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| REVISIONS | | | |
|-----------|------------------------|---------|----------|
| REV. | DESCRIPTION | DATE | APPROVED |
| - | RELEASED ON ECN #E0726 | 4/28/98 | 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 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 SANTA FE SPRINGS, CA | | |
| | DRAWN | | | | |
| | CHECKED | | TITLE | 240 X 128 GRAPHICS LCD MODULE | |
| | ISSUED | | DWG. NO. | LM4529 | SHEET 1 OF 8 |

1.0 DESCRIPTION

Dot matrix display module consisting of liquid Crystal Display, 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). FSTN (Film supertwisted Nematic) and FSTN-H (extended temperature range FSTN).

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

2.0 MECHANICAL CHARACTERISTICS

| Item | Specifications | Unit |
|---------------------|--------------------------------------|------|
| Package Dimensions | 144.0 (W) x 104.0 (H) x 17.6 max (D) | mm |
| Display format | 240 dots (W) x 128 dots (H) | - |
| Driving method | 1/128 | duty |
| Dot size | 0.40 (W) x 0.40 (H) | mm |
| Dot pitch | 0.45 (W) x 0.45(H) | mm |
| Active display area | 107.95(W) x 57.55 (H) | mm |
| Viewing area | 114.0 (W) x 64.0 (H) | mm |
| Weight | | g |

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

3.0 ABSOLUTE MAXIMUM RATINGS

VSS=0V;Ta=25°C

| Item | Symbol | FSTN,NTN | | FSTN-H,NTN-H | | Unit |
|------------------------------|---------|----------|------|--------------|--------------|-------------|
| | | Min. | Max. | Min. | Max. | |
| Logic supply voltage | VDD-VSS | 0 | 7 | 0 | 7 | V |
| LC driver supply voltage | VDD-VEE | 0 | 25 | 0 | 25 | V |
| Operating temperature | TOP | 0 | +50 | -20 | +70 (Note 3) | °C |
| Storage temperature (Note 1) | TST | -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

VDD=5±0.25V;Ta=25°C

| Item | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|-----------------------|-----------------|--------------------------|-----------------|------|-----------------|------|
| Input "High" voltage | V _{IH} | - | 3.5 | - | V _{DD} | V |
| Input "Low" voltage | V _{IL} | - | V _{SS} | - | 1.5 | V |
| Output "High" voltage | V _{OH} | I _{OH} =0.205mA | 4.6 | - | - | V |
| Output "Low" voltage | V _{OL} | I _{OL} =1.2mA | - | - | .4 | V |
| Power supply current | I _{EE} | V _{EE} =-20V | - | 2 | - | 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±0.25V

| Temperature | FSTN | FSTN-H | NTN | NTN-H |
|------------------------|------|--------|------|-------|
| T _a = -20°C | - | 19.6 | - | 24.3 |
| T _a = 0°C | 18.3 | 18.3 | 21.0 | 21.0 |
| T _a = 25°C | 17.3 | 17.3 | 18.5 | 18.5 |
| T _a = 50°C | 16.0 | 16.0 | 16.8 | 16.8 |
| T _a =70°C | - | 15.0 | - | 15.7 |

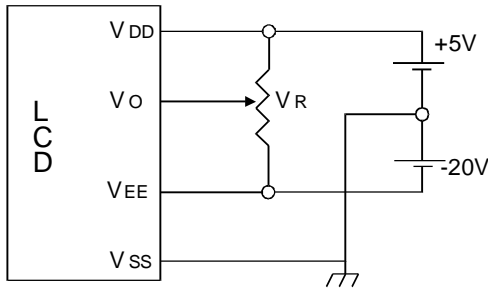
6.0 BACKLIGHT SPECIFICATIONS:

T_a=20°C,60%RH,Darkroom.

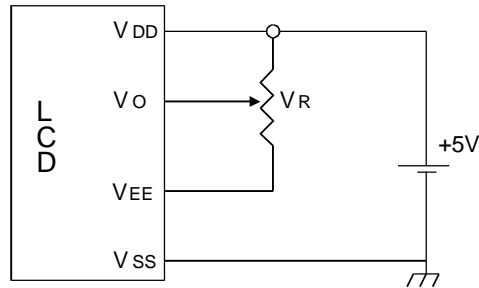
| Item | Symbol | Typ. | Max. | Unit |
|---|------------------|--------------|------|------------------|
| LED lamp input voltage | V _{LED} | 5 | 6 | V _{rms} |
| LED lamp input current | I _{LED} | 660 | 730 | mA |
| Build-in current limit resistor | R1 | - | - | Ohms, W |
| Recommended external current limit resistor | R2 | 1.7 Ohms, 2W | - | Ohms, W |
| Number of Nodes | N | 110 | - | - |

7.0 POWER SUPPLY

NTN, NTN-H

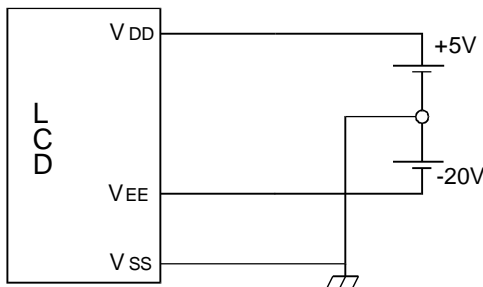


NTN, NTN-H with on-board negative voltage generator

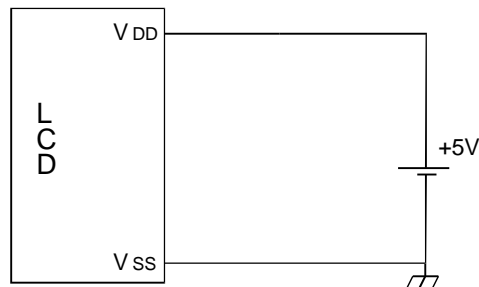


V_R = 10K - 20K ohm

NTN, NTN-H with temperature compensation



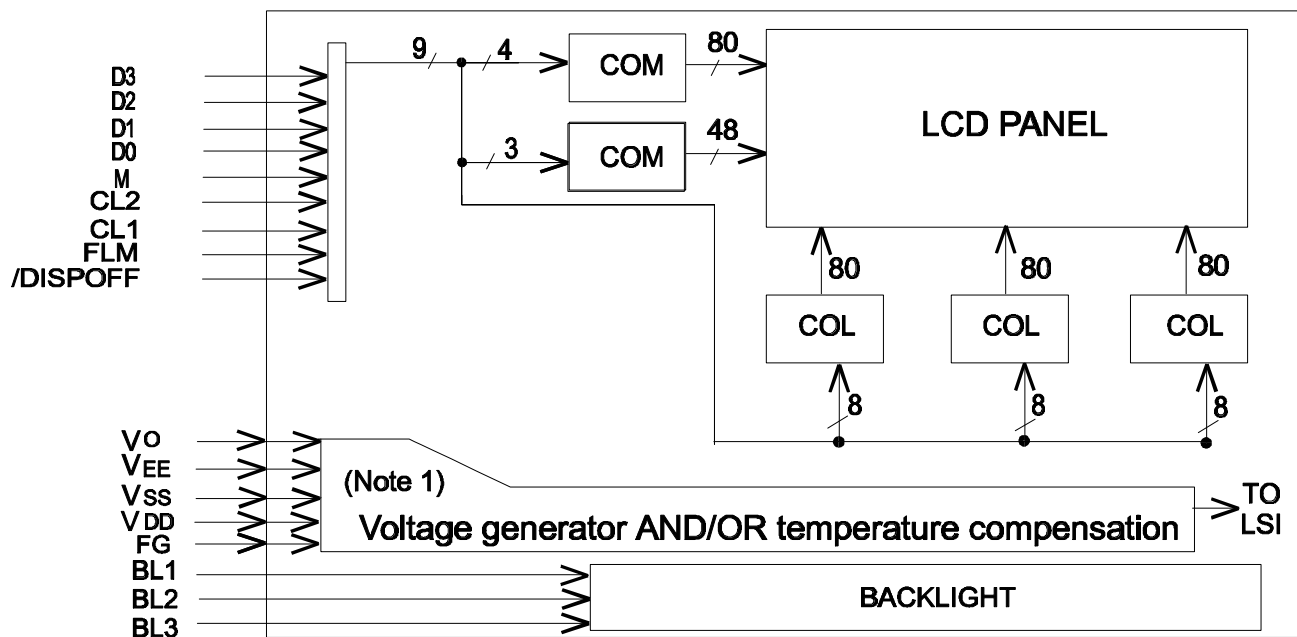
NTN, NTN-H with on-board negative voltage generator and temperature compensation



8.0 INTERFACE DESCRIPTION

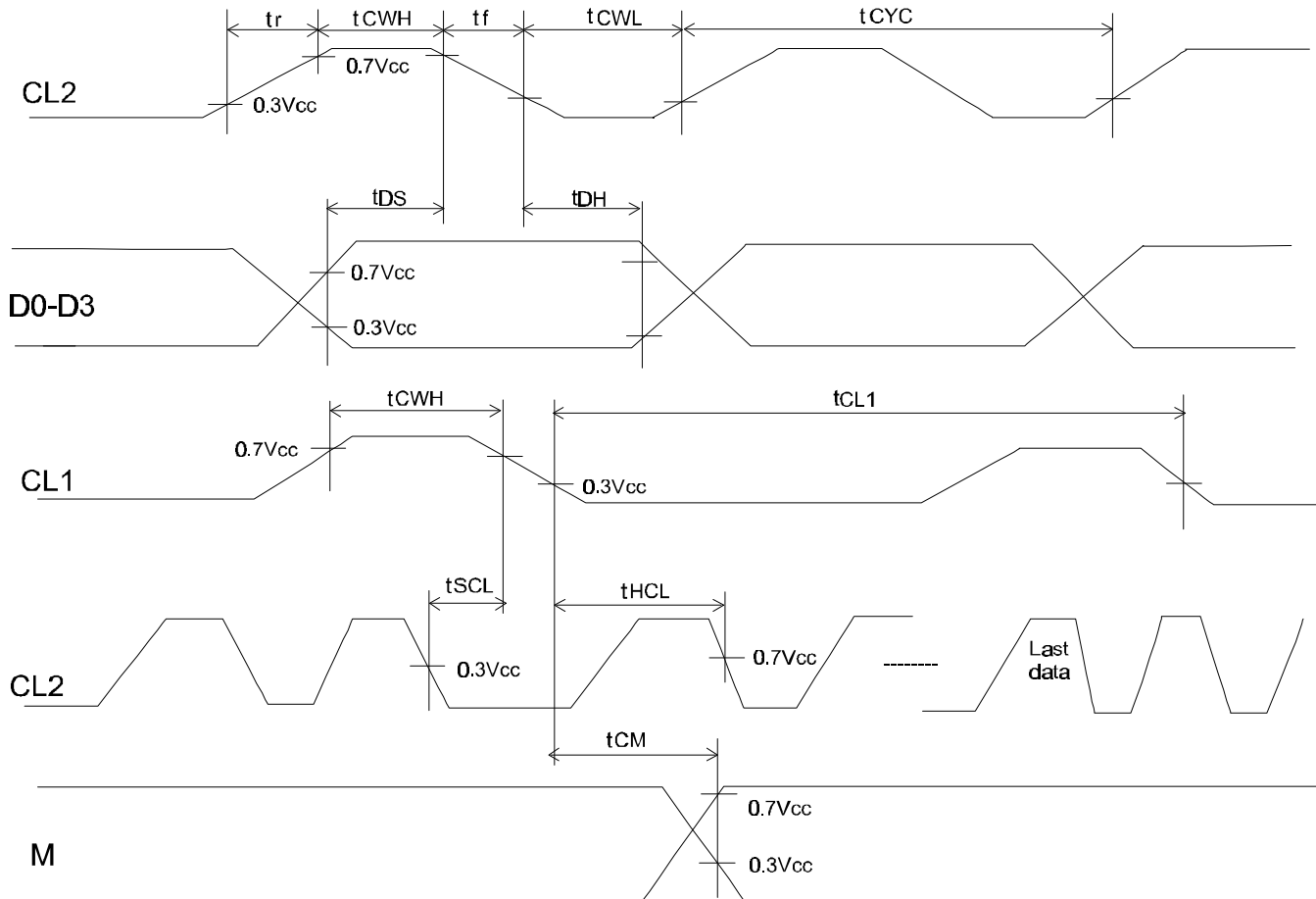
| Pin No. | Symbol | I/O | Function |
|---------|---------|-----|--|
| 1 | Vo | - | Operating voltage for LC drive |
| 2 | Vee | - | Power supply for LC driving (-10V) |
| 3 | DB3 | I/O | Bi-directional data bus line 3 |
| 4 | DB2 | I/O | Bi-directional data bus line 2 |
| 5 | DB1 | I/O | Bi-directional data bus line 1 |
| 6 | DB0 | I/O | Bi-directional data bus line 0 |
| 7 | M | I | Control signal for A.C. drive |
| 8 | Vss | - | Ground |
| 9 | Vdd | - | Power supply for logic circuit (+5V) |
| 10 | CL2 | I | Clock signal for shifting the serial data |
| 11 | CL1 | I | The CL1 latches the serial data in the shift registers |
| 12 | FRM | I | First Row Marker indicates the beginning of each display cycle |
| 13 | DISPOFF | I | "L" : Display OFF "H" : Display ON |
| 14 | FG | - | Frame Ground |
| BL1 | VLED+ | - | Cathode (-): LED backlight input voltage |
| BL2 | VLED- | - | Anode (+): LED backlight input voltage |

9.0 BLOCK DIAGRAM:



10.0 TIMING CHARACTERISTICS

| Item | Symbol | Pins | Min. | Max. | Unit | Notes |
|--------------------------|------------------|------------|-----------------------|--------|------|-------|
| Clock cycle time | t _{CYC} | CL2 | 125 | - | nS | |
| Clock high-level width 1 | t _{CWH} | CL1,CL2 | 45 | - | nS | |
| Clock low-level width | t _{CWL} | CL2 | 45 | - | nS | |
| Clock Setup time | t _{SCL} | CL1,CL2 | 80 | - | nS | |
| Clock hold time | t _{HCL} | CL1,CL2 | 80 | - | nS | |
| Clock rise time | t _r | CL1,CL2 | - | Note 1 | nS | 1 |
| Clock fall time | t _f | CL1,CL2 | - | Note 1 | nS | 1 |
| Data setup time | t _{DS} | D0-D3, CL2 | 20 | - | nS | |
| Data hold time | t _{DH} | D0-D3, CL2 | 20 | - | nS | |
| M phase difference time | t _{CM} | M, CL2 | - | 300 | nS | |
| CL1 cycle time | t _{CL1} | CL1 | t _{CYC} x 50 | - | nS | |

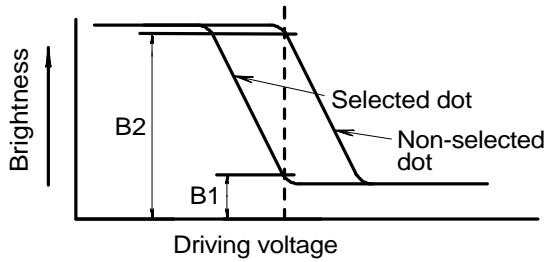


12.0 OPTICAL CHARACTERISTICS

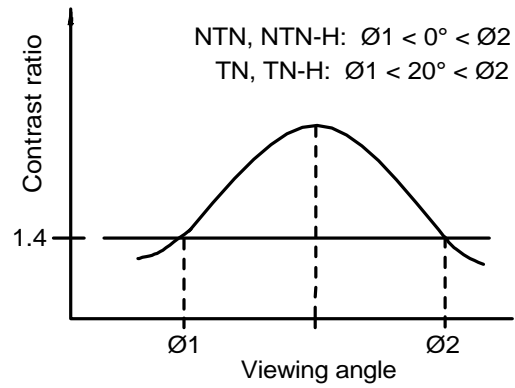
| Item | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|----------------|---------------------|----------------------------------|----------|------|------|------|
| Contrast ratio | K | $\theta=20^\circ \theta=0^\circ$ | 4 | - | - | - |
| Viewing angle | $\theta_2-\theta_1$ | $\theta=0^\circ K \geq 1.4$ | 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)

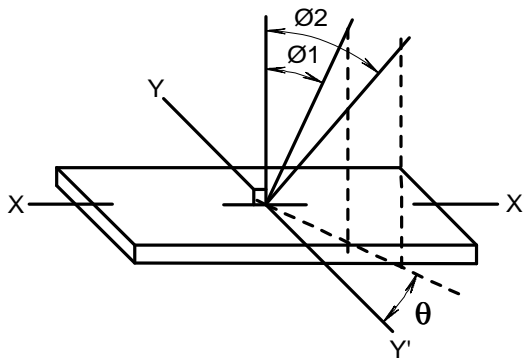
$$K = \frac{\text{Brightness of non-selected dots}}{\text{Brightness of selected dots}}$$



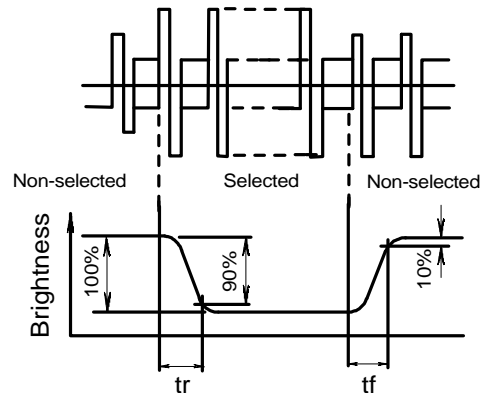
CONTRAST VERSUS VIEWING ANGLE



DEFINITION OF ANGLES θ AND θ



DEFINITION OF OPTICAL RESPONSE



14.0 PART NUMBER DESCRIPTION FOR AVAILABLE OPTIONS

LM4529①②128G240③④⑤

①

POLARIZER TYPE

B = Transflective: light background , backlit

E = Transmissive: dark background

②

LED BACKLIGHT COLOUR

G = Yellow-Green

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

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

N = NTN, NTN-H

F = FSTN (Film Supertwisted Nematic), FSTN-H

⑤

BACKGROUND COLOUR

B = Blue (transmissive polarisers)

G = Gray background

Y = Yellow background