2A Step-Down Synchronous DC-DC Converters

General Description

ME3104 is a step-down current-mode, DC-DC converter. supports a range of input voltages from 2.5V to 5V, allowing the use of a single Li+/Li-polymer cell, multiple Alkaline/NiMH cell, USB, and other standard power sources. The output voltage is adjustable from 0.6V to the input voltage, All versions employ internal power switch and synchronous rectifierfor to minimize external part count and realize high efficiency. During shutdown, the input is disconnected from the output and the shutdown current is less than 0.1 uA. Other key features include under-voltage lockout to prevent deep battery discharge. Over current limit and Thermal Shutdown.

Features

- Efficiency up to 96%
- Only 40uA (TYP.) Quiescent Current
- Output Current: Up to 2A
- Internal Synchronous Rectifier
- 1.5MHz Switching Frequency
- Soft Start
- Under-Voltage Lockout
- Short Circuit Protection
- Thermal Shutdown

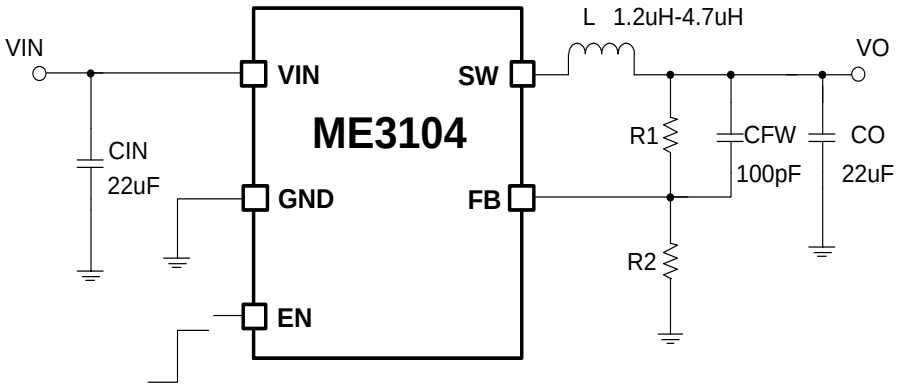
Applications

- Cellular Phone
- Portable Electronics
- Wireless Devices
- Cordless Phone
- Computer Peripherals
- Battery Powered Widgets
- Electronic Scales
- Digital Frame

Package

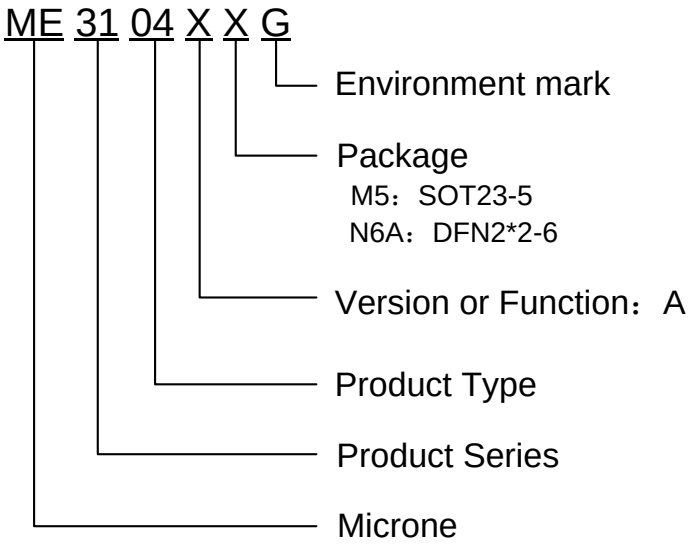
- 5 pin：SOT23-5
- 6 pin：DFN2*2-6

Typical Application Circuit



VO=0.6x(1+R1/R2)

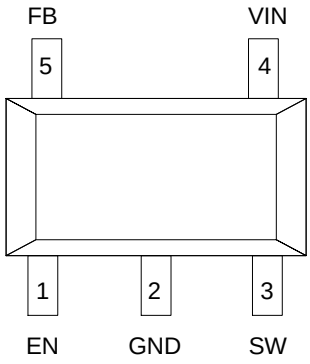
Selection Guide



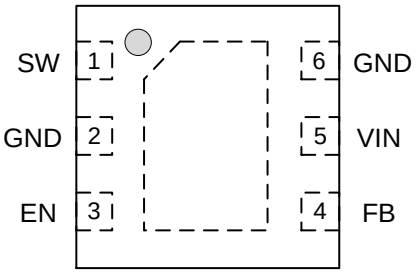
product series	product description
ME3104AM5G	V_{FB} =0.6V，Package：SOT23-5
ME3104AN6AG	V_{FB} =0.6V，Package：DFN2*2-6

NOTE: If you need other voltage and package, please contact our sales staff。

Pin Configuration



SOT23-5

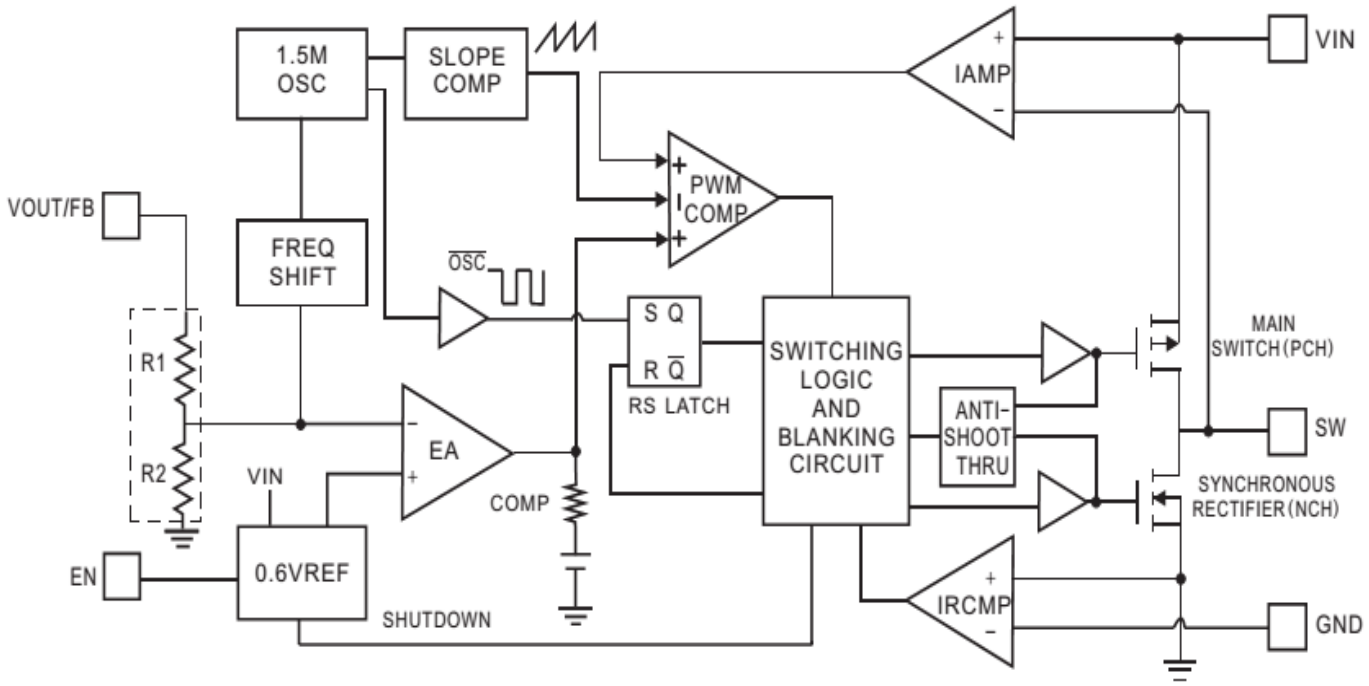


DFN2*2-6

Pin Assignment

SOT23-5	DFN2*2-6	Name	Function
1	3	EN	Enable control input
2	2,6	GND	Ground
3	1	SW	The drains of the internal main and synchronous power MOSFET
4	5	VIN	Chip main power supply pin
5	4	FB	Feedback voltage

Block Diagram



Absolute Maximum Ratings

Parameter		Maximum	Unit
Input Voltage：VIN		5.5	V
EN,FB PIN		5.5	V
SW PIN		-0.3-VIN	V
Thermal resistance (Junction to air) θja	SOT23-5	210	ºC /W
	DFN2*2-6	78	
Internal Power Dissipation Pd	SOT23-5	0.6	W
	DFN2*2-6	1.6	
Operating Ambient Temperature Range		-40~85	ºC
Storage Temperature Range		-55~150	ºC
Maximum junction temperature		-40~150	ºC
Soldering Temperature		+260（10秒）	ºC

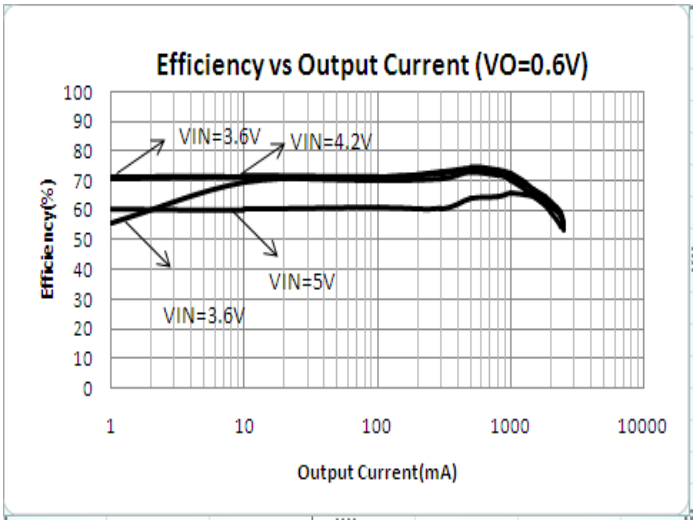
Note: Exceeding these ratings may damage the device.

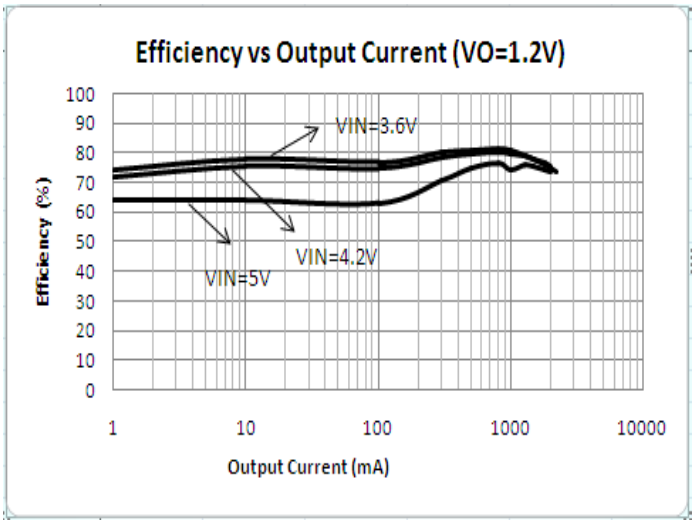
Electrical Characteristic

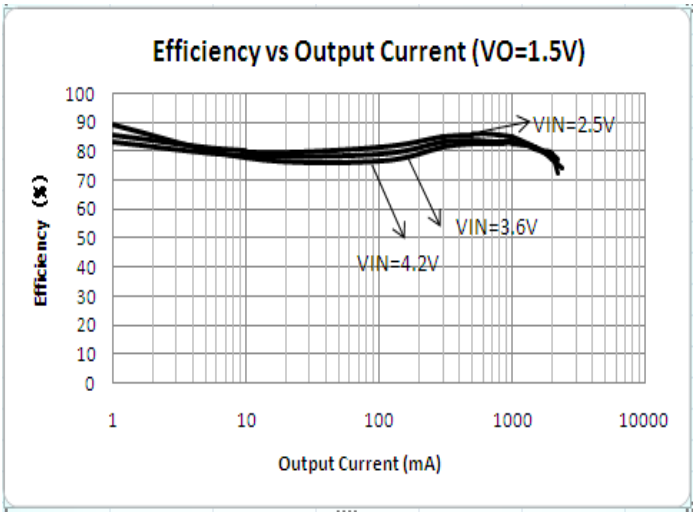
(TA = 25 ºC, VIN= 3.6V,VO=1.8V, CIN=22uF,L=2.2uH， unless otherwise noted)

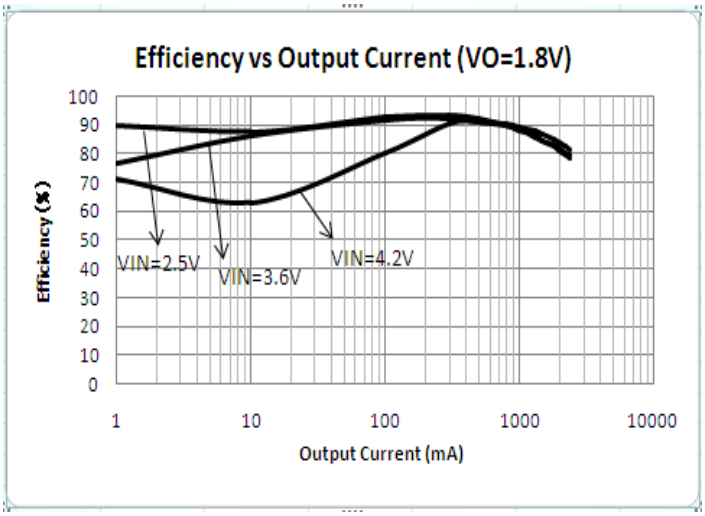
Symbol	Parameter	Test Conditions		Min	Typ	Max	Units
VIN	Input Voltage Range			2.5	-	5	V
Vuvlo+	High undervoltage lockout threshold	V_{EN}=1.5 I_O=10mA, VIN=1.75V→2.3V，		-	2.0	-	V
Vuvlo-	Low undervoltage lockout threshold	V_{EN}=1.5V IO=10mA, VIN=2.3V→1.75V		-	1.8	-	V
V_{FB}	Regulated Feedback Voltage			0.588	0.6	0.612	V
Vo		Io=100mA		-3	-	+3	%
LNR	Output Voltage Line Regulation	Vin=2.5V to 5V,Io=10mA		-	0.3	0.5	%
I_Q	Quiescent Current	No load		-	40	70	uA
Isd	Shutdown Current	Ven=0V		-	0.1	1	uA
Ilimit	Current Limit			-	2.7	-	A
I_{LSW}	SW Leakage Current			-1	-	1	uA
Fosc	Oscillator Frequency	Vout=100%		1.2	1.5	1.8	MHz
		Vfb=0V or Vout=0V		-	500	-	KHz
R_{DSON}	On-resistance	I_{DS}=100mA	P MOSFET	-	0.12	0.18	Ω
			N MOSFET	-	0.15	0.22	Ω
η	High Efficiency			-	96	-	%
VEH	EN Threshold High			1.5	-	-	V
VEL	EN Threshold Low			-	-	0.3	V
OTP	Over Temperature Protection			-	150	-	°C
OTH	OTP Hysteresis			-	30	-	°C

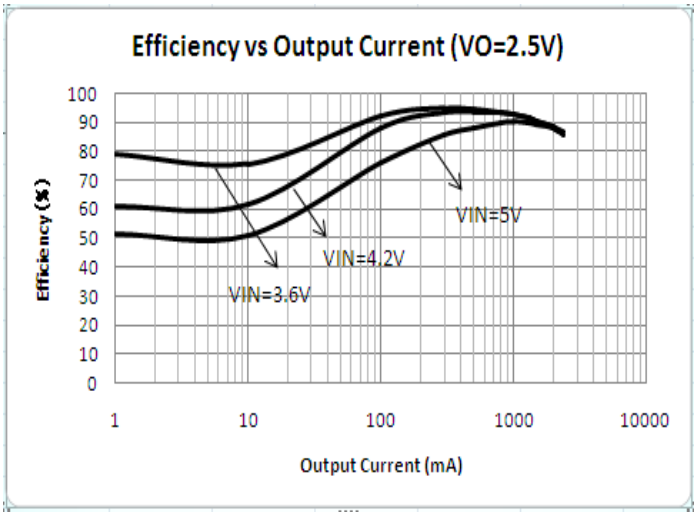
Typical Performance Characteristics

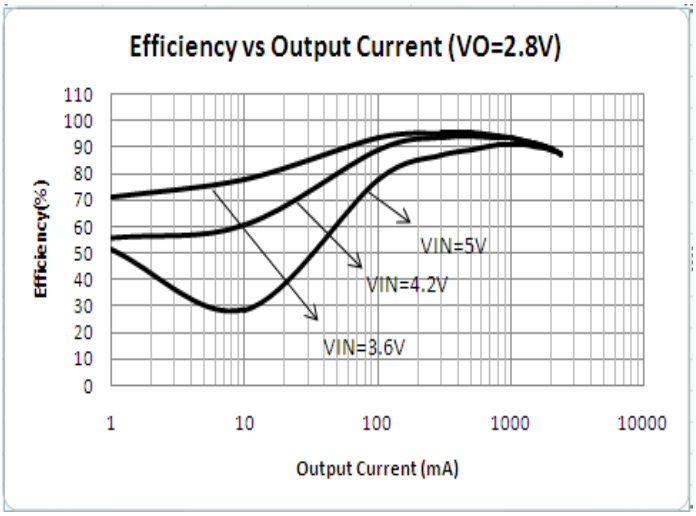


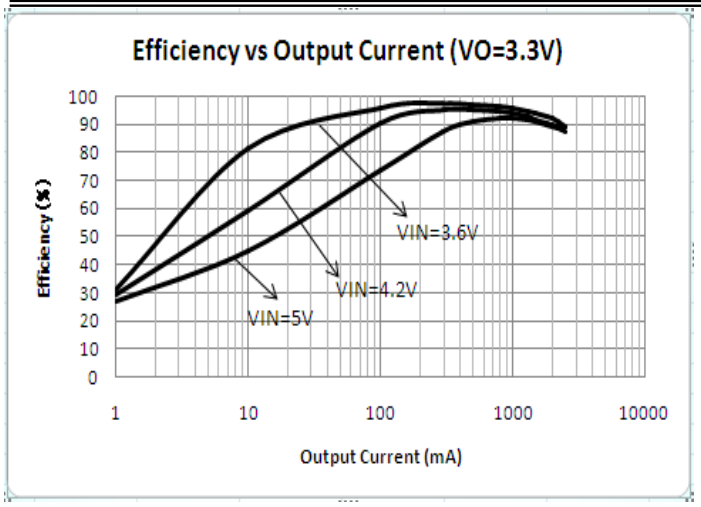


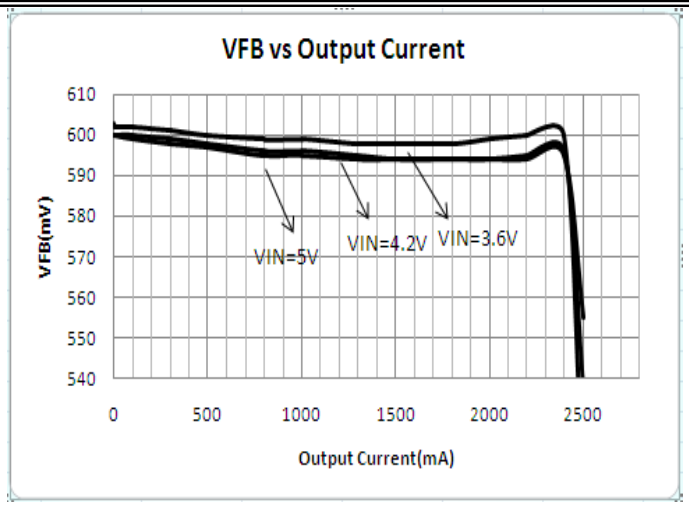


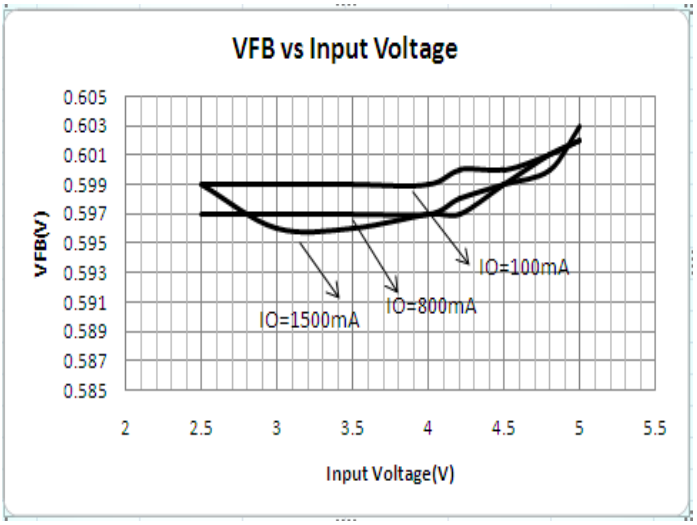


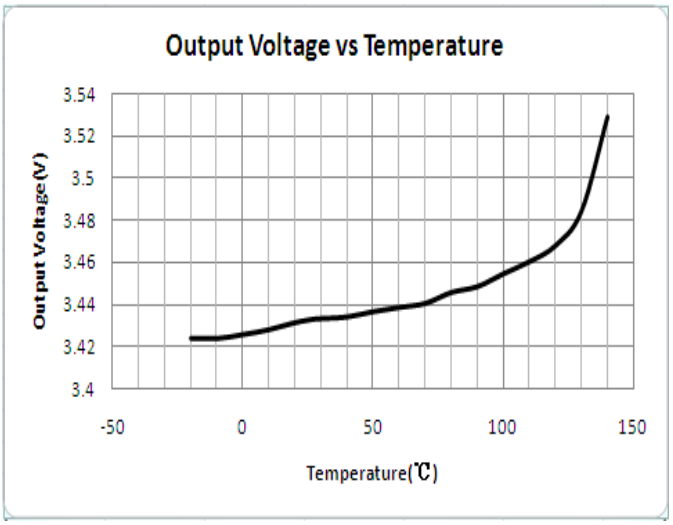


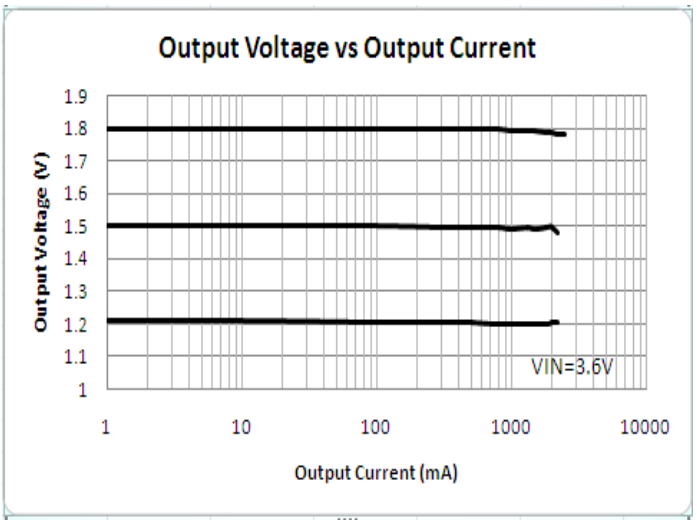


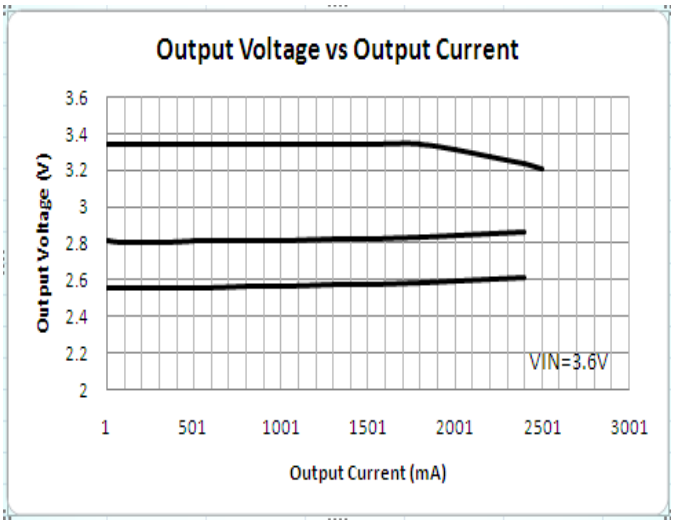

Efficiency vs Output Current (VO=3.3V)
Efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
1
10
100
1000
10000
Output Current (mA)
VIN=3.6V
VIN=4.2V
VIN=5V

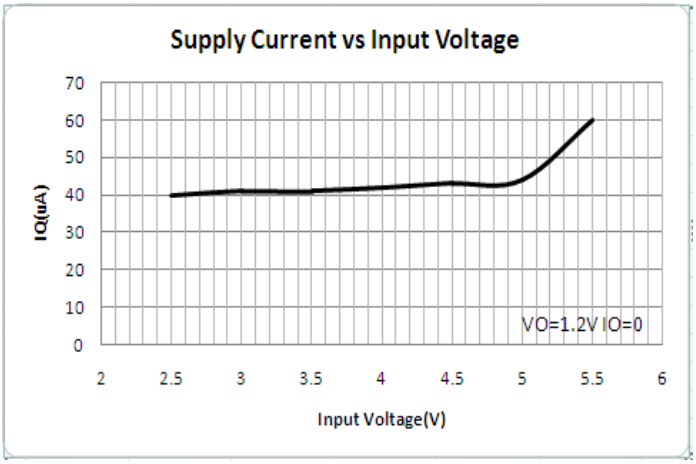

VFB vs Output Current
VFB(mV)
610
600
590
580
570
560
550
540
0
500
1000
1500
2000
2500
Output Current(mA)
VIN=5V
VIN=4.2V
VIN=3.6V

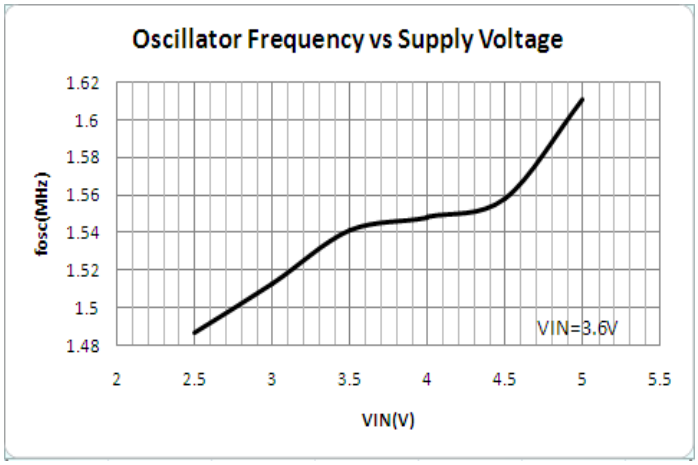

VFB vs Input Voltage
VFB(V)
0.605
0.603
0.601
0.599
0.597
0.595
0.593
0.591
0.589
0.587
0.585
2
2.5
3
3.5
4
4.5
5
5.5
Input Voltage(V)
IO=100mA
IO=800mA
IO=1500mA


Output Voltage vs Temperature
Output Voltage(V)
3.54
3.52
3.5
3.48
3.46
3.44
3.42
3.4
-50
0
50
100
150
Temperature(℃)

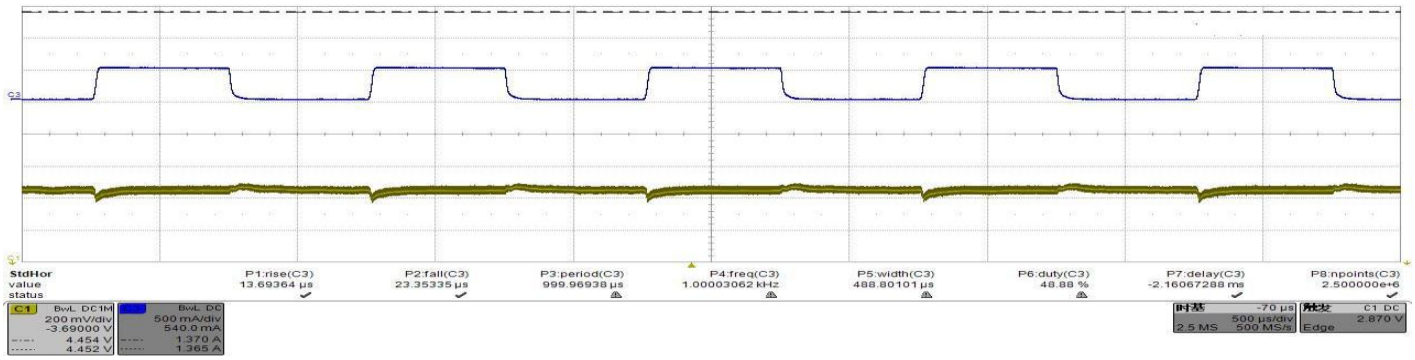

Output Voltage vs Output Current
Output Voltage (V)
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
1
10
100
1000
10000
Output Current (mA)
VIN=3.6V


Output Voltage vs Output Current
Output Voltage (V)
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1
501
1001
1501
2001
2501
3001
Output Current (mA)
VIN=3.6V

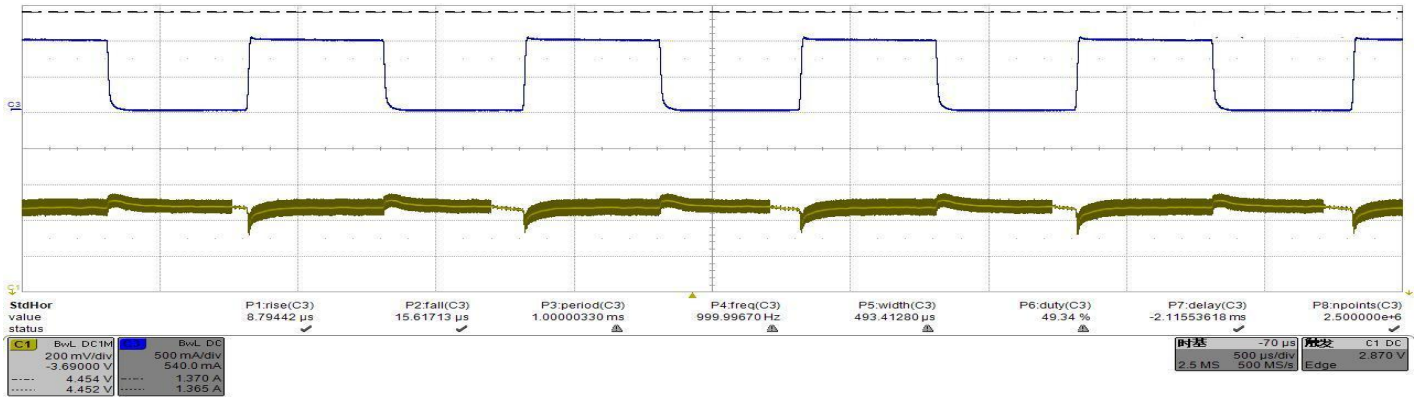




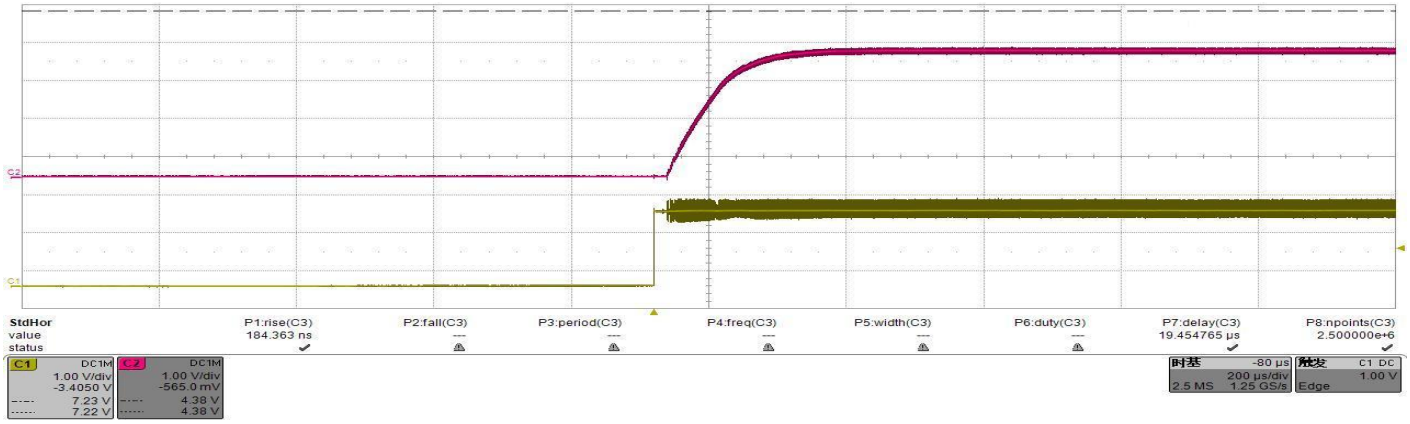
Load Transient IO=0-500mA VO=3.3V VIN=5V



Load Transient IO=0-1000mA VO=3.3V VIN=5V



Start-up from EN VO=3.3V VIN=4.2V



Application Information

Inductor Selection

ME3104 For most applications, the value of the inductor will fall in the range of 1μH to 4.7μH. 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 V or Vout also increases the ripple current as shown in equation 1. A reasonable starting point for setting ripple current is I = 800mA (40% of 2A).

$$L_{min} > \frac{V_o \cdot (1 - D_{min})}{\Delta I \cdot f_s}$$

VO	0.6V	1.2V	1.5V	1.8V	2.5V	2.8V	3.3V
L	1.2uH	1.2uH	2.2uH	2.2uH	2.2uH	2.2uH	3.3uH

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 3A rated inductor should be enough for most applications (2A + 400mA). For better efficiency, choose a low DC-resistance inductor

CIN and COUT 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:

$$\text{CIN required } I_{RMS} = I_{OMAX} \frac{[VOUT(VIN-VOUT)]^{1/2}}{VIN}$$

This formula has a maximum at V =2Vout,where IRMS=IOUT I/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. 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 I (P-P) requirement. The output ripple Vout is determined by:

$$\Delta VO \approx \Delta IL(ESR + 1/8f \times COUT)$$

Where f = operating frequency, C =output capacitance and ΔI = ripple current in the inductor. For a fixed output voltage, the output ripple is highest at maximum input voltage since Δ I increases with input voltage.

Higher values, lower cost ceramic capacitors are now becoming available in smaller case sizes.Their high ripple current, high voltage rating and low ESR make them ideal for switching regulator applications. Using ceramic

capacitors can achieve very low output ripple and small circuit size.

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.

Setting the Output Voltage

The internal reference is 0.6V (Typical). The output voltage is calculated as below:

$$VO = 0.6 \times (1 + \frac{R1}{R2})$$

VO	R1	R2
1.2V	100k	100k
1.5V	150k	100k
1.8V	200k	100k
2.5V	380k	120k
3.3V	540k	120k

100% Duty Cycle Operation

As the input voltage approaches the output voltage, the converter turns the P-channel transistor continuously on. In this mode the output voltage is equal to the input voltage minus the voltage drop across the P – channel transistor:

$$VO = VIN - I_{LOAD}(R_{dson} + R_L)$$

where R dson = P-channel switch ON resistance, I LOAD = Output current, R L = Inductor DC resistance

UVLO and Soft-Start

The reference and the circuit remain reset until the VIN crosses its UVLO threshold. The ME3104 has an internal soft-start circuit that limits the in-rush current during start-up. This prevents possible voltage drops of the input voltage and eliminates the output voltage overshoot. The soft-start acts as a digital circuit to increase the switch current in several steps to the P-channel current limit (2700mA).

Short Circuit Protection

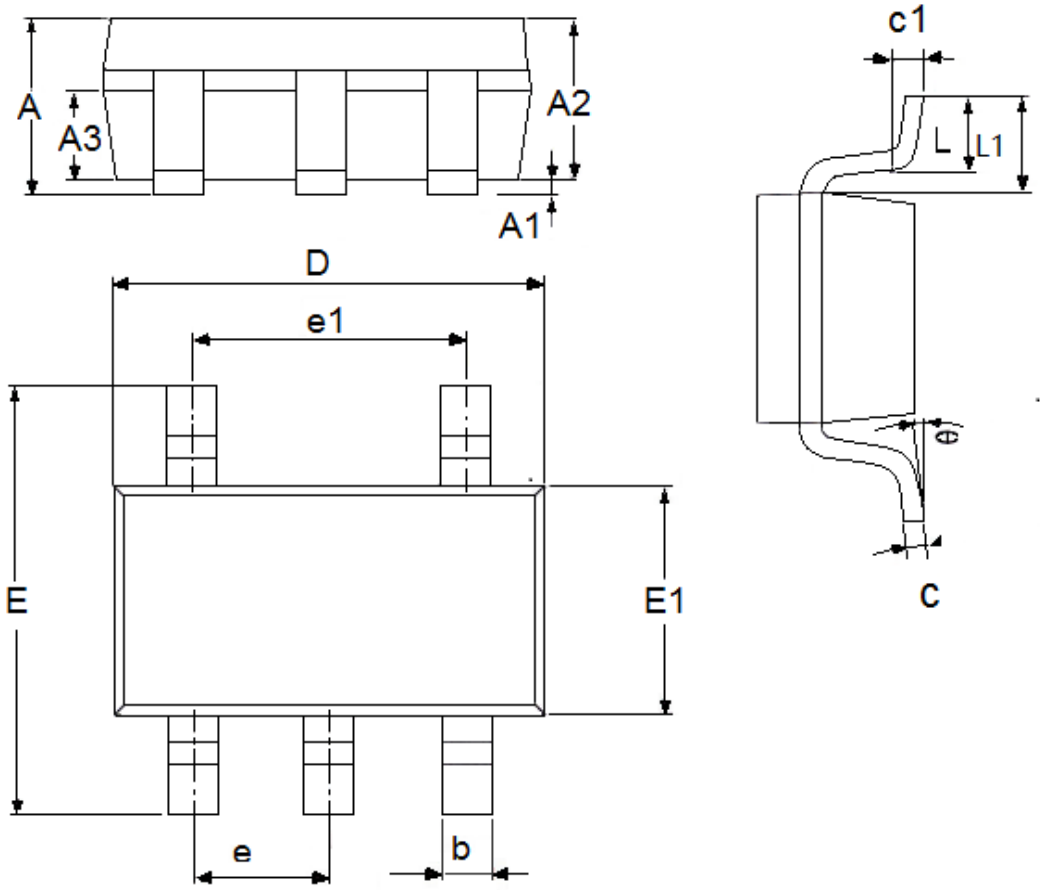
The switch peak current is limited cycle-by-cycle to a typical value of 2700mA. In the event of an output voltage short circuit, the device operates with a frequency of 400kHz and minimum duty cycle, therefore the average input current is typically 200mA.

Thermal Shutdown

When the die temperature exceeds 150℃, a reset occurs and the reset remains until thetemperature decrease to 120℃, at which time the circuit can be restarted.

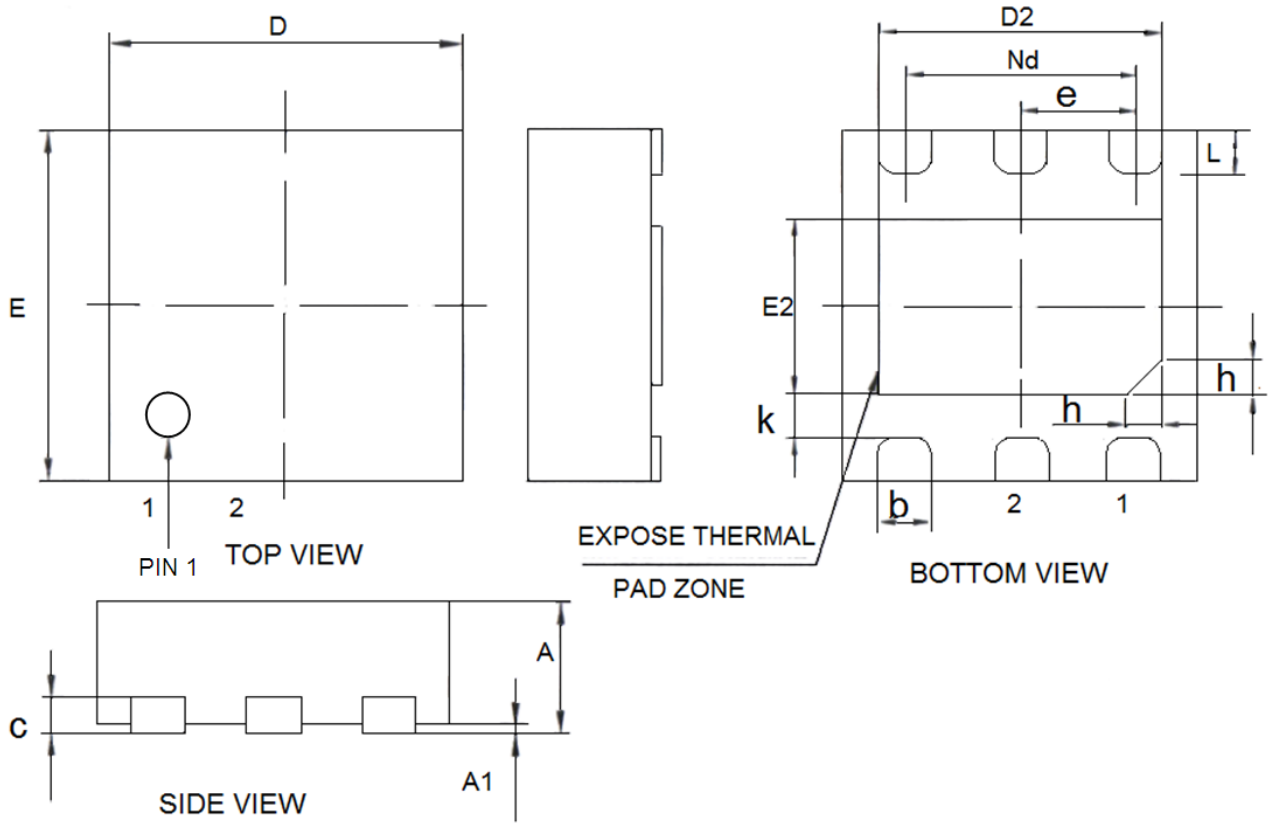
Packaging Information

- **Packaging Type: SOT23-5**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	1.05	1.45	0.0413	0.0571
A1	0	0.15	0.0000	0.0059
A2	0.9	1.3	0.0354	0.0512
A3	0.6	0.7	0.0236	0.0276
b	0.25	0.5	0.0098	0.0197
c	0.1	0.23	0.0039	0.0091
D	2.82	3.05	0.1110	0.1201
e1	1.9(TYP)		0.0748(TYP)	
E	2.6	3.05	0.1024	0.1201
E1	1.5	1.75	0.0512	0.0689
e	0.95(TYP)		0.0374(TYP)	
L	0.25	0.6	0.0098	0.0236
L1	0.59(TYP)		0.0232(TYP)	
θ	0	8°	0.0000	8°
c1	0.2(TYP)		0.0079(TYP)	

- **Packaging Type: DFN2*2-6**



DIM	Millimeters		Inches	
	Min	Max	Min	Max
A	0.7	0.8	0.0276	0.0315
A1	0	0.05	0	0.002
c	0.18	0.25	0.0071	0.0098
b	0.25	0.35	0.0098	0.0138
D	1.9	2.1	0.0748	0.0827
Nd	1.3(TYP)		0.0512(TYP)	
E	1.9	2.1	0.0748	0.0827
E2	0.9	1.1	0.0354	0.0433
e	0.65(TYP)		0.0256(TYP)	
L	0.2	0.3	0.0079	0.0118
h	0.15	0.25	0.0059	0.0098
D2	1.5	1.7	0.0591	0.0669
K	0.2	0.3	0.0079	0.0118

- The contents of this document will be updated with the product's improvement without prior notice. Please consult our sales staff before using this document to ensure that you are using the latest version.
- The application circuit examples described in this document are only used to indicate the representative use of the product and do not guarantee the design of mass production.
- Please use this product within the limits stated in this document. We will not be responsible for any damage caused by improper use.
- The products described in this document are not allowed to be used in equipment or devices that affect the human body without the written permission of our company, including but not limited to: health equipment, medical equipment, disaster prevention equipment, fuel control equipment, automobile equipment, aviation equipment and vehicle equipment.
- Although our company has always been committed to improving product quality and reliability, semiconductor products have a certain probability of malfunction or wrong work. To prevent personal injury or property damage caused by such accidents, please pay full attention to safety design, for example: Alternate design, fire protection design, and prevention of wrong action design.
- When exporting this product or this document overseas, you should abide by applicable import and export control laws.
- Copying or reprinting part or all of this document in any form without the permission of our company is strictly prohibited.