

## Low-Noise Step-Up Current Mode PWM Converter



### General Description

The FP6290 is a current mode boost DC-DC converter. Its PWM circuitry with built-in 0.2Ω power MOSFET makes this converter highly power efficiently. Selectable high switching frequency allows faster loop response and easy filtering with a low noise output. The non-inverting input its error amplifier is connected to an internal 1.24V precision reference voltage. Soft-Start time can be programmed with an external capacitor, which sets the input current ramp rate. Current mode control and external compensation network make it easy and flexible to stabilize the system.

The FP6290 is available in the MSOP-8L package. Combined with low ESR capacitors, it reduced PCB space for step-up applications.

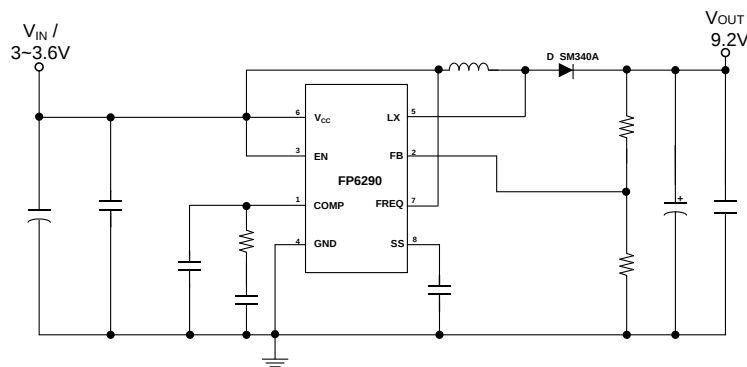
### Features

- Adjustable Output from  $V_{CC}$  to 12V
- Internal Fixed PWM Frequency: 640KHz / 1.2MHz
- Frequency Selection Pin
- Precision Feedback Reference Voltage: 1.24V
- Internal 0.2Ω, 1.6A, 14V Power MOSFET
- External Programmable Soft-Start Function (SS)
- Shutdown Current : 0.1μA
- Over Current Protection
- Package: MSOP-8L

### Applications

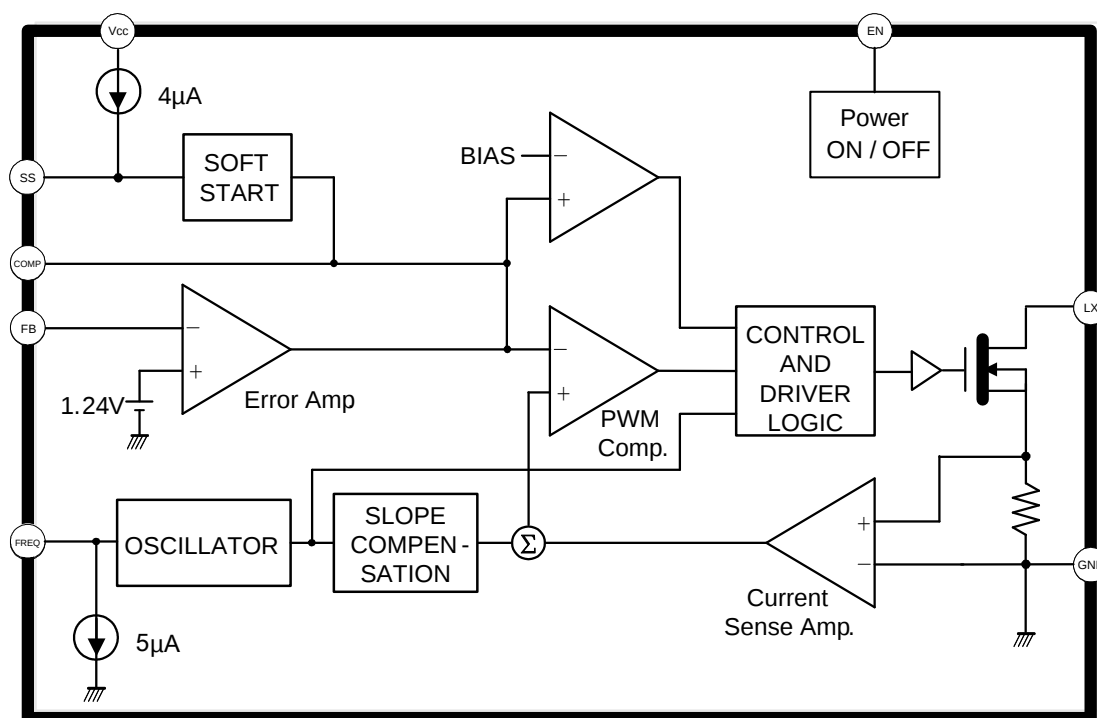
- LCD Display
- Digital Camera
- Handheld Device
- Portable Product

### Typical Application Circuit



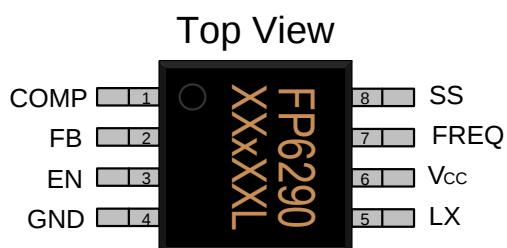
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## Function Block Diagram



## Pin Descriptions

### MSOP-8L



| Name            | No. | I / O | Description                         |
|-----------------|-----|-------|-------------------------------------|
| COMP            | 1   | O     | Error Amplifier Compensation Output |
| FB              | 2   | I     | Error Amplifier Inverting Input     |
| EN              | 3   | I     | Enable Control                      |
| GND             | 4   | P     | IC Ground                           |
| LX              | 5   | O     | Switch Output                       |
| V <sub>CC</sub> | 6   | P     | IC Power Supply                     |
| FREQ            | 7   | O     | Frequency Selection                 |
| SS              | 8   | I     | Soft-start Control                  |

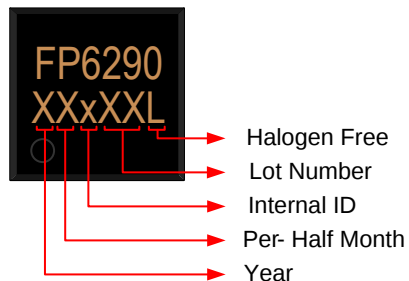
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## Marking Information

### MSOP-8L



**Halogen Free:** Halogen free product indicator

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

For Example → Lot : 123456 → XXx-56L

**Internal ID:** Internal Identification Code

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

For Example : A → First Half Month of January  
B → Second Half Month of January  
C → First Half Month of February  
D → Second Half Month of February

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

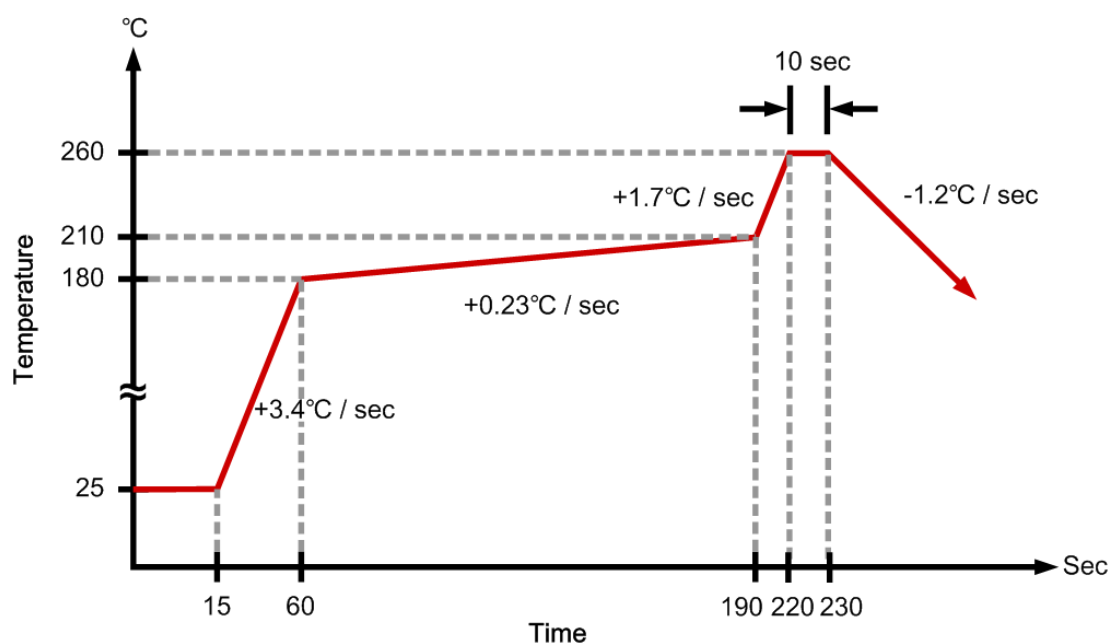
## Ordering Information

| Part Number | Operating Temperature | Package | MOQ    | Description |
|-------------|-----------------------|---------|--------|-------------|
| FP6290TR-LF | -40°C ~ +85°C         | MSOP-8L | 3000EA | Tape & Reel |

## Absolute Maximum Ratings

| Parameter                            | Symbol        | Conditions | Min. | Typ. | Max.         | Unit   |
|--------------------------------------|---------------|------------|------|------|--------------|--------|
| Supply Voltage                       | $V_{CC}$      |            |      |      | 6            | V      |
| RMS LX Current                       |               |            |      |      | 1.2          | A      |
| LX to GND                            |               |            | -0.3 |      | 14           | V      |
| SS,COMP to GND                       |               |            | -0.3 |      | $V_{CC}+0.3$ | V      |
| EN,FREQ,FB to GND                    |               |            | -0.3 |      | $V_{CC}$     | V      |
| Junction Temperature                 | $T_J$         |            |      |      | +150         | °C     |
| Storage Temperature                  | $T_S$         |            | -65  |      | +150         | °C     |
| Thermal Resistance                   | $\theta_{JA}$ | MSOP-8L    |      |      | 172          | °C / W |
|                                      | $\theta_{JC}$ |            |      |      | 71           | °C / W |
| Lead Temperature (soldering, 10 sec) |               |            |      |      | +260         | °C     |

## Suggested IR Re-flow Soldering Curve



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## Recommended Operating Conditions

| Parameter             | Symbol   | Conditions | Min. | Typ. | Max. | Unit |
|-----------------------|----------|------------|------|------|------|------|
| Supply Voltage        | $V_{IN}$ |            | 2.6  |      | 5.5  | V    |
| Operating Temperature |          |            | -40  |      | 85   | °C   |

## DC Electrical Characteristics ( $V_{IN}=3V$ , $T_A=25^{\circ}C$ , $V_{FREQ}=0V$ , unless otherwise noted)

| Parameter                                  | Symbol                                | Test Conditions                    | Min.  | Typ.  | Max.  | Unit   |
|--------------------------------------------|---------------------------------------|------------------------------------|-------|-------|-------|--------|
| Reference Section                          |                                       |                                    |       |       |       |        |
| Output Voltage                             | V <sub>REF</sub>                      | COMP connected to FB               | 1.222 | 1.240 | 1.258 | V      |
| Line Regulation                            | Δ V <sub>REF</sub> / V <sub>REF</sub> | V <sub>CC</sub> =2.6V~5.5V         |       | 0.05  |       | % / V  |
| Output Voltage Change with Temperature     |                                       | T <sub>A</sub> =-40°C to 25°C      |       | 1     |       | %      |
|                                            |                                       | T <sub>A</sub> = 25°C to 85°C      |       | 1     |       | %      |
| Under Voltage Lockout Section              |                                       |                                    |       |       |       |        |
| Upper Threshold Voltage (V <sub>CC</sub> ) | V <sub>UPPER</sub>                    | T <sub>A</sub> =25°C               |       | 2.38  | 2.53  | V      |
| Lower Threshold Voltage (V <sub>CC</sub> ) | V <sub>LOW</sub>                      |                                    |       | 2.33  | 2.48  | V      |
| Hysteresis (V <sub>CC</sub> )              | V <sub>HYS</sub>                      |                                    |       | 50    |       | mV     |
| Soft-Start Section                         |                                       |                                    |       |       |       |        |
| Reset Switch Resistance                    | R <sub>SS</sub>                       |                                    |       |       | 100   | Ω      |
| Input Source Current                       | I <sub>SS</sub>                       | V <sub>SS</sub> =1.2V              | 1.5   | 4.0   | 7.0   | μA     |
| Oscillator Section                         |                                       |                                    |       |       |       |        |
| Frequency                                  | f                                     | FREQ=GND                           | 540   | 640   | 740   | KHz    |
|                                            |                                       | FREQ=V <sub>CC</sub>               | 1.00  | 1.22  | 1.50  | MHz    |
| Frequency Change with Voltage              | Δ f / Δ V                             | V <sub>CC</sub> =2.6V to 5.5V      |       | 2     |       | % / V  |
| Frequency Change with Temperature          | Δ f / Δ V                             | T <sub>A</sub> =-40°C to 85°C      |       | 10    |       | %      |
| Maximum Duty Cycle                         | T <sub>DUTY</sub>                     | FREQ=GND                           | 79    | 88    |       | %      |
|                                            |                                       | FREQ=V <sub>CC</sub>               |       | 88    |       | %      |
| Error–Amplifier Section                    |                                       |                                    |       |       |       |        |
| FB Input Bias Current                      | I <sub>BIAS</sub>                     | V <sub>FB</sub> =1.24V             |       |       | 40    | nA     |
| Trans-conductance                          | gm                                    | Δ I=5μA                            | 70    | 140   | 240   | μA / V |
| Voltage Gain                               | Av                                    |                                    |       | 700   |       | V / V  |
| Output Section                             |                                       |                                    |       |       |       |        |
| NMOS Current Limit                         | I <sub>LIM</sub>                      | V <sub>FB</sub> =1V,Duty Cycle=65% | 1.2   | 1.6   | 2.3   | A      |
| NMOS On Resistance                         | R <sub>DS (ON)</sub>                  | I <sub>LX</sub> =1.2A              |       | 0.2   | 0.5   | Ω      |
| Output Leakage Current                     | I <sub>LXOFF</sub>                    | V <sub>LX</sub> =12V               |       | 0.01  | 20    | μA     |
| Current-Sense Trans-Resistance             | R <sub>CS</sub>                       |                                    |       | 0.56  |       | V / A  |

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| Parameter                    | Symbol        | Test Conditions                       | Min.               | Typ.               | Max.               | Unit    |
|------------------------------|---------------|---------------------------------------|--------------------|--------------------|--------------------|---------|
| <b>Control Input Section</b> |               |                                       |                    |                    |                    |         |
| Input High Voltage           | $V_{IH}$      | EN, FREQ pin<br>$V_{CC}=2.6V\sim5.5V$ | $0.7\times V_{CC}$ |                    |                    | V       |
| Input Low Voltage            | $V_{IL}$      | EN, FREQ pin<br>$V_{CC}=2.6V\sim5.5V$ |                    |                    | $0.3\times V_{CC}$ | V       |
| Hysteresis                   |               | EN, FREQ                              |                    | $0.1\times V_{CC}$ |                    | V       |
| FREQ Pull-Down Current       | $I_{FREQ}$    |                                       | 1.8                | 5                  | 9                  | $\mu A$ |
| EN Input Current             | $I_{EN}$      |                                       |                    | 1                  |                    | nA      |
| <b>Total Device</b>          |               |                                       |                    |                    |                    |         |
| Disable Supply Current       | $I_{DISABLE}$ | EN=GND                                |                    | 0.1                | 10                 | $\mu A$ |
| Standby Supply Current       | $I_{SBY}$     | $V_{FB}=1.3V$                         |                    | 0.20               | 0.35               | mA      |
| Average Supply Current       | $I_{AVG}$     | $V_{FB}=1.0V$                         |                    | 2.0                | 5.0                | mA      |

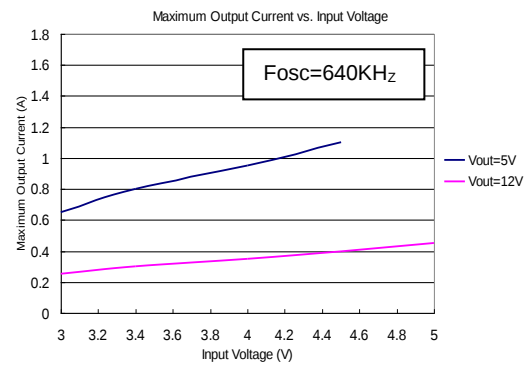
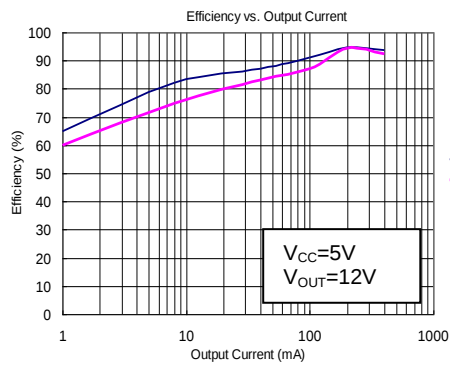
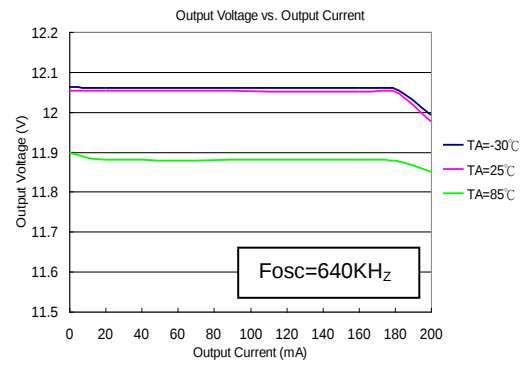
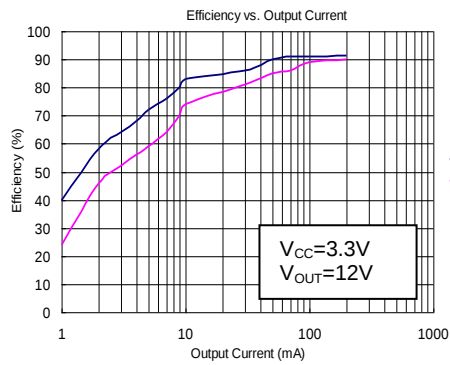
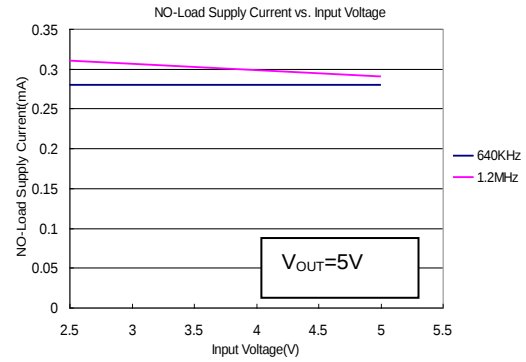
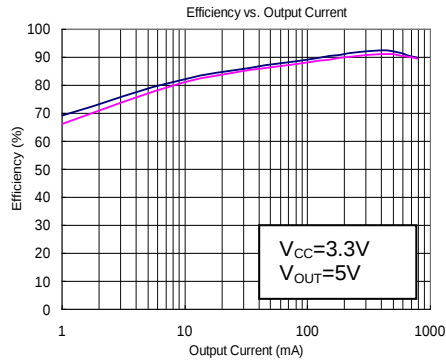
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## Typical Operating Characteristics

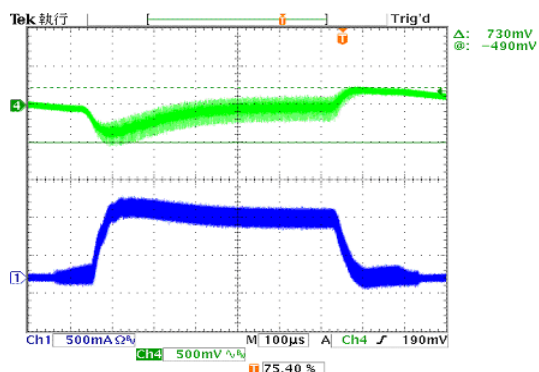
( $T_A = 25^\circ\text{C}$ , unless otherwise noted)



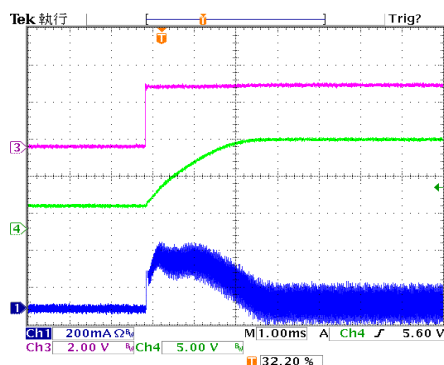
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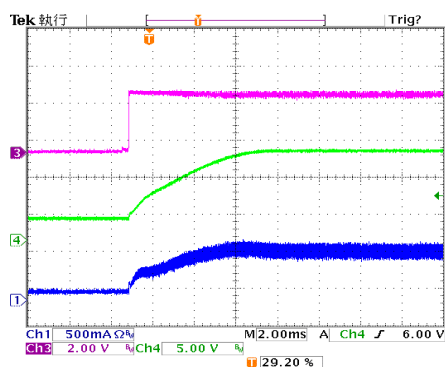
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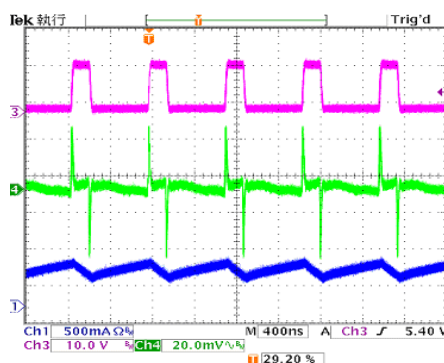
CH1=Inductor Current, CH3=EN, CH4=V<sub>OUT</sub>  
V<sub>CC</sub>=3.3V, V<sub>OUT</sub>=12V  
I<sub>LOAD</sub>=10mA~200mA  
Frequency=640KHz



CH1=Inductor Current, CH4= V<sub>OUT</sub>  
V<sub>CC</sub>=3.3V, V<sub>OUT</sub>=12V  
I<sub>LOAD</sub>=10mA  
Frequency=640KHz



CH1=Inductor Current, CH3=EN, CH4=V<sub>OUT</sub>  
V<sub>CC</sub>=3.3V, V<sub>OUT</sub>=12V  
I<sub>LOAD</sub>=200mA  
Freq=640KHz



CH1=Inductor Current, CH3=LX, CH4= V<sub>OUT</sub>  
AC-Coupled  
V<sub>CC</sub>=3.3V, V<sub>OUT</sub>=12V  
I<sub>LOAD</sub>=200mA  
Freq=1.2MHz

## Function Description

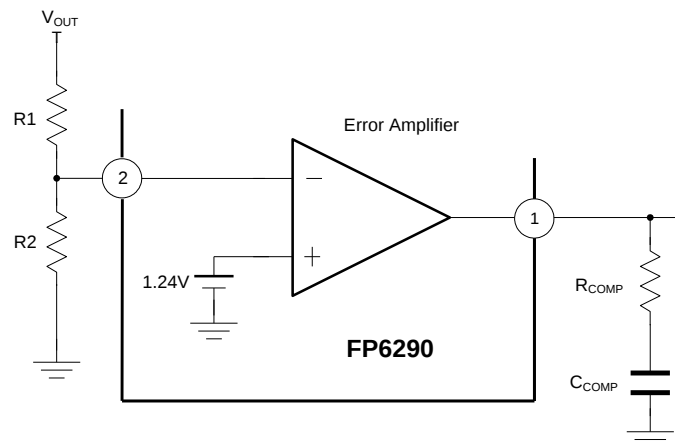
### Voltage Reference

A 1.24V reference regulator supplies to the FP6290 error amplifier's non-inverting terminal.

### Error Amplifier

The error amplifier compares a sample of the dc-dc converter output voltage with the 1.24V ( $V_{REF}$ ) reference and generates an error signal for the PWM comparator. Output voltage of dc-dc converter is setting with the resistor divider by the following equation:

$$V_{OUT} = \left(1 + \frac{R1}{R2}\right) \times 1.24$$



### Oscillator

The switching frequency of FP6290 can be selected to operate at either 640KHz or 1.2MHz. Connect the FREQ pin to GND for 640KHz operation, or  $V_{CC}$  for 1.2MHz operation. FREQ pin has an internal pull-down current around 5 $\mu$  A. It gives user the option of selecting 640KHz operation by leaving FREQ unconnected.

### Soft Start

The soft start is functional after power on. The interval of soft start time is determined by a capacitor connected to SS pin. When EN pin is taken high, the soft start capacitor ( $C_{SS}$ ) is charged by a constant current of 4 $\mu$  A (typ). During this interval, the SS voltage directly controls the peak inductor current. The maximum load current is available after the soft-start interval is completed. Once the EN pin is taken low, the soft-start capacitor is discharged to ground to prepare for next start-up.

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The load must wait for the soft-start interval to finish before drawing a significant amount of load current. The duration after which the load can begin to draw maximum load current is:

$$T_{MAX} = 6.77 \times 10^5 C_{SS}$$

## EN

The FP6290 can be turned off to reduce the supply current to 0.1μ A when EN is low. In this mode, the internal reference, error amplifier, comparators, and biasing circuitry turn off while the N-channel MOSFET is turned off. The boost converter's output is connected to V<sub>CC</sub> by the external inductor and catch diode.

## Output Current Capability

The output current capability of the FP6290 is a function of current limit, input voltage, operation frequency, and inductor value. Because of the slope compensation used to stabilize the feedback loop, the duty cycle affects the current limit. The output current capability is governed by the following equation:

$$I_{OUT(MAX)} = [I_{LIM} \times (1.26 - 0.4 \times \text{Duty}) - 0.5 \times \text{Duty} \times V_{IN} / (f_{OSC} \times L)] \times \eta \times V_{IN} / V_{OUT}$$

Where:

I<sub>LIM</sub>=current limit specified at 65%

$$\text{Duty} = \frac{(V_{OUT} - V_{IN} + V_{DIODE})}{V_{OUT} - I_{LIM} \times R_{ON} + V_{DIODE}}$$

V<sub>DIODE</sub>=catch diode forward voltage at I<sub>LIM</sub>

η=conversion efficiency, 85% nominal

## Current Limitation

The internal power-MOS switch current is monitored cycle-by-cycle and is limited to the value not exceed 1.6A (Typ.). When the switch current reaches the limited value, the internal power-MOS is turned off immediately until the next cycle.

## Typical Application

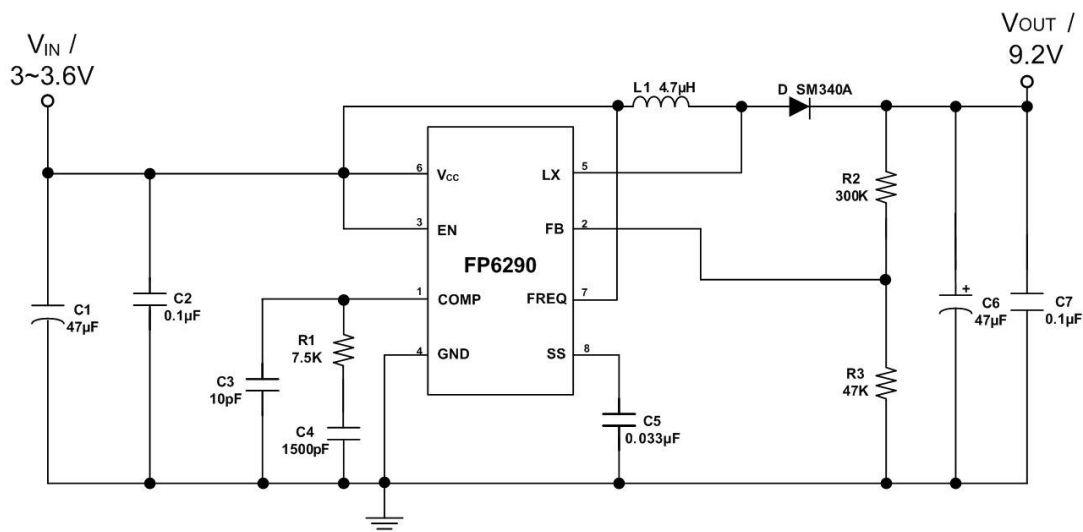


Figure 1 Typical Application Circuits

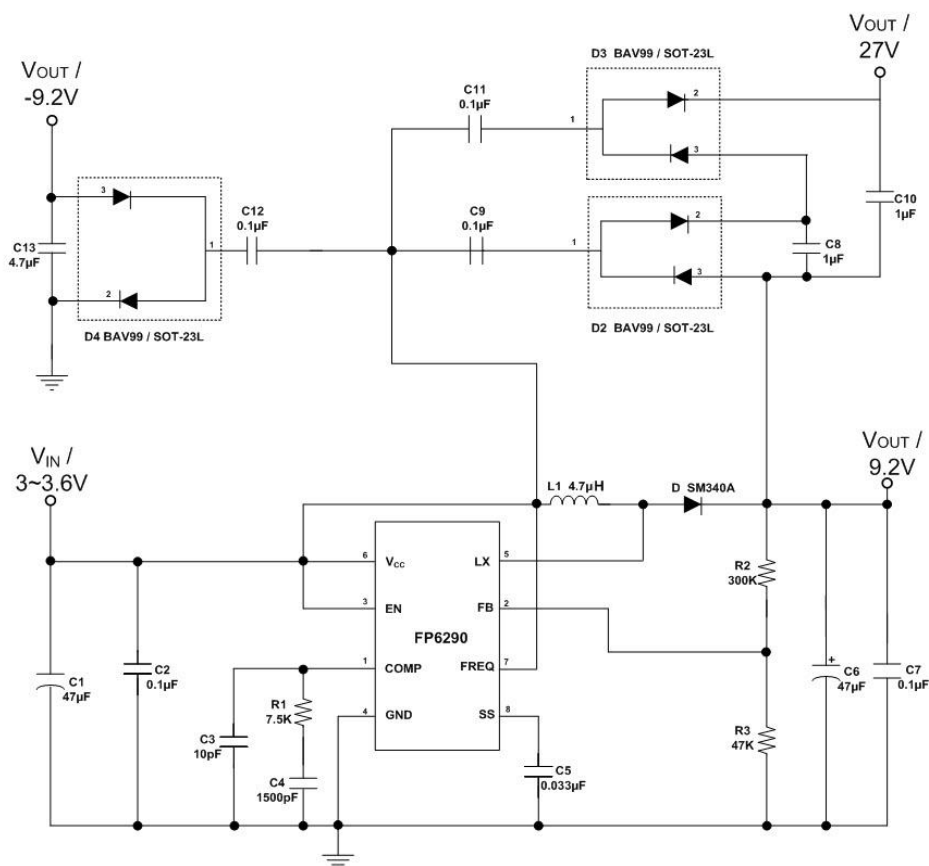
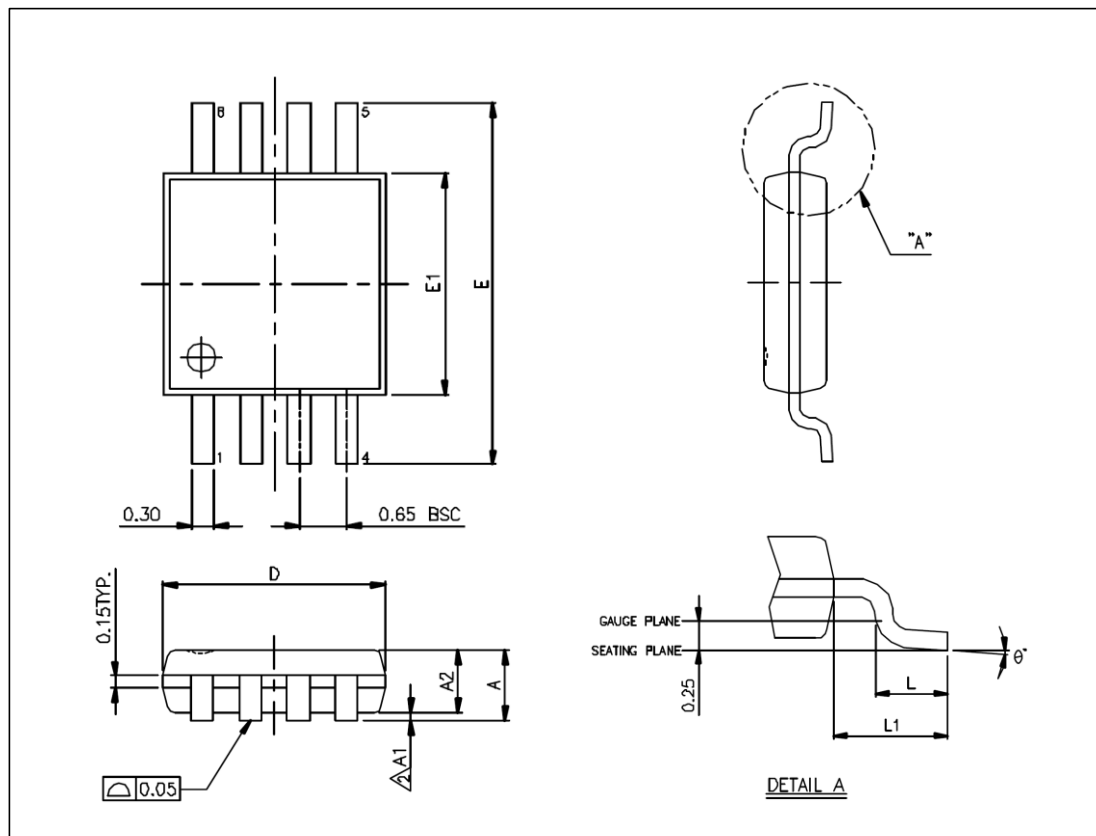


Figure 2 TFT Panel Power Supply Application Circuits

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## Package Outline

### MSOP-8L



Unit: mm

| Symbols        | Min. (mm) | Max. (mm) |
|----------------|-----------|-----------|
| A              |           | 1.100     |
| A1             | 0.000     | 0.150     |
| A2             | 0.750     | 0.950     |
| D              | 3.000 BSC |           |
| E              | 4.900 BSC |           |
| E1             | 3.000 BSC |           |
| L              | 0.400     | 0.800     |
| L1             | 0.950 REF |           |
| $\theta^\circ$ | $0^\circ$ | $8^\circ$ |

#### Note:

1. Package dimensions are in compliance with JEDEC outline: MO-187 AA.
2. Dimension "D" does not include molding flash, protrusions or gate burrs.
3. Dimension "E1" does not include inter-lead flash or protrusions.

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