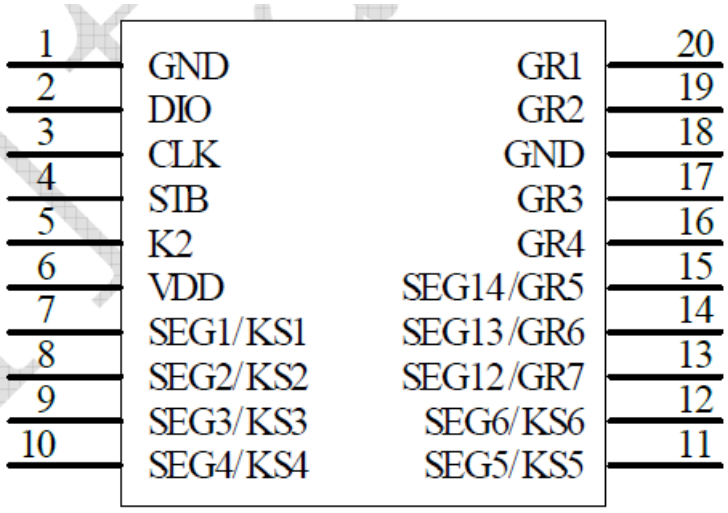
1. Overview

TM1620B is a special LED (light emitting diode display) drive control circuit with a keyboard scanning interface. It integrates MCU digital interface, data latch, LED high-voltage driver, keyboard scanning and other circuits. This product has excellent performance and reliable quality. Mainly used in display drivers for VCR, VCD, DVD and home theater products. Adopt SOP20 package form.

2. Feature description

- Adopt power CMOS process
- Display mode (6 segments × 7 digits ~ 9 segments × 4 digits)
- Buttons (6×1Bit)
- Brightness adjustment circuit (8 levels of duty cycle adjustable)
- Serial interface (CLK, STB, DIO)
- Oscillation mode: built-in RC oscillation (450KHz±5%)
- Built-in power-on reset circuit
- Package form:SOP20

3. Pin definition



4. Pin function definition

Symbol	Pin name	Explanation
DIO	Data input/output	Input/output serial data on the rising edge of the clock, starting from the low bit;
STB	Chip Select	Initialize the serial interface on a rising or falling edge and then wait for instructions to be received. The first byte after STB is low serves as an instruction. When the instruction is processed, other current processing is terminated. When STB is high, CLK is neglect
CLK	clock input	Serial data is input/outputted on the rising edge.
K2	Key scan data entry	The data input to this pin is latched after the display period ends.
Seg1/KS1～ Seg6/KS6	output(segment)	Segment output (also used for key scan), p-channel open-drain output
GR1～ GR4	output (bits)	Bit output, N-channel open drain output
Seg12/GR7 ～ Seg14/GR5	Output (segment/bit)	Segment multiplexing output
VDD	Logic power	5V±10%
GND	Ground	Connect to system ground

▲ Note: When the DIO port outputs data, it is an N-tube open-drain output. When reading keys, an external 1K-10K pull-up resistor is required. Our company recommends a 10K pull-up resistor. DIO controls the action of the N tube on the falling edge of the clock. At this time, the reading is unstable. You can refer to Figure (6). The reading is stable on the rising edge of the clock.

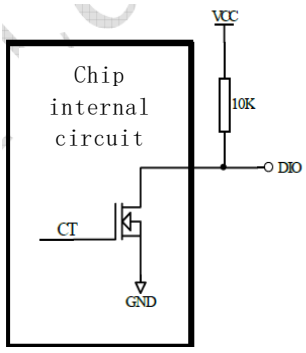


Figure (1)

5. Display register address and display mode

This register stores data transmitted from external devices to TM1620B through the serial interface. The address ranges from 00H to 0DH in 14-byte units, which correspond to the LED lights connected to the SGE and GRID pins of the chip respectively. The distribution is as follows:

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

SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	X	X	X	X	X	SEG12	SEG13	SEG14	X	X	
xxHL (Low four bits)				xxHU (High four bits)				xxHL (Low four bits)				xxHU (High four 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

Figure (2)

6. Key scan and key scan data register

The key scan matrix is 6×1bit, as shown below:

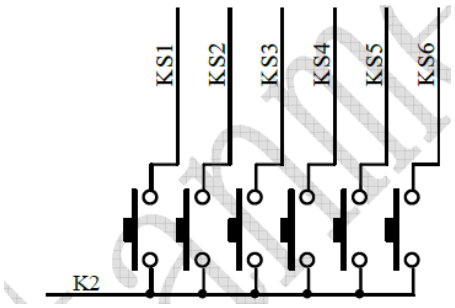


Figure (3)

The key scan data storage address is as follows. After the key read command is sent first, the key data BYTE1-BYTE3 bytes are read. The read data is output from the low bit, among which bits B0, B2, B3, B5, B6 and B7 are invalid bits. , at this time the chip output is 0. When the buttons corresponding to the K and KS pins of the chip are pressed, the BIT bit in the corresponding byte is 1.

B0	B1	B2	B3	B4	B5	B6	B7	
K1	K2	K3	K1	K2	K3			
KS1			KS2			0	0	BYTE1
KS3			KS4			0	0	BYTE2
KS5			KS6			0	0	BYTE3

Figure (4)

▲Note:

1. TM1620B can read up to 3 bytes, more reading is not allowed.

2. Reading data bytes can only be read from BYTE1-BYTE3 in order, and cannot be read across bytes. For example: when the corresponding buttons of K2 and KS6 on the hardware are pressed, if you want to read the button data, you must read the 4th bit of the 3rd byte before you can read the data.

7. Instruction description

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

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

If STB is set high during a command or data transmission, serial communication is initialized and the command or data being transmitted is invalid (the previously transmitted command or data remains valid).

(1) Display mode setting:

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	display mode
0	0	Irrelevant items , Fill in 0				0	0	4 digits 9 segments
0	0					0	1	5 digits 8 segments
0	0					1	0	6 digits 7 segments
0	0					1	1	7 digits 6 segments

This instruction is used to set the number of selected segments and bits (4 to 7 bits, 6 to 9 segments). When the command is executed, the display is forced off. To send a display control command to turn on the display, the data content originally displayed will not be changed, but when the same mode is set, the above situation does not occur.

(2) Data command settings:

This instruction is used to set data writing and reading. B1 and B0 bits are not allowed to be set to 01 or 11.

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	Function	Explanation
0	1	For irrelevant items, fill in 0				0	0	Data read and write mode settings	Write data to display register
0	1					1	0		Read key scan data
0	1				0			Address addition mode setting	Automatic address addition
0	1				1				fixed address
0	1			0				Test mode settings (internal use)	Normal mode
0	1			1					test mode

(3) Address command settings:

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	Show address
1	1	For irrelevant items, fill in 0		0	0	0	0	00H
1	1			0	0	0	1	01H
1	1			0	0	1	0	02H
1	1			0	0	1	1	03H
1	1			0	1	0	0	04H
1	1			0	1	0	1	05H
1	1			0	1	1	0	06H
1	1			0	1	1	1	07H
1	1			1	0	0	0	08H
1	1			1	0	0	1	09H
1	1			1	0	1	0	0AH
1	1			1	0	1	1	0BH
1	1			1	1	0	0	0CH
1	1			1	1	0	1	0DH

This instruction is used to set the address of the display register. If the address is set to 0EH or higher, the data is ignored until a valid address is set. When powered on, the address is set to 00H by default.

(4) Display control:

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	Function	Explanation
1	0	For irrelevant items, fill in 0			0	0	0	Extinction quantity setting	Set the pulse width to 1/16
1	0				0	0	1		Set the pulse width 2/16
1	0				0	1	0		Set the pulse width 4/16
1	0				0	1	1		Set the pulse width 10/16
1	0				1	0	0		Set the pulse width 11/16
1	0				1	0	1		Set the pulse width 12/16
1	0				1	1	0		Set the pulse width 13/16
1	0				1	1	1		Set the pulse width 14/16
1	0			0				Display switch settings	Show off
1	0			1					Show on

8. Serial data transmission format

Both reading and receiving 1 BIT operate on the rising edge of the clock.

Data reception (write data)

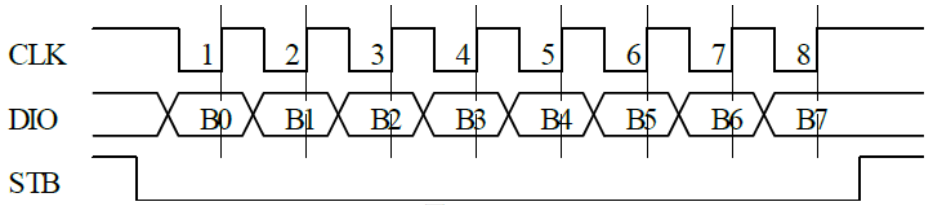


Figure (5)

Data reading (reading data)

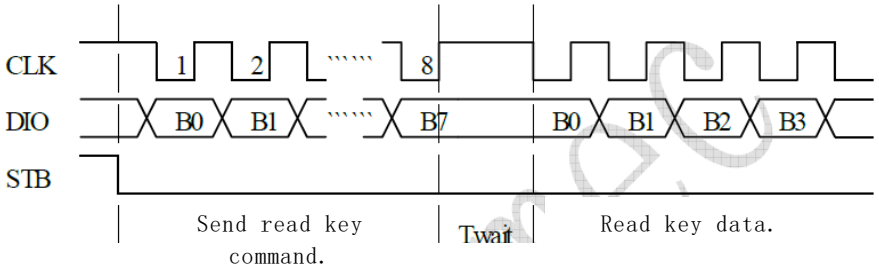


Figure (6)

▲ Note: When reading data, a waiting time Twait (minimum 1μS) is required between setting the instruction from the 8th rising edge of the serial clock CLK to reading data on the falling edge of CLK.

9. Display and key scanning

（1） show:

1、Driving common cathode digital display:

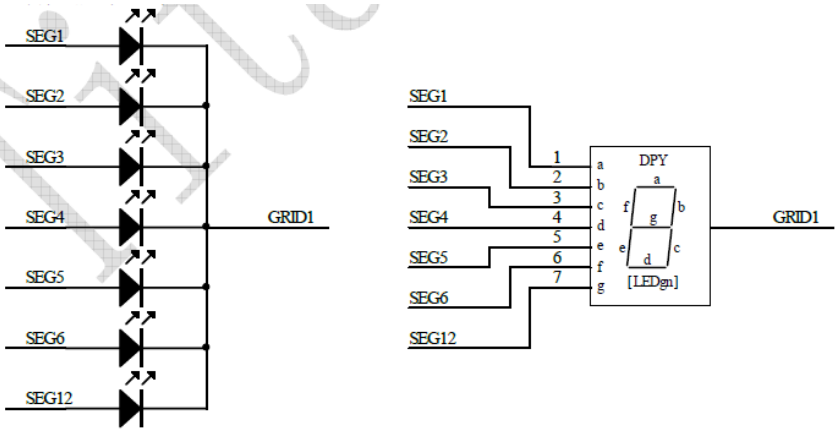


Figure (7)

Figure 7 shows the connection diagram of the common cathode digital tube. If you want the digital tube to display "0", then you need to make SEG1, SEG2, SEG3, SEG4, SEG5, and SEG6 high when GRID1 is low level. SEG12 is low level, View the address table shown in Figure (2). You only need to write data 3FH in the 00H address unit and 00H in the 01H address unit to make the digital tube display "0".

SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	
0	0	1	1	1	1	1	1	00H
B7	B6	B5	B4	B3	B2	B1	B0	

2、Driving common anode digital tube:

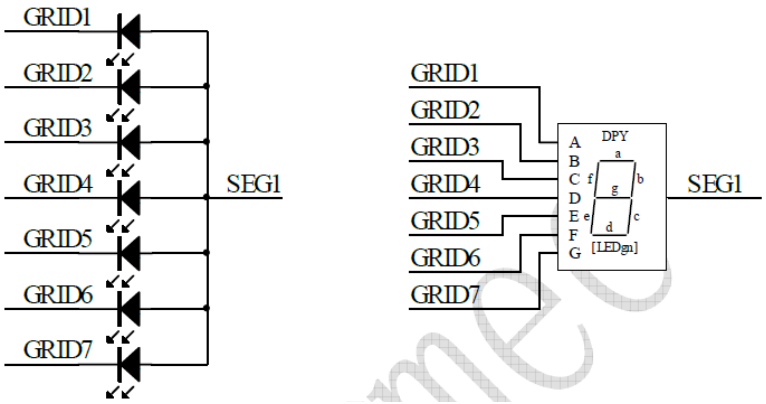


Figure (8)

Figure 8 shows the connection diagram of the common anode digital tube. If you want the digital tube to display "0", then you need to make SEG1 high when GRID1, GRID2, GRID3, GRID4, GRID5, and GRID6 are low. Let SEG1 be low when GRID7 is low. Write data 01H to address units 00H, 02H, 04H, 06H, 08H, and 0AH respectively, and write data 00H to all other address units.

SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	
0	0	0	0	0	0	0	1	00H
0	0	0	0	0	0	0	1	02H
0	0	0	0	0	0	0	1	04H
0	0	0	0	0	0	0	1	06H
0	0	0	0	0	0	0	1	08H
0	0	0	0	0	0	0	1	0AH
0	0	0	0	0	0	0	0	0CH
B7	B6	B5	B4	B3	B2	B1	B0	

▲Note: SEG1-11 is a P-channel open-drain output, and GRID1-7 is an N- channel open-drain output. When in use, SEG1-11 can only be connected to the anode of the LED, and GRID can only be connected to the cathode of the LED, and cannot be connected in reverse.

(2) Keyboard scanning:

You can use an oscilloscope to observe the output waveforms of SEG1/KS1 and SEG2/KS2 as shown in Figure (9), and the waveform of SEGN/KSN output. See Figure (10).

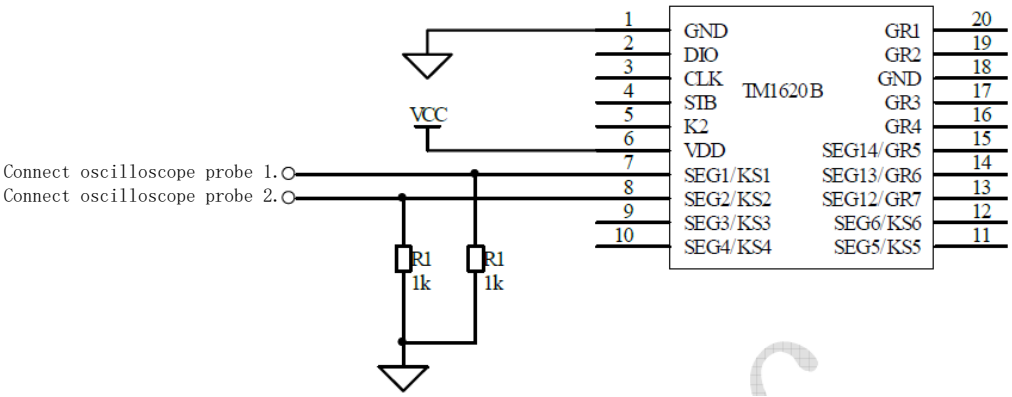


Figure (9)

SEGN/KSN waveform when the IC is scanning the keyboard:

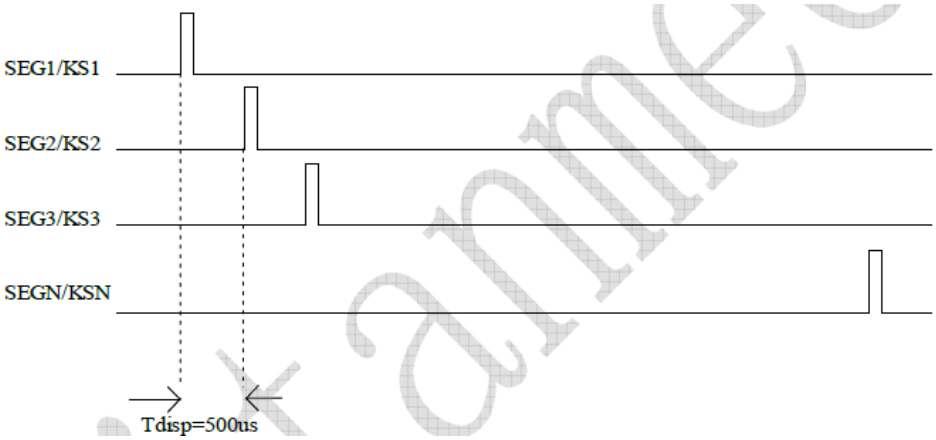


Figure (10)

Tdisp is related to the oscillation frequency of IC operation. Our company's TM1620B has been improved many times, and the oscillation frequency is not completely consistent. 500US is for reference only, actual measurement shall prevail.

Under normal circumstances, using Figure (11) can meet the requirements of button design.

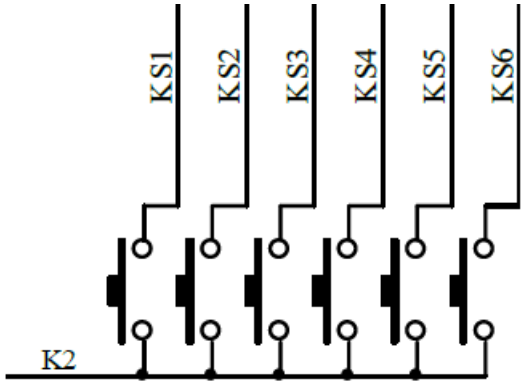


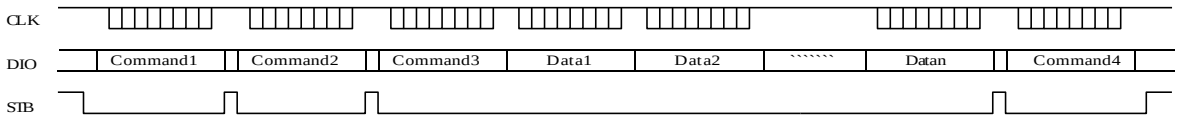
Figure (11)

When S1 is pressed, "1" is read in B0 of the first byte. If multiple buttons are pressed, multiple "1"s will be read. When S2 and S3 are pressed, "1" can be read in the first byte B1 and B3.

10. Transmission of serial data during application

(1) Address increasing mode

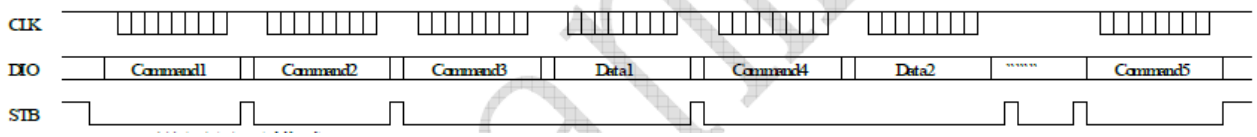
Using the address automatic increment mode, setting the address is actually setting the starting address where the transmitted data stream is stored. After the start address command word is sent, "STB" does not need to be set high immediately followed by data transmission, up to 14 BYTE, and "STB" is set high only after the data transmission is completed.



Command1: Set display mode
Command2: Set data command
Command3: Set display address
Data 1～ n: Transfer display data to the Command3 address and subsequent addresses (up to 14 bytes)
Command4: display control commands

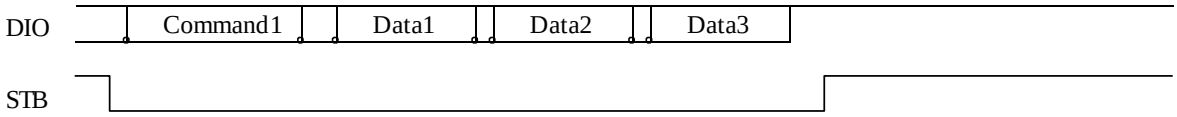
(2) Fixed address mode

Using the fixed address mode, setting the address is actually setting the address where the 1BYTE data that needs to be transmitted is stored. After the address is sent, "STB" does not need to be set high. The 1BYTE data is transmitted immediately, and "STB" is set high after the data transmission is completed. Then reset the address where the second data needs to be stored. After the data transmission of up to 14BYTE is completed, "STB" is set high.



Command1: Set display mode
Command2: Set data command
Command3: Set display address 1
Data1: Transmit display data 1 to the Command3 address
Command4: Set display address 2
Data2: Transmit display data 2 to the Command4 address
Command5: Display control command

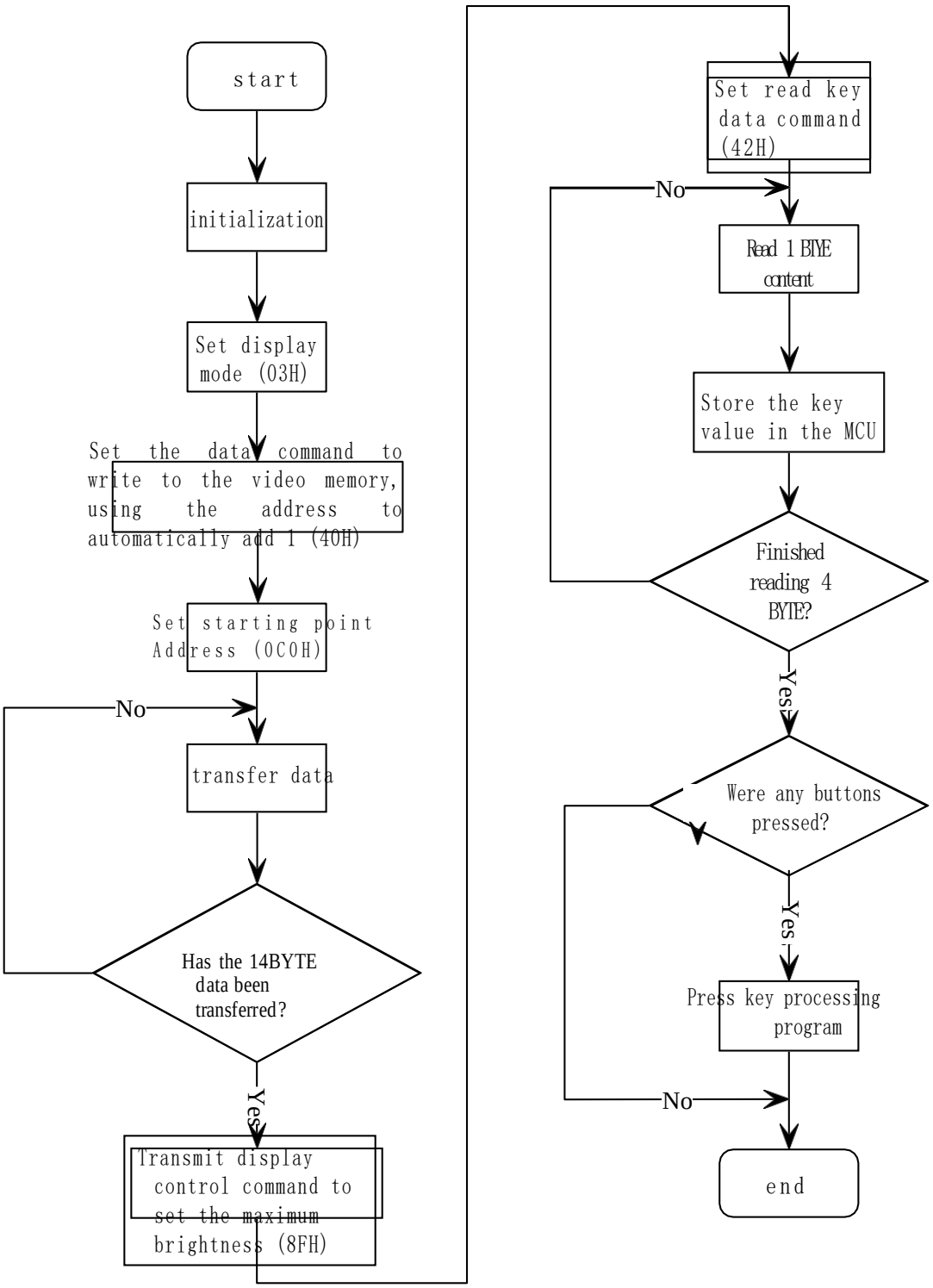
(3) Read button timing



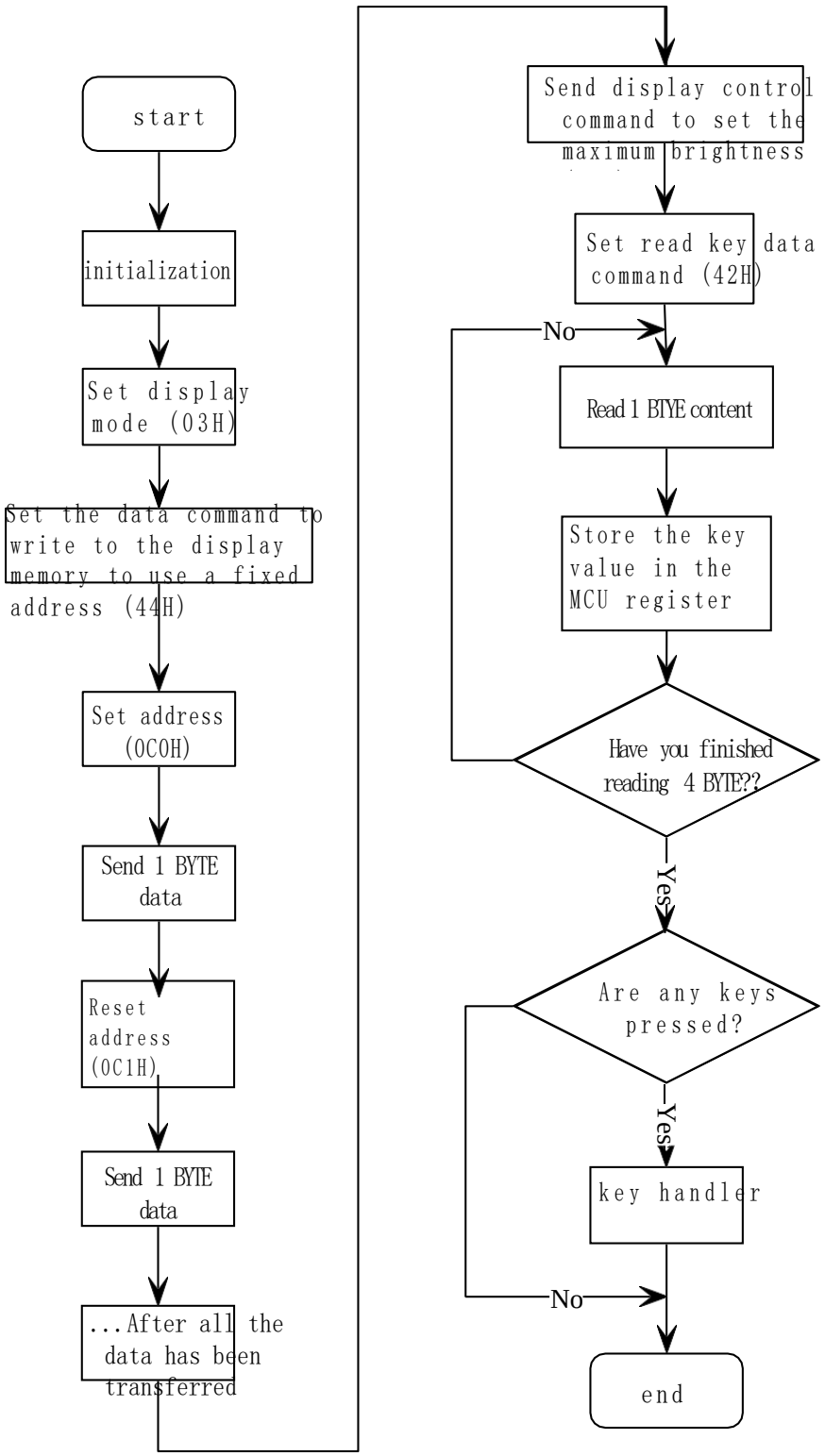
Command1: Set display mode
Data1～3: Read key data

(4) Program design flow chart:

The program design flow chart using the address to automatically add 1:



Programming flow chart using fixed address:



11. Application circuit

Typical application circuit of TM1620B used to drive common cathode digital screen (16):

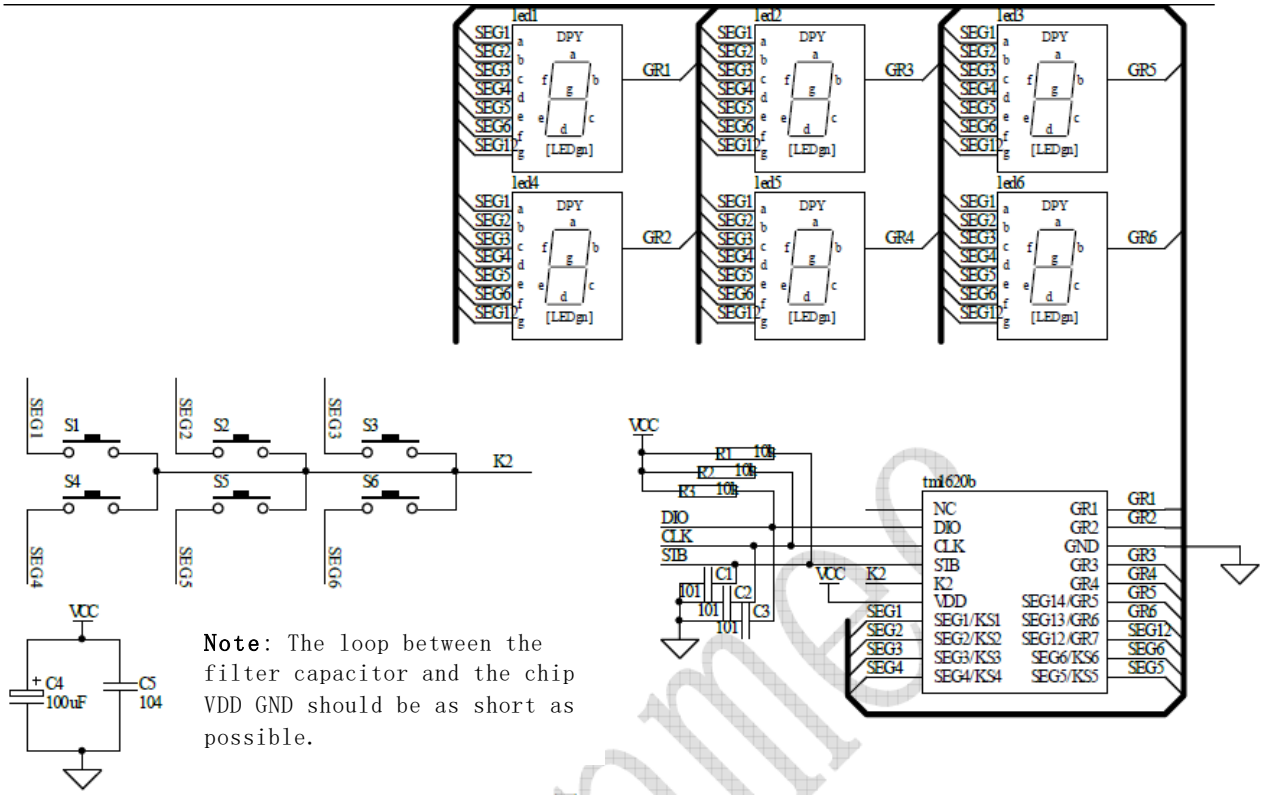


Figure (16)

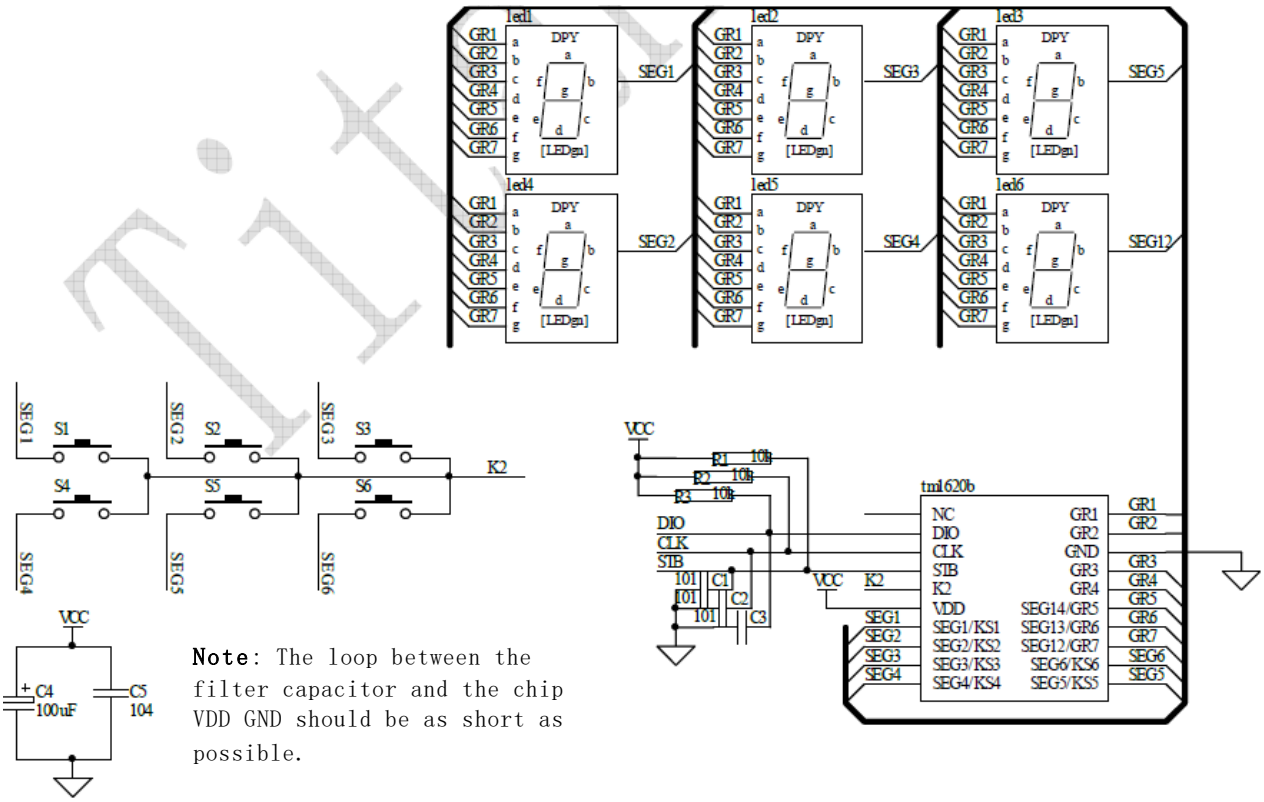


Figure (17)

▲ Note: 1. The filter capacitor between VDD and GND should be placed as close as possible to the TM1620B chip in the PCB wiring to enhance the filtering effect.
2. Three 100P capacitors connected to the DIO, CLK, and STB communication ports can reduce interference to the communication ports.
3. Since the on-voltage drop of the blue-ray digital tube is about 3V, 5V should be used for the power supply of TM1620B.

12. Electrical parameters

Limit parameters （Ta = 25℃, Vss = 0 V）

Parameter	Symbol	Scope	Unit
Logic supply voltage	VDD	-0.5 ～+7.0	V
Logic input voltage	VI1	-0.5 ～ VDD + 0.5	V
LED Seg drive output current	IO1	-50	mA
LED Grid driver output current	IO2	+200	mA
Power loss	PD	400	mW
Operating temperature	Topt	-40 ～ +80	℃
Storage temperature	Tstg	-65 ～+150	℃

Normal working range（Ta = -20 ～ +70℃, Vss = 0 V）

Parameter	Symbol	Min	Typical	Max	Unit	Test Conditions
Logic supply voltage	VDD		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	Typical	Max	Unit	Test Conditions
High level output current	Ioh1	20	25	40	mA	Seg1~Seg11, Vo = vdd-2V

	Ioh2	20	30	50	mA	Seg1~Seg11, Vo = vdd-3V
Low level input current	IOL1	80	140	-	mA	Grid1~Grid6 Vo=0.3V
Low level output current	Idout	4	-	-	mA	VO = 0.4V, dout
High level output current allowable amount	Itolsg	-	-	5	%	VO = VDD - 3V, Seg1～Seg11
Output pull-down resistor	RL		10		KΩ	K1~K3
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
Hysteresis voltage	VH	-	0.35	-	V	CLK, DIN, STB
Dynamic current consumption	IDDdyn	-	-	5	mA	No load, display off

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

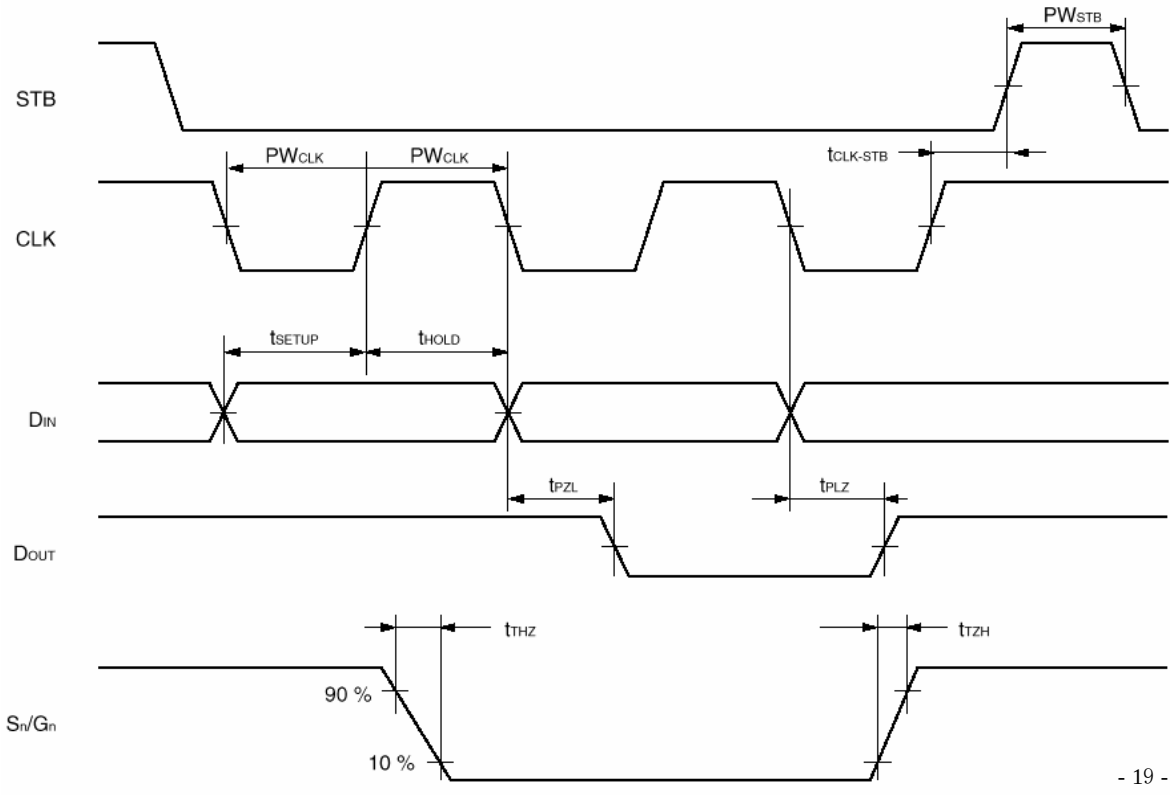
Parameter	Symbol	Min	Typical	Max	Unit	Test Conditions	
Oscillation frequency	fosc	-	500	-	KHz	R = 16.5 KΩ	
Transmission delay time	tPLZ	-	-	300	ns	CLK → DOUT	
	tPZL	-	-	100	ns	CL = 15pF, RL = 10K Ω	
Rise Time	TTZH 1	-	-	2	μs	CL = 300p F	Seg1～Seg11
	TTZH 2	-	-	0.5	μs		Grid1～Grid4 Seg12/Grid7～Seg14/Grid5

Fall time	TTHZ	-	-	120	μs	CL = 300pF, Segn, Gridn
maximum clock frequency	Fmax	1	-	-	MHz	Duty cycle 50%
Input capacitance	CI	-	-	15	pF	-

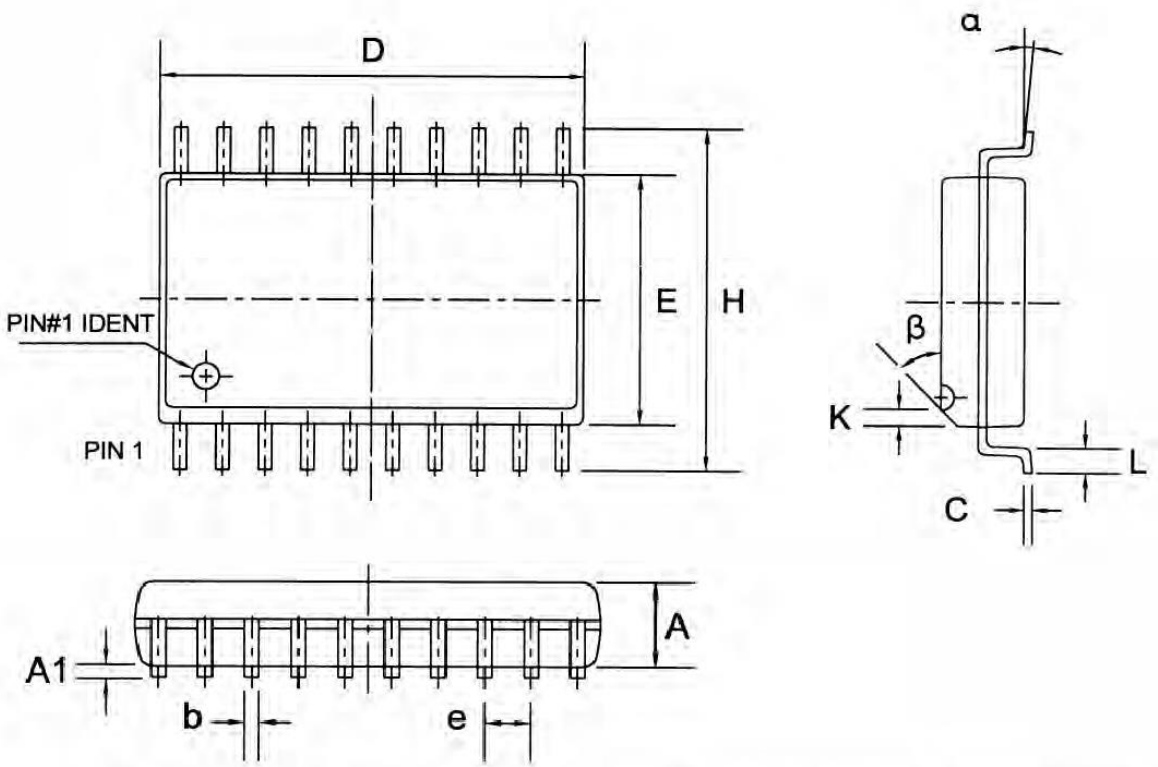
Timing characteristics（**Ta = -20 ～ +70℃，VDD = 4.5 ～ 5.5 V**）

Parameter	Symbol	Min	Typical	Max	Unit	Test Conditions
clock pulse width	PWCLK	400	-	-	ns	-
trobe pulse width	PWSTB	1	-	-	μs	-
Data creation time	tSETUP	100	-	-	ns	-
Data retention time	tHOLD	100	-	-	ns	-
CLK →STB time	tCLK STB	1	-	-	μs	CLK↑→STB↑
Waiting time	tWAIT	1	-	-	μs	CLK↑→CLK↓

Timing waveform diagram:



13. IC packaging diagram



Symbol	Dimensions In Millmeters			Dimensions In Inches		
	Min	Nom	Max	Min	Nom	Max
A	2.15	2.35	2.55	0.085	0.093	0.100
A1	0.05	0.15	0.25	0.002	0.006	0.010
b	—	0.40	—	—	0.016	—
C	—	0.25	—	—	0.010	—
D	12.40	12.70	13.00	0.488	0.500	0.512
E	7.40	7.65	7.90	0.291	0.301	0.311
e	—	1.27	—	—	0.050	—
H	10.15	10.45	10.75	0.400	0.411	0.423
K	—	0.50	—	—	0.020	—
L	0.60	0.80	1.00	0.024	0.031	0.039
α	0°	—	8°	0°	—	8°
β	—	45°	—	—	45°	—

● All specs and applications shown above subject to change without prior notice.
(The above circuits and specifications are for reference only and may be revised by our company without prior notice.)

This application document was last updated on: 2008-8-4