DESCRIPTION

A7406 is a sync Buck DC-DC converter IC, which integrates two NMOSFET power switches with low on-resistance. And R_{DSON} of high side and low side switches are 170mΩ and 410mΩ respectively. This product is capable of delivering 1A load current. In light load condition, A7406 works in the PFM mode which has good efficiency performance. When load current goes heavy, A7406 works in a quasi PWM mode. At this time, it has a constant switching frequency of 1 MHZ. A7406 incorporates OTP, input UVLO, cycle by cycle current limit protection and output short circuit protection to improve reliability.

The A7406 is available in SOT-26 package.

FEATURES

- Input Voltage Range：4.7V ~ 40V
- Shutdown Current：8uA
- Quiescent Current：120uA
- R_{DSON}(LSD/HSD)：170mΩ/410mΩ
- Switching Frequency：1MHz
- Reference Voltage：0.6V ±2%
- Cycle by Cycle Peak Current Limit：1.9A
- Short Circuit Protection：Hiccup Mode
- Overtemperature Protection：160°C

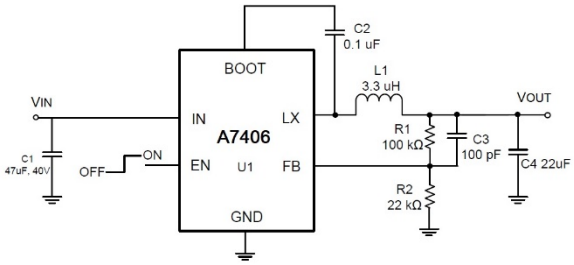
APPLICATION

- Set Top Box
- LCD TV
- DSL Modem
- Digital TV

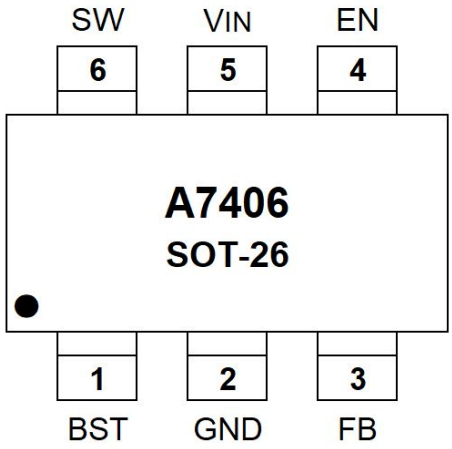
ORDERING INFORMATION

Package Type	Part Number	
SOT-26 SPQ: 3,000pcs/Reel	E6	A7406E6R
		A7406E6VR
Note	V: Halogen free Package R: Tape & Reel	
AiT provides all RoHS products		

TYPICAL APPLICATION



PIN DESCRIPTION



SOT-26, E6

Top View

Pin #	Symbol	Function
1	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.
2	GND	Ground pin.
3	FB	Feedback voltage pin. Inverting input port of error amplifier.
4	EN	Enable input pin. High logic enables the IC.
5	V_{IN}	Power input pin. Power supply for controller and switches.
6	SW	SW is the switching node that supplies power to the output. Connect the output LC filter from SW to the output load.

ABSOLUTE MAXIMUM RATINGS

V_{IN}, V_{IN} Pin Voltage Range	-0.3V ~40V
V_{SW}, SW Pin Voltage Range	-0.3V (-6.5V<5ns) ~ 40V
V_{BST_SW}, Voltage Between BST Pin and SW Pin	-0.3V ~6V
V_{EN}, EN Pin Voltage Range	-0.3V ~40V
V_{FB}, FB Pin Voltage Range	-0.3V ~40V
P_D, Internal Power Dissipation	0.63W
θ_{JA}, Thermal Resistance (Junction to air)	200℃/W
T_A, Operating Temperature Range	-40 ~ +85℃
T_{STG}, Storage Temperature Range	-55 ~ +150℃
T_J, Maximum Junction Temperature	-40 ~ +150℃

Stresses above 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 in the Electrical Characteristics are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Min.	Typ.	Max.	Unit
Input Voltage	V_{IN}	4.7	12	40	V
Output Voltage	V_{OUT}	0.6	3.3	12	V
Inductor Value	L	1.2	3.3	6	uH
Output Capacitor	C_{OUT}	10	20	-	uF
Operating Ambient Temperature	T_A	-40	-	85	℃

ELECTRICAL CHARACTERISTICS

V_{IN}=12V, V_{OUT}=3.3V, T_A=25ºC, unless otherwise noted.

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range	V_{IN}		4.7	-	40	V
Shutdown Current	I_{SD}	V_{IN} = 40 V, IC is enabled.	-	8	15	μA
Quiescent Current	I_Q	V_{IN} = 40V, V_{FB} =0.66V, IC is enabled	-	120	200	μA
Feedback Reference Voltage	V_{REF}		0.588	0.600	0.612	V
High Side On-Resistance	R_{DSON_H}	V_{BST} – V_{SW} = 4.3 V	-	410	500	mΩ
Low Side On-Resistance	R_{DSON_L}		-	170	210	mΩ
Peak Current Limit	I_{LIM_PEAK}		-	1.9	2.5	A
Valley Current Limit	I_{LIM_VALLEY}		-	1.4	1.9	A
EN Rising Threshold	V_{ENH}	V_{EN} rises.	-	1.3	1.5	V
EN Falling Threshold	V_{ENL}		0.8	1.0	-	V
Input UVLO Threshold	V_{IN_UVLO}	V_{IN} falls	-	4.55	4.7	V
Input UVLO Hysteresis	V_{IN_HYS}		-	0.2	-	V
Minimum On Time	T_{min_on}		-	100	150	ns
Minimum Off Time	T_{min_off}		-	150	200	ns
Switching Frequency	F_{SW}		-	1.0	-	MHz
Soft Startup Time	t_{ss}		-	2.3	-	ms
Over Temperature Protection	T_{OTP}		-	160	-	°C
Over Temperature Protection Hysteresis	T_{HYS}		-	40	-	°C

TYPICAL APPLICATION CIRCUITS

Fig 1. Efficiency vs. I_{OUT}

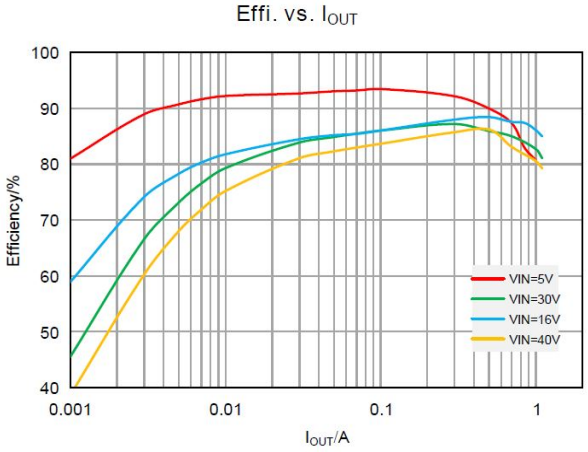


Fig 2. Reference Voltage vs. Temp.

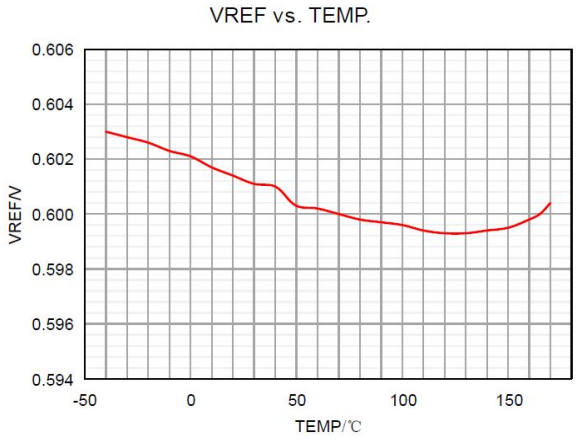


Fig 3. Soft Startup (V_{IN}=40V, V_{OUT}=3.3V, I_{OUT}=1A)

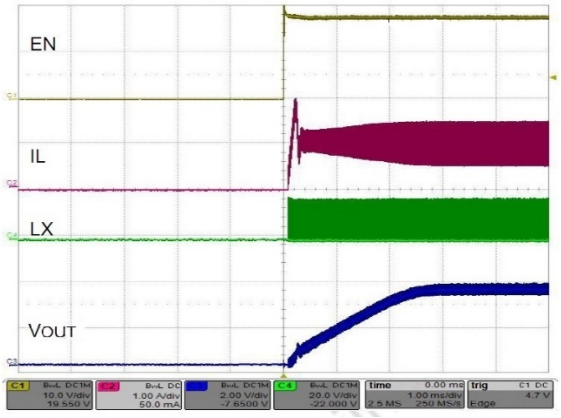


Fig 4. Shutdown

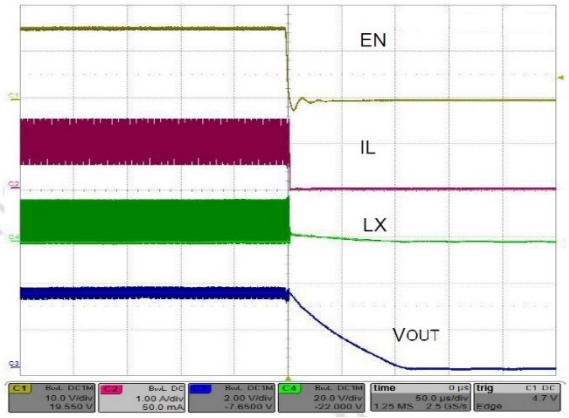


Fig 5. Switching Waveform
(V_{IN}=18V, V_{OUT}=3.3V, I_{OUT}=0.2A)

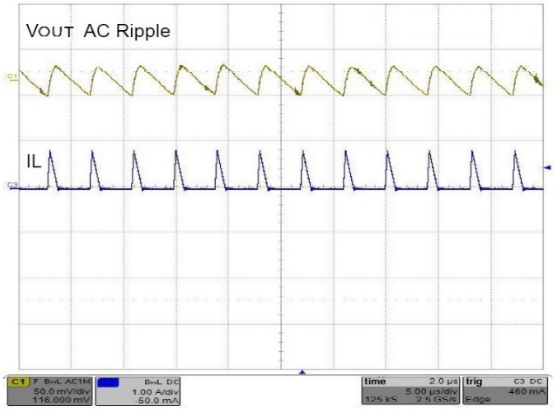


Fig 6. Switching Waveform
(V_{IN}=18V, V_{OUT}=3.3V, I_{OUT}=1A)

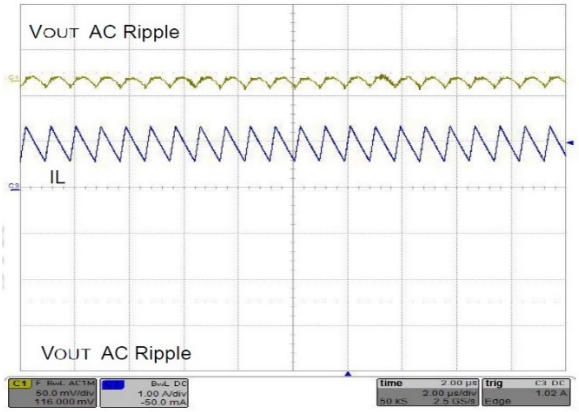


Fig 7. Load Transient Response
(V_{IN}=18V, V_{OUT}=3.3V, I_{OUT}:0.1A-1A)

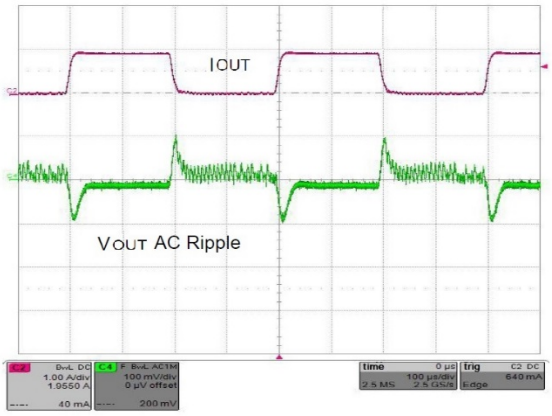
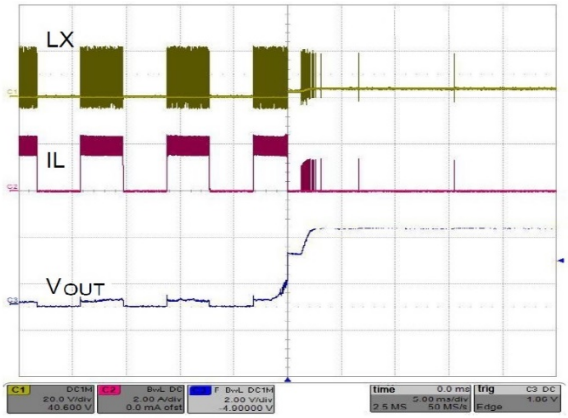
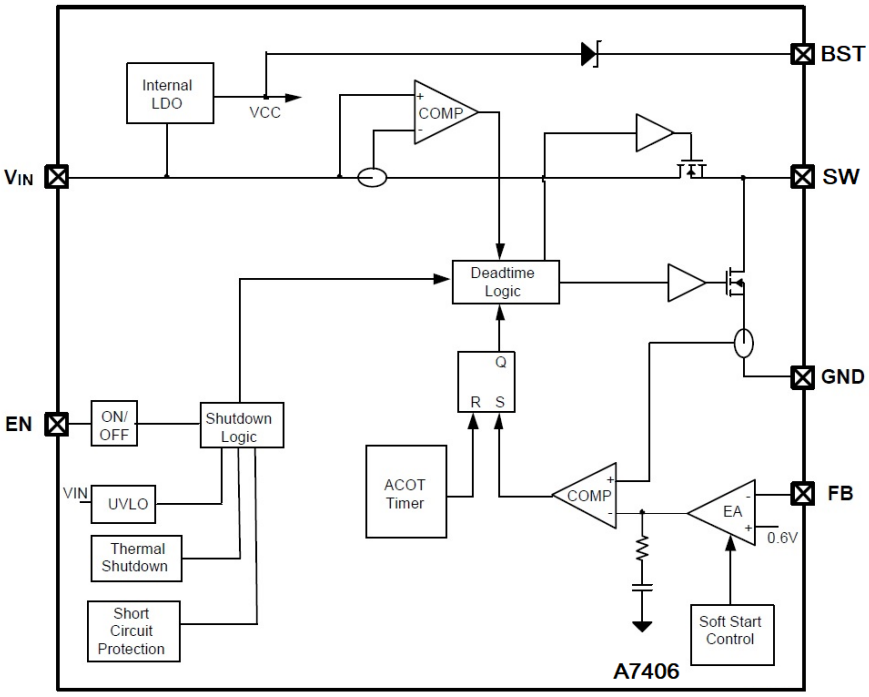


Fig 8. Short Circuit Protection and Recovery



BLOCK DIAGRAM



DETAILED INFORMATION

A7406 is a highly efficient sync buck converter integrated circuits. It integrates two NMOSFET power switches of low on resistance. Power of driver of high side switch is supplied by bootstrap capacitor. The input voltage reaches up to 40V. This converter can deliver 1A output current. A7406 adopts constant on time architecture and has fast load transient response. In light load condition, it works in the PFM mode. In heavy load condition, it works in the quasi PWM mode.

Soft Startup

When the EN pin is pulled high, the blocks in the IC start to work in order. After the 0.6 V reference voltage settles down, a small current charge the soft startup capacitor. And the voltage of soft startup capacitor is used to control error amplifier. During the soft startup phase of about 2.3 ms, the soft startup voltage rises to 0.6 V gradually and V_{OUT} ramps up to the setting point accordingly. Soft startup can avoid large inrush current and V_{OUT} overshoot.

PFM Mode

When the load current decreases from heavy load, inductor current is reduced accordingly. And if the inductor valley current touches zero level, the device works in the DCM. Each switching period starts with charging inductor with constant time. Then the output voltage rises to a higher level. After the constant on time, the high side switch cuts off and the inductor current discharges to zero level. Because of the smaller load current, it takes longer time to discharge the output voltage to the reference level. And the switching frequency is reduced, proportional to the load current.

Shot Circuit Protection

When output is short to the ground, the device will shut down for about 3.5ms. Then the chip can resume soft startup automatically. After it maintains working for about 3ms, the device will stop from switching again. The device will repeat to shut down and resume soft startup until the output short condition is released. Then output voltage will softly start up to the setting value.

APPLICATION INFORMATION

A7406 can be used in applications in which power supply is converted from high level to low level. Because of the integrated power switches in IC, only input capacitor CIN, output inductor L, output capacitor COUT and feedback resistors are selected for the desired application.

Setting Output Voltage

The output voltage can be set by selecting proper feedback resistors R1 and R2. To achieve good noise and power performance, it's recommended to using resistors between 10kΩ and 1 MΩ. The resistor R1 can be calculated by the following equation.

$$R_1 = R_2 \times [(V_{OUT} / 0.6V) - 1]$$

Inductor Selection

To guarantee the normal work of the power system, the output inductor peak current should be below the peak current limit of 1.9A. The inductor peak current can be calculated by the following equation. In consideration of magnetic saturation of inductor, the peak current should be also smaller than the saturate current of the inductor. And low DCR can help to meet desired power efficiency requirement.

$$I_{PEAK} = I_{OUT} + \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{2 \times V_{IN} \times L} \times T$$

Bootstrap Capacitor

A 0.1uF ceramic capacitor connected between the SW pin and the BST pin is required to supply power for the high side switch in applications based on A7406.

Input Capacitor

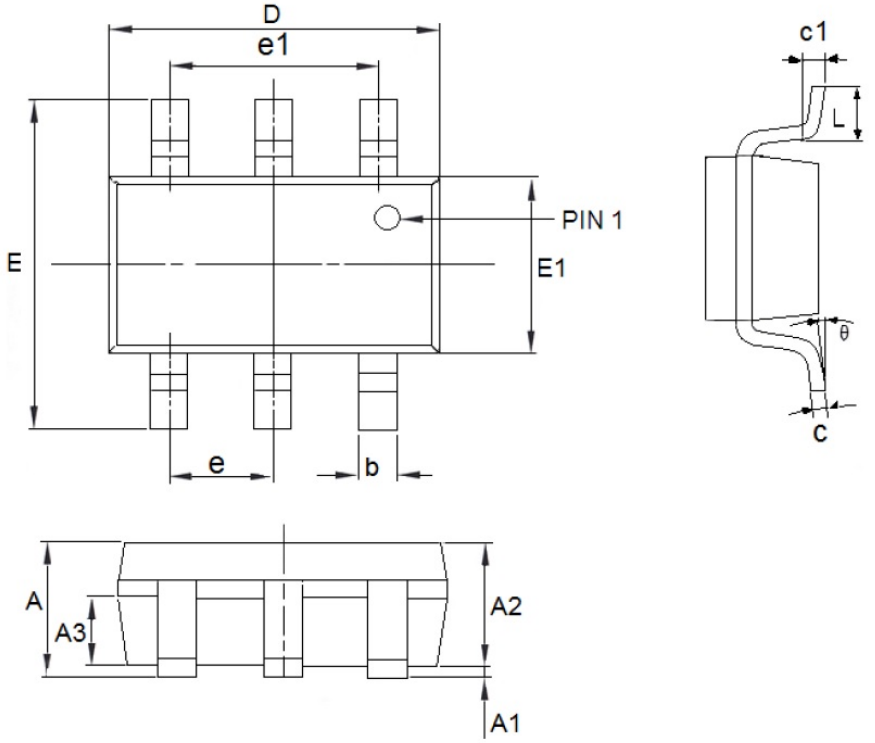
In the buck converter system, severe interference exists between the V_{IN} pin and ground. The input capacitor C_{IN} can help to reduce interference and improve system stability. Because the effective capacitance can be reduced significantly at the DC biasing voltage, so the rated voltage of input capacitor should exceed the highest input voltage. And recommends the input capacitor should be placed as closely as possible to the V_{IN} pin of the A7406.

Output Capacitor

The stepdown DC-DC converter needs output filter capacitor. Small output capacitor may result in system instability. When output short circuit condition is released, the output voltage may overshoot the safe level, which can damage the following devices permanently.

PACKAGE INFORMATION

Dimension in SOT-26 Package (Unit: mm)



Symbol	MILLIMETERS	
	Min.	Max.
A	1.050	1.450
A1	0.000	0.150
A2	0.900	1.300
A3	0.550	0.750
b	0.250	0.500
c	0.100	0.250
c1	0.200 TYP	
D	2.700	3.120
E	2.600	3.100
E1	1.400	1.800
e	0.950 TYP	
e1	1.900 TYP	
θ	0°	8°

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