DESCRIPTION

The A7406B is a wide input range, high-efficiency, and high frequency DC-to-DC step-down switching regulator, capable of delivering up to 0.6A of output current.

With a fixed switching frequency of 1.6MHz, this current mode PWM controlled converter allows the use of small external components, such as ceramic input and output caps, as well as small inductors.

Including cold crank and double battery jump-starts, the minimum input voltage may be as low as 4.5V and the maximum up to 45V, with even higher transient voltages. With these high input voltages, linear regulators cannot be used for high supply currents without overheating the regulator. Instead, high efficiency switching regulators such as A7406B must be used to minimize thermal dissipation.

The A7406B is available in SOT-26 package.

ORDERING INFORMATION

<table>
<tr><th>Package Type</th><th colspan="2">Part Number</th></tr>
<tr><td rowspan="2">SOT-26
SPQ: 3,000pcs/Reel</td><td rowspan="2">E6</td><td>A7406BE6R</td></tr>
<tr><td>A7406BE6VR</td></tr>
<tr><td>Note</td><td colspan="2">V: Halogen free Package
R: Tape & Reel</td></tr>
<tr><td colspan="3">AiT provides all RoHS products</td></tr>
</table>

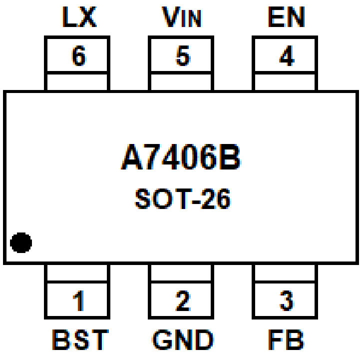
FEATURES

- Wide Input Operating Range from 4.5V to 45V
- 420mΩ internal NMOS
- Up to 95% Efficiency at 16V in 12V out L=47uH with 300mA loading
- Internal compensation
- Capable of Delivering 600mA continuous output current
- Fixed 1.6MHz PWM operation
- Internal soft start
- Output voltage adjustable down to 0.795V
- Cycle-by-cycle current limit
- Current Mode control
- Short-circuit protection
- Logic Control Shutdown EN can be short to V_{IN}
- Thermal shutdown and UVLO
- Available in SOT-26 Package

APPLICATION

- Smart/Industrial/Power Meters
- Industrial Applications
- Automotive Applications

PIN DESCRIPTION



Top View

Pin #	Symbol	Function
1	BST	Bootstrap pin for top Switch. In Typ. application, a 0.1uF or larger capacitor should be connected between this pin and the LX pin to supply current to the top Switch gate and top Switch driver.
2	GND	Analog Ground
3	FB	Output feedback pin. In Typ. application, FB senses the output voltage and is regulated by the control loop to 800mV. Connect a resistive divider at FB.
4	EN	Drive EN pin high to turn on the regulator and low to turn off the regulator.
5	V_{IN}	Input voltage pin, In Typ. application, V_{IN} supplies power to the IC. Connect a 4.5V to 45V supply to V_{IN} and bypass V_{IN} to GND with a suitably large capacitor to eliminate noise on the input to the IC.
6	LX	LX is the Switching node that supplies power to the output Connect the output LC filter from LX to the output load.

ABSOLUTE MAXIMUM RATINGS

Input Voltage Range		-0.3V~50V
T_J, Max Operating Junction Temperature		150℃
LX, EN Voltage		-0.3V ~ V_{IN}+0.3V
BST Voltage		-0.3V~ LX+6.0V
FB Voltage		-0.3V ~ 6.0V
LX to Ground Current		Internally limited
T_O, Operating Temperature		-40°C ~ 85°C
θ_{JC}, Package Thermal Resistance	SOT-26	110℃/W
T_S, Storage Temperature		-55°C ~ 150℃
ESD Rating		2000V

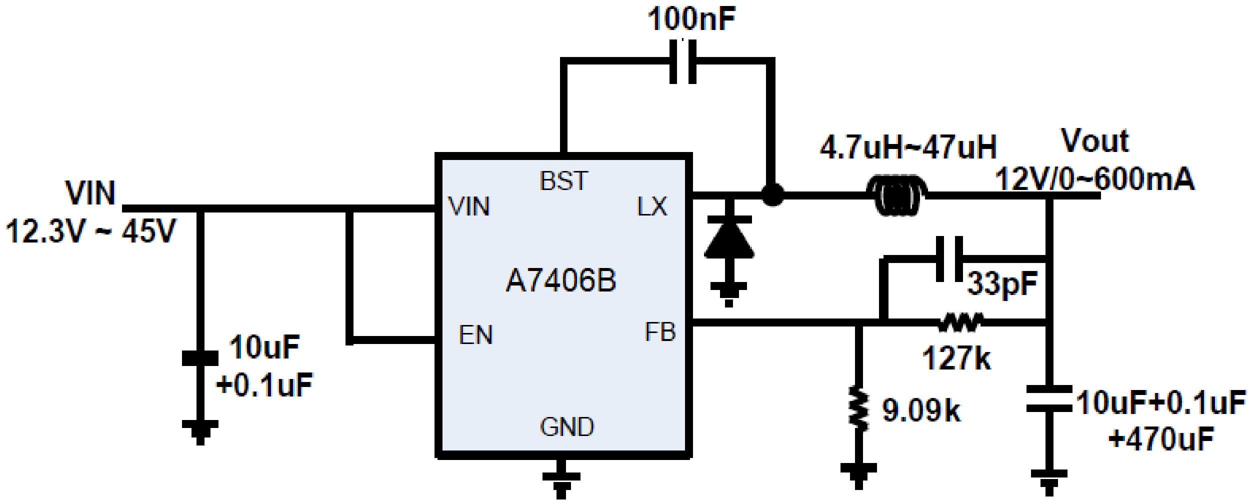
Stress beyond above listed “Absolute Maximum Ratings” may lead permanent damage to the device. These are stress ratings only and operations of the device at these or any other conditions beyond those indicated in the operational sections of the specifications are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

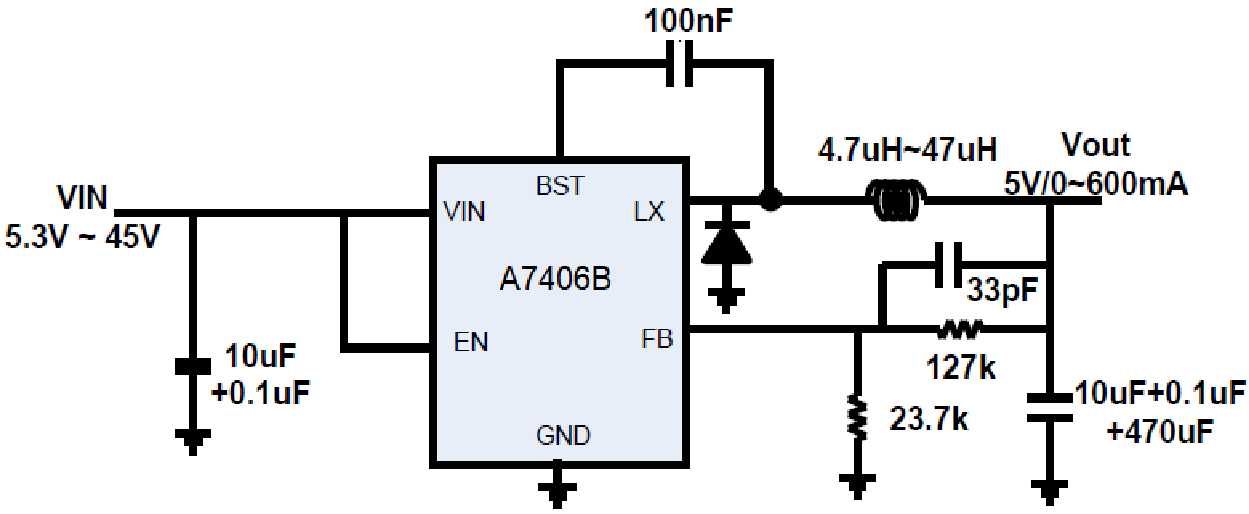
ELECTRICAL CHARACTERISTICS

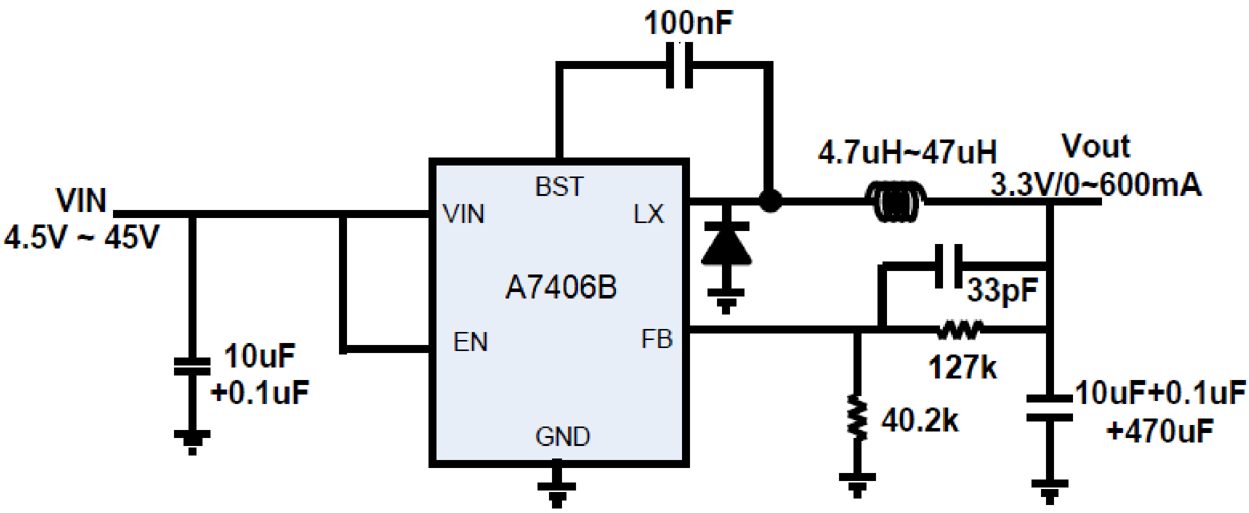
Typical values are at T_A = 25ºC, V_{IN}=V_{EN}=16V, unless otherwise stated.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range	V_{IN}		4.5	-	45	V
Input UVLO	$V_{IN(UVLO)}$		2.3	-	2.9	V
Input UVLO Hysteresis	$V_{IN(UVLO)HYS}$		-	0.26	-	V
Input Supply Current	I_Q	V_{FB}=5V, No loading	-	690	-	μA
Input Shutdown Current	I_{SD}	V_{EN}<0.3V	-	-	8	μA
Feedback Voltage	V_{FB}	3.3<V_{IN}<40V	0.778	0.795	0.810	V
Load Regulation	V_{FB_LOAD}	120mA<load<600mA	-	0.5	-	%
Line Regulation	V_{FB_line}	Load =600mA	-	0.03	-	%/V
Feedback Voltage Input Current	I_{FB}	V_{FB}=800mV	-	400	-	nA
ENABLE						
EN High Level	V_{EN_Hi}	V_{FB}=0V,rising	1.2	-	-	V
EN Low Level	V_{EN_Lo}	V_{FB}=0V,falling	-	-	0.4	V
EN Hysteresis	V_{EN_HYS}	V_{FB}=0V	-	0.2	-	V
Enable Input Current	I_{EN}		-	-	3	μA
MODULATOR						
OSC Frequency	f_{OSC}		1.28	1.6	1.92	MHz
	Dmax		-	87	-	%
Min on Time	$t_{ON\ MIN}$		-	130	-	ns
Limited Current	I_{LIM}		0.75	0.95	-	A
LX Leakage Current	I_{SWLEAK}	V_{EN}=0V, V_{LX}=0V, V_{IN}=40V	-	-	10	μA
Thermal Shutdown	Temp	Temp rising	-	150	-	°C
		Temp falling	-	110	-	°C
Soft-Start Time	t_{SS}	FB from 0 to 0.8V	-	1.8	-	msec
POWER STAGE OUTPUT						
NMOS Leakage	$I_{leakage}$	V_{EN}=0V, V_{LX}=0V	-	-	10	μA
NMOS on Resistance	R_{DSON}	V_{IN}=12V, V_{BST}-V_{LX}=5V	-	420	-	mΩ

TYPICAL APPLICATION CIRCUITS



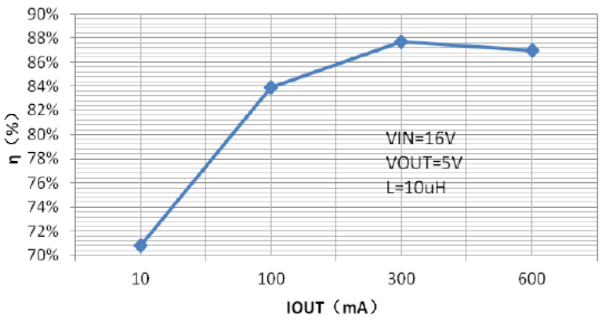




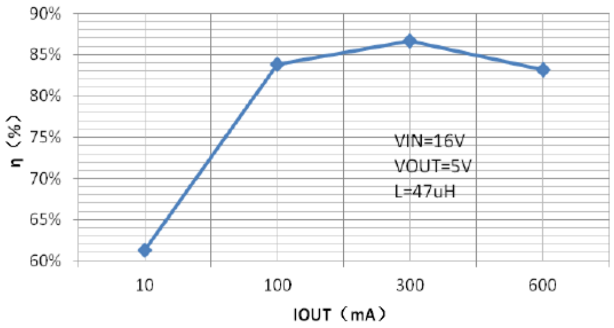
TYPICAL PERFORMANCE CHARACTERISTIC

Typical values are at T_A = 25℃,unless otherwise specified.

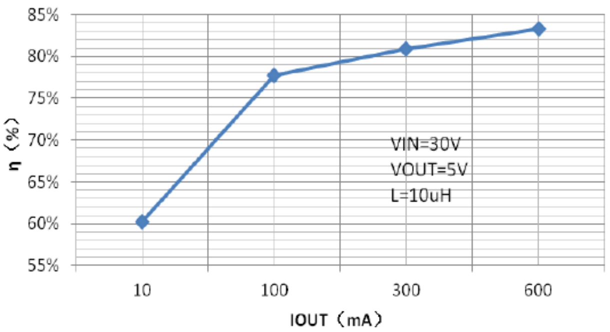
1. Efficiency vs. I_{OUT}



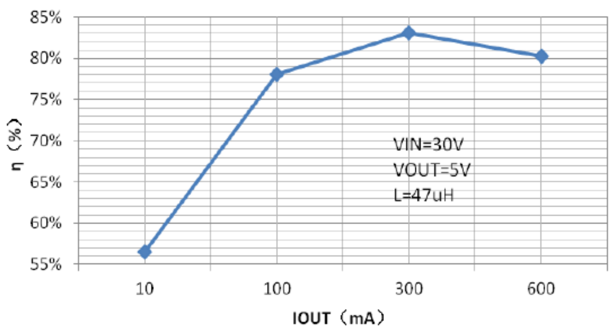
2. Efficiency vs. I_{OUT}



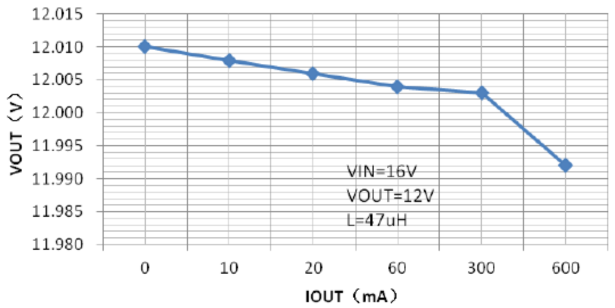
3. Efficiency vs. I_{OUT}



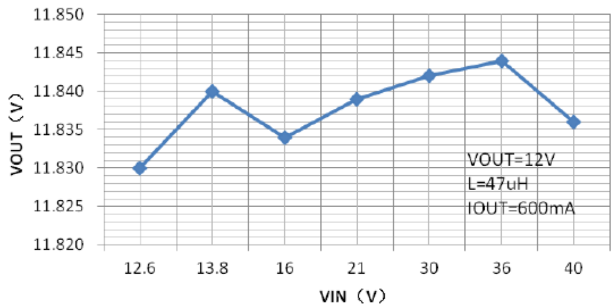
4. Efficiency vs. I_{OUT}



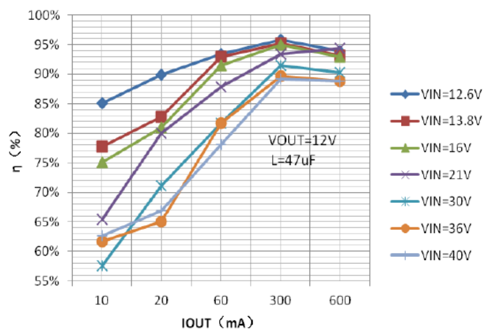
5. V_{OUT} vs. I_{OUT}



6. V_{OUT} vs. V_{IN}



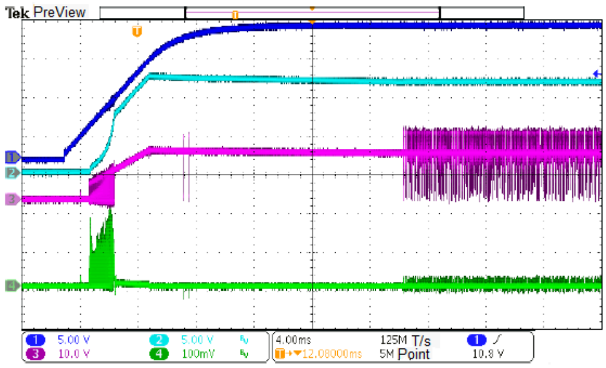
7. Efficiency vs. I_{OUT}



8. Start-up Waveform with EN=V_{IN}

V_{IN}=18V,V_{OUT}=12V,I_{OUT}=0A,L=47uH

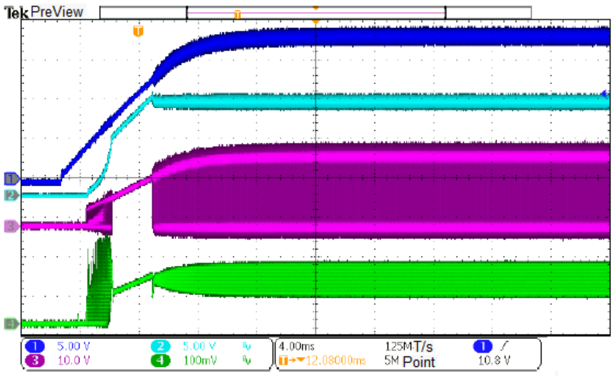
CH1 (V_{IN}),CH2(V_{OUT}),CH3(LX),CH4(IL)



9. Start-up Waveform with EN=V_{IN}

V_{IN}=18V,V_{OUT}=12V,I_{OUT}=125mA,L=47uH

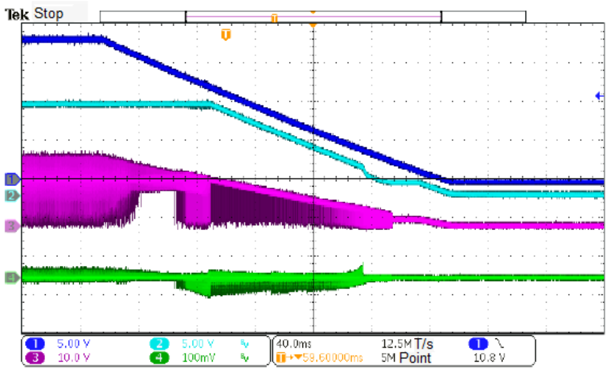
CH1 (V_{IN}),CH2(V_{OUT}),CH3(LX),CH4(IL)



10. Shutdown Waveform with EN=V_{IN}

V_{IN}=18V,V_{OUT}=12V,I_{OUT}=0A,L=47uH

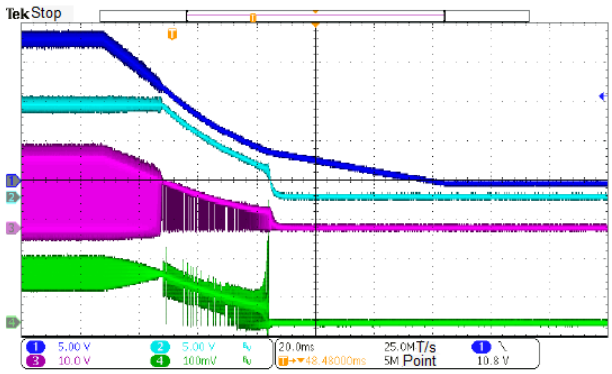
CH1 (V_{IN}),CH2(V_{OUT}),CH3(LX),CH4 (IL)



11. Shutdown Waveform with EN=V_{IN}

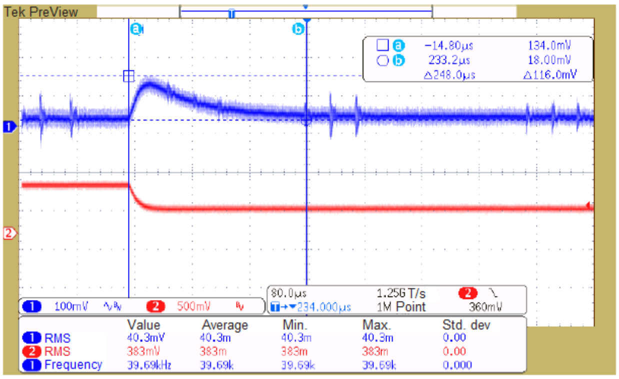
V_{IN}=18V,V_{OUT}=12V,I_{OUT}=125mA,L=47uH

CH1 (V_{IN}),CH2(V_{OUT}),CH3(LX),CH4(IL)



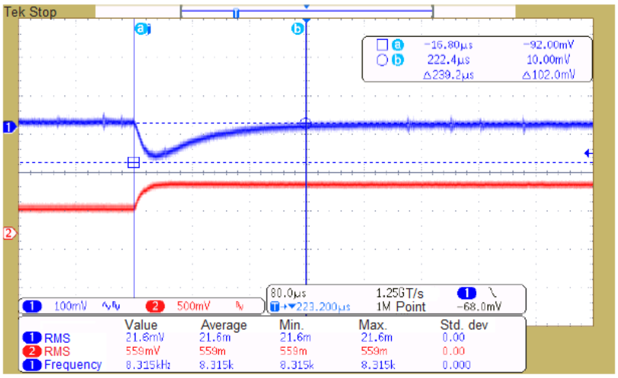
12. Trans response Waveform V_{IN}=16V,V_{OUT}=12V, L=47uH, I_{OUT}=600mA to 300mA

CH1 (V_{OUT}),CH2(Iload)

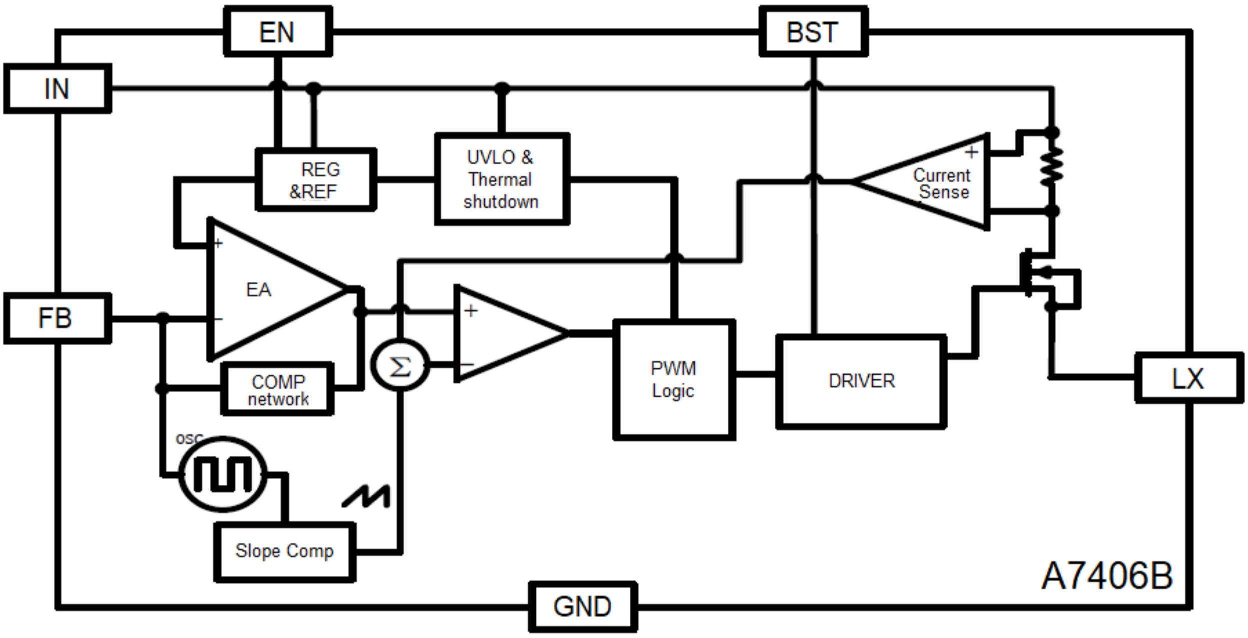


13. Trans response Waveform V_{IN}=16V,V_{OUT}=12V, L=47uH, I_{OUT}=300mA to 600mA

CH1 (V_{OUT}),CH2(Iload)



BLOCK DIAGRAM



DETAILED INFORMATION

Loop Operation

The A7406B is a wide input range, high-efficiency, DC-to-DC step-down switching regulator, capable of delivering up to 0.6A of output current, integrated with a 420mΩ high side MOSFET. It uses a PWM current-mode control scheme. An error amplifier integrates error between the FB signal and the internal reference voltage. The output of the integrator is then compared to the sum of a current-sense signal and the slope compensation ramp. This operation generates a PWM signal that modulates the duty cycle of the power MOSFETs to achieve regulation for output voltage.

APPLICATION INFORMATION

Setting Output Voltages

Output voltages are set by external resistors. The FB threshold is 0.795V.

$$R_{TOP} = R_{BOTTOM} \times [(V_{OUT} / 0.795) - 1]$$

Inductor Selection

The peak-to-peak ripple is limited to 30% of the maximum output current. This places the peak current far enough from the minimum over current trip level to ensure reliable operation while providing enough current ripples for the current mode converter to operate stably. In this case, for 0.6A maximum output current, the maximum inductor ripple current is 180mA. The inductor size is estimated as following equation:

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

Therefore, for V_{OUT}=5V, The inductor values is calculated to be L = 15.43μH. Chose 15μH

For V_{OUT} =3.3V, The inductor values is calculated to be L = 10.62μH. Chose 10μH

Output Capacitor Selection

For most applications a nominal 22μF or larger capacitor is suitable. The A7406B internal compensation is designed for a fixed corner frequency that is equal to FC= 8.7kHz

For example, for V_{OUT}=5V, L=15μH, C_{OUT}=22μF.

The output capacitor keeps output ripple small and ensures control-loop stability. The output capacitor must also have low impedance at the switching frequency. Ceramic, polymer, and tantalum capacitors are suitable, with ceramic exhibiting the lowest ESR and high-frequency impedance. Output ripple with a ceramic output capacitor is approximately as follows:

$$V_{RIPPLE} = I_{L(PEAK)}[1 / (2\pi \times f_{OSC} \times C_{OUT})]$$

If the capacitor has significant ESR, the output ripple component due to capacitor ESR is as follows:

$$V_{RIPPLE(ESR)} = I_{L(PEAK)} \times ESR$$

Input Capacitor Selection

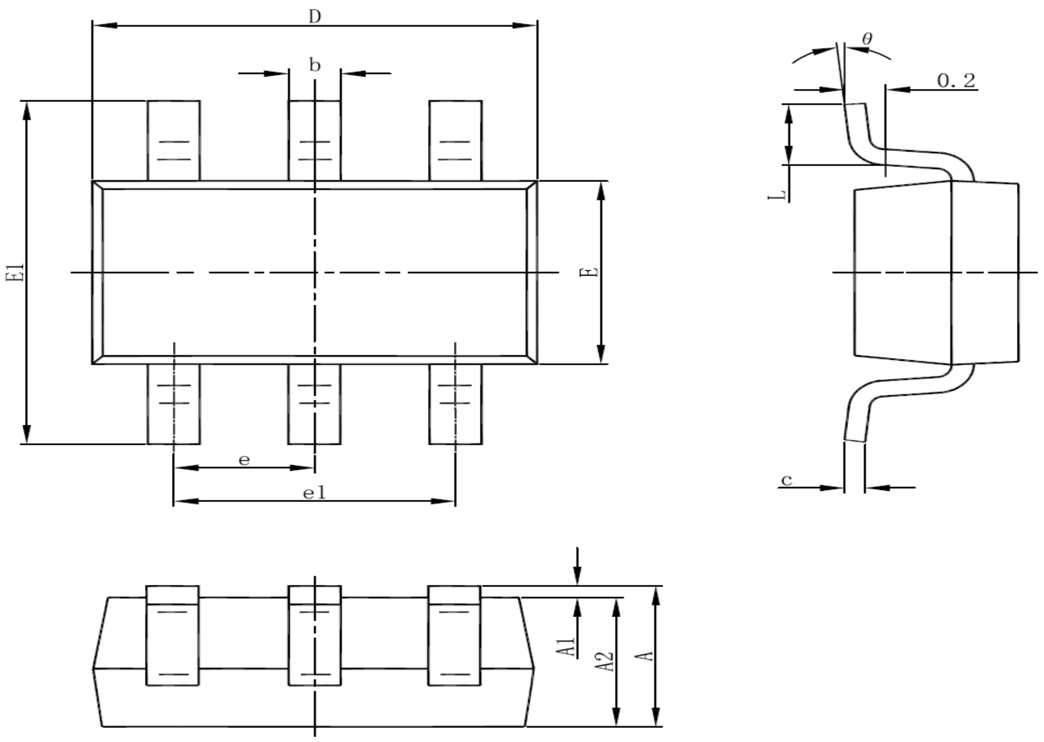
The input capacitor in a DC-to-DC converter reduces current peaks drawn from the battery or other input power source and reduces switching noise in the controller. The impedance of the input capacitor at the switching frequency should be less than that of the input source so high-frequency switching currents do not pass through the input source. The output capacitor keeps output ripple small and ensures control-loop stability.

Components Selection

V_{OUT} (V)	C_{OUT} (μF)	L (μH)
12	22	15 to 22
5	22	10 to 15
3.3	22	6.8 to 10

PACKAGE INFORMATION

Dimension in SOT-26 Package (Unit: mm)



Symbol	Millimeters		Inches	
	Min	Max	Min	Max
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.950(BSC)		0.037(BSC)	
e1	1.800	2.000	0.071	0.079
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

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