Synchronous Buck DC/DC Converter CYT3406

Description

The CYT3406 is high efficiency synchronous, PWM step-down DC/DC converters working under an input voltage range of 2.5V to 5.5V. This feature makes the CYT3406 suitable for single Li-Ion battery-powered applications. 100% duty cycle capability extends battery life in portable devices, while the quiescent current is 200uA with no load, and drops to < 1uA in shutdown.

The internal synchronous switch is desired to increase efficiency without an external Schottky diode. The 1.4 MHz fixed switching frequency allows the using of tiny, low profile inductors and ceramic capacitors, which minimized overall solution footprint.

The CYT3406 converters are available in the industry standard SOT-23-5 power packages (or upon request).

Features

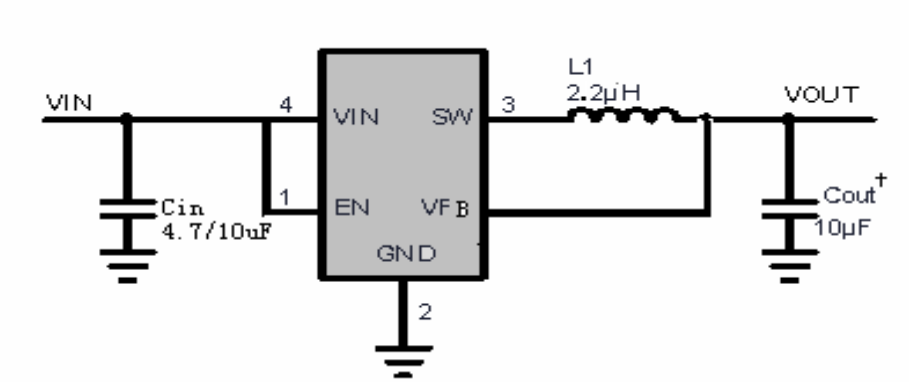
- Up to 95% Efficiency
- Current mode operation for excellent line and load transient response
- Low quiescent current: 230uA
- Low Switch on Resistance RDS(ON), Internal Switch: 0.35 Ω
- Output voltage：0.6V～5.5V
- Automatic PWM/PFM mode switching
- No Schottky diode required。
- 1.4MHz fixed frequency switching
- Short-Circuit protection
- Shutdown quiescent current: < 1uA
- Low profile SOT-23-5 package (lead-free

Application

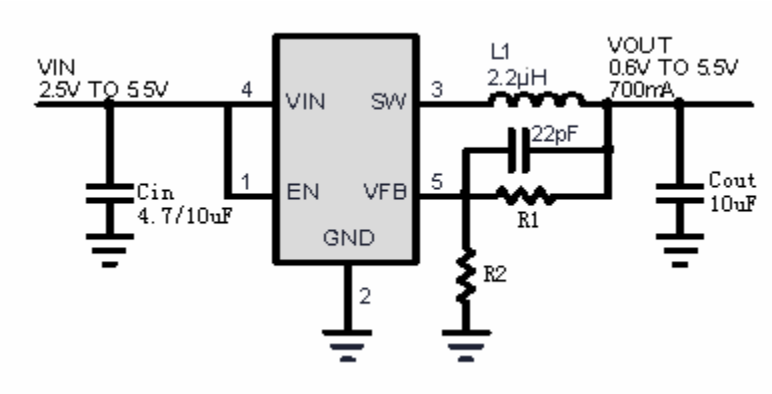
- Digital cameras and MP3
- Palmtop computers / PDAs
- Cellular phones
- Wireless handsets and DSL modems
- PC cards
- Portable media players

Typical Applications

FIXED OUTPUT VOLTAGE



ADJUSTABLE OUTPUT VOLTAGE

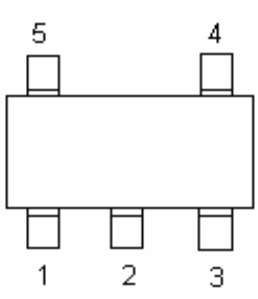


Order Information

CYT3406-①②

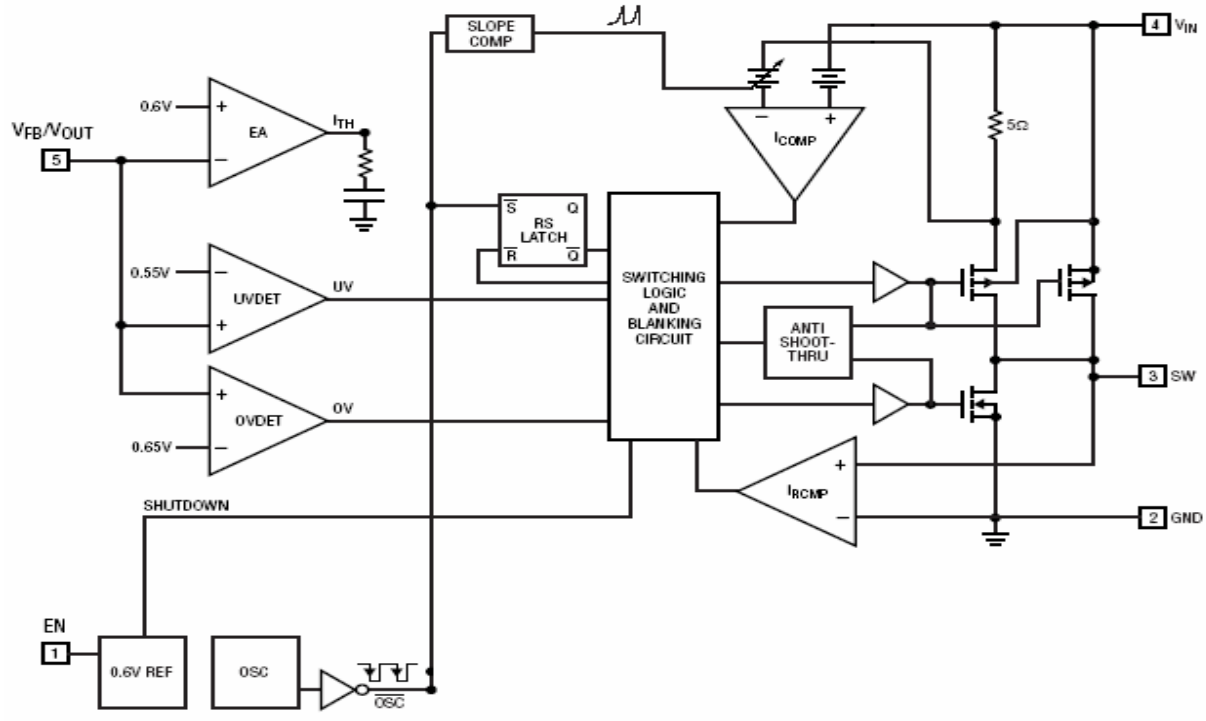
Symbol	Description
①	Denotes Output voltage: K:1.2V Output B : 1.5V Output; C : 1.8V Output; G:3.3V Output A : Adjustable Output
②	Denotes Package Types: E: SOT-23-5

Pin Assignment



PIN NUMBER SOT-23- 5	PIN NAME	FUNCTION
1	EN	ON/OFF Control (High Enable)
2	GND	Ground
3	SW	Switch Output
4	Vin	Input
5	Vfb	Output

Functional Diagram



Absolute Maximum Ratings

Power Dissipation	Internally limited
V_{IN}	- 0.3 V ~ + 6 V
$V_{ON/OFF}$	- 0.3 V ~ (V_{IN} + 0.3) V
V_{SW}	- 0.3 V ~ (V_{IN} + 0.3) V
V_{FB}	- 0.3 V ~ + 6 V
I_{SW}	1.3A
Operating Temperature Range	- 40℃ ~ + 85℃
Lead Temperature (Soldering 10 sec.)	+ 300℃
Storage Temperature Range	- 65℃ ~ + 150℃
Junction Temperature	+ 125℃

Electrical Characteristics

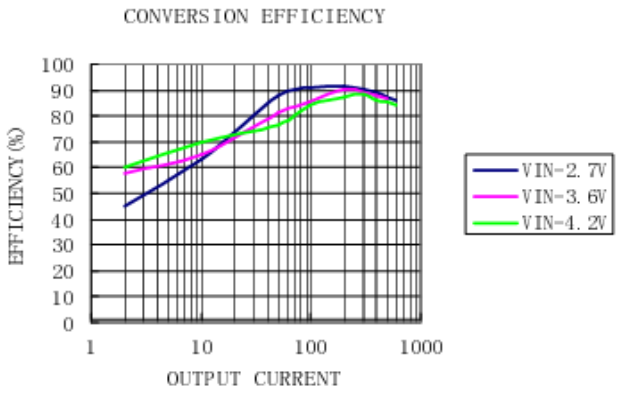
Operating Conditions:Ta=25°C,Vin= 3.6Vunless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Vout	Output Voltage	I_{OUT}=100mA, R1/R2=2	1.75	1.80	1.85	V
Vin	Input Voltage Range		2.5		5.5	V
Vfb	Regulated Voltage	Ta=25°C	0.5880	0.6	0.6120	V
Ifb	Feedback Current				±30	nA
ΔVfb	Vref	Vin=2.5V~5.5V		0.03	0.4	%V
Fosc	Oscillator Frequency	Vfb=0.6Vor Vout=100%	1.1	1.4	1.7	MHz
IQ	Quiescent Current	Vfb=0.5VorVout=90%, Iload=0A		200	300	uA
Is	Shutdown Current	Ven=0V,Vin=4.2V		0.1	1	uA
Ipk	Peak Inductor Current	Vin=3V,Vfb=0.5VorVout=90%,Duty Cycle<35%	0.75	0.9	1	A
Rpfet	Rds(on)of P-channel FET	Isw=100mA		0.4	0.5	Ω
Rnfet	Rds(on)of N-channel FET	Isw= -100mA		0.35	0.45	Ω
EFFT*	Efficiency	When connected to ext.components Vin=EN=3.6V, Iout=100mA		93		%
ΔVout	Vout Line Regulatinon	Vin=2.5V~5.5V		0.03	0.3	%V
Vloadreg	Vout Load Regulatinon			0.33		%

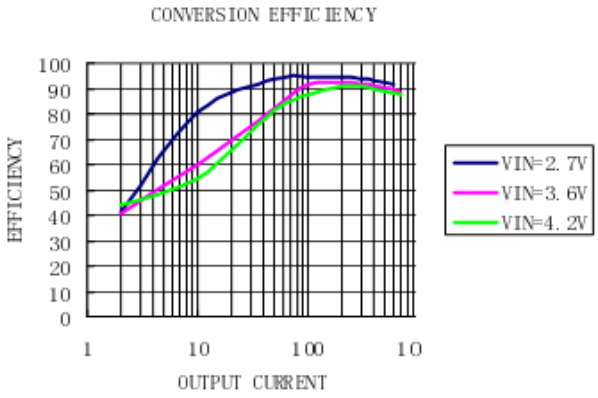
* EFFI = [(Output Voltage × Output Current) / (Input Voltage × Input Current)] × 100%

Typical Performance Characteristis

VOUT=1.8V

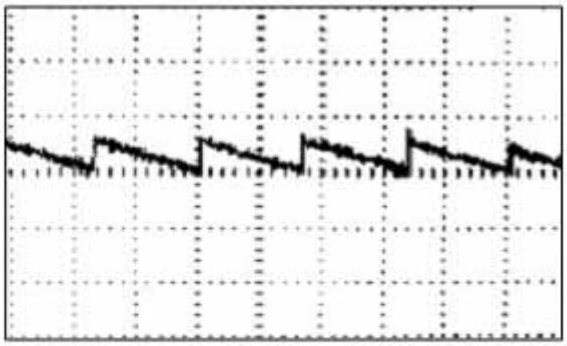


VOUT=2.5V



Output Noise
100mV/DIV
AC COUPLED

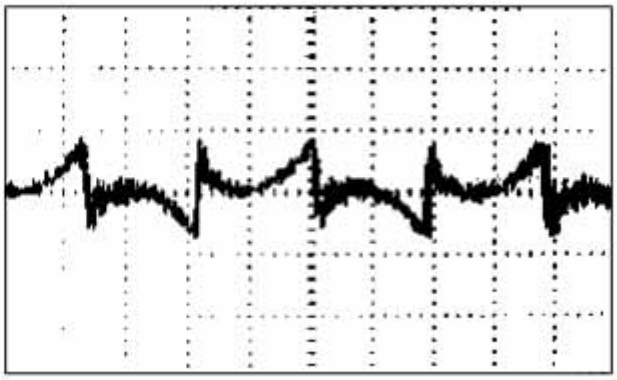
VIN=3.6V
VOUT=1.8V
ILOAD=0mA



2ms/DIV

Output Noise
10mV/DIV
AC COUPLED

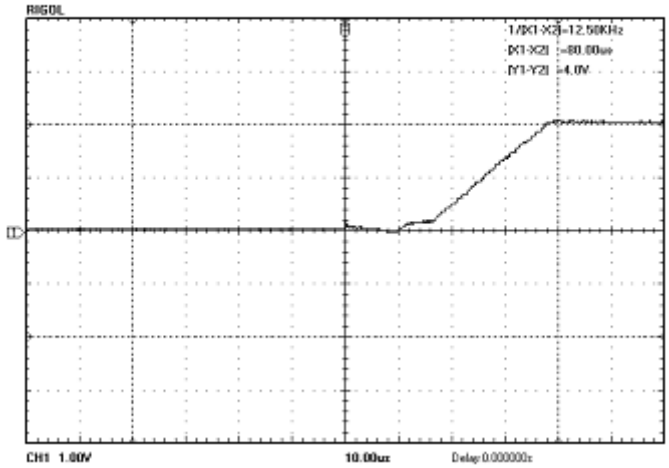
VIN=3.6V
VOUT=1.8V
ILOAD=200mA



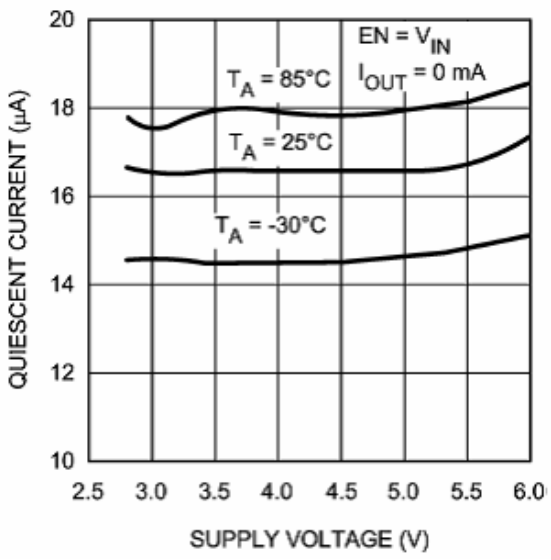
200ns/DIV

Typical Performance Characteristis

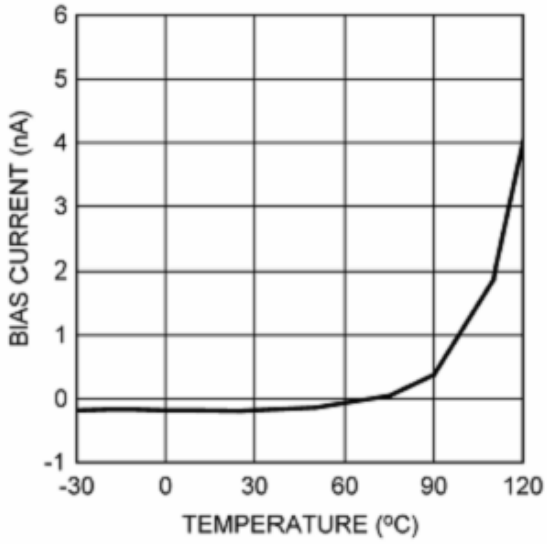
Start –up from shutdown



Quiescent Supply Current vs. Supply Voltage

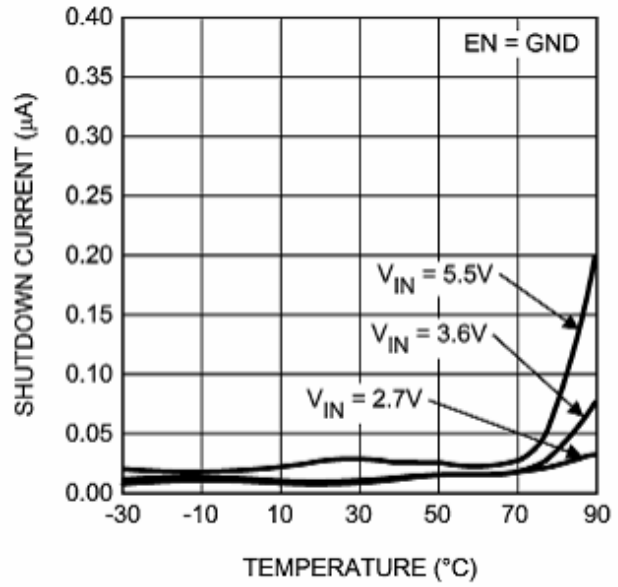


Feed back Bias Current vs. Temp

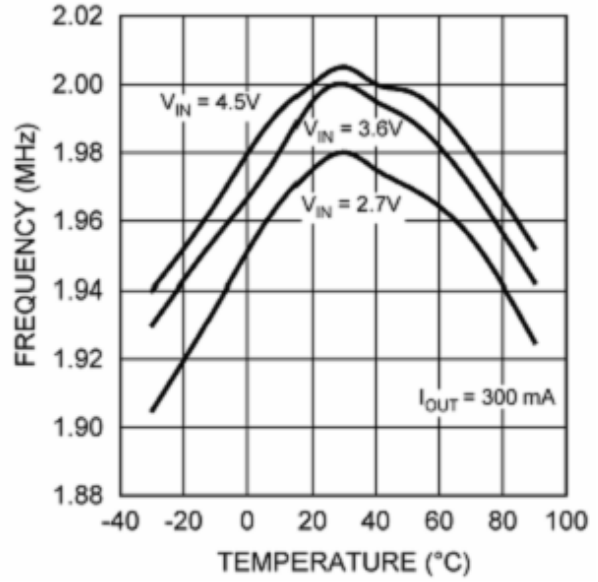


Typical Performance Characteristis

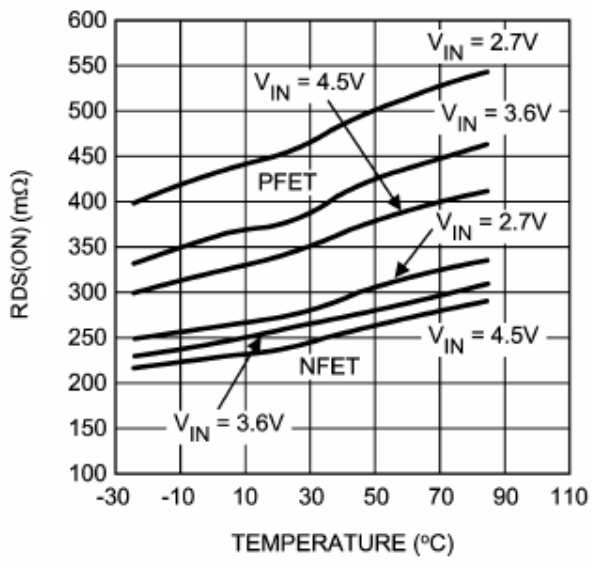
Shutdown Current vs. Temp



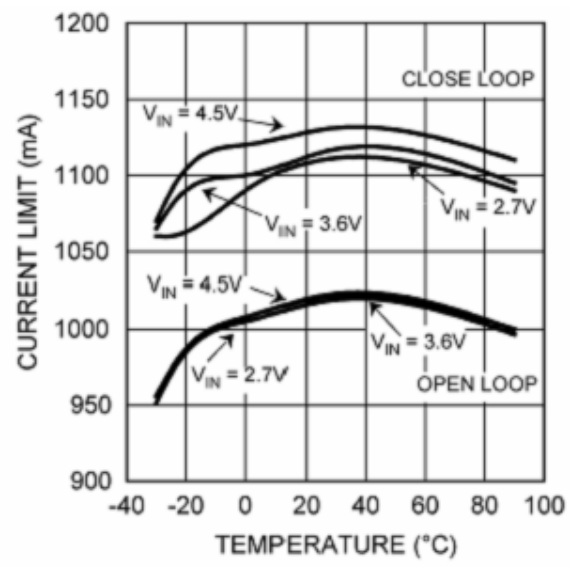
Switching Frequency vs. Temp



Rds(on) vs. Temp



Open/Closed Loop Current Limit vs. Temp



Application Information

PIN ASSIGNMENT

EN (Pin 1): En Control Input. Forcing this pin above 1.5V enables the part. Forcing this pin below 0.3V shutdown the device. In shutdown, all functions are disabled drawing <1μA supply current. Do not leave EN floating.

GND (Pin 2): Ground Pin.

SW (Pin 3): Switch Node Connection to Inductor. This pin connects to the drains of the internal main and synchronous power MOSFET switches.

Vin (Pin 4): Main Supply Pin. Must be closely decoupled to GND, Pin 2, with a 2.2μF or greater ceramic capacitor.

Vfb (Pin 5): (CYT3406-AE): Feedback Pin. Receives the feedback voltage from an external resistive divider across the output. In the adjustable version, the output voltage is set by a resistive divider according to the following formula Vout = 0.6V • [1 + (R1/R2)]

Vout (Pin 5): (CYT3406-KE/CYT3406-BE/CYT3406-CE): Output Voltage Feedback Pin. An internal resistive divider divides the output voltage down for comparison to the internal reference voltage.

PCB LAYOUT GUIDELINES

When laying out the printed circuit board, the following checklist should be used to ensure proper operation of the CYT3406. These items are also illustrated graphically in Figures 1 and 2. Check the following in your layout:

1. The power traces, consisting of the GND trace, the SW trace and the Vin trace should be kept short, direct and wide.

2. Does the Vfb pin connect directly to the feedback resistors? The resistive divider R1/R2 must be connected between the (+) plate of Cout and ground.

3. Does the (+) plate of Cin connect to Vin as closely as possible? This capacitor provides the AC current to the internal power MOSFETS.

4. Keep the switching node, SW, away from the sensitive Vfb node.

5. Keep the (–) plates of Cin and Cout as close as possible.

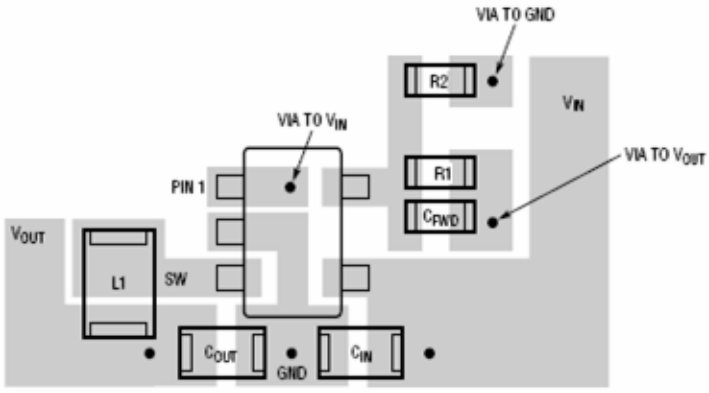


Figure1. CYT3406-AE Suggested Layout

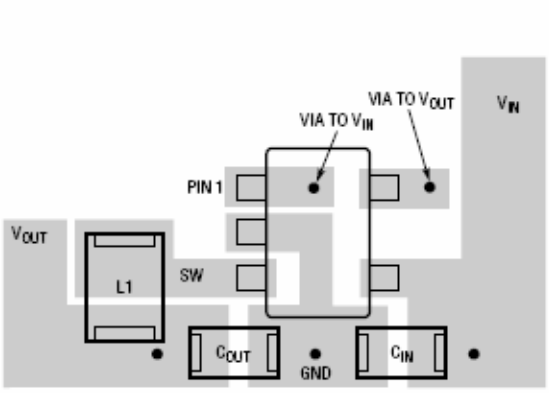


Figure2.CYT3406-KE/CYT3406-CE/CYT3406-BE/CYT3406-GE Suggested Layout

INDUCTOR SELECTION

For most applications, the value of the inductor will fall in the range of 1μH to 4.7uH. Its value is chosen based on the desired ripple current. Large value inductors lower ripple current and small value inductors result in higher ripple currents. Higher Vin or Vout also increases the ripple current as shown in equation 1. A reasonable starting point for setting ripple current is△IL= 240mA (40% of 600mA).

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

The DC current rating of the inductor should be at least equal to the maximum load current plus half the ripple current to prevent core saturation. Thus, a 720mA rated inductor should be enough for most applications (600mA +120mA). For better efficiency, choose a low DC-resistance inductor. Different core materials and shapes will change the size/current and price/current relationship of an inductor. Toroid or shielded pot cores in ferrite or permalloy materials are small and don't radiate much energy, but generally cost more than powdered iron core inductors with similar electrical characteristics. The choice of which style inductor to use often depends more on the price vs size requirements and any radiated field/EMI requirements than on what the CYT3406 requires to operate. Table 1 shows some typical surface mount inductors that work well in CYT3406 applications.

Table 1. Recommended Inductors

Part	L(uH)	Max DCR(mΩ)	Max DC Current(A)	Size W × L × H (mm^3)	Vendor
CDRH3D16	2.2	75	1.20	3.8 × 3.8 × 1.8	Sumida
CDH3B16	2.2	70	1.20	4.0 × 4.0 × 1.8	Ceaiya

OUTPUT AND INPUT CAPACITOR SELECTION

In continuous mode, the source current of the top MOSFET is a square wave of duty cycle Vout/Vin. To prevent large voltage transients, a low ESR input capacitor sized for the maximum RMS current must be used. The maximum RMS capacitor current is given by:

$$C_{IN} \text{ required } I_{RMS} \cong I_{OMAX} \frac{\left[V_{OUT}(V_{IN} - V_{OUT})\right]^{1/2}}{V_{IN}}$$

This formula has a maximum at Vin = 2Vout, where Irms=Lout/2. This simple worst-case condition is commonly used for design because even significant deviations do not offer much relief. Note that the capacitor manufacturer's ripple current ratings are often based on 2000 hours of life. This makes it advisable to further derate the capacitor, or choose a capacitor rated at a higher temperature than required. Always consult the manufacturer if there is any question.

The selection of Cout is driven by the required effective series resistance (ESR).

Typically, once the ESR requirement for Cout has been met, the RMS current rating generally far exceeds the Iripple(p.p) requirement. The output ripple △Vout is determined by:]

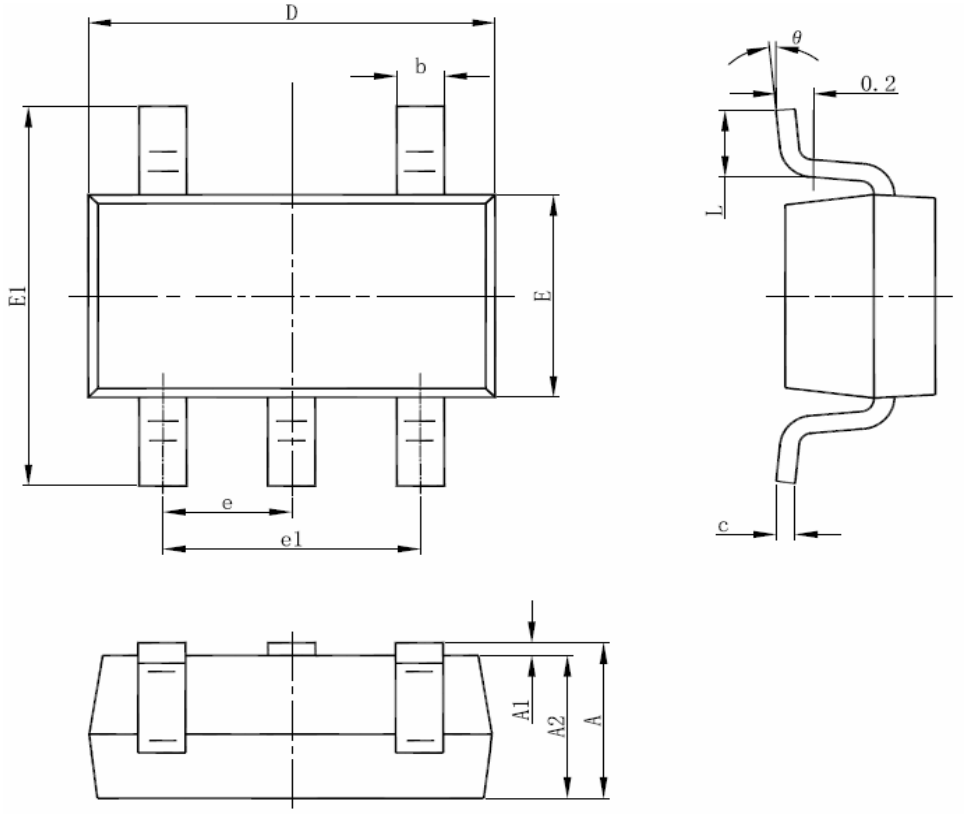
$$\Delta V_{OUT} \cong \Delta I_L \left(ESR + \frac{1}{8fC_{OUT}} \right)$$

where f = operating frequency, Cout = output capacitance and △IL = ripple current in the inductor. For a fixed output voltage, the output ripple is highest at maximum input voltage since △IL increases with input voltage.

Aluminum electrolytic and dry tantalum capacitors are both available in surface mount configurations. In the case of tantalum, it is critical that the capacitors are surge tested for use in switching power supplies. An excellent choice is the AVX TPS series of surface mount tantalum. These are specially constructed and tested for low ESR so they give the lowest ESR for a given volume. Other capacitor types include Sanyo POSCAP, Kemet T510 and T495 series, and Sprague 593D and 595D series. Consult the manufacturer for other specific recommendations.

Packaging Information

SOT-23-5 Package Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In 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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MAIN SITE(China):

SHENZHEN CYT OPTO-ELECTRONIC TECHNOLOGY CO.,LTD.

Address: Rm201-205, Building 4, Software park, Gaoxin center 2nd Rd, Nanshan District, Shenzhen

TEL:+86-755-86168222 FAX:+86-755-86168622 Technical support:+86-755-86169530

Business mail address: cyt@szcyt.com Website: www.szcyt.com