GENERAL DESCRIPTION

The CM3706A is a high efficiency monolithic synchronous buck regulator using a constant frequency, current mode architecture. The device is available in an adjustable version. Supply current with no load is 300uA and drops to <1uA in shutdown. The 2.5V to 6.5V input voltage range makes the CM3706A ideally suited for single Li-Ion, two to four AA battery-powered applications. 100% duty cycle provides low dropout operation, extending battery life in portable systems. PWM pulse skipping mode operation provides very low output ripple voltage for noise sensitive applications. Switching frequency is internally set at 1.5MHz, allowing the use of small surface mount inductors and capacitors. The internal synchronous switch increases efficiency and eliminates the need for an external Schottky diode. Low output voltages are easily supported with the 0.6V feedback reference voltage.

FEATURES

- High Efficiency: Up to 96%
- 1.5Mhz Constant Switching Frequency
- 600mA Output Current at V_{IN}=3V
- Integrated Main switch and synchronous rectifier. No Schottky Diode Required
- 2.5V to 6.5V Input Voltage Range
- Output Voltage as Low as 0.6V
- 100% Duty Cycle in Dropout
- Low Quiescent Current: 300μA
- Slope Compensated Current Mode Control for Excellent Line and Load Transient Response
- Short Circuit Protection
- Thermal Fault Protection
- <1uA Shutdown Current
- Space Saving 5-Pin Thin TSOT23 package

APPLICATIONS

- Cellular and Smart Phones
- Microprocessors and DSP Core Supplies
- Wireless and DSL Modems
- PDAs
- MP3 / MP4 Player
- Portable Instruments
- Digital Still and Video Cameras

TYPICAL APPLICATIONS

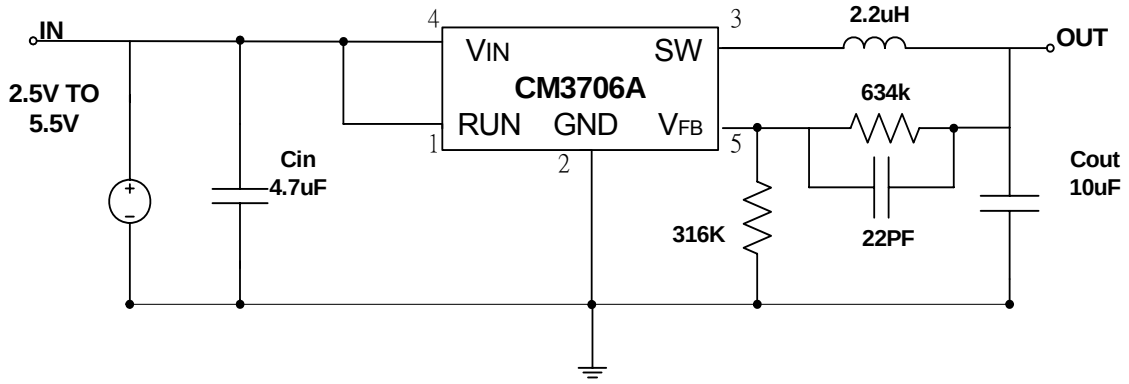
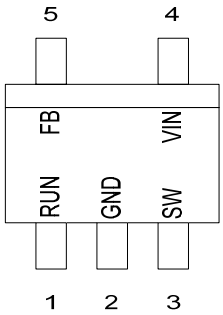


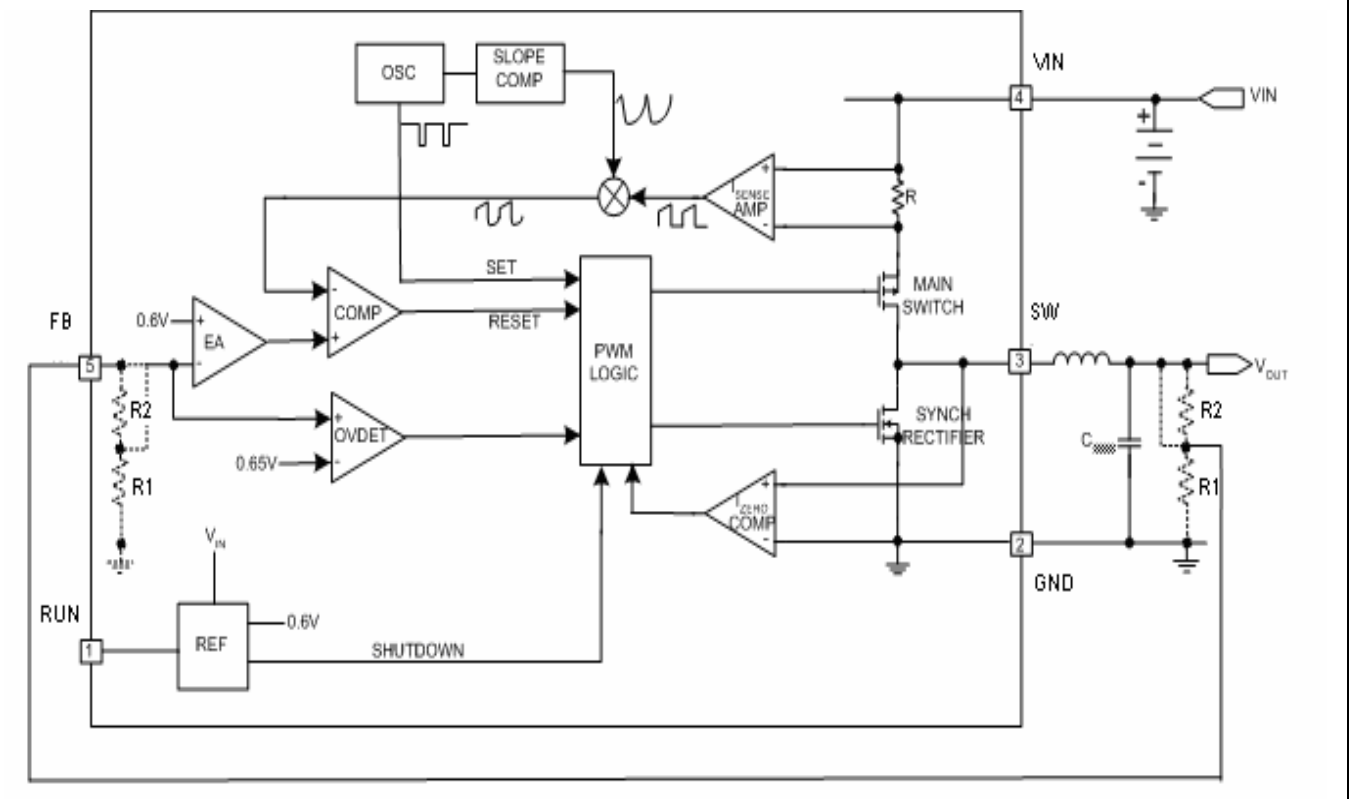
Figure 1. Basic Application Circuit with CM3706A adjustable version

PIN CONFIGURATION

TSOT23-5
Top View



BLOCK DIAGRAM



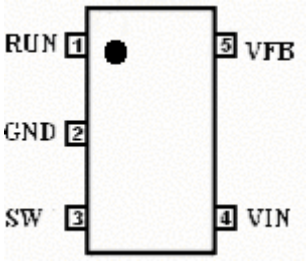
* FOR ADJUSTABLE OUTPUT R1+R2 IS EXTERNAL

PIN DESCRIPTION

Pin No.	Symbol	Description
1	RUN	Regulator Enable control input. Drive RUN above 1.5V to turn on the part. Drive RUN below 0.3V to turn it off. In shutdown, all functions are disabled drawing <1μA supply current. Do not leave RUN floating.
2	GND	Ground Pin.
3	SW	Power Switch Output. It is the Switch note connection to Inductor. This pin connects to the drains of the internal P-CH and N-CH MOSFET switches.
4	VIN	Supply Input Pin. Must be closely decoupled to GND, Pin 2, with a 2.2μF or greater ceramic capacitor.
5	FB	VFB (CM3706A): Feedback Input Pin. Connect FB to the center point of the external resistor divider. The feedback threshold voltage is 0.6V.

ORDERING INFORMATION/ MARKING

Adjustable Output Version



Part Number	Output	Top Mark	Temp Range
CM3706AGIM25	Adj	A1XY	-40°C to +85°C

ABSOLUTE MAXIMUM RATINGS(Note 1)

Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Input Supply Voltage.....–0.3V to 7.0V
RUN, VFB Voltages ……..….– 0.3V to (VIN + 0.3V)
SW Voltage.....……..…….…….…… – 0.3V to (VIN + 0.3V)
Operating Temperature Range.....……..…-40°C to +85°C
Peak SW Sink and Source Current……..…….. 1.5A
Junction Temperature (Note 2) .... 125°C
Storage Temperature Range ..... – 65°C to 150°C
Lead Temperature (Soldering, 10 sec)..... 300°C

OPERATING CONDITIONS

Temperature Range ..... -40°C to 85°C
Vin Operating Range .....2.5V to 5.5V

Thermal Resistance (Note 3):

Package	Θ_{JA}	Θ_{JC}
TSOT23-5	250°C/W	110°C/W

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:

CM3706A : $T_J = T_A + (P_D) \times (\Theta_{JA})$

Note 3: Thermal Resistance is specified with approximately 1 square of 1 oz copper.

ELECTRICAL CHARACTERISTICS **(Unless otherwise stated, these specifications apply T_A=25°C; VIN=+3.6V)** maximum ratings are stress ratings only and functional device operation is not implied.

Parameter	Conditions	MIN	TYP	MAX	unit
Input Voltage Range		2.5		6.5	V
Input DC Supply Current Active Mode	V_{FB}=0.5V		300	400	µA
Shutdown Mode	V_{FB}=0V, V_{IN}=4.2V		0.1	1.0	µA
Regulated Feedback Voltage	T_A = +25°C	0.5880	0.6000	0.6120	V
	T_A= 0°C ≤ T_A ≤ 85°C	0.5865	0.6000	0.6135	V
	T_A= -40°C ≤ T_A ≤ 85°C	0.5820	0.6000	0.6180	V
V_{FB} Input Bias Current	V_{FB} = 0.65V			±30	nA
Reference Voltage Line Regulation	V_{IN} = 2.5V to 5.5V,		0.01	0.4	%/V
Output Voltage Line Regulation	VIN = 2.5V to 5.5V,IOUT=10mA		0.04	0.40	%/V
Output Voltage Load Regulation	IOUT from 10 to 600mA		0.0015		%/mA
Peak Inductor Current	V_{IN}=3V, V_{FB}=0.5V or V_{OUT}=90% Duty Cycle <35%	0.75	1.00	1.25	A
Oscillator Frequency	V_{FB}=0.6V or V_{OUT}=100%	1.2	1.5	1.8	MHz
$R_{DS(ON)}$ of P-CH MOSFET	I_{SW} = 300mA		0.4	0.50	Ω
$R_{DS(ON)}$ of N-CH MOSFET	I_{SW} = -300mA		0.35	0.45	Ω
SW Leakage	VRUN = 0V, VSW= 0V or 5V, VIN = 5V		±0.01	±1	µA
RUN Threshold	-40°C ≤ T_A ≤ 85°C	0.3	0.45	1.5	V
RUN Leakage Current			±0.1	±1	µA
Thermal Shutdown Trip Threshold			150		℃
Output over voltage lockout	ΔVOVL = VOVL – VFB		60		mV

Note 4: 100% production test at +25°C. Specifications over the temperature range are guaranteed by design and characterization.

FUNCTIONAL DESCRIPTION

Operation

CM3706A is a monolithic switching mode Step-Down DC-DC converter. It utilizes internal MOSFETs to achieve high efficiency and can generate very low output voltage by using internal reference at 0.6V. It operates at a fixed switching frequency, and uses the slope compensated current mode architecture. This Step-Down DC-DC Converter supplies 600mA output current at VIN = 3V with input voltage range from 2.5V to 6.5V.

Current Mode PWM Control

Slope compensated current mode PWM control provides stable switching and cycle-by-cycle current limit for excellent load and line responses and protection of the internal main switch (P-Ch MOSFET) and synchronous rectifier (N-CH MOSFET). During normal operation, the internal P-Ch MOSFET is turned on for a certain time to ramp the inductor current at each rising edge of the internal oscillator, and switched off when the peak inductor current is above the error voltage. The current comparator, I_{COMP}, limitsthe peak inductor current. When the main switch is off, the synchronous rectifier will be turned on immediately and stay on until either the inductor current starts to reverse, as indicated by the current reversal comparator, I_{ZERO}, or the beginning of the next clock cycle. The OVDET comparator controls output transient overshoots by turning the main switch off and keeping it off until the fault is no longer present.

Dropout Operation

When the input voltage decreases toward the value of the output voltage, the CM3706A allows the main switch to remain on for more than one switching cycle and increases the duty cycle (Note 5) until it reaches 100%. The output voltage then is the input voltageminus the voltage drop across the main switch and the inductor. At low input supply voltage, the $R_{DS}(ON)$ of the P-Channel MOSFET increases, and the efficiency of the converter decreases. Caution must be exercised to ensure the heat dissipated not to exceed the maximum junction temperature of the IC.

Idle Mode Operation

At very light loads, the CM3706A automatically enters Idle Mode. In the Idle Mode, the inductor current may reach zero or reverse on each pulse. The PWM control loop will automatically skip pulses to
maintain output regulation. The bottom MOSFET is turned off by the current reversal comparator, I_{ZERO}, and the switch voltage will ring. This is discontinuous mode operation, and is normal behavior for the switching regulator.

Maximum Load Current

The CM3706A will operate with input supply voltage as low as 2.5V, however, the maximum load current decreases at lower input due to large IR drop on the main switch and synchronous rectifier. The slope compensation signal reduces the peak inductor current as a function of the duty cycle to prevent sub-harmonic oscillations at duty cycles greater than 50%. Conversely the current limit increases as the duty cycle decreases.

Note 5: The duty cycle D of a step-down converter is defined as:

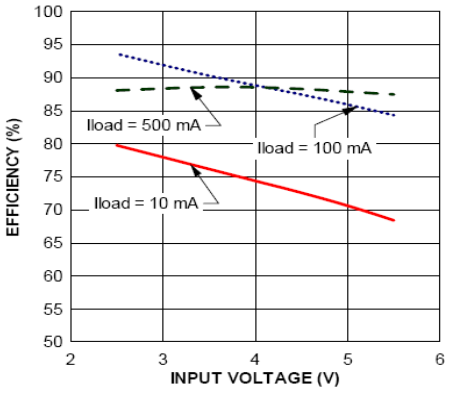
$$D = T_{ON} \times f_{OSC} \times 100\% \approx \frac{V_{OUT}}{V_{IN}} \times 100\%$$

where T_{ON} is the main switch on time, and f_{OSC} is the oscillator frequency (1.5Mhz).

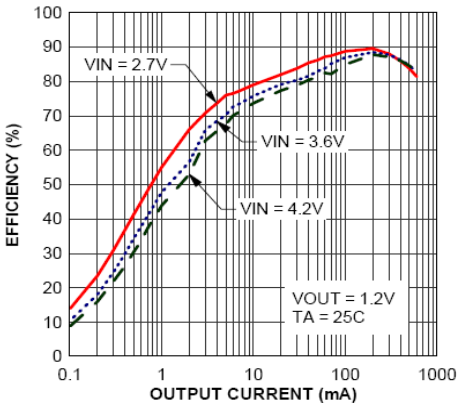
Typical Performance Characteristics

(Test Figure 1 above unless otherwise specified)

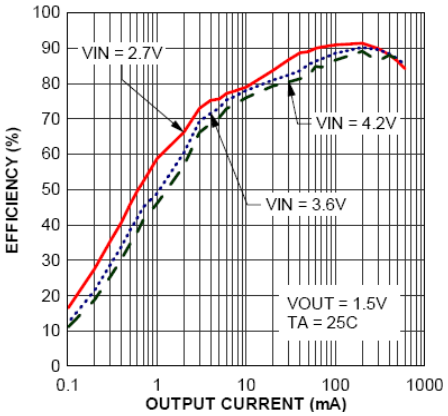
Efficiency vs Input Voltage



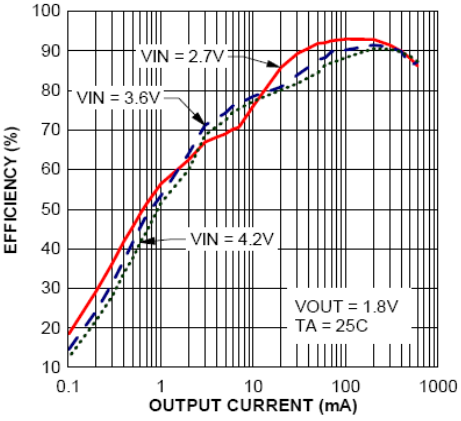
Efficiency vs Output Current



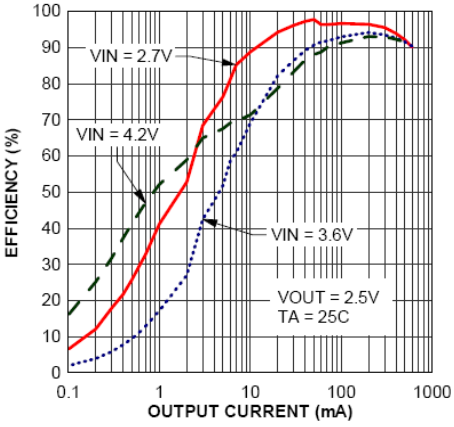
Efficiency vs Output Current



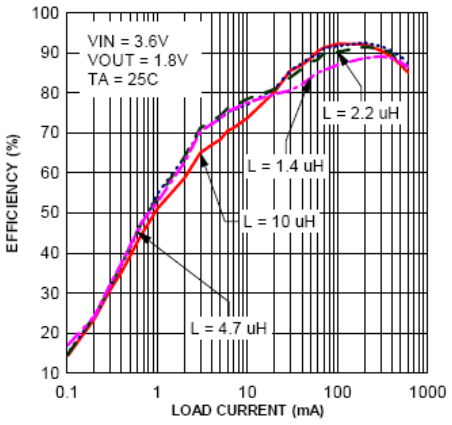
Efficiency vs Output Current



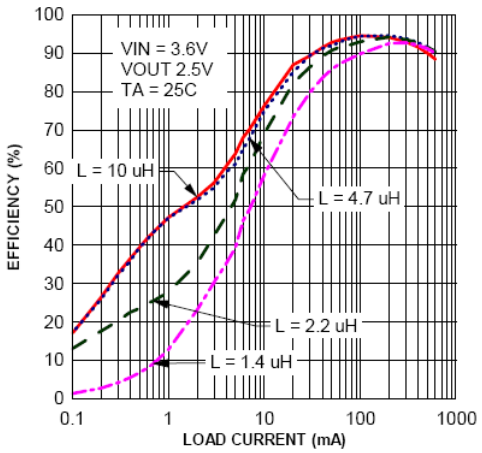
Efficiency vs Output Current



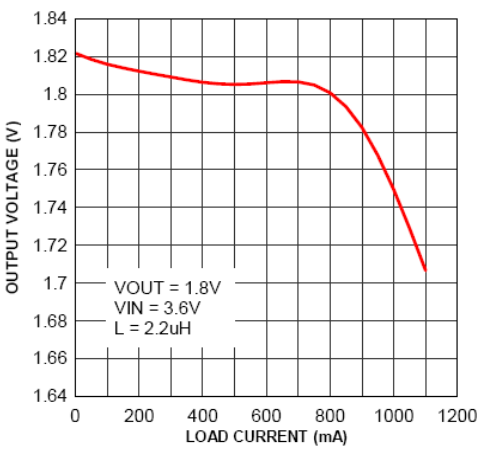
Efficiency vs Load Current



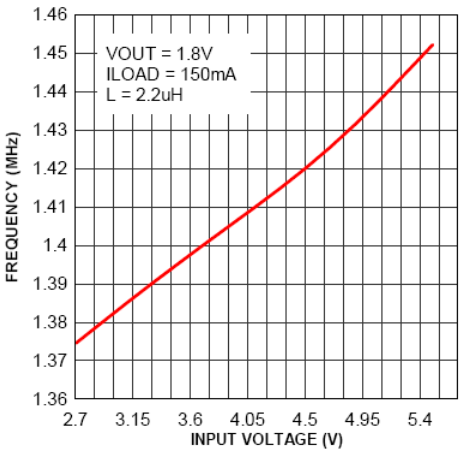
Efficiency vs Load Current



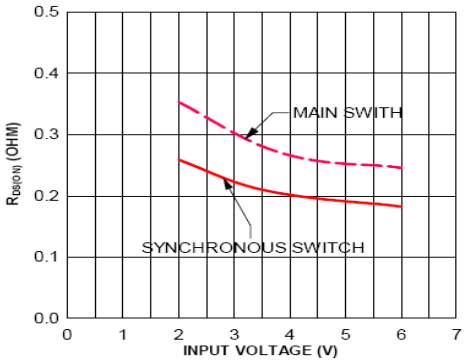
Outpu Voltage vs Load Current



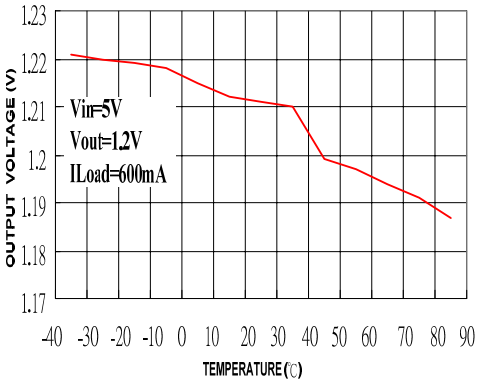
Frequency vs Input Voltage



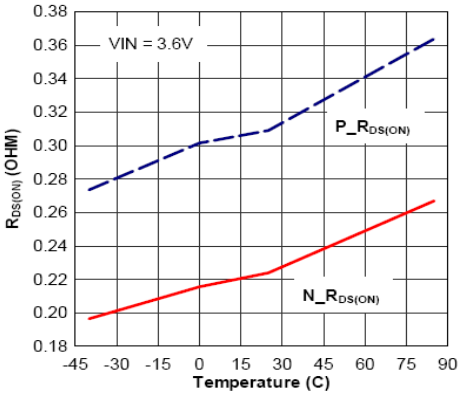
$R_{DS(ON)}$ vs Input Voltage



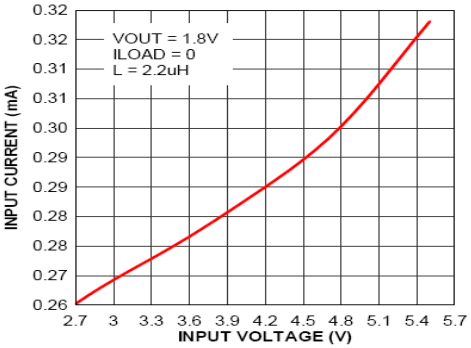
Output Voltage vs Temperature



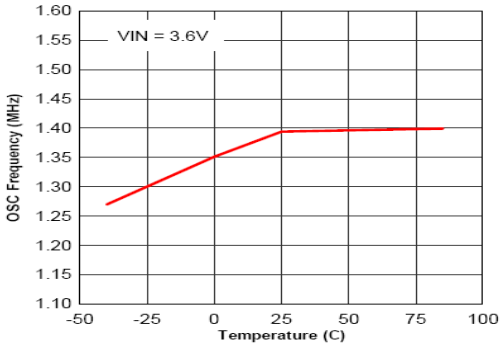
$R_{DS(ON)}$ vs Temperature



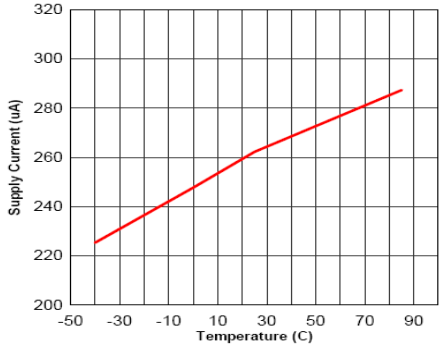
Input Voltage vs Input Current



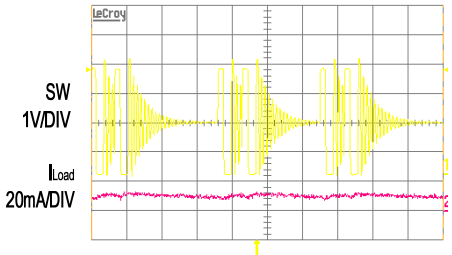
Frequency vs Temperature



Supply Current vs Temperature

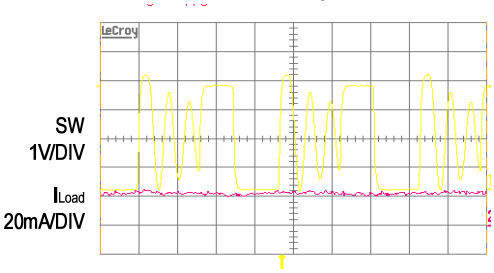


Pulse Skipping Mode Operation



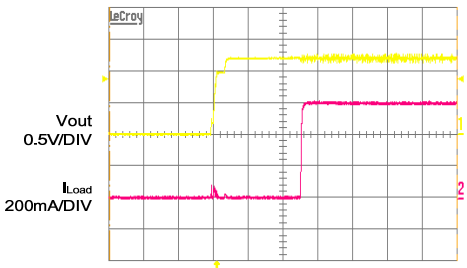
Vin=3.6V
Vout=1.8V
Iload=10.29mA

Discontinuous Operation



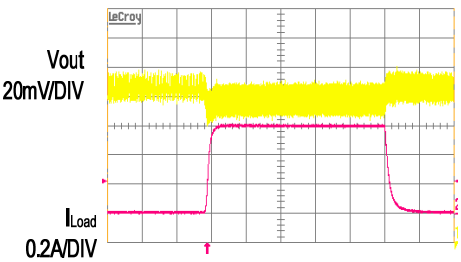
Vin=3.6V
Vout=1.8V
Iload=22.24mA

Start-Up from shutdown



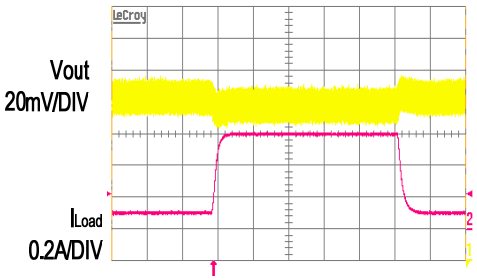
Vin=3.6V
Vout=1.2V
Iload=600mA

Load step



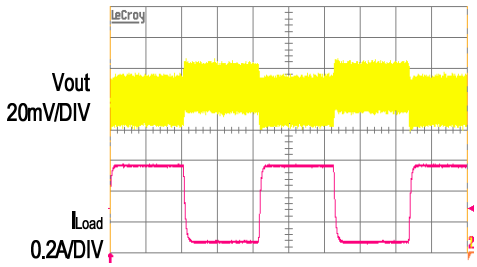
Vin=5V
Vout=2.5V
ILOAD=0mA TO 600mA

Load step



Vin=5V
Vout=2.5V
ILOAD=50mA TO 600mA

Load step



Vin=5V
Vout=2.5V
ILOAD=100mA TO 600mA

APPLICATIONS INFORMATION

Setting the Output Voltage

Figure 2 above shows the basic application circuit with CM3706A adjustable output version. The external resistor sets the output voltage according to the following equation:

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

R1=316KΩ ; R2= 316KΩ ; V_{OUT} =1.2V
R1=316KΩ ; R2= 470KΩ ; V_{OUT} =1.5V
R1=316KΩ ; R2= 630KΩ ; V_{OUT} =1.8V
R1=316KΩ ; R2= 1MΩ ; V_{OUT} =2.5V
R1=316KΩ ; R2= 1.42MΩ ; V_{OUT} =3.3V.

Input Capacitor Selection

The input capacitor reduces the surge current drawn from the input and switching noise from the device. The input capacitor impedance at the switching frequency shall be less than input source impedance to prevent high frequency switching current passing to the input. A low ESR input capacitor sized for maximum RMS current must be used Ceramic capacitors with X5R or X7R dielectrics are highly recommended because of their low ESR and small temperature coefficients. A 4.7μF ceramic capacitor for most applications is sufficient.

Inductor Selection

For most designs, the CM3706A operates with inductors of 1μH to 4.7μH. Low inductance values are physically smaller but require faster switching, which results in some efficiency loss. The inductor value can be derived from the following equation:

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

Where ΔI_L is inductor Ripple Current. Large value inductors lower ripple current and small value inductors result in high ripple currents. Choose inductor ripple current approximately 35% of the maximum load current 600mA, or ΔI_L =210mA.

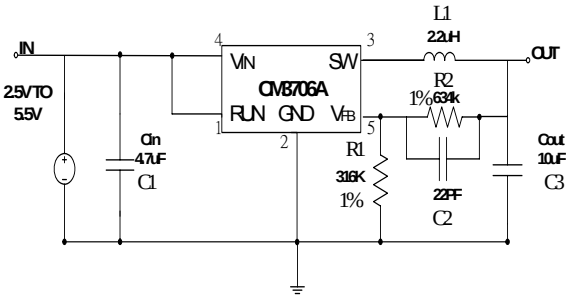


Figure2 Application Circuit with adjustable output versions

For output voltages above 2.0V, when light-load efficiency is important, the minimum recommended inductor is 2.2μH.

For optimum voltage-positioning load transients, choose an inductor with DC series resistance in the 50mΩ to 150mΩ range. For higher efficiency at heavy loads, or minimal load regulation (but some transient overshoot), the resistance should be kept below 100mΩ. 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 (600mA+105mA).

Output Capacitor Selection

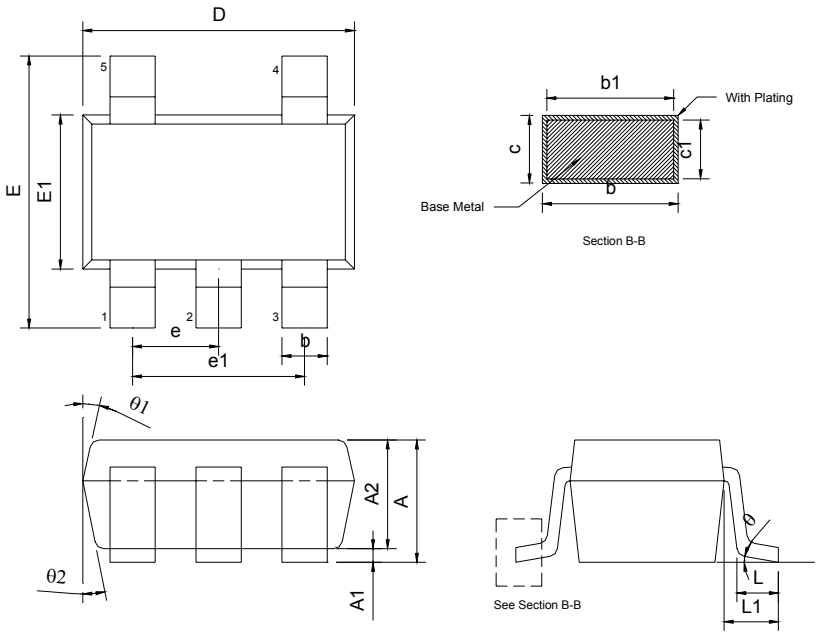
The output capacitor is required to keep the output voltage ripple small and to ensure regulation loop stability. The output capacitor must have low impedance at the switching frequency. Ceramic capacitors with X5R or X7R dielectrics are recommended due to their low ESR and high ripple current.The output ripple V_{OUT} is determined by:

$$\Delta V_{OUT} \le \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times f_{OSC} \times L} \times \left(ESR + \frac{1}{8 \times f_{osc} \times C3} \right)$$

Input Zener Selection

In USB device application, we will add zener. The zener can be reduced the surge voltage when device plug in and plug out. Application circuit is show in Figure3.

PACKAGE DIMENSION



SYMBOLS	DIMENSIONS IN MILLIMETERS			DIMENSIONS IN INCHS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	1.05	---	1.35	0.041	---	0.053
A1	0.05	---	0.15	0.002	---	0.006
A2	1.00	1.10	1.20	0.039	0.043	0.047
b	0.25	---	0.50	0.010	---	0.020
b1	0.25	0.40	0.45	0.010	0.016	0.018
c	0.08	---	0.20	0.003	---	0.008
c1	0.08	0.11	0.15	0.003	0.004	0.006
D	2.70	2.90	3.00	0.106	0.114	0.118
E	2.60	2.80	3.00	0.102	0.110	0.118
E1	1.50	1.60	1.70	0.059	0.063	0.067
L	0.35	0.45	0.55	0.014	0.018	0.022
L1	0.60 REF			0.024 REF		
e	0.95 BSC			0.037 BSC		
e1	1.90 BSC			0.075 BSC		
θ	0°	5°	10°	0°	5°	10°
θ1	3°	5°	7°	3°	5°	7°
θ2	6°	8°	10°	6°	8°	10°

Note5: Package outline exclusive of mold flash and metal burr.

IMPORTNT NOTICE

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