1MHz, Forced-PWM, High Output current Synchronous Step-Up Converter

DESCRIPTION

ETA1093 is an ETA Solutions' high efficiency, high frequency synchronous Step-Up converter, capable of delivering output current up to 3A at a 5V output from a 3.6V input. With a low Rdson Power MOS and a built-in synchronous rectifier, its efficiency can be as high as 93% at a 5V/2.1A load. This greatly minimizes power dissipation and reduces heat on the IC, making it ideal for applications that require small board space and have stringent temperature constraints, such as power banks and mobile devices. ETA1093 also incorporates ETA Solutions' True-Shutoff® technology that protects against overload and short-circuit conditions. All of these features are integrated in a tiny QFN3x3-16 package. With 1MHz switching frequency, small external input and output capacitors and inductor can be used.

ETA1093 employs a FORCED-PWM control scheme; therefore, the switching frequency is fixed at any load. It makes ETA1093 perfect for systems that sensitive to low frequency noise, like audio system and communication system.

FEATURES

- Up to 97% Energy Converting Efficiency
- Up to 3A output current at 5V output, 3.6V input
- Externally adjustable output voltage
- True Shut off during shutdown and output short-circuit protection
- Thermal Shutdown
- Forced PWM at light load
- QFN3x3-16

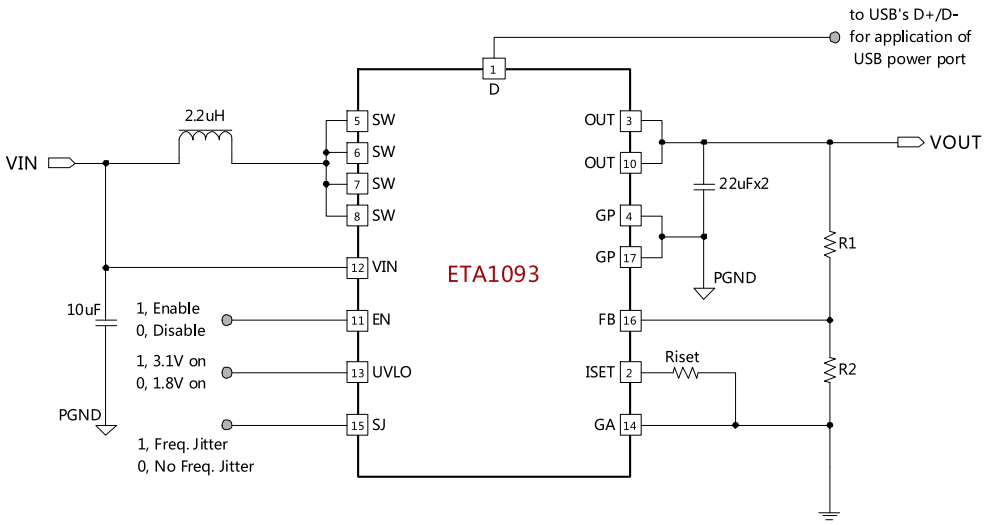
APPLICATIONS

- Power Bank
- Mobile 3G/4G Mi-Fi
- Mobile Bluetooth music player and speaker

ORDERING INFORMATION

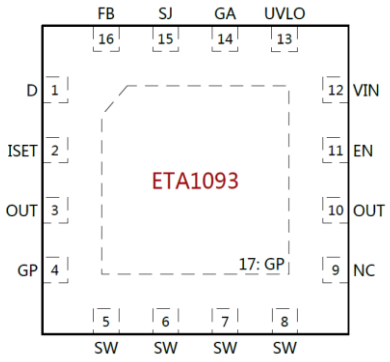
PART	PACKAGE PIN	TOP MARK
ETA1093Q3Q	QFN3x3-16	ETA1093 YWW2L

TYPICAL APPLICATION



Typical Application Circuit

PIN CONFIGURATION



QFN3x3-16

ABSOLUTEMAXIMUM RATINGS

(Note: Exceeding these limits may damage the device. Exposure to absolute maximum rating conditions for long periods may affect device reliability.)

All Pins Voltage.....–0.3V to 5.5V
Operating Temperature Range .....–40°C to 85°
Storage Temperature Range .....–55°C to 150°C

Thermal Resistance	θ_{JC}	θ_{JA}	
QFN3X3-16	10	50	°C/W

Lead Temperature (Soldering, 10ssec) .....260°C
ESD HBM (Human Body Mode) 2KV
ESD MM (Machine Mode) 200V

ELECTRICAL CHACRACTERISTICS

(V_{IN} =3.3V, V_{OUT}=3.8V, AGND=PGND, unless otherwise specified. Typical values are at TA = 25°C.)

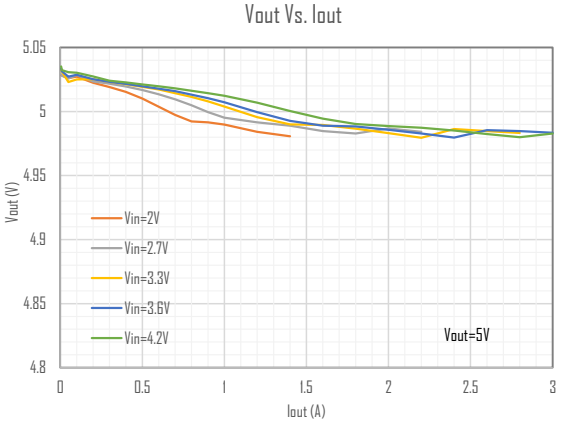
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Quiescent Current	EN=IN, No load		10		mA
Shutdown Supply Current at V_{IN}	V_{EN} =GND		0.5	5	μA
V_{UVLO}	UVLO=GND, IN rising		1.8		V
	UVLO=IN, IN rising		3.1		V
IN UVLO hysteresis			0.3		V
Feedback Voltage	V_{OUT} =2.1 to 5V	0.588	0.6	0.612	V
FB Leakage Current			0		nA
Output Over Voltage Protection	Hysteresis=500mV		6		V
NMOS Switch On Resistance			40		mΩ
PMOS Switch On Resistance			55		mΩ
SW Leakage Current	V_{OUT}=5V,V_{SW}=0 or 5V, V_{EN}=GND			10	μA
Start-up Current Limit			2.5		A
Switching Frequency		0.7	1	1.3	MHz
Short Circuit Hiccup time	ON		3.75		ms
	OFF		75		ms
NMOS Switch Current Limit	R_{ISET}=51kΩ	2.5	3.5	4.5	A
	R_{ISET}=30kΩ		6		A
EN Input Current	V_{EN}=3V		1.5		μA
EN logic high voltage		1.6			V
EN logic low voltage				0.6	V
UVLO Input Current	V_{UVLO}=3V		1.5		μA
UVLO logic high voltage		1.6			V
UVLO logic low voltage				0.6	V
Thermal Shutdown	Rising, Hysteresis=20°C		150		°C

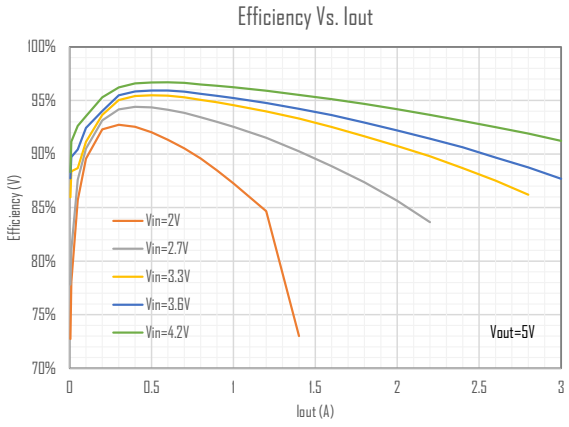
PIN DESCRIPTION

PIN #	NAME	DESCRIPTION
1	D	Connected to the D+ and D- line of USB connect, provide the correct voltage with attached portable equipment for USB Dedicated Charging Port (DCP) Emulator, and Apple / Samsung adaptors.
2	ISET	Programmable peak-current-limit control. Connect an external resistor (Riset) between ISET and AGND to set the peak NMOS current-limit threshold. The current-limit threshold may be adjusted from 0.6A to 5.0A, And if follows following equation: Ipeak=(180/Riset)*1000 (A)
3, 10	OUT	Output pin. Bypass with a 22μF or larger ceramic capacitor closely between this pin and ground.
4, 17	GP	Power ground pin. Please be noted that Pin 17 is the thermal pad of the IC.
5,6,7,8	SW	Switching node of the Switching Regulator. Connect a 1uH to 2.2μH inductor between IN and SW pin.
9	NC	No Connect. Connecting this pin to GND for routing out the power ground of Pin17.
11	EN	Enable pin for the IC. Drive this pin high to enable the IC, low or floating to disable.
12	VIN	Input pin. Bypass IN to GND with a 10uF or greater ceramic capacitor.
13	UVLO	Select IN UVLO.
14	GA	Analog ground pin. GA is internally connected to the analog ground of the control circuitry.
15	SJ	Select Jitter or not. When SJ floating, the IC works at Jitter mode. SJ=GND, the IC works at no Jitter.
16	FB	Feedback Input. Connect an external resistor divider from the output to FB and GND to set V_{OUT}, with the equation: Vout = 0.6 x (R1+R2)/R2

TYPICAL CHARACTERISTICS

(Typical values are at T_A = 25°C unless otherwise specified.)





APPLICATION INFORMATION

Loop Operation

The ETA1093 is a wide input range, high-efficiency, DC/DC step up switching regulator, integrated with a 40mΩ Low Side Main MOSFET and 55mΩ synchronous MOSFET. It uses a PWM current-mode control scheme. An error amplifier integrates error between the FB signal and the internal reference voltage. The output of the integrator is then compared to the sum of a current-sense signal and the slope compensation ramp. This operation generates a PWM signal that modulates the duty cycle of the power MOSFETs to achieve regulation for output voltage.

The output voltage is adjustable by external resistor. The peak current of the NMOS switch is also sensed to limit the maximum current flowing through the switch and the inductor. The maximum peak current limit is set to 6A and can be tuned by external resistor. An internal temperature sensor prevents the device from getting overheated in case of excessive power dissipation.

Forced-PWM operation

ETA1093 features a forced-pwm operation that it maintains a constant switching frequency during full range of load current. This feature is designed for applications that requires low output ripples or are sensitive to frequency variance such as audio applications.

Short-Circuit Protection

Unlike most step-up converters, the ETA1093 allows for short circuits on the output. In the event of a short circuit, the device first turns off the NMOS when the sensed current reaches the current limit. After V_{OUT} drops below V_{IN} the device then enters a linear charge period with the current limited same as with the start-up period. In addition, the thermal shutdown circuits disable switching if the die temperature rises above 150°C.

Down Mode (V_{IN}>V_{OUT}) Operation

The ETA1093 will continue to supply the output voltage even when the input voltage exceeds the output voltage. Since the PMOS no longer acts as a low-impedance switch in this mode, power dissipation increases within the IC to cause a sharp drop in efficiency. Limit the maximum output current to maintain an acceptable junction temperature.

Output Voltage Setting

The ETA1093 has an internal reference voltage set at 0.6V as a feedback voltage for setting external output voltage. By connecting a resistor (R1) between Vout and FB, and a resistor (R2) between FB and GND, one can set the output voltage by following equation, and please make sure the output voltage is set higher than the maximum input voltage

$$Vout = 0.6 \times (R1+R2)/R2$$

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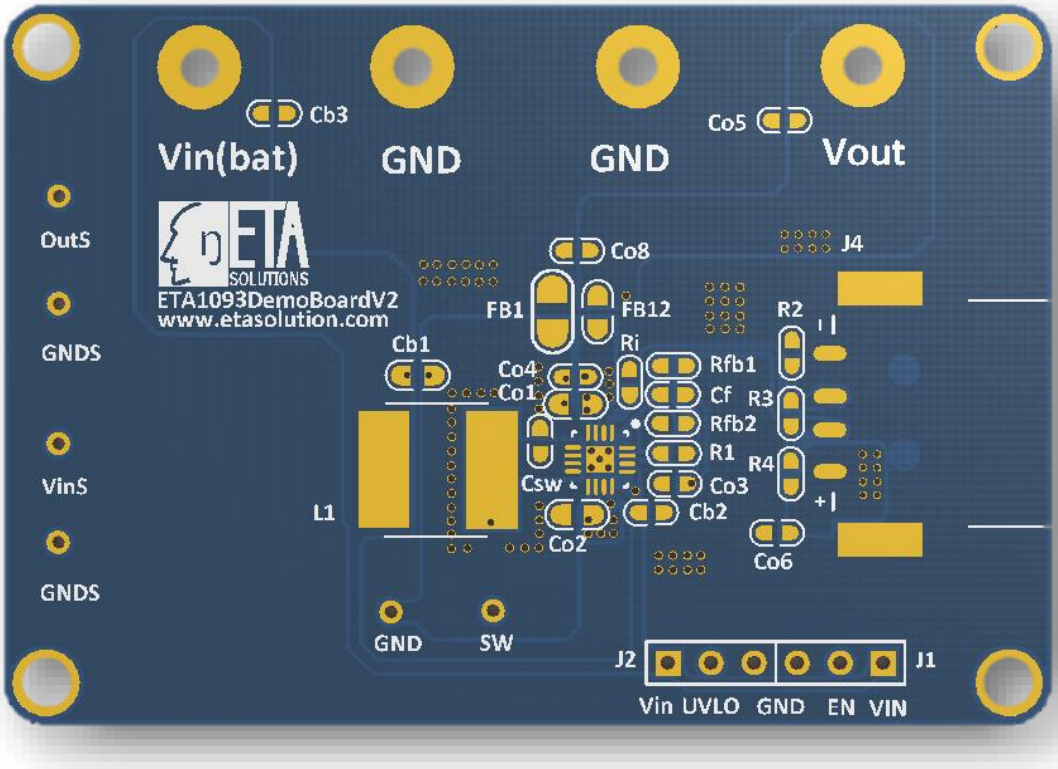
Switching Peak Current Setting

The ETA1093 allows one to set the switching peak current by external resistor (Riset). The switching peak current limit is more like an input current limit given a fixed inductor value. If one need an output current limit, input voltage, output voltage, and efficiency have to be all taken into account to calculate the input current at first. The switching peak current setting follows the equation: Ipeak=(180/Riset)*1000 (A)

PCB GUIDELINES

A typical ETA1093 demo board is shown below. Because the ETA1093 has Vout pins on opposite sides of the chip, please always place 2 output capacitors (Co1, and CO2) closest to the Vout pins (pin3 and pin10) and GP (pin4 and thermal pad thru pin9), with one capacitor on each side. As one can see on the demo board, Co1 is connecting pin 3 and pin4 on one side and the Co2 is connecting pin9 and pin10 on the other side.

There are many peripheral devices which are not necessary for real application, such as Csw, FB (ferrite-bead) , and many small capacitors along the power trace. These are the options for fine-tuning the EMI characteristics of the demo board.

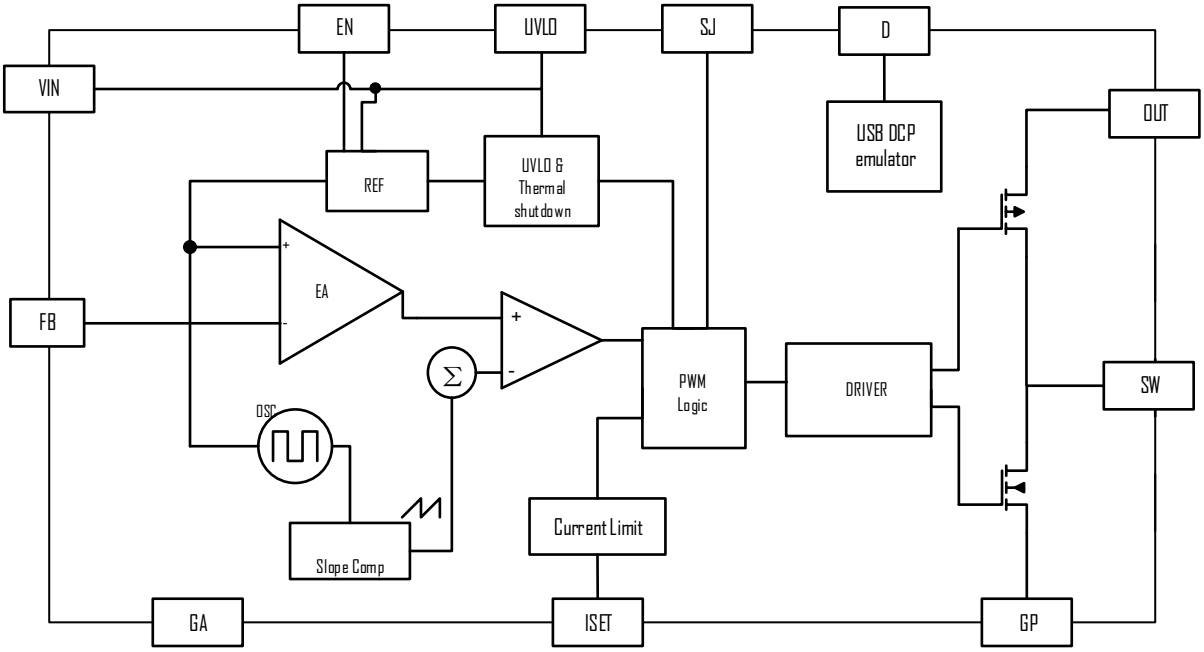


THERMAL CONSIDERATIONS

As the ETA1093 has a power MOSFET with internal current limit up to 6A, heat dissipation is always needed to be considered when designing the PCB for such high-power step-up converter. ETA1093 employs a package of QFN3x3-16 with only 10 ^{0}C/W thermal resistance from chip to its thermal pad. So it is crucial for one to lay a large area of copper (in most case, it is the large ground plane), directly contacting the thermal pad of the chip through more than 2 large vias from bottom, to spread the heat away to the ambient environment as fast as possible.

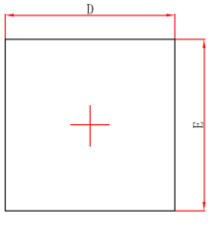
A thicker copper foil is always recommended to help the heat dissipation, so a PCB with 2oz copper thickness is a much better choice than that of 1oz copper.

BLOCK DIAGRAM

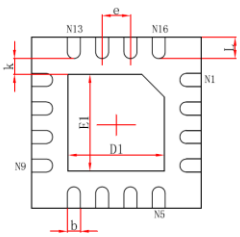


PACKAGE OUTLINE

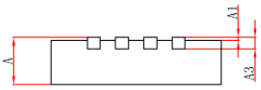
Package: QFN3x3-16



Top View



Bottom View



Side View

Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700/0.800	0.800/0.900	0.028/0.031	0.031/0.035
A1	0.000	0.050	0.000	0.002
A3	0.203REF.		0.008REF.	
D	2.924	3.076	0.115	0.121
E	2.924	3.076	0.115	0.121
D1	1.600	1.800	0.063	0.071
E1	1.600	1.800	0.063	0.071
k	0.200MIN.		0.008MIN.	
b	0.180	0.280	0.007	0.011
e	0.500TYP.		0.020TYP.	
L	0.324	0.476	0.013	0.019