Miniature LCD Character Modules Data Sheet

A range of compact intelligent, alphanumeric, dot matrix modules with integral CMOS microprocessor and LCD display drivers. The modules utilise a 5 x 8 dot matrix font format with cursor, and are capable of displaying 189 different alphanumeric characters and symbols. The modules are available as reflective or transflective in super twisted nematic green mode. The transflective type incorporate an LED backlight.

Applications

- Data terminals
- Medical instruments
- Hand-held instruments
- Hand-held data terminals
- Electronic typewriters
- Point of sale terminals
- Test instruments
- Word processors.

Features

- Single 5 volt power supply
- Low power consumption
- Wide viewing angle
- High contrast
- Easy interface to 4 or 8-bit data bus
- ASCII compatible
- Powerful instruction set
- 192 different characters and symbols
- 8 user programmable characters
- Chip-on-board technology (COB)
- Compact and lightweight

Absolute maximum rating

Item	Symbol	Value	Unit
Power supply voltage	Vdd - Vss	-0.3 ~ + 7.0	V
Driver supply voltage	Vlcd	Vdd - 13.5 ~ Vdd +0.3 V	
Input voltage	Vin	-0.3 ~ Vdd +0.3	
Operating temperature range	Top	0 ~ +50	°C
Storage temperature range	Tst	-20 ~ +60	

Description of terminals

Pin No	Symbol	Input/ Output	Function
1	Vss	I	0v power supply (Gnd)
2	Vdd	I	+5v power supply
3	Vo	I	LCD contrast adjustment voltage
4	RS	I	Register select RS=1 data register for read and write RS=0 Instruction register for write Busy flag/Address count for read
5	R/W	I	Read/Write select R/W=1 Read mode R/W=0 Write mode
6	E	I	Enable signal initiate read or write of data
7	DB0	I/O	Four low order bidirectional three-state data bus lines. Used to transfer data to the LCD module. Note, not used during 4-bit operation.
8	DB1	I/O	
9	DB2	I/O	
10	DB3	I/O	
11	DB4	I/O	Four high order bidirectional three-state data bus lines. Used to transfer data to the LCD module. Note, DB7 can be used as a busy flag.
12	DB5	I/O	
13	DB6	I/O	
14	DB7	I/O	
15	A	I	LED backlight Anode. Transflective models only
16	K	I	LED backlight Cathode. Transflective models only

Electrical Characteristics
(VDD-VSS = 4.5v ~ 5.5v, Ta = 25°C)

Parameter	Sym	Condition	Pin	Min	Typ	Max	Unit
Logic Voltage	V_{DD}	Vss = 0v	V_{DD}	4.5	5.0	5.5	V
Logic Current	I_{DD}	V_{DD}=5v, f_{OSC}=270khz	-	-	0.6	1.0	mA
Input Voltage	V_{IH}	-	DB0~DB7, RS, R/W, E	2.2	-	V_{DD}	V
	V_{IL}	-		-0.3	-	0.6	V
Output Voltage	V_{OH}	I_{OH} = -0.2 mA	DB0 ~ DB7	V_{DD}-1	-	V_{DD}	V
	V_{OL}	I_{OL} = 1.2 mA		-0.2	-	1.0	V
I/O leakage current	I_{LKG}	V_{IN} = 0 to V_{DD}	-	-1	-	-1	$_{U}$A
Input Low current	V_{IL}	V_{IN}= 0v, V_{DD} = 5v	-	-50	-125	-250	$_{U}$A
Internal Clock	f_{OSC}	R_f=91kΩ ±2%	-	190	270	350	khz
LCD drive voltage	V_{LCD}	V_{DD} - Vo	Vo	3.0	-	11.0	V

LED Backlight Characteristics

Dm Part Number	Condition	Symbol	Typ	Max	Unit
DMA20203STFY, DMA16203STFY	Ta=25°C	I_f	30	40	mA

AC Characteristics
(VDD-VSS = 4.5v ~ 5.5v, Ta = 0 ~ +55°C)

Mode	Characteristic	Symbol	Min	Typ	Max	Unit
Write Mode (refer to fig -6)	E cycle time	t_c	500	-	-	nS
	E Rise / Fall time	t_R, t_F	-	-	20	
	E Pulse width (High, Low)	t_W	230	-	-	
	R/W and RS setup time	t_{SU1}	40	-	-	
	R/W and RS hold time	t_{H1}	10	-	-	
	Data setup time	t_{SU2}	60	-	-	
	Data hold time	t_{H2}	10	-	-	
Read Mode (refer to fig -5)	E cycle time	t_C	500	-	-	nS
	E Rise / Fall time	t_R, t_F	-	-	20	
	E Pulse width (High, Low)	t_W	230	-	-	
	R/W and RS setup time	t_{SU}	40	-	-	
	R/W and RS hold time	t_H	10	-	-	
	Data output delay time	t_D	-	-	120	
	Data hold time	t_{DH}	5	-	-	

Fig 5. Read Mode Timing Diagram

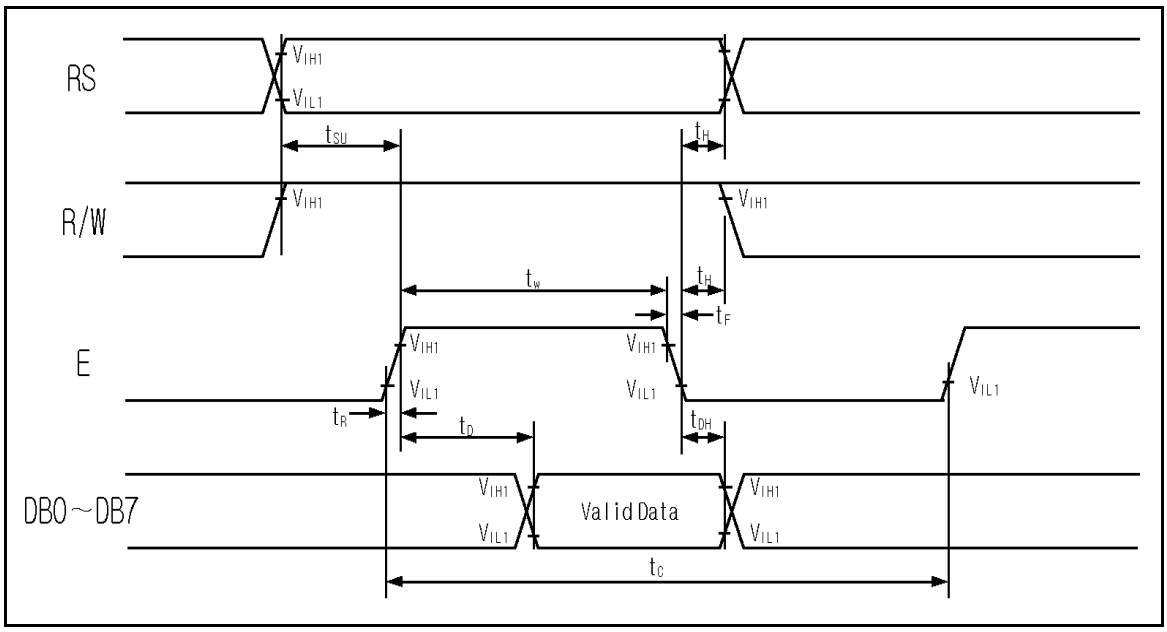
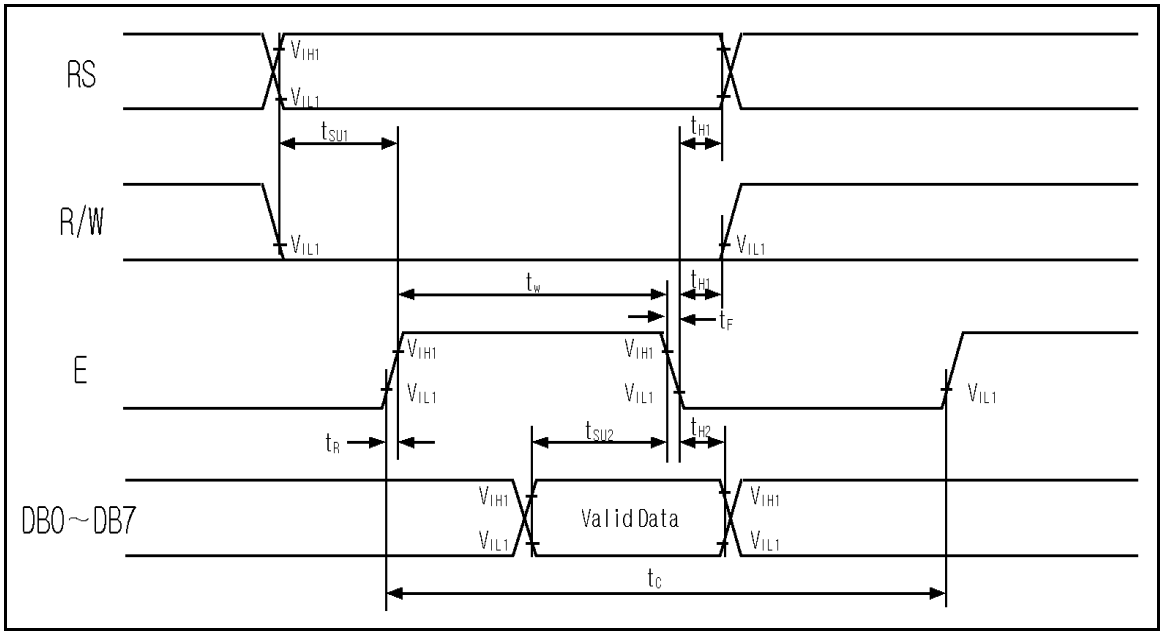


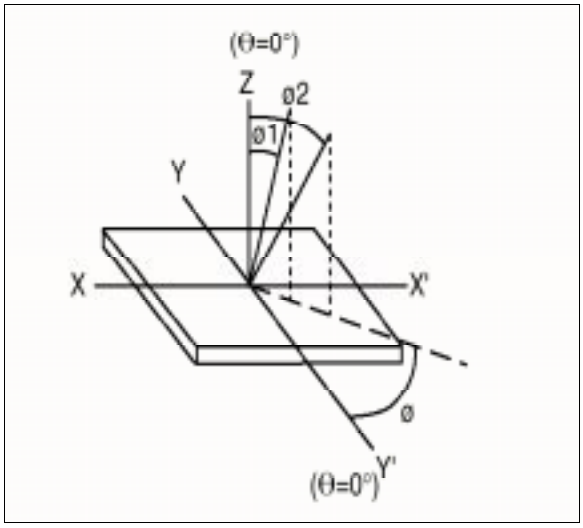
Fig 6. Write Mode Timing Diagram



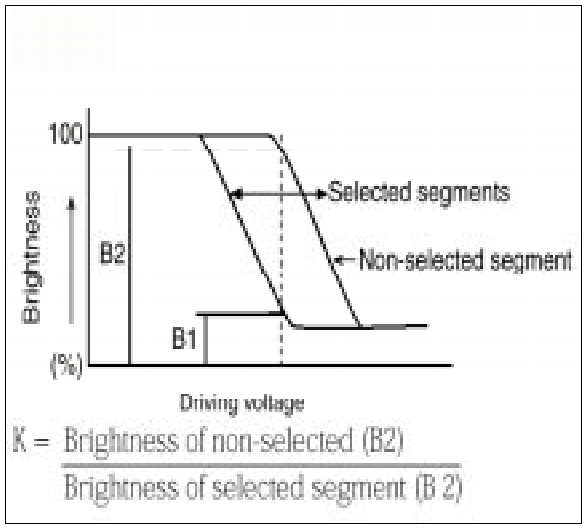
Optical Characteristics

Item	Symbol	Condition	Min	Typ	Max	Unit	diag
Viewing angle	Φ2 - Φ1	K = 1.4	60	-	-	deg	1, 2
Contrast ratio	K	Φ = 10°C θ = 0°C	5	-	-	-	3
Response time (rise)	tr	Φ = 10°C θ = 0°C	-	150	250	mS	4
Response time (fall)	tf	Φ = 10°C θ = 0°C	-	200	300	mS	4

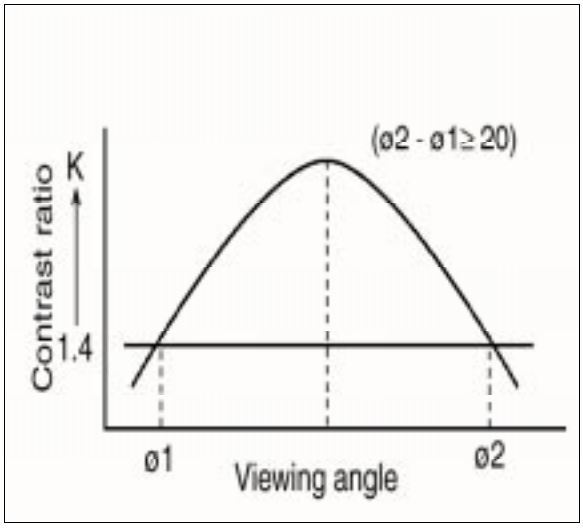
Diag.1 Definition of θ and Φ



Diag.3 Definition of contrast ratio



Diag.2 Contrast vs viewing angle



Diag.4 Definition of optical response

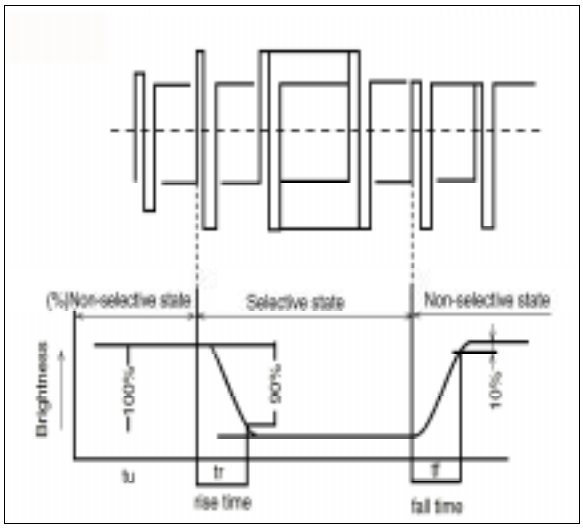


Table 5. Instruction Table

Instruction	Instruction Code										Description	Execution time (fosc=270khz)
	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0		
Clear Display	0	0	0	0	0	0	0	0	0	1	Write “20H” to DDRAM and set DDRAM address to “00H” from AC	1.52 mS
Return Home	0	0	0	0	0	0	0	0	1	X	Set DDRAM address to “00H” from AC and return cursor to its original position if shifted. Contents of DDRAM not changed	1.52 mS
Entry Mode	0	0	0	0	0	0	0	1	I/D	SH	Assign cursor moving direction and shift entire display enable	37 uS
Display ON/OFF Control	0	0	0	0	0	0	1	D	C	B	Set display (D), cursor (C) and blinking cursor (B) ON/OFF control bits	37 uS
Cursor or Display Shift	0	0	0	0	0	1	S/C	R/L	X	X	Set cursor moving and display shift direction control bits without changing the DDRAM data.	37 uS
Function Set	0	0	0	0	1	DL	N	F	X	X	Set interface data length (DL:4-bit / 8-bit),number of display lines (N: 1 line / 2line), display font type (F: 5*8 dots / 5*11 dots)	37 uS
Set CGRAM Address	0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0	Set CGRAM address in address counter.	37 uS
Set DDRAM Address	0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Set DDRAM address in address counter.	37 uS
Read Busy Flag and Address	0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0	Allows busy flag and the contents of the address counter to be read	0 uS
Write Data to RAM	1	0	D7	D6	D5	D4	D3	D2	D1	D0	Write data into internal RAM (DDRAM/CGRAM)	43 uS
Read Data from RAM	1	1	D7	D6	D5	D4	D3	D2	D1	D0	Read data into internal RAM (DDRAM/CGRAM)	43 uS

Note: “X” = don’t care.

Instruction Description

Outline

To overcome the speed difference internal clock of the KS0066 and the MPU clock, the KS0066 performs internal operations by storing control information in IR or DR.
The internal operation is determined according to the signal from the MPU composed of read/write and data bus. (Refer to Table 5)
Instructions can be divided into four kinds:

1. KS0066 function set instructions (set display methods, set data length, etc)
2. Address set instructions to internal RAM.
3. Data transfer instructions with internal RAM.
4. Others.

The address of internal RAM is automatically increased or decreased by 1.

Note: During internal operations, the busy flag (DB7) is read high. The busy flag check must precede the next instruction.

1. **Clear Display**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	0	1

Clear the display by writing “20H” (space code) to all DDRAM addresses, and set DDRAM address to “00H” into AC (address counter). Return the cursor to the original status, namely, bring the cursor to the left edge of the first line of the display. Make entry mode increment (I/D = “1")

2. **Return Home**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	0	1	-

Returns cursor to the home position.
Set DDRAM address to “00H” into AC (address counter). Return cursor to the left edge of the first line of the display and returns the display to its original status, if shifted. Contents of DDRAM not changed.

3. **Entry Mode Set**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	0	1	I/D	SH

Set the moving direction of the cursor and display, where:

I/D = 0 (low) cursor moves to the left and DDRAM is decreased by 1.
I/D = 1 (high) cursor moves to the right and DDRAM is increased by 1.

Sh = 0 (low) when a DDRAM or CGRAM operation is performed the display does not move.
Sh = 1 (high) when a DDRAM write operation is performed the entire display is shifted where:
I/D = 0 (low) shift display right.
I/D = 1 (high) shift display left.

4. **Display ON/OFF Control**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	0	1	D	C	B

Control display / cursor / blink ON/OFF. (1 bit registers) where:

D = 0 (low) display turned off, data remains in the DDRAM.
D = 1 (high) display turned on.

C = 0 (low) cursor turned off, but its position is maintained in I/D register.
C = 1 (high) cursor turned on.

B = 0 (low) cursor blink turned off.
B = 1 (high) cursor blink turned on.

5. **Cursor or Display Shift**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	0	1	S/C	R/L	-	-

Without writing or reading display data, shift the cursor or display position left/right.

The instruction is used to correct or search the display data. (See table 4)
During 2-line mode display, the cursor moves to the 2nd line after the 40th digit of the 1st line.
Note that display shift is performed simultaneously on all lines.

Table 4.

RS	R/W	Operation
0	0	Shift cursor to the left, AC decreased by 1
0	1	Shift cursor to the right, AC increased by 1
0	0	Shift the display to the left.
0	0	Shift the display to the right.

6. **Function Set**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	DL	N	F	-	-

DL = 0 (low) 4 bit bus mode interface with MPU. All data transfers are sent as two 4 bit nibbles.
DL = 1 (high) 8 bit bus mode interface with MPU. All data transfers are sent as one 8 bit byte.

N = 0 (low) 1 line display mode.
N = 1 (high) 2 line display mode.

F = 0 (low) 5 * 8 dots font display mode.
F = 1 (high) 5 * 11 dots font display mode.

7. **Set CGRAM Address**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	1	AC5	AC4	AC3	AC2	AC1	AC0

Set CGRAM address to AC.
The instruction makes CGRAM data available to the MPU.

8. **Set DDRAM Address**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	1	AC6	AC5	AC4	AC3	AC2	AC1	AC0

Set DDRAM address to AC.
The instruction makes DDRAM data available to the MPU, where:

1 line display (N=0) DDRAM is from “00H” to “4FH”

2 line display (N=1) DDRAM is from “00H” to “27H” line 1
“40H” to “67H” line 2

9. **Read Busy flag & Address**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	1	BF	AC6	AC5	AC4	AC3	AC2	AC1	AC0

This instruction shows whether the KS0066 is busy with an internal operation. The instruction also allows the value of the address register to be read.

If BF = 0 controller not busy
If BF = 1 controller busy, MPU must wait until BF = 0

10. **Write data to DDRAM or CGRAM**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	0	D7	D6	D5	D4	D3	D2	D1	D0

11. **Read data from DDRAM or CGRAM**

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
1	1	D7	D6	D5	D4	D3	D2	D1	D0

INTERFACE WITH MPU

1) Interface with 8-bits MPU

When interfacing data length is 8-bit, transfer is performed at a time through 8 ports, from DB0 to DB7.
Example of timing sequence is shown below.

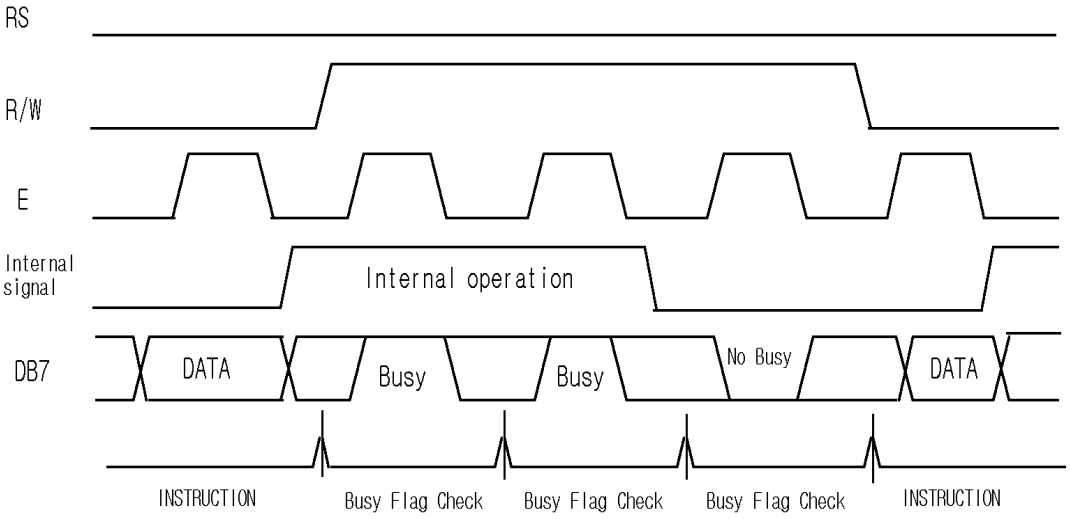


Fig 4. Example of 8-bit Bus Mode Timing Diagram

2) Interface with 4-bits MPU

When interfacing data length is 4-bit, only 4 ports, from DB4 to DB7, are used as data bus.
At first higher 4-bit (in case of 8-bit bus mode, the contents of DB4 - DB7) are transferred, and then lower 4-bit (in case of 8-bit bus mode, the contents of DB0 - DB3) are transferred. So transfer is performed by two times. Busy Flag outputs "High" after the second transfer are ended.
Example of timing sequence is shown below.

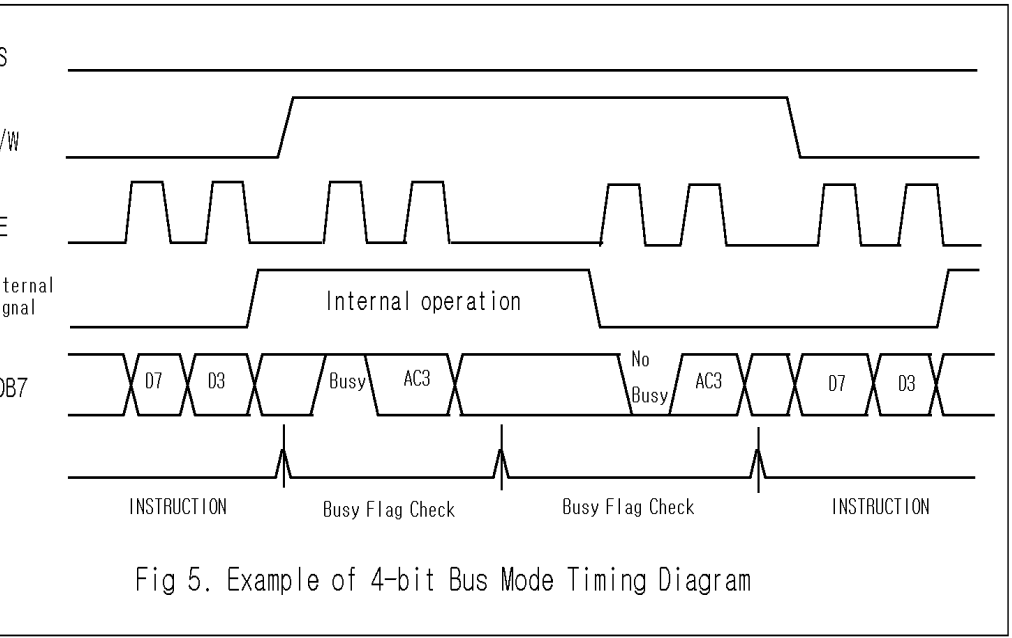


Fig 5. Example of 4-bit Bus Mode Timing Diagram

Power Supply Reset

The internal reset circuit will only operate when the following power supply conditions are satisfied. If it does not operate properly, the unit should be initialised via instructions.

Item	Symbol	Measuring	Standard Value			Unit
		condition	min	typ	max	
Power supply rise time	trcc	***	0.1	-	10	mS
Power supply off time	toff	***	1	-	-	mS

Reset Function - initialisation via internal reset circuit

The KS066 automatically initialises (resets) when power is supplied. The following instructions are executed in the initialisation. The busy flag (BF) is kept busy until initialisation ends. (BF=1) The busy state is 10ms after V_{DD} reaches 4.5V with respect to V_{SS}

1. Display clear
2. Function set: DL = 1 8 bit data interface
N = 0 1 line display
F = 0 5 * 8 character font
3. Display on/off control: D = 0 Display off
C = 0 Cursor off
B = 0 Blinking off
4. Entry mode set: I/D = 1 Increment by 1
S = 0 No shift

Reset Function - initialisation via instructions

The (BF) **must not** be checked in between sending the first three instruction below (function set)

8 Bit interface

Power On

Wait for >20ms after Vdd rises to 4.5v

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

Wait for >4.1ms

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

Wait for >100us

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	N	F	*	*
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	1
0	0	0	0	0	0	0	0	I/D	S

4 Bit interface

Power On

Wait for >20ms after Vdd rises to 4.5v

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

Wait for >4.1ms

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

Wait for >100us

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	0
0	0	0	0	1	0
0	0	N	F	*	*
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	1
0	0	0	0	0	0
0	0	0	1	I/D	S

Standard Character Font

Upper 4bit / Lower 4bit	LLLL	LLLH	LLHL	LLHH	LHLL	LHLH	LHHL	LHHH	HLLL	HLLH	HLHL	HLHH	HHLL	HHLH	HHHL	HHHH
LLLL	CG RAM (1)															
LLLH	(2)															
LLHL	(3)															
LLHH	(4)															
LHLL	(5)															
LHLH	(6)															
LHHL	(7)															
LHHH	(8)															
HLLL	(1)															
HLLH	(2)															
HLHL	(3)															
HLHH	(4)															
HHLL	(5)															
HHLH	(6)															
HHHL	(7)															
HHHH	(8)															

Handling Precautions

a) The display surface is covered with a polariser which is soft and easily damaged. Avoid touching, pressing or rubbing the display with hard objects (e.g. tweezers)

b) The display is made of glass. Avoid dropping or subjecting the module to strong mechanical shocks.

c) Applying pressure to the display surface or its periphery will cause it to change colour. Care must be exercised to keep the area free of unreasonable pressure.

d) Never use organic solvents to clear the display panel as these solvents may adversely affect the polariser. To clean the display panel and dampen a bit of absorbent cotton with Isopropyl alcohol and gently wipe the panel.

e) Avoid touching the PCB terminals / electrodes or LSI leads.

f) Avoid using the LCM under high temperature and high humidity conditions.

g) Never disassemble the module.

h) Anti static precautions must be taken, as the circuit of the module contains a CMOS LSI.

Operation Precautions

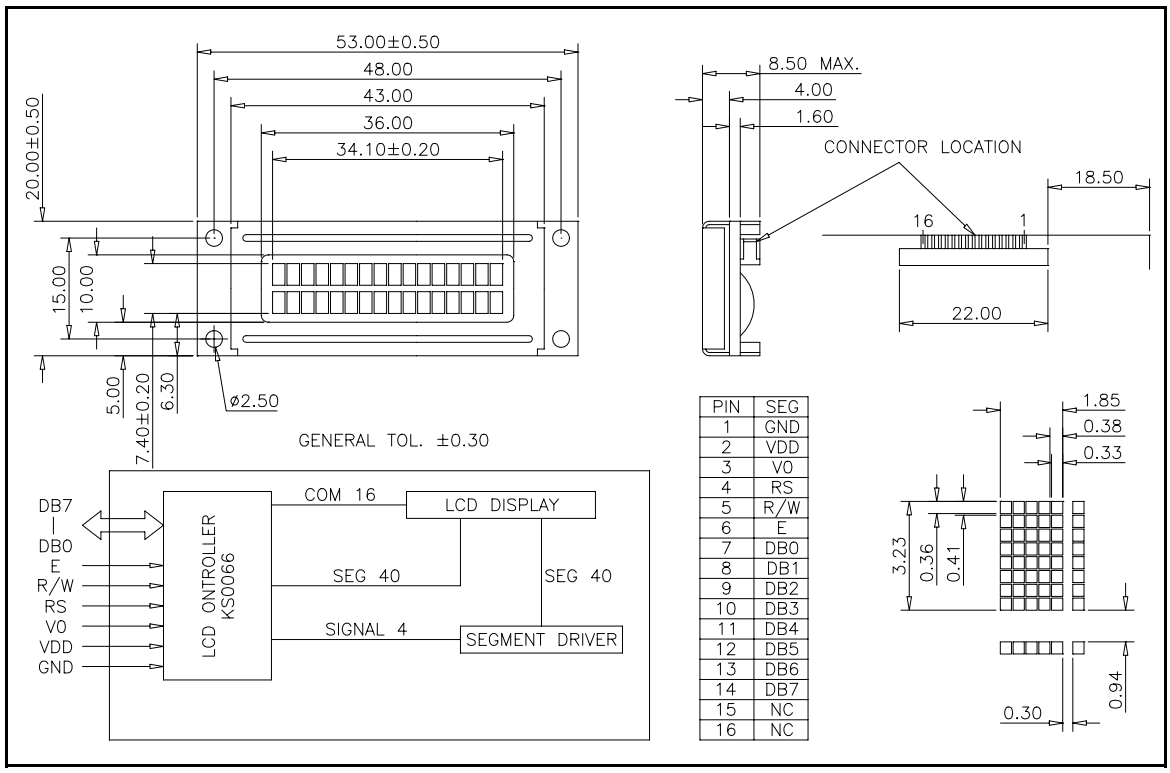
a) Never connect or disconnect the LCM from the main system while power is being supplied.

b) If the operating temperature drops below the temperature limits, the blinking speed of the display will decrease, while if it rises above the prescribed limits, the entire display will turn black. When the temperature returns to within normal limits, the display will operate normally.

Storage Precautions

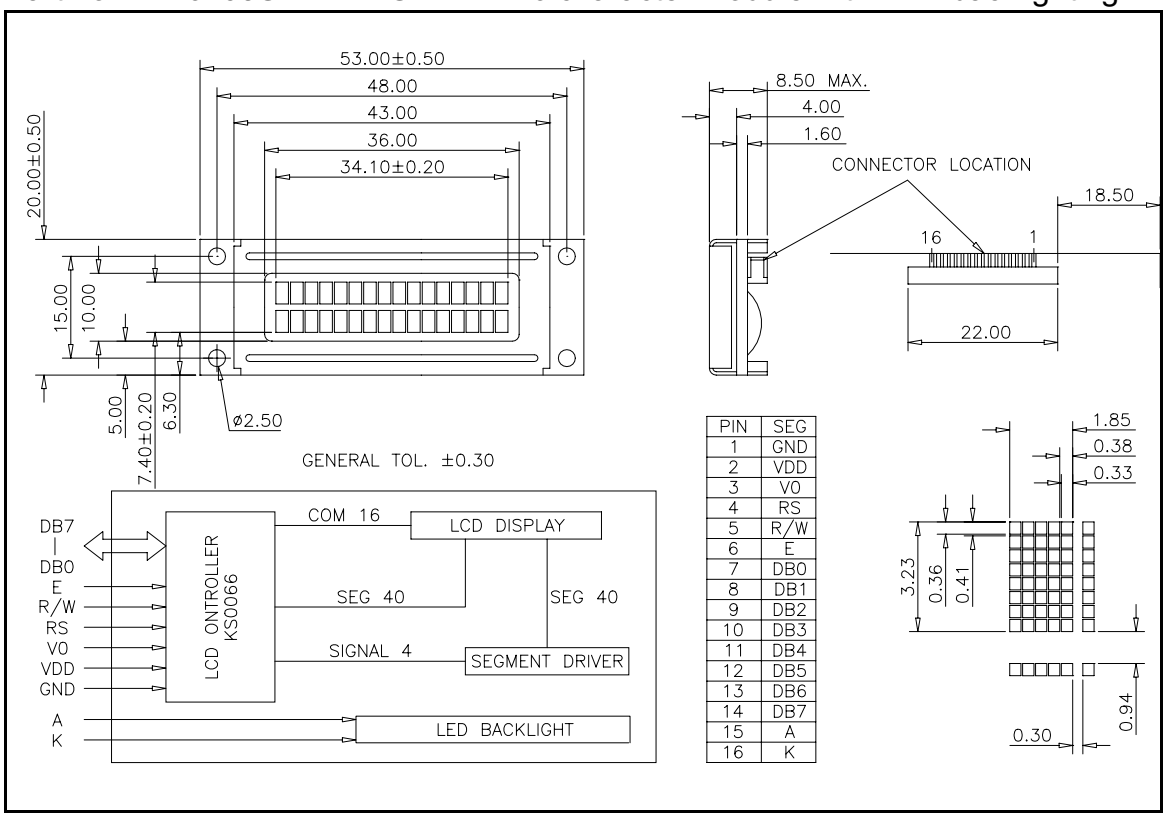
a) Store away from direct sunlight and flourescent light, and in a relatively low temperature area (avoid places of high temperature and high humidity or any place where the temperature is expected to drop below 0°C) after placing the LCD module in an electrostatic protection bag. Ideally, the module should be stored in the package provided by the supplier.

Part no. TH16203SRY STN 2 x 16 character module



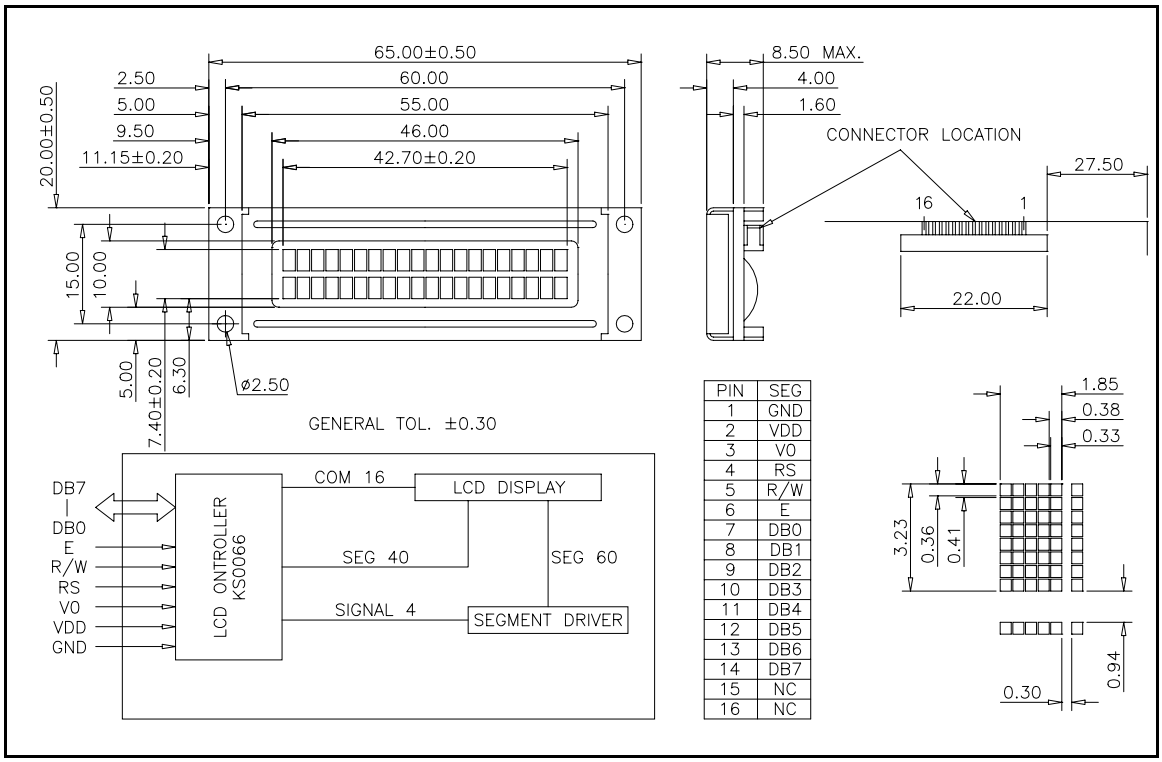
PIN	SEG
1	GND
2	VDD
3	V0
4	RS
5	R/W
6	E
7	DB0
8	DB1
9	DB2
10	DB3
11	DB4
12	DB5
13	DB6
14	DB7
15	NC
16	NC

Part no. TH16203STFY STN 2 x 16 character module with LED backlighting



PIN	SEG
1	GND
2	VDD
3	V0
4	RS
5	R/W
6	E
7	DB0
8	DB1
9	DB2
10	DB3
11	DB4
12	DB5
13	DB6
14	DB7
15	A
16	K

Part no. TH20203SRY STN 2 x 20 character module



Part no. TH20203STFY STN 2 x 20 character module with LED backlighting