



AT1366B

Preliminary Product Information

1MHz, 800mA Synchronous Buck Converter

Features

- High efficiency (95%) possible
- No Schottky Diode Required
- 800mA Output Current at 5V input 3.3V output
- Oscillation frequency 1.0MHz
- Built-in ON/OFF Function
- Built-in Short Circuit Protection
- Low Dropout Operation: 100% Duty Cycle
- Stand-by current max. 1 μ A
- Input voltage: 2.5V ~5.5V

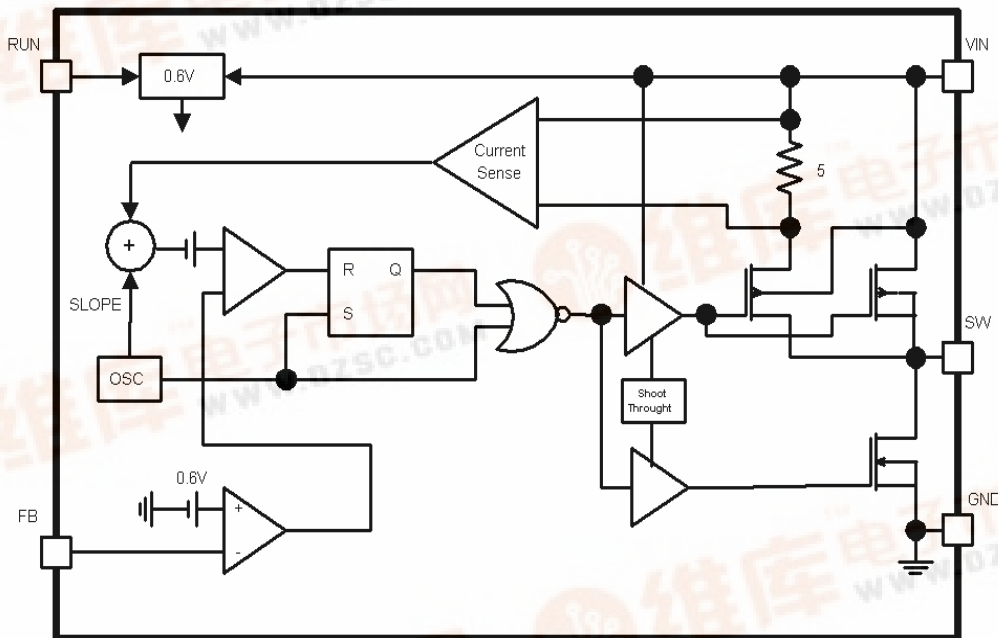
Applications

- Power Supply for portable devices

General Description

The AT1366B provides complete control for a DC/DC converter optimized for high-performance microprocessor applications. It is operated on current mode architecture for excellent line and load transient response. 1MHz operation frequency is allowing the use of small surface mount inductor and capacitor. The internal synchronous switch increases efficiency and eliminates the need for an external Schottky diode. The AT1366 is a family of low-noise synchronous step-down DC/DC converters that is ideally suited for systems powered from a 1-cell Li-ion battery or from a 3-cell to 4-cell NiCd, NiMH, or alkaline battery. It can also be used to USB-Based power system.

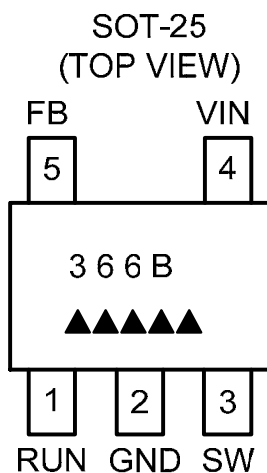
Block Diagram



Aimtron reserves the right without notice to change this circuitry and specifications.



Pin Configuration



Ordering Information

Part number	Package	Marking
AT1366BX	SOT-25	▲▲▲▲▲ : Date Code
AT1366BX_GRE	SOT-25,Green	▲▲▲▲▲ : Date Code with one bottom line

**For more marking information, contact our sales representative directly*

Pin Description

Symbol	Pin No.	Descript
RUN	1	ON/OFF Control
GND	2	Power ground
SW	3	Switch Node Connection to Inductor
VIN	4	Power Supply
FB	5	Output Feedback

Absolute Maximum Ratings

Parameter	Condition	Rated Value		Unit
		Min.	Max.	
Power Supply Voltage	—	-0.3	+6.0	V
Input Pin Voltage	RUN,FB	-0.3	VIN	V
	SW	-0.3	VIN+0.3	V
P-Channel Switch Source Current (DC)	—	-	1000	mA
N-Channel Switch Sink Current (DC)	—	-	1000	mA
Peak SW Sink and Source Current	—	-	1.5	A
Thermal Resistance from Junction to Ambient θ_{JA}	SOT-25	-	200	$^{\circ}\text{C}/\text{W}$
Operating temperature T_A	—	-35	+85	$^{\circ}\text{C}$
Storage temperature	—	-55	+150	$^{\circ}\text{C}$
ESD Susceptibility *2	HBM	2		KV
	MM	200		V

1. Stresses beyond those listed under “Absolute Maximum Ratings” 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 operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.
2. Device are ESD sensitive. Handling precaution recommended. The Human Body model is a 100pF capacitor discharged through a 1.5K Ω resistor into each pin.

Recommended Operating Conditions

(Ta=+25 $^{\circ}\text{C}$)

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Power supply voltage	V _{IN}	2.5	--	5.5	V
Operating temperature*	T _A	-20	+25	+85	$^{\circ}\text{C}$
Operating junction temperature	T _J	-	-	+150	$^{\circ}\text{C}$

*Using X5R or X7R input capacitors.

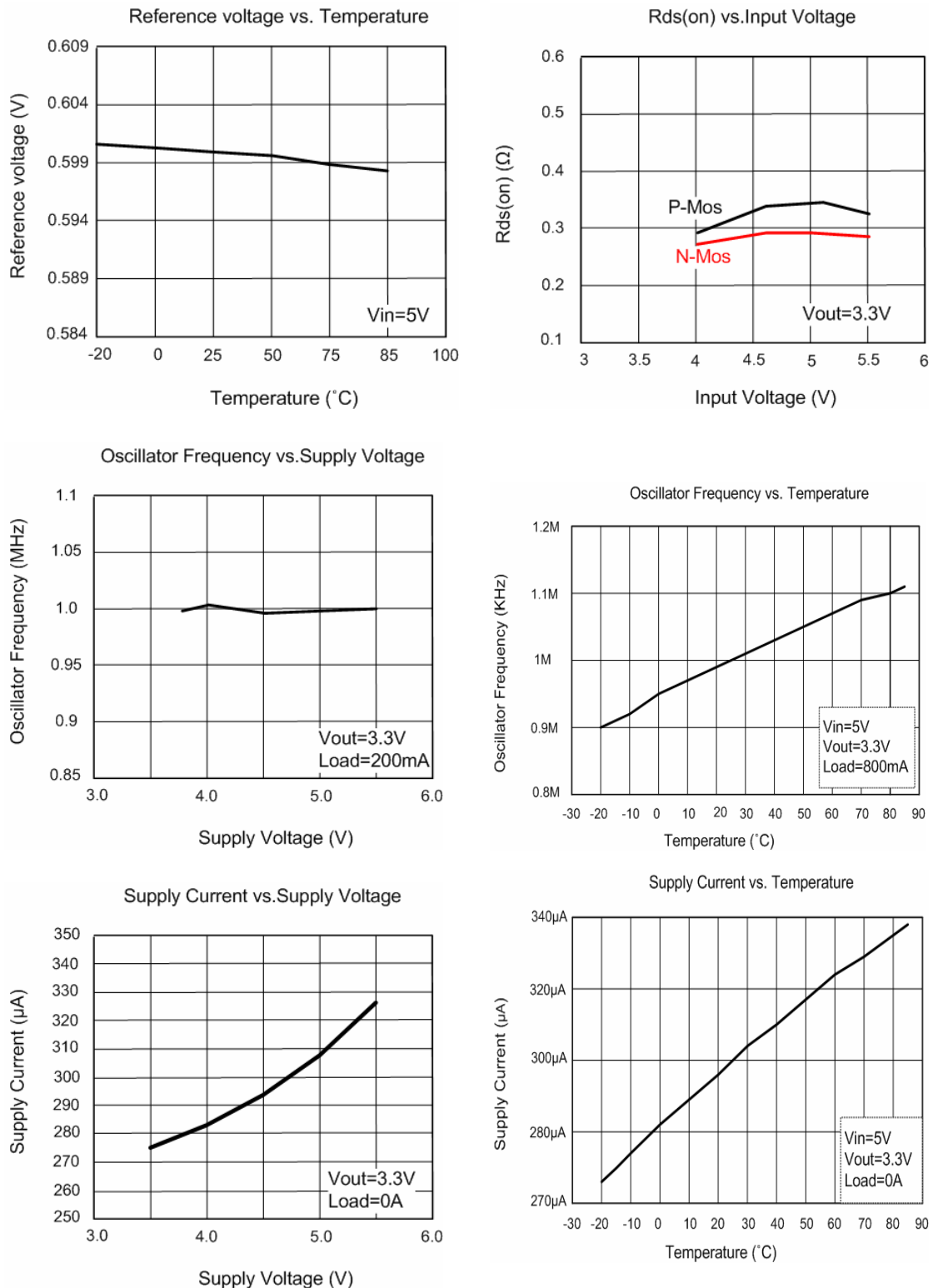
Electrical Characteristics

(VIN = 3.6V, Ta = +25 , unless otherwise noted.)

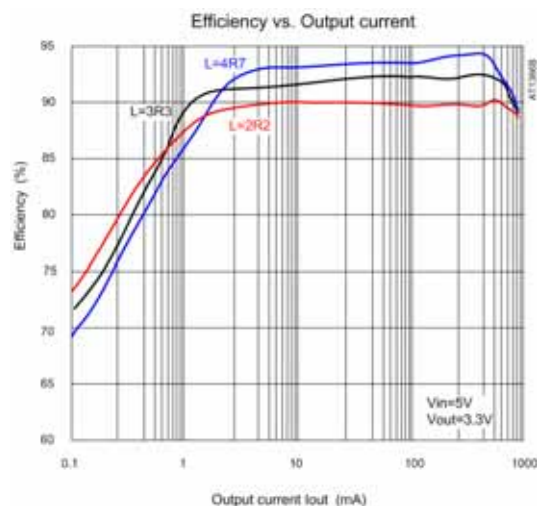
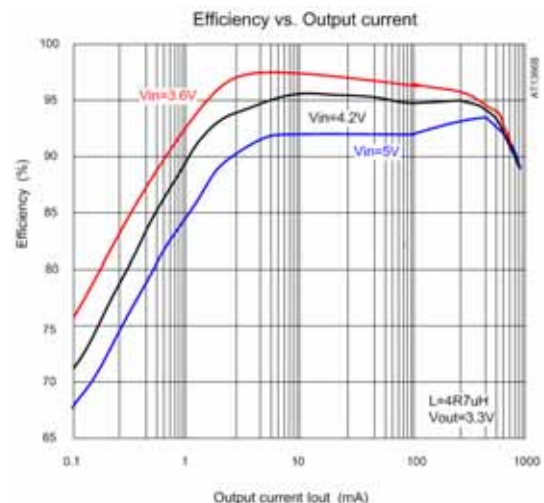
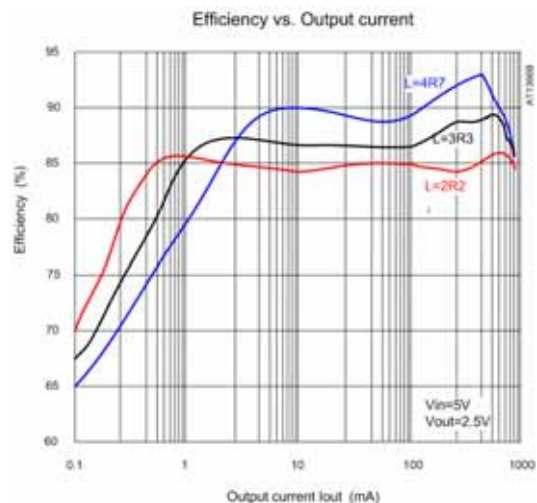
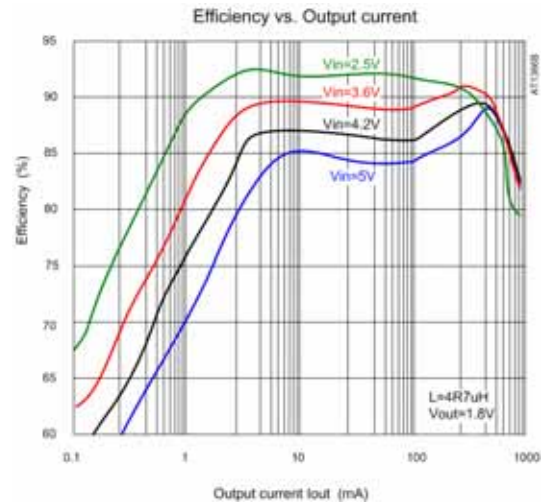
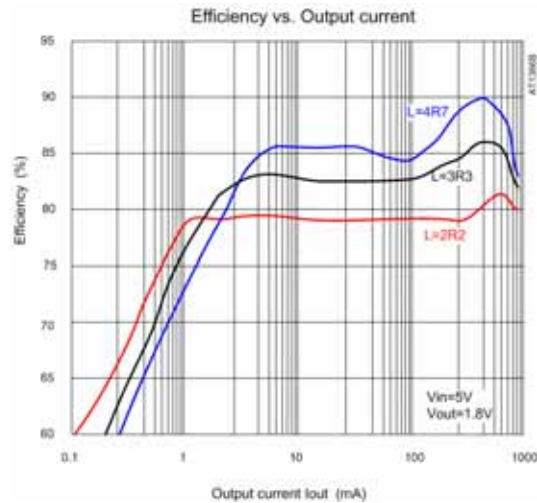
Parameter	Symbol	Condition	Values			Unit
			Min.	Typ.	Max.	
Input Supply Range	V _{IN}		2.5	--	5.5	V
Quiescent Current*	I _S	FB=0.6V, I _{load} =0A Active Mode	--	300	--	μA
Current in standby mode	I _{ST}	RUN=0V, VIN=5.5V	--	0.5	1	μA
Feedback Voltage	V _{FB}	T _a = -20 to +85	0.588	0.600	0.612	V
Feedback Voltage line-regulation	V _{FB-Line}	VCC=2.5V to 5.5V	--	0.1	0.5	%
Feedback Variation with Temperature		T _a = -20 to +85	--	0.5	1.0	%
Feedback current	I _{FB}		--	--	±200	nA
Peak Inductor Current*	I _{PK}	VIN=5V, VOUT=3.3V	1.10	1.25	1.50	A
Maximum Output Current*	I _O	VIN=5V±5%, VOUT=3.3V, L=4.7μH	-	-	800	mA
Oscillator Frequency	fosc1	FB=0.6V	0.8	1.0	1.2	MHz
	fosc2	FB=0V	--	200	--	KHz
RDS(ON) of P-Channel MOSFET	R _{PFET}	ISW=600mA	--	0.4	0.5	Ω
RDS(ON) of N-Channel MOSFET	R _{NFET}	ISW=-600mA	--	0.35	0.45	Ω
SW Leakage Current	I _{LSW}	RUN=0V, SW=0V or 5V, VIN=5V	--	±0.1	±1	μA
RUN Threshold	V _{RUN}		0.3	1.0	1.5	V
RUN leakage Current	I _{RUN}		--	±0.1	±1	μA

$$*I_{PK} = I_O + \frac{\Delta I}{2} = I_O + \frac{(V_{IN} - V_{OUT}) \times t_{ON}}{2 \times L}$$

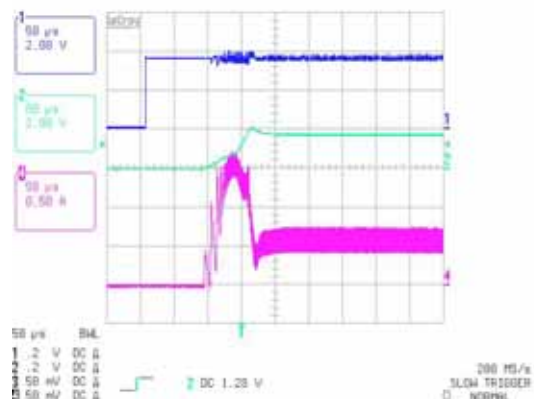
Typical characteristics : (refer to Figure 2)



Typical characteristics :

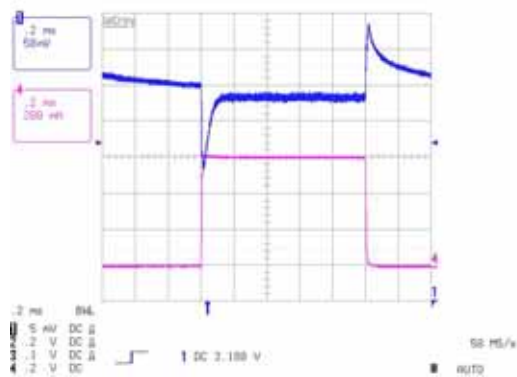


Start-Up from Shutdown($V_{IN}=3.6V$)

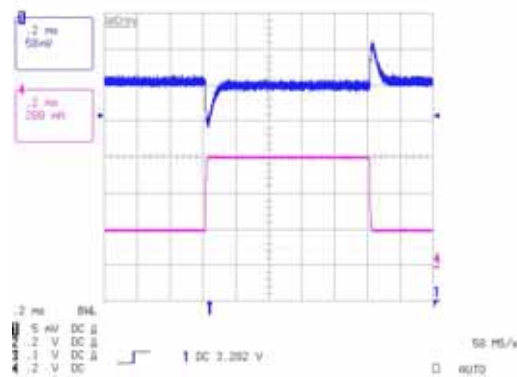
CH1:RUN CH2:V_{OUT} CH4:I_L

Typical characteristics (Continued)

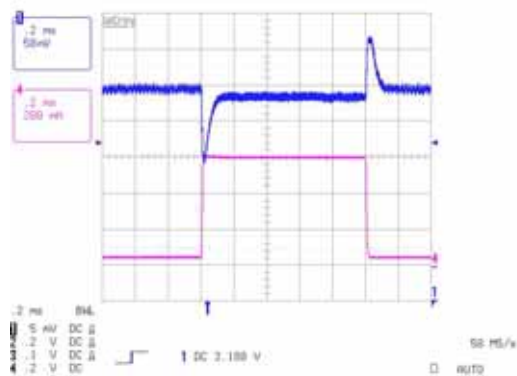
$V_{IN}=5V, V_{OUT}=3.3V$ CH2: V_{OUT} CH4: I_{OUT}



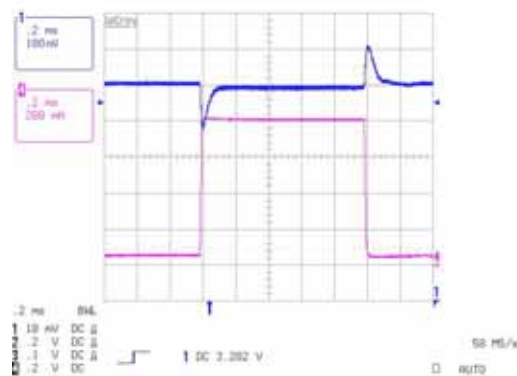
$I_{LOAD}=0mA$ to 600mA



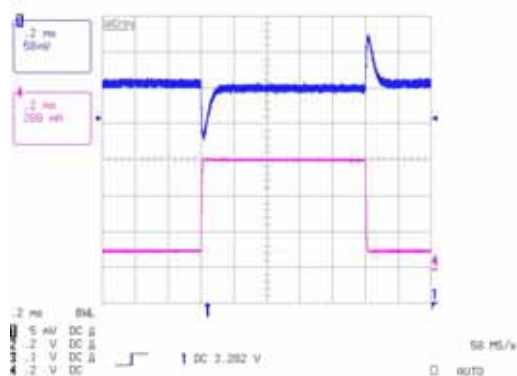
$I_{LOAD}= 200mA$ to 600mA



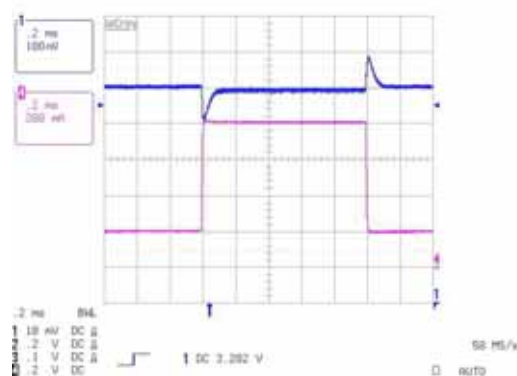
$I_{LOAD}= 50mA$ to 600mA



$I_{LOAD}= 50mA$ to 800mA

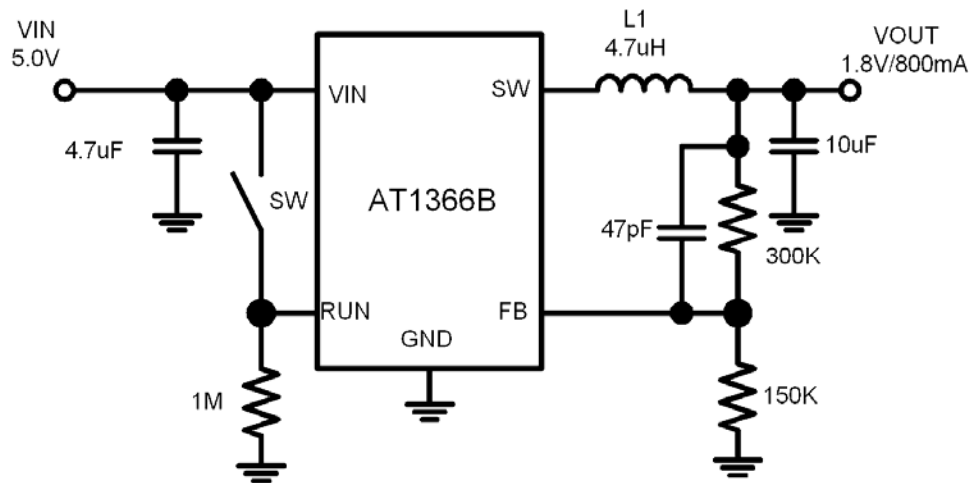


$I_{LOAD}= 100mA$ to 600mA



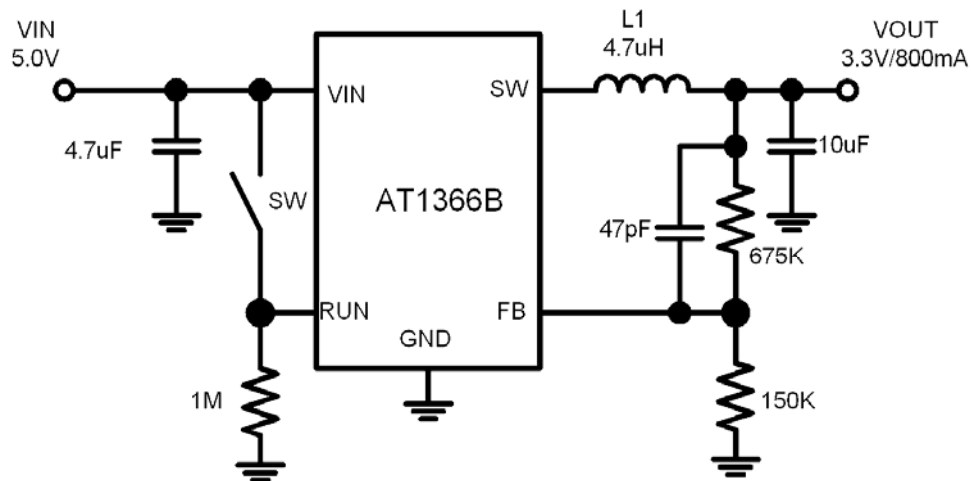
$I_{LOAD}= 200mA$ to 800mA

Typical Application Circuit



L1:ABC SH40284R7YSB

Figure 1



L1:ABC SH40284R7YSB

Figure 2

Application Information

Short Circuit Protection Function

The AT1366B has short circuit protection(see the Electrical Characteristics frequency item). When the output is shorted to ground, the frequency of the oscillator is reduced to about 200KHz. This frequency foldback ensures that the inductor current has more time to decay. It will prevent the inductor current and internal P-MOSFET current runaway to damage the device. The frequency will return to the normal values when the short circuit condition is removed and the feedback voltage reaches 0.6V.

Capacitor Selection

In continuous mode, the source current of the top MOSFET is square wave of duty cycle. The Primary function of the input capacitor is to provide a low impedance loop for the edges of pulsed current drawn by the AT1366B. A load step at the output can induce ringing at the input VIN. This ringing can couple to the output and be mistaken as loop instability. The oscillation can be improved by add the capacitance of the input capacitor. A typical value is 4.7~22μF ceramic (X5R or X7R), POSCAP or Aluminum Polymer. These capacitors will provide good high frequency bypassing and their low ESR will reduce resistive losses for higher efficiency. The input capacitor RMS current varies with the input voltage and the output voltage. The equation for the maximum RMS current in the input capacitor is:

$$I_{RMS} = I_{OMAX} \sqrt{\frac{V_O}{V_{IN}} \left(1 - \frac{V_O}{V_{IN}}\right)}$$

The output capacitor depends on the suitable ripple voltage. Low ripple voltage corresponds to lower effective series resistance (ESR). The output ripple voltage is determined by:

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

The output capacitor RMS ripple current is given by:

$$I_{RMS} = \frac{1}{2\sqrt{3}} \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{L \times f \times V_{IN}}$$

When choosing the input and output ceramic capacitors, choose the **X5R** or **X7R** dielectric formulations. These dielectrics have the best temperature and voltage characteristics of all the ceramics for a given value and size.

Inductor Selection

The inductor is chosen based on the desired ripple current. Large value inductors lower ripple current and small value inductors result in higher ripple current. Always consider the losses associated with the DCR and its effect on the total converter efficiency when selecting an inductor. The inductor is selected to limit the ripple current to some predetermined value, typically 20~40% of the full load current at the maximum input voltage. The formula of inductance value is as below:

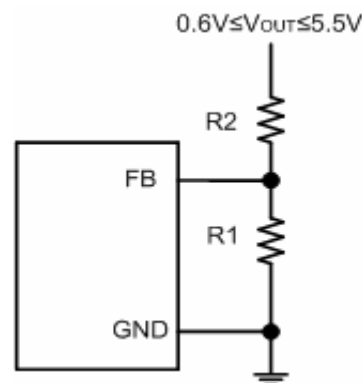
$$\Delta I_L = 0.2 \sim 0.4 \times I_{OUT(MAX)}$$

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

Adjustable Output Voltage

The AT1366B appears a 0.6V reference voltage at FB pin. The output voltage is set by a resistive divider which is according to the following formula:

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



*R1=150KΩ for stability consideration.

The Dissipation

The power loss is given by:

$$P_{LOSS} = I_O^2 \times R_{DS(ON)-P} \times D + I_O^2 \times R_{DS(ON)-N} \times (1-D) + V_{IN} \times I_O \times (t_r + t_f) \times f_s + I_s \times V_{IN}$$

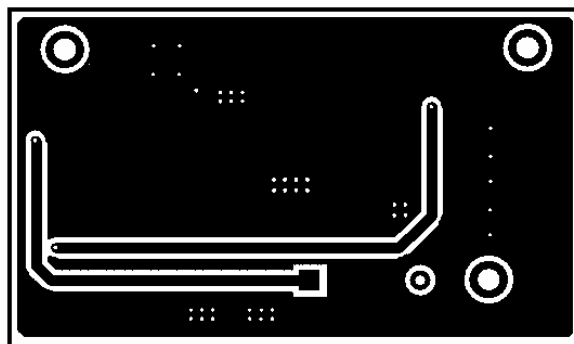
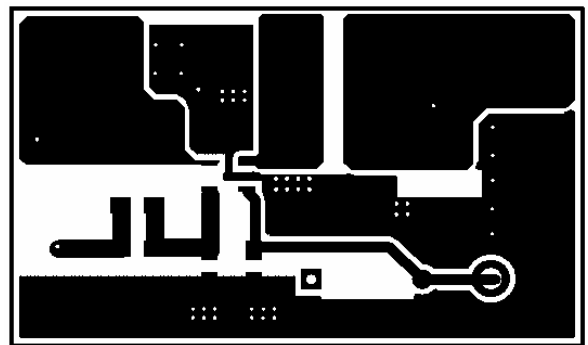
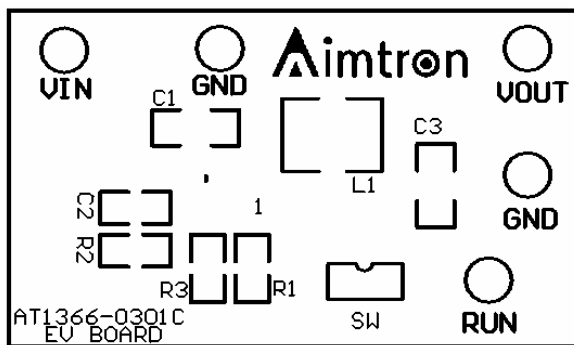
$$T_{J(MAX)} = T_A + \theta_{JA} \times P_{LOSS}$$

Inductors Surface Mount		
Inductance(μH)	Manufacturer/Part No.	Manufacturer Website
3.3	Sumida CDRH4D28-3R3	www.sumida.com
4.7	Sumida CDRH5D18-4R7	
3.3	Mitsumi C3-K1.8L-3R3 Mitsumi C4-K1.8L-3R3	www.mitsumi.co.jp
3.3	ABC SH40283R3YSB	www.atec-group.com
4.7	ABC SH40284R7YSB	

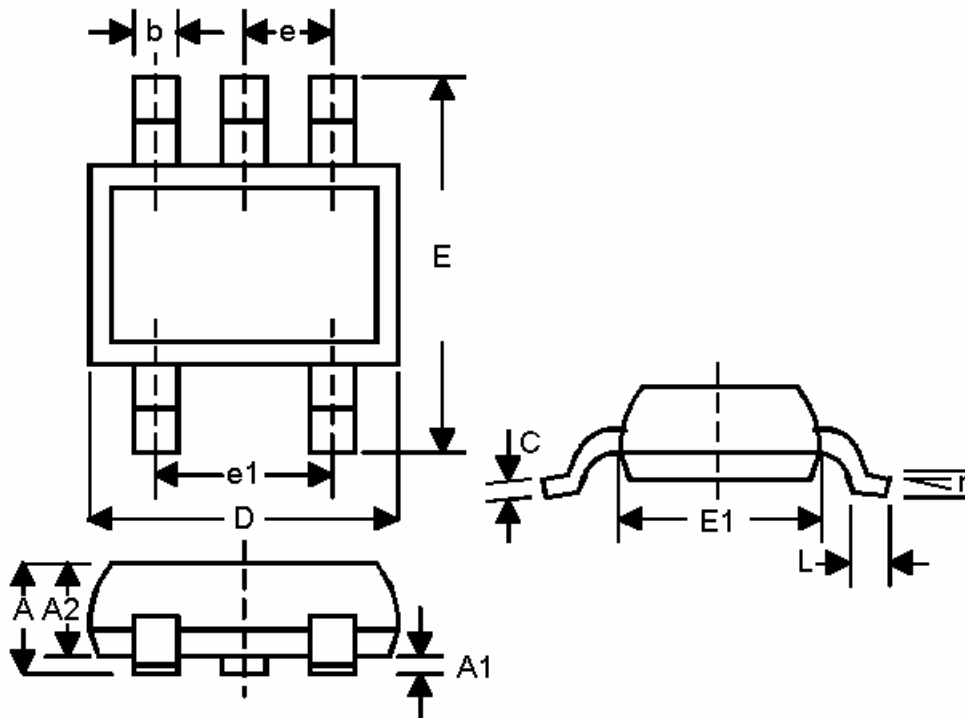
Capacitors Surface Mount		
Capacitance(μF)	Manufacturer/Part No.	Manufacturer Website
22	TDK C3216X5R0J226M	www.tdk.com
47	TDK C3225X5R0J46M	www.tdk.com
10	GRM42-6X5R 106K6.3	www.murata.com
4.7	TAIYO JMK212BJ475MG	www.t-yuden.com

PC Board Layout

1. The most critical aspect of the layout is the placement of the input capacitor C1. It must be placed as close as possible to the AT1366B to reduce the input ripple voltage.
2. Power loops on the input and output of the converter should be laid out with the shortest and widest traces possible. The longer and narrower the trace, the higher resistance and inductance it will have. The length of traces in series with the capacitors increases its ESR and ESL and reduces their effectiveness at high frequency.
3. The FB pin should connect to feedback resistors directly. And the route should be away from the noise source, such as inductor of SW line.
4. Grounding all components at the same point may effectively reduce the occurrence of loop.

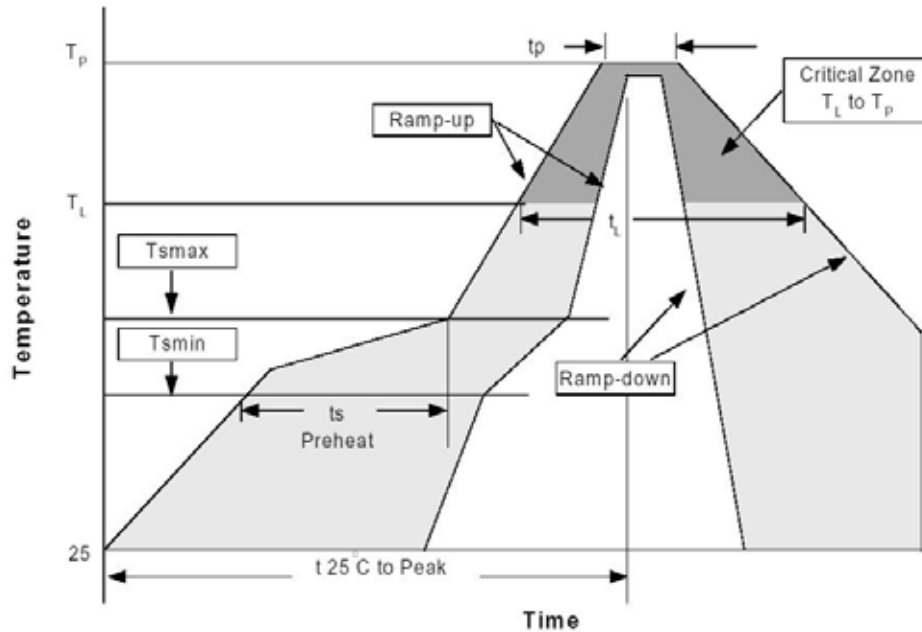


Package Outline :SOT-25



SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.035	0.057	0.90	1.45	-
A1	0.000	0.006	0.00	0.15	-
A2	0.035	0.051	0.90	1.30	-
b	0.010	0.020	0.25	0.50	-
C	0.003	0.008	0.08	0.20	-
D	0.110	0.122	2.80	3.10	-
E	0.102	0.118	2.60	3.00	-
E1	0.059	0.069	1.50	1.75	-
L	0.014	0.022	0.35	0.55	-
e	0.037ref		0.95ref		-
e1	0.075ref		1.90ref		-
r	0 ⁰	10 ⁰	0 ⁰	10 ⁰	-

Reflow Profiles



Profile Feature	Sn-Pb Eutectic Assembly		Pb-Free Assembly	
	Large Body Pkg. thickness ≥2.5mm or Pkg. volume ≥350mm ³	Small Body Pkg. thickness <2.5mm or Pkg. volume <350mm ³	Large Body Pkg. thickness ≥2.5mm or Pkg. volume ≥350mm ³	Small Body Pkg. thickness ≥2.5mm or Pkg. volume ≥350mm ³
Average ramp-up rate (T _L to T _P)	3°C/second max.		3°C/second max.	
Preheat -Temperature Min(Tsmin) -Temperature Max (Tsmax) -Time (min to max)(ts)	100°C 150°C 60-120 seconds		150°C 200°C 60-180 seconds	
Tsmax to T _L -Ramp-up Rate			3°C/second max.	
Time maintained above: -Temperature (T _L) -Time (t _L)	183°C 60-150 seconds		217°C 60-150 seconds	
Peak Temperature(T _P)	225+0/-5°C	240+0/-5°C	245+0/-5°C	250+0/-5°C
Time within 5°C of actual Peak Temperature (tp)	10-30 seconds	10-30 seconds	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max.		3°C/second max.	
Time 25°C to Peak Temperature	6 minutes max.		8 minutes max.	

*All temperatures refer to topside of the package, measured on the package body surface.