GS5581A

1.5MHz, 1A Synchronous Step-Down Converter

Product Description

The GS5581A is a high efficiency, DC-to-DC step-down switching converter, capable of delivering up to 1A of output current. The devices operate from an input voltage range of 2.7V to 5.5V making the GS5581A ideal for low voltage power conversions.

Running at a fixed frequency of 1.5MHz allows the use of small inductance value and low DCR inductors, thereby achieving higher efficiencies. Other external components, such as ceramic input and output caps, can also be small due to higher switching frequency, while maintaining exceptional low noise output voltages.

Built-in EMI reduction circuitry makes this converter ideal power supply for RF applications. Internal soft-start control circuitry reduces inrush current. Short-circuit and thermal-overload protection improves design reliability.

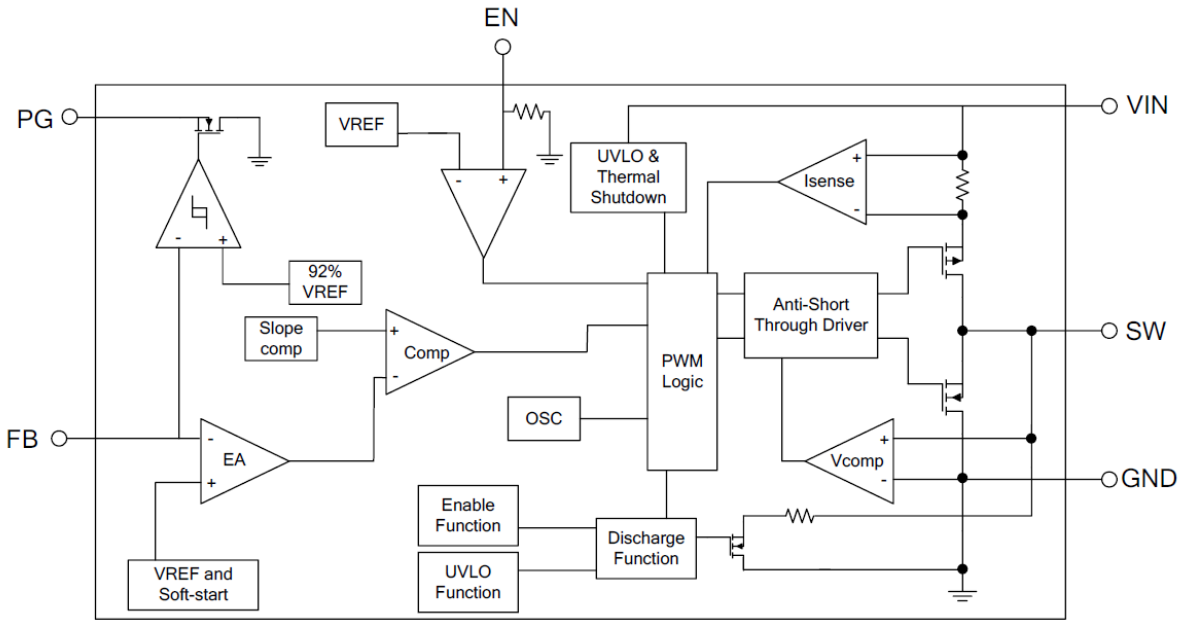
Features

- 100% Duty Operation
- Fixed 1.5MHz Switching Frequency
- 1A Output Current
- Light Load Operation
- 2.7V to 5.5V Input Voltage Range
- Internal Compensation
- Tiny DFN2x2-6L and SOT23-5L Packages
- RoHS Compliant, 100%Pb & Halogen Free

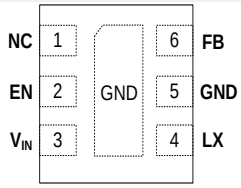
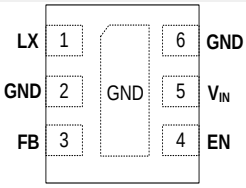
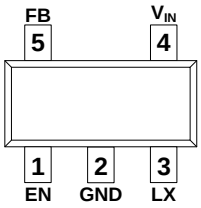
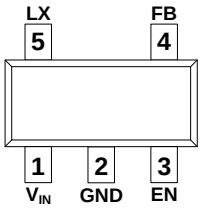
Applications

- Cellular and Smart Phones
- Set Top Boxes
- Hot Swaps
- USB ports/Hubs
- Tablet PC

Block Diagram

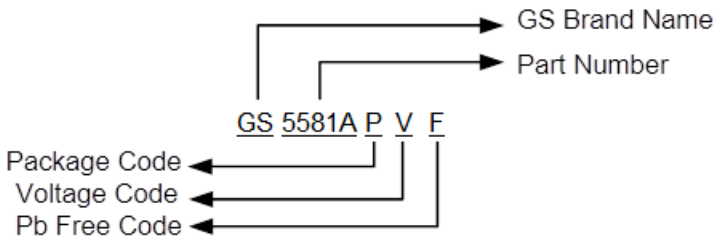


Packages & Pin Assignments

GS5581AFAF(DFN2x2-6L)	GS5581AFBF(DFN2x2-6L)
 (Top View)	 (Top View)
GS5581ALAF(SOT23-5L)	**GS5581ALBF(SOT23-5L)**
 (Top View)	 (Top View)

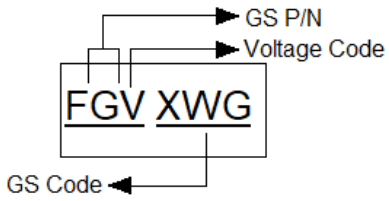
Pin Name	Description
EN	Chip Enable Pin. Drive EN above 1.5V to turn on the part. Drive EN below 0.4V to turn it off. Do not leave EN floating.
GND	Analog ground pin.
LX	Power Switch Output. It is the switch node connection to Inductor. This pin connects to the drains of the internal P-ch and N-ch MOSFET switches.
V_{IN}	Analog supply input pin.
NC	No connected.
FB	Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage.

Ordering Information



Part Number	Temperature Range	Output Voltage	Package
GS5581AFAF	-40ºC to 85ºC	ADJ	DFN2x2-6L
GS5581AFBF	-40ºC to 85ºC	ADJ	DFN2x2-6L
GS5581ALAF	-40ºC to 85ºC	ADJ	SOT23-5L
GS5581ALBF	-40ºC to 85ºC	ADJ	SOT23-5L

Marking Information

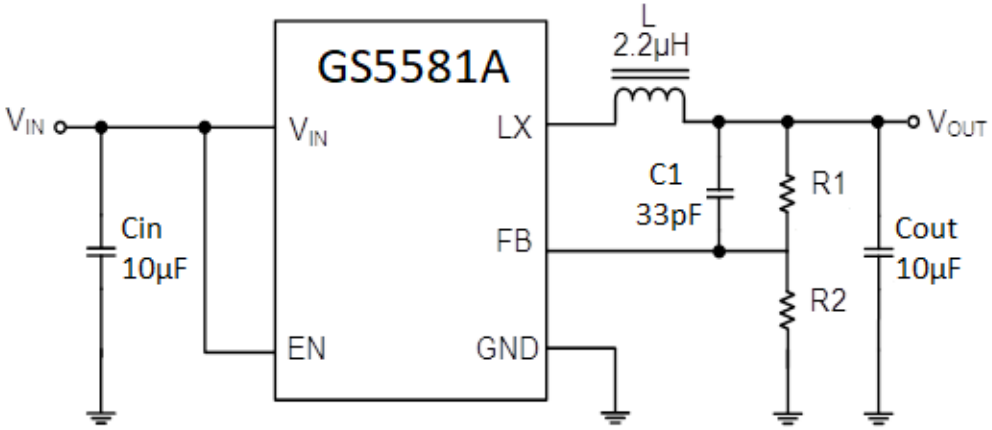


Part Number	Package	GS P/N	Voltage Code	GS Code
GS5581AFAF	DFN2x2-6L	FG	A	XWG
GS5581AFBF	DFN2x2-6L	FG	B	XWG
GS5581ALAF	SOT23-5L	FG	A	XWG
GS5581ALBF	SOT23-5L	FG	B	XWG

Absolute Maximum Ratings (Note 1)

Symbol	Description	Value		Units
V_{IN}	Supply Voltage	-0.3 to 6.0		V
	LX, FB, EN Voltages	-0.3 to 6.0		V
T_A	Operating Temperature Range	-40 to +85		°C
T_J	Junction Temperature **(Note 2)**	-40 to +125		°C
T_{STG}	Storage Temperature Range	-65 to +150		°C
T_{LEAD}	Lead Temperature	260		°C
$V_{(ESD)}$	HBM(Human Body Mode)	±2000		V
	MM(Machine Mode)	±200		
θ_{JA}	Thermal Resistance Junction to Ambient	DFN2x2-6L	78	ºC/W
		SOT-23-5L	167	

Typical Application Circuit



Electrical Characteristics

(V_{IN} = 5V, unless otherwise specified. Typical values are at TA = 25°C)

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage	-	2.7	-	5.5	V
I_{OFF}	Input Shutdown Current	V_{EN}=GND	--	-	1	μA
I_{IN}	Input Supply Current	V_{FB} =0.65V	-	150	-	μA
V_{FB}	Feedback Voltage	V_{IN}=2.7 to 5V	0.591	0.600	0.609	V
I_{FB}	FB Input Current		-	0.01	-	μA
D_{MAX}	Maximum Duty		100			%
I_{PK}	Switch Current Limit of PMOS		-	2.2	-	A
V_{UVLO}	UVLO Threshold	V_{IN} Rising, Hysteresis=180mV	-	2.5	-	V
V_{EN_H}	V_{EN} High-level Input Voltage		1.5	-	-	V
V_{EN_L}	V_{EN} Low-level Input Voltage			--	0.4	V
I_{EN}	I_{EN} Input Current	V_{EN}=2V	-	-	1.0	μA
$R_{DS(ON)H}$	On Resistance of PMOS	I_{SW}=200mA	-	0.14	-	Ω
$R_{DS(ON)L}$	ON Resistance of NMOS		-	0.12	-	
$T_{ON(MIN)}$	Minimum On Time			70		ns
tss	Soft-Start interval			1		ms
R_{DCHG}	Output Discharge Switch On Resistance	V_{EN}=LOW		80		Ω
F_{OSC}	Oscillator Frequency		-	1.5	-	MHz
F_{FB}	Fold-back Switching Frequency		-	370	-	KHz
I_{SW}	SW Leakage Current	V_{IN}=5.5V V_{LX}=5Vor GND V_{FB}=0.65V	-	-	10	μA
T_{SD}	Thermal Shutdown			160		°C

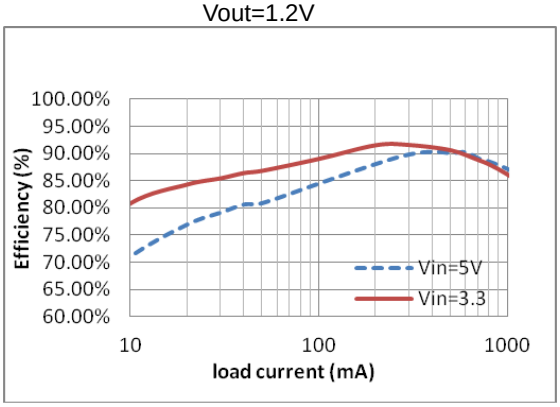
Note 1: Stresses listed as the above "Absolute Maximum Ratings" may cause permanent damage to the device. These are for stress ratings. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may remain possibility to affect device reliability.

Typical Performance Characteristics

T_A=25ºC, unless Otherwise noted

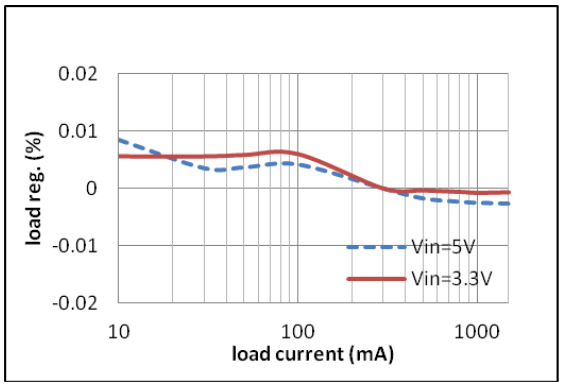
Efficiency V.S Load Current

Vout=1.2V



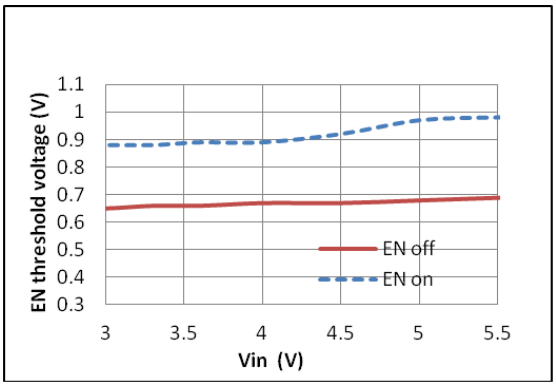
Load Regulation

Vout=1.2V

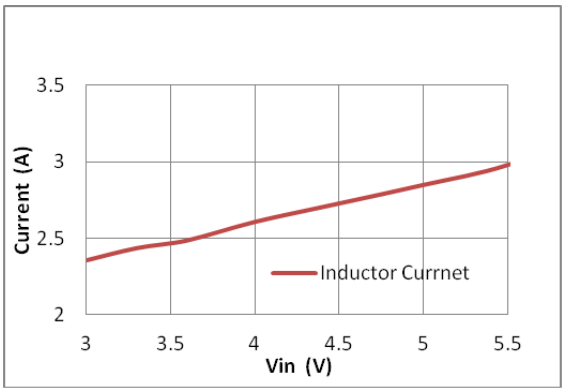


Current Limit vs. Input voltage

Vout=1.2V

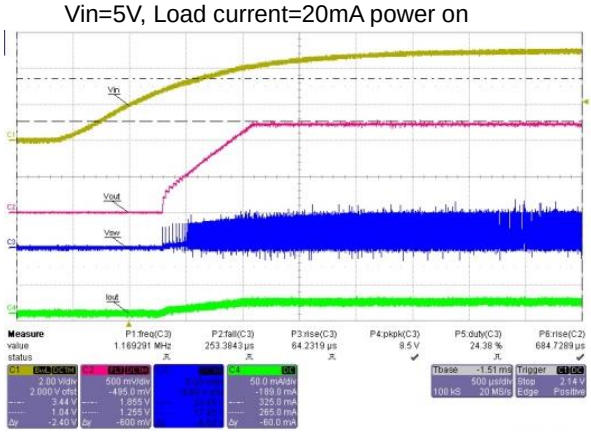


Enable Threshold Voltage vs. Input voltage



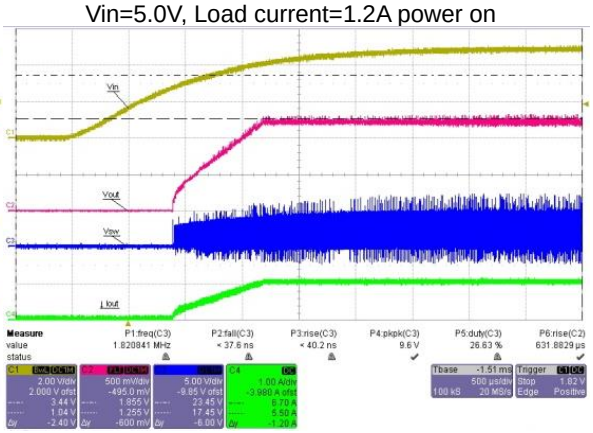
Power On from EN

Vin=5V, Load current=20mA power on



Power On from EN

Vin=5.0V, Load current=1.2A power on

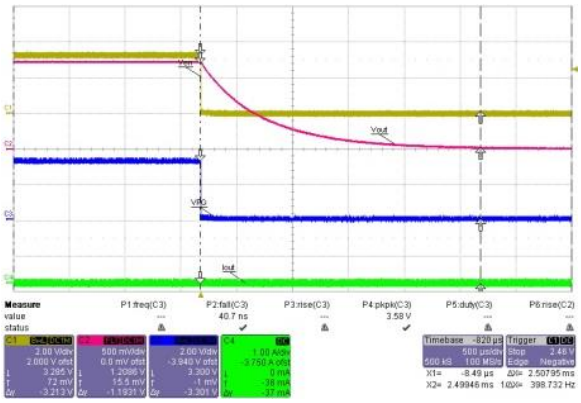


Typical Performance Characteristics (Continue)

T_A=25ºC, unless Otherwise noted

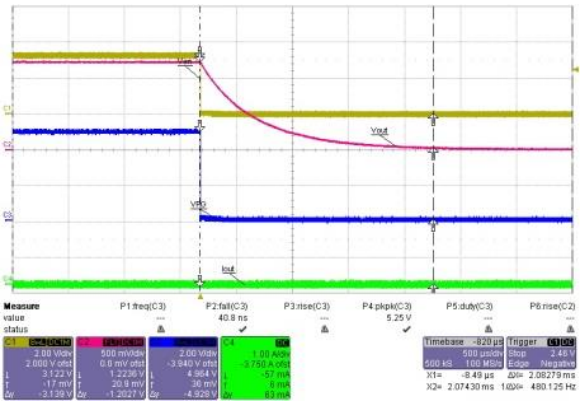
Power Off from EN

Vin=3.3V, no load, Eanble off



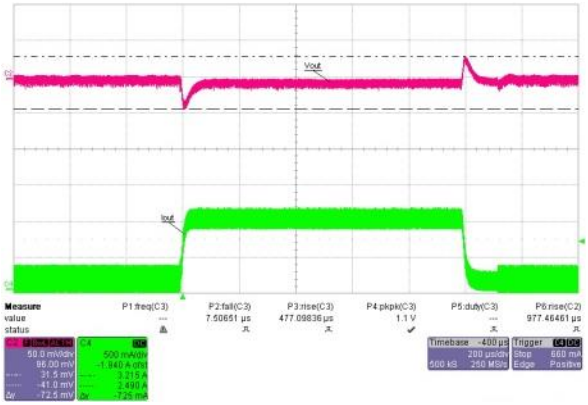
Power Off from EN

Vin=5.0V, no load, Eanble off



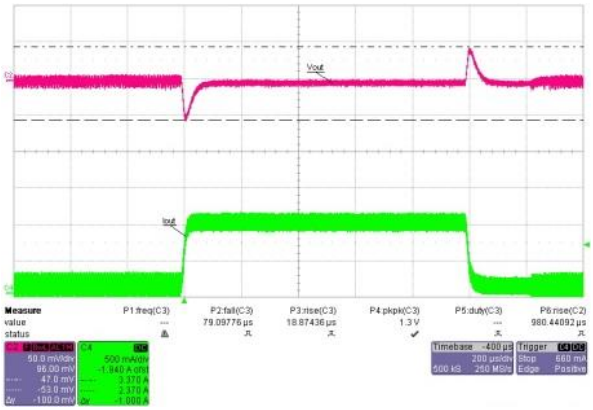
Load Transient (C_{FB}=33pF)

Vin=3.3V, Vout=1.2V, Iout=0.1A to 1 A



Load Transient (C_{FB}=33pF)

Vin=5.0V, Vout=1.2V, Iout=0.1A to 1 A



Functional Description

The GS5581A high efficiency switching regulator is a small, simple, DC-to-DC step-down converter capable of delivering up to 1A of output current. The device operates in pulse-width modulation (PWM) at 1.5MHz from a 2.7V to 5.5V input voltage and provides an output voltage from 0.6V to VIN, making the GS5581A ideal for on-board post-regulation applications. An internal synchronous rectifier improves efficiency and eliminates the typical Schottky free-wheeling diode. Using the on resistance of the internal high-side MOSFET to sense switching currents eliminates current-sense resistors, further improving efficiency and cost.

Loop Operation

GS5581A uses a PWM current-mode control scheme. An open-loop comparator compares the integrated voltage-feedback signal against the sum of the amplified current-sense signal and the slope compensation ramp.

At each rising edge of the internal clock, the internal high-side MOSFET turns on until the PWM comparator terminates the on cycle. During this on-time, current ramps up through the inductor, sourcing current to the output and storing energy in the inductor.

The current mode feedback system regulates the peak inductor current as a function of the output voltage error signal.

During the off cycle, the internal high-side P-channel MOSFET turns off, and the internal low-side N-channel MOSFET turns on. The inductor releases the stored energy as its current ramps down while still providing current to the output.

Current Sense

An internal current-sense amplifier senses the current through the high-side MOSFET during on time and produces a proportional current signal, which is used to sum with the slope compensation signal. The summed signal then is compared with the error amplifier output by the PWM comparator to terminate the on cycle.

Current Limit

There is a cycle-by-cycle current limit on the high-side MOSFET. When the current flowing out of SW exceeds this limit, the high-side MOSFET turns off and the synchronous rectifier turns on.

GS5581A utilizes a frequency fold-back mode to prevent overheating during short-circuit output conditions. The device enters frequency fold-back mode when the FB voltage drops below 250mV, limiting the current to I_{PEAK} and reducing power dissipation. Normal operation resumes upon removal of the short-circuit condition.

Soft-start

GS5581A has an internal soft-start circuitry to reduce supply inrush current during startup conditions. When the device exits under-voltage lockout (UVLO), shutdown mode, or restarts following a thermal-overload event, the l soft-start circuitry slowly ramps up current available at SW.

UVLO and Thermal Shutdown

If VIN drops below 2.5V, the UVLO circuit inhibits switching. Once VIN rises above 2.7V, the UVLO clears, and the soft-start sequence activates. Thermal-overload protection limits total power dissipation in the device.

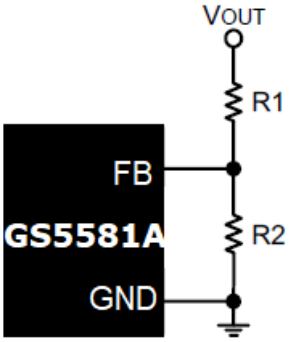
When the junction temperature exceeds T_J= +160°C, a thermal sensor forces the device into shutdown, allowing the die to cool.

The thermal sensor turns the device on again after the junction temperature cools by 60°C, resulting in a pulsed output during continuous overload conditions. Following a thermal-shutdown condition, the soft-start sequence begins.

Applications Information

Setting the Output Voltage

The resistive voltage divider allows the FB pin to sense a fraction of the output voltage shown as below.



For adjustable voltage mode, the output voltage is set by an external resistive voltage divider according to the following equation:

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

The peak-to-peak ripple is set to 30% of the output current. This places the peak current far enough from the minimum over current trip level to ensure reliable operation while providing enough current ripples for the current mode converter to operate stably. The inductance is determined as expressed in the following equation:

$$L \geq \frac{(V_{IN}-V_{OUT})\times D}{\Delta I_L \times f_{SW}}$$

Where

ΔI_L is the inductor peak-to-peak ripple current

D is the duty cycle determined by V_{OUT}/V_{IN}

f_{SW} is the switching frequency

Output Capacitor Selection

For most applications a nominal 10μF or 22μF capacitor is suitable. The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and Tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance. Output ripple with a ceramic output capacitor is approximately as follows:

$$\Delta V_{OUT} \leq \Delta I_L\left[ESR+\frac{1}{8fC_{OUT}}\right]$$

Input Capacitor Selection

The input capacitance, CIN, is needed to filter the trapezoidal current at the source of the top MOSFET. To prevent large ripple current, a low ESR input capacitor sized for the maximum RMS current should be used. The RMS current is given by :

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

This formula has a maximum at $V_{IN} = 2V_{OUT}$, where $I_{RMS} = I_{OUT} / 2$.

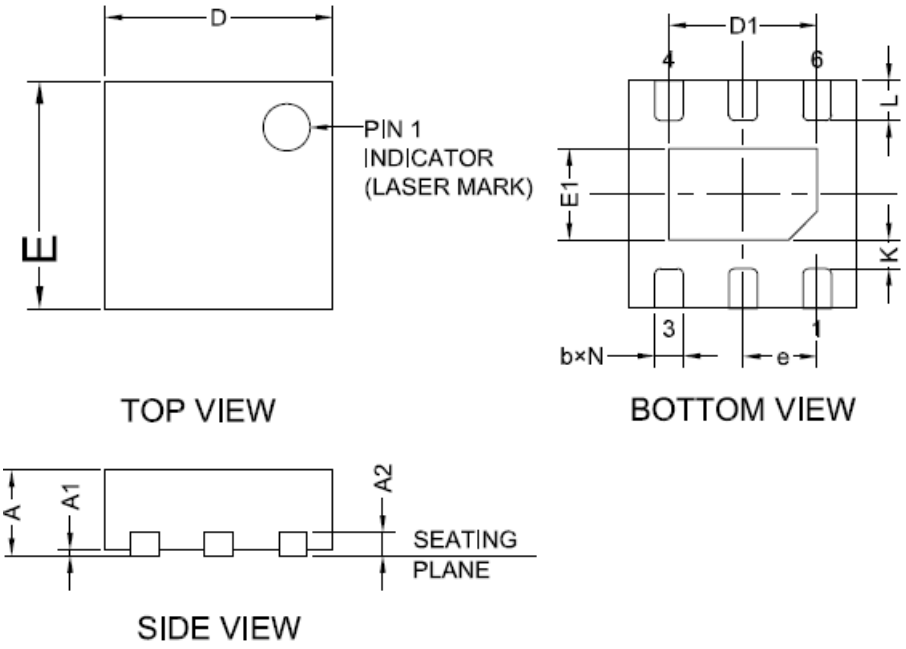
This simple worst-case condition is commonly used for design because even significant deviations do not offer much relief. Choose a capacitor rated at a higher temperature than required.

Higher values, lower cost ceramic capacitors are now becoming available in smaller case sizes. Their high ripple current, high voltage rating and low ESR make them ideal for switching regulator applications.

When a ceramic capacitor is used at the input and the power is supplied by a wall adapter through long wires, a load step at the output can induce ringing at the input, VIN. At best, this ringing can couple to the output and be mistaken as loop instability.

Package Dimension

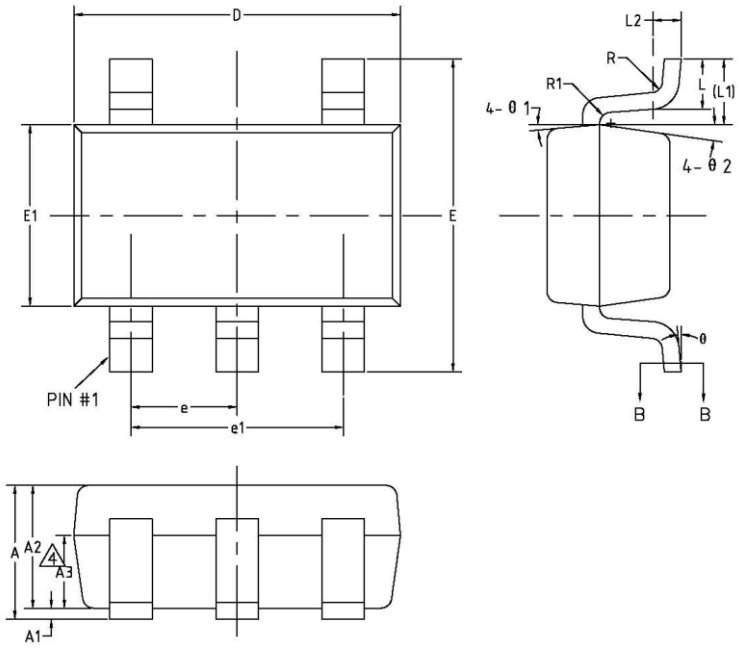
DFN2x2-6L PLASTIC PACKAGE



Dimensions						
SYMBOL	Millimeters			Inches		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.70	0.75	0.80	0.028	0.030	0.031
A1	0.00	0.02	0.05	0.000	0.001	0.002
A2		0.203			0.008	
b	0.20	0.25	0.30	0.008	0.010	0.012
D	1.95	2.00	2.05	0.077	0.079	0.081
D1	1.20	1.30	1.40	0.047	0.051	0.055
e		0.65 BSC			0.026 BSC	
E	1.95	2.00	2.05	0.077	0.079	0.081
E1	0.70	0.80	0.90	0.028	0.031	0.035
L	0.30	0.35	0.40	0.012	0.014	0.016
K	0.20	-	-	0.008	-	-
N		6			6	

Package Dimension

SOT23-5L PLASTIC PACKAGE



Dimensions				
SYMBOL	Millimeters		Inches	
	MIN	MAX	MIN	MAX
A	-	1.45	-	0.057
A1	0.00	0.15	0.000	0.006
A2	0.90	1.30	0.035	0.051
A3	0.60	0.70	0.024	0.028
b	0.39	0.49	0.015	0.019
b1	0.38	0.45	0.015	0.018
c	0.12	0.19	0.005	0.007
c1	0.11	0.15	0.004	0.006
D	2.85	3.05	0.112	0.120
E	2.60	3.00	0.102	0.118
E1	1.55	1.75	0.061	0.069
e	0.85	1.05	0.033	0.041
e1	1.80	2.00		
L	0.35	0.60	0.014	0.024
L1	0.59 REF		0.023 REF	
L2	0.25 BSC		0.010 BSC	
θ	0°	8°	0°	8°

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CONTACT US

GS Headquarter	
	4F.,No.43-1,Lane11,Sec.6,Minquan E.Rd Neihu District Taipei City 114, Taiwan (R.O.C)
	886-2-2657-9980
	886-2-2657-3630
	sales_twn@gs-power.com

RD Division	
	824 Bolton Drive Milpitas. CA. 95035
	1-408-457-0587