GS5484H

40V,3A 350KHz Synchronous Step-Down DC/DC Converter

Product Description

The GS5484H is a synchronous step-down DC/DC converter that provides wide 4.8V to 40V input voltage range and 3A continuous load current capability.

Fault protection includes cycle-by-cycle current limit, input UVLO, output over voltage protection and thermal shutdown. Besides, adjustable soft-start function prevents inrush current at turn-on. This device uses current mode control scheme that provides fast transient response. In shutdown mode, the supply current is less than 1uA.

The GS5484H is available in an PSOP-8 package, provides a very compact system solution and good thermal conductance.
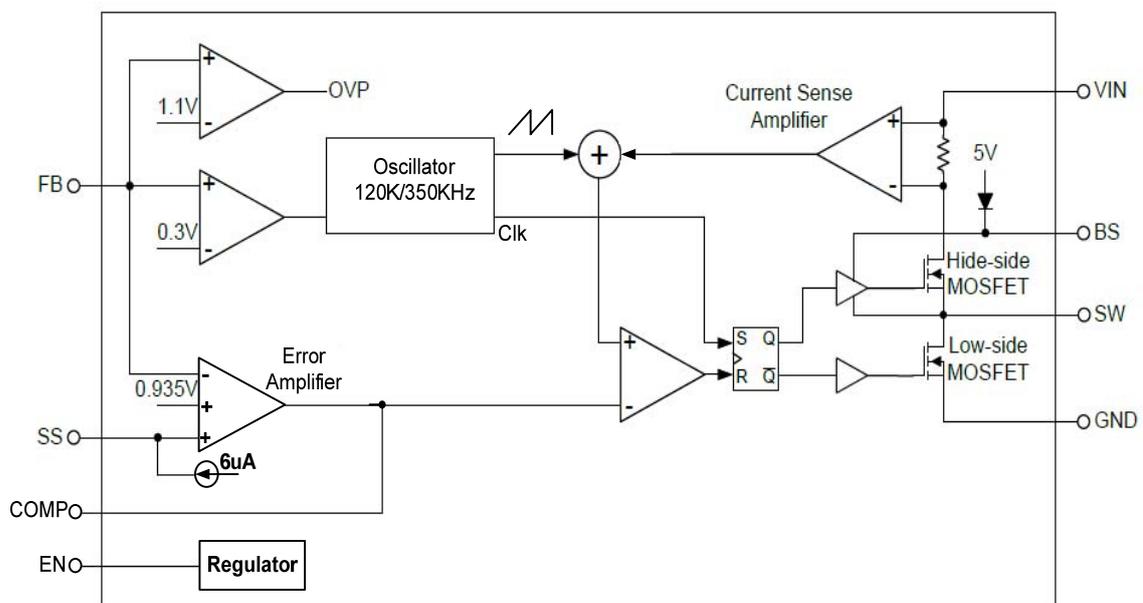
Features

- Wide Input Voltage from 4.8V to 40V
- 3A Output Current
- Adjustable Output Voltage from 1V to 25V
- High Efficiency Up to 93%
- Fixed 350KHz Switching Frequency
- Current Mode Operation
- Adjustable Soft-Start
- Cycle-by-Cycle current limit
- Input Under Voltage Lockout
- Over-Temperature Protection
- Thermal Enhanced PSOP-8 Package
- RoHS Compliant, 100%Pb & Halogen Free

Applications

- Set-Top-Box
- DVD, LCD Displays
- Distributed Power System
- Datacom, XDSL
- Pre-Regulator for Linear Regulators

Block Diagram

Packages & Pin Assignments

GS5484HPSF (PSOP-8)

Top View

Pin No	Pin Name	Top View Description
1	BS	High Side Gate Drive Boost Input. A 10nF or greater capacitor must be connected from this pin to SW. It can boost the gate drive to fully turn on the internal high side NMOS.
2	V_{IN}	Power Supply Input Pin. Drive 4.8V to 40V voltage to this pin to power on this chip. Connecting a 10uF ceramic bypass capacitor between V_{IN} and GND to eliminate noise.
3	SW	Power Switching Output. It is the output pin that internal high side NMOS switching to supply power.
4/EP	GND	Ground Pin. Connecting EP(exposed pad) to Pin 4.
5	FB	Voltage Feedback Input Pin. Connecting FB and V_{OUT} with a resistive voltage divider. This IC senses feedback voltage via FB and regulate it at 0.935V.
6	COMP	Compensation Pin. This pin is used to compensate the regulation control loop. Connect a series RC network from COMP pin to GND.
7	EN	Enable Input Pin. This pin provides a digital control to turn the converter on or off. Connect to V_{IN} with a 100KΩ resistor for self-startup.
8	SS	Soft-Start Input Pin. This pin controls the soft-start period. Connect a capacitor from SS to GND to set the soft start period.

Ordering Information
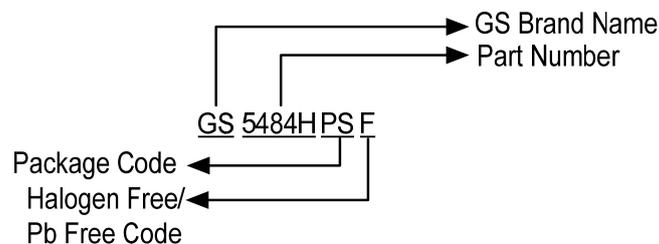
GS Complete P/N	Package	Q'ty / Reel
GS5484HPSF	PSOP-8	4000 PCS

Marking Information
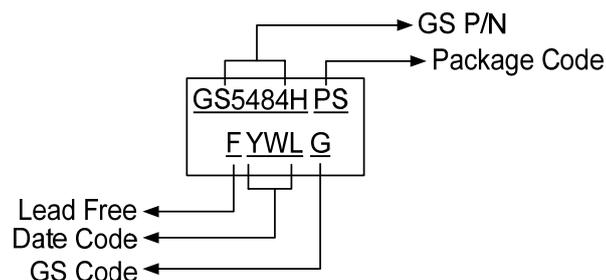
Absolute Maximum Ratings (1)

Symbol	Parameter	Maximum Rating	Units
V_{IN}	Input Voltage	-0.3 ~ 41	
V_{SW}	SW Voltage	-0.3 (-5 for < 10ns) ~ 41 (43 for < 5ns)	V
V_{EN}	EN Voltage	-0.3 ~ 41	
V_{BS}	Boost Voltage	V_{SW} + 5	V
	All Other Pins Voltage	-0.3 ~6	V
T_J	Maximum Junction Temperature	150	ºC
T_{STG}	Storage Temperature	-65 ~ 150	ºC
T_{LEAD}	Lead Temperature (Soldering 10 sec)	260	ºC
HBM	ESD Classification	Class 2	

Recommended Operating Conditions (2)

Symbol	Parameter	Maximum Rating	Units
V_{IN}	Input Supply Voltage	4.8 ~ 40	V
V_{OUT}	Output Voltage	1 ~ 25	V
T_A	Ambient Temperature	-40 ~85	ºC
θ_{JA}	Thermal Resistance Junction to Ambient	75	ºC/W
θ_{JC}	Thermal Resistance Junction to Case	15	ºC/W

Note (1): Stresses exceed those ratings may damage the device.
Note (2): If out of its operation conditions, the device is not guaranteed to function.

Electrical Characteristics

(V_{IN}=12V, T_A=25℃, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	TYP	Max	Units
V_{IN}	Input Supply Voltage (3)		4.8		40	V
I_Q	Supply Current	V_{EN}=V_{IN},V_{FB}=1.0V		1.5		mA
I_S	Shutdown Supply Current	V_{EN}=0V		0.3	3	uA
V_{FB}	Feedback Voltage	4.8V$\leq$$V_{IN}$$\leq$40V	917	935	953	mV
		-40℃$\leq$$T_A$$\leq$85℃	907		963	mV
	Feedback OVP Threshold Voltage		1.05	1.1	1.15	V
$R_{DS(ON)\_P}$	High-Side MOSFET $R_{DS(ON)}$ (4)			130		mΩ
$R_{DS(ON)\_N}$	Low-Side MOSFET $R_{DS(ON)}$ (4)			100		mΩ
I_{SW}	High-Side MOSFET Leakage Current	V_{EN}=0V,V_{SW}=0V			10	uA
I_{LIM_P}	High-Side MOSFET Current Limit (4)		3.3	4.5		A
I_{LIM_N}	Low-Side MOSFET Current Limit (4)	From drain to source		1.5		A
G_{CS}	COMP to Current sense Transconductance			7		A/V

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Electrical Characteristics (continued)
(V_{IN}=12V, T_A=25℃, unless otherwise specified)

Symbol	Parameter	Test Conditions	Min	TYP	Max	Units
G_{EA}	Error Amplifier Transconductance	ΔI_{COMP} =±10µA		820		uA/V
A_{EA}	Error Amplifier Voltage Gain			400		V/V
F_{OSC}	Oscillation frequency		280	350	420	KHz
F_{OSC}	Short Circuit Oscillation Frequency	V_{FB}=0V		120		KHz
D_{MAX}	Maximum Duty Cycle	V_{FB}=0.7V	80	90		%
T_{ON}	Minimum On Time			180		ns
V_{UVLO}	Input UVLO Threshold	V_{IN} Rising		4.3	4.6	V
	Under Voltage Lockout Threshold Hysteresis			200		mV
I_{SS}	Soft-Start Current	V_{COMP}=0V, V_{SS}=0V		6		uA
T_{SS}	Soft-Start Period	C_{SS}=0.1uF		15		ms
	EN Shutdown Threshold Voltage			1.5	2.0	V
T_{SD}	Thermal Shutdown Threshold (4)			160		℃

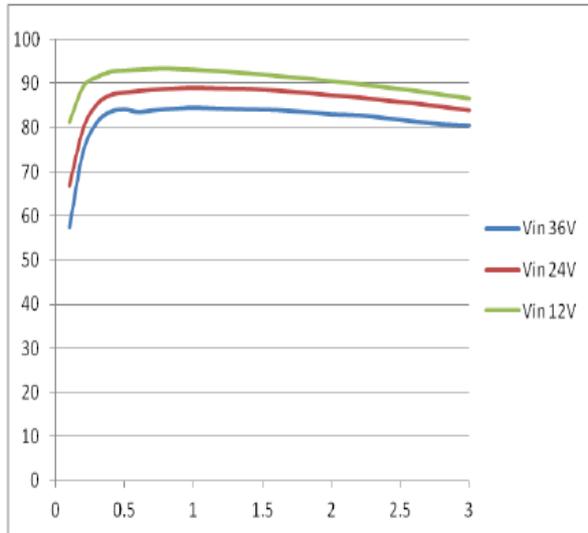Note (3): When V_{IN}=4.8V, V_{OUT}=3.3V, only load 1.2A.
Note (4): Guaranteed by design.
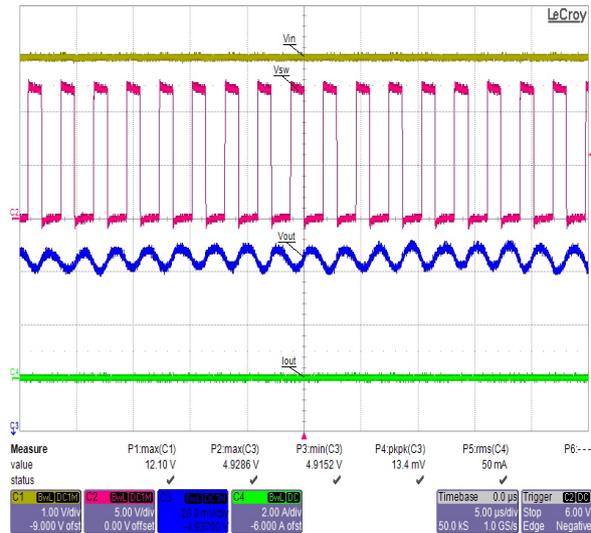
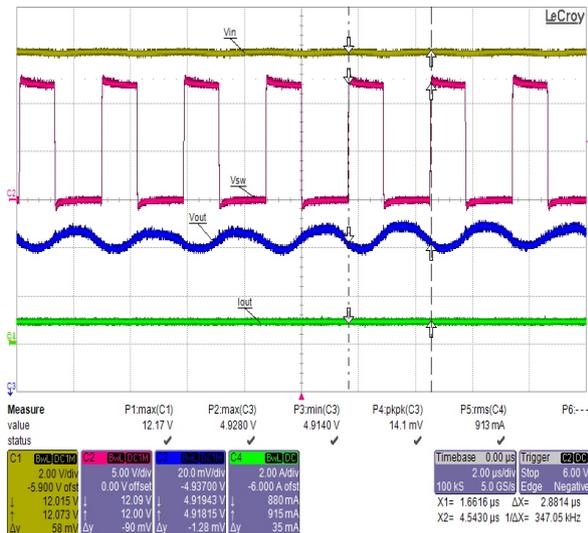## Typical Application Circuit
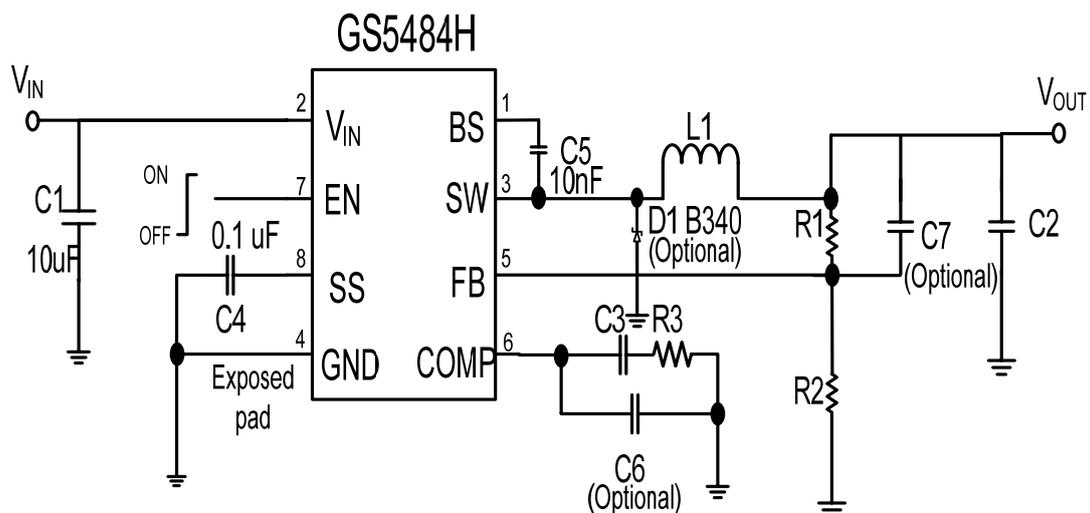
Typical Performance Characteristics

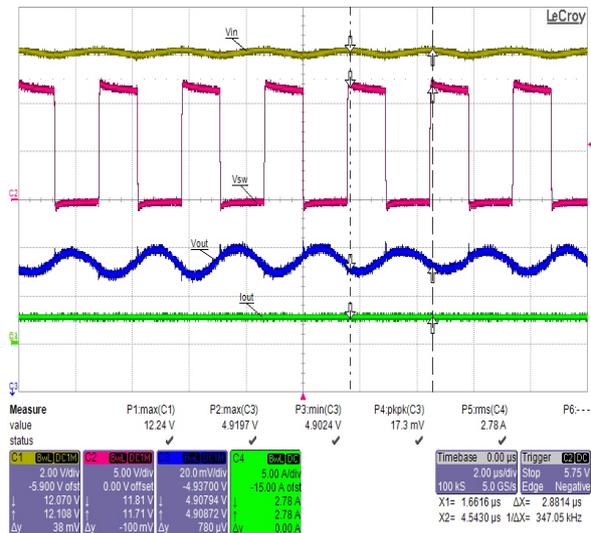(C1=10uF, C2=22uF*2, L1=10uH, C4=NA, T$_A$=25℃, unless otherwise noted)
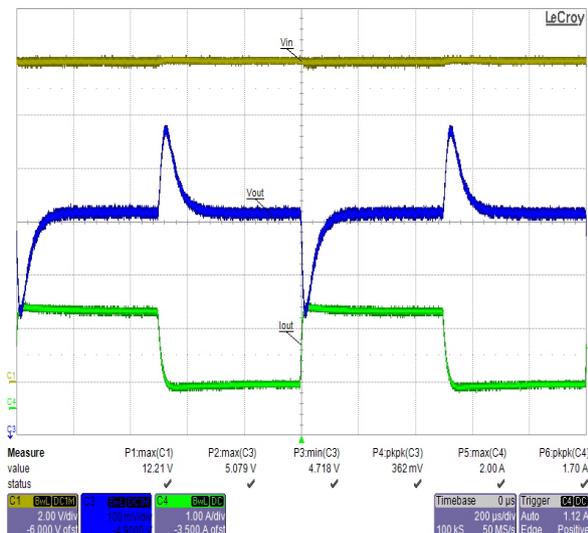

Efficiency (V$_{OUT}$=5V)

Steady State (V$_{IN}$=12V, V$_{OUT}$=5V, I$_{OUT}$=0A)

Steady State (V$_{IN}$=12V, V$_{OUT}$=5V, I$_{OUT}$=1A)

Steady State (V$_{IN}$=12V, V$_{OUT}$=5V, I$_{OUT}$=3A)

Load Transient (V$_{IN}$=12V, V$_{OUT}$=5V, I$_{OUT}$=0.5A to 2A)
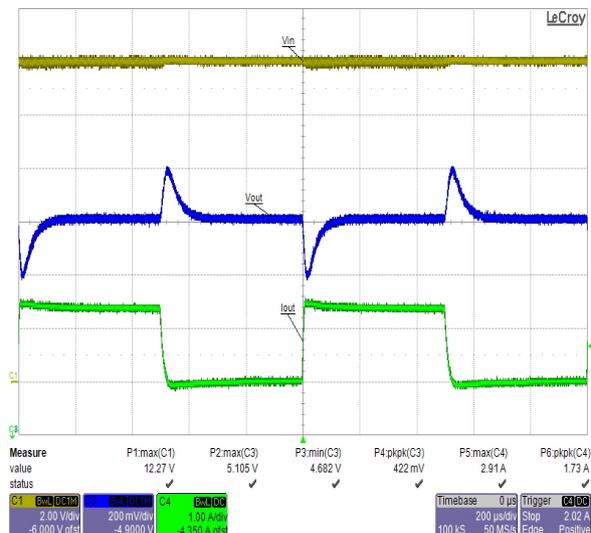
Load Transient (V$_{IN}$=12V, V$_{OUT}$=5V, I$_{OUT}$=1.5A to 3A)

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Application Information

Function Description

The GS5484H is a constant frequency current mode boost asynchronous DC/DC converter. It regulates input voltage from 4.8V to 40V, boost to an output voltage as high as 1V, and can provide up to 3A of continuous load current.

Control Loop

During normal operation, the output voltage is sensed at FB pin through a resistive voltage divider and amplified through the error amplifier. The voltage of error amplifier output pin – COMP is compared to the switch current to controls the RS latch. At each cycle, the high side NMOS would be turned on when the oscillator sets the RS latch and would be turned off when current comparator resets the RS latch. When the load current increases, the FB pin voltage drops below 0.935V, it causes the COMP voltage increase until average inductor current arrive at new load current.

Enable

The GS5484H EN pin provides digital control to turn on/turn off the regulator. When the voltage of EN exceeds the threshold voltage, the regulator starts the soft start function. If the EN pin voltage is below than the threshold voltage, only the bandgap voltage is alive. If the EN pin voltage is below than the shutdown threshold voltage, the regulator will be disable and into the shutdown mode.

Maximum Load Current

The maximum load current decreases at lower input voltage because of large IR drop on the high side switch and low side switch. The slope compensation signal reduces the peak inductor current as a function of the duty cycle to prevent sub-harmonic oscillations at duty cycles greater than 50%.

Output Over Voltage Protection

When the FB pin voltage exceeds 20% of the regulation voltage, the output over voltage protection function will discharge the COMP pin and the SS pin to GND, turning the high side MOSFET off.

Input Under Voltage Lockout

When the GS5484H power on, the internal circuits are held inactive until V_{IN} exceeds the input UVLO threshold voltage. And the regulator will be disabled when V_{IN} below the input UVLO threshold voltage.

Short Circuit Protection

The GS5484H provides short circuit protection function to prevent the device damage from short condition. When the output short to ground, the oscillator frequency is reduced to prevent the inductor current increasing beyond the current limit. In the meantime, the current limit is also reduced to lower the short current. Once the short condition is removed, the frequency and current limit will return to normal.

Over Temperature Protection

The GS5484H incorporates an over temperature protection circuit to protect itself from overheating. When the junction temperature exceeds the thermal shutdown threshold temperature, the regulator will be shutdown.

Compensation

The stability of the feedback circuit is controlled through COMP pin. The compensation value of the application circuit is optimized for particular requirements. If different conversions are requires, some of the components may need to be changes to ensure stability.

Application Information (Continue)

Output Voltage Setting

The output voltage V_{OUT} is set by a resistive divider from the output to FB. The FB pin regulated voltage is 0.935V. Thus the output voltage is:

$$V_{OUT} = 0.935x \left(1 + \frac{R1}{R2} \right)$$

R2 recommended value is 10kΩ, so R1 is determined by:

$$R1 = 10.7x(V_{OUT} - 0.935) \text{ k}\Omega$$

Table1 lists recommended value of R1 and R2 for most used output voltage.

V_{OUT}	R1	R2
12V	46.2 kΩ	3.9 kΩ
5V	43.5 k	10 k
3.3V	40.5 k	16 k
2.5V	12.6 k	7.5 k
1.8V	11.1 k	12 k

Table1 Recommended Resistance Values

Place resistors R1 and R2 close to FB pin to prevent stray pickup.

Input Capacitor Selection

The use of the input capacitor is controlling the input voltage ripple and the MOSFETS switching spike voltage. Because the input current to the step-down converter is discontinuous, the input capacitor is required to supply the current to the converter to keep the DC input voltage. The capacitor voltage rating should be 1.25 times to 1.5 times greater than the maximum input voltage. The input capacitor ripple current RMS value is calculated as:

$$I_{IIN(RMS)} = I_{OUT} \times \sqrt{D \times (1-D)}$$

Where D is the duty cycle and the value is V_{OUT} / V_{IN}. A low ESR capacitor is required to keep the noise minimum. Ceramic capacitors are better, but tantalum or low ESR electrolytic capacitors may also suffice. When using tantalum or electrolytic capacitors, a 0.1uF ceramic capacitor should be placed as close to the IC as possible.

Output Capacitor Selection

The output capacitor is used to keep the DC output voltage and supply the load transient current. Low ESR capacitors are preferred. Ceramic, tantalum or low ESR electrolytic capacitors can be used, depends on the output ripple requirement. Add a 100uF or 470uF low ESR electrolytic capacitor when operated in high input voltage range ($V_{IN} > 20V$). It can improve the device's stability. The output ripple voltage ΔV_{OUT} is described as:

$$\Delta V_{OUT} = \frac{V_{OUT}}{fs \cdot L} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}} \right) \cdot \left(R_{ESR} + \frac{1}{8 \cdot fs \cdot C_2} \right)$$

Where f_S is the switching frequency, L is the inductance value, V_{IN} is the input voltage, V_{OUT} is the output voltage, R_{ESR} is the equivalent series resistance value of the output capacitor, and the C2 is the output capacitor. When using the ceramic capacitors, the R_{ESR} can be ignored and the output ripple voltage ΔV_{OUT} is shown as:

$$\Delta V_{OUT} = \frac{V_{OUT}}{8 \cdot f_S^2 \cdot L \cdot C_2} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}} \right)$$

The characteristics of the output capacitor also affect the stability of the regulation system. The GS5484H can be optimized for a wide range of capacitance and ESR values.

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Application Information (Continue)

Inductor

The output inductor is used for store energy and filter output ripple current. A large value inductor will result in less ripple current and lower output ripple voltage. But the trade-off condition often happens between maximum energy storage and the physical size of the inductor. The first consideration for selecting the output inductor is to make sure that the inductance is large enough to keep the converter in the continuous current mode. That will lower ripple current and results in lower output ripple voltage. A good rule for determining the inductance is set the peak-to-peak inductor ripple current ΔI almost equal to 30% of the maximum load current. Then the minimum inductance can be calculated with the following equation:

$$L \geq \frac{V_{OUT}}{f_S \cdot \Delta I} \cdot \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

$$\Delta I = 0.3 \times I_{LOAD(MAX)}$$

Where V_{IN} is the input voltage, f_S is the switching frequency, ΔI is the peak-to-peak inductor ripple current and $I_{LOAD(MAX)}$ is the maximum load current. Choose an inductor that will cause the peak inductor current satisfying the equation:

$$I_{LP} = I_{LOAD(MAX)} + \frac{V_{OUT}}{2 \cdot f_S \cdot L}\left(1 - \frac{V_{OUT}}{V_{IN}}\right) \leq I_{LIMIT}$$

Where $I_{LIMI}T$ is the high-side MOSFET current limit value.

Optional Schottky Diode

During the transition between switching MOSFETs, the body diode of the low-side MOSFET conducts the inductor current. The forward voltage of this body diode is large. An optional Schottky diode may be connected between SW pin and GND pin to improve overall efficiency.

Compensation Components

The system stability and transient response are controlled through the COMP pin. Selecting the appropriate compensation value by the following procedure:

1. Calculate the R3 value with the following equation:

$$R_3 < \frac{2\pi \cdot C_2 \cdot f_S \cdot V_{OUT}}{10 \cdot G_{EA} \cdot G_{CS} \cdot V_{FB}}$$

where G_{EA} is the error amplifier transconductance, and G_{CS} is the current sense transconductance.

2. Calculate the C3 value with the following equation:

$$C_3 > \frac{4 \cdot 10}{2\pi \cdot R_3 \cdot f_S}$$

3. If the C_2 ESR zero is less than half of the switching frequency, use C_6 to cancel the ESR zero:

$$C_6 = \frac{C_2 \times R_{ESR}}{R_3}$$

External Boost Diode Selection

For input voltage lower than 5.5V or duty cycle larger than 65% applications, it is recommended that an external boost diode be added. This helps improve the efficiency. The boost diode can be a low cost one such as 1N4148.
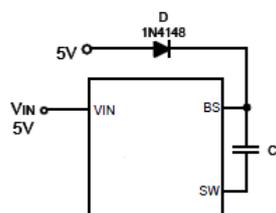
PCB Layout Recommendation

The device's performance and stability is dramatically affected by PCB layout. It is recommended to follow these general guidelines show bellow:

1. Place the input capacitors, output capacitors as close to the device as possible. Trace to these capacitors should be as short and wide as possible to minimize parasitic inductance and resistance.

2. Place V_{IN} bypass capacitors close to the V_{IN} pin.

3. Place feedback resistors close to the FB pin.

4. Place compensation components close to the COMP pin.

5. Keep the sensitive signal (FB, COMP) away from the switching signal (SW).

6. The exposed pad of the package should be soldered to an equivalent area of metal on the PCB. This area should connect to the GND plane and have multiple via connections to the back of the PCB as well as connections to intermediate PCB layers. The GND plane area connects to the exposed pad should be maximized to improve thermal performance.

7. Multi-layer PCB design is recommended.
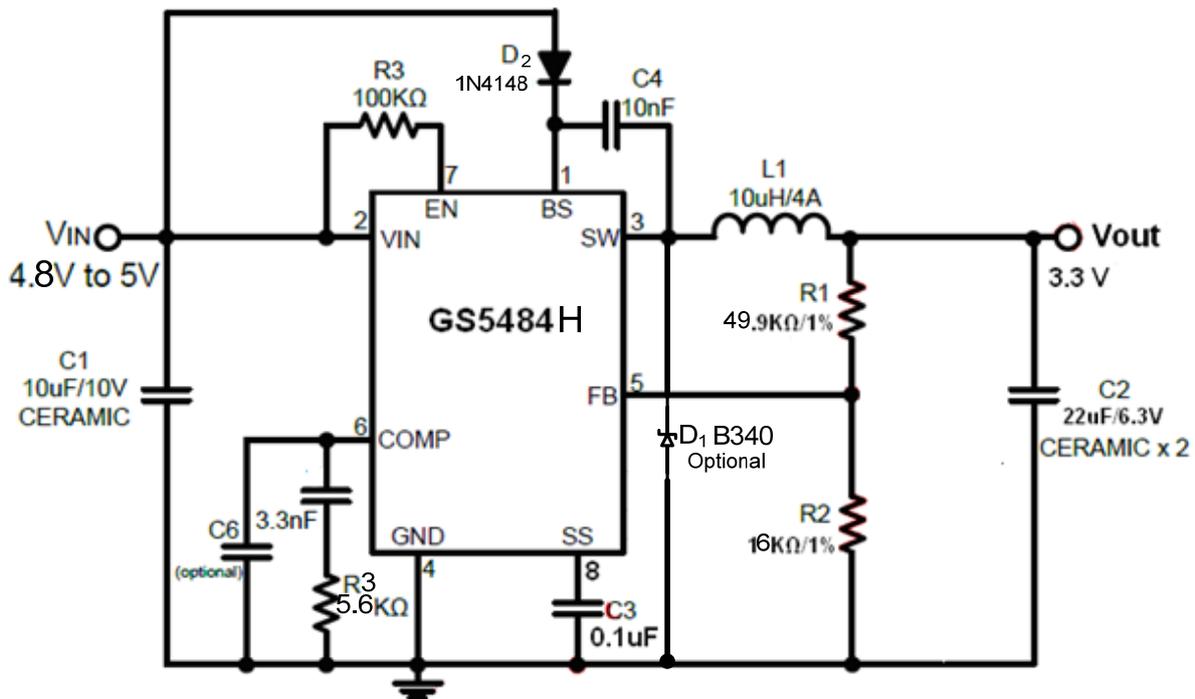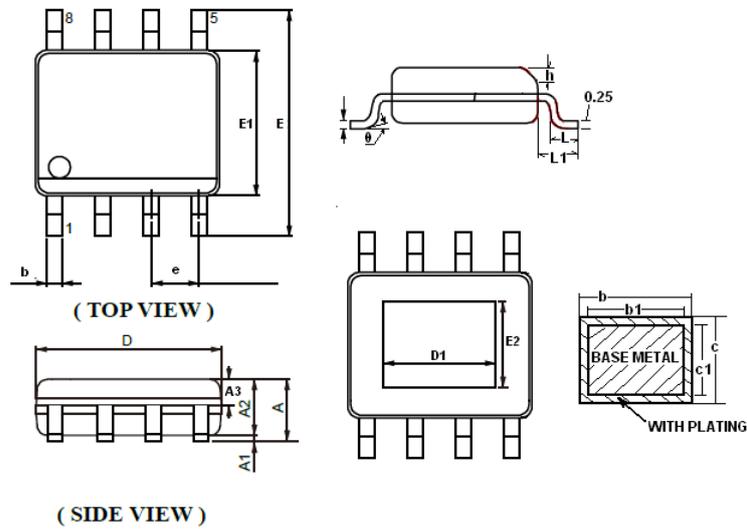
Typical Application Circuit

Figure 2 Low Input Voltage Application Circuit

Package Dimension

(PSOP-8)

(TOP VIEW)

(SIDE VIEW)

Dimensions

SYMBOL	Millimeters			Inches		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	1.75	-	-	0.069
A1	0.05	-	0.15	0.002	-	0.006
A2	1.3	1.4	1.5	0.051	0.055	0.059
A3	0.6	0.65	0.7	0.024	0.026	0.028
b	0.39	-	0.48	0.015	-	0.019
b1	0.38	0.41	0.43	0.015	0.016	0.017
c	0.21	-	0.26	0.008	-	0.010
c1	0.19	0.2	0.21	0.007	0.008	0.008
D	4.84	-	5.025	0.189	-	0.196
D1	2.8	2.90	3.0	0.102	0.114	0.118
E	5.8	6	6.2	0.228	0.236	0.244
E1	3.7	3.9	4.1	0.146	0.154	0.161
E2	1.9	2.0	2.1	0.075	0.079	0.083
e	1.27 BSC			0.050		
h	0.25	-	0.5	0.010	-	0.020
L	0.5	-	0.8	0.020	-	0.031
L1	1.05 BSC			0.041		
θ	0	-	8	0	-	8

GS5484H

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NOTICE

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