

### GENERAL DESCRIPTION

The LM2596 Series are step-down switching regulators with all required active functions. It is capable of driving 3A load with excellent line and load regulations. These devices are available in fixed output voltages of 3.3V, 5V, and an adjustable output version.

The LM2596 series operates at a switching frequency of 150kHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators. It substantially not only reduces the area of board size but also the size of heat sink, and in some cases no heat sink is required. The  $\pm 4\%$  tolerance on output voltage within specified input voltages and output load conditions is guaranteed. Also, the oscillator frequency accuracy is within  $\pm 10\%$ . External shutdown is included. Featuring 100 $\mu$ A (typical) standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

### Features

- Output voltage: 3.3V, 5V & adjustable version
- Adjustable output voltage range 1.23V~38.5V
- 150kHz fixed switching frequency
- Voltage mode Non-synchronous PWM control
- Thermal shutdown and current limit protection
- ON/OFF shutdown control input
- Short circuit protect (SCP)
- Operating voltage can be up to 40V
- Output load current 3A

### Applications


- Simple High-efficiency Step down Regulator
- On-Card Switching Regulators
- Positive to Negative Converter

### TYPICAL APPLICATION


| OUTPUT VOLTAGE | PART NO.     | PACKAGE                        | PACKING           |
|----------------|--------------|--------------------------------|-------------------|
| 3.3V           | LM2596SX-3.3 | TO-263-5L (D <sup>2</sup> PAK) | 500pcs / 13" Reel |
| 5.0V           | LM2596SX-5.0 | TO-263-5L (D <sup>2</sup> PAK) | 500pcs / 13" Reel |
| ADJ            | LM2596SX-ADJ | TO-263-5L (D <sup>2</sup> PAK) | 500pcs / 13" Reel |

### Marking:


LM2596SX-3.3

|   |             |
|---|-------------|
|  | TECH PUBLIC |
|   | LM2596S     |
| -3.3  | P+          |

LM2596SX-5.0

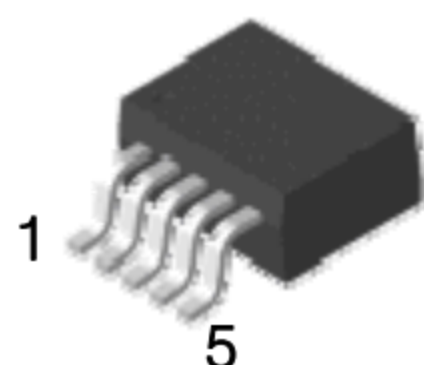
|   |             |
|---|-------------|
|  | TECH PUBLIC |
|   | LM2596S     |
| -5.0  | P+          |

LM2596SX-ADJ

|  |             |
|--|-------------|
|  | TECH PUBLIC |
|  | LM2596S     |
| -ADJ   | P+          |

## PIN CONFIGURATION

TO-263-5L (D<sup>2</sup>PAK)



**Pin Definition:**

1. Input
2. SW Output
3. Ground
4. Feedback
5. Enable

## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                          | SYMBOL           | LIMIT              | UNIT |
|------------------------------------|------------------|--------------------|------|
| Maximum Supply Voltage             | $V_{CC}$         | +45                | V    |
| Recommend Operating Supply Voltage | $V_{OP}$         | +4.5 to +40        | V    |
| SW, EN Pin Input Voltage           | $V_{SW}, V_{EN}$ | -0.3 to +40        | V    |
| Feedback Pin Voltage               | $V_{FB}$         | -0.3 to +12        | V    |
| Power Dissipation                  | $P_D$            | Internally Limited | W    |
| Output Voltage to Ground           | $V_{OUT}$        | -1                 | V    |
| Storage Temperature Range          | $T_{ST}$         | -65 ~ +150         | °C   |
| Operating Temperature Range        | $T_{OP}$         | -40 ~ +125         | °C   |
| ESD Susceptibility (HBM)           |                  | 2                  | kV   |

## THERMAL INFORMATION

| PARAMETER                              | SYMBOL          | LIMIT | UNIT |
|--|-----------------|-------|------|
| Junction to Case Thermal Resistance    | $R_{\theta JC}$ | 2     | °C/W |
| Junction to Ambient Thermal Resistance | $R_{\theta JA}$ | 50    | °C/W |

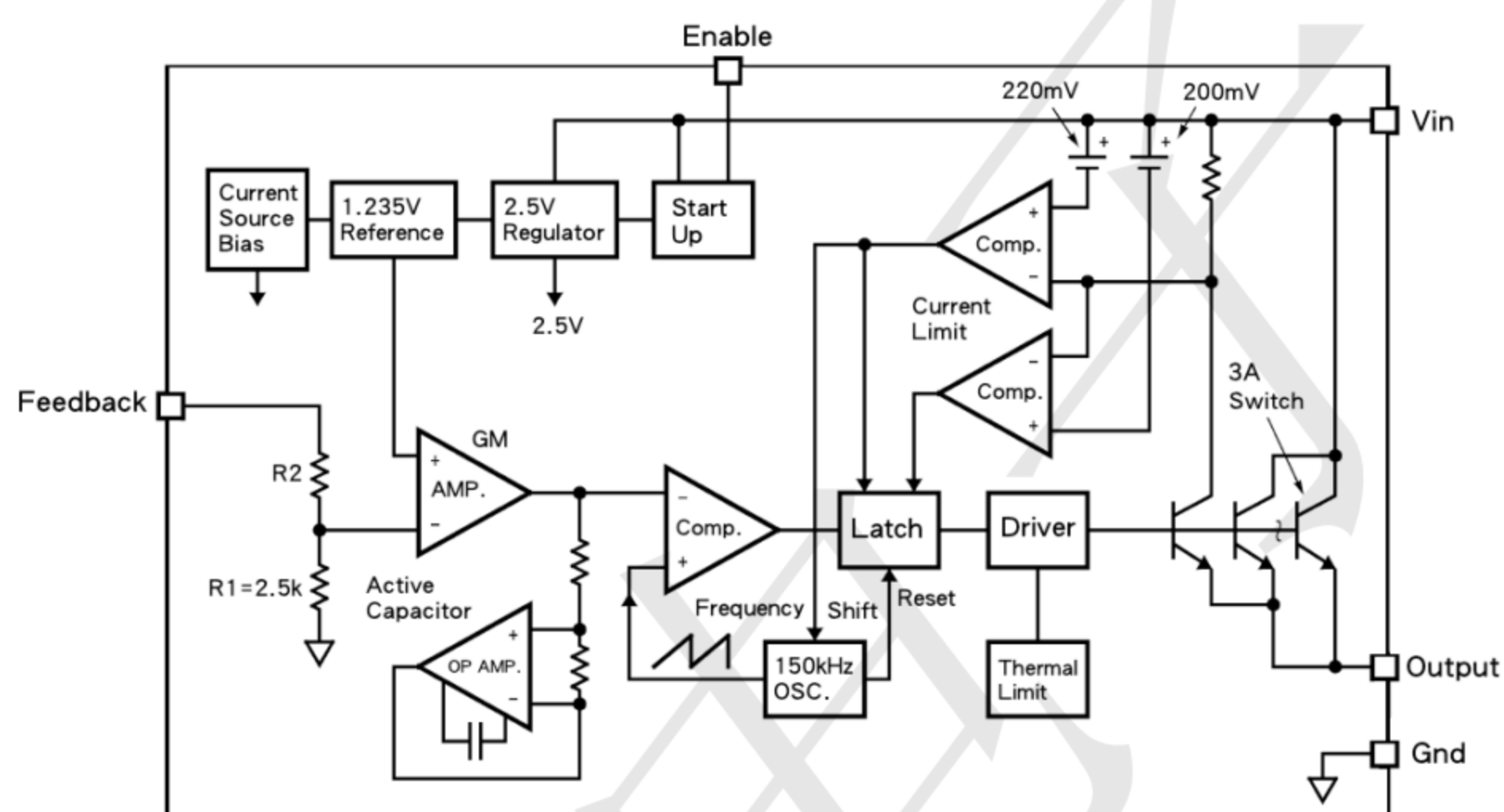


### Electrical Characteristics (T<sub>A</sub>=25°C unless otherwise noted)

(V<sub>IN</sub> = 12V for 3.3V, 5V, Adjustable Version, I<sub>LOAD</sub> = 0.3A, T<sub>A</sub> = 25°C unless otherwise noted)

| PARAMETER                                     |             | CONDITION   | SYMBOL            | MIN   | TYP  | MAX   | UNIT |
|---|-------------|---|-------------------|-------|------|-------|------|
| Output Feedback                               | ADJ         | 4.5V ≤ V <sub>IN</sub> ≤ 40V<br>0.2A ≤ I <sub>LOAD</sub> ≤ 3A                     | V <sub>FB</sub>   | 1.180 | 1.23 | 1.280 | V    |
| Efficiency                                    |             | V <sub>IN</sub> = 12V, I <sub>LOAD</sub> = 3A,<br>V <sub>OUT</sub> = 5V           | η                 | --    | 77   | --    | %    |
| Output Feedback                               | 3.3V        | 4.75V ≤ V <sub>IN</sub> ≤ 40V<br>0.2A ≤ I <sub>LOAD</sub> ≤ 3A                    | V <sub>FB</sub>   | 3.135 | 3.3V | 3.465 | V    |
| Efficiency                                    |             | V <sub>IN</sub> = 12V, I <sub>LOAD</sub> = 3A                                     | η                 | --    | 75   | --    | %    |
| Output Feedback                               | 5V          | 7V ≤ V <sub>IN</sub> ≤ 40V<br>0.2A ≤ I <sub>LOAD</sub> ≤ 3A                       | V <sub>FB</sub>   | 4.75  | 5    | 5.25  | V    |
| Efficiency                                    |             | V <sub>IN</sub> = 12V, I <sub>LOAD</sub> = 3A                                     | η                 | --    | 80   | --    | %    |
| Feedback Bias Current                         |             | V <sub>FB</sub> = 1.3V (Adj version only)   | I <sub>FB</sub>   | --    | 10   | 100   | nA   |
| Oscillator Frequency                          |             |   | F <sub>OSC</sub>  | 127   | 150  | 173   | kHz  |
| Soft-Start Time                               |             | Rising edge of EN on to I <sub>CL</sub>   | T <sub>SS</sub>   | --    | 3    | --    | ms   |
| Current Limit                                 |             | Pear Current, no outside circuit<br>V <sub>FB</sub> = 0V force driver on          | I <sub>CL</sub>   | 3.3   | --   | --    | A    |
| Oscillator Frequency of Short Circuit Protect |             | When current limit occurred and V <sub>FB</sub> < 0.5V, Ta = 25°C                 | F <sub>SCP</sub>  | 110   | 150  | 173   | KHz  |
| Saturation Voltage                            |             | I <sub>OUT</sub> = 3A, No outside circuit<br>V <sub>FB</sub> = 0V force driver on | V <sub>SAT</sub>  | --    | 1.15 | 1.50  | V    |
| ON/OFF Pin Logic Input Threshold Voltage      |             | Low (regulator ON)  | V <sub>IL</sub>   | --    | 1.3  | 0.6   | V    |
|   |             | High (regulator OFF)  | V <sub>IH</sub>   | 2.0   | 1.3  | --    | V    |
| ON/OFF Pin Logic Input Current                |             | V <sub>LOGIC</sub> = 2.5V (OFF)   | I <sub>H</sub>    | --    | 5    | 15    | μA   |
|   |             | V <sub>LOGIC</sub> = 0.5V (ON)  | I <sub>L</sub>    | --    | 0.02 | 5     |      |
| Maximum Duty Cycle (ON)                       |             | V <sub>FB</sub> = 0V force driver on  | DC                | --    | 100  | --    | %    |
| Maximum Duty Cycle (OFF)                      |             | V <sub>FB</sub> = 12V force driver off  |                   | --    | 0    | --    |      |
| Quiescent Current                             |             | V <sub>FB</sub> = 12V force driver off  | I <sub>Q</sub>    | --    | 5    | 10    | mA   |
| Standby Quiescent Current                     |             | ON/OFF pin = 5V   | I <sub>STBY</sub> | --    | 80   | 200   | μA   |
|   |             | V <sub>IN</sub> = 40V   |                   | --    |      | 250   |      |
| SW Pin Leakage Current                        | SW pin = 0  | No outside circuit,<br>V <sub>FB</sub> = 12V force driver off                     | I <sub>SWL</sub>  | --    | 0.3  | 2     | mA   |
|   | SW pin = -1 | V <sub>IN</sub> = 12V   |                   | --    | 7.5  | 30    | mA   |

## BLOCK DIAGRAM





## **PIN FUNCTION DESCRIPTION**

### **V<sub>CC</sub>**

This is the positive input supply for the IC switching regulator. A suitable input bypass capacitor must be presented at this pin to minimize voltage transients and to supply the switching currents needed by the regulator.

### **Ground**

Circuit ground

### **SW Output**

Internal switch. The voltage at this pin switches between  $(+V_{CC} - V_{SAT})$  and approximately  $-0.5V$ , with a duty cycle of approximately  $V_{OUT} / V_{CC}$ . To minimize coupling to sensitive circuitry, the PC board copper area connected to this pin should be minimized.

### **Feedback**

Sense the regulated output voltage to complete the feedback loop.

### **Enable**

Allows the switching regulator circuit to be shutdown using logic level signals thus dropping the total input supply current to approximately  $100\mu A$ . Pulling this pin below a threshold voltage of approximately  $1.3V$  turns the regulator on, and pulling this pin above  $1.3V$  (up to a maximum of  $V_{CC}$ ) shuts the regulator down. If this shutdown feature is not needed, the EN pin can be wired to the ground pin.

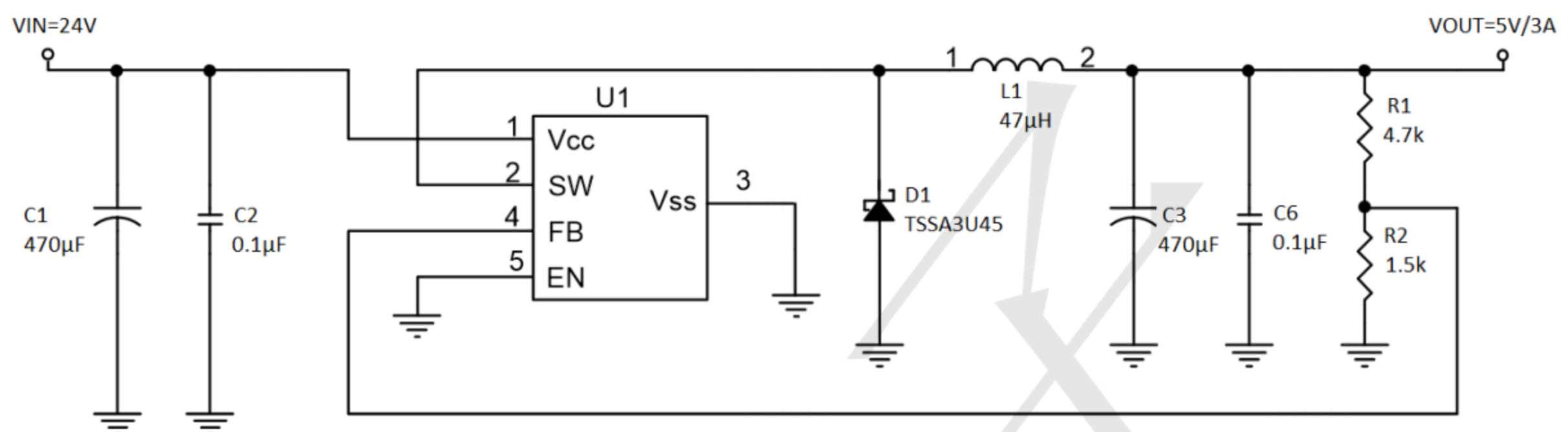
### **Thermal Considerations**

The LM2596 (TO-263-5L package) junction temperature rise above ambient temperature with a 3A load for various input and output voltages. This data was taken with the circuit operating as a buck switching regulator with all components mounted on a PC board to simulate the junction temperature under actual operating conditions. This curve can be used for a quick check for the approximate junction temperature for various conditions, but be aware that there are many factors that can affect the junction temperature. When load currents higher than 3A are used, double sided or multilayer PC boards with large copper areas and/or airflow might be needed, especially for high ambient temperatures and high output voltages.

For the best thermal performance, wide copper traces and generous amounts of printed circuit board copper should be used in the board layout. (Once exception to this is the output (switch) pin, which should not have large areas of copper.) Large areas of copper provide the best transfer of heat (lower thermal resistance) to the surrounding air, and moving air lowers the thermal resistance even further.

## TYPICAL APPLICATION CIRCUIT

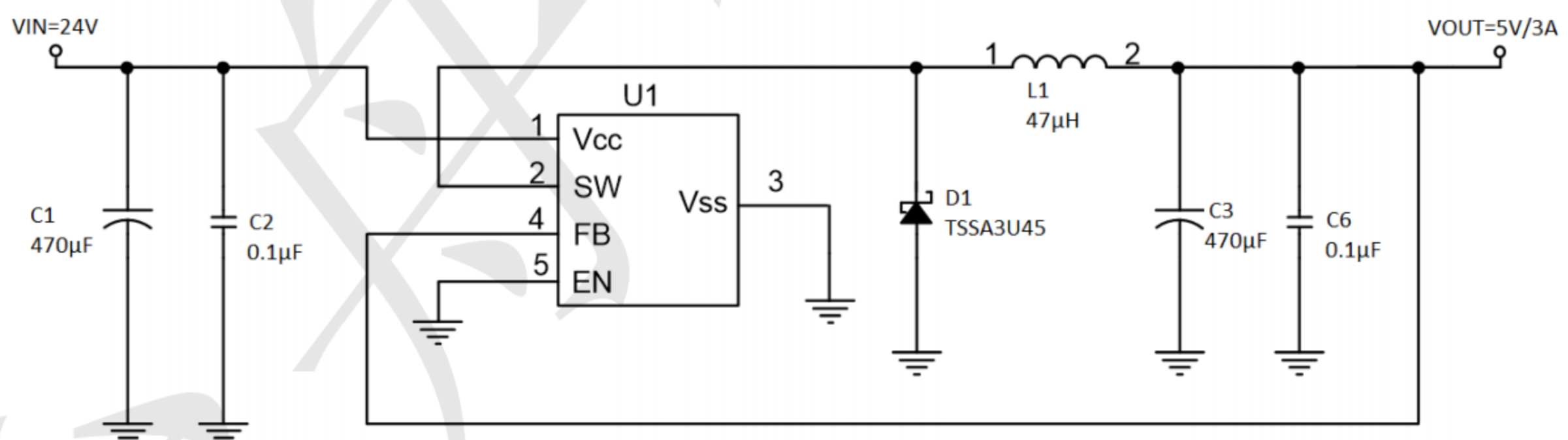
### Adjustable Output Voltage Version



$$V_{OUT} = V_{FB} \times \left(1 + \frac{R1}{R2}\right), V_{FB} = 1.23V, R2 = 0.7k \sim 3k$$

| V <sub>OUT</sub> | R2    | R1    |
|------------------|-------|-------|
| 5.0V             | 1.5kΩ | 4.7kΩ |
| 3.3V             | 1.5kΩ | 2.5kΩ |
| 2.5V             | 1.5kΩ | 1.5kΩ |

### Fixed Output Voltage Version



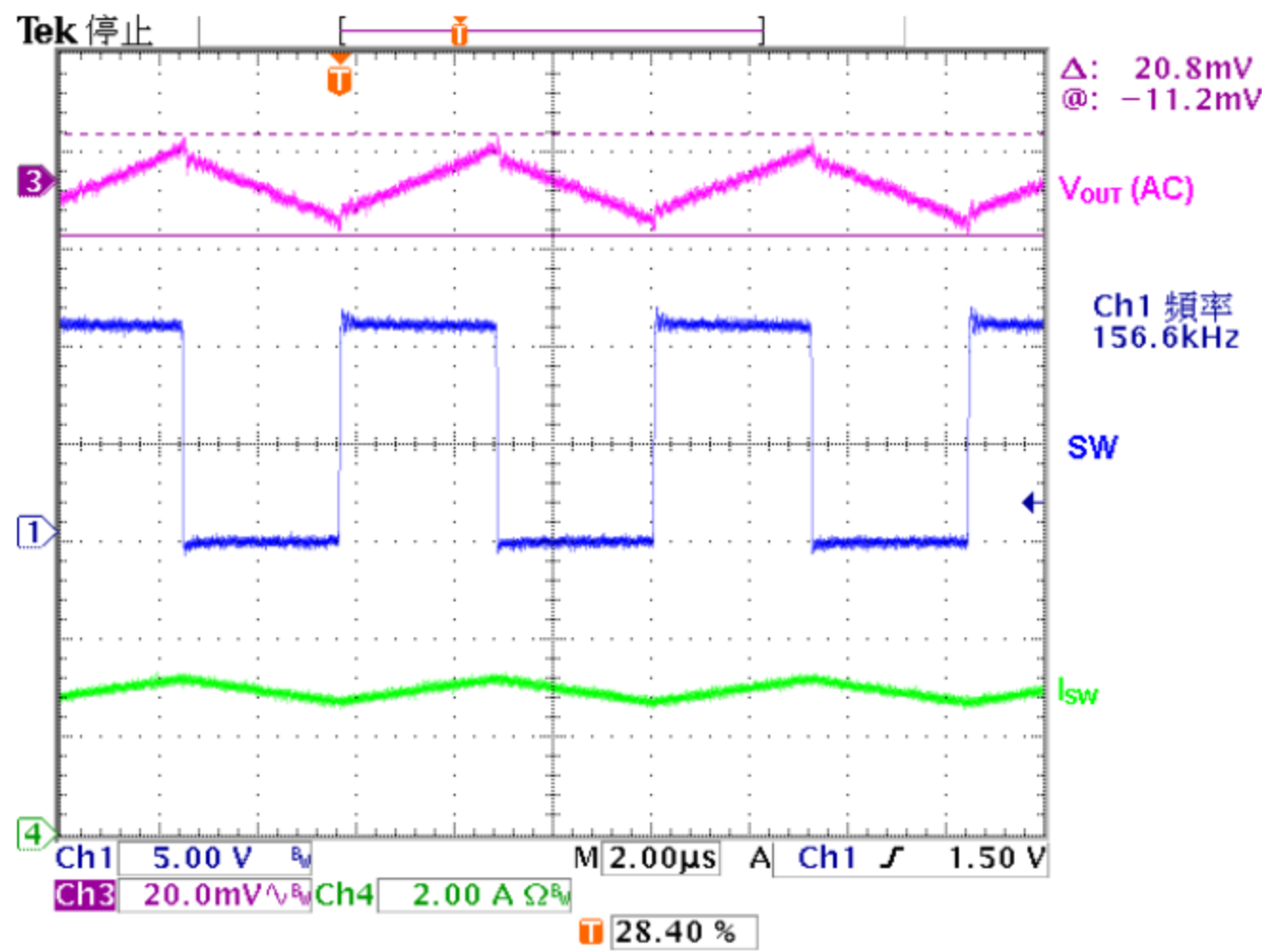
| L1 recommend value (I <sub>OUT</sub> =3A,) |      |      |         |      |
|--|------|------|---------|------|
| V <sub>OUT</sub>                           | 2.5V | 3.3V | 5V      | 12V  |
| V <sub>IN</sub> =12V                       | 33µH | 33µH | 33~47µH | NA   |
| V <sub>IN</sub> =24V                       | 33µH | 33µH | 47µH    | 68µH |



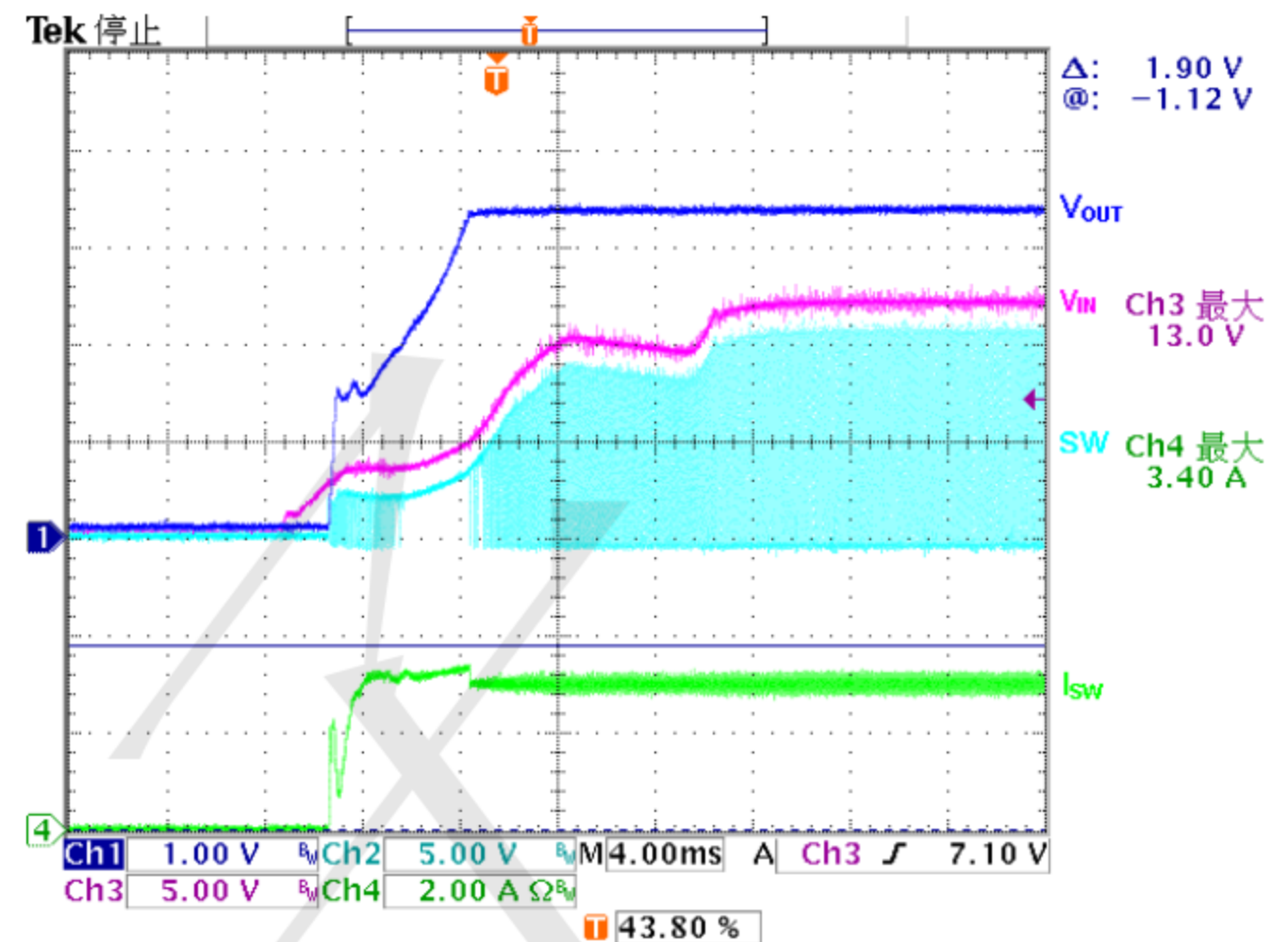
**ELECTRICAL CHARACTERISTICS CURVES**

[www.sot23.com.tw](http://www.sot23.com.tw)

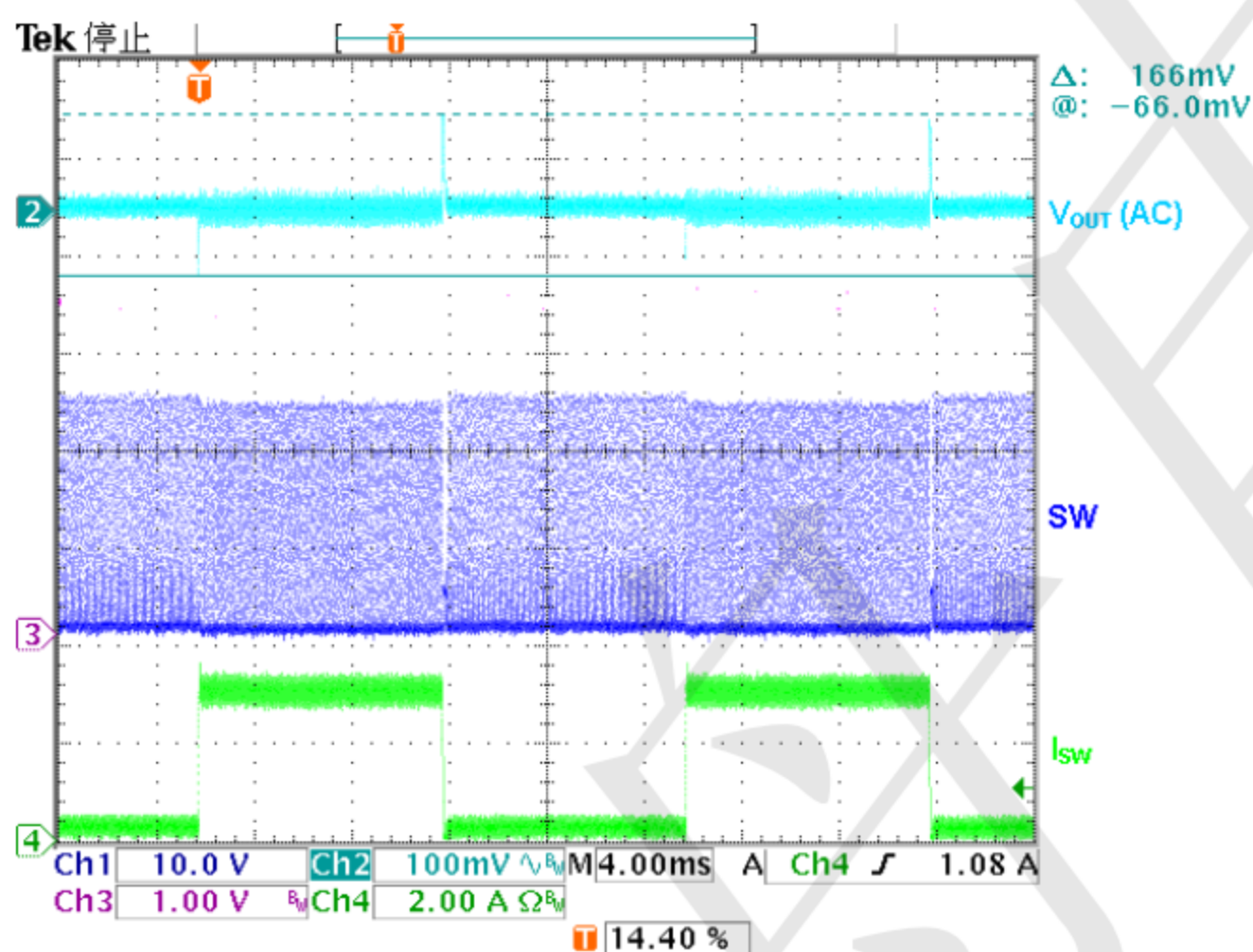
( $T_C = 25^\circ\text{C}$  unless otherwise noted)



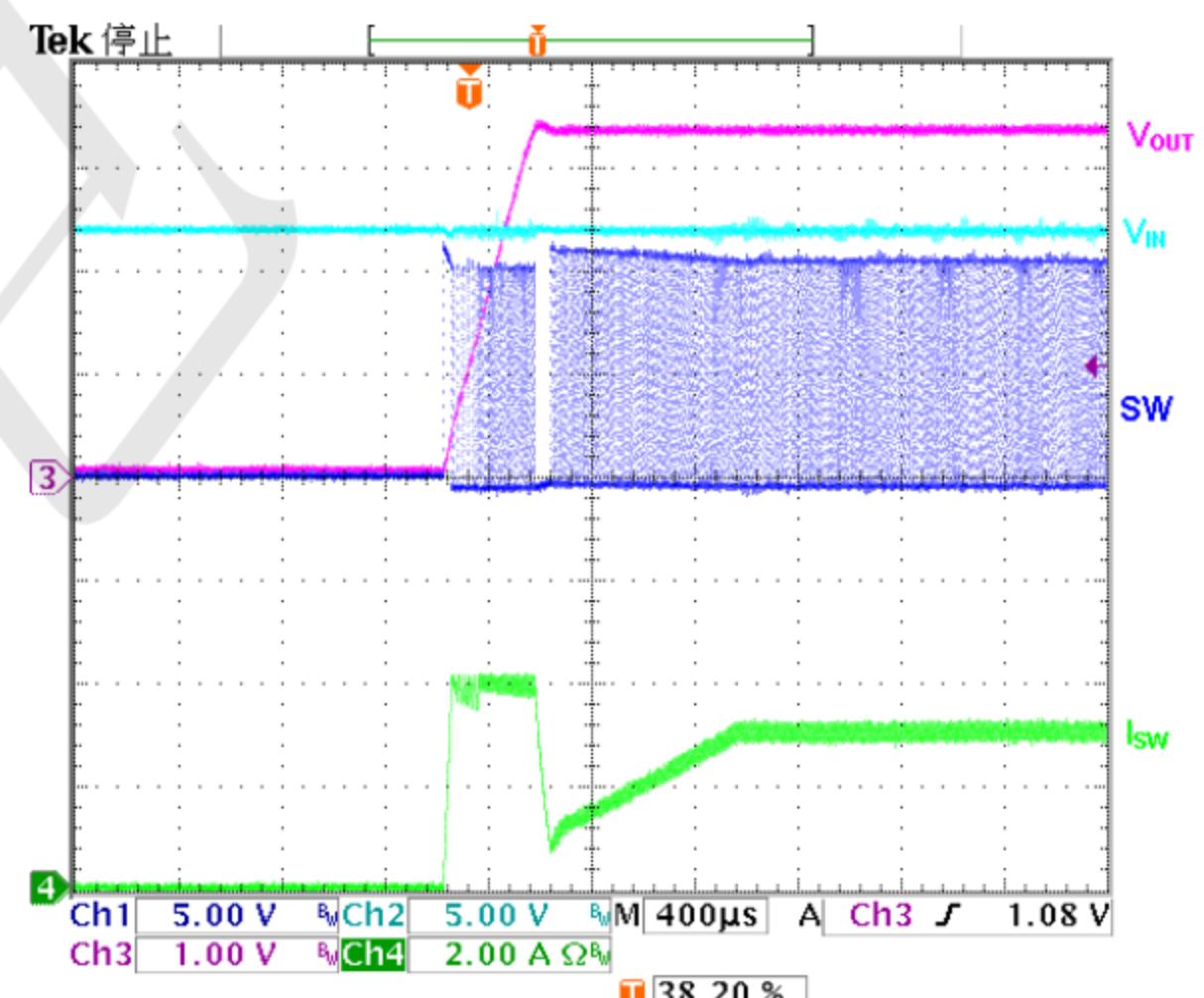
**Figure 1. Output Ripple**  
( $V_{IN}=12\text{V}$ ,  $V_{OUT}=5\text{V}$ ,  $I_O=3\text{A}$ )



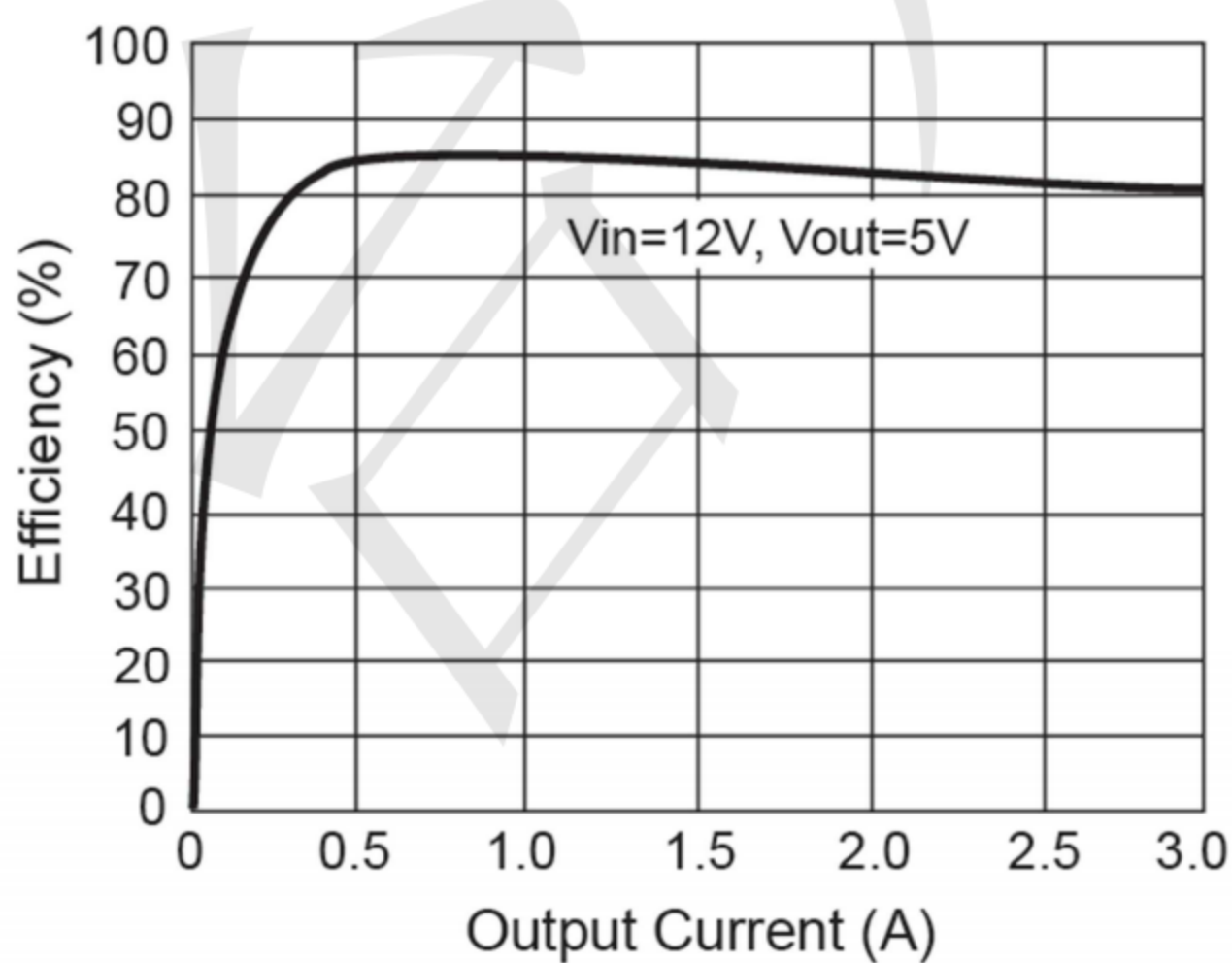
**Figure 2. Power On Test Wave**  
( $V_{IN}=12\text{V}$ ,  $V_{OUT}=5\text{V}$ ,  $I_O=3\text{A}$ )



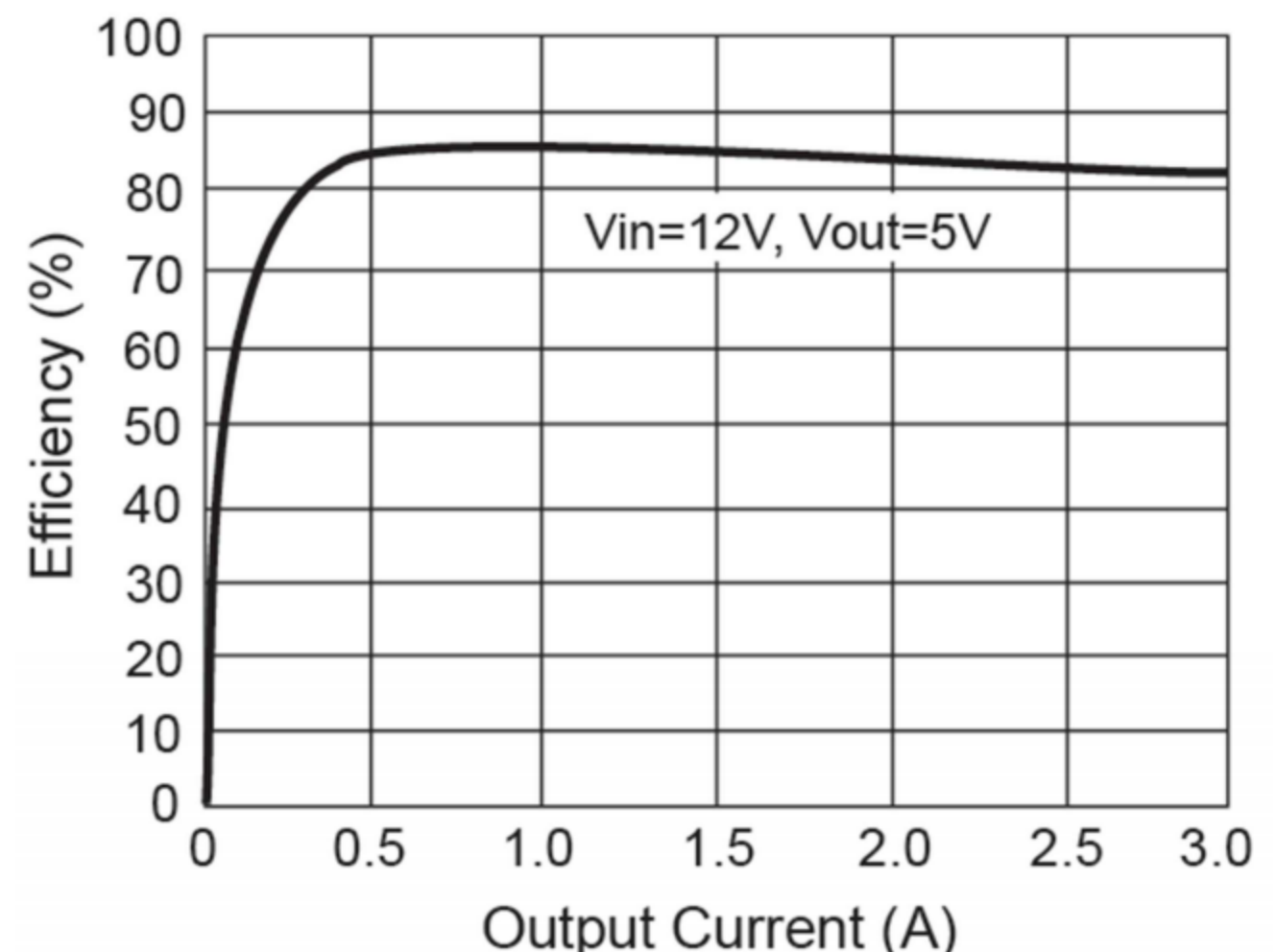
**Figure 3. Load Transient Response**  
( $V_{IN}=12\text{V}$ ,  $V_{OUT}=5\text{V}$ ,  $I_O=0.2\sim 3\text{A}$ )



**Figure 4. EN On Test Wave**  
( $V_{IN}=12\text{V}$ ,  $V_{OUT}=5\text{V}$ ,  $I_O=3\text{A}$ )



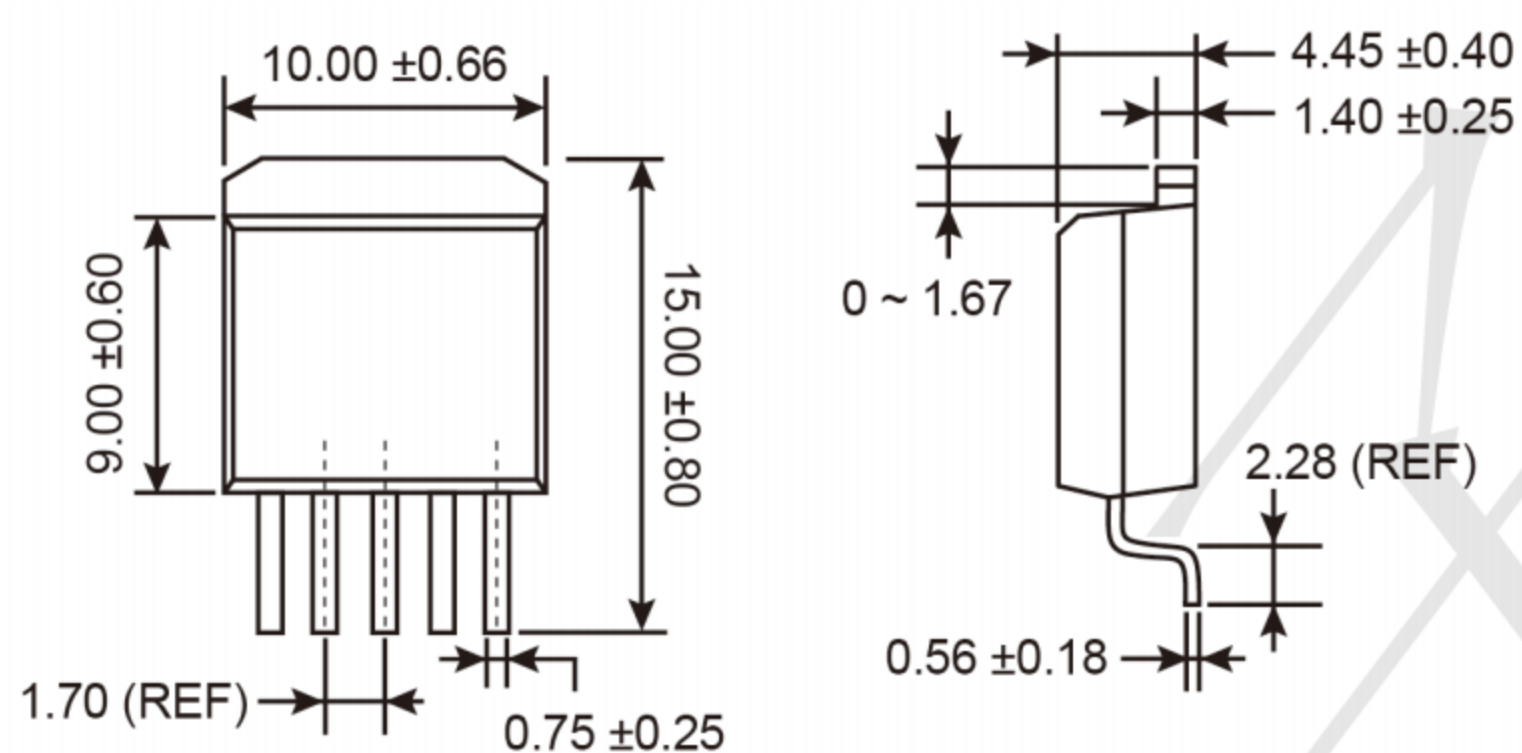
**Figure 5. Efficiency**



**Figure 6. Efficiency**

**PACKAGE OUTLINE DIMENSIONS** (Unit: Millimeters)

**TO-263-5L (D<sup>2</sup>PAK)**



**SUGGESTED PAD LAYOUT** (Unit: Millimeters)

