



**3A, 23V, 350kHz SYNCHRONOUS RECTIFIED  
STEP-DOWN CONVERTER**

**FEATURES**

- Wide 4.75V to 23V Operating Input Range
- Integrated 100mΩ Power MOSFET Switches
- Output Adjust from VFB to 20V
- Up to 95% Efficiency
- 3A Output Current
- Programmable Soft-Start
- Stable with Low ESR Ceramic Output Capacitors
- Fixed 350KHz Frequency
- Cycle-by-Cycle Over Current Protection
- Thermal Shutdown and Short Circuit Protections
- ESOP-8 Package

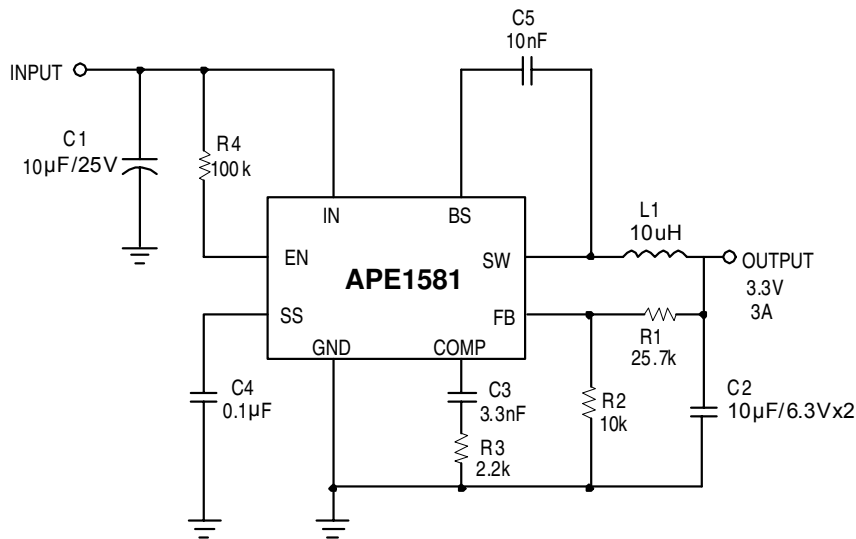
**DESCRIPTION**

The APE1581 is a monolithic synchronous buck regulator. The device integrates two 100mΩ MOSFETs, and provides 3A of continuous load current over a wide input voltage of 4.75V to 23V. Current mode control provides fast transient response and Cycle-by-Cycle current limit.

An adjustable soft-start prevents inrush current at turn-on, and in shutdown mode the supply current drops to 1μA.

This device, available in an ESOP-8 package, provides a very compact solution with minimal external components.

**TYPICAL APPLICATION**



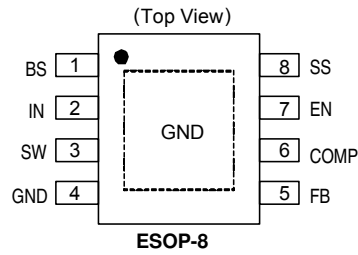
$$V_{OUT} = V_{FB} \times (1 + R1/R2), \quad V_{FB} = 0.925V, \quad R2 \text{ suggest } 10k \sim 30K\Omega$$

Table Recommended Component Selection

V <sub>IN</sub> (V)	V <sub>OUT</sub> (V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	C3 (nF)	L1 (μH)	C <sub>OUT</sub> (μF)
12	5	44.1	10	2.2	3.3	15	10 X 2
5 or 12	3.3	25.7	10	2.2	3.3	10	10 X 2
5 or 12	1.8	9.5	10	2.2	3.3	4.7	10 X 2
5 or 12	1.2	3	10	2.2	3.3	3.3	10 X 2
5 or 12	1	0.81	10	2.2	3.3	2.2	10 X 2



**PACKAGE/ORDERING INFORMATION**



**ABSOLUTE MAXIMUM RATINGS (at T<sub>A</sub>=25°C)**

Input Voltage (V <sub>IN</sub> )	- 0.3V to + 24V
Switch Node Voltage (V <sub>SW</sub> )	-1V to V <sub>IN</sub> +0.3V
Boost Voltage (V <sub>BS</sub> )	V <sub>SW</sub> – 0.3V to V <sub>SW</sub> + 6V
All Other Pins	- 0.3V to + 6V
Power Dissipation (P <sub>D</sub> )	Internally Limited
Lead Temperature (T <sub>Lead</sub> )	260°C
Storage Temperature Range (T <sub>ST</sub> )	-65°C To 150°C
Junction Temperature (T <sub>J</sub> )	150°C
Output Voltage (V <sub>OUT</sub> )	0.925V to 20V
Ambient Operating Temperature (T <sub>A</sub> )	-40°C To 85°C
Thermal Resistance from Junction to case (R <sub>thjc</sub> )	15°C/W
Thermal Resistance from Junction to ambient (R <sub>thja</sub> ) <sup>Note</sup>	40°C/W

Note: R<sub>thja</sub> is measured with the PCB copper area of approximately 1 in<sup>2</sup>(Multi-layer).

**ELECTRICAL SPECIFICATIONS**

(V<sub>IN</sub> = 12V, T<sub>A</sub>=25°C, unless otherwise noted)

Characteristics	Symbol	Conditions	Min	Typ	Max	Units
Operating Voltage	V <sub>IN</sub>		4.75	-	23	V
Shutdown Supply Current	I <sub>SD</sub>	V <sub>EN</sub> = 0V	-	1	3	μA
Feedback Voltage	V <sub>FB</sub>	4.75V ≤ V <sub>IN</sub> ≤ 23V	0.9	0.925	0.95	V
High-Side Switch On Resistance (Note)	R <sub>DS(ON)1</sub>		-	100	-	mΩ
Low-Side Switch On Resistance (Note)	R <sub>DS(ON)2</sub>		-	100	-	mΩ
High-Side Switch Leakage Current		V <sub>EN</sub> = 0V, V <sub>SW</sub> = 0V	-	-	10	μA
Switch Current Limit			3.8	-	-	A
Oscillation Frequency	F <sub>OSC1</sub>		280	350	430	KHz
Short Circuit Oscillation Frequency	F <sub>OSC2</sub>	V <sub>FB</sub> = 0V	-	90	-	KHz
Maximum Duty Cycle	D <sub>MAX</sub>	V <sub>FB</sub> = 0.8V	-	90	-	%
EN Shutdown Threshold Voltage	ENH	V <sub>EN</sub> Rising	1.1	1.5	2	V
EN Shutdown Threshold Voltage Hysteresis			-	210	-	mV
Soft-Start Current	I <sub>SS</sub>	V <sub>SS</sub> = 0V	-	6	-	μA
Soft-Start Period		C <sub>SS</sub> = 0.1μF	-	15	-	ms
Thermal Shutdown	T <sub>SD</sub>		-	160	-	°C
Thermal Shutdown Hysteresis	T <sub>SH</sub>		-	35	-	°C

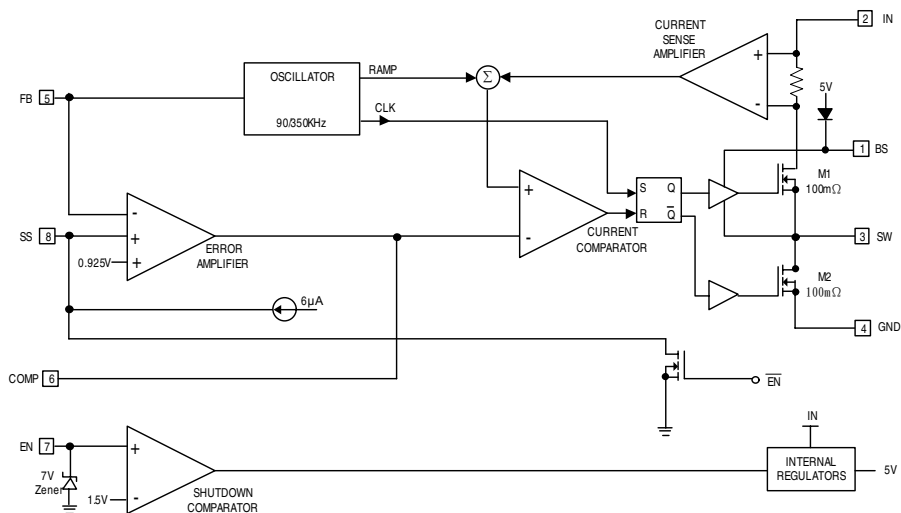
Note: Guaranteed by design.



**PIN DESCRIPTIONS**

PIN SYMBOL	PIN DESCRIPTION
<b>BS</b>	High-Side Gate Drive Boost Input. BS supplies the drive for the high-side N-Channel MOSFET switch. Connect a 0.01 $\mu$ F or greater capacitor from SW to BS to power the high side switch.
<b>IN</b>	Power Input. IN supplies the power to the IC, as well as the step-down converter switches. Drive IN with a 4.75V to 23V power source. Bypass IN to GND with a suitably large capacitor to eliminate noise on the input to the IC. See Input Capacitor.
<b>SW</b>	Power Switching Output. SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load. Note that a capacitor is required from SW to BS to power the high-side switch.
<b>GND</b>	Ground.
<b>FB</b>	Feedback Input. FB senses the output voltage to regulate that voltage. Drive FB with a resistive voltage divider from the output voltage. The feedback threshold is 0.925V. See Setting the Output Voltage.
<b>COMP</b>	Compensation Node. COMP is used to compensate the regulation control loop. Connect a series RC network from COMP to GND to compensate the regulation control loop. In some cases, an additional capacitor from COMP to GND is required. See Compensation Components.
<b>EN</b>	Enable Input. EN is a digital input that turns the regulator on or off. Drive EN high to turn on the regulator, drive it low to turn it off. Pull up with 100k $\Omega$ resistor for automatic startup.
<b>SS</b>	Soft-Start Control Input. SS controls the soft start period. Connect a capacitor from SS to GND to set the soft-start period. A 0.1 $\mu$ F capacitor sets the soft-start period to 15ms. To disable the soft-start feature, leave SS unconnected.

**BLOCK DIAGRAM**





---

## **FUNCTION DESCRIPTION**

The APE1581 is a synchronous rectified, current-mode, step-down regulator. It regulates input voltages from 4.75V to 23V down to an output voltage as low as 0.925V, and supplies up to 3A of load current.

The APE1581 uses current-mode control to regulate the output voltage. The output voltage is measured at FB through a resistive voltage divider and amplified through the internal Transconductance error amplifier. The voltage at the COMP pin is compared to the switch current measured internally to control the output voltage.

The converter uses internal N-Channel MOSFET switches to step-down the input voltage to the regulated output voltage. Since the high side MOSFET requires a gate voltage greater than the input voltage, a boost capacitor connected between SW and BS is needed to drive the high side gate. The boost capacitor is charged from the internal 5V rail when SW is low.

---

## **APPLICATION INFORMATION**

### **COMPONENT SELECTION**

#### **Setting the Output Voltage**

The output voltage is set using a resistive voltage divider from the output voltage to FB pin. The voltage divider divides the output voltage down to the feedback voltage by the ratio:

$$V_{FB} = V_{OUT} \times [R2 / (R1 + R2)]$$

Where  $V_{FB}$  is the feedback voltage and  $V_{OUT}$  is the output voltage.  
Thus the output voltage is:

$$V_{OUT} = 0.925 \times (R1 + R2) / R2$$

R2 can be as high as 100k $\Omega$ , but a typical value is 10k $\Omega$ . Using the typical value for R2, R1 is determined by:

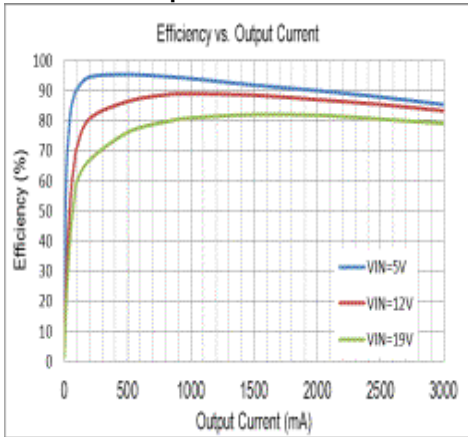
$$R1 = 10.811 \times (V_{OUT} - 0.925) \text{ (k}\Omega\text{)}$$

For example, for a 3.3V output voltage, R2 is 10k $\Omega$ , and R1 is 25.7k $\Omega$ .

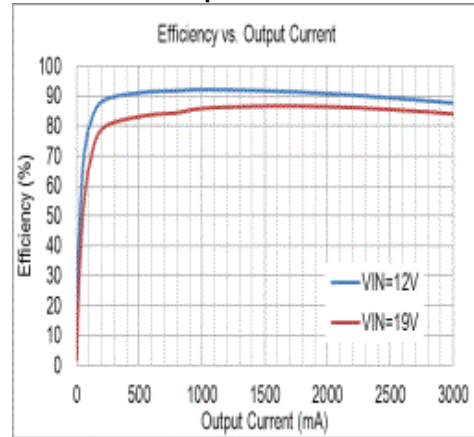


# TYPICAL PERFORMANCE CHARACTERISTICS

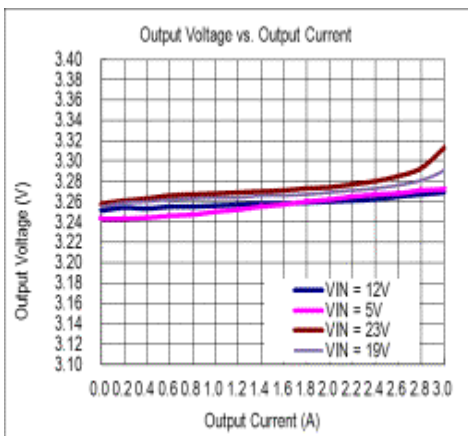
Output=3.3V



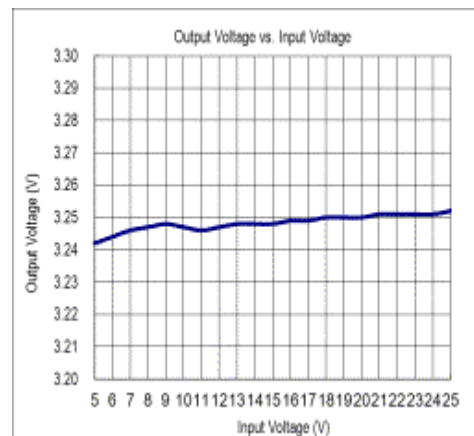
Output=5V



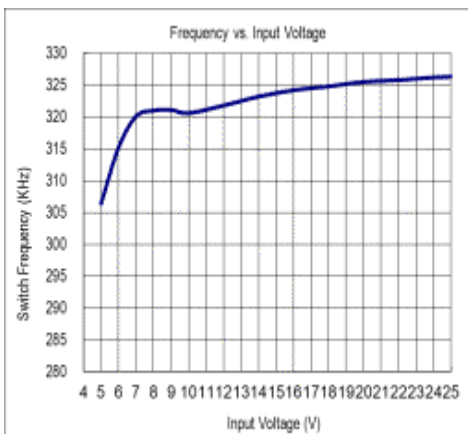
Output Voltage vs. Output Current



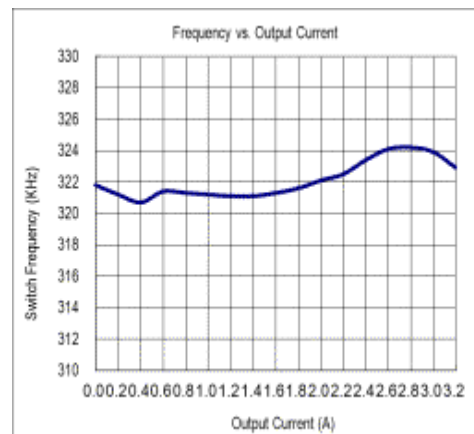
Output Voltage vs. Input Voltage



Frequency vs. Input Voltage



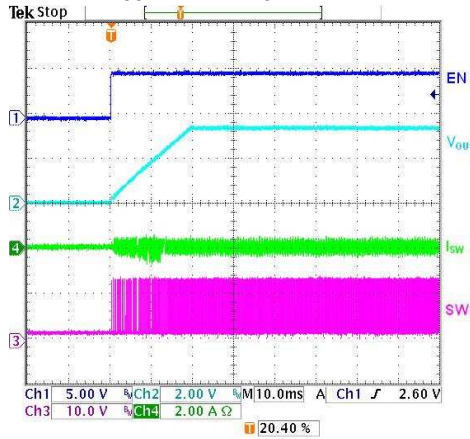
Frequency vs. Output Current



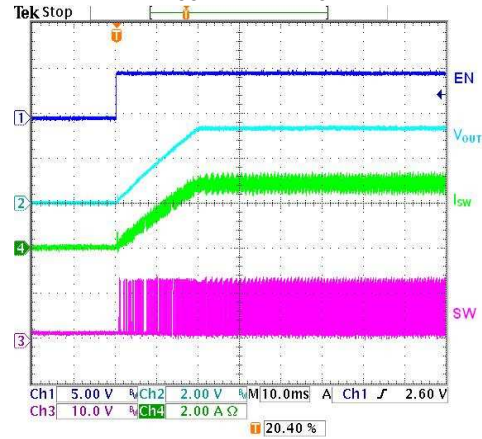


TYPICAL PERFORMANCE CHARACTERISTICS

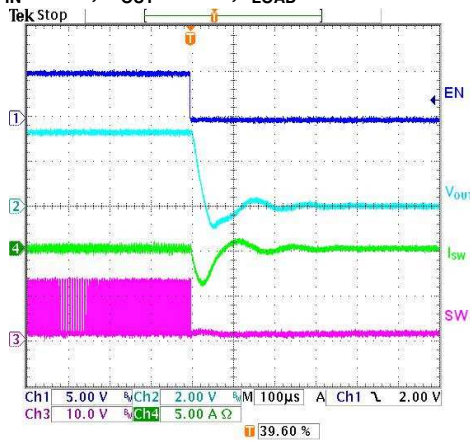
$V_{IN} = 12V, V_{OUT} = 3.3V, I_{LOAD} = \text{No Load}$



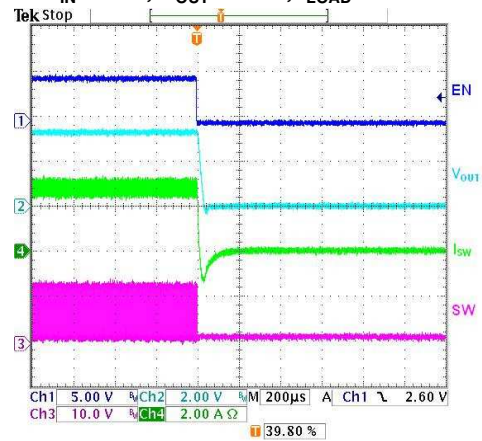
$V_{IN} = 12V, V_{OUT} = 3.3V, I_{LOAD} = 3A$



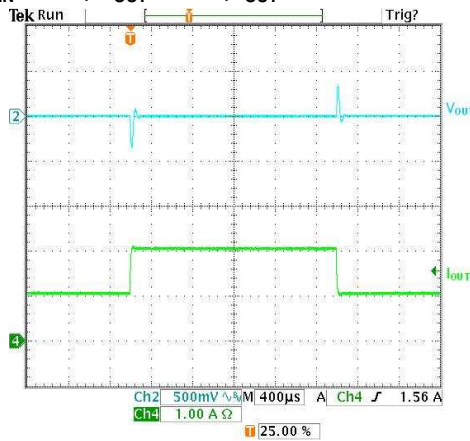
$V_{IN} = 12V, V_{OUT} = 3.3V, I_{LOAD} = \text{No Load}$



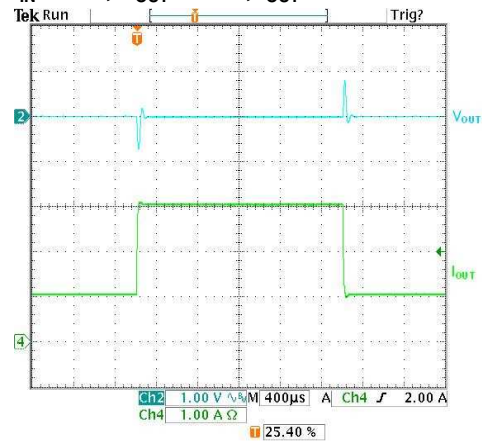
$V_{IN} = 12V, V_{OUT} = 3.3V, I_{LOAD} = 3A$



$V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 1A \leftrightarrow 2A$



$V_{IN} = 12V, V_{OUT} = 3.3V, I_{OUT} = 1A \leftrightarrow 3A$





---

**MARKING INFORMATION**

ESOP-8

