LM16152E
Dot Matrix LCD Unit

FEATURES

- The unit consists of a dot-matrix LCD panel, CMOS driver LSI and backlight LED with high brightness and stable radiation so that it is easily visible even in dark locations.
- Thin, lightweight design and low power consumption permit easy installation in a variety of equipment.
- Allowing for being connected at general-purpose CMOS signal level, the unit can be easily interfaced to a microcomputer with common 4-bit and 8-bit parallel inputs and outputs.
- Internal character generator ROM and RAM and display data RAM:
  - Character generator ROM – 5 × 7 dots, 160 kinds of characters (alphanumeric and Japanese characters)
  - Character generator RAM – 5 × 7 dots, 8 characters (write capability by program)
  - Display data RAM – 80 × 8 bits
- Extensive instruction set:
  - Display clear, display ON/OFF, character blink, and display shift
- Internal automatic reset circuit at power-on. (For the operational conditions, refer to the separate manual 'Dot Matrix LCD Unit with Built-In Controllers.')
- Built-in an LCD panel which operates from a single 5 V power supply and in a wide range of temperature, offering stable display.

DESCRIPTION

The SHARP LM16152E Dot Matrix LCD Unit consists of a combination of a 5 × 7-dot 16-character 1-line dot-matrix LCD panel, LCD driver, controller LSI, and yellow-green LED backlight fabricated on a single PCB. 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.

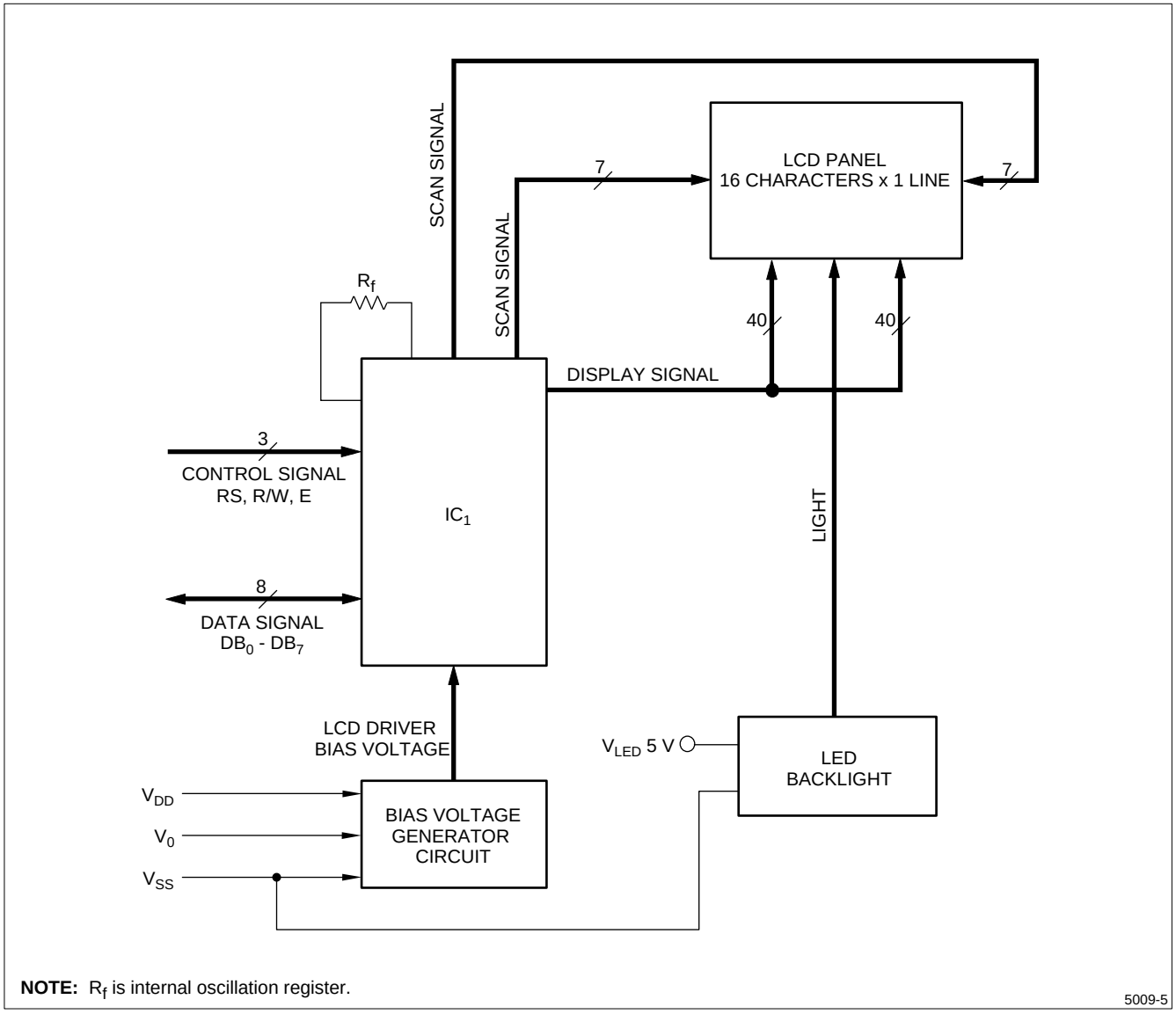


Figure 1. LM16152E Block Diagram

MECHANICAL SPECIFICATIONS

PARAMETER	SPECIFICATIONS	UNIT
Outline Dimensions	115 (W) × 39.5 (H) × 16 max (D)	mm
Effective Viewing Area	99 (W) × 13 (H)	mm
Number of Characters	16 Characters × 1 line	–
Character Format	5 × 7 dots	–
Character Size	4.9 (W) × 7.95 (H)	mm
Dot Size	0.9 (W) × 1.05 (H)	mm
Dot Spacing	0.10	mm
Character Color	Dark Blue	–
Backlight Color	Yellow-Green	–
Weight	Approximately 60	g

ABSOLUTE MAXIMUM RATINGS

SYMBOL	PARAMETER	MIN.	MAX.	UNIT	NOTE
$V_{DD} – V_{SS}$	Supply Voltage (Logic)	–0.3	+7.0	V	–
$V_{DD} – V_O$	Supply Voltage (LCD Driver)	0	13.5	V	–
I_{LED}	Supply Current (LED Backlight)	–	150	mA	t_A = 25°C
V_{IN}	Input Voltage	–0.3	V_{DD} +0.3	V	–
T_{STG}	Storage Temperature	–25	+70	degrees	–
T_{OPR}	Operating Temperature	0	+50	degrees	–
V_{LED}	Reverse Voltage (LED Backlight)	–5	–	V	–

ELECTRICAL CHARACTERISTICS (t_A = 25°C)

SYMBOL	PARAMETER		MIN.	TYP.	MAX.	UNIT	NOTE
$V_{DD} – V_{SS}$	Supply Voltage (Logic)		4.75	5.0	5.25	V	–
$V_O – V_{SS}$	Supply Voltage (LCD Driver)		–	1	–	V	V_{DD} = 5.0 V
V_{IL}	Input Voltage	'L'	–0.3	–	0.6	V	–
V_{IH}		'H'	2.2	–	V_{DD}	V	–
V_{OL}	Output Voltage	'L'	–	–	0.4	V	I_{OL} = 1.2 mA
V_{OH}		'H'	2.4	–	–	V	$–I_{OH}$ = 0.205 mA
I_{IL}	Input Leakage Current		–	–	1	µA	–
f_{OSC}	Internal Oscillating Frequency		–	250	–	kHz	–
I_{DD}	Supply Current		–	1.5	2	mA	V_{DD} = 5 V, V_O = 0 V
I_{LED}			–	75	100	mA	V_{LED} = 5 V
P_D	Power Dissipation		–	7.5	10	mW	V_{DD} = 5 V, V_O = 0 V (LED Backlight OFF)
			–	382.5	510	mW	$V_{DD} = V_{LED}$ = 5 V, V_O = 0 V (LED Backlight ON)
$V_{LED} – V_{SS}$	Supply Voltage (LED Backlight)		4.75	5.0	5.25	V	–

INTERFACE TIMING (V_{DD} = 5.0 V ±5%, t_A = 0 – 50°C)

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
t_{cycE}	Enable Cycle Time	1000	–	–	ns
PW_{EH}	Enable Pulse Width	450	–	–	ns
t_{ER}, t_{EF}	Enable Rise and Fall Time	–	–	25	ns
t_{AS}	RS, R/W Setup Time	140	–	–	ns
t_{AH}	Address Hold Time	10	–	–	ns
t_{DSW}	Data Setup Time	195	–	–	ns
t_{DDR}	Data Delay Time	–	–	320	ns
t_H	Data Hold Time (Write)	10	–	–	ns
t_{DHR}	Data Hold Time (Read)	20	–	–	ns

NOTE:

1. Timing Chart: See Figure 2.

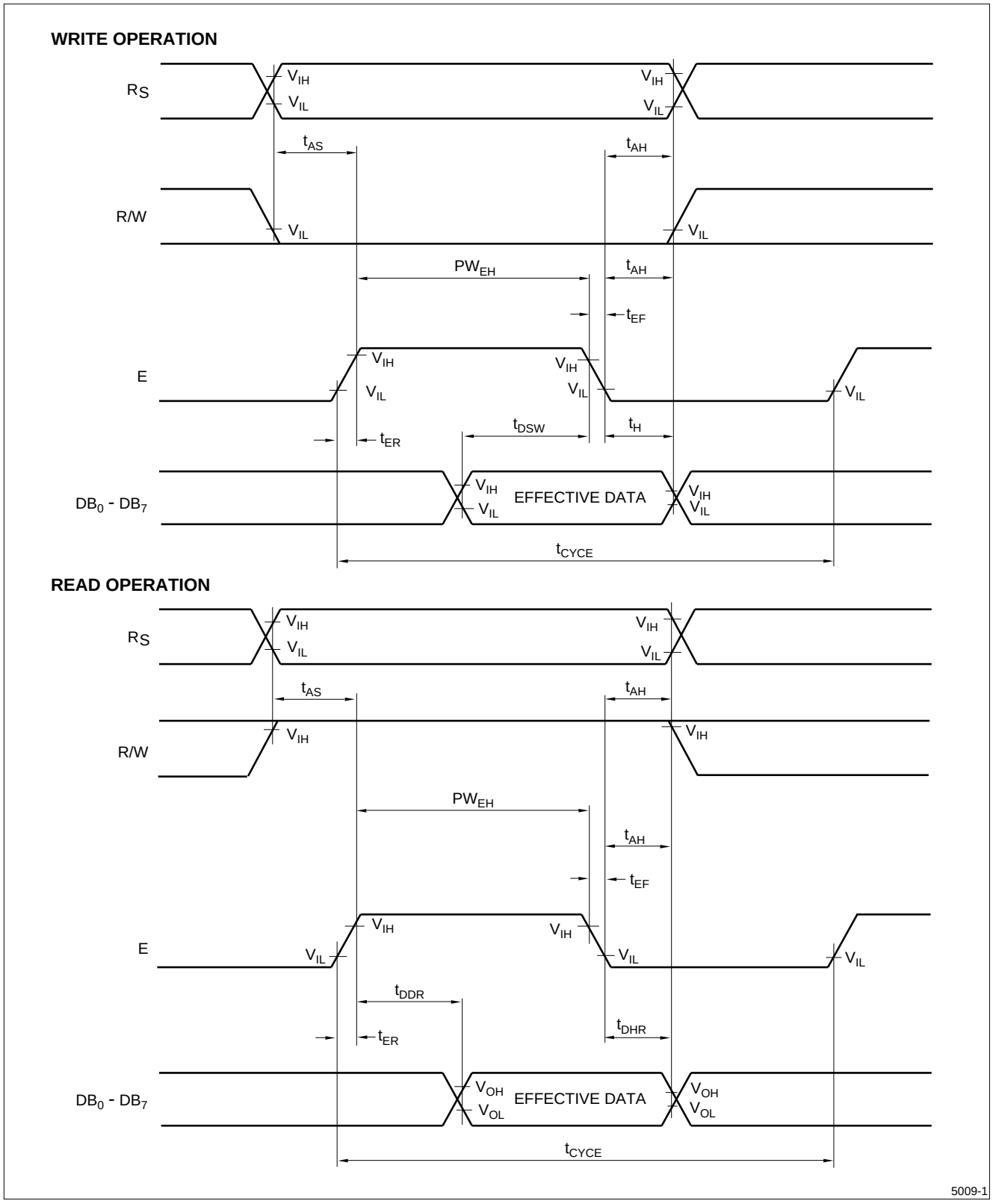


Figure 2. Interface Timing Chart

PIN CONNECTIONS

PIN NUMBER	SYMBOL	DESCRIPTION	CONNECTION
1	V_{SS}	Ground Potential	GND: 0 V
2	V_{DD}	Power Supply	Supply 5 V
3	V_O	Contrast Adjustment Voltage	Adjust the contrast by changing the supply voltage from 0 V to 5 V.
4	RS	Register Select Pin	Control signal inputs (For details, refer to Pin Description).
5	R/W	Read/Write Pin	
6	E	Enable Pin	
7	DB_0	Code I/O Data LSB	Data bus line • DB_7 doubles as busy flag output. • When the unit is interfaced to a microcomputer with 4-bit parallel outputs, pins DB_0 – DB_3 are not used. (For details, refer to Pin Description)
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 For LED Backlight	Supply 5 V

OPTICAL CHARACTERISTICS – BACKLIGHT LED OFF ($V_{DD} - V_O = 4$ V, $t_A = 25°C$)

SYMBOL	PARAMETER		CONDITION		MIN.	TYP.	MAX.	UNIT	NOTE
$\theta_2 - \theta_1$	Viewing Angle Range		ø = 0°	$C_O \geq 2.0$	30	–	–	degrees	1
θ_1			$\theta_1 < \theta_2$	$C_O = 2.0$	–	–	15		
θ_2					40	–	–		
$\theta_2 - \theta_1$			ø = 45° 315°	$C_O \geq 2.0$	30	–	–		
θ_1			$\theta_1 < \theta_2$	$C_O = 2.0$	–	–	20		
θ_2					45	–	–		
C_O	Contrast Ratio		$\theta = 15°$		2.0	3.0	–	–	2
t_R	Response Speed	Rise	$\theta = 15°$		–	150	300	ms	3
t_D		Decay	θ 15°		–	200	400	ms	

NOTES:

1. The viewing angle range may be defined as shown in Figure 3.
2. 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.
   $$\text{Contrast ratio} = \frac{\text{Photodetector output voltage with non-select waveform being applied}}{\text{Photodetector output voltage with select waveform being applied}}$$
3. 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 photo-detector output are measured as shown in Figure 5.

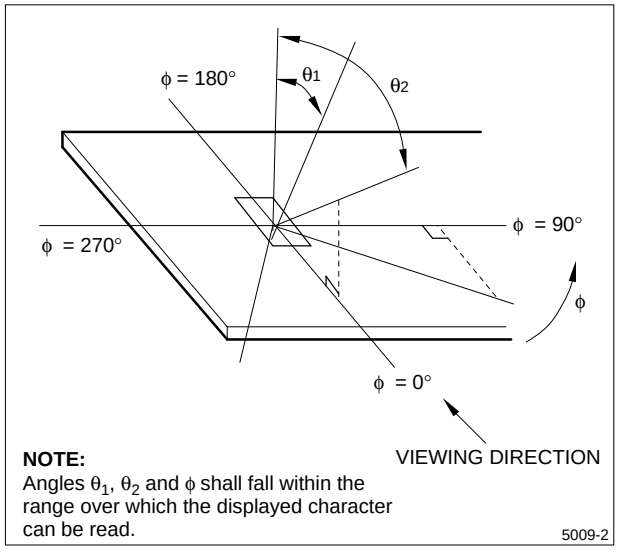


Figure 3. Definition of Viewing Angle

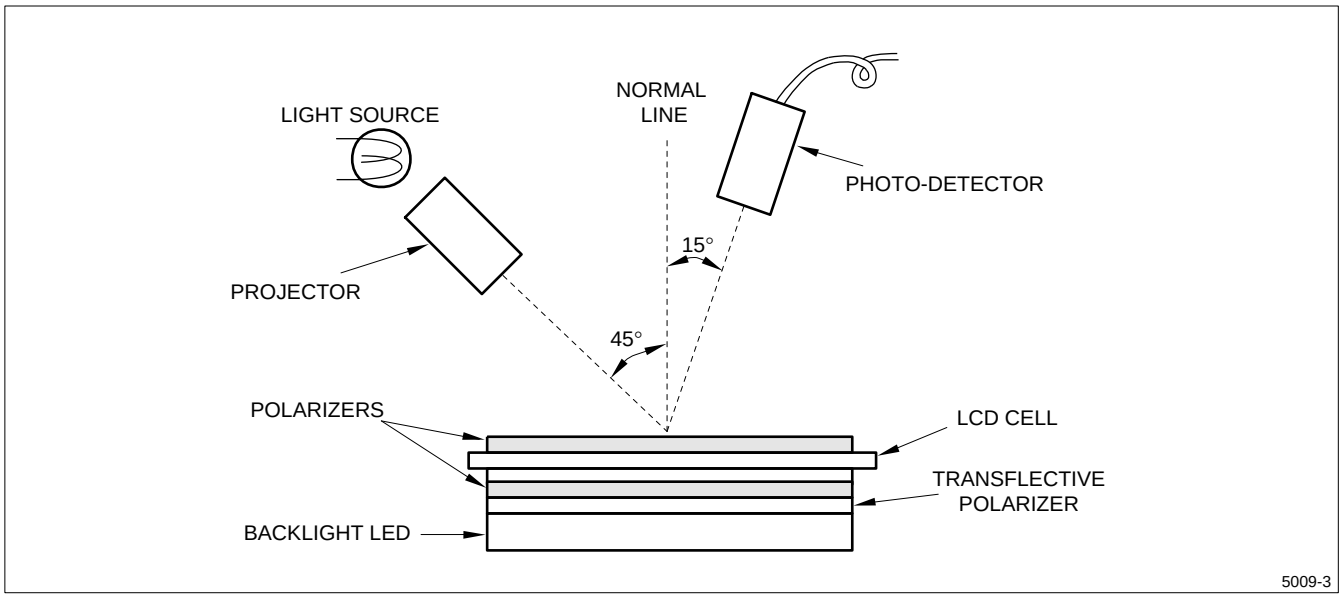


Figure 4. Optical Characteristics Test Method

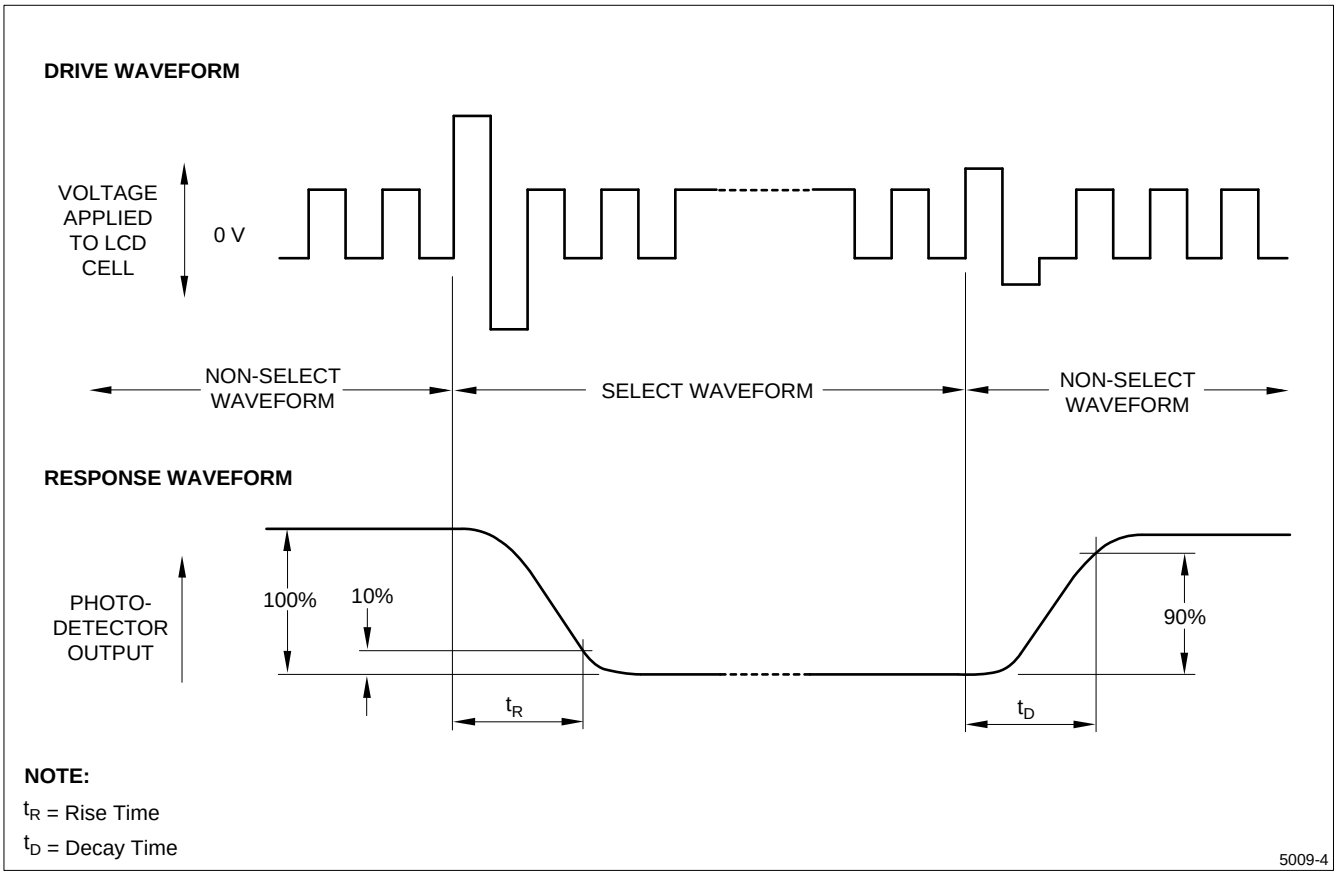


Figure 5. Definition of Response Time

CHARACTERISTICS OF BACKLIGHT LED (LCD OFF) (V_{LED} = 5 V, t_A = 25°C)

PARAMETER	MIN.	TYP.	MAX.	UNIT	NOTE
Average Luminosity	2.9	11.4	–	cd/m^2	1

NOTE:

1. Average Luminosity is defined as follows:

$$\text{Average Luminosity} = \frac{\text{Luminous intensity of effective radiating area}}{\text{Effective radiating area}} \left(cd/m^2\right)$$

$$(99 \times 13 \times 10^{-6} m^2)$$

PIN DESCRIPTION

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. Each voltage necessary to drive the LCD is generated in the unit.

RS Pin

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

RS pin selects these registers. IR serves to store instruction codes for display clear, shift, 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.

DB_0 to DB_7 Pins

Tri-state bidirectional data bus pins. The bus allows data to be transmitted to or received from the external circuit. DB_7 serves also as busy flag output. When the unit is interfaced to a microcomputer with 4-bit parallel outputs, DB_0 to DB_3 pins are not used.

V_0 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} Pin

Power supply for LED backlight. (By changing the supply voltage, backlight luminosity can be adjusted.)

APPLICABLE INSPECTION STANDARDS

There shall be no scratches, stains, chips, distortions and other external drawbacks that may affect the display function.

Rejection criteria meets the following Inspection Standard: S-A-082.

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	Clear the entire display.
Internal Cursor Home [1]	0	0	0	0	0	0	0	0	1	*	Returns internal cursor to home position (address 0). Restores display from shift. The contents of DD RAM remain unchanged.
Entry Mode Set	0	0	0	0	0	0	0	1	I/D	S	Decides whether display is to be shifted. The above operation is performed during a write or read cycle.
Display ON/OFF Control	0	0	0	0	0	0	1	D	*	B	Turns on and off display (D); blinks the character in the *internal cursor position*[*1] (B).
Internal Cursor/ Display Shift	0	0	0	0	0	1	S/C	R/L	*	*	Shift the internal cursor and display while the contents of DD RAM unchanged.
Function Set	0	0	0	0	1	DL	1	0	*	*	Selects interface data length (DL).
CG RAM Address Set	0	0	0	1	A_{CG}						Sets CG RAM address (A_{CG}). The subsequent data is CG RAM data.
DD RAM Address Set	0	0	1	A_{DD}							Sets DD RAM address (A_{DD}). The subsequent data is DD RAM data.
Busy Flag/ Address Read	0	1	BF	AC							Reads out busy flag (BF) denoting internal operation and 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								Read data from DD RAM or CG RAM.

NOTES:

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

1. Address to be accessed in the next.

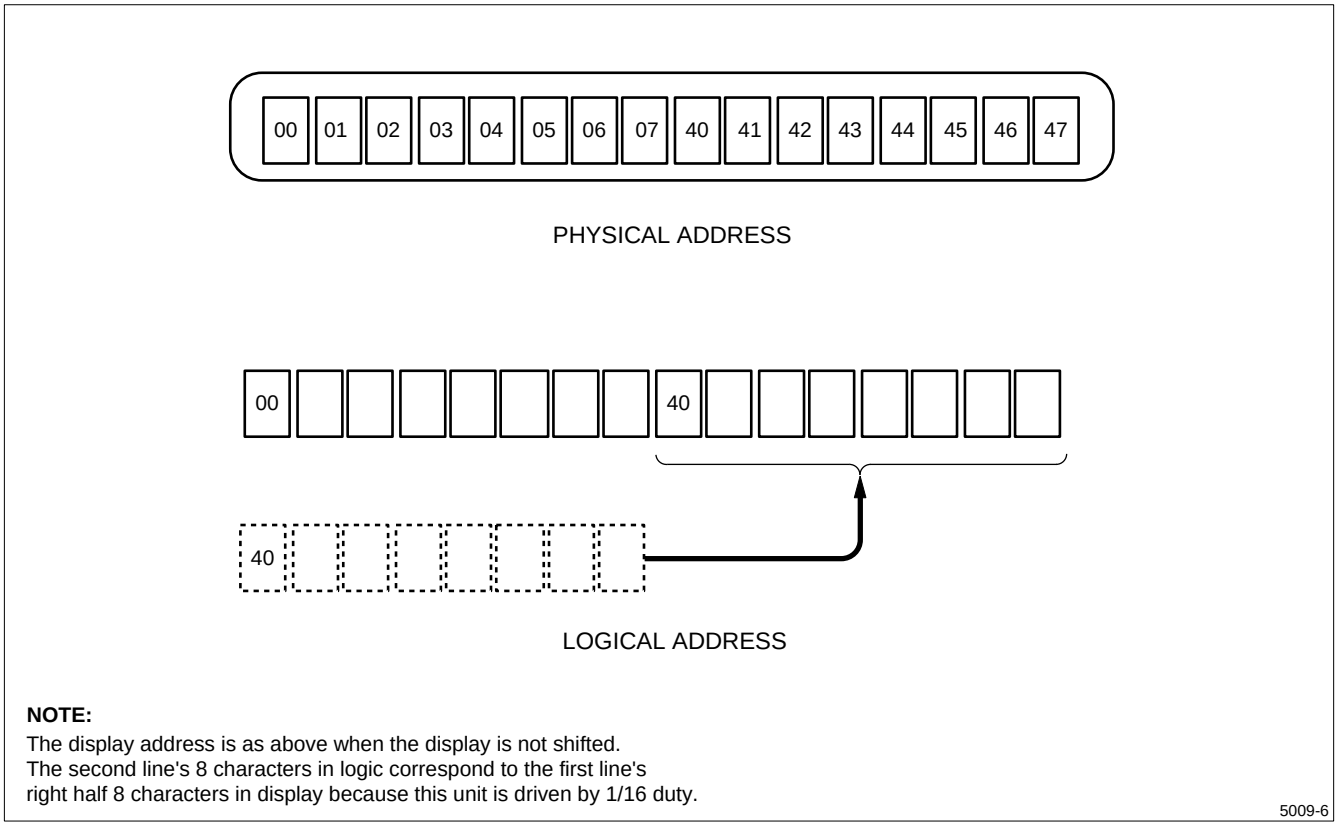
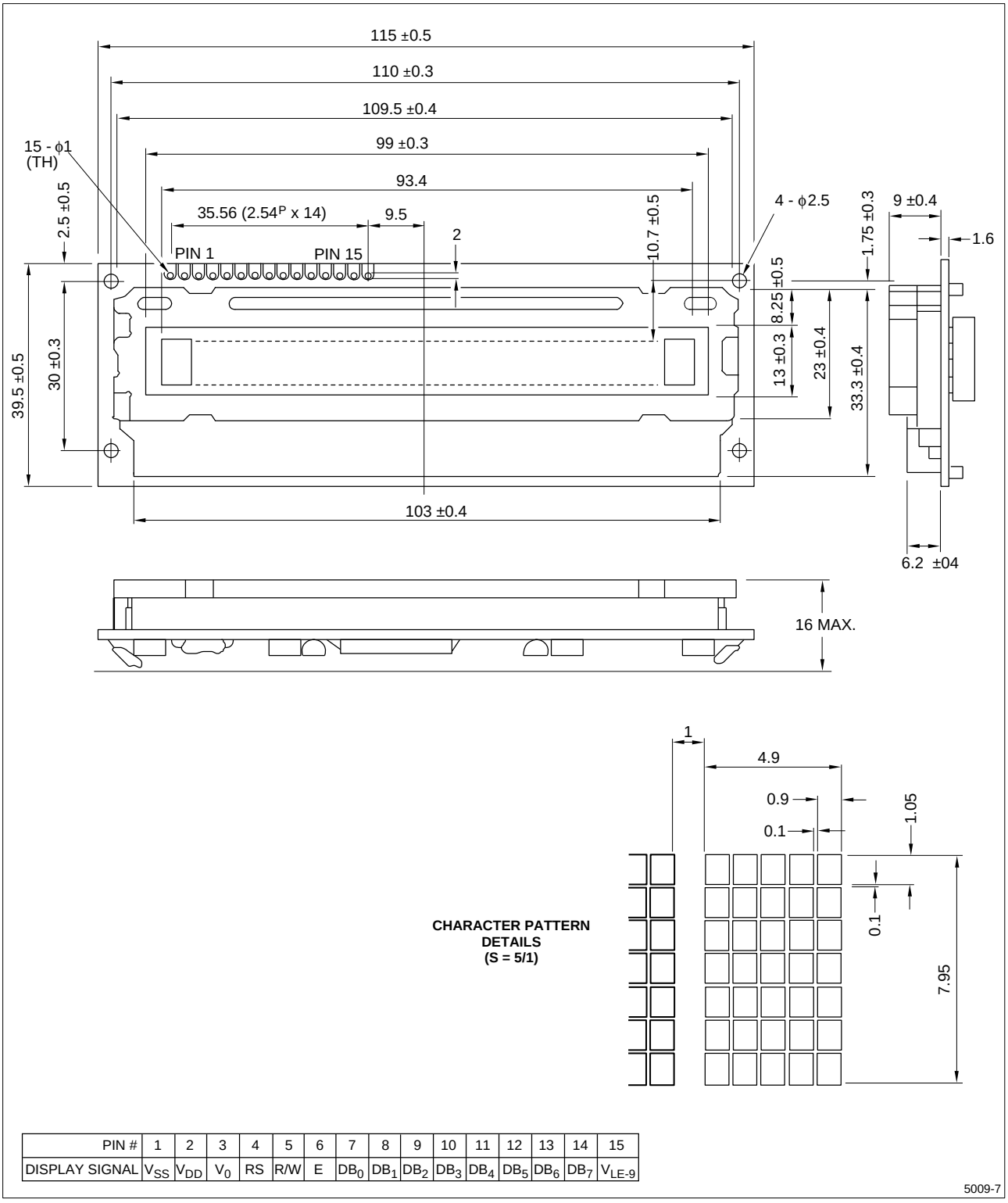


Figure 6. Display Address

HIGH-ORDER 4 BIT / LOW-ORDER 4 BIT	0000	0010	0011	0100	0101	0110	0111	1010	1011	1100	1101	1110	1111
xxxx0000	CG RAM (1)												
xxxx0001	(2)												
xxxx0010	(3)												
xxxx0011	(4)												
xxxx0100	(5)												
xxx0101	(6)												
xxx0110	(7)												
xxxx0111	(8)												
xxxx1000	(1)												
xxxx1001	(2)												
xxxx1010	(3)												
xxxx1011	(4)												
xxxx1100	(5)												
xxxx1101	(6)												
xxxx1110	(7)												
xxxx1111	(8)												

Figure 7. Input Code vs. Character Pattern

OUTLINE DIMENSIONS



PIN #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
DISPLAY SIGNAL	V_{SS}	V_{DD}	V_0	RS	R/W	E	DB_0	DB_1	DB_2	DB_3	DB_4	DB_5	DB_6	DB_7	V_{LE-9}

5009-7