AT7252

2A, 20V Synchronous Step-Down Converter

Immense Advance Tech.

FEATURES

- 4.5V to 20V input voltage range
- 2A load current capability
- Up to 95% efficiency
- High efficiency at light load
- Fixed 500KHz Switching frequency
- Input under voltage lockout
- Start-up current run-away protection
- Over current protection and Hiccup
- Thermal protection
- Available in TSOT-26 package

APPLICATION

- Distributed Power Systems
- Networking Systems
- FPGA, DSP, ASIC Power Supplies
- Green Electronics/ Appliances
- Notebook Computers
- LCD TV

DESCRIPTION

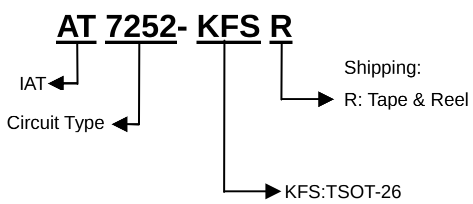
AT7252 develops high efficiency synchronous step-down DC-DC converter capable of delivering 2A load current. AT7252 operates over a wide input voltage range from 4.5V to 20V. It also integrates main switch and synchronous switch with very low $R_{DS(ON)}$ to minimize the conduction loss.

At light loads, regulators operate in low frequency to maintain high efficiency and low output ripple.

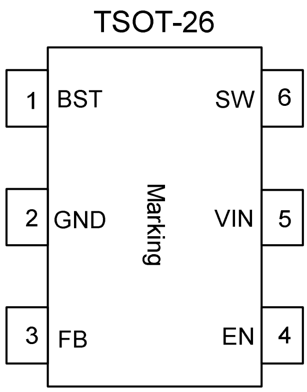
The AT7252 guarantees robustness with over current protection, thermal protection, start-up current run-away protection, and input under voltage lockout.

The AT7252 is available in TSOT-26 package, which provides a compact solution with minimum external components.

ORDER INFORMATION



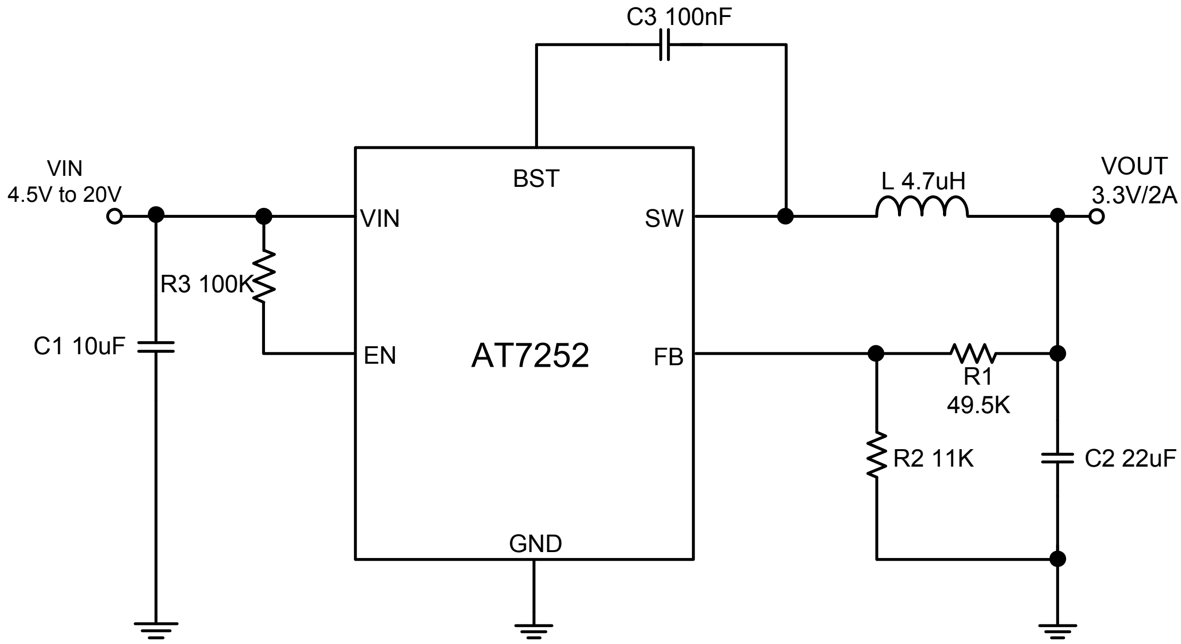
PIN CONFIGURATIONS (TOP VIEW)



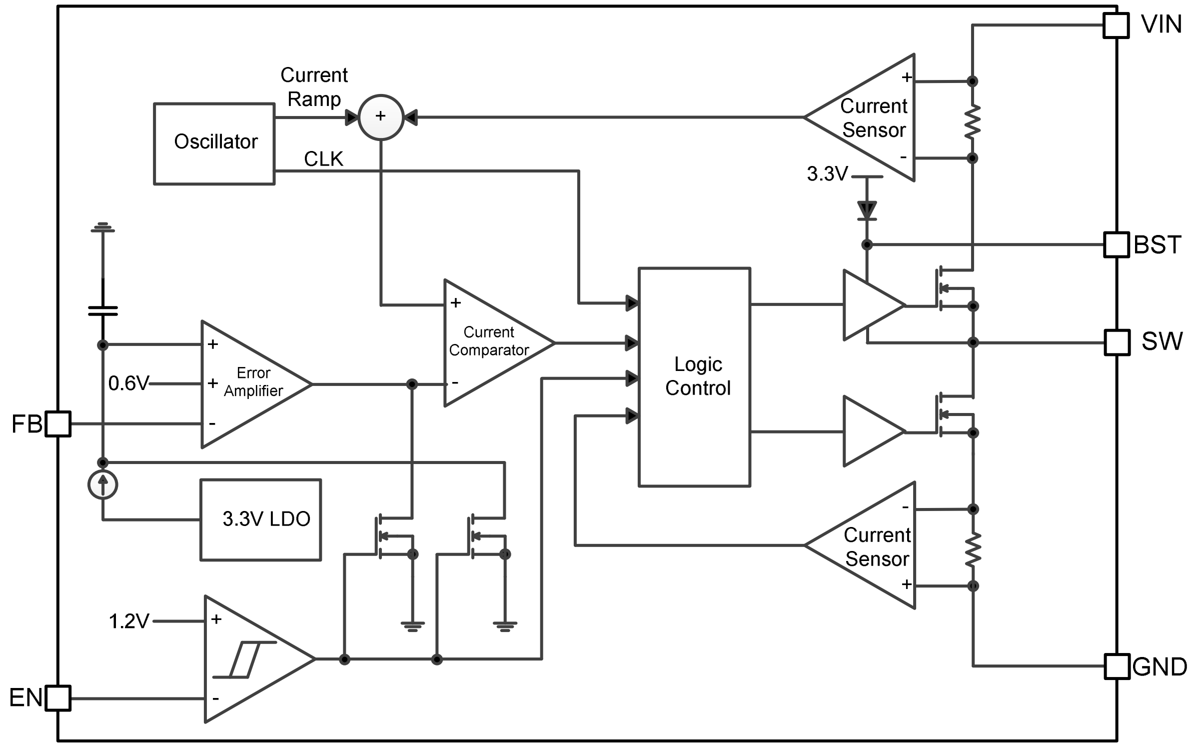
PIN DESCRIPTIONS

Pin Name	Pin Description
GND	Ground.
SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.
VIN	Input voltage pin. VIN supplies power to the IC. Connect a 4.5V to 20V supply to VIN and bypass VIN to GND with a suitably large capacitor to eliminate noise on the input to the IC.
FB	Output feedback pin. FB senses the output voltage and is regulated by the control loop to 0.8V. Connect a resistive divider at FB.
EN	Drive EN pin high to turn on the regulator and low to turn off the regulator.
BST	Bootstrap pin for top switch. A 0.1uF or larger capacitor should be connected between this pin and the SW pin to supply current to the top switch and top switch driver.

TYPICAL APPLICATION CIRCUITS



BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS (Note 1)

Parameter	Symbol	Max Value	Unit
VIN, EN, SW Pin		-0.3 to 22	V
BST Pin	V_{BST}	V_{SW}-0.3 to V_{SW}+5.0	V
FB Pin		-0.3 to 2.5	V
Junction Temperature Range	T_J	-40 to 150	℃
Storage Temperature Range	T_{STG}	-65 to +150	℃
Lead Temperature(Soldering) 5 Sec.	T_{LEAD}	260	℃
Power Dissipation P_D @ T_A=25℃ (Note 2)	P_D	450	mW
Thermal Resistance Junction to Ambient	θ_{JA}	220	℃/W
Thermal Resistance Junction to Case	θ_{JC}	106.6	℃/W
ESD Rating (Human Body Model) (Note 3)	V_{ESD}	2	kV
ESD Rating (Machine Model) (Note 3)	V_{ESD}	200	V

RECOMMENDED OPERATING CONDITIONS (Note 4)

Parameter	Symbol	Operation Conditions	Unit
Input Voltage Range	V_{IN}	4.5 to 20	V
Output Voltage Range	V_{OUT}	0.6 to 16	V
Operating Junction Temperature Range	T_J	-40 to +125	℃
Operating Ambient Temperature Range	T_{OPA}	-40 to +85	℃

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.

Note 2: Thermal Resistance is specified with the component mounted on a low effective thermal conductivity test board in free air at T_A=25℃.

Note 3: Devices are ESD sensitive. Handing precaution recommended.

Note 4: The device is not guaranteed to function outside its operating conditions.

ELECTRICAL CHARACTERISTICS

V_{IN} = 12V, T_A= +25℃, unless otherwise noted.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Input Voltage Range	V_{IN}		4.5	—	20	V
V_{IN} Under Voltage Lock-out Threshold	V_{IN_MIN}	V_{IN} falling	—	3.9	4.1	V
V_{IN} Under voltage Lockout Hysteresis	$V_{IN\_MIN\_HYST}$	V_{IN} rising	—	300	—	mV
Shutdown Supply Current	I_{SD}	V_{EN}=0V	—	—	1	μA
Supply Current	I_Q	V_{EN}=5V, V_{FB}=2V	—	50	120	μA
Feedback Voltage	V_{FB}		0.582	0.6	0.618	V
Top Switch Resistance (Note 5)	$R_{DS(ON)T}$		—	160	—	mΩ
Bottom Switch Resistance (Note 5)	$R_{DS(ON)B}$		—	80	—	mΩ
Top Switch Leakage Current	I_{LEAK_TOP}	V_{IN}=20V, V_{EN}=0V, V_{SW}=0V	—	—	0.5	μA
Bottom Switch Leakage Current	I_{LEAK_BOT}	V_{IN}=20, V_{EN}=0V, V_{SW}=0V	—	—	0.5	μA
Top Switch Current Limit	I_{LIM_TOP}	Minimum Duty Cycle	—	3.8	—	A
Switch Frequency	F_{SW}		400	500	600	kHz
Minimum On Time	T_{ON_MIN}		—	120	—	ns
Minimum Off Time	T_{OFF_MIN}	V_{FB}=0.5V	—	120	—	ns
EN shut down threshold voltage	V_{EN_TH}	V_{EN} falling, FB=0V	1.12	1.2	1.27	V
EN shut down hysteresis	V_{EN_HYST}	V_{EN} rising, FB=0V	—	120	—	mV
Thermal Shutdown (Note 5)	T_{TSD}		—	145	—	℃
Thermal Shutdown hysteresis (Note 5)	T_{HYS}		—	15	—	℃

Note 5: Guaranteed by design.

FUNCTIONAL DESCRIPTION

The AT7252 is a synchronous, current-mode, step-down converter.

Current-Mode Control

The AT7252 utilizes current-mode control to regulate the FB voltage. Voltage at the FB pin is regulated at 0.6V so that by connecting an appropriate resistor divider between VOUT and GND, designed output voltage can be achieved.

PFM Mode

The AT7252 operates in PFM mode at light load. In PFM mode, switch frequency decreases when load current drops to boost power efficiency at light load by reducing switch-loss, while switch frequency increases when load current rises, minimizing output voltage ripples.

Internal Soft-Start.

Soft-start makes output voltage rising smoothly by following an internal SS voltage until SS voltage is higher than the internal reference voltage. It can prevent the overshoot of output voltage during startup.

Power Switch

N-Channel MOSFET switches are integrated on the AT7252 to down convert the input voltage to the regulated output voltage. Since the top MOSFET needs a gate voltage greater than the input voltage, a boost capacitor connected between BST and SW pins is required to drive the gate of the top switch. The boost capacitor is charged by the internal 3.3V rail when SW is low.

Vin Under-Voltage Protection

A resistive divider can be connected between Vin and ground, with the central tap connected to EN, so that when Vin drops to the pre-set value, EN drops below 1.2V to trigger input under voltage lockout protection.

Output Current Run-Away Protection

At start-up, due to the high voltage at input and low voltage at output, current inertia of the output inductor can be easily built up, resulting in a large start-up output current. A valley current limit is designed in the AT7252 so that only when output current drops below the valley current limit can the top power switch be turned on. By such control mechanism, the output current at start-up is well controlled.

Output Current Protection and Hiccup

AT7252 has a cycle-by-cycle current limit. When the inductor current triggers current limit, AT7252 enters hiccup mode and periodically restart the chip. AT7252 exits hiccup mode while not triggering current limit.

Thermal Protection

When the temperature of the AT7252 rises above 145℃, it is forced into thermal shut-down.

Only when core temperature drops below 130℃ can the regulator becomes active again.

APPLICATION INFORMATION

Output Voltage Set

The output voltage is determined by the resistor divider connected at the FB pin, and the voltage ratio is:

$$V_{FB} = V_{OUT} \times \frac{R2}{R2 + R1}$$

where V_{FB} is the feedback voltage and V_{OUT} is the output voltage.

Choose R2 around 10kΩ~15kΩ, and then R1 can be calculated by:

$$R1 = R2 \times \left(\frac{V_{OUT}}{0.6V} - 1 \right)$$

The following table lists the recommended values.

V_{OUT}(V)	R1(kΩ)	R2(kΩ)
2.5	47	15
3.3	49.5	11
5	110	15

Input Capacitor

The input capacitor is used to supply the AC input current to the step-down converter and maintaining the DC input voltage. The ripple current through the input capacitor can be calculated by:

$$I_{C1} = I_{LOAD} \times \sqrt{\frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)}$$

where I_{LOAD} is the load current, V_{OUT} is the output voltage, V_{IN} is the input voltage.

Thus the input capacitor can be calculated by the following equation when the input ripple voltage is determined.

$$I_{C1} = \frac{I_{LOAD}}{f_S \times \Delta V_{IN}} \times \frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

where I_{C1} is the input capacitance value, fs is the switching frequency, $\triangle V_{IN}$ is the input ripple voltage.

The input capacitor can be electrolytic, tantalum or ceramic. To minimizing the potential noise, a small X5R or X7R ceramic capacitor, i.e. 0.1uF, should be placed as close to the IC as possible when using electrolytic capacitors.

A 22uF ceramic capacitor is recommended in typical application.

Output Capacitor

The output capacitor is required to maintain the DC output voltage, and the capacitance value determines the output ripple voltage. The output voltage ripple can be calculated by:

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

where C2 is the output capacitance value and R_{ESR} is the equivalent series resistance value of the output capacitor.

The output capacitor can be low ESR electrolytic, tantalum or ceramic, which lower ESR capacitors get lower output ripple voltage.

The output capacitors also affect the system stability and transient response, and a 22uF ceramic capacitor is recommended in typical application.

Inductor

The inductor is used to supply constant current to the output load, and the value determines the ripple current which affect the efficiency and the output voltage ripple. The ripple current is typically allowed to be 30% of the maximum switch current limit, thus the inductance value can be calculated by:

$$L = \frac{V_{OUT}}{f_S \times \Delta I_L} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

where V_{IN} is the input voltage, V_{OUT} is the output voltage, fs is the switching frequency, and $\triangle I_L$ is the peak-to-peak inductor ripple current.

External Boostrap Capacitor

A boostrap capacitor is required to supply voltage to the top switch driver. A 0.1uF low ESR ceramic capacitor is recommended to connected to the BST pin and SW pin.

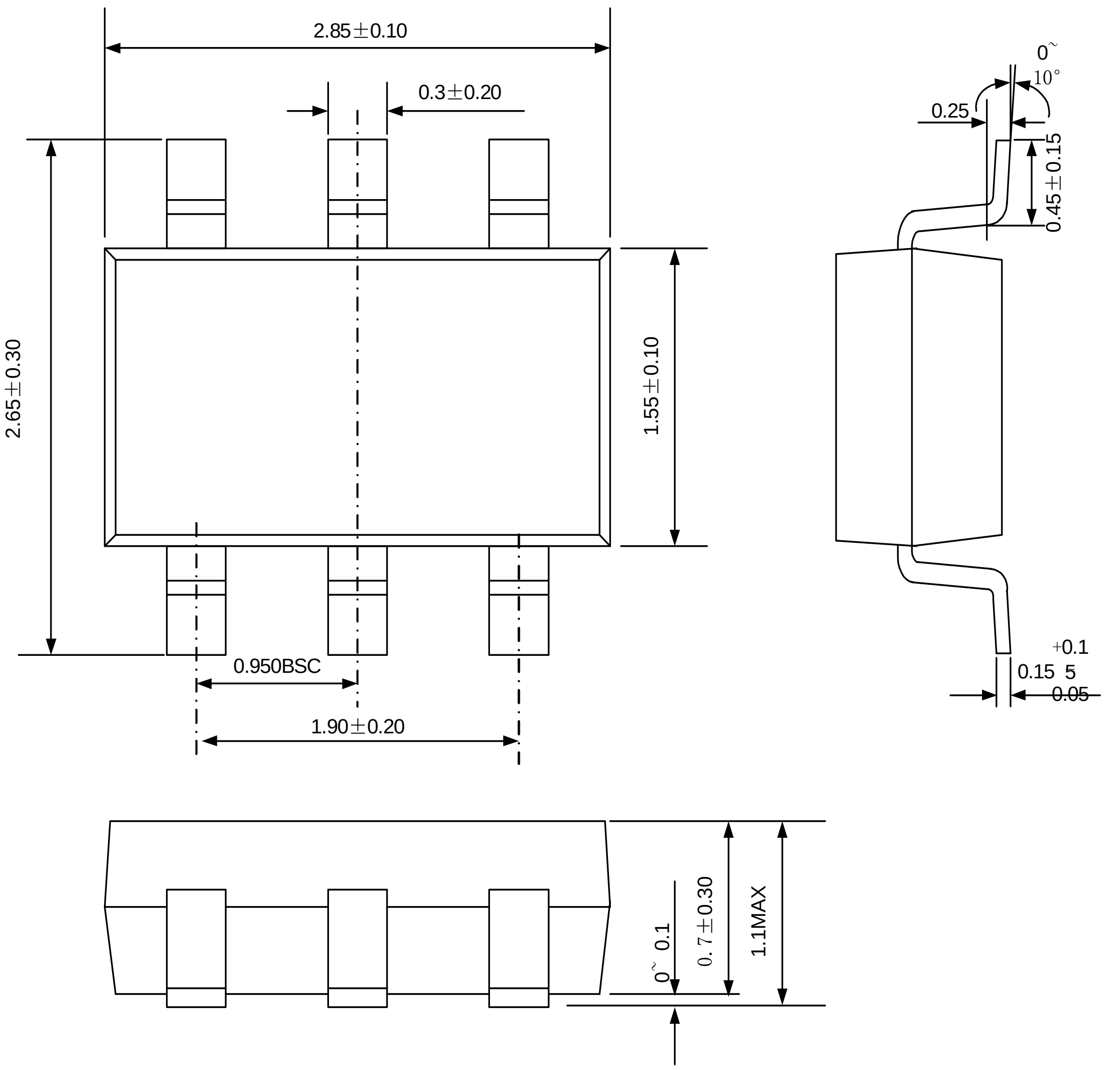
PCB Layout Note

For minimum noise problem and best operating performance, the PCB is preferred to following the guidelines as reference.

- Place the input decoupling capacitor as close to AT7252 (VIN pin and PGND) as possible to eliminate noise at the input pin. The loop area formed by input capacitor and GND must be minimized.
- Put the feedback trace as far away from the inductor and noisy power traces as possible.
- The ground plane on the PCB should be as large as possible for better heat dissipation

PACKAGE OUTLINE DIMENSIONS

TSOT-26 PACKAGE OUTLINE DIMENSION



Note :

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