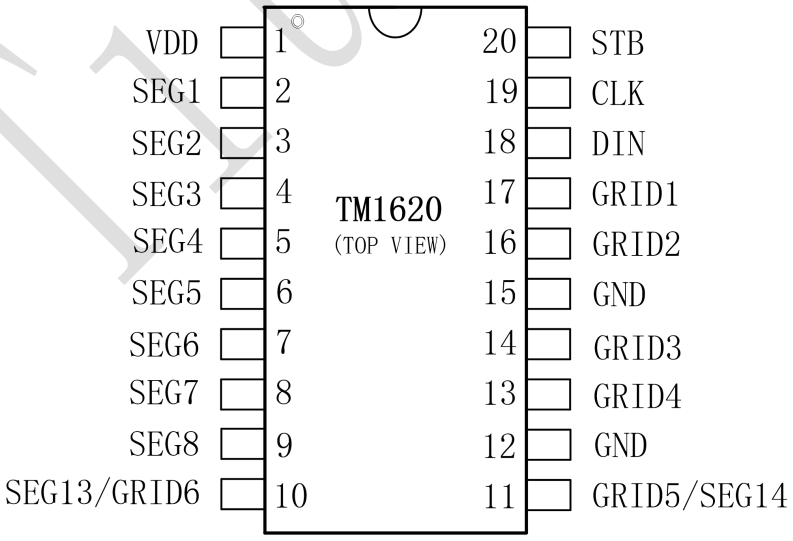
I. Overview

TM 1620 is a kind of LED (light-emitting diode display) drive control dedicated IC. The internal integrated circuits include MCU digital interface, data latch, and LED drive etc. The product is featured by reliable quality, stable performance and strong anti-jamming capacity. It is available for nixie tube or LED display equipment, such as household appliances (intelligent water heater、microwave oven, washer, air-conditioning, and induction cooker), set top box, electronic scale, and smart meters etc.

II. Features Descriptions

- **Apply CMOS technological process**
- **Display mode (8 segment × 4 bit ~ 10 segment × 4 bit)**
- **Brightness regulating circuit (adjustable duty ratio of Class 8)**
- **Serial interface (CLK, STB, DIN)**
- **Oscillation way: built-in RC oscillation**
- **Built-in power-on reset circuit**
- **Built-in digital latch circuit**
- **Built-in optimized circuit for the light problem due to the LED reverse leakage of electricity**
- **Strong anti-jamming capacity**
- **Package mode: SOP20**

III. Pin Definition:



IV. Pin function Definition:

Symbol	Pin Name	Pin No.	Descriptions
DIN	Digital input	18	Input serial data at rising edge of clock with beginning from low bit.There is one built-in pull-up resistor of 13.3KΩ.
CLK	Clock input	19	Read serial data at rising edge and export data from falling edge. There is one built-in pull-up resistor of 13.3KΩ.
STB	Chip select input	20	Initialize serial interface at falling edge and wait for receiving instruction. STB takes the first byte after the instruction is low; other processes shall be stopped when processing the instruction. CLK shall be ignored when STB is high. There is one built-in pull-up resistor of 13.3KΩ.
SGE1 - SEG8	Output (segment)	2-9	Segment output, P pin open-drain output; There is one built-in pull-down resistor of 4KΩ.
GRID1 - GRID4	Output (bit)	16-17 13-14	Bit output, N pit open-drain output; There is one built-in pull-up resistor of 2.7KΩ.
SEG13/DRID6 - SEG14/GRID5	Output (segment & bit)	10-11	Reuse output of segment/ bit; only the segment or bit output can be selected.
VDD	Logic power	1	Connect to positive pole of power
GND	Logic earth	12, 15	Connect to earth pole of the system

V. Instruction Description:

The instruction is used for setting the display mode and the status of LED driver.

The first byte inputted by DIN behind the STB falling edge is the instrument. With decoding, we take the maximum B7 and B6 bits to distinguish different instructions.

B7	B6	Instruction
0	0	Display Mode Command Setting
0	1	Data Command Setting
1	0	Display Control Command Setting
1	1	Address Command Setting

If STB is set at high level in instruction or data transmission, the serial communication is initialized and the instruction or data under transmission is invalid (the instruction or data transmitted before are still in effect).

(1) Display mode command setting:

This instruction is used for setting the number of selected segment and bit (4 - 6 bits, 8 - 10 segments). The display is forced to shut down when the instrument is executed. The data in video memory shall not be changed and the display control order can control display switch when the display mode remains unchanged.

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	Display mode
0	0	Irrelevant item, filled with 0				0	0	4 bit × 10 segment
0	0					0	1	5 bit × 9 segment
0	0					1	0	6 bit × 8 segment

(2) Data command Setting:

The instrument is used for setting the writing and reading for data. The B1 and B0 shall not be set as 01 or 11.

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	Function	Description
0	1	Irrelevant item, filled with 0				0	0	Data mode setting	Write data to display register
0	1				0			Address increment mode setting	Auto increment
0	1				1				Fixed address
0	1			0				Test mode setting (For inner use)	Normal mode
0	1			1					Test mode

(3) Display control command setting:

The instrument is used for setting display switch and brightness adjustment of display. There are 8 classes of brightness for selection and adjustment.

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	Function	Description
1	0	Irrelevant item, filled with 0			0	0	0	Extinction Number Setting	Set pulse width to 1/16
1	0				0	0	1		Set pulse width to 2/16
1	0				0	1	0		Set pulse width to4/16
1	0				0	1	1		Set pulse width to10/16
1	0				1	0	0		Set pulse width to 11/16
1	0				1	0	1		Set pulse width to 12/16
1	0				1	1	0		Set pulse width to13/16
1	0				1	1	1		Set pulse width to14/16
1	0			0				Display Switch Setting	Display closed
1	0			1					Display closed

(4) Address command setting:

The instrument is used for setting the address of display register. The maximum digit of effective address is 12 (00H-0BH). The default address is set as 00H when powering on.

MSB LSB

B7	B6	B5	B4	B3	B2	B1	B0	Display address
1	1	Irrelevant item, filled with 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

VI. Display Register Address:

The register memory receives data transmitted to TM1620 from external components with serial interface. The maximum digit of effective address is 12 bytes unit (00H-0BH), which respectively corresponds to chip SEG and GRID pin. The specific allocation is shown in Table (2):

Carry out operation with display address from low bit to high bit and date byte from low bit to high bit while writing LED display data.

SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	SEG8	X	X	X	X	SEG13	SEG14	X	X	
xxHL (four lower bits)				xxHU (four upper bits)				xxHL (four lower bits)				xxHU (four upper 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**

Figure (2)

▲**Note**: The value stored within display register of chip may be random when powering on. Some display messy code may appear if the customer sends screen turning-on command. Therefore, we suggest customers to carry out one zero clearing operation of powering on to display register; namely, input 0x00 in video memory address (00H-0BH) with 12 bits after powering on integrally.

VII. Display:

Drive common cathode nixie tube:

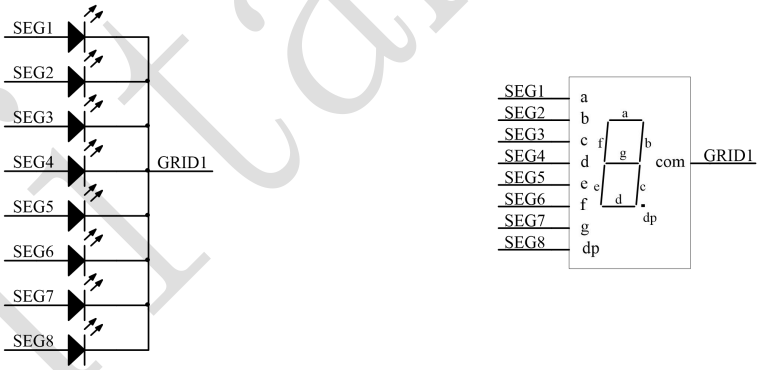


Figure (7)

Figure 7 is the connection diagram for common cathode nixie tube. Input 0x3F to 00H address (GRID1) from lower bit to enable this nixie tube to show "0". The data of SEG1-SEG8 corresponding to 00H are shown in the following table at the same time.

SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	
0	0	1	1	1	1	1	1	GRID1(00H)
B7	B6	B5	B4	B3	B2	B1	B0	

VIII. Transmission format of serial data:

Reading and receiving 1 Bit are all operated at the rising edge of the clock.

Data receiving (writing data)

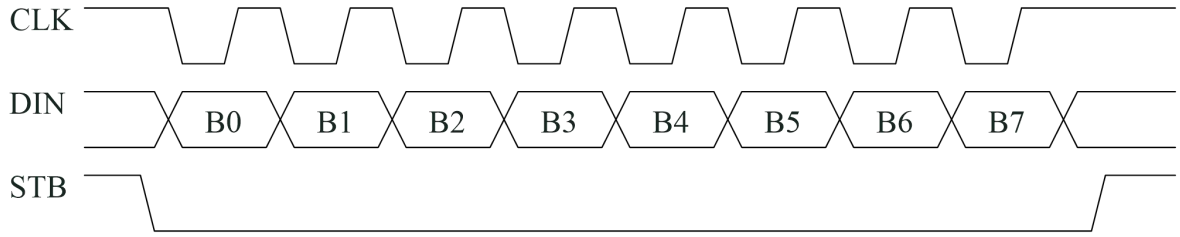
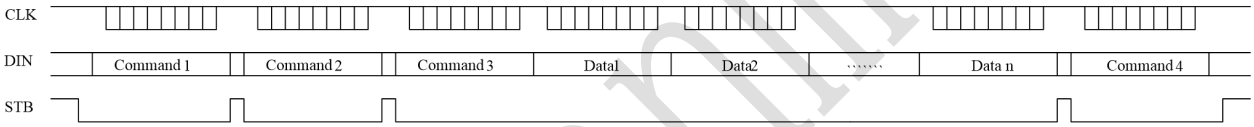


Figure (5)

XI. Transmission of serial data in application:

(1) Address increment mode

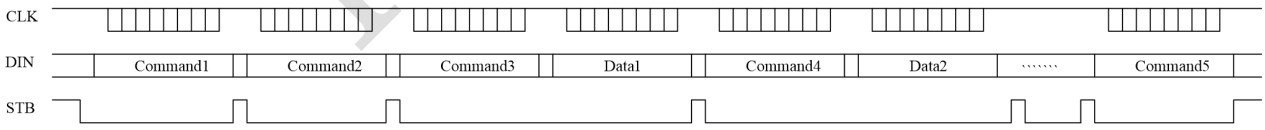
Using the auto increment mode to set address is to set the initial storage address for transmitted data flow actually. "STB" does not need to be increased to transmit data after finishing sending of command words for initial address, it is 14 BYTE at most, and can "STB" only be increased after data transmission is completed.



Command1: Set display mode
Command2: Set data command
Command3: Set display address
Data1- n: Transmit display data to address in Command 3 and the latter addresses (12 bytes at most).
Command4: Display control command

(2) Fixed address Mode

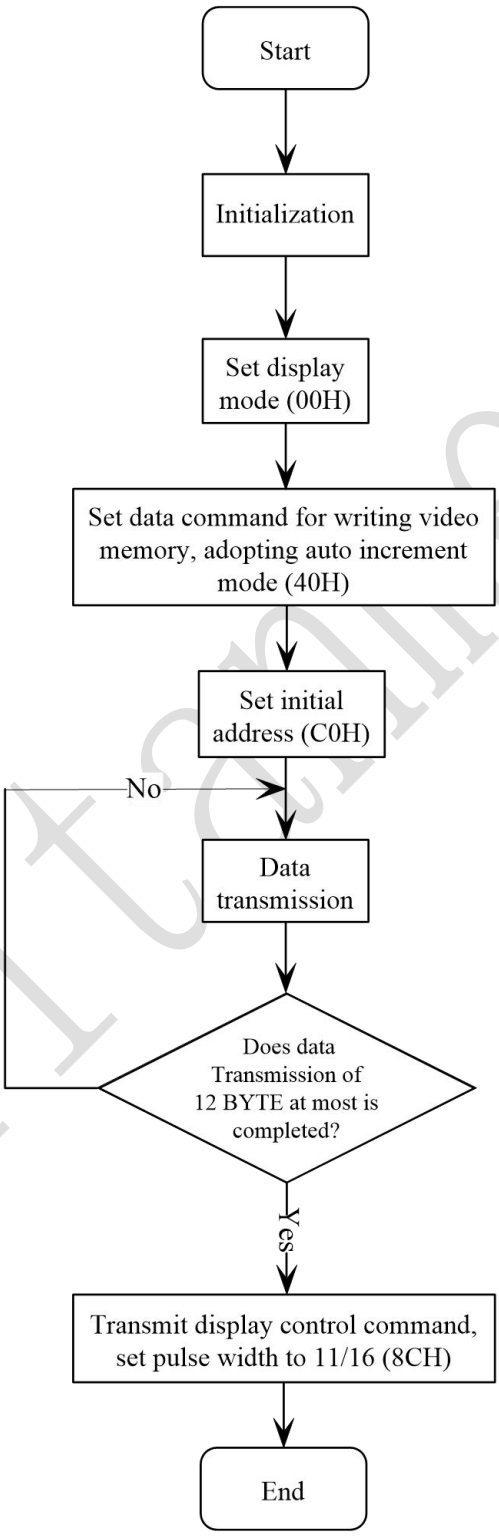
Using the fixed address mode of to set address is to set the storage address of 1BYTE data for transmission actually. "STB" does not need to be increased to transmit 1BYTE data after finishing address sending, can "STB" only be increased after finishing data transmission. Reset the storage address for second data. "STB" can be increased after finishing data transmission for 12 BYTE at most.



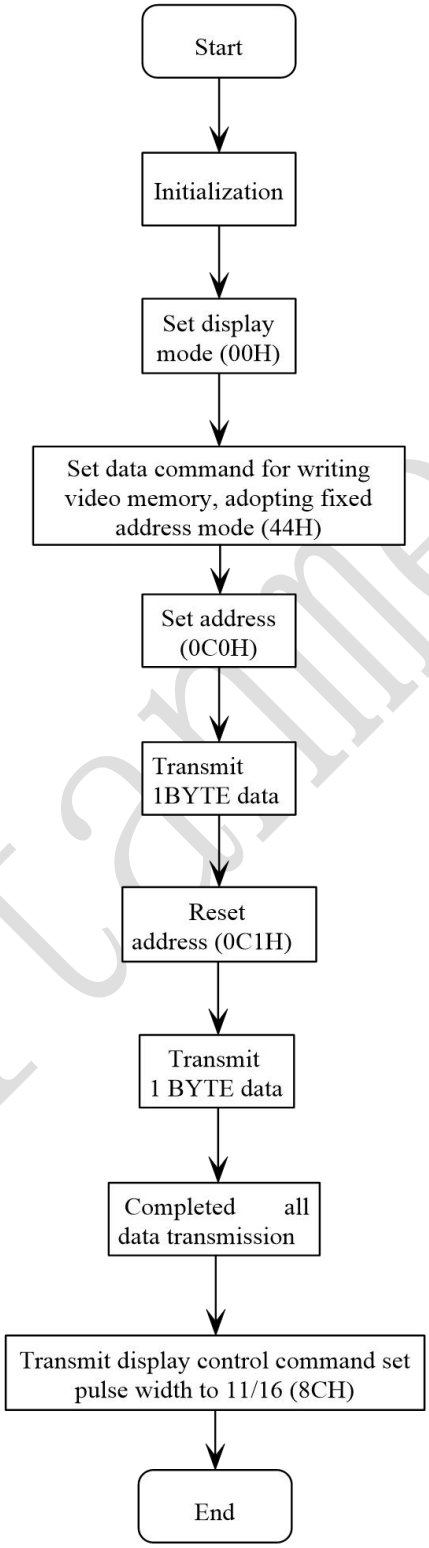
Command1: Set display mode
Command2: Set data command
Command3: Set display address1
Data1: Transmit display digital1 to Command3 address
Command4: Set display address2
Data2: Transmit display digital 2 to Command4 address
Command5: Display control command

（4）Flow diagram of programming design adopting auto increment mode and fixed address mode:

Flow diagram of programming design adopting auto increment mode:



Programming flow diagram adopting fixed address mode:



XII. Application circuit:

Hardware circuit diagram (18) of TM1620 drive common cathode digital screen

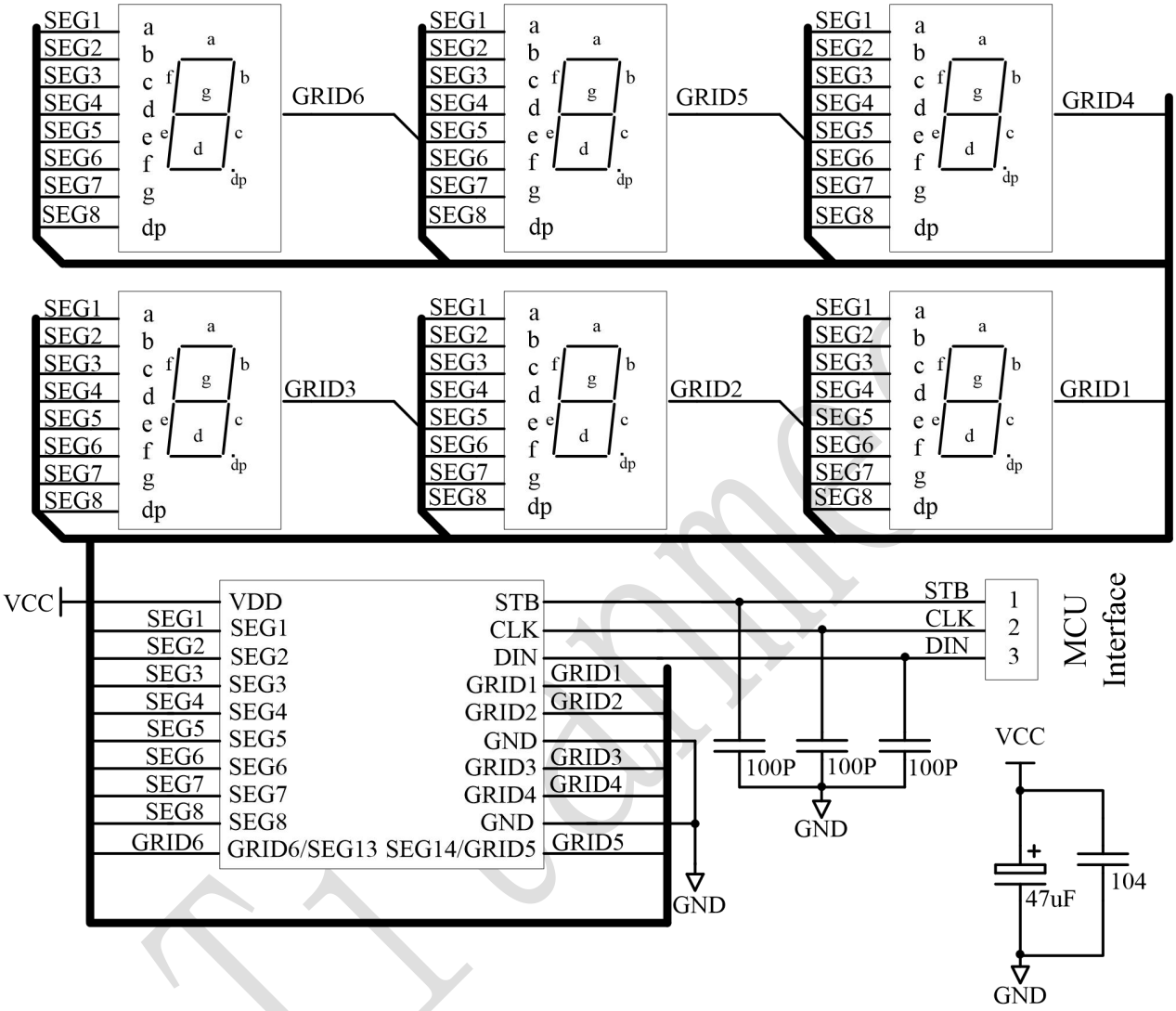


Figure (18)

▲Notes:

1. The filter capacitor between VDD and GND at wiring on PCB board should be placed near TM1620 chip as much as possible to strengthen filtering effect.
2. Pull down three 100pF capacitors on communication ports of DIN, CLK and STB can reduce the interference to the communication port.
3. As the drop voltage for blue-light nixie tube is about 3V, the power supply for TM1620 should be 5V.

XIII. Electric Parameters

Limit Parameters (Ta = 25℃, Vss = 0V)

Parameter	Symbol	Range	Unit
Logic power supply voltage.	VDD	-0.5 - +7.0	V
Logic input voltage	VI1	-0.5 - VDD + 0.5	V
LED SEG driving output current	IO1	-50	mA
LED GRID driving output current	IO2	+200	mA
Power loss	PD	400	mW
Working temperature	Topt	-40 - +85	℃
Storage temperature	Tstg	-65 - +150	℃
ESD	MM (machine mode)	200	V
	HBM (Human Beings mode)	2000	V

Normal operating range (Vss = 0V)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test condition
Logic power supply voltage.	VDD	3	5	6	V	-
High level input voltage	VIH	0.7 VDD	-	VDD	V	-
Low level input voltage	VIL	0	-	0.3 VDD	V	-

Electric Features (VDD = 5V,Vss=0)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test condition
High level output current	Ioh1	20	35	60	mA	SEG1 - SEG8 Vo = VDD -3V
Low level input current	I_{OL}	80	120	-	mA	GRID1 - GRID6 Vo=0.3V
Low level output current	Idout	3	-	-	mA	Vo = 0.4V, Dout
High level output current tolerance	Itolsg	-	-	5	%	Vo = VDD – 3V, SEG1 - SEG8
High level input voltage	VIH	0.7 VDD	-		V	CLK, DIN, STB
Low level input voltage	VIL	-	-	0.3 VDD	V	CLK, DIN, STB

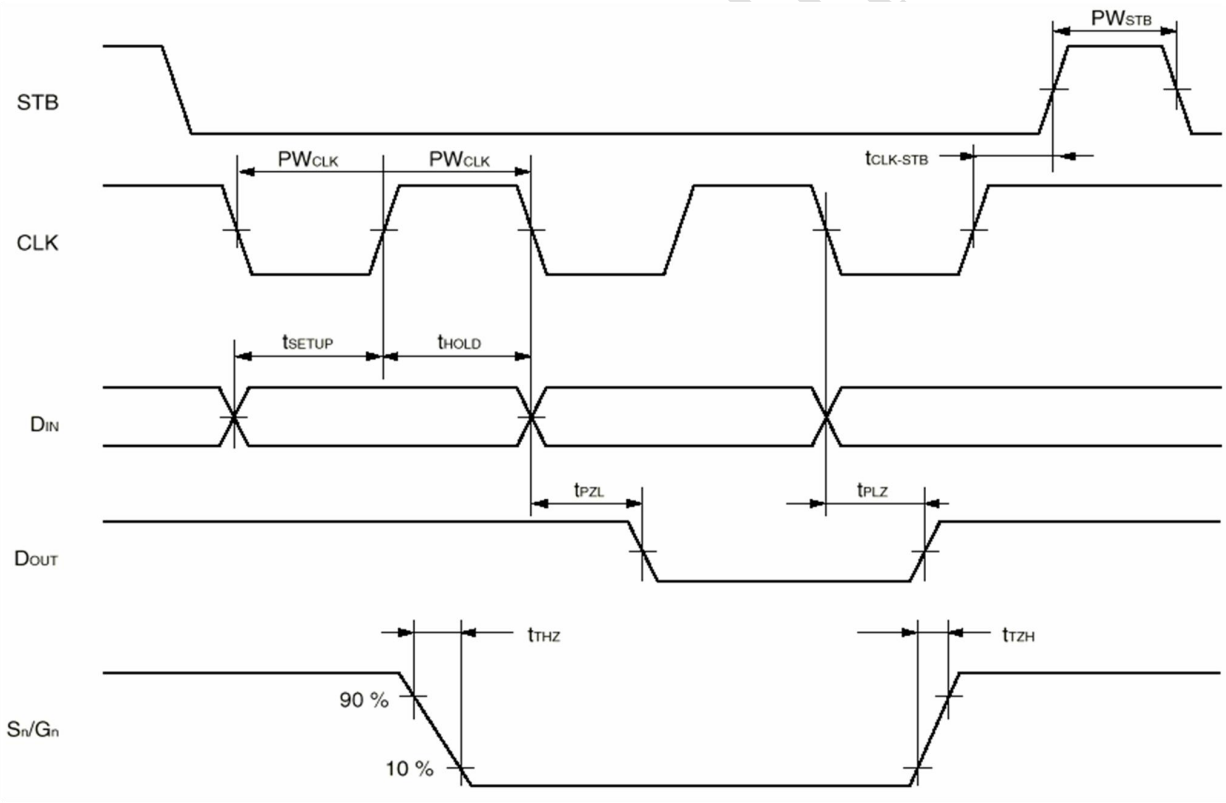
Switch features (VDD = 5V)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test condition	
Transmission delay time	t_{PLZ}	-	-	300	ns	CLK → DIN	
	t_{PZL}	-	-	100	ns	CL = 15pF, RL = 10K Ω	
Raising time	$t_{TZH\,1}$	-	-	2	μs	CL = 300pF	SEG1 - SEG8
	$t_{TZH\,2}$	-	-	0.5	μs		GRID1 - GRID4 SEG13/GRID6 - SEG14/GRID5
Falling time	t_{THZ}	-	-	1.5	μs	CL = 300pF,SEGn,GRIDn	
Maximum input clock frequency	Fmax	-	-	1	MHz	Duty cycle 50%	
Input capacitance	CI	-	-	15	pF	-	

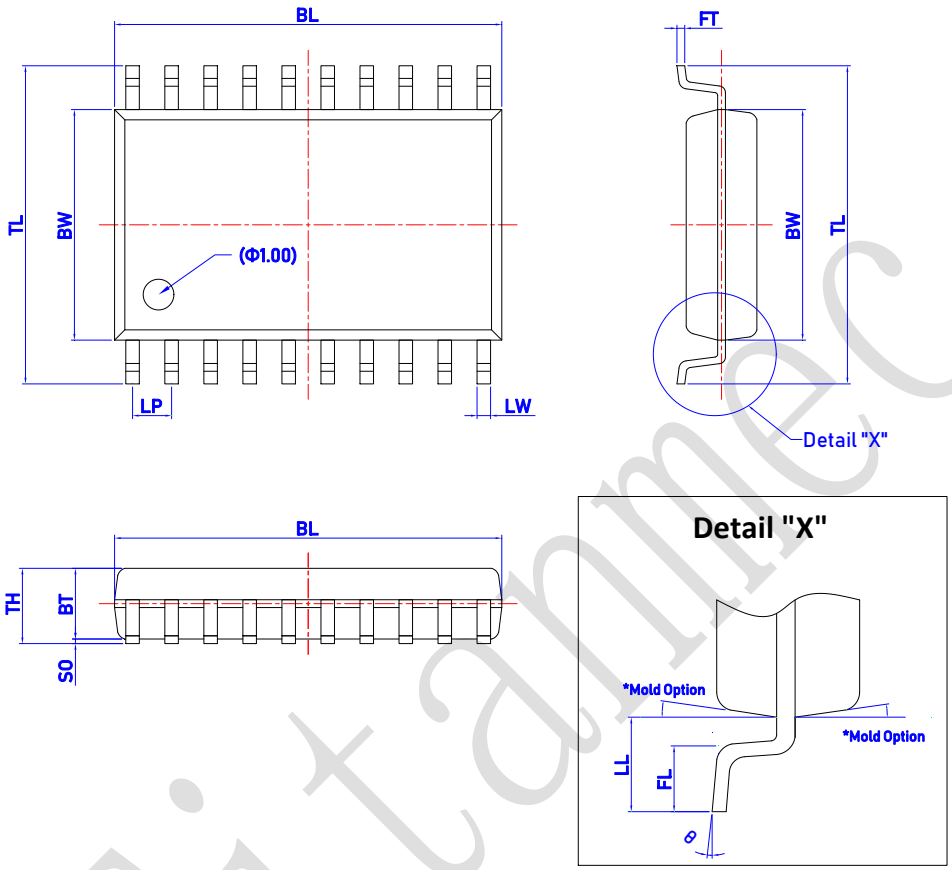
Timing sequence features (VDD = 5V)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test condition
Clock-pulse width	PW_{CLK}	500	-	-	ns	-
Gate width	PW_{STB}	1	-	-	μs	-
Data set up time	t_{SETUP}	100	-	-	ns	-
Data hold time	t_{HOLD}	100	-	-	ns	-
CLK →STB Time	$t_{CLK-STB}$	1	-	-	μs	CLK↑→STB↑

Time sequence oscillogram :



XIV. Schematic diagram of IC package: SOP20-300



Dimensions

Item	BL	BW	TL	LW	LP	FT	BT	SO	TH	LL	FL	θ
表示	总长	胶体宽度	跨度	脚宽	脚间距	脚厚	胶体厚度	站高	胶体高度	单边长	脚长	脚角度
Unit	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	?
Spec	12.70 (12.60) 12.50	7.55 (7.50) 7.45	10.50 (10.35) 10.20	0.440 TYP	1.270 TYP	0.300 (0.250) 0.200	2.40 (2.30) 2.20	0.250 (0.150) 0.100	2.550 Max.	1.50 (1.40) 1.30	0.90 (0.80) 0.70	8 (4) 0

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