

ABOV SEMICONDUCTOR  
8 SEGMENT X 5 GRID LED DRIVER WITH KEYSKAN

# MC2003

*Data Sheet (Ver. 1.20)*

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**Version 1.20**

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FAE Team

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# REVISION HISTORY

**VERSION 1.20 (2010. 01. 07)**

Modified the Operating Temperature on page 9.

**VERSION 1.10 (2009. 04. 20) This Book.**

Modified the Dout of Transmission (Data Read) FORMAT.

Modified the Key scan data read sequence.

**VERSION 1.00 (2008. 12. 15)**

The first Edition

## DESCRIPTION

The MC2003 is specifically designed for LED and LED DISPLAY driver.

The MC2003 has max 9 segment output lines, max 5 grid output lines, one display memory, control circuit, 4 line serial data interface, and max 8 x 2 matrix key scan .

The more detail spec is listed below as Table 1.1.

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.

MC2003'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 : 10 ~ 13
- Grid output line selection by command : 4~7
- 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 SOP Package

## APPLICATION

- Segment LED display : VCR, DVD, MWO

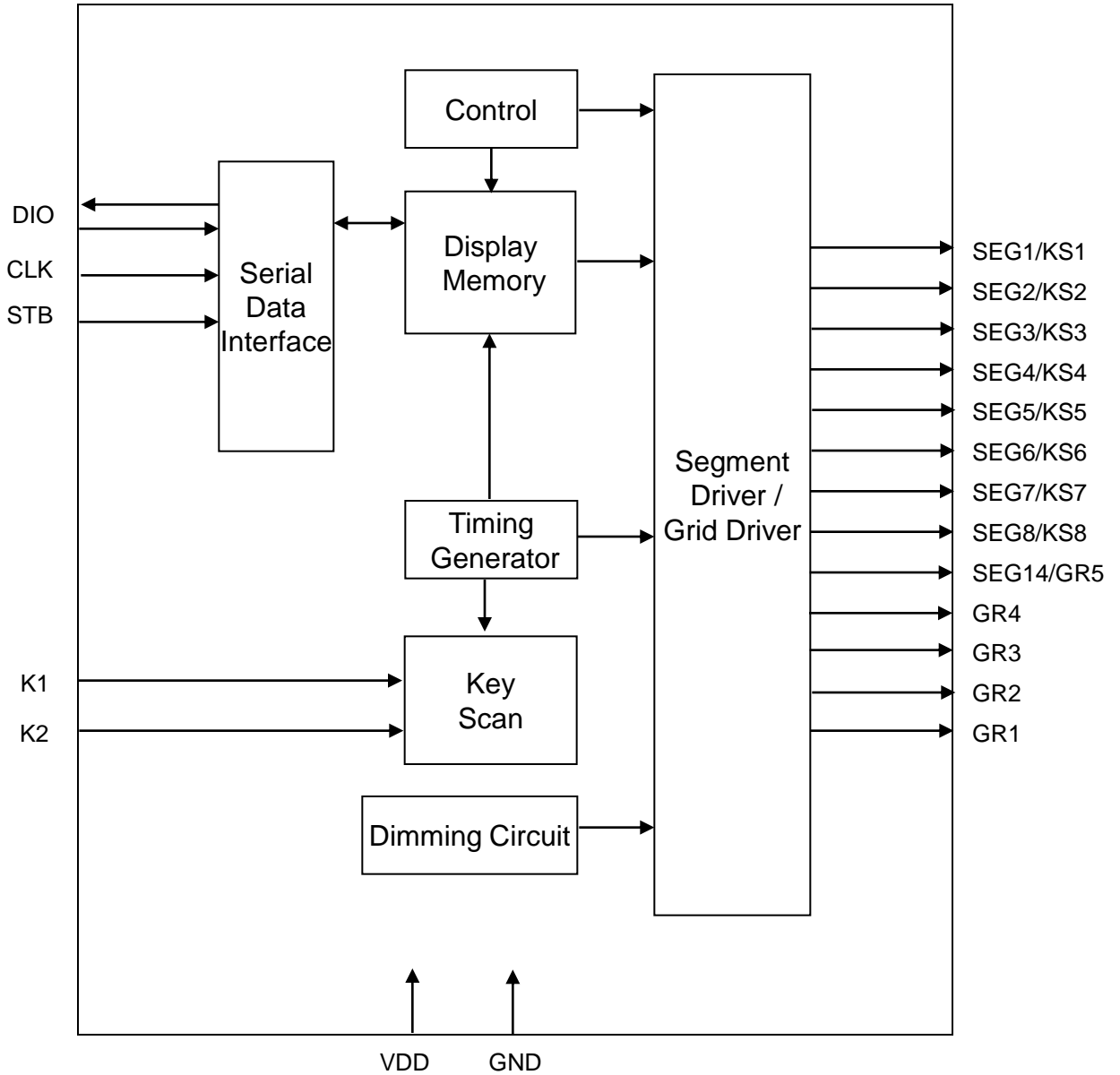
Device 명	Segment 수	Grid 수	Key Scanning	PKG TYPE
MC2003	8~9 Segment	4~5 Grid	8 X 2 Matrix	20pin, SOP

(Table 1.1)

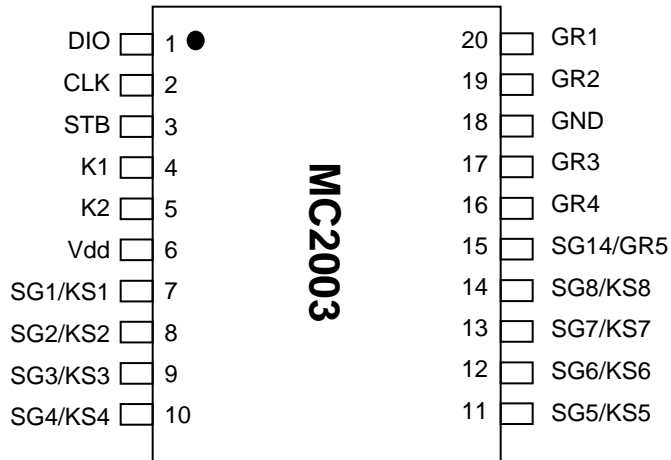
## PIN DESCRIPTION

PIN NAME	I/O	DESCRIPTION	PIN No.
DIO	I/O	Serial Data Input / Output Pin This pin outputs at CLK falling edge. This pin inputs serial data at the rising edge of CLK signal.	1
CLK	I	Serial clock input pin. Input data is trigger at rising edge. Output data is trigger at falling edge.	2
STB	I	When this pin is HIGH, CLK signal is ignored. The data input after the STB has fallen is processed as a command.	3
K1,K2	I	Key scan input pins. This pins are operated with SEG1/KS1 to SEG10/KS10 pins. This pins have Pull down resistor internally.	4,5
VDD	-	Power Supply	6
SEG1/KS1 to SEG8/KS8	O	Segment output pins. ( P-channel open drain) Also key scan source pins.	7~14
SEG14/GR5	O	Segment / Grid output pin.	15
GR4 to GR1	O	Grid output pin.	16,17 19,20
GND	-	Ground pin.	18

# BLOCK DIAGRAM

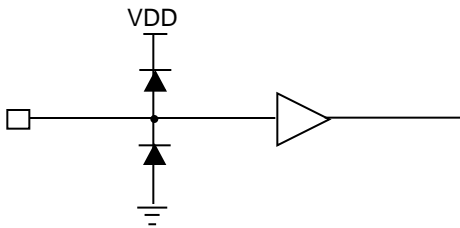


## PIN CONFIGURATION

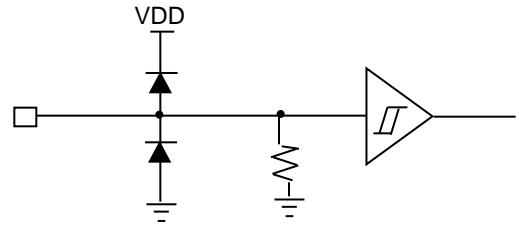


## INPUT/OUTPUT PINS SCHEMATIC DIAGRAM

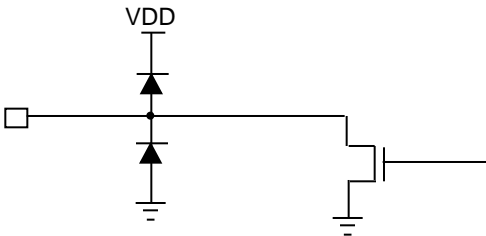
Input pins : CLK,STB



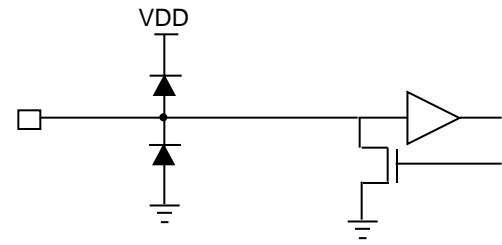
Input pins : K1,K2



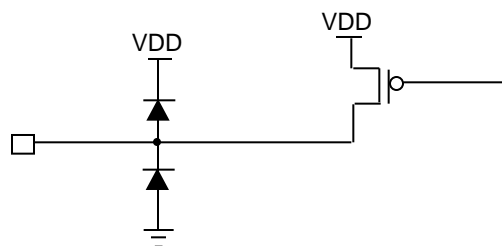
Output pins : GR1 to GR4



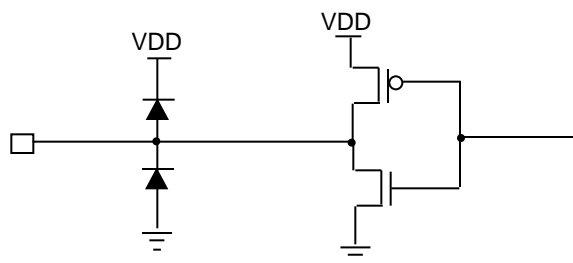
Input / Output pins : DIO



Output pins : SEG1/KS1 to SEG8/KS8



Output pin : SEG14/GR5





## ABSOLUTE MAXIMUM RATINGS

(Ta=25°C, 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°C, 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	0.6VDD	-	VDD	V
Low-Level Input Voltage	VIL	0	-	0.4 VDD	V

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

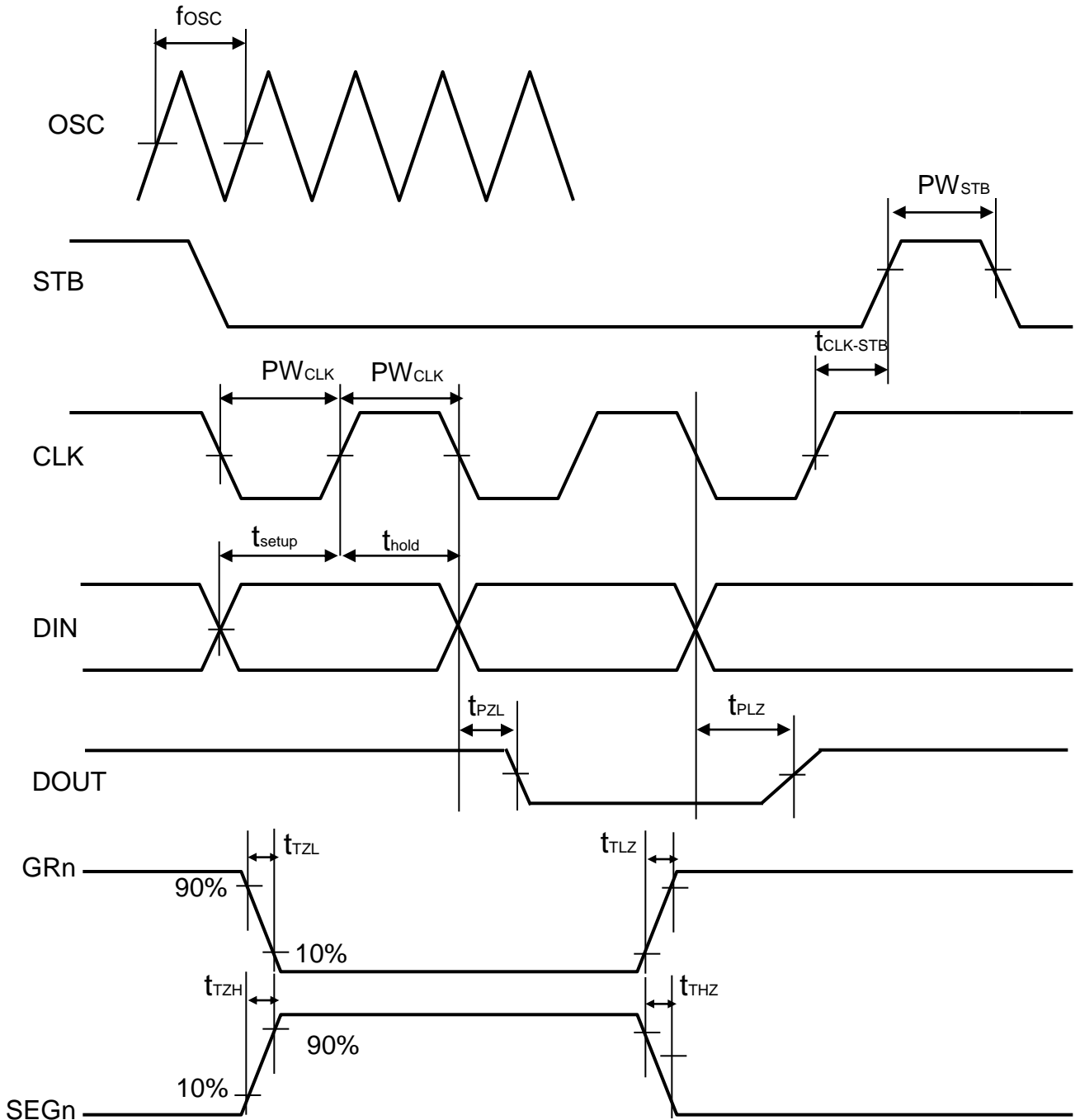
## ELECTRICAL CHARACTERISTICS

(VDD=5V, GND=0V, Ta=25°C)

PARAMETER	SYMBOL	Test Condition	Min.	TYP.	MAX.	UNIT
High-Level Output Current	IOHSG1	$V_O = V_{DD} - 2V$ SEG1 to SEG11. SEG12/GR7 to SEG14/GR5	-20	-25	-40	mA
	IOHSG2	$V_O = V_{DD} - 3V$ SEG1 to SEG11. 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	IOLDOU T	$V_O = 0.4V$ DOUT	4	-	-	mA
Segment High-Level Output Current Tolerance	ITOLSG	$V_O = V_{DD} - 3V$ SEG1 TO SEG11. SEG12/GR7 to SEG14/GR5	-	-	±5	%
High-Level Input Voltage	VIH	-	0.6VDD	-	VDD	V
Low-Level Input Voltage	VIL	-	0	-	0.4VDD	V
Oscillation Frequency	fOSC	-	350	500	650	kHz
K1 to K3 Pull Down Resistor	KSR	VDD=5V	40	-	100	kΩ

## SWITCHING CHARACTERISTIC WAVEFORM

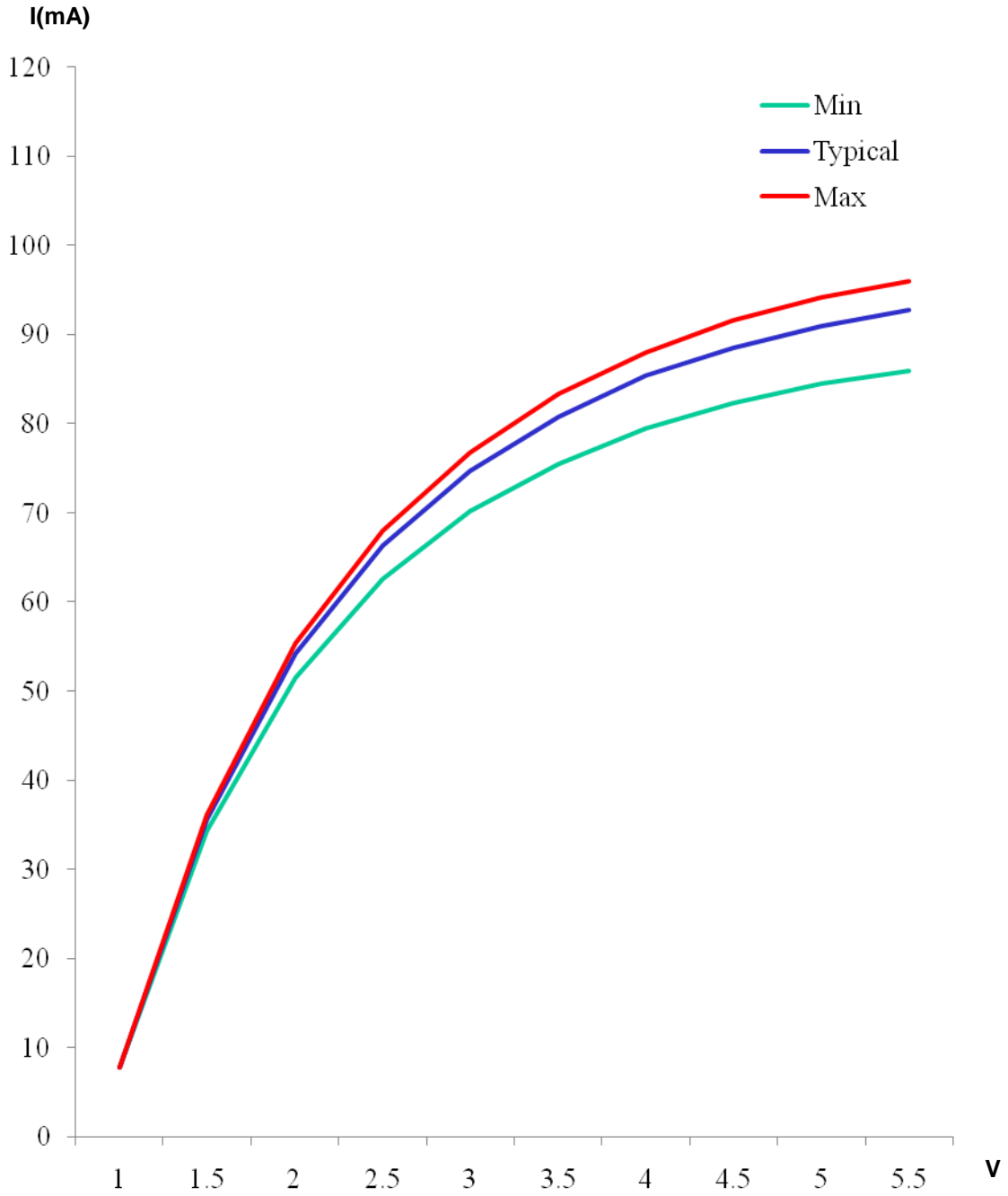
MC2003 Switching Characteristics Waveform is given below.



$PW_{CLK}$  (Clock Pulse Width)  $\geq 400ns$   
 $t_{setup}$  (Data Setup Time)  $\geq 100ns$   
 $t_{CLK-STB}$  (Clock - Strobe Time)  $\geq 1\mu s$   
 $t_{TZH}$  (Rise Time)  $\leq 1\mu s$   
 $t_{TZL} < 1\mu s$

$PW_{STB}$  (Strobe Pulse Width)  $\geq 1\mu s$   
 $t_{hold}$  (Data Hold Time)  $\geq 100ns$   
 $t_{THZ}$  (Fall Time)  $\leq 10\mu s$   
 $f_{osc}$  = Oscillation Frequency  
 $t_{TIZ} < 10\mu s$   
 $t_{PZL}$  (Propagation Delay Time)  $\leq 100ns$   
 $t_{PLZ}$  (Propagation Delay Time)  $\leq 300ns$

### SEG PIN Resistance



## FUNCTIONAL DESCRIPTION

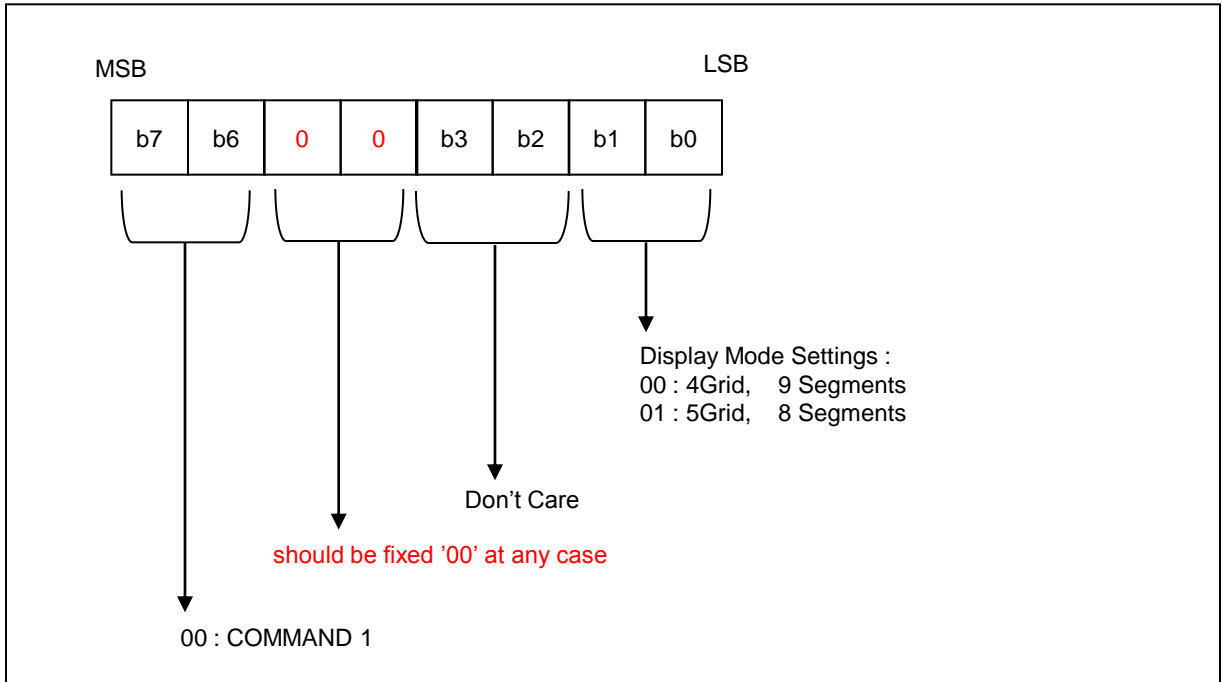
### COMMANDS

The MC2003 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. 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.

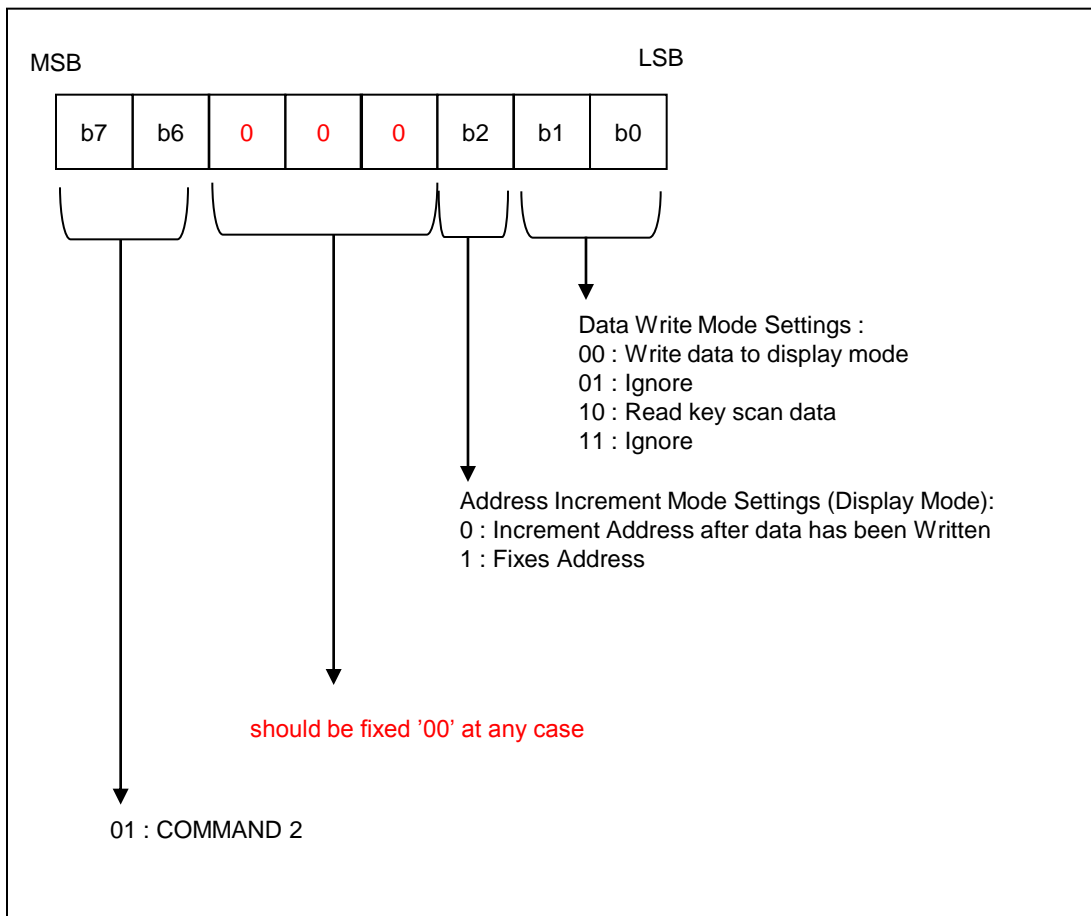


## COMMAND 2 : DATA SETTING COMMAND

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.

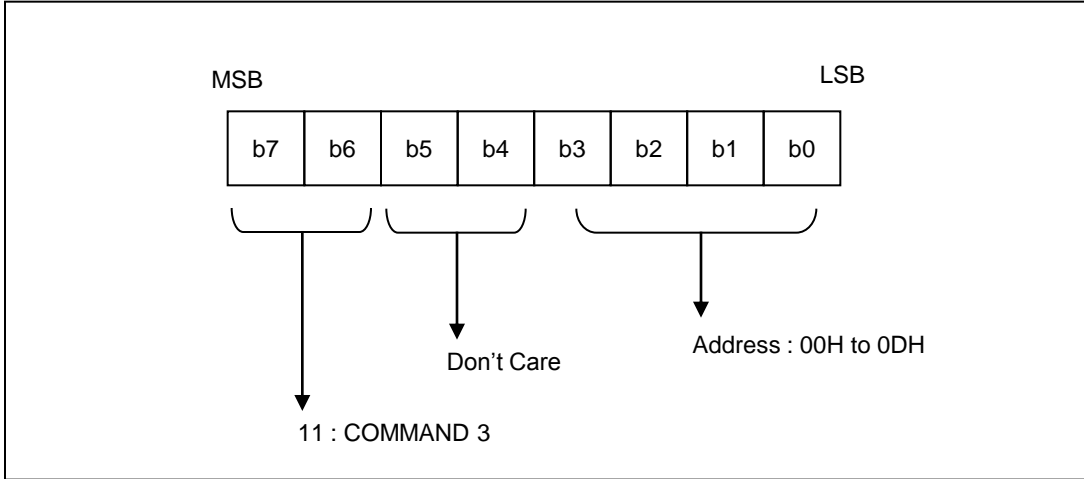
The Data write mode settings have 2bit (b1,b0) for writing data to display mode and read key scan data. Address increment mode setting has 1bit (b2) for selecting address Increment or fixed.

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**

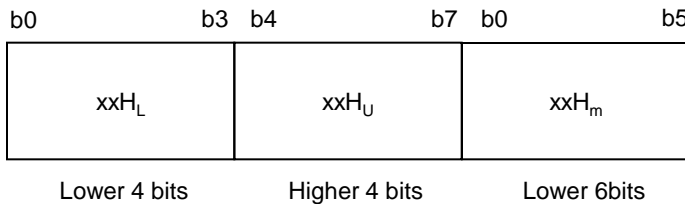
The display memory is addressed by Address Setting Command. The valid address range is "00H" to 0DH". If the address is set to 0EH to 0FH, the data is ignored until a valid address is set. When power is turned ON, the address is set at "00H".



**Display Mode and RAM Address**

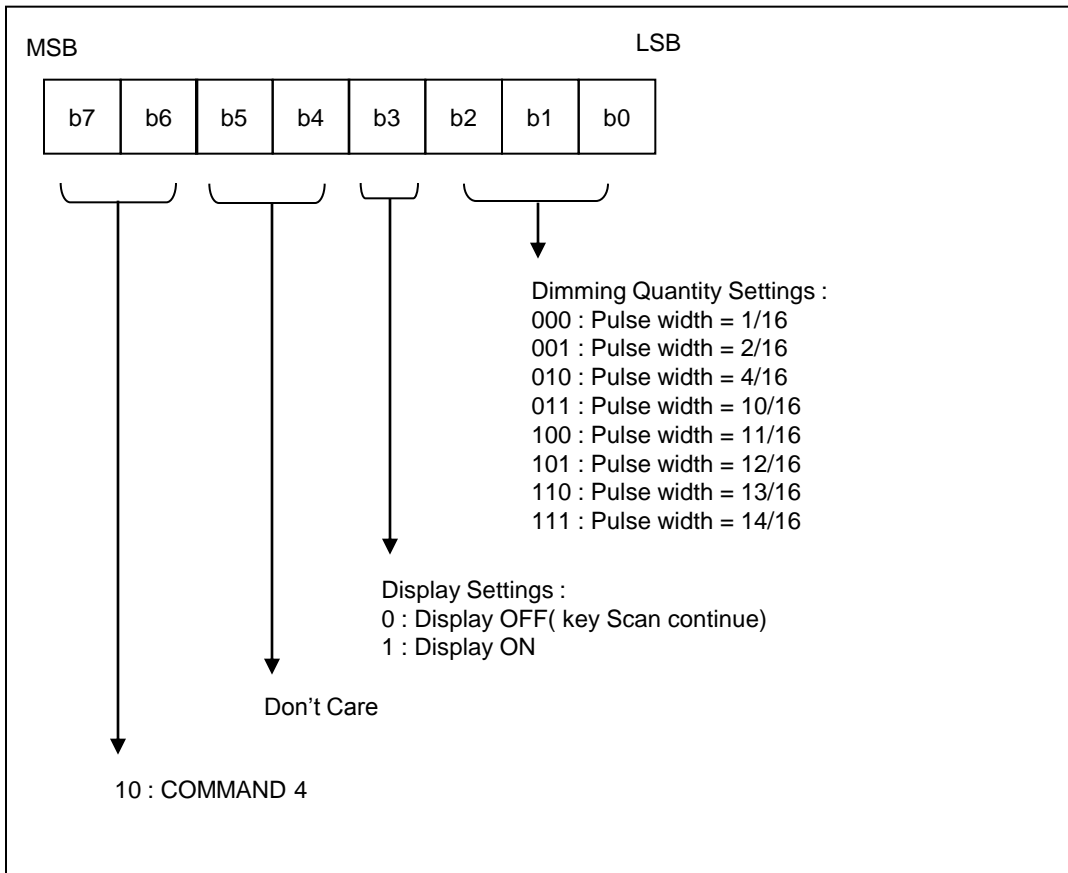
Data transmitted from an external device to MC2003 via the serial interface are stored in the Display RAM and are assigned addresses. The RAM Addresses of MC2003 are given below in 8 bit unit.

SEG1	SEG4	SEG5	SEG8	SEG9	SEG14	
00H <sub>L</sub>		00H <sub>U</sub>			01H <sub>m</sub>	GR1
02H <sub>L</sub>		02H <sub>U</sub>			03H <sub>m</sub>	GR2
04H <sub>L</sub>		04H <sub>U</sub>			05H <sub>m</sub>	GR3
06H <sub>L</sub>		06H <sub>U</sub>			07H <sub>m</sub>	GR4
08H <sub>L</sub>		08H <sub>U</sub>			09H <sub>m</sub>	GR5
0AH <sub>L</sub>		0AH <sub>U</sub>			0BH <sub>m</sub>	GR6
0CH <sub>L</sub>		0CH <sub>U</sub>			0DH <sub>m</sub>	GR7

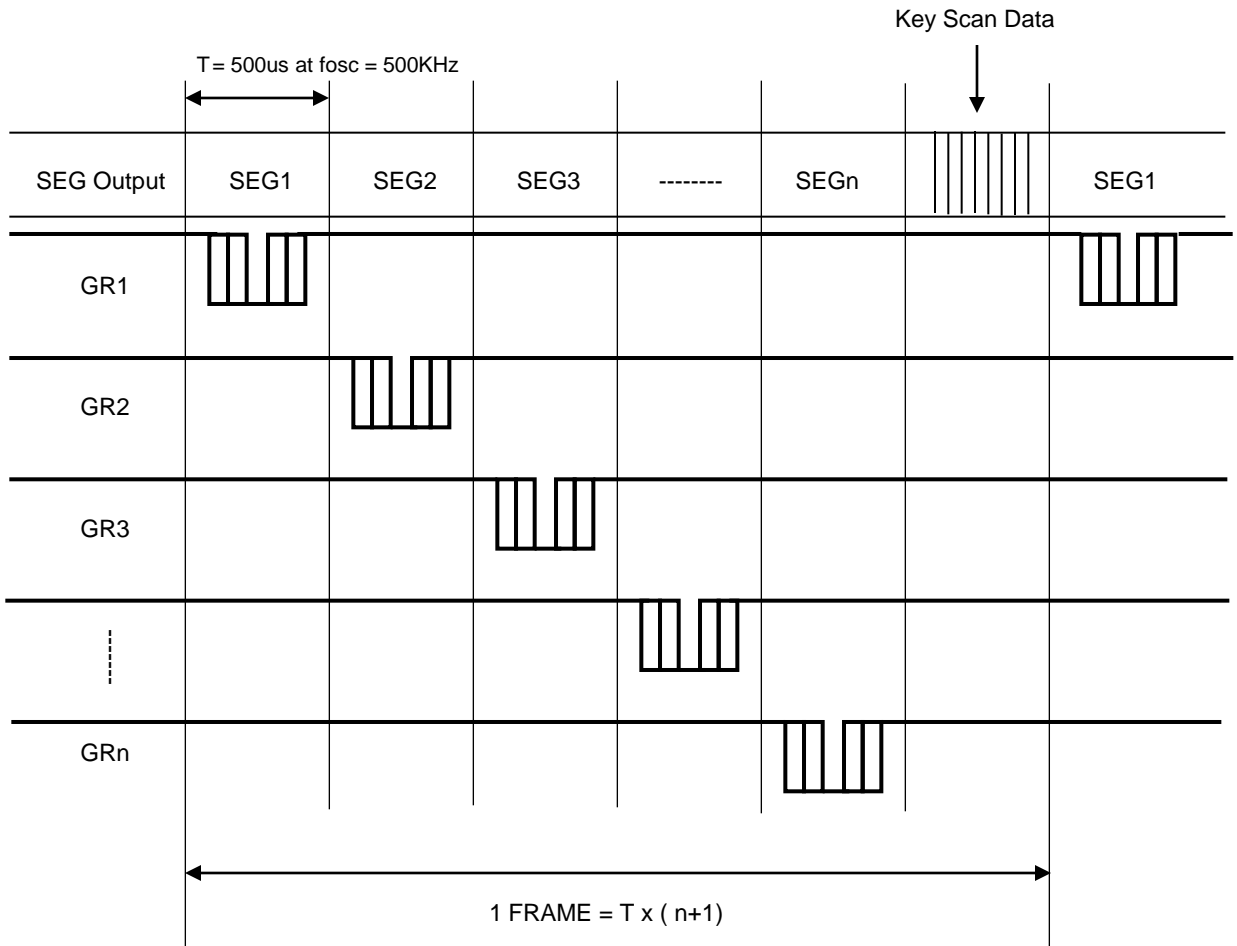


## COMMAND 4 : DISPLAY CONTROL COMMANDS

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

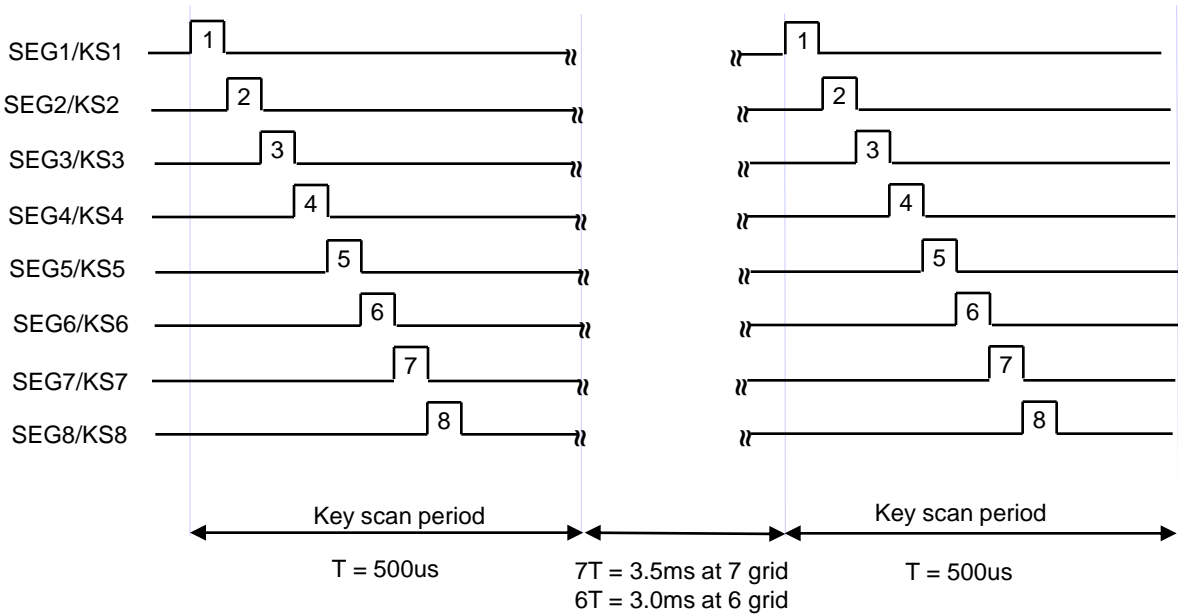




### KEY SCAN

#### 1) Key Scan Timing

The key scan period is 500us at oscillator=500Khz.



#### 2) Key scan operation

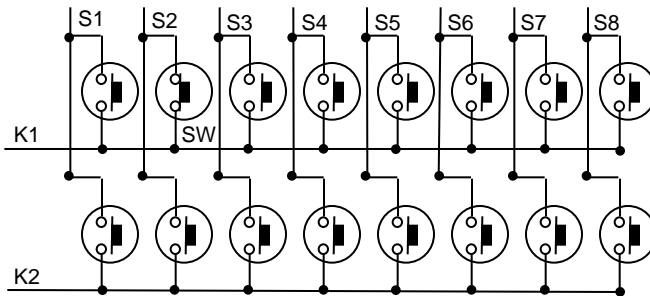
- The key scan is operated always.
- Multiple key presses are recognized by determining whether multiple key data bits are set.

#### 3) Key scan data read sequence

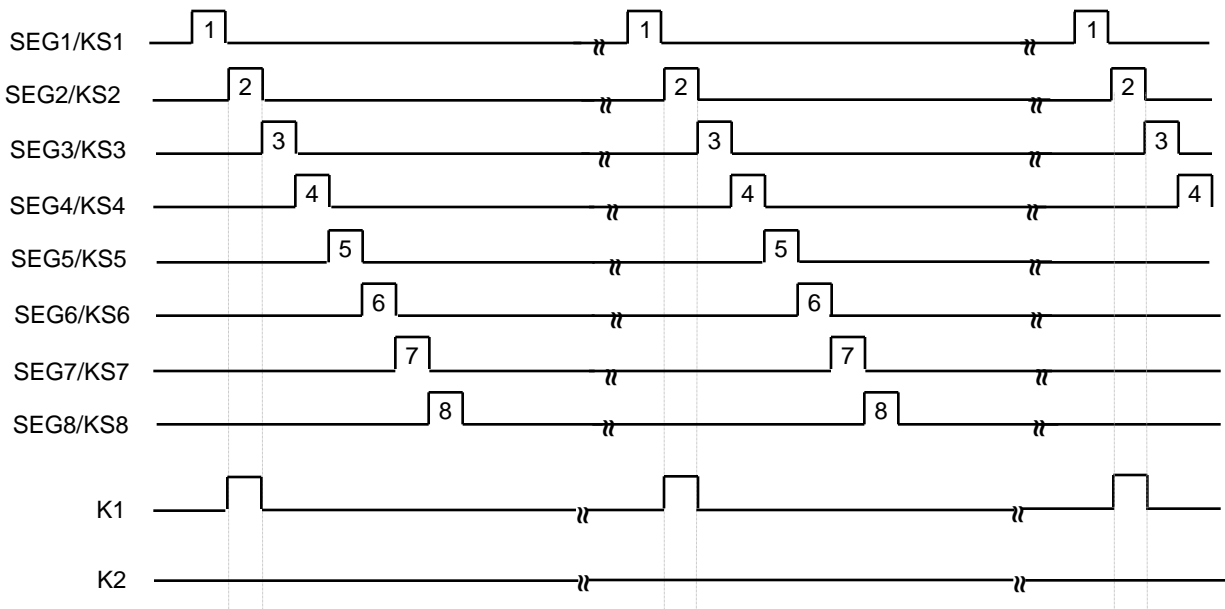
K1	K2	don't care	K1	K2	don't care			
SEG1/KS1			SEG2/KS2			0	1	1'st byte read
SEG3/KS3			SEG4/KS4			0	1	2'nd byte read
SEG5/KS5			SEG6/KS6			0	1	3'rd byte read
SEG7/KS7			SEG8/KS8			0	1	4'th byte read
SEG9/KS9			SEG10/KS10			0	1	5'th byte read
SEG11/KS11			X			0	1	6'th byte read
b0	b1	b2	b3	b4	b5	b6	b7	

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

4) Key Scan Example



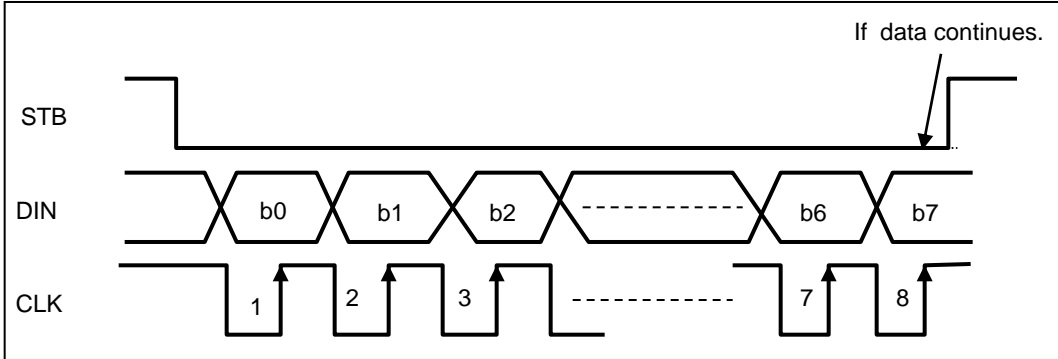
If SW switch is pressed, the K1 of key input pin is high by KS2 at key scan timing. So the K1 pin input is high.



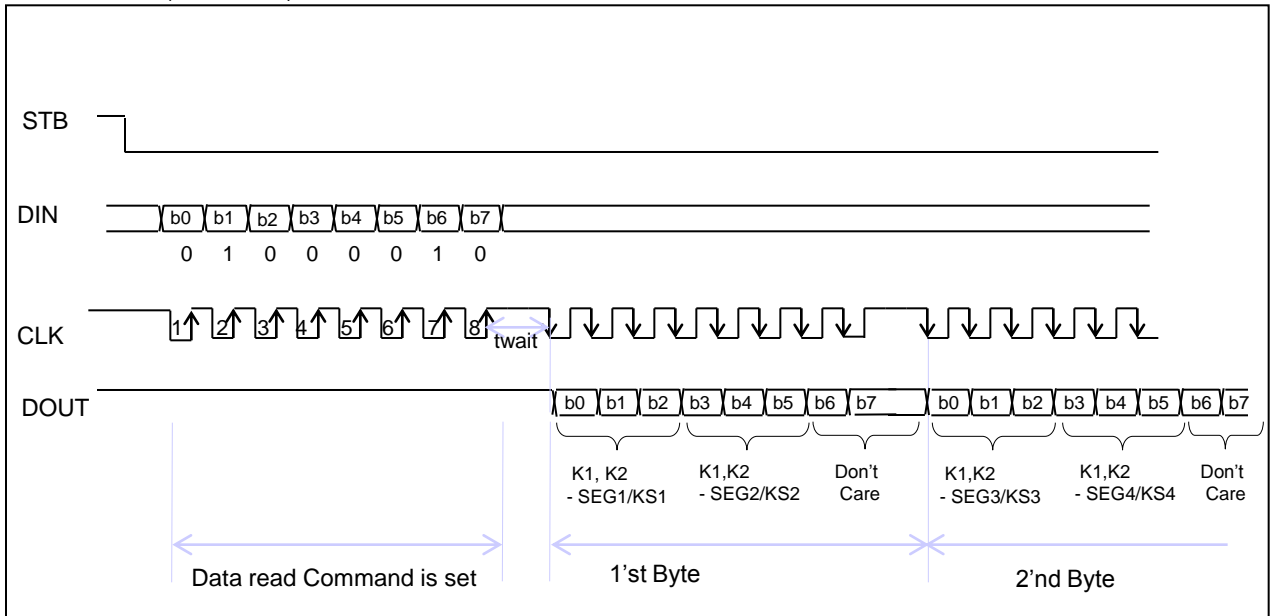
### SERIAL COMMUNICATION FORMAT

The following diagram shows the MC2003 serial communication format.

RECEPTION (Data/Command Write)



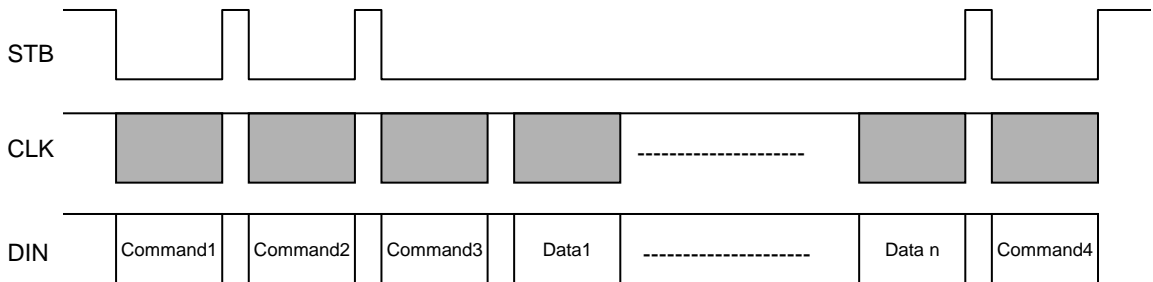
Transmission (Data Read)



Twait (waiting Time)  $\geq 1\mu s$

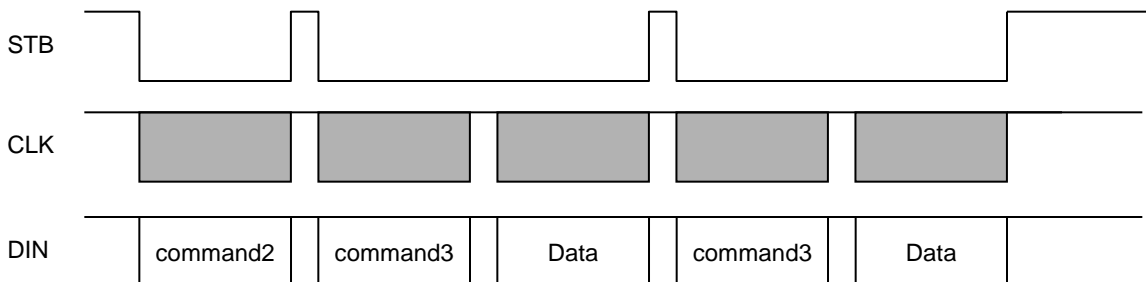
### SERIAL COMMUNICATION EXAMPLES

Serial communication timing diagram for initialization setting.



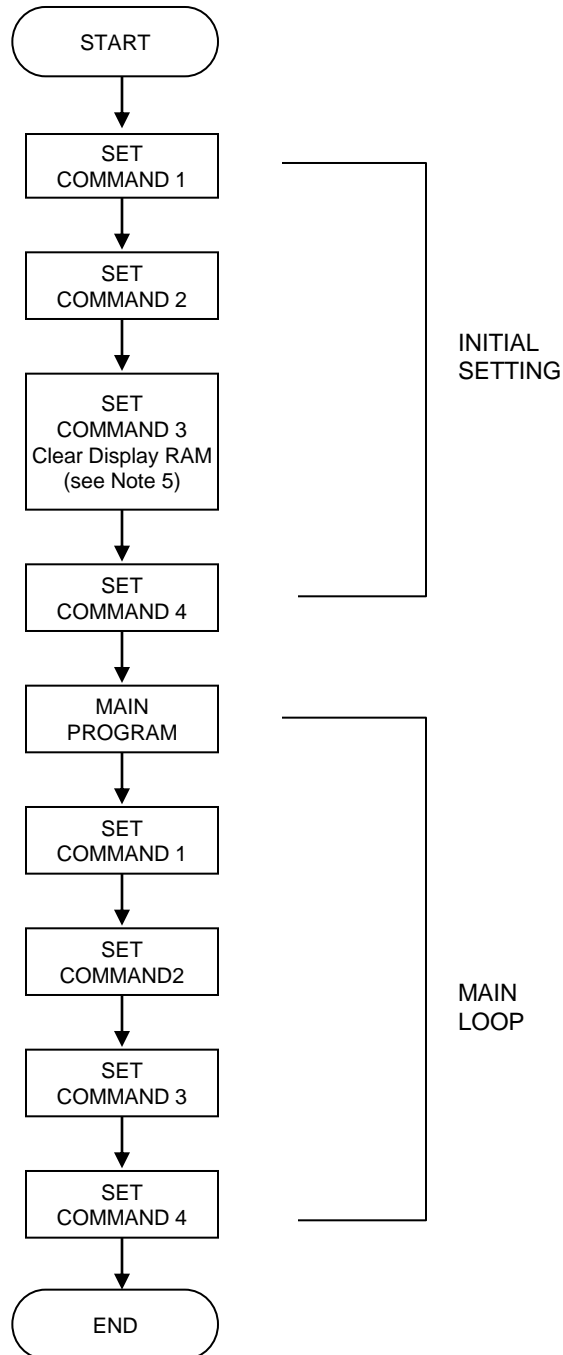
Where : Command 1 : Display Mode Setting  
 Command 2 : Data Setting Command  
 Command 3 : Address Setting Command  
 Data 1 to n : Transfer Display Data (14 Bytes max.)  
 Command 4 : Display Control Command

Memory updating timing diagram.



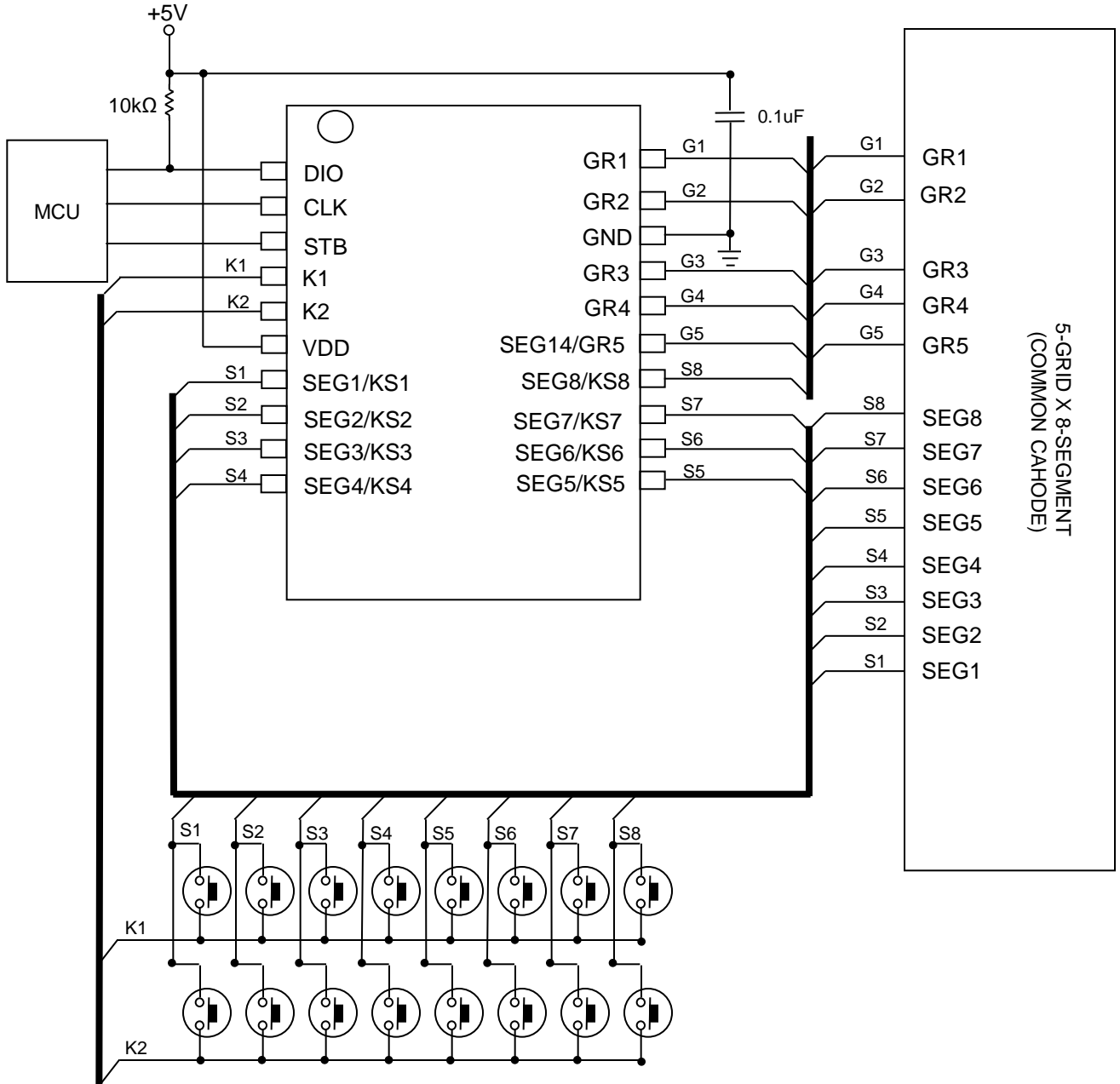
Where : Command 2 -- Data Setting Command  
 Command 3 -- Address Setting Command  
 Data -- Display Data

## RECOMMENDED SOFTWARE PROGRAMMING FLOW CHART

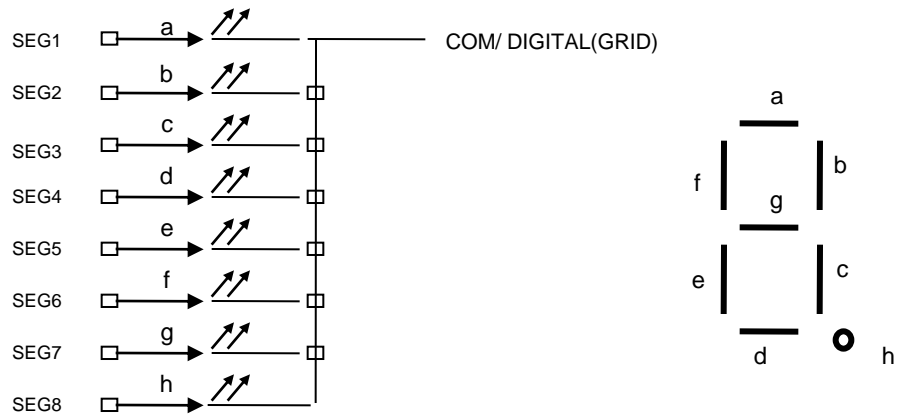


- **Note** : 1. Command 1 : Display Mode Setting
- 2. Command 2 : Data Setting Commands
- 3. Command 3 : Address Setting Commands
- 4. Command 4 : Display Control Commands
- 5. When IC power is applied for the first time, the contents of the Display RAM are not defined : thus, it is strongly suggested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

### TYPICAL APPLICATION CIRCUIT

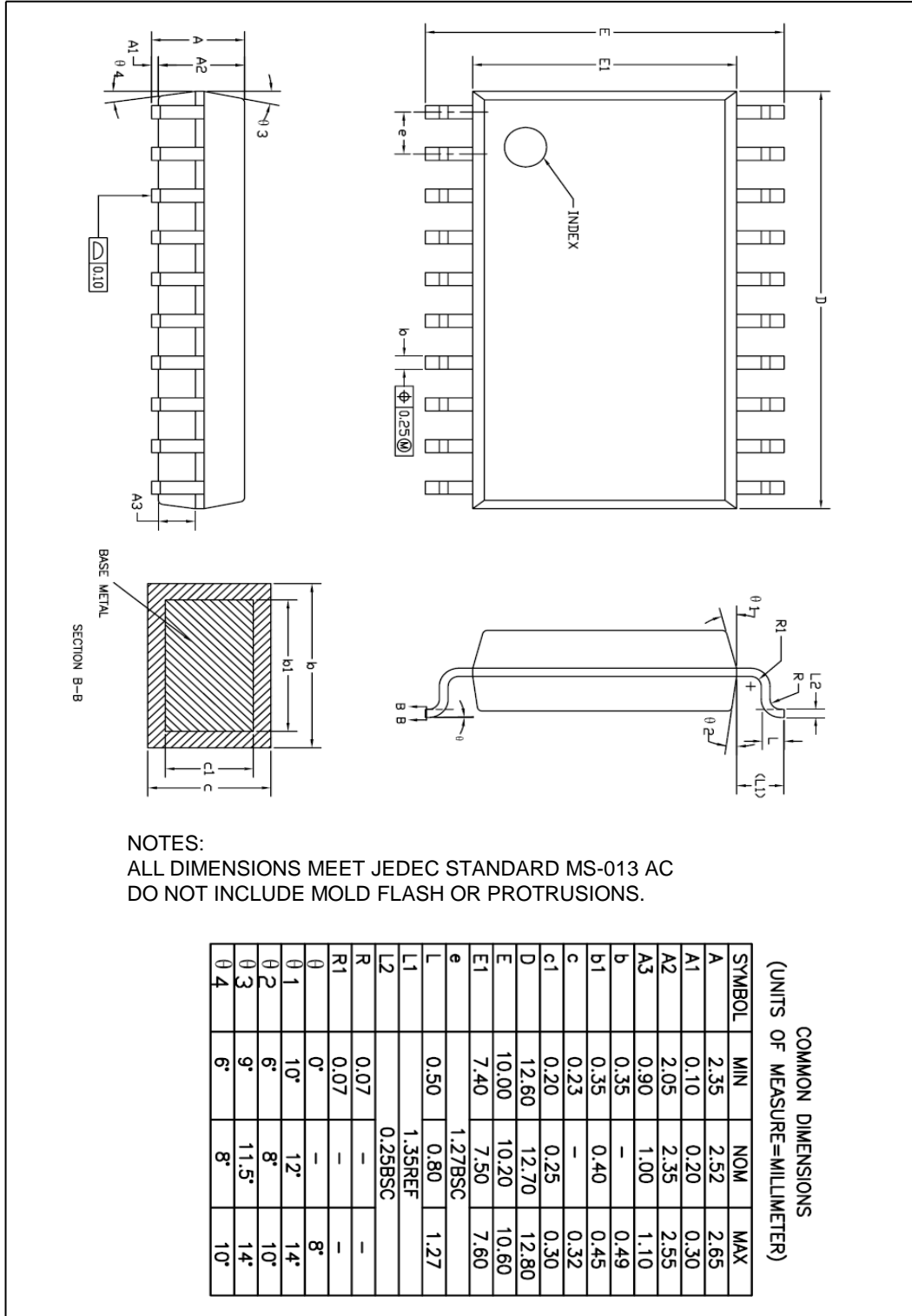


## LED PANEL FOR CATHODE TYPE



# PACKAGE INFORMATION

## SOP 20



NOTES:  
 ALL DIMENSIONS MEET JEDEC STANDARD MS-013 AC  
 DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.

SYMBOL	MIN	NOM	MAX
A	2.35	2.52	2.65
A1	0.10	0.20	0.30
A2	2.05	2.35	2.55
A3	0.90	1.00	1.10
b	0.35	-	0.49
b1	0.35	0.40	0.45
c	0.23	-	0.32
c1	0.20	0.25	0.30
D	12.60	12.70	12.80
E	10.00	10.20	10.60
E1	7.40	7.50	7.60
e	1.27BSC		
L	0.50	0.80	1.27
L1	1.35REF		
L2	0.25BSC		
R	0.07	-	-
R1	0.07	-	-
θ	0°	-	8°
θ1	10°	12°	14°
θ2	6°	8°	10°
θ3	9°	11.5°	14°
θ4	6°	8°	10°

COMMON DIMENSIONS  
 (UNITS OF MEASURE=MILLIMETER)