Characteristic description

TM1926 is a 12-channel LED fixed constant current drive control circuit, which integrates circuits such as MCU single-wire digital interface, data latch, LED fixed constant current drive, PWM brightness control and so on. The chip can be cascaded through a single-wire digital interface (DI, DO), and the external controller can control the chip and other chips cascaded with it through a single wire. The PWM brightness of the output port of TM1926 can be set by an external controller. VDD pin has built-in 5V voltage regulator with less peripheral components. This product has excellent performance and reliable quality.

Features

- It adopts voltage power CMOS process
- The withstand voltage of OUT port is 24V
- VDD has built-in 5V regulator, and supports voltage of 6-24V with resistor in series
- Brightness adjustment circuit, adjustable with 256-level brightness
- Single wire serial cascade interface
- Oscillation mode: The built-in RC oscillates and carries out clock synchronization according to the signals on the data cable. After receiving the data of this unit, the subsequent data can be automatically sent to the lower level through the data output terminal. The signals will not be distorted or attenuated as the cascade goes further.
- Built-in power-on reset circuit
- Internal control mode (colorful flashing)
- PWM control terminal can achieve 256-level adjustment, the scanning frequency is 7KHz
- The receiving and decoding of data can be accomplished by a signal line
- When the refresh rate is 30 frames/s, the number of cascades is not less than 1024 points
- The data transmission speed reaches 800Kbps
- The transmission distance of any two points is not less than 30m
- Packaging mode:： SOP16、DIP16

Internal Structural Block Diagram

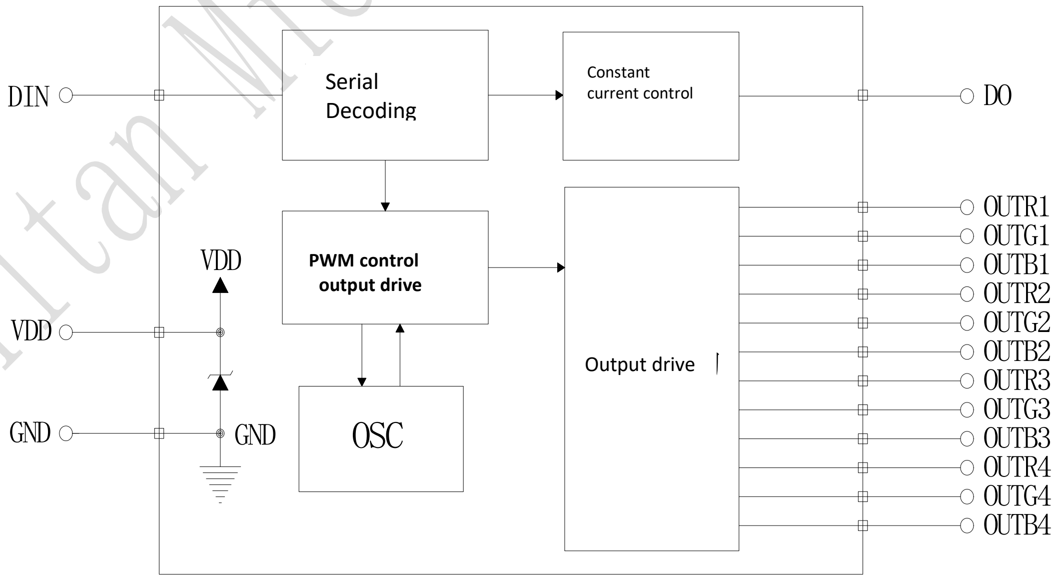


Figure 1

Pin arrangement

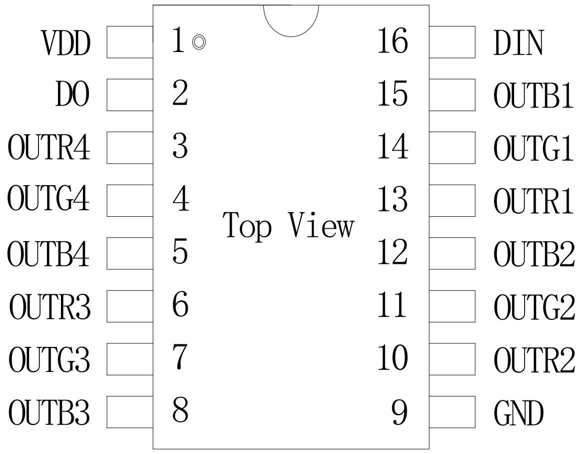


Figure 2

Pin function

Port		I/O	Function description
Pin name	Pin No.		
DIN	16	I	Data input
DO	2	O	Data output
OUTB1	15	O	Blue PWM constant current output
OUTG1	14	O	Green PWM constant current output
OUTR1	13	O	Red PWM constant current output
OUTB2	12	O	Blue PWM constant current output
OUTG2	11	O	Green PWM constant current output
OUTR2	10	O	Red PWM constant current output
OUTR3	6	O	Red PWM constant current output
OUTG3	7	O	Green PWM constant current output
OUTB3	8	O	Blue PWM constant current output
OUTR4	3	O	Red PWM constant current output
OUTG4	4	O	Green PWM constant current output
OUTB4	5	O	Blue PWM constant current output
VDD	1	-	Logic power
GND	9	-	Grounding system

Input/Output equivalent circuit

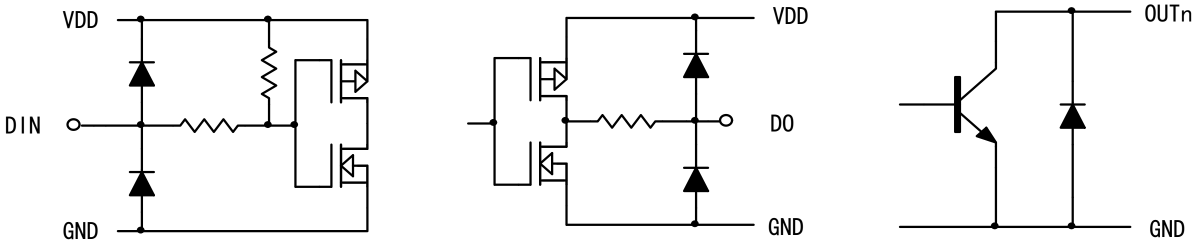


Figure 3

Integrated circuit system is electrostatic sensitive device, which is susceptible to generate a large amount of static electricity when applied in the dry season or dry environment, and the electrostatic discharge can damage the integrated circuit, Titan Micro Electronics suggests that all appropriate prevention measures shall be taken as precaution measures. Improper operation and welding may cause the damage of ESD or performance degradation, resulting in the failure of chip to work normally.

Absolute Rating Parameter (1) (2)

Parameter			Range	Unit
VDD	Logic power voltage		-0.4～+7.0	V
Vin	Voltage range at input terminal	DIN	-0.4～VDD+0.7V	V
Iout	Current at output terminal	OUTR,OUTG,OUTB	21	mA
Vout	Voltage range at output terminal	OUTR,OUTG,OUTB	-0.4～+30.0	V
Fosc	DIN clock rate	DIN	400～900	KHz
Topr	Operating temperature		-40～+85	℃
Tstg	Storage temperature		-55～+150	℃
ESD	Human body mode (HBM)		3000	V
	Machine mode (MM)		200	V

（1）For these grades in the table above, when the chip works for long hours under the aforementioned condition of the limit parameters, it may cause the reduction in the reliability or permanent damage to the components, Titan Micro Electronics does not recommend in actual application any parameter reaches or exceeds the limit value.
（2）All the voltage values are relative to the systematic testing

Recommended working condition scope

Testing at -40℃～+85℃下,GND=0V unless otherwise specified			TM1926			Unit
Parameter		Test Condition	Minimum Value	Typical Value	Maximum Value	
VDD	Power voltage		4.5	5.0	5.5	V
V_{DIN}	DIN input withstand voltage range	VDD = 5V, DIN is connected to 1K resistor in series	-0.5	--	VDD+0.4	V
V_{DO}	DO output withstand voltage range	VDD = 5V, DIN is connected to 1K resistor in series	-0.5	--	VDD+0.4	V
V_{OUT}	OUT output withstand voltage range	OUT=OFF	-0.5	--	24.0	V
TA	Working temperature range		-40		+85	℃
TJ	Working junction temperature range		-40		+125	℃

Electrical characteristics

（At VDD=5.0V 和-40℃～+85℃下， Typical Value VDD=5.0V and TA=+25℃） unless otherwise specified			TM1926			Unit
Parameter		Test Condition	Minimum Value	Typical Value	Maximum Value	
VOH	High level output voltage	IOH=-6mA：DO	VDD-0.5	VDD	VDD+0.5	V
VOL	Low leve output voltage	IOL=10mA：DO			0.4	V
VIH	High level input voltage	VDD=5.0V	3.5		VDD	V
VIL	Low level input voltage	VDD=5.0V	0		1.35	V
IOH	High level output current	VDD=5.0V,SDO=5.0V		1		mA
IOL	Low level output current	VDD=5.0V,SDO=1.0V		10		mA
Iin	Input current	DIN is connected to VDD or GND	-1		1	μA
Icco	Logic power current（VDD）	OUTR, OUTG, OUTB, DIN, DO = open circuit	1.2	3.0	4.2	mA
Iolc	Constant output current range	OUTR,OUTG,OUTB= 3.0V	19	20	21	mA
Iolkg	Output leakage current	OUTR,OUTG, OUTB =OFF	0		0.3	μA
T_{PWM}	Duty cycle of OUT port	OUT connect to pull-up resistor	135	140	145	μs
ΔIolc0	Constant current error (Channel to channel)	OUTR,OUTG, OUTB =ON ,VOUTn =1V			±2.5	%
ΔIolc1	Constant current error (chip to chip)	OUTR,OUTG, OUTB =ON ,VOUTn =1V			±5	%
ΔIolc2	Linear adjustment	OUTR,OUTG, OUTB =ON ,VOUTn =1V		±0.5	±1	%/V
ΔIolc3	Load adjustment	OUTR,OUTG, OUTB =ON ,VOUTn =1V～3V		±1	±3	%/V
IDDdyn	Dynamic current loss	OUTR, OUTG, OUTB =OFF DO= open circuit			3	mA
Rth(j-a)	Thermal resistance	--	79.2		190	℃/W
PD	Power consumption	(Ta=25°C)			1.5	W

Switching Characteristics

（At VDD=5.0V and -40℃～+85℃，Typical Value VDD=5.0V and TA=+25℃） unless otherwise specified						
Symbol	Parameter	Test Condition	Minimum Value	Typical Value	Maximum Value	Unit
Fosc	DIN clock rate	VDD=5.0V	-	800	-	KHz
FOUT	OUT PWM output frequency	OUTR, OUTG, OUTB	6.5	7	7.5	KHz
tPLZ	Transmission delay time	DIN → DOUT			200	ns
tPZL	--	CL = 15pF, RL = 10K Ω			100	ns
TTHZ	Descending time	CL=300pF. OUTR.OUTG、OUTB			80	μs
CI	Input capacitance	--			15	pF

Time Sequence Characteristics

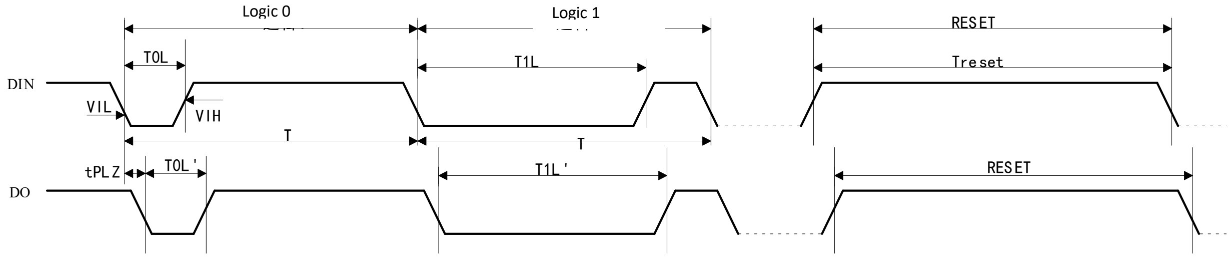


Figure 4

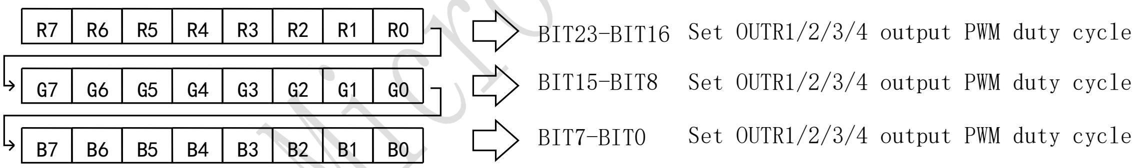
Functional Specifications

The chip adopts single-wire communication mode and sends the signal by return-to-zero code. After power-on and reset, the chip receives the data sent from the DIN terminal. After receiving 24×4bit, DO port begins to forward data from the DIN terminal to provide input data for the next cascaded chip.DO port is always high before forwarding data. If DIN input RESET signal, the chip will output corresponding PWM duty cycle according to the received 24*4 bit data after successful reset, and the chip waits for new data to be received again. After receiving the initial 24*4 bit data, the chip will forward data through DO port. Before receiving RESET signal, the original output of OUTR, OUTG and OUTB pins will remain unchanged.
The chip adopts automatic shaping and forwarding technology, and the signal is not distorted and attenuated, so that the number of cascades of the chip is not limited by signal transmission, and is limited only by the screen refreshing speed.

Data structure

PWM mode command:

If in a 24 bit packet, the packet is PWM set data with the following structure:



The above is the data to set the data format for group 1 RGB PWM, 4 packets of data in the same format are required for setting one TM1926.

PWM duty cycle is continuously adjustable from 0-256. When sending 24 *4bit data, the high bit is sent first, and the data is sent in the sequence of RGB. Each 24-bit can be divided into 3 8-bit data for sending, note that the high-level time between bytes and bytes should not exceed the RESET signal time, otherwise, the chip will reset, after resetting, data transmission can not be realized if it re-receives data.

Communication rate

Symbol	Parameter	Testing condition	Min value	Typical value	Max value	Unit
T0L	Enter 0 code, low level time	VDD=5V GND=0V	150	300	450	ns
T1L	Input 1 code, low level time		600	750	900	ns
T0L'	Output 0 code, low level time		--	340	--	ns
T1L'	Output 1 code, low level time		--	680	--	ns
T	Cycle time of 0 code or 1 code		--	1200	--	ns
Treset	Reset code, high level time		140	500		μs

Note: The typical cycle time for sending 1 code or 0 code is 1200ns (frequency is 800KHz).

Data transmission and transformation

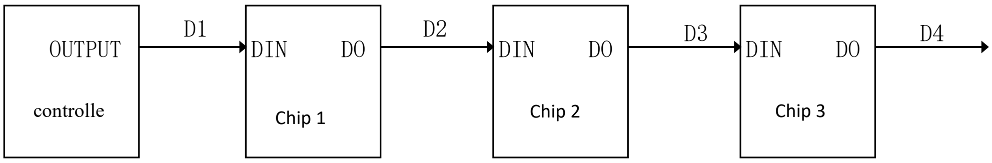


Figure 5

Among them, S1 is the data sent by the controller, S2, S3 and S4 are the data forwarded by cascaded TM3130.

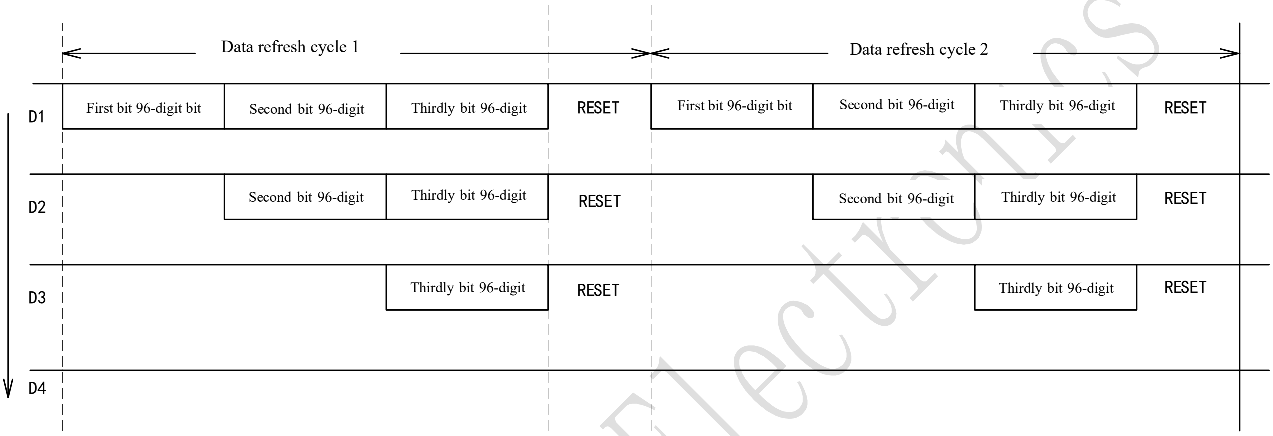


Figure 6

Chip cascade and data transmission and forwarding process: controller sent data (D1), when chip 1 received the first 96 bit, chip 1 has not yet re-data (D2), and then the controller continued to send data, chip 1 received the second 96 bit, because chip 1 already has the first 96 bit, Therefore, chip 1 forwarded the second 96 bit through DO, chip 2 received data from chip 1 forwarded (D2), at this time, chip 2 did not forward data (D3); The controller continues to send data, chip 1 to receive the third 96 bit forward to chip 2, because chip 2 also has a 96 bit, so chip 2 to the third 96 bit forward (D3), chip 3 to receive the third 96 bit, if the controller sends a RESET high-level signal, all chips reset and decode the 96 bit data they receive to control four sets of RGB port outputs, completing a data refresh cycle. The chip returns to the receiving ready state.

Internal control model

When the chip power supply is normal, and there is no DIN signal input, or the original signal is normal, then the signal suddenly lost 600mS, the chip enters into the internal control mode with flashing as the following cycle.

The flashing rule of internal control mode is as follows:

	RGB status		
Status S/N	**R**	**G**	**B**
0	0	0	0
1	1	0	0
2	0	1	0
3	1	1	0
4	0	0	1
5	1	0	1
6	0	1	1
7	1	1	1

Note: The '0' indicator is off and the '1' indicator is on.

Application Information

1. How to calculate the data refresh rate

Data refresh time is calculated based on how many pixels are cascaded in a system. A group of RGB is usually one pixel (or a segment), and a TM1926 chip can control four groups of RGB.

Calculate according to normal mode:

The maximum transmission rate of a BIT is 1200ns (frequency is 800KHz). One pixel data packet includes 24BIT bits of red (8BIT), green (8BIT), and blue (8BIT). The transmission time is 24*1.2uS=28.8uS. If there are 2000 pixels in a system, the time of refreshing the whole display at one time is 28.8uS*2000=57.6mS (ignoring RESET code time), that is, the refresh rate in one second is 1÷57.6*1000≈17.36Hz.

Here's a table of the highest data refresh rates for cascading points:

	Normal mode	
Pixel point	**Fastest once data refresh time (mS)**	**Highest refresh rate (Hz)**
1～500	14.4	69
1～800	23.04	44
1～1000	28.8	35
1～1500	43.2	23
1～1800	51.84	19
1～2000	57.6	17

If the system does not require a high data refresh rate, there is no requirement for the number of cascaded pixel lattices. As long as the power supply is normal, the TM1926 can theoretically be cascaded indefinitely.

2. How to make TM1926 work in optimum constant current state

TM1926 output is driven by fixed constant current, when outputting, it is known according to constant current curve, when the constant current 20mA, enter into the constant current region OUT end voltage shall be over 1.2V, then the chip has constant current effect, but not the higher the OUT end voltage the better, the higher the voltage, the higher the power consumption on the chip, the chip will become hot serious, which may reduce the reliability of the whole system. Therefore, it is suggested that the voltage Vout should be controlled at 1.2-3V when the OUT end is opened. It is commonly used with resistor in in series. The following is the method of theoretically calculating the resistance:

System driving system: VDD
Single LED on voltage drop: Vled
Number of LEDs in series: n
Constant current: Iout
Constant voltage: 1.5V
Resistance: R

$$R=(VDD-1.5-n\times Vled)/Iout$$

For example: The power supply of the system is 24V, the voltage drop of a single LED is 2V, the number of LEDs in series is 6, and the constant current is 20mA, according to the above formula, it can be calculated that R=(24-1.5-2*6)/0.02=525Ω, it only needs to connect about 525Ω resistance in series on the OUT pin.

3. How to expand flow with TM1926

Each OUT terminal of the TM1926 can only output a maximum constant current of 20mA. If the user needs to expand the constant current drive, three of the OUT terminals can be shorted and used. Each short circuit of one OUT terminal, the maximum current will increase by 20mA. After the short circuit of three channels, the maximum constant current is about 60mA, but the disadvantage of this method is that the software needs to cooperate with the control at the same time, and write three sets of register values respectively. The advantage is that the desired current value can be accurately obtained and the constant current is high.

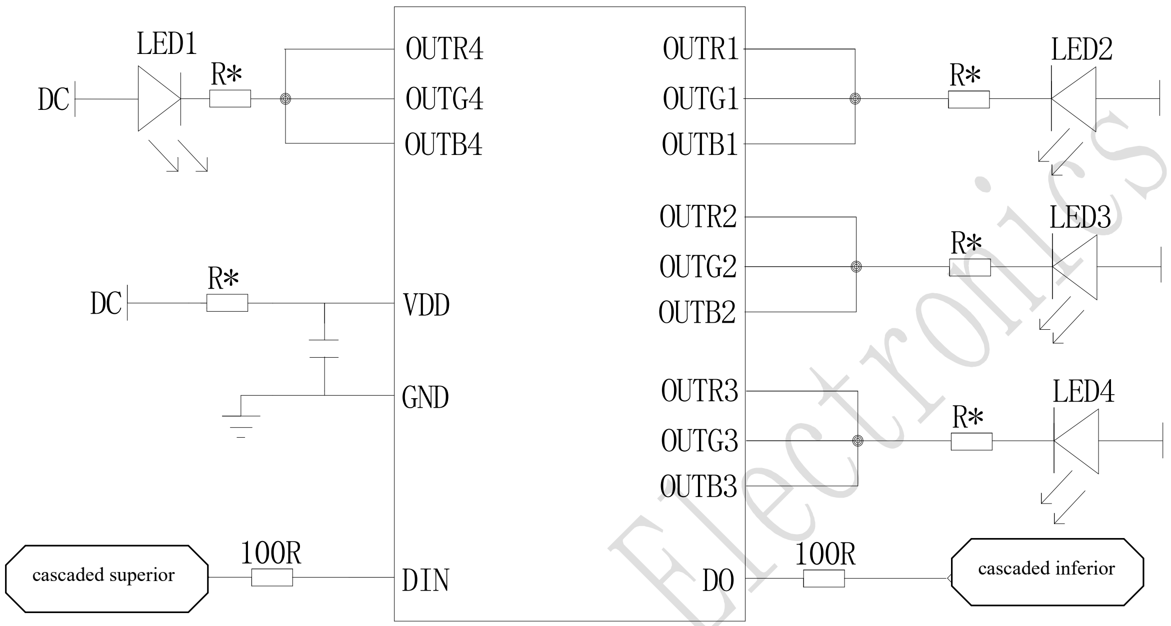


Figure 7

4. Power Supply Configuration

TM1926 can be configured to supply power with 6-24V, but different supply resistors should be configured depending on the input voltage. The method of calculating resistance: Since the power supply voltage will decrease as the load increases in practical applications. The current flowing through the VDD pin is 10mA, therefore, the resistance of the VDD in series is R = (DC - 5.5V)/10 mA (DC is the power supply voltage).

The typical value list of configured resistors is as follows:

Power supply voltage DC	Suggested connection resistance between power interface and VDD
5V	There's no need to connect the resistor, the internal regulator doesn't work
6V	50 Ω
9V	350 Ω
12V	650 Ω
24V	1.8K Ω

5. Method of driving LED with program

5.1 In order to realize the brightness control of to the LED with chip, first of all, ensure the RGB port voltage, so that the chip can enter the constant current work status (refer to the "constant current curve").

5.2 Power on and reset the chip, port voltage reaches 1.2V, the RGB fixed constant current at the output channel is 20mA, then the allowed maximum current flow is 20mA.

5.3 Continuously change the value of PWM to adjust the brightness of LED at will. Set the PWM value to 0, all outputs are high, and the LED is off. Set the PWM value to FFH, output the maximum low level duty cycle, LED is brightest.

Constant current curve

When TM1926 is applied to the LED panel design, the current difference between channels and even between chips is very small. This is due to the excellent features of the TM1926:

- In addition, the stability of the output current is not affected when the load-end voltage changes, as shown in Figure 8 below.
- The TM1926 port drive current is a fixed constant current value.

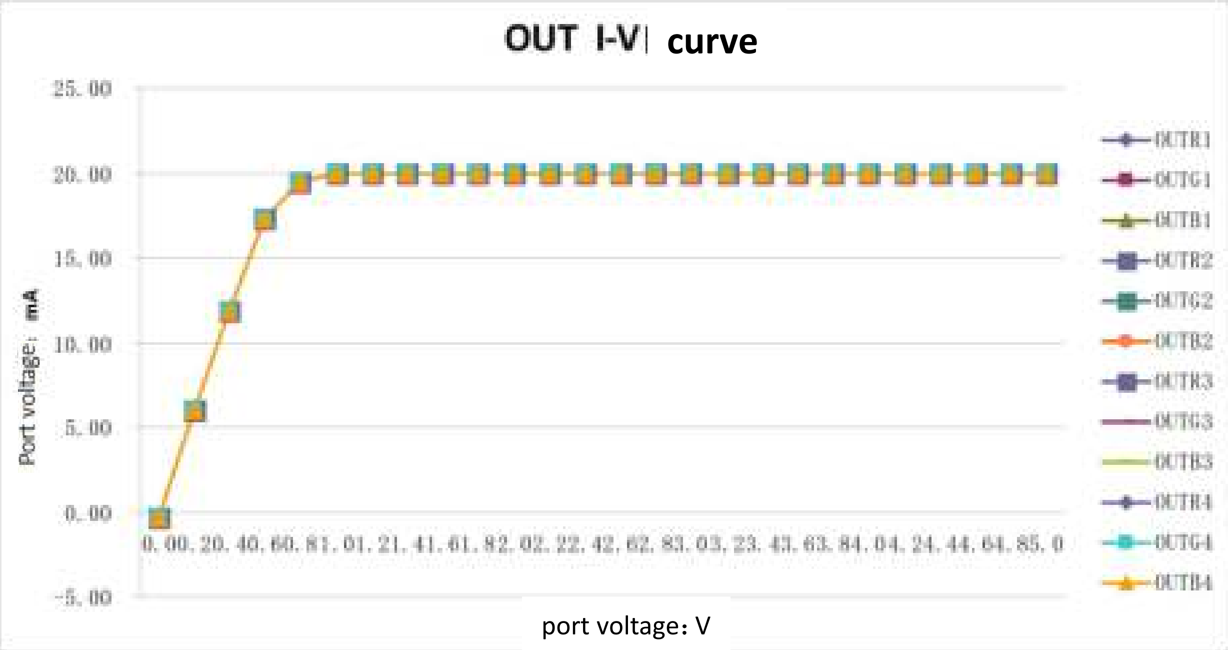
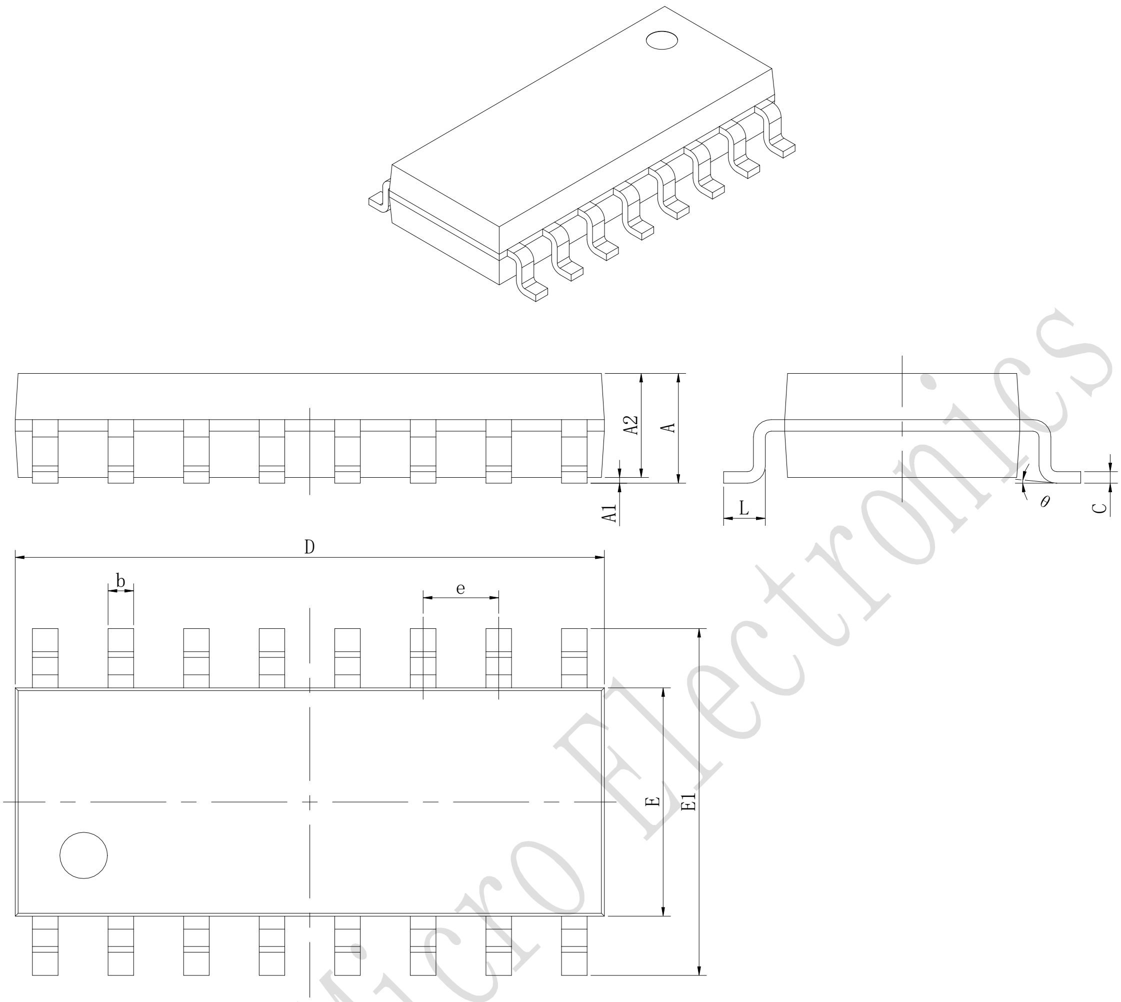


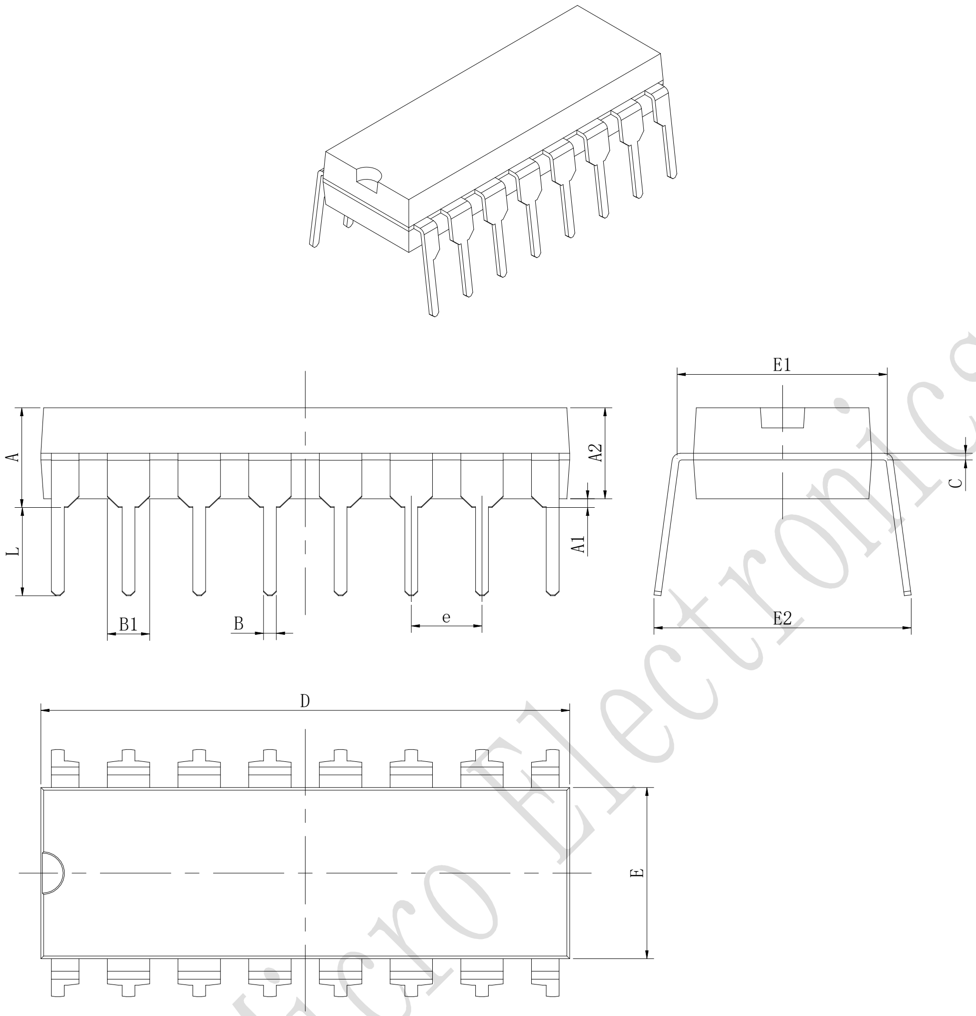
Figure 8

Packaging Schematic (SOP16)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.007	0.010
D	9.800	10.200	0.386	0.402
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.270(BSC)		0.050(BSC)	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

Packaging Schematic（DIP16）



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	3.710	4.310	0.146	0.170
A1	0.510		0.020	
A2	3.200	3.600	0.126	0.142
B	0.380	0.570	0.015	0.022
B1	1.524(BSC)		0.060(BSC)	
C	0.204	0.360	0.008	0.014
D	18.800	19.200	0.740	0.756
E	6.200	6.600	0.244	0.260
E1	7.320	7.920	0.288	0.312
e	2.540(BSC)		0.100(BSC)	
L	3.000	3.600	0.118	0.142
E2	8.400	9.000	0.331	0.354

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