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REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	E0158		

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 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		TITLE: 2 LINE X 16 CHARACTERS LCD MODULE	
	CHECKED			
	ISSUED		DWG. NO. LM2000	SHEET 1 OF 8

1.0 DESCRIPTION

Dot matrix display module consisting of a Liquid Crystal Display, CMOS driver and controller LSI, printed circuit board and metal support frame.

Available LC fluids types are: TN (twisted nematic), TN-H (extended temperature range TN), NTN (supertwisted nematic), NTN-H (extended temperature range NTN).

Options include electroluminescent (EL) backlighting.

2.0 MECHANICAL CHARACTERISTICS

Item	Specifications	Unit
Package Dimensions	80.0 (W) x 36.0 (H) x 10.6 max. (D)	mm
Display format	2 line x 16 characters	-
Character font format	5 (W) x 7 (H) with attached cursor	dots
Driving method	1/16	duty
Dot size	0.55 (W) x 0.5 (H)	mm
Dot pitch	0.60 (W) x 0.55 (H)	mm
Character Size	2.95 (W) x 4.35 (H)	mm
Active display area	57.7 (W) x 9.4 (H)	mm
Viewing area	64.5 (W) x 13.8 (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	TN, NTN		TN-H, 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_O	0	6	0	13	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. It is not recommended to operate EL lamp above 50°C.

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}	-	2.2	-	V_{DD}	V
Input “Low” voltage	V_{IL}	-	-	-	0.6	V
Output “High” voltage	V_{OH}	I_{OH}=0.205mA	2.4	-	-	V
Output “Low” voltage	V_{OL}	I_{OL}=1.2mA	-	-	0.4	V
Power supply current	I_{DD}	V_{DD}=5.0V	-	1	-	mA

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

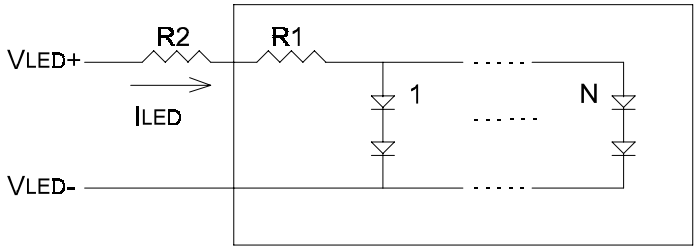
V_{DD}=5.0±0.25V

Temperature	TN	TN-H	NTN	NTN-H
T_a= -20°C	-	9.7	-	9.5
T_a= 0°C	5.0	9.2	4.5	8.9
T_a= 25°C	4.7	8.7	4.3	8.4
T_a= 50°C	4.3	8.3	4.0	8.2
T_a=70°C	-	8.0	-	7.9

6.0 BACKLIGHT SPECIFICATIONS:

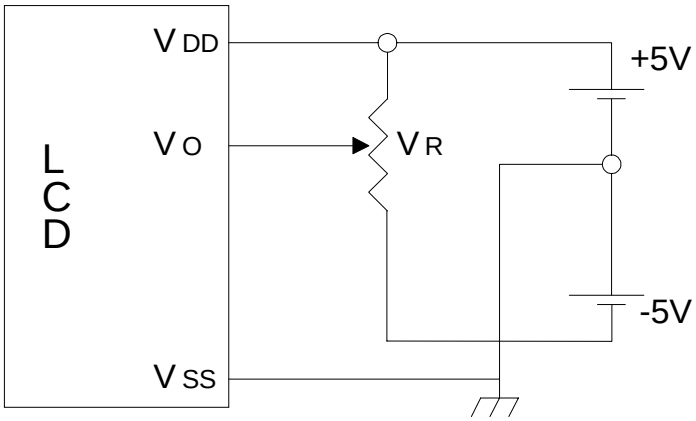
T_a=20°C,60%RH,Darkroom.

Item	Symbol	Typ.	Max.	Unit
EL lamp input voltage	V_{EL}	100	150	Vrms
EL lamp input current	I_{EL}	1.5	3.0	mA
EL lamp input frequency	F_{EL}	400	800	Hz
Life to half initial brightness	-	2500	3000	Hours
Recommended backlight inverter	-	DAS5V4	-	-

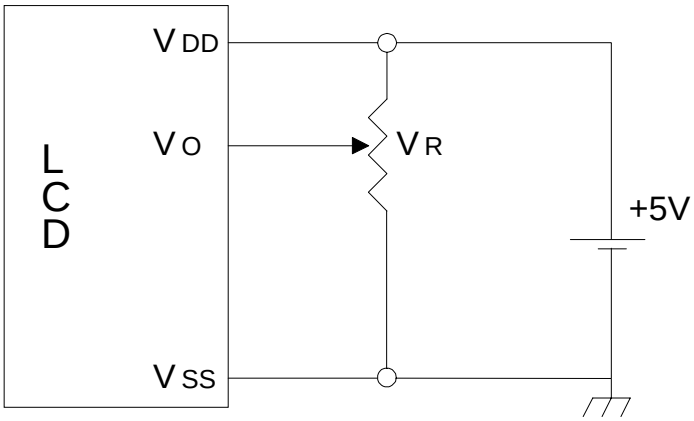


7.0 POWER SUPPLY

TN-H, NTN-H



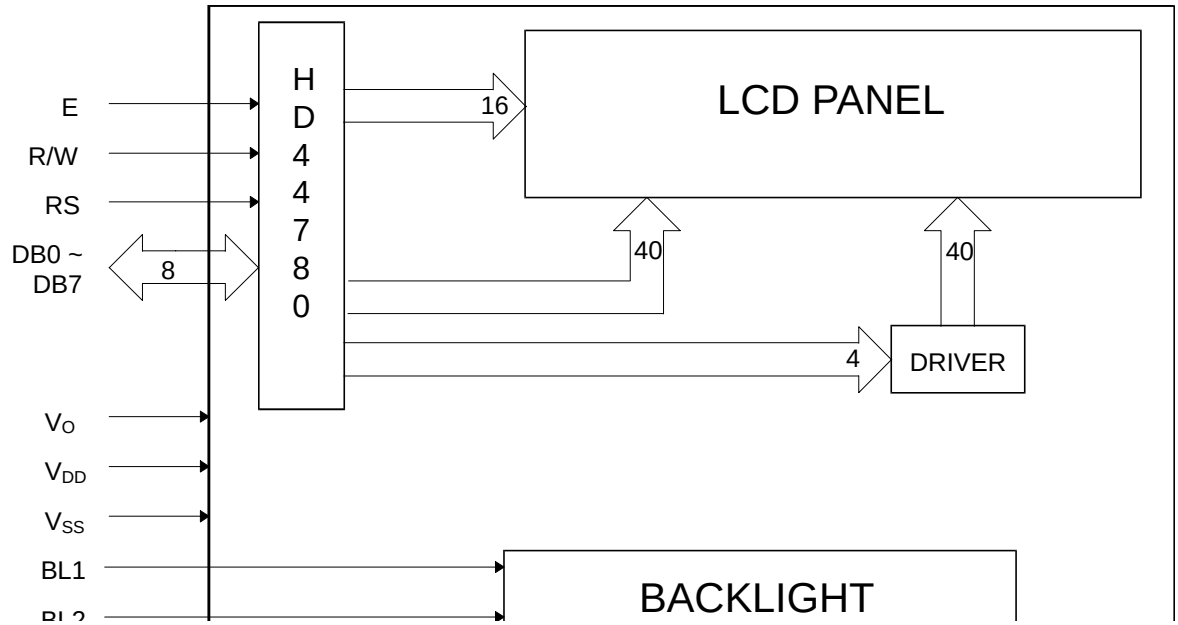
TN, NTN



V_R = 10K - 20K ohm

8.0 INTERFACE DESCRIPTION

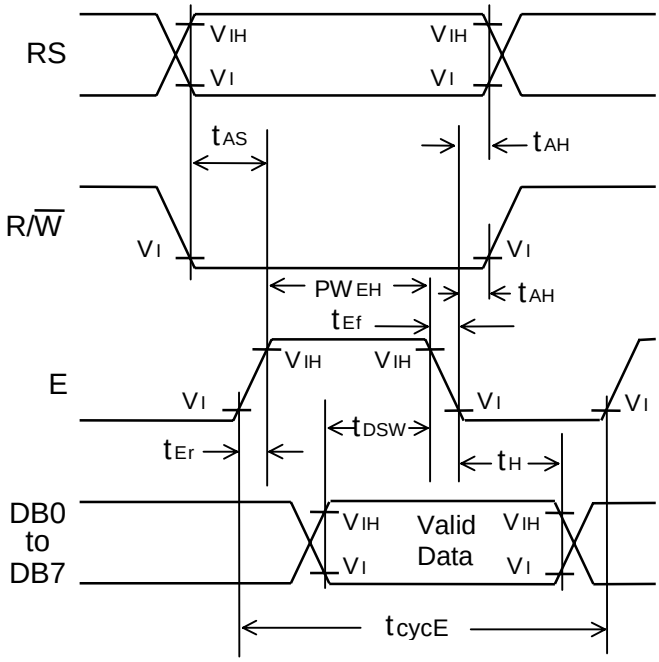
Pin No.	Symbol	I/O	Function
1	V_{SS}	-	Ground (0V)
2	V_{DD}	-	Logic Supply Voltage (+5V)
3	V_O	-	LC Drive voltage for contrast adjustment
4	RS	I	Register Select 0: Instruction Register 1: Data Register
5	R/W	I	Read / Write 0: Data Write (Module←MPU) 1: Data Read (Module→MPU)
6	E	I	Enable Signal Active High (H→L)
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
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)



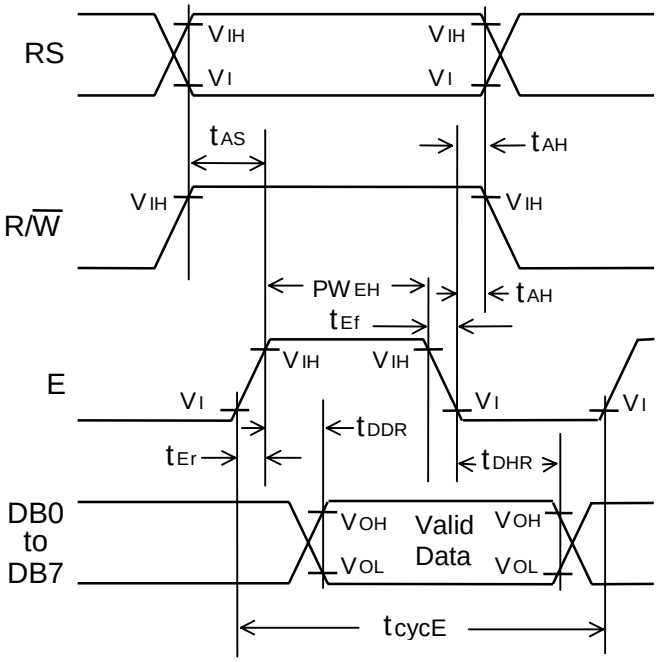
10.0 TIMING CHARACTERISTICS

Item	Symbol	Min.	Typ.	Max.	Unit
Enable cycle time	T_{cycE}	500	-	-	nS
Enable pulse width	PW_{EH}	230	-	-	nS
Enable rise / fall time	t_{Er}/t_{Ef}	-	-	20	nS
Address set-up time	t_{AS}	40	-	-	nS
Address hold time	t_{AH}	10	-	-	nS
Data delay time	t_{DDR}	-	-	160	nS
Data hold time (Write)	t_{DHW}	10	-	-	nS
Data hold time (Read)	t_{DHR}	5	-	-	nS
Data set-up time	t_{DSW}	80	-	-	nS

WRITE OPERATION



READ OPERATION



11.0 DD RAM ADDRESS vs. DISPLAY POSITION

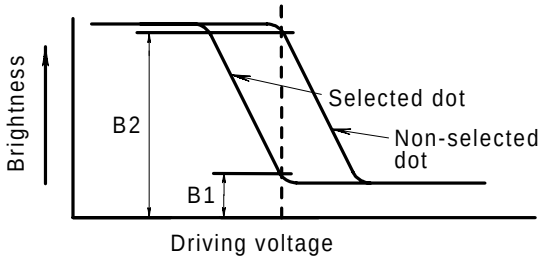
Character	1	2	3	4	5	6	7	8	9	10	11	---	14	15	16
Line 1	00	01	02	03	04	05	06	07	08	09	0A	---	0D	0E	0F
Line 2	40	41	42	43	44	45	46	47	48	49	4A	---	4D	4E	4F

12.0 OPTICAL CHARACTERISTICS

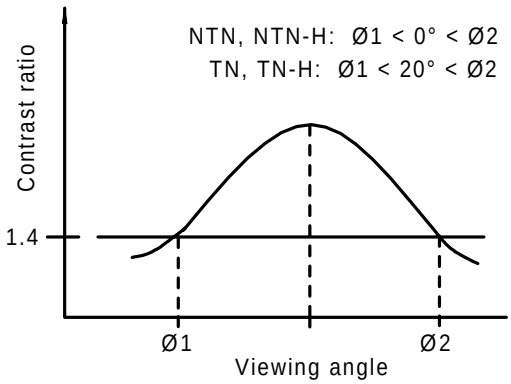
Item	Symbol	Test Condition	Min.	Typ.	Max.	Unit
Contrast ratio TN, TN-H	K	Ø=20° θ=0°	3	-	-	-
Contrast ratio NTN	K	Ø=20° θ=0°	4	-	-	-
Contrast ratio NTN-H	K	Ø=20° θ=0°	5	-	-	-
Viewing angle TN, TN-H	Ø2-Ø1	θ=0° K≥1.4	20	-	-	Deg.
	θ	Ø=20° K=1.4	±30	-	-	Deg.
Viewing angle NTN	Ø2-Ø1	θ=0° K≥1.4	40	-	-	Deg.
	θ	Ø=20° K=1.4	±30	-	-	Deg.
Viewing angle NTN-H	Ø2-Ø1	θ=0° K≥1.4	40	-	-	Deg.
	θ	Ø=20° K=1.4	±40	-	-	Deg.
Response time Rise	t_r	Ø=20° θ=0°	-	150	250	mS
Fall	t_f	Ø=20° θ=0°	-	150	250	mS

DEFINITION OF CONTRAST RATIO (K)

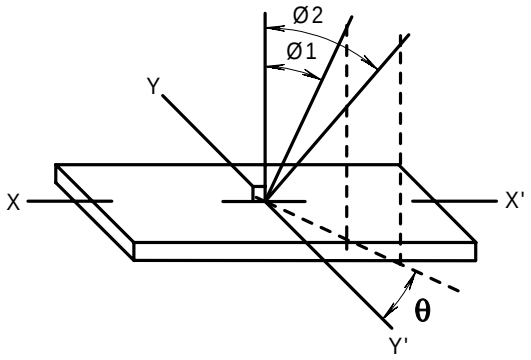
$$K = \frac{\text{Brightness of non-selected dots}}{\text{Brightness of selected dots}}$$



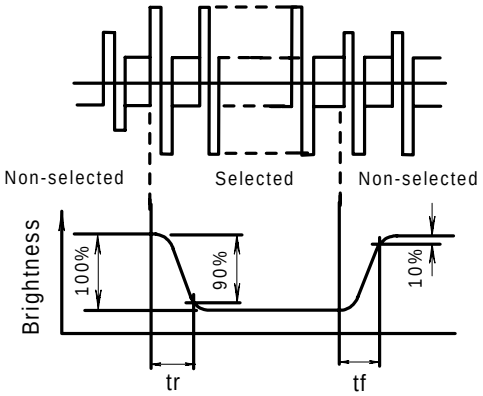
CONTRAST VERSUS VIEWING ANGLE



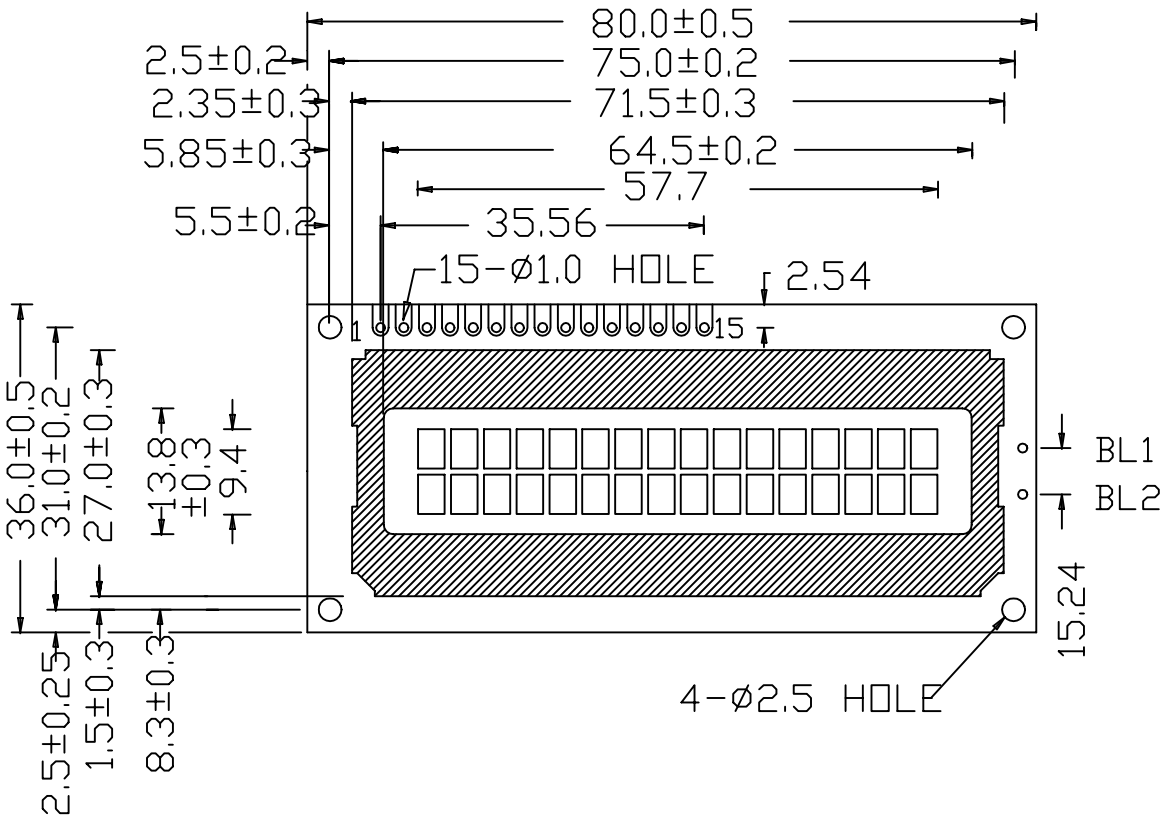
DEFINITION OF ANGLES Ø AND θ

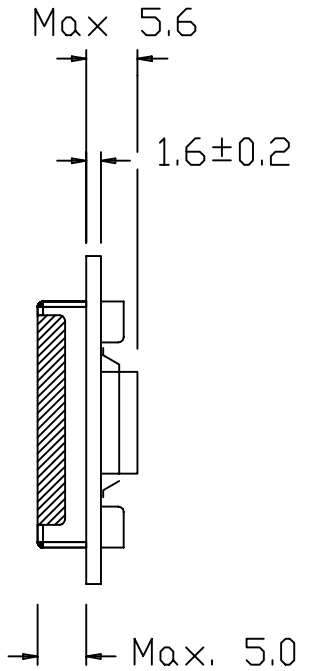


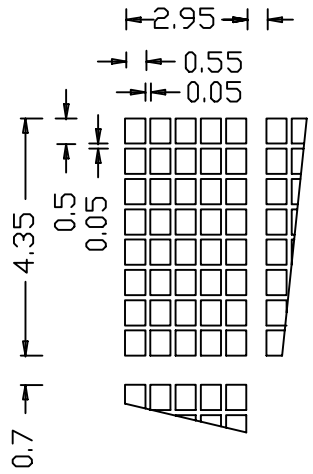
DEFINITION OF OPTICAL RESPONSE



13.0 MODULE DIMENSIONS







DWG. NO.			REV.
	LM2000	SHEET 8 of 8	A

14.0 PART NUMBER DESCRIPTION FOR AVAILABLE OPTIONS

LM2000①②2C16③④⑤

OPTION 36.DOC

①

Polarizer Type

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

②

Not applicable - LEAVE BLANK

③

Fluid Type and Power Supply

C = TN with +5VDC operation or TN-H with ±5VDC operation
S = NTN with +5VDC operation
H = NTN-H with ±5VDC operation

④

Fluid Type/TN Viewing Direction

B = TN, TN-H bottom viewing
T = TN, TN-H top viewing
N = NTN, NTN-H

⑤

Background Color for NTN, NTN-H or TN Temperature Range

B = Blue background
G = Gray background
Y = Yellow background
H = TN-H