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

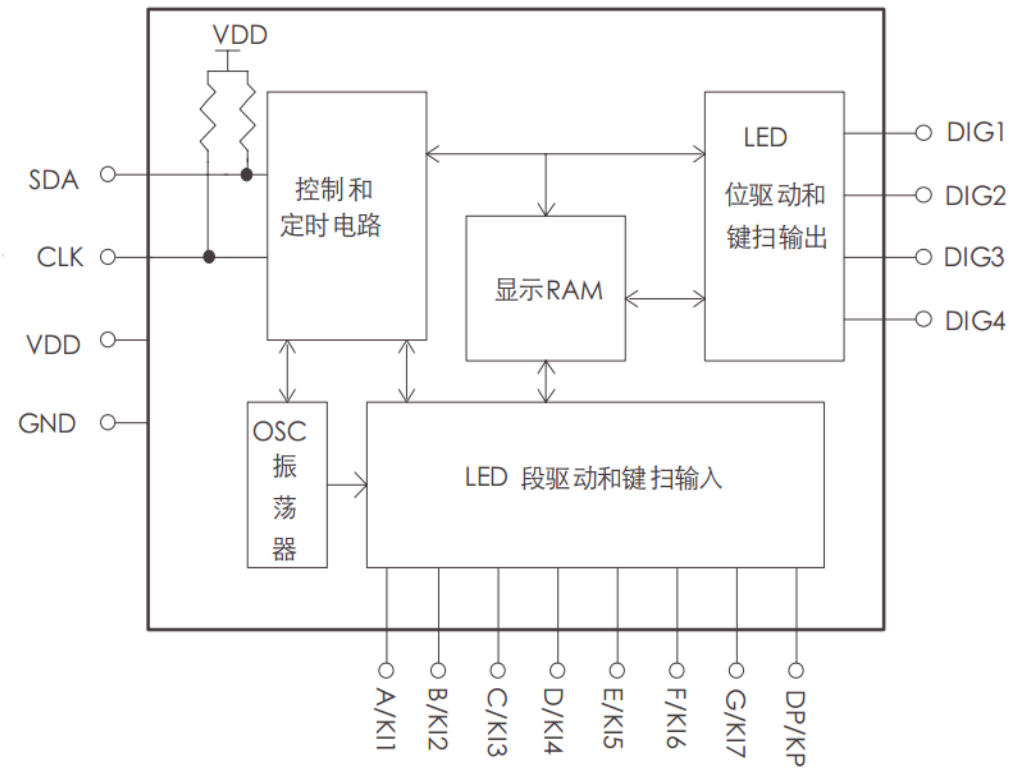
Features

two display modes: × 4 bit and 8 of paragraph 7 × 4位
segment drive current is greater than 25mA, bit driver current is greater than 150mA
provide 8 brightness control
keyboard scan: 7 × 4bit internal integration transistor drive
high speed two wire serial interface
Built in clock oscillator circuit
Built in power on reset circuit
Support 2.8V 5.5V power supply voltage
provide DIP16 and SOP16 package

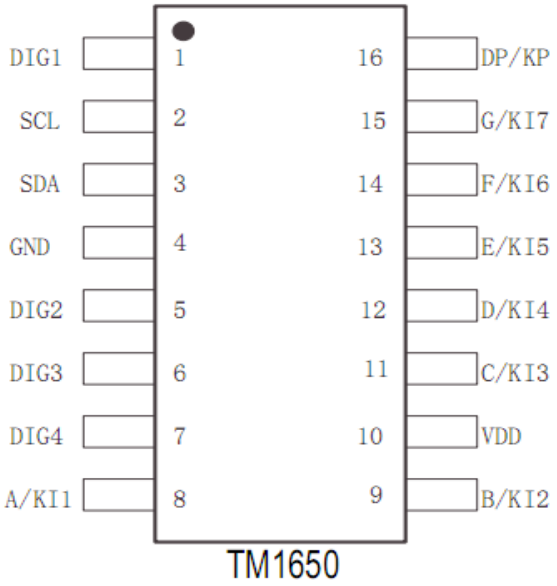
适用领域：

✧ 家用电器产品如机顶盒、空调、DVD/VCD等显示的驱动。

内部结构框图



管脚信息



管脚功能

端口		I/O	功能描述
名称	管脚		
DIG1	1	O	LED Segment drive output 1/keyboard scan output 1
DIG2	5	O	LED Segment drive output 2/keyboard scan output 2
DIG3	6	O	LED Segment drive output 3/keyboard scan output 3
DIG4	7	O	LED Segment drive output 4/keyboard scan output 4
SCL	2	I	Data Clock
SDA	3	I	Data Input
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 driver output H / key scan input KIP
GND	4	-	逻辑地
VDD	10	-	逻辑电源

在干燥季节或者干燥使用环境内，容易产生大量静电，静电放电可能会损坏集成电路，天微电子建议采取一切适当的集成电路预防处理措施，如果不正当的操作和焊接，可能会造成 ESD 损坏或者性能下降， 芯片无法正常工作。

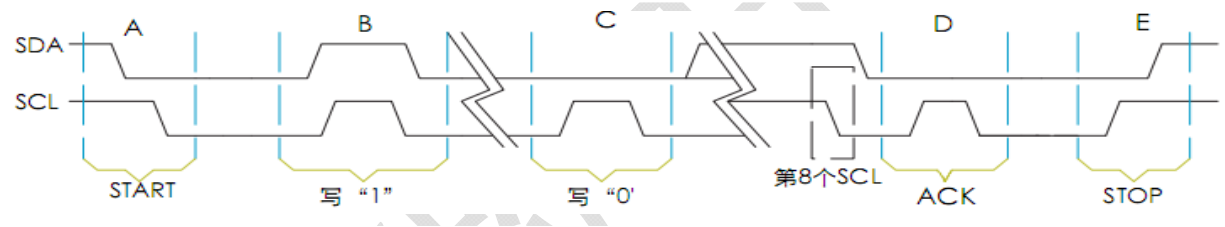
通讯协议

TM1650 2 wire serial transmission protocol

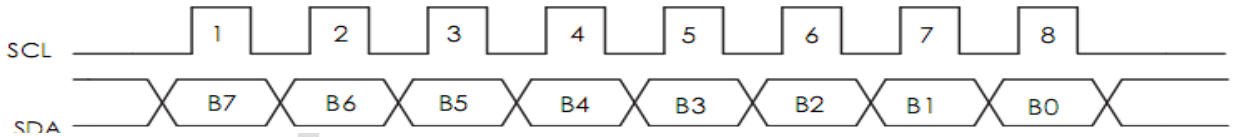
1: The start signal (START) / end signal (STOP)
Start signal: Keep SCL is "1" level, SDA from "1" jump "0", that is the start signal,
As (Figure 3) A section;
End signal: Keep SCL is "1" level, SDA from "0" jump "1", that is the end of the signal,
As (Figure 3) E segment;

2: ACK signal
If this communication is normal, the chip after the falling edge of the eighth clock serial communication, TM1650 initiative SDA low. Until inspection
Measured to the rising edge of SCL, SDA released as an input, such as (Figure 3) D segment (in terms of chips).

3: Write "1" and write "0."
Writing "1": Keep SDA is "1" level, SCL from "0" to jump to "1", from "1" to move to the "0", it is considered to be written to "1"
As (Figure 3) B segment.
Writing "0": Keep SDA "0" level, SCL from "0" to jump to "1", from "1" to move to the "0", then that is written to "0"
As (Figure 3) C segment.

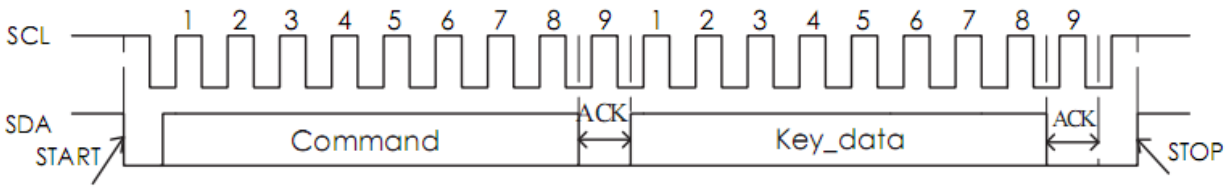


4: a byte of data transmission format
A byte data transmission format shown in Figure 4, the data is sent MSB first, LSB last. Microprocessor data via a two wire bus
Communication interfaces and TM1650, when the input data when SCL is high, SDA signal must remain unchanged; only on SCL
The clock signal is low, the signal on to change the SDA. Start condition data input is SCL is high, SDA changes from high
Low; end condition is SCL is high, SDA from low to high.



图（4）

5: Read the key data timing
When reading data, SCL falling edge, the data from the TM1650 SDA pin output.



Command: sends a read command buttons.
Key_data: read keyboard scan codes.

键盘扫描码：

TM1650 corresponding to keyboard scan codes:

编址	DIG4	DIG3	DIG2	DIG1
A/KI1	47H	46H	45H	44H
B/KI2	4FH	4EH	4DH	4CH
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 series 2K resistor. It does not support the key combination.

控制命令

1, the data command

B7	B6	B5	B4	B3	B2	B1	B0	说明
0	1	0	0	1	0	0	0	Mode command
0	1	0	0	1	×	×	1	Key data read command

Note: The play is 1 × bit can be 0, 0 is written recommendations. The other is to be a fixed value.

2, the display command

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	功能	说明
×	0	0	0		×	×		Brightness settings	8level brightness
×	0	0	1		×	×			1级亮度
×	0	1	0		×	×			2级亮度
×	0	1	1		×	×			3级亮度
×	1	0	0		×	×			4级亮度
×	1	0	1		×	×			5级亮度
×	1	1	0		×	×			6级亮度
×	1	1	1		×	×			7级亮度
×				0	×	×		7/8 segment display control bit	8 segment display
×				1	×	×			7 segment display
×					×	×	0	On / off the display position	Display On
×					×	×	1		Display Off

Note: The play is 1 × bit can be 0, 0 is written recommendations.

Memory Address:

The register stores transferred from an external device via the serial interface to the TM1650 data of 4byte units, respectively, with chip
A / KIDP / KP and DIG pins are connected to the corresponding LED lights allocated as follows:
Write LED display data, the address from high to low, from the high to the lowbyte of data from the operation display.

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

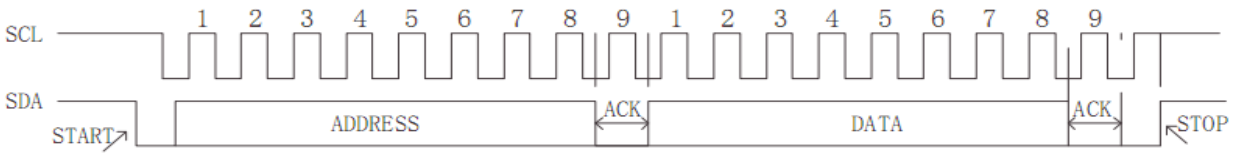
1: Memory address command:

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	Memory address
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

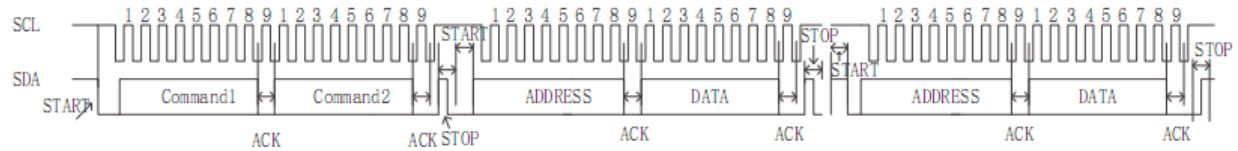
NOTE: This command is used to set the address register display

2: write data to the memory address timing:



ADDRESS: TM1650 write to memory address
DATA: TM1650 to write data to be displayed.

A complete write display timing



Command1: Data Command: 48H.
Command2: display on, display brightness level.
ADDRESS: Memory address.
DATA: The display data.

Absolute maximum rating

参数			范围	单位
VDD	逻辑电源电压		-0.5～+7.0	V
VIN	Logic input voltage range	SDA,SCL	-0.5～VDD+0.5V	V
Topr	工作温度范围		-40～+85	℃
Tstg	储存温度范围		-55～+125	℃
ESD	人体模式（HBM）		3000	V
	机器模式（MM）		200	V

(1) in the table above these levels, the chip under conditions of prolonged use, may cause permanent damage to the device can reduce device reliability.
Meeting in any other condition,the chip parameters exceed these limits work.
(2) All voltage values are with respect to network testing
Highlevel input voltage

Recommended operating conditions

参数		测试条件	TM1650			单位
			最小值	典型值	最大值	
VDD	电源电压	-	2.8	5.0	7.0	V
VIH	High level input voltage		0.7VDD	-	VDD	V
VIL	Low level input voltage		0	-	0.3VDD	V
TA	工作温度范围	-	-40		+85	℃
TJ	工作结温范围	-	-40		+125	℃

电气特性

（在 VDD=3.0V~5.5V 和-40℃~+85℃下，(测试时电压为 VDD=5.0V 和 TA=+25℃）除非另有说明

参数		测试条件	TM1650			单位
			最小值	典型值	最大值	
VDD	电压电压		2.8	5.0	7.0	V
IDD	Supply Current		0.2		150	mA
IC_S	静态电流	SCL,SDA,KP 为高		0.2		mA
VIL	低电平输入电压			2.8		V
VIH	高电平输入电压			2.8		V
VOH	高电平输出电压		VDD-0.4		VDD	V
VOL	低电平输出电压				0.3	V
VOLdig	DIG 引脚低电平输出电压	I_{DIG}= -200mA	-		1.3	V
VOLdig	DIG 引脚低电平输出电压	I_{DIG}= -100mA			0.9	V
VOHdig	DIG 引脚高电平输出电压	I_{DIG}= 5mA	4.5			V
VOLki	KI 引脚低电平输出电压	I_{KI}= -20mA			0.2	V
VOLki	KI 引脚低电平输出电压	I_{KI}= 20mA			0.5	V
IDN1	KI 引脚输入下拉电流	V_{KI}=5.0V		85		mA
VR	上电复位的默认电压门限			2.5		V

内部时序参数（测试条件：Ta=25℃，VDD=5V）

参数	符号	最小	典型	最大	单位
电源上电检测产生的复位时间	TPR	10	30	60	ms
Display scan period	TP		7		ms
Keyboard scanning interval, the key response time	TKS		40		ms

注：本表时序参数是内置时钟周期的倍数，内置时钟频率随电源电压的降低而降低。

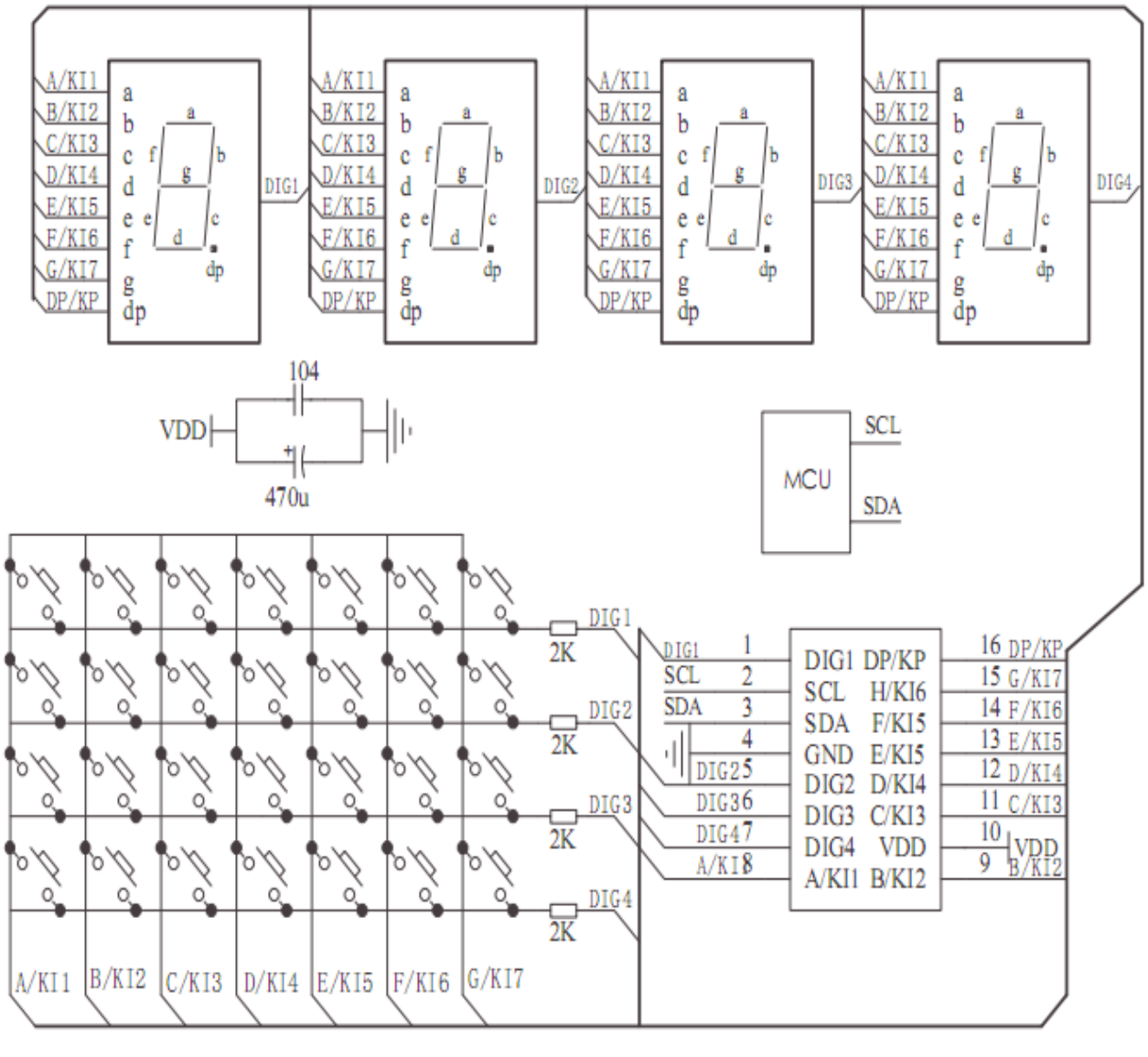
接口时序参数（测试条件：Ta=25℃，VDD=5V）

参数	符号	最小	典型	最大	单位
SDA 下降沿启动信号的建立时间	TSSTA	100			ns
SDA 下降沿启动信号的保持时间	THSTA	100			ns
SDA 上升沿停止信号的建立时间	TSST0	100			ns
SDA 上升沿停止信号的保持时间	THST0	100			ns
SCL 时钟信号的低电平宽度	TCLOW	100			ns
SCL 时钟信号的高电平宽度	TCHIG	100			ns
SDA 输入数据对 SCL 上升沿的建立时间	TSDA	40			ns
SDA 输入数据对 SCL 上升沿的保持时间	THDA	10			ns
SDA 输出数据有效对 SCL 下降沿的延时	TAA	2			ns
SDA 输出数据无效对 SCL 下降沿的延时	TDH	2			ns
平均数据传输速率	Rate			4M	bps

注：本表计量单位以纳秒即 10^{-9}，未注明最大值则理论值可以无穷大。

典型应用电路

TM1650 drive common cathode LED screen wiring diagram:



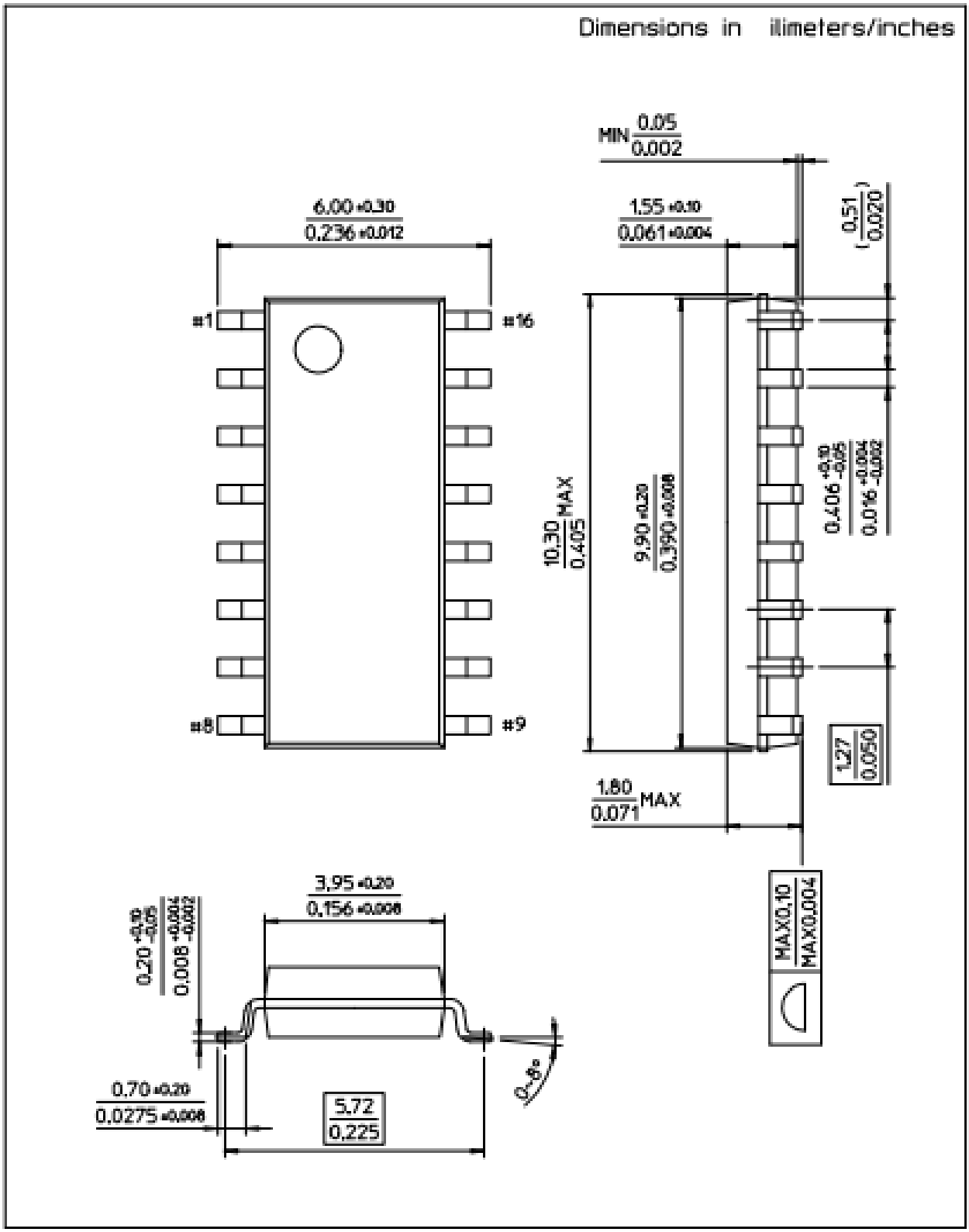
Remarks:

1) Chip filter capacitor in the layout should be as close to the TM1650 when the pin is placed to enhance the filtering effect.
2) Chip power and ground network when you try to widen the width of the wire.
3) Due to voltage drop blue digital tube is about 3.0V, so the TM1650 power supply should be selected 5.0V.

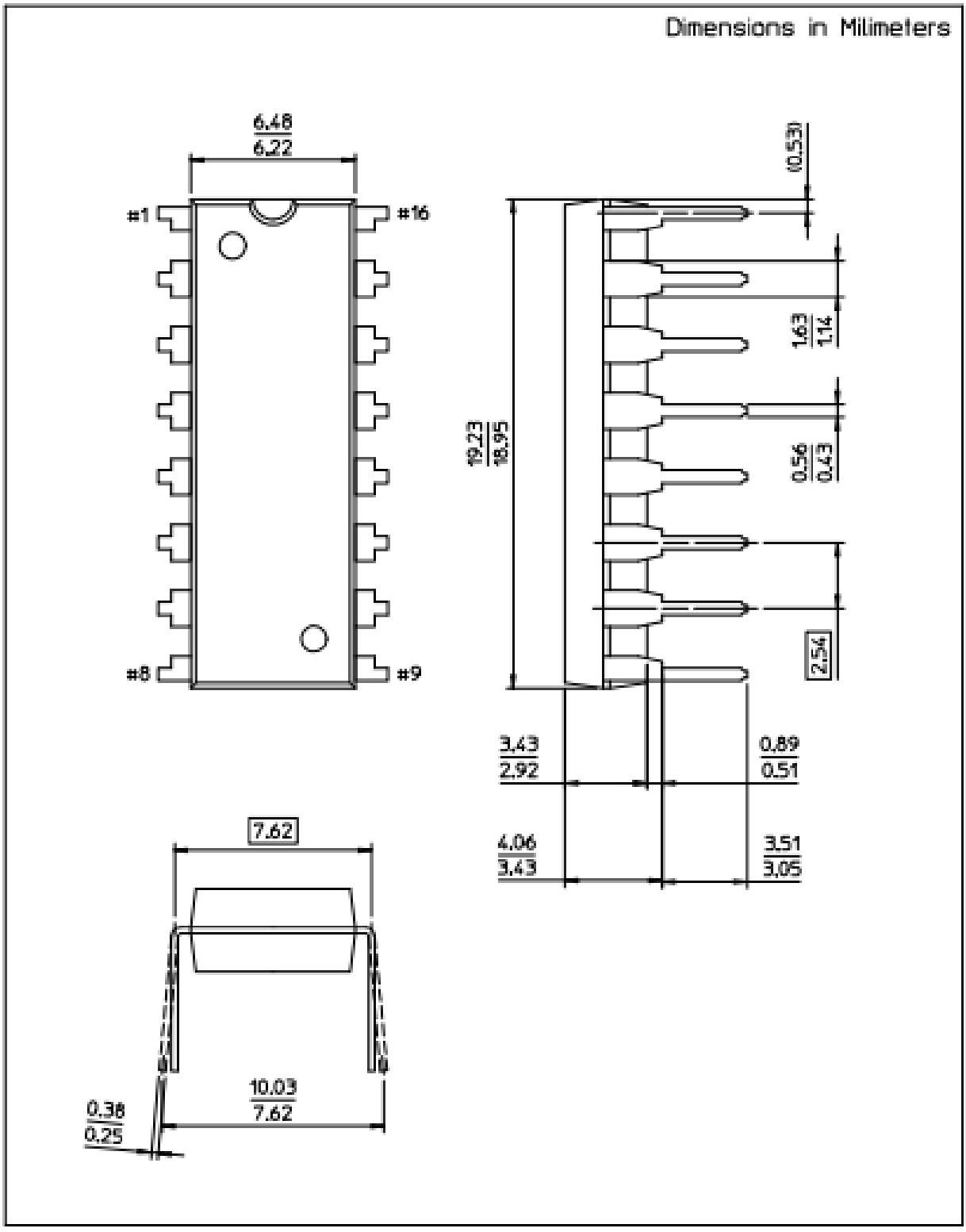
All specs and applications shown above subject to change without prior notice.

(以上电路及规格仅供参考,如本公司进行修正，恕不另行通知。

IC 封装示意图（SOP16）：



IC 封装示意图（DIP16）:



修订历史

版本	发行日期	修订简介
V1.0	2012-08-28	初版发行