4.5V-16V Input, 2.5A, COT Synchronous Step-Down Converter

FEATURES

- **COT Control Mode**
- **Fast Transient Response**
- **700KHz Pseudo-fixed Frequency Operation (5V Output)**
- **2.5A Output Current**
- **4.5V to 16V Input Voltage Range**
- **0.8V Reference**
- **Integrated internal compensation**
- **Stable with Low ESR Ceramic Output Capacitors**
- **Over Current Protection with Hiccup-Mode**
- **Thermal Shutdown**
- **Inrush Current Limit and Soft Start**
- **Available in SOT23-6 Package**
- **-40°C to +85°C Temperature Range**

APPLICATIONS

- **Distributed Power Systems**
- **Digital Set Top Boxes**
- **Flat Panel Television and Monitors**
- **Wireless and DSL Modems**
- **Notebook Computer**

GENERAL DESCRIPTION

FC1470B is a constant on-time mode synchronous buck converter. The main control loop of FC1470B uses the COT mode for control that provides a fast transient response without the need for external compensation components. Under a 1.2V output, the transient value from 0 to 2.5A is merely 35mV. The constant on-time control technology enables seamless transition between the PWM mode under higher load conditions and operation at light loads, allowing FC1470B to maintain high efficiency in light load situations.

FC1470B operates from 4.5V to 16V VIN input. The output voltage can be programed within the range of 0.8V to 6V. Internally, it features functions such as soft start, over-temperature protection, under-voltage protection, and cycle-by-cycle current limiting.

TYPICAL APPLICATION

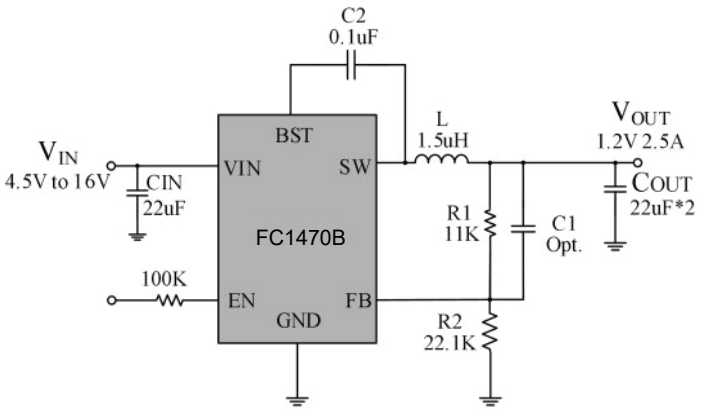
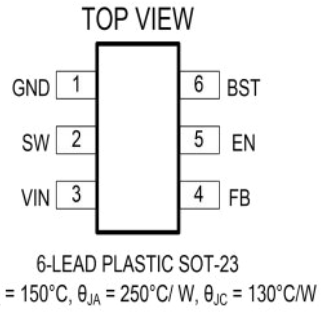


Figure 1. Basic Application Circuit

ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Supply Voltage.....-0.3V to 17V
EN Voltages.....-0.3V to 6V
FB Voltages.....-0.3V to 6V
SW Voltage.....-0.3V to (V_{IN}+0.5V)
BS Voltage.....(V_{SW}-0.3V) to (V_{SW}+5V)
Power Dissipation.....0.6W
Thermal Resistance θ_{JC}.....130°C/W
Thermal Resistance θ_{JA}.....170°C/W
Junction Temperature(Note2).....150°C
Operating Temperature Range....-40°C to 85°C
Lead Temperature(Soldering,10s).....300°C
Storage Temperature Range.....-65°C to 150°C
ESD HBM(Human Body Mode).....2kV
ESD MM(Machine Mode).....200V

PACKAGE/ORDER INFORMATION



Order Part Number	Package	Top Marking
FC1470B	SOT23-6	A42FDC

D:year, C:week

PIN DESCRIPTION

Pin Name	Pin Number	Description
GND	1	Analog ground pin.
SW	2	Switching Pin.
VIN	3	Power supply Pin.
FB	4	Adjustable version feedback input. Connect FB to the center point of the external resistor divider.
EN	5	Enable pin. Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable the IC and enter shutdown mode.
BS	6	Bootstrap pin. A capacitor connected between SW and BS pins is required to form a floating supply across the high-side switch driver.

ELECTRICAL CHARACTERISTICS (Note 3)

(V_{IN}=12V, T_A = 25°C, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
Input Voltage Range		4.5		16	V
Supply Current in Operation	V_{EN}=2.0V, V_{FB}=0.9V		350	600	μA
Supply Current in Shutdown	V_{EN} =0 or EN = GND		3.6	10	μA
EN rising threshold		1.6			V
EN falling threshold				0.6	V
Regulated Feedback Voltage	T_A = 25°C, 4.5V≤ V_{IN} ≤18V	0.784	0.8	0.816	V
FB Pin Leakage Current	V_{FB}=0.9V, V_{SW}=0V		0	±0.15	μA
High-Side Switch On-Resistance	V_{BST}-SW=5.5V		100		mΩ
Low-Side Switch On-Resistance			50		mΩ
Soft-start Time			1		mS
Valley Current Limit	L=1.5μH		3.2		A
On-Time	V_O=1.2V		120		nS
Minimum Off-Time			260	330	nS
Thermal Shutdown	Shutdown Temperature		165		℃
	Hysteresis		25		℃
UVLO	VIN Rising		4.15		V
	Hysteresis		0.1		V

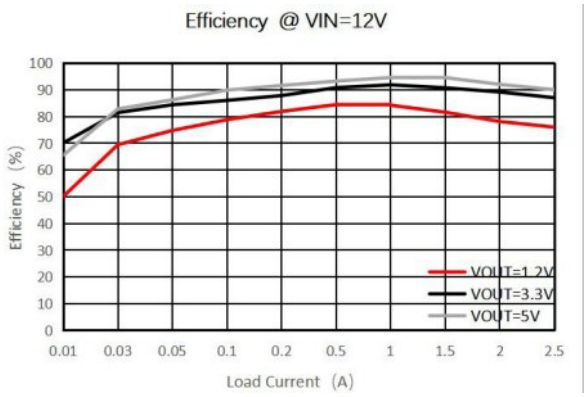
Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

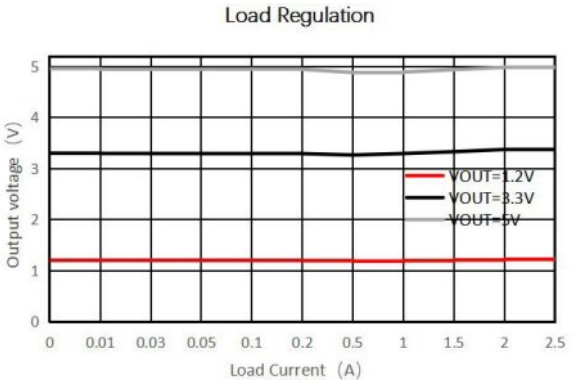
Note 2: T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + (P_D)$ x (170°C/W).

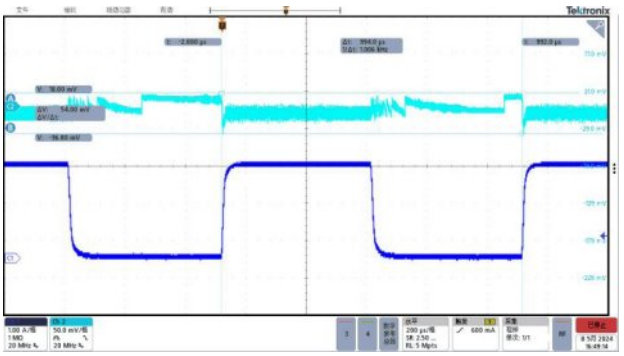
Note 3: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

TYPICAL PERFORMANCE CHARACTERISTICS

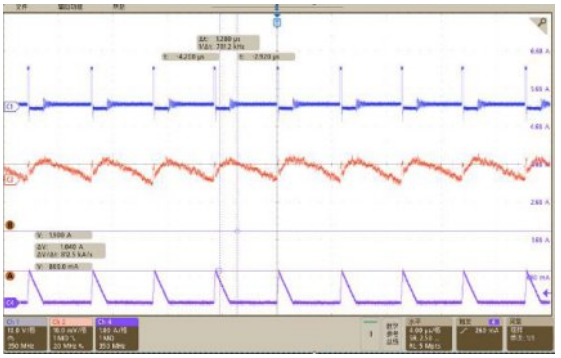
(V_{IN} = 12V, V_{OUT} = 1.2V, L = 1.5µH, T_A = +25°C, unless otherwise noted.)



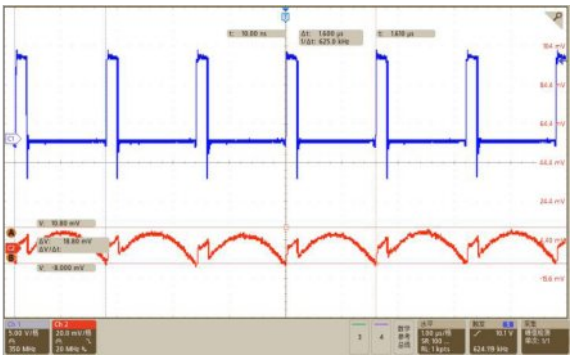




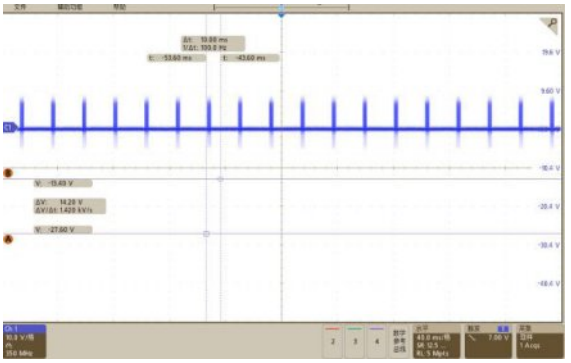
Transient Response I_{LOAD}=0A-2.5A



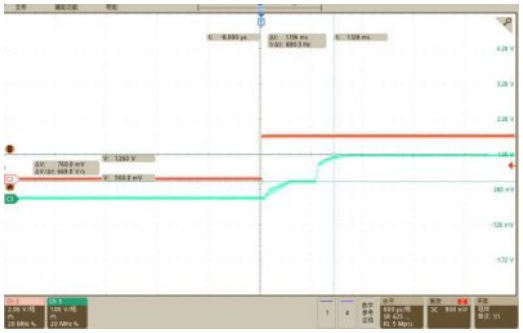
I_{LOAD}=0.1A



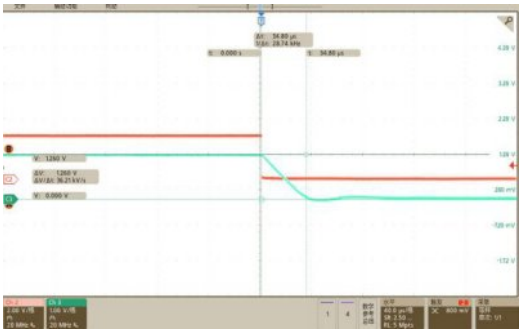
I_{LOAD}=2.5A



Output Short



Soft Start@ I_{LOAD}=2.5A



Shut Down@ I_{LOAD}=2.5A

FUNCTIONAL BLOCK DIAGRAM

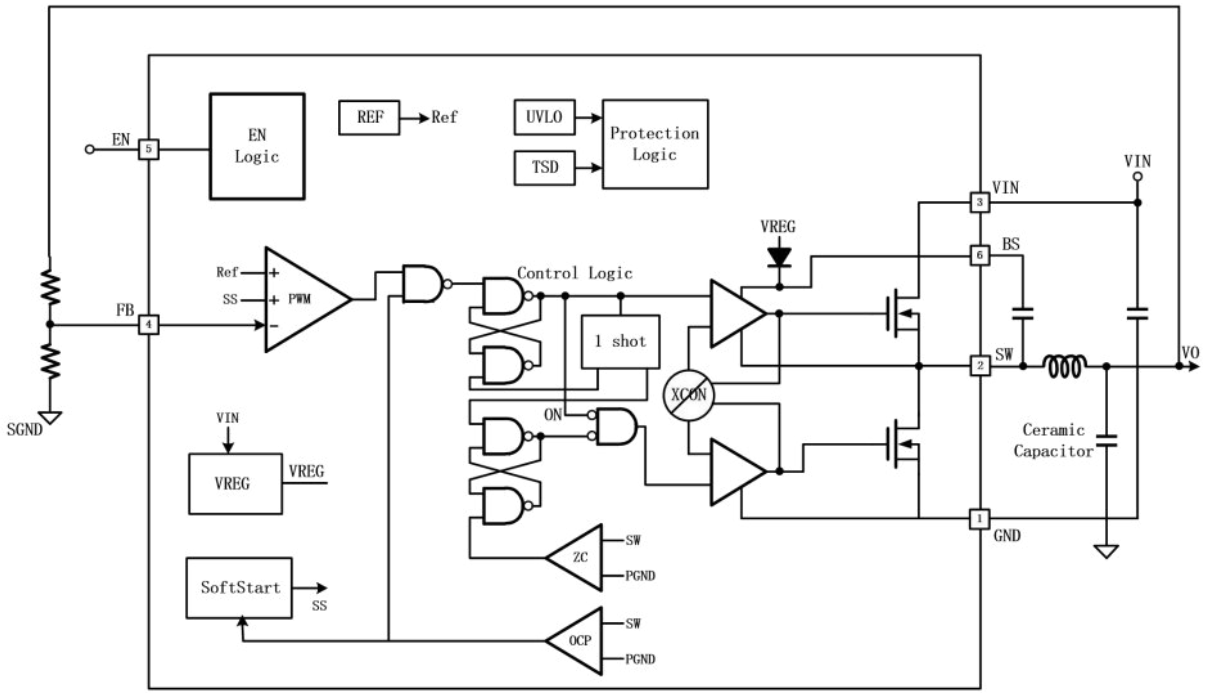


Figure 2. FC1470B Block Diagram

FUNCTIONAL DESCRIPTION

The FC1470B is a COT-mode 2.5A synchronous buck converter with two N-type MOSFETs integrated inside. The COT control mode has excellent transient response capability, and the chip does not require additional external compensation devices. Dedicated internal circuit design allows peripheral use of low ESR ceramic capacitors. The chip uses pseudo-constant frequency control and operates at an approximate operating frequency of 700KHz.

EN control

The EN pin is a digital control pin that starts the chip at high power levels and enters shutdown mode at low power levels. The EN is a low-voltage pin that is clamped with a Zener inside. If the EN pin is to be connected to the VIN, a resistance of more than 100K is required in series.

Overcurrent protection and short circuit protection

FC1470B has the function of overcurrent protection and short circuit protection, and adopts the control mode of valley current limit. With the LS MOSFET on, the inductive current is monitored. When the inductive current reaches the valley setting value, the device enters overcurrent protection mode. At the same time, the output voltage drops, when the VFB voltage is lower than 75% of the reference value, the chip is in the short-circuit protection state, that is, it enters the hiccup mode, the chip will disable the output power level, soft start and restart.

Output voltage setting

The output voltage can be set by the following formula 1, which can be referred to Table 1. In order to ensure the output accuracy, the resistance accuracy should be 1%.

$$V_{OUT} = 0.8 \times \left(1 + \frac{R1}{R2}\right) \qquad (1)$$

Recommended values for peripheral devices

The output circuit of FC1470B is an LC filter. The COT control mode has double poles at LC:

$$F_P = \frac{1}{2\Pi \sqrt{Lout * Cout}} \qquad (2)$$

At the double poles, the gain decreases at a rate of -40dB, and the phase decreases rapidly. In order to ensure the stability of the loop, sufficient phase margin is provided. It is recommended to use the values in Table 1:

Table 1. Recommended values for peripheral devices

V_{OUT} (V)	R1 (kΩ)	R2 (kΩ)	C1(pF)	L1 (μH)	C8 + C9 (μF)
1	5.5	22.1		1.0 - 1.5	22 - 68
1.05	6.9	22.1		1.0 - 1.5	22 - 68
1.2	11	22.1		1.0 - 1.5	22 - 68
1.5	19.3	22.1		1.5	22 - 68
1.8	27.6	22.1	22（Opt.）	1.5	22 - 68
2.5	46.9	22.1	22（Opt.）	2.2	22 - 68
3.3	69	22.1	22（Opt.）	2.2	22 - 68
5	116	22.1	22（Opt.）	3.3	22 - 68

Bootstrap capacitor selection

A 0.1μF ceramic capacitor must be connected between the VBST and SW pins for proper operation.

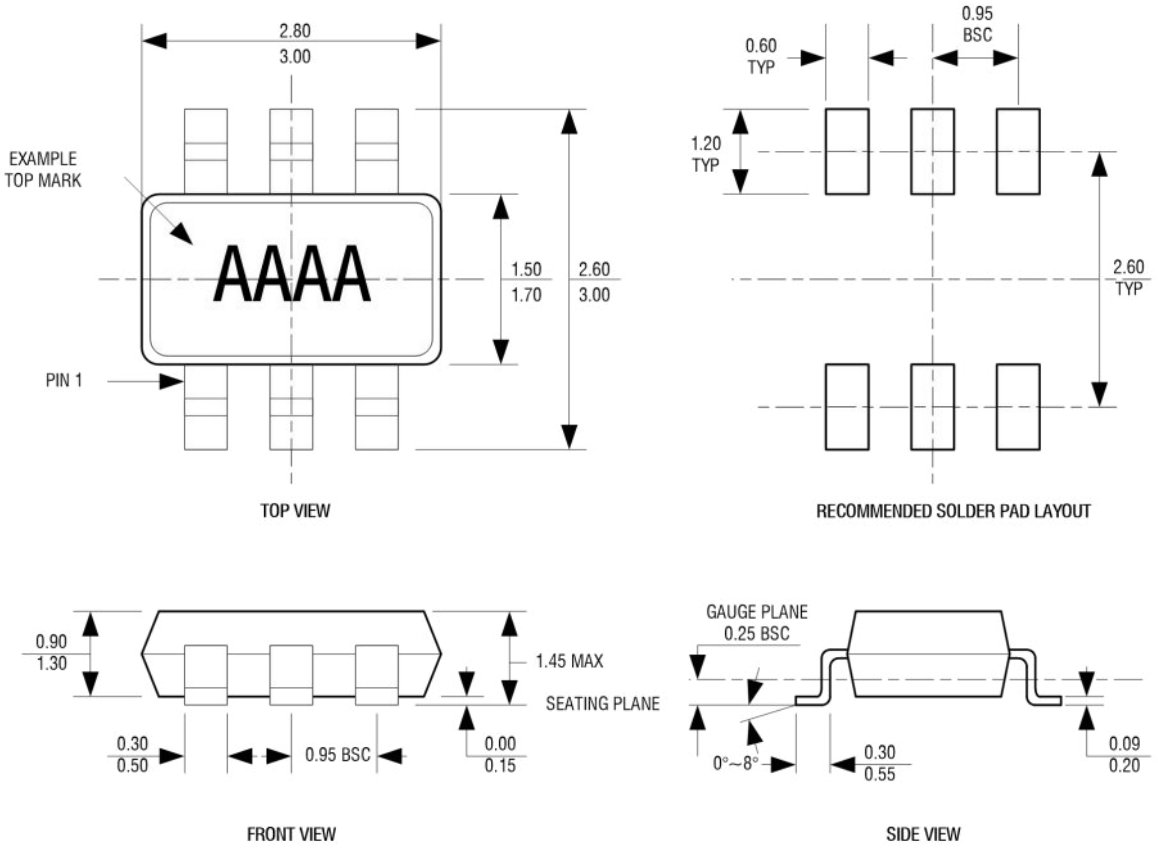
PCB layout

1. The input and output capacitors must be near the GND pin of the IC to reduce the current loop area.
2. Large AC currents will flow through VIN, SW and VOUT tracks, so make sure these tracks are short and wide.
3. The copper at the SW foot, because there is alternating voltage on it, needs to be controlled in a relatively small area to prevent EMI.
4. The FB pin is a high-impedance node, and the FB wire should be short enough to avoid the output voltage fluctuation caused by picking noise.

Place the feedback resistor as close as possible to the IC, while the GND of R2 should be placed as close as possible to the GND pin of the IC, and the wiring of VOUT to R1 should be far away from the inductor and switch nodes.

PACKAGE DESCRIPTION

SOT23-6



NOTE:
1.DIMENSIONS ARE IN MILLIMETERS.
2.DRAWING NOT TO SCALE.
3.DIMENSIONS ARE INCLUSIVE OF PLATING.
4.DIMENSIONS ARE EXCLUSIVE OF MOLD FLASH AND METAL BURR.