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.

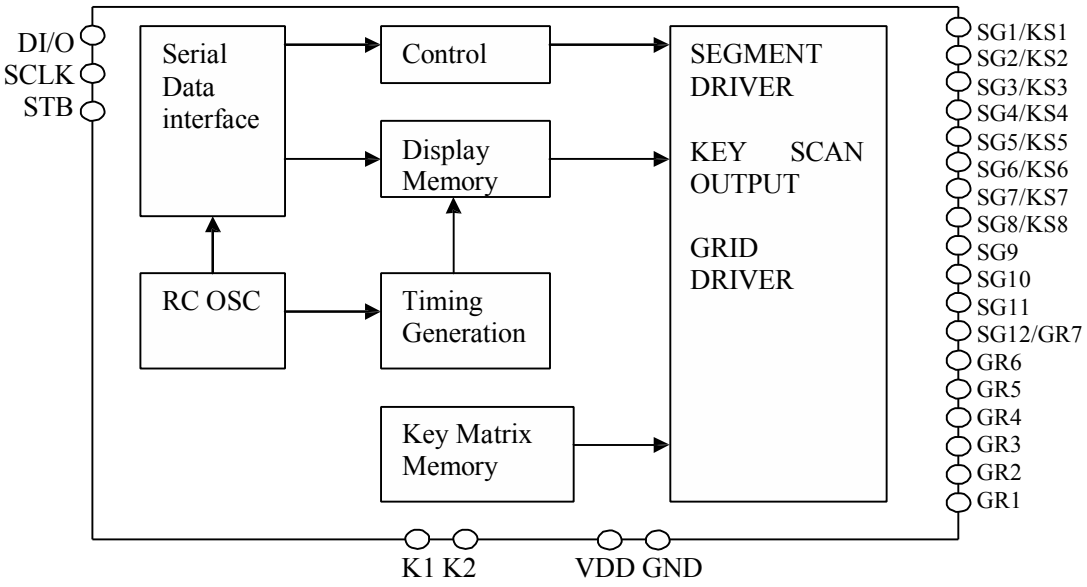
FEATURES

- 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



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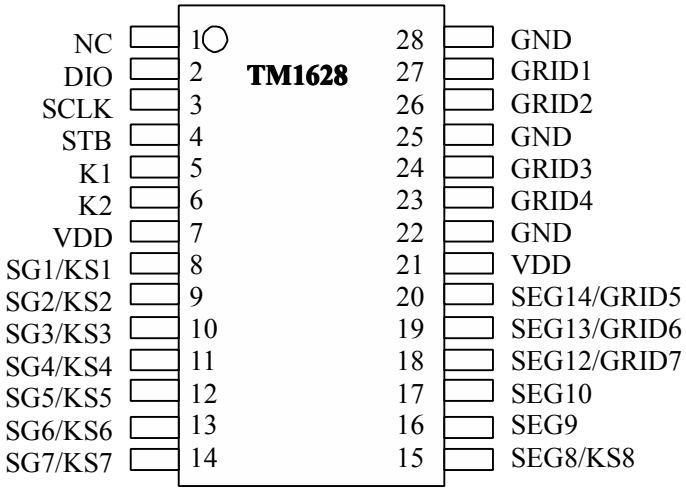
PIN CONFIGURATION



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

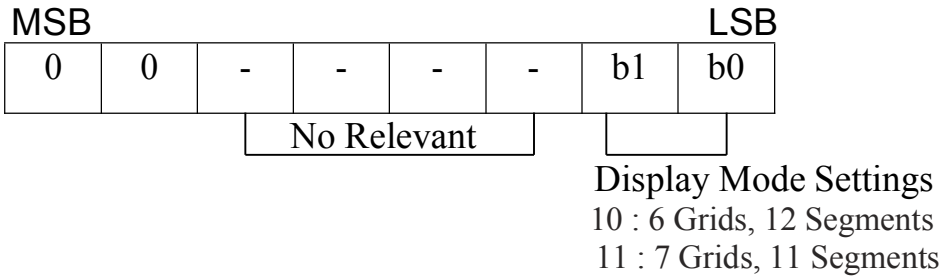
COMMANDS

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.

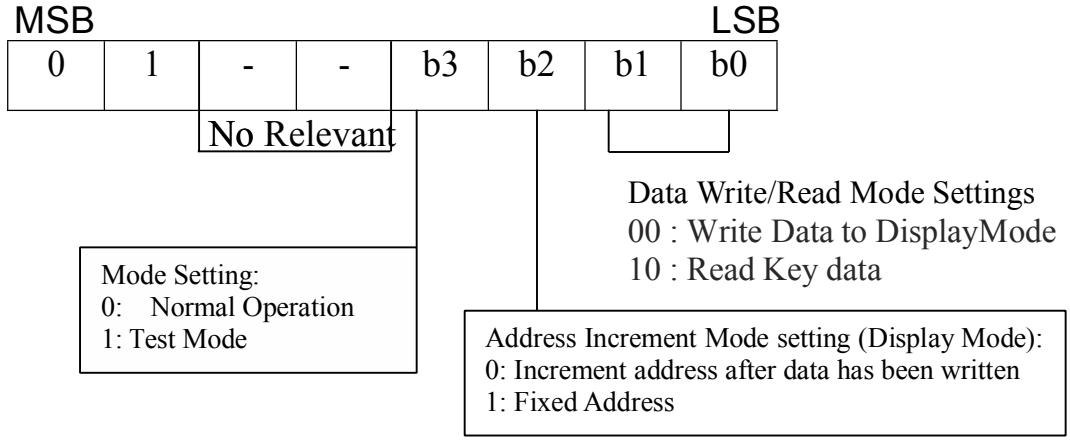
The Display Mode Setting Commands determine the number of segments and grids to be used (12 to 11 segments, 6 to 7 grids). A display command ON must be executed in order to resume display. If the same mode setting is selected, no command execution is take place, therefore, nothing happens. When Power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



Command 2: Data Setting Commands

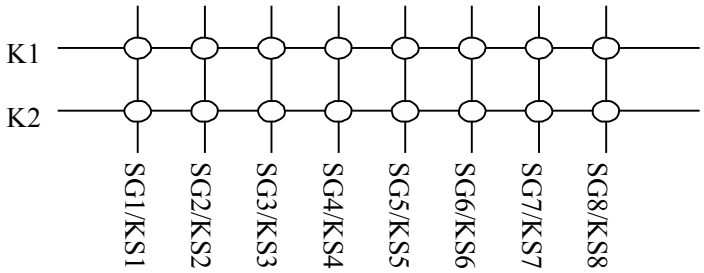
The Data Setting Commands executes the Data Write or Data Read Modes for TM1628. The data Setting Command, the bits 5 and 6 (b4, b5) are ignored, bit 7 (b6) is given the value of 1 while bit 8 (b7) is given the value of 0. Please refer to the diagram below.

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

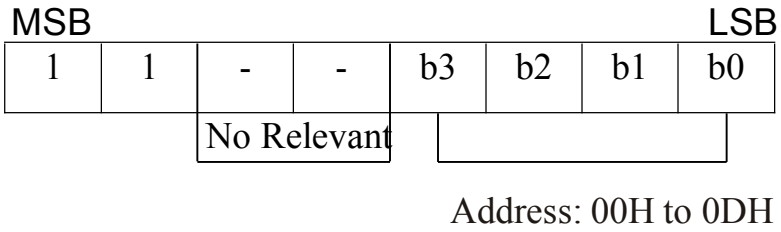
READING SEQUENCE

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

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

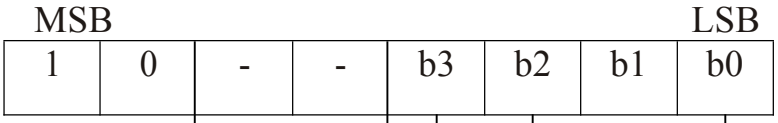
Data transmitted from an external device to TM1628 via the serial interface are stored in the Display RAM and are assigned addresses. The RAM addresses of TM1628 are given below in 8 bits unit.

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

b0- b3	b4- b7
xxHL	xxHU
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 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).

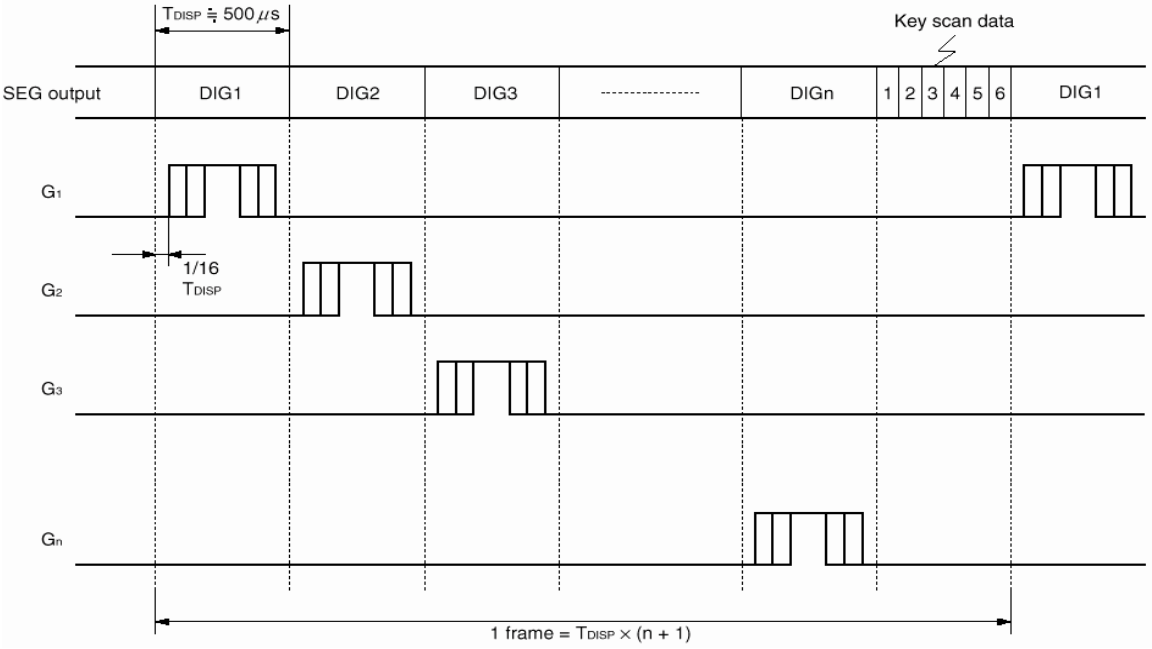


Dimming Quantity Settings:
000: Pulse width = 1/16
001: Pulse width = 2/16
010: Pulse width = 4/16
011: Pulse width = 10/16
100: Pulse width = 11/16
101: Pulse width = 12/16
110: Pulse width = 13/16
111:: Pulse width = 14/16

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.

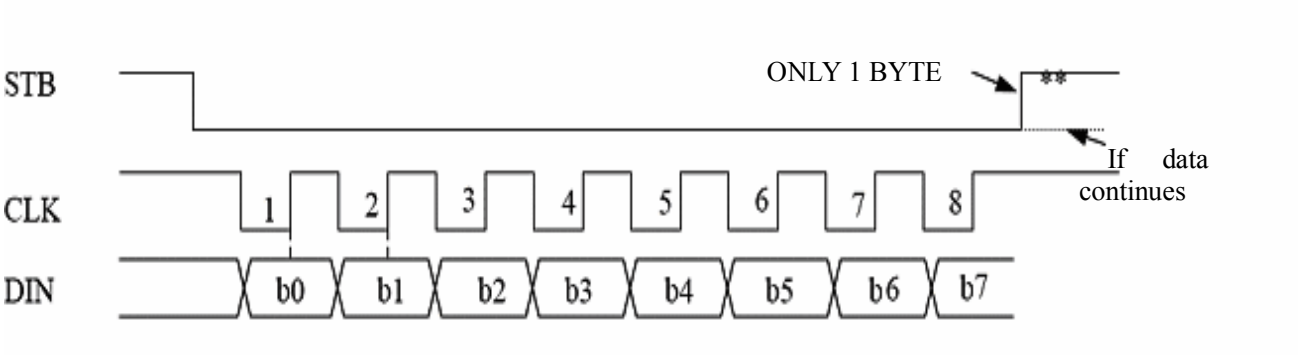


SERIAL COMMUNICATION FORMAT

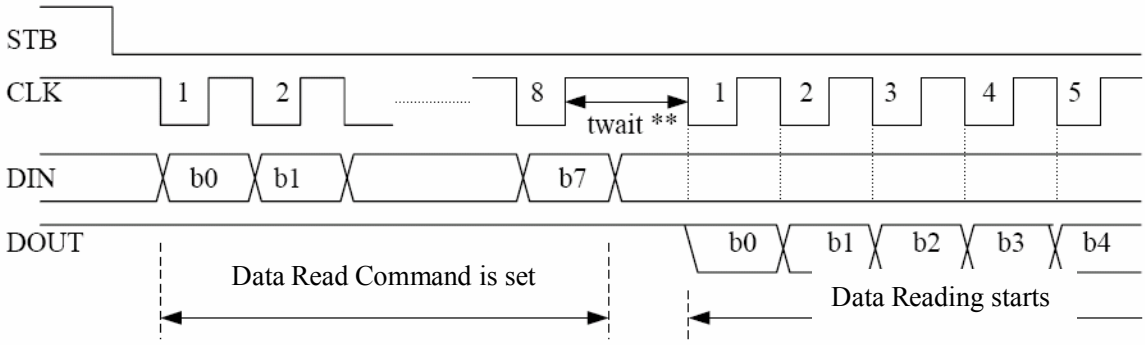
The following diagram shows the TM1628 serial communication format. The DOUT Pin is an N-channel, open drain output pin, therefore, it

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)

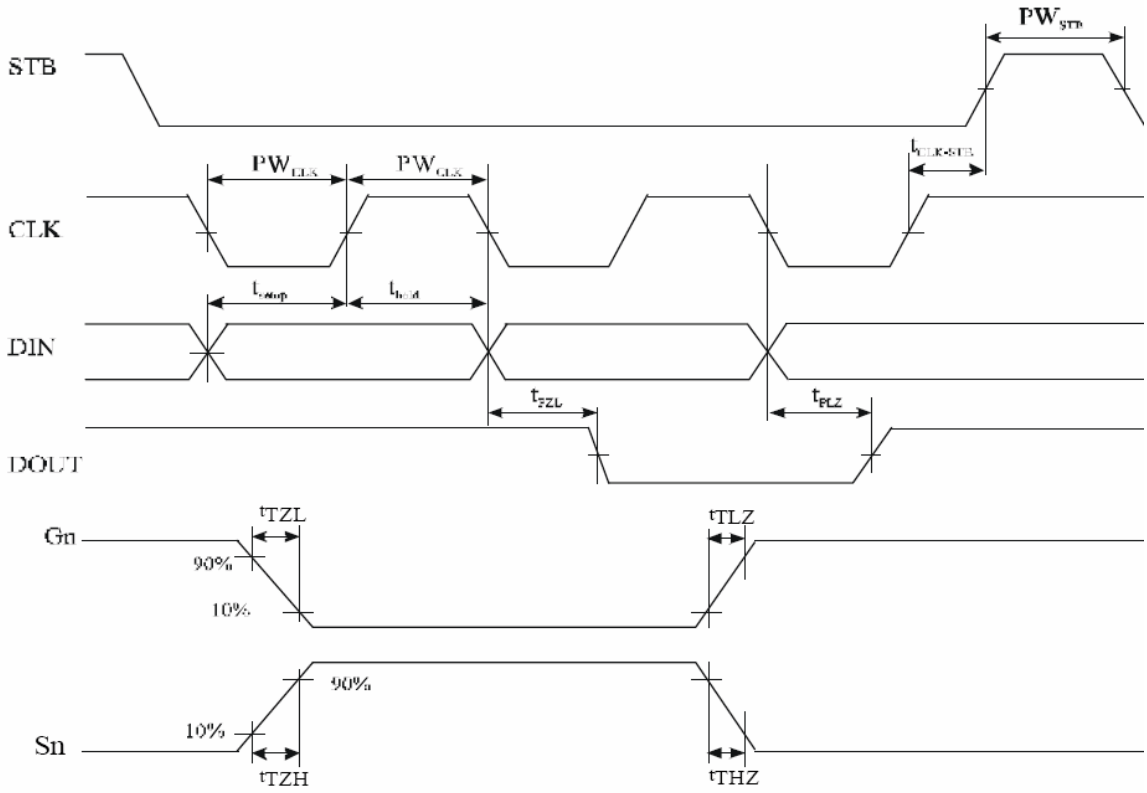


where: twait (waiting time) > 1μs

It must be noted that when the data is read, the waiting time(t) 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 1μ s.

SWITCHING CHARACTERISTIC WAVEFORM

TM1628 Switching Characteristics Waveform is given below.



where: PW_{CLK}(Clock Pulse Width)≥400ns PW_{STB}(Strobe Pulse Width)≥1μ s
tsetup(Data Setup Time)≥100ns thold(Data Hold Time)≥100ns
$t_{CLK-STB}$(Clock-Strobe Time)≥1μ s t_{THZ}(Fall Time)≤10μ s
t_{TZH}(Rise Time)≤1μ s t_{PZL}(Propagation Delay Time)≤100ns
fosc=Oscillation Frequency t_{PLZ}(Propagation Delay Time)≤300ns
t_{TZL}<1μ s t_{TLZ}<10μ s

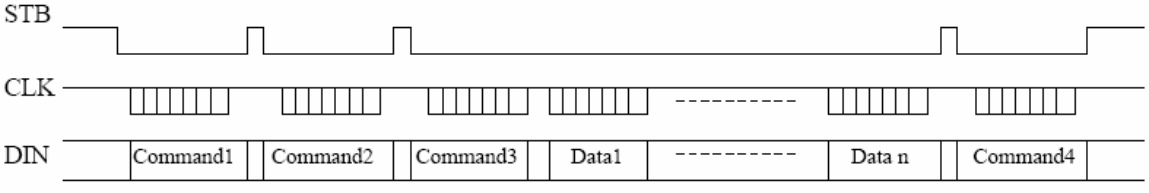
Note: Test condition under

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

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

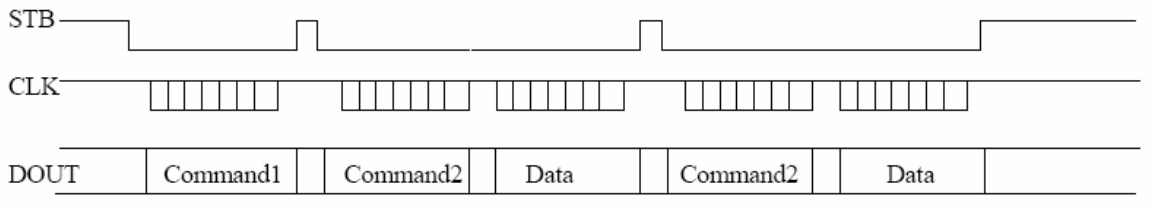
APPLICATIONS

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

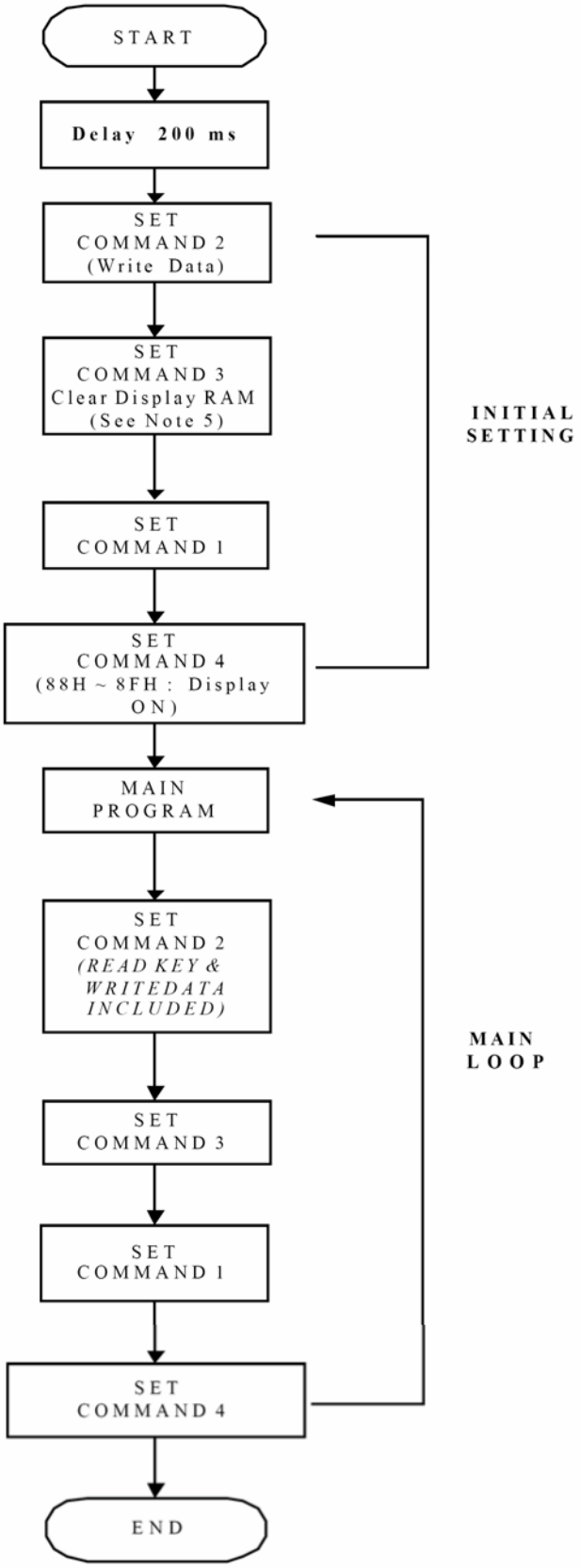
Data 1 to n : Transfer Display Data (14 Bytes max.)
Command 4: Display Control Command
The following diagram shows the waveforms when updating specific addresses.



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.


START
Delay 200 ms
SET COMMAND 2 (Write Data)
SET COMMAND 3 Clear Display RAM (See Note 5)
SET COMMAND 1
SET COMMAND 4 (88H ~ 8FH : Display ON)
INITIAL SETTING
MAIN PROGRAM
SET COMMAND 2 (READ KEY & WRITEDATA INCLUDED)
SET COMMAND 3
SET COMMAND 1
SET COMMAND 4
MAIN LOOP
END

ABSOLUTE MAXIMUM RATINGS

(Unless otherwise stated, Ta=25oC, 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 +70oC, 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	-	0.3V_{DD}	V

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

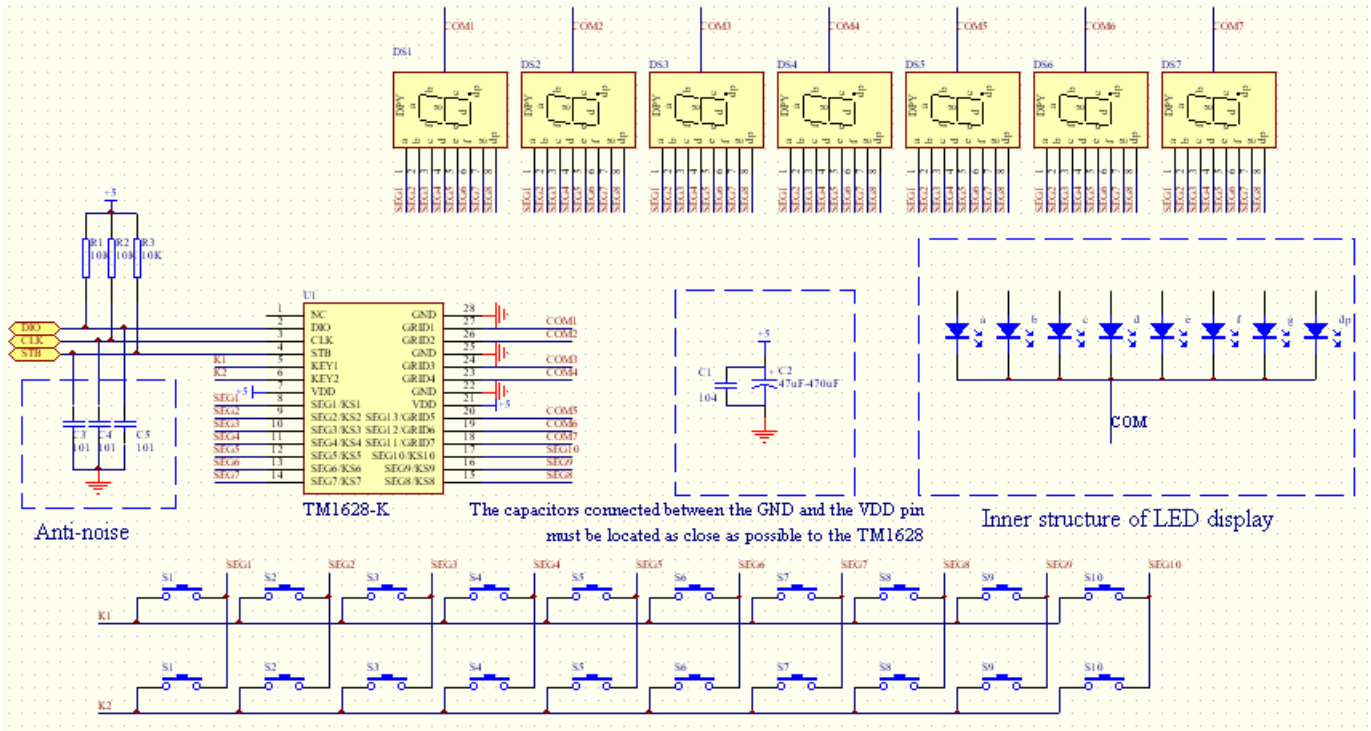
ELECTRICAL CHARACTERISTICS

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

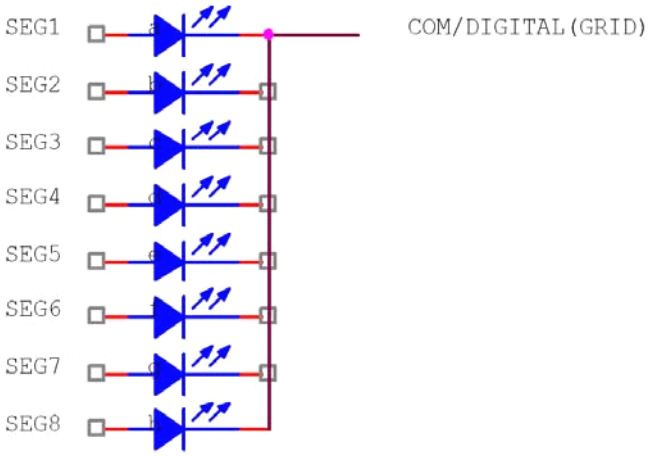
Parameter	Symbol	Test Condition	Min.	Typ.	Max.	Unit
High-Level Output Current	IOHSG1	Vo=VDD-2V SG1 to SG11, SG12 / GR7	-20	-25	-40	mA
	IOHSG2	Vo=VDD-3V SG1 to SG11, SG12/GR7	- 25	-30	-50	mA
Low-Level Output Current	IOLGR	Vo=0.3V GR1 to GR6, SG12/GR7	1 0 0	1 4 0	-	mA
Low-Level Output Current	IOLDOUT	V o = 0.4V	4	-	-	mA
Segment High-Level Output Current Tolerance	ITOLSG	Vo=VDD-3V SG1 to SG11, SG12/GR7	-	- + 5	-	%
High-Level Input Voltage	VIH	-	0.8VDD	-	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:



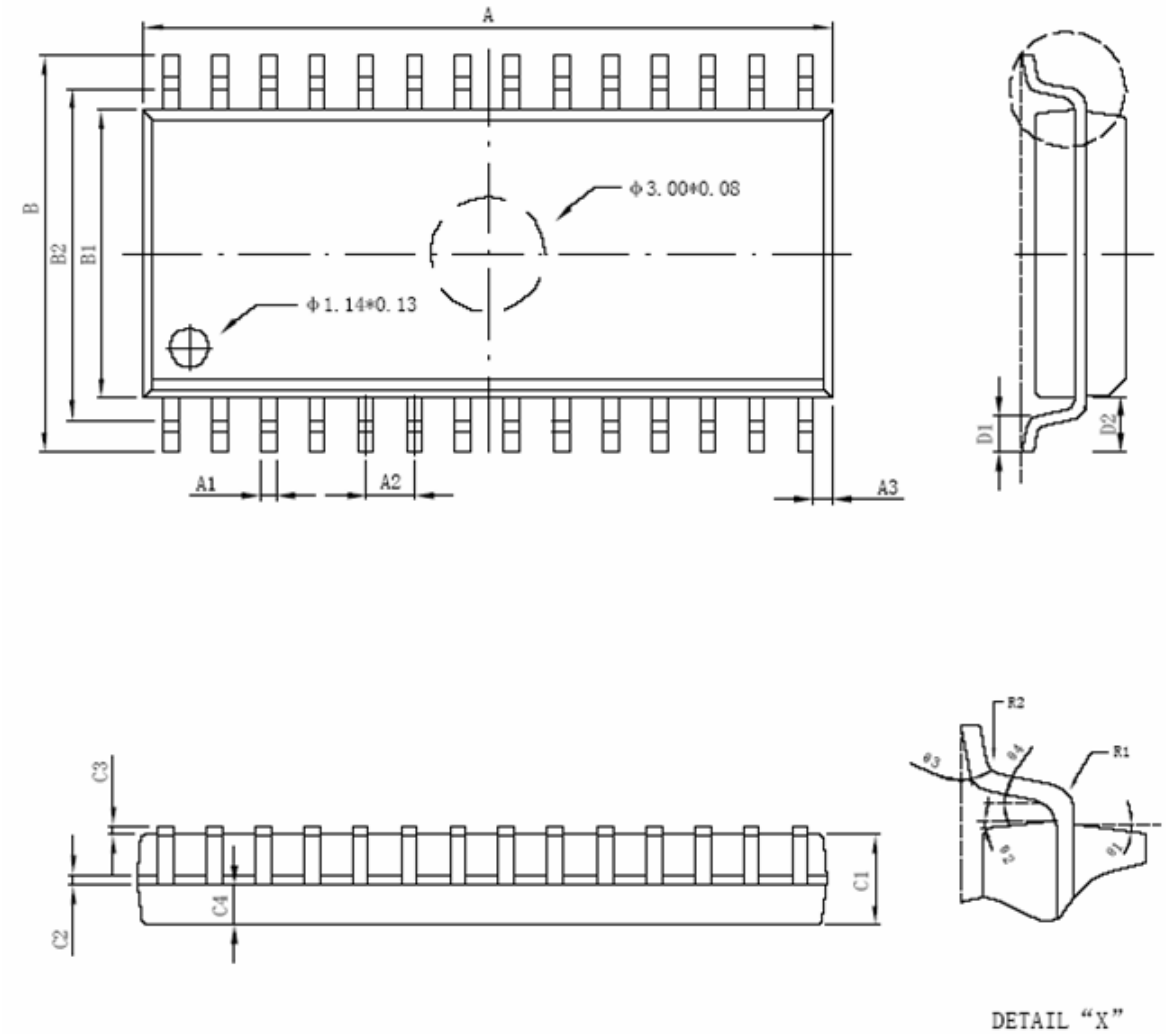
Note:

1. The capacitor (0.1μF，47－470uF) 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.

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