Texas Instruments

Technology for Innovators™

Reference Design Cookbook

Power Management Products

3Q 2005

Welcome

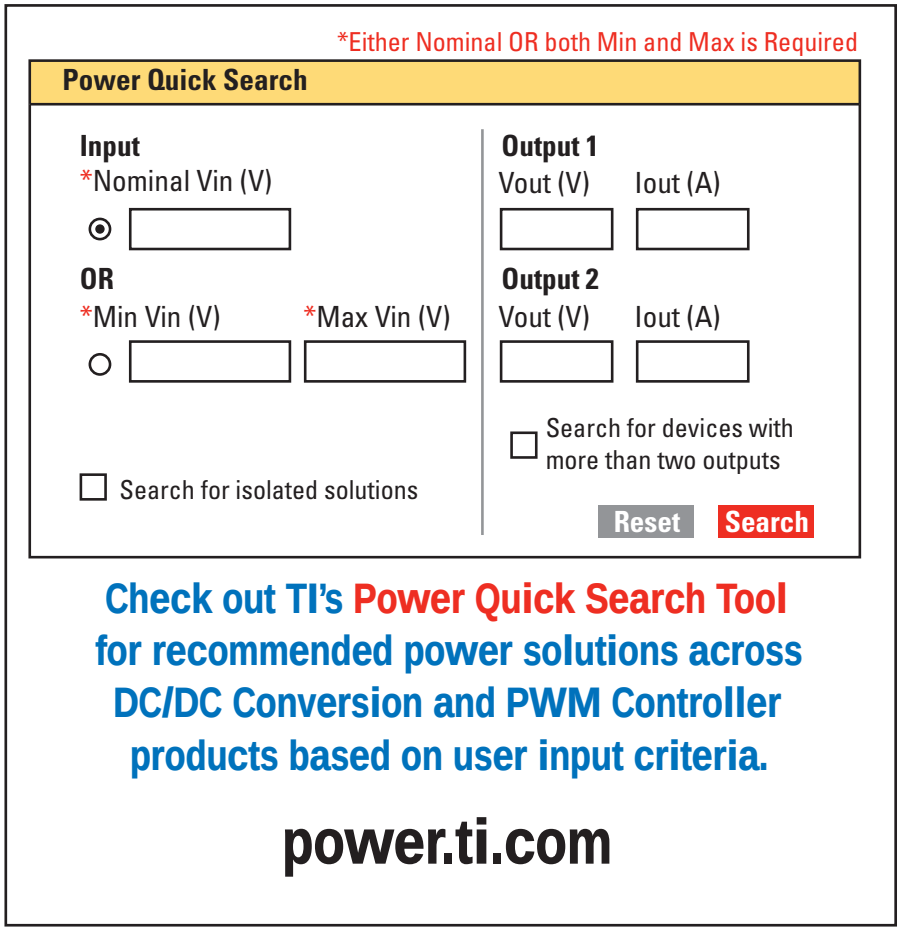
Welcome to TI's first Power Management Cookbook. Many thanks to Robert Kollman and his Design Services Team and TI Applications Engineering for supplying this collection of complete power solutions and design documentation from TI's extensive library of reference designs and evaluation modules (EVMs) available to our customers.

TI also has many other reference designs that can be found at: **www.ti.com/powerreferencedesigns**. If you do not find what you are looking for in this booklet, please check this website. It is frequently updated with new circuits.

TI hopes that this Cookbook will help to simplify and streamline your power supply designs.

Enjoy!

Power Quick Search Tool



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Inside

TI also has many other reference designs that can be found at:

www.ti.com/powerreferencedesigns

Description

The TPS6222x family of synchronous buck converters with integrated FETs in ThinSOT-23 can provide up to 400 mA of output current from inputs as low as 2.5 V. The circuit below was configured to provide 1.8 V at 400 mA with a 4.7-µH inductor and 10-µF output capacitor. The TPS6222x achieves high efficiency over the entire load current range by switching from traditional pulse width modulation (PWM) at high load to pulsed frequency modulation (PFM or Power Save Mode) at light load.

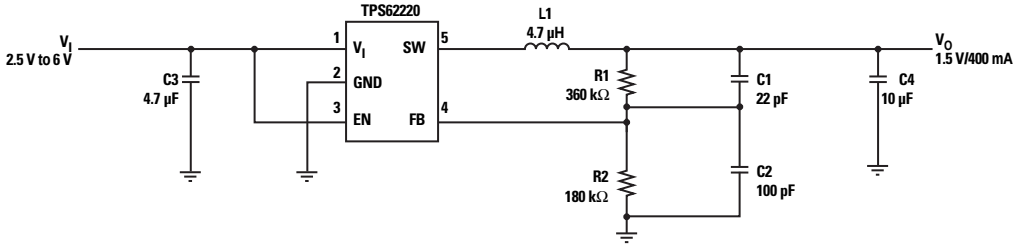
Web Links

Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS62220**

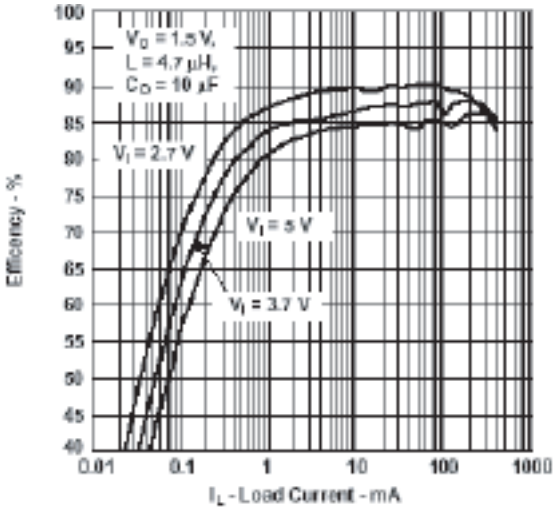
Specifications					
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		2.5	3.6	6.0	V
Output Voltage		1.455	1.5	1.545	V
Load Current		0		400	mA
Output Ripple Voltage	V_{IN} = 3.6 V; I_O = 10 mA		25	40	mV_{PP}
	V_{IN} = 3.6 V; I_O = 400 mA		5	10	mV_{PP}
Efficiency	V_{IN} = 2.7 V; I_O = 100 mA		90		%
	V_{IN} = 3.7 V; I_O =100 mA		87		%

Evaluation Module - TPS62220EVM-014

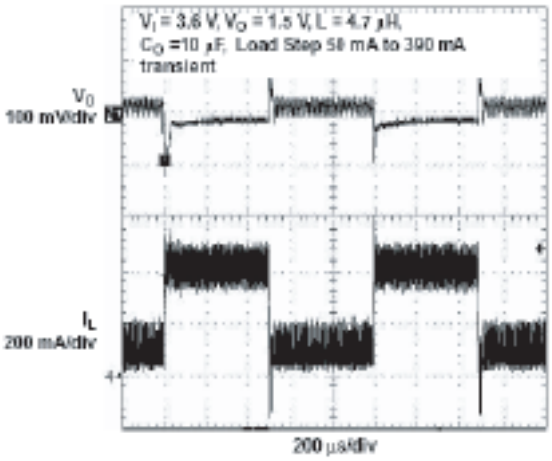


Test Results

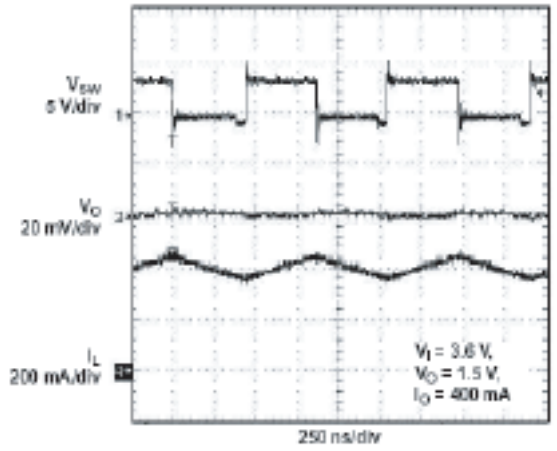
Efficiency vs. Load Current



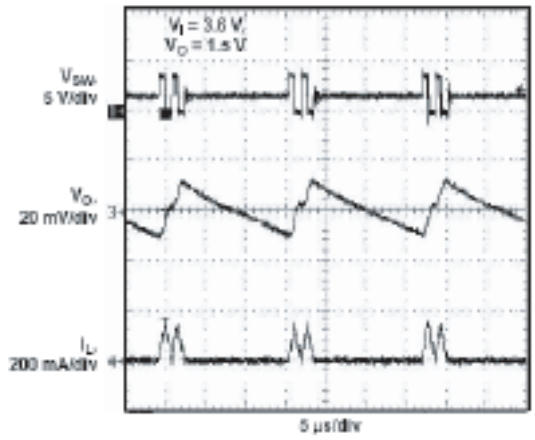
Load Transient Response



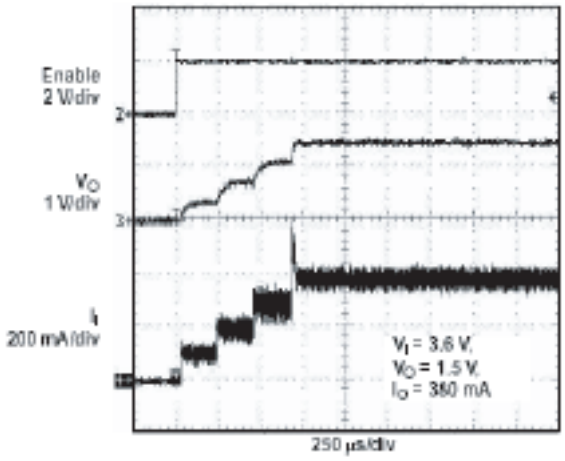
PWM Mode Operation



Power Save Mode Operation



Startup



Description

The TPS6204x family of synchronous buck converters with integrated FETs in 10-pin MSOP PowerPad™ or 3x3 QFN can provide up to 1.2 A of output current from inputs as low as 2.5 V. The circuit below was configured to provide 1.8 V with a 4.7-µH inductor and 22-µF output capacitor. The TPS6204x achieves high efficiency over the entire load current range by switching from traditional pulse width modulation (PWM) at high load to pulsed frequency modulation (PFM or Power Save Mode) at light load. Power save mode can be disabled by tying the MODE pin to V_{IN}.

Web Links

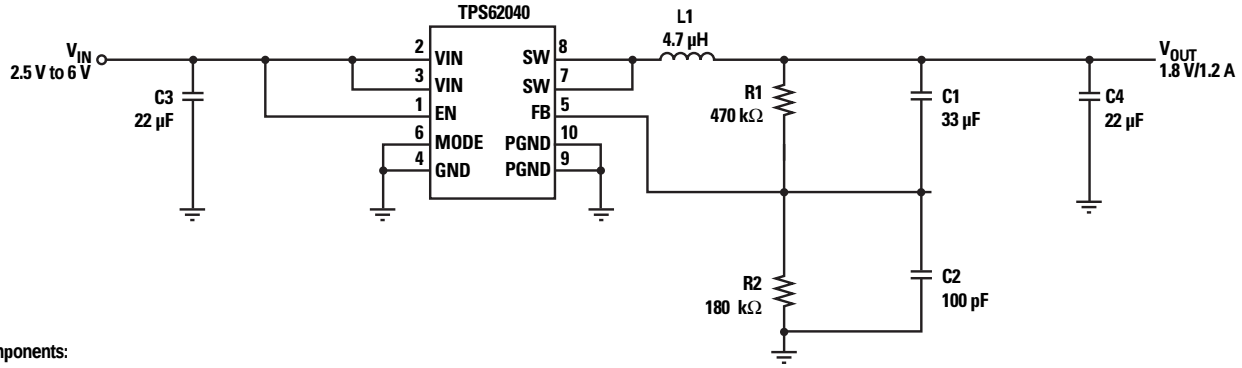
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS62040**

Specifications

Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		2.5	3 - 6	6.0	V
Output Voltage		1.75	1.8	1.85	V
Load Current		0		1200	mA
Output Ripple Voltage	V_{IN} = 3.6 V; I_O = 10 mA		30	40	mV_{PP}
	V_{IN} = 3.6 V; I_O = 1000 mA		10	15	mV_{PP}
Efficiency	V_{IN} = 2.7 V; I_O = 1000 mA		90		%
	V_{IN} = 3.6 V; I_O =1000 mA		87		%

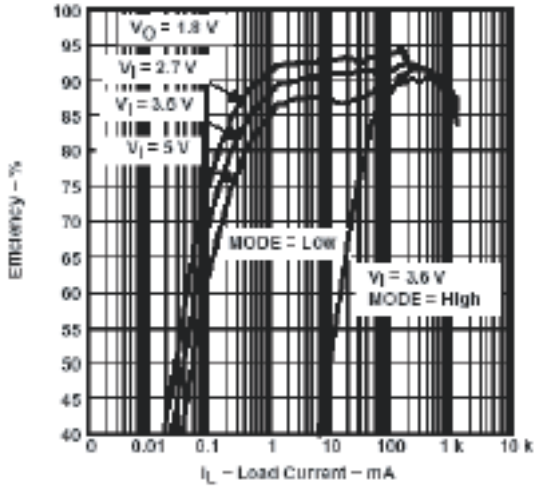
Evaluation Module - TPS62040



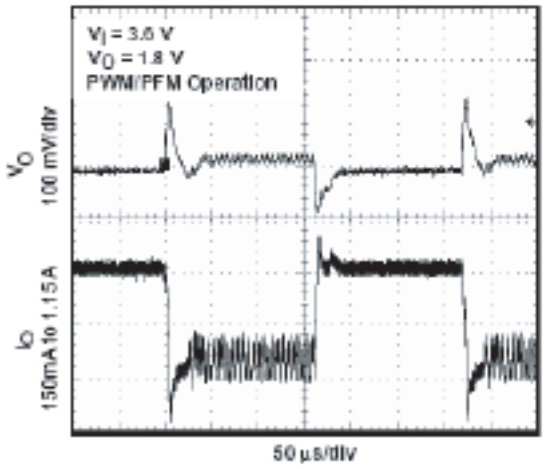
Components:
C1: Taiyo Yuden JMK316BJ226ML
C2: Taiyo Yuden JMK316BJ226ML
L1: Sumida CDRH4D28C-4R7

Test Results

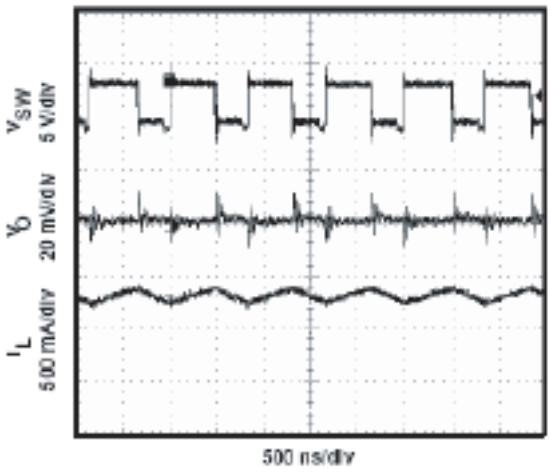
Efficiency vs. Load Current



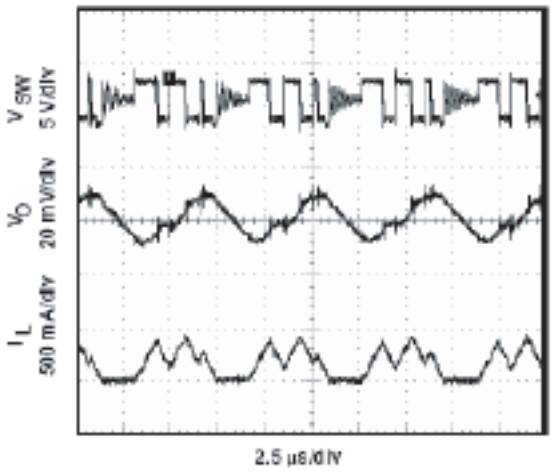
Load Transient Response



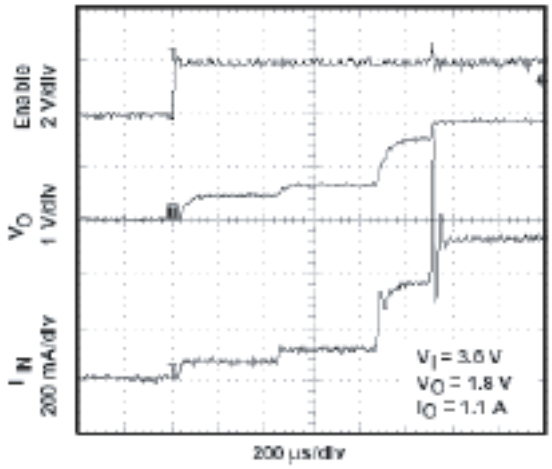
PWM Mode Operation



Power Save Mode Operation



Startup



Description

The TPS54350 is a medium output current synchronous buck PWM converter with an integrated high-side MOSFET and a gate driver for an optional low-side external MOSFET. Features include a wide input voltage range (4.5 to 20 V_{DC}) with an adjustable output voltage down to 0.9 V, an adjustable switching frequency up to 700 kHz, as well as current limit, adjustable under-voltage lockout circuit, an internal slow-start circuit to limit in-rush currents, and a power good output to indicate valid output conditions. The synchronization feature is configurable as either an input or an output for easy 180° out-of-phase synchronization. This device is also available in a thermally enhanced PowerPAD™ package.

Web Links

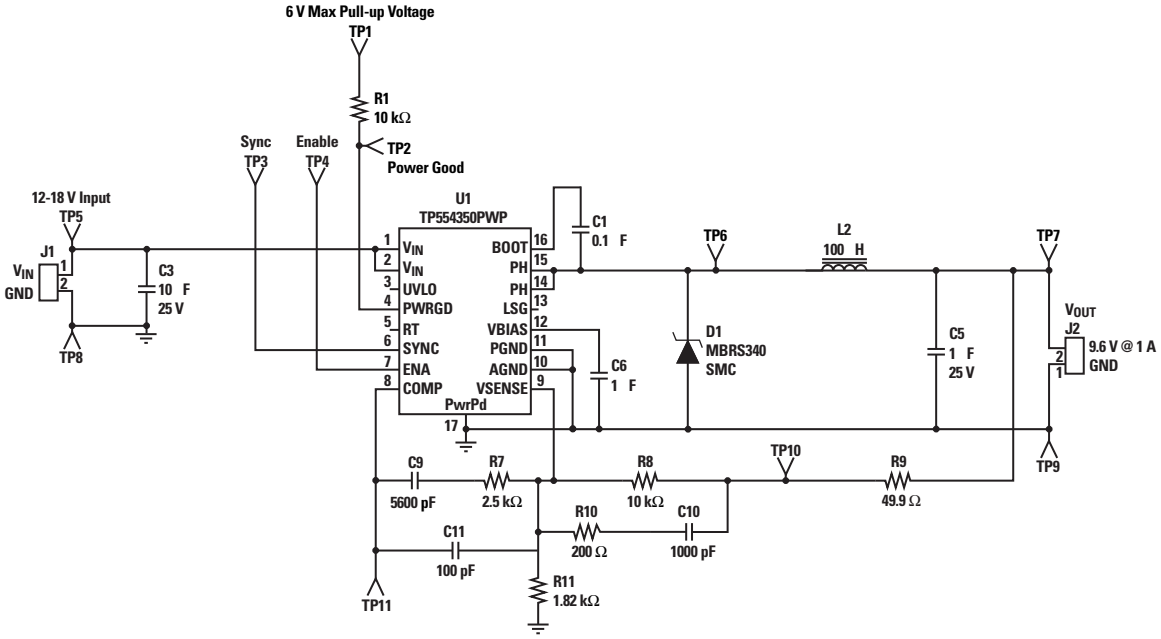
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS54350**

Specifications

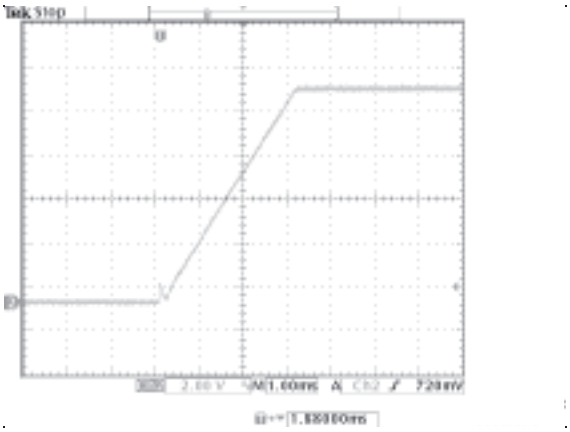
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		12		18	V
Output Voltage		9.67	9.68	9.69	V
Load Current		0.02		1	A
Switching Frequency			500		kHz
Output Ripple Voltage	V_{IN} = 18 V; V_{OUT} = 9.68 V; I_O = 1A		8		mV_{PP}
Efficiency	V_{IN} = 12 V; V_{OUT}= 9.68 V; I_O = 1A		95		%
	V_{IN} = 18 V; V_{OUT} = 9.68 V; I_O = 1A		94		%

Reference Design Number - PMP 718

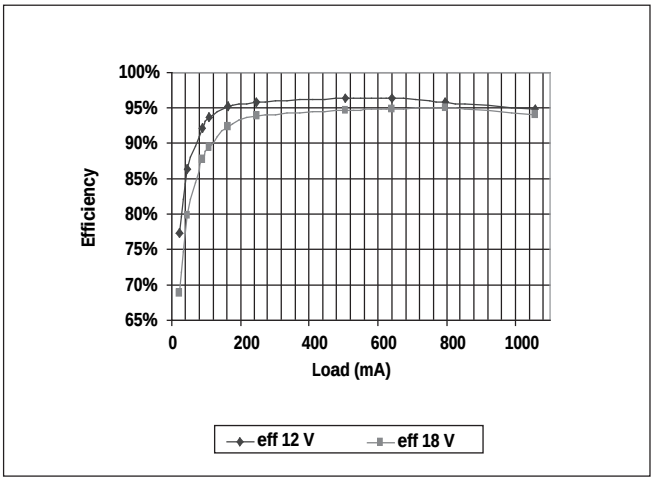


Test Results

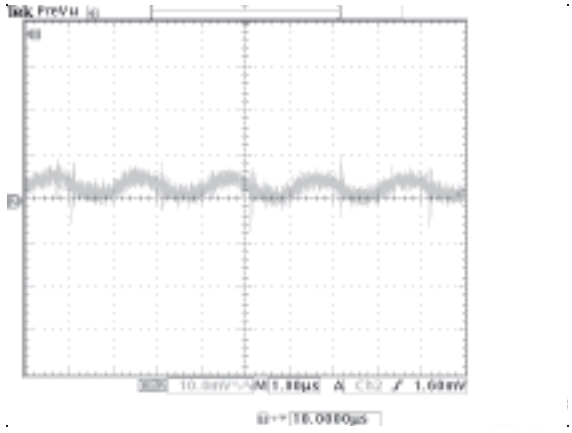
Startup Waveform
Turn On V_{IN} = 18 V, V_{OUT} = 9.68 V at 1 A



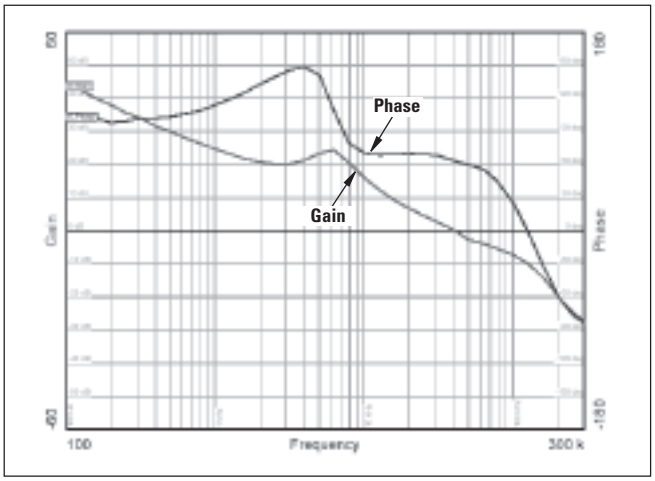
Efficiency



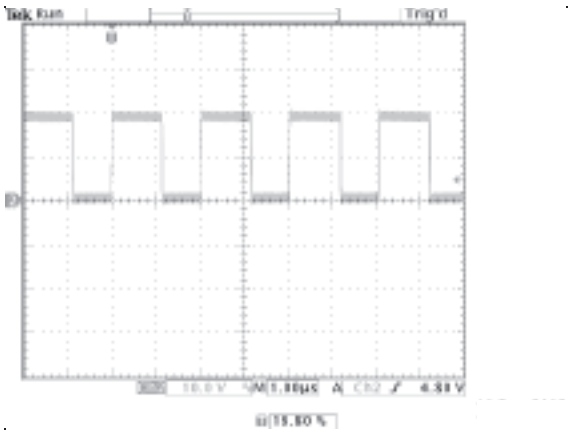
Output Ripple (across C5)
V_{IN} = 18 V at 1 A



Control Loop Gain/ Phase
V_{IN} = 15 V at 1 A



Phase Node Waveform (TP6 to GND from schematic pg. 8)
V_{IN} = 18 V; V_{OUT} = 9.68 V_{OUT} at 1 A



Description

PMP 546 uses the TPS54350 in a buck-boost mode to generate negative voltage from a positive one. This configuration can be used when the input plus the output voltage do not exceed the device's voltage limitations of 20 V and when the sum of the input and output current do not exceed the device's rated current of 3 A. The circuit functions by turning the hide-side switch on to increase the inductor current. Then the low switch or diode charges the output capacitor. Note, the output current is discontinuous so significant filtering is required.

Web Links

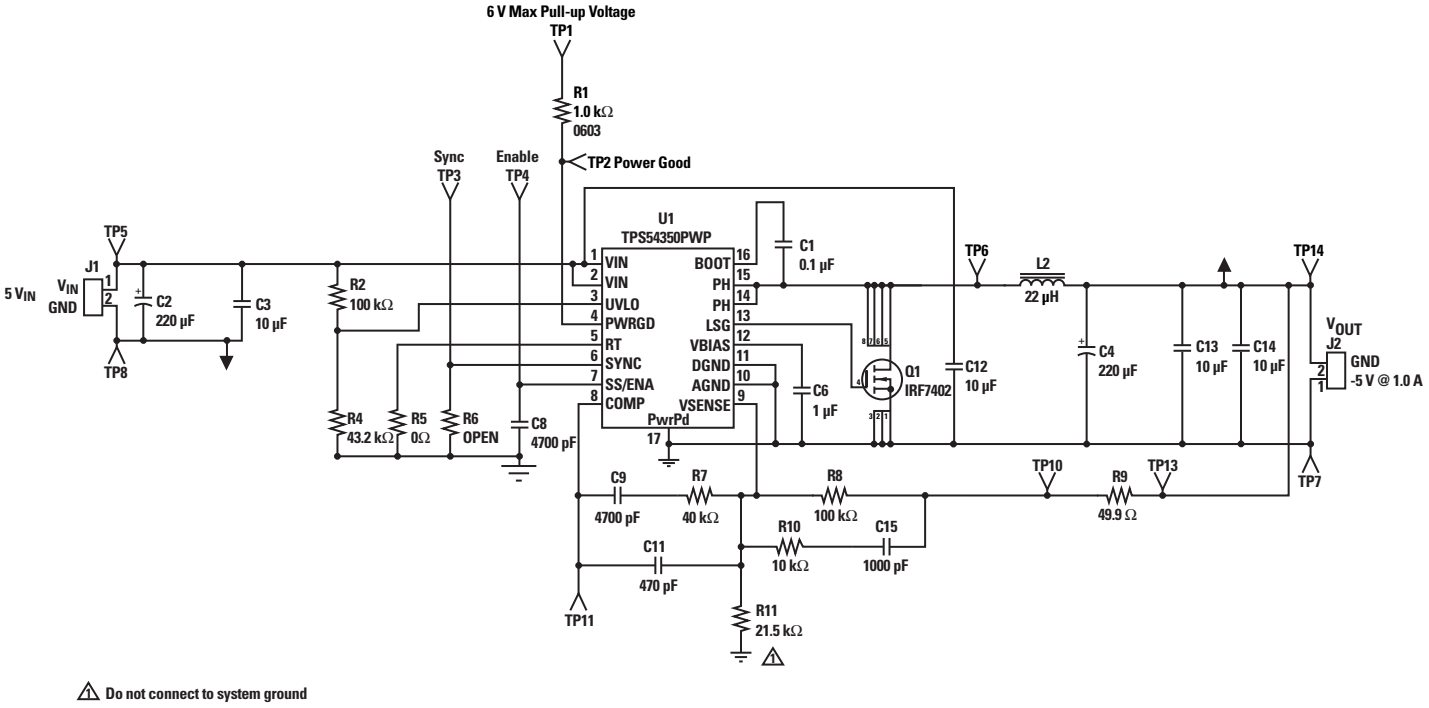
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS54350**

Specifications

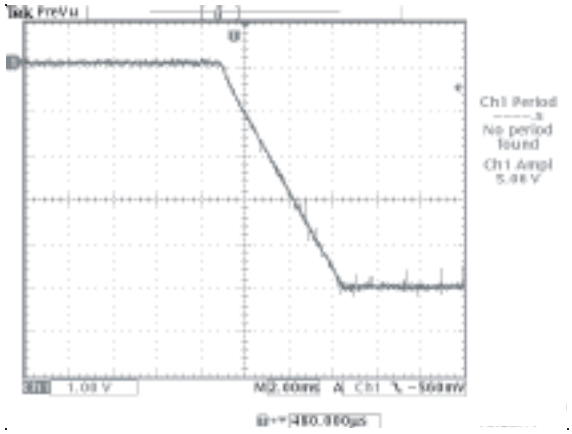
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage			5		V
Output Voltage		–5.06	–5.05	–5.05	V
Load Current		0.03		1.5	A
Switching Frequency		250	500	700	kHz
Output Ripple Voltage	V_{IN} = 5 V; V_{OUT} = –5.05 V; I_O = 1.2 A		100		mV_{PP}
Efficiency	V_{IN} = 5 V; V_{OUT} = –5.05 V; I_O = 0.56 A	75		88	%

Reference Design Number - PMP 546

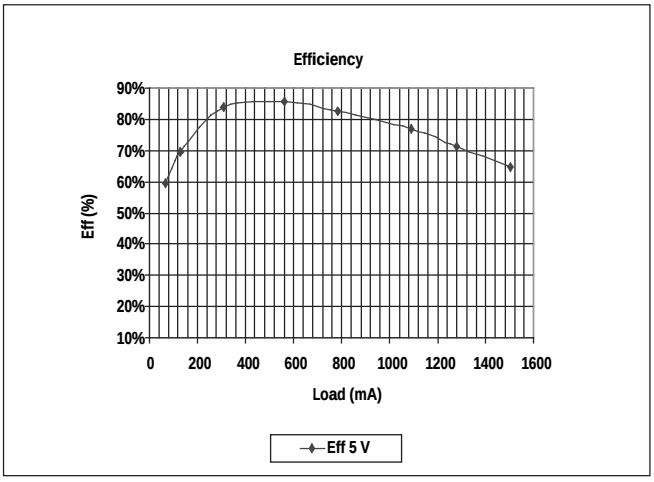


Test Results

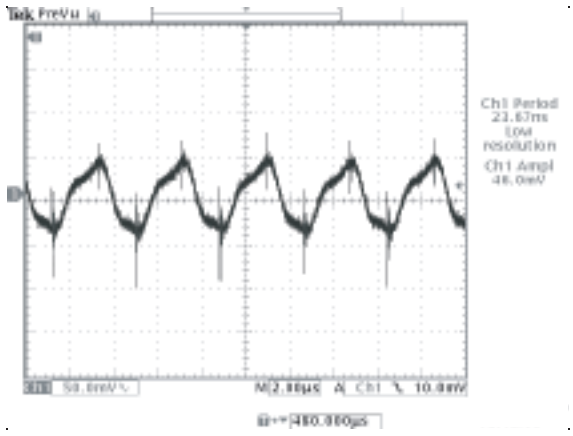
Startup Waveform
Turn On V_{IN} = 5 V, V_{OUT} = –5.05 V at 1.0 A



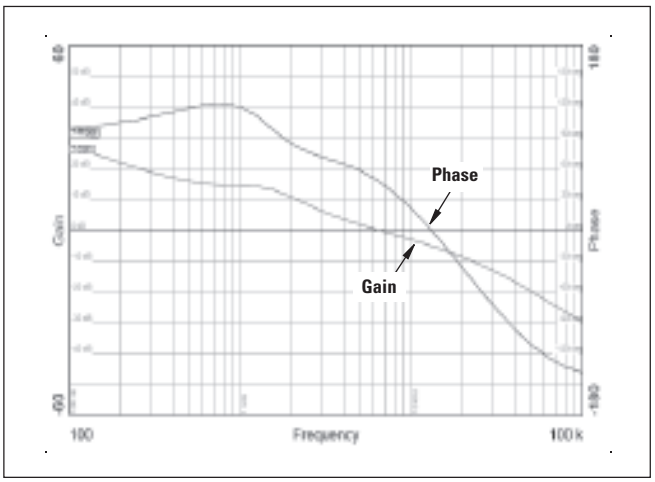
Efficiency 5 V_{IN}



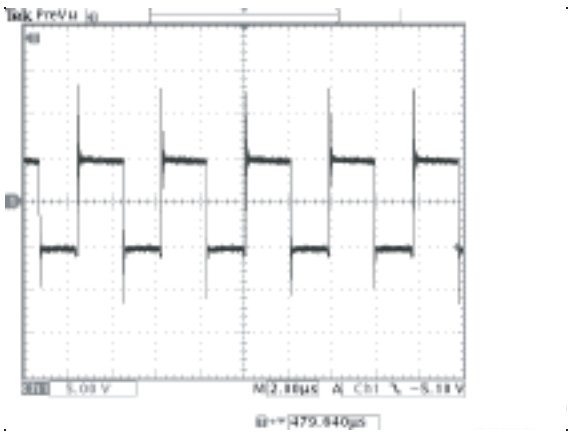
Output Ripple (across C14)
V_{IN} = 5 V_{OUT} at 1.0 A



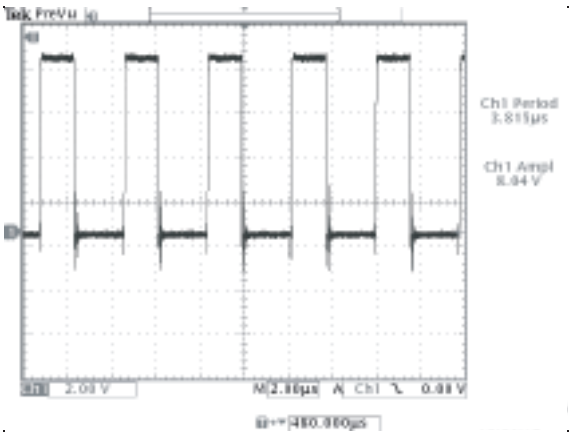
Control Loop
V_{IN} = 5 V_{OUT} at 1.0 A



Phase Node Waveform
(TP6 to GND from schematic on page 10)
V_{IN} = 5 V; V_{OUT} = –5.05 V at 1.0 A



Phase Node Waveform
(LSG Pin 13 of TPS54350)
V_{IN} = 5 V; V_{OUT} = –5.05 V at 1.0 A



Description

The TPS54610 is a member of the SWIFT™ family of synchronous buck PWM converters. The TPS54610 DC/DC regulator is ideal for low input voltage, high output current applications. The TPS54610 integrates all required active components including a true, high-performance, voltage-error amplifier that enables maximum performance and flexibility in choosing the output filter L and C components; an under-voltage-lockout circuit to prevent Startup until the input voltage reaches 3 V; an internally or externally set slow-start circuit to limit inrush currents; and a power good output useful for processor/logic reset, fault signaling, and supply sequencing. The TPS54610 is available in a thermally enhanced 28-pin TSSOP (PWP) PowerPAD™ package, which eliminates bulky heatsinks. TI provides evaluation modules and the SWIFT designer software tool to aid in quickly achieving high-performance power supply designs to meet aggressive equipment development cycles.

Web Links

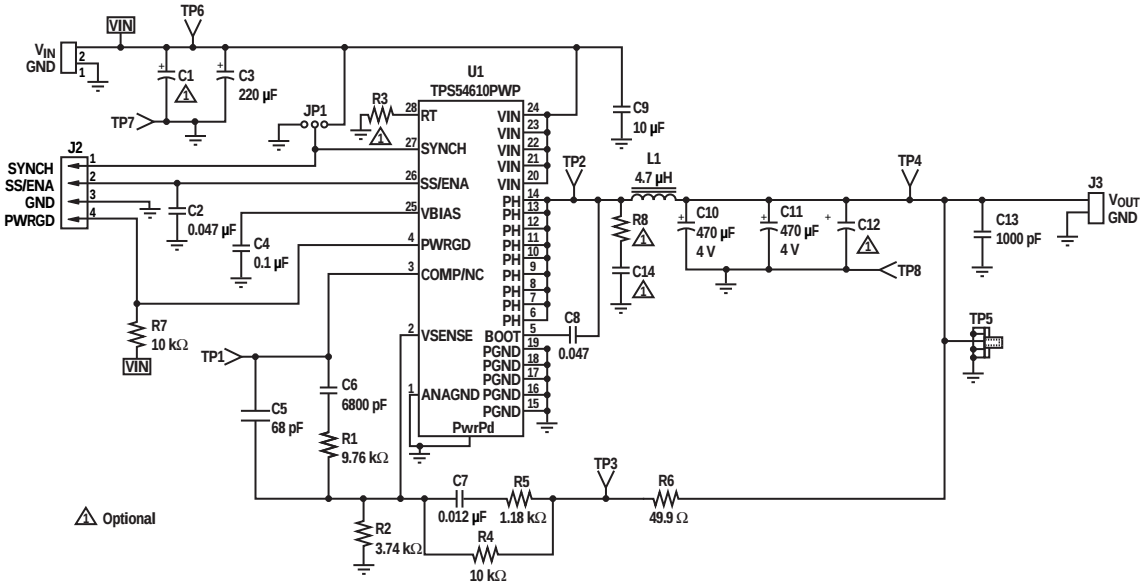
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS54610**

Specifications

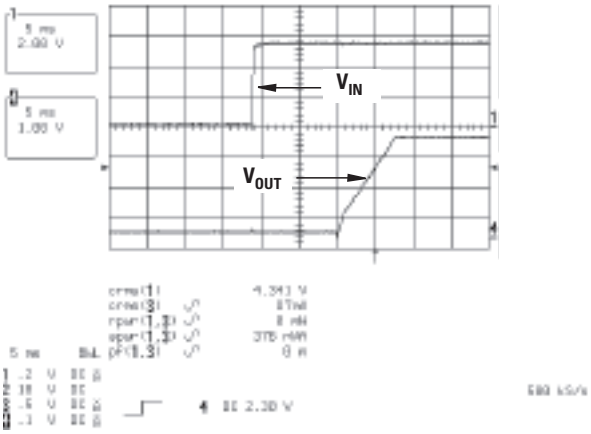
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		4.0	5.0	6.0	V
Output Voltage		3.27	3.3	3.3	V
Load Current		0	5	6	A
Switching Frequency			550		kHz
Output Ripple Voltage	V_{IN} = 5 V; I_O = 5 A		50		mV_{PP}
Efficiency	V_{IN} = 5 V; I_O = 1 A		95.7		%
	V_{IN} = 5 V; I_O = 5 A		91.4		%

Reference Design Number - PMP 771

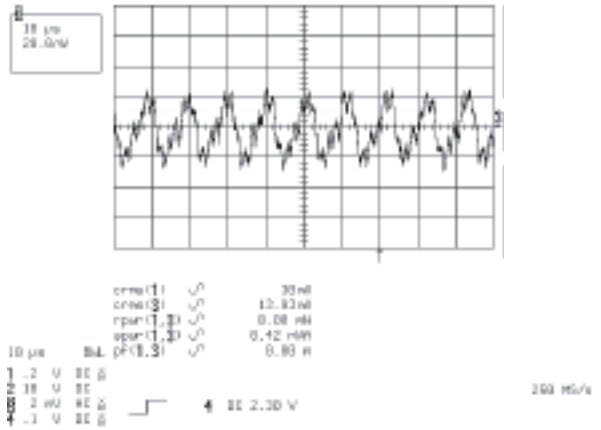


Test Results

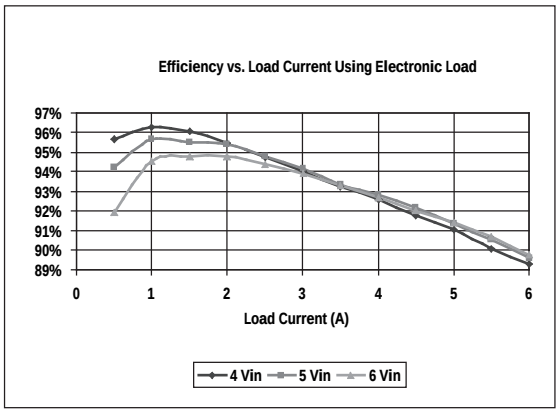
Startup: The input voltage was set at 5.5 V with no load on the output.



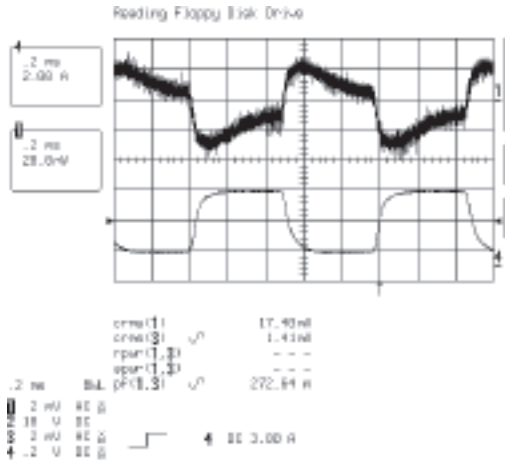
Output Ripple Voltage: The image was taken with a 5-A load and 5-V input.



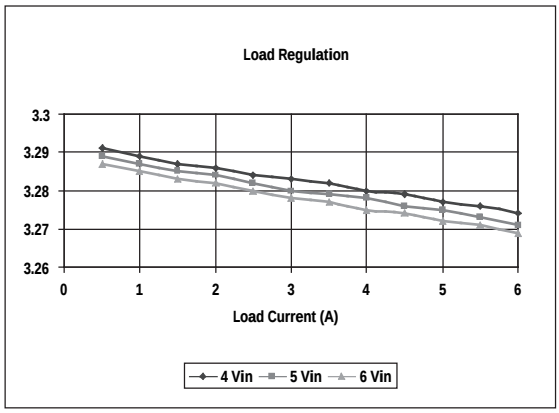
Efficiency



Load Transients: The input voltage was set to 5 V. The 4-A load step shown below results in 60 mV_{PP} of output ripple.



Load Regulation



Description

The TPS6103x family of synchronous boost converters provides a power solution for one-cell lithium or two to three-cell alkaline, NiCd, or NiMH based systems. The TPS6103x is also the ideal solution for circuits that require a 3.3-V to 5.0-V conversion. The circuit below was configured to provide 5.0 V at 1000 mA with a 6.8-µH inductor and 220-µF output capacitor. The TPS6103x achieves high efficiency over the entire load current range by switching from a fixed frequency mode of operation at high loads to a power save mode at light loads. The power save mode can be disabled by connecting the SYNC pin to V_{DD}. The design also features a low battery detection circuit configured to pull LBO low when the input voltage reaches approximately 1.8 V.

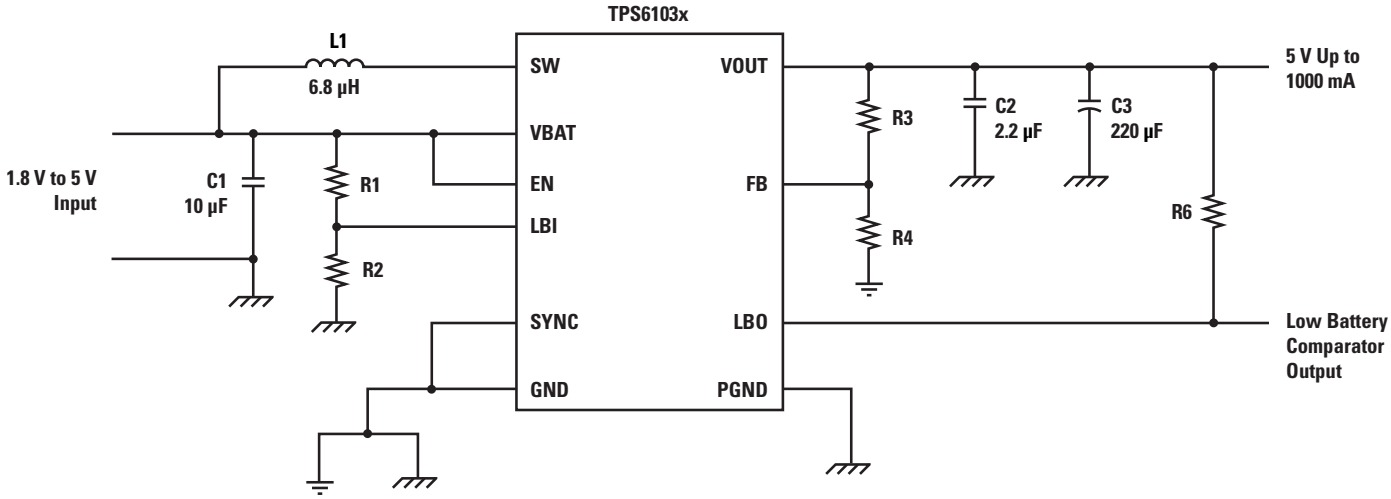
Web Links

Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS61030**

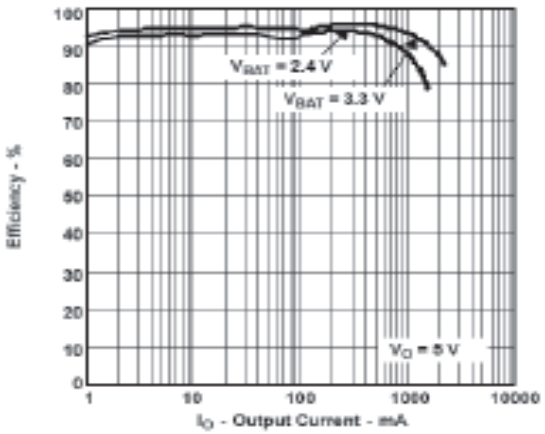
Specifications					
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		1.8		5.5	V
Output Voltage		V_{IN}		5.5	V
Output Current			1000		mA
Output Ripple Voltage	V_{IN} = 3.3 V; I_O = 1 A; Sync = V_{DD}		25	40	mV_{PP}
	V_{IN} = 3.3 V; I_O = 50 mA; Sync = GND		5	10	mV_{PP}
Efficiency	V_{IN} = 3.3 V; I_O = 300 mA			96	%
	V_{IN} = 2.4 V; I_O = 300 mA			93	%

Evaluation Module - TPS61030

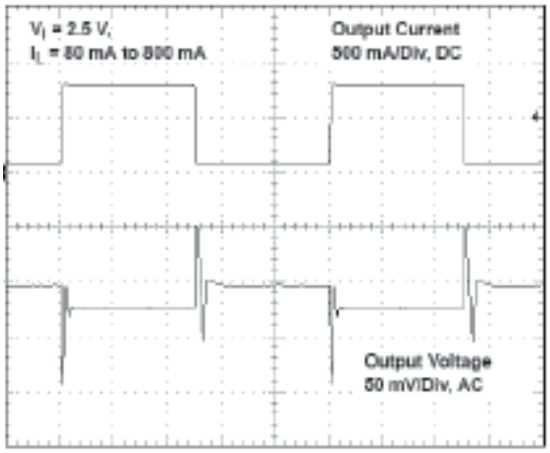


Test Results

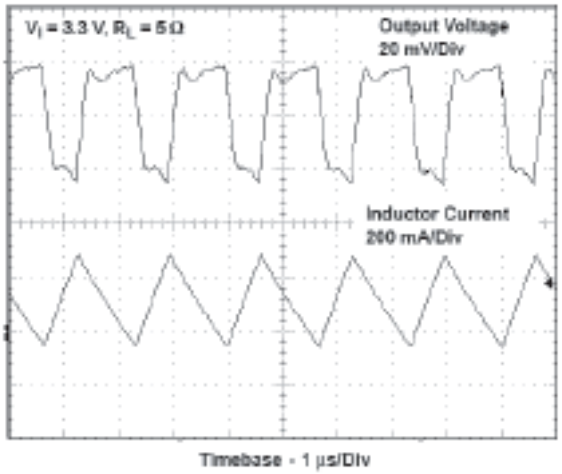
Efficiency vs. Output Current



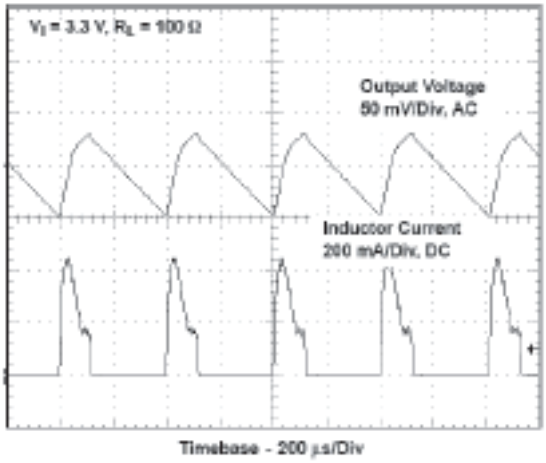
Load Transient Response



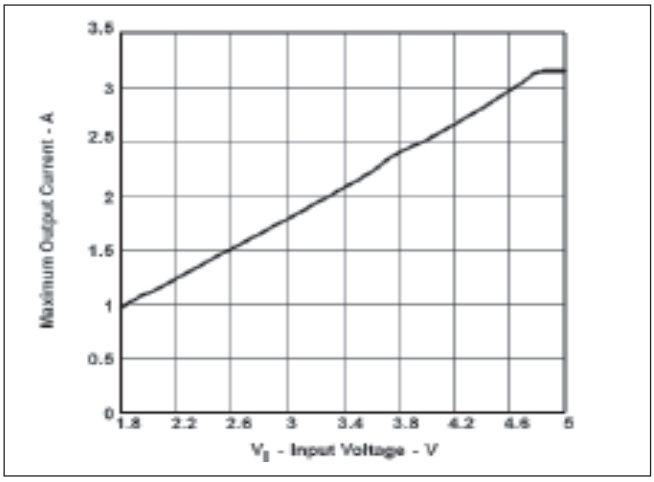
Output Voltage in Continuous Mode



Output Voltage in Power Save Mode



Maximum Output Current vs. Input Voltage



Description

The TPS64201 is a member of the TPS6420x family of non-synchronous step-down controllers. The TPS6420x controllers are ideal for systems powered from a 5-V or 3.3-V bus or for applications powered from a 1-cell Li-Ion battery or from a 2- to 4-cell NiCd, NiMH, or alkaline battery. These step-down controllers drive an external P-channel MOSFET allowing design flexibility. To achieve highest efficiency over a wide load current range, this controller uses a minimum on time, minimum off time control scheme and consumes only 20-µA quiescent current. The minimum on time of typically 600 ns (TPS64203) allows the use of small inductors and capacitors. When disabled, the current consumption is reduced to less than 1 µA. The TPS6420x is available in the 6-pin SOT23 (DBV) package and operates over a free air temperature range of –40 °C to 85 °C.

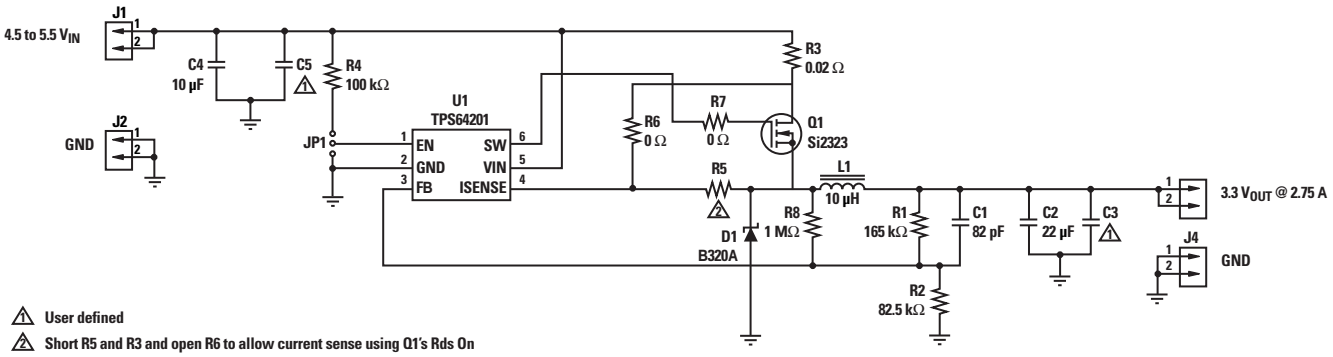
Web Links

Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS64201**

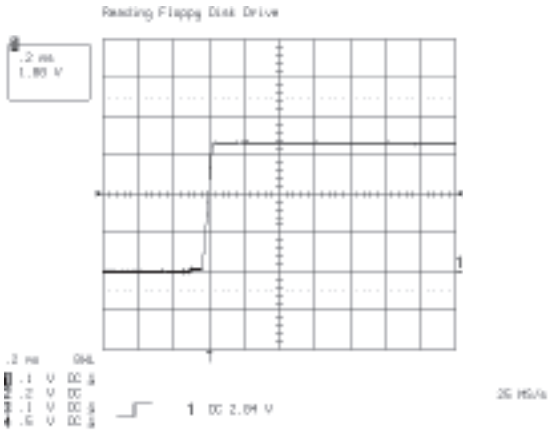
Specifications					
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		4.5	5.0	5.5	V
Output Voltage		3.23	3.3	3.33	V
Load Current		0	2.25	3	A
Switching Frequency		0	450	600	kHz
Output Ripple Voltage	V_{IN} = 5 V; I_O = 1 A		10	20	mV_{PP}
Efficiency	V_{IN} = 5 V; I_O = 1 A		93.1		%
	V_{IN} = 5 V; I_O = 2.5 A		90.3		%

Reference Design Number - PMP 756

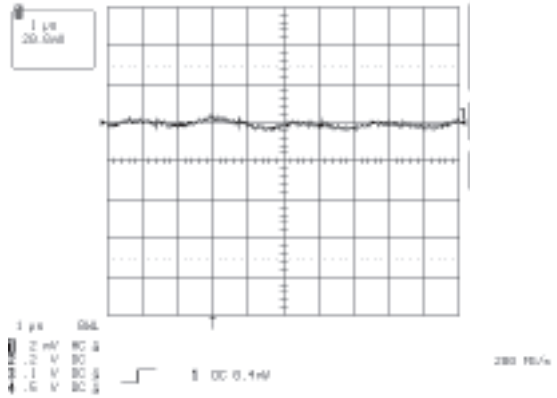


Test Results

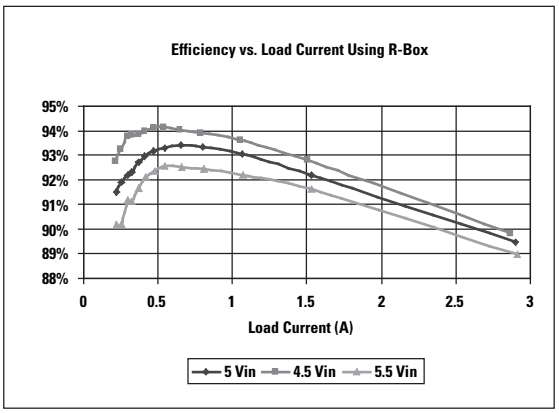
Startup: The input voltage was set at 5 V with no load on the output.



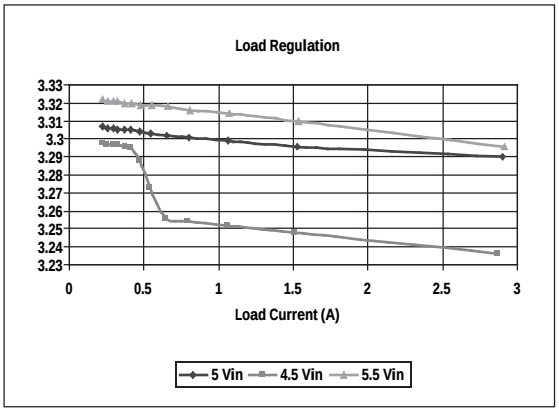
Output Ripple Voltage: The image was taken with a 1-A load and a 5-V input.



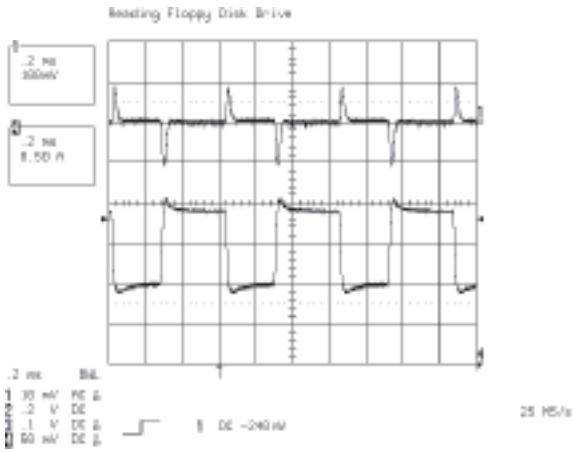
Efficiency



Load Regulation



Load Transients: The input voltage was set to 5 V. The 1-A load step shown below results in 200 mV of output ripple.
Channel 1: V_{OUT} (AC coupled)
Channel 2: Load Current (1 A –> 2 A)



TPS43000: SEPIC Converter - High Frequency Synchronous Controller

Description

This reference design uses the TPS43000 in SEPIC topology to convert from 3.0 to 4.2 V input to 3.3 V at 3-A output. The TPS43000 in SEPIC topology is ideal for nickel, alkaline or lithium-ion battery applications. The TPS43000 operates either in a fixed-frequency mode, where the user programs the frequency, or in an automatic PFM mode. In the automatic mode, the controller goes to sleep when the inductor current goes discontinuous, and wakes up when the output voltage has fallen by 2%. The TPS43000 also has a user programmable discontinuous or continuous conduction mode.

Web Links

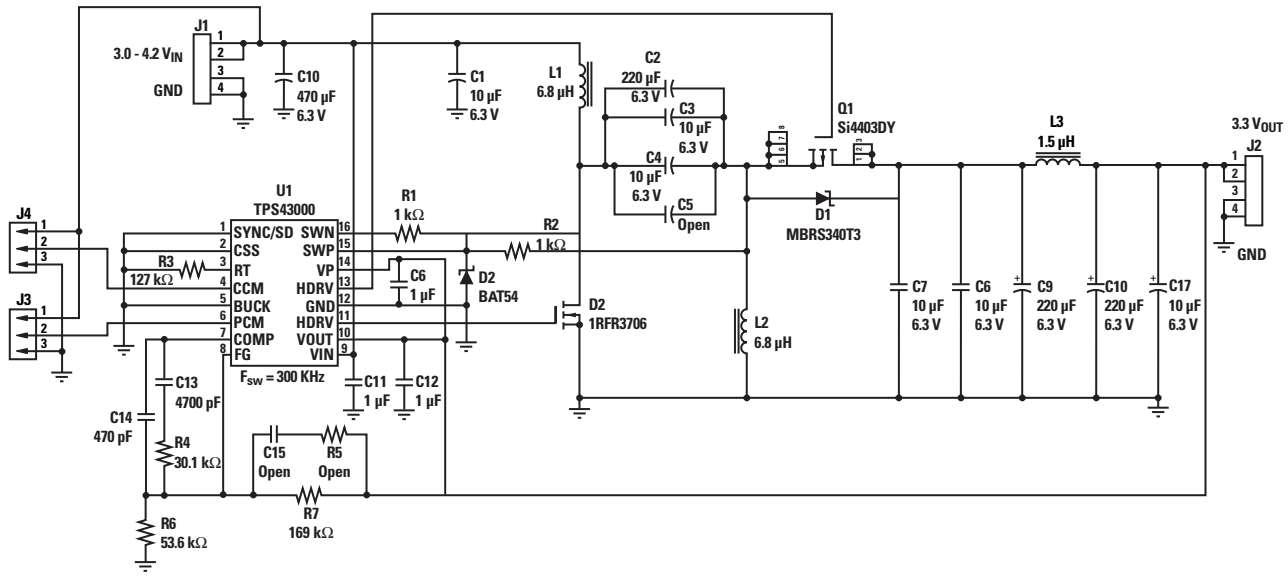
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS43000**

Specifications

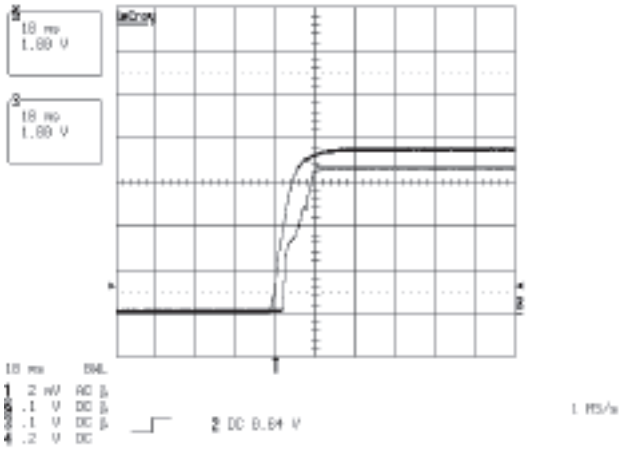
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		3.0	3.7	4.2	V
Output Voltage		3.267	3.3	3.33	V
Load Current		0	2	3	A
Switching Frequency			300		kHz
Output Ripple Voltage	V_{IN} = 3.7 V; I_O = 3 A		12		mV_{PP}
Efficiency	V_{IN} = 4.2 V; I_O = 1 A		87		%
	V_{IN} = 4.2 V; I_O = 3 A		85		%
	V_{IN} = 3.0 V; I_O = 1 A		88.5		%
	V_{IN} = 3.0 V; I_O = 3 A		80.5		%

Reference Design Number - PMP 169

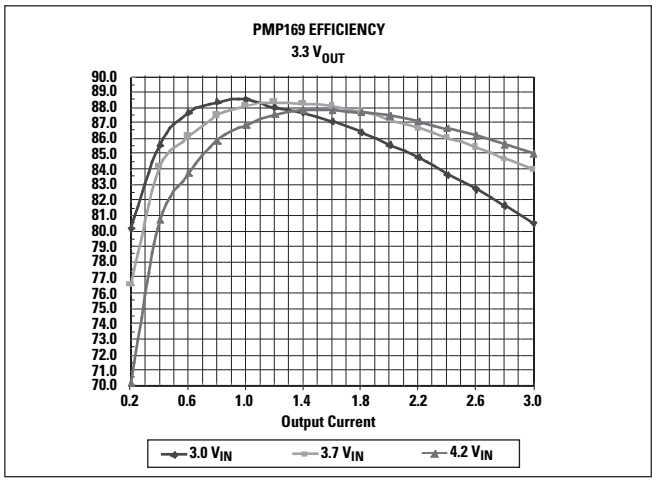


Test Results

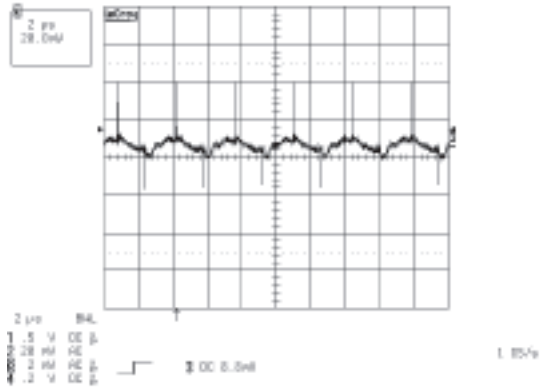
Turn On V_{IN} = 3.7 V_{OUT}; No Load
Channel 1: V_{IN}; Channel 2: V_{OUT}



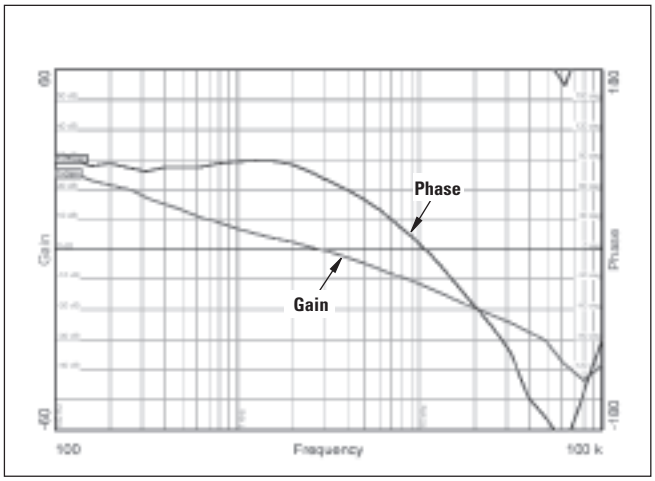
Efficiency



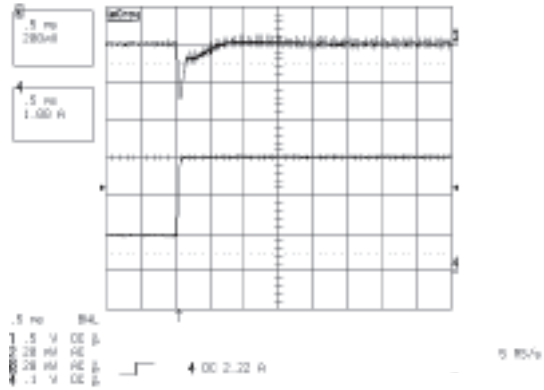
Output Ripple
3.7 $V_{IN;}$ I_O = 3 A



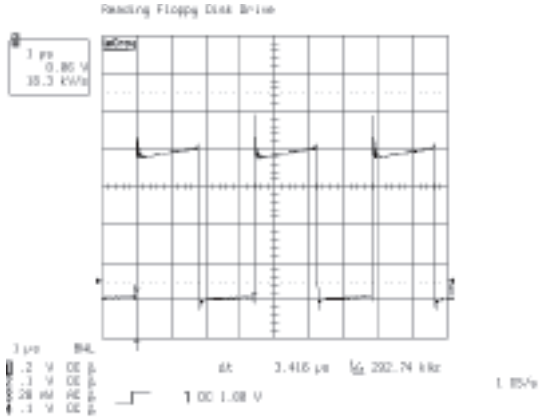
Control Loop
3.7 $V_{IN;}$ I_O = 3 A



Transient Response
Top Trace: V_O at 200 mV/div; Bottom Trace: I_O at 1 A/div



FET Drain Voltage
4.2 V_{IN} at 3 A



Description

The TPS40007 synchronous buck controller generates a 2.5-V output at up to 15 A from either a 3.3-V or 5-V input. The TPS40007 is a voltage-mode, synchronous buck PWM controller that utilizes TI's proprietary Predictive Gate Drive™ technology to wring maximum efficiency from step-down converters. Predictive Gate Drive technology controls the delay from main switch turn-off to synchronous rectifier turn-on and also the delay from rectifier turn-off to main switch turn-on. This allows minimization of both reverse recovery and conduction losses in the MOSFET body diodes. The TPS40007 allows this design to achieve a peak efficiency greater than 94%.

Web Links

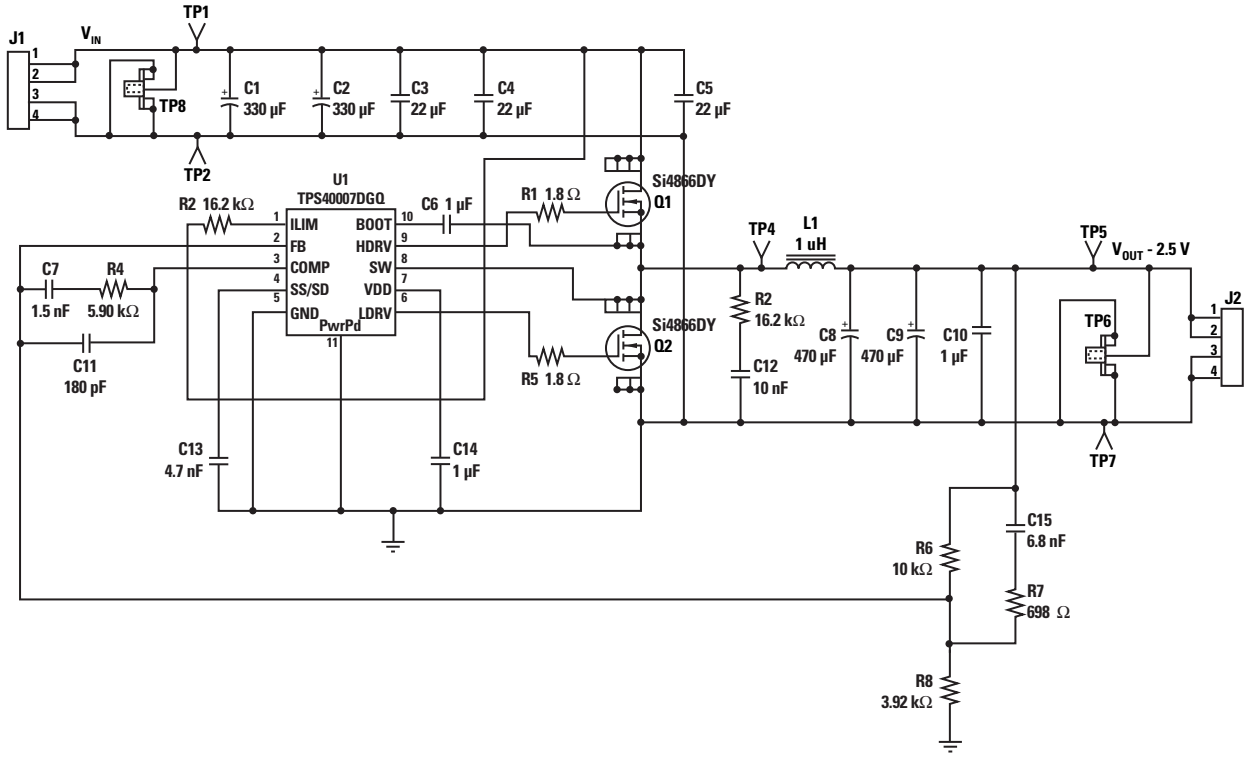
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS40007**

Specifications

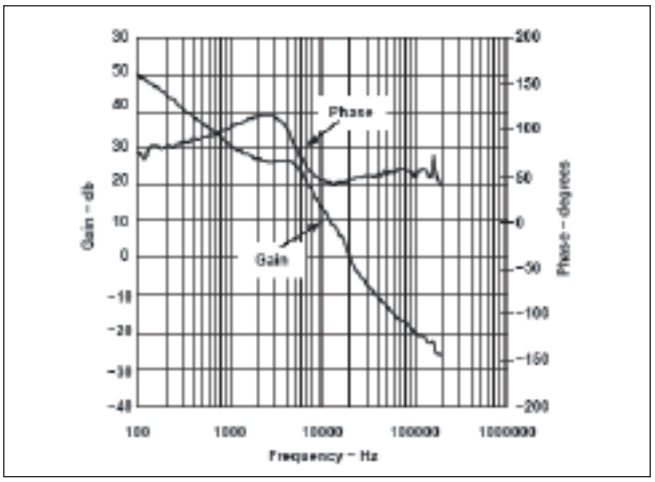
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		3.0		5.5	V
Output Voltage		2.425	2.500	2.575	V
Load Current		0		15	A
Switching Frequency		250	300	350	kHz
Output Ripple Voltage	V_{IN} = 5 V; I_O = 15 A		20	25	mV_{PP}
Efficiency	V_{IN} = 5 V; I_O = 6 A		94.5		%
	V_{IN} = 3.3 V; I_O = 9 A		93		%

Evaluation Module - TPS40007EVM-001

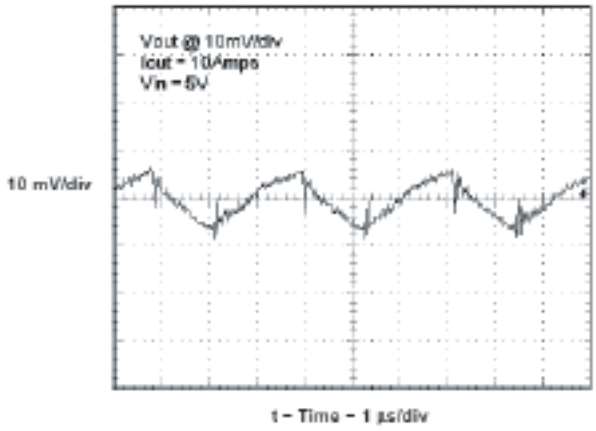


Test Results

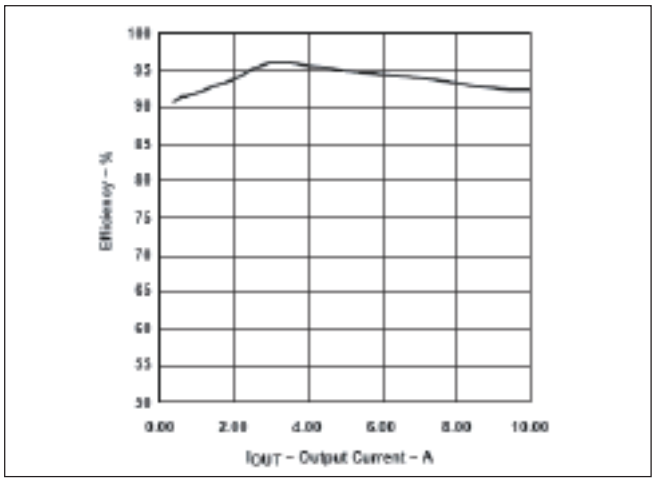
Gain and Phase Margin vs. Frequency



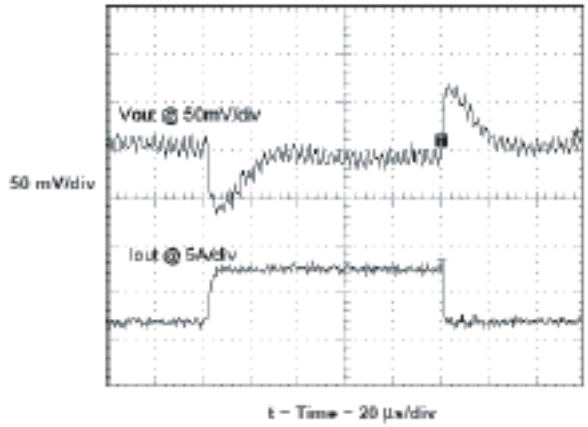
Output Voltage Ripple



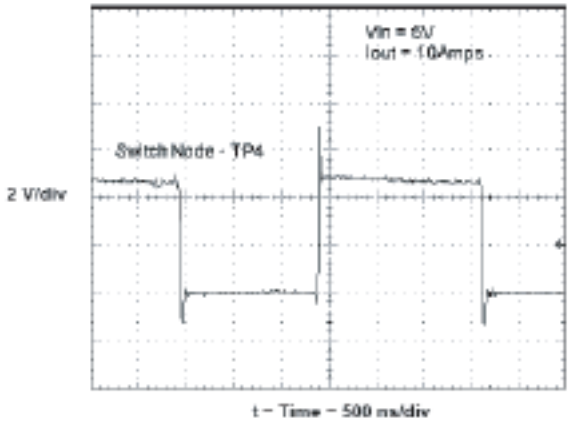
Efficiency vs. Output Current



Transient Response



Typical Switch Node Waveform



Description

The TPS40055 is a family of high-voltage, wide-input, synchronous, step-down converters. This family of controllers offers design flexibility with a variety of user programmable functions including soft start, UVLO, voltage feedforward, high-side current limit, and loop compensation. This design consists of two tracking, synchronized buck converters using the TPS40055 and TPS40052. The TPS40055 generates a 3.3-V/0.3-A output and the TPS40052 generates a 1.2-V/5.9-A output. The input to both converters is $12V_{DC}$. The output voltage of each converter tracks both at power up and power down. The TPS40052 converter is synchronized to run at the same frequency (phase shifted 180°) as the TPS40055 converter.

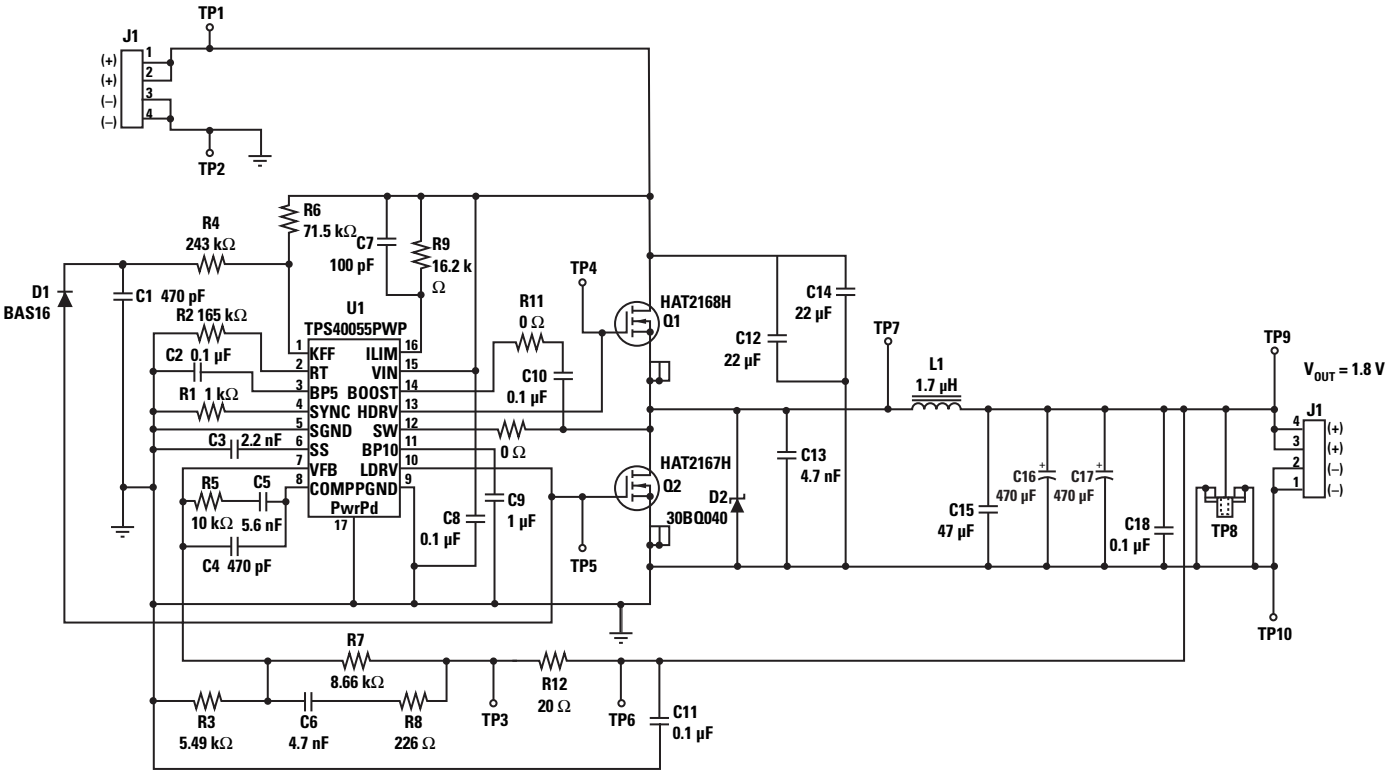
Web Links

Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS40055**

Specifications					
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		10.8	12	13.2	V
V_{OUT}		1.75	1.80	1.85	V
I_{OUT}		0	10	15	A
Switching Frequency			300		kHz
Output Ripple				35	mV_{PP}
Efficiency	I_{OUT} = 6 A		92		%

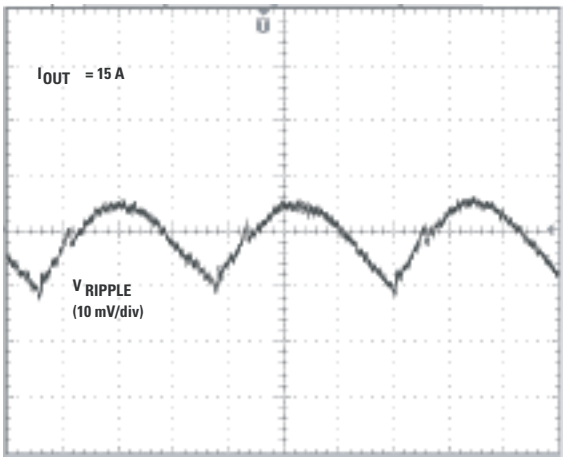
Evaluation Module - TPS40055EVM-001



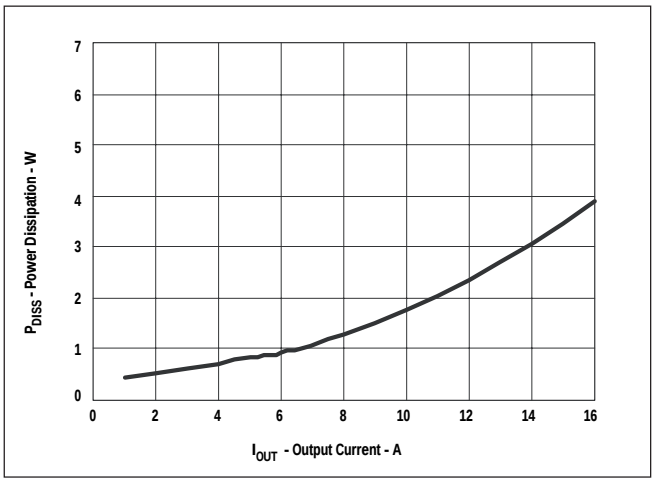
Test Results

Efficiency vs. Load

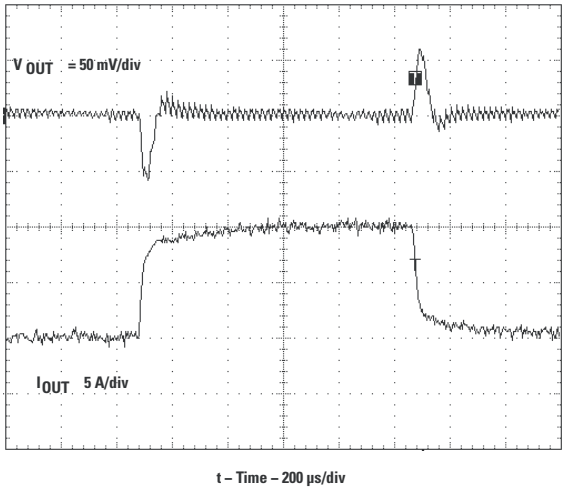
Output Voltage Ripple



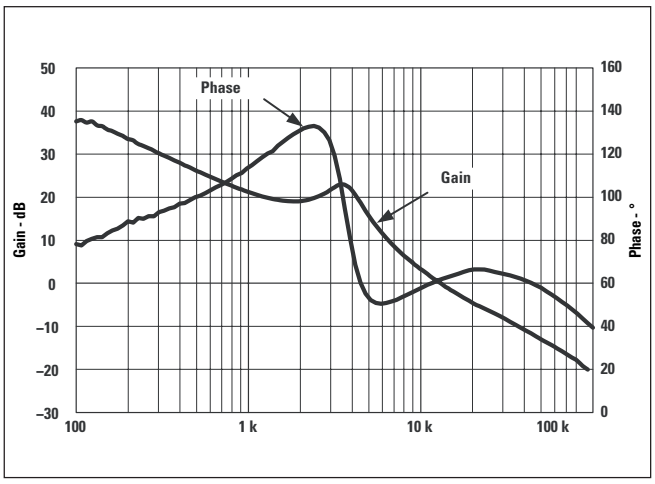
Power Dissipation vs. Load



Transient Response



Overall Gain and Phase vs. Frequency



UC3572 PWM: Negative Output Flyback Converter

Description

The UC3572 is a negative output flyback pulse width modulator used to convert a positive 12-V input voltage to a regulated –12-V output voltage at a current up to 0.5 A. The chip is optimized for use in a single inductor negative flyback switching converter employing an external PMOS switch. The controller consists of a precision reference, an error amplifier configured for voltage mode operation, an oscillator, a PWM comparator with latching logic, and a 0.5-A peak gate driver. The UC3572 includes an undervoltage lockout circuit to insure sufficient input supply voltage is present before any switching activity can occur, and a pulse-by-pulse current limit. Output current is sensed and limited to a defined maximum value. The UVLO circuit turns the chip off when the input voltage is below the UVLO threshold. The UC3572 allows this design to achieve a peak efficiency of 83%.

Web Links

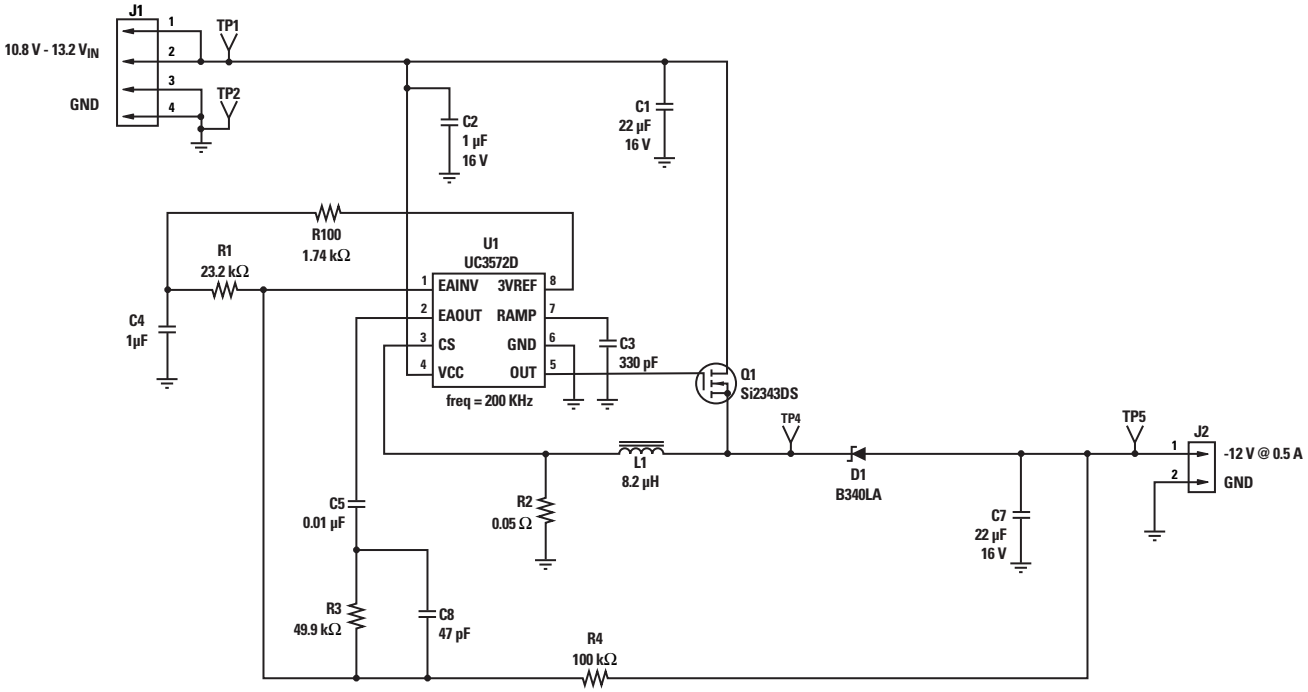
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **UC3572**

Specifications

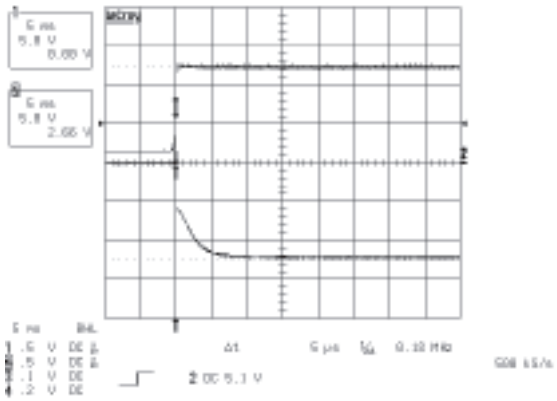
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		10.8	12	13.2	V
Output Voltage		–12.36	–12	–11.64	V
Load Current		0		0.5	A
Switching Frequency		170	200	230	kHz
Output Ripple Voltage	V_{IN} = 12 V; I_O = 0.5 A		120	150	mV_{PP}
Efficiency	V_{IN} = 12 V; I_O = 0.5 A		83		%
	V_{IN} = 12 V; I_O = 0.25 A		82		%

Reference Design Number - PMP 703

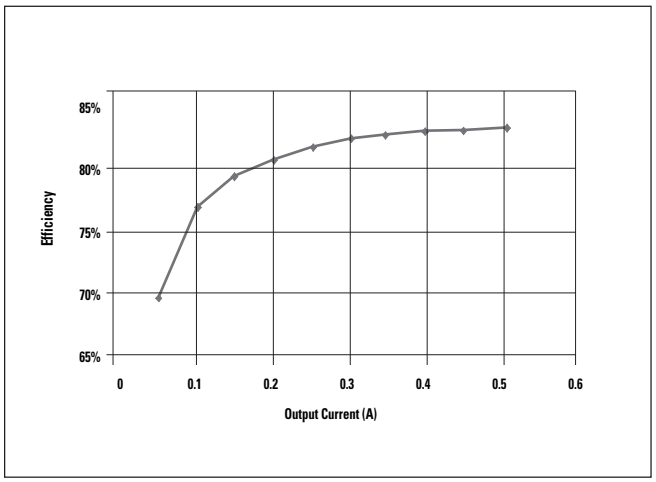


Test Results

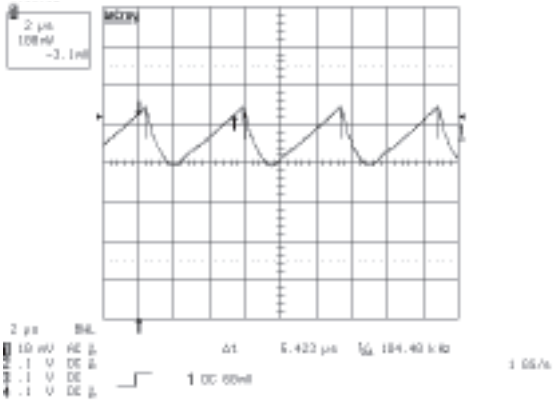
Turn On V_{IN} = 12 V; 0.5-A Load
Channel 1: V_{OUT}; Channel 2: V_{IN}



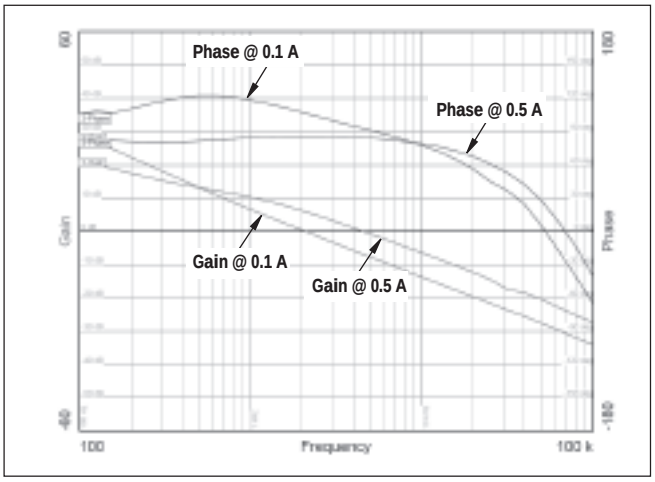
Efficiency



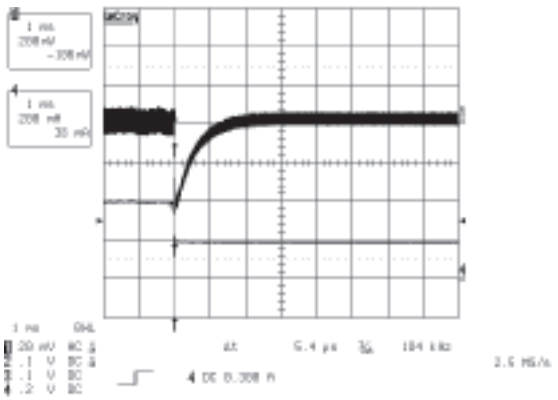
Output Ripple
V_{IN} = 12 V; I_O = 0.5 A, 0.1 V/div



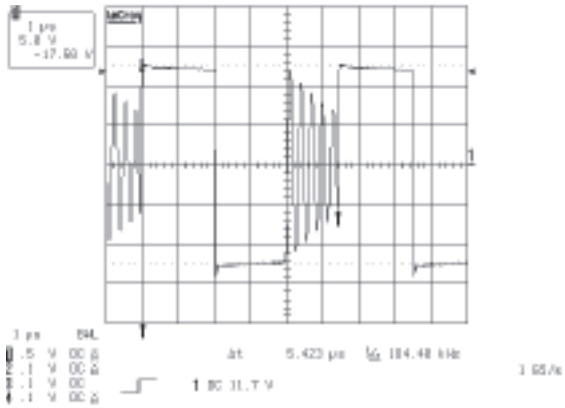
Control loop
V_{IN} = 12 V; I_O = 0.1 A/0.5 A



Transient Response
Top Trace: V_O at 200 mV/div
Bottom Trace: I_O at 200 mA/div



Switch Mode Waveform
Voltage at TP4 (5 V/div)



Description

The TPS40071EVM-001 evaluation module (EVM) is a synchronous buck converter which utilizes Predictive Gate Drive (PGD) to maximize conversion efficiency by minimizing the body diode conduction loss. The use of the TPS40071 midrange input synchronous buck controller allows the EVM to deliver 10 A from a bus voltage ranging from 5 to 14 V. The output voltage is originally set to 1.8 V, but can also be configured to provide 1.2 V to 3.3 V at a load current up to 10 A by changing one surface mount resistor.

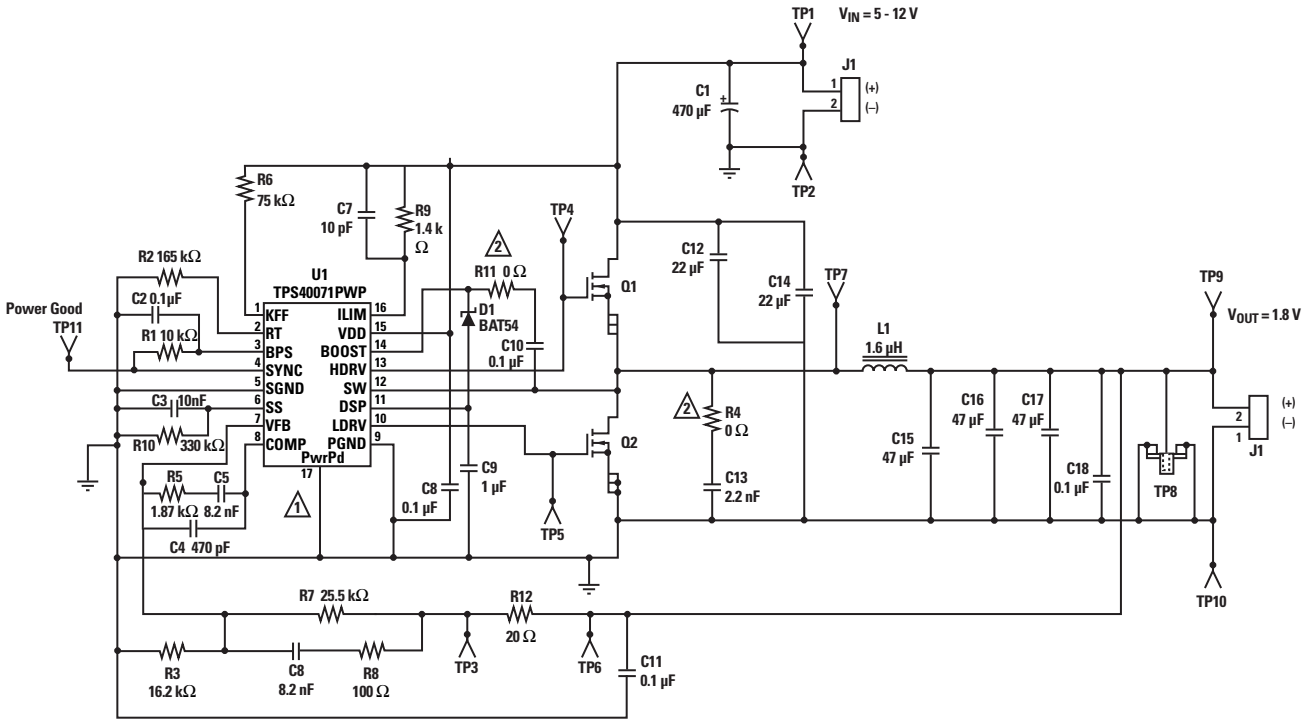
Web Links

Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS40071**

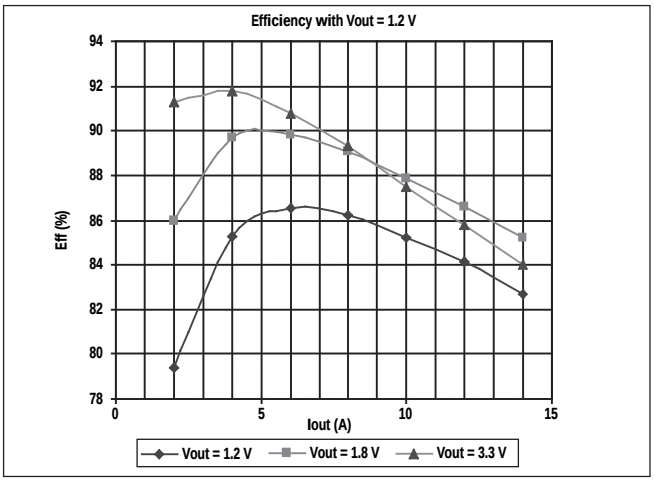
Specifications					
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		4.75	5/12	14	V
V_{OUT}		1.76	1.8	1.84	V
I_{OUT}		0	6	10	A
Switching Frequency			300		kHz
Output Ripple	V_{IN} = 5 V			16	mV_{PP}
Efficiency	V_{IN} = 5 V		94		%

Evaluation Module - TPS40071EVM-001

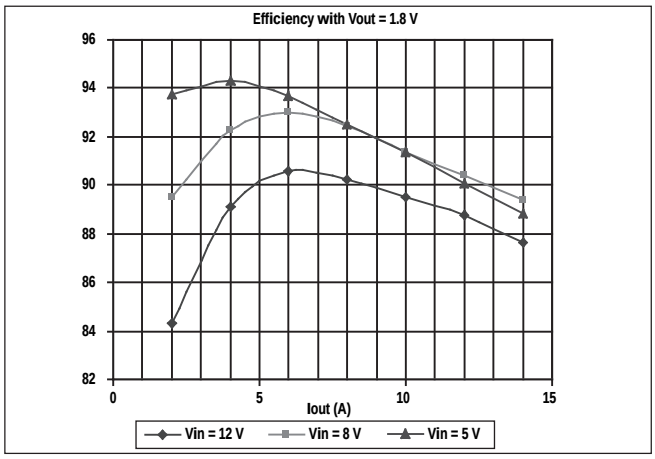


Test Results

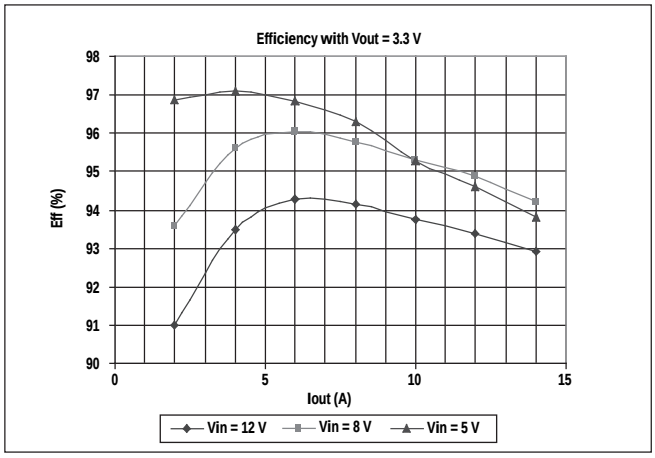
Efficiency with V_{OUT} = 1.2 V



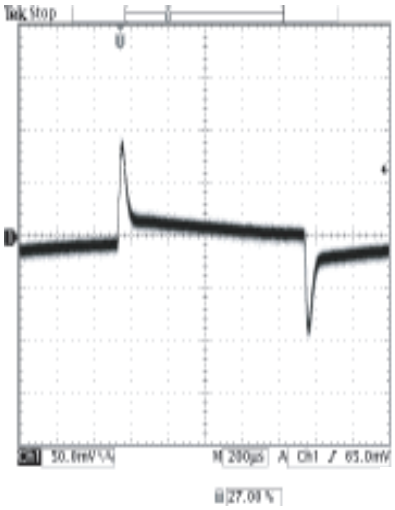
Efficiency with V_{OUT} = 1.8 V



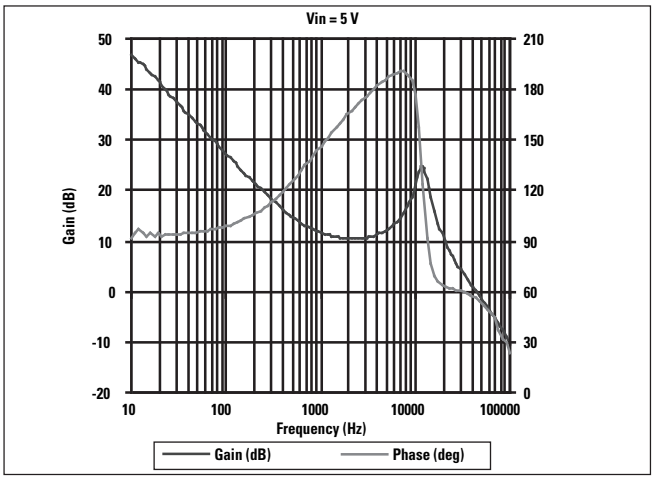
Efficiency with V_{OUT} = 3.3 V



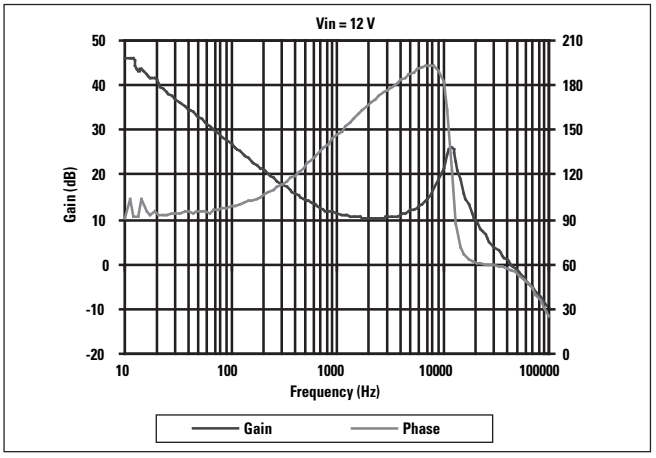
Transient Response



Loop Gain
V_{OUT} = 5 V



Phase Frequency Response
V_{OUT} = 12 V



Description

This reference design uses the TPS51020 in a dual synchronous buck application that provides output voltages of 5 V/14 A and 3.3 V/10 A from a wide 9-V to 18-V input. The TPS51020 utilizes feed-forward voltage mode control to attain high efficiency without sacrificing line response. Each converter runs 180 degrees out of phase with respect to the other, effectively reducing the input capacitor requirement. Other features of the TPS51020 are adjustable short circuit protection, selectable Autoskip operation for improved light load efficiency, selectable DDR tracking option, and a built-in 5-V bias regulator.

Web Links

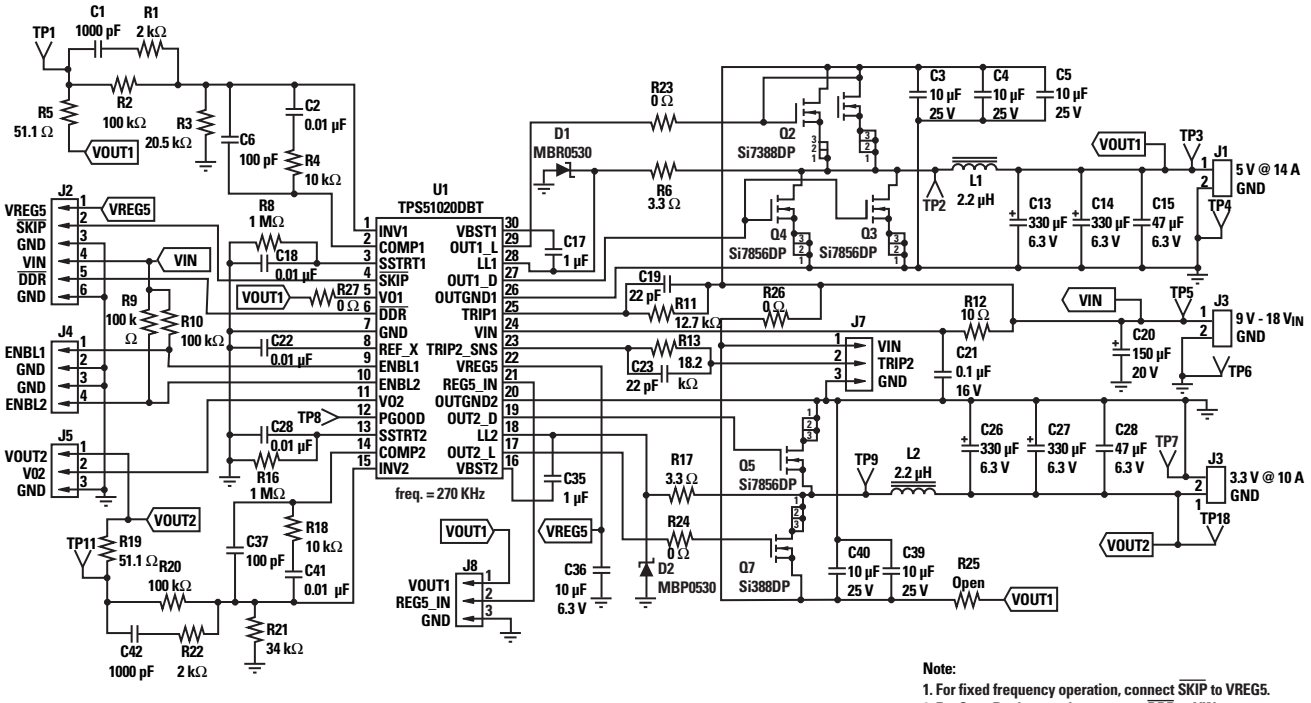
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS51020**

Specifications

Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		9	12	18	V
Output Voltage 1		4.85	5.00	5.15	V
Output Voltage 2		3.25	3.35	3.45	V
Load Current 1		0		14	A
Load Current 2		0		10	A
Switching Frequency		229	270	311	kHz
Output Ripple Voltage 1	V_{IN} = 12 V; I_O = 14 A		25	50	mV_{PP}
Output Ripple Voltage 2	V_{IN} = 12 V; I_O = 10 A		20	33	mV_{PP}
Efficiency 1	V_{IN} = 12 V; I_O = 6 A		95		%
Efficiency 2	V_{IN} = 12 V; I_O = 6 A		93		%

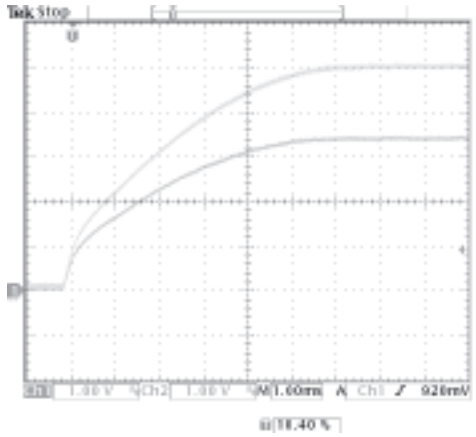
Reference Design Number - PMP 839



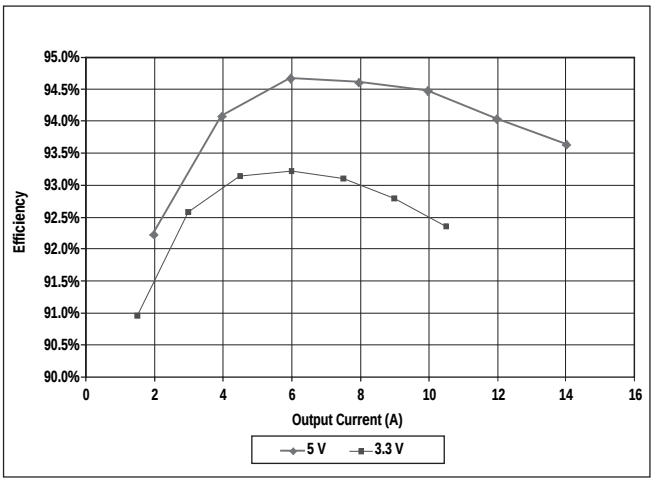
Note:
1. For fixed frequency operation, connect $\overline{SKIP}$ to VREG5.
2. For Sync Buck operation, connect $\overline{DDR}$ to VIN.
3. To discharge outputs at turnoff, connect VOx to VOUTx, GND V0x if discharge is not required.
4. Connect REG5_IN to 5 V output voltage.
5. Connect TRIP2 to VIN for sync buck output.

Test Results

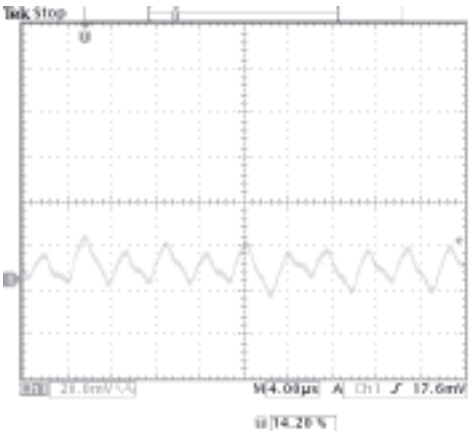
Turn on: V_{IN} = 12 V; 0-A Loads



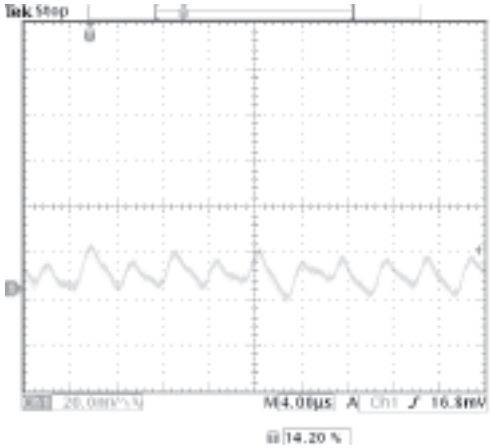
Efficiency



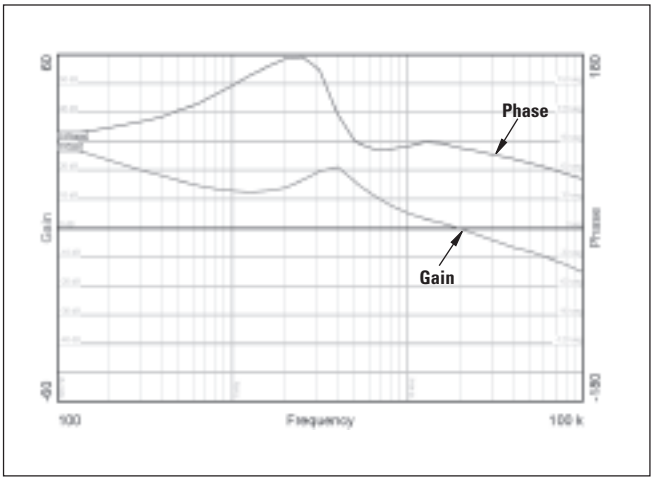
5-V Output Ripple
V_{IN} = 12 V; I_O = 14 A, 20 mV/div



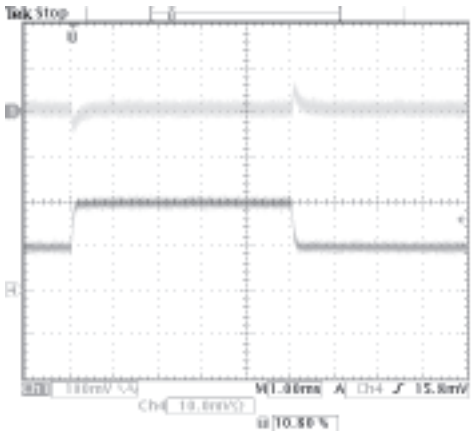
3.3-V Output Ripple
V_{IN} = 12 V; I_O = 10 A, 20 mV/div



5-V Control Loop
V_{IN} = 12 V; I_O = 14 A



5-V Transient Response
Top Trace: 5 V_{OUT} at 100 mV/div
Bottom Trace: I_O at 5 A/div



Description

The TPS40060EVM evaluation module (EVM) is a high-efficiency, wide input range synchronous buck converter providing a fixed 3.3-V output at 4 A from a 10-V to 55-V input. The EVM is designed to start up from a supply, so no additional bias voltage is required for start-up directly from the supply. The module uses the TPS40060 with P-channel, high-side MOSFET.

TPS40060EVM works over the full input range of the TPS40060 to produce a regulated 3.3-V output at up to 4 A of load current. Using lossless $R_{DS(ON)}$ current sense and a high-side, P-channel MOSFET simplifies the circuit design without sacrificing performance.

The evaluation module provides test points for input voltage, output voltage, key waveforms and a 50-Ω connection point in the feedback loop for non-invasive measurements of the feedback loop along with an oscilloscope jack for easy measurements of output ripple.

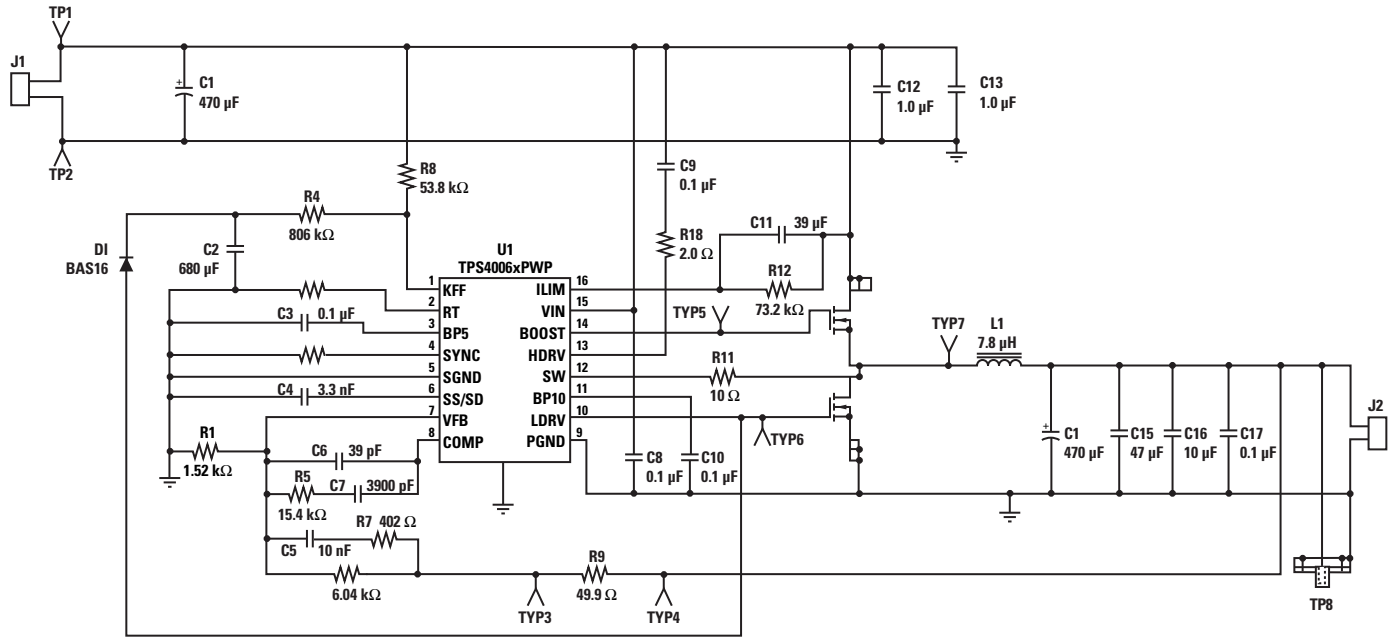
Web Links

Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS40060**

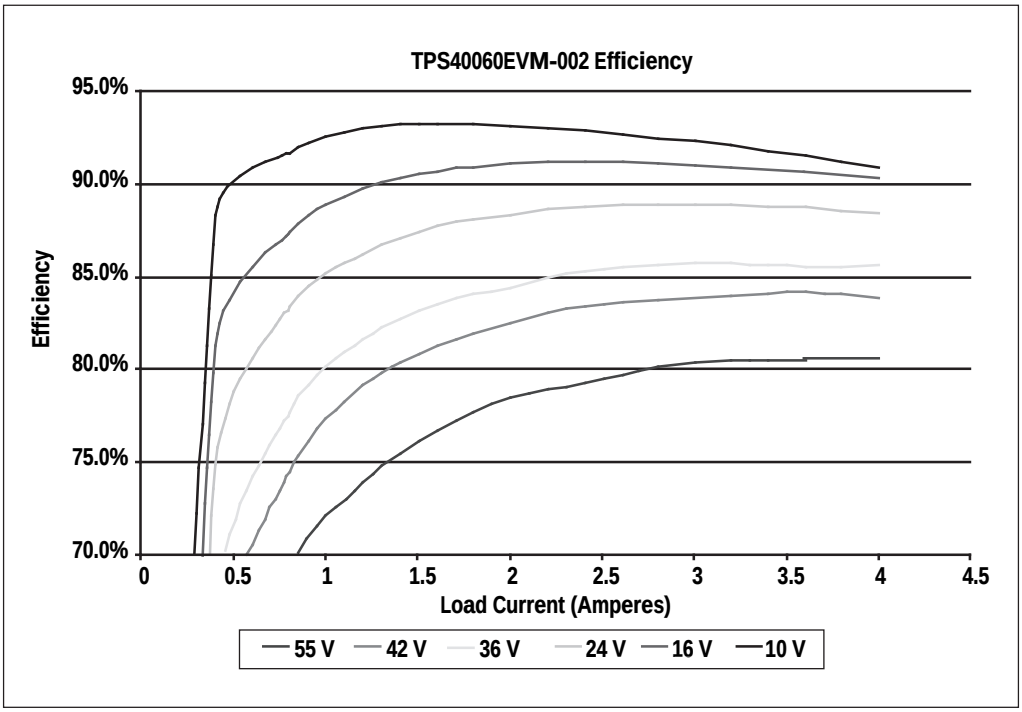
Specifications					
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		10		55	V
Output Voltage		3.0	3.3	3.6	V
Load Current		0		4	A
Switching Frequency		225	250	275	kHz
Output Ripple Voltage	V_{IN} = 55 V; I_O = 4 A		30		mV_{PP}
Efficiency	V_{IN} = 12 V; I_O = 3 A		90		%

Evaluation Module - TPS40060EVM

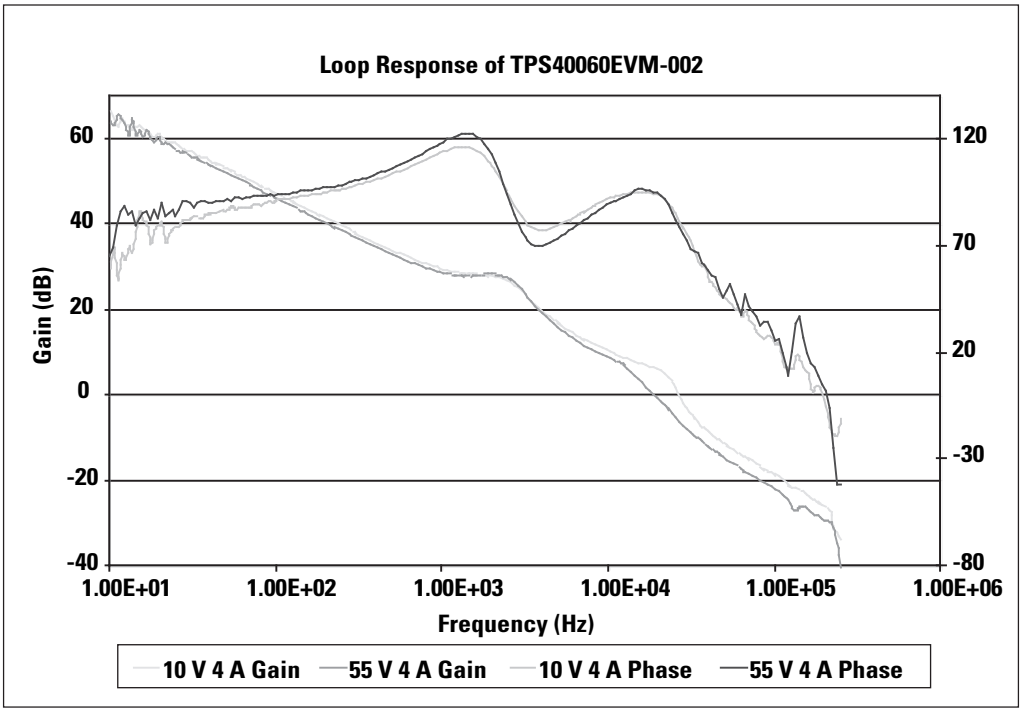


Test Results

Efficiency V_{IN} = 10 to 55 V; I_{OUT} = 0-4 A



Loop Response Gain and Phase Plot



Description

The TPS40130EVM-001 evaluation module (EVM) is a high-efficiency, two-phase synchronous buck converter providing a fixed 1.5 V output at up to 40 A from a 12-V input bus. The EVM is designed to start up from a single supply, so no additional bias voltage is required for start-up. The module uses the TPS40130 high-frequency two-phase controller.

Web Links

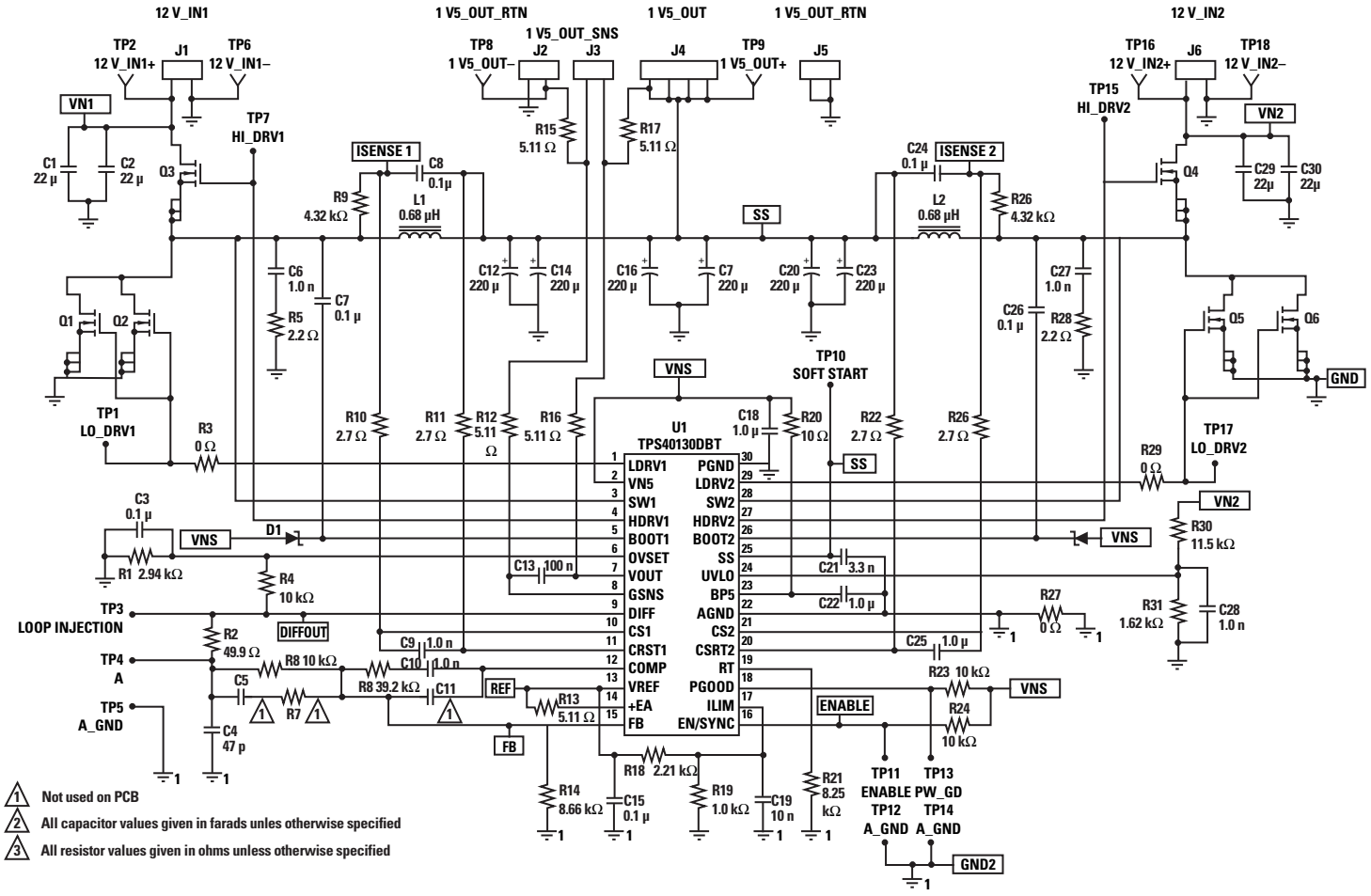
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **TPS40130**

Specifications

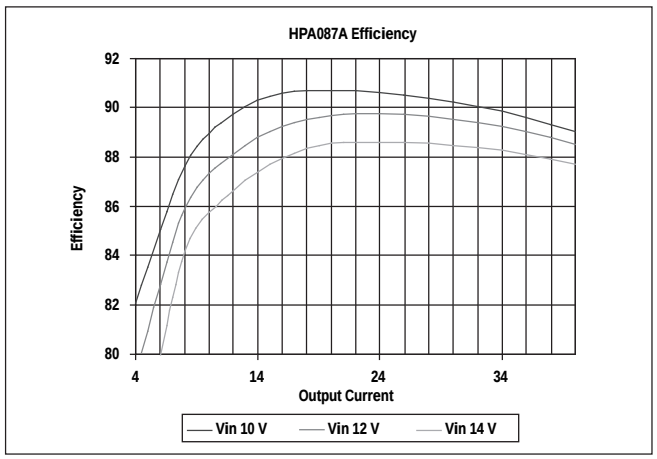
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		10	-	14	V
Output Voltage	R14 = 8.88 kΩ	0.7	-	3.3	V
Load Current	V_{IN} = 14 V; I_O = 0 A		40		A
Ripple Frequency			660		kHz
Output Ripple Voltage	V_{IN} = 14 V; I_O = 40 A		30		mV_{PP}
Efficiency	V_{IN} = 12 V; I_O = 20 A		91		%

Evaluation Module - TPS40130EVM-001

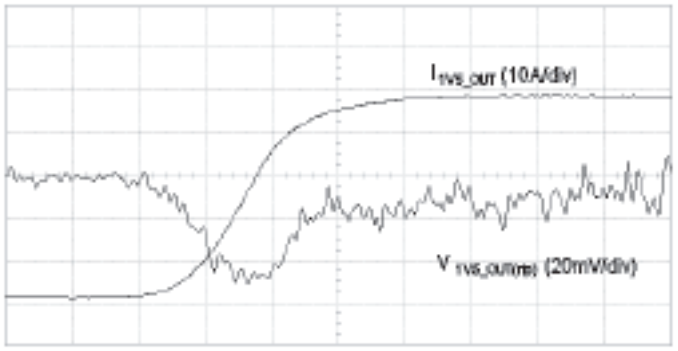


Test Results

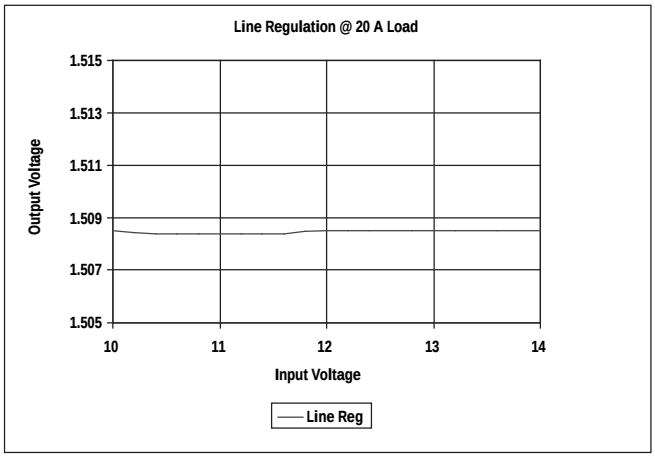
Efficiency



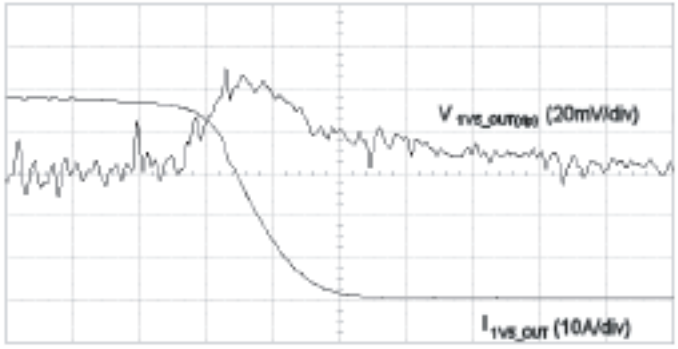
Transient Response: 5-55 A at 3A/ms, I_{1V5_OUT} (10 A/div), $V_{1V5\_OUT(rip)}$ (20 mV/div), Time 10 ms/div



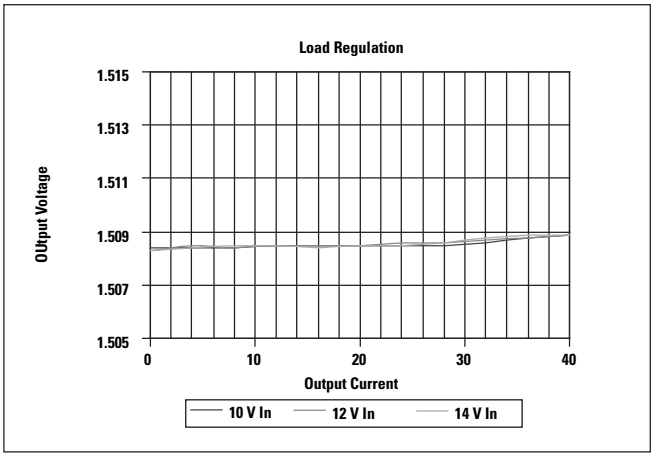
Line Regulation
V_{IV5_OUT} = 20 A



Negative Transient: 5-55 A at 3A/ms, I_{1V5_OUT} (10 A/div), $V_{1V5\_OUT(rip)}$ (20 mV/div), Time 10 ms/div



Load Regulation



Description

This reference design uses the UCC38C43 in boost topology to convert from +12 V to +24 V at 3.5 A. The boost topology with Schottky output diodes enables PMP781 to achieve efficiencies greater than 95%. One note of caution with this topology is that it does have short-circuit protection. A short on the output shorts through the inductor and output diode. Even if current mode control were added, this path still exists. If short circuit protection is needed, using a different topology such as flyback, SEPIC or a current limit circuit such as a fuse, polyfuse or hot swap should be considered.

Web Links

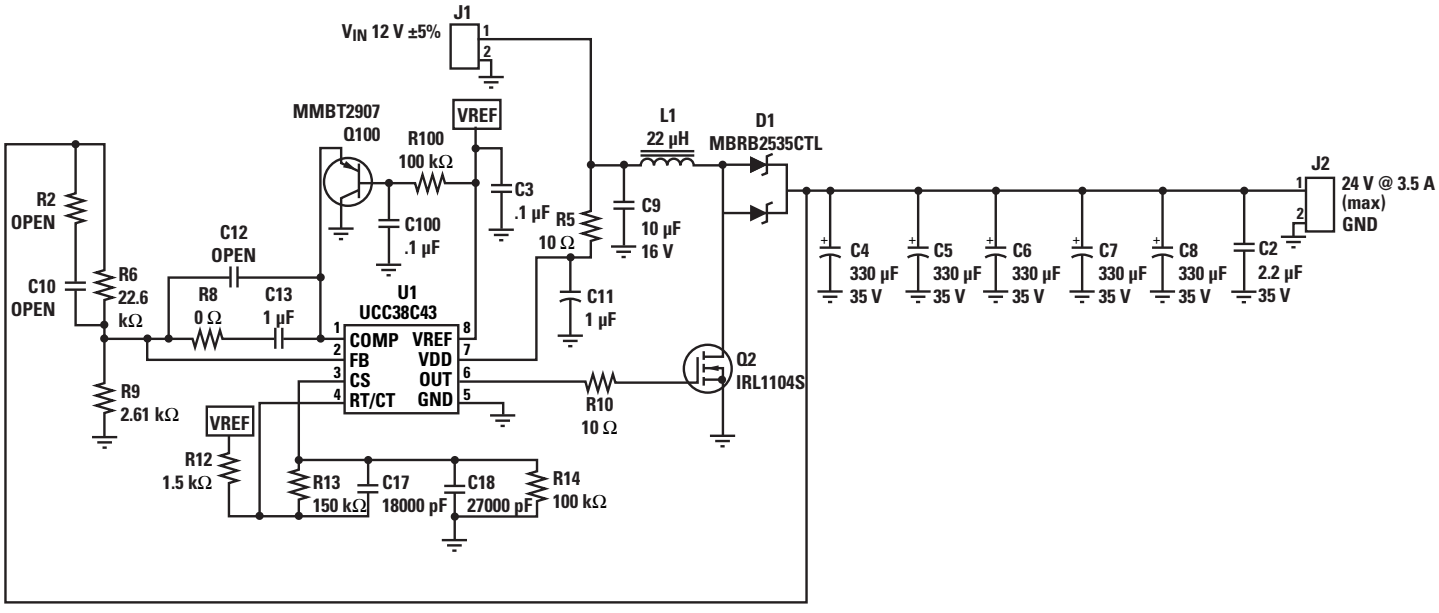
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **UCC38C4X**

Specifications

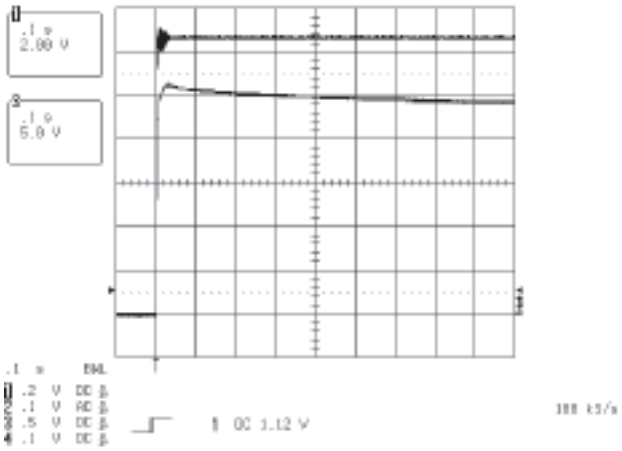
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		11	12	13	V
Output Voltage		23.25	24	24.73	V
Load Current		0	2	3.5	A
Switching Frequency			100		kHz
Output Ripple Voltage	V_{IN} = 12 V; I_O = 3.5 A		200		mV_{PP}
Efficiency	V_{IN} = 12 V; I_O = 1 A		91		%
	V_{IN} = 12 V; I_O = 3 A		94		%

Reference Design Number - PMP 781

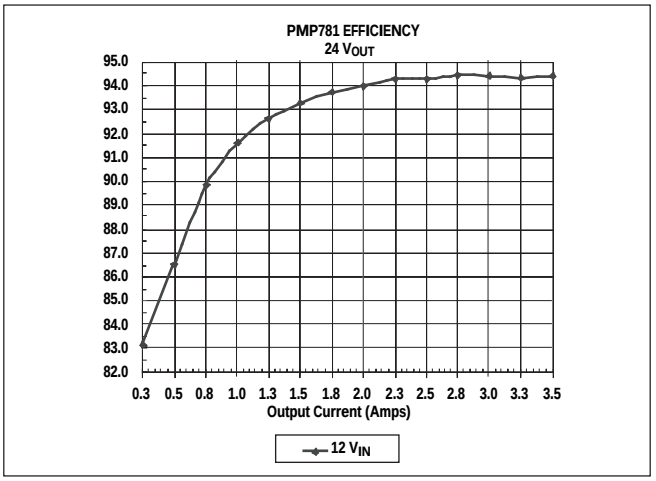


Test Results

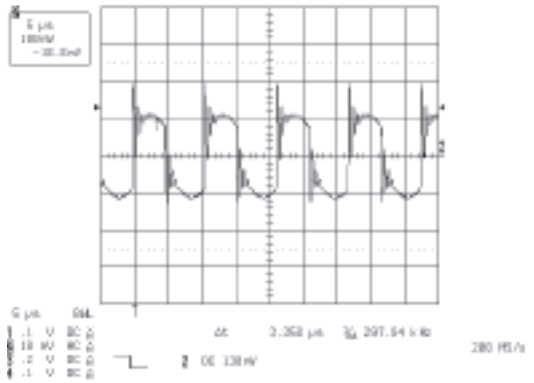
Turn On V_{IN} = 12 V; No Load
Channel 1: V_{IN}; Channel 2: V_{OUT}



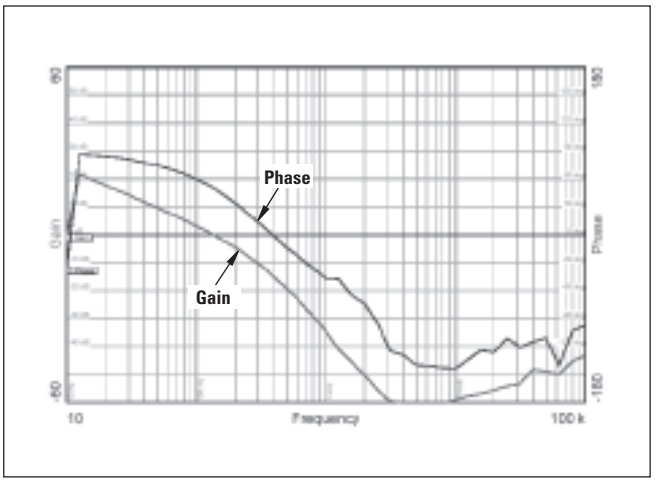
Efficiency



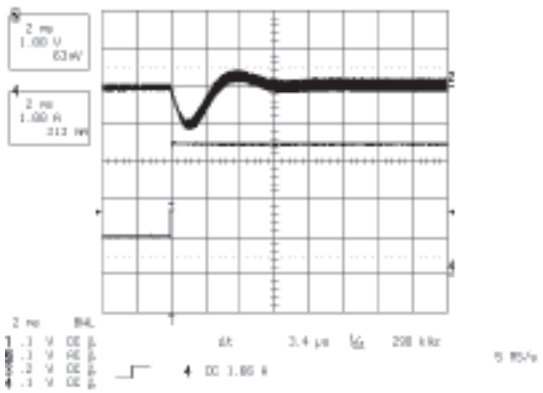
Output Ripple
V_{IN} = 48 V; I_O = 3 A



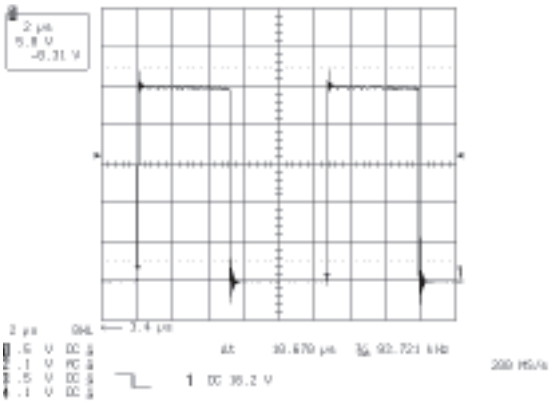
Control Loop
V_{IN} = 12 V; I_O = 3 A



Transient Response
Top Trace: V_O at 1 V/div;
Bottom Trace: I_O at 1 A/div



FET Drain Voltage



Description

This reference design uses the UCC3809, a current mode controlled synchronous flyback converter that can deliver 5 A of continuous output current at 3.3 V from an input range of 36 to 75 V_{DC}. The UCC3809 provides all necessary functions for the control of isolated off line and DC/DC power converters. This design results in a highly efficient, small, cost-effective solution for low-power isolated applications. Peak efficiency using the UCC3809 and synchronous rectification are greater than 88%.

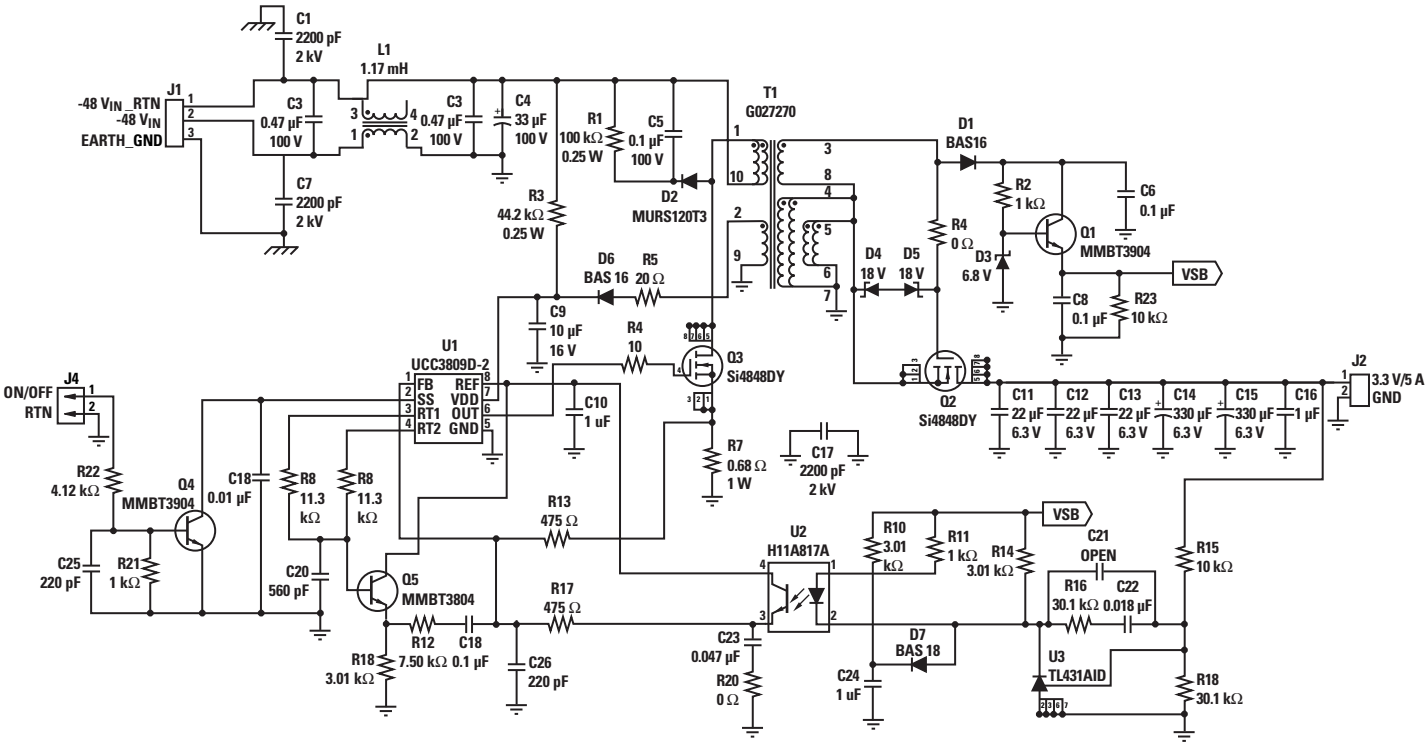
Web Links

Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **UCC3809**

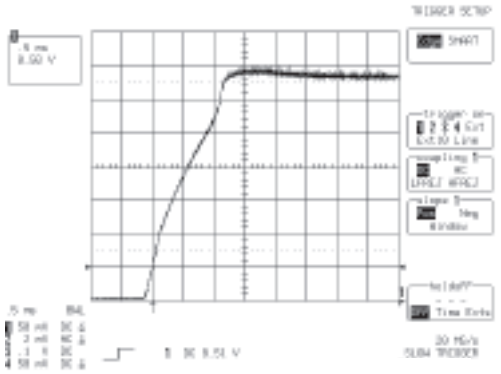
Specifications					
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		36	48	75	V
Output Voltage		3.0	3.3	3.6	V
Load Current		0		5	A
Switching Frequency			100		kHz
Output Ripple Voltage	V_{IN} = 48 V; I_O = 5 A		50		mV_{PP}
Efficiency	V_{IN} = 48 V; I_O = 5 A		85		%

Reference Design Number - PMP 665

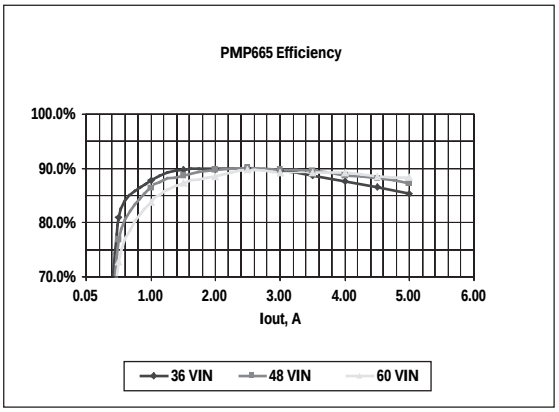


Test Results

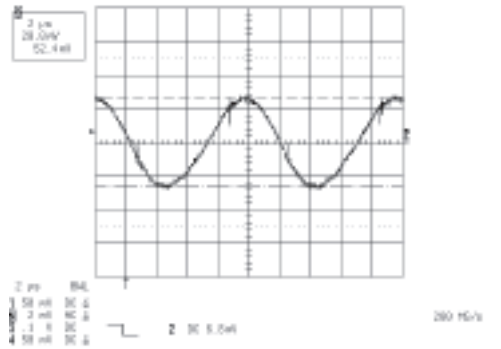
Turn On V_{IN} = 48 V; No Load



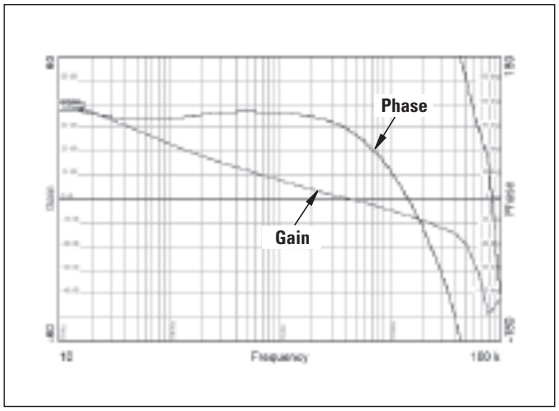
Efficiency



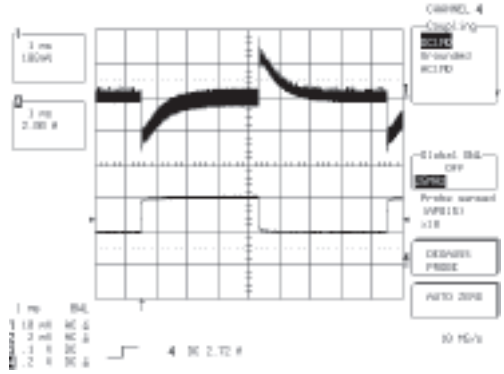
Output Ripple
V_{IN} = 48 V; I_O = 5 A



Control Loop
V_{IN} = 5 V; I_O = 15 A



Transient Response
Top Trace: V_O at 100 mV/div;
Bottom Trace: I_O at 2 A/div



UCC3813: Triple-Output Flyback, Low-Power Economy PWM Controller

Description

The UCC3813-5 controller is used in a continuous flyback converter to generate three output voltages. The outputs are +12 V/1 A, +5 V/0.5 A and –5 V/0.3 A. The input voltage ranges from 5 V to 24 V. The UCC3813 family of high-speed, low-power integrated circuits contain all of the control and drive components required for off line and DC/DC fixed-frequency current mode switching power supplies with minimal parts count.

Web Links

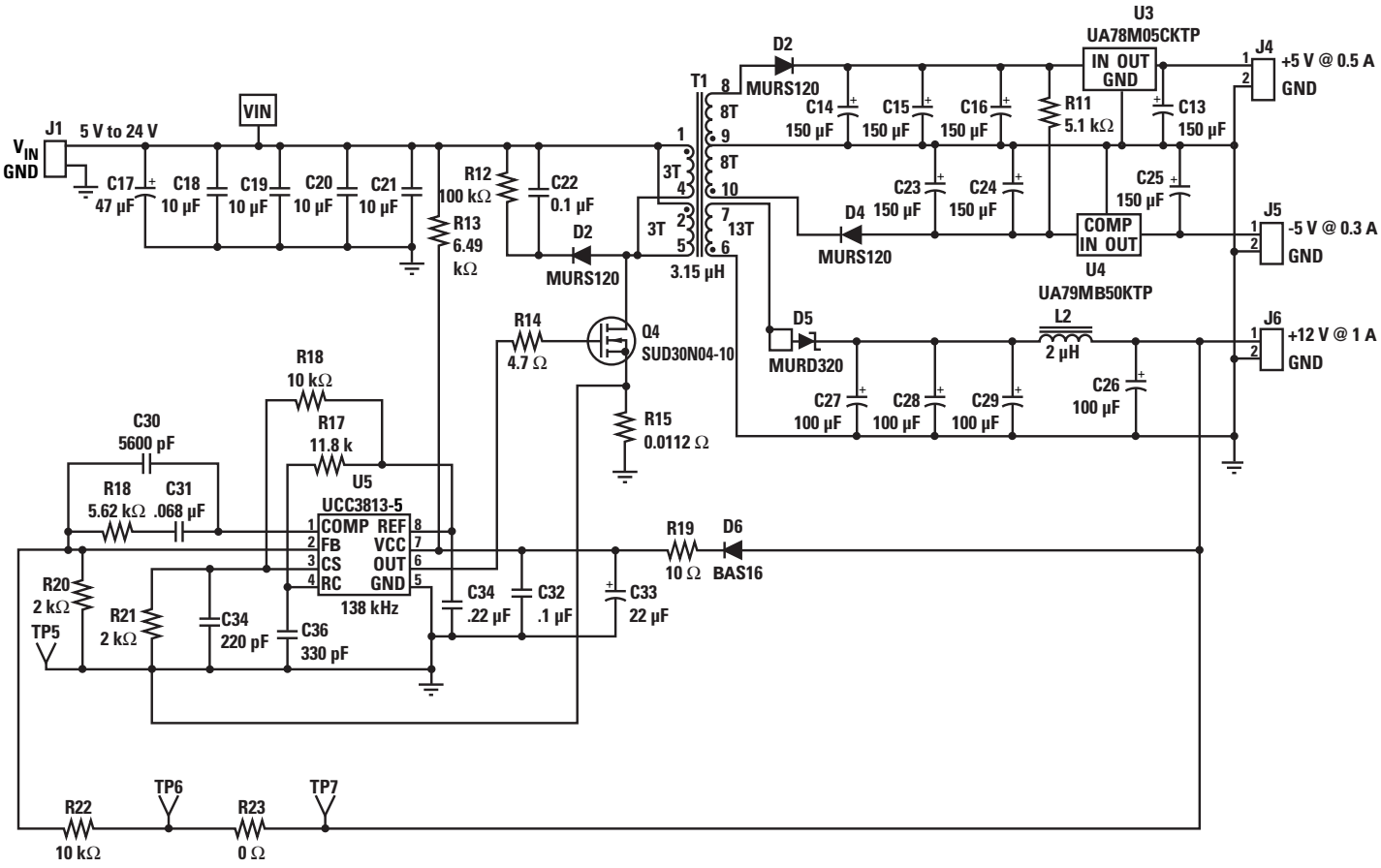
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **UCC3813**

Specifications

Parameter	Min	Typ	Max	Units
Input Voltage	+5		+24	V
V_{OUT1}	+11.40	+12	+12.6	V
I_{OUT1}	0.25		1.00	A
V_{OUT2}	+4.75	+5.00	+5.25	V
I_{OUT2}	0		0.50	A
V_{OUT3}	–4.75	–5.00	–5.25	V
I_{OUT3}	0		0.30	A
Switching Frequency		130		kHz

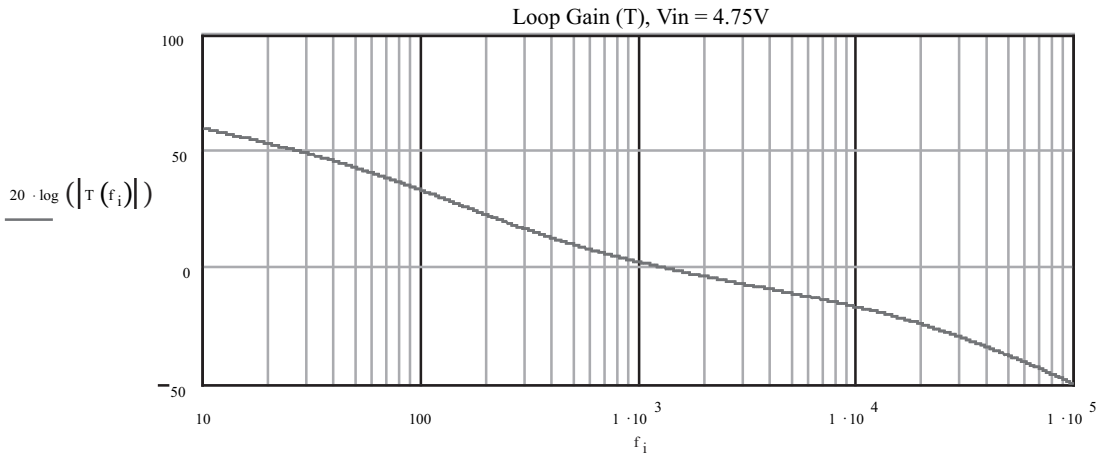
Reference Design Number - PMP 469

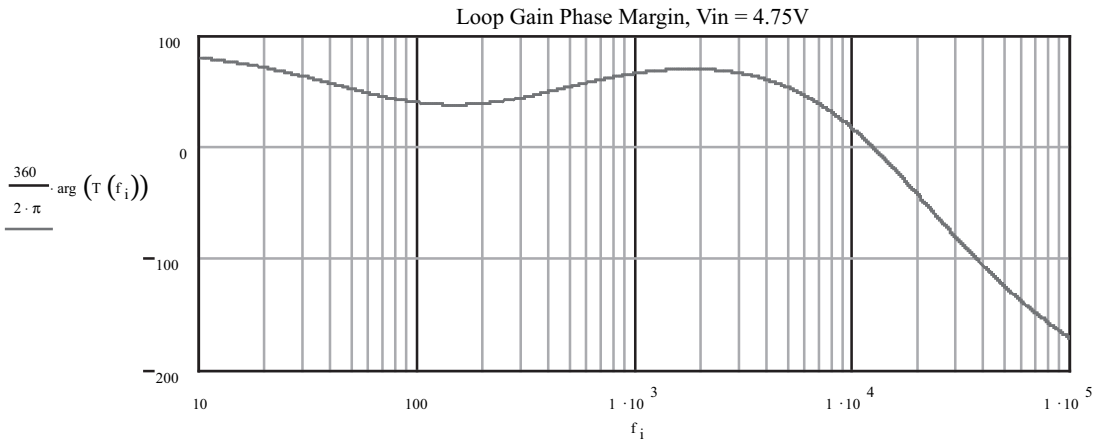


Test Results

Regulation and Efficiency								
V_{IN} (V)	I_{IN} (A)	V_{OUT1} (V)	I_{OUT1} (A)	V_{OUT2} (V)	I_{OUT2} (A)	V_{OUT3} (V)	I_{OUT3} (A)	Efficiency (%)
5.00	4.46	+11.93	1.008	+4.94	0.400	–5.03	0.400	71.8
12.01	1.761	+11.94	1.008	+4.94	0.400	–5.03	0.400	75.7
24.03	0.899	+11.94	1.008	+4.94	0.400	–5.03	0.400	74.1
4.97	2.133	+11.94	0.500	+4.97	0.200	–5.03	0.200	75.2
12.00	0.876	+11.95	0.500	+4.97	0.200	–5.03	0.200	75.9
24.04	0.449	+11.95	0.500	+4.97	0.200	–5.03	0.200	73.9
5.00	1.069	+11.94	0.250	+4.98	0.100	–5.03	0.100	74.4
12.04	0.446	+11.95	0.250	+4.98	0.100	–5.03	0.100	74.1
24.02	0.232	+11.95	0.250	+4.98	0.100	–5.03	0.100	71.4

Calculated Loop Gain





Description

This reference design uses the UCC2580 in an active-clamp forward converter that can deliver up to 30 A of continuous current at 3.3 V from an input range of –36 V to –72 V. The active-clamp topology with self-driven secondary synchronous MOSFETs allows PMP 206 to achieve efficiencies greater than 90%. The design includes remote sense connections for point-of-load regulation.

Web Links

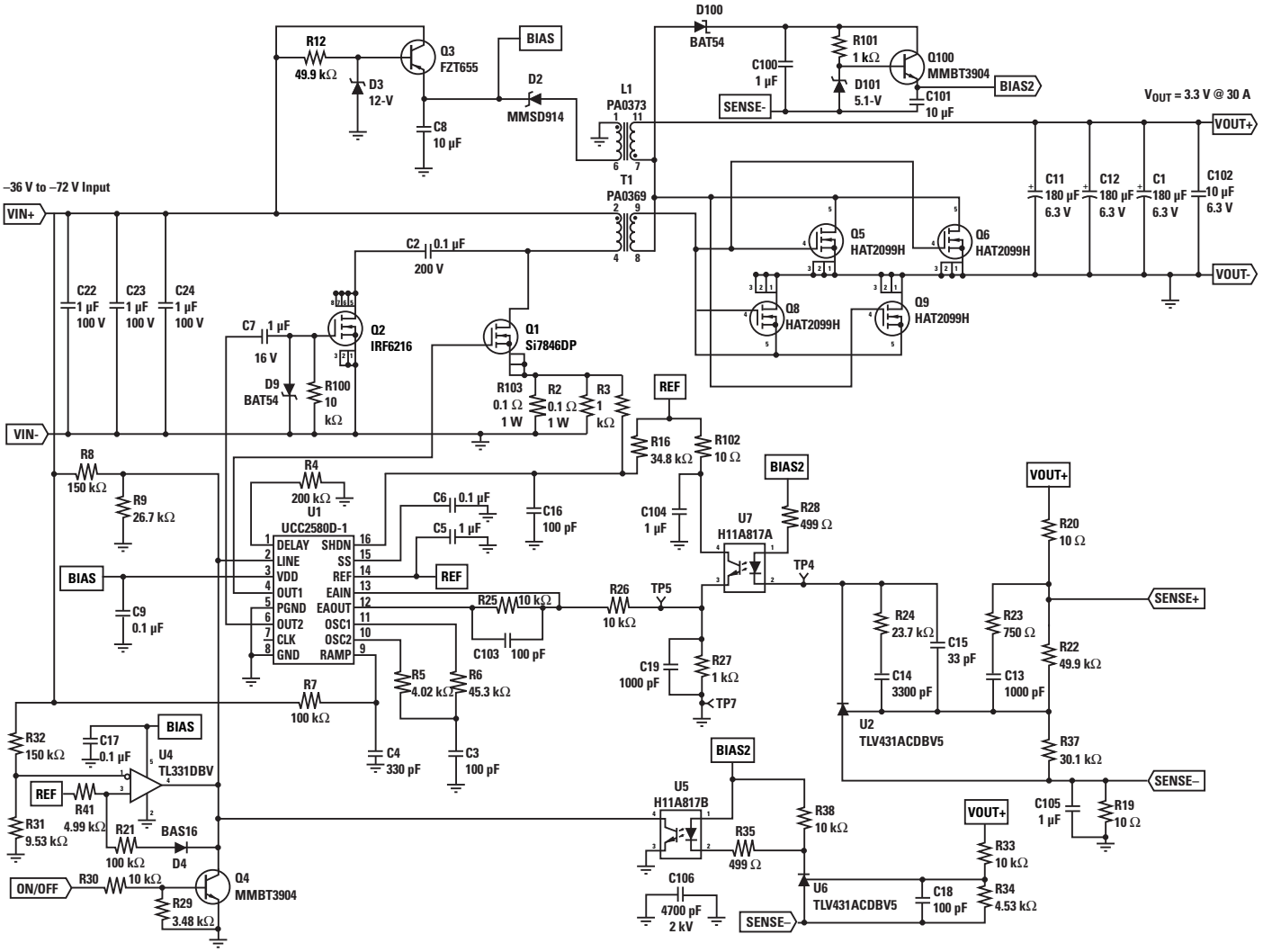
Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **UCC2580**

Specifications

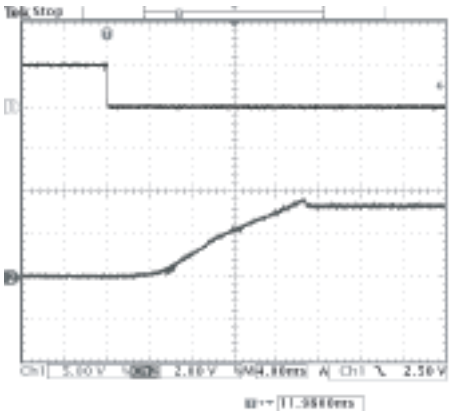
Parameter	Test Conditions	Min	Typ	Max	Unit
Input Voltage		–36	–48	–72	V
Output Voltage		3.2	3.3	3.4	V
Load Current		0		30	A
Switching Frequency			300		kHz
Output Ripple Voltage	V_{IN} = –48 V; I_O = 30 A		25		mV_{pp}
Efficiency	V_{IN} = –48 V; I_O = 10 A		93		%
	V_{IN} = –48 V; I_O = 30 A		89		%

Reference Design Number - PMP 206

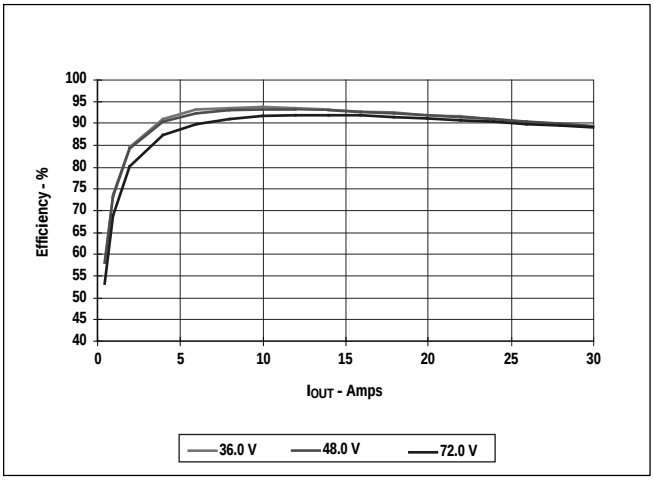


Test Results

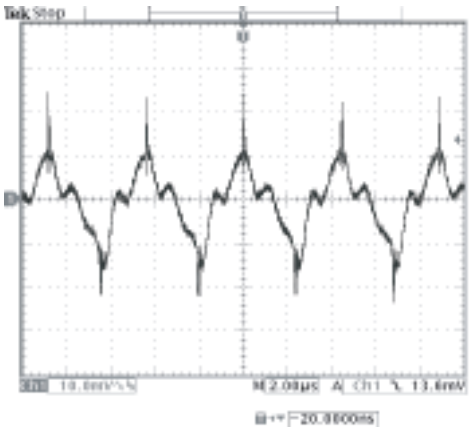
Turn On V_{IN} = –48 V; No Load
Top Trace: Enable at 5 V/div;
Bottom Trace: V_{out} at 2 V/div



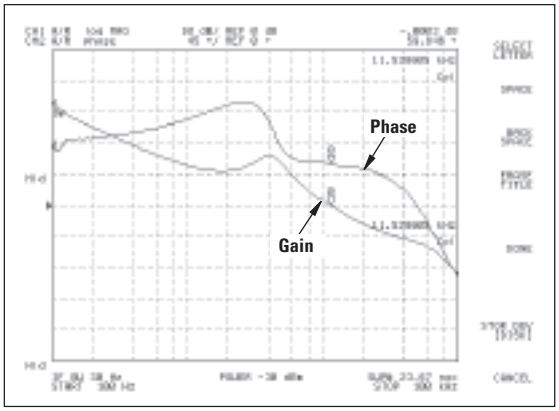
Efficiency



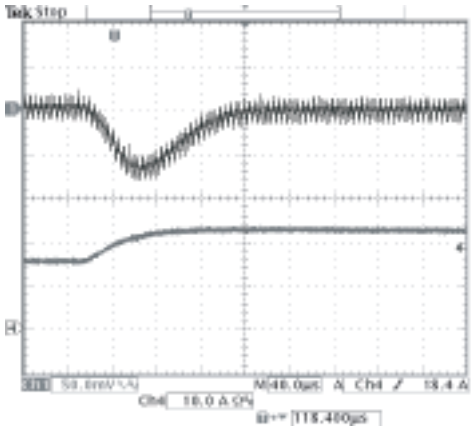
Output Ripple
V_{IN} = –48 V; I_O = 30 A



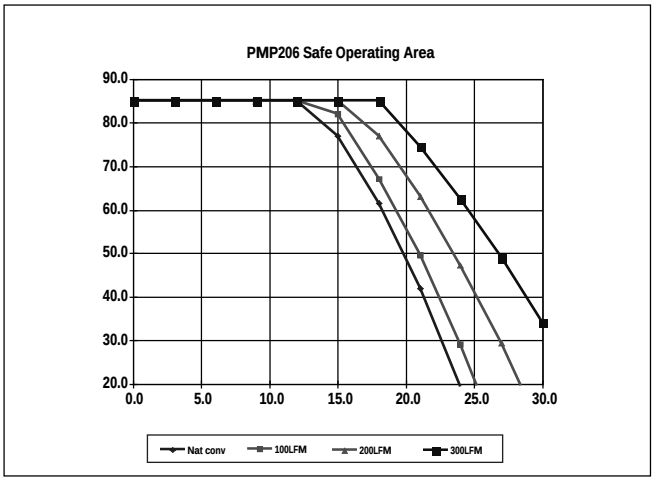
Control Loop
V_{IN} = –48 V; I_O = 30 A



Transient Response
Top Trace: V_O at 50 mV/div;
Bottom Trace: I_O at 10 A/div



SOA for –48-V Input



bq24103: Synchronous, Switch-Mode Lithium-Ion Charger

Description

The bq241xx is a synchronous, switch-mode battery charger with internal power FETs capable of supplying up to 2 A of charge current. It enables higher charge current while reducing the amount of heat generated, making it ideal for use in systems that incorporate one-, two- and three-series cell lithium-ion or lithium-polymer battery packs. Applications include portable DVD and media players, smart handhelds, medical, industrial and other portable equipment. The integrated PWM controller operates at a fixed frequency of 1.1 MHz, allowing the use of a small inductor and output capacitor. The IC delivers high-accuracy current and voltage regulation for precise battery charging, over-voltage protection, multiple charge status outputs for charge progress indication and charge termination. Charge termination is based on a minimum current level. A programmable charge timer provides a safety backup for termination. Other versions of the IC also allow the portable system's microcontroller to control the battery charging profile and termination with digital inputs to the IC.

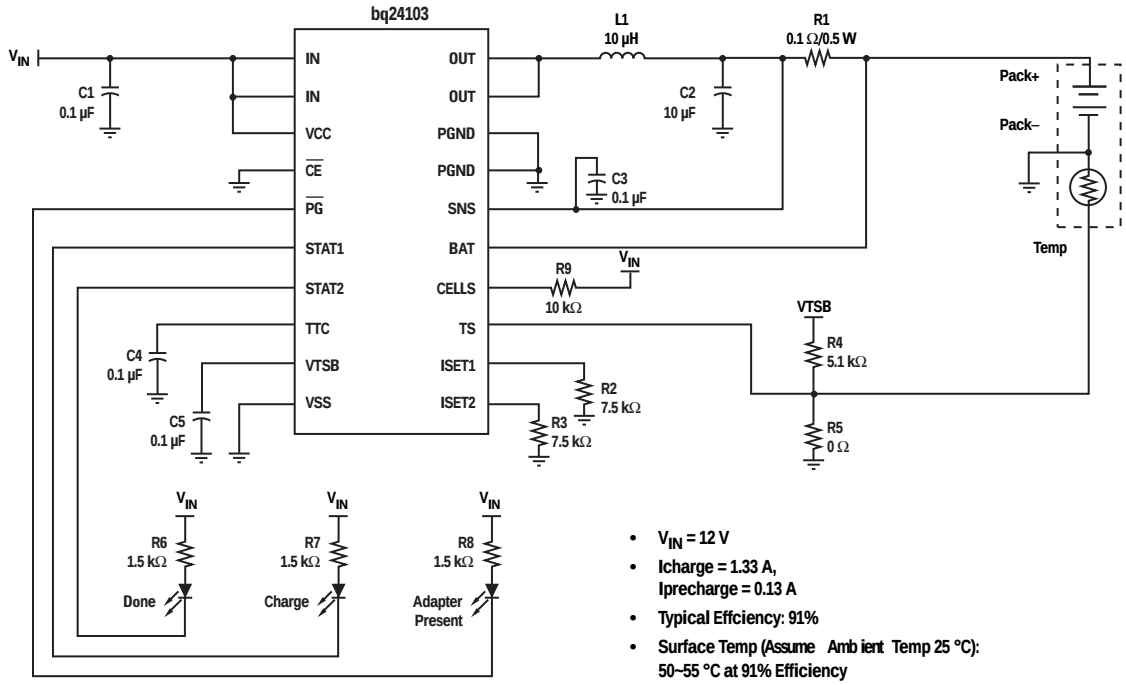
Web Links

Reference Designs:
http://www.ti.com/powerreferencedesigns

Datasheets, User's Guides, Samples:
www.ti.com
Part Number Search: **bq24103**

Specifications				
Parameter	Min	Typ	Max	Unit
Input Voltage	4.35		16	V
Charge Current			2	A
Sync PWM		1.1		MHz

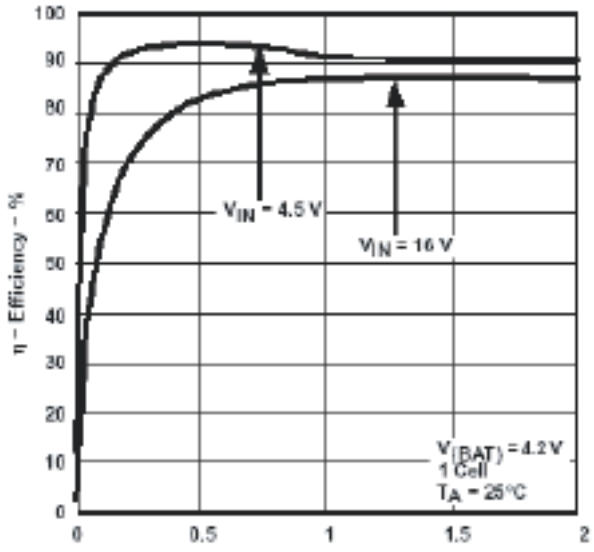
Evaluation Module - bq24103EVM



- V_{IN} = 12 V
- Icharge = 1.33 A, Iprecharge = 0.13 A
- Typical Effciency: 91%
- Surface Temp (Assume Amb ient Temp 25 °C): 50~55 °C at 91% Efficiency

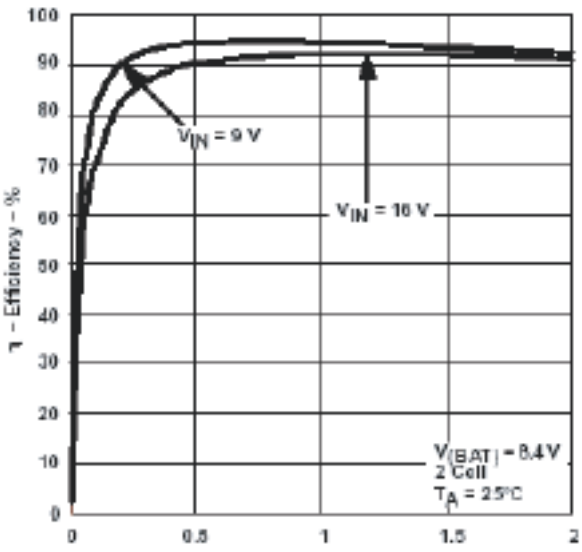
Test Results

Efficiency vs. Output Charge Current



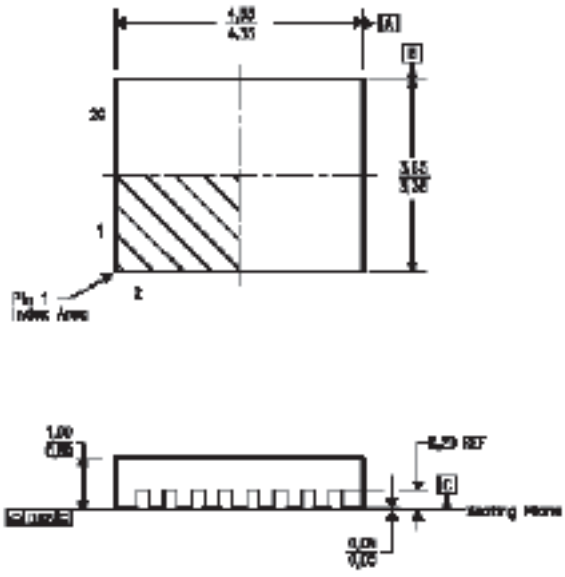
$I_{O(CHARGE)}$ = Output Charge Current - A

Efficiency vs. Output Charge Current



$I_{O(CHARGE)}$ = Output Charge Current - A

QFN Package



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