SM18635E

Feature

- Input power-supply voltage: 4.0~36V
- Adopt RZ code protocol to transmit data
- Built-in data shaping, data cascade without attenuation
- Adaptive RZ code data rate: 400Kbps~800Kbps
- Constant current characteristics

a) Built-in current gain, adjust OUTR/G/B/W/Y current 6~350mA;

b) Output current deviation ≤ ±4%;

c) Low constant current knee point voltage;

I_{OUT_RGBWY} =350mA@V_{DS}=0.9V, VIN=12V

- Dimming grayscale: 65536 level (16bit)
- OUT PWM frequency: 4/8/12KHz
- The OUT port is turned off by default when powering on
- Built-in OUT width compensation function
- Standby mode is supported, and the standby power consumption is <2mw
- OUTR/G/B/W/Y port breakdown voltage: 40V
- Built-in OTP (Over Temperature Protection)
- Package: ESOP8

Application

- LED lighting
- LED backlight

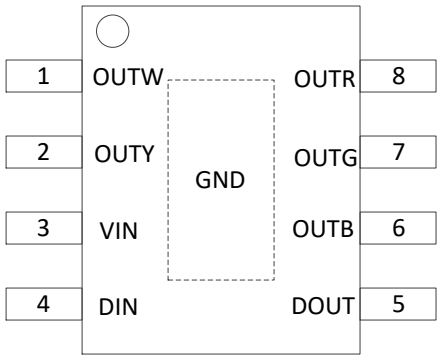
Description

The SM18605E is a single-wire, RZ code protocol 5-CH low-voltage linear constant current driver IC, which can realize low voltage constant current on and high output current accuracy. The chip has a built-in RZ code decoding module, an over-temperature protection module, a constant current drive module, and a RZ code data shaping output module. Each of the OUTR/G/B/W/Y has 6bits current gain adjustment bit, and the output current is set to 6~350mA.

The SM18605E OUTR/G/B/W/Y has 65536 level grayscale dimming, and its PWM frequency may be set between 4 and 12 KHz to prevent flickering when taking pictures.

The SM18605E chip enters standby mode when DIN inputs standby signal for low standby power consumption; it also detects DIN input data and automatically exits standby mode.

Pin Diagram



ESOP8

Internal Function Diagram

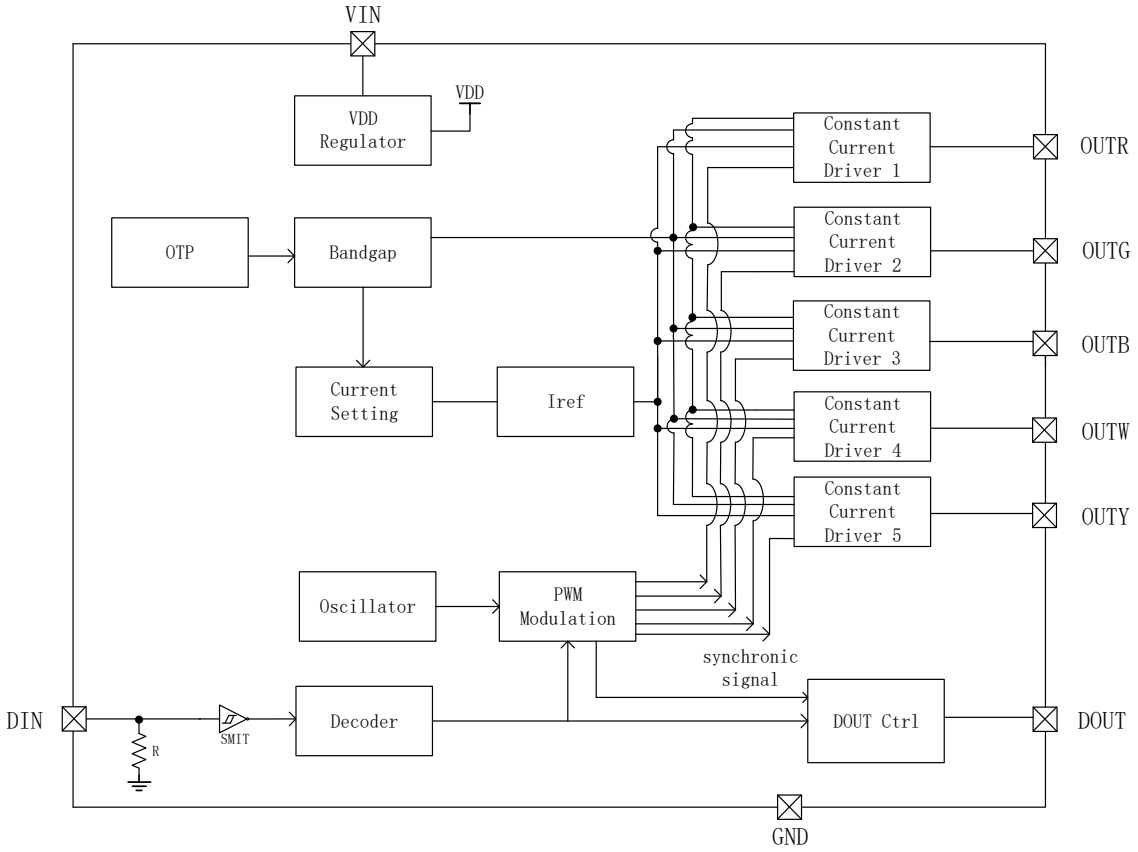


Fig. SM18635E internal function diagram

Pin Definition

Pin No.	Pin Name	Description
1	OUTW	Current drive port
3	VIN	Chip power supply
4	DIN	RZ code data input port
5	DOUT	Cascading data output
6	OUTB	Current drive port
7	OUTG	Current drive port
8	OUTR	Current drive port
Substrate	GND	Ground
2	OUTY	Current drive port

Order Information

Type	Package	Packing	Reel Size
		Tape	
SM18635E	ESOP8	4000 pcs/tape	13 inches

Absolute Maximum Parameter (Note 1)

Unless otherwise stated, T_A=25°C.

Symbol	Description	Range	Unit
VIN	IC power supply voltage	-0.4~38	V
V_I	Logic input voltage	-0.4~5.5	V
BV_{OUT}	OUT R/G/B/W/Y breakdown voltage	45	V
I_{OUT_MAX}	Maximum output current of port OUTR/G/B/W/Y	370	mA
$R_{\theta JA}$	PN junction to ambient thermal resistance (Note 2)	65	°C/W
P_D	Power consumption (Note 3)	1.25	W
T_A	Operating temperature (Note 4)	-40~85	°C
T_J	Operating junction temperature range	-40~150	°C
T_{STG}	Storage temperature range	-55~150	°C
V_{HBM}	HBM ESD	±4	KV

Note 1: The maximum output power is limited to chip junction temperature. The maximum limit means that the chip can be damaged beyond the scope of the work. When the device works within the limit parameter range, the device functions normally, but it is not completely guaranteed to meet the individual performance indexes.

Note 2: $R_{\theta JA}$ was measured on a single-layer thermal conductivity test plate according to the JEDEC JESD51 thermal measurement standard under natural convection at T_A=25 ° C.

Note 3: The maximum power consumption will definitely decrease when the temperature increases, which is also determined by T_{JMAX}, $R_{\theta JA}$, and the ambient temperature T_A. The maximum permissible power consumption is $P_D = (T_{JMAX}-T_A)/R_{\theta JA}$, or the lower of the value given in the limit range.

Note 4: Operating temperature refers to the allowable ambient temperature for the chip to work.

Electrical Operating Parameter（Note 5, 6）

Unless otherwise stated, VIN=24V, T_A=25°C.

Symbol	Description	Condition	Min.	Typ.	Max.	Unit
VIN	External power supply	-	4.0	-	36	V
V_{DD}	Internal power supply	VIN=24V，R_{IN}=2.2KΩ	-	5.1	-	V
I_{DD}	static current	OUT “ON”	-	2.7	-	mA
I_{DD_SE}	Energy-saving current	All grayscale data are 0	-	1.4	-	mA
I_{DD_STB}	Standby current	Standby mode	-	65	-	uA
V_{IH}	DIN flip high level	DIN input high level, the register flip level parameter is 1	V_{DD}*0.5	-	-	V
		DIN input high level, the register flip level parameter is 0	V_{DD}*0.45	-	-	V
V_{IL}	DIN flip low level	DIN input low level	-	-	V_{DD}*0.3	V
I_{OH_DOUT}	DOUT output current	DOUT output high level	-	16	-	mA
I_{OL_DOUT}	DOUT sink current	DOUT output low level	-	18	-	mA
I_{OUT}	OUT R/G/B/W/Y drive current	OUT R/G/B/W/Y current gain: 000000	-	6	-	mA
		OUT R/G/B/W/Y current gain:111111	-	350	-	mA
dI_{OUT}	Between channel I_{OUT} deviation	VIN>6V, I_{OUT_RGBWY} = 6~350mA	-4	-	4	%
	Between ICs I_{OUT} deviation		-4	-	4	%
V_{DS_S}	OUT R/G/B/W/Y constant current knee point voltage	VIN>6V, I_{OUT_RGBWY}=180 mA	-	0.6	-	V
		VIN>6V, I_{OUT_RGBWY}= 350 mA	-	0.9	-	V
R_{down}	DIN pull-down resistor	-	-	106	-	KΩ
T_{OTP}	Over-temperature protection temperature (Note 7)	-	-	140	-	℃
$BV_{\_OUT}$	OUT R/G/B/W/Y breakdown voltage	OUT R/G/B/W/Y “OFF”, Leakage current =1uA	45	-	-	V

Note 5: Electrical operating parameters define the DC and AC parameters of the device within the operating range and under test conditions that guarantee specific performance specifications. The specification does not guarantee accuracy for parameters for which no upper or lower limit values are given, but typical values are reasonable reflections of device performance.

Note 6: The minimum and maximum parameter ranges of the datasheet are guaranteed by testing, and the typical values are guaranteed by design, testing, or statistical analysis.

Note 7: This temperature refers to the chip junction temperature.

Dynamic properties

Unless otherwise stated, VIN=24V, T_A=25°C.

Symbol	Characteristic	Test Condition	Min.	Typ.	Max.	Unit
f_{PWM}	Output PWM frequency	I_{OUT}=180mA, the OUT is connected in series with a 15Ω resistor to a 5V supply, and the register adjusts the PWM frequency	4	-	12	KHz
d_{fpwm}	OUT PWM frequency accuracy	f_{PWM} sets 4~32KHz	-5	-	5	%
t_{PLH}	Signal transmission delay (Note 8)	Output port load capacitance to ground 30pF, the delay in the transmission of the signal from the input to the output	-	70	-	ns
t_{PHL}			-	70	-	ns
t_{TLH}	Output conversion time (Note 9)	The output port has a 30pF load capacitance to ground	-	34	-	ns
t_{THL}			-	24	-	ns
t_{OR1}	OUT conversion time (Note 10)	Current gain I_{OUT}=350mA, the duty cycle is 50%, the OUT is connected to a 5Ω resistor to a 5V power supply, and the dynamic response is set to fast response	-	168	-	ns
t_{OF1}			-	1060	-	ns
t_{OR2}		Current gain I_{OUT}=350mA, the duty cycle is 50%, the OUT is connected to a 5Ω resistor to a 5V power supply, and the dynamic response is set to slow response	-	235	-	ns
t_{OF2}			-	1350	-	ns

Note 8, Note 9 and Note 10 are shown below.

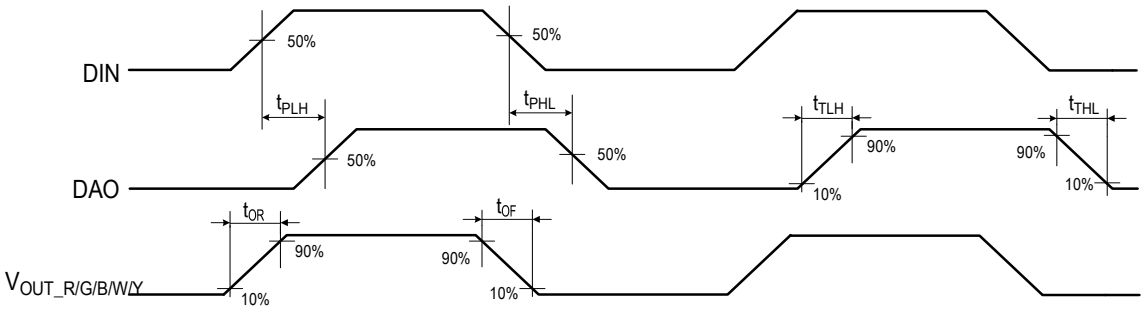


Fig. SM18635E dynamic parameter test diagram

Data Communication Protocols

The SM18635E uses a unipolar RZ code protocol, and each symbol must have a low level. Each symbol in this protocol starts high, and the time width of the high determines the “0” or “1” code.

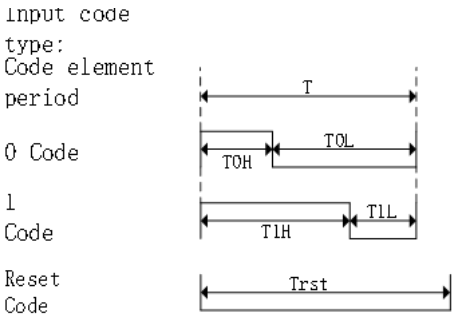


Fig. SM18635E RZ code data communication protocol diagram

Symbol	Parameter	Min.	Typ.	Max.	unit
T	Code element period	1250	-	2500	ns
T0H	0, high level	200	1/4*T	3/8*T	ns
T0L	0,low level	-	3/4*T	-	ns
T1H	1, high level	5/8*T	3/4*T	7/8*T	ns
T1L	1, low level	-	1/4*T	-	ns
Trst	Reset, low level	200	-	-	us

Note 11: The high level time of “0” code and “1” code shall be in accordance with the range specified in the above table, and the low level time of “0” code and “1” code shall be less than 20us.

Note 12: The first bit of each frame must send an adaptive high level, the length of the high level is t_H：t_H=8*T, and the length of the low level is t_L：200ns≤t_L≤20us (T: Code element period).

At the start of each frame, SM18635E requires an adaptive code element with a high level lasting 8*T (T: symbol period) and a low level lasting between 200ns and 20us; each chip inputs 96 bits of data, including an 8 bits checksum, 16 bits of grayscale data for each OUT R/G/B/W/Y, 8 bits of control data, and 48 bits of trailing data at the end of each frame. As shown below, both grayscale and current gain data are MSB-first.

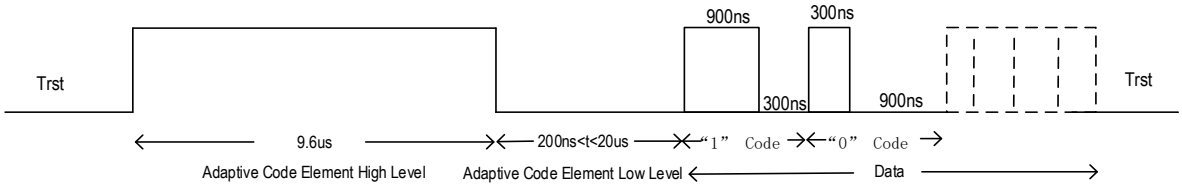


Fig.SM18635E One frame data structure (rate: 800Kbps)

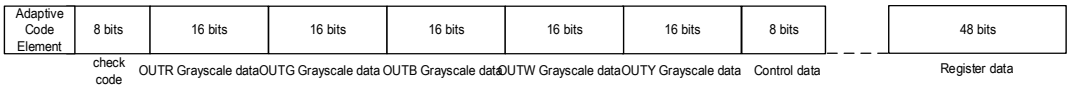


Fig.SM18635E Single chip data format

The cascading data format of SM18635E is shown in the figure below. After transmitting a frame of data, the cascaded N chips refresh the data synchronously and output the corresponding OUT currents.

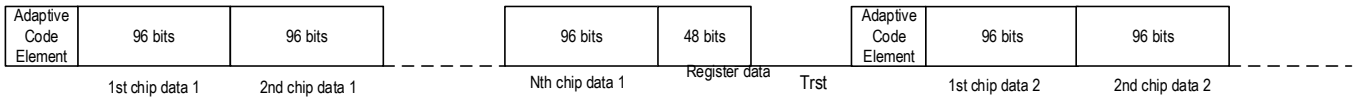


Fig.SM18635E Cascading data format

Standby Mode

SM18635E features a built-in standby mode. When a standby command is input via DIN, the chip enters standby with a current consumption of less than 80μA. During normal grayscale display, set the standby mode bit to “0”. The chip defaults to standby mode upon power-up.

Wake-up Mode

The chip automatically exits standby after receiving valid data via DIN. The first frame after wake-up is invalid; the second frame contains valid data.

Energy-saving Mode

The chip enters energy-saving mode when all grayscale data is zero and exits when any grayscale data is non-zero. Data transmission remains unaffected during mode transitions.

OUT Width Compensation

The built-in OUT width compensation with 0~8 levels improves low-gray display quality.

Over-temperature Protection

The chip includes over-temperature protection. When the internal temperature reaches 140°C, the output current is automatically reduced to prevent overheating, enhancing operational reliability.

Constant Current Characteristics

When the voltage at the OUT port of SM18635E reaches the set constant current knee point voltage, the output current I_{OUT} no longer changes with the increase of the OUT port voltage V_{DS}. The relationship curve between I_{OUT} and V_{DS} is shown as follows:

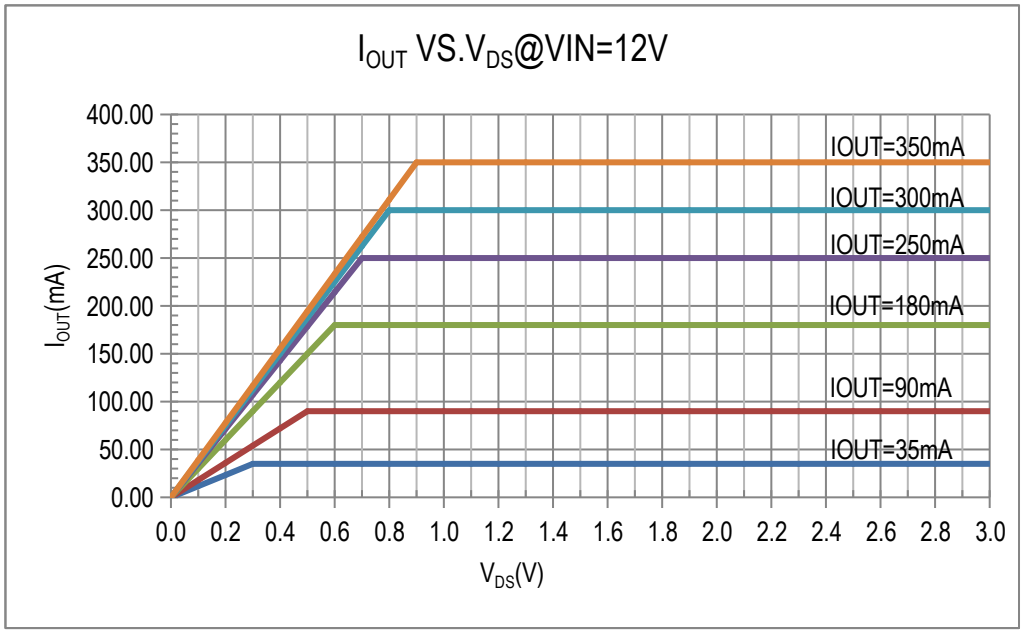


Fig. SM18635E relationship curve between I_{OUT} and V_{DS}

Current Gain Adjustment (D5~D0 from high to low)

Current gain	D5	D4	D3	D2	D1	D0	Corresponding current value (mA)	Current gain	D5	D4	D3	D2	D1	D0	Corresponding current value (mA)
0	0	0	0	0	0	0	6.0	32	1	0	0	0	0	0	188.7
1	0	0	0	0	0	1	11.9	33	1	0	0	0	0	1	194.2
2	0	0	0	0	1	0	17.9	34	1	0	0	0	1	0	199.7
3	0	0	0	0	1	1	23.9	35	1	0	0	0	1	1	205.1
4	0	0	0	1	0	0	29.7	36	1	0	0	1	0	0	210.4
5	0	0	0	1	0	1	35.6	37	1	0	0	1	0	1	215.9
6	0	0	0	1	1	0	41.4	38	1	0	0	1	1	0	221.2
7	0	0	0	1	1	1	47.2	39	1	0	0	1	1	1	226.6
8	0	0	1	0	0	0	53.1	40	1	0	1	0	0	0	232.0
9	0	0	1	0	0	1	59.0	41	1	0	1	0	0	1	237.3
10	0	0	1	0	1	0	64.8	42	1	0	1	0	1	0	242.5
11	0	0	1	0	1	1	70.6	43	1	0	1	0	1	1	247.9
12	0	0	1	1	0	0	76.3	44	1	0	1	1	0	0	253.0
13	0	0	1	1	0	1	82.0	45	1	0	1	1	0	1	258.2
14	0	0	1	1	1	0	87.8	46	1	0	1	1	1	0	263.5
15	0	0	1	1	1	1	93.5	47	1	0	1	1	1	1	268.8
16	0	1	0	0	0	0	99.6	48	1	1	0	0	0	0	273.9
17	0	1	0	0	0	1	105.4	49	1	1	0	0	0	1	279.2
18	0	1	0	0	1	0	111.1	50	1	1	0	0	1	0	284.6
19	0	1	0	0	1	1	116.8	51	1	1	0	0	1	1	289.8
20	0	1	0	1	0	0	122.3	52	1	1	0	1	0	0	294.8
21	0	1	0	1	0	1	128.0	53	1	1	0	1	0	1	300.0
22	0	1	0	1	1	0	133.7	54	1	1	0	1	1	0	305.1
23	0	1	0	1	1	1	139.4	55	1	1	0	1	1	1	310.2
24	0	1	1	0	0	0	144.8	56	1	1	1	0	0	0	315.4
25	0	1	1	0	0	1	150.5	57	1	1	1	0	0	1	320.4
26	0	1	1	0	1	0	156.1	58	1	1	1	0	1	0	325.6
27	0	1	1	0	1	1	161.6	59	1	1	1	0	1	1	330.6
28	0	1	1	1	0	0	167.0	60	1	1	1	1	0	0	335.7
29	0	1	1	1	0	1	172.5	61	1	1	1	1	0	1	340.7
30	0	1	1	1	1	0	178.2	62	1	1	1	1	1	0	345.7
31	0	1	1	1	1	1	183.5	63	1	1	1	1	1	1	350.0

Typical Applications

SM18635E RGBWY typical application circuit diagram

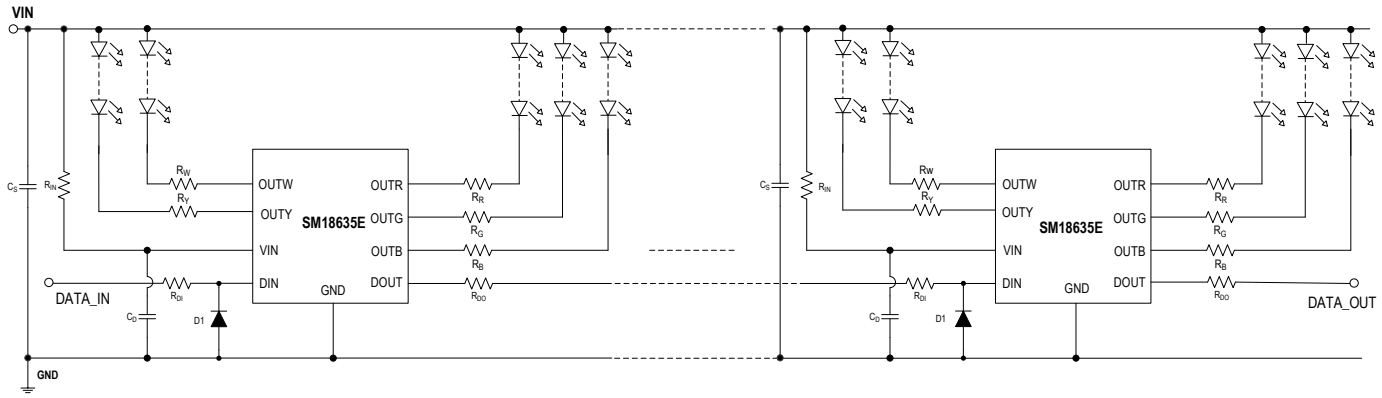


Fig. SM18635E typical application circuit diagram

Typical application circuit parameters of SM18605E include power supply input voltage VIN, current limiting protection resistor R_{IN}, system power filter capacitor C_S, VIN regulator capacitor C_D, R/G/B/W/Y LED divider resistors R_R, R_G, R_B , R_W and R_Y , signal input protection resistor R_{DI} and signal output protection resistor R_{DO}.

(1) VIN is the input power supply voltage, and R_{IN} is the voltage regulator current limiting resistor, which is used to limit the working current of the internal voltage regulator module when the voltage regulation function of the chip is turned on. The larger the R_{IN} resistance, the lower the system power consumption, but the system anti-interference ability is weak. The smaller the R_{IN} resistance, the greater the system power consumption, and the higher the operating temperature. The design reference values of different input supply voltages VIN and current limiting resistors R_{IN} are as follows:

VIN（V）	5V	12V	24V	36V
R_{IN} (Ω)	-	510	1K	2K

(2) C_S is the capacitance of the system power supply to the ground, which is used to reduce the fluctuation of the power supply, and the capacitance of 0.1uF-10uF can be selected according to the actual load of the system;

(3) C_D is the chip filter capacitor, which is used to stabilize the VIN voltage of the chip and ensure the normal operation of the chip, and the recommended value of C_D is 100nF;

(4) R_{DI} and R_{DO} are signal port protection resistors to prevent live hot plugging, reverse connection between the positive and negative poles of the power supply and the signal line, etc. The recommended value of R_{DI} and R_{DO} is 220Ω~330Ω;

(5)The voltage divider resistors of the OUTR/G/B/W/Y ports (R_R, R_G, R_B, R_W, R_Y) are used to reduce the voltage of the OUTR/G/B/W/Y ports and reduce the power consumption of the chip, It is calculated as follows: $R_R/R_G/R_B/R_W/R_Y = \frac{VCC - N * V_{LED} - V_{DS}}{I_{LED}}$, Among them, VIN is the input voltage, V_{LED} is the voltage drop of the LED lamp, I_{LED} is the port output current, V_{DS} is the OUTR/G/B/W port voltage, and the OUTR/G/B/W current can be continuously output when reaching 1V. Considering the attenuation of the voltage in practical applications, the voltage of the OUTR/G/B/W/Y port should be considered as appropriate in the design to ensure the constant current output of the port. It is recommended that the OUTR/G/B/W/Y voltage V_{DS} is designed to be about 3.0V, which is subject to the actual application. The voltage drop V_{LED} of different color lamps IS as follows: the voltage drop of the red lamp is about 2.2V, the voltage drop of the green lamp is about 3.2V, the voltage drop of the blue lamp is about 3.2V, and the voltage drop of the white lamp is about 3.2V, which is subject to the actual specifications of the lamps.

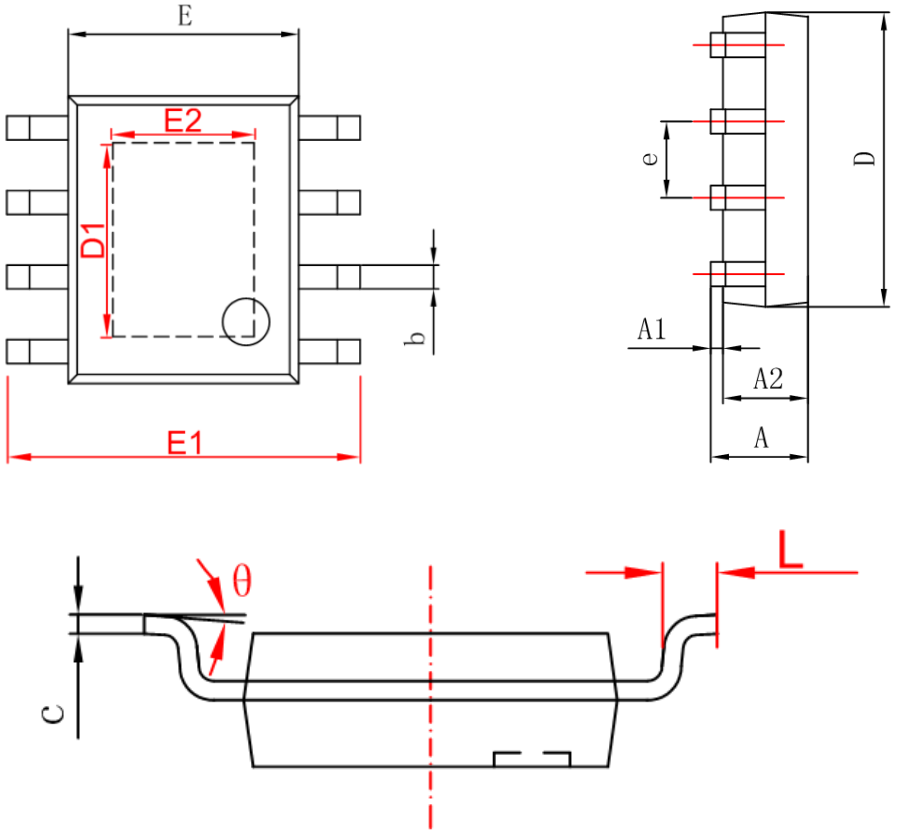
In the default application, according to different input voltages and different number of lamp beads, the recommended values of each parameter are as follows:

OUT output current (mA)	Supply voltage VIN	OUTR/G/B/W/Y port number of LEDs connected in series (pcs)	R_{IN}(Ω)	C_D（nF）	R_{DI}(Ω)	R_{DO}(Ω)	R_R(Ω)	$R_G/R_B/R_W/R_Y$(Ω)
100mA	12V	3	510	100	320	320	30	-
	24V	6	1K	100	320	320	91	30
180mA	12V	3	510	100	320	320	16	-
	24V	6	1K	100	320	320	51	16
300mA	12V	3	510	100	320	320	10	-
	24V	6	1K	100	320	320	30	10

Note12: $R_R/R_G/R_B/R_W/R_Y$ adjust the package size according to the resistor power.

Package

ESOP8



Symbol	Min(mm)	Max(mm)
A	1.25	1.95
A1	-	0.1
A2	1.25	1.75
b	0.25	0.7
c	0.1	0.35
D	4.6	5.3
D1	3.12(REF)	
E	3.7	4.2
E1	5.7	6.4
E2	2.34(REF)	
e	1.270(BSC)	
L	0.2	1.5
Θθ	0°	10°

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