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REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
-	E0298		

1. **Specification subject to change without notice.**
2. **All dimensions and specifications apply to standard modules. This information may vary for modules with optional features.**
3. **All dimensions are in millimeters.**
4. **Precautions: These precautions apply equally to modules from all makers, not just Densitron. Violation of these guidelines may void the warranty and can cause problems ranging from erratic operation to catastrophic display failure.**

Handling precautions:

- ◆ This device is susceptible to Electro-Static Discharge (ESD) damage. Observe Anti-Static precautions.

Power supply precautions:

- ◆ Identify and, at all times, observe absolute maximum ratings for both logic and LC drivers. Note that there is some variance between models.
- ◆ Prevent the application of reverse polarity to VDD and Vss, however briefly.
- ◆ Use a clean power source free from transients. Power up conditions are occasionally "jolting" and may exceed the maximum ratings of the module.
- ◆ The +5V power of the module should also supply the power to all devices which may access the display. Don't allow the data bus to be driven when the logic supply to the module is turned off.
- ◆ DO NOT install a capacitor between the Vo (contrast) pin and ground. VDD must, at all times, exceed the Vo voltage level. The capacitor combines with the contrast potentiometer to form an R-C network which "holds-up" Vo, at power-down, possibly damaging the module.

Operating precautions:

- ◆ DO NOT plug or unplug the module when the system is powered up.
- ◆ Minimize the cable length between the module and host MPU. (Recommended max. length 30 cm).
- ◆ For models with EL or CCFL backlights, do not disable the backlight by interrupting the HV line. Unloaded inverters produce voltage extremes which may arc within a cable or at the display.
- ◆ Operate the module within the limits of the modules temperature specifications.

Mechanical / Environmental precautions:

- ◆ Improper soldering is the major cause of module difficulty. Use of flux cleaner is not recommended as they may seep under the elastomeric connection and cause display failure. Densitron recommends the use of Kester "245" no-clean solder.
- ◆ Mount the module so that it is free from torque and mechanical stress.
- ◆ Surface of LCD panel should not be touched or scratched. The display front surface is an easily scratched, plastic polarizer. Avoid contact and clean only when necessary with soft, absorbent cotton dampened with petroleum benzene.
- ◆ ALWAYS employ anti-static procedure while handling the module.
- ◆ Prevent moisture build-up upon the module and observe the environmental constraints for storage temperature and humidity.
- ◆ DO NOT store in direct sunlight.
- ◆ If leakage of the liquid crystal material should occur, avoid contact with this material, particularly ingestion. If the body or clothing becomes contaminated by the liquid crystal material, wash thoroughly with water and soap.

Notes: (unless otherwise specified)

Unless otherwise specified: Dimensions are mm Tolerances are: X = ± 3 .X = ± 0.5 .XX = ± 0.05	APPROVALS	DATE	DENSITRON CORPORATION TORRANCE, CA	
	DRAWN			
	CHECKED		TITLE	64 X 128 GRAPHICS LCD MODULE
ISSUED		DWG. NO.	LM4228	SHEET 1 OF 8

1.0 DESCRIPTION

Dot matrix display module consisting of liquid Crystal Display, CMOS driver and Toshiba T6963C controller LSI, printed circuit board, metal support frame and Light Emitting Diode (LED) backlight.

Available LC fluid types are: NTN (supertwisted nematic) and NTN-H (extended temperature range NTN).

Other options include on-board negative voltage generation circuitry and on-board temperature compensation circuitry.

2.0 MECHANICAL CHARACTERISTICS

Item	Specifications	Unit
Package Dimensions	87.0 (W) x 71.0 (H) x 17.6 max. (H)	mm
Display format	128 dots (W) x 64 dots (H)	-
Driving method	1/64	duty
Dot size	0.4 (W) x 0.56 (H)	mm
Dot pitch	0.44 (W) x 0.60 (H)	mm
Active display area	56.28 (W) x 38.36 (H)	mm
Viewing area	62.5 (W) x 43.5 (H)	mm
Weight		g

Notes:W-Width;H-Height;D-Depth.

3.0 ABSOLUTE MAXIMUM RATINGS

V_{SS}=0V;T_a=25°C

Item	Symbol	NTN		NTN-H		Unit
		Min.	Max.	Min.	Max.	
Logic supply voltage	V _{DD} -V _{SS}	0	7	0	7	V
LC driver supply voltage	V _{DD} -V _{EE}	0	24	0	24	V
Operating temperature	T _{OP}	0	+50	-20	+70 (Note 3)	°C
Storage temperature (Note 1)	T _{ST}	-20	+70	-30	+80	
Humidity: Operating (@40°C)	-	-	85%	-	85%	RH (Note 2)
Non-operating (@40°C)	-	-	95%	-	95%	RH (Note 2)

Notes: 1: Tested to 100 hrs.
2: Refers to non-condensing conditions.
3: With backlight off.

4.0 ELECTRICAL CHARACTERISTICS

V_{DD}=5±0.25V;T_a=25°C

Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input "High" voltage	V _{IH}	-	0.8	-	V _{DD}	V
Input "Low" voltage	V _{IL}	-	V _{SS}	-	0.2V _{DD}	V
Output "High" voltage	V _{OH}	I _{OH} =0.205mA	2.2	-	-	V
Output "Low" voltage	V _{OL}	I _{OL} =1.2mA	-	-	0.8	V
Power supply current	I _{EE}	V _{EE} =-18V	-	6	-	mA
Power supply current	I _{DD}	V _{DD} =5.0V	-	10	-	mA

5.0 RECOMMENDED LC DRIVE VOLTAGE ($V_{DD}-V_o$)

$V_{DD}=5.0\pm 0.25V$

Temperature	NTN	NTN-H
$T_a = -20^\circ C$	-	23.6
$T_a = 0^\circ C$	21.1	21.1
$T_a = 25^\circ C$	19.4	19.4
$T_a = 50^\circ C$	17.3	17.3
$T_a = 70^\circ C$	-	15.8

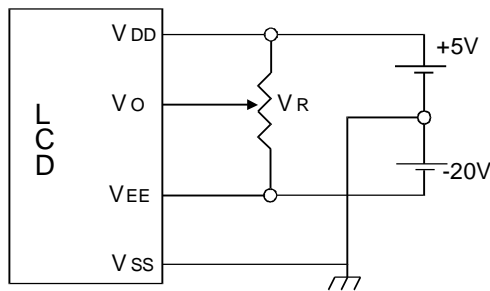
6.0 BACKLIGHT SPECIFICATIONS:

$T_a=20^\circ C, 60\%RH, \text{Darkroom.}$

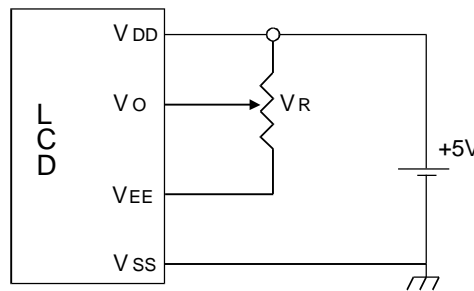
Item	Symbol	Typ.	Max.	Unit
LED input voltage	VLED	5	6	V
LED input current	ILED	480	550	mA
Built-in current limit resistor	R1	-	-	Ohms, W
Recommended external current limit resistor	R2	1.6 Ohm, 1W	-	Ohms, W
Number of LED nodes	N	48	-	-

7.0 POWER SUPPLY

NTN, NTN-H

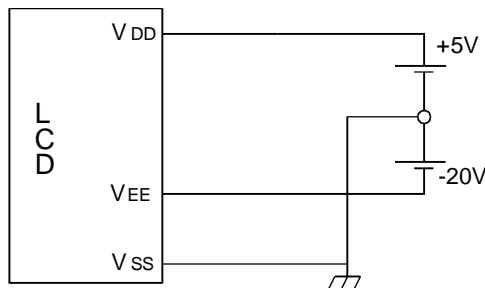


NTN, NTN-H with on-board negative voltage generator

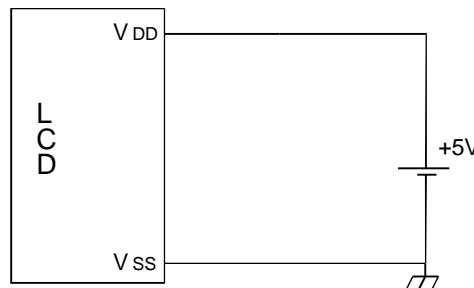


$V_R = 10K - 20K \text{ ohm}$

NTN, NTN-H with temperature compensation



NTN, NTN-H with on-board negative voltage generator and temperature compensation



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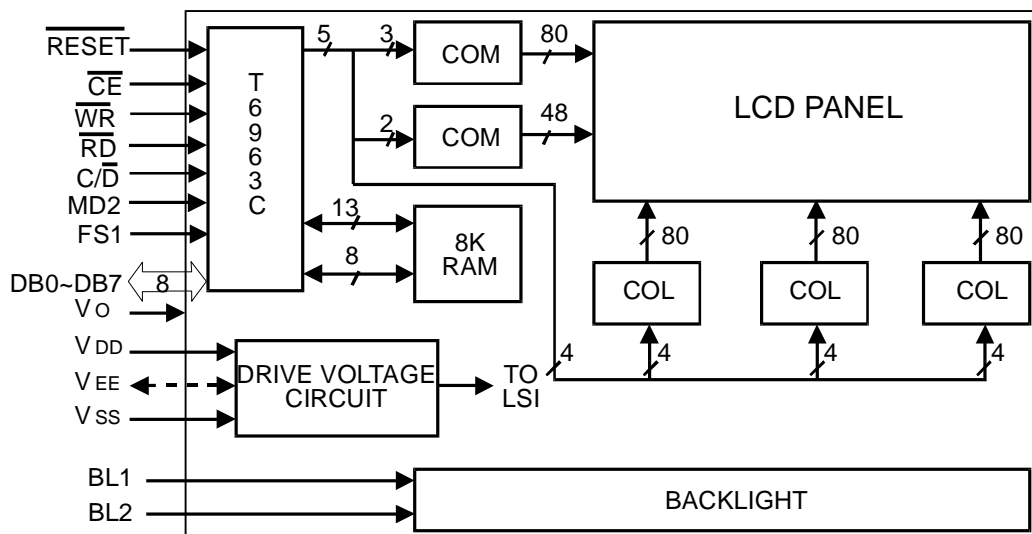
8.0 INTERFACE DESCRIPTION

Pin No.	Symbol	I/O	Function
1	V _{SS}	-	Ground (0V)
2	V _{DD}	-	Logic Supply Voltage (+5V)
3	V _O	-	LC drive voltage for contrast adjustment
4	C/D	I	WR="L"...C/D="H" : Command write C/D="L": Data write RD="L"...C/D="H" : Status read C/D="L": Data read
5	RD	I	Data read Active Low
6	WR	I	Data write Active Low
7	DB0	I/O	Bi-directional data bus line 0
8	DB1	I/O	Bi-directional data bus line 1
9	DB2	I/O	Bi-directional data bus line 2
10	DB3	I/O	Bi-directional data bus line 3
11	DB4	I/O	Bi-directional data bus line 4
12	DB5	I/O	Bi-directional data bus line 5
13	DB6	I/O	Bi-directional data bus line 6
14	DB7	I/O	Bi-directional data bus line 7
15	CE	I	Chip enable Active Low
16	RESET	I	Chip reset Active Low
17	V _{EE}	I(O)	Negative voltage input for LC drive (Negative voltage output for models with on-board negative voltage generator)
18	MD2	I	Mode Selection (see below)
19	FS1	I	Terminals for selection of font size
20	HALT	-	Halt Function (H= Normal, L = Stop oscillation)
BL1	V _{LED+}	-	Anode (+): LED backlight input voltage
BL2	V _{LED-}	-	Cathode (-): LED backlgith input voltage

8.2 Font Selection

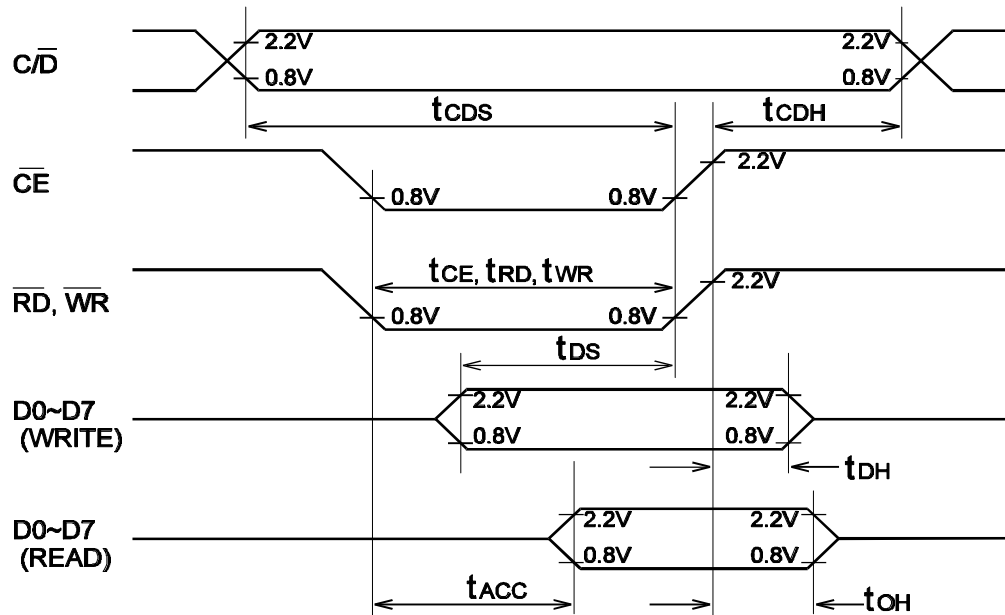
Font Selection	MD2	FS1
6X8	L	H
8X8	H	L

9.0 BLOCK DIAGRAM:



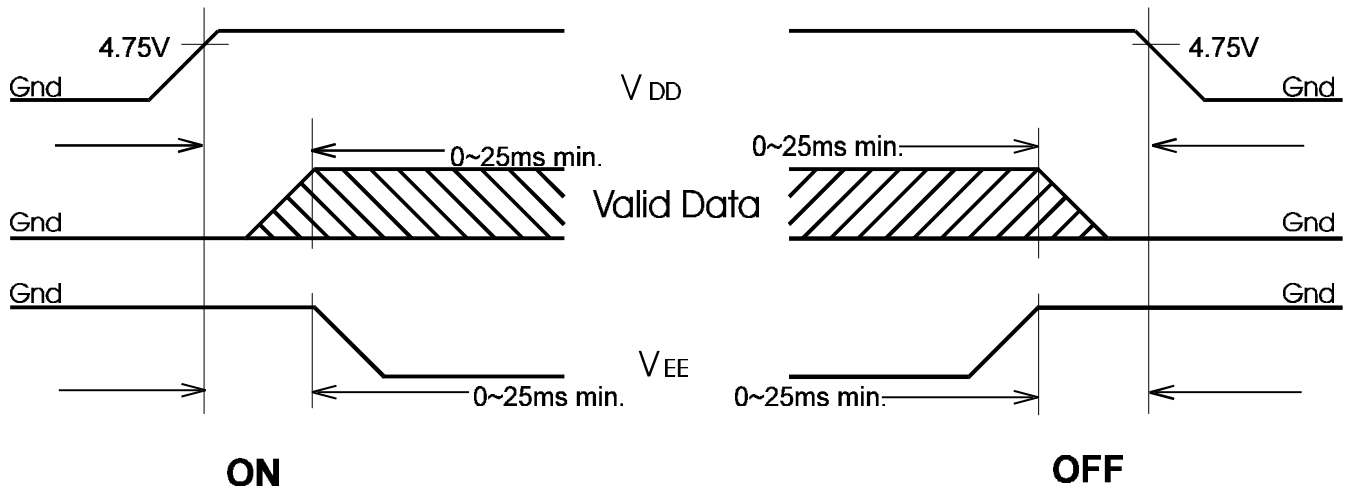
10.0 TIMING CHARACTERISTICS

Item	Symbol	Min.	Typ.	Max.	Unit
C/D Set up time	t _{CDS}	100	-	-	nS
C/D Hold time	t _{CDH}	10	-	-	nS
CE, RD, WR pulse width	t _{CE} , t _{RD} , t _{WR}	80	-	-	nS
Data set up time	t _{DS}	80	-	-	nS
Data hold time	t _{DH}	40	-	-	nS
Access time	t _{ACC}	-	-	150	nS
Output hold time	t _{OH}	10	-	50	nS



11.0 VOLTAGE SEQUENCING

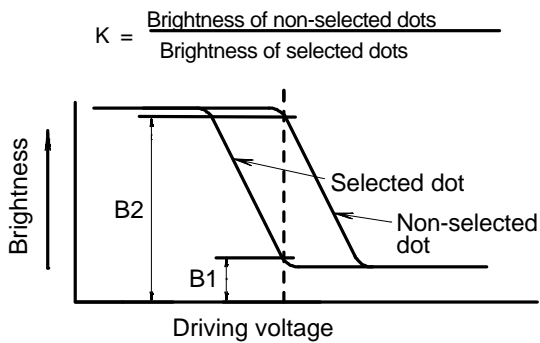
To prevent applying a DC voltage to the LC panel and inducing an electro-chemical effect, please observe the following power supply ON/OFF sequence to prevent DC driving of LC panel or latching-up of CMOS LSI circuits:



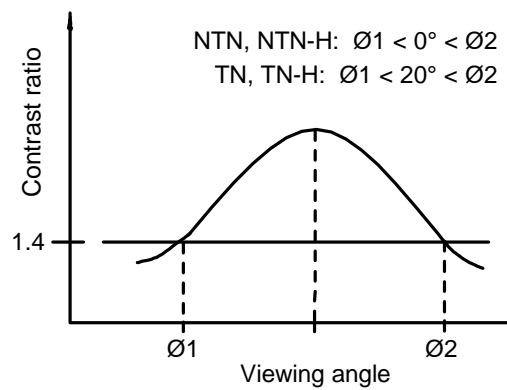
12.0 OPTICAL CHARACTERISTICS

Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Contrast ratio	K	$\theta=20^\circ \theta=0^\circ$	4	-	-	-
Viewing angle	$\theta_2-\theta_1$	$\theta=0^\circ K \geq 1.4$	40	-	-	Deg.
	θ	$\theta=20^\circ K=1.4$	± 30	-	-	Deg.
Response time	Rise	$\theta=20^\circ \theta=0^\circ$	-	150	250	mS
	Fall	$\theta=20^\circ \theta=0^\circ$	-	150	250	mS

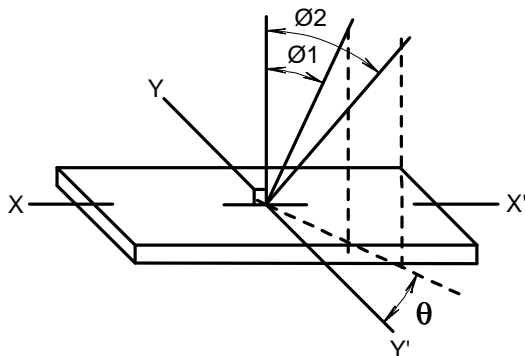
DEFINITION OF CONTRAST RATIO (K)



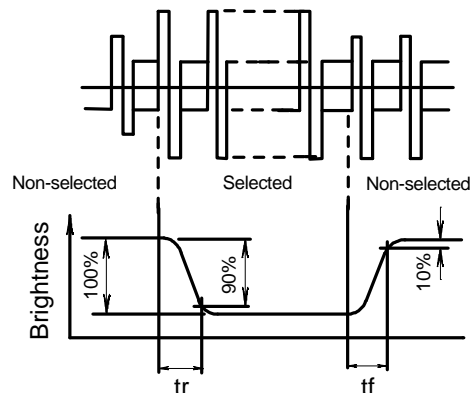
CONTRAST VERSUS VIEWING ANGLE



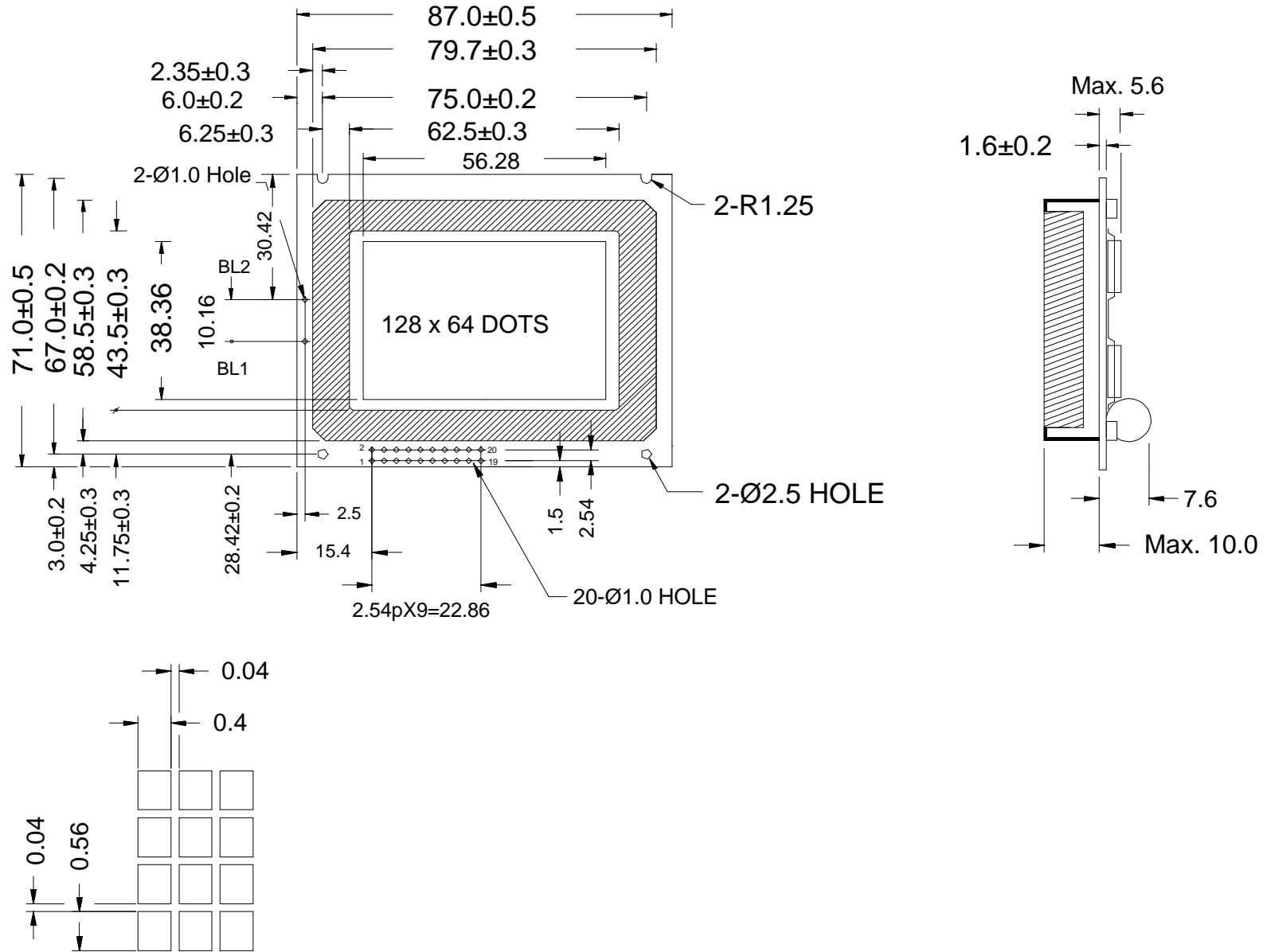
DEFINITION OF ANGLES θ AND θ



DEFINITION OF OPTICAL RESPONSE



13.0 MODULE DIMENSIONS



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14.0 PART NUMBER DESCRIPTION FOR AVAILABLE OPTIONS

LM4228①②64G128③④⑤

①

POLARIZER TYPE

B = Transflective: light background with LED backlight
E = Transmissive: dark background with LED backlight

②

BACKLIGHT COLOR

G - Yellow-Green (Standard)

③

FLUID TYPE AND POWER SUPPLY

D = NTN with +5VDC and external negative voltage operation
S = NTN with +5VDC operation (on-board negative voltage generation)
H = NTN-H with +5VDC and external negative voltage operation
W = NTN-H with +5VDC operation (on-board negative voltage generation)

④

FLUID TYPE AND TEMPERATURE COMPENSATION CIRCUIT

N = NTN, NTN-H

⑤

COLOR FOR NTN FLUID

B = Blue background (available for E polarizer type only)
G = Gray background (available for B polarizers types only)
Y = Yellow background (available for B polarizers types only)