



## High Efficiency 2A, 1.0MHZ Synchronous Step-Up DC/DC Converter

### General Description

The ME2185 is synchronous, 2A, 1.0MHZ step-up DC-DC Converter, which mainly consists of a reference voltage source, an oscillation circuit, an error amplifier, a phase compensation circuit, a PWM / PFM switching control circuit and an adjustable output current limit circuit. With an internal low-ON-resistance N-ch Power MOS and P-ch Power MOS. This product is ideal for applications requiring high efficiency and a high output current.

### Features

- High efficiency.( up to 94%)
- Up to 92.5% Efficiency at  $I_{OUT}=2A$   $V_{OUT} = 5V$  from 3.3V Input.
- Guaranteed 2.5A Output Current at  $V_{OUT} = 5V$  from 3.3V Input
- Synchronous and internal P-ch Power MOSFET and N-ch power MOSFET, No Schottky Diode Required
- Oscillator frequency: 1.0MHz
- Reference voltage : 1.25V ( $\pm 2\%$ )
- Input voltage range: 2.9 V to 4.4 V
- Continuous output current: 2.0A typ.  
( $V_{IN}=3V$ ,  $V_{OUT}=5.0V$ )
- Soft start function
- Shutdown function:1.0  $\mu A$  max.
- UVLO (under-voltage lockout) function
- Current Limit: adjustable by the Rcs using different valve
- Thermal Shutdown Protection:156°C

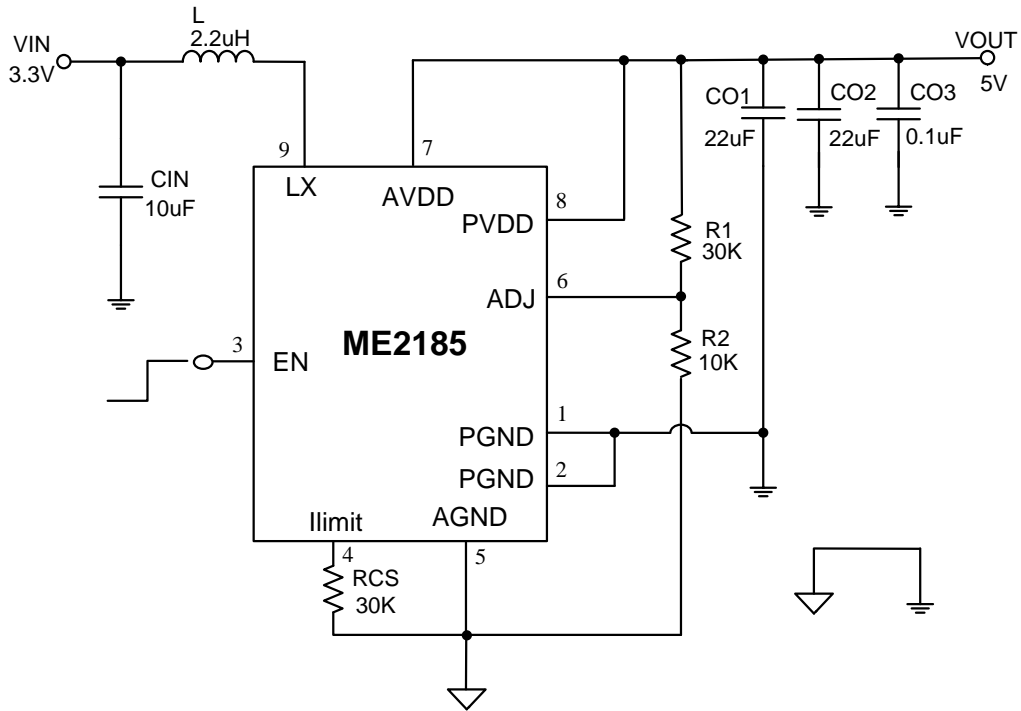
### Typical Application

- Portable charger, mobile power.
- Digital cameras, GPS, wireless transceiver
- Ipad-like computers, smart phones and portable handheld devices

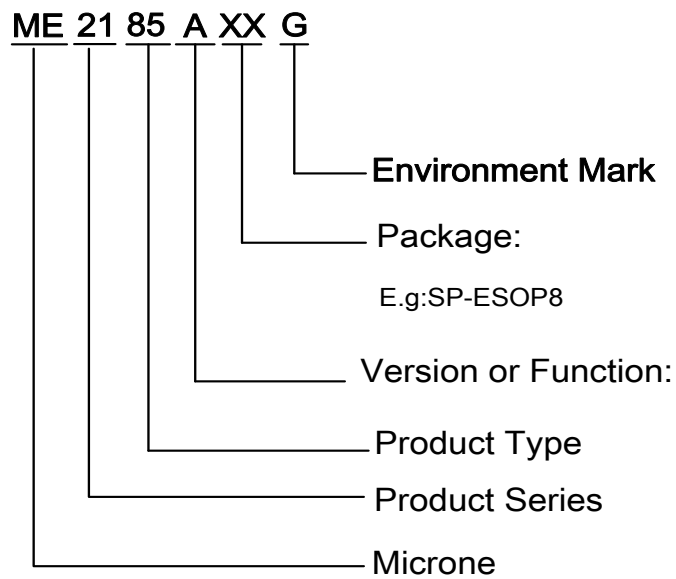
### Package

- 8-pin ESOP8

## Typical Application Circuit



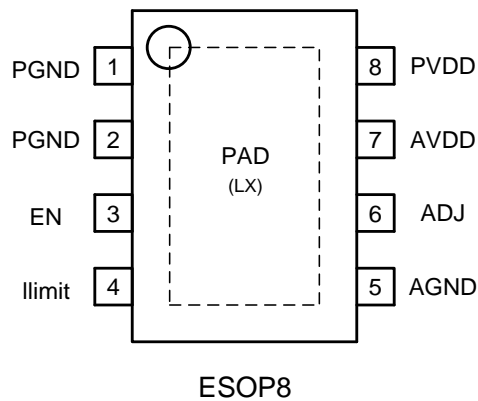
## Selection Guide



| product series | product description                |
|----------------|------------------------------------|
| M2185ASPG      | $V_{ADJ} = 1.25V$ ; Package: ESOP8 |

**NOTE:** If you need other voltage and package, please contact our sales staff.

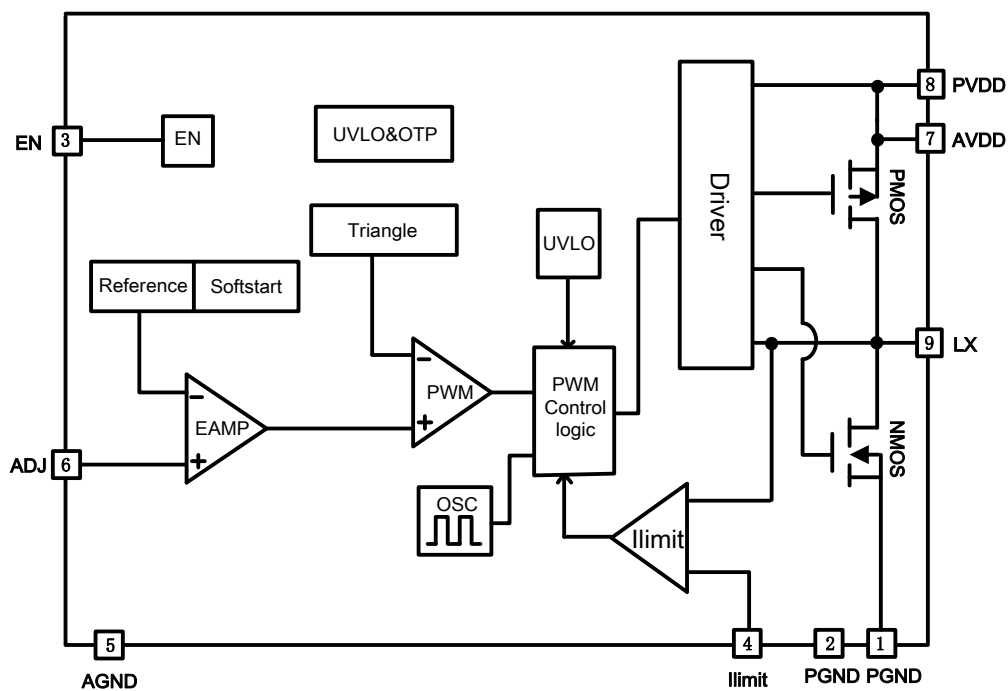
## Pin Configuration & Pin Assignment



## Pin Assignment

| Pin Number | Pin Name | Function   |
|------------|----------|--|
| 1          | PGND     | Power Ground   |
| 2          | PGND     | Power Ground   |
| 3          | EN       | Power-enable<br>“H” : Power-on (normal operation)<br>“L” : Power-off (standby) |
| 4          | Ilimit   | Current limit External transistor  |
| 5          | AGND     | Analog Ground  |
| 6          | ADJ      | Feed Back voltage pin  |
| 7          | AVDD     | IC Analog power supply pin   |
| 8          | PVDD     | IC power supply pin  |
| 9          | LX       | Power switching pin  |

## Block Diagram



## Absolute Maximum Ratings

| Parameter                   | Symbol           | Rating       | Unit |
|-----------------------------|------------------|--------------|------|
| VDD Pin Voltage             | AVDD,PVDD        | -0.3~6.0     | V    |
| LX Pin Voltage              | V <sub>LX</sub>  | -0.3~VDD+0.3 | V    |
| ADJ Pin Voltage             | V <sub>ADJ</sub> | -0.3~VDD+0.3 | V    |
| EN Pin Voltage              | V <sub>EN</sub>  | -0.3~VDD+0.3 | V    |
| Power Dissipation (ESOP8)   | Pd               | 2000         | mW   |
| Operating Temperature Range | T <sub>Opr</sub> | -40~+85      | °C   |
| Storage Temperature Range   | T <sub>stg</sub> | -40~+125     | °C   |

## External Parts List When Measuring Electrical Characteristics

| Element Name     | Symbol   | Value   | Unit |
|------------------|----------|---------|------|
| Inductor         | L        | ≤2.2    | uH   |
| Input capacitor  | CIN      | 10      | uF   |
| Output capacitor | Co1, Co2 | 22      | uF   |
| Output capacitor | Co3      | 0.1     | uF   |
| ADJ Resistance   | R1,R2    | 30K,10K | Ω    |

## Electrical Characteristics

Measuring conditions: V<sub>IN</sub>=V<sub>EN</sub>= 3.3V, V<sub>OUT</sub>=5.0V, Ta=25°C。 Unless otherwise specified。

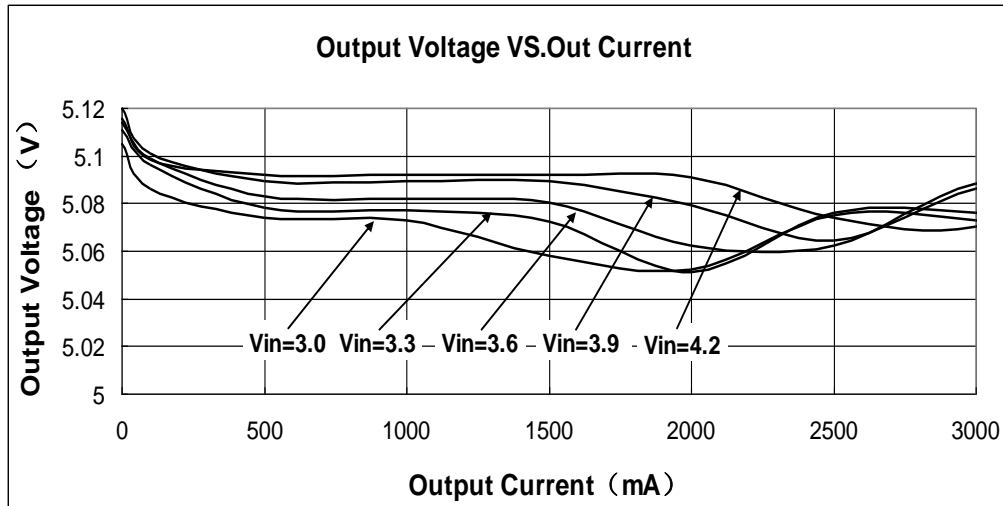
| Parameter                           | Symbol               | Condition   | Min   | Typ. | Max   | Unit |
|-------------------------------------|----------------------|---|-------|------|-------|------|
| Feedback voltage                    | V <sub>ADJ</sub>     | -   | 1.225 | 1.25 | 1.275 | V    |
| Input voltage                       | V <sub>IN</sub>      | -   | 2.9   | -    | 4.4   | V    |
| Current consumption 1               | I <sub>SS1</sub>     | At switching operation, no external components ,AVDD=PVDD=V <sub>EN</sub> =3.3V, V <sub>ADJ</sub> =V <sub>ADJ</sub> (S)×0.95, | -     | 4    | 6     | mA   |
| Current consumption 2               | I <sub>SS2</sub>     | At switching stop, no external components, AVDD=PVDD=V <sub>EN</sub> =3.3V V <sub>ADJ</sub> =V <sub>ADJ</sub> (S)+ 0.5V,      | -     | 150  | 300   | μA   |
| Current consumption during shutdown | I <sub>SSS</sub>     | AVDD=PVDD= 3.3V, V <sub>EN</sub> =0V, no external components  | -     | -    | 1.0   | μA   |
| Oscillation frequency               | Fosc                 | -   | 0.8   | 1.0  | 1.2   | MHz  |
| Max. duty ratio                     | MAXDUTY              | V <sub>IN</sub> =V <sub>EN</sub> = 0.9V, no load  |       | 81   |       | %    |
| PWM/PFM switching duty ratio        | PFMDUTY              | V <sub>IN</sub> =V <sub>EN</sub> = 3.3V,no load   |       | 18   |       | %    |
| High level input voltage            | V <sub>SH</sub>      | V <sub>IN</sub> = 2.9 V to4.4V, EN pin  | 0.9   | -    | -     | V    |
| Low level input voltage             | V <sub>SL</sub>      | V <sub>IN</sub> = 2.9 V to 4.4 V, EN pin  | -     | -    | 0.2   | V    |
| ADJ pin input current               | I <sub>ADJ</sub>     | AVDD= PVDD= V <sub>EN</sub> =2.9 V to4.4V, ADJ pin  | -0.1  | 0    | 0.1   | μA   |
| UVLO release voltage                | V <sub>UVLO+</sub>   |   |       |      | 2.4   | V    |
| UVLO hysteresis width               | V <sub>UVLOHYS</sub> |   |       | 0.4  |       | V    |
| Soft start time                     | t <sub>SS</sub>      | -   |       | 3    |       | mS   |

|                             |     |  |  |     |  |    |
|-----------------------------|-----|--|--|-----|--|----|
| Thermal Shutdown Protection | Tsd |  |  | 156 |  | °C |
|-----------------------------|-----|--|--|-----|--|----|

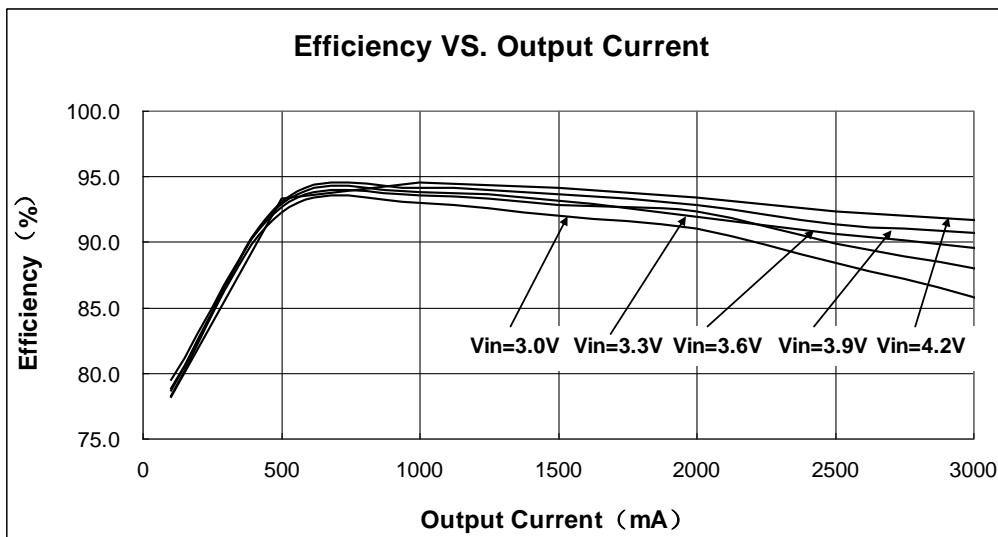
- Note:**
- $V_{ADJ(S)}$  is a setting value for ADJ voltage.
  - $V_{OUT(S)}$  is a setting value for output voltage.  $V_{OUT}$  is the typical value of actual output voltage.  $V_{OUT(S)}$  can be set by using the rate of  $V_{ADJ}$  and output voltage setting resistors ( $R1, R2$ ).

## Typical Characteristics

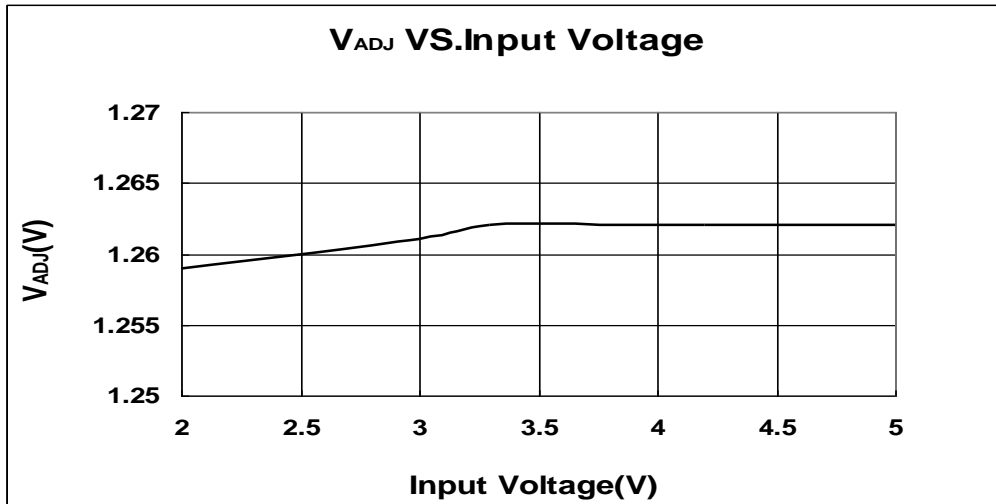
### 1、Output Voltage VS. Output Current ( $V_{OUT}=5.0V$ )



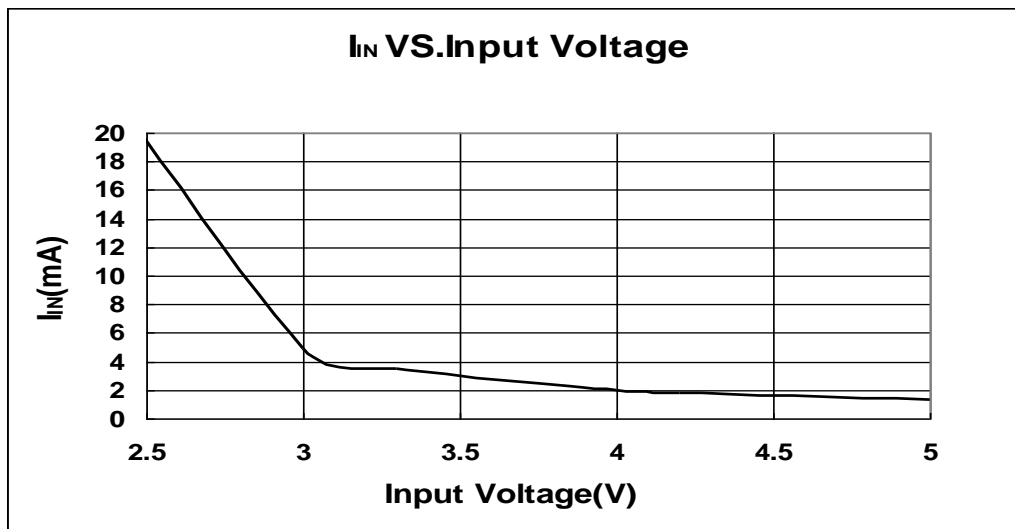
### 2、Efficiency VS. Output Current ( $V_{OUT}=5.0V$ )



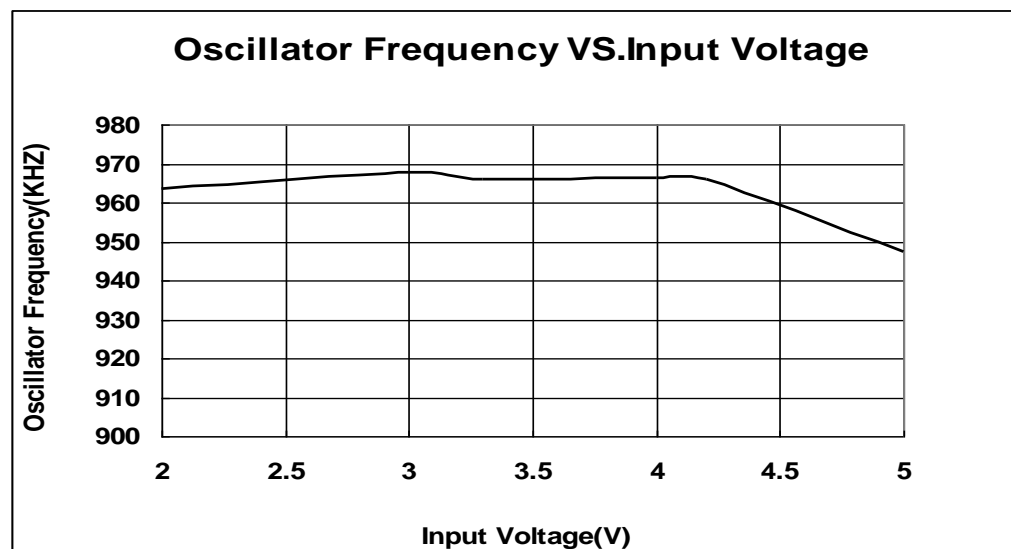
3、 $V_{ADJ}$  VS. Input Voltage ( $I_{OUT}=10mA$ )



4、 $I_{IN}$  VS. Input Voltage (system testing, No load)



5、Oscillator Frequency VS. Input Voltage ( $V_{in}=3.3V, I_{OUT}=500mA$ )



## Application information

### PWM / PFM switching control

The ME2185 switching regulator controller automatically switches between the pulse width modulation method (PWM) and pulse frequency modulation method (PFM) according to the load current. A low ripple power can be supplied by operating on PWM control for which the pulse width changes from 15% to 85% in the range where the output load current is large. The ME2185 operates on PFM control when the output load current is small and the fixed pulses which have the width of 15% are skipped according to the load current amount. Therefore, the oscillation circuit intermittently oscillates, reducing the self-current consumption. This avoids decreased efficiency when the output load current is small. The point at which PWM control switches to PFM control varies depending on the external element (inductor, diode, etc.), input voltage value, and output voltage value.

### Soft-start function

The ME2185 has a soft-start circuit. The output voltage ( $V_{OUT}$ ) gradually rises after power-on or startup when the EN pin is set to high, suppressing rush current and overshooting the output voltage. The soft-start time (tss) for the ME2185 is defined as the time from startup until  $V_{OUT}$  reaches 90% of the output set voltage value ( $V_{OUT(S)}$ ). A reference voltage adjustment method is used as the soft-start method and the reference voltage gradually rises from 0 V after soft-start.

### UVLO function

The ME2185 has a UVLO (under voltage lockout) circuit for avoiding IC malfunctions due to power supply voltage drops. The ME2185 stops switching operation upon UVLO detection and retains the external transistor in the off state. After entering the UVLO detection status once, the soft-start function is reset.

Note, however, that the other internal circuits operate normally and that the status differs from the power-off status.

## CURRENT LIMIT DESIGNING

The ME2185 has a cycle-by-cycle current limit to maximum inductor peak current ( $I_{PK}$ ), adjust inductor peak current limit ( $I_{pklimit}$ ) by the  $R_{CS}$  with calculating the value for  $R_{CS}$  as

$$R_{CS} \approx \frac{5}{I_{pklimit} \times R_{DSON}} \times 1000$$

The  $R_{DSON}$  is the ON-resistance of Nch Power MOS and the value of  $R_{DSON}$  is about 40m $\Omega$  in this product.. When an over current condition is detected, the device reduces the output voltage accordingly.

When Output Current ( $I_{OUT}$ ) increases The inductor peak current ( $I_{pk}$ ) increases, as The inductor peak current up to  $I_{pklimit}$ , the Output Current is the  $I_{OLIMIT}$

$L=2.2\mu H$ ,  $Co1, Co2=22\mu F$ ,  $V_{OUT}=5V$

Table 1. Common  $R_{CS}$  Resistor Selections

| VIN=3.3V |               |
|----------|---------------|
| $R_{CS}$ | $I_{pklimit}$ |
| 60K      | 2.15A         |
| 30K      | 4.30A         |
| 25K      | 5.16A         |
| 20K      | 6.45A         |

NOTE: When selecting an  $R_{CS}$ , be careful about the influence of temperature at the  $R_{DS(ON)}$  and other devices, select an  $R_{CS}$  inductor such that that  $I_{pklimit}$  does not exceed the allowable current

## External parts selection for DC/DC converter

### ● Inductor

The recommended L value of ME2185 is 2.2 $\mu$ H or less for 1.0 MHz products. Note the following when changing the inductance. The inductance (L) has a strong influence on the maximum output current ( $I_{OUT}$ ) and efficiency ( $\eta$ ). The inductor peak current ( $I_{pk}$ ) increases when L is decreased, which improves the circuit stability and increases the  $I_{OUT}$  users can obtain. If L is decreased further, the ability of the external transistor to drive the current becomes insufficient, reducing the efficiency and decreasing  $I_{OUT}$ .

The loss due to the  $I_{pk}$  of the switching transistor is decreased by increasing L and the efficiency maximizes at a certain L value. If L is increased further, the loss due to the serial resistance of the inductor increases, lowering the efficiency.

Caution: When selecting an inductor, be careful about its allowable current. If a current exceeding the allowable current flows through the inductor, magnetic saturation occurs, substantially lowering the efficiency and destroying ICs due to large current. Therefore, select an inductor such that  $I_{pk}$  does not exceed the allowable current.

### 2. Capacitor ( $C_{IN}$ , $C_{O1}$ , $C_{O2}$ )

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 $\mu$ F for ME2185. An output capacitor ( $C_{O}$ ), 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 $\mu$ F ceramic capacitor is recommended for ME2185. 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, another 22 $\mu$ F can be used without problems.

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



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

### 3. Output voltage setting resistors (R1 , R2 )

For ME2185, VOUT can be set to any value by using external divider resistors. Connect the divider resistors between the VOUT and VSS pins. Because VADJ = 1.25 V typ., VOUT can be calculated by using the following equation :

$$V_{OUT} = \left( \frac{R1 + R2}{R2} \right) \times 1.25 \text{ (V)}$$

Connect divider resistors R1 and R2 as close to the IC as possible to minimize the effects of noise.

The typical constants based on our evaluation are shown in the next Table:

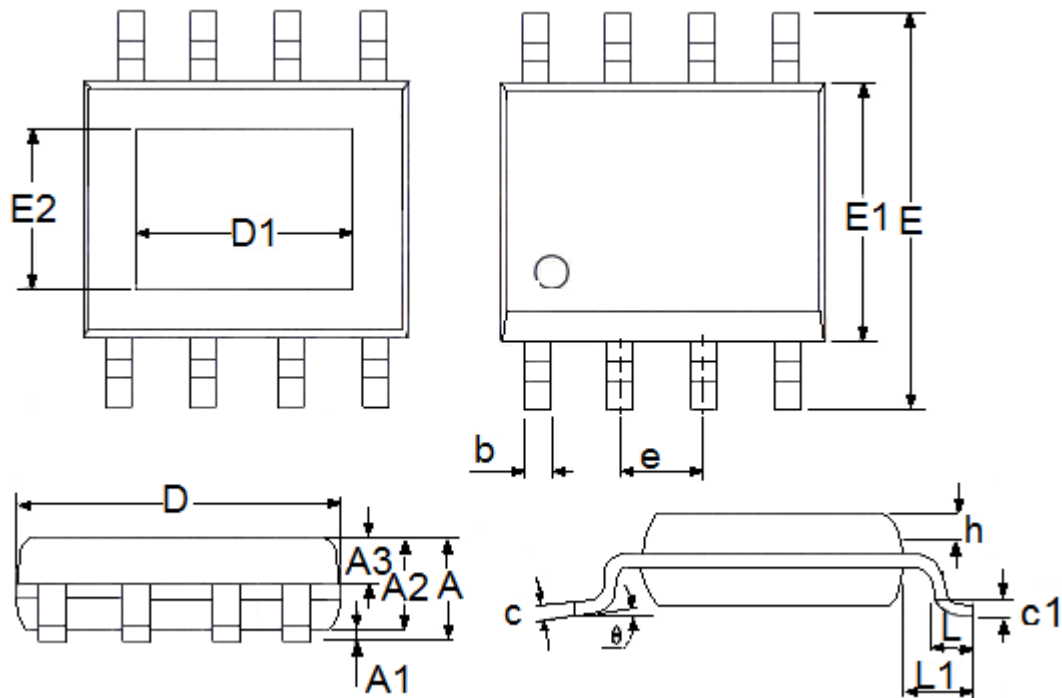
| V <sub>OUT(S)</sub> (V) | V <sub>IN</sub> (V) | R1 (KΩ) | R2 (KΩ) | L (μH) | Co1,Co2 (μF) |
|-------------------------|---------------------|---------|---------|--------|--------------|
| 3.3                     | 2.4                 | 16.4    | 10      | 2.2    | 22           |
| 5                       | 3.3                 | 30      | 10      | 2.2    | 22           |

### 4. Precautions

- Mount external capacitors, a diode, and a coil as close as possible to the IC.
- Characteristics ripple voltage and spike noise occur in IC containing switching regulators. Moreover rush current flows at the time of a power supply injection. Because these largely depend on the inductor, the capacitor and impedance of power supply used, fully check them using an actually mounted model.
- The 0.1 μF capacitor connected between the VIN and GND pins is a bypass capacitor. It stabilizes the power supply in the IC when application is used with a heavy load, and thus effectively works for stable switching regulator operation. **Allocate the bypass capacitor as close to the IC as possible, prioritized over other parts.**
- Although the IC contains a static electricity protection circuit, static electricity or voltage that exceeds the limit of the protection circuit should not be applied.
- The power dissipation of the IC greatly varies depending on the size and material of the board to be connected. Perform sufficient evaluation using an actual application before designing.

## Packaging Information

- Packaging Type: ESOP8



| DIM        | Millimeters |      | Inches      |        |
|------------|-------------|------|-------------|--------|
|            | Min         | Max  | Min         | Max    |
| A          | 1.3         | 1.75 | 0.0512      | 0.0689 |
| A1         | 0           | 0.2  | 0.0000      | 0.0079 |
| A2         | 1.25        | 1.65 | 0.0492      | 0.0650 |
| A3         | 0.5         | 0.7  | 0.0197      | 0.0276 |
| b          | 0.33        | 0.51 | 0.0130      | 0.0201 |
| c          | 0.17        | 0.25 | 0.0067      | 0.0098 |
| D          | 4.7         | 5.1  | 0.1850      | 0.2008 |
| E          | 5.8         | 6.2  | 0.2283      | 0.2441 |
| E1         | 3.8         | 4    | 0.1496      | 0.1575 |
| e          | 1.27(TYP)   |      | 0.05(TYP)   |        |
| h          | 0.25        | 0.5  | 0.0098      | 0.0197 |
| L          | 0.4         | 1.27 | 0.0157      | 0.0500 |
| L1         | 1.04(TYP)   |      | 0.0409(TYP) |        |
| $\theta$   | 0           | 8°   | 0.0000      | 8°     |
| c1         | 0.25(TYP)   |      | 0.0098(TYP) |        |
| D1(90*90)  | 2.09(TYP)   |      | 0.0823(TYP) |        |
| D1(95*130) | 3.1(TYP)    |      | 0.122(TYP)  |        |
| E2(90*90)  | 2.09(TYP)   |      | 0.0823(TYP) |        |
| E2(95*130) | 2.21(TYP)   |      | 0.087(TYP)  |        |

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