2MHz, 3A Synchronous Step Down Converter

Features

- Two internal MOSFETs with typical Rds(on) of 50mΩ for high efficiency at 3A loads
- Switching frequency from 200kHz to 2MHz
- Voltage reference of 0.803V ± 1%
- Synchronizes to external clock from 300kHz to 2MHz
- Adjustable Slow Start/Sequencing
- UV and OV Power-Good Output
- Low Operating and Shutdown Quiescent Current
- Cycle-by-Cycle Current Limit, Thermal and Frequency Fold Back Protection
- RoHS-compliant and halogen-free (HF)

APPLICATIONS

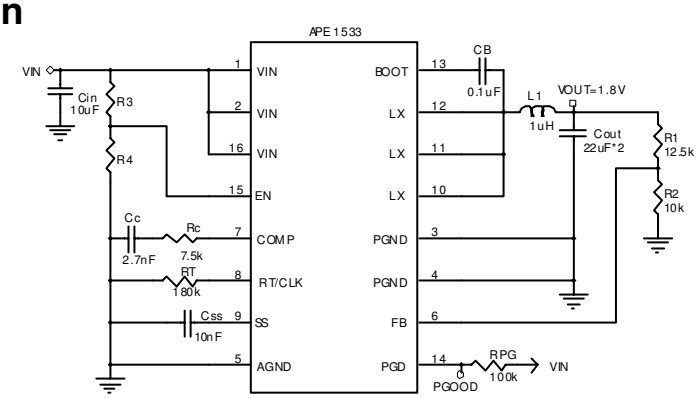
- DSPs, FPGAs, ASIC, and Microprocessors
- I/O Supplies
- System Power Supplies

Description

The APE1533 is a synchronous step-down converter with integrated MOSFETs. The current-mode PWM DC/DC converter reduces the external component count and the high switching frequency (up to 2MHz) allows the use of smaller inductors.

The APE1533 combination of integrated MOSFETs and 400uA operation current maximizes the efficiency. The highly accurate reference voltage (1%) over the temperature range provides for good load regulation. The soft start time is adjustable using an external resistor at the SS pin. The UVLO threshold is set at 2.6V internally and can be increased using an external resistor at the EN pin. The APE1533 also features frequency fold-back and thermal shutdown to protect the device against over-current fault conditions.

Typical Application



Ordering information

Example:

APE1533VN3-HF-3TR : in RoHS-compliant, halogen-free VQN3x3, shipped on tape and reel (3000 pcs/reel).

Absolute Maximum Ratings (at T_A = 25℃)

At the pin:

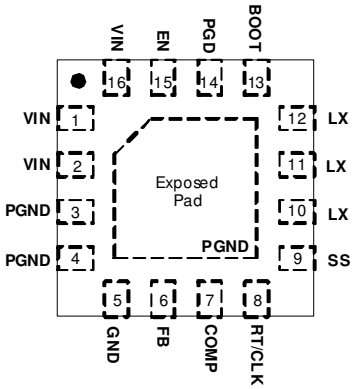
VIN	-0.3V to 6V
EN	-0.3V to 6V
LX	-0.3V to 6V
BOOT	LX+6V
RT/CLK	-0.3V to 6V
FB, SS	-0.3V to 6V
PGD	-0.3V to 6V
PGD Sink Current	10mA
GND, PGND	-0.3V to 0.3V
Storage Temperature Range (T_{ST})	-65 to +150℃
Junction Temperature (T_J)	150℃
Lead Temperature (Soldering, 10sec.)	260℃
Thermal Resistance from Junction to Ambient (Rth_{JA})	
QFN-16 (3mmX3mm)	60℃/W

RECOMMENDED OPERATING CONDITIONS

VIN	2.95V to 6V
EN	-0.3V to 6V
LX	-0.3V to 6V
Operating Temperature Range	-40℃ to 85℃

Pin Assignment

Top View
QFN 3x3-16L



Pin Functional Descriptions

PIN No.	PIN SYMBOL	PIN DESCRIPTION
1, 2, 16	VIN	Input supply voltage from 2.95V to 6V.
3, 4	PGND	Power ground.
5	GND	Analog ground.
6	FB	Output feedback pin.
7	COMP	Compensation pin. Connect frequency compensation components at this pin.
8	RT/CLK	Resistor timing or external clock input pin.
9	SS	Soft-start pin. Connect an external capacitor to adjust the output rise time.
10, 11, 12	LX	Switching node.
13	BOOT	Supply input for internal high-side N-MOSFET gate drive (boot terminal). Connect a bootstrap capacitor from this pin to LX node.
14	PGD	Power good output pin. PGD is an open-drain output. Pull up to VIN rail with a pull-up resistor.
15	EN	Enable pin, internal pull-up current source.
17	Exposed pad	Connect to power ground directly.

Electrical Characteristics

(V_{IN}=2.95 to 6V, T_A =25℃, unless otherwise specified)

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNIT
Input						
Operation Voltage Range	V_N		2.95		6	V
Under Voltage Lockout Threshold	UVLO	Rising		2.6	2.8	V
		hysteresis		200		mV
Quiescent Current	I_Q	V_{IN}=5V, V_{FB}=0.9V, RT=400kΩ		400		uA
Shutdown Current	I_{SD}	EN=0V, 0.95V≦VIN≦6V		3		uA
EN Threshold	V_{EN}	Rising		1.25		V
		Falling		1.18		V
EN Input Current	I_{EN}	V_{EN} + 50mV		-3.2		uA
		V_{EN} - 50mV		-0.65		uA
Reference Voltage	V_{FB}	VIN=2.95 to 6V	0.795	0.803	0.811	V
Controller						
High Side Switch Resistance (Note1)	R_{DRVH}	BOOT-LX=5V		50		mΩ
		BOOT-LX=2.95V		64		mΩ
Low Side Switch Resistance (Note1)	R_{DRVL}	V_{IN}=5V		50		mΩ
		V_{IN}=2.95V		64		mΩ
Switching Current Limit	I_{LM}		5			A
LX Rise/Fall Time (Note1)		V_{IN}=5V		1.5		V/ns
BOOT Charge Resistance		V_{IN}=5V		16		Ω
Error Amplifier						
COMP Leakage Current				7		nA
EA Transconductance (Note1)	gm	I_{COMP} = ± 2uA, V_{COMP}=1V		225		uA/V
COMP Sink/Source Current		V_{COMP}=1V, 0.1V overdrive		±20		uA
Current Sense to COMP Transconductance (Note1)	gm_{CS}			13		A/V

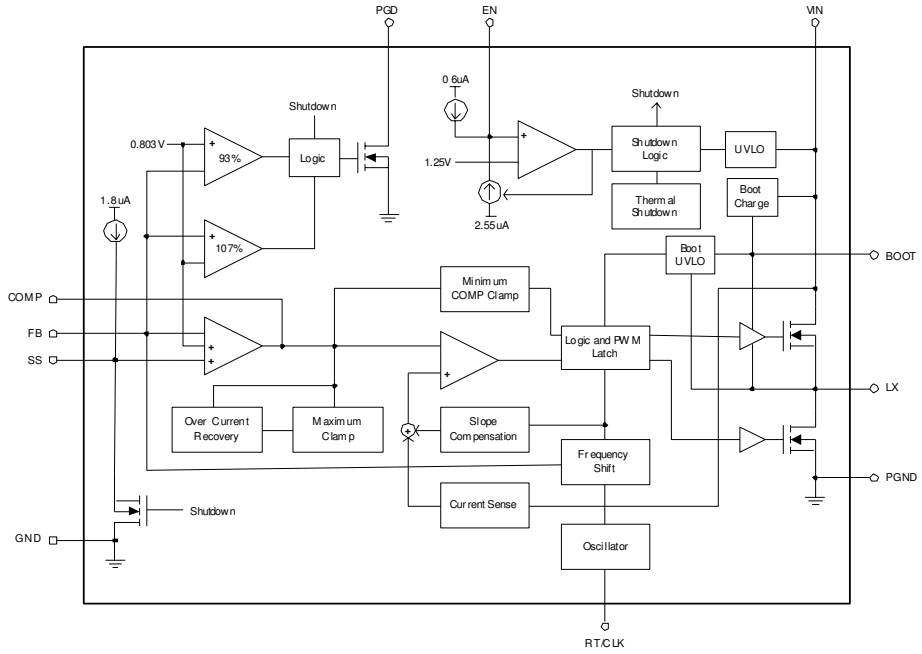
Electrical Characteristics

(T_A =25°C, unless otherwise specified)

PARAMETER	SYM	TEST CONDITION	MIN	TYP	MAX	UNIT
Resistor Timing and External Clock (RT/CLK)						
Switching Frequency Range		RT mode	200		2000	kHz
		CLK mode	300		2000	kHz
Switching Frequency	fsw	RT=400kΩ	400	500	600	kHz
Minimum CLK ON Time	T_{CLK_MIN}			75		ns
RT/CLK Voltage	$V_{RT/CLK}$	RT=400kΩ		0.5		V
RT/CLK Threshold		High		1.6	2.2	V
		Low	0.4	0.6		V
Delay Time (Note1)	t_D	RT/CLK falling to LX rising edge, fsw=500kHz, with RT resistor		150		ns
Soft Start (SS)						
SS Charge Current	I_{SS}	Vss=0.4V		1.8		uA
SS Discharge Current	I_{SS-D}	UVLO, EN, Tthermal fault, V_{IN}=5V, Vss=0.5V		1.25		mA
		Over-current, V_{FB}=0V		20		uA
Power Good (PGD)						
FB Threshold (Good)	V_{FB-R1}	Rising		93		$\%V_{FB}$
	V_{FB-F1}	Falling		105		$\%V_{FB}$
FB Threshold (Fault)	V_{FB-R2}	Rising		91		$\%V_{FB}$
	V_{FB-F2}	Falling		107		$\%V_{FB}$
PGD Leakage Current	I_{PGD}	V_{FB}=V_{REF}, V_{PGD}=5.5V		0.1		uA
PGD On Resistance (Note1)	R_{PGD}			10		Ω
PGD Output Low		I_{PGD}=3.5mA		0.3		V
Minimum VIN for Valid PGD Output		V_{PGD}<0.5V at 100uA		1.2		V
Thermal Shutdown						
Thermal Shutdown Threshold (Note1)	T_{SD}			175		°C
		Hysteresis		15		°C

Note1: Guarantee by design, not production tested.

Block Diagram



Typical Characteristics

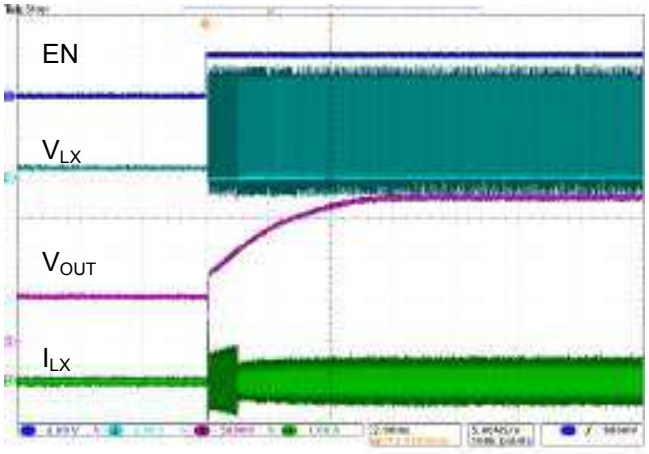


Fig.1 Enable, 1 √o/0A

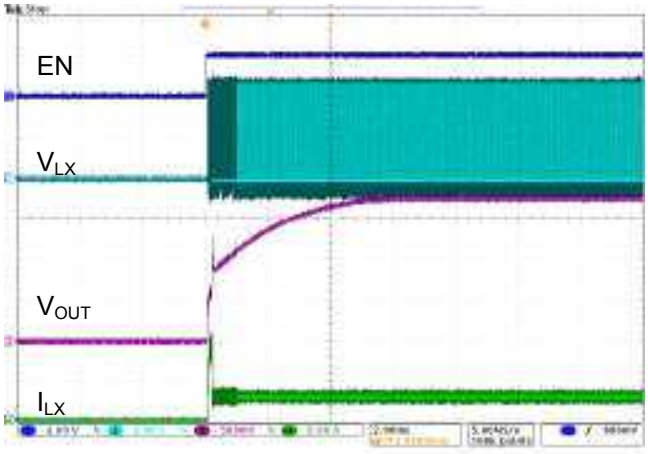


Fig.2 Enable, /i to 1.8Vo/3A

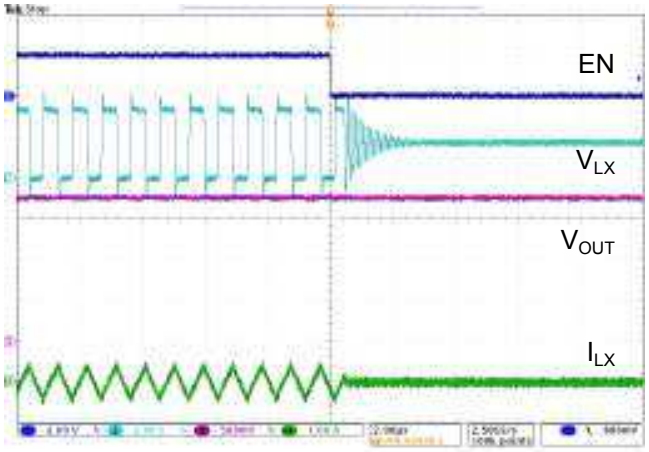


Fig.3 Disable, i Vo/0A

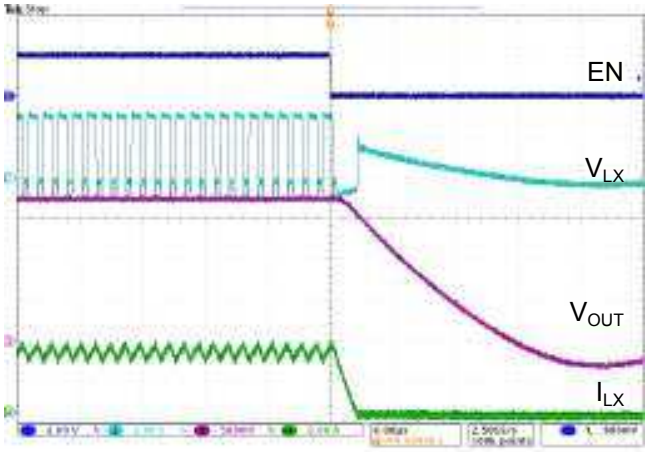


Fig.4 Disable, √i to 1.8Vo/3A

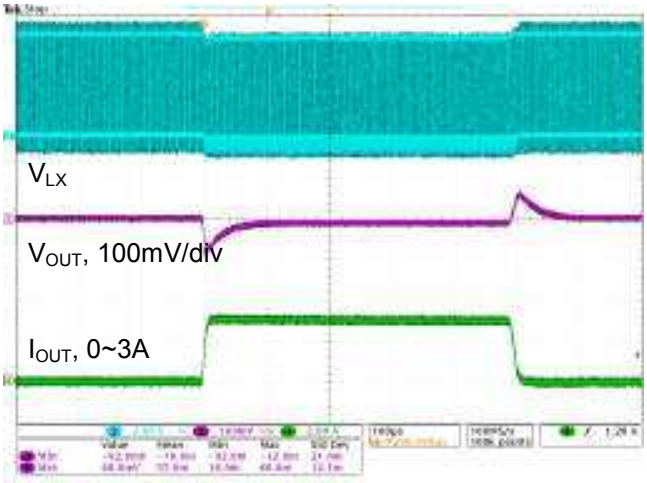


Fig.5 Load Transient, V, Vo=1.8V

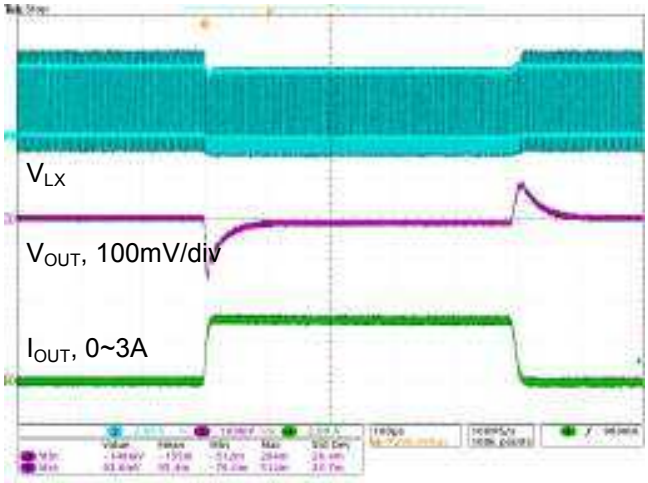


Fig.6 Load T , Vin=3.3V, Vo=1.8V

Typical Characteristics

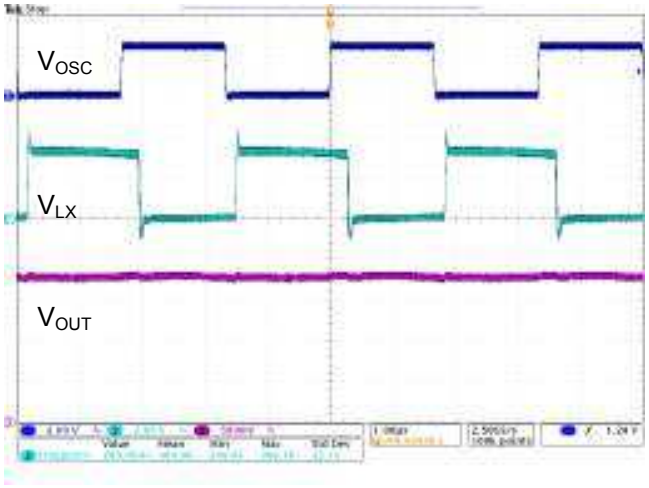


Fig.7 External PWM at RT pin, fosc=300kHz

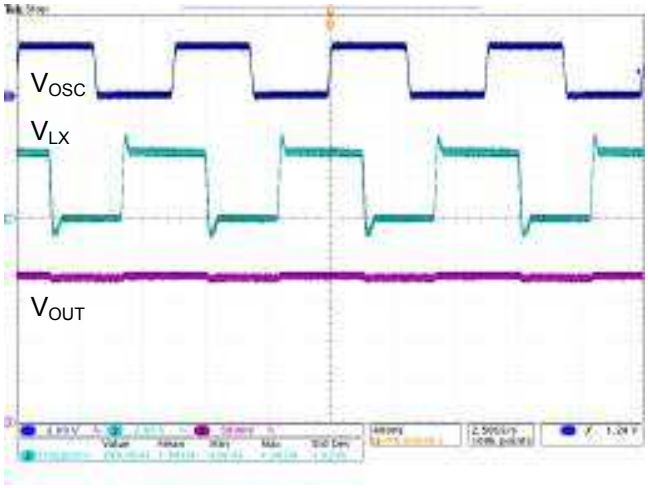


Fig.8 M a RT pin, fosc=1MHz

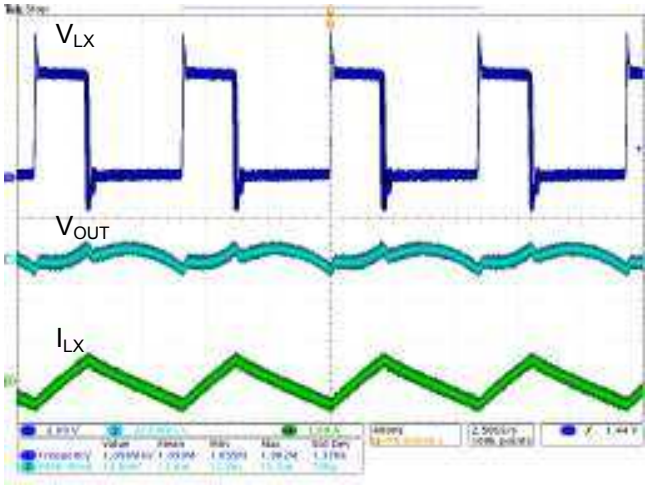


Fig.9 Output R =1.8V, Io=0A

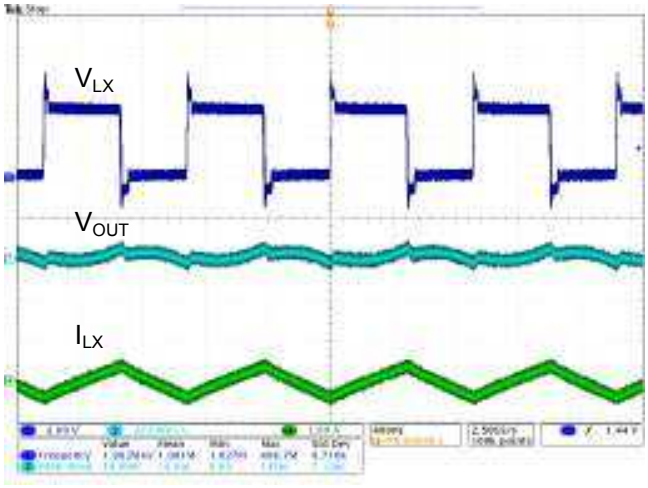


Fig.10 Output Ripple, =3.3V, Vo=1.8V, Io=0A

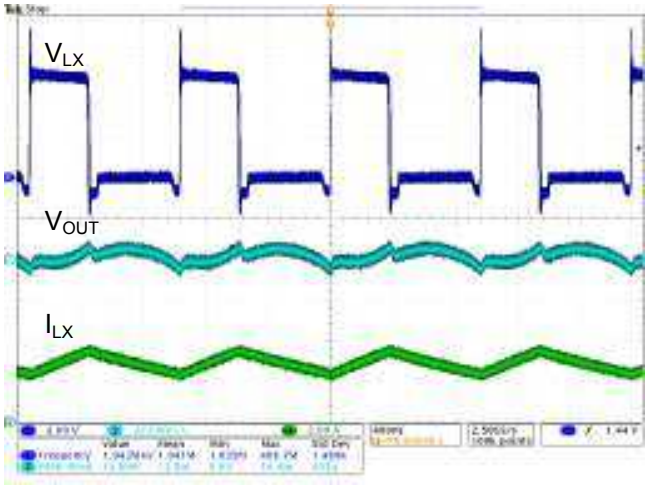


Fig.11 Output Ripple, i o=1.8V, Io=3A

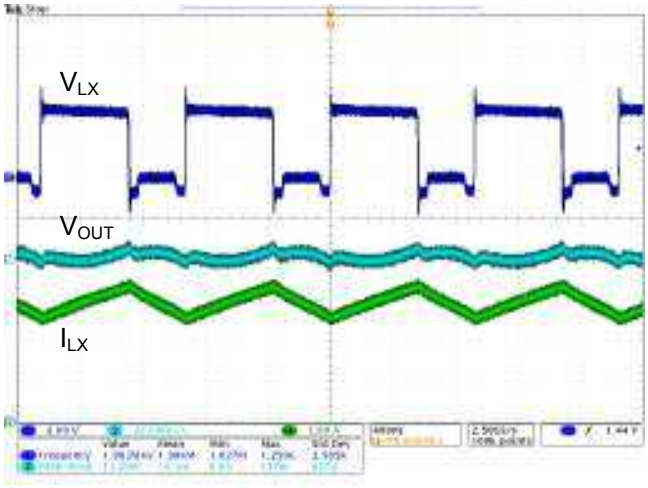


Fig.12 Output Ripple, =3.3V, Vo=1.8V, Io=3A

Typical Characteristics

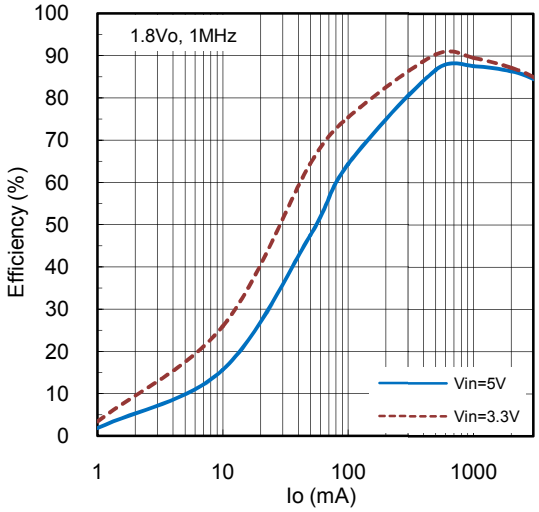


Fig.13 Efficiency =1.8V

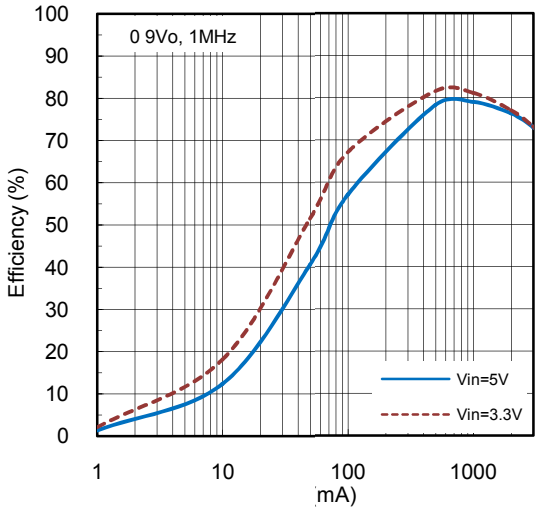


Fig.14 :y for Vo=0.9

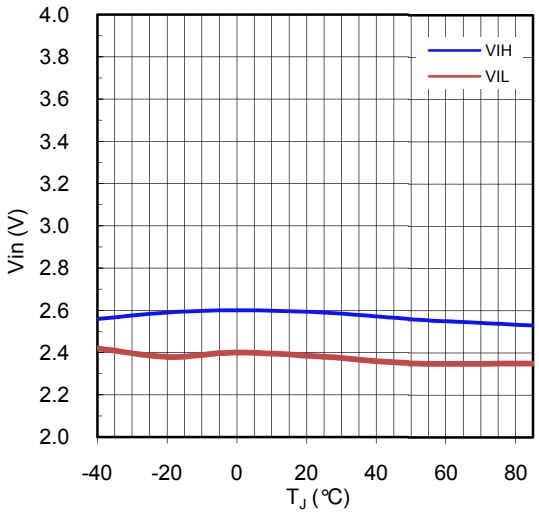


Fig.15 UVLO Threshold vs. Temperature

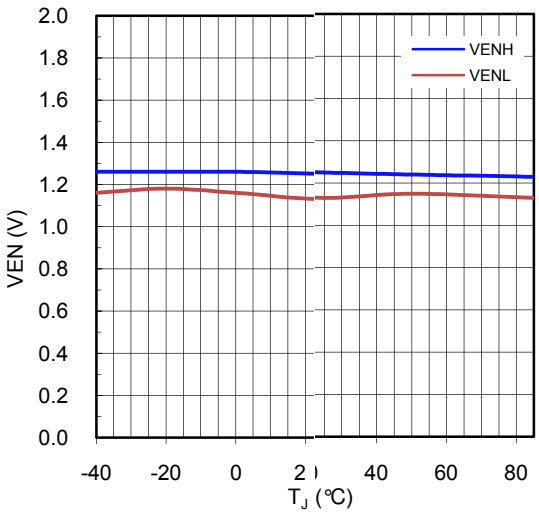


Fig.16 EN T d vs. Temperature

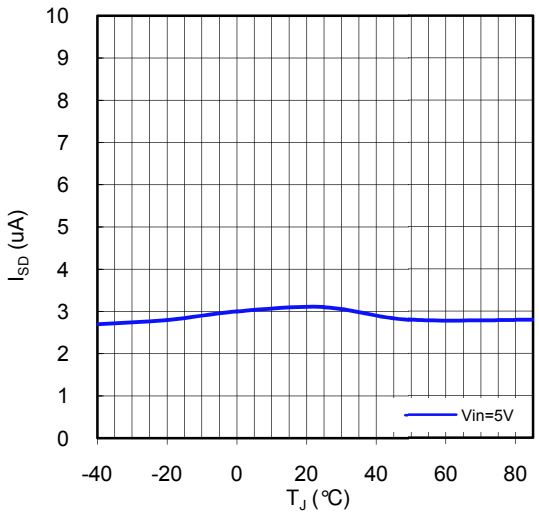


Fig.17 Shutdown Current vs. Temperature

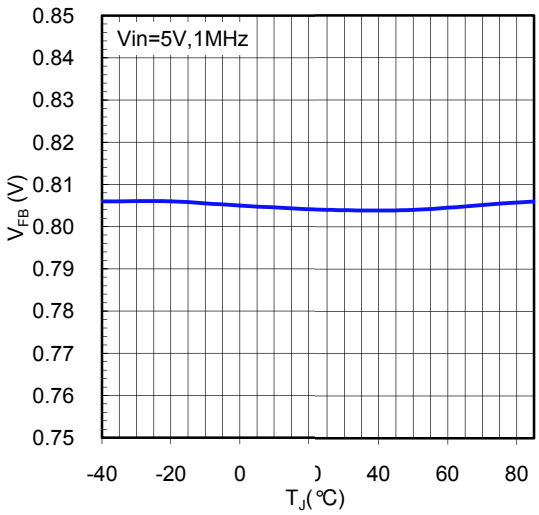
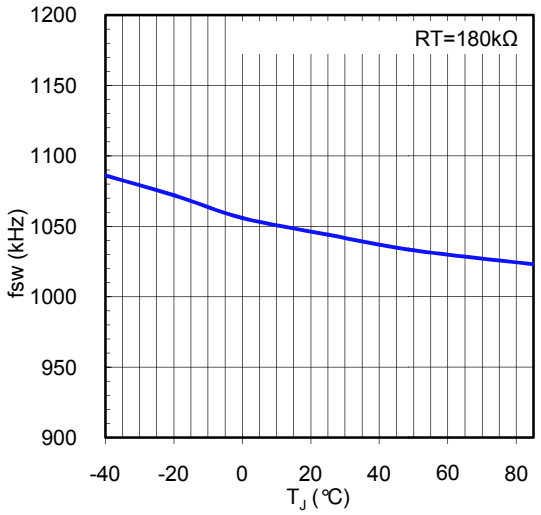


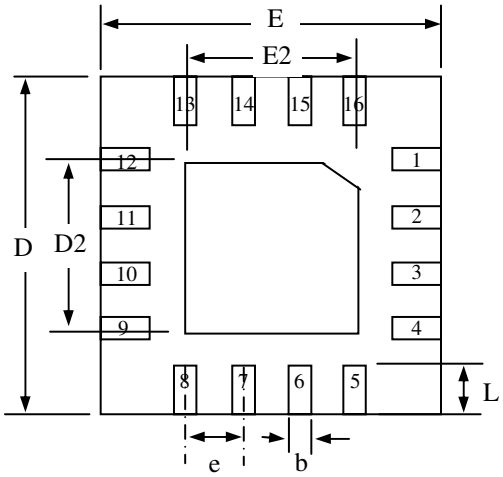
Fig.18 Feedback Voltage vs. Temperature

Typical Characteristics

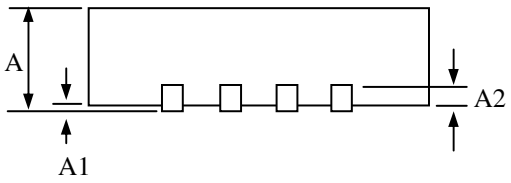


e y Temperature

Package Dimensions: VQN3x3-16



BOTTOM VIEW



SYMBOLS	Millimeters		
	MIN	NOM	MAX
A	0.75	0.85	1.00
A1	0.00	0.02	0.05
A2	0.175	0.200	0.250
b	0.18	0.23	0.30
D	2.95	3.00	3.05
D2	1.50	1.55	1.60
E	2.95	3.00	3.05
E2	1.50	1.55	1.60
e	0.50 (ref.)		
L	0.35	0.40	0.45

1. All dimensions are in millimeters.
2. Dimensions do not include mold protrusions.

Marking Information: