

**LED DRIVER**

**TM1628**

**DESCRIPTION**

TM1628 is an LED Controller driven on a 1/7 to 1/8 duty factor. Eleven segment output lines, six grid output lines, 1 segment/grid output lines, one display memory, control circuit, key scan circuit are all incorporated into a single chip to build a highly reliable peripheral device for a single chip microcomputer. Serial data is fed to TM1628 via a three-line serial interface. Housed in a 28-pin SO Package, TM1628 pin assignments and application circuit are optimized for easy PCB Layout and cost saving advantages.

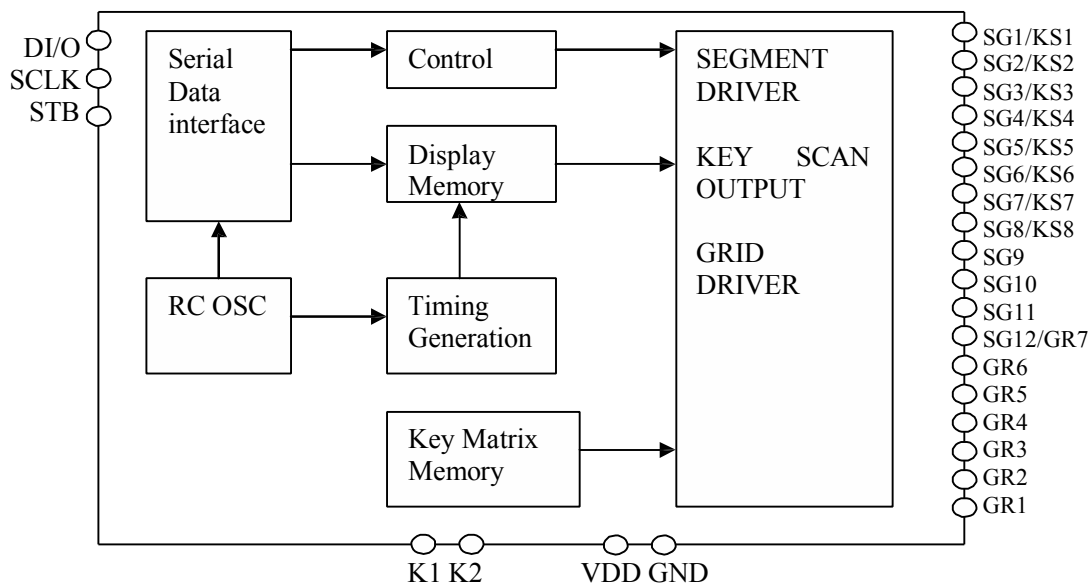
**FEATURES**

- CMOS Technology
- Low Power Consumption
- Multiple Display Modes (12 segment, 6 Grid to 11 segment, 7 Grid)
- Key Scanning (8 x 2 Matrix)
- 8-Step Dimming Circuitry
- Serial Interface for Clock, Data Input/Output, Strobe Pins
- Available in 28-pin, SOP Package

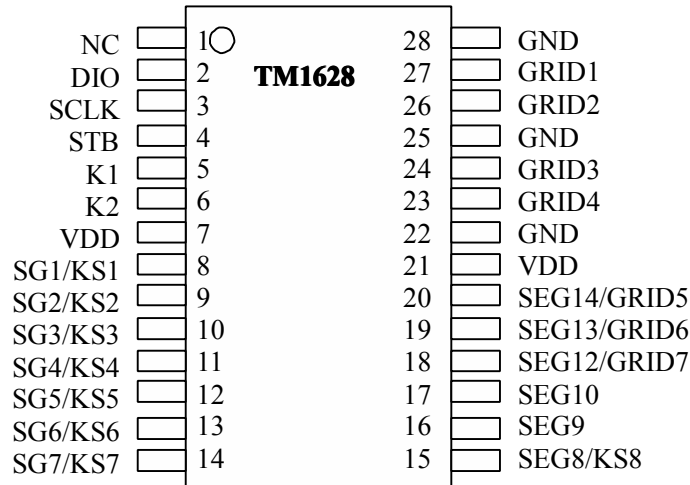
**APPLICATION**

- Micro-computer Peripheral Device
- VCR set
- Combi set

**BLOCK DIAGRAM**



## PIN CONFIGURATION



## PIN DESCRIPTION

Pin Name	I/O	Description	Pin No.
DIO	I/O	Data Input Output Pin ( N-Channel , Open-Drain) This pin outputs serial data at the falling edge of the shift clock. This pin inputs serial data at the rising edge of the shift clock (starting from the lower bit)	2
SCLK	I	Clock Input Pin This pin reads serial data at the rising edge and outputs data at the falling edge.	3
STB	I	Serial Interface Strobe Pin The data input after the STB has fallen is processed as a command. When t his pin is "HIGH", CLK is ignored.	4
K1, K2	I	Key Data Input Pins The data sent to these pins are latched at the end of the display cycle.(Internal Pull-Low Resistor)	5, 6
GND	-	Ground Pin	22, 25, 28
SEG1-SEG8	O	Segment Output Pins (p - channel, open drain) Also acts as the Key Source	8-15
SEG9-SEG10	O	Segment Output pins (P-Channel, open drain)	16, 17
SG12-SEG14	O	Segment/Grid Output Pins	18-20
VDD	-	Power Supply	21
GRID1-GRID4	O	Grid Output Pins	23, 24, 26, 27
1		No Connection	1

## FUNCTIONAL DESCRIPTION

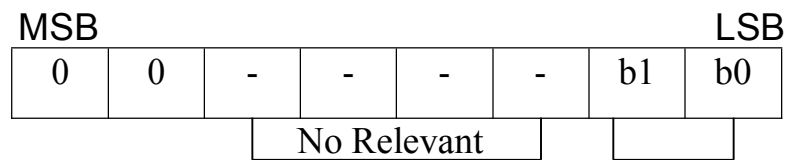
### COMMANDS

A command is the first byte (b0 to b7) inputted to TM1628 via the DIN Pin after STB Pin has changed from HIGH to LOW State. If for some reason the STB Pin is set to HIGH while data or commands are being transmitted, the serial communication is initialized, and the data/commands being transmitted are considered invalid.

#### **Command 1: Display Mode Setting Commands**

TM1628 provides 2 display mode settings as shown in the diagram below: As stated earlier a command is the first one byte (b0 to b7) transmitted to TM1628 via the DIN Pin when STB is LOW. However, for these commands, the bit 3 to bit 6 (b2 to b5) are ignored, bit 7 & bit 8 (b6 to b7) are given a value of 0.

The Display Mode Setting Commands determine the number of segments and grids to be used (12 to 11 segments, 6 to 7 grids). A display command ON must be executed in order to resume display. If the same mode setting is selected, no command execution is take place, therefore, nothing happens. When Power is turned ON, the 7-grid , 11-segment modes is selected.

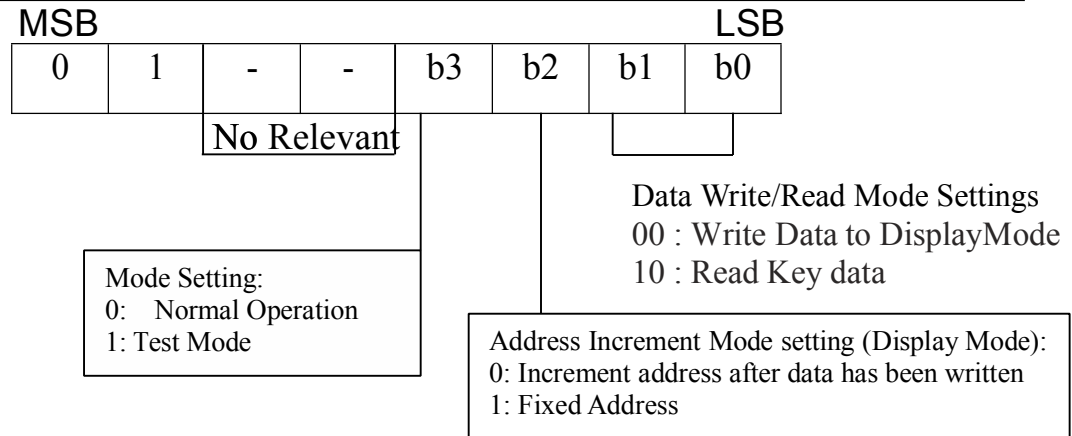


Display Mode Settings  
 10 : 6 Grids, 12 Segments  
 11 : 7 Grids, 11 Segments

#### **Command 2: Data Setting Commands**

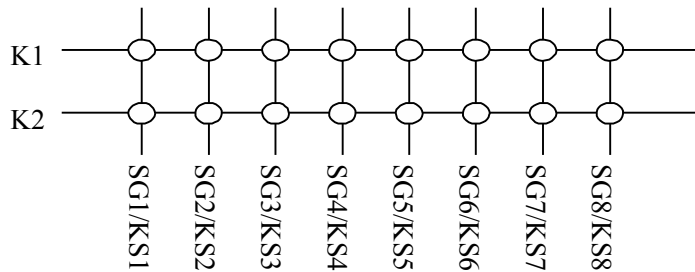
The Data Setting Commands executes the Data Write or Data Read Modes for TM1628. The data Setting Command, the bits 5 and 6 (b4, b5) are ignored, bit 7 (b6) is given the value of 1 while bit 8 (b7) is given the value of 0. Please refer to the diagram below.

When power is turned ON, bit 4 to bit 1 (b3 to b0) are given the value of 0.



**TM1628 KEY MATRIX & KEY INPUT DATA STORAGE RAM**

TM1628 Key Matrix consists of 8 x 2 array as shown below:



Each data entered by each key is stored as follows and read by a READ Command, starting from the last significant bit. When the most significant bit of the data (b0) has been read, the least significant bit of the next data (b7) is read.

K1	K2	K1	K2					
SG1/KS1		SG2/KS2		x				
SG3/KS3		SG4/KS4		x				
SG5/KS5		SG6/KS6		x				
SG7/KS7		SG8/KS8		x				
b0	b1	b2	b3	b4	b5	b6	b7	

READING  
SEQUENCE  
↓

Note: b6 and b7 do not care.

**Command 3: Address Setting Commands**

Address Setting Commands are used to set the address of the display memory. The address is considered valid if it has a value of 00H to 0DH. If the address is set to 0EH or higher, the data is ignored until a valid address is

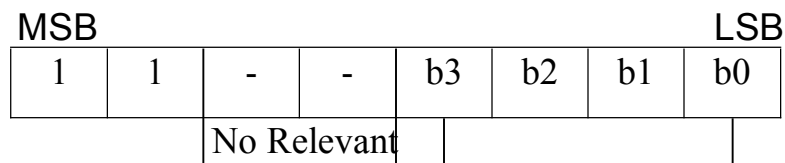
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set. When power is turned ON, the address is set at 00H.  
 Please refer to the diagram below.



Address: 00H to 0DH

**DISPLAY MODE AND RAM ADDRESS**

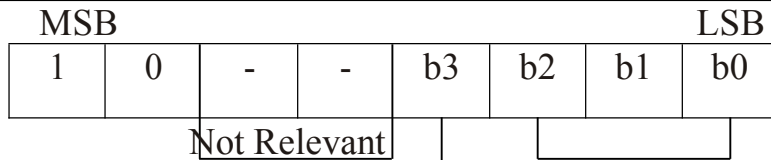
Data transmitted from an external device to TM1628 via the serial interface are stored in the Display RAM and are assigned addresses. The RAM addresses of TM1628 are given below in 8 bits unit.

SG1-SG4	SG5-SG8	SG9-SG12	
00HL	00HU	01HL	DIG1
02HL	02HU	03HL	DIG2
04HL	04HU	05HL	DIG3
06HL	06HU	07HL	DIG4
08HL	08HU	09HL	DIG5
0AHL	0AHU	0BHL	DIG6
0CHL	0CHU	0DHL	DIG7



**Command 4: Display Control Commands**

The Display Control Commands are used to turn ON or OFF a display. It 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 displayed is turned OFF (the key scanning is started).



**Dimming Quantity Settings:**

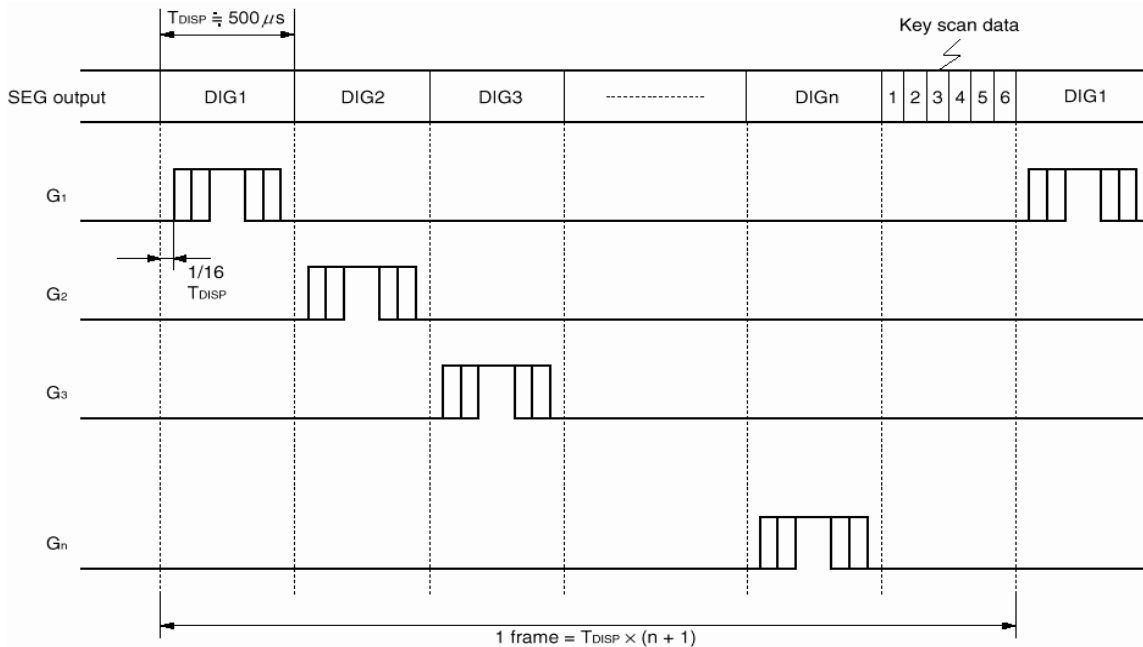
- 000: Pulse width = 1/16
- 001: Pulse width = 2/16
- 010: Pulse width = 4/16
- 011: Pulse width = 10/16
- 100: Pulse width = 11/16
- 101: Pulse width = 12/16
- 110: Pulse width = 13/16
- 111: Pulse width = 14/16

**Display Settings:**

- 0: Display OFF (Key Scan Continues)
- 1: Display ON

**SCANNING AND DISPLAY TIMING**

The Key Scanning and Display Timing diagram is given below. One cycle of key scanning consists of 2 frames. The data of the are 8x 2 matrix is stored in the RAM.



**SERIAL COMMUNICATION FORMAT**

The following diagram shows the TM1628 serial communication format. The DOUT Pin is an N-channel, open drain output pin, therefore, it

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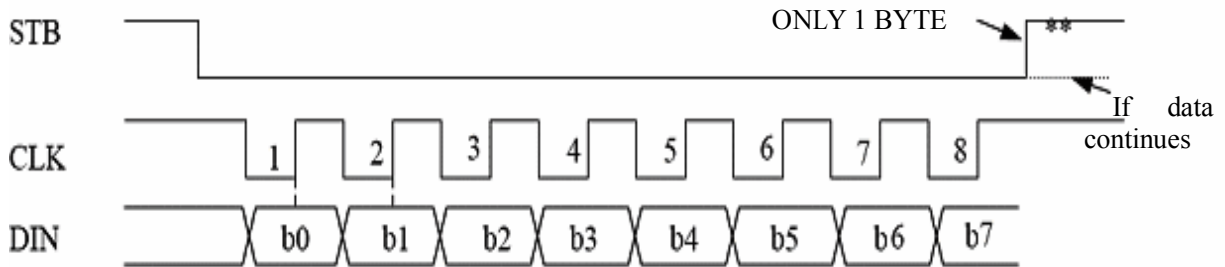
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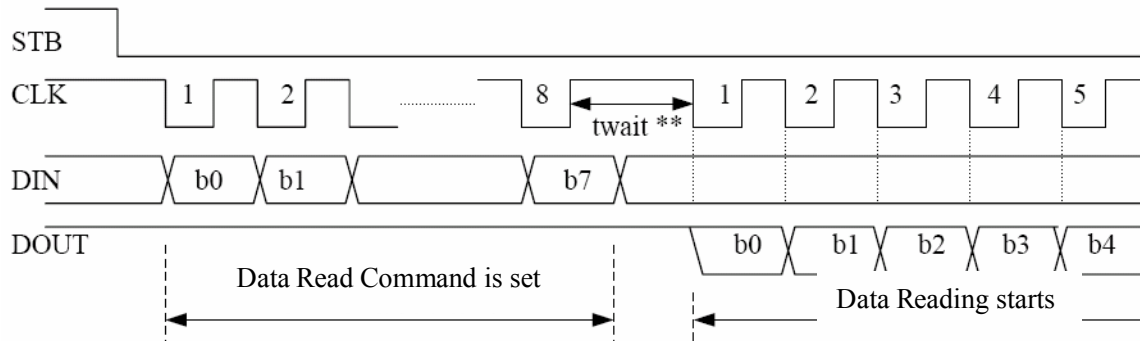
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is highly recommended that an external pull-up resistor (1 KOhms to 10 KOhms) must be connected to DIO.

Reception (Data/Command Write)



Transmission (Data/Read)

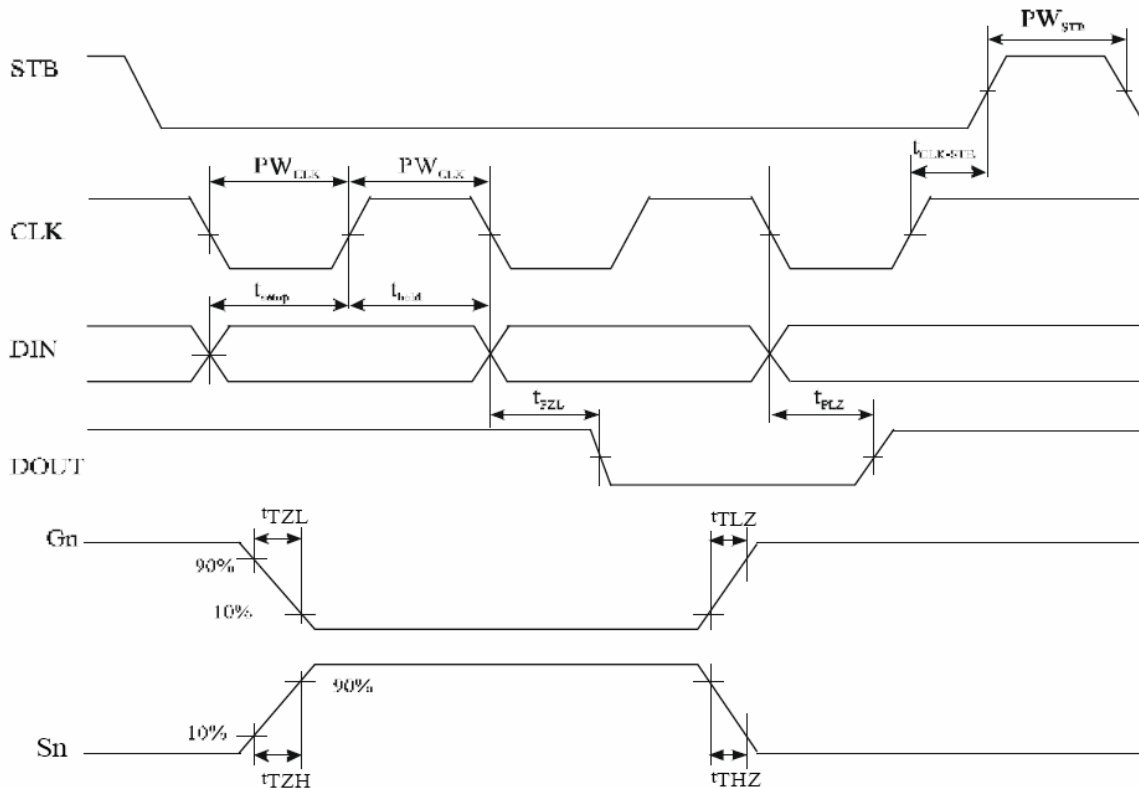


where:  $t_{wait}$  (waiting time)  $> 1\mu s$

It must be noted that when the data is read, the waiting time( $t_{wait}$ ) wait between the rising of the eighth clock that has set the command and the falling of the first clock that has read the data is greater or equal to  $1\mu s$ .

## **SWITCHING CHARACTERISTIC WAVEFORM**

TM1628 Switching Characteristics Waveform is given below.



where:  $PW_{CLK}$ (Clock Pulse Width) $\geq 400ns$        $PW_{STB}$ (Strobe Pulse Width) $\geq 1\mu s$   
 $t_{setup}$ (Data Setup Time) $\geq 100ns$        $t_{hold}$ (Data Hold Time) $\geq 100ns$   
 $t_{CLK-STB}$ (Clock-Strobe Time) $\geq 1\mu s$        $t_{THZ}$ (Fall Time) $\leq 10\mu s$   
 $t_{TZL}$ (Rise Time) $\leq 1\mu s$        $t_{PZL}$ (Propagation Delay Time) $\leq 100ns$   
 $f_{osc}$ =Oscillation Frequency       $t_{PLZ}$ (Propagation Delay Time) $\leq 300ns$   
 $t_{TZL} < 1\mu s$        $t_{TLZ} < 10\mu s$

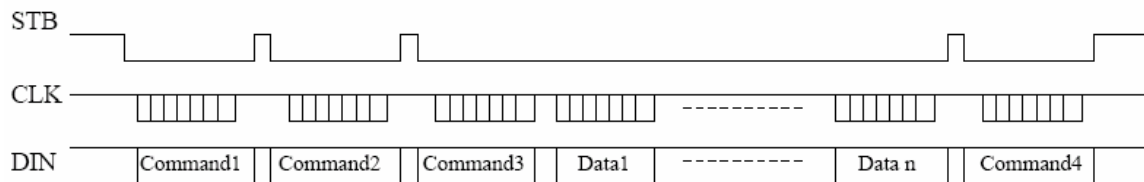
Note: Test condition under

$t_{THZ}$  (Pull low resistor=10k ohms, Loading capacitor=300pf)

$t_{TLZ}$  (Pull high resistor=10k ohms, Loading capacitor=300pf)

## APPLICATIONS

Display memory is updated by incrementing addresses. Please refer to the following diagram.



where: Command 1: Display Mode Setting Command

Command 2: Data Setting Command

Command 3: Address Setting Command

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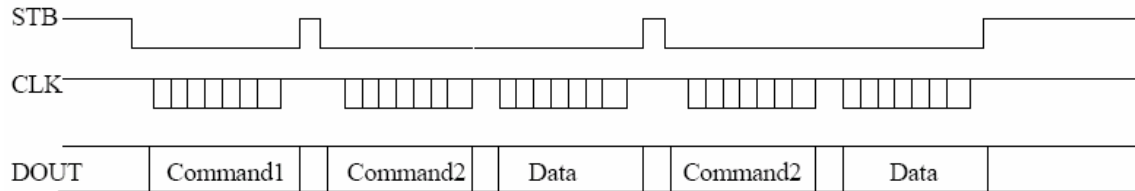
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Data 1 to n : Transfer Display Data (14 Bytes max.)

Command 4: Display Control Command

The following diagram shows the waveforms when updating specific addresses.



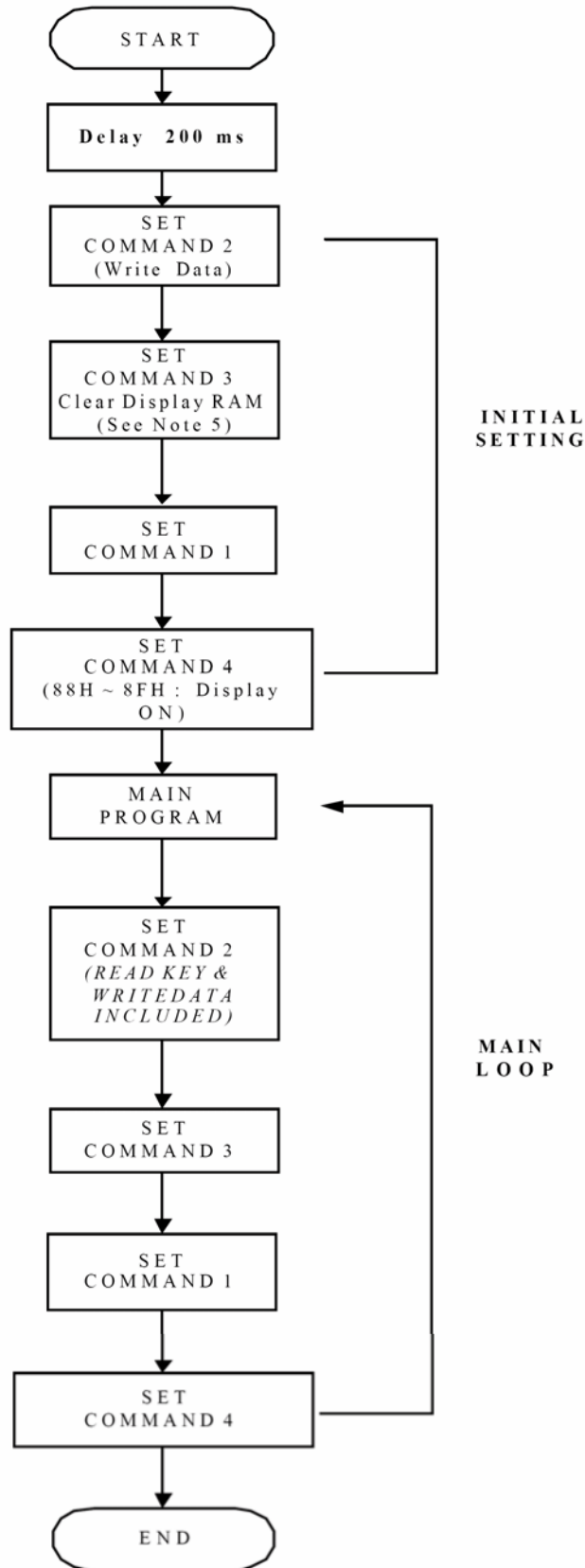
Command1: Data Setting Command

Command2: Address Setting Command

Data : Display Data

## **RECOMMENDED SOFTWARE PROGRAMMING FLOWCHART**

- Note:
1. Command 1: Display Mode Commands
  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 is not defined; thus, it is strongly suggested that the contents of the Display RAM must be cleared during the initial setting.



## ABSOLUTE MAXIMUM RATINGS

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

Parameter	Symbol	Ratings	Unit
Supply Voltage	$V_{DD}$	-0.5 to +7	Volts
Logic Input Voltage	$V_I$	-0.5 to $V_{DD} + 0.5$	Volts
Driver Output Current	$I_{OLGR}$	+250	mA
	$I_{OHSG}$	-50	mA
Maximum Driver Output Current / Total	$I_{TOTAL}$	400	mA

## RECOMMENDED OPERATING RANGE

(Unless otherwise stated, Ta=-20 to +70°C, GND=0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Logic Supply Voltage	$V_{DD}$	4.5	5	5.5	V
Dynamic Current ( see Note )	$I_{DDdyn}$	-	-	5	mA
High-Level Input Voltage	$V_{IH}$	0.8 $V_{DD}$	-	$V_{DD}$	V
Low-Level Input Voltage	$V_{IL}$	0	-	0.3 $V_{DD}$	V

Note: Test Condition: Set Display Control Commands = 80H (Display Turn OFF State & under no load)

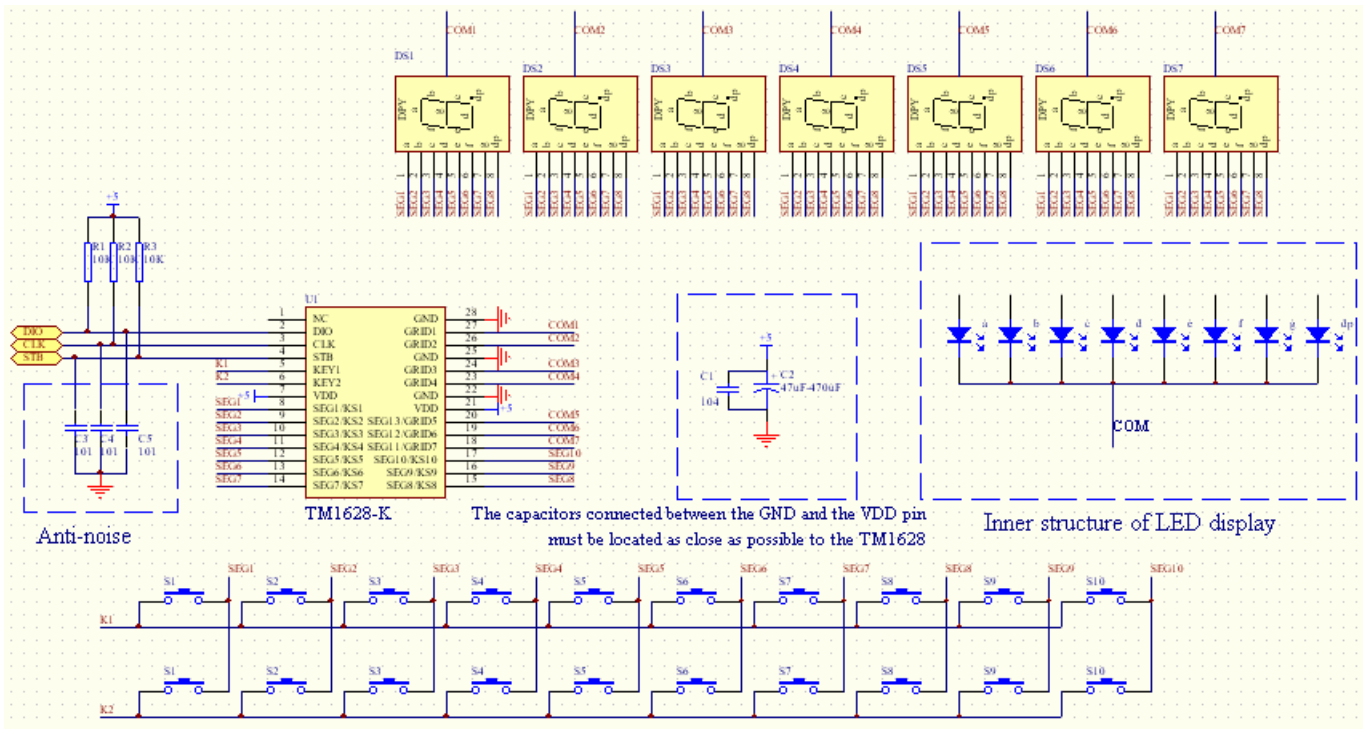
## ELECTRICAL CHARACTERISTICS

(Unless otherwise stated,  $V_{DD}=5V$ , GND=0V, Ta=25°C)

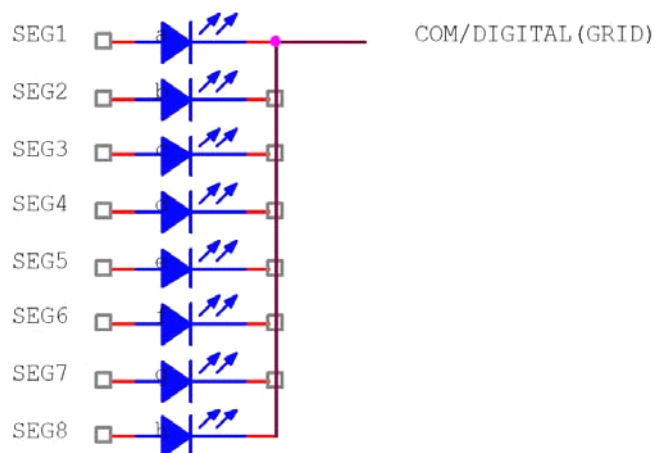
Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
High-Level Output Current	IOHSG1	$V_o = V_{DD} - 2V$ SG1 to SG11, SG12 / GR7	-20	-25	-40	mA
	IOHSG2	$V_o = V_{DD} - 3V$ SG1 to SG11, SG12/GR7	-25	-30	-50	mA
Low-Level Output Current	IOLGR	$V_o = 0.3V$ GR1 to GR6, SG12/GR7	100	140	-	mA
Low-Level Output Current	IOLDOUT	$V_o = 0.4V$	4	-	-	mA
Segment High-Level Output Current Tolerance	ITOLSG	$V_o = V_{DD} - 3V$ SG1 to SG11, SG12/GR7	-	+5	-	%
High-Level Input Voltage	$V_{IH}$	-	0.8 $V_{DD}$	-	5	V

Low-Level Input Voltage	VIL	-	0	-	0.3VDD	V
Oscillation Frequency	fosc		350	500	650	kHz
K1 to K2 Pull Down Resistor	RKN	K1 to K2 VDD=5V	2	-	15	kohm

### APPLICATION CIRCUIT



COMMON CATHODE TYPE LED PANEL:



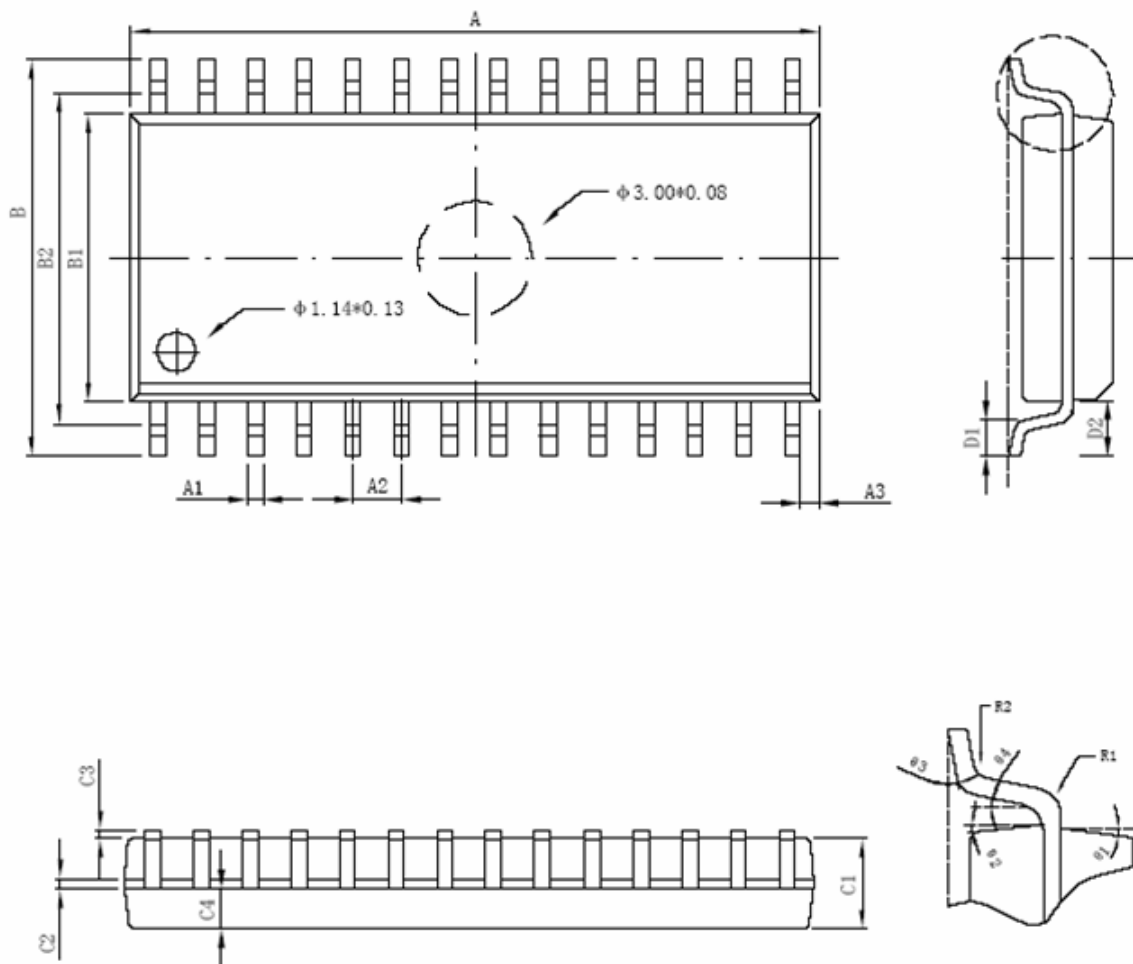
Note:

1. The capacitor (0.1 $\mu$ F, 47—470 $\mu$ F) connected between the GND and the VDD pins must be located as close as possible to the TM1628 chip.
2. The TM1628 power supply is separate from the application system power supply.

**Package Size**

**SOP28:**

Size Label	Min.(mm)	Max.(mm)	Size Label	Min.(mm)	Max.(mm)
A	17.83	18.03	C4	1.043 TYP	
A1	0.4064 TYP		D1	0.70	0.90
A2	1.27 TYP		D2	1.395 TYP	
A3	0.51 TYP		R1	0.508 TYP	
B	9.90	10.50	R2	0.508 TYP	
B1	7.42	7.62	Φ1	7° TYP	
B2	8.9 TYP		Φ2	5° TYP	
C1	2.24	2.44	Φ3	4° TYP	
C2	0.204	0.33	Φ4	10° TYP	
C3	0.10	0.25			



● All specs and applications shown above subject to change without prior notice.