REVISIONS			
REV.	DESCRIPTION	DATE	APPROVED
A	RELEASED ON ECN #E0760	10/15/98	MA

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 V_{DD} and V_{SS}, 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 V_O (contrast) pin and ground. V_{DD} must, at all times, exceed the V_O voltage level. The capacitor combines with the contrast potentiometer to form an R-C network which "holds-up" V_O, 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 SANTA FE SPRINGS, CA.	
	DRAWN			
	CHECKED		TITLE 128 X 128 GRAPHICS LCD MODULE	
	ISSUED		DWG. NO. LM3065	SHEET 1 OF 8

1.0   DESCRIPTION

Dot matrix display module consisting of liquid Crystal Display, CMOS drivers, printed circuit board, metal support frame. Available LC fluid types are: NTN (supertwisted nematic) and NTN-H (extended temperature range NTN).

Other options include electroluminescent (EL) backlighting and on-board negative voltage generation and temperature compensation circuitry.

2.0   MECHANICAL CHARACTERISTICS

Item	Specifications	Unit
Package Dimensions	88.0 (W) x 88.0 (H) x 20.3 max. (D)	mm
Display format	128 dots (W) x 128 dots (H)	-
Driving method	1/128	duty
Dot size	0.46 (W) x 0.46 (H)	mm
Dot pitch	0.5 (W) x 0.5 (H)	mm
Active display area	63.96 (W) x 63.96 (H)	mm
Viewing area	69.0 (W) x 69.0 (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	Min.	Max.	V
Logic supply voltage	V_{DD}-V_{SS}	0	7	V
LC driver supply voltage TN,NTN	V_{DD}-V_O	0	6	V
LC driver supply voltage TN-H, NTN-H	V_{DD}-V_O	0	13	V
EL lamp input voltage (if installed)	V_{EL}	0	150	V
Operating temperature TN, NTN	T_{OP}	0	+50	°C
Storage T° (Note 1)	T_{ST}	-20	+70	
Operating temperature TN-H, NTN-H	T_{OP}	-20	+70 (Note 3)	°C
Storage T° (Note 1)	T_{ST}	-30	+80	
Humidity: Operating (@40°C)	-	-	85%	RH (Note 2)
Non-operating (@40°C)	-	-	95%	RH (Note 2)

Notes: 1: Tested to 100 hrs.
2: Refers to non-condensing conditions.
3. It is not recommended to operate EL lamp above +50°C

4.0   ELECTRICAL CHARACTERISTICS

$V_{DD}=5\pm0.25V; T_a=25°C$

Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Input "High" voltage	V_{IH}	-	2.2	-	V_{DD}	V
Input "Low" voltage	V_{IL}	-	-	-	0.8	V
Output "High" voltage	V_{OH}	I_{OH}=0.205mA	V_{DD}-0.4	-	-	V
Output "Low" voltage	V_{OL}	I_{OL}=1.2mA	-	-	0.4	V
Power supply current	I_{EE}	V_{EE}=18.0V	-	10.0	-	mA
Power supply current	I_{DD}	V_{DD}=5.0V	-	6.0	-	mA

5.0 RECOMMENDED LC DRIVE VOLTAGE (V$_{DD}$-V$_O$)

VDD=5.0±0.25V

Temperature	NTN	NTN-H
Ta= -20°C	-	23.6
Ta= 0°C	21.1	21.1
Ta= 25°C	19.4	19.4
Ta= 50°C	17.3	17.3
Ta= 70°C	-	15.8

6.0 BACKLIGHT SPECIFICATIONS:

Ta=20°C,60%RH,Darkroom.

Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
EL lamp input voltage	VEL	-	-	100	-	Vrms
EL lamp input frequency	FEL	-	-	400	800	Hz
Operating current	-	VEL=100Vrms, 400Hz	-	12.0	-	mA
Life to half initial brightness	-	VEL=100Vrms, 400Hz	-	2500	-	Hours

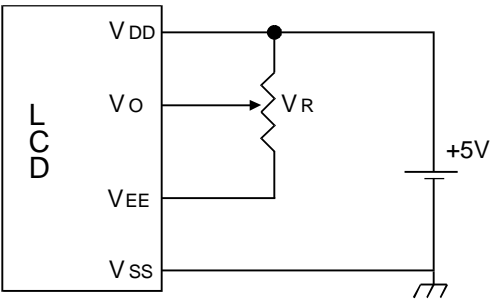**Note:** Recommended EL Backlight Inverter is Densitron DC-AC inverter, part number DAS5V14
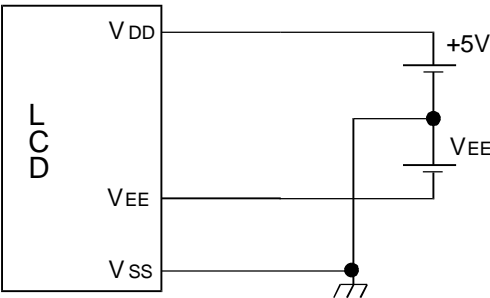
7.0 POWER SUPPLY

- NTN, NTN-H

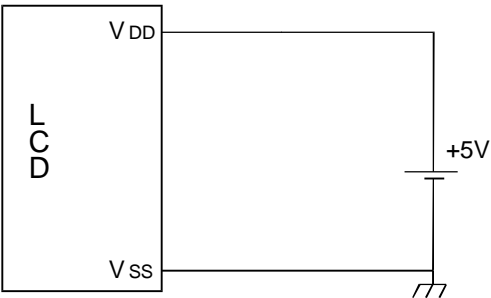- NTN, NTN-H with on-board negative voltage generator
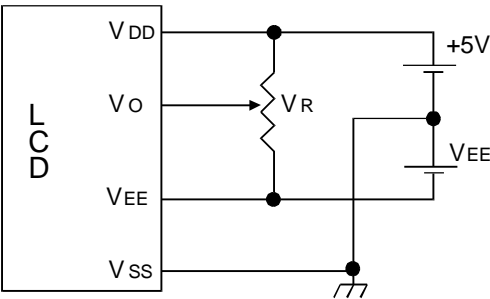
V$_R$= 10K - 20K ohm

- NTN, NTN-H with temperature compensation

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

8.0 INTERFACE DESCRIPTION

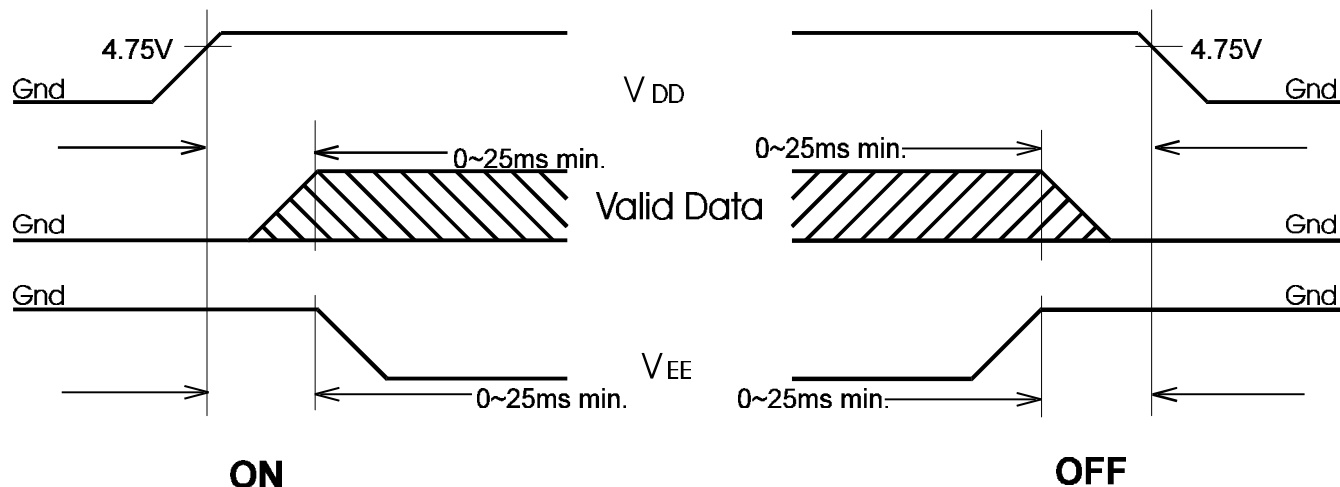| Pin No.	Symbol	I/O	Function
1	D	-	Display Data
2	FLM	-	First Line Marker
3	M	-	Control Signal for A.C. Driving
4	CL1	-	Latches serial data in the shift registers
5	CL2	-	Clock signal for shifting the serial data
6	n/c	-	No Connection
7	Vdd	-	Logic Supply Voltage (+5V)
8	Vss	-	Ground (OV)
9	Vee	I	-18v Input For LC Driving
10	Vo	-	IC drive voltage for contrast adjustment
BL1	V_{EL}	-	EL backlight input voltage (from output of DC-AC inverter)
BL2	V_{EL}	-	EL backlight input voltage (from output of DC-AC inverter)

9.0 BLOCK DIAGRAM:

DWG. NO.	LM3065	SHEET 4 OF 8	REV. A
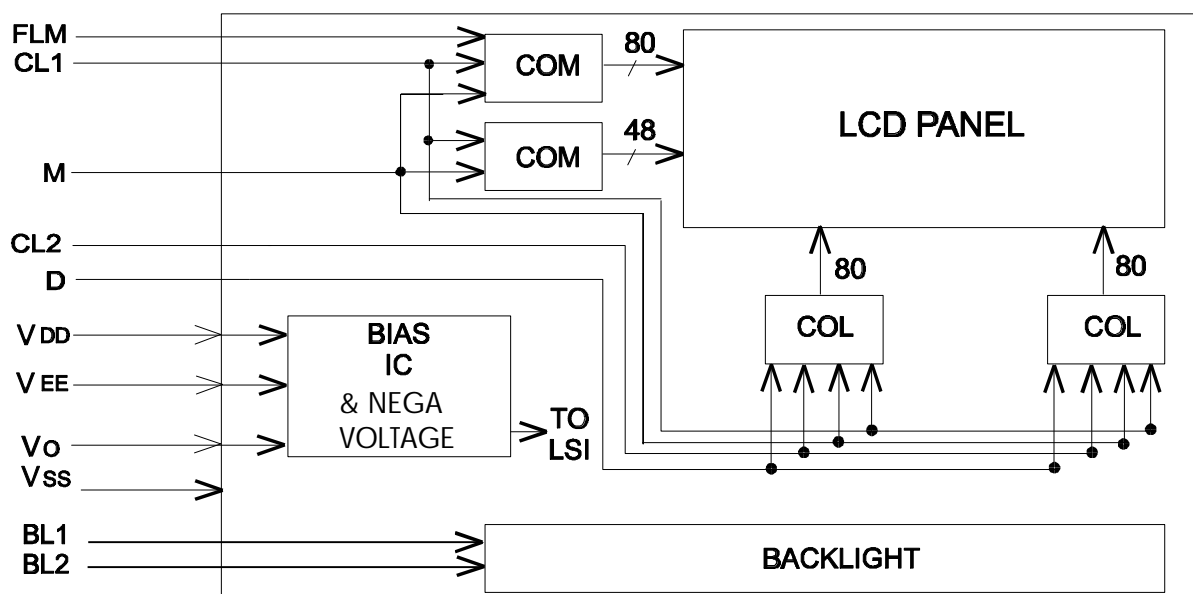
10.0 TIMING CHARACTERISTICS

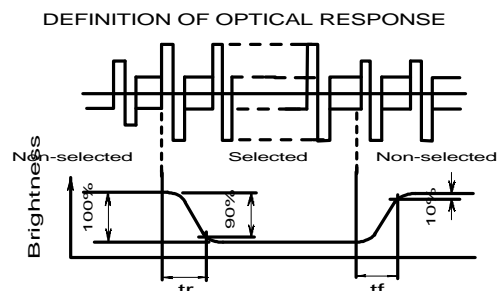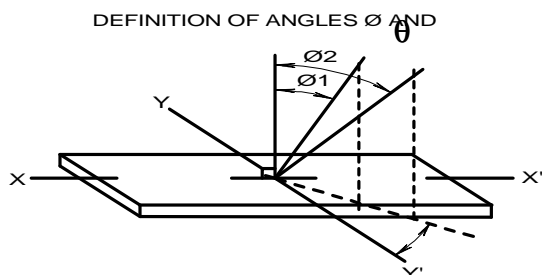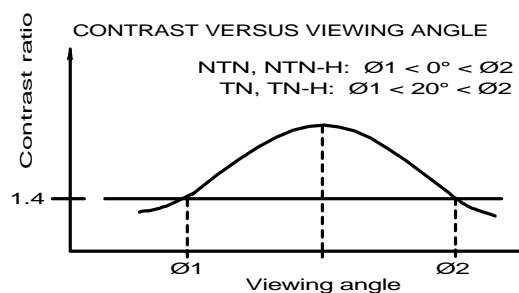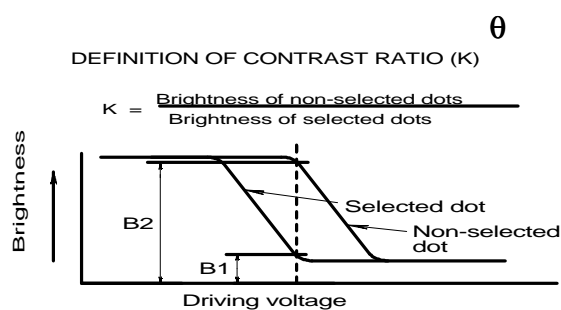| Item	Symbol	Min.	Typ.	Max.	Unit
Max Clock Frequency	f_{cp}	3.3	-	-	MHz
Clock Pulse Width	$t_{w(CP)}$	125	-	-	nS
LOAD Pulse Width	$t_{w(L)}$	125	-	-	nS
Data Set-up Time	t_{setup}	50	-	-	nS
CP→LOAD time	t_{CL}	250	-	-	nS
LOAD→CP time	t_{LC}	0	-	-	nS
CP Rise/Fall time	$t_{r(CP)1}$ $t_{f(CP)}$	-	-	50	nS
LOAD Rise/Fall time	$t_{r(L)1}$ $t_{f(L))}$	-	-	1	μs
Data Hold time	t_{hold}	50	-	-	ns
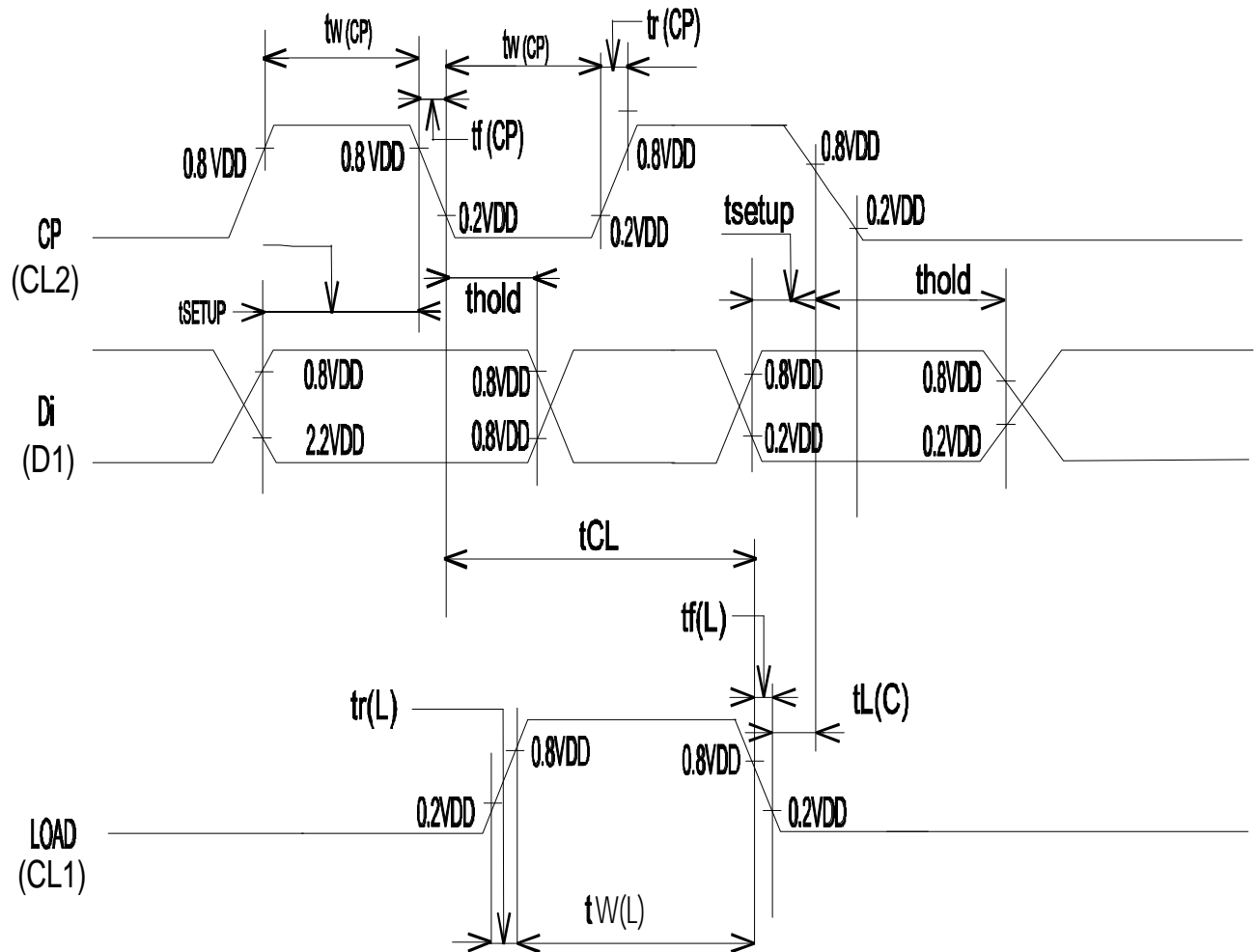
11.0 VOLTAGE SEQUENCING

Always observe the following power supply ON/OFF sequence. Failure to so may cause latch up of CMOS LSI circuits or DC induced damage to LC panel.
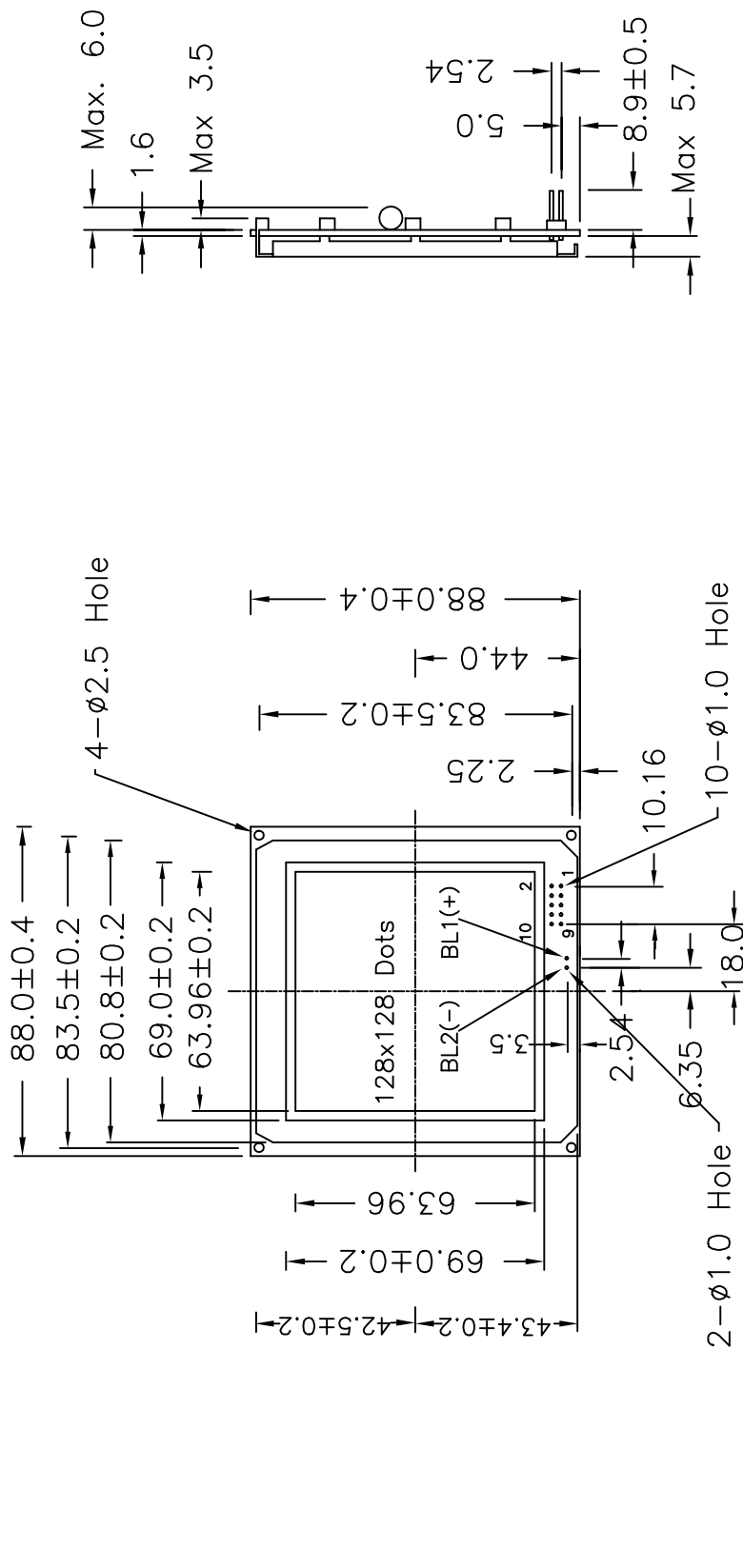

4.75V V_{DD} 4.75V

Gnd   Gnd

0~25ms min.   Valid Data   0~25ms min.

Gnd   Gnd

Gnd   Gnd

V_{EE}

0~25ms min.   0~25ms min.

ON   **OFF**

12.0 OPTICAL CHARACTERISTICS

Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Contrast ratio NTN	K	$\emptyset=20°$ $\theta=0°$	4	-	-	-
Contrast ratio NTN-H	k	$\emptyset=20°$ $\theta=0°$	5			
Viewing angle NTN (Fig. 6 & 8)	$\emptyset2-\emptyset1$	$\theta=0°$ K$\geq$1.4	40	-	-	Deg.
	θ	$\emptyset=20°$ K=1.4	±30	-	-	Deg.
Viewing angle NTN-H (Fig. 6 & 8)	$\emptyset2-\emptyset1$	$\theta=0°$ K$\geq$1.4	40	-	-	Deg.
	θ	$\emptyset=20°$ K=1.4	±40	-	-	Deg.
Response time Rise	t_r	$\emptyset=20°$ $\theta=0°$	-	150	250	mS
Fall	t_f	$\emptyset=20°$ $\theta=0°$	-	150	250	mS

DEFINITION OF CONTRAST RATIO (K)

$K = \dfrac{\text{Brightness of non-selected dots}}{\text{Brightness of selected dots}}$

CONTRAST VERSUS VIEWING ANGLE

NTN, NTN-H: $\emptyset1 < 0° < \emptyset2$
TN, TN-H: $\emptyset1 < 20° < \emptyset2$

DEFINITION OF ANGLES $\emptyset$ AND θ

DEFINITION OF OPTICAL RESPONSE

DWG. NO.	LM3065	SHEET 6 OF 8	REV. A

13.0 MODULE DIMENSIONS

14.0 PART NUMBER DESCRIPTION FOR AVAILABLE OPTIONS

LM3065①②128G128③④⑤

① POLARIZER TYPE

A = Reflective:light background, no backlight
B = Transflective: light background with blue-green EL backlight

② FLUID TYPE AND POWER SUPPLY

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

③ FLUID TYPE

N = NTN, NTN-H
C = NTN, NTN-H with on-board temperature compensation

④ BACKGROUND COLOR FOR NTN, NTN-H OR TN TEMPERATURE RANGE

G = Gray background (available for B polarizer type only)
y = Yellow background (available for B polarizer type only)

DWG. NO.	LM3065	SHEET 8 OF 8	REV. A