operation after turning the module off and on.
4. Moisture on the terminals could cause an electrochemical reaction resulting in an open terminal connection. If the environmental temperature is higher than 50 $^{\circ}\text{C}$ , it is required that the relative humidity is 50% or less.

### **Long-time storage**

For long-term storage the following methods are highly recommended:

1. Store the product in a polyethylene bag with a sealed opening to prevent fresh air entering from the outside. Placing it with a desiccant is not necessary.
2. Store the product in a dark place, with the temperature in the range from -10 $^{\circ}\text{C}$  to 50 $^{\circ}\text{C}$ .
3. Keep the sensitive polarizer surface of the LCD panels clear of any contact. We recommend using the container that was used by BOCEN to deliver the products.

### **Cleaning of product**

To clean the product make sure to use absorbent cotton cloth or other soft material like chamois. Make sure to rub it gently and do not use chemicals when cleaning.

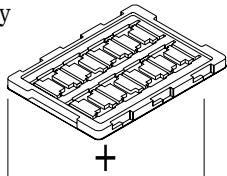
# Bocen Display Technology Co., Ltd.

Tel: +86-0755-23145782 E-mail: info@bocentech.com Website: www.bocentech.com  
 Address: 603 Esun Tech Building, No.22 Jia'an South Road, Bao'an District, 518101 Shenzhen, China.

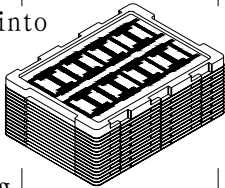
## 14. PACKAGING INFORMATION

Packaging Material				
No.	Item	Model	Dimensions (mm)	Quantity
1	LCM	-	-	--
2	POF	-	-	--
3	TRAY	-	-	--
4	SMALL BOX	-	385.0×315.0×200.0	2
5	BIG BOX	-	398.0×331.0×430.0	1

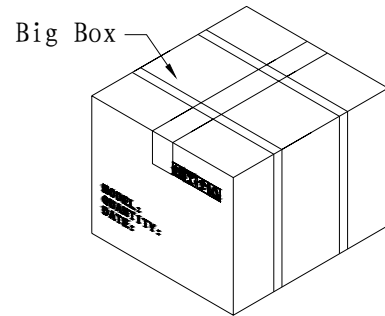
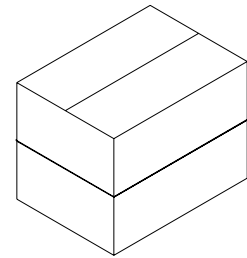
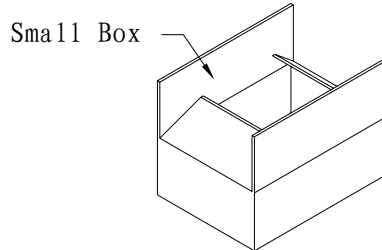
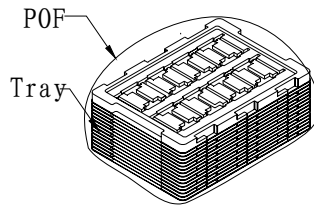
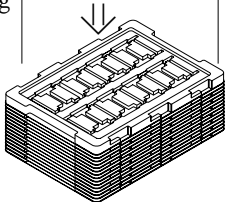
Use empty tray



Put products into the tray



Tray stacking



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## 15. FONT TABLE

Table 1. NT7605H-BDT01 Correspondence between Character Codes and Character Patterns (NOVATEK Standard 192 Character CG ROM)

		Higher 4-bit (D4 to D7) of Character Code (Hexadecimal)																
		0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	
Lower 4-bit (D0 to D3) of Character Code (Hexadecimal)	0	CG RAM (1)			Q	A	P	\	P				—	9	E	o	p	
	1	CG RAM (2)		!	1	A	Q	a	a				a	7	*	4	3	g
	2	CG RAM (3)		"	2	B	R	b	r				r	4	v	x	p	e
	3	CG RAM (4)		#	3	C	S	c	s				j	5	t	e	e	w
	4	CG RAM (5)		\$	4	D	T	d	t				v	6	h	h	p	a
	5	CG RAM (6)		%	5	E	U	e	u				.	7	*	1	5	ü
	6	CG RAM (7)		&	6	F	V	v	v				7	8	2	a	p	z
	7	CG RAM (8)		'	7	G	W	w	w				7	9	3	g	g	π
	8	CG RAM (1)		(	8	H	X	h	x				4	0	4	u	j	x
	9	CG RAM (2)		)	9	I	Y	i	y				5	1	5	u	y	
	A	CG RAM (3)		*	A	J	Z	j	z				5	2	6	v	j	f
	B	CG RAM (4)		+	B	K	k	k	k				6	3	7	o	k	f
	C	CG RAM (5)		,	C	L	l	l	l				6	4	8	n	o	f
	D	CG RAM (6)		-	D	M	m	m	m				7	5	9	o	k	÷
	E	CG RAM (7)		.	E	N	n	n	n				8	6	0	o	n	
	F	CG RAM (8)		/	F	O	o	e	e				9	7	1	ö		