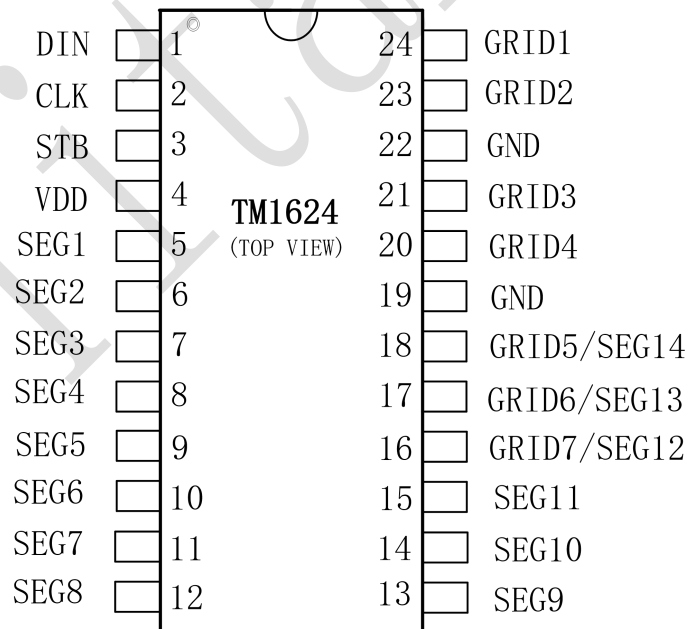# I. Introduction

TM1624 is an IC dedicated to LED (light emitting diode display) drive control. It integrates MCU digital interface, data latch, LED drive, and other circuits. This product is reliable in quality, stable in performance and strong in interference resistance. It is mainly used for household electrical appliances (smart water heaters, microwave ovens, washing machines, air conditioners, and electric stove), set-top boxes, electronic scale, smart meters and other other digital tube or LED display devices.

II. Features

- **CMOS technology**
- **Multiple display modes （11 segments ×7 bits ～ 14 segments ×4 bits）**
- **Brightness adjustment circuit (8-level adjustable duty ratio)**
- **Serial interfaces (CLK, STB, DIN)**
- **Oscillation mode: built-in RC oscillation**
- **Built-in power-on reset circuit**
- **Built-in data-latching circuit**
- **Built-in circuit optimized for brightness issue resulting from reverse-bias leakage of LED**
- **Good interference resistance.**
- **Package type: SOP24、QSOP24**

III. Pin definition:

	TM1624 (TOP VIEW)	
DIN	1	24 GRID1
CLK	2	23 GRID2
STB	3	22 GND
VDD	4	21 GRID3
SEG1	5	20 GRID4
SEG2	6	19 GND
SEG3	7	18 GRID5/SEG14
SEG4	8	17 GRID6/SEG13
SEG5	9	16 GRID7/SEG12
SEG6	10	15 SEG11
SEG7	11	14 SEG10
SEG8	12	13 SEG9

IV. Definition of pin function

Symbol	Pin Name	Pin ID	Description
DIN	Data Input	1	Input serial data at rising edge of the clock, starting from lower bits.Built-in 13.3KΩ pull-up resistor
CLK	Clock input	2	Read serial data at rising edge and output data at falling edge. Built-in 13.3KΩ pull-up resistor
STB	Chip selection input	3	Initialize the serial interface at falling edge, then wait to receive instructions. The first byte after STB becomes low is considered as an instruction. When an instruction is being processed, other current processes are terminated. When STB is high, CLK is ignored. Built-in 13.3KΩ pull-up resistor
SGE1～SEG11	Output (segment)	5～15	Segment output. This is a PMOS open drain output with a 4KΩ pull-down resistor
GRID1～ GRID4	Output (bit)	20～21 23～24	Bit output. This is a NMOS open drain output with a 2.7KΩ pull-up resistor
SEG12/DRID7 ～ SEG14/GRID5	Output (segment/bit)	16～18	Multiplexed output of either segment or bit
VDD	Logic Supply	4	Power +
GND	Logic GND	19、22	System GND

V. Description of Instructions

This instruction is used to set the display mode and the status of LED drive.

The first byte input by DIN after the falling edge of STB is considered as an instruction. After decoding, obtain the topmost B7 and B6 bits to distinguish different instructions.

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

If STB is set high during instruction or data transmission, serial communication is initialized, and the instruction or data being transmitted is invalid (but the instruction or data transmitted before remains active.)

（1） **Setting of Display Mode Command:**

This instruction is used to set the number of selectable segments and bits (4~7 bits, 11~14 segments) Display is forced off when this instruction is being executed. While the display mode remains unchanged, the data in the display memory will not be changed. The display control commend controls the ON and OFF of display. When powered on, the display mode by default is 7 bits×11 segments.

MSB | | | | | | | LSB | |

B7	B6	B5	B4	B3	B2	B1	B0	Display mode
0	0					0	0	4 bits, 14 segments
0	0	Unrelated item. Leave it to be 0				0	1	5 bits, 13 segments
0	0					1	0	6 bits, 12 segments
0	0					1	1	7 bits, 11 segments

（2） **Setting of Data Command:**

This instruction is used to set data writing and reading. Bits B1 and B0 cannot set to 01 or 11.

MSB | | | | | | | LSB | | |

B7	B6	B5	B4	B3	B2	B1	B0	Function	Description
0	1					0	0	Setting of data read-write mode	Write data to the display register
0	1	Unrelated item. Leave it to be 0				1	0		Read key scanning data
0	1			0				Sett address increment mode	Auto increment
0	1			1					Fixed address
0	1		0					Test mode setting (for internal use)	Normal mode
0	1		1						Test mode

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（3） **Setting of Display Control Command:**

This instruction is used to set the ON/OFF and brightness of display. A total of 8 levels of luminance are offered for adjustment.

MSB   LSB

B7	B6	B5	B4	B3	B2	B1	B0	Function	Description
1	0				0	0	0		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	Unrelated item. Leave it to be 0			0	1	1	Setting of display luminance	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				Setting of display switch	Display Off
1	0			1					Display ON

（4） **Setting of Address Command：**

This instruction is used to set the address of the display register. In the maximum case, there are 14 valid addresses (00H-0DH). If the address is OEH or higher, data will be ignored until a valid address is set. On power-up, the address is set to 00H by default.

MSB   LSB

B7	B6	B5	B4	B3	B2	B1	B0	Display address
1	1			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	Unrelated item. Leave it to be 0		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

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VI. Address of display register:

The register stores data transmitted through the serial interface from an external device to TM1624, or, at valid addresses of 14 bytes ranging from 00H-0DH in the maximum case, each corresponding to the Chip SEG and GRID pins, as assigned below:

LED display data are written in an ascending order of both display address and data byte.

SEG1	SEG2	SEG3	SEG4	SEG5	SEG6	SEG7	SEG8	SEG9	SEG10	SEG11	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	
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)

▲ Note: The moment the display register of the chip is powered on, the values stored inside may be random, at which point, user may directly send a command to turn on the screen, and messy codes are likely to appear. Considering that, the company advise customers to clear the display register upon power-on, i.e., writing 0x00 into all the 14-byte memory addresses (00H-0DH).

VII. Display:

1. Driving common cathode LEDs:

Figure (7)

Figure 7 is a diagram for the wiring of common cathode LEDs. To display 0 off the LED segment display, customers only need to write 0x3F to the 00H (GRID1) address starting from lower bits, at which point, 00H corresponds to the data in SEG1-SEG8 as shown in the table below.

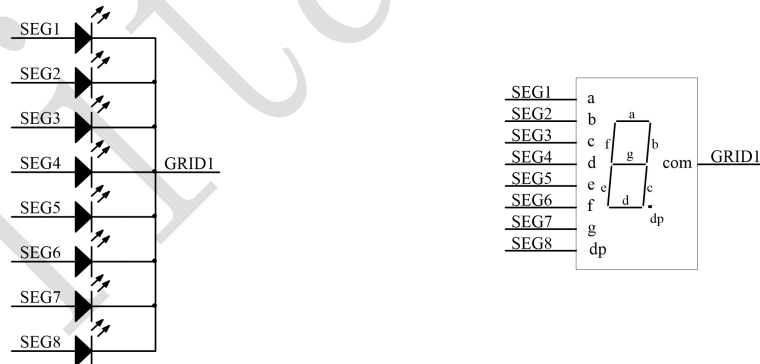| SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	
0	0	1	1	1	1	1	1	GRID1(00H)
B7	B6	B5	B4	B3	B2	B1	B0	

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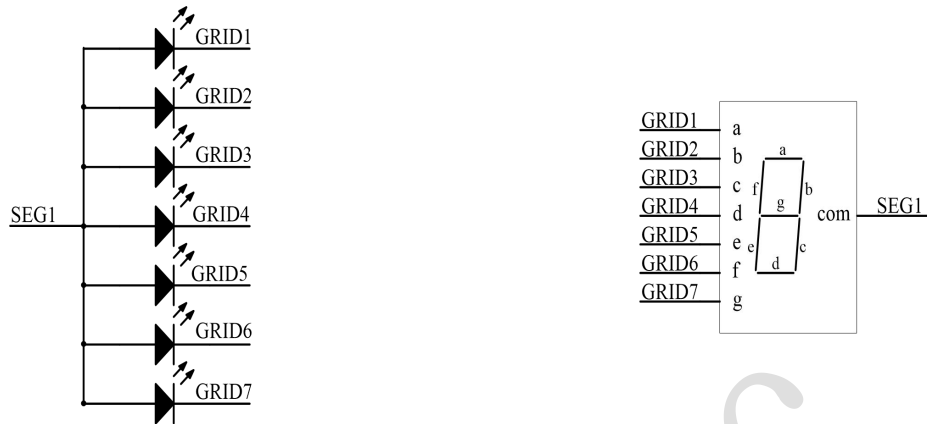
V2.1

2. Driving common anode LEDs:

Figure (8)

Figure 8 is a diagram for the wiring of common anode LEDs. To display 0 off the LED segment display, customers only need to write O1H into 00H (GRID1), 02H (GRID2), 04H (GRID3), 06H (GRID4), 08H (GRID5),and 0AH (GRID6), and 00H into 0CH (GRID7). SEG1-SEG8 correspond to the data table below.

SEG8	SEG7	SEG6	SEG5	SEG4	SEG3	SEG2	SEG1	
0	0	0	0	0	0	0	1	GRID1(00H)
0	0	0	0	0	0	0	1	GRID2(02H)
0	0	0	0	0	0	0	1	GRID3(04H)
0	0	0	0	0	0	0	1	GRID4(06H)
0	0	0	0	0	0	0	1	GRID5(08H)
0	0	0	0	0	0	0	1	GRID6(0AH)
0	0	0	0	0	0	0	0	GRID7(0CH)
B7	B6	B5	B4	B3	B2	B1	B0	

▲ Note: To drive common cathode LEDs or common anode LEDs, SEG pins can only be connected with LED anode, and GRID, only with LED cathode. Do not connect them in reverse direction.

VIII. Transmission format of serial data:

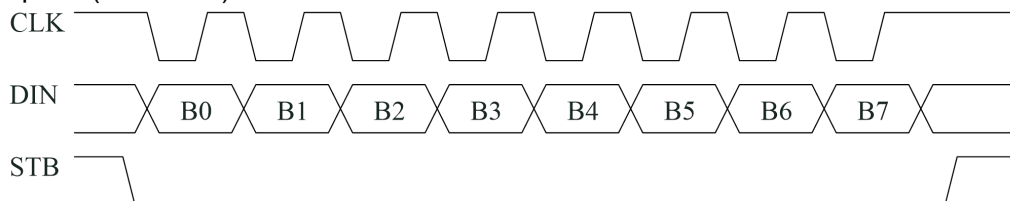A BIT is received at rising edge of the clock.

Data reception (write data)

Figure (5)

IX. Transmission of serial data in application:

(1) Address increment mode

If address automatically increments by 1, the essence of address setting is to set the starting address where a data stream transmitted is stored. After the command word of the Starting Address has been sent, "STB" does not need to be set high to transmit data immediately thereafter, given 14 BYTEs at most. It is advisable to set STB high after data transmission.
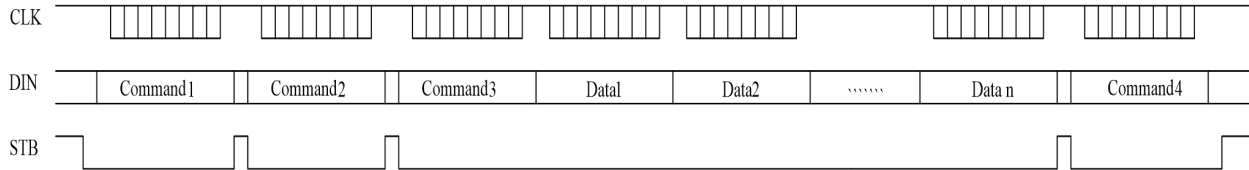
Command1:   Set display mode
Command2:   Set data command
Command3:   Set display address
Data1～ n: Transmit display data to the Command3 address and the following addresses (14 bytes at most)
Command4:   Set display control command

(2) Fixed Address Mode

If fixed address mode is adopted, the essence of address setting is to set the address where 1 BYTE data to be transmitted is stored. After transmission of address, it is not necessary to set "STB" high to transmit 1BYTE data immediately thereafter. It is advisable to set STB high after data transmission. Then users may set the address where the second data is stored. After transmission of date up to 14 BYTES at most, "STB" is set high.
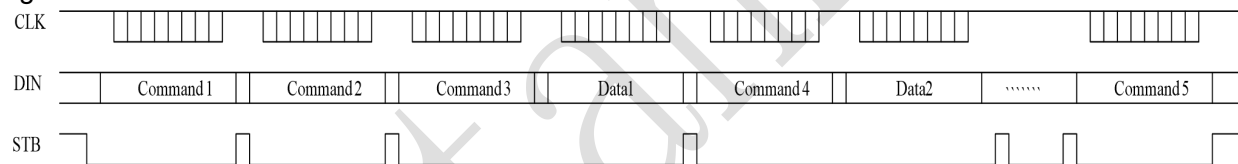
Command1:   Set display mode
Command2:   Set data command
Command3:   Set display address1
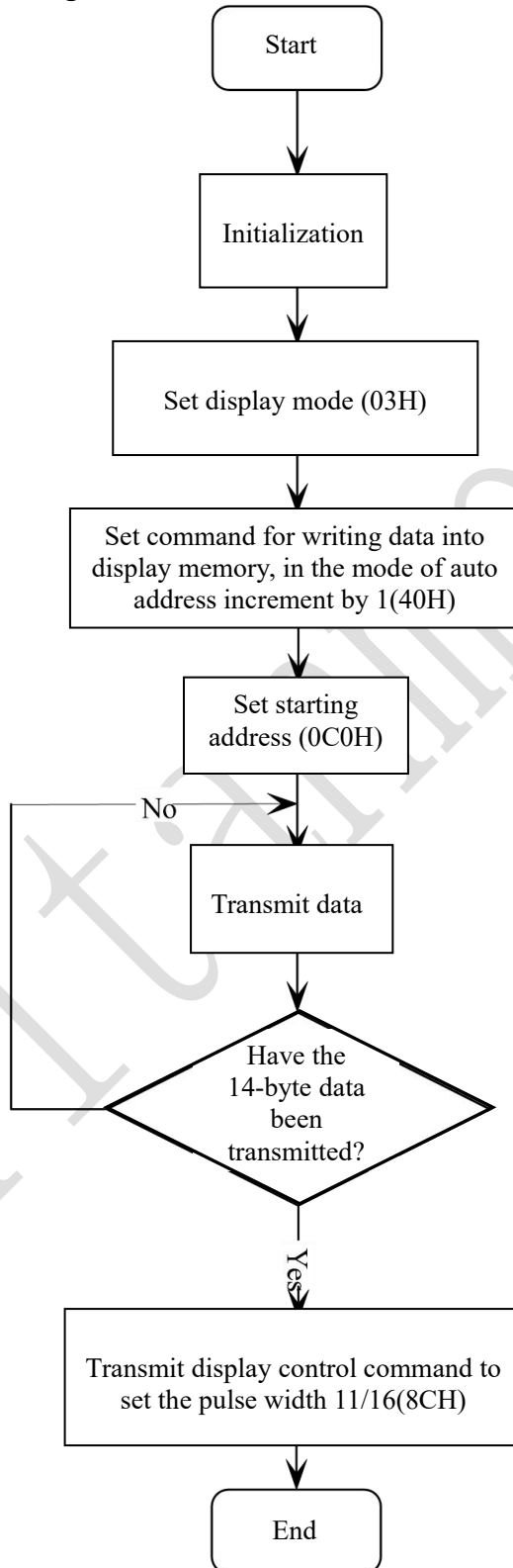Data1:   Transmit display data 1 to Command3 address
Command4:   Set display address 2
Data2:   Transmit display data 2 to Command4 address
Command5:   Set display control command

(4) Flowchart for program design in the modes of auto address increment by 1 and fixed address:
Flow chart for program design in the mode of auto address increment by 1:

```
                    ┌──────────────┐
                    │    Start     │
                    └──────┬───────┘
                           │
                    ┌──────▼───────┐
                    │ Initialization│
                    └──────┬───────┘
                           │
                ┌──────────▼──────────┐
                │ Set display mode (03H)│
                └──────────┬──────────┘
                           │
          ┌────────────────▼────────────────┐
          │ Set command for writing data into │
          │ display memory, in the mode of auto│
          │  address increment by 1(40H)      │
          └────────────────┬────────────────┘
                           │
                  ┌────────▼────────┐
                  │  Set starting   │
                  │ address (0C0H)  │
                  └────────┬────────┘
           No              │
       ┌──────────────────►│
       │          ┌────────▼────────┐
       │          │  Transmit data  │
       │          └────────┬────────┘
       │                   │
       │           ┌───────▼───────┐
       │          ╱  Have the      ╲
       │         ╱   14-byte data   ╲
       └────────▏    been            ▏
                 ╲   transmitted?    ╱
                  ╲────────┬────────╱
                           │ Yes
          ┌────────────────▼────────────────┐
          │ Transmit display control command to│
          │  set the pulse width 11/16(8CH)   │
          └────────────────┬────────────────┘
                           │
                    ┌──────▼───────┐
                    │     End      │
                    └──────────────┘
```

Flowchart for program design in the mode of fixed address:

```
            ┌─────────────┐
            │    Start    │
            └─────────────┘
                   │
                   ▼
            ┌─────────────┐
            │Initialization│
            └─────────────┘
                   │
                   ▼
            ┌─────────────┐
            │ Set display │
            │ mode (03H)  │
            └─────────────┘
                   │
                   ▼
      ┌───────────────────────────┐
      │ Set command for writing   │
      │ data into display memory, │
      │ in the mode of fixed      │
      │ address (44H)             │
      └───────────────────────────┘
                   │
                   ▼
            ┌─────────────┐
            │ Set address │
            │   (0C0H)    │
            └─────────────┘
                   │
                   ▼
            ┌─────────────┐
            │Transmit 1 byte│
            │    data     │
            └─────────────┘
                   │
                   ▼
            ┌─────────────┐
            │Set a new address│
            │   (0C1H)    │
            └─────────────┘
                   │
                   ▼
            ┌─────────────┐
            │ Transmit 1  │
            │ byte data   │
            └─────────────┘
                   │
                   ▼
            ┌─────────────┐
            │…Transit the rest│
            │    data     │
            └─────────────┘
                   │
                   ▼
            ┌─────────────┐
            │     End     │
            └─────────────┘
```

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X. Application Circuit:

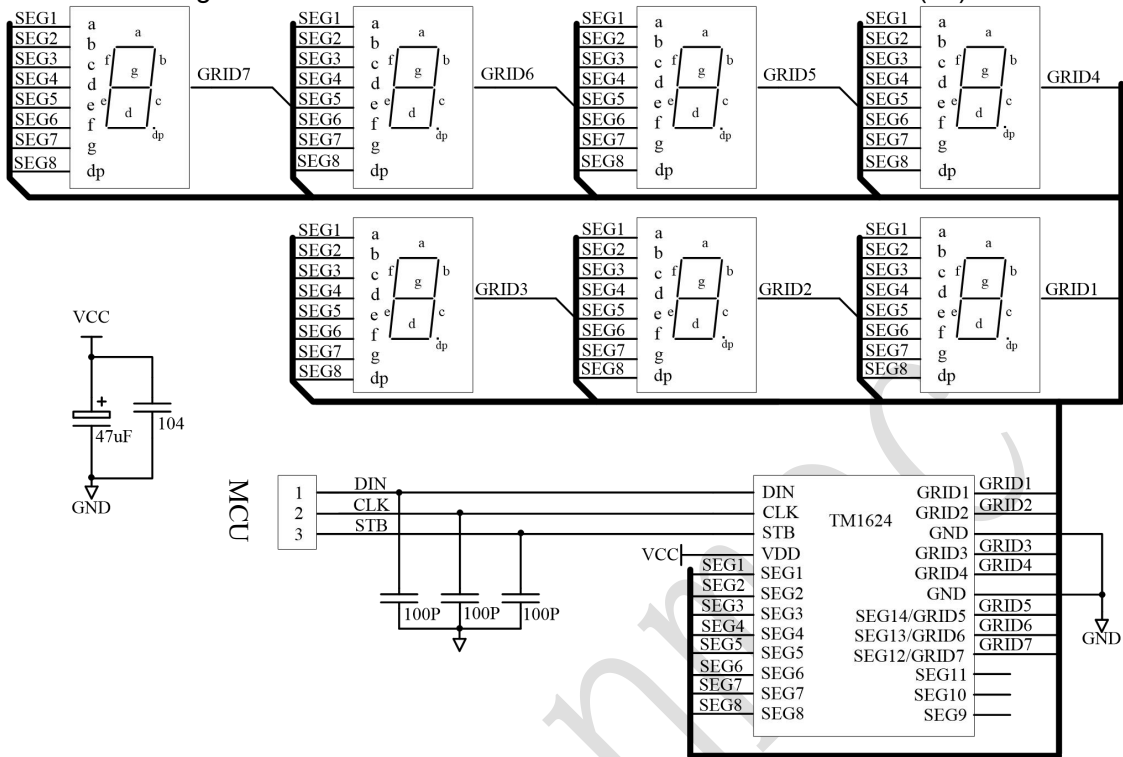Hardware circuit diagram for TM1624 to drive a common cathode LED screen (18):

Figure (18)

Hardware circuit diagram for TM1624 to drive a common anode LED screen (19):
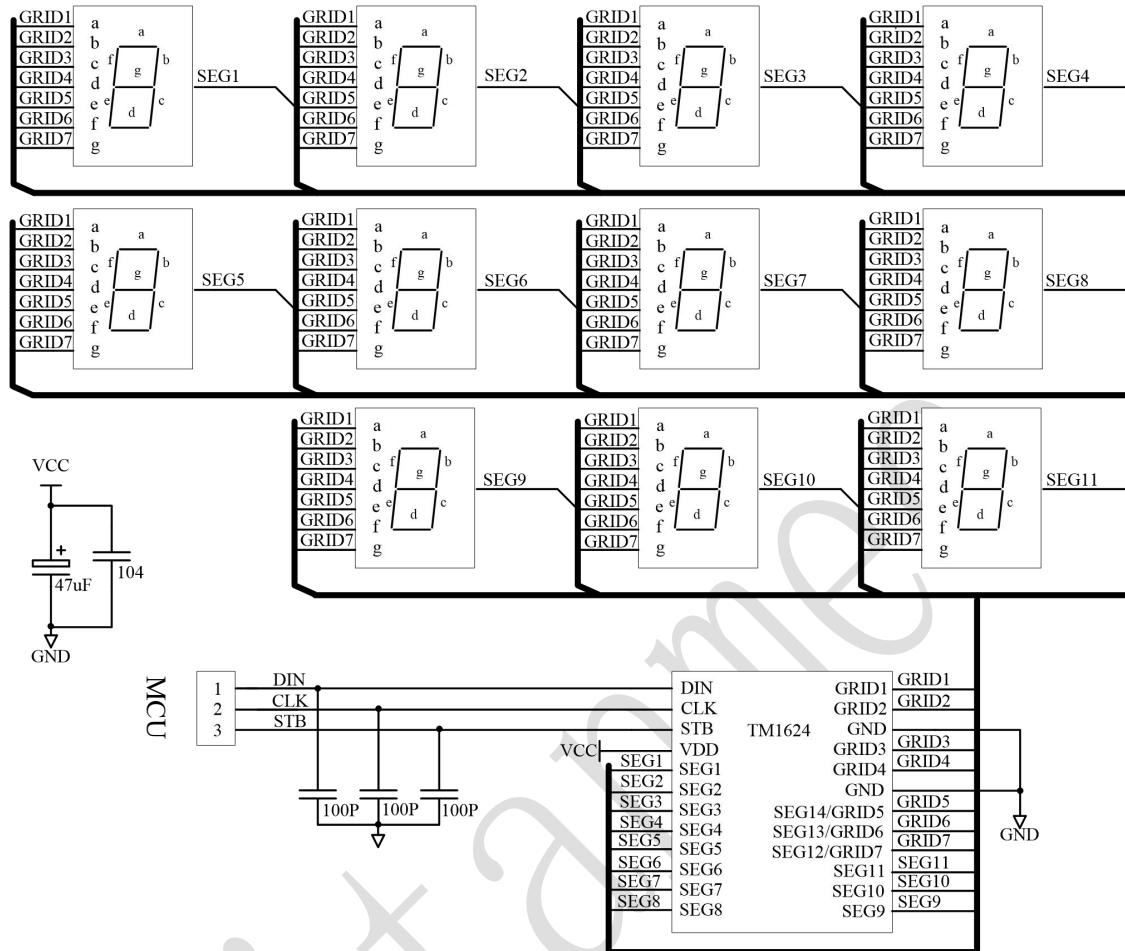

Figure (19)

▲ **Note**: 1. During PCB board wiring, the filter capacitor between VDD and GND shall be placed as close as possible to TM16234 to strengthen the filtering effect.

2. The three 100pF capacitors connected to the three communication ports, DIN, CLK, and STB will reduce interference with the communication ports.

3. Considering the turn-on voltage drop of blue digital led display is about 3V, the power supply for TM1624 should be 5V.

XI. Electrical Parameters:

Limit parameter (Ta = 25 ℃, Vss = 0V)

Parameter	Symbol	Scope	Unit
Logic Supply Voltage	VDD	-0.5～+7.0	V
Logic input voltage	VI1	-0.5 ～ VDD + 0.5	V
Output current for LED SEG drive	IO1	-50	mA
Output current for LED Grid drive	IO2	+200	mA
Power loss	PD	400	mW
Operating temperature	Topt	-40 ～ +85	℃
Storage temperature	Tstg	-65～+150	℃
ESD	MM (Machine Mode)	200	V
	HBM (Human Body Mode)	2000	V

Normal operating range (Vss = 0V)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test Conditions
Logic 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	-

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Electrical Characteristics　（**VDD = 5V, V$_{SS}$ = 0V**）

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test Conditions
High-level output current	Ioh1	20	35	60	mA	SEG1～SEG11, Vo = VDD -3V
Low-level input voltage	IOL	80	120	-	mA	GRID1～GRID7 Vo=0.3V
Tolerance of high-level output current	Itolsg	-	-	5	%	Vo = VDD – 3V, SEG1～SEG11
High-level input voltage	VIH	0.7 VDD	-		V	CLK,DIN,STB
Low-level input voltage	VIL	-	-	0.3 VDD	V	CLK,DIN,STB

Switching Characteristics 　（ **VDD = 5V**）

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test Conditions	
Transmission delay time	t$_{PLZ}$	-	-	300	ns	CLK → DIN	
	t$_{PZL}$	-	-	100	ns	CL = 15pF, RL = 10K Ω	
Rise Time	t$_{TZH\,1}$	-	-	2	μs	CL = 300p F	SEG1～SEG11
	t$_{TZH\,2}$	-	-	0.5	μs		GRID1～GRID4 SEG12/GRID7 ～ SEG14/GRID5
Fall Time	t$_{THZ}$	-	-	1.5	μs	CL = 300pF,SEGn,GRIDn	
Maximum input clock frequency	Fmax	-	-	1	MHz	Duty ratio=50%	
Input capacitance	CI	-	-	15	pF	-	

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Timing Characteristics （ VDD = 5V）

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Test Conditions
Clock pulse width	PW$_{CLK}$	500	-	-	ns	-
Strobing pulse width	PW$_{STB}$	1	-	-	μs	-
Data setup time	t$_{SETUP}$	100	-	-	ns	-
Data Hold Time	t$_{HOLD}$	100	-	-	ns	-
CLK → STB time	t$_{CLK-STB}$	1	-	-	μs	CLK↑→STB↑

Timing Waveforms:
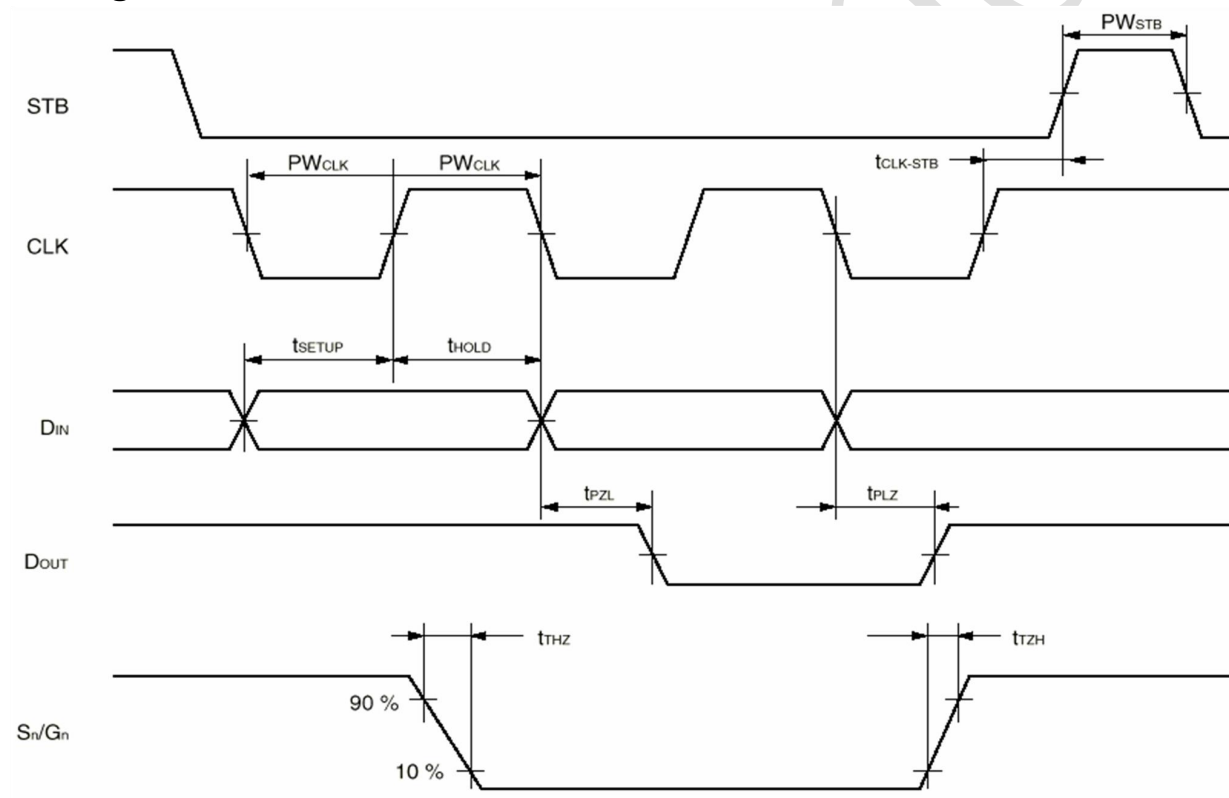
XII. Schematic diagram of IC packaging
Package size for SOP24-300:

Detail "X"

Dimensions

Item	BL	BW	TL	LW	LP	FT	BT	S0	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	15.44 (15.34) 15.24	7.62 (7.52) 7.42	10.60 (10.20) 9.80	0.406 TYP	1.270 TYP	0.300 (0.250) 0.200	2.44 (2.34) 2.24	0.300 (0.150) 0.100	2.640 Max.	1.50 (1.40) 1.30	0.90 (0.80) 0.70	8 (4) 0

Package size for QSOP24-150:
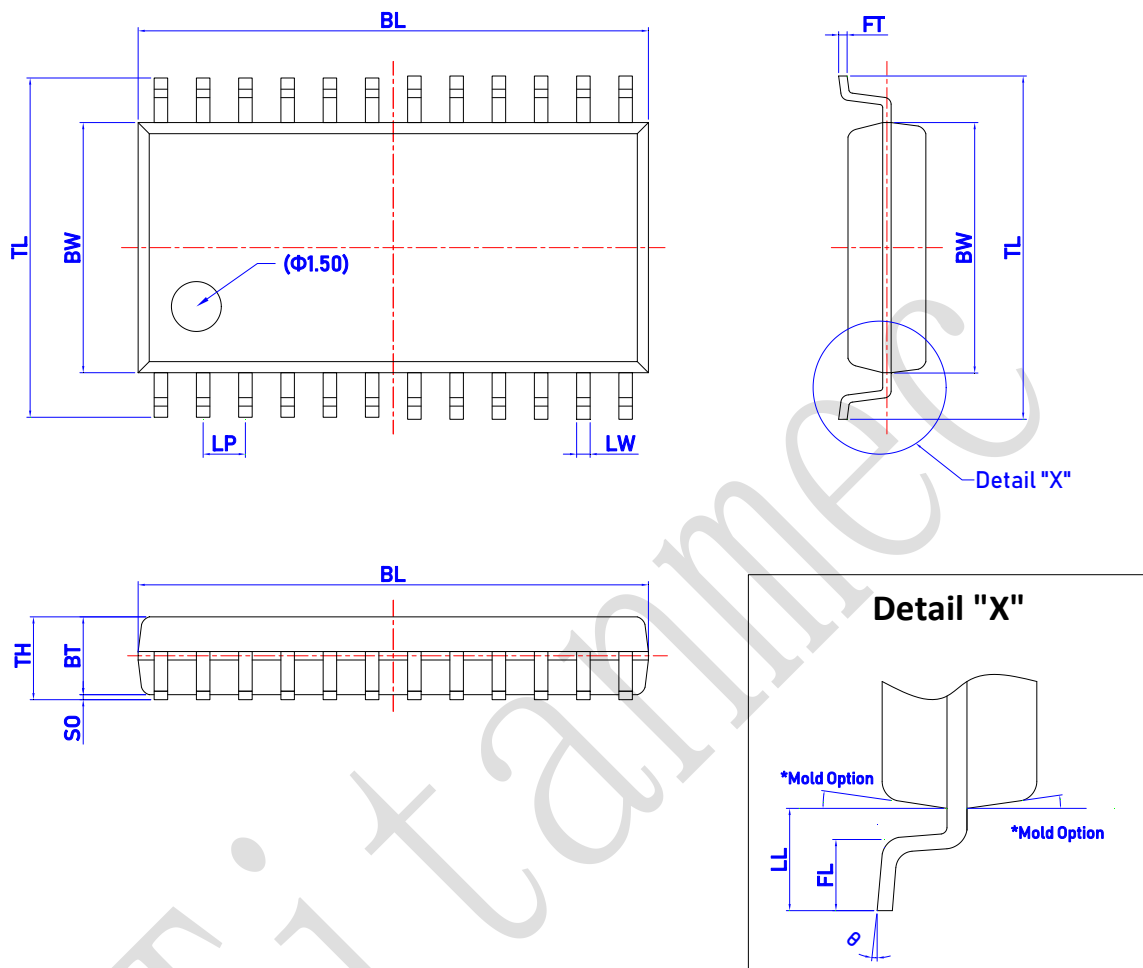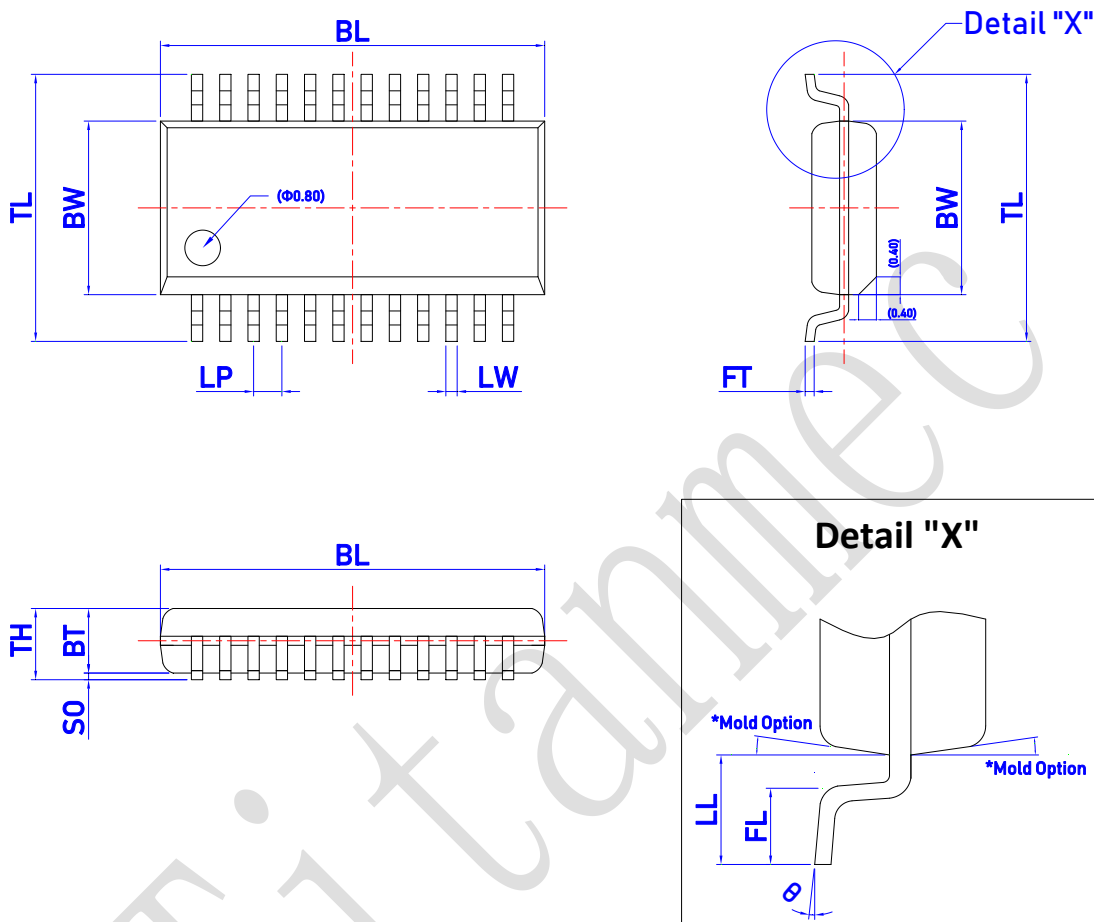
Dimensions

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	8.73 (8.63) 8.53	4.00 (3.90) 3.80	6.20 (6.00) 5.80	0.254 TYP	0.635 TYP	0.250 (0.200) 0.150	1.55 (1.45) 1.25	0.200 (0.150) 0.100	1.650 Max.	1.25 (1.04) 0.80	0.80 (0.60) 0.45	8 (4) 0

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