ABOV SEMICONDUCTOR
6 SEGMENT X 7 GRID LED Driver with key scan and Voltage Detector

MC1002

Data Sheet (Ver. 1.0)

Version 1.0

Published by
FAE Team

REVISION HISTORY

VERSION 1.0(2010. 6.22)
The first Edition

DESCRIPTION

The MC1002 is specifically designed for LED and LED DISPLAY driver.
The MC1002 has max 9 segment output lines, max 7 grid output lines, one display memory, control circuit, 4 line serial data interface, and max 6 x 1 matrix key scan .
Those functions are all incorporated into a single chip to build a highly reliable peripheral device for a single chip microcomputer.
It is very convenient to control for numeric display.
MC1002's pin assignments and application circuit are optimized for easy PCB Layout and cost saving advantages.

FEATURES

- CMOS Technology
- Segment output line selection by command : 6 ~ 9 Segment
- Grid output line selection by command : 4~7 Grid
- Operation voltage : 2.7V ~ 5.5V
- Low Power Consumption
- 8-Step Dimming control by command
- Serial Interface for Clock, Data Input, Strobe Pins, Data output
- 20-pin TSSOP Package

- Embedded High-Precision Voltage Detector
- Detection voltage level 4.2V, 4.0V, 2.9V, 2.7V, 2.5V
- Dynamic Current (Display Turn OFF State) consumption 700uA typ
- High-precision detection voltage ± 5%
- Hysteresis characteristic 5% typ
- Output form Nch open-drain output (Active Low)

APPLICATION

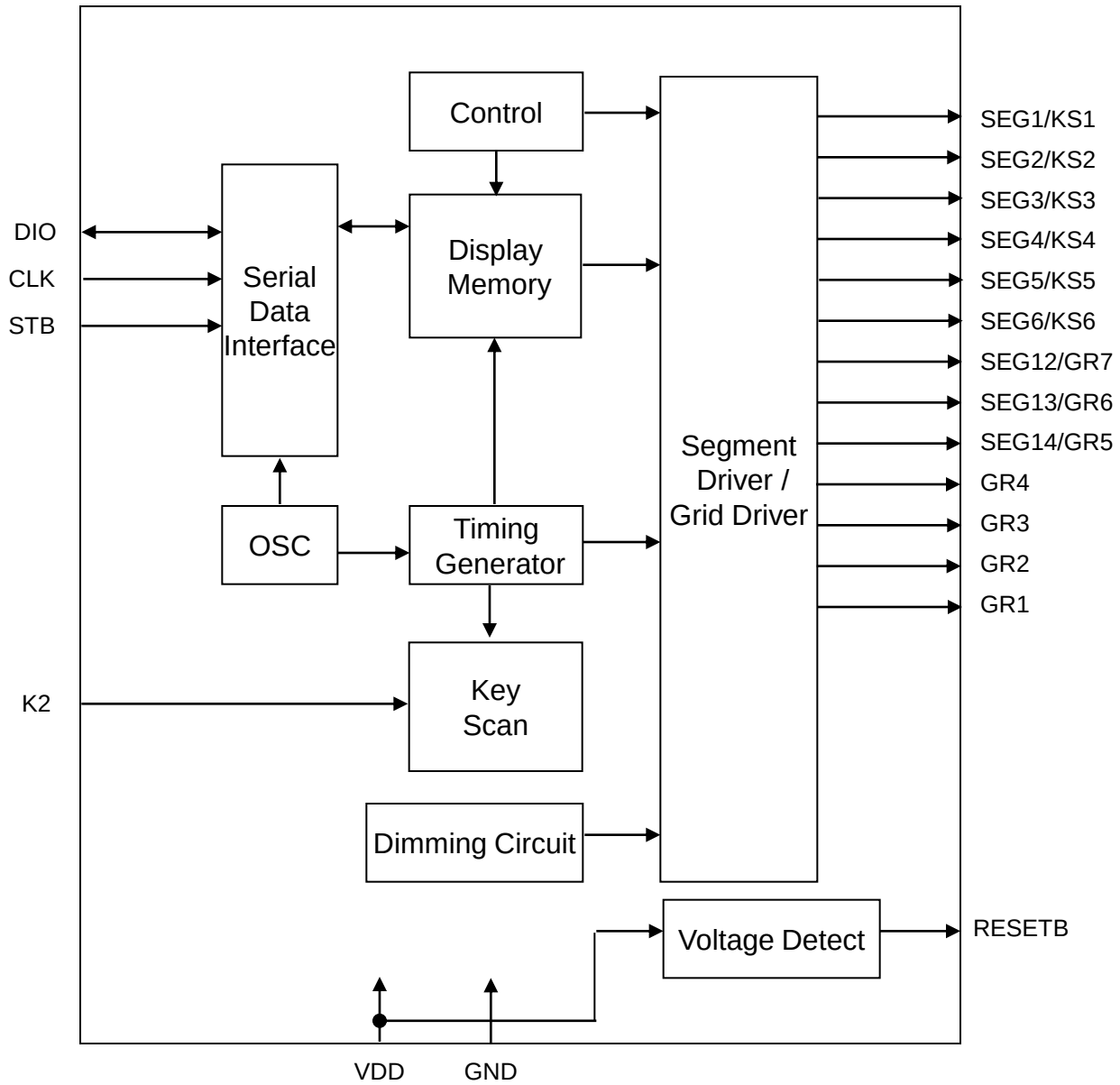
- Segment LED display : VCR, DVD, MWO

Device 명	Segment 수	Grid 수	Key Scanning	PKG TYPE
MC1002	6~9 Segment	4~7 Grid	6 X 1 Matrix	20pin, TSSOP

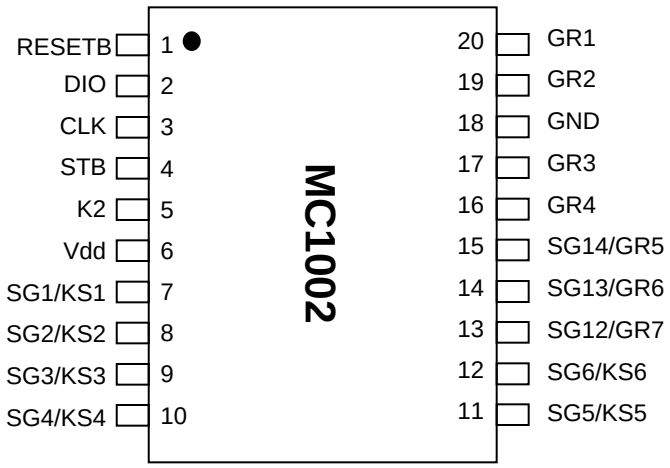
PIN DESCRIPTION

PIN NAME	I/O	DESCRIPTION	PIN No.
RESETB	O	Voltage detection output pin	1
DIO	I/O	Serial Data Input/output Pin (N-channel open drain) This pin outputs at CLK falling edge. This pin inputs serial data at the rising edge of CLK signal. LSB first input.	2
CLK	I	Serial clock input pin. Input data is trigger at rising edge. Output data is trigger at falling edge.	3
STB	I	When this pin is HIGH, CLK signal is ignored. The data input after the STB has fallen is processed as a command.	4
K2	I	Key scan input pins. This pin is readable during SEG1/KS1 to SEG10/KS10 pins. This pins have Pull down resistor internally.	5
VDD	-	Power Supply	6
SEG1/KS1 to SEG6/KS6	O	Segment output pins. (P-channel open drain) Also key scan source pins.	7 ~ 12
SEG12/GR7 to SEG14/GR5	O	Segment / Grid output pin.	13,14,15
GR4 to GR1	O	Grid output pin.	16,17,19, 20
GND	-	Ground pin.	18

BLOCK DIAGRAM

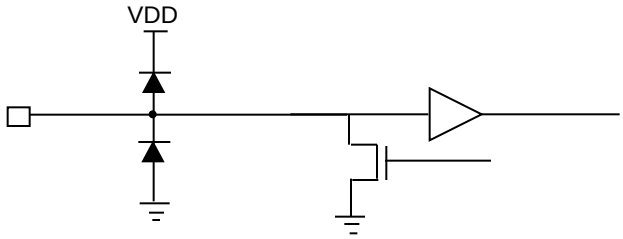


PIN CONFIGURATION

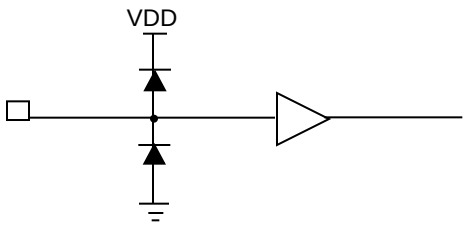


INPUT/OUTPUT PINS SCHEMATIC DIAGRAM

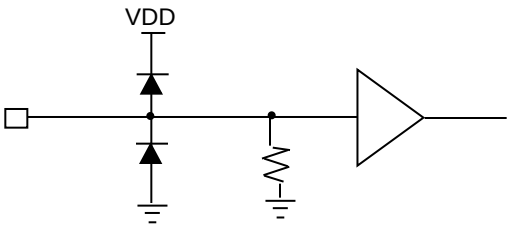
Input pins : DIO



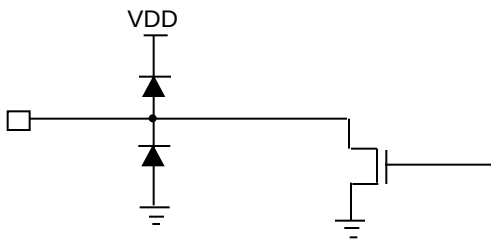
Input pins : CLK,STB



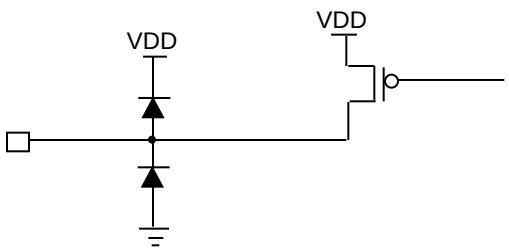
Input pins : K2



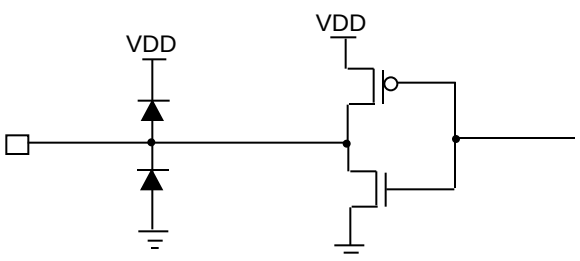
Output pins : GR1 to GR4, RESETB



Output pins : SEG1/KS1 to SEG6/KS6



Output pin : SEG12/GR7 to SEG14/GR5



ABSOLUTE MAXIMUM RATINGS

(Unless otherwise stated, Ta=25℃, GND=0V)

PARAMETER	SYMBOL	RATING	UNIT
Supply Voltage	VDD	-0.5 to +7.0	V
Logic Input Voltage	VI	-0.5 to VDD+0.5	V
Driver Output Current/Pin	IOLGR	+250	mA
	IOHSG	-50	mA
Maximum Driver Output Current/Total	ITOTAL	400	mA

RECOMMENDED OPERATING RANGE

(Ta= -40 to +85℃, GND=0V)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Logic Supply Voltage	VDD	2.7	5	5.5	V
Dynamic Current (see Note)	IDDdyn	-	-	5	mA
High-Level Input Voltage	VIH	0.8VDD	-	VDD	V
Low-Level Input Voltage	VIL	0	-	0.3 VDD	V

• Note : Test Condition : Set Display Control Commands = 80H (Display Turn OFF State)

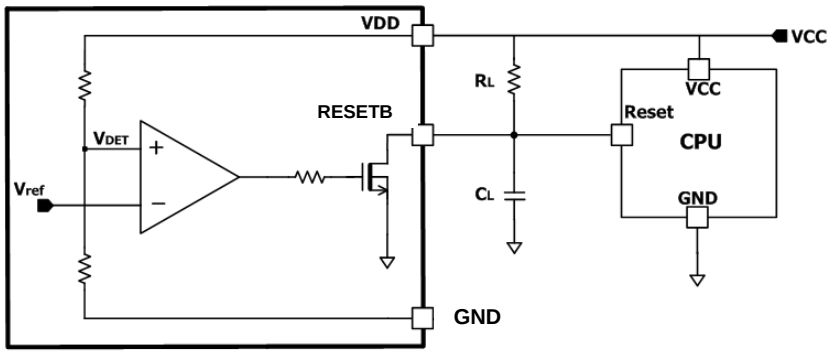
ELECTRICAL CHARACTERISTICS

V_{DD}=5V, GND=OV, Ta=25℃,

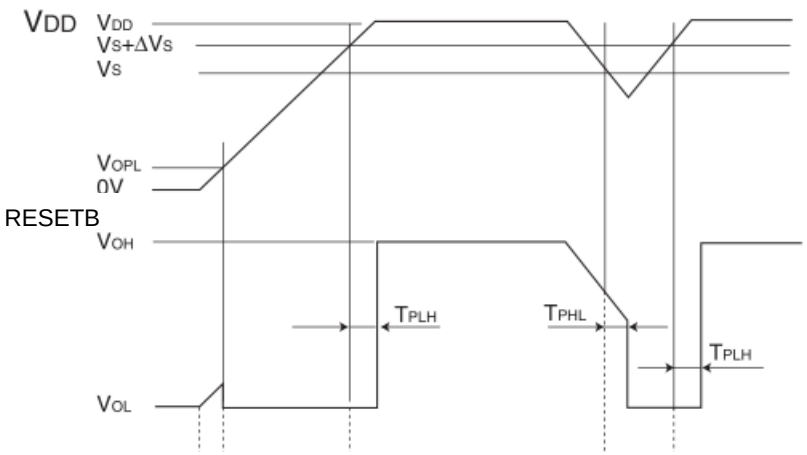
Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
High-Level Output Current	IOHSG1	$V_O = V_{DD}$ - 2V SEG1 to SEG6. SEG12/GR7 to SEG14/GR5	-20	-25	-40	mA
	IOHSG2	$V_O = V_{DD}$ - 3V SEG1 to SEG6. SEG12/GR7 to SEG14/GR5	-25	-30	-50	mA
Low-Level Output Current	IOLGR	V_O = 0.3V GR1 TO GR4 SEG12/GR7 TO SEG14/GR5	100	140	-	mA
Low-Level Output Current	IOLDOUT	V_O = 0.4V DOUT	4	-	-	mA
Segment High-Level Output Current Tolerance	ITOLSG	$V_O = V_{DD}$ - 3V SEG1 TO SEG6. SEG12/GR7 to SEG14/GR5	-	-	±5	%
High-Level Input Voltage	VIH	-	0.8VDD	-	VDD	V
Low-Level Input Voltage	VIL	-	0	-	0.2VDD	V
Oscillation Frequency	fOSC	-	350	460	650	kHz
K2 Pull Down Resisto	KSR	VDD=5V	40	-	100	kΩ

Voltage Detector

Block diagram



Timing Waveform



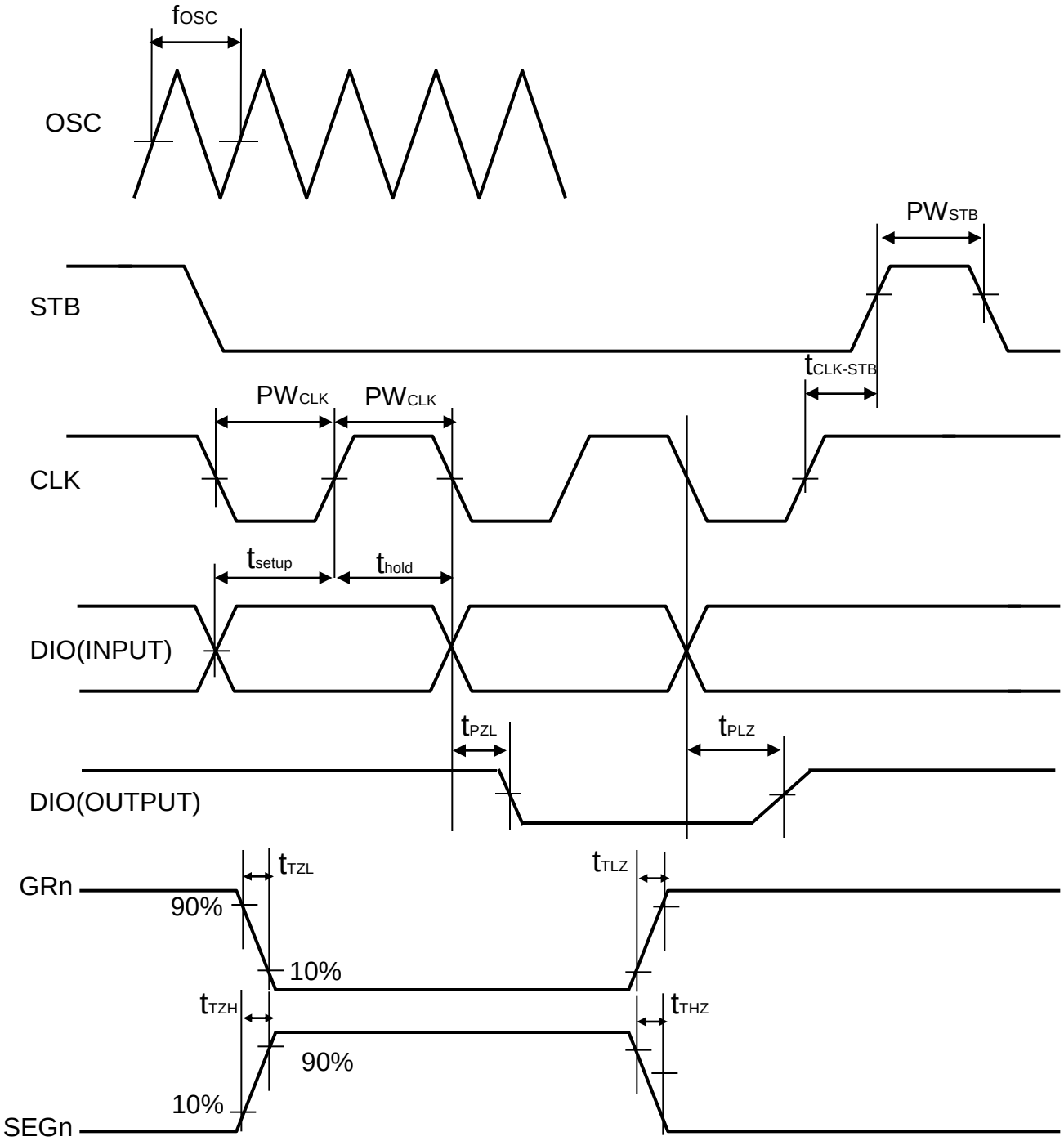
Electrical Characteristics

(T_A : -40°C to +85°C)

Parameter		Symbol	MIN	TYP	MAX	Unit	Condition
Operating Voltage		V_{DD}	1.3	-	5.5	V	
Detecttion Voltage	MC1002X42	V_S	V_S x 0.95	4.2	V_S x 1.05	V	T_A = -40°C~85°C
	MC1002X40			4.0			
	MC1002X29			2.9			
	MC1002X27			2.7			
	MC1002X25			2.5			
Hysteresis Voltage		ΔV_S	ΔV_S x 0.03	ΔV_S x 0.05	ΔV_S x 0.08	V	RL=100KΩ VDD=L->H->L
"H" transfer delay time		TPLH	-	-	100	µs	CL=100pF, RL=100kΩ RESETB=GND->0.5VDD
"L" transfer delay time		TPHL	-	-	100	µs	CL=100pF, RL=100kΩ RESETB=VDD->0.5VDD
Output Current		IOL	2.88	5	-	mA	VDD=2.4V, VDS=0.5V

SWITCHING CHARACTERISTIC WAVEFORM

MC1002 Switching Characteristics Waveform is given below.

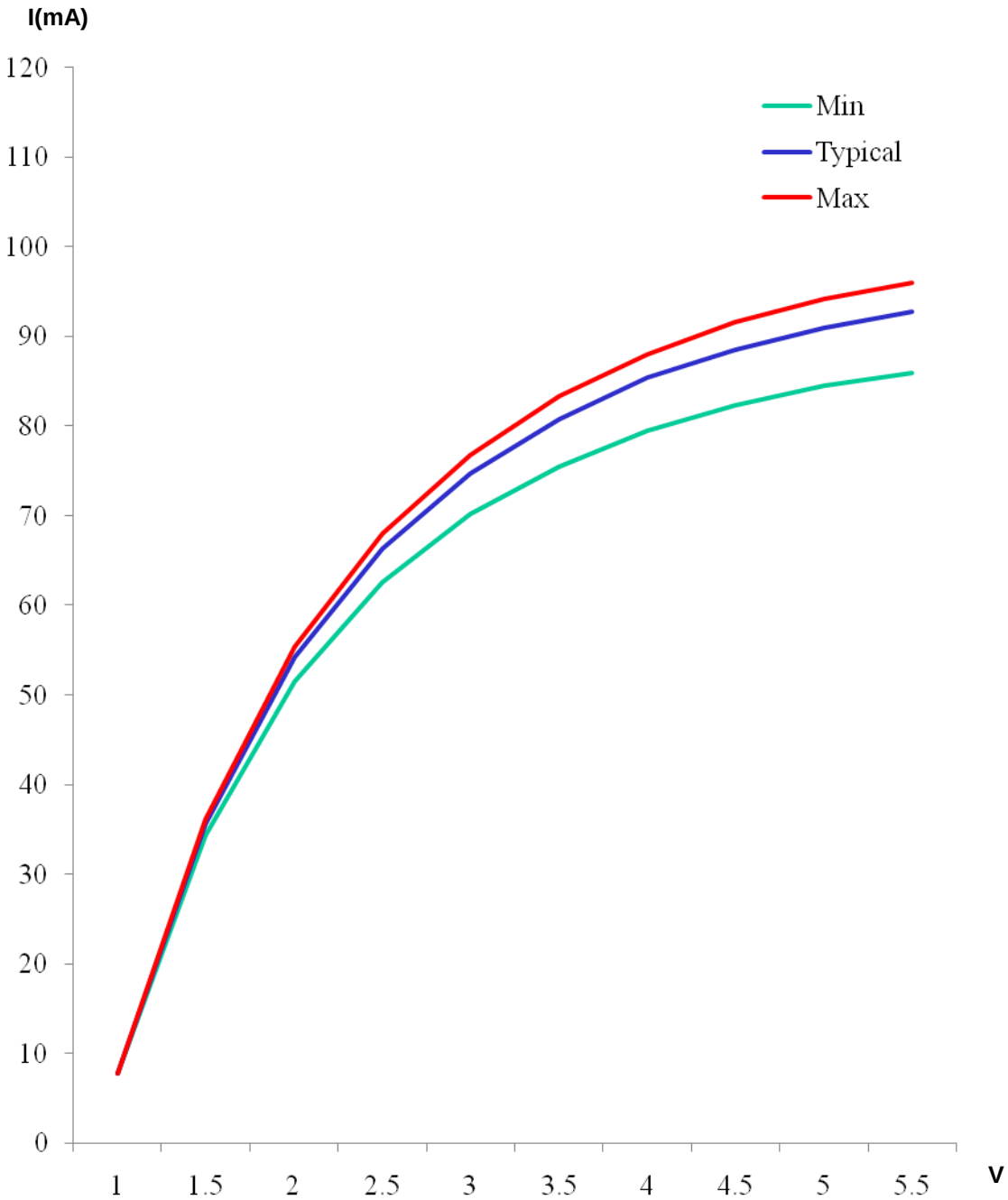


PW $_{CLK}$ (Clock Pulse Width) ≥400ns
t setup (Data Setup Time) ≥ 100ns
t $_{CLK-STB}$ (Clock - Strobe Time) ≥ 1㎲
t $_{TZH}$ (Rise Time) ≤ 1㎲
t $_{TZL}$ <1㎲

PW$_{STB}$ (Strobe Pulse Width) ≥ 1㎲
thold (Data Hold Time) ≥ 100ns
t $_{THZ}$ (Fall Time) ≤ 10㎲
fosc = Oscillation Frequency
t $_{TIZ}$ <10㎲
t $_{PZL}$ (Propagation Delay Time) ≤ 100ns
t $_{PLZ}$ (Propagation Delay Time) ≤ 300ns

SEG PIN Resistance

MC1002 SEG pins Resistor Characteristics is given below.



FUNCTIONAL DESCRIPTION

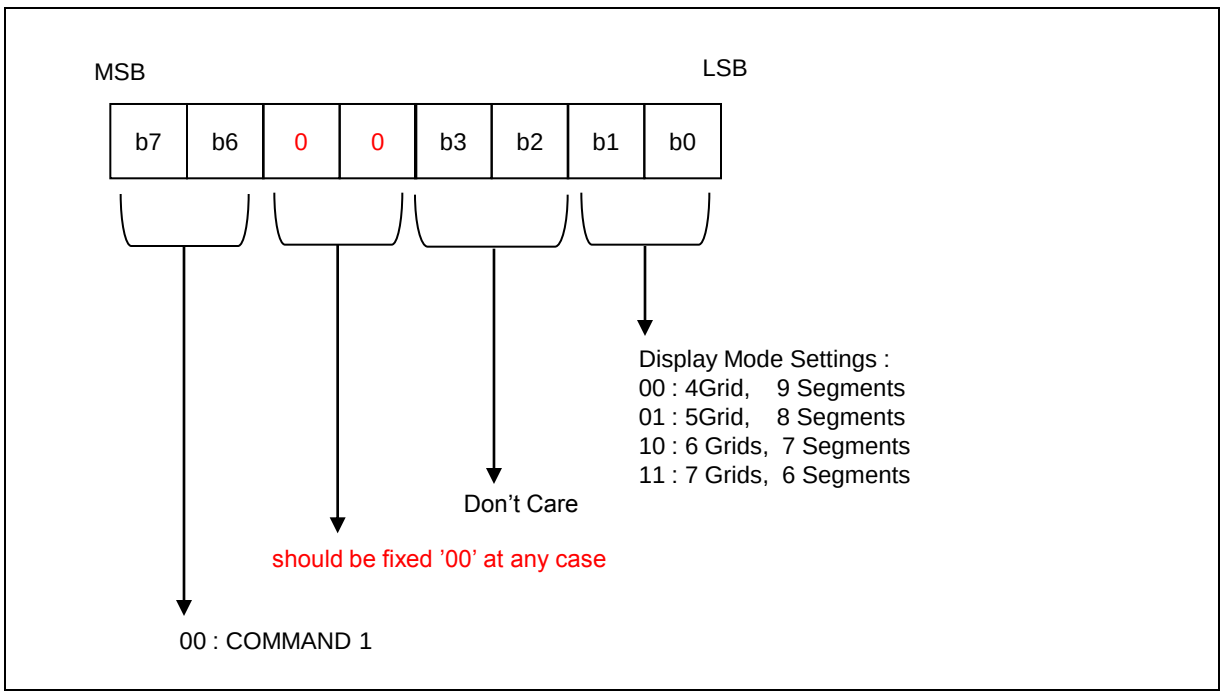
COMMANDS

The MC1002 has 4 kind of commands. The first command is display setting commands, the second command is data setting command. The third command is address setting command and the fourth command is display control command.

COMMAND 1 : DISPLAY MODE SETTING COMMAND

The Display mode setting command has 2bit (b1,b0) for display mode setting and 2bit (b7,b6) for commands. And 2bits(b5 ~ b4) should be fixed '00' at any case.. The 2bits (b3 ~ b2) are don't care bit. The command bits (b7,b6) are "0","0" for COMMAND1.

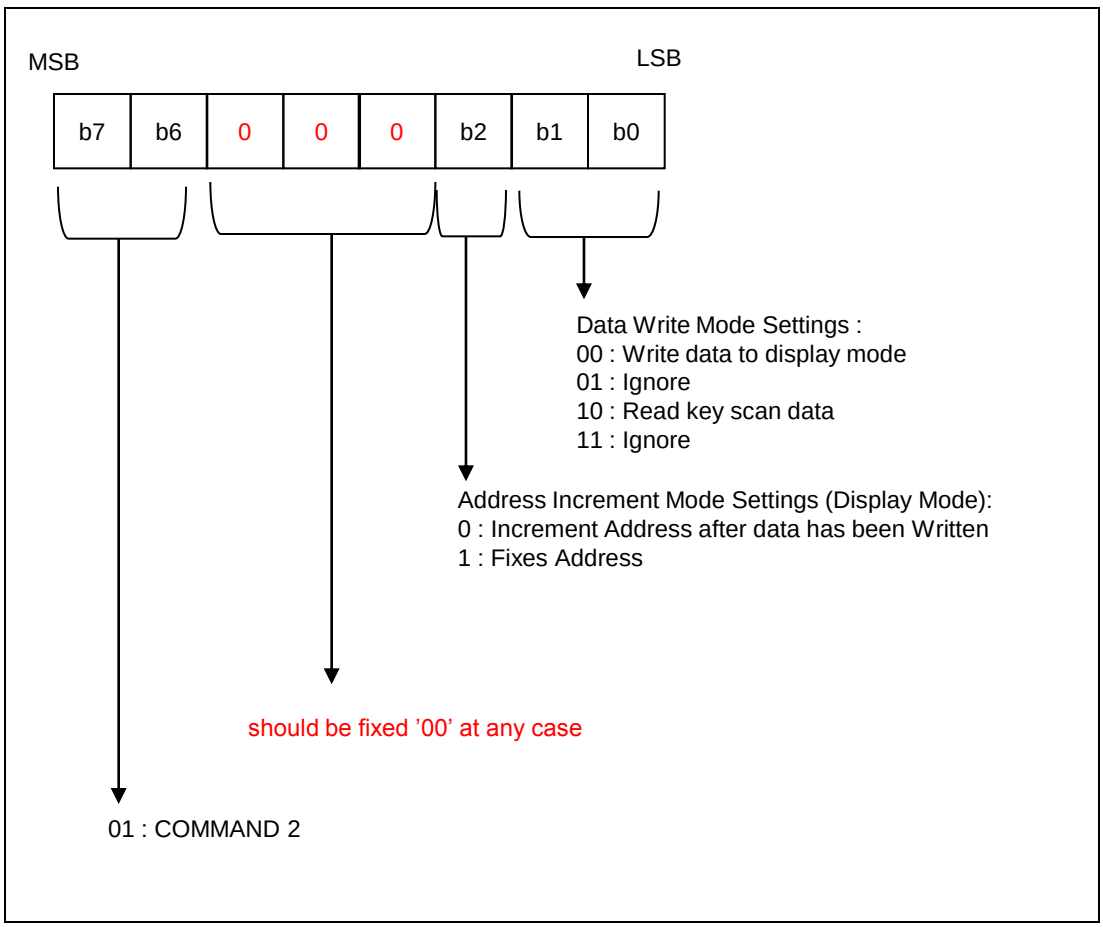
The display mode setting command determines the number of segments and grids. This command should be executed for display off. And the default of b1,b0 are "1","1" for power on. This status is selected 7 grids, 6 segments and key scan enable. If b1,b0 are "1","0" then 6 grids 7 segments and key scan enable selected. If b1,b0 are "0","1" then 5 grid 8 segments and key scan enable selected. If b1, b0 are "0","0" then 4 grids 9 segments and key scan enable selected.



COMMAND 2 : DATA SETTING COMMAND

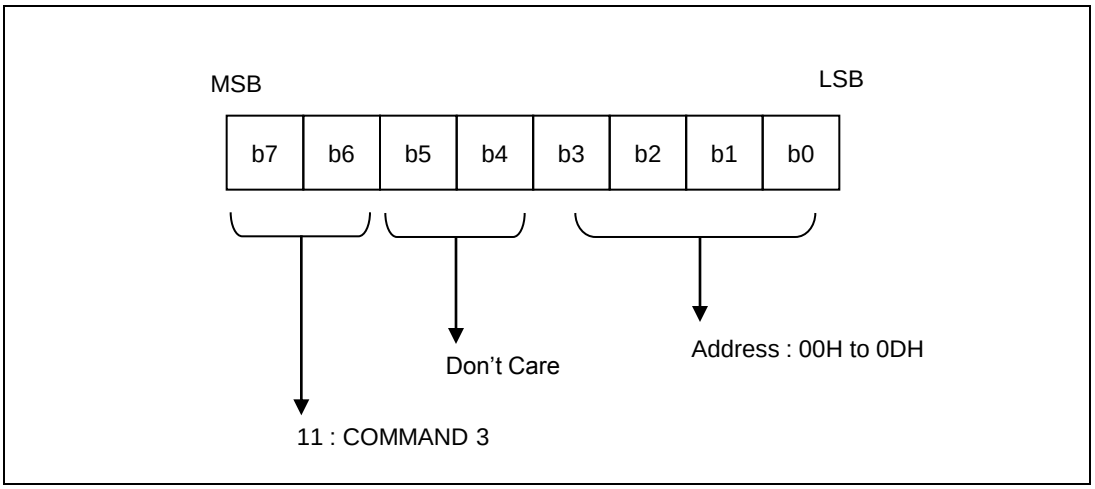
The data setting command consists of data write mode setting, address increment mode setting and mode setting . And the default of b3 to b0 are all “0” for power on.

The Data write mode settings have 2bit (b1,b0) for writing data to display mode and read key scan data.
Address increment mode setting has 1bit (b2) for selecting address Increment or fixed.
And 2bits(b5 ~ b3) should be fixed ’000’ at any case.
The command bits (b7,b6) are “0”,”1” for COMMAND2.



COMMAND 3 : ADDRESS SETTING COMMAND

The display memory is addressed by Address Setting Command. The valid address range is "00H" to 0DH". If the address is set to 0EH to 0FH, the data is ignored until a valid address is set. When power is turned ON, the address is set at "00H".



Display Mode and RAM Address

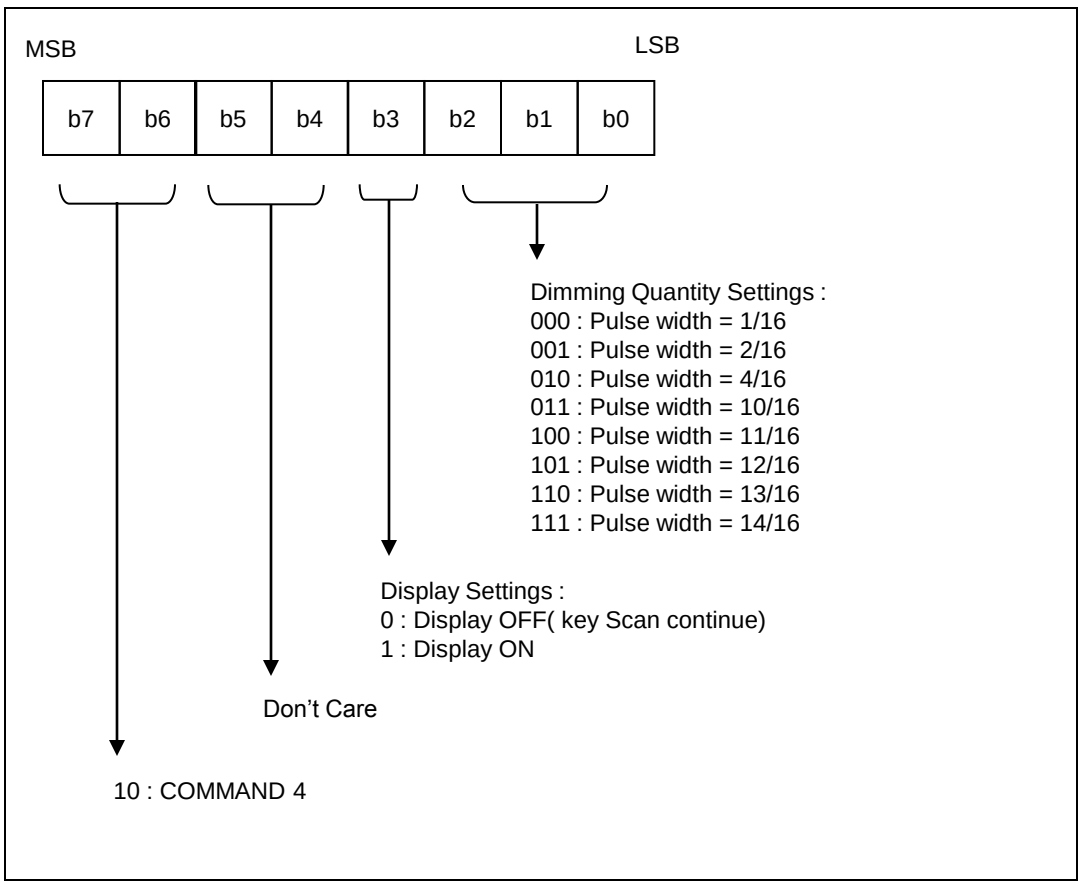
Data transmitted from an external device to MC1002 via the serial interface are stored in the Display RAM and are assigned addresses. The RAM Addresses of MC1002 are given below in 8 bit unit.

SEG1 SEG4	SEG5 SEG8	SEG9 SEG14	
$00H_L$	$00H_U$	$01H_m$	DIG1
$02H_L$	$02H_U$	$03H_m$	DIG2
$04H_L$	$04H_U$	$05H_m$	DIG3
$06H_L$	$06H_U$	$07H_m$	DIG4
$08H_L$	$08H_U$	$09H_m$	DIG5
$0AH_L$	$0AH_U$	$0BH_m$	DIG6
$0CH_L$	$0CH_U$	$0DH_m$	DIG7

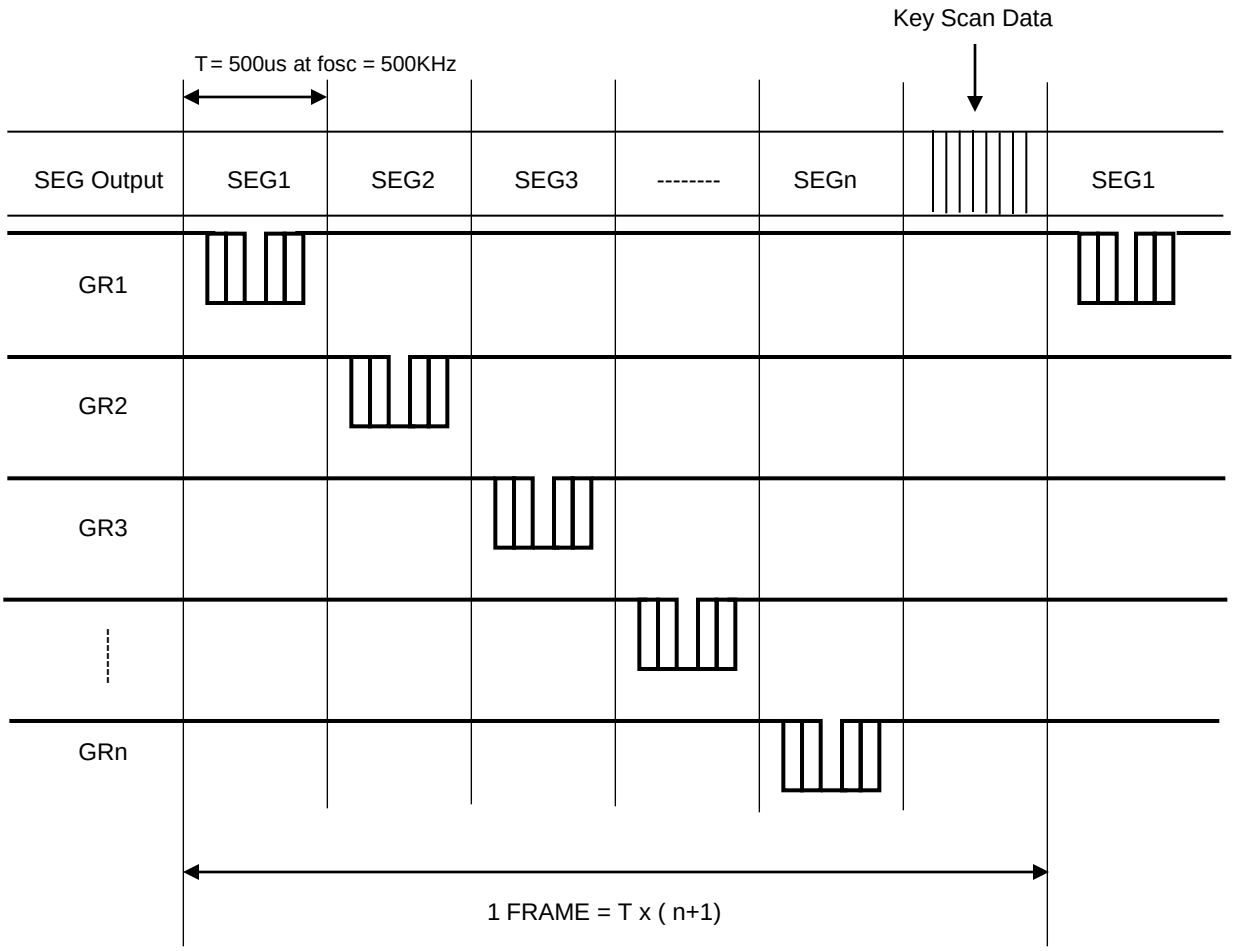
b0 b3	b4 b7	b0 b5
xxH_L	xxH_U	xxH_m
Lower 4 bits	Higher 4 bits	Lower 6bits

COMMAND 4 : DISPLAY CONTROL COMMANDS

The Display Control Commands are used to turn ON or OFF a display. It is also used to set the pulse width. Please refer to the diagram below. When the power is turned ON, a 1/16 pulse width is selected and the display is turned OFF.



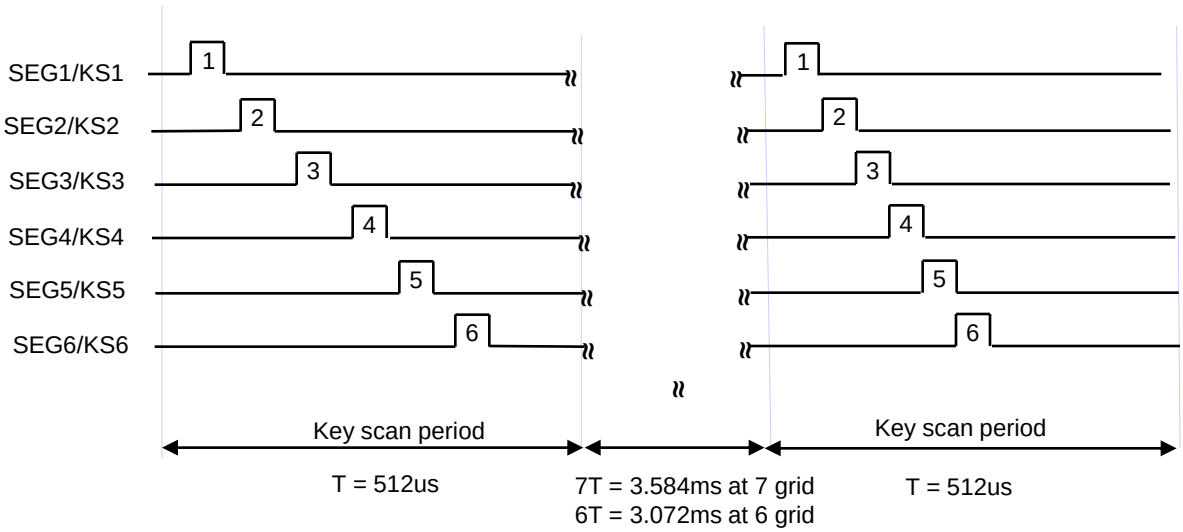
DISPLAY TIMING WAVEFORM



KEY SCAN

1) Key Scan Timing

The key scan period is 512us at oscillator=500Khz.
Pulse width : 32us, Non overlap : 8us



2) Key scan operation

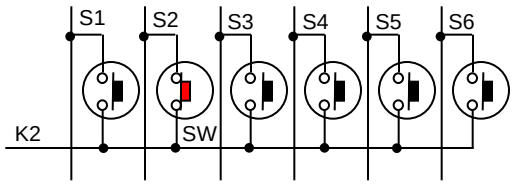
- The key scan is operated always.
- Multiple key presses are recognized by determining whether multiple key data bits are set.

3) Key scan data read sequence

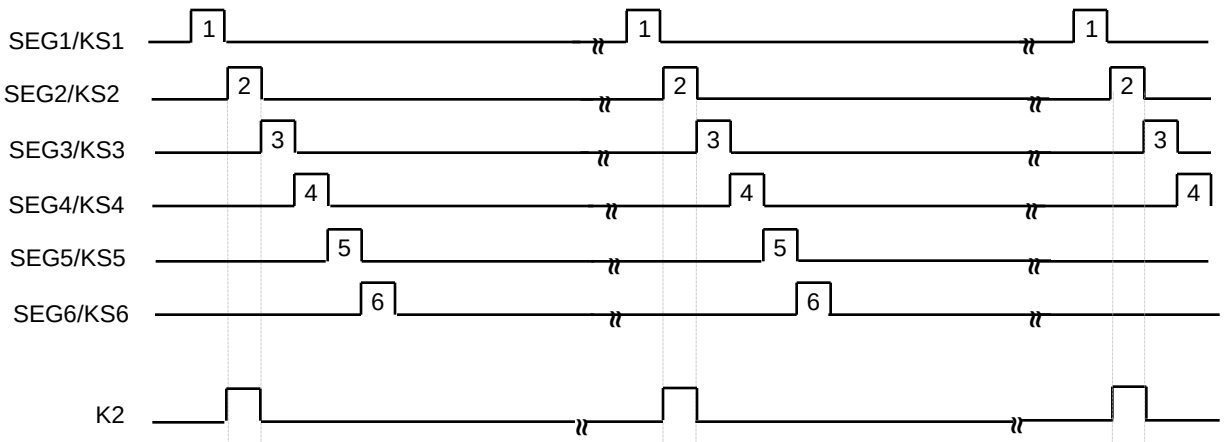
-	K2	-	-	K2	-	-	-	
0	SEG1/KS1	0	0	SEG2/KS2	0	0	0	1'st byte read
0	SEG3/KS3	0	0	SEG4/KS4	0	0	0	2'nd byte read
0	SEG5/KS5	0	0	SEG6/KS6	0	0	0	3'rd byte read
b0	b1	b2	b3	b4	b5	b6	b7	

Key press = "1", Key no press = "0" read.

4) Key Scan Example



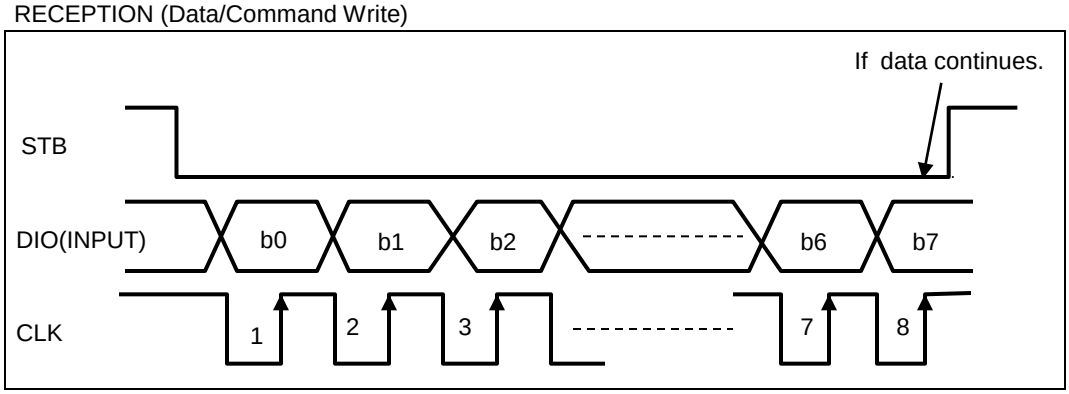
If SW switch is pressed, the K2 of key input pin is high by S2 at key scan timing.
So the K2 pin input is high.



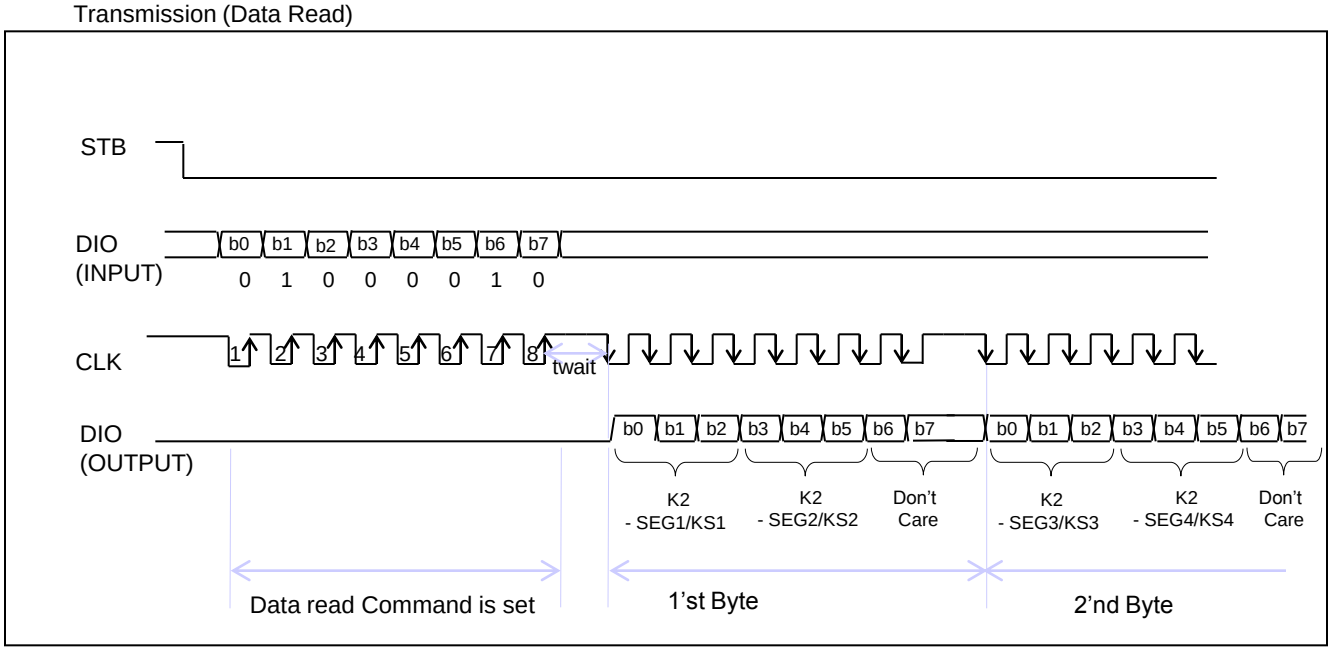
SERIAL COMMUMICATION FORMAT

The following diagram shows the MC1002 serial communication format.

RECEPTION (Data/Command Write)



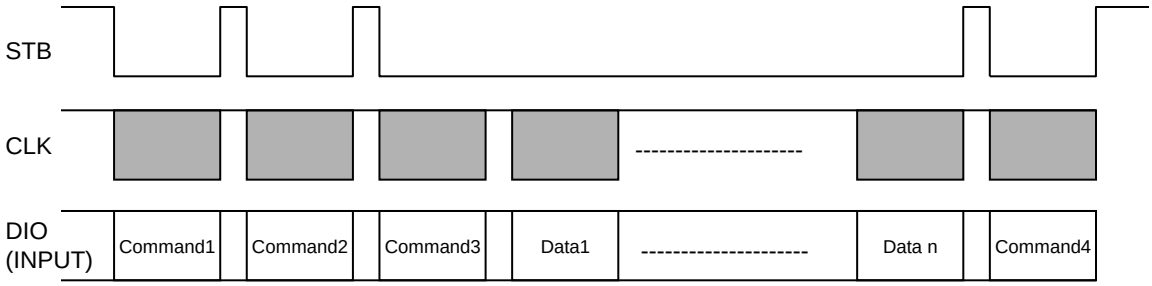
Transmission (Data Read)



Twait (waiting Time) ≥ 1㎲

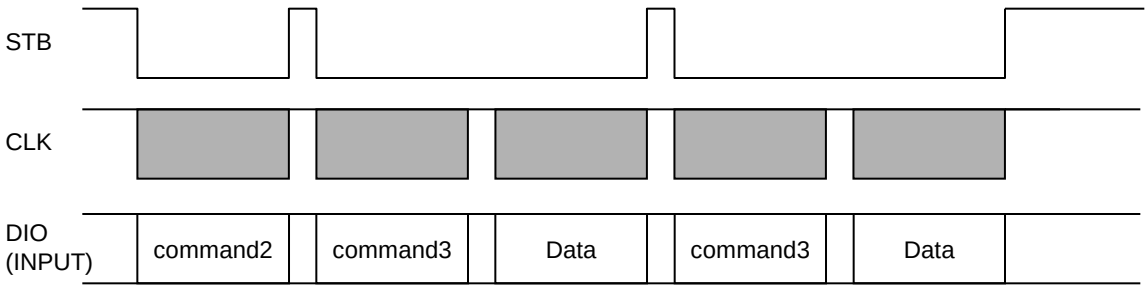
SERIAL COMMUNICATION EXAMPLES

Serial communication timing diagram for initialization setting.



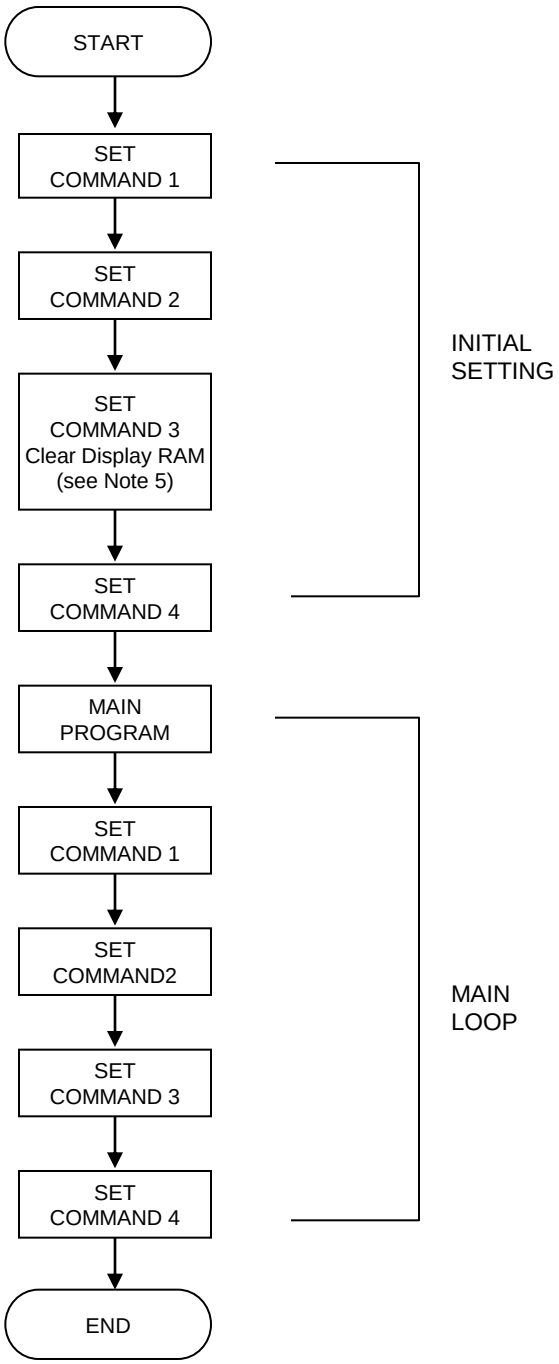
Where : Command 1 : Display Mode Setting
Command 2 : Data Setting Command
Command 3 : Address Setting Command
Data 1 to n : Transfer Display Data (14 Bytes max.)
Command 4 : Display Control Command

Memory updating timing diagram.



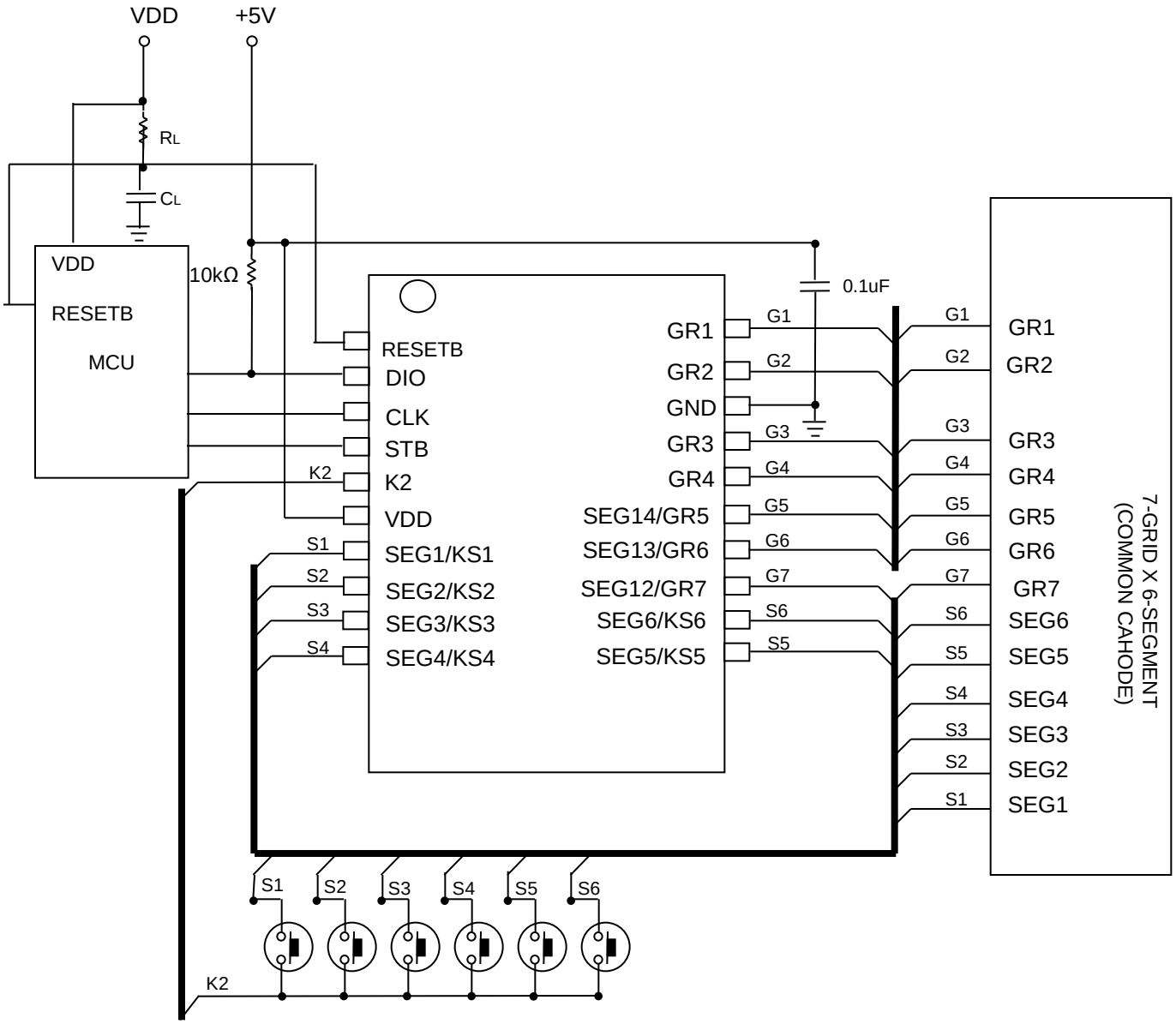
Where : Command 2 -- Data Setting Command
Command 3 -- Address Setting Command
Data -- Display Data

RECOMMENDED SOFTWARE PROGRAMMING FLOW CHART

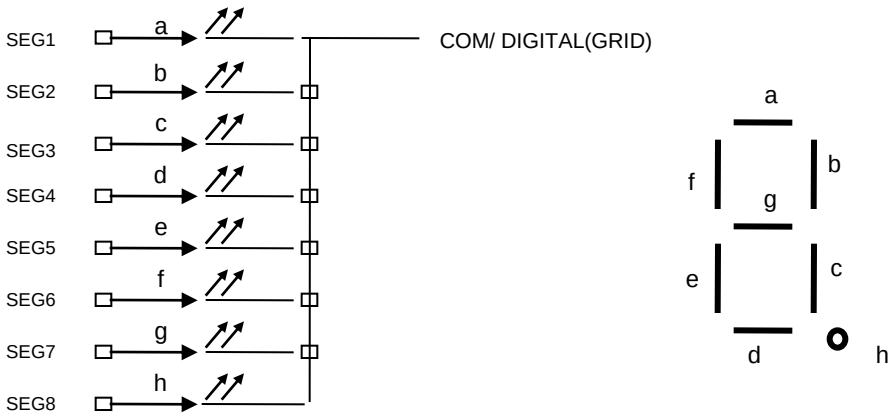


- Note : 1. Command 1 : Display Mode Setting
  2. Command 2 : Data Setting Commands
  3. Command 3 : Address Setting Commands
  4. Command 4 : Display Control Commands
  5. When IC power is applied for the first time, the contents of the Display RAM are not defined : thus, it is strongly suggested that the contents of the Display RAM must be cleared during the initial setting.

TYPICAL APPLICATION CIRCUIT

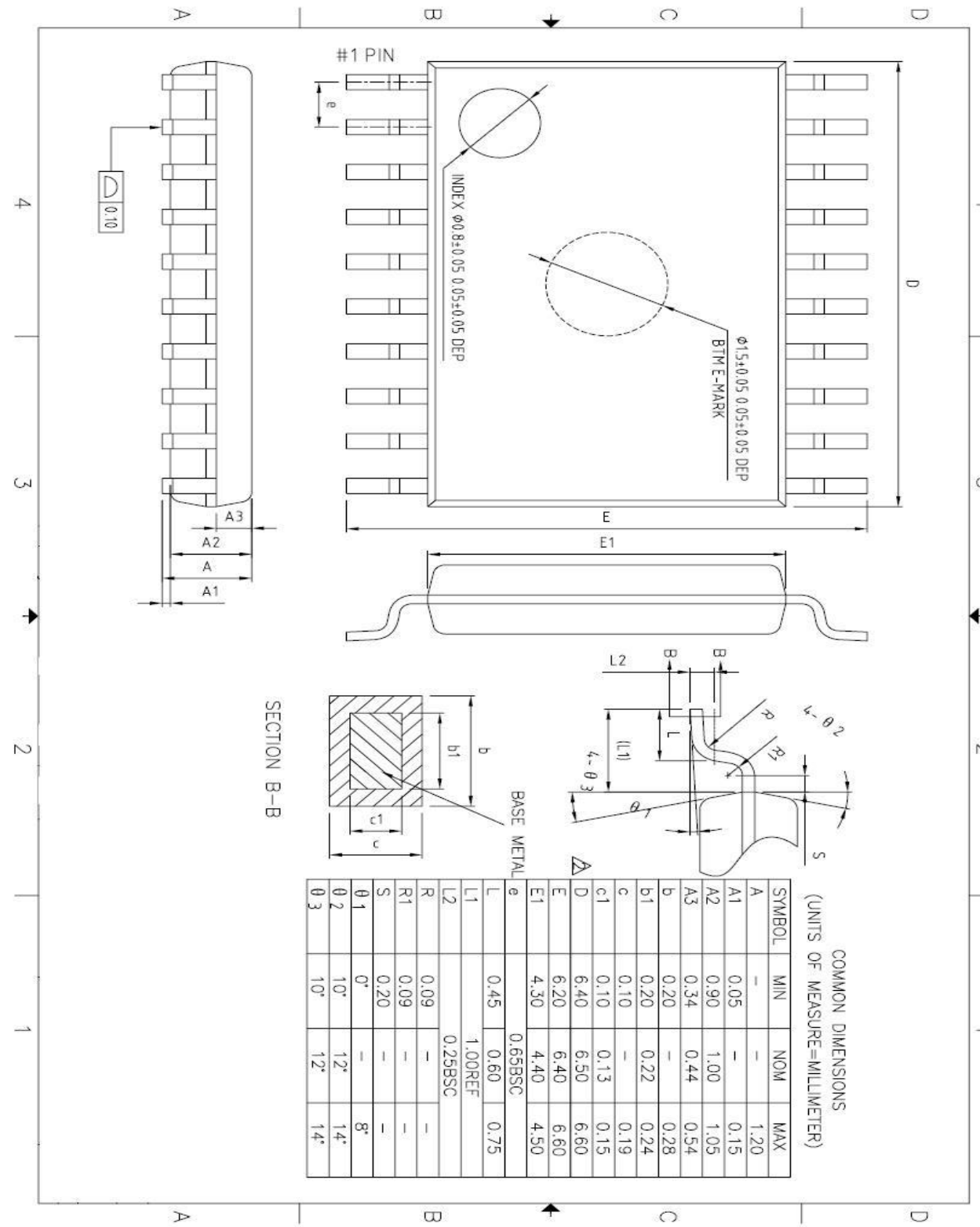


LED PANEL FOR CATHODE TYPE



PACKAGE INFORMATION

TSSOP 20



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	–	–	1.20
A1	0.05	–	0.15
A2	0.90	1.00	1.05
A3	0.34	0.44	0.54
b	0.20	–	0.28
b1	0.20	0.22	0.24
c	0.10	–	0.19
c1	0.10	0.13	0.15
D	6.40	6.50	6.60
E	6.20	6.40	6.60
E1	4.30	4.40	4.50
e		0.65BSC	
L	0.45	0.60	0.75
L1		1.00REF	
L2		0.25BSC	
R	0.09	–	–
R1	0.09	–	–
S	0.20	–	–
θ1	0°	–	8°
θ2	10°	12°	14°
θ3	10°	12°	14°