ABOV SEMICONDUCTOR
11 SEGMENT X 7 GRID LED Driver with key scan

MC2301

Data Sheet (Ver. 4.1)

REVISION HISTORY

Please note that the referring page numbers in this section are referred to this document. The referring revision in this section are referring to the document revision.

VERSION 4.1 (2010. 04. 06) This Book.
Modified the Command 1 Setting Value.

VERSION 4.0 (2009. 07. 17)
Modified the Key scan data read sequence.

VERSION 3.3 (2009. 04. 20)
Modified the Dout of Transmission (Data Read) FORMAT.
Modified the Key scan data read sequence.

Ver. 3.2
Add SEG Pin resistance graph.(10page)
Add Key Scan example.(17page)

Ver. 3.1
Fixed some errata.

Ver. 3.0
19page : A capacitor value that is connected ground port was misprinted (0.1pF) in the previous datasheet and was changed to the right value (0.1uF)

Ver. 2.0
Logic Supply Voltage : min 4.5V → min 3V
14 page : Key Scan contents are changed.

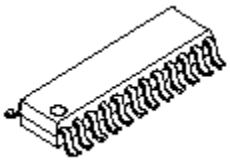
Ver. 1.0
Oscillation Frequency (fOSC) of “ELECTRICAL CHARACTERISTICS” is changed.
fOSC = 350(Min)→200(Min), 500(Typ) →350(Typ), 650(Max) → 500(Max)

Version 4.1

Published by FAE Team

DESCRIPTION

The MC2301 is specifically designed for LED and LED DISPLAY drivers.
The MC2301 has 12/11 segment output lines, 7 to 6 grid output lines, one display memory, control circuit, 4 line serial data interface, and 10 x 3 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.
MC2301's pin assignments and application circuit are optimized for easy PCB Layout and cost saving advantages.



SOP32

FEATURES

- CMOS Technology
- Segment output line selection by command : 11 ~ 12
- Grid output line selection by command : 7 ~ 6
- Operation voltage : 5V, 3V
- Low Power Consumption
- 8-Step Dimming control by command
- Serial Interface for Clock, Data Input, Strobe Pins, Data output
- 32-pin, SOP Package

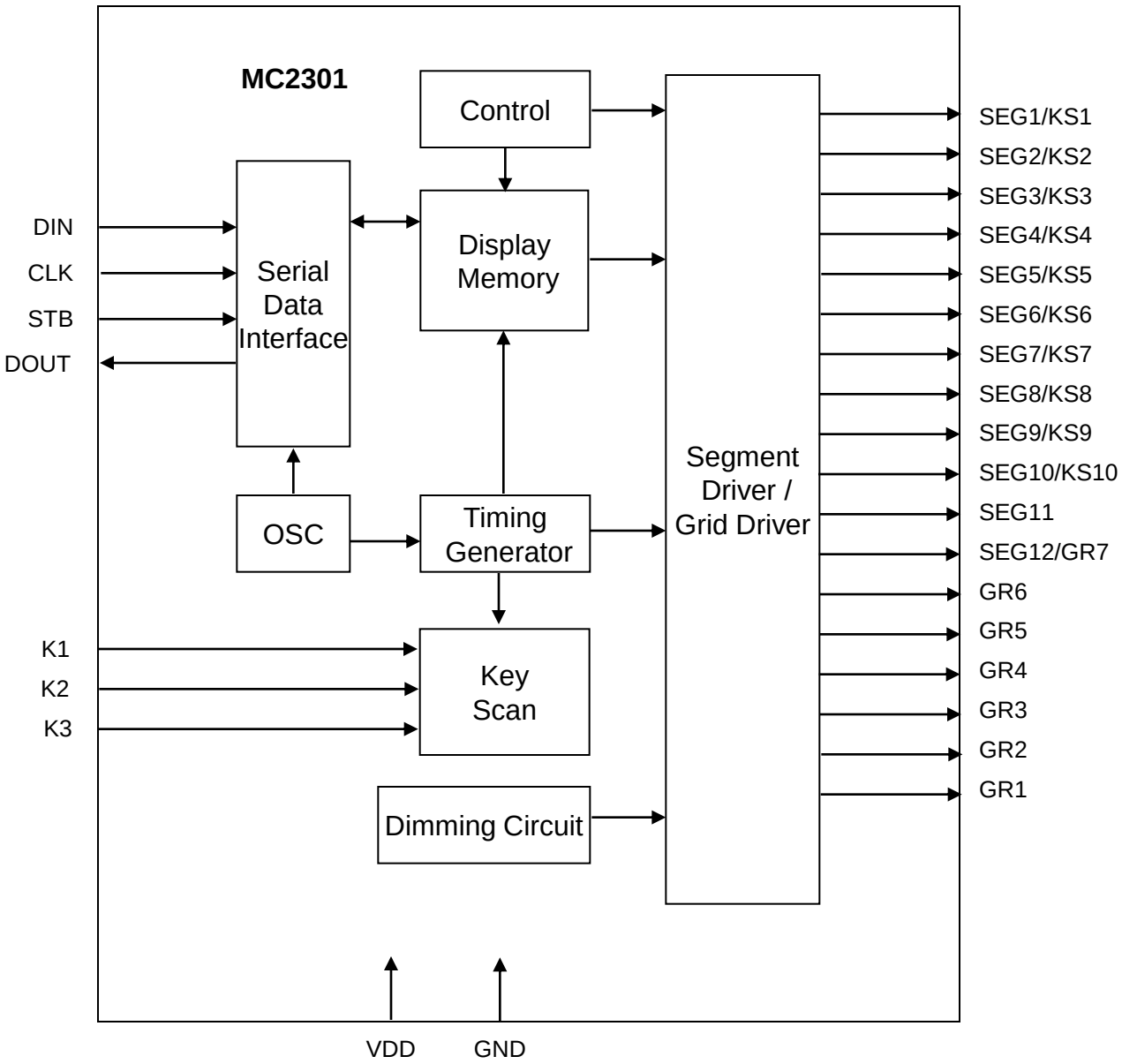
APPLICATION

- Segment LED display : VCR, DVD, MWO

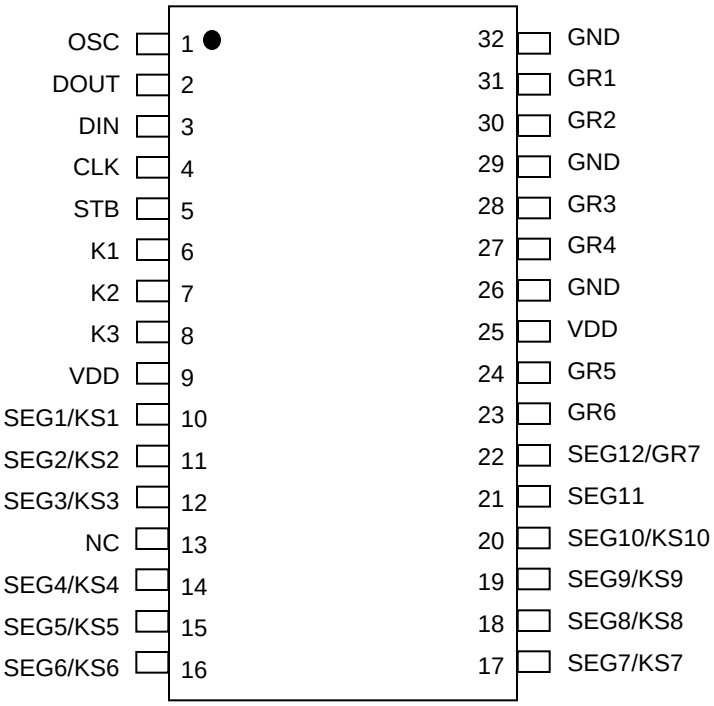
PIN DESCRIPTION

PIN NAME	I/O	DESCRIPTION	PIN No.
OSC	I	Oscillator Input pin. This pin is recommended open for operation.	1
DOUT	O	Serial Data Output Pin (N-channel open drain) This pin outputs at CLK falling edge.	2
DIN	I	Serial Data Input pin. This pin inputs serial data at the rising edge of CLK signal. LSB first input.	3
CLK	I	Serial clock input pin. Input data is trigger at rising edge. Output data is trigger at falling edge.	4
STB	I	When this pin is HIGH, CLK signal is ignored. The data input after the STB has fallen is processed as a command.	5
K1,K2,k3	I	Key scan input pins. This pins are operated with SEG1/KS1 to SEG10/KS10 pins. This pins have Pull down resistor internally.	6,7,8
VDD	-	Power Supply	9,25
SEG1/KS1 to SEG10/KS10	O	Segment output pins. (P-channel open drain) Also key scan source pins.	10 ~ 12 14 ~ 20
SEG11	O	Segment output pins. (P-channel open drain)	21
SEG12/GR7	O	Segment / Grid output pin.	22
GR6 to GR1	O	Grid output pins	23,24,27, 28,30,31
GND	-	Ground Pin	26,29,32
NC	-	No connection	13

BLOCK DIAGRAM

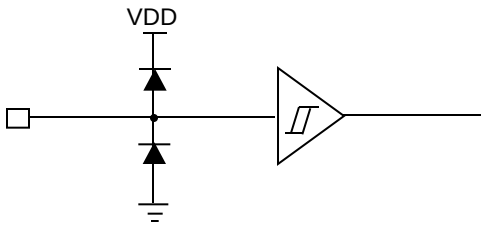


PIN CONFIGURATION

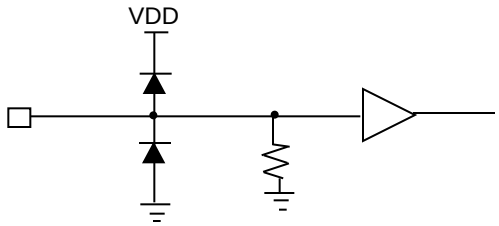


INPUT/OUTPUT PINS SCHEMATIC DIAGRAM

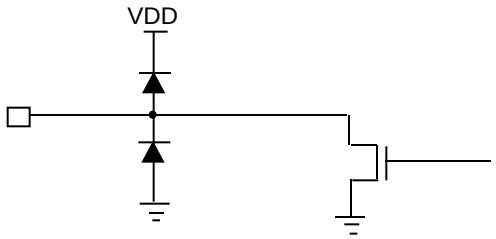
Input pins : CLK,STB,DIN



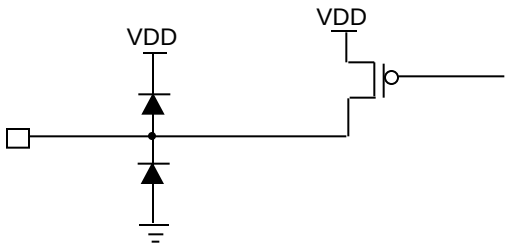
Input pins : K1,K2,K3



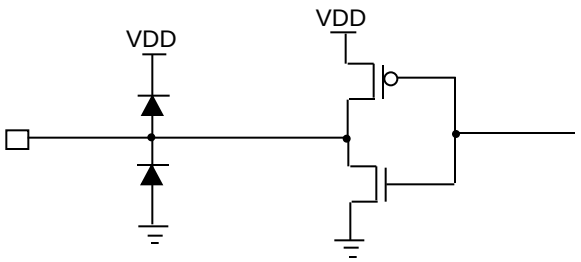
Output pins : DOUT, GR1 to GR6



Output pins : SEG1/KS1 to SEG10/KS10, SEG11



Output pin : SEG12/GR7



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= -20 to +70℃, GND=0V)

PARAMETER	SYMBOL	MIN.	TYP.	MAX.	UNIT
Logic Supply Voltage	VDD	3.0	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	.	0.2 VDD	V

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

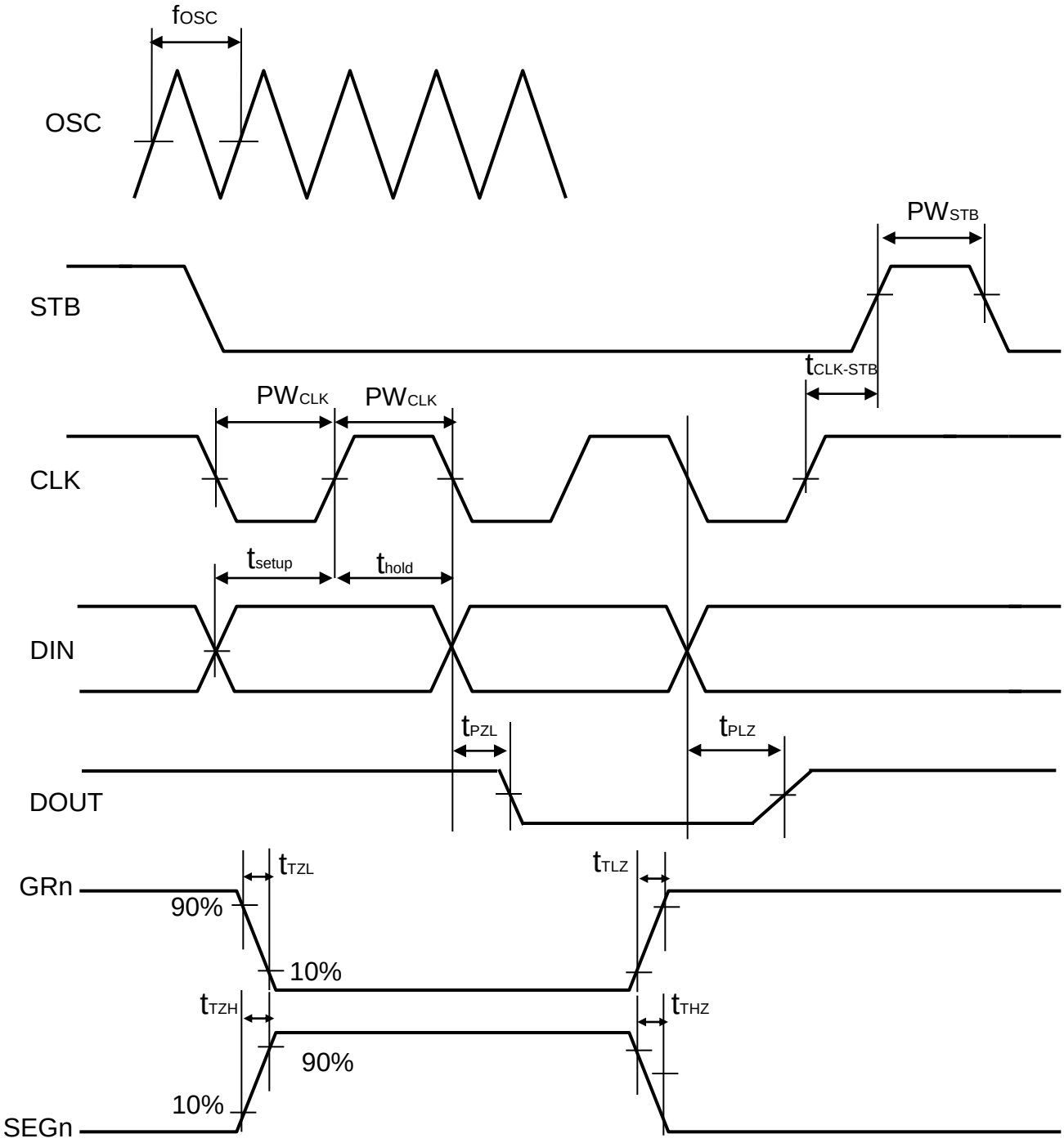
ELECTRICAL CHARACTERISTICS

(Unless otherwise stated, 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 SEG11. SEG12/GR7	-20	-25	-40	mA
	IOHSG2	$V_O = V_{DD}$ - 3V SEG1 to SEG11. SEG12/GR7	-25	-30	-50	mA
Low-Level Output Current	IOLGR	V_O = 0.3V GR1 TO GR6 SEG12/GR7	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	-	-	±5	%
High-Level Input Voltage	VIH	-	0.8VDD	-	VDD	V
Low-Level Input Voltage	VIL	-	0	-	0.2VDD	V
Oscillation Frequency	fOSC	-	200	350	500	kHz
K1 to K3 Pull Down Resistor	KSR	VDD=5V	40	-	100	kΩ

SWITCHING CHARACTERISTIC WAVEFORM

MC2301 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

FUNCTIONAL DESCRIPTION

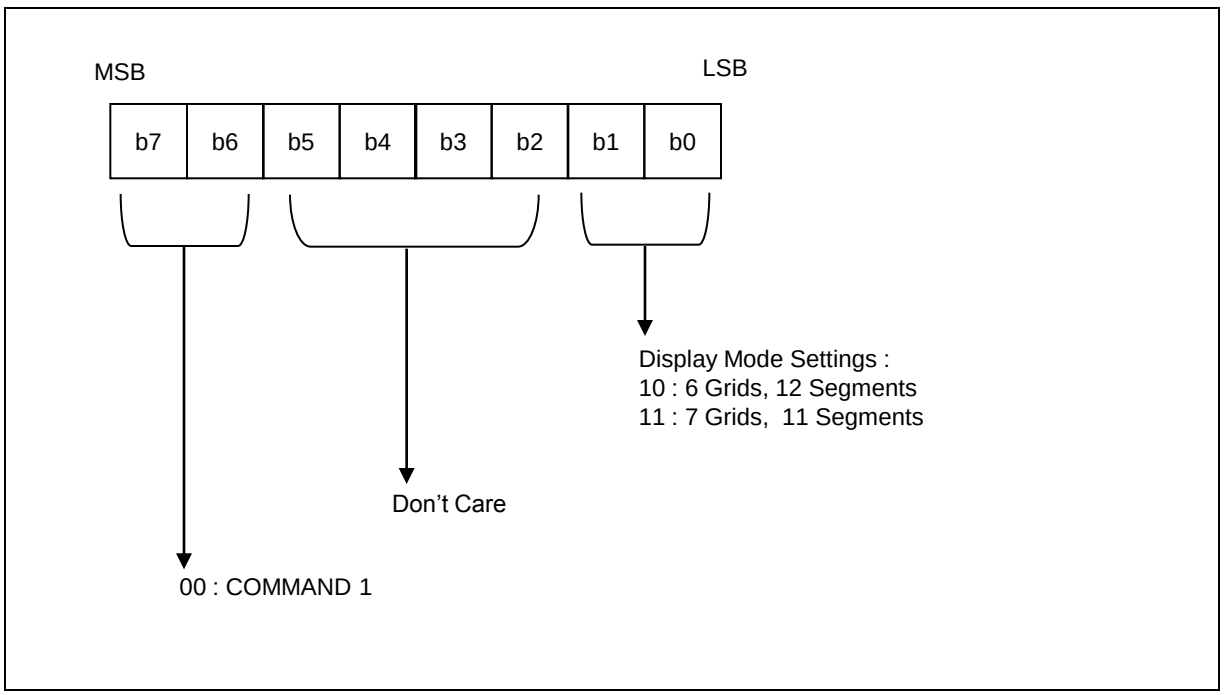
COMMANDS

The MC2301 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 4bits (b5 ~ b2) are don't care bit. The command bits (b7,b6) are "0","0" for COMMAND1.

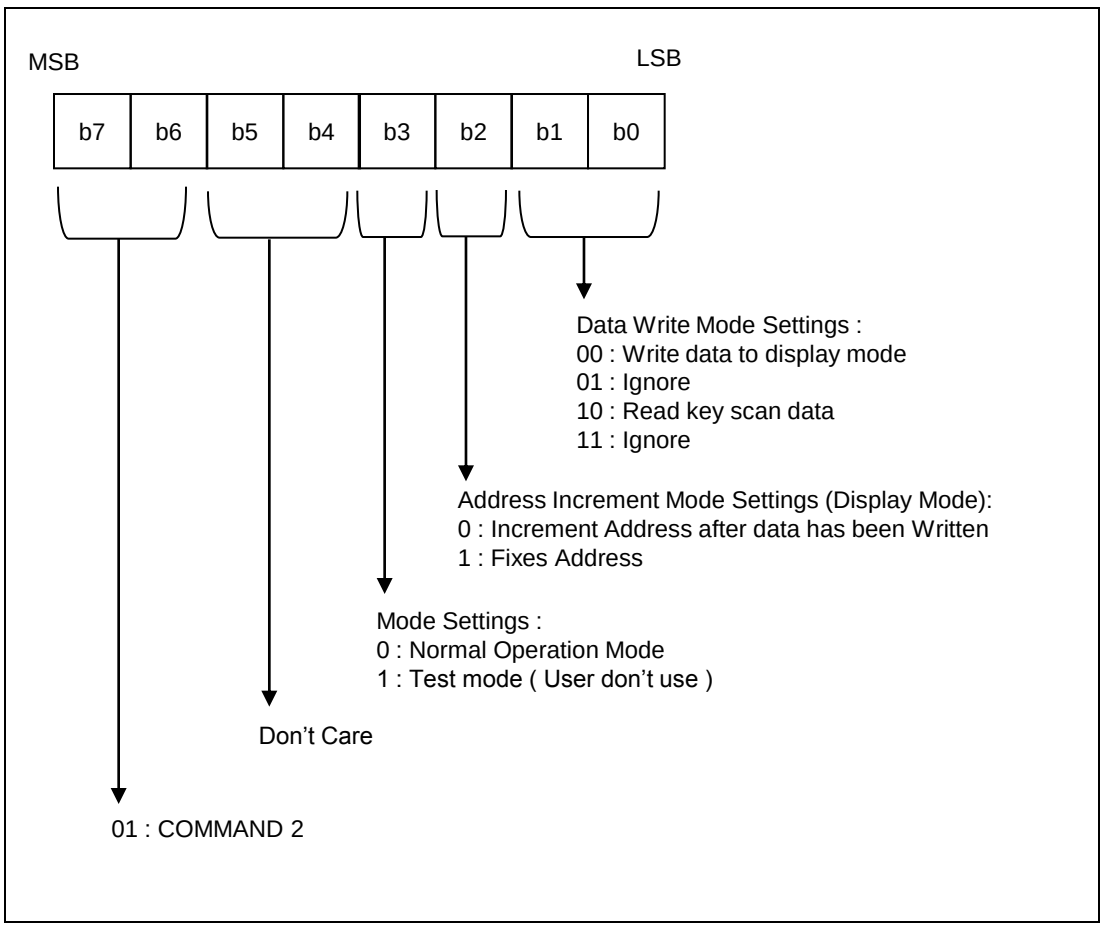
The display mode setting command determines the number of segments and grids. This command should be executed for display off. And the default of b1,b0 are "1","1" for power on. This status is selected 7 grids, 11 segments and key scan enable. If b1,b0 are "1","0" then 6 grids 12 segments and key scan enable selected. If b1,b0 are "0","1" or "0","0" then 6 grids 11 segments and key scan disable selected.



COMMAND 2 : DATA SETTING COMMAND

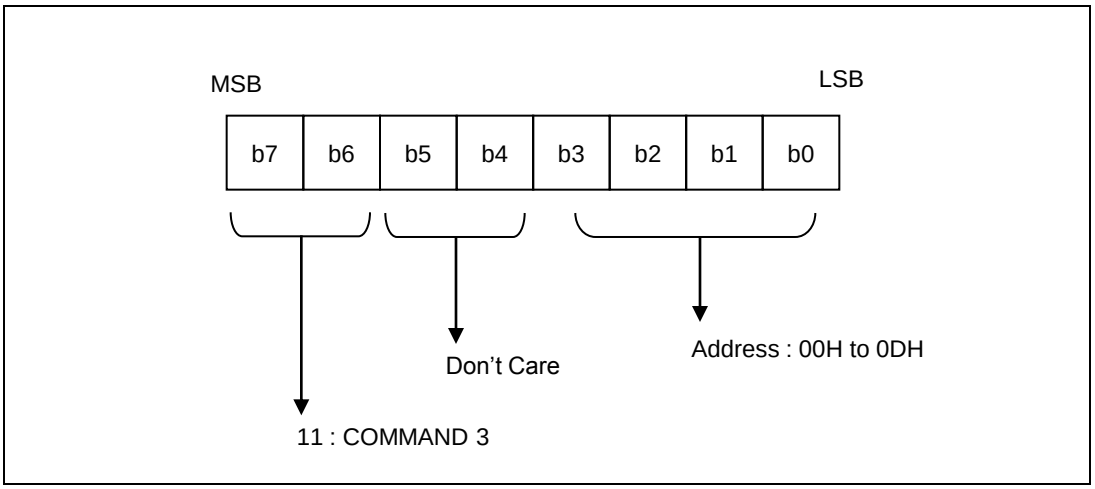
The data setting command consists of data write mode setting, address increment mode setting and mode setting . And the default of b3 to b0 are all “0” for power on.

The Data write mode settings have 2bit (b1,b0) for writing data to display mode and read key scan data. And address increment mode setting has 1bit (b2) for selecting address Increment or fixed. And mode setting has1bit (b3) for selecting normal operation or test mode. 2bits(b5,b4) are don’t care bits. 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

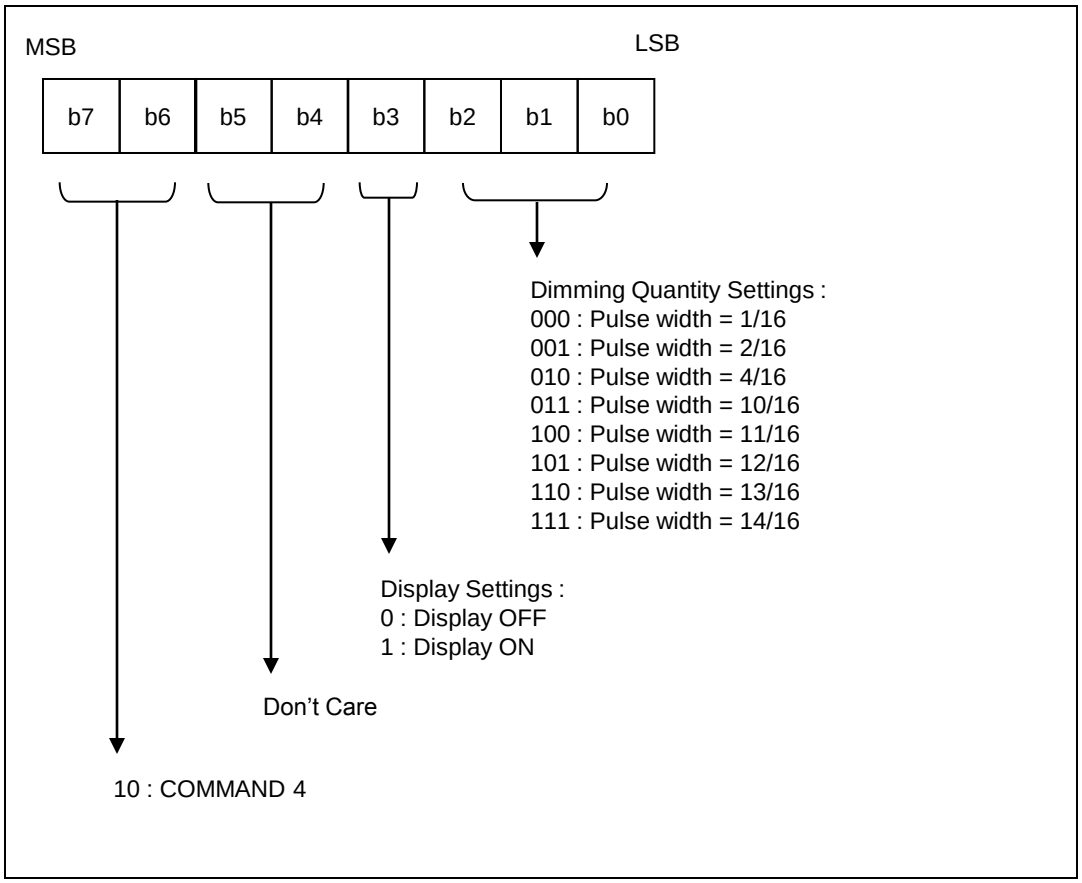
Data transmitted from an external device to MC2301 via the serial interface are stored in the Display RAM and are assigned addresses. The RAM Addresses of MC2301 are given below in 8 bit unit.

SEG1 SEG4	SEG5 SEG8	SEG9 SEG12	
$00H_L$	$00H_U$	$01H_L$	DIG1
$02H_L$	$02H_U$	$03H_L$	DIG2
$04H_L$	$04H_U$	$05H_L$	DIG3
$06H_L$	$06H_U$	$07H_L$	DIG4
$08H_L$	$08H_U$	$09H_L$	DIG5
$0AH_L$	$0AH_U$	$0BH_L$	DIG6
$0CH_L$	$0CH_U$	$0DH_L$	DIG7

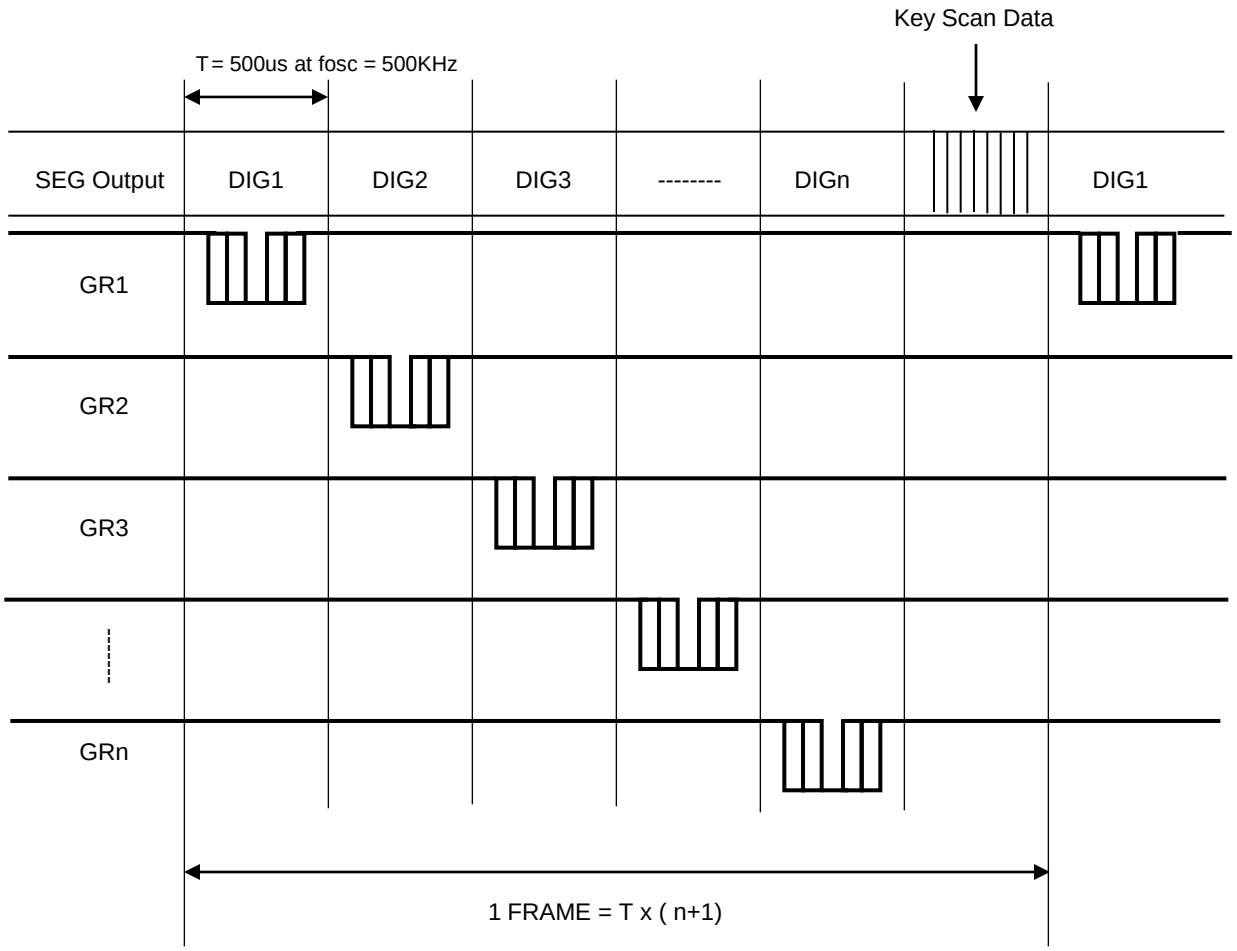
b0 b3	b4 b7
xxH_L	xxH_U
Lower 4 bits	Higher 4 bits

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.



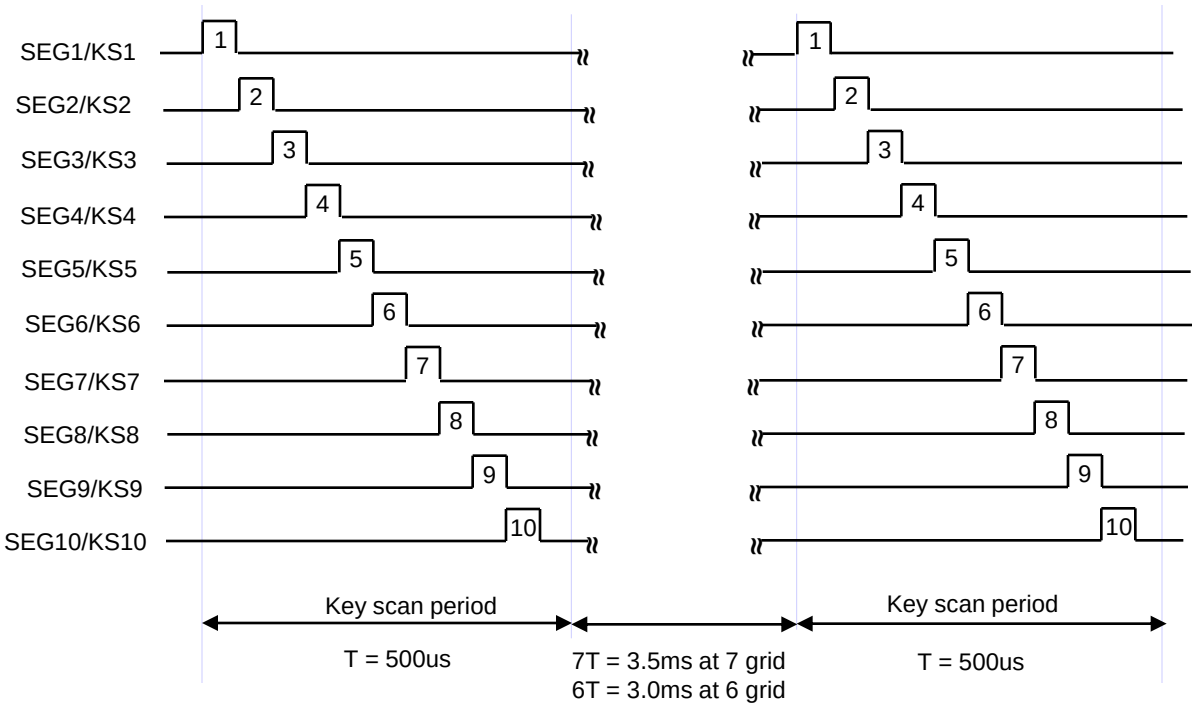
DISPLAY TIMING WAVEFORM



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

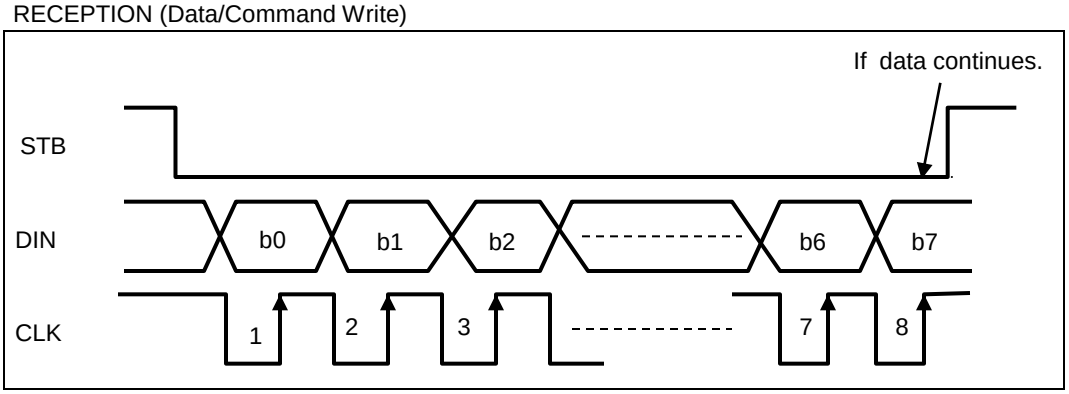
K1	K2	K3	K1	K2	K3			
SEG1/KS1			SEG2/KS2			0	0	1'st byte read
SEG3/KS3			SEG4/KS4			0	0	2'nd byte read
SEG5/KS5			SEG6/KS6			0	0	3'rd byte read
SEG7/KS7			SEG8/KS8			0	0	4'th byte read
SEG9/KS9			SEG10/KS10			0	0	5'th byte read
SEG11/KS11			X			0	0	6'th byte read
b0	b1	b2	b3	b4	b5	b6	b7	

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

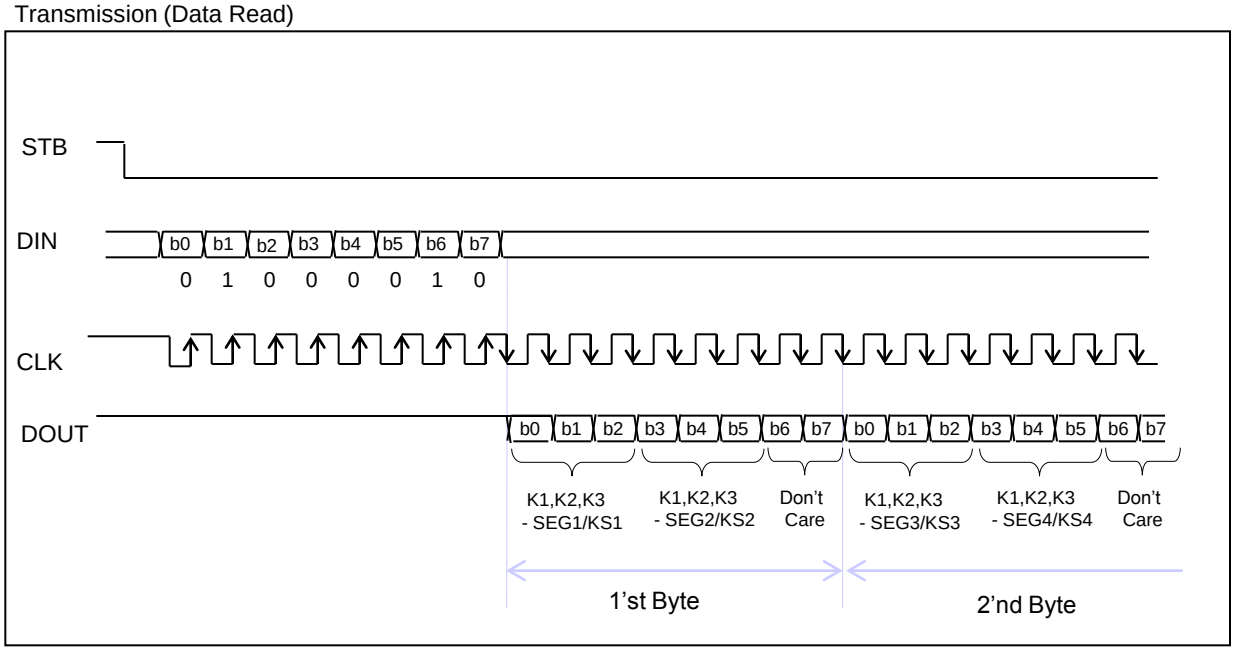
SERIAL COMMUMICATION FORMAT

The following diagram shows the MC2301 serial communication format.

RECEPTION (Data/Command Write)

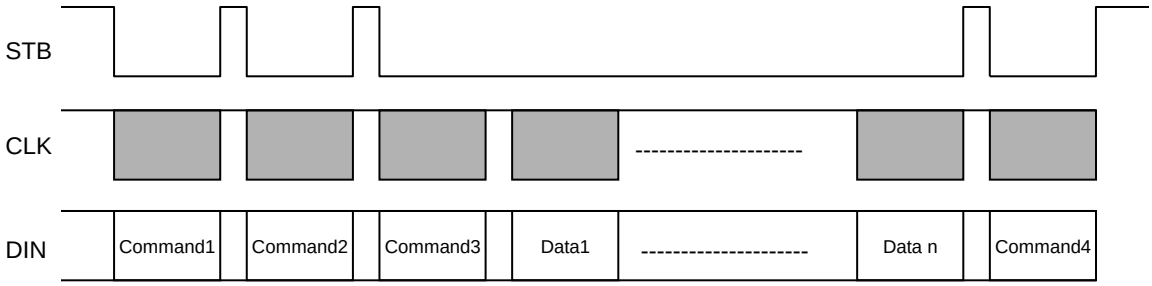


Transmission (Data Read)



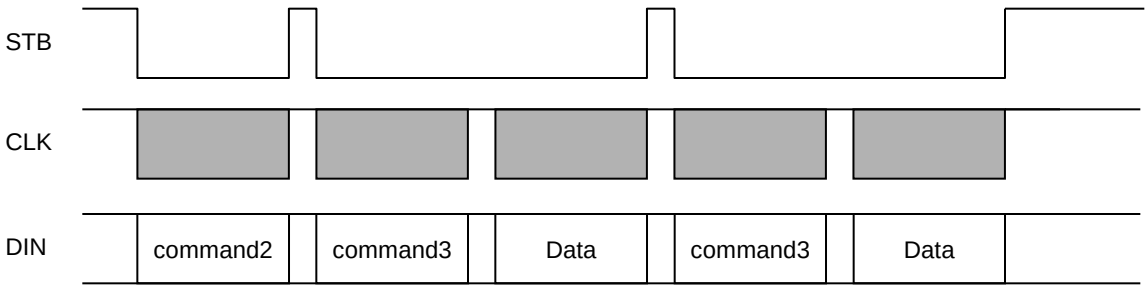
SERIAL COMMUNICATION EXAMPLES

Serial communication timing diagram for initialization setting.



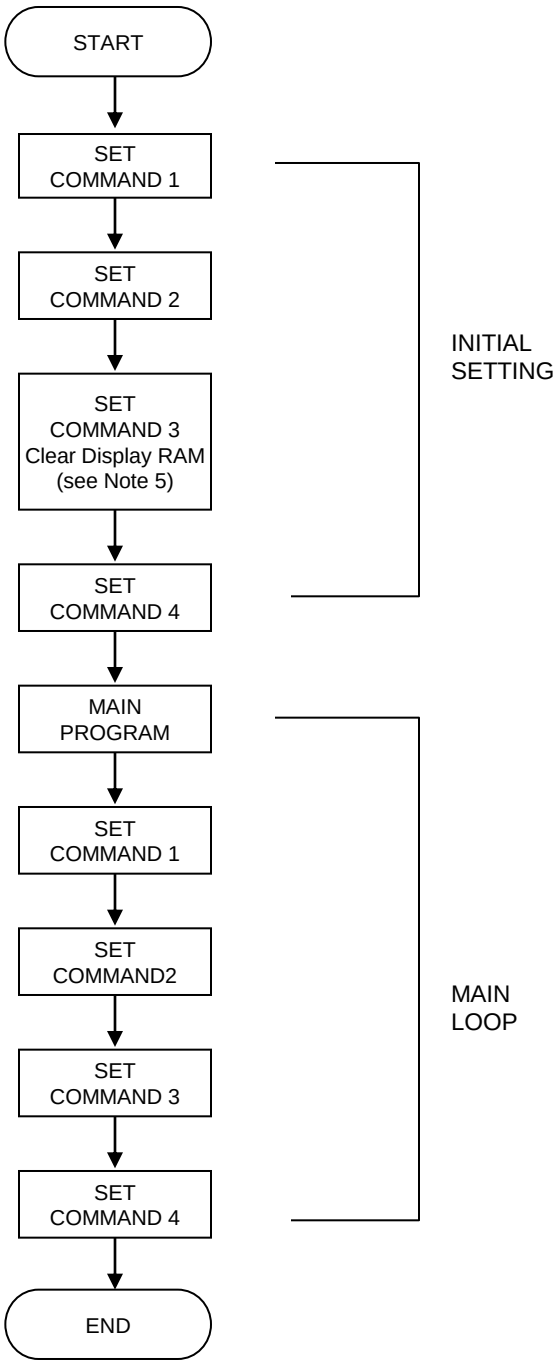
Where : Command 1 : Display Mode Setting
Command 2 : Data Setting Command
Command 3 : Address Setting Command
Data 1 to n : Transfer Display Data (14 Bytes max.)
Command 4 : Display Control Command

Memory updating timing diagram.



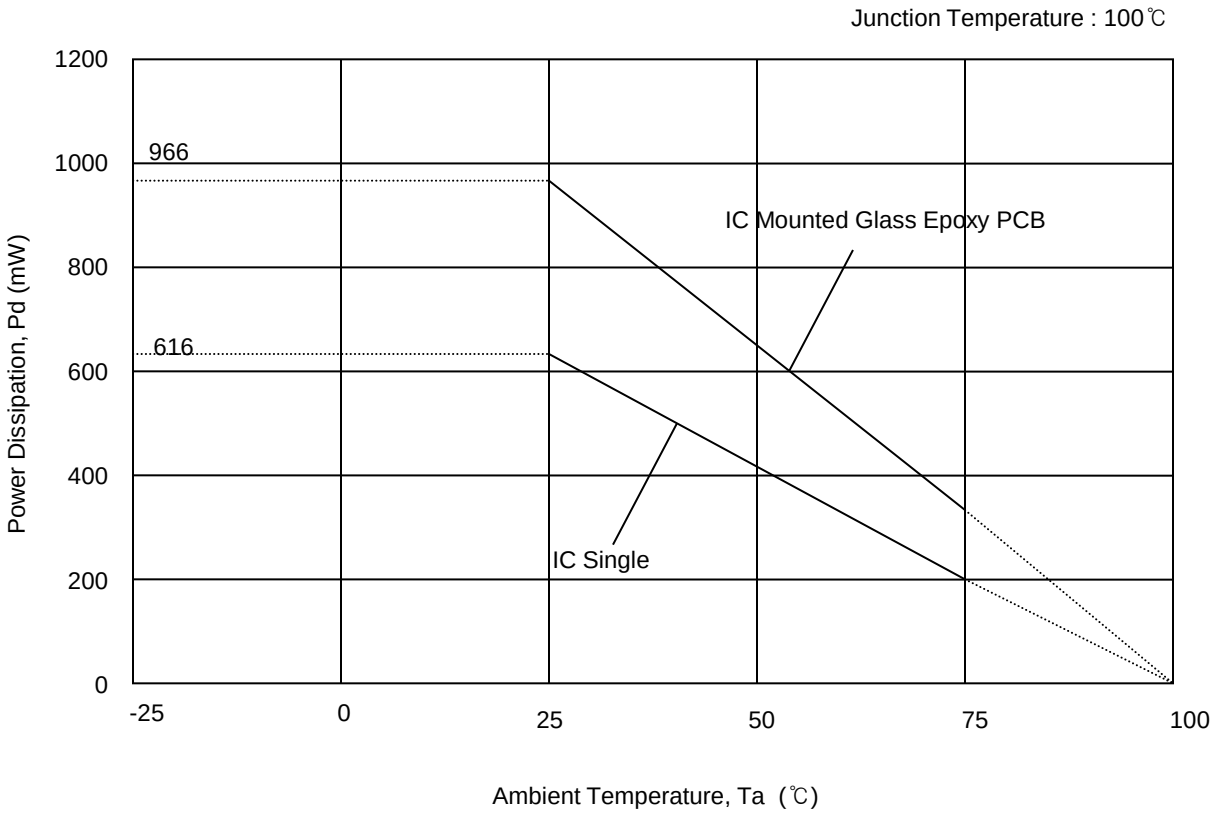
Where : Command 2 -- Data Setting Command
Command 3 -- Address Setting Command
Data -- Display Data

RECOMMENDED SOFTWARE PROGRAMMING FLOW CHART

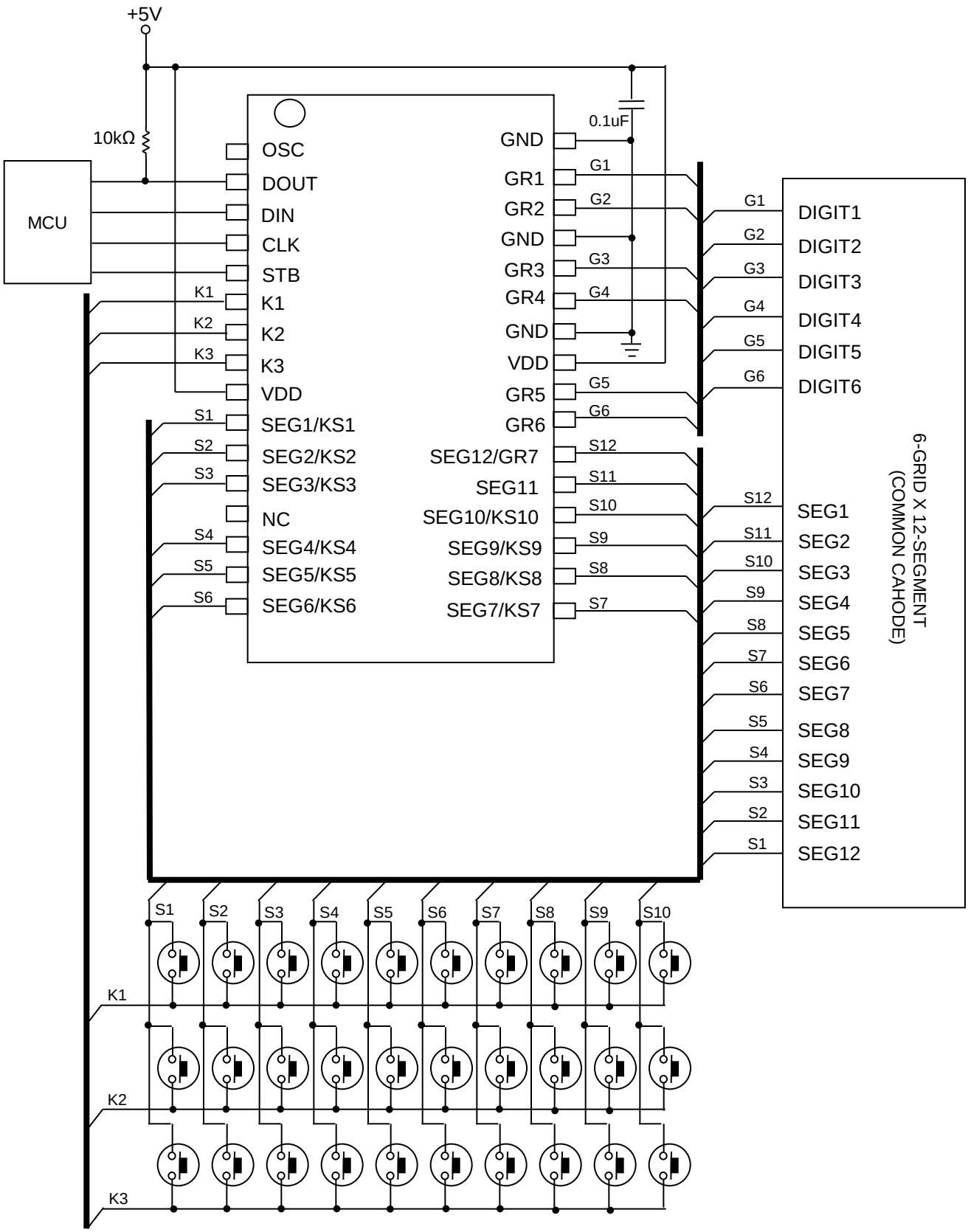


- Note : 1. Command 1 : Display Mode Setting
  2. Command 2 : Data Setting Commands
  3. Command 3 : Address Setting Commands
  4. Command 4 : Display Control Commands
  5. When IC power is applied for the first time, the contents of the Display RAM are not defined : thus, it is strongly suggested that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

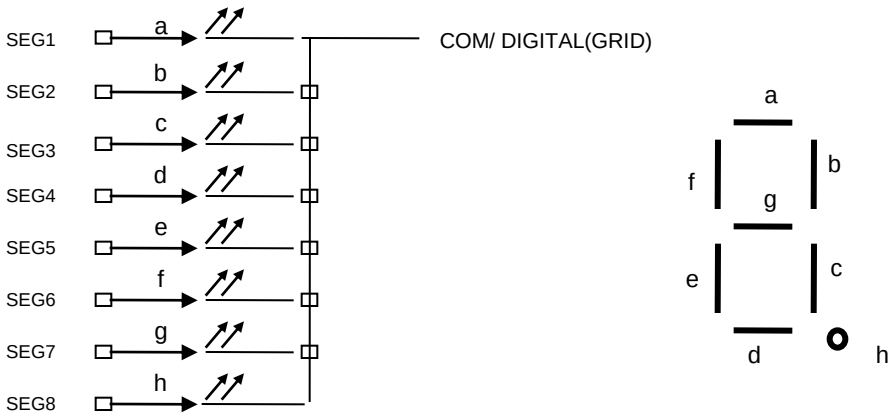
SOP 32 (300 MIL) THERMAL PERFORMANCE IN STILL AIR



TYPICAL APPLICATION CIRCUIT



LED PANEL FOR CATHODE TYPE



PACKAGE INFORMATION

SOP 32

Unit : mm