

DESCRIPTION

TM1618 is an LED Controller driven on a 1/5 to 1/8 duty factor. 8 segment output lines, 4 grid output lines, 3 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 TM1618 via a three-line serial interface. Housed in a 18-pin DIP, TM1618 pin assignments and application circuit are optimized for easy PCB Layout and cost saving advantages.

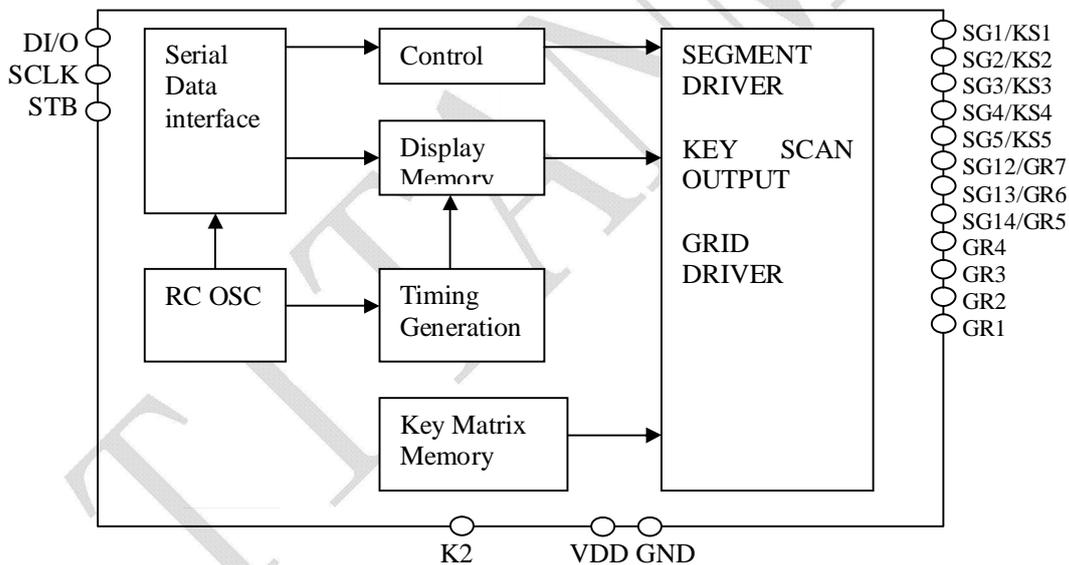
FEATURES

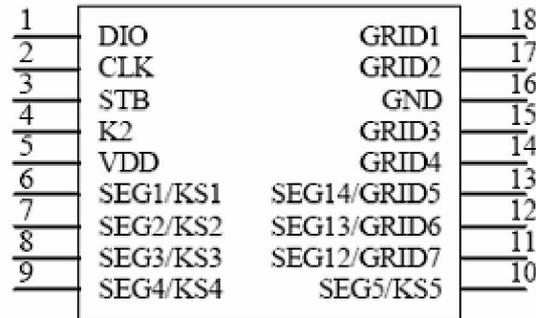
- CMOS Technology
- Low Power Consumption
- Multiple Display Modes (5 segment, 7 Grid to 8 segment, 4 Grid)
- Key Scanning (5 x 1 Matrix)
- 8-Step Dimming Circuitry
- Serial Interface(CLK , STB , DIO)
- Oscillatory Manners: RC Oscillation (450KHz ± 5%)
- Available in 18-pin, DIP/SOP Package

APPLICATION

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

BLOCK DIAGRAM



PIN CONFIGURATION


TM1618

PIN FUNCTION DESCRIPTION

Pin No.	Pin Name	I/O	FUNCTION
1	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	CLK	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 this pin is "HIGH", CLK is ignored.
4	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)
16	GND	-	Ground Pin
6-10	SEG1/KS1-SEG5/KS5	O	Segment Output Pins (p - channel, open drain) Also acts as the Key Source
18 ,17 ,15 , 27	GRID1-GRID4	O	Grid Output Pins
18-20	SG12/GRID7-SEG14/ GRID5	O	Segment/Grid Output Pins
5	VDD	-	Power Supply

COMMANDS DESCRIPTION

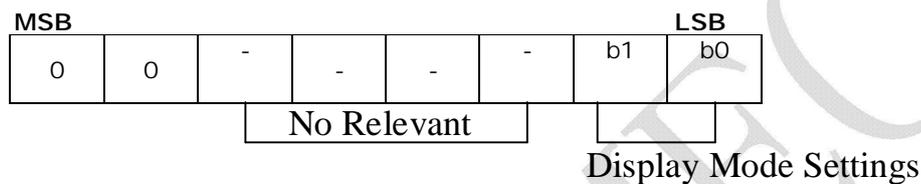
A command is the first byte (b0 to b7) inputted to TM1618 via the DIN Pin after STB Pin has changed from HIGH to LOW State. If for some reason the STB Pin is set to HIGH while data or commands are being transmitted, the serial communication is initialized, and the data/commands being transmitted are considered invalid.

Command 1: Display Mode Setting Commands

TITAN MICRO™ ELECTRONICS LED DRIVER TM1618

TM1618 provides 4 display mode settings as shown in the diagram below: As stated earlier a command is the first one byte (b0 to b7) transmitted to TM1618 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 & bit8 (b6 to b7) are given a value of 0.

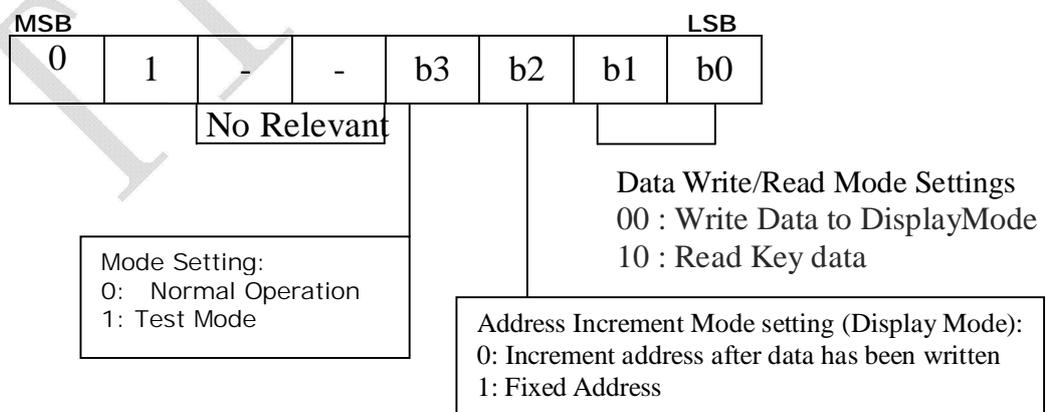
The Display Mode Setting Commands determine the number of segments and grids to be used (5 to 8 segments, 4 to 7 grids). A display command ON must be executed in order to resume display. If the same mode setting is selected, no command execution is take place, therefore, nothing happens.



b1	b0	Display Mode
0	0	4 Grids, 8 Segments
0	1	5 Grids, 7 Segments
1	0	6 Grids, 6 Segments
1	1	7 Grids, 5 Segments

Command 2: Data Setting Commands

The Data Setting Commands executes the Data Write or Data Read Modes for TM1618. 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.



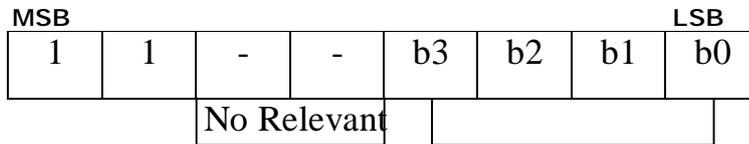
Command 3: Address Setting Commands

Address Setting Commands are used to set the address of the display memory. The

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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.

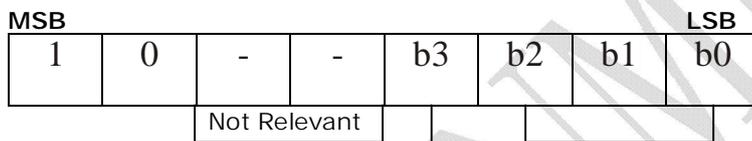
Please refer to the diagram below.



Address: 00H to 0DH

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

DISPLAY MODE AND RAM ADDRESS

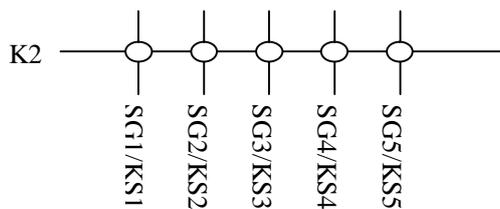
Data transmitted from an external device to TM1618 via the serial interface are stored in the Display RAM and are assigned addresses. The RAM addresses of TM1618 are given below in 8 bits unit.

Seg1	Seg2	Seg3	Seg4	Seg5					Seg1	Seg1	Seg1				
xxHL(Lower 4 bits)				xxHU(Higher 4 bits)				xxHL(Lower 4 bits)				xxHU(Higher 4 bits)			

B0	B1	B2	B3	B4	B5	B6	B7	B0	B1	B2	B3	B4	B5	B6	B7	
00HL				00HU				01HL				01HU				GRID1
02HL				02HU				03HL				03HU				GRID2
04HL				04HU				05HL				05HU				GRID3
06HL				06HU				07HL				07HU				GRID4
08HL				08HU				09HL				09HU				GRID5
0AHL				0AHU				0BHL				0BHU				GRID6
0CHL				0CHU				0DHL				0DHU				GRID7

KEY MATRIX & KEY INPUT DATA STORAGE RAM

TM1618 Key Matrix consists of 5 x1 array as shown below:

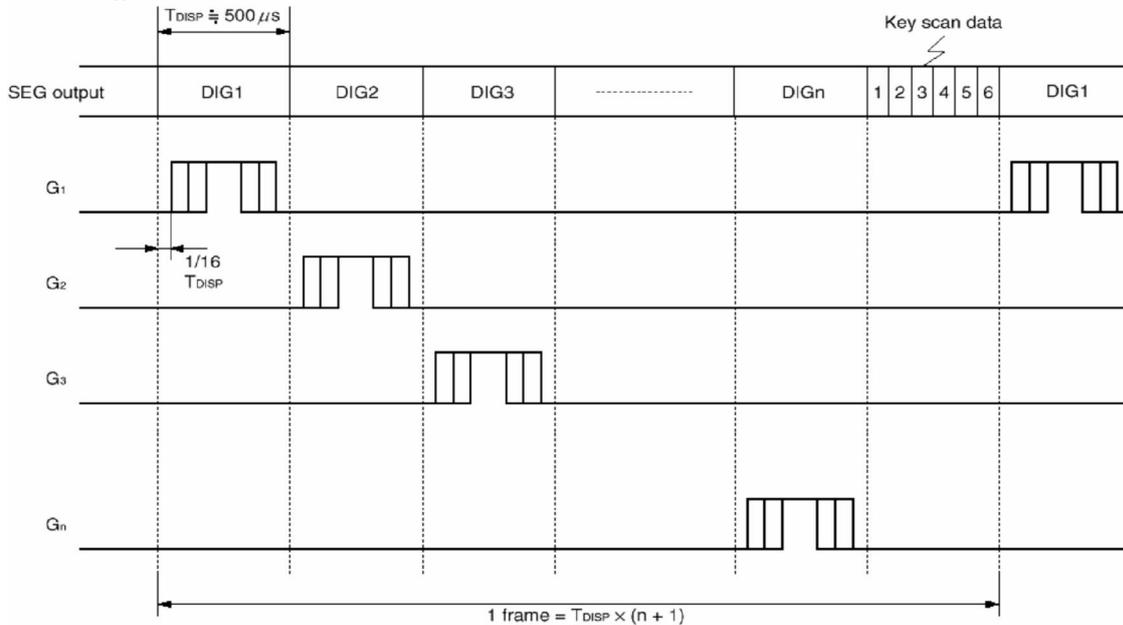


Each data entered by each key is stored as follows and read by a READ Command, starting from the last significant bit. When the most significant bit of the data (b0) has been read, the least significant bit of the next data (b7) is read.

b0	b1	b2	b3	b4	b5	b6	b7	
-	K2	-	-	K2	-	-	-	
0	KS1	0	0	KS2	0	0	0	Byte1
0	KS3	0	0	KS4	0	0	0	Byte2
0	KS5	0	0	0	0	0	0	Byte3

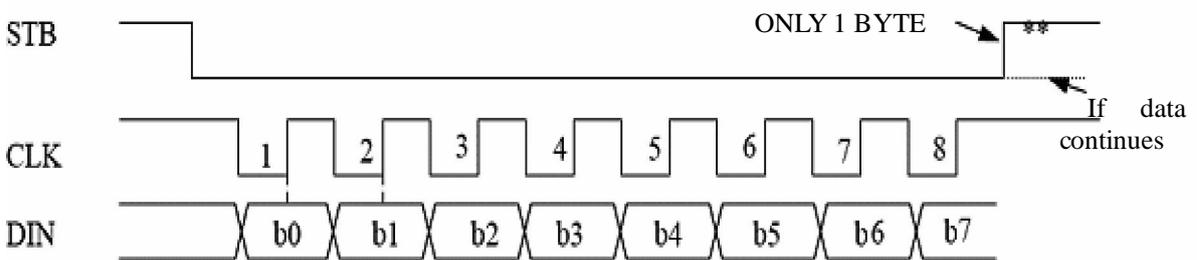
SCANNING AND DISPLAY TIMING

The Key Scanning and Display Timing diagram is given below. One cycle of key scanning consists of 2 frames. The data of the are 5x 1 matrix is stored in the RAM.

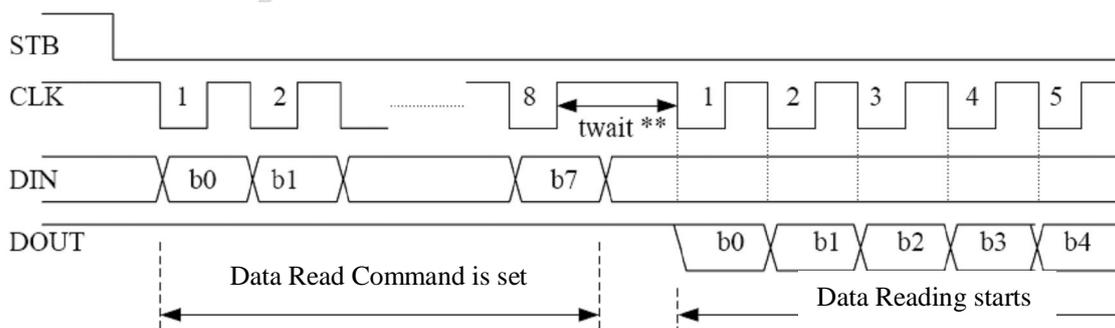


SERIAL COMMUNICATION FORMAT

The following diagram shows the TM1618 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)

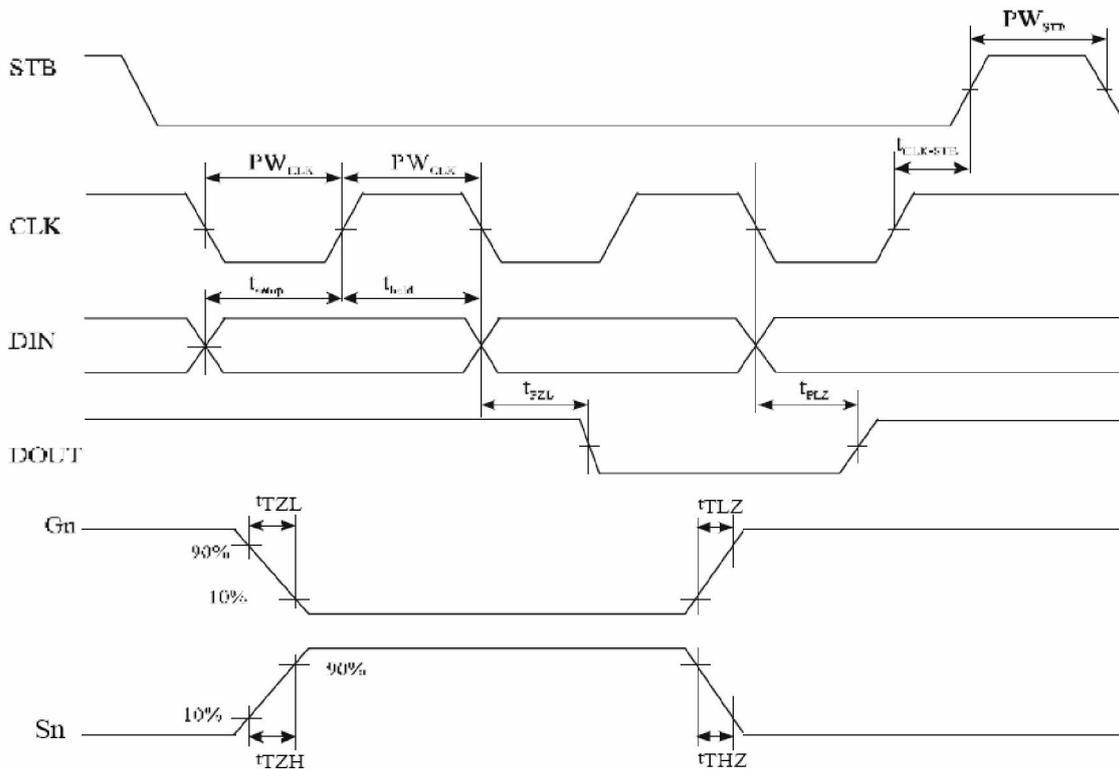


where: t_{wait} (waiting time) $> 1\mu s$

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 $1\mu s$.

SWITCHING CHARACTERISTIC WAVEFORM

TM1618 Switching Characteristics Waveform is given below.



where: 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) $\leq 1\mu s$
 f_{osc} =Oscillation Frequency
 $t_{FZL} < 1\mu s$

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

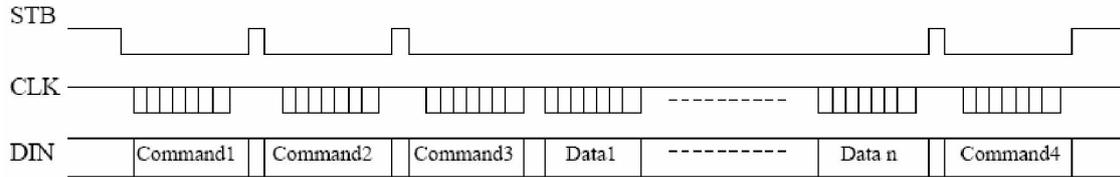
Note: Test condition under

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

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

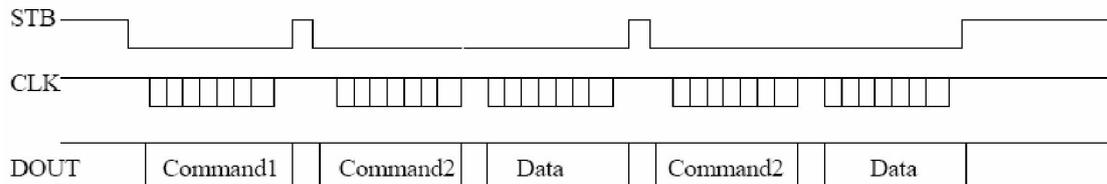
APPLICATIONS

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
 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.

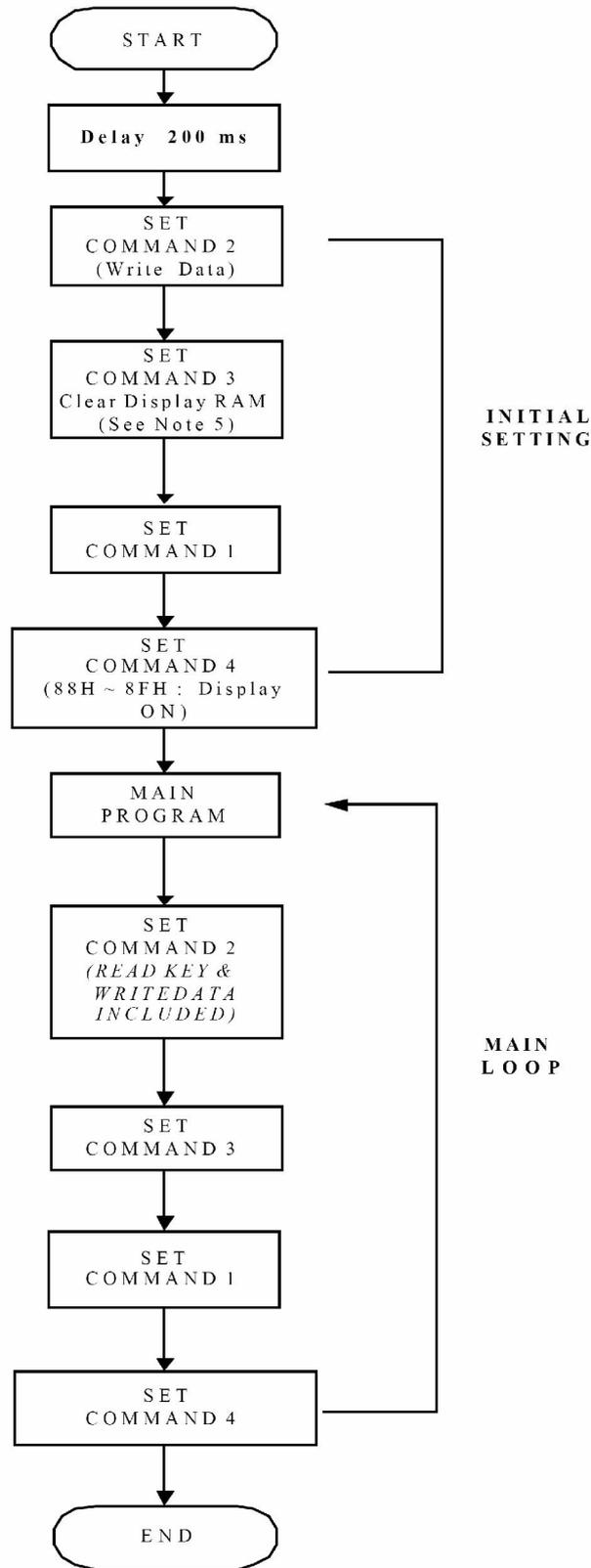


Command1: Data Setting Command
 Command2: Address Setting Command
 Data : Display Data

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 (Ta = 25 , Vss = 0 V)

Parameter	Symbol	Ratings	Unit
Logic supply voltage	VDD	-0.5 ~ +7.0	V
Logic input voltage	VI1	-0.5 ~ VDD + 0.5	V
Segment driver output	IO1	-50	mA
Grid driver output	IO2	+200	mA
Power Loss	PD	400	mW
Supply Temperature	Topt	-40 ~ +80	
Storage Temperature	Tstg	-65 ~ +150	

RECOMMENDED OPERATING RANGE

(Ta = -20 ~ +70 , Vss = 0 V)

Parameter	Symbol	min	Typ	Max	Unit	TestCondition
Logic supply voltage	VDD	3	5		V	-
High-level input voltage	VIH	0.7 VDD	-	VDD	V	-
Low-level input voltage	VIL	0	-	0.3 VDD	V	-

ELECTRICAL CHARACTERISTICS

(Ta = -20 ~ +70 , VDD = 4.5 ~ 5.5 V, Vss = 0 V)

Parameter	Symbol	Min	Typ	Max	Unit	TestCondition
High-level output current	Ioh1	20	25	40	mA	Vo = vdd-2V
	Ioh2	20	30	50	mA	Vo = vdd-3V
Low-level output current	IOL1	-80	-140	-	mA	Vo=0.3V
Low-level output current	Idout	4	-	-	mA	VO = 0.4V , dout
High-level output	Itolsg	-	-	5	%	VO = VDD - 3V ,

current tolerance						Seg
Output pull-down	RL		10		K	K2
Input current	II	-	-	±1	μA	VI = VDD / VSS
High-level input voltage	VIH	0.7 VDD	-		V	CLK , DIN , STB
Low-level input voltage	VIL	-	-	0.3 VDD	V	CLK , DIN , STB
Lag voltage	VH	-	0.35	-	V	CLK , DIN , STB
Dynamic Current ulation	IDDdyn	-	-	5	mA	Display off, No-load

SWITCHING CHARACTERISTICS

(Ta = -20 ~ +70 , VDD = 4.5 ~ 5.5 V)

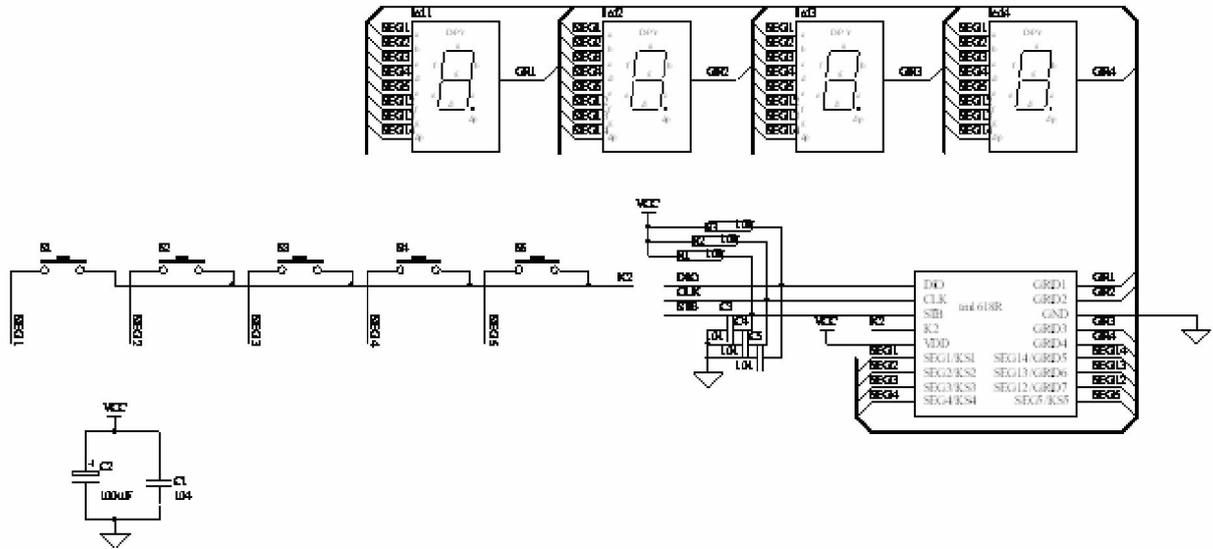
Parameter	Symbol	Min.	Typ	Max.	Unit	TestCondition
Oscillation Frequency	fosc	-	500	-	KHz	R = 16.5 K
Propagation delay time	tPLZ	-	-	300	ns	CLK DOUT
	tPZL	-	-	100	ns	CL = 15pF, RL = 10K
Rise time	TTZH 1	-	-	2	μs	CL = 300pF Seg1 ~ Seg11
	TTZH 2	-	-	0.5	μs	CL = 300pF Grid1 ~ Grid4 Seg12/Grid7 ~ Seg14/Grid5
Fall time	TTHZ	-	-	120	μs	CL = 300pF , Segn , Gridn
Maximal clock frequency	Fmax	1	-	-	MHz	On 50% duty factor
Input capacitance	CI	-	-	15	pF	-

TIMING DIAGRAM ($T_a = -20 \sim +70$, $V_{DD} = 4.5 \sim 5.5$ V)

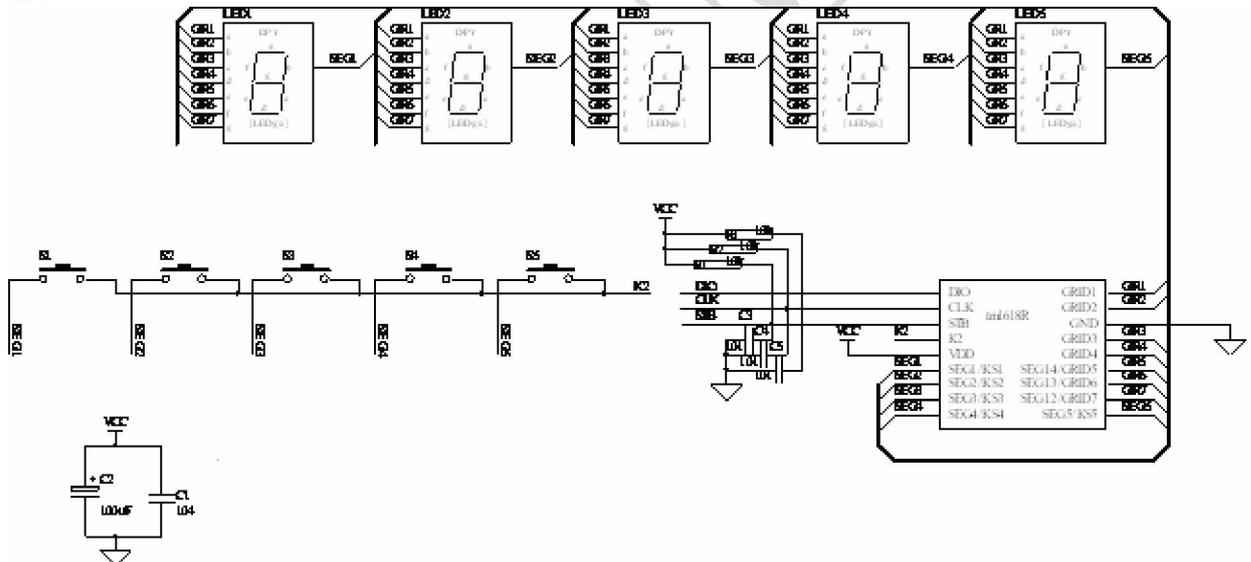
Parameter	Symbol	Min.	Typ	Max.	Unit	Test Condition
Oscillation Frequency	PWCLK	400	-	-	ns	-
Propagation delay time	PWSTB	1	-	-	μ s	-
Rise time	tSETUP	100	-	-	ns	-
Fall time	tHOLD	100	-	-	ns	-
CLK STB time	tCLK STB	1	-	-	μ s	CLK STB
Wait time	tWAIT	1	-	-	μ s	CLK CLK

APPLICATION CIRCUIT

1:



2:



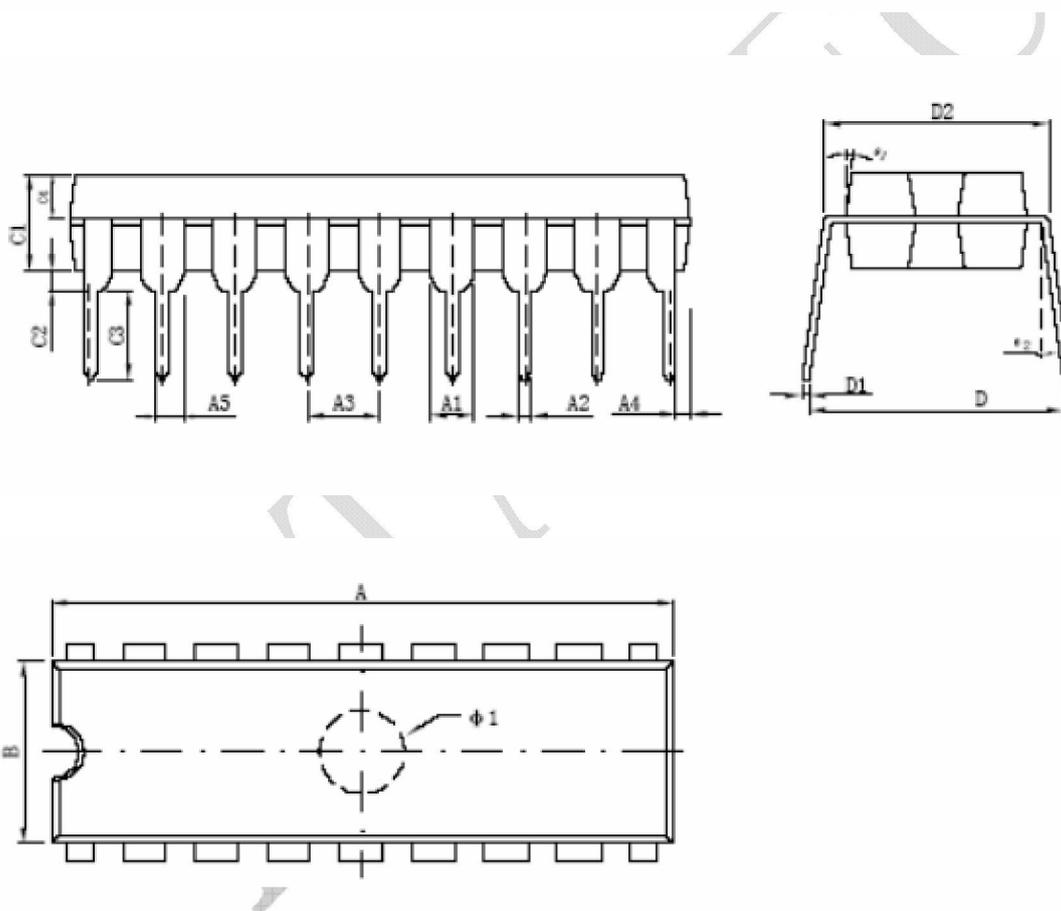
Note:

1. The capacitor (0.1µF) connected between the GND and the VDD pins must be located as close as possible to the TM1618 chip.
2. It is strongly suggested that the NC pin (pins 1) be connected to the GND.
3. The TM1618 power supply is separate from the application system power supply.

Package

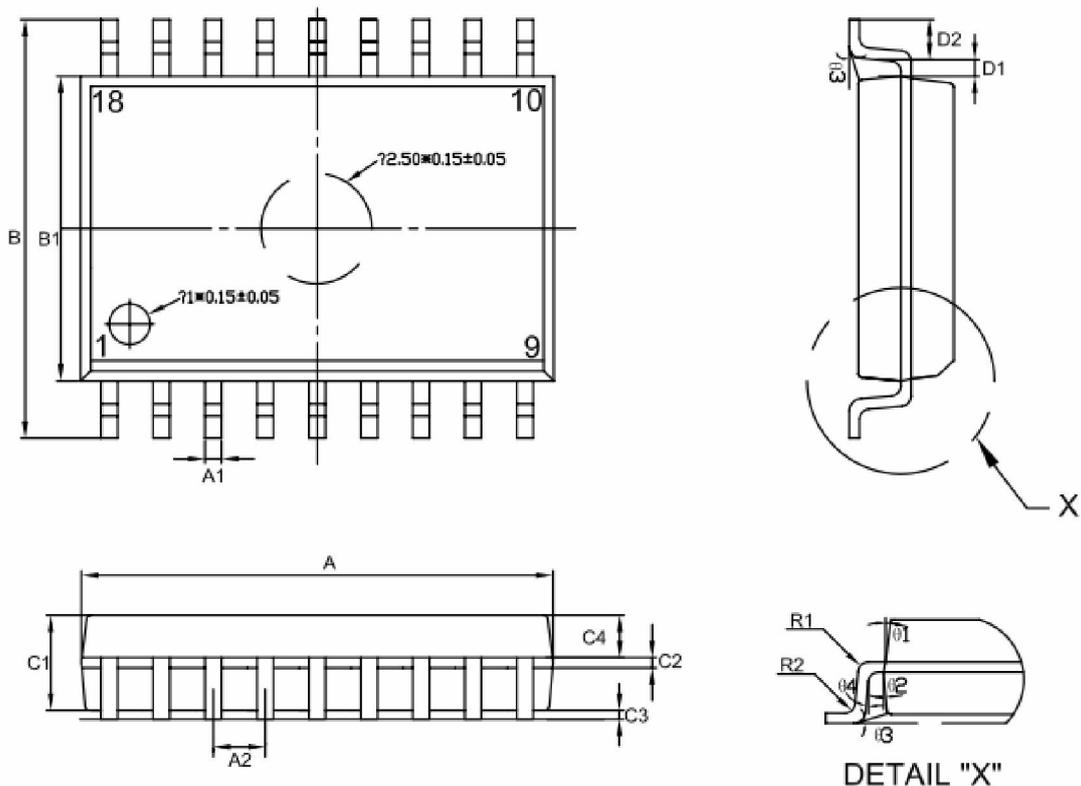
DIP18:

尺寸 标注	最小 (mm)	最大 (mm)	尺寸 标注	最小 (mm)	最大 (mm)
A	21.90	22.10	C3	3.4	3.6
A1	1.40IYP		C4	1.58IYP	
A2	0.43	0.57	D	8.10	8.60
A3	2.54IYP		D1	0.20	0.35
A4	0.59IYP		D2	7.62	7.87
A5	0.95IYP		φ1	3.0IYP	
B	6.3	6.5	θ1	8° IYP	
C1	3.4	3.6	θ2	5° IYP	
C2	0.6	0.8			



SOP18:

尺寸 标注	最小 (mm)	最大 (mm)	尺寸 标注	最小 (mm)	最大 (mm)
A	11.35	11.68	D1	0.5TYP	
A1	0.36	0.51	D2	0.7	0.97
A2	1.27TYP		R1	0.25TYP	
B	10.01	10.64	R2	0.25TYP	
B1	7.37	7.62	θ1	7° TYP	
C1	2.2	2.6	θ2	7° TYP	
C2	0.204~0.33		θ3	0°	8°
C3	0.10~0.25		θ4	10° TYP	
C4	1.0TYP				



Note:

1. Formed lead shall be planar with respect to one another within 0.004 inches,
2. Both package length and width do not include mold flash and burr.

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