SM16306SJ

Feature

- 16-channel constant current source output
- Operation voltage: 3.3V~5.5V
- Output current external Rext resistance adjustable
- Built-in shadow-elimination function
- Constant current range:
  3~32mA@V_{DD}=4.2V,
  3~22mA@V_{DD}=3.3V
- Low constant current knee voltage:
  I_{OUT}=20mA @V_{DS}=0.25V, V_{DD}=4.2V
  I_{OUT}=20mA @V_{DS}=0.25V, V_{DD}=3.3V
- Constant current deviation:
  Between channels<±2.5%, between ICs<±3.5%
- Fast output current response, $\overline{OE}$ （minimum): 35ns
- Up to 25MHz clock frequency
- Package: QSOP24

Application

- LED display
- LED lighting

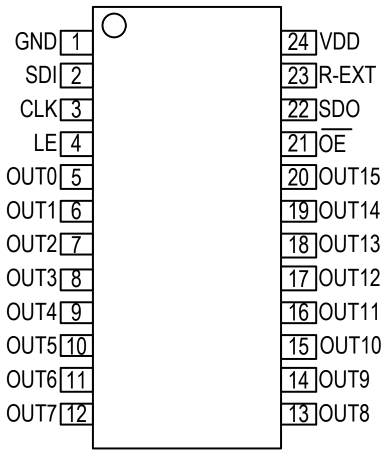
Description

SM16306SJ is an LED constant current driver chip with built-in CMOS shift register and latch function. It can convert serial input data into parallel output data format.

SM16306SJ has a working voltage of 3.3V~5.5V, and provides 16 current sources, which can provide a constant current of 3mA~32mA at each output port; and the output current difference of a single IC chip is less than ± 2.5%; the output between multiple ICs The current difference is less than ± 3.5%; the channel output current does not vary with the change of the output voltage (V_{DS}); and the current is less than 1% affected by the voltage and ambient temperature; the output current of each channel is adjusted by an external resistor.

The SM16306SJ supports the clock frequency up to 25MHz, which can meet the system requirement for massive data transmission.

Pin Definition



QSOP24

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Internal Function Diagram

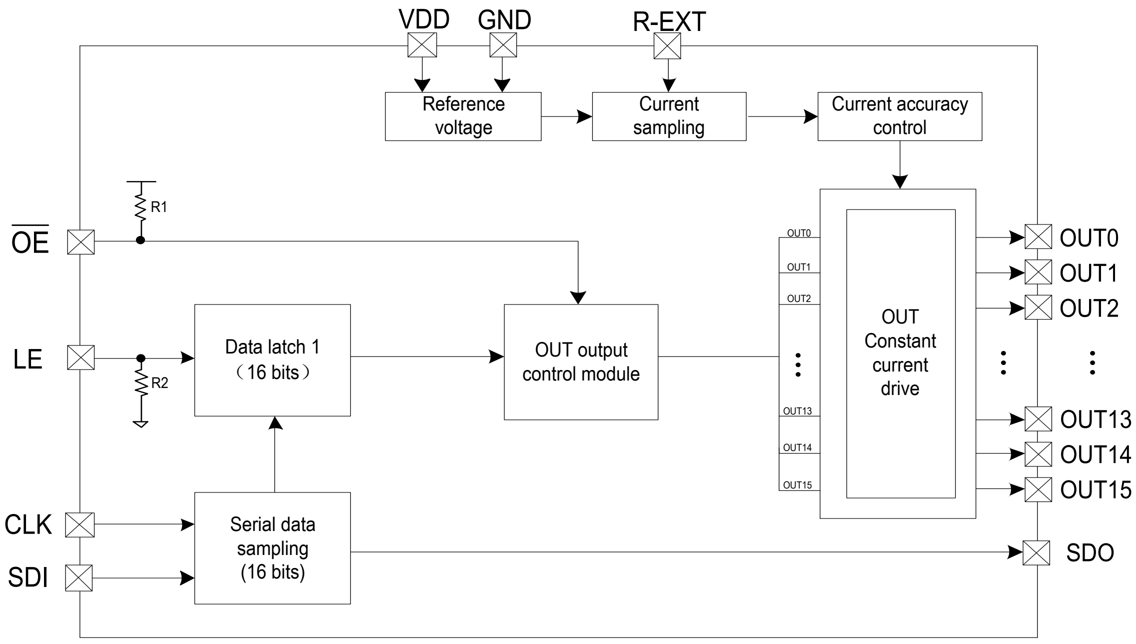


Fig. SM16306SJ Internal function diagram

Pin Description

Pin Name	Pin Description
GND	Ground of control logic and drive current
SDI	Serial-data input port
CLK	Serial-clock signal input port; shift data of rising clock
LE	Data latch control port. When LE is high level, the serial data is passed to the output latch; when LE is low level, the data is latched.
OUT0~OUT15	Constant current output ports
$\overline{OE}$	Output enable control port. When it is low level, OUT0~OUT15 output will be enabled; when it is high level, OUT0~OUT15 output will be turned off.
SDO	Serial-data output port. It can connect to the SDI of next chip
R-EXT	Input port that connects external resistor. This external resistor can set all the output current of output channels.
VDD	Chip power supply

Order Information

Type	Package	Packing		Reel Size
		Tube	Tape	
SM16306SJ	QSOP24	100000 pcs/box	4000 pcs/tape	13 inches

Absolute Maximum Parameter (Note 1)

Unless otherwise stated, T_A=25°C.

Symbol	Characteristic	Range	Unit
V_{DD}	Power Voltage	0~7.0	V
V_{SDI},V_{CLK},V_{LE},V_{OE}	Logic input voltage	-0.4~V_{DD}+0.4	V
I_{OUT}	OUT port maximum current	40	mA
BV_{OUT_MAX}	Out port maximum withstand voltage	11	V
f_{CLK_MAX}	Maximum clock frequency	30	MHz
$R_{\theta JA}$	PN junction to ambient thermal resistance (Note 2)	80	°C/W
T_J	Operating junction temperature	-40~+150	°C
T_{stg}	Storage temperature	-55~+150	°C
V_{HBM}	HBM (Human Body Discharge Mode)	>6	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. The maximum limit value is the work in the limit parameter range, the device function is normal, but it is not completely guaranteed to meet the individual performance indexes.

Note 2: RθJA measures the flow of water according to the JEDEC JESD51 thermal measurement standard on the single-layer thermal conductivity test board under TA=25°C.

Electrical Operating Parameters

DC Characteristic (Note 1, 2)

(V_{DD}= 4.2V, T_A = 25℃)

Symbol	Characteristic	Test Condition		Min.	Typ.	Max.	Unit
V_{DD}	Supply voltage	-		3.3	4.2	5.5	V
I_{DD}	Quiescent current	Rext: NC, OUT = OFF		-	1.06	-	mA
		Rext=3.10Ω, OUT =OFF		-	1.74	-	mA
		Rext=1.55KΩ, OUT =OFF		-	2.38	-	mA
I_{OH}	SDO port output current	SDO output is high, short-circuit to GND		-	16.1	-	mA
I_{OL}	SDO port sink current	SDO output is low, short-circuit to VDD		-	16.6	-	mA
V_{IH}	Input port high level threshold voltage	SDI/CLK/LE/ $\overline{OE}$		0.6*V_{DD}	-	-	V
V_{IL}	Input port low level threshold voltage			-	-	0.3*V_{DD}	V
V_{REXT}	REXT voltage	VDD=4.2V		-	0.92	-	
V_{DS}	Knee point voltage of OUT port constant current	V_{DD}=4.2V, I_{OUT}=3mA		-	0.18	-	V
		V_{DD}=4.2V, I_{OUT}=15mA		-	0.24	-	V
		V_{DD}=4.2V, I_{OUT}=32mA		-	0.34	-	V
BV_{OUT}	OUT withstand voltage	V_{DD}=4.2V, OUT = OFF, I_{OUT}=0.2uA		-	10.2	-	V
I_{OUT}	OUT output current	I_{OUT} works, V_{DS} =1.0V		3	~	32	mA
		V_{DS}=1.0V，R_{EXT} = 3.10KΩ		-	6	-	mA
		V_{DS}=1.0V，R_{EXT} = 1.55KΩ		-	12	-	mA
dI_{OUT}	Output current deviation	Between channels	I_{OUT}=6mA/12mA V_{DS}=1.0V	-	±2.5	-	%
		Between ICs		-	±3.5	-	%
%/ΔTemp	Output current deviation / Temp. variation	T_A=-35°C~85°C, I_{OUT}=12mA		-	-	±2.0	%/°C
%/ΔV_{DS}	Output current deviation /V_{DS} variation	V_{DS}=1.0V~3.0V, I_{OUT}=12mA		-	1	-	%/V
%/ΔV_{DD}	Output current deviation /V_{DD} variation	V_{DD}=3.3V~5.5V, I_{OUT}=12mA		-	1	-	%/V
R_{down_OE}	Pull-up resistor	$\overline{OE}$		-	154	-	KΩ
R_{down_LE}	Pull-down resistor	LE		-	153	-	KΩ

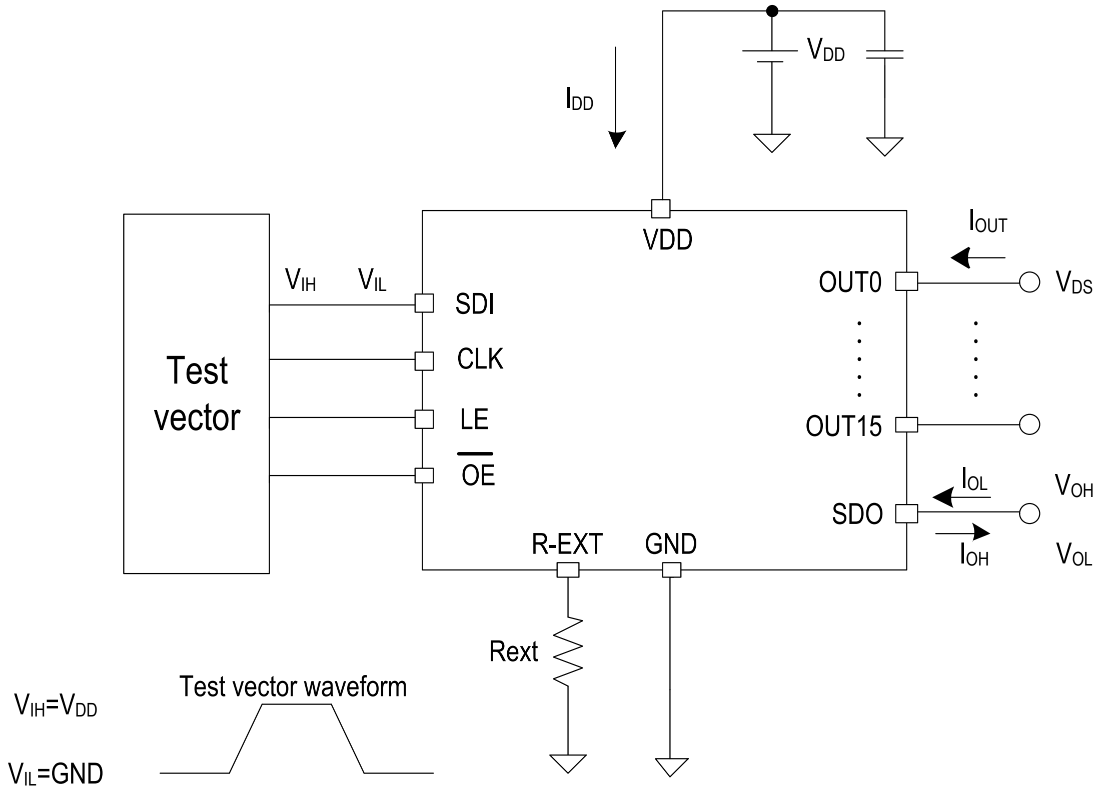
(V_{DD}= 3.3V, T_A = 25℃)

Symbol	Characteristic	Test Condition	Min.	Typ.	Max.	Unit
V_{DD}	Supply voltage	-	3.3	3.3	5.5	V
I_{DD}	Quiescent current	Rext: NC, OUT = OFF	-	1.03	-	mA
		Rext=3.10KΩ, OUT =OFF	-	1.70	-	mA
		Rext=1.55KΩ, OUT =OFF	-	2.35	-	mA
I_{OH}	SDO port output current	SDO output is high, short-circuit to GND	-	11.0	-	mA
I_{OL}	SDO port sink current	SDO output is low, short-circuit to VDD	-	11.7	-	mA
V_{IH}	Input port high level threshold voltage	SDI/CLK/LE/$\overline{OE}$	0.6*V_{DD}	-	-	V
V_{IL}	Input port low level threshold voltage		-	-	0.3*V_{DD}	V
V_{REXT}	REXT voltage	VDD=3.3V	-	0.92	-	V
V_{DS}	Knee point voltage of OUT port constant current	V_{DD}=3.3V, I_{OUT}=3mA	-	0.18	-	V
		V_{DD}=3.3V, I_{OUT}=15mA	-	0.24	-	V
		V_{DD}=3.3V, I_{OUT}=32mA	-	0.34	-	V
BV_{OUT}	OUT withstand voltage	V_{DD}=3.3V, OUT = OFF, I_{OUT}=0.2uA	-	10.2	-	V
I_{OUT}	OUT output current	I_{OUT} works, V_{DS}=1.0V	3	-	22	mA
		V_{DS}=1.0V，R_{EXT} = 3.10KΩ	-	6	-	mA
		V_{DS}=1.0V，R_{EXT} = 1.55KΩ	-	12	-	mA
dI_{OUT}	Output current deviation	Between channels; I_{OUT}=6mA/12mA, V_{DS}=1.0V	-	±2.5	-	%
		Between ICs; I_{OUT}=6mA/12mA, V_{DS}=1.0V	-	±3.5	-	%
%/ΔTemp	Output current deviation / Temp. (Variation)	T_A=-35°C~85°C, I_{OUT}=12mA	-	-	±2.0	%/°C
%/ΔV_{DS}	Output current deviation /V_{DS} (Variation)	V_{DS}=1.0V~3.0V，I_{OUT}=12mA	-	1	-	%/V
%/ΔV_{DD}	Output current deviation /V_{DD} (Variation)	V_{DD}=3.3V~5.5V，I_{OUT}=12mA	-	1	-	%/V
R_{down_OE}	Pull-up resistor	$\overline{OE}$	-	154	-	KΩ
R_{down_LE}	Pull-down resistor	LE	-	153	-	KΩ

Note 1: The electrical operating parameters define the DC parameters of the device within the working range and under test conditions that ensure a specific performance indicator. The specification does not guarantee the accuracy of the parameters that are not given the upper and lower limit values, but the typical values reflect the performance of the device.

Note 2: The minimum and maximum parameter range of the datasheet is guaranteed by the test, and the typical value is guaranteed by design, test or statistical analysis.

DC Characteristic Test Circuit



Dynamic Characteristics

(V_{DD}= 4.2V, T_A = 25℃)

<table>
<tr><th>Symbol</th><th colspan="2">Characteristic</th><th>Test Condition</th><th>Min.</th><th>Typ.</th><th>Max.</th><th>Unit</th></tr>
<tr><td>t_{PLH1}</td><td rowspan="2">Delay time
(“L” to “H”)</td><td>$\overline{OE}$—— OUT</td><td rowspan="7">V_{DD}=4.2V
V_{IH}=V_{DD}
V_{IL}=GND
Rext=3.1KΩ
V_{LED}=4.2V
R_L=500Ω
C_1=100nF
C_2=10uF
C_L=10pF
C_{SDO}=10p</td><td>-</td><td>53.2</td><td>-</td><td>ns</td></tr>
<tr><td>t_{PLH2}</td><td>CLK —— SDO</td><td>-</td><td>22.4</td><td>-</td><td>ns</td></tr>
<tr><td>t_{PHL1}</td><td rowspan="2">Delay time
(“H” to “L”)</td><td>$\overline{OE}$ —— OUT</td><td>-</td><td>66.5</td><td>-</td><td>ns</td></tr>
<tr><td>t_{PHL2}</td><td>CLK —— SDO</td><td>-</td><td>23.3</td><td>-</td><td>ns</td></tr>
<tr><td>t_{OR}</td><td colspan="2">Rising edge time of current output</td><td>-</td><td>24.9</td><td>-</td><td>ns</td></tr>
<tr><td>t_{OF}</td><td colspan="2">Falling edge time of current output</td><td>-</td><td>45.0</td><td>-</td><td>ns</td></tr>
<tr><td>F_{CLK}</td><td colspan="2">Data clock frequency</td><td>-</td><td>-</td><td>30</td><td>MHz</td></tr>
</table>

(V_{DD}= 3.3V, T_A = 25℃)

<table>
<tr><th>Symbol</th><th colspan="2">Characteristic</th><th>Test Condition</th><th>Min.</th><th>Typ.</th><th>Max.</th><th>Unit</th></tr>
<tr><td>t_{PLH1}</td><td rowspan="2">Delay time
(“L” to “H”)</td><td>$\overline{OE}$—— OUT</td><td rowspan="7">V_{DD}=3.3V
V_{IH}=V_{DD}
V_{IL}=GND
Rext=3.1KΩ
V_{LED}=3.3V
R_L=500Ω
C_1=100nF
C_2=10uF
C_L=10pF
C_{SDO}=10p</td><td>-</td><td>75.6</td><td>-</td><td>ns</td></tr>
<tr><td>t_{PLH2}</td><td>CLK —— SDO</td><td>-</td><td>23.3</td><td>-</td><td>ns</td></tr>
<tr><td>t_{PHL1}</td><td rowspan="2">Delay time
(“H” to “L”)</td><td>$\overline{OE}$ —— OUT</td><td>-</td><td>83.1</td><td>-</td><td>ns</td></tr>
<tr><td>t_{PHL2}</td><td>CLK —— SDO</td><td>-</td><td>23.5</td><td>-</td><td>ns</td></tr>
<tr><td>t_{OR}</td><td colspan="2">Rising edge time of current output</td><td>-</td><td>34.2</td><td>-</td><td>ns</td></tr>
<tr><td>t_{OF}</td><td colspan="2">Falling edge time of current output</td><td>-</td><td>42.7</td><td>-</td><td>ns</td></tr>
<tr><td>F_{CLK}</td><td colspan="2">Data clock frequency</td><td>-</td><td>-</td><td>30</td><td>MHz</td></tr>
</table>

Note: As shown in the figure below, if there is no special description for the test point, the rising edge is 90% of the high level, and the falling edge is 10% of the high level.

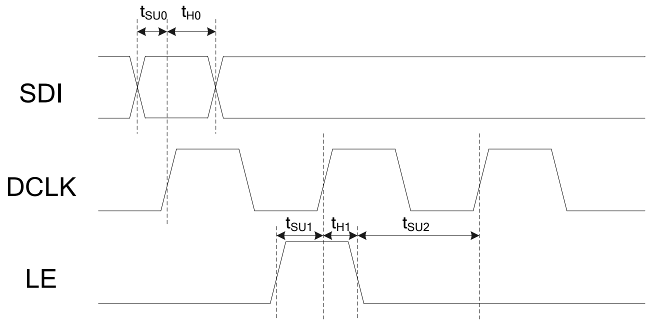


Fig. Data sampling timing

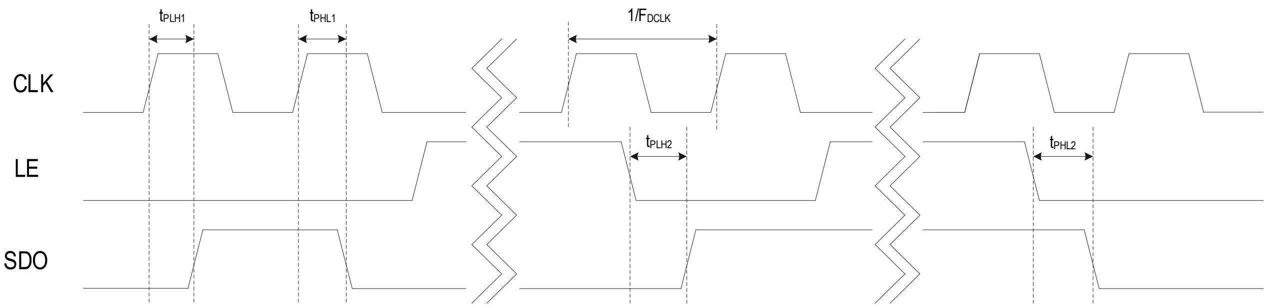


Fig. Instruction sending timing

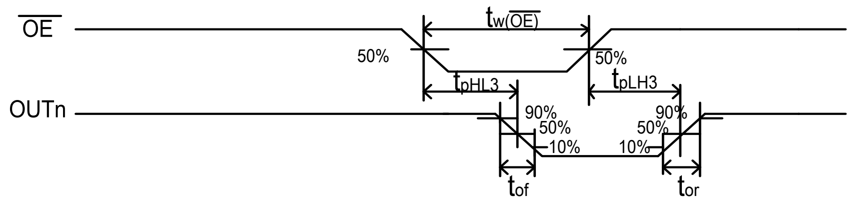
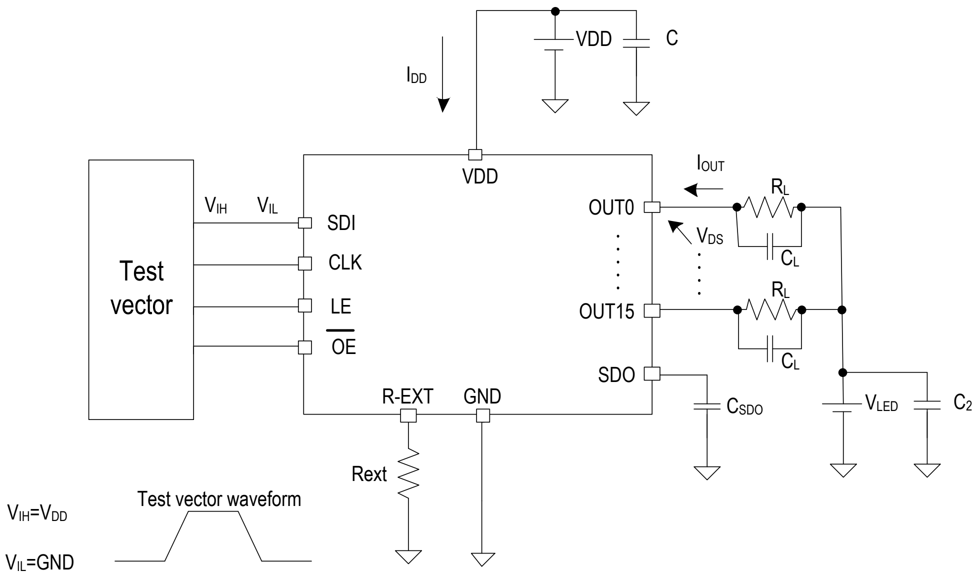


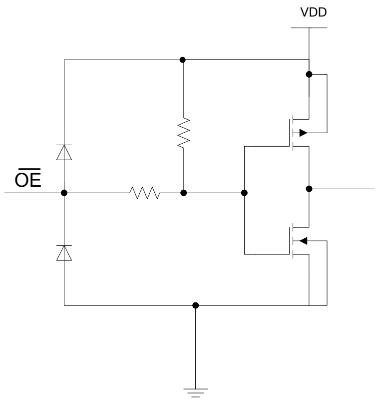
Fig. Grayscale output timing

Dynamic Characteristic Test Circuit

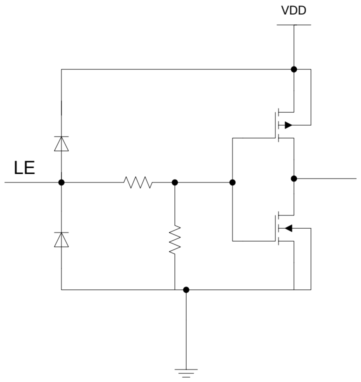


Equivalent Circuits of Outputs and Inputs

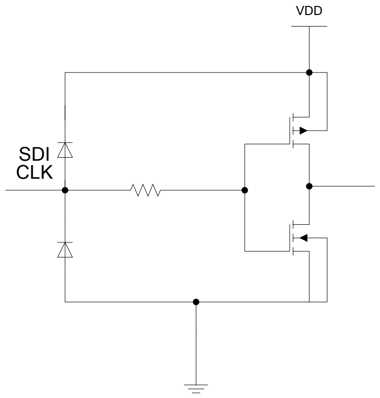
- $\overline{OE}$ input port



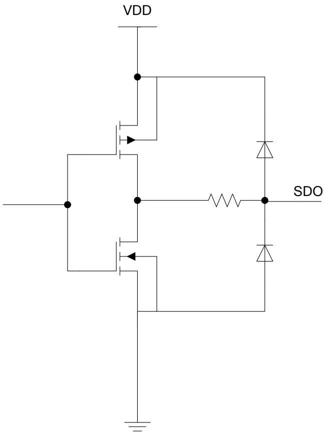
LE input port



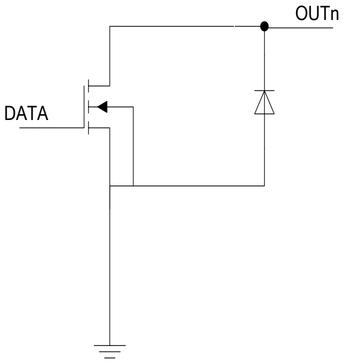
- CLK,SDI input port



SDO output port



- OUT0~OUT15 output port



Constant current characteristics

The SM16306SJ provides nearly no variations in current from channels and from ICs. This is derived from the excellent constant current output characteristics of the SM16306SJ:

- The maximum current deviation between channels is less than ±2.5%, and that between ICs is less than ±3.5%.
- When load voltage(V_{DS}) is changing, the output current will stay constant, the relationship is given by:

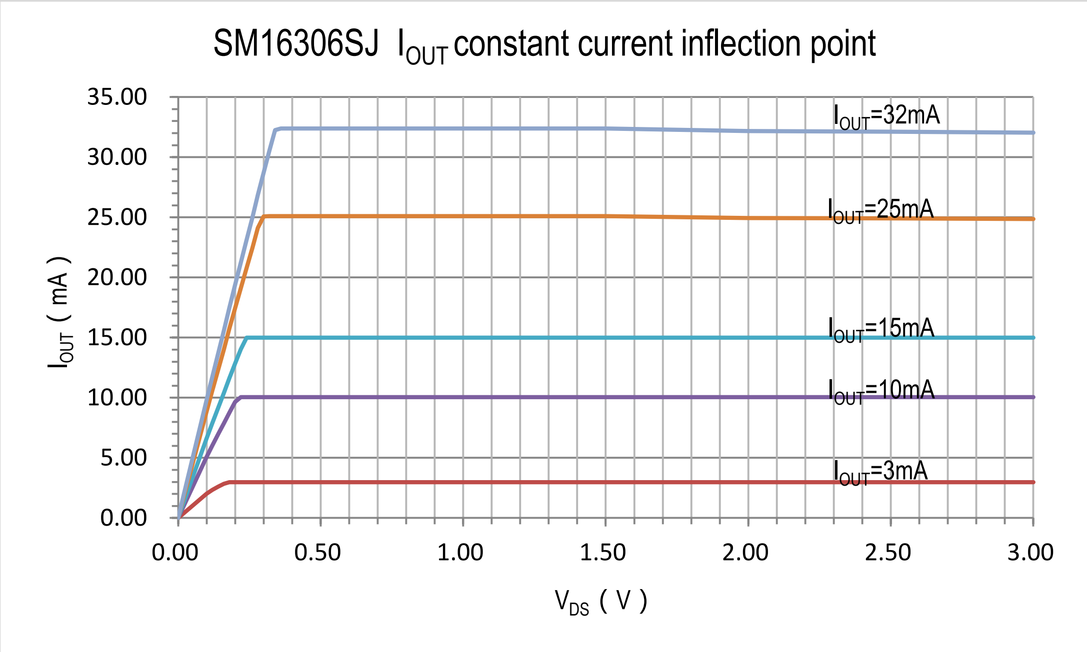


Fig. SM16306SJ I_{OUT} Constant current characteristic curve

Output Current Regulation

As shown below, the output current of each channel (I_{OUT}) is set by external Rext. The output current can be given by the formula:

$$I_{OUT} = 18600/Rext \quad mA$$

In the formula:

Rext refers to the resistance value that externally connected to the R-EXT to GND, and the current unit is mA;

For example:

1) When using 3000Ω resistor, the current IOUT=18600/3000=6.2mA can be calculated according to the formula;

2) In the application, the design current is 10mA, then Rext=18600/10=1860Ω can be inversely calculated according to the above formula.

The relationship curve between Rext and I_{OUT} is as follows:

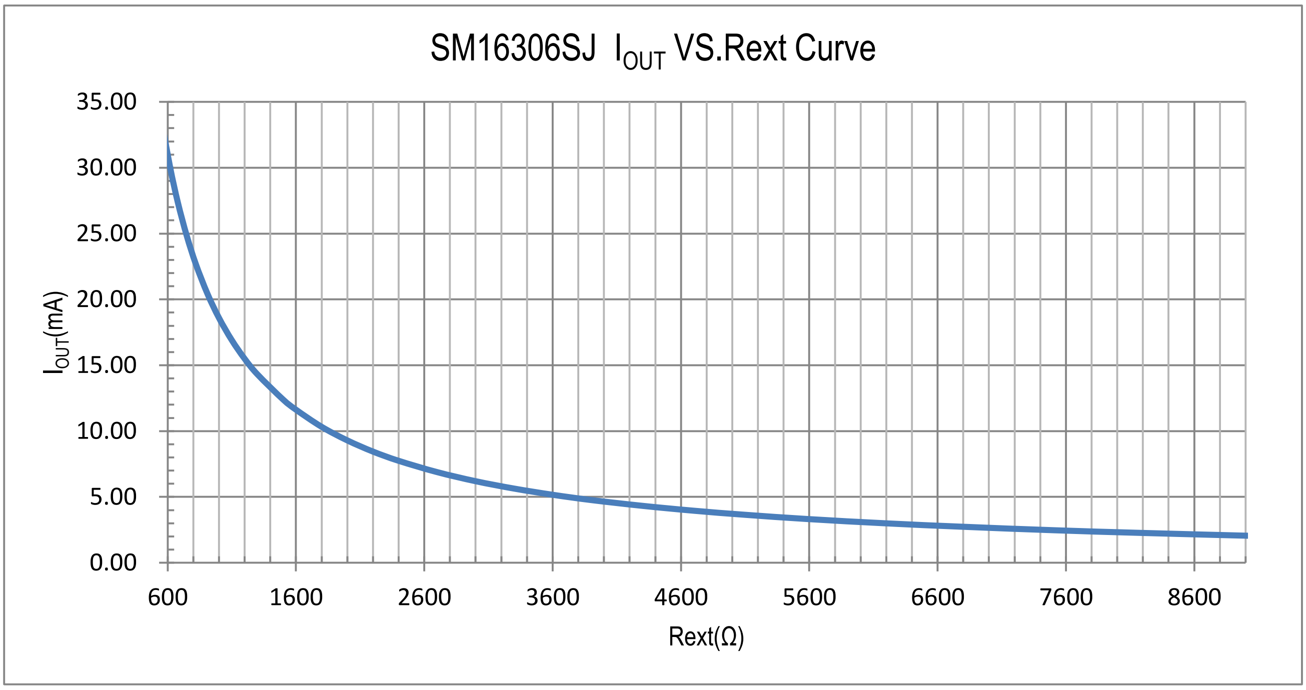
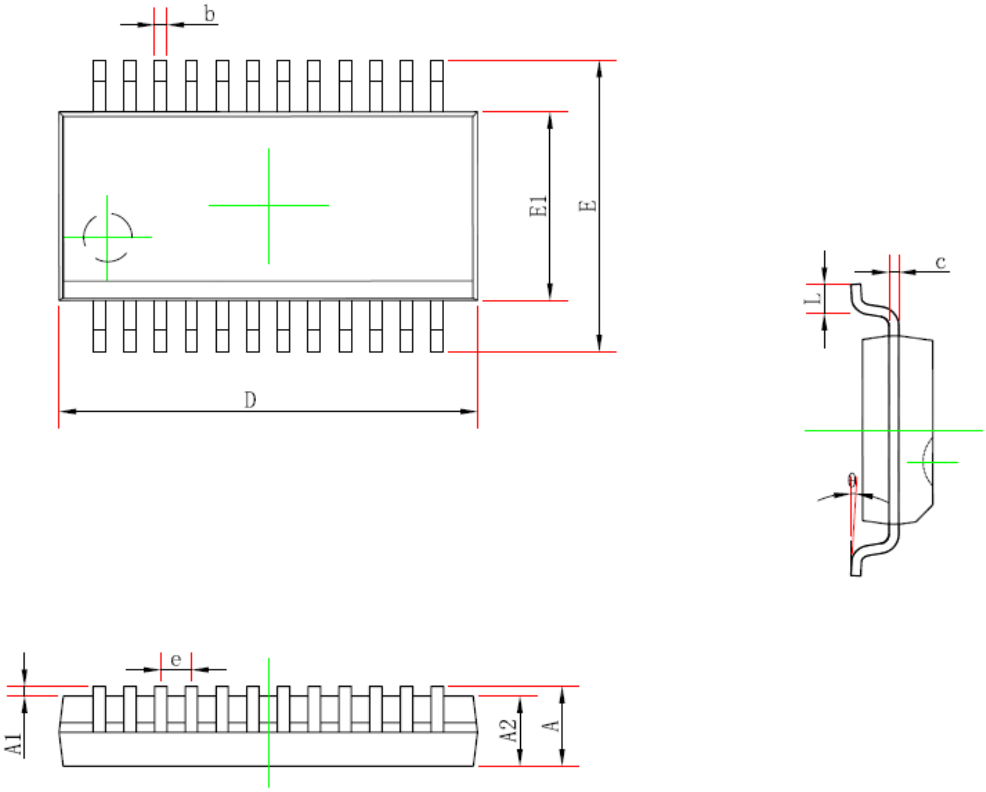


Fig. SM16306SJ output port current curve between I_{OUT} and Rext

Package

QSOP24



Symbol	Min(mm)	Max(mm)
A	-	1.95
A1	0.05	0.35
A2	1.05	-
b	0.1	0.4
c	0.05	0.254
D	8.2	9.2
E1	3.6	4.2
E	5.6	6.5
e	0.635TYP	
L	0.3	1.5
θ	0°	10°

Package Heat Dissipation Power (P_D)

The maximum heat dissipation power of package is given by:

$$P_{D(max)} = \frac{(T_J - T_A)}{R_{th(J\text{-}A)}}$$

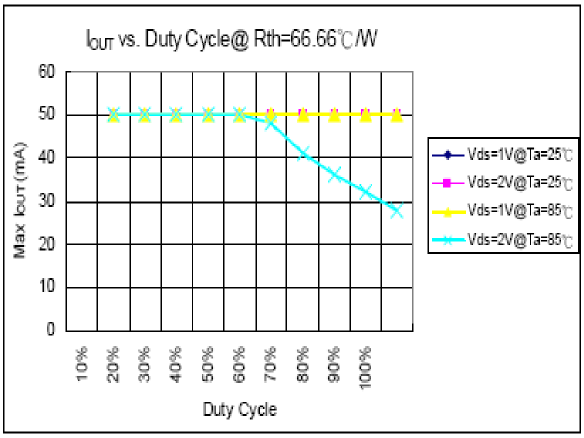
When 16 output channels are turned on simultaneously, the actual power consumption is:

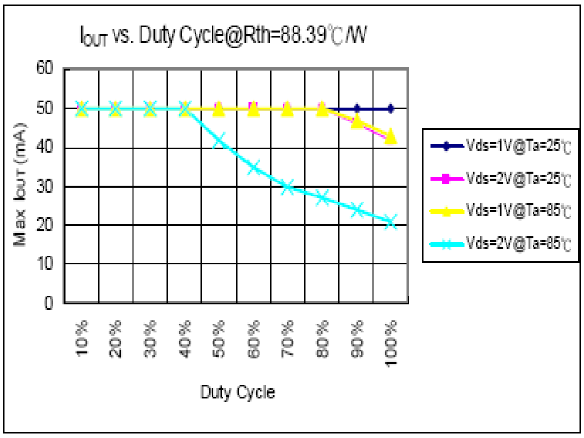
$$P_{D(act)} = I_{DD} \times V_{DD} + I_{OUT} \times Duty \times V_{DS} \times 16$$

The actual power consumption must lower than maximum power consumption, In order to keep $P_{D(act)} < P_{D(max)}$, the relationship between maximum output current and duty cycle is given by:

$$I_{OUT} = \frac{\frac{T_J - T_A}{R_{th(J-A)}} - I_{DD} \times V_{DD}}{V_{DS} \times Duty \times 16}$$

T_J is the IC operating temperature, T_A is the ambient temperature, V_{DS} is the constant current output voltage, Duty is the duty cycle, $R_{th(J\text{-}A)}$ is the thermal resistance of packaging. The relationship of maximum output current and the duty cycle is given by:





If larger output current is needed, then a certain number of heat sink needs to be added, and the formula is:

By

$$\frac{1}{R_{th(J-A)}} + \frac{1}{R_{fc}} = \frac{P_{D(act)}}{T_J - T_A}$$

$$R_{fc} = \frac{R_{th(J-A)} \times (T_J - T_A)}{P_{D(act)} \times R_{th(J-A)} - T_J + T_A}$$

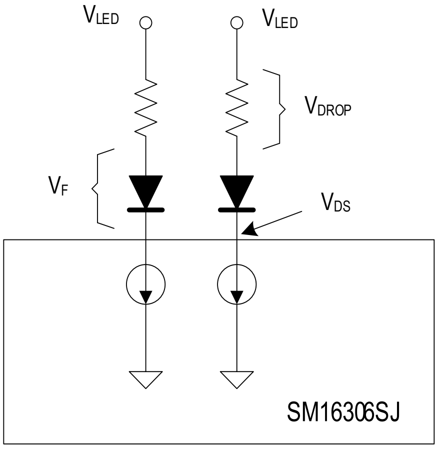
In the formula:

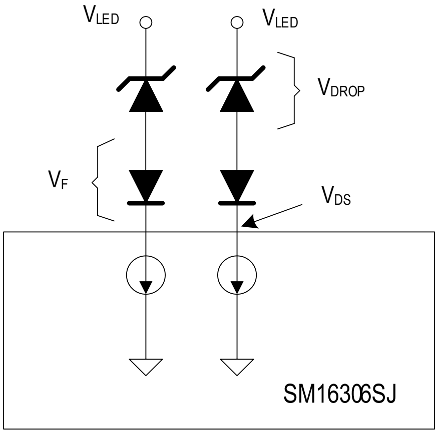
$$P_{D(act)} = I_{DD} \times V_{DD} + I_{OUT} \times Duty \times V_{DS} \times 16$$

Therefore, if larger current I_{OUT} is needed, according to the formula, the heat sink with thermal resistor R_{fc} must be added to IC.

Load Voltage (V_{LED})

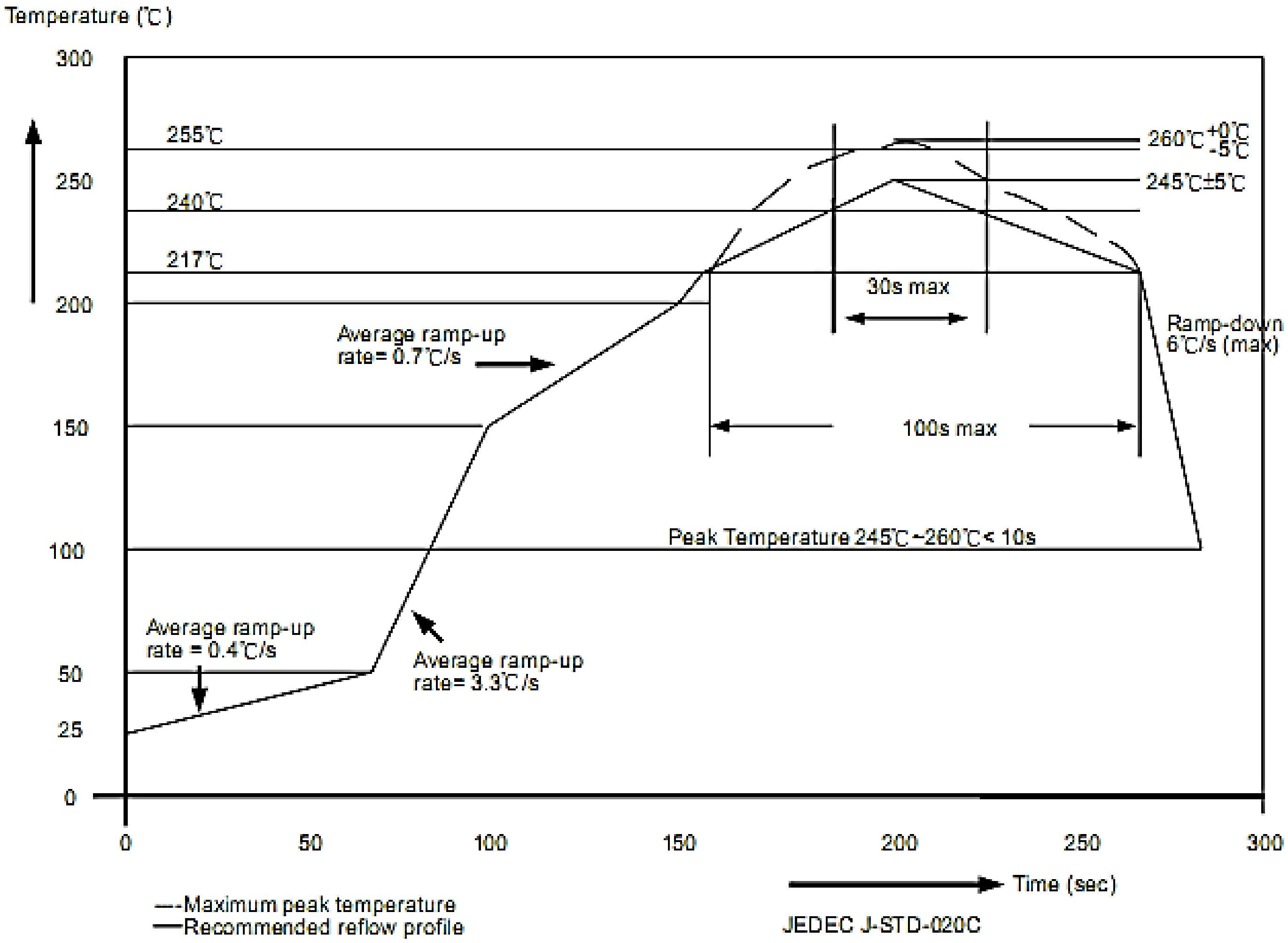
For the best of package heat dissipation performance, it is recommended that the best working range of output voltage (V_{DS}) is about 0.6V (I_{OUT}=3mA~32mA). If $V_{DS}=V_{LED}-V_F$ and V_{LED} =4.2V, excessive output voltage (V_{DS}) may cause P_D(act) > P_D(max). In this condition, suggest to use a lower V_{LED} voltage supply, external resistor or stabilivolt can also be used as V_{Drop}, which may cause $V_{DS}=(V_{LED}-V_F)-V_{DROP}$ to lower the output voltage(V_{DS}).





Encapsulation Soldering Process

Semiconductors of Sunmoon follow the European RoHs standard, solder temperature in encapsulation soldering process follows J-STD-020 standard.



Encapsulation Thickness	Volume mm³ < 350	Volume mm³：350~2000	Volume mm³ ≥ 2000
<1.6mm	260+0℃	260+0℃	260+0℃
1.6mm~2.5mm	260+0℃	250+0℃	245+0℃
≥2.5mm	250+0℃	245+0℃	245+0℃

Declaration

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