MPQ8636A-10

High Efficiency, 10A, 18V Synchronous, Step-Down Converter

The Future of Analog IC Technology

DESCRIPTION

The MPQ8636A-10 is a fully-integrated, high-frequency, synchronous, rectified, step-down, switch-mode converter. It offers a very compact solution to achieve 10A output current over a wide input supply range, with excellent load and line regulation. The MPQ8636A-10 operates at high efficiency over a wide output-current–load range.

The MPQ8636A-10 uses Constant-On-Time (COT) control to provide a fast transient response and ease loop stabilization.

An external resistor programs the operating frequency from 200kHz to 1MHz, and the frequency keeps nearly constant as input supply varies with the feed-forward compensation.

The default under-voltage lockout threshold is internally set at 4.1V, but a resistor network on the enable pin can increase this threshold. The soft-start pin controls the output-voltage startup ramp. An open-drain power-good signal indicates that the output is within nominal voltage range.

It has fully-integrated protection features that include over-current protection, over-voltage protection and thermal shutdown.

The MPQ8636A-10 requires a minimal number of readily-available standard external components and is available in a 16-Pin QFN 3mm×4mm package.

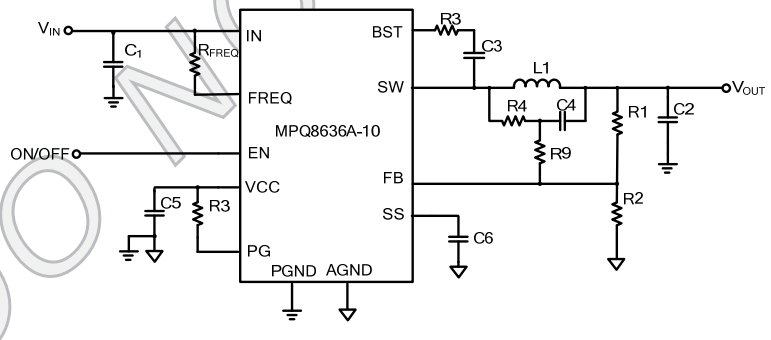
FEATURES

- Wide 4.5V-to-18V Operating Input Range
- 10A Output Current
- Optimal Low R_{DS}(ON) Internal Power MOSFETs Per Device
- Proprietary Switching-Loss–Reduction Technique
- Adaptive COT for Ultrafast Transient Response
- 0.5% Reference Voltage Over 0°C to 70°C Junction Temperature Range
- Programmable Soft-Start Time
- Pre-Bias Start-Up
- Programmable Switching Frequency from 200kHz to 1MHz
- OCP, OVP and Thermal Shutdown
- Output Adjustable from 0.611V to 13V

APPLICATIONS

- Telecom and Networking Systems
- Base Stations
- Servers
- Personal Video Recorders
- Flat-Panel Televisions and Monitors
- Distributed Power Systems

TYPICAL APPLICATION



ORDERING INFORMATION

Part Number	Package	Top Marking
MPQ8636AGLE-10*	QFN-16(3mmx4mm)	See Below

* For Tape & Reel, add suffix –Z (e.g. MPQ8636AGLE-10–Z):

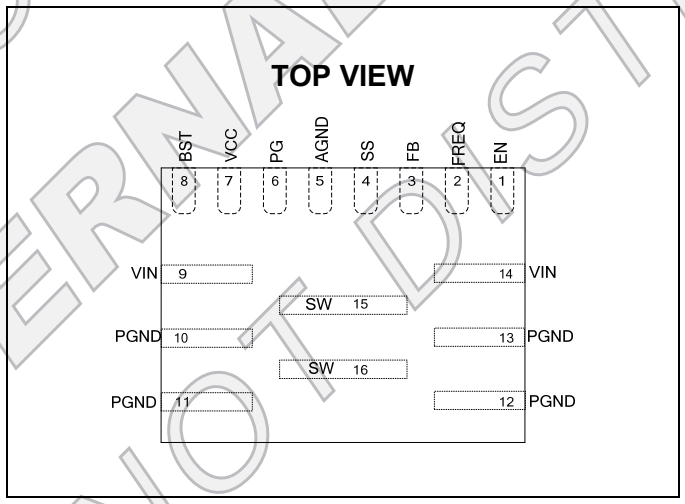
TOP MARKING

MPYW
8636
ALLL
E10

MP: MPS prefix;
Y: year code;
W: week code:
8636: first four digits of the part number;
A: fifth digit of the part number;
LLL: lot number;
E: package type suffix;
10: part no, suffix

PACKAGE REFERENCE

TOP VIEW



ABSOLUTE MAXIMUM RATINGS (1)

Supply Voltage V_{IN} 21V
V_{SW} ..... -0.3V to V_{IN} + 0.3V
V_{SW} (30ns) ..... -3V to V_{IN} + 3V
V_{BST} ..... V_{SW} + 6V
V_{BST} (30ns) ..... V_{SW} + 6.5V
Enable Current I_{EN} (2) 2.5mA
All Other Pins ..... –0.3V to +6V
Continuous Power Dissipation (T_A=+25°) (3)
QFN3X4 ..... 2.7W
Junction Temperature ..... 150°C
Lead Temperature ..... 260°C
Storage Temperature ..... -65°C to +150°C

Recommended Operating Conditions (4)

Supply Voltage V_{IN} ..... 4.5V to 18V
Output Voltage V_{OUT} ..... 0.611V to 13V
Enable Current I_{EN} 1mA
Operating Junction Temp. (T_J). -40°C to +125°C

Thermal Resistance (5)

	θ_{JA}	θ_{JC}	
QFN-16 (3mmx4mm)	46	9	°C/W

Notes:

1) Exceeding these ratings may damage the device.
2) Refer to the section “Configuring the EN Control”.
3) The maximum allowable power dissipation is a function of the maximum junction temperature T_J(MAX), the junction-to-ambient thermal resistance θ_{JA}, and the ambient temperature T_A. The maximum allowable continuous power dissipation at any ambient temperature is calculated by $P_D(MAX)=(T_J(MAX)-T_A)/\theta_{JA}$. Exceeding the maximum allowable power dissipation will cause excessive die temperature, and the regulator will go into thermal shutdown. Internal thermal shutdown circuitry protects the device from permanent damage.
4) The device is not guaranteed to function outside of its operating conditions.
5) Measured on JESD51-7, 4-layer PCB.

ELECTRICAL CHARACTERISTICS

V_{IN} = 12V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
Supply Current						
Supply Current (Shutdown)	I_{IN}	V_{EN} = 0V		0	1	μA
Supply Current (Quiescent)	I_{IN}	V_{EN} = 2V, V_{FB} = 1V	700	860	1000	μA
MOSFET						
High-Side Switch-On Resistance	HS_{RDS-ON}			19.6		mΩ
Low-Side Switch-On Resistance	LS_{RDS-ON}			7.8		mΩ
Switch Leakage	SW_{LKG}	V_{EN} = 0V, V_{SW} = 0V or 12V		0	10	μA
Current Limit						
High-Side Peak Current Limit	I_{LIMIT_PEAK}		13	17.3	21.6	A
Low-Side Valley Current Limit(6)	I_{LIMIT_VALLEY}		9.5	11	12.5	A
Low-Side Negative Current Limit(6)	$I_{LIMIT\_NEGATIVE}$		-6.5	-5	-4.5	A
Timer						
One-Shot ON Time	T_{ON}	R_{FREQ}=453kΩ, V_{OUT}=1.2V		250		ns
Minimum On Time(6)	T_{ON_MIN}		20	30	40	ns
Minimum OFF Time(6)	T_{OFF_MIN}		50	100	150	ns
Over-Voltage and Under-Voltage Protection						
OVP Latch Threshold(6)	V_{OVP_LATCH}		127%	130%	133%	V_{FB}
UVP Threshold(6)	V_{UVP}		47%	50%	53%	V_{FB}
Reference and Soft Start						
Reference Voltage	V_{REF}	T_J = 0°C to +70°C	608	611	614	mV
		T_J = 0°C to +125°C	605	611	617	mV
		T_J = -40°C to +125°C	602	611	620	mV

ELECTRICAL CHARACTERISTICS *(continued)*

V_{IN} = 12V, T_J = -40°C to +125°C, unless otherwise noted.

Parameters	Symbol	Condition	Min	Typ	Max	Units
Feedback Current	I_{FB}	V_{FB} = 611mV		50	100	nA
Soft Start Charging Current	I_{SS}	V_{SS}=0V	16	20	25	µA
Enable And UVLO						
Enable Input, Low Voltage	VIL_{EN}		1.1	1.3	1.5	V
Enable, Hysteresis	V_{EN-HYS}			250		mV
Enable, Input Current	I_{EN}	V_{EN} = 2V		0		µA
		V_{EN} = 0V		0		
VCC Regulator						
VCC Under-Voltage Lockout, Threshold Rising	VCC_{Vth}			4.0		V
VCC Under-Voltage Lockout, Threshold Hysteresis	VCC_{HYS}			500		mV
VCC Regulator	VCC			5.0		V
VCC Load Regulation		Icc=5mA		0.5		%
Power-Good						
Power-Good, Rising Threshold	PG_{Vth-Hi}		87%	91%	94%	V_{FB}
Power-Good, Falling Threshold	PG_{Vth-Lo}			80%		V_{FB}
Power-Good, Low-to High-Delay	PG_{Td}			2.5		ms
Power Good, Sink Current Capability	I_{OL}	V_{OL}=600mA			12	mA
Power Good, Leakage Current	I_{PG_LEAK}	V_{PG} = 3.3V		10		nA
Thermal Protection						
Thermal Shutdown(6)	T_{SD}		150			°C
Thermal Shutdown, Hysteresis				25		°C

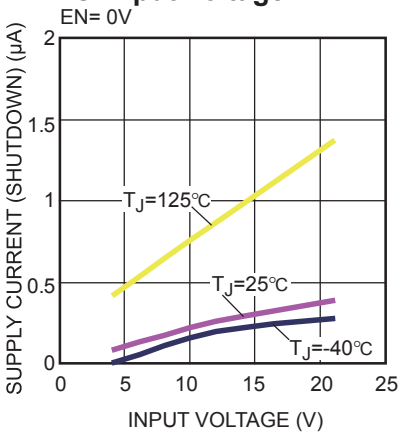
Note:

6) Guaranteed by design.

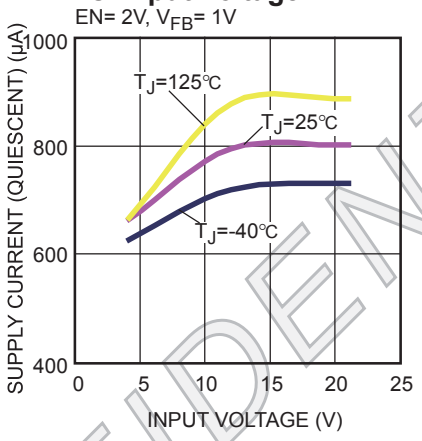
TYPICAL CHARACTERISTICS

MPQ8636A-10, V_{IN} = 12V, V_{OUT} = 1V, L = 1µH, T_A = 25°C, unless otherwise noted.

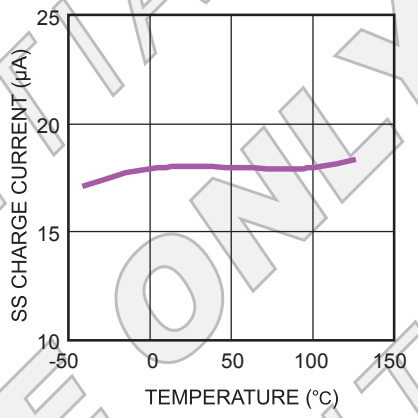
Supply Current (Shutdown) vs. Input Voltage



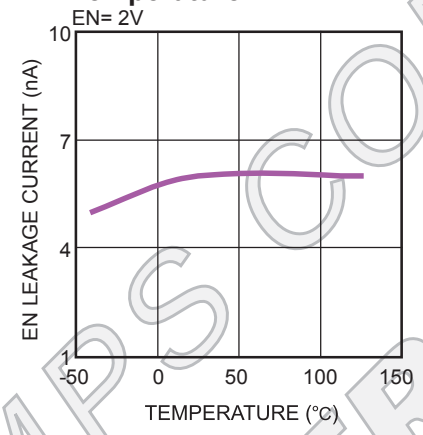
Supply Current (Quiescent) vs. Input Voltage



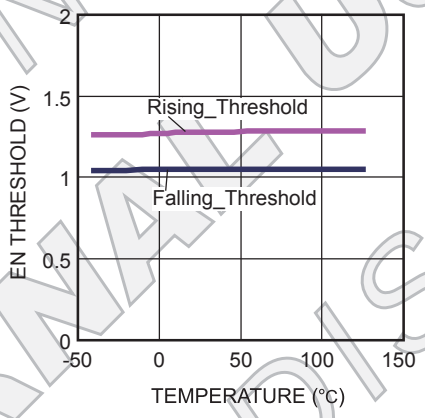
SS Charge Current vs. Temperature



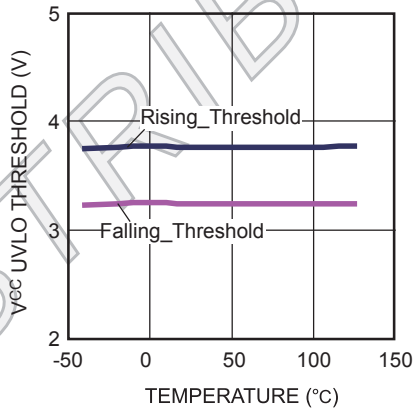
EN Leakage Current vs. Temperature



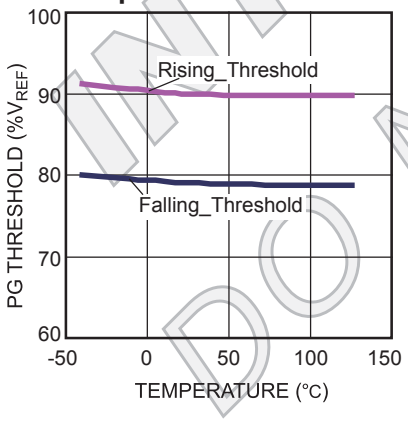
EN Threshold vs. Temperature



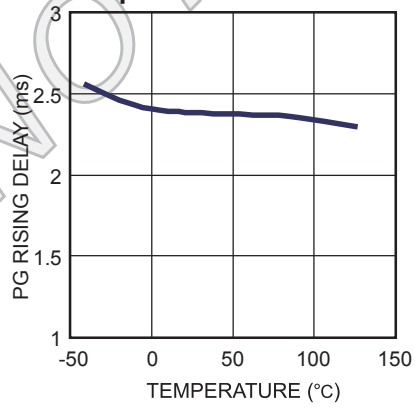
V_{CC} UVLO Threshold vs. Temperature



PG Threshold vs. Temperature



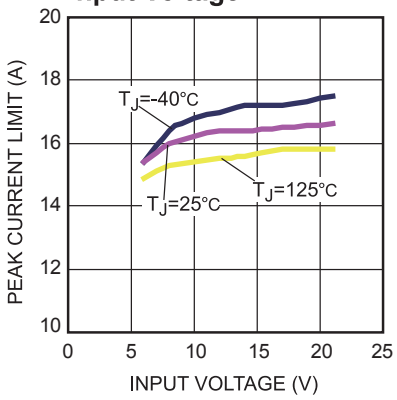
PG Rising Delay vs. Temperature



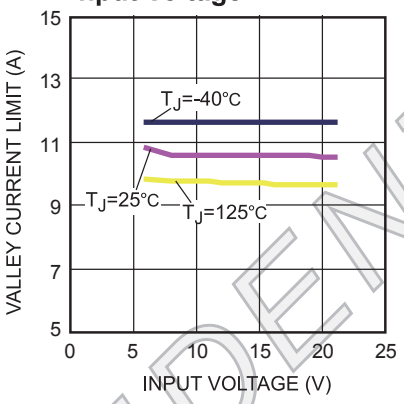
TYPICAL CHARACTERISTICS *(continued)*

MPQ8636A-10, V_{IN} = 12V, V_{OUT} = 1V, L = 1µH, T_A = 25°C, unless otherwise noted.

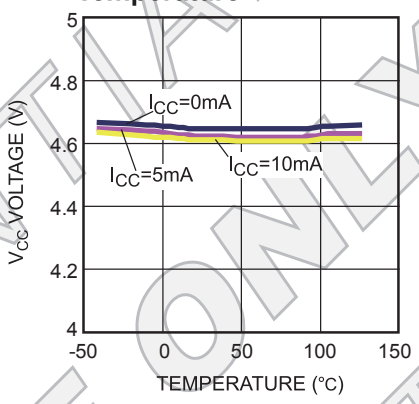
Peak Current Limit vs. Input Voltage



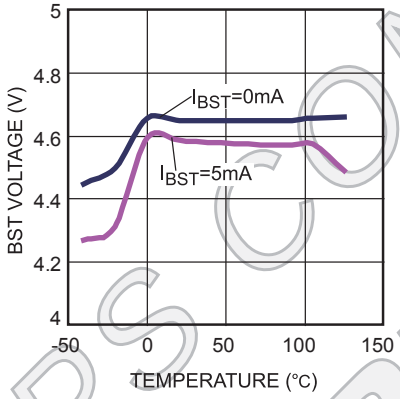
Valley Current Limit vs. Input Voltage



V_{CC} Voltage vs. Temperature

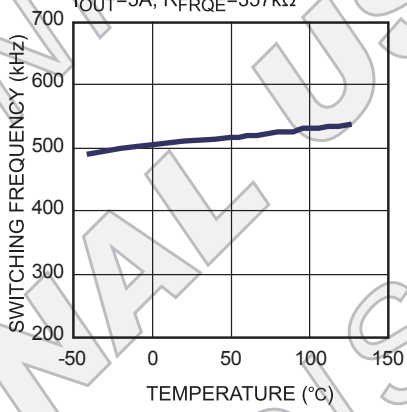


BST Voltage vs. Temperature

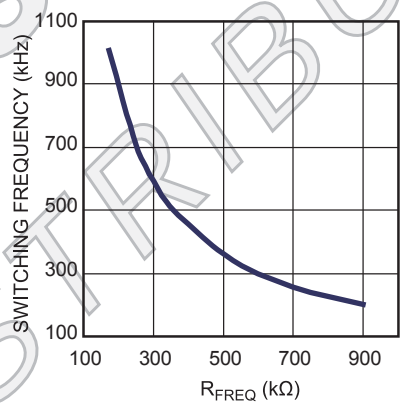


Switching Frequency vs. Temperature

I_{OUT}=5A, R_{FRQE}=357kΩ

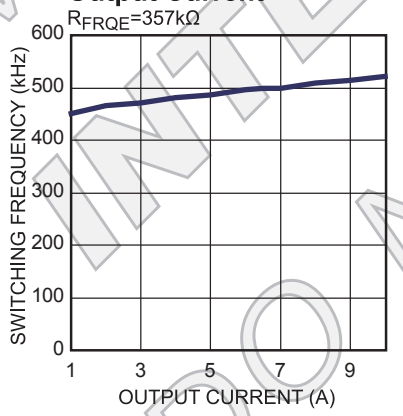


Switching Frequency vs. R_{FREQ}



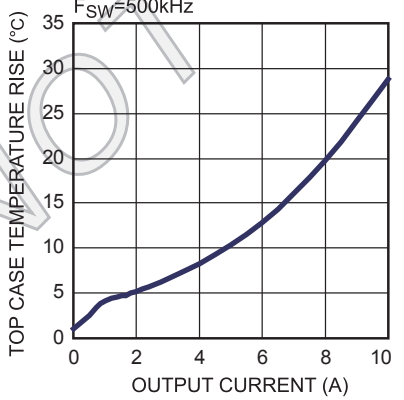
Switching Frequency vs. Output Current

R_{FRQE}=357kΩ



Case Temperature Rise vs. Output Current

F_{SW}=500kHz

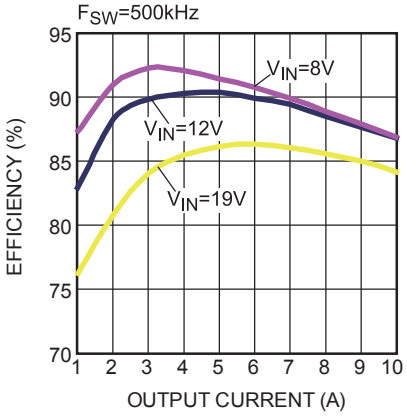


TYPICAL PERFORMANCE CHARACTERISTICS

MPQ8636A-10, V_{IN} = 12V, V_{OUT} = 1V, L = 1µH, T_A = 25°C, unless otherwise noted.

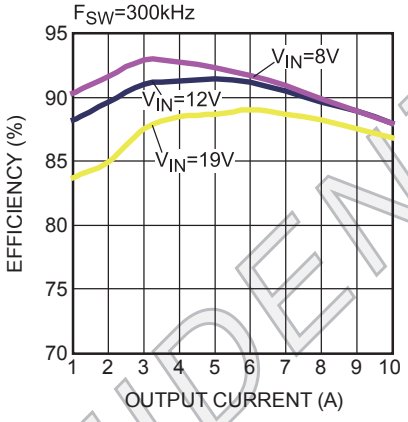
Efficiency vs. Output Current

F_{SW}=500kHz



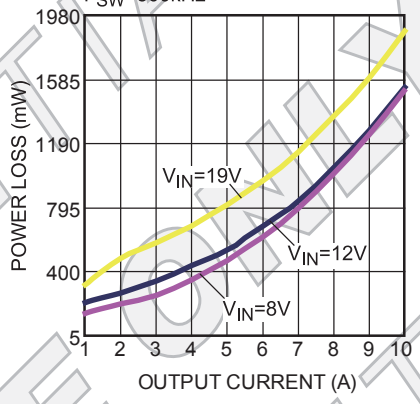
Efficiency vs. Output Current

F_{SW}=300kHz



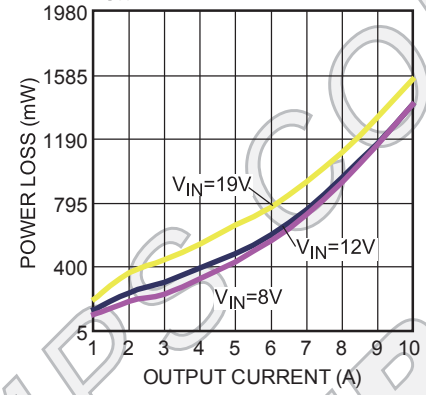
Power Loss vs. Output Current

F_{SW}=500kHz



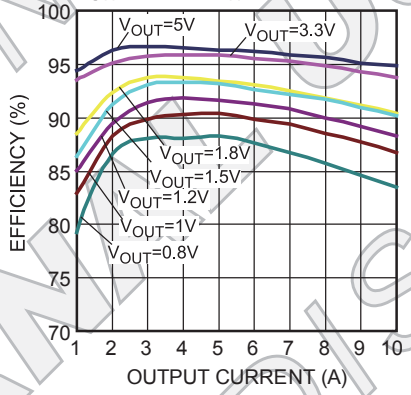
Power Loss vs. Output Current

F_{SW}=300kHz

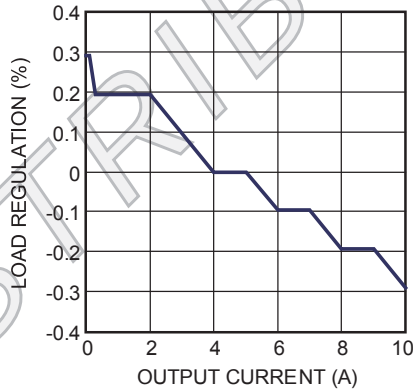


Efficiency vs. Output Current

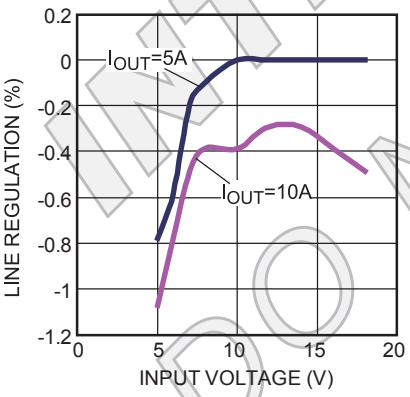
F_{SW}=500kHz, V_{IN}=12V



Load Regulation vs. Output Current



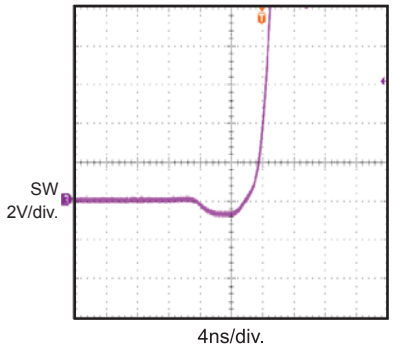
Line Regulation vs. Input Voltage



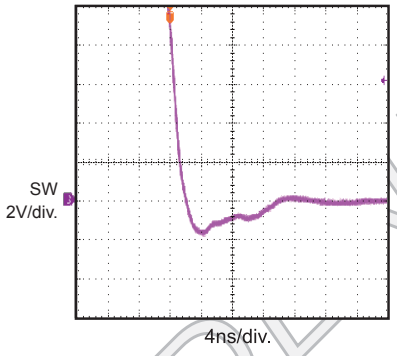
TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

MPQ8636A-10, V_{IN}=12V, V_{OUT} =1V, L=1µH, T_A=+25°C, unless otherwise noted.

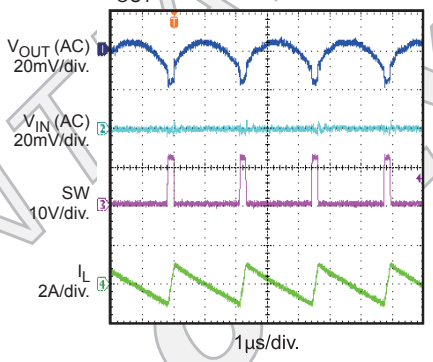
Dead Time (on)
I_{OUT} = 10A



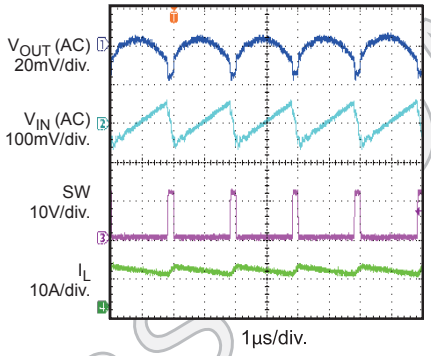
Dead Time (off)
I_{OUT} = 10A



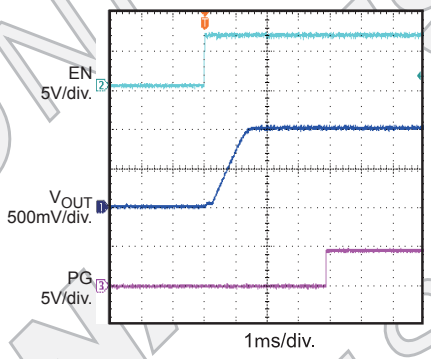
Input/Output Voltage Ripple
I_{OUT} = 0A



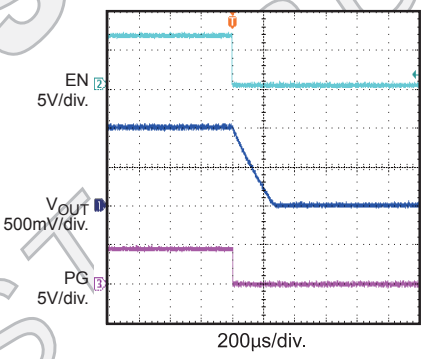
Input/Output Voltage Ripple
I_{OUT} = 10A



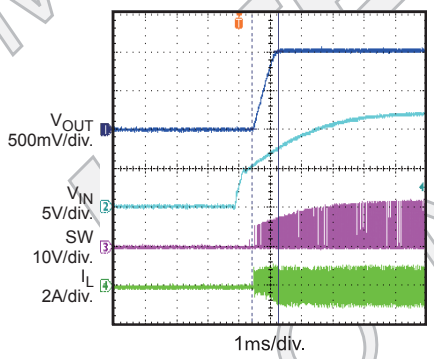
Power Good through EN Start Up
I_{OUT} = 0.5A, C_{SS} = 33nF,



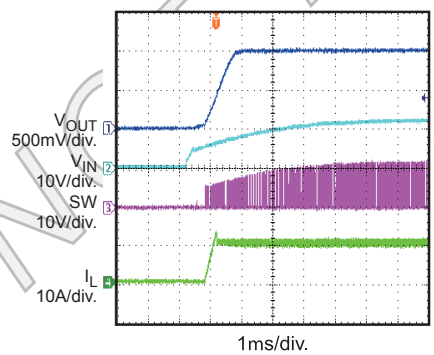
Power Good through EN Shutdown
I_{OUT} = 0.5A, C_{SS} = 33nF,



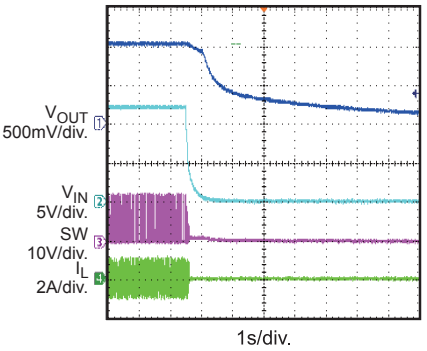
Start Up Through V_{IN}
I_{OUT} = 0A



Start Up Through V_{IN}
I_{OUT} = 10A



Shutdown Through V_{IN}
I_{OUT} = 0A

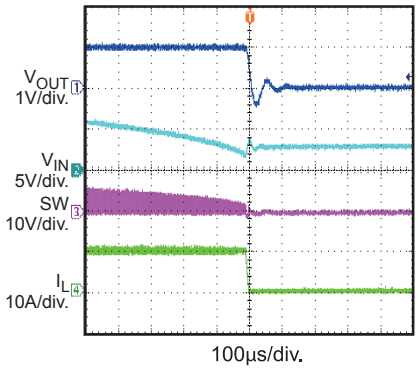


TYPICAL PERFORMANCE CHARACTERISTICS *(continued)*

MPQ8636AGLE-10, V_{IN}=12V, V_{OUT} =1V, L=1µH, T_A=+25°C, unless otherwise noted.

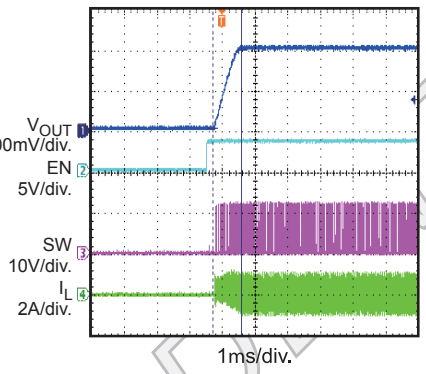
Shutdown Through V_{IN}

I_{OUT} = 10A



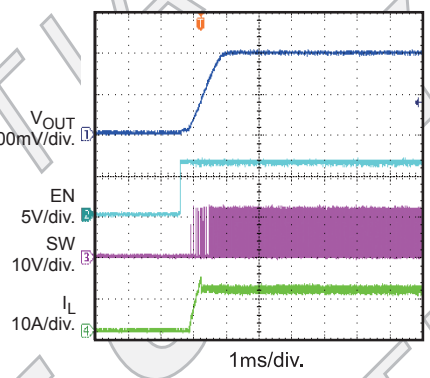
Start up through EN

I_{OUT} = 0A



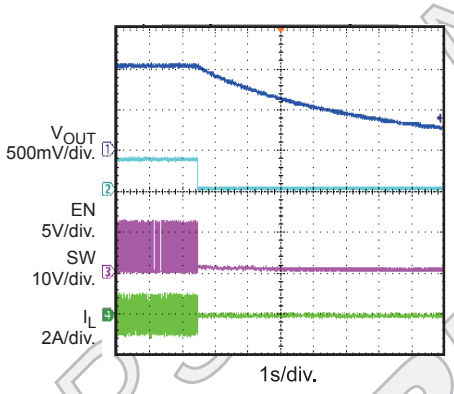
Start up through EN

I_{OUT} = 10A



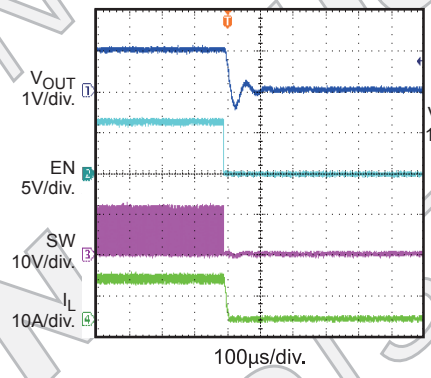
Shutdown Through EN

I_{OUT} = 0A



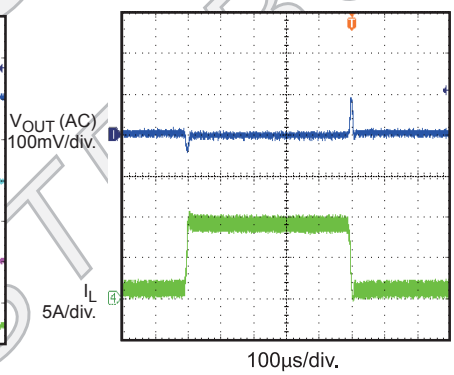
Shutdown Through EN

I_{OUT} = 10A



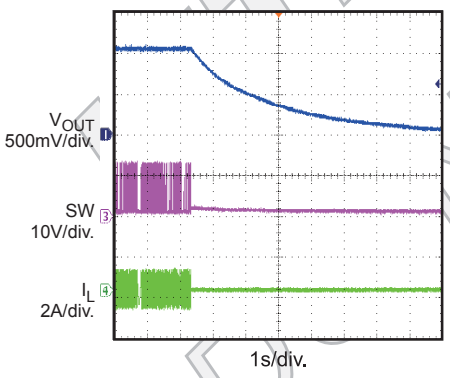
Transient

I_{OUT} = 1-9A @1.6A/µs,
F_{SW}=500kHz, C_{OUT}=3×22µF



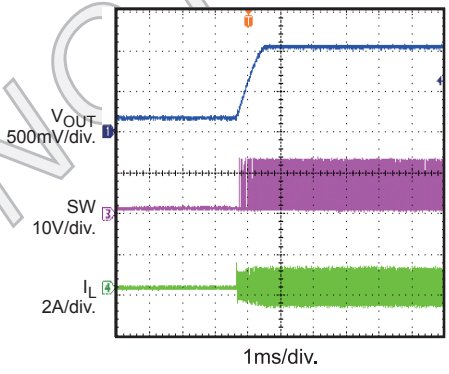
Thermal Shutdown

I_{OUT} = 0A



Thermal Recovery

I_{OUT} = 0A



PIN FUNCTIONS

PIN #	Name	Description
1	EN	Enable. Digital input that turns the regulator on or off. Drive EN high to turn on the regulator; drive it low to turn it off. Connect EN to IN through a pull-up resistor or a resistive voltage divider for automatic startup. Do not float this pin.
2	FREQ	Frequency Set. Require a resistor connected between FREQ and IN to set the switching frequency. The input voltage and the resistor connected to the FREQ pin determine the ON time. The connection to the IN pin provides line feed-forward and stabilizes the frequency during input voltage's variation.
3	FB	Feedback. Connect to the tap of an external resistor divider from the output to GND to set the output voltage. FB is also configured to realize over-voltage protection (OVP) by monitoring output voltage. MPQ8636A-10 provide Latch-OFF OVP mode. Please refer to the section "Over-Voltage-Protection (OVP)". Place the resistor divider as close to FB pin as possible. Avoid using vias on the FB traces.
4	SS	Soft-Start. Connect an external capacitor to program the soft start time for the switch mode regulator.
5	AGND	Analog Ground. The control circuit reference.
6	PG	Power-Good. The output is an open drain signal. Requires a pull-up resistor to a DC voltage to indicate HIGH if the output voltage exceeds 91% of the nominal voltage. There is a delay from FB ≥ 91% to when PG goes high.
7	VCC	Internal 5V LDO Output. Powers the driver and control circuits. Decouple with a ≥1μF ceramic capacitor as close to the pin as possible. For best results, use X7R or X5R dielectric ceramic capacitors for their stable temperature characteristics.
8	BST	Bootstrap. Require a capacitor connected between SW and BST pins to form a floating supply across the high-side switch driver.
9, 14	IN	Supply Voltage. Supplies power to the internal MOSFET and regulator. The MPQ8636A-10 operates from a 4.5V-to-18V input rail. Requires an input decoupling capacitor. Connect using wide PCB traces and multiple vias.
10, 11, 12, 13	PGND	System Ground. Reference ground of the regulated output voltage. PCB layout requires extra care. Connect using wide PCB traces.
15, 16	SW	Switch Output. Connect to the inductor and bootstrap capacitor. The high-side switch drives the pin up to the V_{IN} during the PWM duty cycle's ON time. The inductor current drives the SW pin negative during the OFF-time. The low-side switch's ON-resistance and the internal Schottky diode clamp the negative voltage. Connect using wide PCB traces.

BLOCK DIAGRAM

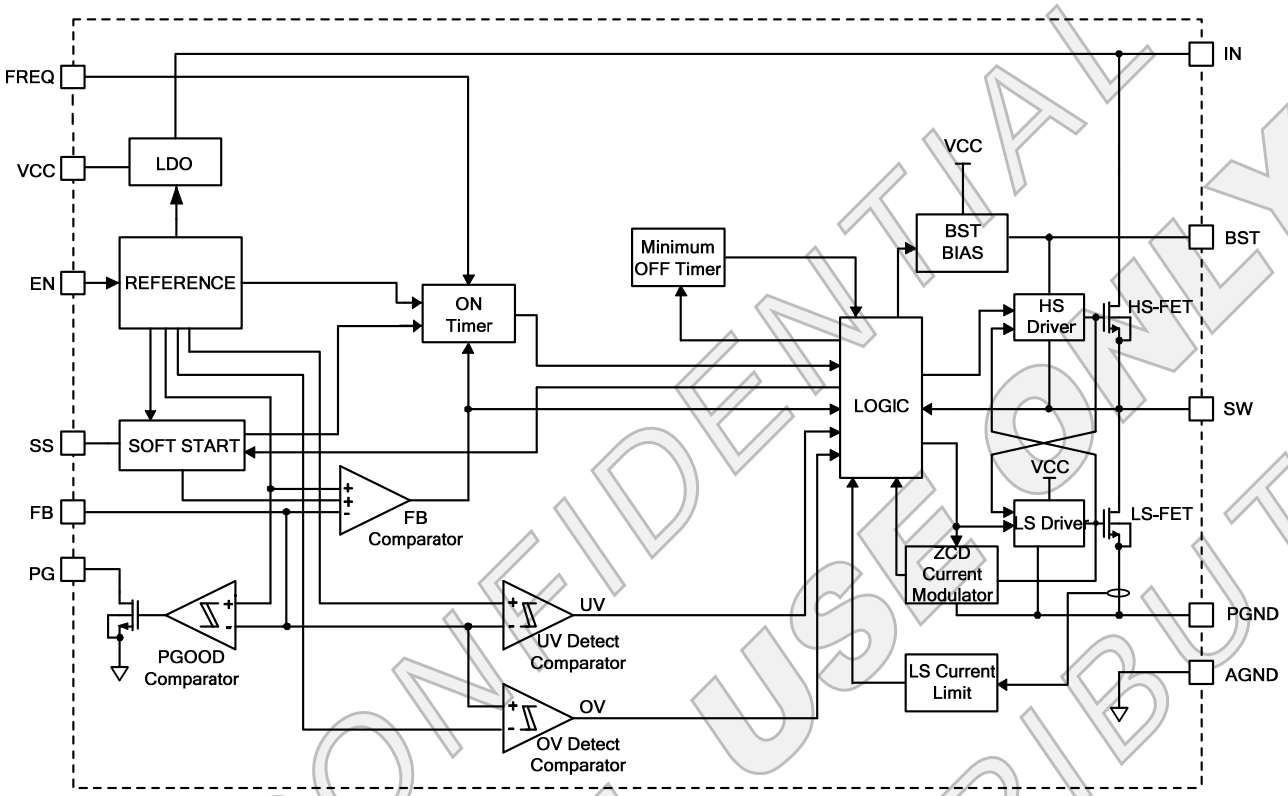


Figure 1— Functional Block Diagram