ABOV SEMICONDUCTOR
10 SEGMENT X 7 GRID LED DRIVER WITH KEYSCAN

MC2102

Data Sheet (Ver. 1.21)

ABOV
SEMICONDUCTOR

Version 1.21

REVISION HISTORY

VERSION 1.21 (2010. 12. 03)
Corrected A1 and A2 dimension of the PACKAGE INFORMATION on page 24.

VERSION 1.20 (2010.01.05) This Book.
Modified the Operating Temperature on page 9.

VERSION 1.10 (2009. 04. 20)
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 MC2102 is specifically designed for LED and LED DISPLAY driver.
The MC2102 has max 13 segment output lines, max 7 grid output lines, one display memory,
control circuit, 4 line serial data interface, and max 10 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.
MC2102'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
- 24-pin SOP Package
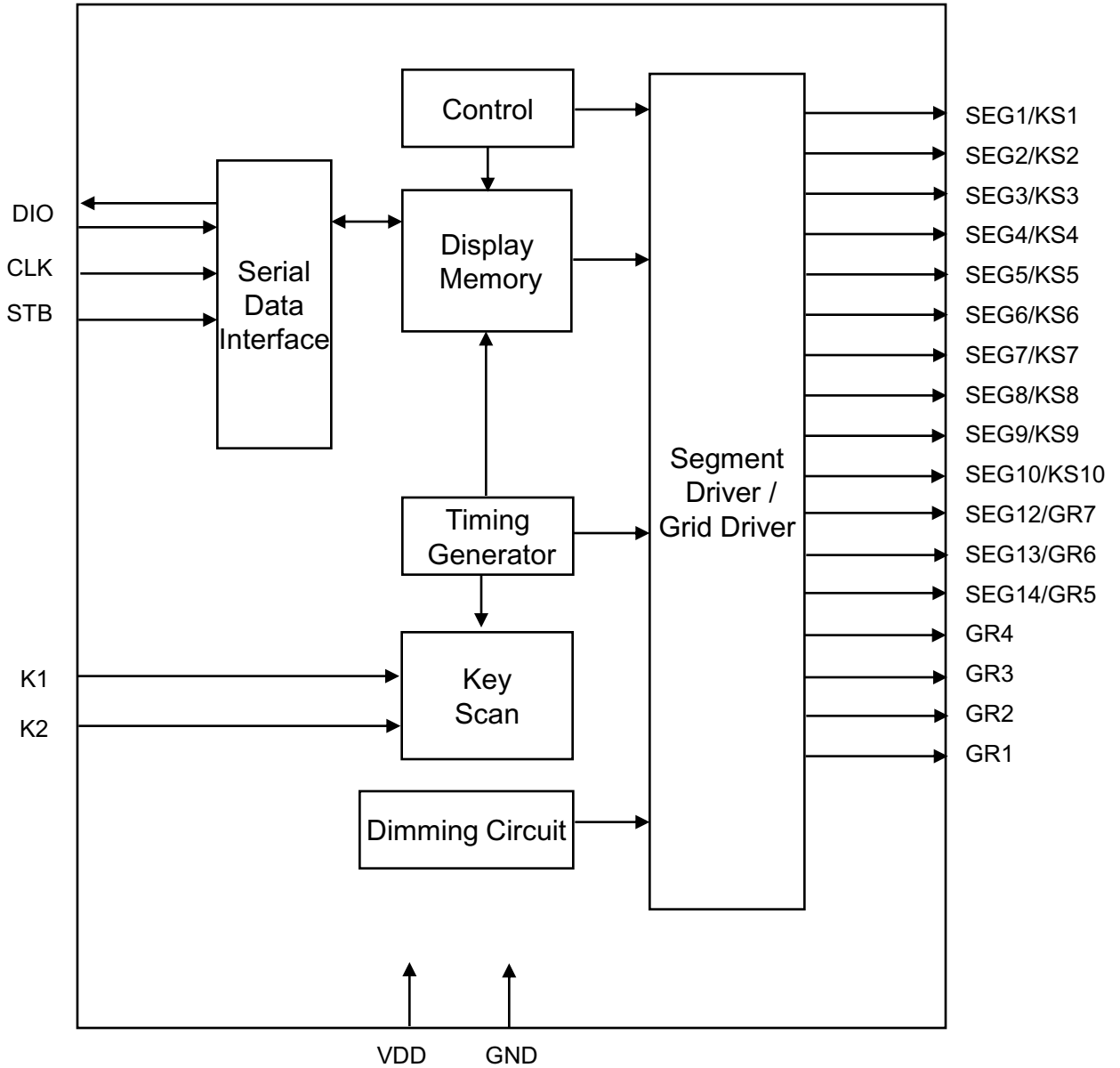
APPLICATION

- Segment LED display : VCR, DVD, MWO

Device 명	Segment 수	Grid 수	Key Scanning	PKG TYPE
MC2102	10~13 Segment	4~7 Grid	10 X 2 Matrix	24pin, SOP

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 SEG10/KS10	O	Segment output pins. (P-channel open drain) Also key scan source pins.	7~16
SEG12/GR7 to SEG14/GR5	O	Segment / Grid output pin.	17,18,19
GR4 to GR1	O	Grid output pin.	24,23, 21,20
GND	-	Ground pin.	22

BLOCK DIAGRAM

PIN CONFIGURATION

```
              DIO ⊏    1 ●            24 ⊐ GR1
              CLK ⊏    2             23 ⊐ GR2
              STB ⊏    3             22 ⊐ GND
               K1 ⊏    4             21 ⊐ GR3
               K2 ⊏    5             20 ⊐ GR4
              VDD ⊏    6    MC2102   19 ⊐ SG14/GR5
          SG1/KS1 ⊏    7             18 ⊐ SG13/GR6
          SG2/KS2 ⊏    8             17 ⊐ SG12/GR7
          SG3/KS3 ⊏    9             16 ⊐ SG10/KS10
          SG4/KS4 ⊏   10             15 ⊐ SG9/KS9
          SG5/KS5 ⊏   11             14 ⊐ SG8/KS8
          SG6/KS6 ⊏   12             13 ⊐ SG7/KS7
```

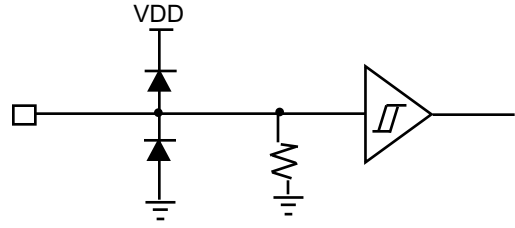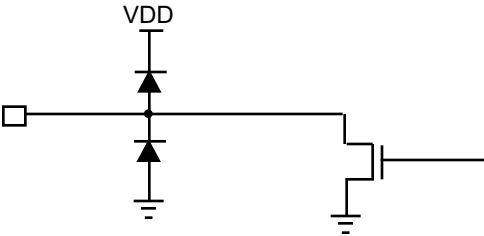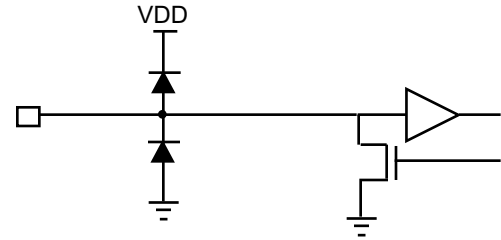## INPUT/OUTPUT PINS SCHEMATIC DIAGRAM
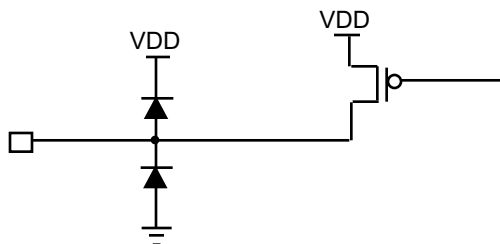
Input pins : CLK,STB

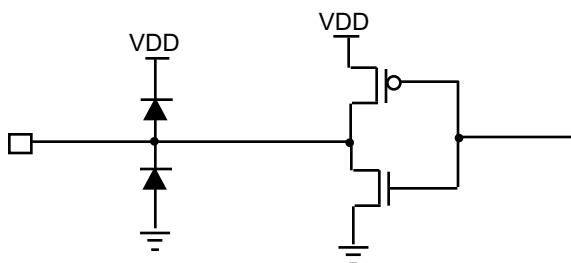**Input pins : K1,K2**

Output pins : GR1 to GR4

Input / Output pins : DIO

Output pins : SEG1/KS1 to SEG10/KS10

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
(Unless otherwise stated, 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	0.6VDD	-	VDD	V
Low-Level Input Voltage	VIL	0	-	0.4 VDD	V

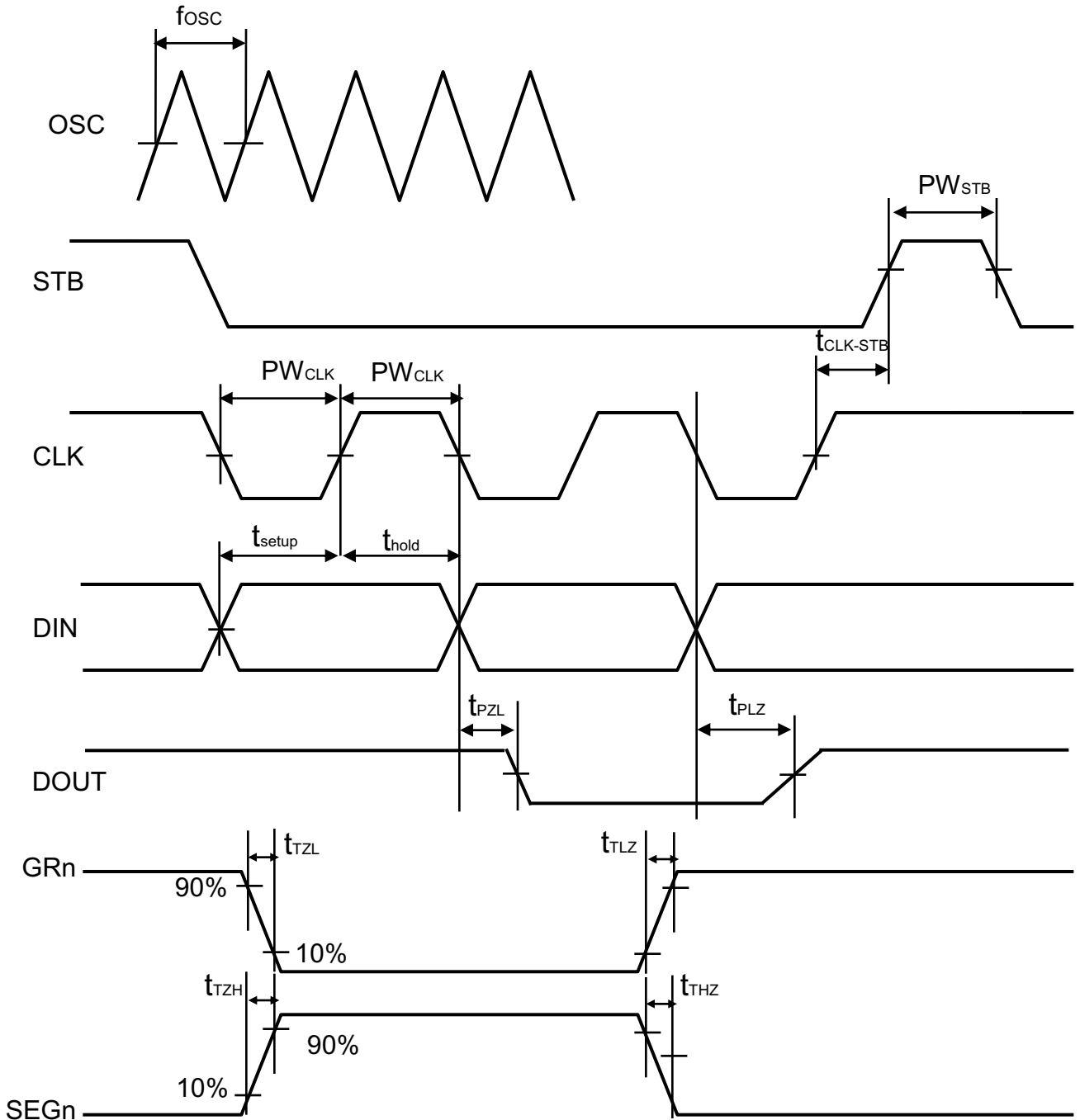• Note : Test Condition : Set Display Control Commands = 80H (Display Turn OFF State)

ELECTRICAL CHARACTERISTICS
(Unless otherwise stated, V_{DD}=5V, GND=0V, Ta=25℃)

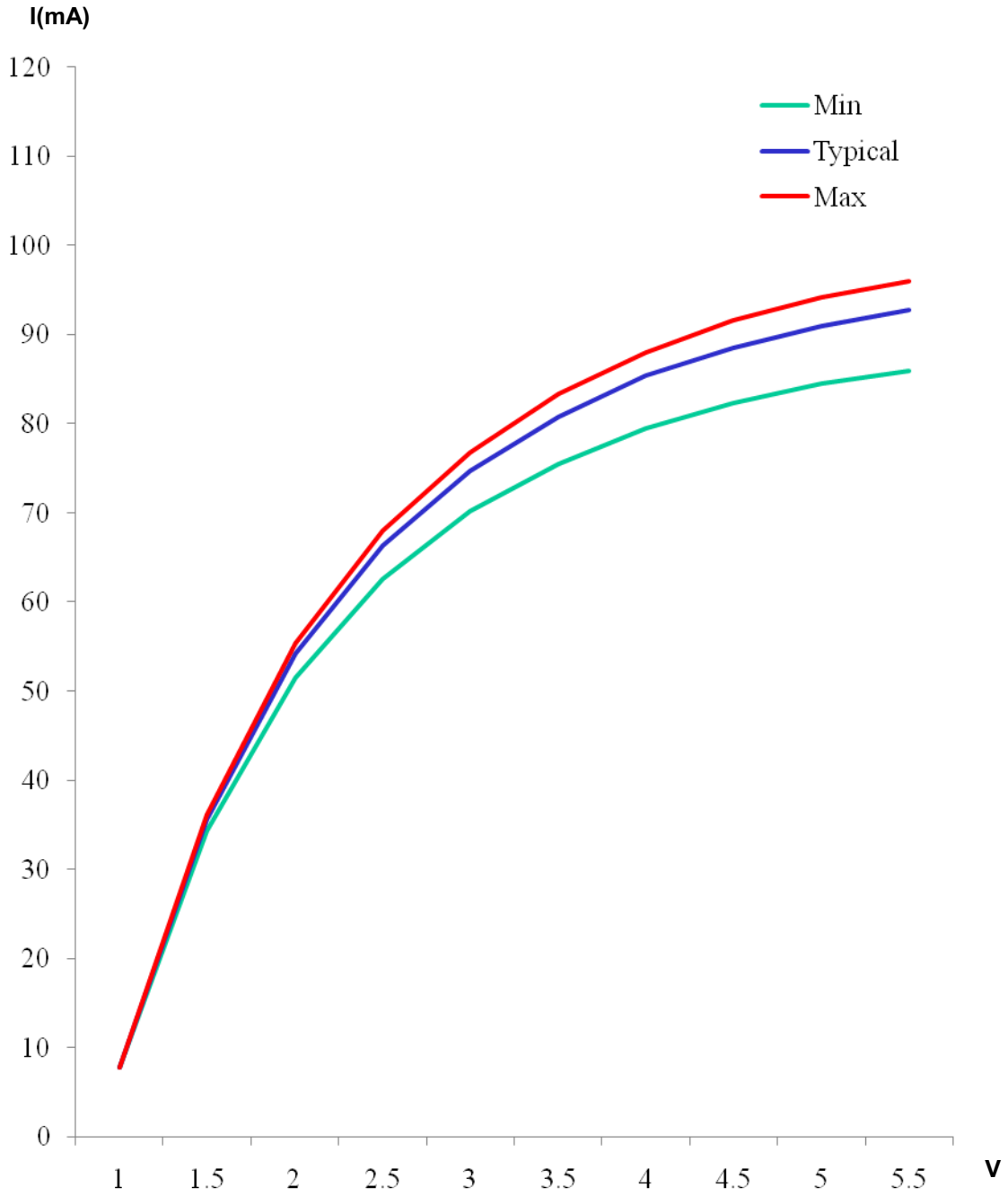| PARAMETER	SYMBOL	Test Condition	Min.	TYP.	MAX.	UNIT
High-Level Output Current	IOHSG1	$V_O = V_{DD}$ - 2V SEG1 to SEG11. SEG12/GR7 to SEG14/GR5	-20	-25	-40	mA
	IOHSG2	$V_O = V_{DD}$ - 3V SEG1 to SEG11. SEG12/GR7 to SEG14/GR5	-25	-30	-50	mA
Low-Level Output Current	IOLGR	V_O = 0.3V GR1 TO GR4 SEG12/GR7 TO SEG14/GR5	100	140	-	mA
Low-Level Output Current	IOLDOUT	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

MC2102 Switching Characteristics Waveform is given below.

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

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

SEG PIN Resistance
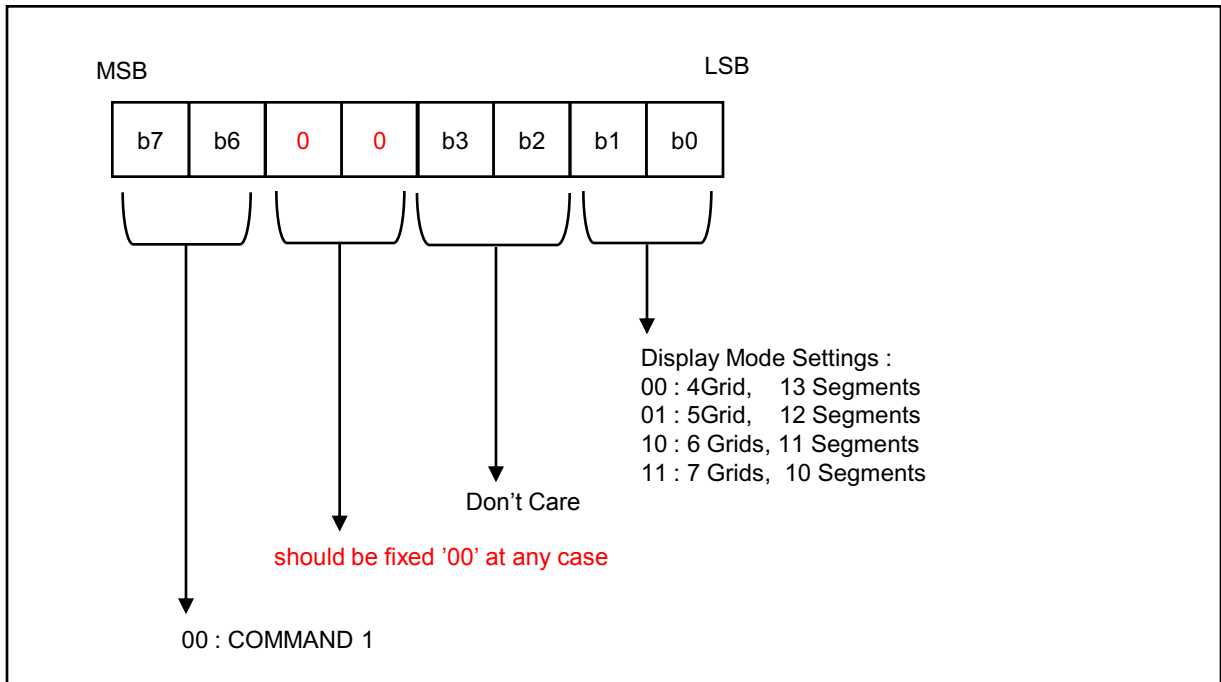
FUNCTIONAL DESCRIPTION

COMMANDS

The MC2102 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, 10 segments and key scan enable. If b1,b0 are "1","0" then 6 grids 11 segments and key scan enable selected. If b1,b0 are "0","1" then 5 grid 12 segments and key scan enable selected. If b1, b0 are "0","0" then 4 grids 13 segments and key scan enable selected.

MSB   LSB

| b7 | b6 | 0 | 0 | b3 | b2 | b1 | b0 |

Display Mode Settings :
00 : 4Grid,   13 Segments
01 : 5Grid,   12 Segments
10 : 6 Grids, 11 Segments
11 : 7 Grids, 10 Segments

Don't Care

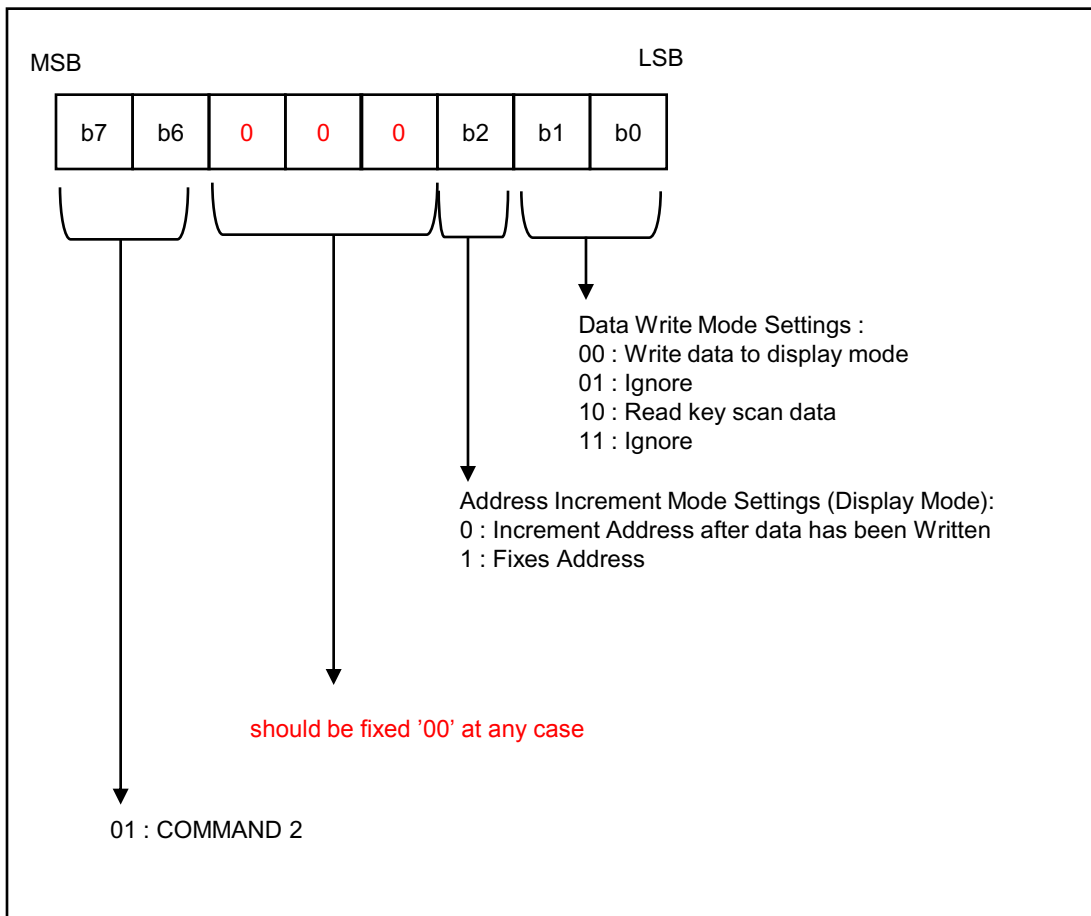should be fixed '00' at any case

00 : COMMAND 1

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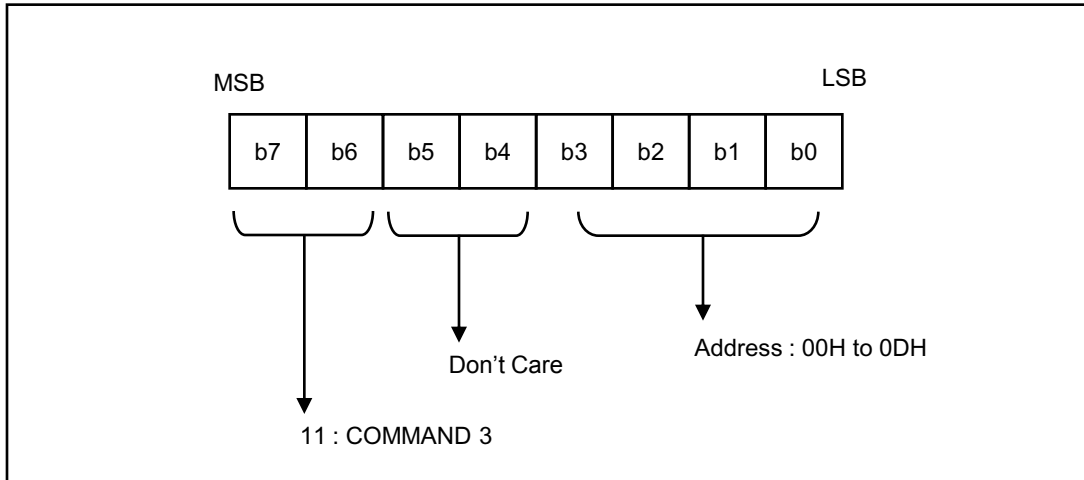
The Data write mode settings have 2bit (b1,b0) for writing data to display mode and read key scan data.
Address increment mode setting has 1bit (b2) for selecting address Increment or fixed.
And 2bits(b5 ~ b3) should be fixed '000' at any case.
The command bits (b7,b6) are "0","1" for COMMAND2.

MSB							LSB
b7	b6	0	0	0	b2	b1	b0

Data Write Mode Settings :
00 : Write data to display mode
01 : Ignore
10 : Read key scan data
11 : Ignore

Address Increment Mode Settings (Display Mode):
0 : Increment Address after data has been Written
1 : Fixes Address

should be fixed '00' at any case

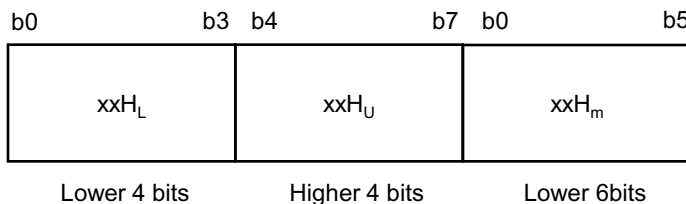01 : COMMAND 2

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".

MSB   LSB

b7	b6	b5	b4	b3	b2	b1	b0

11 : COMMAND 3

Don't Care

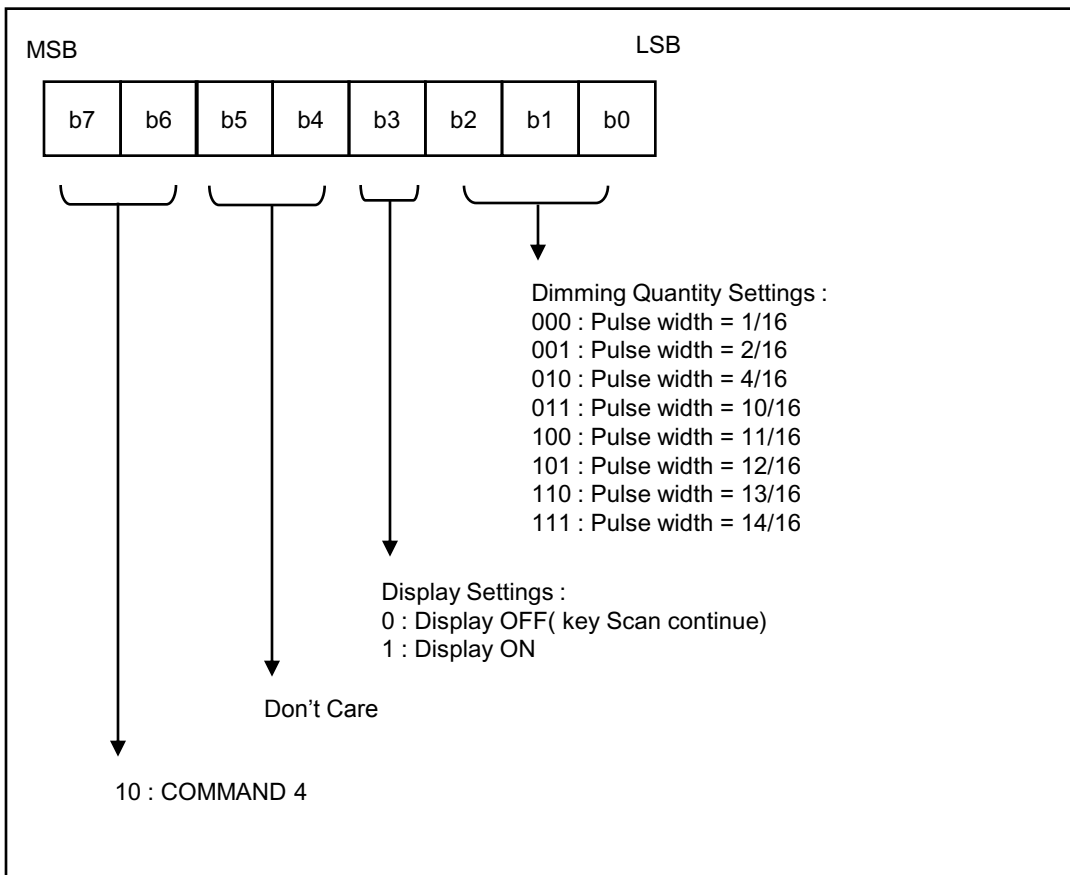Address : 00H to 0DH

Display Mode and RAM Address

Data transmitted from an external device to MC2102 via the serial interface are stored in the
Display RAM and are assigned addresses. The RAM Addresses of MC2102 are given below in
8 bit unit.

SEG1 SEG4	SEG5 SEG8	SEG9 SEG14	
$00H_L$	$00H_U$	$01H_m$	GR1
$02H_L$	$02H_U$	$03H_m$	GR2
$04H_L$	$04H_U$	$05H_m$	GR3
$06H_L$	$06H_U$	$07H_m$	GR4
$08H_L$	$08H_U$	$09H_m$	GR5
$0AH_L$	$0AH_U$	$0BH_m$	GR6
$0CH_L$	$0CH_U$	$0DH_m$	GR7

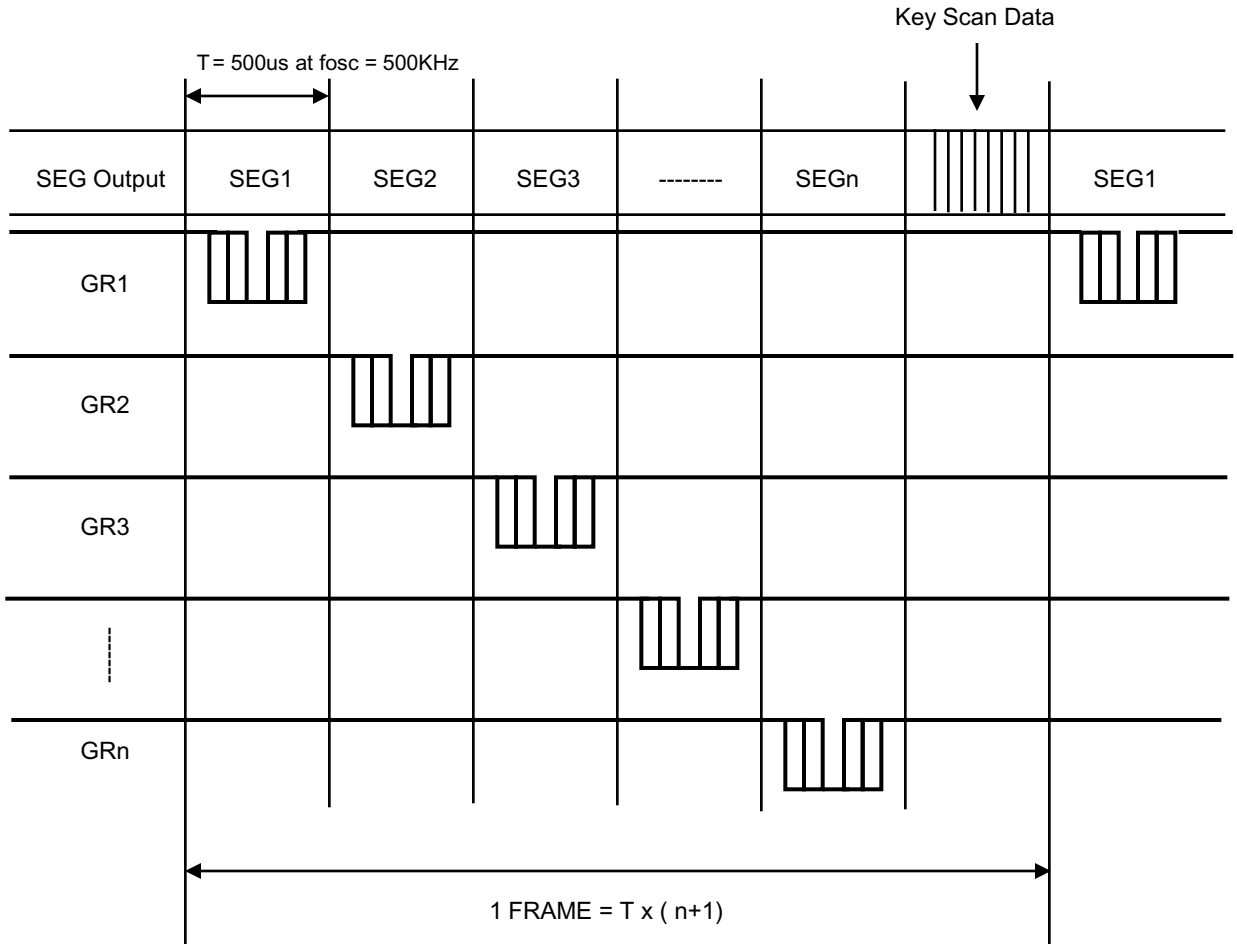| b0 b3	b4 b7	b0 b5
xxH_L	xxH_U	xxH_m
Lower 4 bits	Higher 4 bits	Lower 6bits

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.
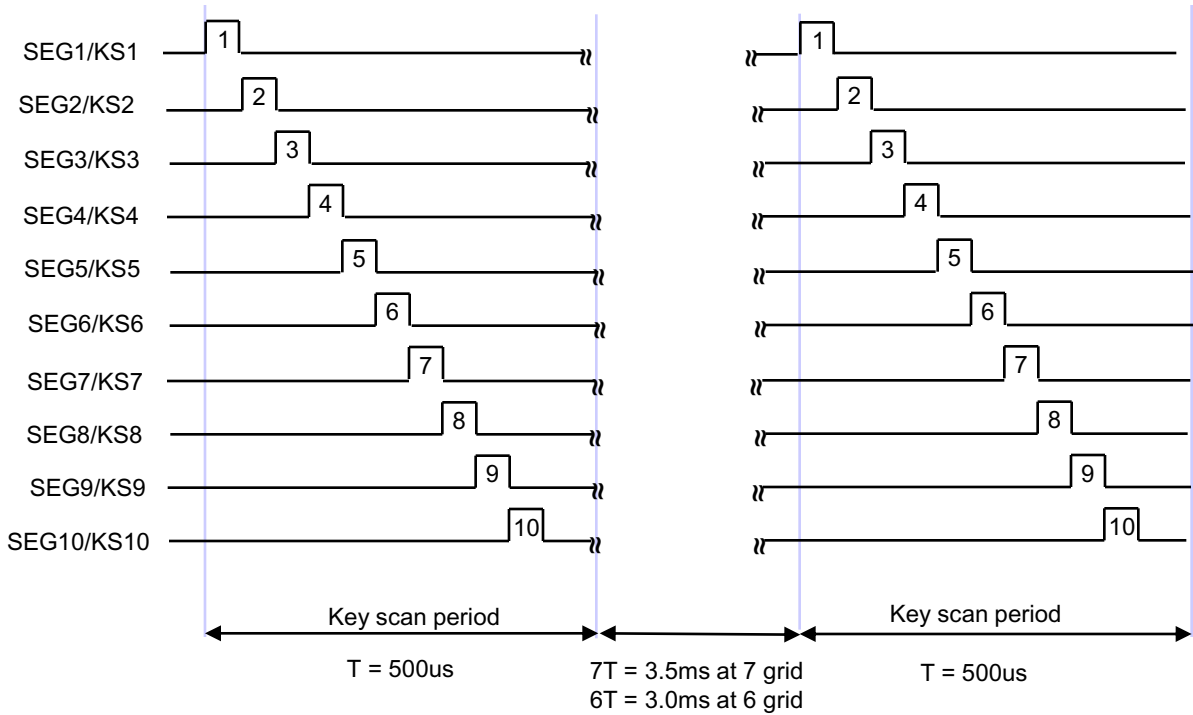

MSB   LSB

| b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 |

Dimming Quantity Settings :
000 : Pulse width = 1/16
001 : Pulse width = 2/16
010 : Pulse width = 4/16
011 : Pulse width = 10/16
100 : Pulse width = 11/16
101 : Pulse width = 12/16
110 : Pulse width = 13/16
111 : Pulse width = 14/16

Display Settings :
0 : Display OFF(key Scan continue)
1 : Display ON

Don't Care

10 : COMMAND 4

DISPLAY TIMING WAVEFORM

KEY SCAN

1) Key Scan Timing

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

SEG1/KS1	1		
SEG2/KS2	2		
SEG3/KS3	3		
SEG4/KS4	4		
SEG5/KS5	5		
SEG6/KS6	6		
SEG7/KS7	7		
SEG8/KS8	8		
SEG9/KS9	9		
SEG10/KS10	10		

Key scan period

T = 500us   7T = 3.5ms at 7 grid   T = 500us
                 6T = 3.0ms at 6 grid

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

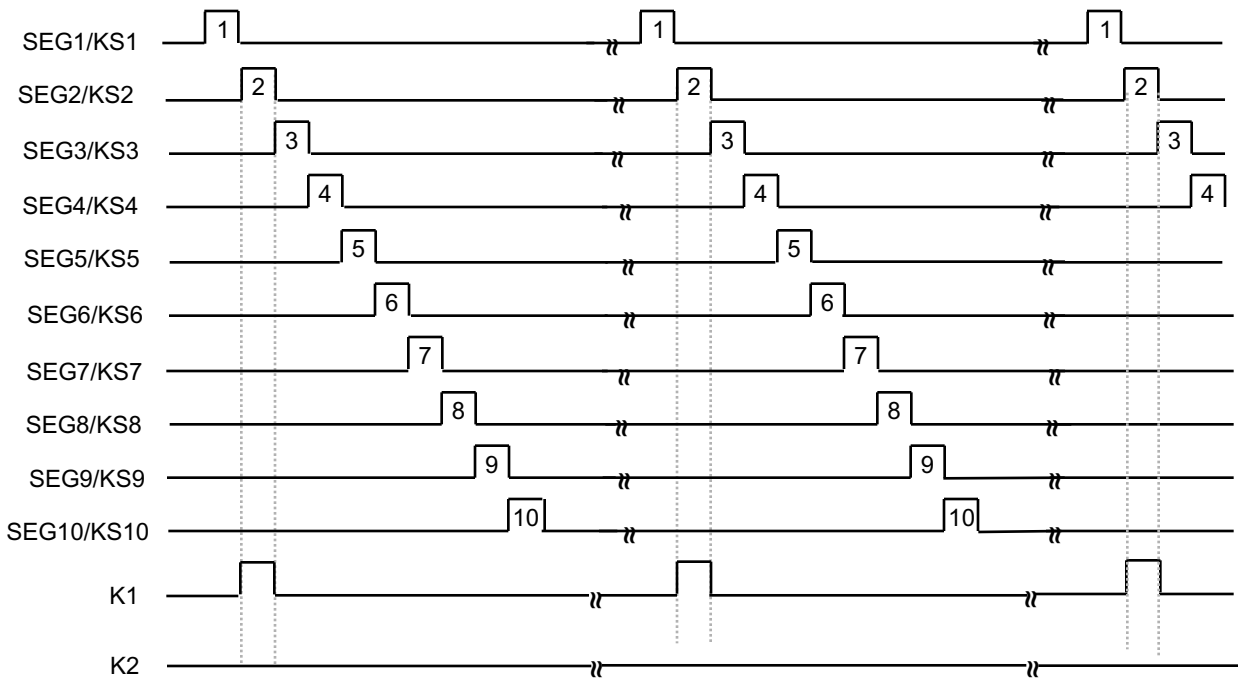|				
SEG1/KS1	SEG2/KS2	0	1	1'st byte read
SEG3/KS3	SEG4/KS4	0	1	2'nd byte read
SEG5/KS5	SEG6/KS6	0	1	3'rd byte read
SEG7/KS7	SEG8/KS8	0	1	4'th byte read
SEG9/KS9	SEG10/KS10	0	1	5'th byte read
SEG11/KS11	X	0	1	6'th byte read

b0   b1   b2   b3   b4   b5   b6   b7

Key press = "1", Key no press = "0" read.
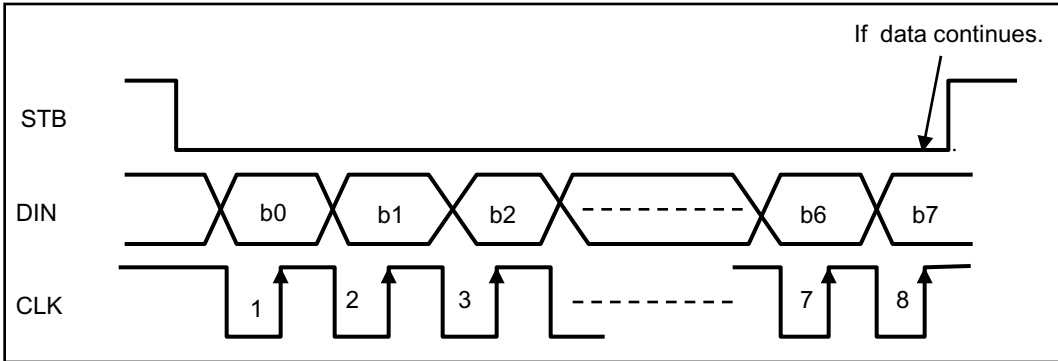
4) Key Scan Example

If SW switch is pressed, the K1 of key input pin is high by S2 at key scan timing.
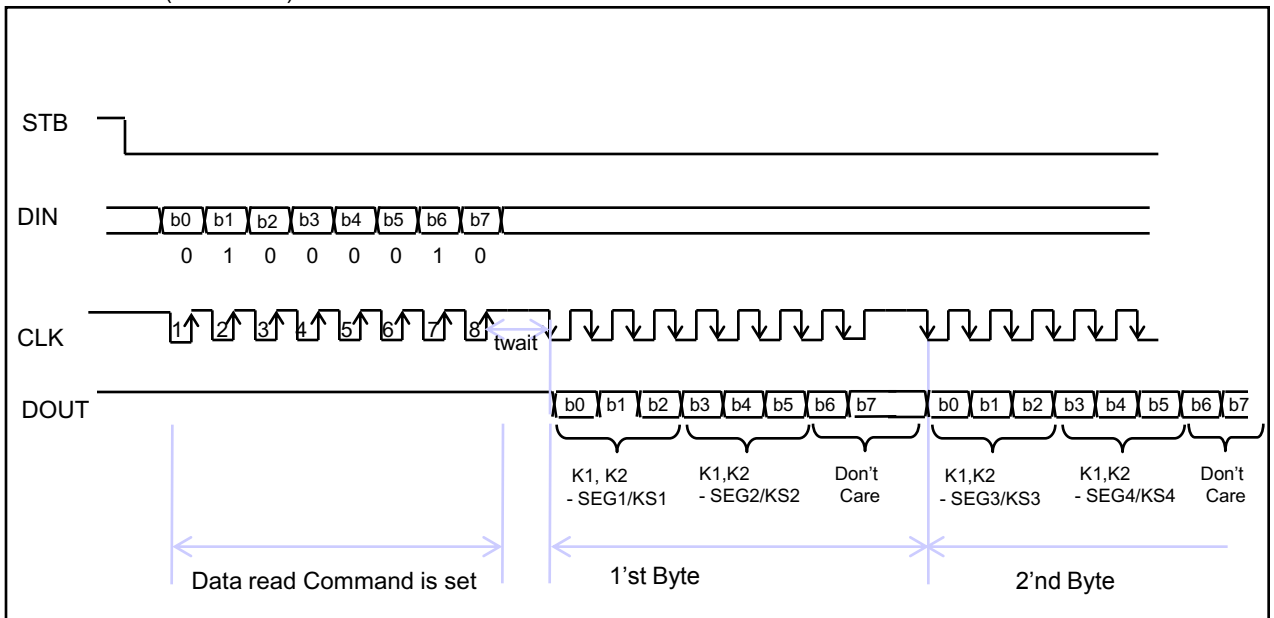So the K1 pin input is high.

SERIAL COMMUMICATION FORMAT

The following diagram shows the MC2102 serial communication format.
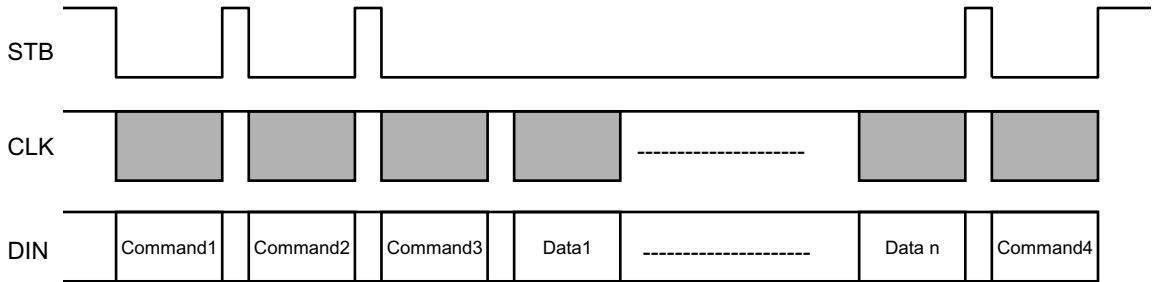
RECEPTION (Data/Command Write)

Transmission (Data Read)

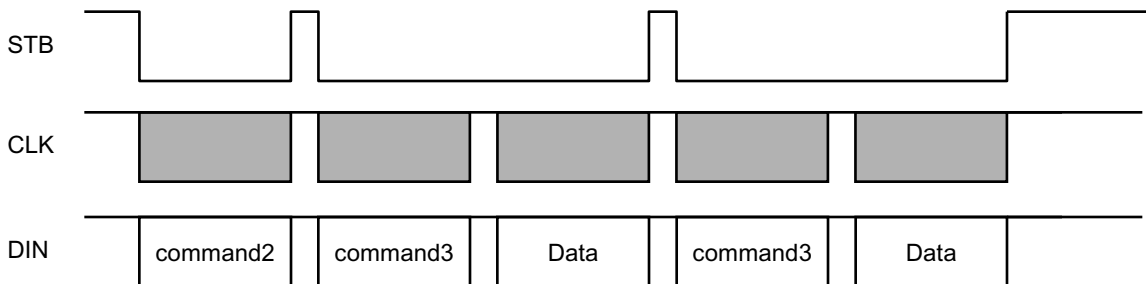Twait (waiting Time) ≥ 1µs

SERIAL COMMUNICATION EXAMPLES

Serial communication timing diagram for initialization setting.
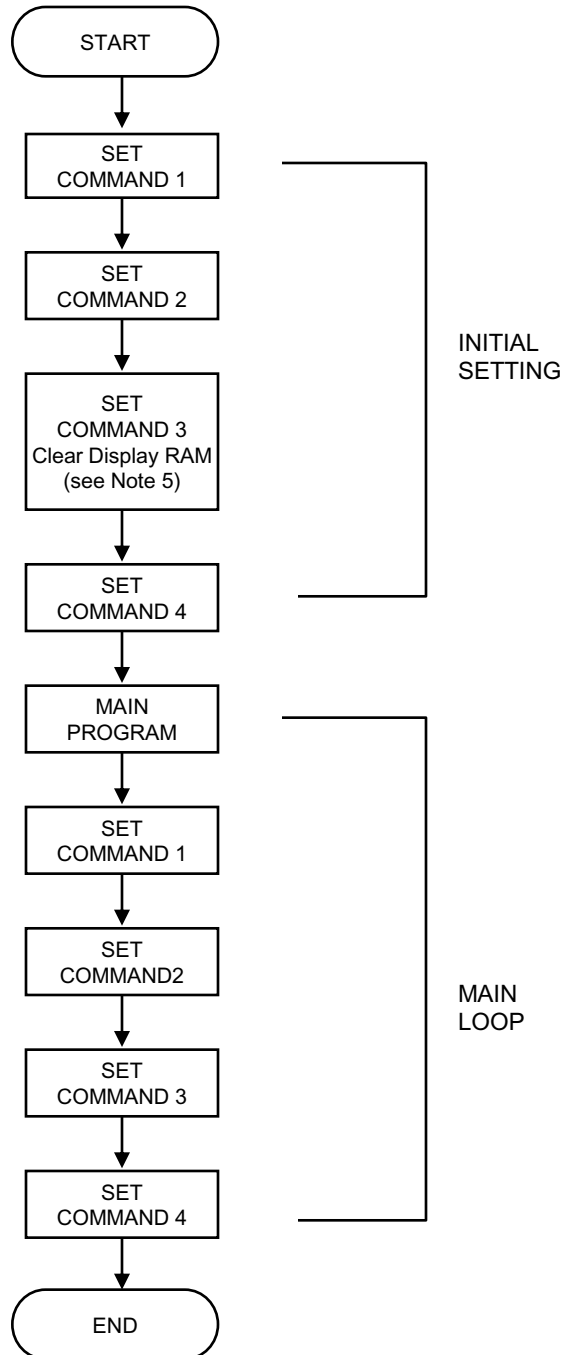

Where : Command 1 : Display Mode Setting
   Command 2 : Data Setting Command
   Command 3 : Address Setting Command
   Data 1 to n   : Transfer Display Data (14 Bytes max.)
   Command 4 : Display Control Command
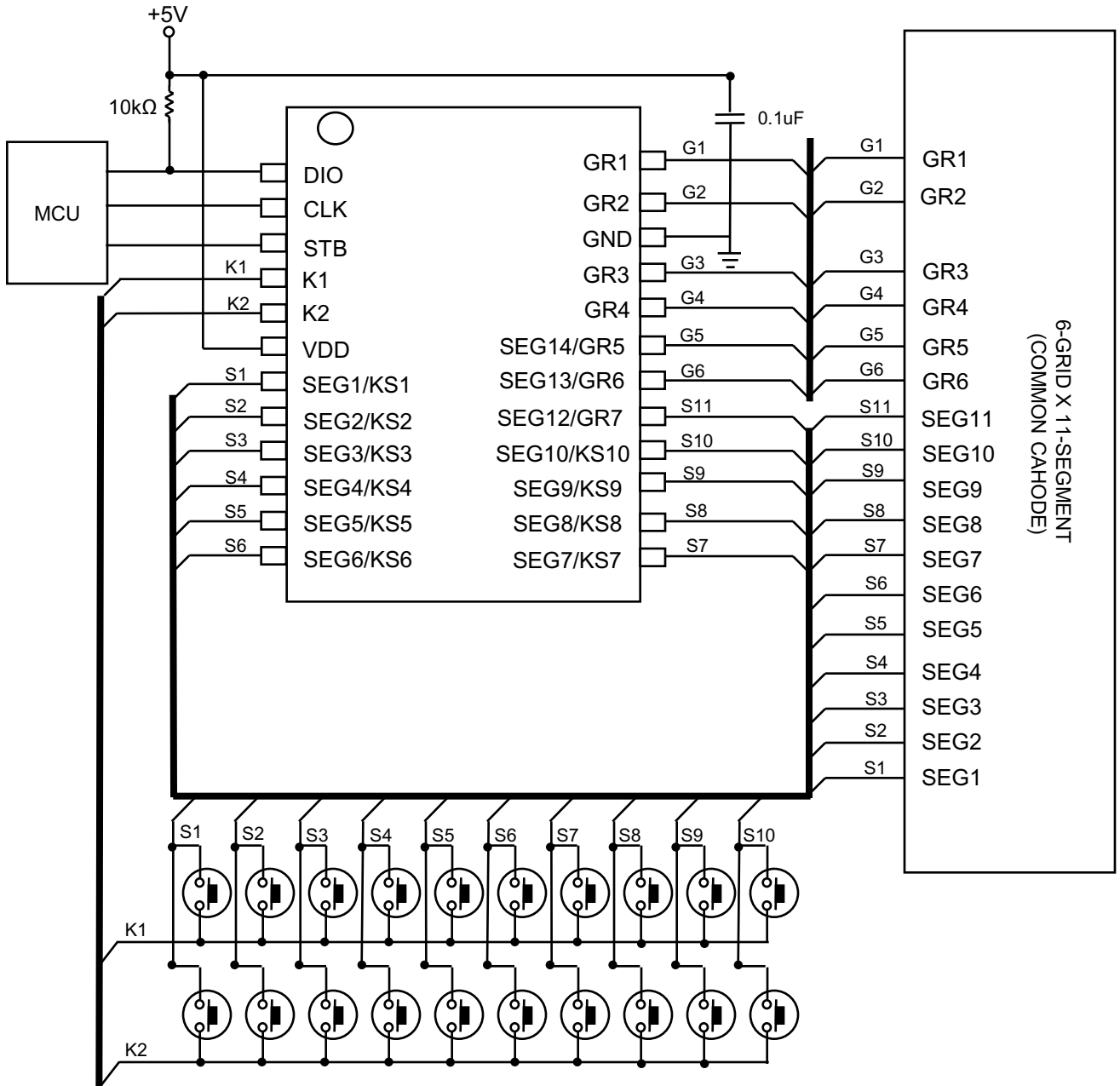
Memory updating timing diagram.

Where : Command 2 -- Data Setting Command
   Command 3 -- Address Setting Command
   Data -- Display Data
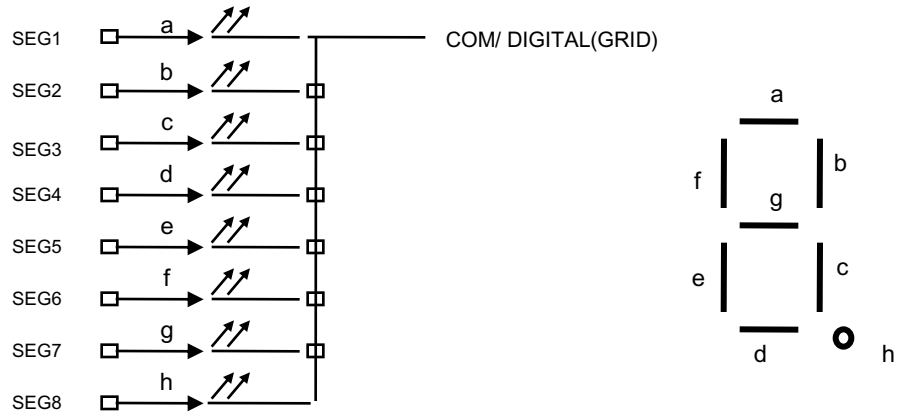
RECOMMENDED SOFTWARE PROGRAMMING FLOW CHART

- 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 24

Symbol	MIN	NOR	MAX
A1	2.25	2.45	2.65
A2	0.05	0.15	0.30
b	0.36	--	0.49
C	0.21	--	0.34
D	15.15	--	15.70
E	9.80	10.20	10.60
E1	7.40	--	7.65
e	--	1.27BSC	--
L	0.40	0.60	0.80
Θ	0°	--	8°

24 SOP Package Outline Dimension
(Dimensions in Millimeter)