

## ULTRA-SMALL PACKAGE PWM/PFM SWITCHING CONTROL

### STEP-UP SWITCHING REGULATOR

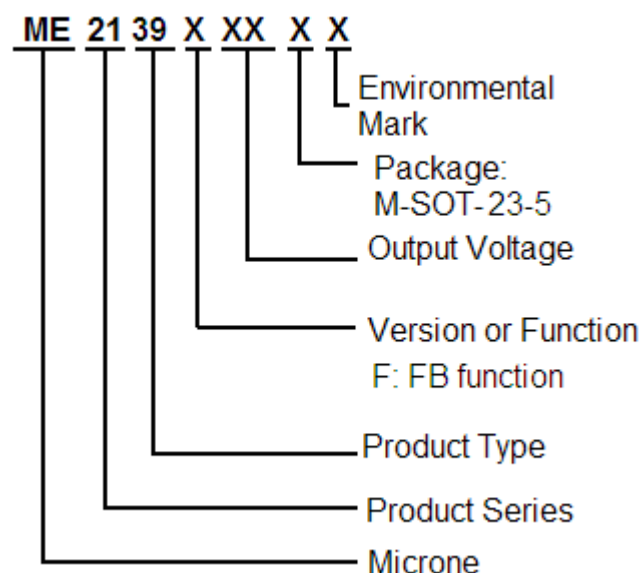
#### Description

The ME2139 series is a CMOS step-up switching regulator which mainly consists of a reference voltage source, an oscillation circuit, an error amplifier, a phase compensation circuit, a PWM/PFM switching control circuit. With an external low-ON-resistance Nch Power MOS, this product is applicable to applications requiring high efficiency and high output current. The ME2139 series switches its operation to the PFM control circuit whose duty ratio is 15 % with to the PWM/PFM switching control circuit under a light load and to prevent decline in the efficiency by IC operation current.

#### Feature

- Low voltage operation: Start-up is guaranteed from 0.9 V( $I_{OUT}=1\text{ mA}$ )
- Duty ratio: Built-in PWM/PFM switching control circuit 15 to 78 % .
- oscillator frequency: 1.0MHz
- External parts: coil, diode, capacitor, and transistor
- Output voltage range: 1.5V ~6.5 V
- Output voltage accuracy:  $\pm 2\%$
- Soft start function: 2 mS.
- PACKAGE: SOT23-5

#### Selection Guide

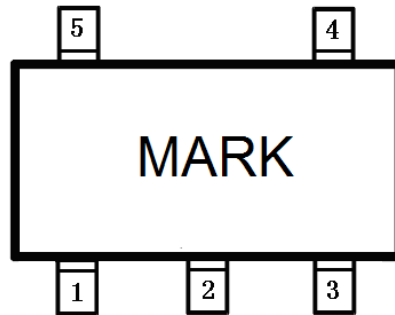


#### Typical Application

- MP3 players, digital audio players
- Digital cameras, GPS, wireless transceiver
- Portable devices

## Pin Configuration

| TYPE    | POSFIX | PACKAGE | SWICHING TRANSISTOR | CE FUNCTION | VDD FUNCTION | FB FUNCTION | FEATURE |
|---------|--------|---------|---------------------|-------------|--------------|-------------|---------|
| ME2139F | M5     | SOT23-5 | External Transistor | Yes         | Yes          | Yes         | Ext+FB  |



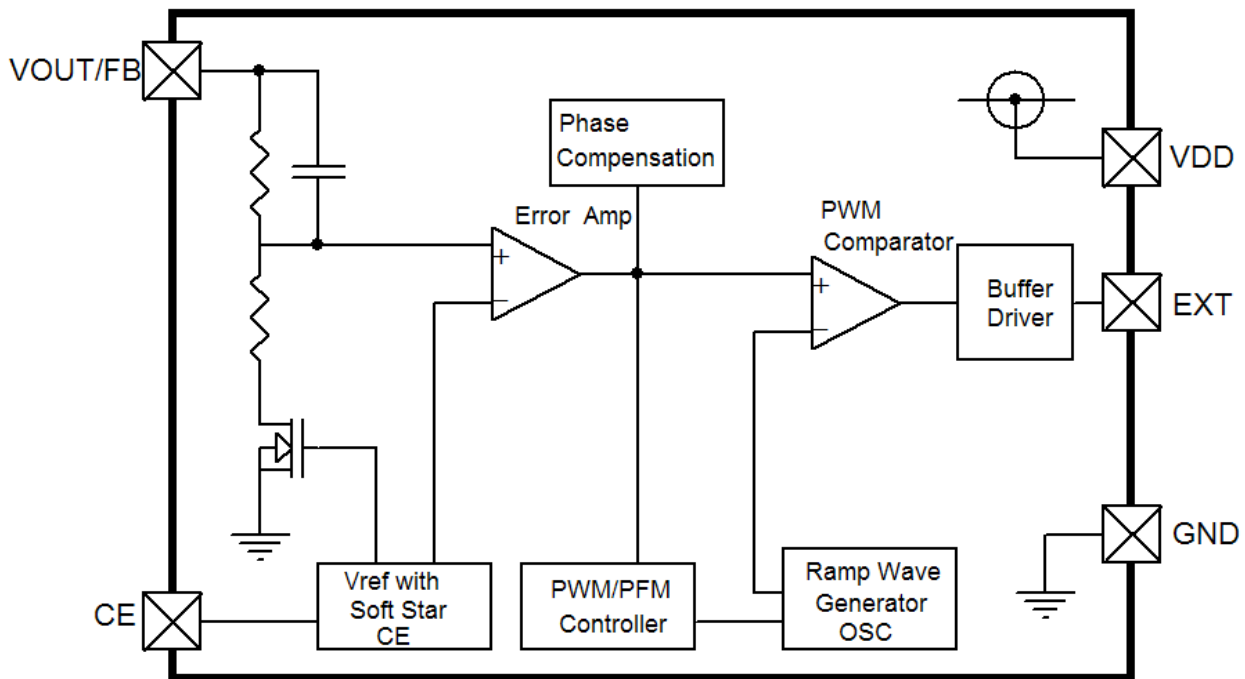
**SOT-23-5**

## Pin information

### ME2139F

| Pin Number | Pin Name | Function                           |
|------------|----------|------------------------------------|
| SOT23-5    |          |                                    |
| 1          | FB       | Feed Back voltage pin              |
| 2          | VDD      | IC power supply pin                |
| 3          | CE       | Shutdown pin                       |
| 4          | GND      | GND pin                            |
| 5          | EXT      | External transistor connection pin |

## Block Diagram



## Absolute Maximum Rang

| PARAMETER                   | SYMBOL           | RATING       | UNIT |
|-----------------------------|------------------|--------------|------|
| VDD Pin Voltage             | VDD              | -0.3~6.5     | V    |
| EXT Pin Voltage             | EXT              | -0.3~VDD+0.3 | V    |
| CE Pin Voltage              | V <sub>CE</sub>  | -0.3~Vin+0.3 | V    |
| EXT Pin Current             | I <sub>EXT</sub> | ±1000        | mA   |
| Power Dissipation (SOT23-5) | Pd               | 250          | mW   |
| Operating Temperature Range | T <sub>Opr</sub> | -25~+85      | °C   |
| Storage Temperature Range   | T <sub>stg</sub> | -40~+125     | °C   |

## Electrical Characteristics

### ME2139F

Measuring conditions:  $V_{DD}=V_{CE}=3.3V$ ,  $T_{opt}=25^{\circ}C$ . Unless otherwise specified.

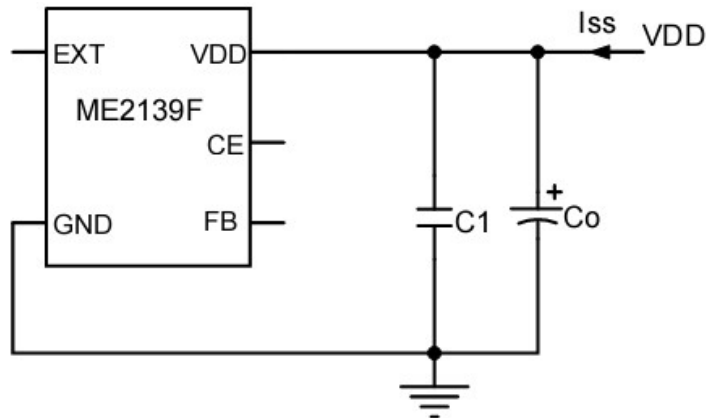
| Parameter                                 | SYMBOL            | CONDITION   |                        | MIN   | TYP  | MAX   | UNIT  | Circuit |
|---|-------------------|---|------------------------|-------|------|-------|-------|---------|
| Feedback voltage                          | V <sub>FB</sub>   | -   |                        | 1.225 | 1.25 | 1.275 | V     | 2       |
| Input voltage                             | V <sub>IN</sub>   | -   |                        |       | -    | 6     | V     | 2       |
| Operation start voltage                   | V <sub>ST1</sub>  | I <sub>OUT</sub> =1mA   |                        | -     | -    | 0.9   | V     | 2       |
| Oscillation start voltage                 | V <sub>ST2</sub>  | No external parts, voltage applied to V <sub>OUT</sub>              |                        | -     | -    | 0.7   | V     | 1       |
| Operation holding voltage                 | V <sub>HLD</sub>  | I <sub>OUT</sub> =1mA, Measured by decreasing VIN voltage gradually |                        | 0.7   | -    | -     | V     | 2       |
| Current consumption 1                     | I <sub>SS1</sub>  | V <sub>FB</sub> =V <sub>FB</sub> (S)× 0.95                          |                        | -     | 200  | -     | μA    | 1       |
| Current consumption 2                     | I <sub>SS2</sub>  | V <sub>FB</sub> =1.5V   |                        | -     | 15   | -     | μA    | 1       |
| Current consumption during shutdown       | I <sub>SSS</sub>  | V <sub>CE</sub> =0V   |                        | -     | 0.02 | 0.5   | μA    | 1       |
| EXT pin output current                    | I <sub>EXTH</sub> | V <sub>EXT</sub> =V <sub>OUT</sub> -0.4V                            |                        | -     | -25  | -     | mA    | 1       |
|   | I <sub>EXTL</sub> | V <sub>EXT</sub> =0.4V  |                        | -     | 40   | -     | mA    | 1       |
| Feed back voltage temperature coefficient |                   | Ta=-25-85℃  |                        | -     | ±50  | -     | ppm/℃ | 2       |
| Oscillation frequency                     | Fosc              | -   |                        | 0.8   | 1.0  | 1.2   | MHz   | 1       |
| Max. duty ratio                           | MAXDUTY           | V <sub>FB</sub> =V <sub>FB</sub> (S)× 0.95                          |                        | -     | 78   | -     | %     | 1       |
| PWM/PFM switching duty ratio              | PFMDUTY           | V <sub>FB</sub> =V <sub>FB</sub> (S)× 1.5, no load                  |                        | -     | 15   | -     | %     | 1       |
| Shutdown pin input voltage                | V <sub>SH</sub>   | Measured the oscillation at EXT pin                                 |                        | 0.75  | -    | -     | V     | 1       |
|   | V <sub>SL1</sub>  | Judged the stop of oscillation at EXT pin                           | V <sub>OUT</sub> ≥1.5V | -     | -    | 0.3   | V     | 1       |
|   | V <sub>SL2</sub>  |   | V <sub>OUT</sub> <1.5V | -     | -    | 0.2   | V     | 1       |
| Shutdown pin input voltage                | I <sub>SH</sub>   | V <sub>CE</sub> =V <sub>FB</sub> (S)×0.95                           |                        | -0.1  | -    | 0.1   | μA    | 1       |
|   | I <sub>SL</sub>   | V <sub>CE</sub> =0V   |                        | -0.1  | -    | 0.1   | μA    | 1       |
| Soft start time                           | tss               | -   |                        | -     | 2    | -     | mS    | 2       |
| Efficiency                                | EFFI              | -   |                        | -     | 90   | -     | %     | 2       |

Note:

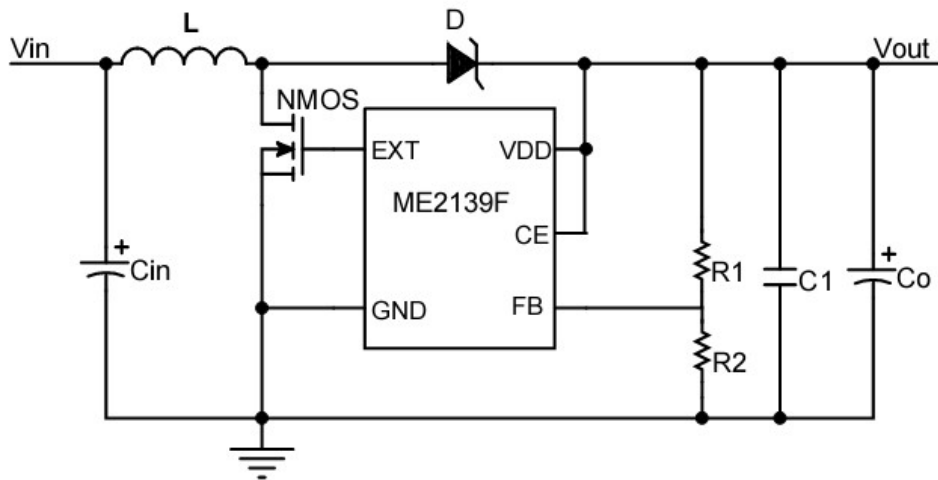
1.  $V_{OUT}(S)$  is the set output voltage value, and  $V_{OUT}$  is the typical value of the output voltage.
2.  $V_{OUT}(S)$  can be set by using the rate of  $V_{FB}$  and output voltage setting resistors ( $R1$ ,  $R2$ ).
3.  $V_{FB}(S)$  is the set output voltage value.
4.  $VDD/V_{OUT}$  separate type:  
 $1.8V \leq VDD < 6V$  is recommended to stabilize the output voltage and oscillation frequency.

## Test Circuit

1.



2.



## External parts (suggest)

- 1、Diode use Schottky diode such as IN5817 or IN5819 (forward voltage drop:0.2V)
- 2、Inductor:  $3.3\mu H$  ( $r < 30m\Omega$ )
- 3、Capacitor: ceramic capacitor  $22\mu F$  (It is best to use two parallel connection ceramic capacitors)
- 4、Feed back resistors:  $R1+R2 < 50K\Omega$

## External parts selection for DC/DC converter

The relationship between major characteristics of the step-up circuit and characteristics parameters of the external parts are shown in Figure 1.

| <u>For larger output current?</u>         | <u>For high efficiency?</u>                            |                          | <u>For smaller ripple voltage?</u> |
|---|--|--------------------------|------------------------------------|
|   | Operation efficiency                                   | Stand-by efficiency      |                                    |
| Smaller inductance                        | Larger inductance                                      |                          |                                    |
| Smaller DC resistance of inductor         |  |                          |                                    |
| Large output capacitance                  |  | Large output capacitance |                                    |
| With MOSFET, smaller ON resistance        | With MOSFET, smaller input capacitance                 |                          |                                    |
| With bipolar transistor, smaller external | With bipolar transistor, larger external resistance Rb |                          |                                    |

Figure 1 Relationship between major characteristics of the step-up circuit and external parts

### 1. Inductor

An inductance has strong influence on maximum output current  $I_{OUT}$  and efficiency  $\eta$ .

Figure 2 shows the relation between  $I_{OUT}$ , and  $\eta$  characteristics to L of ME2139F.

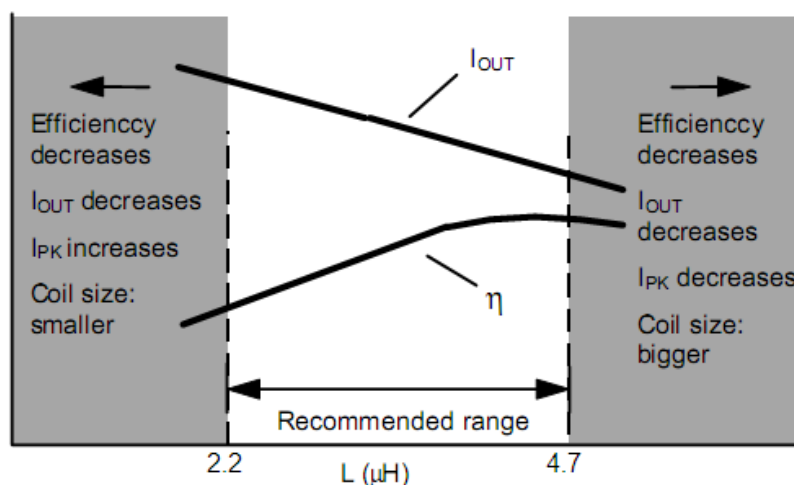


Figure 2  $L-I_{OUT}$  and  $\eta$  characteristics

The peak current ( $I_{PK}$ ) increases by decreasing  $L$  and the stability of a circuit improves and  $I_{OUT}$  increases. If  $L$  is furthermore made small, efficiency falls and in running short,  $I_{OUT}$  decreases. ( Based on the current drive capability

of external switching transistor.)

The loss of  $I_{PK}$  by the switching transistor decreases by increasing  $L$  and the efficiency becomes maximum at a certain  $L$  value. Further increasing  $L$  decreases efficiency due to the loss of DC resistance of the coil. Also,  $I_{OUT}$  decreases, too.

Oscillation frequency is higher, smaller one can be chose and also makes coil smaller. The recommended inductances are 2.2 to 4.7  $\mu\text{H}$  inductor for ME2139F.

Choose a value for  $L$  by referring to the reference data because the maximum output current is due to the input voltage in an actual case. Choose an inductor so that  $I_{PK}$  does not exceed the allowable current. Exceeding the allowable current of the inductor causes magnetic saturation, remarkable low efficiency and destruction of the IC chip due to a large current.

$I_{PK}$  in uncontinuous mode is calculated from the following equation:

$$I_{PK} = \sqrt{\frac{2I_{OUT}(V_{OUT} + V_D - V_{IN})}{f_{OSC} \cdot L}} (A)$$

$f_{OSC}$  = oscillation frequency,  $V_{DD} = 0.4 \text{ V}$ .

## 2. Diode

Use an external diode that meets the following requirements:

- Low forward voltage: ( $V_F < 0.3 \text{ V}$ )
- High switching speed: (50 ns max.)
- Reverse voltage:  $V_{OUT} + V_F$  or more
- Rated current:  $I_{PK}$  or more

## 3. Capacitor ( $C_{IN}$ , $C_O$ )

To improve efficiency, an input capacitor ( $C_{IN}$ ) lowers the power supply impedance and averages the input current. Select  $C_{IN}$  according to the impedance of the power supply used. The recommended capacitance is 10 $\mu\text{F}$  for the ME2139F.

An output capacitor ( $C_{OUT}$ ), which is used to smooth the output voltage, requires a capacitance larger than that of the step-down type because the current is intermittently supplied from the input to the output side in the step-up type. A 22 $\mu\text{F}$  ceramic capacitor is recommended for the ME2139F. However, a higher capacitance is recommended if the output voltage is high or the load current is large. If the output voltage or load current is low, about 10 $\mu\text{F}$  can be used without problems.

Select  $C_{OUT}$  after sufficient evaluation with actual application.

A ceramic capacitor can be used for both the input and output.

#### 4. Enhancement MOS FET type

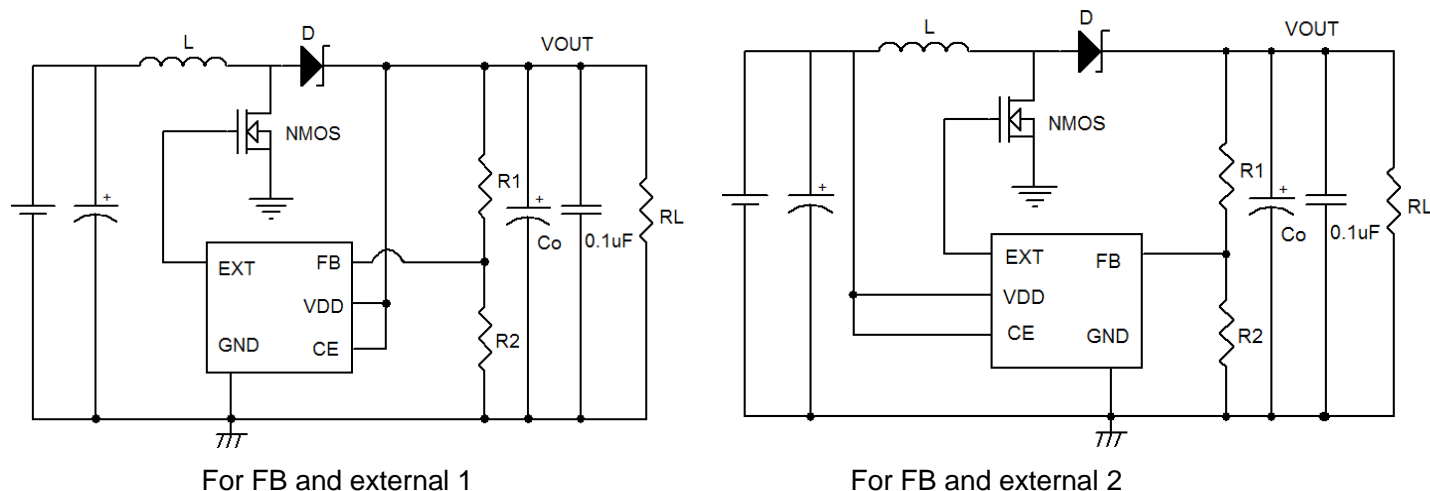
For a MOS FET, an N-channel power MOS FET should be used. Because the gate voltage and current of the external power MOS FET are supplied from the stepped up output voltage  $V_{OUT}$ , the MOS FET is driven more effectively. Depending on the MOS FET you use in your device, there is a chance of a current overrun at power ON. Thoroughly test all settings with your device before deciding on which one to use. Also, try to use a MOS FET with the input capacitance of 700 pF or less.

Since the ON resistor of the MOS FET might depend on the difference between the output voltage  $V_{OUT}$  and the threshold voltage of MOS FET, and affect the output current as well as the efficiency, the threshold voltage should be low. When the output voltage is low, the circuit operates only when the MOS FET has the threshold voltage lower than the output voltage.

## 5. Precautions

- Mount external capacitors, a diode, and a coil as close as possible to the IC.
- Unique ripple voltage and spike noise occur in switching regulators. Because they largely depend on the coil and the capacitor used, check them using an actually mounted model.
- Make sure dissipation of the switching transistor (especially at a high temperature) does not exceed the allowable power dissipation of the package.
- The performance of this IC varies depending on the design of the PCB patterns, peripheral circuits and external parts. Thoroughly test all settings with your device. Also, try to use recommended external parts.

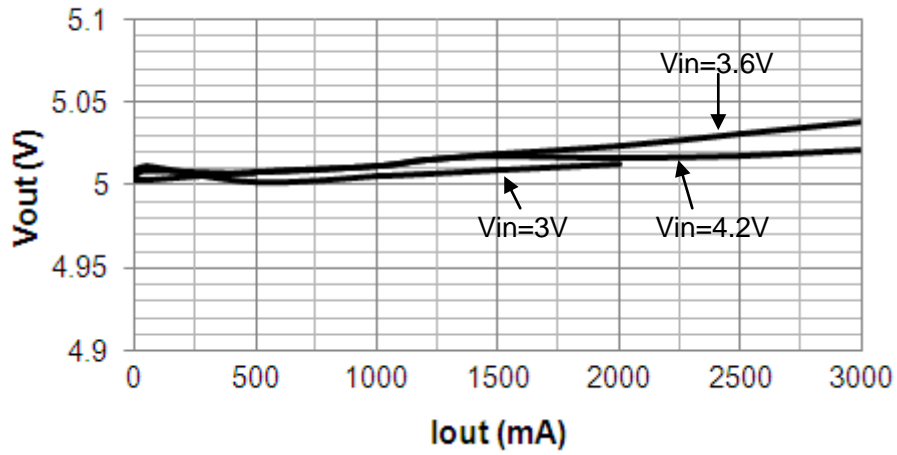
## Typical Application Circuit



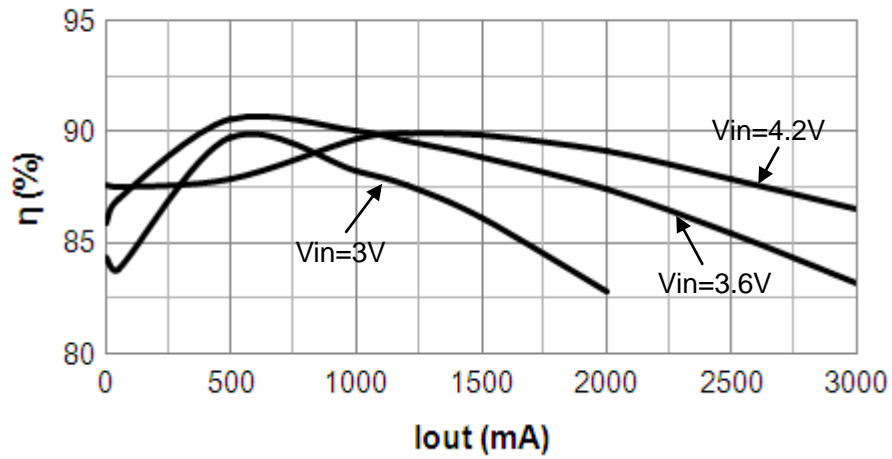


## Typical Performance Characteristics

**Output Voltage vs. Output Current**

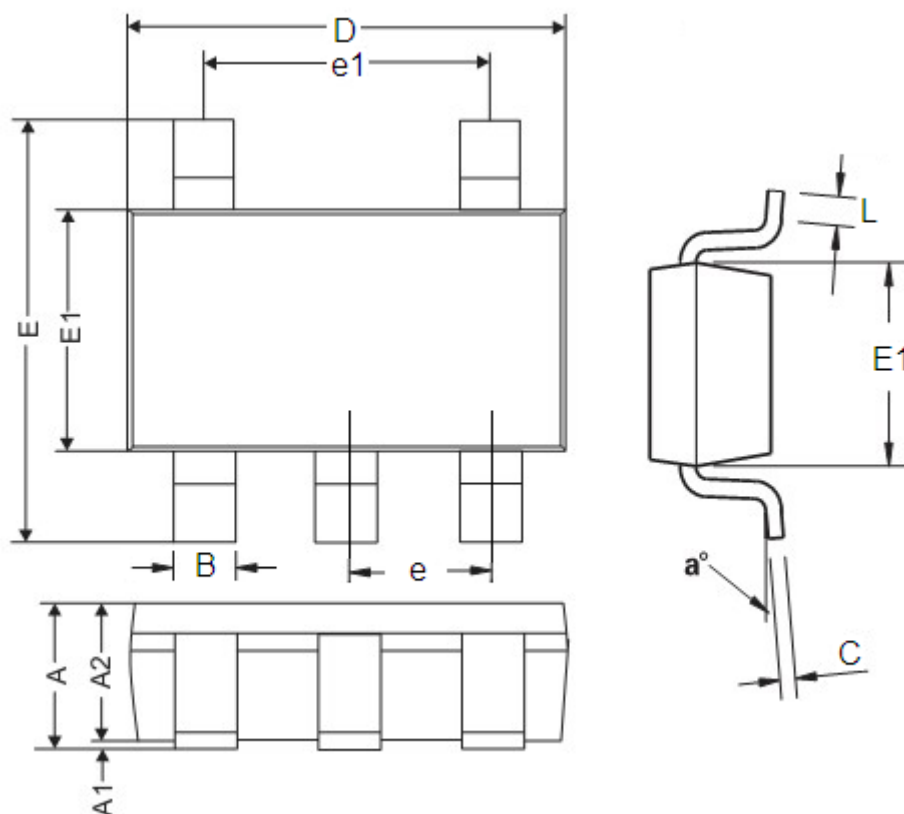


**Efficiency vs. Output Current**



## Package Dimension

Package type:SOT23-5 Unit:mm(inch)



| DIM | Millimeters |      | Inches    |        |
|-----|-------------|------|-----------|--------|
|     | Min         | Max  | Min       | Max    |
| A   | 0.9         | 1.45 | 0.0354    | 0.0570 |
| A1  | 0           | 0.15 | 0         | 0.0059 |
| A2  | 0.9         | 1.3  | 0.0354    | 0.0511 |
| B   | 0.2         | 0.5  | 0.0078    | 0.0196 |
| C   | 0.09        | 0.26 | 0.0035    | 0.0102 |
| D   | 2.7         | 3.10 | 0.1062    | 0.1220 |
| E   | 2.2         | 3.2  | 0.0866    | 0.1181 |
| E1  | 1.30        | 1.80 | 0.0511    | 0.0708 |
| e   | 0.95REF     |      | 0.0374REF |        |
| e1  | 1.90REF     |      | 0.0748REF |        |
| L   | 0.10        | 0.60 | 0.0039    | 0.0236 |
| a°  | 0°          | 30°  | 0°        | 30°    |

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