GS5581/A

1.5MHz, 1A Synchronous Step-Down Converter

Product Description

The GS5581/A are high-efficiency, high frequency synchronous step-down DC-DC regulator ICs capable of delivering up to 1A output currents. The GS5581/A can operate over a wide input voltage range from 2.3V to 6V and integrates main switch and synchronous switch with very low $R_{DS(ON)}$ to minimize the conduction loss.

It is ideal for powering portable equipment that runs from a single cell Lithium-Ion (Li+) battery. The output voltage can be regulated as low as 0.6V.

The GS5581/A can also run at 100% duty cycle for low dropout operation, extending battery life in portable system. This device offers two operation modes, PWM mode and PFM Mode switching control, which allows a high efficiency over the wider range of the load.

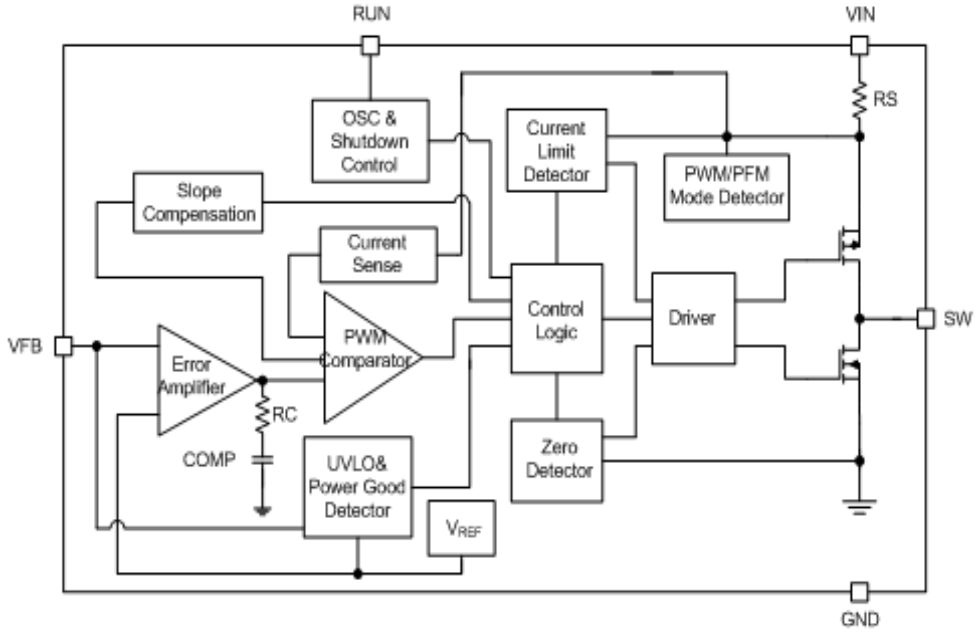
Features

- High Efficiency: Up to 96%
- 1.5MHz Constant Frequency Operation
- 1A Output Current
- No Schottky Diode Required
- 2.3V to 6V Input Voltage Range
- Adjustable Output Voltage Range Options from 0.6V to V_{IN}
- 100% Duty Cycle Low Dropout Operation
- Low Quiescent Current: 35μA
- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response
- Short Circuit Protection
- Thermal Fault Protection
- Inrush Current Limit and Soft Start
- <1μA Shutdown Current
- Tiny DFN2x2-6L and SOT-23-5L Packages
- RoHS Compliant, 100%Pb & Halogen Free

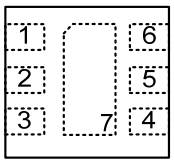
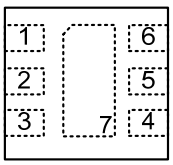
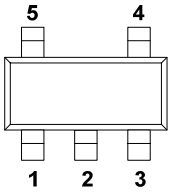
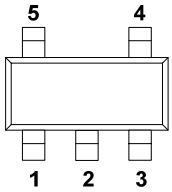
Applications

- Cellular and Smart Phones
- Wireless and DSL Modems
- PDAs
- Digital Still and Video Cameras
- MP3 Players

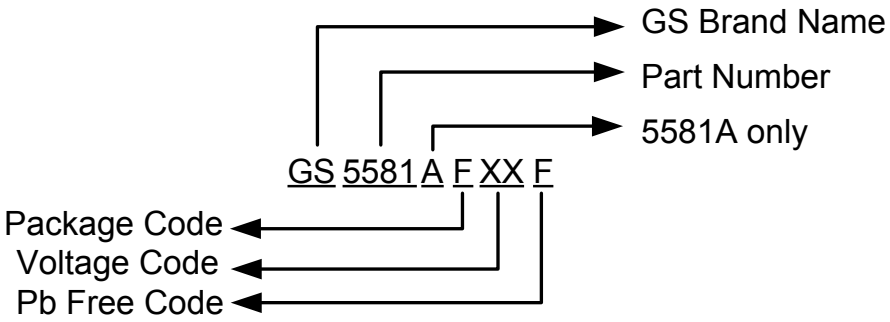
Block Diagram



Packages & Pin Assignments

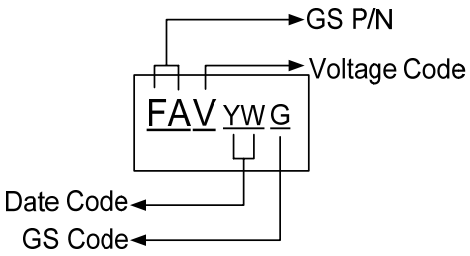
Packages / Pin Assignment		(Top View) GS5581FAF	(Top View) GS5581AFAF	GS5581LAF	GS5581LBF
					
EN	Chip Enable	2	4	1	3
GND	Ground	5、7	2、6、7	2	2
LX	Pin for Switching	4	1	3	5
V_{IN}	Power Input	3	5	4	1
FB	Feedback	6	3	5	4
NC	No Internal Connection	1	-	-	-

Ordering Information



Part Number	Output Voltage	Package
GS5581FAF	ADJ	DFN2x2-6L
GS5581AFAF	ADJ	DFN2x2-6L
GS5581LAF	ADJ	SOT-23-5L
GS5581LBF	ADJ	SOT-23-5L

Marking Information



Part Number	Package	GS P/N	Voltage Code	Date Code
GS5581FAF	DFN2x2-6L	FA	A	YW
GS5581AFAF	DFN2x2-6L	FG	A	YW
GS5581LAF	SOT-23-5L	FA	A	YW
GS5581LBF	SOT-23-5L	FA	B	YW

Absolute Maximum Ratings (Note 1)

Symbol	Description	Value		Units
V_{IN}	Supply Voltage	-0.3 to 6.5		V
	RUN,FB Voltages	-0.3 to 6.5		V
V_{SW}	SW Voltage	-0.3 to (V_{IN}+0.3)		V
I_{PK}	Peak SW sink and Source Current	2.5		A
T_A	Operating Temperature Range	-40 to +85		°C
T_J	Junction Temperature **(Note 2)**	125		°C
T_{STG}	Storage Temperature Range	-65 to +150		°C
T_{LEAD}	Lead Temperature(Soldering,10s)	300		°C
ESD	HBM(Human Body Mode)	2000		V
	MM(Machine Mode)	200		
θ_{JA}	Thermal Resistance Junction to Ambient	DFN2x2-6L	130	°C/W
		SOT-23-5L	250	

Typical Application Circuit

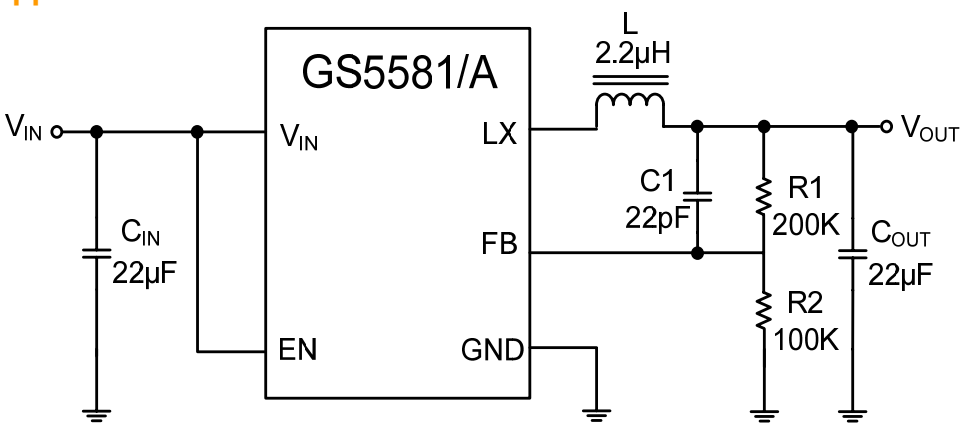


Figure1. GS5581/A Adjustable Output Voltage Regulator

Electrical Characteristics (Note 3)

V_{IN}=V_{RUN}=3.6V, V_{OUT}=1.8V, T_A = 25°C, unless otherwise noted.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
V_{IN}	Input Voltage	-	2.3	-	6	V
V_{UVLO}	UVLO Threshold	V_{IN} Rising	1.7	1.9	2.1	V
I_Q	Input DC Supply Current (PWM Mode)	V_{OUT}=90%, I_{LOAD}=0mA **(Note 4)**	-	140	300	μA
	Input DC Supply Current (PFM Mode)	V_{OUT}=105%, I_{LOAD}=0mA **(Note 4)**	-	35	70	
I_{SHDN}	Shutdown Mode	V_{RUN}=0V, V_{IN}=4.2V **(Note 4)**	-	0.1	1.0	
V_{FB}	Regulated Feedback Voltage	T_A = 25°C	0.588	0.600	0.612	V
		0°C ≤ T_A ≤ 85°C	0.586	0.600	0.613	
		-40°C ≤ T_A ≤ 85°C	0.585	0.600	0.615	
V_{EN}	V_{EN} Threshold	-	0.3	1.0	1.5	V
I_{EN}	I_{EN} Leakage Current	-	-	±0.01	±1.0	μA
I_{SW}	SW Leakage Current	V_{RUN}=0V,V_{IN}=V_{SW}=5V	-	±0.01	±1.0	μA
$R_{DS(ON)H}$	On Resistance of PMOS	I_{SW}=100mA	-	0.13	0.2	Ω
$R_{DS(ON)L}$	ON Resistance of NMOS		-	0.1	0.2	
I_{PK}	Peak Current Limit	V_{IN}= 3V, V_{OUT}=90%	-	2.0	-	A
ΔV_{FB}	Reference Voltage Line Regulation	V_{IN}=2.5V to 6V	-	0.04	0.40	%/V
REG_{LINE}	Output Voltage Line Regulation	V_{IN}=2.5V to 6V	-	0.04	0.40	%
REG_{LOAD}	Output Voltage Load Regulation	-	-	0.5	-	
F_{OSC}	Oscillation Frequency	V_{OUT}=100%, V_{OUT}=0V	-	1.5	-	MHz
			-	300	-	KHz

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

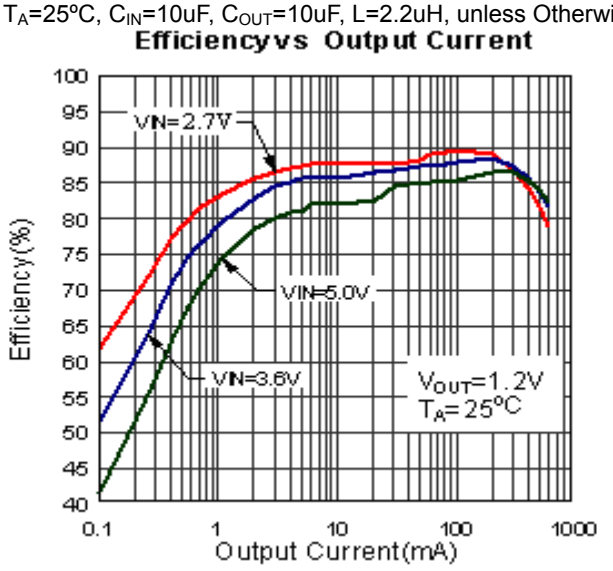
Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + (P_D) \times (\theta_{JA})$.

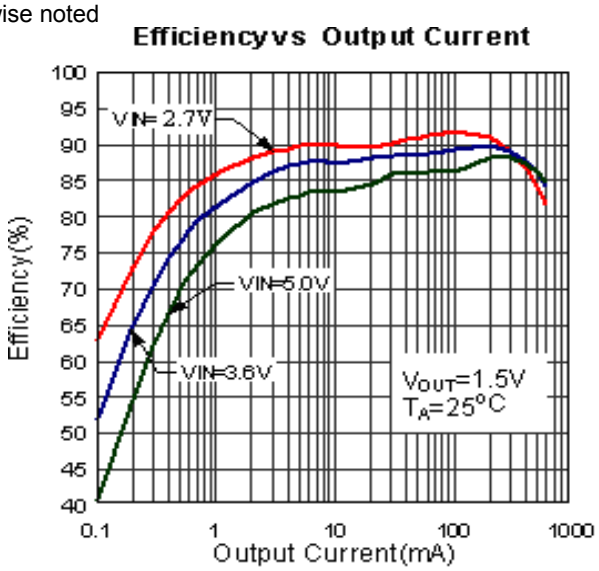
Note 3: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

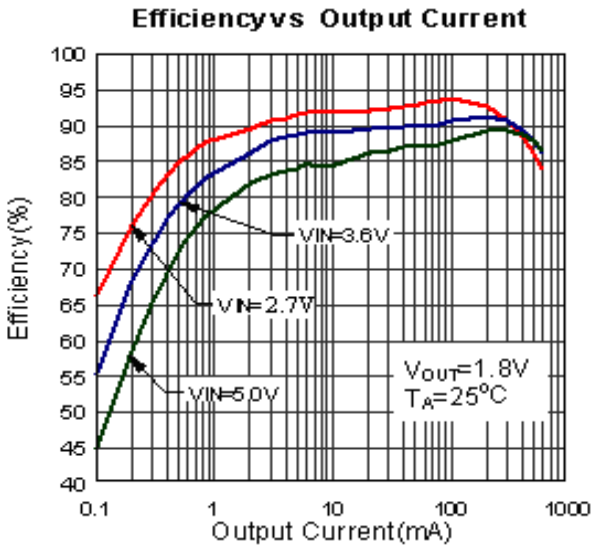
Note 4: Dynamic supply current is higher due to the gate charge being delivered at the switching frequency.

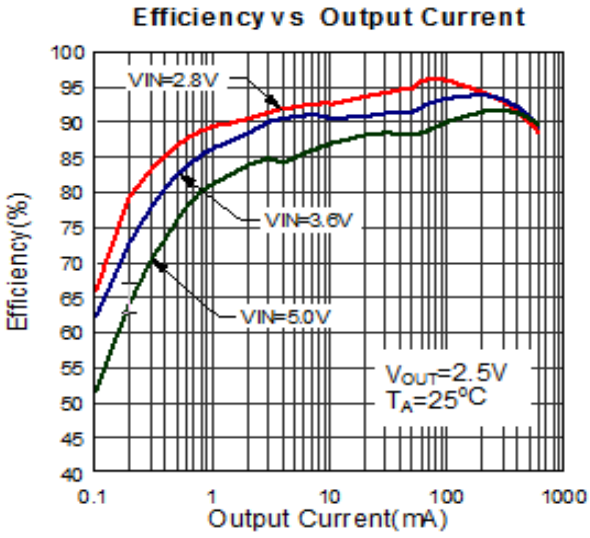
Typical Performance Characteristics

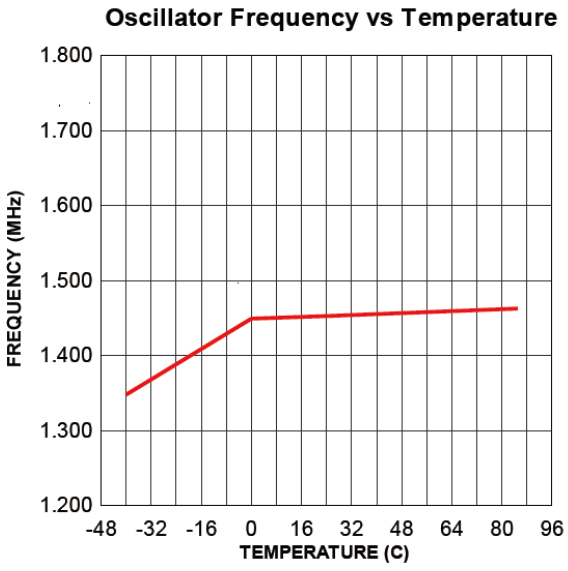
T_A=25ºC, C_{IN}=10uF, C_{OUT}=10uF, L=2.2uH, unless Otherwise noted

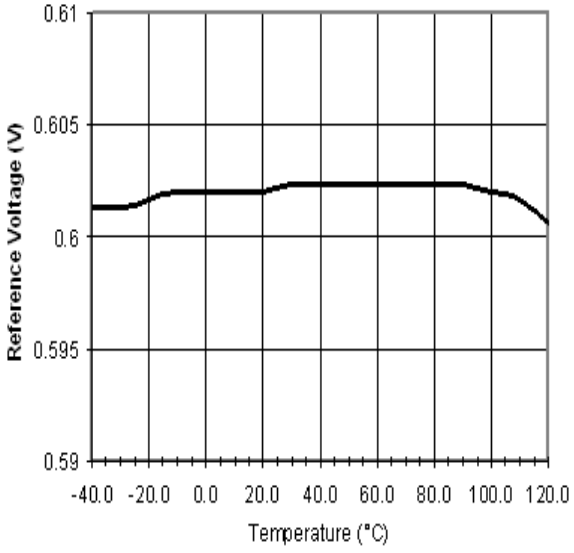








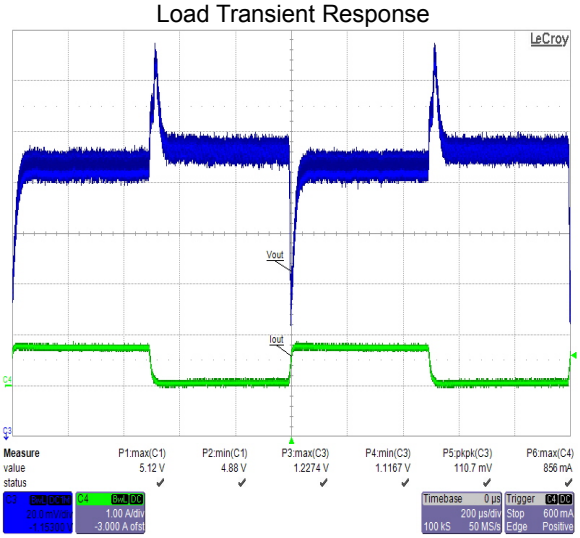




Typical Performance Characteristics **(Continue)**

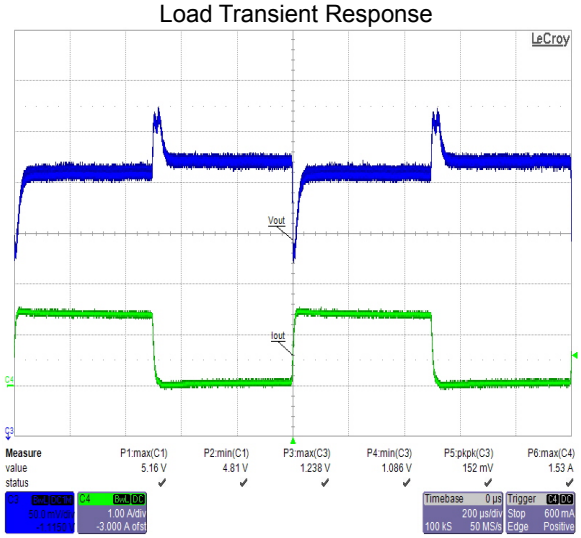
T_A=25ºC, C_{IN}=10uF, C_{OUT}=10uF, L=2.2uH, unless Otherwise noted

Load Transient Response



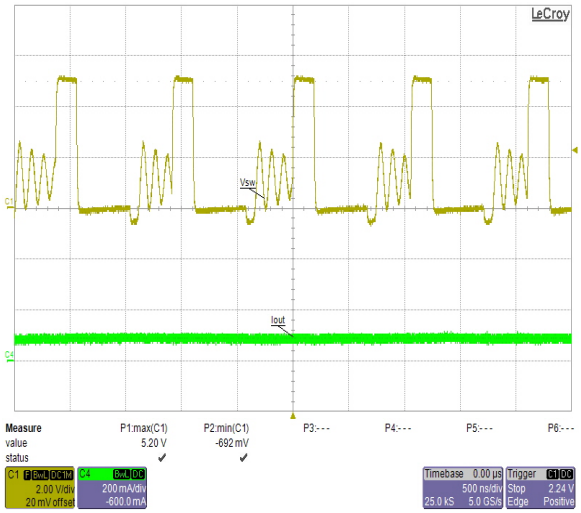
V_{IN}= 5V, V_{OUT}= 1.2V, I_{OUT}=50mA to 800mA

Load Transient Response



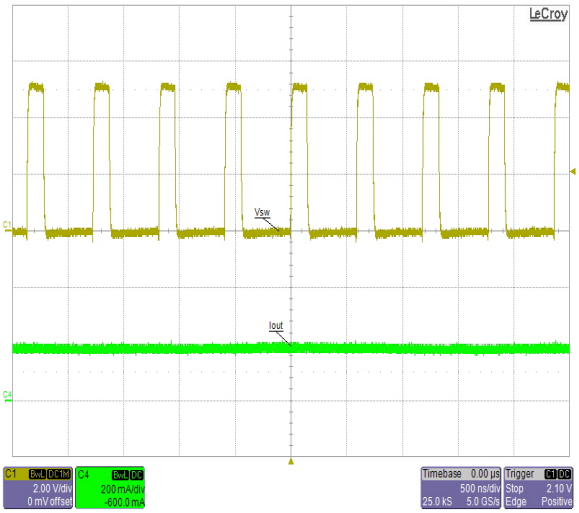
V_{IN}= 5V, V_{OUT}= 1.2V, I_{OUT}=50mA to 1.3A

PFM Mode



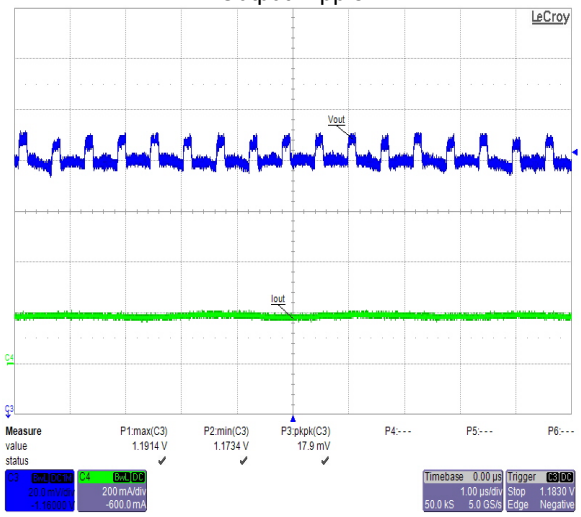
V_{IN}= 5V, V_{OUT}= 1.2V, I_{OUT}=100mA

PWM Mode



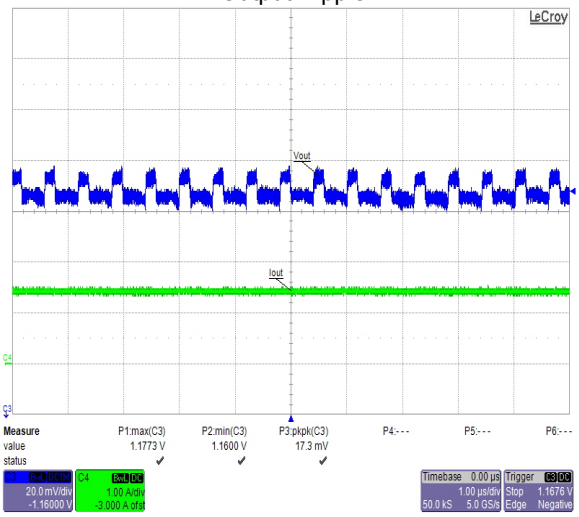
V_{IN}= 5V, V_{OUT}= 1.2V, I_{OUT}=200mA

Output Ripple



V_{IN}= 5V, V_{OUT}= 1.2V, I_{OUT}=200mA

Output Ripple



V_{IN}= 5V, V_{OUT}= 1.2V, I_{OUT}=1.3A

Functional Description

GS5581/A is a synchronous buck regulator IC that integrates the PWM/PFM control, high-side and low-side MOSFETs on the same die to minimize the switching transition loss and conduction loss. With ultra low $R_{DS(ON)}$ power switches and proprietary PWM control, this regulator IC can achieve the highest efficiency and the highest switch frequency simultaneously to minimize the external inductor and capacitor size, and thus achieving the minimum solution footprint.

The GS5581/A requires only three external power components (C_{IN}, C_{OUT} and L). The adjustable version can be programmed with external feedback to any voltage, ranging from 0.6V to the input voltage.

At dropout operation, the converter duty cycle increases to 100% and the output voltage tracks the input voltage minus the $R_{DS(ON)}$ drop of the high-side MOSFET.

The internal error amplifier and compensation provides excellent transient response, load, and line regulation. Soft start function prevents input inrush current and output overshoot during start up.

Applications Information

Setting the Output Voltage

The internal reference V_{REF} is 0.6V(Typical).The output voltage is divided by a resistor,R1 and R2 to the FB pin. The output voltage is given by:

$$V_{OUT} = V_{REF} \times (1 + \frac{R_1}{R_2})$$

Inductor Selection

For most designs, the GS5581/A operates with inductors of 1μH to 4.7μH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times f_{OSC}}$$

Where ΔI_L is inductor Ripple Current. Large value inductors result in lower ripple current and small value inductors result in high ripple current. For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range.

Input Capacitor Selection

With the maximum load current at 1.0A, the maximum ripple current through input capacitor is about 0.6Arms. A typical X7R or better grade ceramic capacitor with 6V rating and greater than 10uF capacitance can handle this ripple current well. To minimize the potential noise problem, place this ceramic capacitor really close to the IN and GND pins. Care should be taken to minimize the loop area formed by C_{IN}, and IN/GND pins.

Output Capacitor Selection

The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current ratings.
The output ripple ΔV_{OUT} is determined by:

$$\Delta V_{OUT} \leq \frac{V_{OUT} x (V_{IN} - V_{OUT})}{V_{IN} x f_{OSC} x L} x \left(ESR + \frac{1}{8 x f_{OSC} x C3} \right)$$

A 10μF ceramic Capacitor can satisfy most applications.

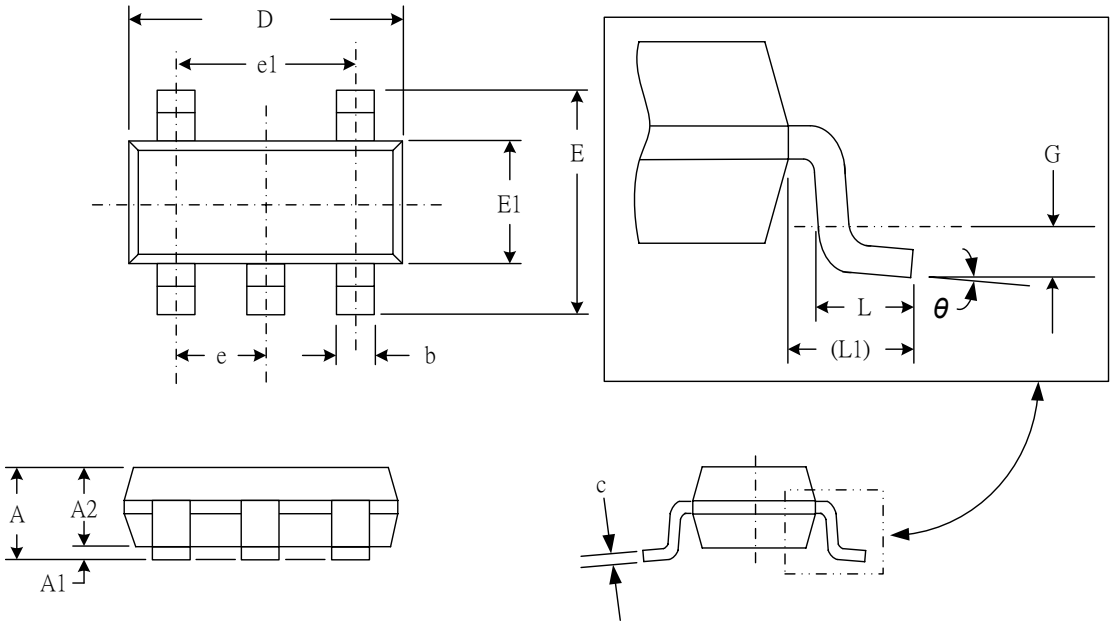
PC Board Layout Checklist

When laying out the printed circuit board, the following checking should be used to ensure proper operation of the GS5581/A. Check the following in your layout:

1. The power traces, consisting of the GND trace, the SW trace and the V_{IN} trace should be kept short, direct and wide.
2. Does the (+) plates of C_{IN} connect to V_{IN} as closely as possible. This capacitor provides the AC current to the internal power MOSFET.
3. Keep the switching node, SW, away from the sensitive V_{OUT} node.
4. Keep the (-) plates of C_{IN} and C_{OUT} as close as possible.

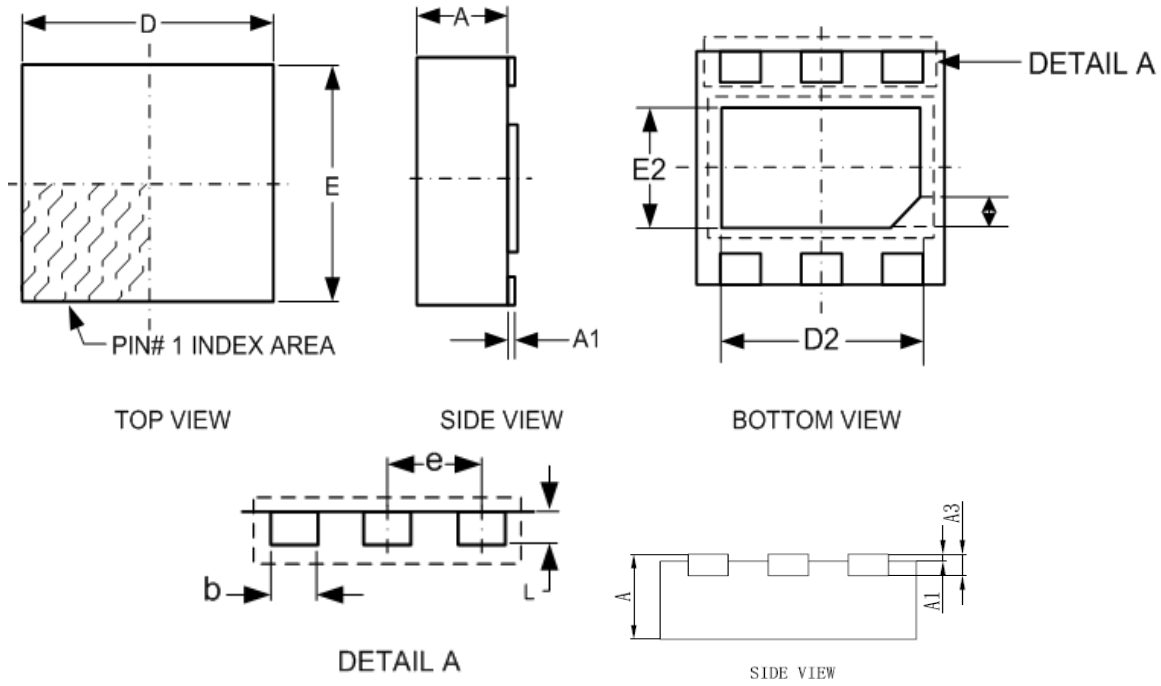
Package Dimension

SOT-23-5L PLASTIC PACKAGE



Dimensions				
SYMBOL	Millimeters		Inches	
	MIN	MAX	MIN	MAX
A	0.95	1.45	.037	.057
A1	0.05	0.15	.002	.006
A2	0.90	1.30	.035	.051
b	0.30	0.50	.012	.020
c	0.08	0.20	.003	.008
D	2.80	3.00	.110	.118
E	2.60	3.00	.102	.118
E1	1.50	1.70	.059	.067
e	0.95 (TYP)		.037 (TYP)	
e1	1.90 (TYP)		.075 (TYP)	
L	0.35	0.55	.014	.022
L1	0.60 (TYP)		.024 (TYP)	
G	0.25 (TYP)		.010 (TYP)	
θ	0°	8°	0°	8°

DFN2x2-6L (0.75-0.65)



Dimensions

SYMBOL	Millimeters			Inches		
	MIN	NOM	MAX	MIN	NOM	MAX
A	0.70	0.75	0.80	0.028	0.030	0.031
A1	-	0.02	0.05	-	0.001	0.002
A3	0.18	0.20	0.25	0.007	0.008	0.010
b	0.25	0.30	0.35	0.010	0.012	0.014
D	1.95	2.00	2.05	0.077	0.079	0.081
D2	1.00	-	1.45	0.039	-	0.057
e	0.65 BSC			0.026 BSC		
E	1.95	2.00	2.05	0.077	0.079	0.081
E2	0.50	-	0.85	0.020	-	0.033
L	0.25	0.30	0.40	0.010	0.012	0.016
h	0.1	0.15	0.2	0.004	0.006	0.008

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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

Wu-Xi Branch	
	No.21 Changjiang Rd., WND, Wuxi, Jiangsu, China (INFO. &. TECH. Science Park Building A 210 Room)
	86-510-85217051
	86-510-85211238
	sales_cn@gs-power.com

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