

18V, 3A Synchronous DC-DC Buck Converter**AT5503****General Description**

The AT5503 is a 500kHz fixed frequency, current mode, PWM synchronous buck (step-down) DC-DC converter, capable of driving a 3A load with high efficiency, excellent line and load regulation. The AT5503 exhibits high efficiency at light load. The device integrates N-channel power MOSFET switch with low on-resistance. Current mode control provides fast transient response and cycle-by-cycle current limit.

The AT5503 employs complete protection to ensure system security, including output Over Voltage Protection, input Under Voltage Lock Out, programmable soft-start, Over Temperature Protection and hiccup mode Short Circuit Protection.

This IC is available in PSOP-8 package.

Features

- Input Voltage Range: 4.5V to 18V
- Fixed 500kHz Frequency
- High Efficiency at Light Load
- Output Current: 3A
- Current Mode Control
- Built-in Over Current Protection
- Built-in Thermal Shutdown Function
- Built-in UVLO Function
- Built-in Over Voltage Protection
- Programmable Soft-start
- Hiccup Mode SCP

Applications

- Monitor
- TV
- STB
- Datacom

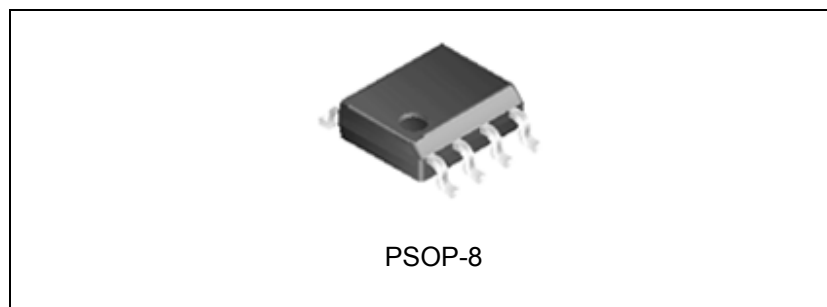


Figure 1. Package Type of AT5503

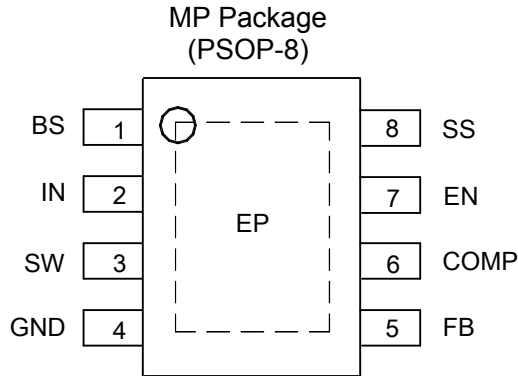
18V, 3A Synchronous DC-DC Buck Converter
AT5503
Pin Configuration


Figure 2. Pin Configuration of AT5503 (Top View)

Pin Description

| Pin Number | Pin Name | Function |
|------------|----------|---|
| 1 | BS | Bootstrap pin. A bootstrap capacitor is connected between the BS pin and SW pin. The voltage across the bootstrap capacitor drives the internal high-side NMOS switch. |
| 2 | IN | Supply input pin. A capacitor should be connected between the IN pin and GND pin to keep the DC input voltage constant. |
| 3 | SW | Power switch output pin. This pin is connected to the inductor and bootstrap capacitor. |
| 4 | GND | Ground pin |
| 5 | FB | Feedback pin. This pin is connected to an external resistor divider to program the system output voltage. When the FB pin voltage exceeds 1.1V, the over voltage protection is triggered. When the FB pin voltage is below 0.3V, the oscillator frequency is lowered to realize short circuit protection. |
| 6 | COMP | Compensation pin. This pin is the output of the transconductance error amplifier and the input to the current comparator. This pin is used to compensate the control loop. Connect a series RC network from this pin to GND pin. In some cases, an additional capacitor from this pin to GND pin is required. |
| 7 | EN | 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 off. Pull up with 100kΩ resistor for automatic startup. |
| 8 | SS | Soft-start control input pin. SS controls the soft start period. Connect a capacitor from SS to GND to set the soft-start period. A 0.1μF capacitor sets the soft-start period to 15ms. To disable the soft-start feature, leave SS unconnected. |
| | EP | Exposed pad. It should be connected to GND in PCB layout. |

18V, 3A Synchronous DC-DC Buck Converter

AT5503

Functional Block Diagram

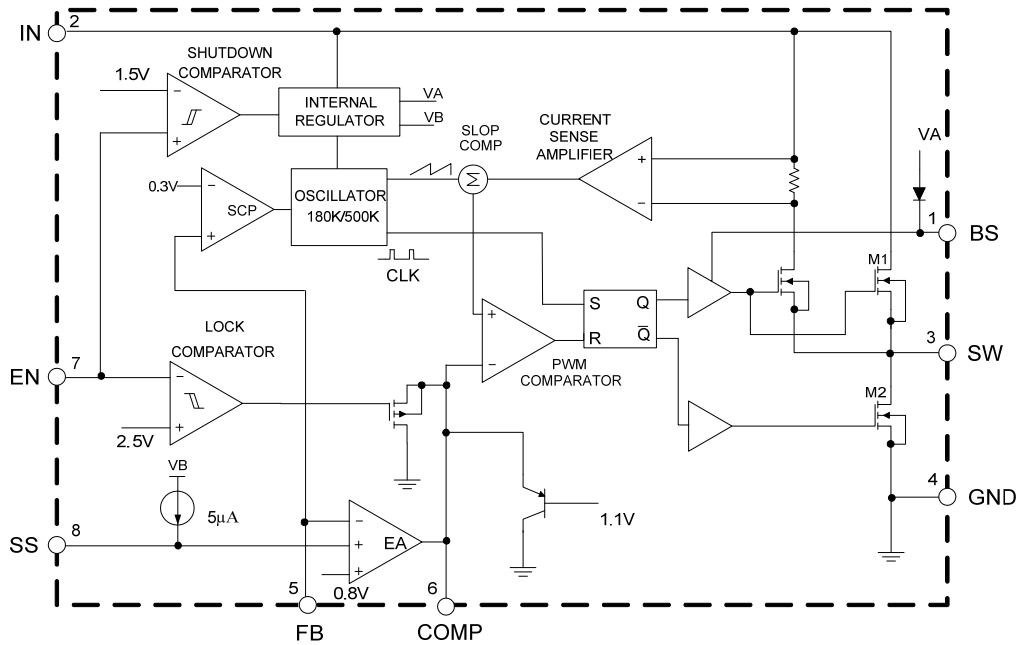
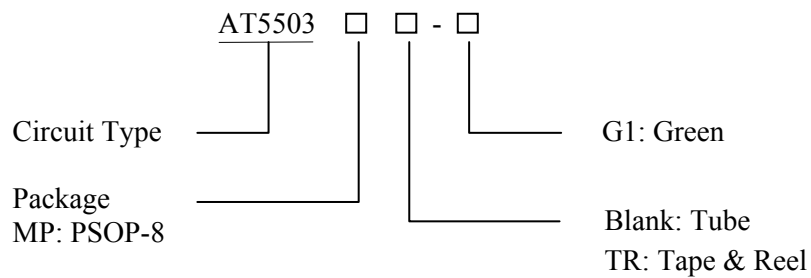


Figure 3. Functional Block Diagram of AT5503

Ordering Information



| Package | Temperature Range | Part Number | Marking ID | Packing Type |
|---------|-------------------|---------------|------------|--------------|
| PSOP-8 | -40 to 85°C | AT5503MP-G1 | 5503MP-G1 | Tube |
| | | AT5503MPTR-G1 | 5503MP-G1 | Tape & Reel |

BCD Semiconductor's Pb-free products, as designated with "G1" suffix in the part number, are RoHS compliant and green.

**18V, 3A Synchronous DC-DC Buck Converter****AT5503****Absolute Maximum Ratings (Note 1)**

| Parameter | Symbol | Value | | Unit |
|---|---------------|--------------------|----|------|
| IN Pin Voltage | V_{IN} | -0.3 to 20 | | V |
| EN Pin Voltage | V_{EN} | -0.3 to V_{IN} | | V |
| SW Pin Voltage | V_{SW} | 21 | | V |
| BS Pin Voltage | V_{BS} | -0.3 to $V_{SW}+6$ | | V |
| FB Pin Voltage | V_{FB} | -0.3 to 6 | | V |
| COMP Pin Voltage | V_{COMP} | -0.3 to 6 | | V |
| SS Pin Voltage | V_{SS} | -0.3 to 6 | | V |
| Operating Junction Temperature | T_J | 150 | | °C |
| Storage Temperature | T_{STG} | -65 to 150 | | °C |
| Lead Temperature (Soldering, 10sec) | T_{LEAD} | 260 | | °C |
| Thermal Resistance (Junction to Ambient) | θ_{JA} | PSOP-8 | 60 | °C/W |
| ESD (Human Body Model) | V_{HBM} | 2000 | | V |
| ESD (Machine Model) | V_{MM} | 200 | | V |

Note 1: Stresses greater than those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “Recommended Operating Conditions” is not implied. Exposure to “Absolute Maximum Ratings” for extended periods may affect device reliability.

Recommended Operating Conditions

| Parameter | Symbol | Min | Max | Unit |
|-------------------------------|----------|-----|-----|------|
| Input Voltage | V_{IN} | 4.5 | 18 | V |
| Operating Ambient Temperature | T_A | -40 | 85 | °C |

**18V, 3A Synchronous DC-DC Buck Converter****AT5503****Electrical Characteristics** $V_{IN}=V_{EN}=12V$, $V_{OUT}=3.3V$, $T_A=25^\circ C$, unless otherwise specified.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---------------|---|-------|-----|-------|------------|
| SUPPLY VOLTAGE (IN PIN) | | | | | | |
| Input Voltage | V_{IN} | | 4.5 | | 18 | V |
| Quiescent Current | I_Q | $V_{FB}=1V$, $V_{EN}=3.3V$ | | 1.2 | 1.4 | mA |
| Shutdown Supply Current | I_{SHDN} | $V_{EN}=0V$ | | 0.1 | 1.0 | μA |
| UNDER VOLTAGE LOCKOUT | | | | | | |
| Input UVLO Threshold | V_{UVLO} | V_{IN} Rising | 3.65 | 4.0 | 4.25 | V |
| Input UVLO Hysteresis | V_{HYS} | | | 0.2 | | V |
| ENABLE (EN PIN) | | | | | | |
| EN Shutdown Threshold Voltage | | | 1.1 | 1.5 | 2 | V |
| EN Shutdown Threshold Voltage Hysteresis (Note 2) | | | | 350 | | mV |
| EN Lockout Threshold Voltage | | | 2.2 | 2.5 | 2.7 | V |
| EN Lockout Hysteresis | | | | 210 | | mV |
| VOLTAGE REFERENCE (FB PIN) | | | | | | |
| Feedback Voltage | V_{FB} | | 0.784 | 0.8 | 0.816 | V |
| Feedback Over Voltage Threshold | V_{FBOV} | | | 1.1 | | V |
| Feedback Bias Current | I_{FB} | $V_{FB}=1V$ | -0.1 | | 0.1 | μA |
| MOSFET | | | | | | |
| High-side Switch On-resistance (Note 3) | $R_{DS(ON)H}$ | $I_{SW}=0.2A\&0.7A$ | | 100 | | m Ω |
| Low-side Switch On-resistance (Note 3) | $R_{DS(ON)L}$ | $I_{SW}=-0.2A\&-0.7A$ | | 100 | | m Ω |
| CURRENT LIMIT | | | | | | |
| High-side Switch Leakage Current | I_{LEAKH} | $V_{IN}=18V$, $V_{EN}=0V$, $V_{SW}=0V$ | | 0.1 | 10 | μA |
| High-side Switch Current Limit | I_{LIMH} | | 4.3 | 5.6 | | A |
| Low-side Switch Current Limit | I_{LIML} | From Drain to Source | | 50 | | mA |
| SWITCHING REGULATOR | | | | | | |
| Oscillator Frequency | f_{OSC1} | | 410 | 500 | 590 | kHz |
| Short Circuit Oscillator Frequency | f_{OSC2} | | | 180 | | kHz |

**18V, 3A Synchronous DC-DC Buck Converter****AT5503****Electrical Characteristics (Continued)** $V_{IN}=V_{EN}=12V$, $V_{OUT}=3.3V$, $T_A=25^{\circ}C$, unless otherwise specified.

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|--|------------|-------------------|-----|-----|-----|-------------|
| Maximum Duty Cycle | D_{MAX} | $V_{FB}=0.7V$ | | 90 | | % |
| Minimum Duty Cycle | D_{MIN} | $V_{FB}=1V$ | | | 0 | % |
| ERROR AMPLIFIER | | | | | | |
| Error Amplifier Voltage Gain (Note 2) | A_{EA} | | | 400 | | V/V |
| Error Amplifier Transconductance | G_{EA} | | | 800 | | $\mu A/V$ |
| COMP to Current Sense Transconductance | G_{CS} | | | 5.2 | | A/V |
| THERMAL SHUTDOWN | | | | | | |
| Thermal Shutdown (Note 2) | T_{OTSD} | | | 160 | | $^{\circ}C$ |
| Thermal Shutdown Hysteresis (Note 2) | T_{HYS} | | | 30 | | $^{\circ}C$ |
| SOFT START (SS PIN) | | | | | | |
| Soft-start Time (Note 2) | t_{SS} | $C_{SS}=0.1\mu F$ | | 15 | | ms |
| Soft-start Current | | | | 5 | | μA |

Note 2: Not tested, guaranteed by design.

$$\text{Note 3: } R_{DS(on)} = \frac{V_{SW1} - V_{SW2}}{I_{SW1} - I_{SW2}}$$

18V, 3A Synchronous DC-DC Buck Converter

AT5503

Typical Performance Characteristics

$V_{IN}=12V$, $V_{OUT}=3.3V$, $L=4.7\mu H$, $T_A=25^\circ C$, unless otherwise noted.

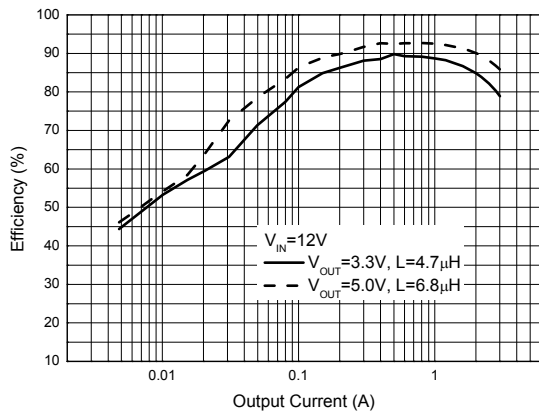


Figure 4. Efficiency vs. Output Current

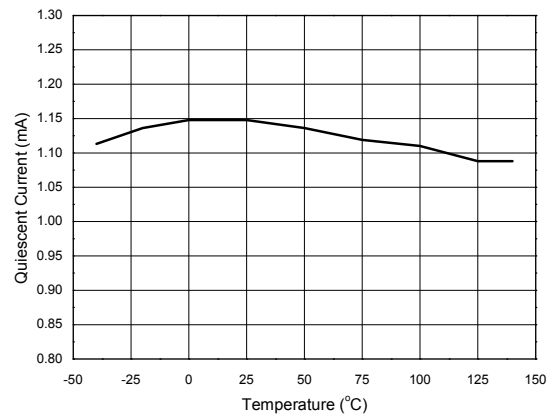


Figure 5. Quiescent Current vs. Temperature

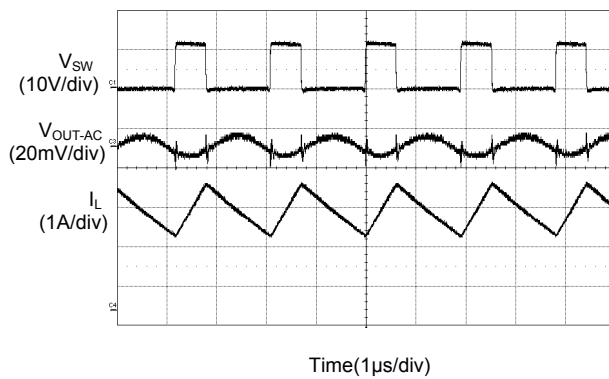


Figure 6. Output Ripple ($I_{OUT}=2.5A$)

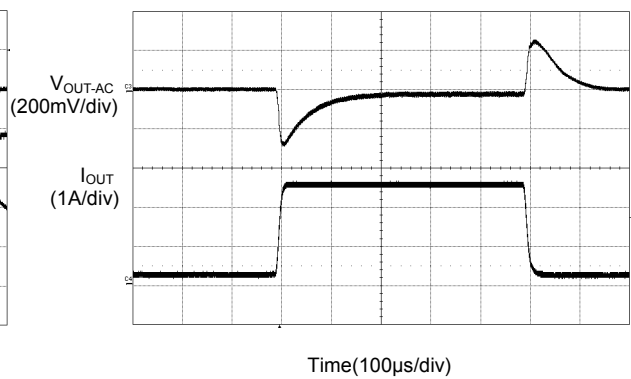


Figure 7. Load Transient Response ($I_{OUT}=0.2A$ to $2.5A$)

18V, 3A Synchronous DC-DC Buck Converter

AT5503

Typical Performance Characteristics (Continued)

$V_{IN}=12V$, $V_{OUT}=3.3V$, $L=4.7\mu H$, $T_A=25^\circ C$, unless otherwise noted.

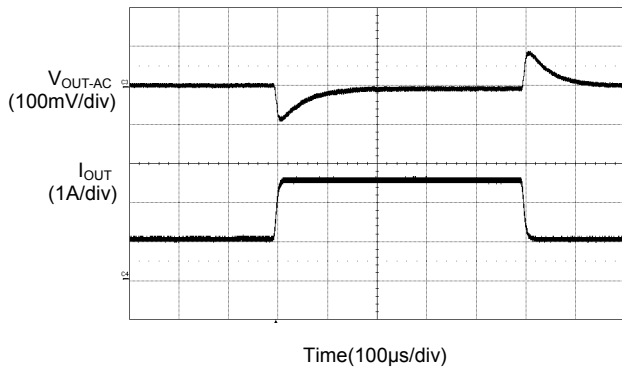


Figure 8. Load Transient Response ($I_{OUT}=1A$ to $2.5A$)

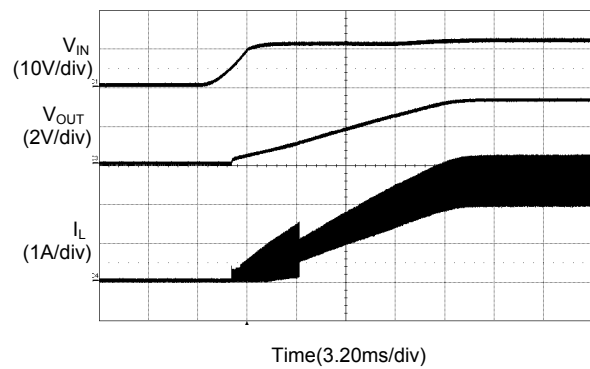


Figure 9. Power On from V_{IN} ($I_{OUT}=2.5A$)

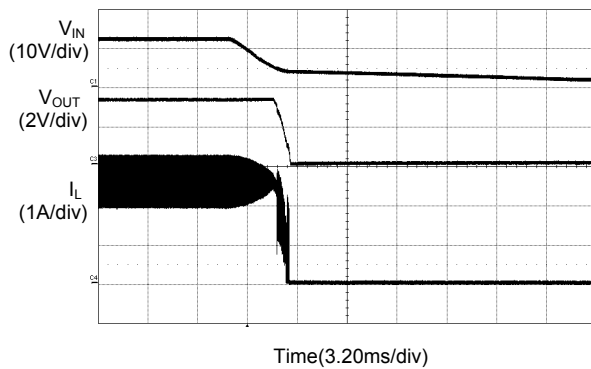


Figure 10. Power Off from V_{IN} ($I_{OUT}=2.5A$)

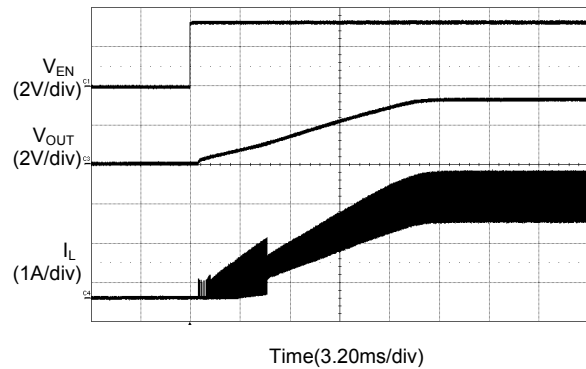
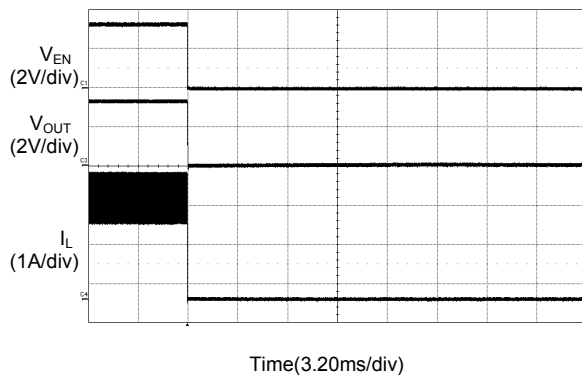
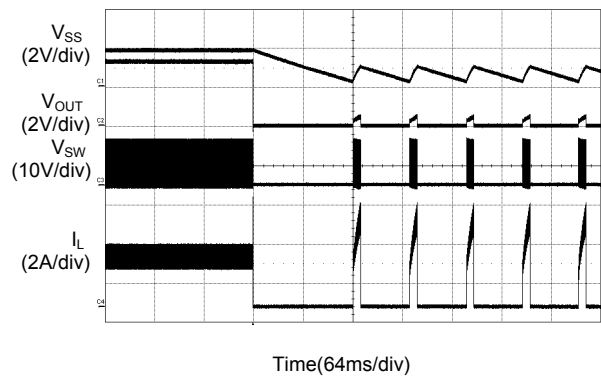
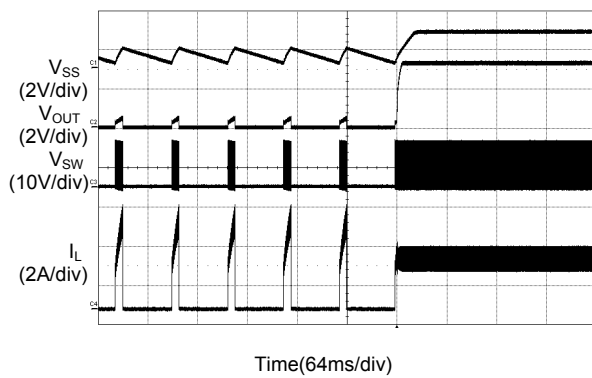


Figure 11. Power On from EN ($I_{OUT}=2.5A$)

18V, 3A Synchronous DC-DC Buck Converter
AT5503
Typical Performance Characteristics (Continued)
 $V_{IN}=12V$, $V_{OUT}=3.3V$, $L=4.7\mu H$, $T_A=25^\circ C$, unless otherwise noted.

 Figure 12. Power Off from EN ($I_{OUT}=2.5A$)

 Figure 13. Short Circuit Protection ($I_{OUT}=2.5A$)

 Figure 14. Short Circuit Protection Recovery ($I_{OUT}=2.5A$)

18V, 3A Synchronous DC-DC Buck Converter

AT5503

Typical Application

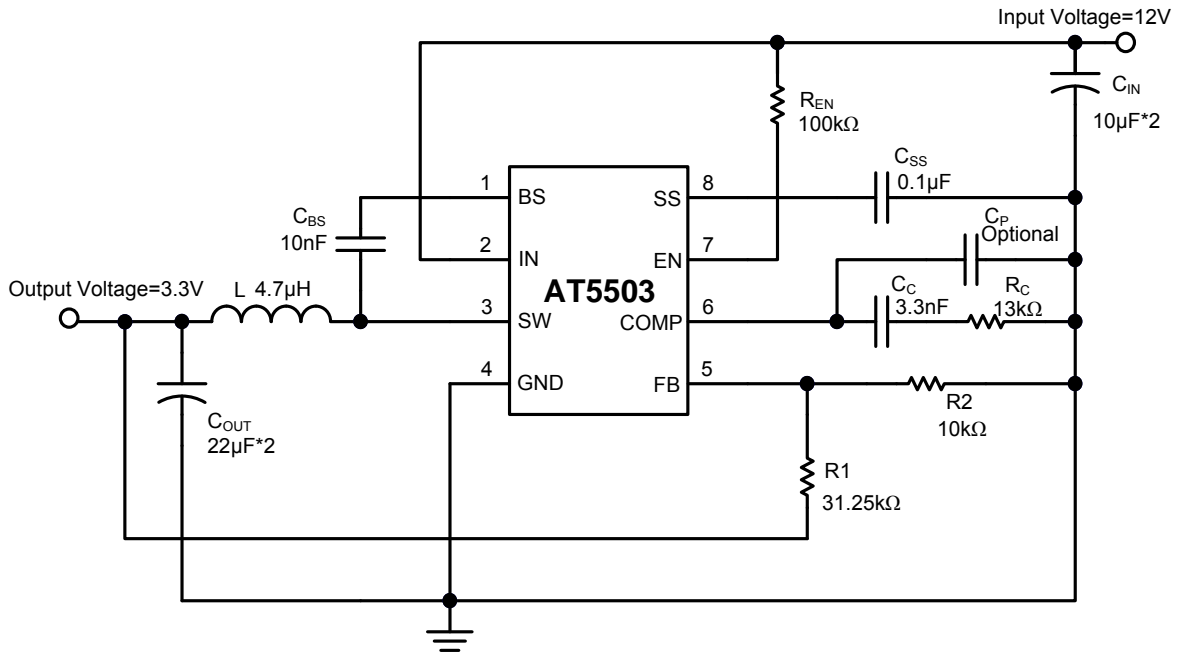
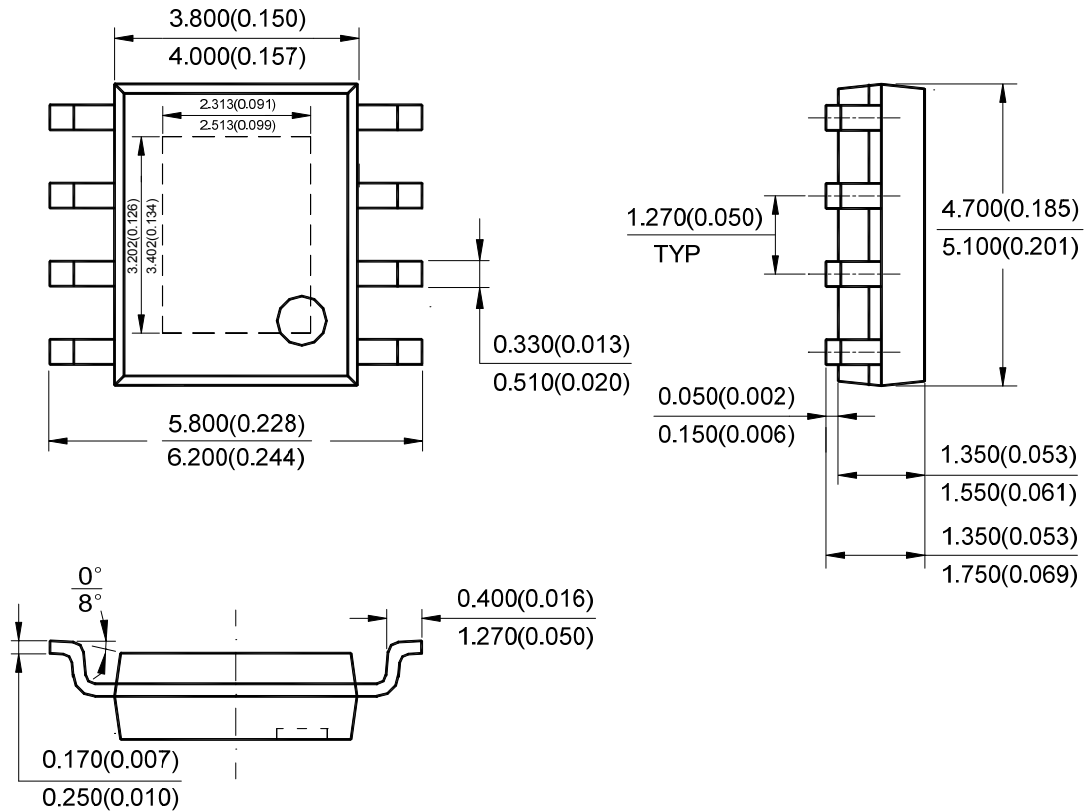


Figure 15. Typical Application Circuit of AT5503

18V, 3A Synchronous DC-DC Buck Converter
AT5503
Mechanical Dimensions
PSOP-8
Unit: mm(inch)


Note: Eject hole, oriented hole and mold mark is optional.



BCD Semiconductor Manufacturing Limited

<http://www.bcdsemi.com>

IMPORTANT NOTICE

BCD Semiconductor Manufacturing Limited reserves the right to make changes without further notice to any products or specifications herein. BCD Semiconductor Manufacturing Limited does not assume any responsibility for use of any its products for any particular purpose, nor does BCD Semiconductor Manufacturing Limited assume any liability arising out of the application or use of any its products or circuits. BCD Semiconductor Manufacturing Limited does not convey any license under its patent rights or other rights nor the rights of others.

MAIN SITE

- Headquarters

BCD (Shanghai) Micro-electronics Limited

No. 1600, Zi Xing Road, Shanghai ZiZhu Science-based Industrial Park, 200241, P. R. C.
Tel: +86-021-2416-2266, Fax: +86-021-2416-2277

- Wafer Fab

Shanghai SIM-BCD Semiconductor Manufacturing Co., Ltd.

800 Yishan Road, Shanghai 200233, China
Tel: +021-6485-1491, Fax: +86-021-5450-0008

REGIONAL SALES OFFICE

Shenzhen Office

Shanghai SIM-BCD Semiconductor Manufacturing Co., Ltd., Shenzhen Office

Unit A Room 1203, Skyworth Bldg., Gaoxin Ave.1.S., Nanshan District
Shenzhen 518057, China

Tel: +86-0755-8660-4900, Fax: +86-0755-8660-4958

Taiwan Office (Taipei)

BCD Semiconductor (Taiwan) Company Limited

3F, No.17, Lane 171, Sec. 2, Jiu-Zong Rd., Nei-Hu Dist., Taipei(114), Taiwan, R.O.C
Tel: +886-2-2656-2808

Fax: +886-2-2656-2806/26562950

Taiwan Office (Hsinchu)

BCD Semiconductor (Taiwan) Company Limited

8F, No.176, Sec. 2, Gong-Dao 5th Road, East District
HsinChu City 300, Taiwan, R.O.C

Tel: +886-3-5160181, Fax: +886-3-5160181

USA Office

BCD Semiconductor Corp.

48460 Kato Road, Fremont, CA 94538, USA
Tel: +1-510-668-1950

Fax: +1-510-668-1990

Korea Office

BCD Semiconductor Limited Korea office.

Room 101-1112, Digital-Empire II, 486 Sin-dong,
Yeongtong-Gu, Suwon-city, Gyeonggi-do, Korea

Tel: +82-31-695-8430