TM1668 – LED Drive control dedicated circuit

[Page 1 – Translated using https://translate.google.nl]

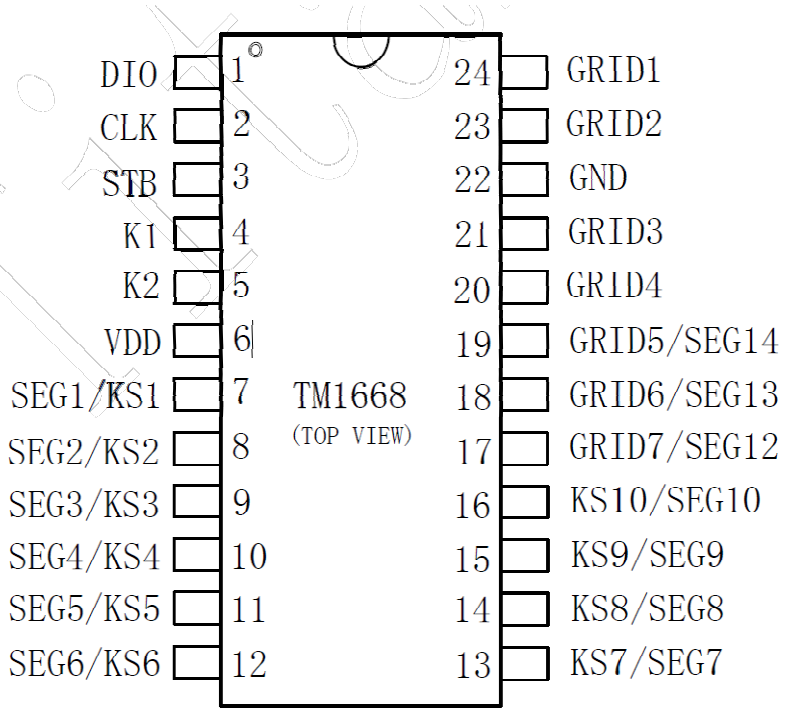
1. Overview

TM1668 is an LED (Light Emitting Diode Display) drive control IC with keyboard scan interface with integrated MCUs word interface, data latch, LED driver, keyboard scan circuit. This product is reliable, good stability, anti-interference ability.
Mainly applied to household appliances (smart water heaters, microwave ovens, washing machines, air conditioners, induction cooker), set-top boxes, electronic said smart electricity table and other digital tube or LED display device.

2. Characteristics

• CMOS technology
• Various display modes (10 segments × 7 digits to 13 segments × 4 digits)
• Maximum support matrix button 10 × 2
• Brightness adjustment circuit (adjustable duty cycle 8)
• Serial Interface (CLK, STB, DIO)
• Oscillation method: Built-in RC oscillation
• Built-in power-on reset circuit
• Built-in data latch circuit
• Built-in optimization circuit for dark LED problems caused by reverse bias of LED
• Strong anti-interference ability
• Package: SOP24, SSOP24, SDIP24

3. Pin definition



4. Pin function definition

Symbol	Pin Name	Pin Number	Description
DIO	Data output/input	1	Enter the serial data on the rising edge of the clock, from low start. The serial data is output on the falling edge of the clock low start. N tube open-drain output when output Set 13.3K Ω pull-up resistor.
CLK	Clock input	2	Read the rising edge of serial data, the falling edge of the output data. Built-in 13.3K Ω pull-up resistor
STB	Chip select input	3	Initialize serial interface on falling edge, then wait Receive instructions. STB is the first byte after low As an instruction, when processing the instruction, other processing is currently performed Was terminated. CLK is ignored when STB is high. Built-in 13.3K Ω pull-up resistor
K1 ~ K2	Key scan signal input	4 ~ 5	The data input to this pin is displayed after the end of the display period latch, built-in 7.2K Ω pull-down resistor
SEG1 / KS1 ~ SEG10 / KS10	Output (section)	7 ~ 16	Segment output (also used as key scan output), P tube open drain output, built-in 4K Ω pull-down resistor
GRID1 ~ GRID4	Output (bits)	24 ~ 23 21 ~ 20	Bit output, N tube open drain output, built-in 2.7K Ω on pull the resistor
SEG12 / GRID7 ~ SEG14 / GRID5	Output (segment / bit)	19 ~ 17	Segments / bit multiplexed output, can only be selected segment or bit output
VDD	Logic power supply	6	Power Positive
GND	Logically ground	22	Ground

5. Instructions:

Instructions are used to set the display mode and LED driver status.
The first byte entered by DIN after the falling edge of STB is used as an instruction. After decoding, take the highest B7, B6 two bits to distinguish between different instructions.

B7	B6	Instruction
0	0	Display mode command setting
0	1	Data command setting
1	0	Display control command settings
1	1	Address command setting

If STB is set high during an instruction or data transfer, serial communication is initialized and the instruction or data being transferred is invalid (the previous transfer
Instructions or data remain valid).

(1) Display mode command setting

This command is used to set the number of selected segments and bits (4 ~ 7 digits, 10 ~ 13 segments). When this command is executed, the display is forcibly turned off. in
When the display mode is the same, the data in the memory will not be changed, and the display control command controls the display switch. At power-on, the default display mode is 7-bit 10 segment.

B7	B6	B5	B4	B3	B2	B1	B0	Display mode
0	0	Nothing to do, fill 0				0	0	4 x 13 segment
0	0					0	1	5 x 12-segment
0	0					1	0	6 x 11 segment
0	0					1	1	7 x 10-segment

(2) Data command setting

This command is used to set the data to be written and read. The B1 and B0 bits do not allow setting 01 or 11.

B7	B6	B5	B4	B3	B2	B1	B0	Functional	Description
0	1	Unrelated items, Fill 0				0	0	Set Data read and write mode	Write data to the display register
0	1					1	0		Read key scan data
					0			Set Address increase mode	Automatic address increase
0	1				1				Fixed address
0	1			0				Set Test mode (internal use)	Normal mode
0	1			1					test mode

(3) Display control command settings:

This command is used to set the display switch and display brightness adjustment. A total of eight brightness to choose from to adjust.

B7	B6	B5	B4	B3	B2	B1	B0	Functional	Description
1	0	Unrelated items, Fill 0			0	0	0	Extinction quantity setting	Set the pulse width to 1/16
1	0				0	0	1		Set the pulse width to 2/16
1	0				0	1	0		Set the pulse width to 4/16
1	0				0	1	1		Set the pulse width to 10/16
1	0				1	0	0		Set the pulse width to 11/16
1	0				1	0	1		Set the pulse width to 12/16
1	0				1	1	0		Set the pulse width to 13/16
1	0				1	1	1		Set the pulse width to 14/16
1	0			0				Display switch settings	Display off
1	0			1					Display on

(4) address command setting:

This command is used to set the address of the display register. The most effective address is 14 bits (C0H-CDH). If the address is set to CEH or higher, the data is ignored
Slightly until the valid address is set. At power-on, the address is set to C0H by default.

B7	B6	B5	B4	B3	B2	B1	B0	Display address
1	1	Unrelated items, Fill 0		0	0	0	0	C0H
1	1			0	0	0	1	C1H
1	1			0	0	1	0	C2H
1	1			0	0	1	1	C3H
1	1			0	1	0	0	C4H
1	1			0	1	0	1	C5H
1	1			0	1	1	0	C6H
1	1			0	1	1	1	C7H
1	1			1	0	0	0	C8H
1	1			1	0	0	1	C9H
1	1			1	0	1	0	CAH
1	1			1	0	1	1	CBH
1	1			1	1	0	0	CCH
1	1			1	1	0	1	CDH

6. The display register address:

This register stores the data transferred from the external device to the TM1668 over the serial interface, with a maximum of 14-byte locations from the C0H-CDH,
Respectively, with the chip SGE and GRID pin corresponding to the specific allocation shown in Figure (2):
Write LED display data, according to the display address from low to high data byte from low to high operation.

SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	SEG8	SEG9	SEG10	X	SEG12	SEG13	SEG14	X	X	
xxHL (low four)				xxHU (high four)				xxHL (low four)				xxHU (high four)				
B0	B1	B2	B3	B4	B5	B6	B7	B0	B1	B2	B3	B4	B5	B6	B7	
C0HL				C0HU				C1HL				C1HU				GRID1
C2HL				C2HU				C3HL				C3HU				GRID2
C4HL				C4HU				C5HL				C5HU				GRID3
C6HL				C6HU				C7HL				C7HU				GRID4
C8HL				C8HU				C9HL				C9HU				GRID5
CAHL				CAHU				CBHL				CBHU				GRID6
CCHL				CCHU				CDHL				CDHU				GRID7

Figure (2)

▲ Note: The value of the internal display of the chip display register at power-on may be random and uncertain. At this time, the customer directly sends an on-screen command,
It will appear garbled. Therefore, our company recommends that the customer display register for a power-on reset operation, that is, 14-bit memory address after power-up
(C0H-CDH) all write data 0x00.

7. Application circuits

(1) Drive common cathode digital tube:

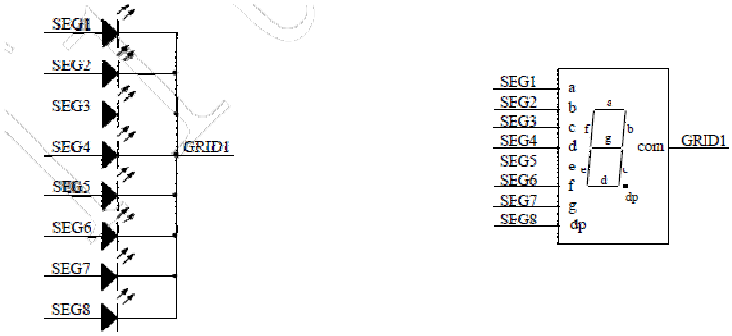


Figure (7)

Figure 7 shows the common cathode digital tube connection diagram, if the digital tube shows "0", only need to 00H (GRID1) address from the low open 0x3F data can be written at this time, 00H corresponds to the data of each SEG1-SEG8 as the following table:

SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	
0	0	1	1	1	1	1	1	GRID1(C0H)
B7	B6	B5	B4	B3	B2	B1	B0	

(2) Drive common anode digital tube:

Figure (8)

Figure 8 shows the common anode digital tube connection diagram, if the digital tube shows "0", to the address unit C0H (GRID1), C2H (GRID2),
Write data 01H in C4H (GRID3), C6H (GRID4), C8H (GRID5), and CAH (GRID6), and all the other addresses CCH (GRID7) according to 00H. The data corresponding to each SEG1-SEG8 is shown in the following table:

SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	
0	0	0	0	0	0	0	1	GRID1(C0H)
0	0	0	0	0	0	0	1	GRID2(C2H)
0	0	0	0	0	0	0	1	GRID3(C4H)
0	0	0	0	0	0	0	1	GRID4(C6H)
0	0	0	0	0	0	0	1	GRID5(C8H)
0	0	0	0	0	0	0	1	GRID6(CAH)
0	0	0	0	0	0	0	0	GRID7(CCH)
B7	B6	B5	B4	B3	B2	B1	B0	

▲ Note: Whether it is driving a common cathode digital tube or driving a common anode digital tube, the SEG pin can only connect with the anode of the LED, and the GRID can only connect with the cathode of the LED. This can not be reversed.

8. Key scan and key scan data register:

The chip supports a maximum of 10 × 2bit key scan matrix, as follows:

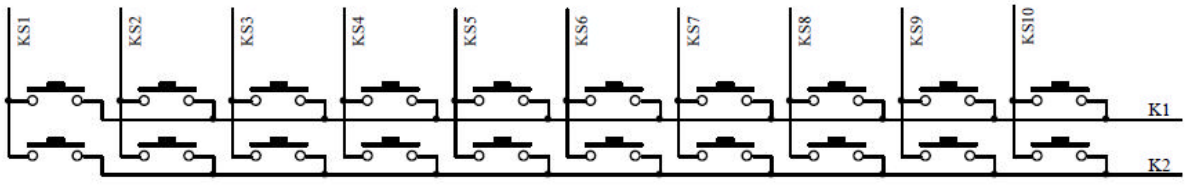


Figure (3)

Key scan data storage address as shown below, first read the key command, start reading 5 bytes of key data BYTE1-BYTE5 read data from the low open start output, where bits B7 and B6 are invalid Bit Fixed output is 0. When the key corresponding to K and KS pins is pressed, the BIT bit in the corresponding byte is 1.

B0	B1	B2	B3	B4	B5	B6	B7	
K1	K2	X	K1	K2	X	X	X	
KS1			KS2			0	0	BYTE1
KS3			KS4			0	0	BYTE2
KS5			KS6			0	0	BYTE3
KS7			KS8			0	0	BYTE4
KS9			KS10			0	0	BYTE5

▲ Note: 1, TM1668 can read up to 5 bytes, not allowed to read more.
2, read the data byte can only be read in order from BYTE1-BYTE5, can not read across the byte. For example: K2 and KS10 on the hardware corresponding keys press, you want to read this key data, you must read the 5th byte of the first 5BIT bit, can read out the data.

9. Keys:

(1) Key scan:

The key scan is done automatically by the TM1668, without user control. The user only needs to read the key value according to the sequence. Complete a key scan
Need two display cycles, a display cycle takes about T = 4ms, in the 8ms has pressed two different keys, two read the key values are the first press the key of that key.

In 7-bit, 10-segment mode, the IC scans SEG1 / KS1-SEG10 / KS10 internally after power-on
The waveform shown in Figure (10)

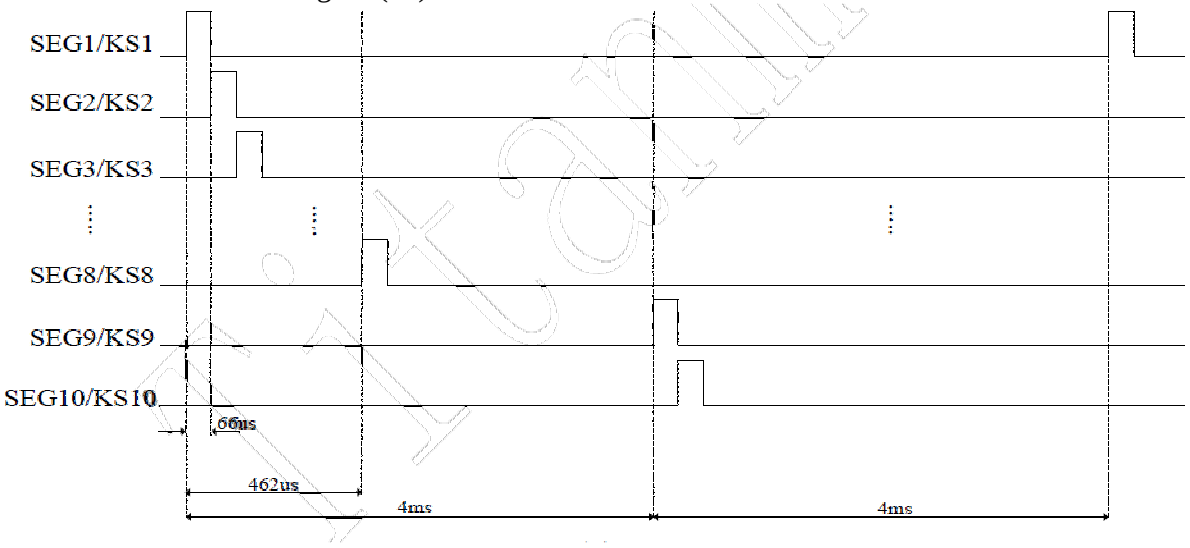


Figure (10)

As shown in Fig. 10, the internal key scanning principle of the chip is as follows: the chip gradually scans from SEG1 / KS1 to the end of SEG10 / KS10, and SEG1 / KS1-SEG8 / KS8 is completed in one cycle and SEG9 / KS9-SEG10 / KS10 is completed in the next cycle.
When sending a read key instruction, if SEG1 / KS1-SEG10 / KS10 end of the key scan high level by the introduction of K1 / K2 / K3 pin pin, the chip will recognize the high and read 5 bytes of key data, the corresponding BIT bit will be set high.

▲ Note: The display cycle and the oscillation frequency of IC work, the oscillation frequency is not exactly the same, the above data is for reference only, with the actual measurement of quasi.

(2) Button reuse:

Composite button problem: SEG1 / KS1-SEG10 / KS10 is displayed and the key scan multiplexing. Taking Fig. 12 as an example,
It is necessary to indicate that D1 is on and D2 is off. It is necessary to set SEG1 to "0" and SEG2 to "1". If S1 and S2 are simultaneously pressed, it corresponds to SEG1 and SEG2 is short-circuited when D1, D2 are lit.

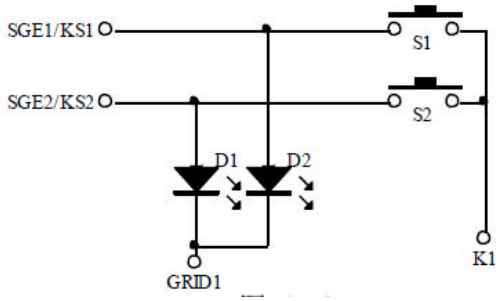


Figure (12)

Solution:
1, on the hardware, you can press the key that needs to be pressed at the same time to set different K lines above (13)

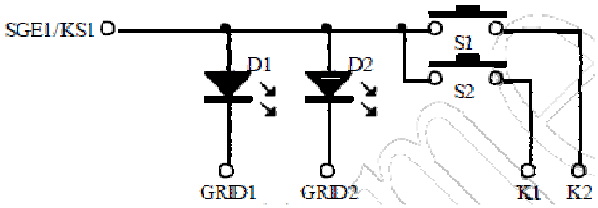


Figure (13)

2, the series diode shown in Figure (14).

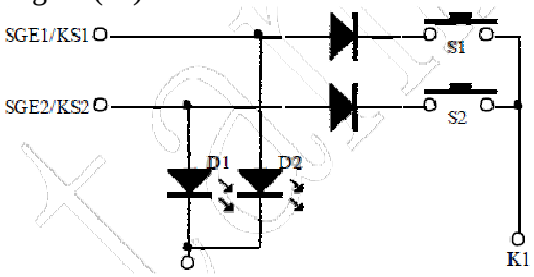


Figure (14)

▲ Note: It is recommended to use the same KS different K key as a composite button.