

FEATURES

- STHC (Super Twisted High Contrast) Yellow Green Transmissive Type
- Low Power Consumption
- Thin, Lightweight Design Permits Easy Installation in a Variety of Equipment
- General-Purpose CMOS:
 - The Unit can be Easily Interfaced to a Microcomputer With Common 4-Bit and 8-Bit Parallel Inputs and Outputs
- Built-In Character Generator ROM, RAM and Display Data RAM:
 - Character Generator ROM – 225 Different 5×7 Dot Matrix Character Patterns
 - Character Generator RAM – Eight Different, User-Programmed 5×7 Dot Matrix Patterns (Write Capability by Program)
 - Display Data RAM – 80×8 Bits

- Extensive Instruction Set:
 - Display Clear, Cursor Home, Display ON/OFF, Cursor ON/OFF, Character Blink, Cursor Shift, and Display Shift
- Internal Automatic Reset Circuit at Power-On. Refer to the Separate User's Manual for Dot Matrix LCD Units With Built-In Controllers
- Operates From a Single 5 V Power Supply and Incorporates an LCD Panel Which Provides a Highly Stable Display Over a Wide Range of Temperatures

DESCRIPTION

The SHARP LM162AS1 Dot Matrix LCD Unit consists of a combination of a 5×7 dot, 16-character 2-line dot matrix LCD panel, LCD driver, and controller LSI and yellow green backlight LED mounted on a single printed circuit board. Incorporating mask ROM-based character generator and display data RAM in the controller LSI, the unit is capable of efficiently displaying the desired characters under microcomputer control. LCD is positive type.

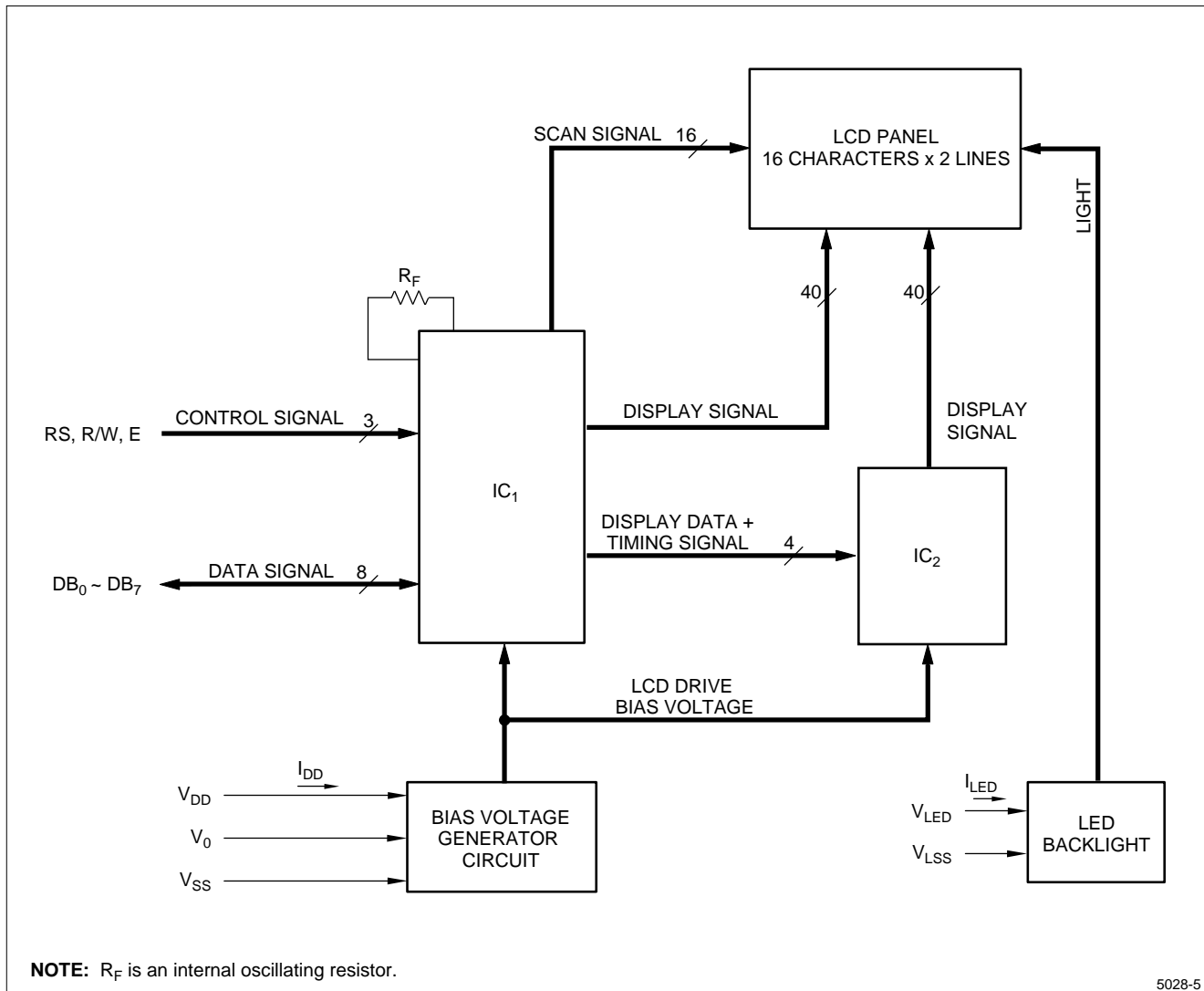


Figure 1. LM162AS1 Block Diagram

MECHANICAL SPECIFICATIONS

| PARAMETER | SPECIFICATIONS | UNIT | NOTE |
|-------------------------|----------------------------------|------|------|
| Unit Outline Dimensions | 85 (W) × 32.6 (H) × 12 max (D) | mm | – |
| Active Area | 62 (W) × 16.0 (H) | mm | – |
| Display Format | 16 characters × 2 lines | – | – |
| Character Format | 5 × 7 dots, with cursor | – | – |
| Character Size | 2.96 (W) × 4.86 (H) (5 × 7 dots) | mm | – |
| Dot Size | 0.56 (W) × 0.66 (H) | mm | – |
| Dot Spacing | 0.04 | mm | – |
| Character Color | Dark blue | – | 1 |
| Backlight Color | Yellow Green | – | 1 |
| Weight | Approximately 35 | g | – |

NOTE:

1. Due to the characteristics of the LC material, the colors vary with environmental temperature.

ABSOLUTE MAXIMUM RATINGS

| SYMBOL | PARAMETER | MIN. | MAX. | UNIT | NOTE |
|---------------------|---------------------------------|------|----------------|------|--------------------------|
| $V_{DD} - V_{SS}$ | Supply Voltage (Logic) | –0.3 | +6.5 | V | – |
| $V_O - V_{SS}$ | Supply Voltage (LCD Drive) | 0 | +6.5 | V | $V_{DD} > V_O$ |
| I_{LED} | Supply Current (Backlight LED) | – | 160 | mA | $t_A = 25^\circ\text{C}$ |
| V_{IN} | Input Voltage | –0.3 | $V_{DD} + 0.3$ | V | – |
| Tstg | Storage Temperature | –25 | +70 | °C | – |
| Topr | Operating Temperature | 0 | +50 | °C | – |
| $V_{LED} - V_{LSS}$ | Reverse Voltage (Backlight LED) | –5 | – | V | – |

ELECTRICAL CHARACTERISTICS ($t_A = 25^\circ\text{C}$)

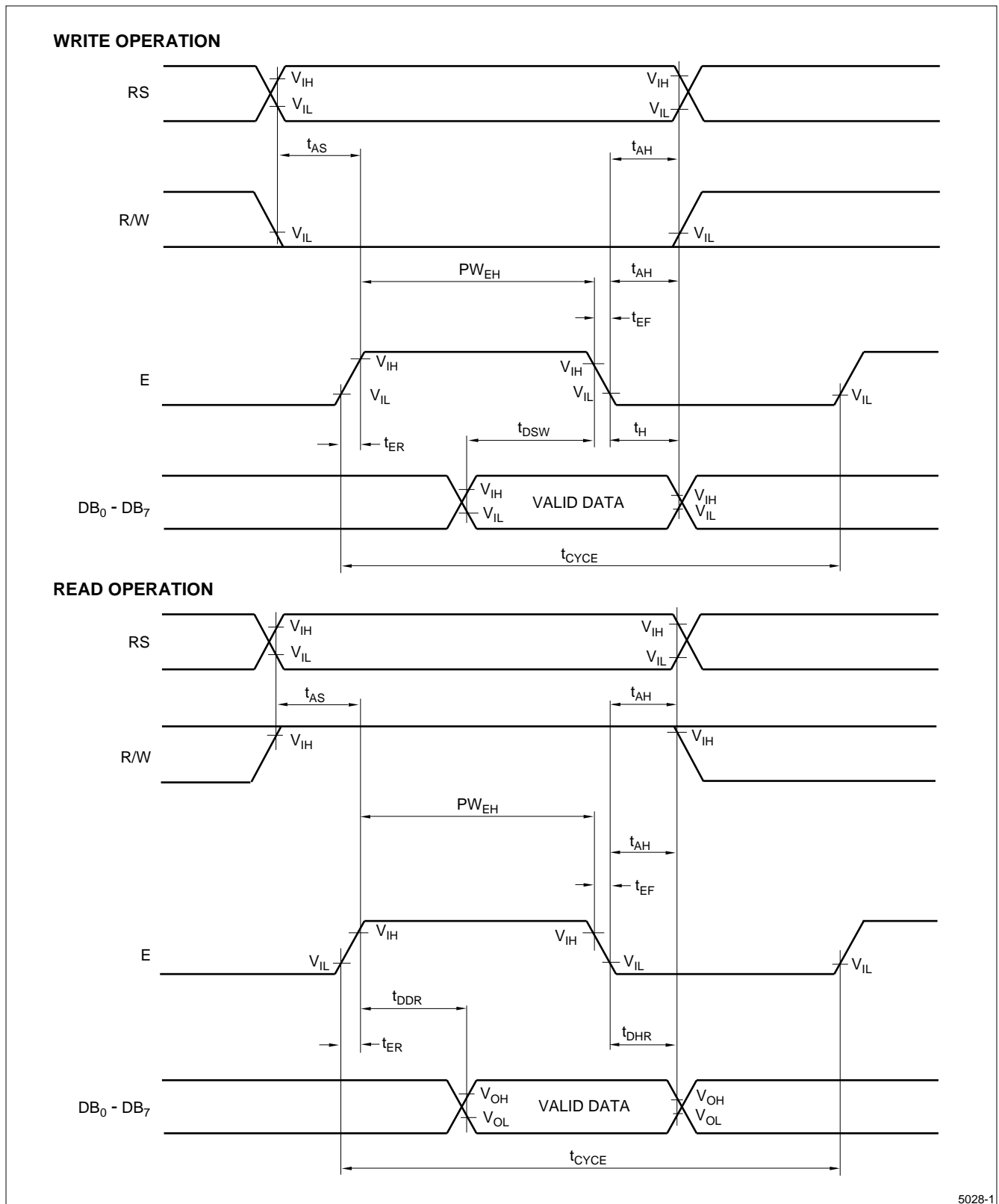
| SYMBOL | PARAMETER | | MIN. | TYP. | MAX. | UNIT | CONDITION | NOTE |
|---------------------|---------------------------------|-----|------|------|------|---------------|--|------|
| $V_{DD} - V_{SS}$ | Supply Voltage (Logic) | | 4.75 | 5.0 | 5.25 | V | – | |
| $V_0 - V_{SS}$ | Supply Voltage (LCD Drive) | | – | 0.65 | – | V | $V_{DD} = 5.0\text{ V}$ | 1 |
| V_{IL} | Input Voltage | ‘L’ | – | – | 0.8 | V | – | |
| V_{IH} | | ‘H’ | 2.0 | – | – | V | – | |
| V_{OL} | Output Voltage | ‘L’ | – | – | 0.4 | V | $I_{OL} = 2.0\text{ mA}$ | |
| V_{OH} | | ‘H’ | 2.4 | – | – | V | $I_{OH} = -1.2\text{ mA}$ | |
| I_{IL} | Input Leakage Current | | – | – | 1 | μA | – | |
| f_{OSC} | Internal Oscillating Frequency | | – | 270 | – | kHz | – | |
| I_{DD} | Supply Current | | – | 2 | 3 | mA | $V_{DD} = 5.0\text{ V}$ $V_0 = 0\text{ V}$ $I_{LED} = 110\text{ mA}$ | |
| $I_{LED} - V_{LSS}$ | Forward Voltage (Backlight LED) | | – | 4.0 | 4.3 | V | | |
| P_D | Power Dissipation | | – | 450 | 488 | mW | | |

NOTE:

1. When more than 30 minutes have elapsed since backlighting began.

INTERFACE TIMING ($V_{DD} = 5.0\text{ V} \pm 5\%$, $t_A = 0\text{ to }50^\circ\text{C}$)

| SYMBOL | PARAMETER | MIN. | TYP. | MAX. | UNIT |
|------------------|------------------------|------|------|------|------|
| t_{CYCE} | Enable Cycle Time | 500 | – | – | ns |
| PW_{EH} | Enable Pulse Width | 220 | – | – | ns |
| t_{ER}, t_{EF} | Enable Rise/Fall Time | – | – | 20 | ns |
| t_{AS} | RS, R/W Setup Time | 40 | – | – | ns |
| t_{AH} | Address Hold Time | 10 | – | – | ns |
| t_{DSW} | Data Setup Time | 60 | – | – | ns |
| t_{DDR} | Data Delay Time | – | – | 120 | ns |
| t_H | Data Hold Time (Write) | 10 | – | – | ns |
| t_{DHR} | Data Hold Time (Read) | 20 | – | – | ns |



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Figure 2. Timing Chart

PIN CONNECTIONS

| PIN NUMBER | SYMBOL | DESCRIPTION | CONNECTION |
|------------|------------------|-----------------------------|---|
| 1 | V _{SS} | Ground Potential | GND: 0 V |
| 2 | V _{DD} | Power Supply | +5 V Power Supply |
| 3 | V ₀ | Contrast Adjustment Voltage | Adjust the contrast by supplying voltage from 0 V to 5 V |
| 4 | RS | Register Select Pin | Control signal inputs |
| 5 | R/W | Read/Write Select Pin | |
| 6 | E | Enable Pin | |
| 7 | DB ₀ | Code I/O Data LSB | <ul style="list-style-type: none"> • Data bus signals • DB₇ may also be used to check the busy flag • Lines DB₀ – DB₃ are not used when interfacing with a 4-bit microprocessor |
| 8 | DB ₁ | Code I/O Data 2nd Bit | |
| 9 | DB ₂ | Code I/O Data 3rd Bit | |
| 10 | DB ₃ | Code I/O Data 4th Bit | |
| 11 | DB ₄ | Code I/O Data 5th Bit | |
| 12 | DB ₅ | Code I/O Data 6th Bit | |
| 13 | DB ₆ | Code I/O Data 7th Bit | |
| 14 | DB ₇ | Code I/O Data MSB | |
| 15 | V _{LED} | Power Supply (+) | Supply current is 110 mA through V _{LED} and V _{LSS} . |
| 16 | V _{LSS} | Power Supply (–) | |

OPTICAL CHARACTERISTICS ($t_A = 25^\circ\text{C}$) (Backlight LED is in OFF State)

The following specifications show the optical characteristics when LCD drive voltage is adjusted to the maximum contrast in $\theta = 0$.

| SYMBOL | PARAMETER | CONDITION | MIN. | TYP. | MAX. | UNIT | NOTE |
|-----------------------|------------------------|--------------------------------------|--|------|------|---------|------|
| $\theta_2 - \theta_1$ | Viewing Angle Range | $\phi = 180^\circ$ $C_0 \geq 2.0$ | 60 | — | — | degrees | 1 |
| θ_1 | | | — | — | -25 | | |
| θ_2 | | $C_0 = 2.0$ | 25 | — | — | | |
| $\theta_2 - \theta_1$ | | | $\phi = 135^\circ$ 225° $\theta_1 < \theta_2$ | 60 | — | | |
| θ_1 | | $C_0 = 2.0$ | | — | — | | |
| θ_2 | | | 25 | — | — | | |
| C_0 | Contrast Ratio | $\theta = 0^\circ, \phi = 180^\circ$ | 5.0 | 8.0 | — | — | 2 |
| t_R | Response Speed – Rise | $\theta = 0^\circ, \phi = 180^\circ$ | — | 150 | 250 | ms | 3 |
| t_D | Response Speed – Decay | $\theta = 0^\circ, \phi = 180^\circ$ | — | 150 | 250 | ms | |

NOTES:

- The viewing angle range is defined as shown in Figure 3.
- Contrast ratio is defined as follows:
When input signal is applied to the unit to select (turn on) the LCD dots (pixels) to be measured in the optical characteristics test method as defined in Figure 4.

$$\text{Contrast ratio} = \frac{\text{Photodetector output voltage with non-select waveform being applied}}{\text{Photodetector output voltage with select waveform being applied}}$$
- When input signal for selecting or non-selecting the dots to be measured are applied using the optical characteristics test method shown in Figure 4. The response characteristics of the photodetector output are measured as shown in Figure 5.

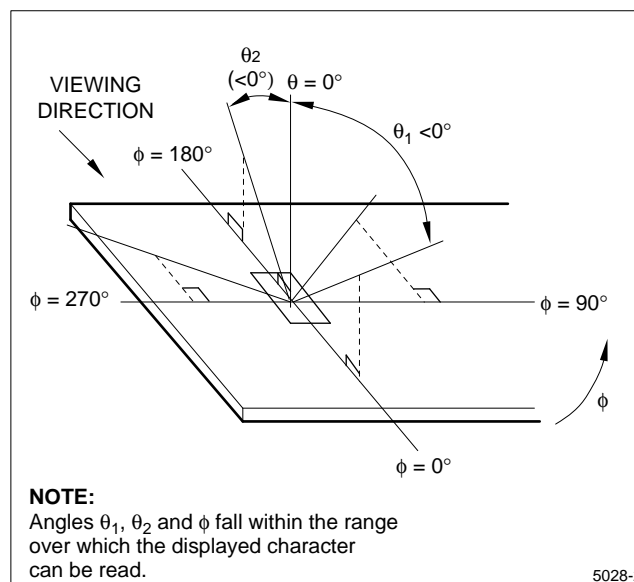


Figure 3. Definition of Viewing Angle

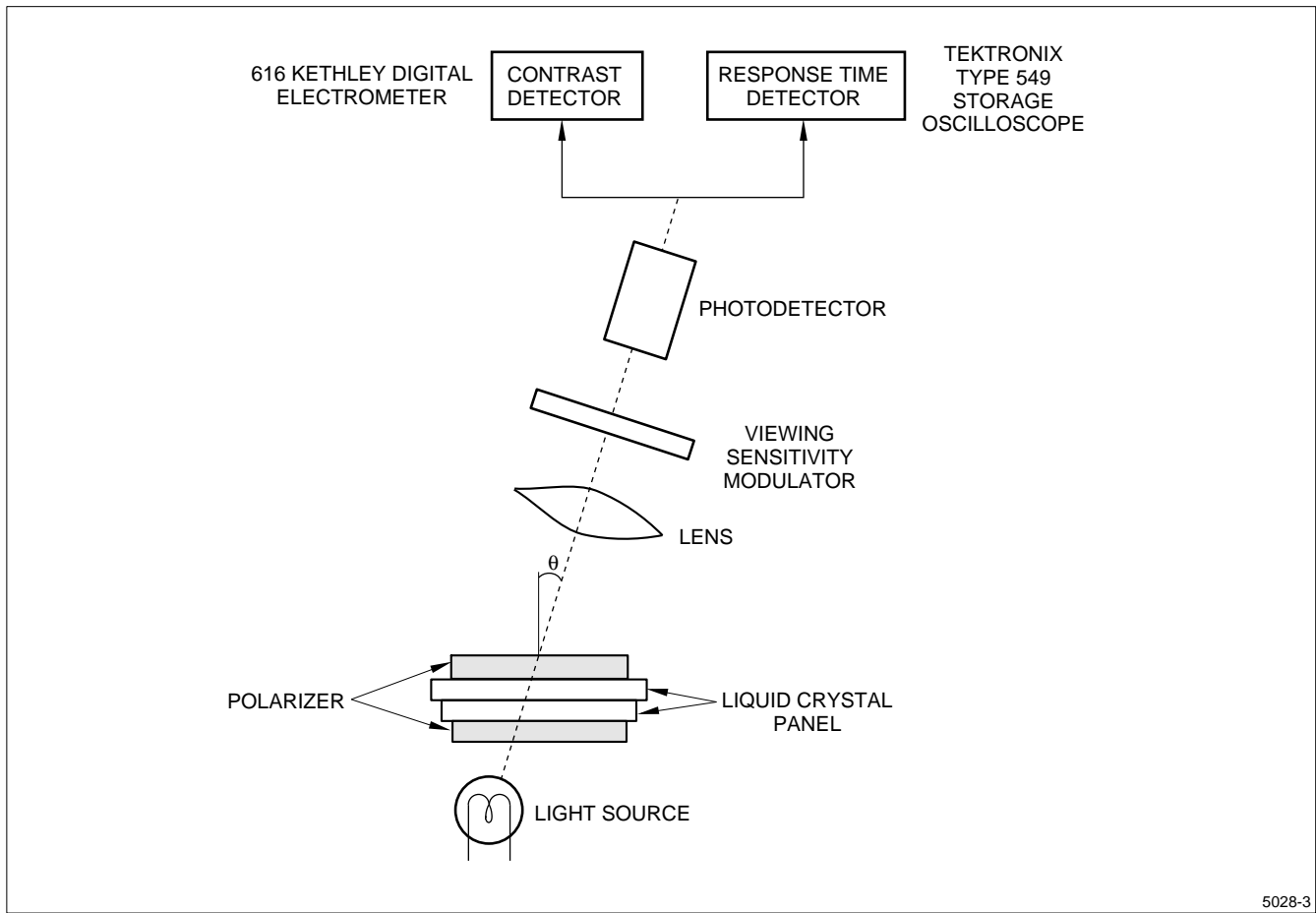


Figure 4. Optical Characteristics Test Method

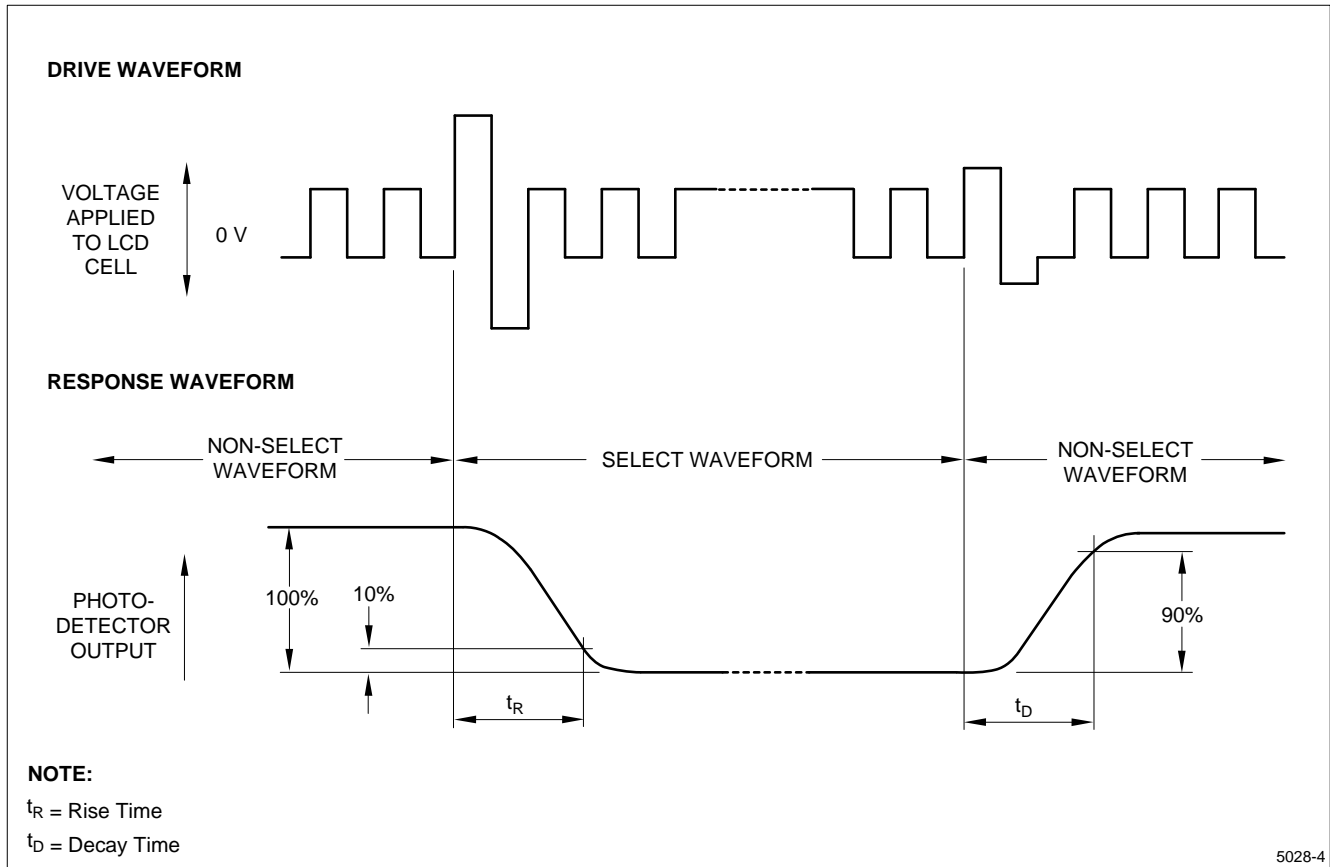


Figure 5. Definition of Response Time

CHARACTERISTICS OF BACKLIGHT (LCD is in OFF State)

| PARAMETER | MIN. | TYP. | MAX. | UNIT | NOTE |
|------------------------------|------|------|------|-------------------|------|
| Luminance | 8 | 22 | — | cd/m ² | 1 |
| Peak Emission Wavelength | — | 565 | — | nm | — |
| Spectrum Radiation Bandwidth | — | 30 | — | nm | — |

NOTE:

1. The center of the unit with LED backlight lit.

PIN DESCRIPTIONS

V_{DD} and V_{SS} Pins

V_{DD} and V_{SS} pins are for power supply. V_{SS} pin is grounded, and V_{DD} pin is supplied with +5 V. Voltages necessary to drive LCD are generated in the unit.

RS Pin

The controller LSI contains two 8-bit registers: instructions register (IR) and data register (DR).

RS pin selects these registers. IR serves to store instruction codes for display clear, shft, etc. and address information for display data RAM (DD RAM), character generator RAM (CG RAM); DR serves to temporarily store data to be written into DD RAM and CG RAM.

'0': Instruction register (Write)
Busy flag register; address counter (Read)

'1': Data register (Read/Write)

R/W Pin

Read or write selection signal pin.

'0': Write

'1': Read

E Pin

Data read or write operation enable signal pin.

DB₀ to DB₇ Pins

Tri-state bidirectional data bus pins. The bus allows data to be transmitted to or received from the external circuit. DB₇ serves also as busy flag output. When the unit is interfaced to a microcomputer with 4-bit parallel outputs, DB₀ to DB₃ pins are not used.

V₀ Pin

Viewing angle is varied and contrast is adjusted by changing input voltage between +5 V to 0 V by applying bias voltage to the LCD driver.

V_{LED} and V_{LSS}

Power supply for LED backlight. Supply current is 110 mA. V_{LED} is plus and V_{LSS} is minus.

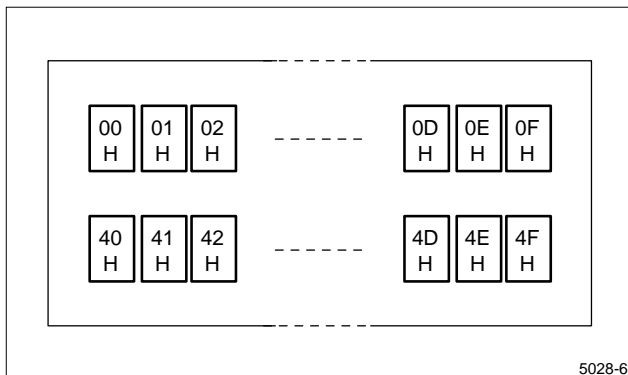
INSTRUCTION SET

| INSTRUCTION | CODES | | | | | | | | | | DESCRIPTION | |
|--------------------------------|-------|-----|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|------------------------------------|--|---|--|
| | RS | R/W | DB ₇ | DB ₆ | DB ₅ | DB ₄ | DB ₃ | DB ₂ | DB ₁ | DB ₀ | | |
| Display Clear | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Clears entire display area, restores display from shift, and loads address counter with DD RAM address 00H. | |
| Display/Cursor Home | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | * | Restores display from shift and loads address counter with DD RAM address 00H. | |
| Entry Mode Set | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | I/D | S | Specifies cursor advance direction and displays shift mode. This operation takes place after each data transfer. |
| Display ON/OFF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | D | C | B | Specifies activation of display (D), cursor (C), and blinking of character at cursor position (B). |
| Cursor/Display Shift | 0 | 0 | 0 | 0 | 0 | 0 | 1 | S/C | R/L | * | * | Shifts display or moves cursor. |
| Function Set | 0 | 0 | 0 | 0 | 0 | 1 | DL | 1 | 0 | * | * | Sets interface data length (DL). |
| CG RAM Address Set | 0 | 0 | 0 | 1 | A _{CG} | | | | | | Loads the address counter with CG RAM address. Subsequent data is CG RAM data. | |
| DD RAM Address Set | 0 | 0 | 1 | A _{DD} | | | | | | Loads the address counter with a DD RAM address. Subsequent data is DD RAM DATA. | | |
| Busy Flag/Address Counter Read | 0 | 1 | BF | AC | | | | | | Reads out busy flag (BF) and contents of address counter (AC). | | |
| CG RAM/DD RAM Data Write | 1 | 0 | Write data | | | | | | Writes data into DD RAM or CG RAM. | | | |
| CG RAM/DD RAM Data Read | 1 | 1 | Read data | | | | | | Reads data from DD RAM or CG RAM. | | | |

NOTES:

I/D = 1: Increment
 S = 1: Display shift
 D = 1: Display ON
 C = 1: Cursor ON
 B = 1: Character at cursor position blinks
 I/D = 0: Decrement
 S = 0: Display freeze
 D = 0: Display OFF
 C = 0: Cursor OFF

B = 0: Character at cursor position unblinks
 S/C = 1: Display shift
 R/L = 1: Right shift
 DL = 1: 8 bits
 BF = 1: During internal operation
 S/C = 0: Internal cursor shift
 R/L = 0: Left shift
 DL = 0: 4 bits
 BF = 0: End of internal operation



**Figure 6. Display Address
 (When the Display is Not Shifted)**

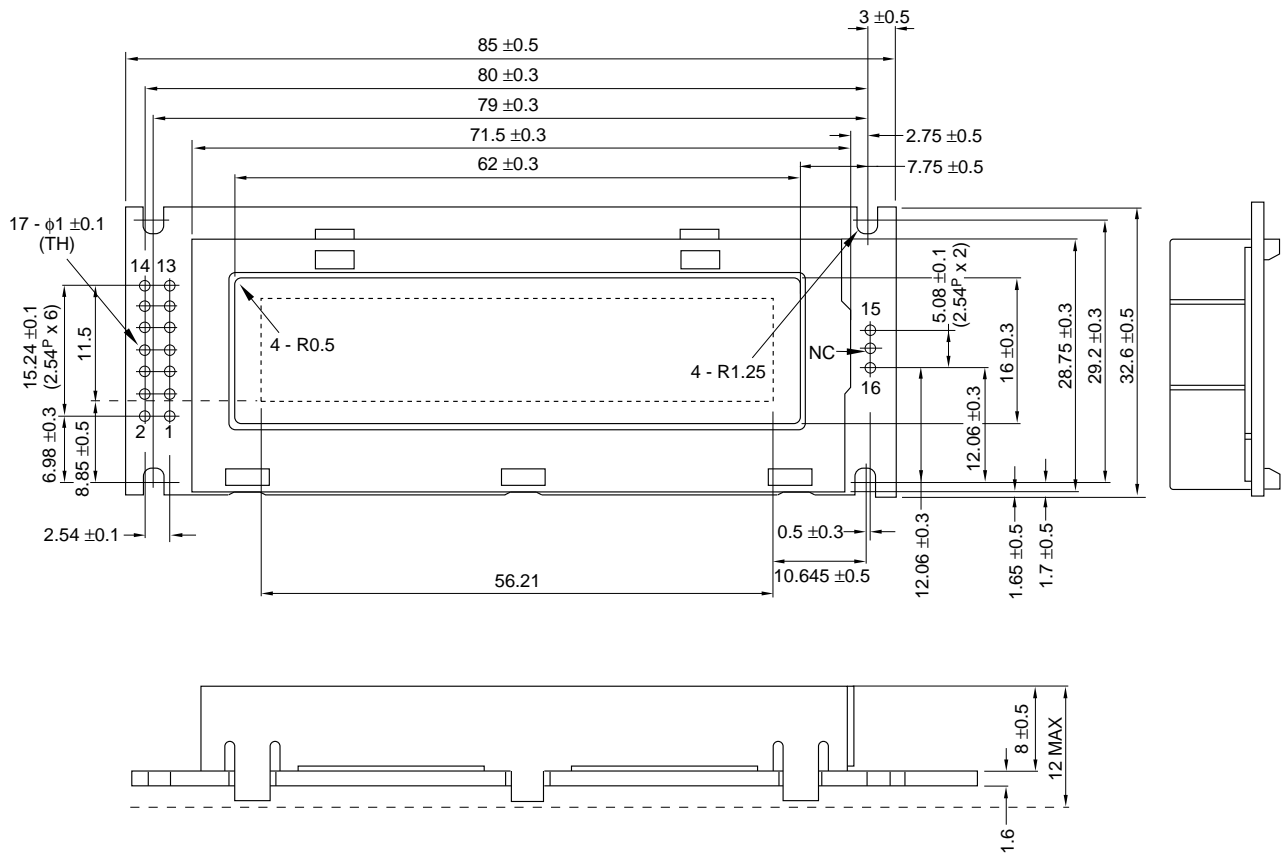
| HIGH-ORDER LOW-ORDER 4 BIT | HIGH-ORDER | | | | | | | | | | | | |
|-------------------------------|------------|------|------|------|------|------|------|------|------|------|------|------|------|
| | 0000 | 0010 | 0011 | 0100 | 0101 | 0110 | 0111 | 1010 | 1011 | 1100 | 1101 | 1110 | 1111 |
| xxxx0000 | CG RAM (1) | | 0 | a | P | \ | F | | - | 9 | E | 0 | * |
| xxxx0001 | (2) | ! | 1 | A | Q | a | 9 | u | 7 | + | 4 | a | * |
| xxxx0010 | (3) | " | 2 | B | R | b | r | r | 4 | W | X | * | 0 |
| xxxx0011 | (4) | # | 3 | C | S | c | s | 1 | 9 | T | E | e | 0 |
| xxxx0100 | (5) | \$ | 4 | D | T | d | t | \ | I | h | + | * | 0 |
| xxx0101 | (6) | % | 5 | E | U | e | u | = | + | + | 1 | 0 | 0 |
| xxx0110 | (7) | & | 6 | F | V | f | v | 9 | h | 2 | 3 | * | Σ |
| xxxx0111 | (8) | ' | 7 | G | W | g | w | 7 | + | 2 | 9 | * | π |
| xxxx1000 | (1) | (| 0 | H | X | h | x | 4 | 9 | * | U | 5 | 2 |
| xxxx1001 | (2) |) | 9 | I | Y | i | y | 9 | 7 | J | U | " | * |
| xxxx1010 | (3) | * | ; | J | Z | j | z | 2 | 3 | n | v | * | + |
| xxxx1011 | (4) | + | ; | K | [| k | [| + | 9 | h | 0 | * | h |
| xxxx1100 | (5) | , | < | L | * | l | l | h | 9 | 7 | 9 | + | h |
| xxxx1101 | (6) | - | = | M |]m |] | u | 2 | 2 | \ | 9 | h | ÷ |
| xxxx1110 | (7) | . | > | N | ^ | n | + | 3 | h | h | " | h | |
| xxxx1111 | (8) | / | ? | O | _ | o | + | u | U | 7 | " | ö | * |

NOTES:

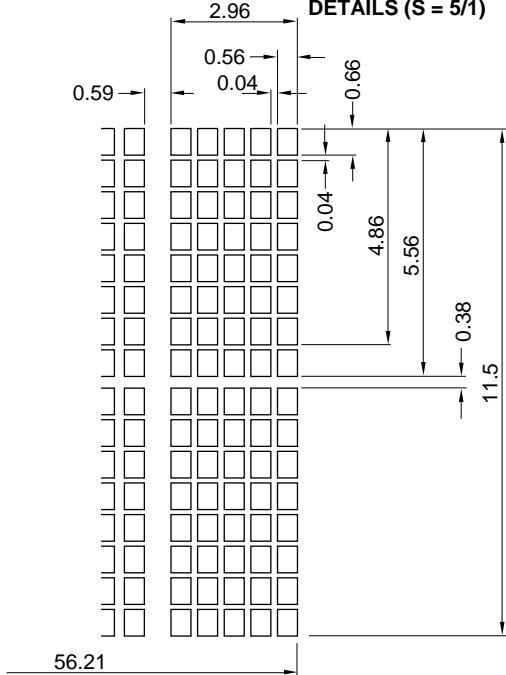
- CG RAM is character generator RAM in which user-definable character patterns are stored.
- X mark: prohibition of input.

Figure 7. Input Code vs. Character Pattern

OUTLINE DIMENSIONS



CHARACTER PATTERN DETAILS (S = 5/1)



| PIN # | SYMBOL | PIN # | SIGNAL |
|-------|-----------------|-------|------------------|
| 1 | V _{SS} | 9 | DB ₂ |
| 2 | V _{DD} | 10 | DB ₃ |
| 3 | V _O | 11 | DB ₄ |
| 4 | RS | 12 | DB ₅ |
| 5 | R/W | 13 | DB ₆ |
| 6 | E | 14 | DB ₇ |
| 7 | DB ₀ | 15 | V _{LED} |
| 8 | DB ₁ | 16 | V _{LSS} |

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