

Six-Channel LED Constant-Current Driver FW1906

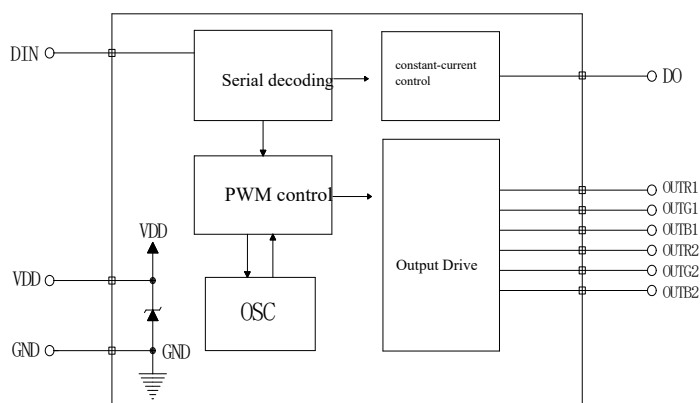
Characteristic Description

The FW1906 is a six-channel LED fixed-current drive control circuit specifically designed for LED lighting applications. It integrates an MCU single-wire digital interface, data latch, LED fixed-current drive circuit, and PWM brightness control circuitry. The chip can be cascaded via the single-wire digital interface (DI/DO), allowing external controllers to manage both the FW1906 and subsequent cascaded chips using a single-wire connection. The PWM brightness level of the FW1906's output ports can be individually configured by the external controller.

Functional Characteristics

- manufactured using CMOS power process; supports a VCC voltage of 24V
- The OUT port withstands a voltage of 24V.
- The OUT port maintains a constant current of 18 mA.
- Luminance adjustment circuit with 256-level luminance adjustment
- Single-line serial cascade interface
- Oscillation mode: Features an integrated RC oscillator with clock synchronization based on signals from the data line. Upon completing data reception for this unit, it automatically regenerates subsequent data and transmits it to downstream units via the data output terminal. The signal remains distortion-free and undiminished regardless of the distance across the cascaded stages.
- It features a built-in power-on reset circuit and emits white light upon power-on.
- The PWM control unit supports 256-level adjustment with a scanning frequency exceeding 2.6 kHz.
- Data reception and decoding can be accomplished via a single signal line.
- When the refresh rate is 30 frames per second, the cascade count must be at least 1024 points.
- The data transmission rate can reach 800 Kbps.
- The transmission distance between any two points shall be no less than 20 meters.
- Packaging format: SSOP10

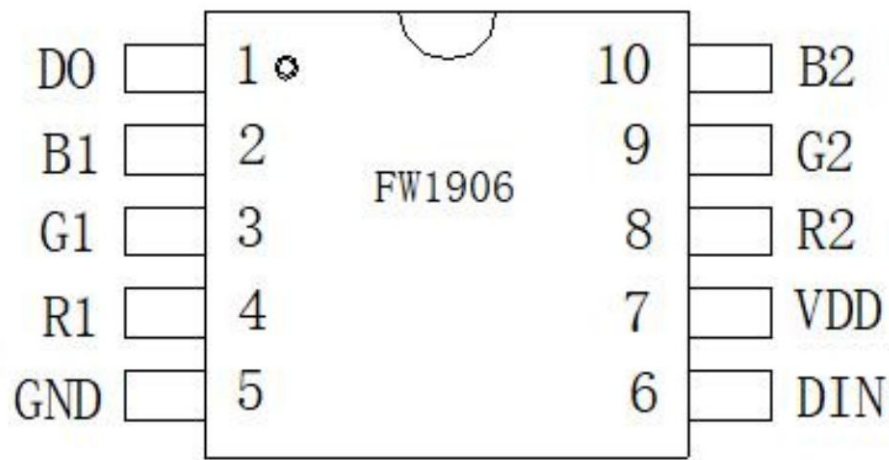
Internal Structure Flowchart



Graph 1

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Pin Configuration



Graph 2

Pin Functions

Port		I/O	Functional description
Name	Pin		
DIN	6	I	Data-in
D0	1	0	Presentation of information
R1	4	0	Red PWM constant-current output
G1	3	0	Green PWM constant-current output
B1	2	0	Blue PWM constant-current output
R2	8	0	Red PWM constant-current output
G2	9	0	Green PWM constant-current output
B2	10	0	Blue PWM constant-current output
VDD	7	-	Logical Power Supply
GND	5	-	Systematically

Table 1

Output and input equivalent circuits

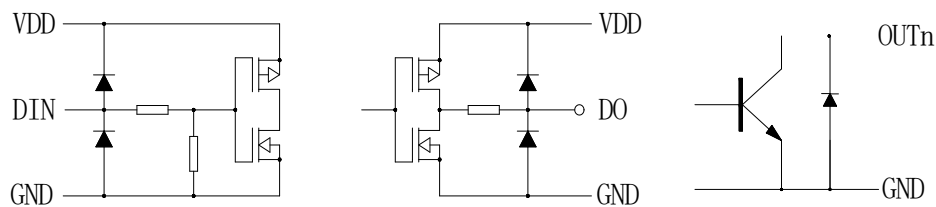


Figure 3: Integrated circuits are electrostatic-sensitive devices. During dry seasons or in dry environments, they are prone to generating significant static electricity. Static discharge can damage integrated circuits; therefore, all appropriate preventive measures should be implemented. Improper operations or soldering practices may cause ESD damage or performance degradation, rendering the chips non-functional.

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Limit parameters ⁽¹⁾ ⁽²⁾

Parameter			Scope	Unit
VDD	Logical power supply voltage		24	V
V _{in}	Input voltage range	DIN、SET	-0.4~5.5	V
I _{out}	Output current (DC)	OUTR, OUTG, OUTB	18	mA
V _{out}	Output voltage range	OUTR, OUTG, OUTB	-0.4~+30.0	V
F _{osc}	DIN clock rate	DIN	400~900	KHz
T _{opr}	Operating temperature range		-40~+85	°C
T _{stg}	Storage temperature range		-55~+150	°C
ESD	Human Body Model (HBM)		4000	V

Table 2

- (1) The grades listed in the table above indicate that prolonged use of the chip may cause permanent damage to the device, reducing its reliability. We strongly advise against operating the chip beyond these limit parameters under any other conditions.
- (2) All voltage values are measured relative to the system ground.

Recommended Range of Working Conditions

(At -40°C to +85°C, GND = 0 V) Unless Otherwise Specified			FW1906			Unit
Parameter		Test condition	Least value	Representative value	Crest value	
VDD	Supply voltage		10	24	27	V
V _{IN}	DIN\SET Input Voltage Range	VDD = 5 V; DIN and SET are connected in series with a 1 KΩ resistor.	-0. 5	5	5. 5	V
V _{DO}	DO Output Voltage Range	VDD = 5 V; DO is connected in series with a 1 KΩ resistor	-0. 5	--	5. 5	V
V _{OUT}	OUT output voltage range	OUT =OFF	-0. 5	--	24. 0	V
T _A	Operating temperature range		-40		+85	°C
T _J	Working temperature range		-40		+125	°C

Table 3

Electrical Character

(At VDD = 5.0 V and Temperatures Ranging from-40°C to +85°C, Typical Values Are VDD = 5.0 V and TA = +25°C) Unless Otherwise Specified			FW1906			Unit
Parameter		Test condition	Least value	Representative value	Crest value	
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	DIN, SET input current	DIN and SET are connected to VDD or GND	-1		1	μ A
Icco	Logical power supply 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		18		mA
Iolk	Output leakage current	OUTR, OUTG, OUTB =OFF	0		0. 3	μ A
TPWM	OUT port duty cycle period	The OUT is connected to a pull-up resistor.	270	280	290	μ s
Δ Iolc0	Constant current error (channel-to-channel)	OUTR, OUTG, OUTB =ON , VOUTn =1V			± 2. 5	%
Δ Iolc1	Constant current error (chip-to-chip)	OUTR, OUTG, OUTB =ON , VOUTn =1V			± 5	%

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ΔI_{olc2}	Linearity control	OUTR, OUTG, OUTB = ON, VOUTn = 1V		± 0.5	± 1	%/V
ΔI_{olc3}	Load regulation	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)	Resistivity value	--	79.2		190	°C/W
PD	Consumed power	(Ta=25° C)			1.5	W

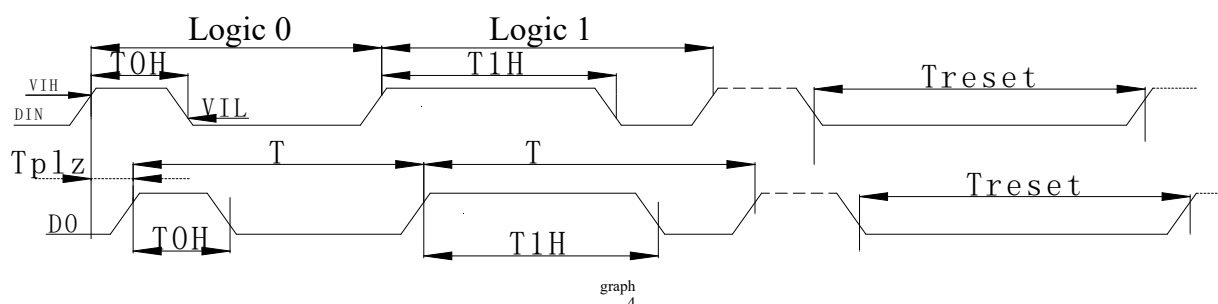
Tab

le 4 Switch Characteristics

(At VDD = 5.0 V and Temperatures Ranging from -40°C to +85°C, Typical Values Are VDD = 5.0 V and TA = +25°C) Unless Otherwise Specified						
symbol	parameter	test condition	least value	representative value	crest value	unit
Fosc	DIN clock rate	VDD=5.0V	—	800	—	KHz
FOUT	OUT PWM Output Frequency	OUTR, OUTG, OUTB	2.2	2.6	3.2	KHz
tPLZ	propagation delay time	DIN → DOUT			300	ns
tPZL	--	CL = 15pF, RL = 10K Ω			100	ns
TTHZ	drop-out time	CL=300pF, OUTR, OUTG, OUTB			80	μ s
CI	input capacitance	--			15	pF

Ta

ble 5: Time Series Characteristics



Function Declaration

This chip employs a single-wire communication method, transmitting signals using a zero-return code. After power-on reset, the chip receives data from the DIN port; upon completing the reception of 24×2 bits, the DO port begins forwarding subsequent data from the DIN port to provide input data for the next cascaded chip. Prior to data forwarding, the DO port remains at a low level. If a RESET reset signal is received on the DIN input, the chip, upon successful reset, outputs the corresponding PWM duty cycle based on the received 24×2 bits of data and enters a waiting state for new data. After completing the initial 24×2 bits of data reception, the chip forwards the data via the DO port. Until a RESET signal is received, the outputs of the OUTR, OUTG, and OUTB pins remain unchanged.

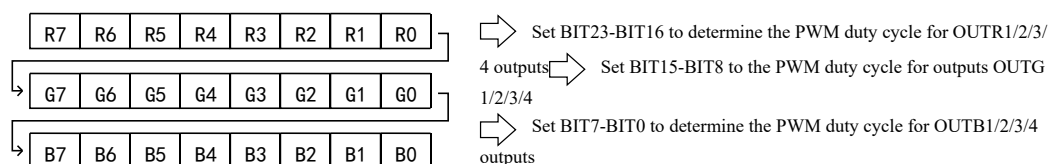
The chip employs automatic shaping and forwarding technology, ensuring no signal distortion or attenuation. This allows the number of cascaded stages to be unrestricted by signal transmission requirements, being limited solely by the screen scanning speed.

Data Structure

PWM mode command:

In a 24-bit data packet, this packet contains PWM setting data, with the following structure:

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The above describes the data format for setting the first group of RGB PWMs; configuring a FW1906 requires two groups of data packets with the same format.

The PWM duty cycle is continuously adjustable from 0 to 256. For 24×2-bit data transmission, the higher bits are sent first in RGB sequence. Each 24-bit stream can be divided into three 8-bit segments for transmission. Note that the low-level duration between consecutive bytes must not exceed the RESET signal duration; otherwise, the chip will reset and resume data reception, preventing successful data transfer.

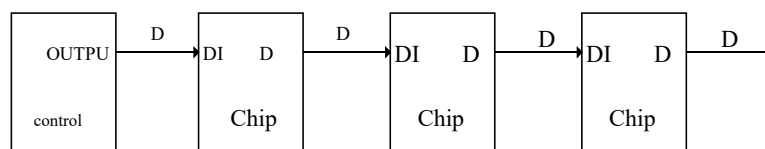
Communication Rate

Symbol	Parameter	Test condition	Least value	Representative value	Crest value	Unit
T0H	Enter 0 code, high-level duration	VDD=5V GND=0V	320	360	400	ns
T1H	Enter a 1-bit code, high-level duration		640	720	800	ns
T0H'	Output 0 code, high level duration		--	360	--	ns
T1H'	Output 1 code, high level duration		--	720	--	ns
T	The period time for code 0 or code 1		--	1250	--	ns
Treset	Reset code, low-level duration		200	500		μs

Table 6

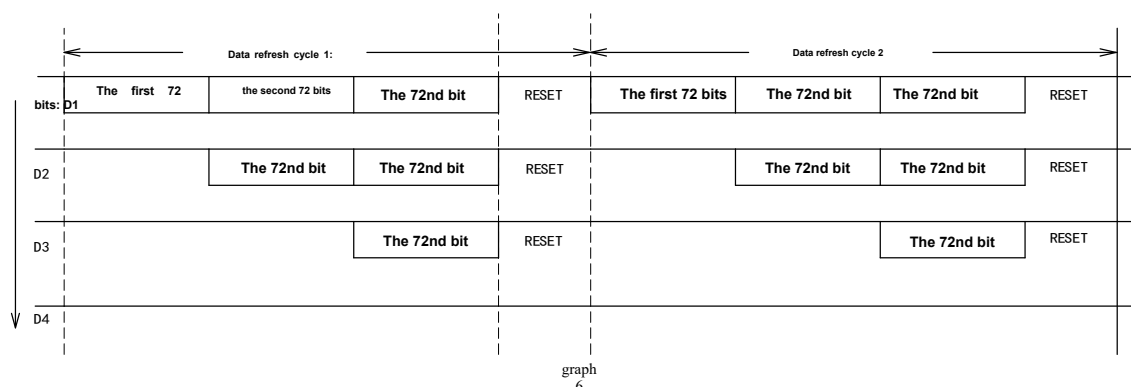
Note: The typical cycle time for sending a 1-bit or 0-bit code is 1250 ns (frequency 800 kHz).

Data Transmission and Forwarding



Graph 5

Here, D1 represents the data transmitted by the controller, while D2, D3, and D4 denote the data forwarded by the cascaded FW1906 unit.



Chip cascading and data transmission/forwarding process: The controller sends data (D1). After Chip 1 receives the first 48 bits but has not yet forwarded the data (D2), the controller continues sending data. Chip 1 then receives the second 48 bits; since it already holds the first 48 bits, it forwards the second 48 bits via DO. Chip 2 receives the forwarded data (D2) from Chip 1 but has not yet forwarded the data (D3). The controller continues sending data, and Chip 1 forwards the received third 48 bits to Chip 2. Since Chip 2 also holds one 48-bit block, it forwards the third 48 bits (D3). Chip 3 receives the third 48 bits; at this point, if the controller sends another data packet...

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The low-level signal from the reset pin (resetRESET) causes all chips to reset, decode their respective 48-bit data, and control the output of four RGB ports, completing one data refresh cycle. The chips then return to the ready-to-receive state.

Application Message

1、 How to Calculate the Data Refresh Rate

The data refresh rate is determined by the number of pixels interconnected within the system. Typically, an RGB unit corresponds to a single pixel (or segment), and a FW1906 chip can control two RGB units.

Calculated in normal mode:

The maximum transmission rate of a bit is 1200 ns (at a frequency of 800 kHz). Each pixel data consists of red (8 bits), green (8 bits), and blue (8 bits), totaling 24 bits, with a transmission time of $24 \times 1.2 \mu\text{s} = 28.8 \mu\text{s}$. For a system containing 2000 pixels, the total time required to refresh all displays is $28.8 \mu\text{s} \times 2000 = 57.6 \text{ ms}$ (ignoring RESET code time). Thus, the refresh rate per second is: $1 \div 57.6 \times 1000 \approx 17.36 \text{ Hz}$.

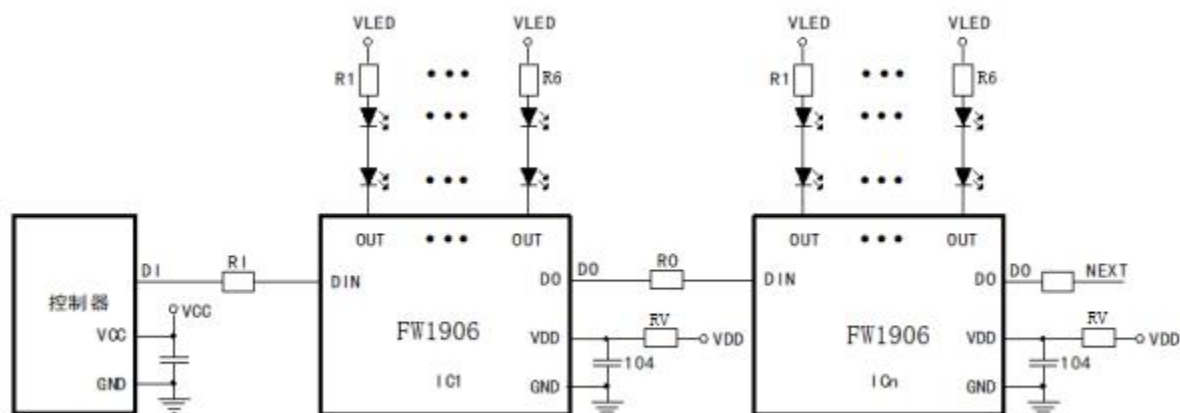
The table below shows the maximum data refresh rates corresponding to cascade points:

Pixel	Normal mode	
	Fastest data refresh time (ms)	Maximum refresh rate (Hz)
1~500	14.4	69
1~800	24	41
1~1000	30	33

Table 7

If the system does not require a high data refresh rate, there is no restriction on the number of cascaded pixel arrays; as long as power supply is stable, the FW1906 can theoretically support infinite cascading.

2、 How to Operate the FW1906 in Optimal Constant Current Mode



The FW1906 provides fixed constant-current drive. According to the constant-current curve, when operating at 18 mA current, the output voltage at the OUT terminal must exceed 1.2 V for the chip to achieve constant-current operation. However, higher output voltages are not always preferable, as increased voltage leads to higher power consumption on the chip, severe heat generation, and reduced system reliability. Therefore, it is recommended to maintain the Vout voltage between 1.2 V and 3 V when enabling the output. A commonly used approach involves employing a series resistor, with the following theoretical calculation method for resistor selection:

System drive voltage: VDD

Single LED on-state voltage drop: Vled

Number of series LEDs: n

Constant current value: Iout

Constant current voltage: 1.5V

resistance : R

$$R = (VDD - 1.5 - n \times V_{led}) / I_{out}$$

Example: The system operates on 24 V, with a single LED's on-state voltage drop of 2 V, six LEDs connected in series, and a constant current of 18 mA. The calculation using the above formula yields:

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Result: $R = (24 - 2 \times 6) / 0.018 = 555 \Omega$; simply connect a 560Ω resistor in series at the OUT pin.

The resistance values of R1–R6 can be automatically adjusted based on the number of LEDs connected in series at the OUT port. It is recommended to connect resistors with resistance values of 75–100 ohms between R1 and R0 for signal isolation, preventing damage to subsequent chips from affecting the preceding stage.

RV is an IC voltage divider resistor; typically, 1.2K is used at DC 12V, while 3K is used at DC 24V.

5、Program-Driven LED Method

5.1 To achieve chip-controlled LED brightness, first ensure the RGB port voltage enables the chip to operate in constant-current mode (refer to the "Constant-Current Curve" for details).

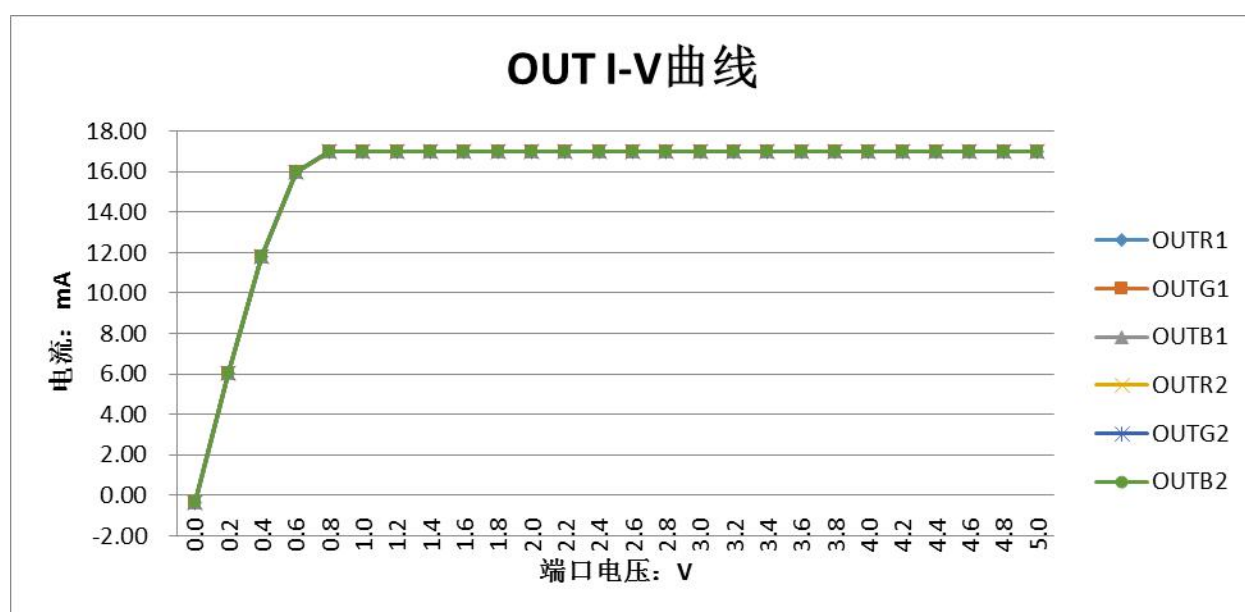
5.2 When the chip is powered-on and reset, the port voltage reaches 1.2 V, and the RGB output channel maintains a constant current of 18 mA. Therefore, the maximum allowable current is 18 mA.

5.3 By continuously adjusting the PWM value, you can freely control the LED brightness. Set the PWM value to 0 for full output level, turning the LED off. Set the PWM value to FFH for the maximum low-level duty cycle, making the LED emit its brightest light.

Constant Current Curve

When applying the FW1906 to LED panel design, the current difference between channels—or even between chips—is minimal. This is attributed to the FW1906's superior characteristics:

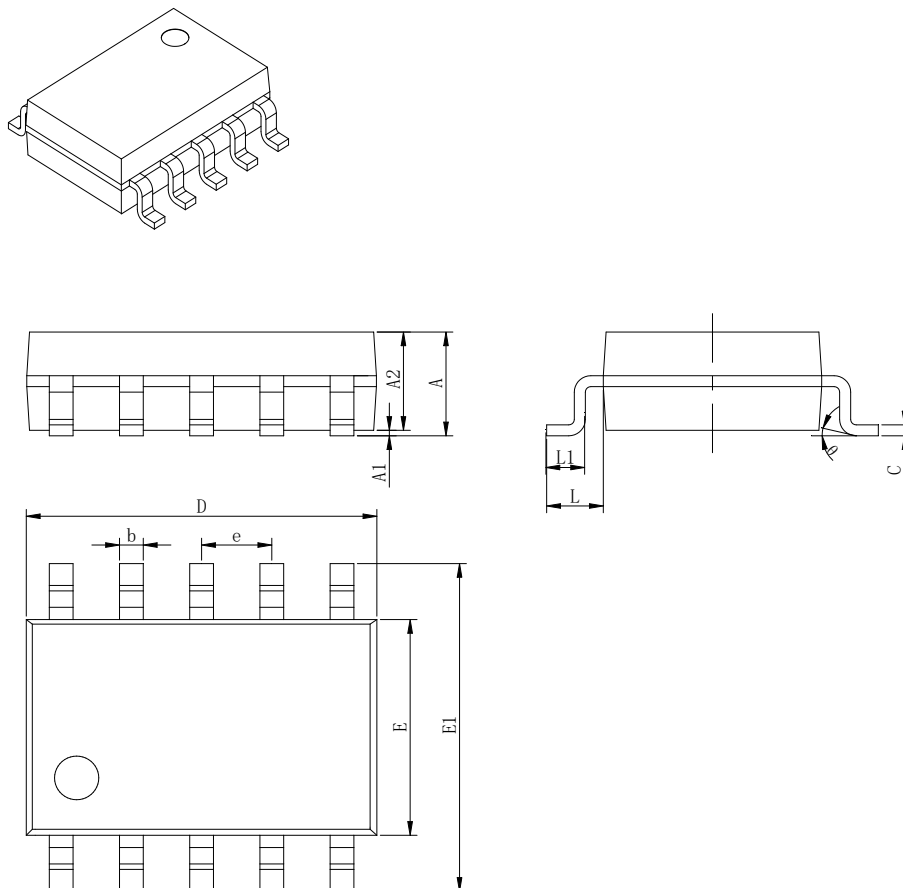
- Additionally, when the load-side voltage changes, the stability of the output current remains unaffected, as shown in Figure 8 below.
- The port drive current for FW1906 is a fixed constant value.



Graph 9

Six-channel LED constant-current driver FW1906

Encapsulation schematic diagram (SSOP10)



Symbol	MSOP10				SSOP10			
	Dimensions In Millimeters		Dimensions In Inches		Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max	Min	Max	Min	Max
A	0.9	1.1	0.035	0.043	–	1.75	–	0.067
A1	0.05	0.15	0.002	0.006	0.10	0.225	0.004	0.009
A2	0.75	0.95	0.030	0.037	1.30	1.50	0.051	0.059
b	0.170	0.270	0.007	0.011	0.39	0.48	0.015	0.019
c	0.085	0.225	0.003	0.009	0.21	0.26	0.008	0.010
D	2.9	3.1	0.114	0.122	4.70	5.10	0.185	0.201
E	2.900	3.1	0.114	0.122	3.70	4.10	0.146	0.161
e	0.5 (BSC)		0.020 (BSC)		1.0 (BSC)		0.039 (BSC)	
E1	4.750	5.05	0.187	0.199	5.80	6.20	0.228	0.244
L1	0.4	0.6	0.016	0.024	0.50	0.80	0.197	0.032
L	0.95 (BSC)		0.037 (BSC)		1.05 (BSC)		0.041 (BSC)	
θ	0°	8°	0°	8°	0°	8°	0°	8°

All specs and applications shown above subject to change without prior notice.
(The above circuit and specifications are for reference only. Should our company make any modifications, no separate notice will be given.)