

## LED drive controller / keyboard scan ASIC TM1650

## Characterization

LED TM1650 is a kind of keyboard scan interface (light emitting diode display) dedicated drive control circuit. Internal integrated MCU Digital input and output control interface, data latches, LED driver, keyboard scanning, brightness adjustment circuit. TM1650 stable performance, quality The amount of reliable, strong anti-jamming capability, suitable for long-term applications 24 hours of continuous work.

## Features

- two display modes:  $\times$  4-bit and 8 of paragraph  $7 \times 4$ 位
- segment drive current is greater than 25mA, bit driver current is greater than 150mA
- provide 8 brightness control
- keyboard scan:  $7 \times 4$ bit 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

## Field of application:

- household products such as set-top boxes, air conditioning, DVD / VCD and other display drivers.

## Internal structure diagram

## Pinning information

## Pin Function

name	port Pin	I / O	function descriptor
DIG1	1	O	Dan LED driver output 1 / keyboard scan output 1
DIG2	5	O	LED drive output Dan 2/2 keyboard scan output
DIG3	6	O	Dan LED drive output 3 / keyboard scan output 3
DIG4	7	O	Dan LED drive output 4/4 keyboard scan output
SCL	2	I	Data input terminal
SDA	3	I	A clock 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 outputs 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 outputs E / key scan input KI5
F / KI6	14	O / I	LED segment driver output F / key scan input KI6
G / KI7	Fifteen	O / I	LED segment driver output G / key scan input KI7
DP / KP	16	O	Segment LED output DP / keyboard flag output KP
GND	4	-	Logically
VDD	10	-	Logic Supply

In the dry season or drying environment, prone to static electricity, electrostatic discharge can damage integrated circuits, microelectronic recomm  
All appropriate preventive measures integrated circuit, if improper operation and soldering, ESD may cause damage or performance degradation, tl  
normal work.

## Protocol

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.

image 3)

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.

Figure 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.

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Keyboard scan codes:

TM1650 corresponding to keyboard scan codes:

Addressing	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.

Control command

1, the data command

B7	B6	B5	B4	B3	B2	B1	B0	Explanation
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				function	Explanation
B7	B6	B5	B4	B3	B2	B1	B0		
×	0	0	0	×	×	×	×	8 brightness	
×	0	0	1	×	×	×	×	A brightness	
×	0	1	0	×	×	×	×	2 Brightness	
×	0	1	1	×	×	×	×	3 Brightness	
×	1	0	0	×	×	×	×	Brightness settings 4 brightness	
×	1	0	1	×	×	×	×	5 brightness	
×	1	1	0	×	×	×	×	6 brightness	
×	1	1	1	×	×	×	×	7 brightness	
×					0	×	×	8 segment display	
×					1	×	×	7/8 segment display control bit 7-segment display	
×						×	×	Off Display	
×						×	1	On / off the display position Open display	

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

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Memory Address:

The register stores transferred from an external device via the serial interface to the TM1650 data of 4-byte 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 low-byte 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				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 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: open display, the display brightness level.

ADDRESS: Memory address.

DATA: The display data.

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Absolute maximum ratings (1) (2)

	parameter	range	unit
VDD	Logic Supply Voltage	-0.5 To + 7.0	V
VIN	Logic input voltage range SDA, SCL	-0.5 ~ VDD + 0.5V	V
Topr	Operating temperature range	-40 ~ + 85	°C
Tstg	Storage temperature range	-55 ~ + 125	°C
ESD	Human Body Model (HBM)	3000	V
	Machine model (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.  
Days: Microelectronics do not build Meeting in any other condition, the chip parameters exceed these limits work.

(2) All voltage values are with respect to network testing.

Recommended operating conditions

parameter	Test Conditions	TM1650			unit
		Min	Typical value	Max	
VDD	voltage	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	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 + VDD = 5.0V and TA = + 25 °C) unless otherwise stated

parameter	Test Conditions	TM1650			unit
		Min	Typ.	Max.	
VDD	Voltage Voltage	2.8	5.0	7.0	V
IDD	Supply Current	0.2		150	mA
IC <sub>S</sub>	Quiescent Current SCL, SDA, KP is high		0.2		mA

VIL	Low level input voltage		2.8	V	
VIH	High-level input voltage		2.8	V	
VOH	High-level output voltage	VDD-0.4	VDD	V	
VOL	Low-level output voltage		0.3	V	
VOLdig	DIG pin low output voltage	$I_{DIG} = -200mA$	-	1.3	V
VOLdig	DIG pin low output voltage	$I_{DIG} = -100mA$		0.9	V
VOHdig	DIG pin high output voltage	$I_{DIG} = 5mA$	forty five		V
VOLki	KI pin low output voltage	$I_{KI} = -20mA$		0.2	V
VOLki	KI pin low output voltage	$I_{KI} = 20mA$		0.5	V
IDN1	KI pin down current	$V_{KI} = 5.0V$	85	mA	
VR	Power-on reset default voltage threshold limits		2.5	V	

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Internal timing parameters (test conditions: Ta = 25 °C, VDD = 5V)

parameter	symbol	Least	typical	maximum	unit
Power-generation detection reset time	TPR	10	30	60	ms
Display scan period	TP		7		ms
Keyboard scanning interval, the key response time	TKS		40		ms

Note: This table is built-in clock cycle timing parameters multiples, with the built-in clock frequency reduces the power supply voltage is reduced.

Interface Timing Parameters (test conditions: Ta = 25 °C, VDD = 5V)

parameter	symbol	Minimum	Typical	Maximum	unit
SDA falling edge of the start-up time signal	TSSTA	100			ns
SDA falling edge of the start signal hold time	THSTA	100			ns
SDA rising time of the signal to stop the establishment	TSSTO	100			ns
SDA rising time of the signal to stop holding	THSTO	100			ns
Low-level width SCL clock signal	TCLOW	100			ns
High-level width SCL clock signal	TCHIG	100			ns
SDA SCL rising edge of the input data set-up time	TSDA	40			ns
SDA SCL rising edge of the input data retention time	THDA	10			ns
SDA output data valid delay the falling edge of SCL	TAA	2			ns
SDA output data is invalid delay the falling edge of SCL	TDH	2			ns
The average data transfer rate	Rate			4M	bps

Note: This table unit of measurement is in seconds. The maximum value can not indicate infinity.

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Typical Application Circuit

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.

(Above circuit and specifications are for reference only, as the company be amended, without notice.

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IC Encapsulation (SOP16):

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IC Encapsulation (DIP16):

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Revision History

version	issue date	Amendment Introduction
V1.0	2012-08-28	Original Issue

