

Feature description

TM1650 is a special circuit for driving and controlling LED (Light Emitting Diode Display) with keyboard scanning interface. It integrates circuits such as MCU input and output control digital interface, data latch, LED driver, keyboard scanning, and brightness adjustment. TM1650 has stable performance, reliable quality and strong anti-interference ability, which can be applied to the application occasions of 24-hour long-term continuous work.

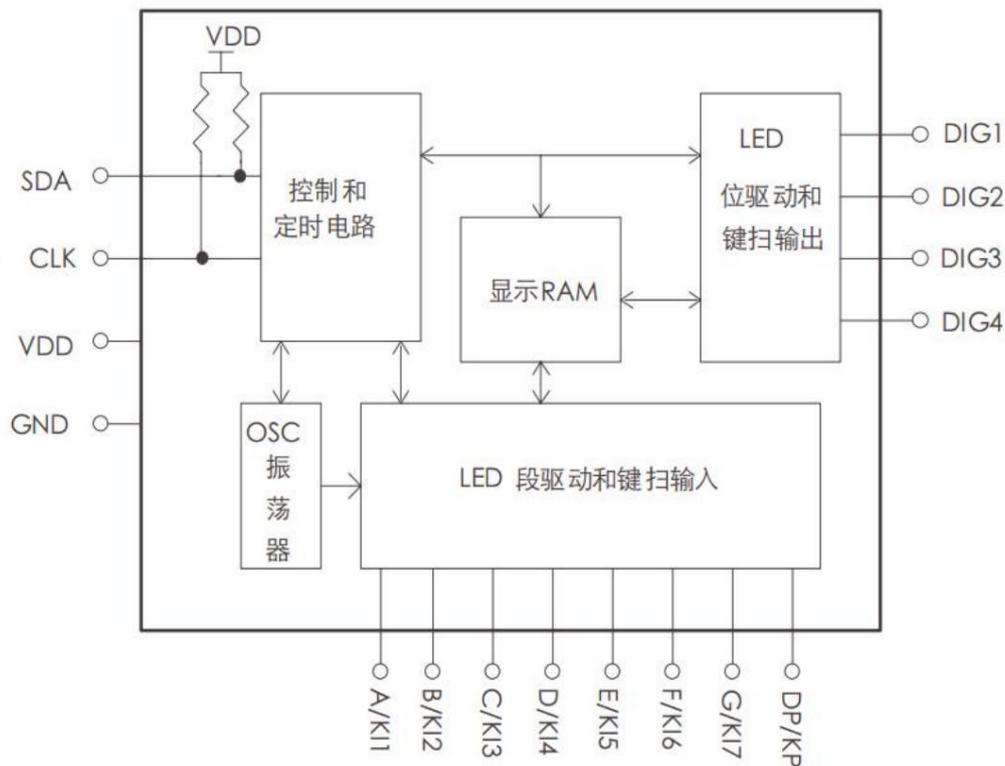
Features

- Two display modes: 8 segments × 4 bits and 7 segments × 4 bits
- Segment drive current is greater than 25mA, bit drive current is greater than 150mA
- Provides 8-level brightness control • Keyboard scanning: 7×4bit internal integrated transistor drive • High-speed two-wire • Built-in clock oscillator circuit • Built-in power-on reset circuit • Support 2.8V-5.5V power supply voltage • Provide DIP16 and SOP16 packages

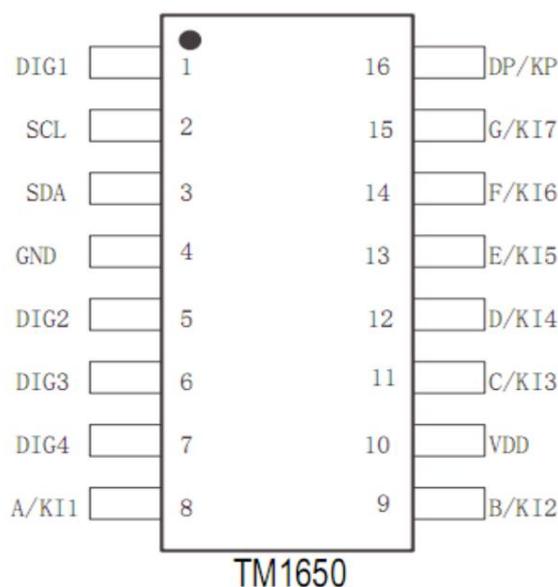
Applicable

fields: • Display driver for household appliances such as set-top boxes, air conditioners, DVD/VCD, etc.

Internal structure block diagram



Pin information



pin function

port		I/O	Function description
name	pin		
DIG1	1	O	LED segment driver output 1/keyboard scan output 1
DIG2	5	O	LED segment driver output 2/keyboard scan output 2
DIG3	6	O	LED segment driver output 3/keyboard scan output 3
DIG4	7	O	LED segment driver output 4/keyboard scan output 4
SCL	2	I	clock input
SDA	3	O/I	data input/output
A/KI1	8	O/I	LED segment driver output A/Key scan input KI1
B/KI2	9	O/I	LED segment driver output B/Key scan input KI2
C/KI3	11	O/I	LED segment driver output C/Key scan input KI3
D/KI4	12	O/I	LED segment driver output D/Key scan input KI4
E/KI5	13	O/I	LED segment driver output E/Key scan input KI5
F/KI6	14	O/I	LED segment driver output F/Key scan input KI6
G/KI7	15	O/I	LED segment driver output G/Key scan input KI7
DP/KP	16	O	LED segment output DP/Keyboard logo output KP
GND	4	-	Logically
VDD	10	-	Logic power



In the dry season or in a dry environment, a large amount of static electricity is easily generated, and electrostatic discharge may damage the integrated circuit. Tianwei recommends taking a
 Take proper integrated circuit precautions. Improper handling and soldering may cause ESD damage or performance degradation, and the chip cannot be
 normal work.

Protocol

TM1650 adopts 2-wire serial transmission protocol for communication.

1: Start signal (START) / end signal (STOP)

Start signal: keep SCL at "1" level, SDA jumps from "1" to "0", it is considered as a start signal, such as (Fig. 3) Section A;

End signal: keep SCL at "1" level, SDA from "1" 0 jumps to "1", which is considered to be the end signal, such as (Figure 3)

E segment;

2: ACK signal

If this communication is normal, TM1650 will take the initiative to pull down SDA after the falling edge of the 8th clock of the serial communication. Until the

rising edge of SCL is detected, SDA is released to the input state (for the chip), such as (Figure 3) D segment. 3: Write "1" and write "0". Write "1": keep SDA at

"1" level, SCL jumps from "0" to "1", and then jumps from "1" to "0", it is considered as writing "1" (Figure 3) B part. Write "0": keep SDA at "0" level, SCL jumps from "0"

to "1", and then jumps from "1" to "0", it is considered as writing "0" (Figure 3) C part.

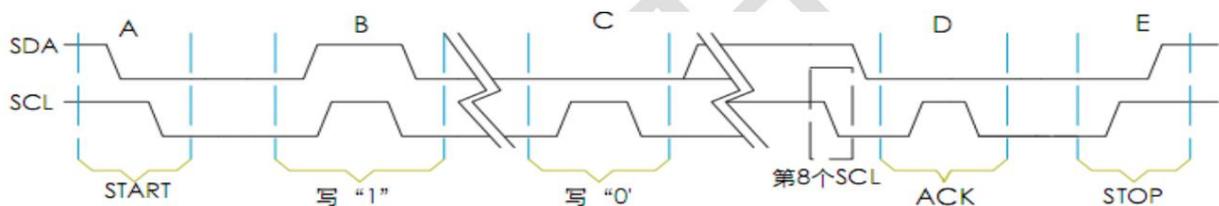


image 3)

4: One-byte data transmission format

The transmission format of one-byte data is shown in Figure 4. When the data is sent, the MSB is in the front and the LSB is in the back. The data of the

microprocessor communicates with TM1650 through the two-wire bus interface. When inputting data, when SCL is high, the signal on SDA must remain unchanged;

only when the clock signal on SCL is low, the signal on SDA can change. The start condition of data input is when SCL is high, SDA changes from high to low; the end

condition is when SCL is high, SDA changes from low to high.

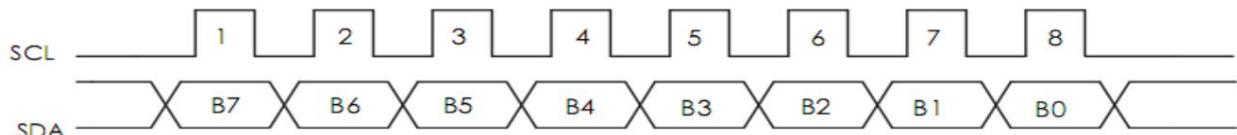
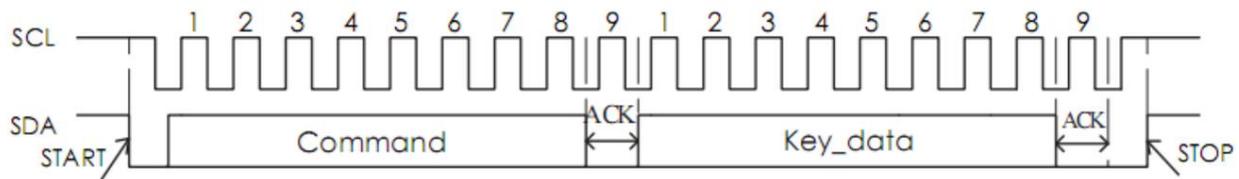


Figure 4)

5: Read key data timing

When reading data, the falling edge of SCL, the data is output from the TM1650 SDA pin.



Command: Send read key command.

Key_data: Read keyboard scan code.

Keyboard scan code:

TM1650 corresponding keyboard scan code:

addressing	DIG4	DIG3	DIG2	DIG1
A/KI1	47H	46H	45H	44H
B/KI2	4FH	4 EH	4DH	4 ONLY
C/KI3	57H	56H	55H	54H
D/KI4	5FH	5EH	5DH	5CH
E/KI5	67H	66H	65H	64H
F/KI6	6FH	6EH	6DH	6CH
G/KI7	77H	76H	75H	74H

Note: When reading the key, DIG and KI are connected in series with a 2K resistor. Key combinations are not supported.

control commands

1. Data command setting

B7 B6 B5	B4 B3 B2 B1	B0	illustrate
0 1 0	0 0 1 0	0	mode command
0 1 0	0 0 1 X	X	read key data command

Note: The items marked with x are irrelevant items. Write 0.

2. Display command settings

MSB							LSB							illustrate			
B7	B6	B5	B4	B3	B2	B1	B0	Function									
none close item fill 0	0 0 0								irrelevant item, fill in 0	Brightness setting							8 levels of brightness
	0 0 1																Level 1 brightness
	0 1 0																Level 2 brightness
	0 1																3 levels of brightness
	1 0 0																4 levels of brightness
	1 0 1																5 levels of brightness
	1 1 0																6 levels of brightness
1 1 1								7 levels of brightness									
						0		7/8 segment display control bits							8 segment display		
						1									7-segment display		
								Turn on/off display bits							0	display off	
															1	open display	

Video memory address:

This register stores the data transmitted from the external device to the TM1650 through the serial interface, a total of 4 byte units, which are respectively related to the chip

A/KI-DP/KP corresponds to the LED lights connected to the DIG pins, and the allocation is as follows:

When writing LED display data, operate according to the display address from high to low, and from high to low of the data byte.

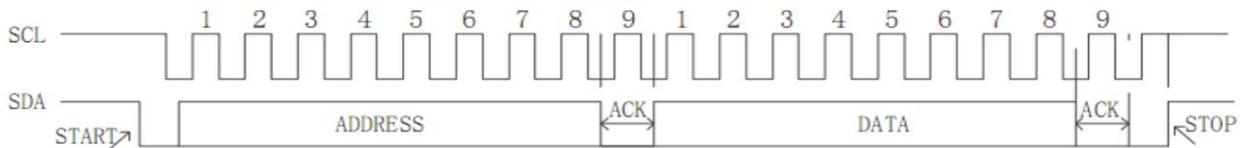
A/KI1	B/KI2 C/KI3	D/KI4		E/KI5	F/KI6	G/KI7	DP/KP	
xxHL (lower four digits)				xxHU (high four digits)				
B0	B1	B2	B3	B4	B5	B6	B7	
68HL				68HU				DIG1
6AHL				6AHU				DIG2
6CHL				6CHU				DIG3
6EHL				6EHU				DIG4

1: Video memory address command:

MSB								LSB	memory address
B7	B6	B5	B4	B3	B2	B1	B0		
0	1	1	0	1	0	0	0	68H	
0	1	1	0	1	0	1	0	6AH	
0	1	1	0	1	1	0	0	6CH	
0	1	1	0	1	1	1	0	6EH	

Note: This command is used to set the address of the display register.

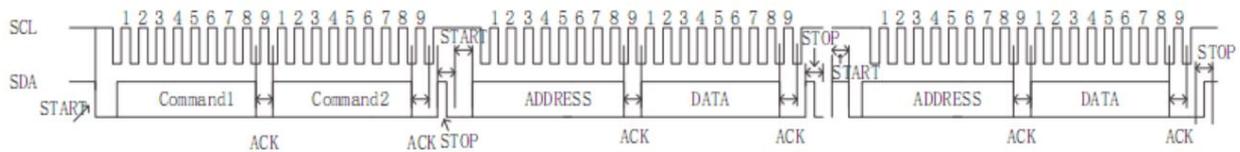
2: Timing of writing data to the video memory address:



ADDRESS: write memory address to TM1650

DATA: Write the data to be displayed to the TM1650.

A complete write display timing



Command1: Data command: 48H.

Command2: On display, display brightness level.

ADDRESS: Video memory address.

DATA: Display Data.

Absolute Maximum Ratings Range(1)(2)

parameter		scope	unit
VDD logic supply	voltage	-0.5V~+7.0	IN
VIN Logic input	voltage range SDA, SCL	-0.5V~VDD+0.5V	IN
Topr operating	temperature range	-40~+85	°C
Tstg storage	temperature range	-55~+125	°C
ESD	Human Body Model (HBM)	3000	IN
	Machine Mode (MM)	200	IN

(1) For these grades in the above table, the chip may cause permanent damage to the device under long-term use conditions, which can reduce the reliability of the device. Sky Microelectronics does not build

It is recommended that under any other conditions, the chip will work beyond these limit parameters.

(2) All voltage values are tested with respect to the network ground.

Recommended Operating Conditions Range

parameter	Test Conditions	TM1650			unit
		Min	Typ	Max	
VDD supply	voltage	2.8	5.0	7.0	IN
VIH high	level input voltage	0.7VDD		VDD	IN
VIL Low	level input voltage	0		0.3VDD	IN
TA operating	temperature range	-40		+85	°C
TJ Operating	Junction Temperature Range	-40		+125	°C

Electrical Characteristics

(At VDD=3.0V~5.5V and -40°C~+85°C, (the test voltage is VDD=5.0V and TA=+25°C) unless otherwise specified

parameter	Test Conditions	TM1650			unit
		Min	Typ	Max	
VDD	voltage	2.8	5.0	7.0	IN
IDD	supply current	0.2		150	mA
ICS	Quiescent Current			0.2	mA
WILL	Low level input voltage			2.8	IN
HIV	High level input voltage			2.8	IN
VOH	High level output voltage	VDD-0.4		VDD	IN
VOL	Low level output voltage			0.3	IN
VOLdig DIG pin	low level output voltage IDIG= -200mA			1.3	IN
VOLdig DIG pin	low level output voltage IDIG= -100mA			0.9	IN
VOHdig DIG pin	high level output voltage	IDIG= 5mA	4.5		IN
VOLki KI pin	low level output voltage	TWO= -20mA		0.2	IN
VOLki KI pin	low level output voltage	TWO= 20mA		0.5	IN
IDN1	KI pin input pull-down current	VKI=5.0V		85	mA
	Default voltage threshold for VR power-on reset			2.5	IN

Internal timing parameters (test conditions: $T_a=25^\circ\text{C}$, $V_{DD}=5\text{V}$)

	Symbol	Minimum	Typical	Maximum	Unit
Parameters reset time generated by power-on detection	TPR	10	30	60	ms
Display scan cycle	TP		7		ms
Keyboard scan interval, key response time	TKS		40		ms

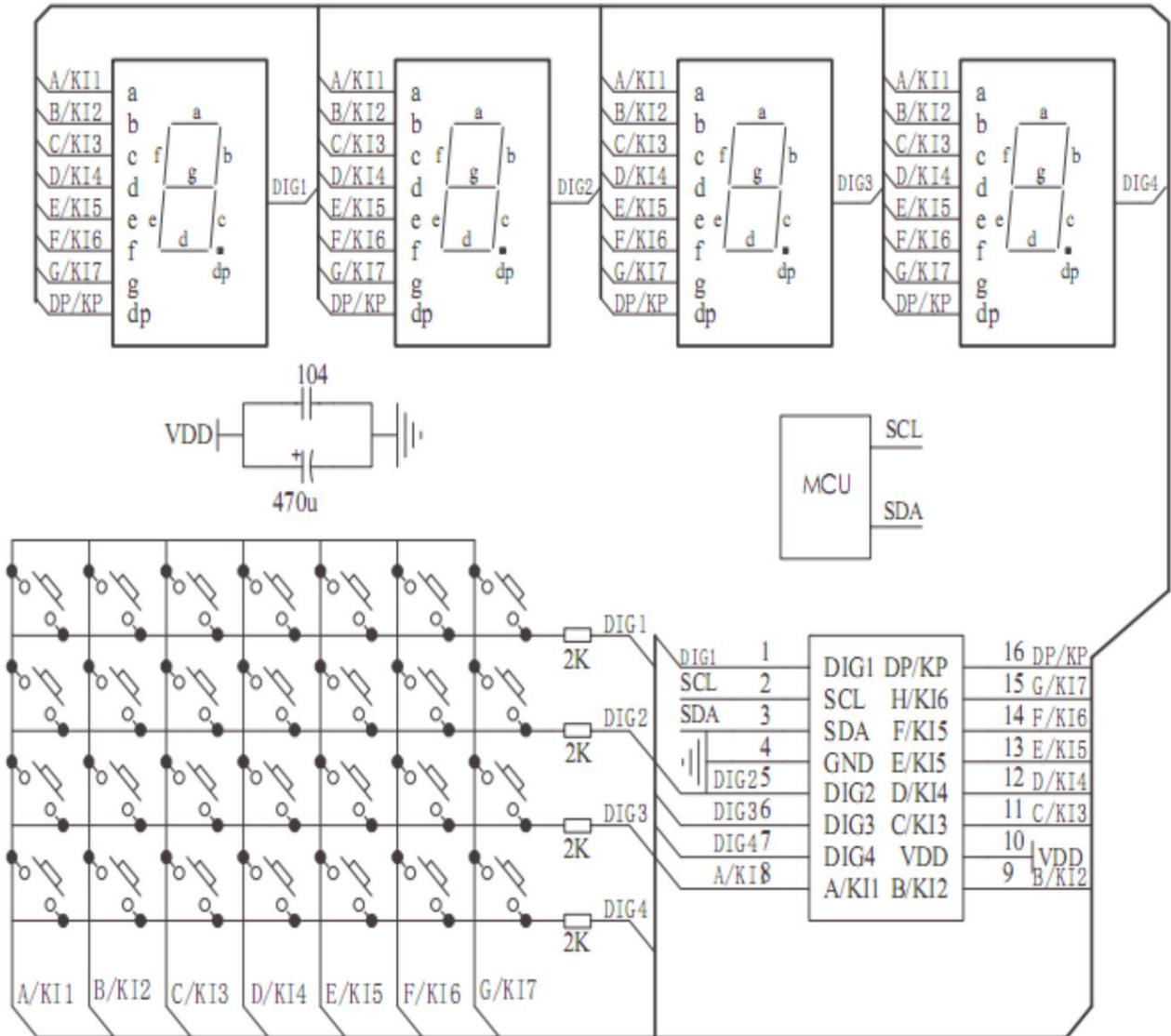
Note: The timing parameters of this table are multiples of the built-in clock period, and the built-in clock frequency decreases with the decrease of the power supply voltage.

Interface timing parameters (test conditions: $T_a=25^\circ\text{C}$, $V_{DD}=5\text{V}$)

	Symbol	Minimum	Typical	Maximum	Unit
Parameters SDA The setup time of the falling edge	TSSTA	100			ns
start signal SDA The hold time of the falling edge	THSTA	100			ns
start signal SDA The setup time of the rising edge	TSST0		100		ns
stop signal SDA The hold time of the rising edge	THST0	100			ns
stop signal SCL The low level width of the clock signal	TCLOW	100			ns
High level width of SCL clock signal	TCHIG	100			ns
SDA input data to SCL rising edge setup time	TSDA	40			ns
SDA input data hold time to SCL rising edge	THDA	10			ns
SDA output data valid delay to SCL falling edge	TAA				ns
SDA output data invalid delay to SCL falling edge	TDH				ns
Average data Transmission rate Note: The measurement unit of this meter is 10 ⁻⁹ in nanoseconds. If the maximum value is not specified, the theoretical value can be infinite.	Rate		2		ns
			2		ns
				4M	bps

Typical Application Circuit

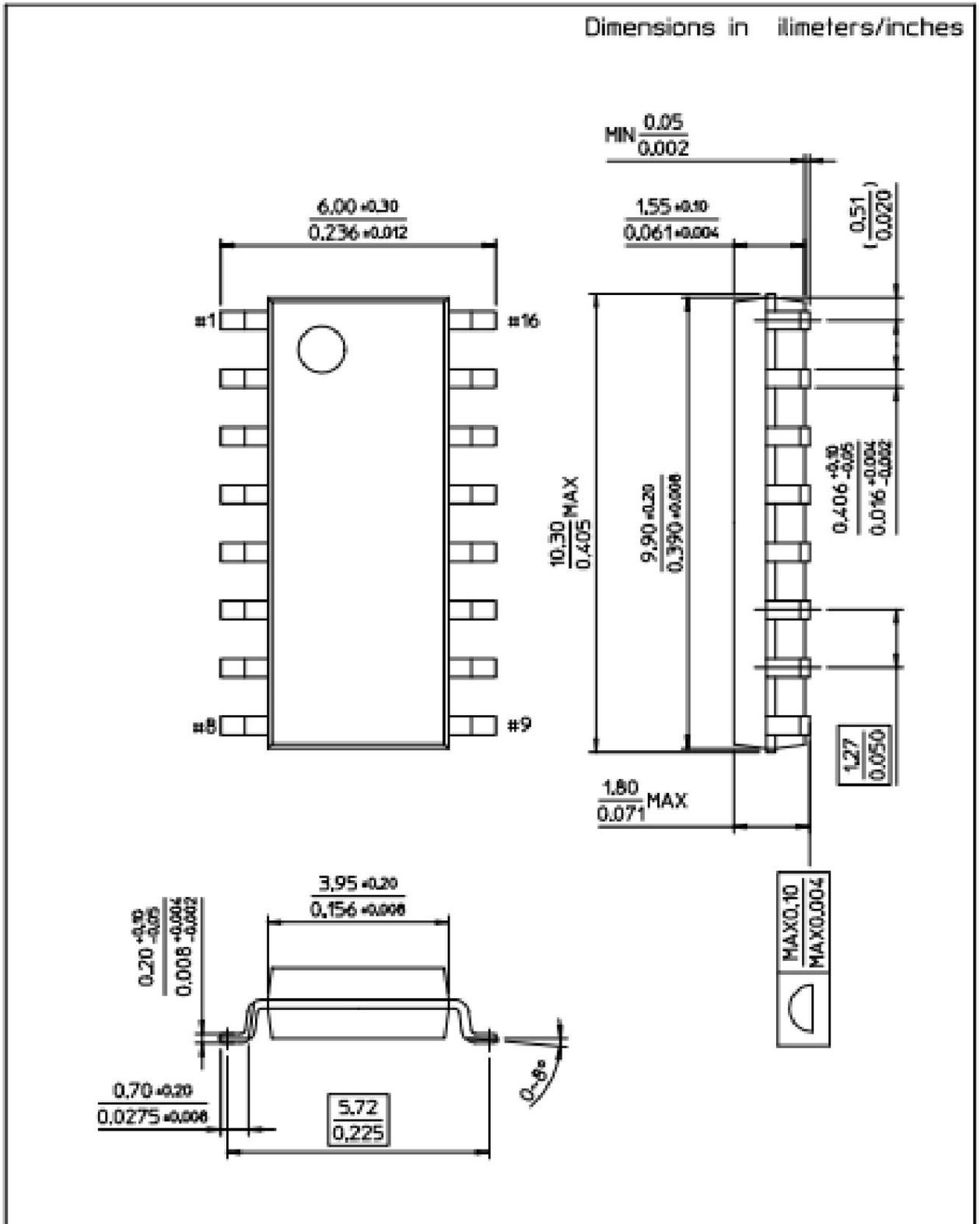
TM1650 drive common cathode digital screen wiring circuit diagram:



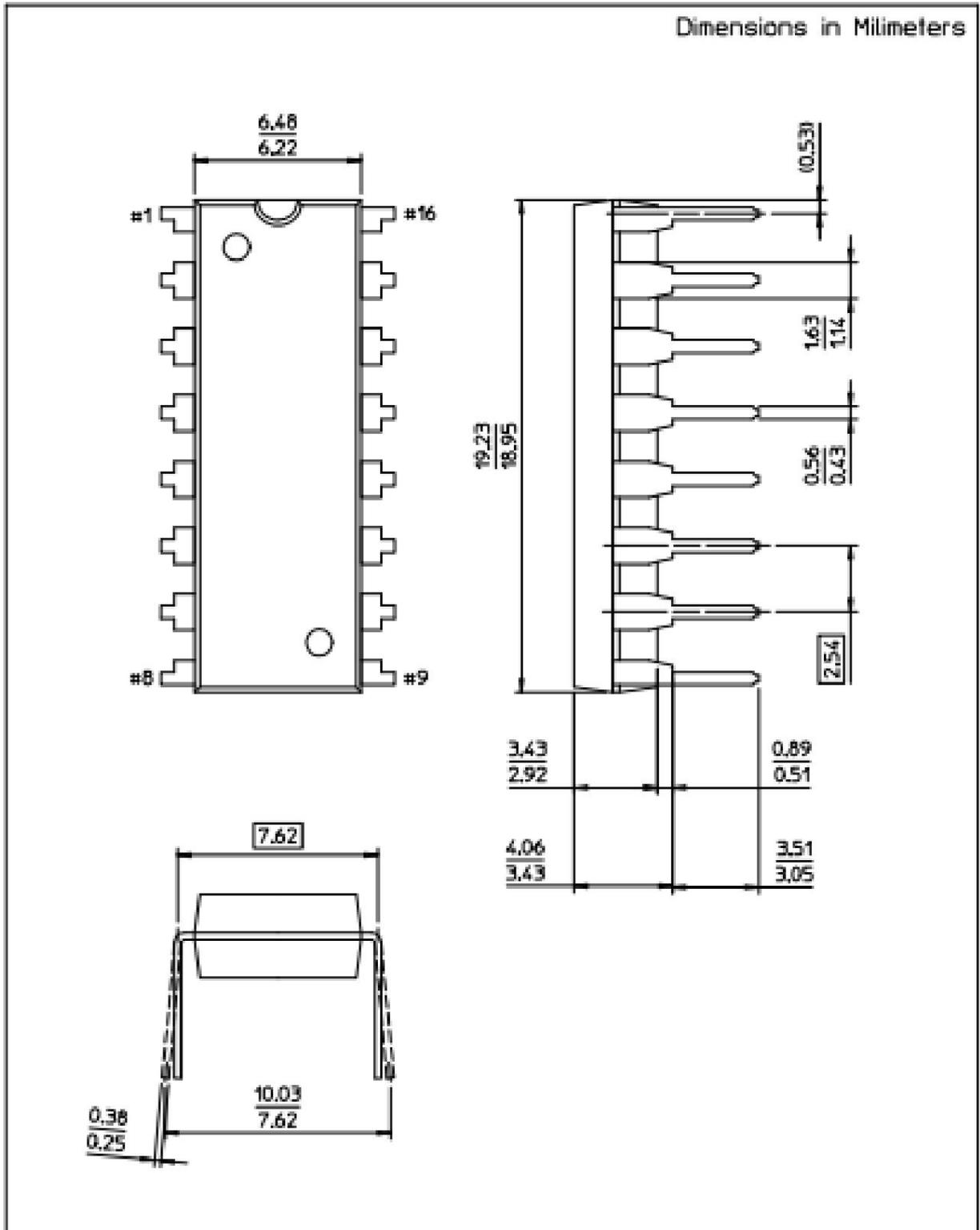
Remark:

- 1) The filter capacitor of the chip should be placed as close to the TM1650 pins as possible when laying out the board to enhance the filtering effect.
- 2) The line width of the chip power supply and the ground network should be widened as much as possible when the line is connected.
- 3) Since the turn-on voltage drop of the blue-light digital tube is about 3.0V, the power supply of TM1650 should be 5.0V.

IC package schematic diagram (SOP16):



IC Package Diagram (DIP16):



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

(The above circuit and specifications are for reference only, if the company makes corrections without prior notice)