# Switching Boost Regulator

## General Description

The FP6201 is a boost topology switching regulator for wide operating voltage applications. The FP6201 includes a high current N-MOSFET, a high precision reference (0.5V) for comparing output voltage with feedback amplifier, an internal dead-time control and oscillator for controlling the maximum duty cycle and PWM frequency. It also has power on programmable soft start time, short circuit NMOS turn-off and auto re-start protection functions.

## Features

➢ Wide Supply Voltage Operating Range: 3.6 to 20V

➢ Built-in N-MOSFET for 2A Loading Capability

➢ Precision Feedback Reference Voltage: 0.5V (2%)

➢ Internal Fixed Oscillator Frequency: 320KHz (Typ.)

➢ Low Current Consumption: 3mA

➢ Programmable Soft-Start Function (SS)

➢ Short Circuit Shutdown and Auto Re-start Function(ARSCP)

➢ Output Adjustable to 20V
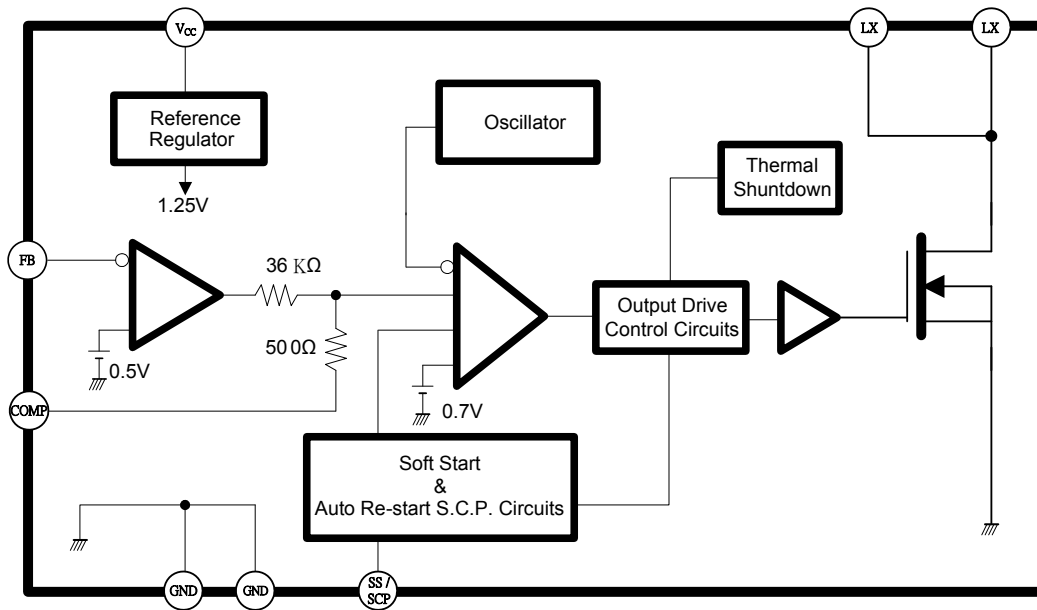
➢ Over Current Protection

➢ Package: SOP-8L

## Typical Application
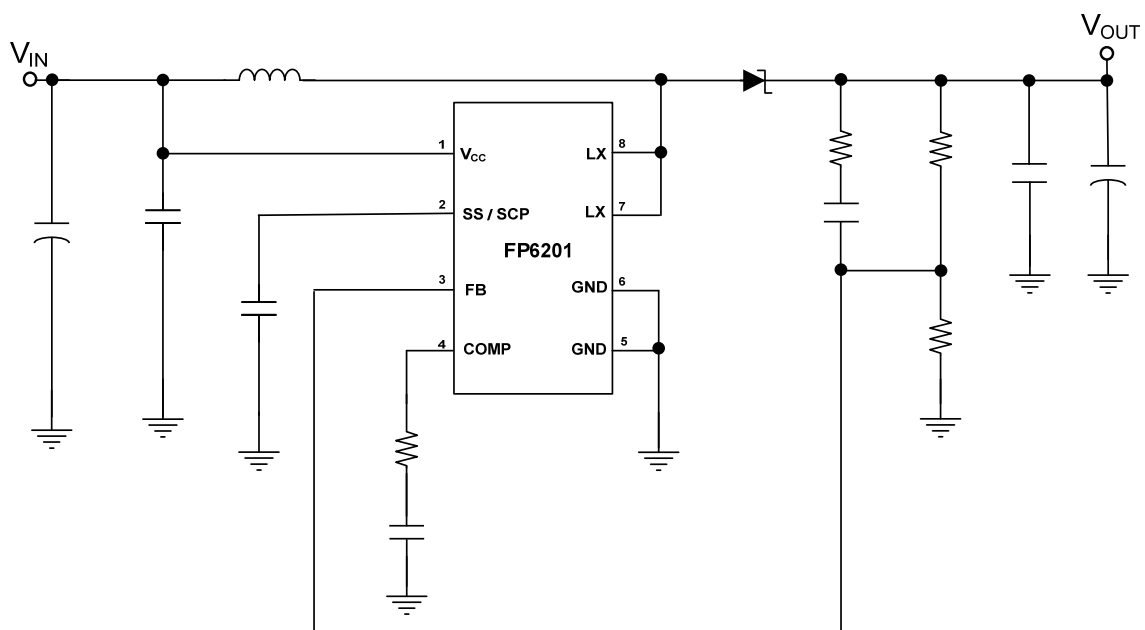
# Function Block Diagram



# Pin Descriptions

**SOP-8L**

### Top View
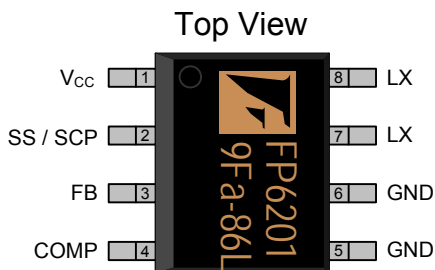


| Name | No. | I / O | Description |
|------|-----|-------|-------------|
| V$_{CC}$ | 1 | P | IC Power Supply |
| SS / SCP | 2 | I | Connecting with a Soft-start & ARSCP Timing Capacitor |
| FB | 3 | I | Error Amplifier Inverting Input |
| COMP | 4 | O | Error Amplifier Compensation Output |
| GND | 5 | P | IC Ground |
| GND | 6 | P | IC Ground |
| LX | 7 | O | Switch Output |
| LX | 8 | O | Switch Output |

# Marking Information

**SOP-8L**
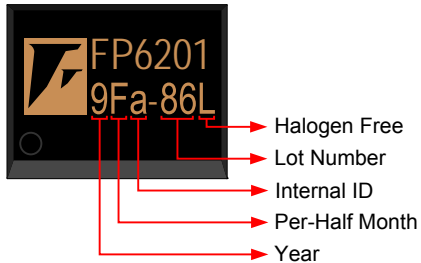


**Halogen Free**: Halogen free product indicator

**Lot Number**: Wafer lot number's last two digits

For Example: 132386TB → 86

**Internal ID**: Internal Identification Code

**Per-Half Month**: Production period indicated in half month time unit

For Example: January → A (Front Half Month), B (Last Half Month)

February → C (Front Half Month), D (Last Half Month)

**Year**: Production year's last digit

## Ordering Information

| Part Number | Operating Temperature | Package | MOQ | Description |
|---|---|---|---|---|
| FP6201DR-LF | -40°C ~ +85°C | SOP-8L | 2500EA | Tape & Reel |

## Absolute Maximum Ratings

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Power Supply Voltage | $V_{CC}$ | | | | +20 | V |
| NMOS Drain Sink Current | | | | | +3 | A |
| LX to GND | $V_{LX}$ | | | | 20 | V |
| Error Amplifier Inverting Input | $V_{FB}$ | | -0.3 | | 1.2 | V |
| Allowable Dissipation (SOP-8L ) | | $T_A \leqq +25°C$ | | | 650 | mW |
| Thermal Resistance Junction to Ambient | $\theta_{JA}$ | | | | +175 | °C / W |
| Thermal Resistance Junction to Case | $\theta_{JC}$ | | | | +55 | °C / W |
| Storage Temperature | $T_S$ | | -55 | | +125 | °C |
| ESD Susceptibility | | HBM (Human Body Mode) | | 2 | | KV |
| | | MM (Machine Mode) | | 200 | | V |
| Lead Temperature (soldering, 10 sec) | | | | | +260 | °C |

## IR Re-flow Soldering Curve
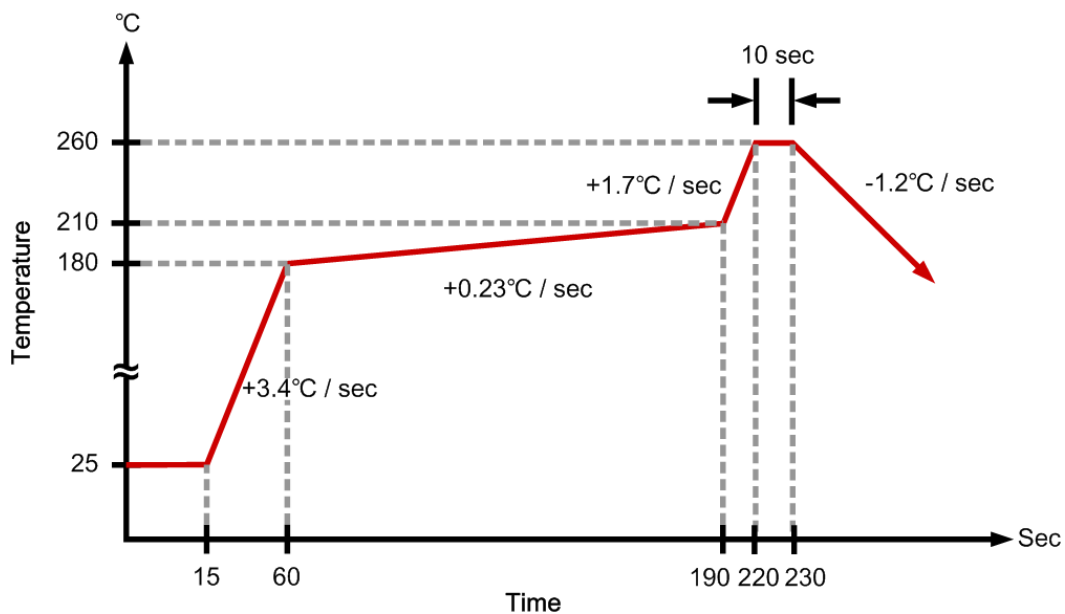
## Recommended Operating Conditions

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{cc}$ | | 3.6 | | +20 | V |
| Operating Temperature | | | -10 | | +85 | ℃ |

**DC Electrical Characteristics** ($V_{IN}$=20V, $T_A$= 25℃, unless otherwise noted)

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Reference** | | | | | | |
| Output Voltage | $V_{REF}$ | COMP connected to FB | 0.490 | 0.5 | 0.510 | V |
| Input Regulation | $\triangle V_{REF}$ | $V_{CC}$ = 3.0 V to 20 V | | 2 | 12.5 | mV |
| Output Voltage Change with Temperature | $\triangle V_{REF} / V_{REF}$ | $T_A$ = -10℃ to 25℃ | | 1 | 2 | % |
| | | $T_A$ = 25℃ to 85℃ | | 1 | 2 | |
| **Soft Start Section (S.S.)** | | | | | | |
| S.S. Source Current | $I_{SS}$ | $V_{SS}$= 0V | -15 | -10 | -7 | µA |
| Soft Start Threshold Voltage | $V_{SST}$ | | 0.8 | 0.9 | 1.0 | V |
| **Short Circuit Protection Section (S.C.P.)** | | | | | | |
| S.C.P. Source Current | $I_{SCP}$ | $V_{SCP}$= 0V | -15 | -10 | -7 | µA |
| SCP re-start / Hold Time | $T_{RS} / T_{HOLD}$ | $V_{COMP}$ >0.8V | | 1 / 10 | | |
| S.C.P. Threshold Voltage | $V_{SCP}$ | $V_{comp}$ > 450mV | 0.9 | 1.0 | 1.1 | V |
| | $V_{SB}$ | $V_{comp}$ < 450mV | | 0.1 | 0.15 | |
| **Oscillator Section** | | | | | | |
| Oscillation Frequency | f | | | 320 | | KHz |
| Frequency Change with Voltage | Δf / ΔV | $V_{CC}$=4V to 15V | | 5 | | % |
| Frequency Change with Temperature | Δf / ΔT | $T_A$ =-10℃ to +85℃ | | 5 | | % |
| **Thermal Shutdown Section** | | | | | | |
| Thermal Shutdown Temperature | | | | +145 | | ℃ |
| **Error Amplifier Section** | | | | | | |
| Input Bias Current | $I_B$ | | -1.0 | -0.2 | 1.0 | µA |
| Voltage Gain | Av | | | 100 | | V / V |
| Frequency Bandwidth | BW | Av=0 dB | | 6 | | MHz |
| Output Voltage Swing ( Positive) | $V_{POS}$ | $V_{FB}$=0.3V | 0.78 | 0.87 | | V |
| Output Voltage Swing ( Negative) | $V_{NEG}$ | $V_{FB}$=0.7V | | 0.05 | 0.2 | V |
| Output Source Current | $I_{SOURCE}$ | $V_{comp}$=500mV | -30 | -45 | | µA |
| Output Sink Current | $I_{SINK}$ | $V_{comp}$=500mV | 30 | 45 | | µA |
| **Idle Period Adjustment Section** | | | | | | |
| Maximum Duty Cycle | $T_{DUTY}$ | $V_{FB}$ =0.2V | | 88 | | % |
| **Total Device Section** | | | | | | |
| Average Supply Current | $I_{AVE}$ | | | 3.8 | 7 | mA |

| Parameter | Symbol | Test Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **Output Section** | | | | | | |
| NMOS D-S Voltage | $V_{DSS}$ | | | 60 | | V |
| NMOS Source Current | $I_D$ | | | -2 | | A |
| NMOS on Resistance | $R_{DS(ON)}$ | $V_{CC}$=4.5V, $V_{FB}$=0V | | 49 | 64 | mΩ |
| | | $V_{CC}$=10V, $V_{FB}$=0V | | 33 | 41 | |
| Output Leakage Current | $I_L$ | SCP Active | | 5 | | μA |
| **Over Current Protection Section** | | | | | | |
| NMOS OCP Current | $I_{OCP}$ | | | 3 | | A |

# Typical Operating Characteristics ($V_{IN}$=7V, $T_A$=25°C , unless otherwise noted)
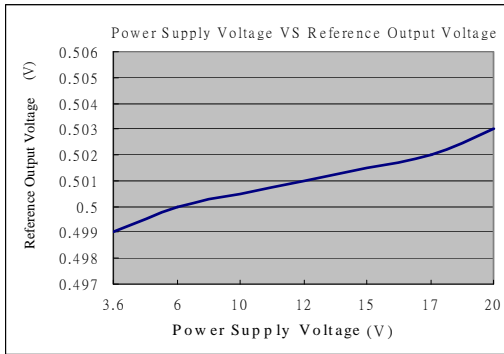

**Figure 1**
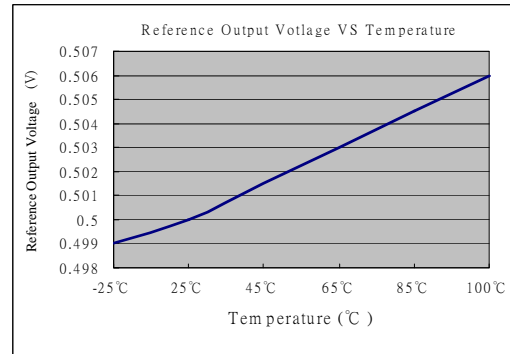

**Figure 2**
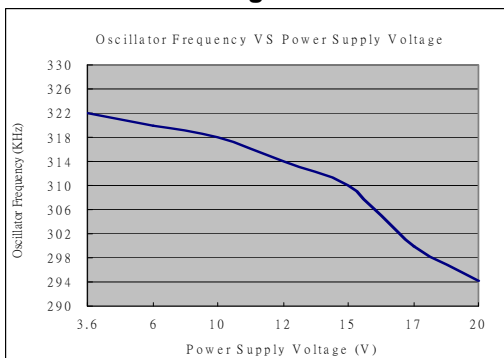

**Figure 3**
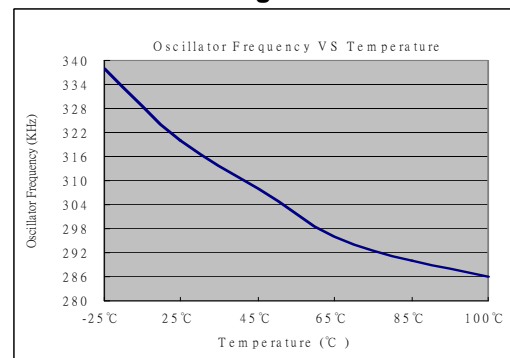

**Figure 4**
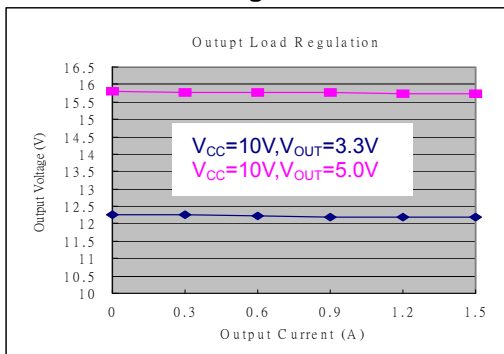

**Figure 5**
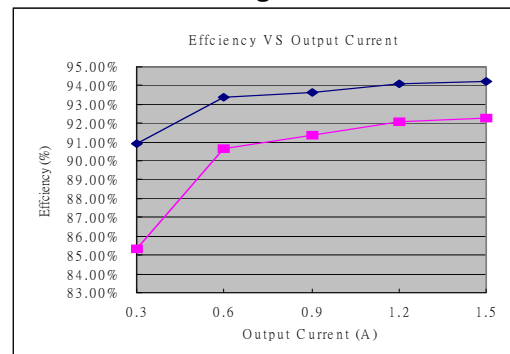

**Figure 6**
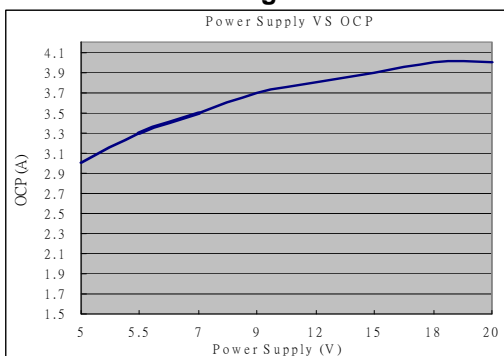

**Figure 7**
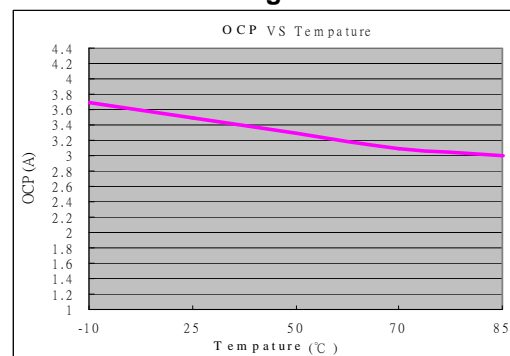

**Figure 8**

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## Timing Waveform

Website: http://www.feeling-tech.com.tw                                                                          Rev. 0.9
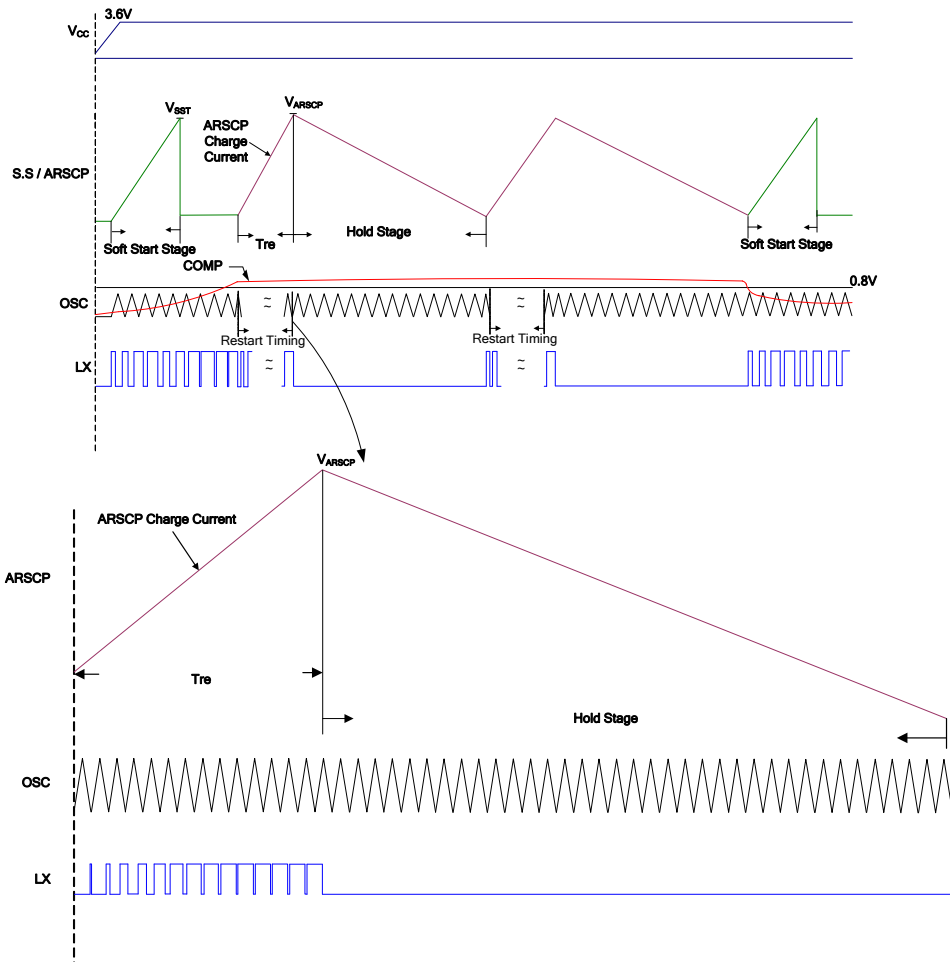
# Application Information

## Voltage Reference

The FP6201 includes a 1.25V reference voltage generator. This voltage is connected to a resistive divider to generate a 0.5V precision reference voltage to the non-inverting input of error amplifier and 1.0V to the SCP comparator.

## Error Amplifier

The error amplifier compares a sample of the DC-DC converter's output voltage with the 0.5V ($V_{REF}$) reference and generates an error signal for the PWM comparator. Output voltage of DC-DC converter is setting by the resistor divider with the following equation (figure 9):

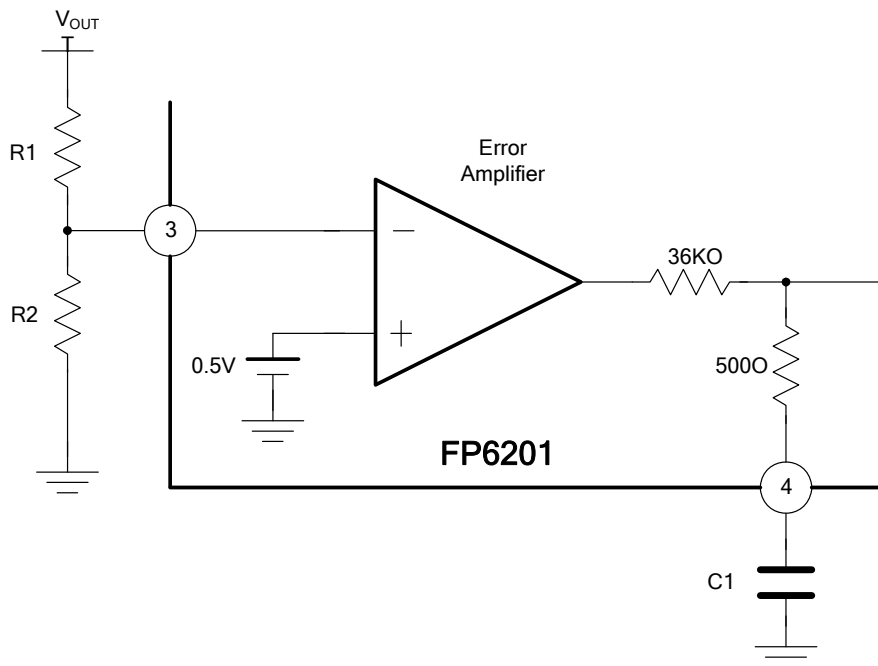$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times V_{REF}$$



Figure 9   Error Amplifier with Feedback Resistance Divider

**Oscillator**

The fixed PWM frequency is generated by an internal RC oscillator. Its typical value is 320KHz.

**Soft Start / Short-Circuit Protection (S.S. / S.C.P.)**

The soft start is enabled after power on. The interval of soft start time is determined by a capacitor connected to SCP pin. After the soft start finished, the internal soft start clamp voltage is setting high, but the external SCP pin is discharged to low. Thus FP6201 turns on short circuit detection / protection function.

The time of soft start is:

$$Tss(ms) = 0.07 \times C(\mu F)$$

When a heavy loading or short circuit condition make output voltage to drop too much, the error amplifier output will rise to very high. Once COMP pin voltage exceeds $V_{POS}$ (typ. 1.0V), the short circuit protection function is triggered. The output switching MOS will be turned off. The SCP capacitor will be charged until it potential exceeds SCP threshold voltage (typ. 1.2V) and then discharged to ground.

The time of short circuit protection is:

$$T_{SCP} = \frac{V \times C_{SCP}}{I} = \frac{(V_{TH} - V_{SS-Start}) \times C_{SCP}}{Isource} = 0.09 \times C_{SCP}(\mu F)$$

Restart timing of short circuit protection is:

$$Tscp = 1.8 \times C[\mu F]$$

**Thermal Protection**

When a heavy loading makes chip internal temperature exceeds 145°C, the thermal protection function is triggered. The FP6201 turns off its output and starts Short Circuit Protection function. After the IC internal temperature is cooled down to below 145°C, it will turn on the output and execute Soft-Start function again.

**Over Current Protection**

When FP6201 senses driver current larger than 3A, it will initiate OCP function and enters ARSCP function. After current drops below 3A, FP6201 turns on the output and continues PWM operation.

## Typical Application
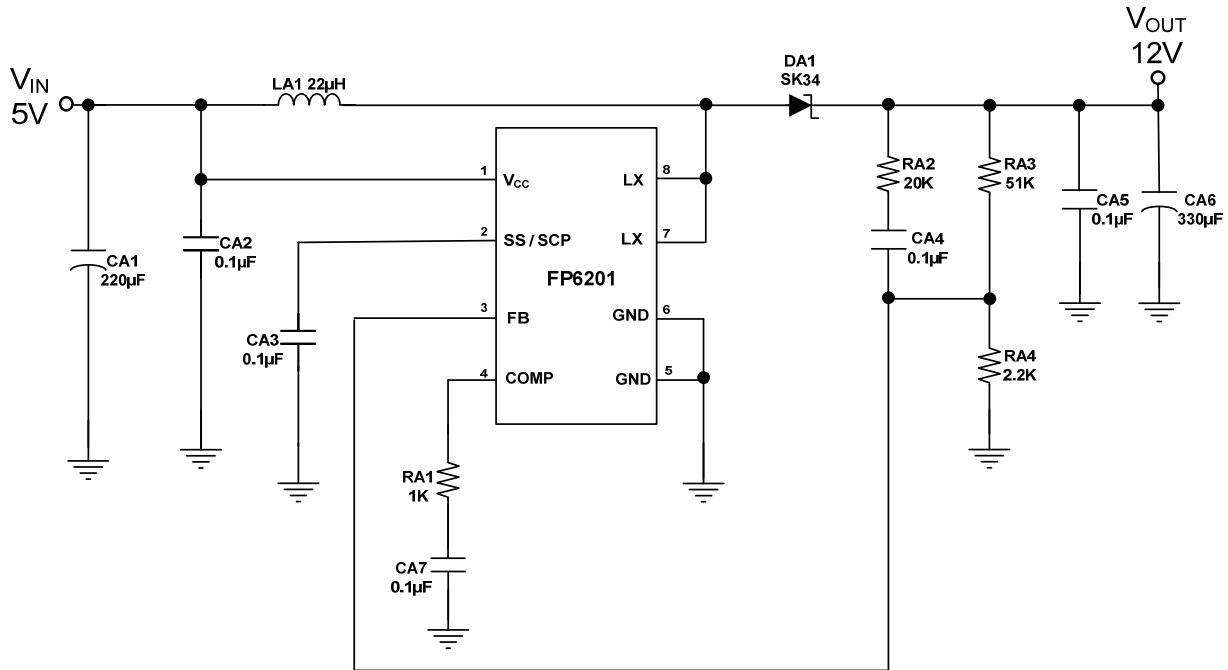


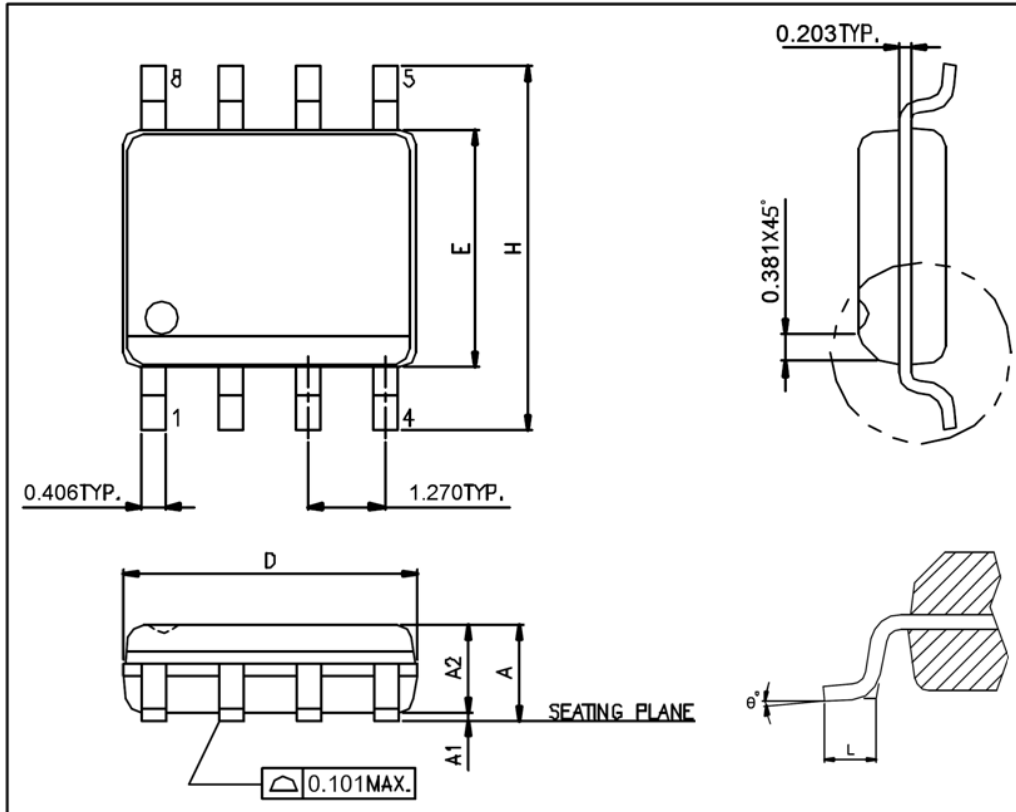FP6201 Basic DC-DC Regulator Circuit

**For example:**

The $V_{IN}$ power supply is 5.0V and the $V_{OUT}$ is designed for 12V / 0.5A solution.

The output voltage equation is:

$$V_{OUT} = \left(1 + \frac{R_1}{R_2}\right) \times V_{IN-} = \left(1 + \frac{56K\Omega}{2.43K\Omega}\right) \times 0.5V = 12.02V$$

## Package Outline

**SOP-8L**



**UNIT: mm**

| Symbols | Min. (mm) | Max. (mm) |
|---------|-----------|-----------|
| A | 1.346 | 1.752 |
| A1 | 0.101 | 0.254 |
| A2 | | 1.498 |
| D | 4.800 | 4.978 |
| E | 3.810 | 3.987 |
| H | 5.791 | 6.197 |
| L | 0.406 | 1.270 |
| θ° | 0° | 8° |

**Note:**

1. Package dimensions are in compliance with JEDEC outline: MS-012 AA.

2. Dimension "D" does not include molding flash, protrusions or gate burrs.

3. Dimension "E" does not include inter-lead flash or protrusions.

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