GENERAL DESCRIPTION

The XRP7657 is a non synchronous voltage mode PWM step down (buck) regulator capable of a constant output current up to 2Amps. A wide 4.75V to 25V input voltage range allows for single supply operations from industry standard 5V, 12V and 24V power rails.

With a 420kHz constant operating frequency and integrated high side switch, the XRP7657 reduces the overall component count and solution footprint. In addition to a 2% output setpoint accuracy, this device provides high efficiency, low ripple and excellent line and load regulation. An enable function and soft start feature allow for controlled power up sequencing implementation.

Built-in over current, output short-circuit and over temperature protection insure safe operations under abnormal operating conditions.

The XRP7657 is offered in a RoHS compliant, "green"/halogen free 8-pin SOIC package.

APPLICATIONS

- **Distributed Power Architectures**
- **Point of Load Converters**
- **Audio-Video Equipments**
- **Medical & Industrial Equipments**

FEATURES

- **2A Constant Output Current**
- **4.75V to 25V Wide Input Voltage**
- **PWM Voltage Mode Control**
  - 420kHz Constant Operations
  - Up to 94% Efficiency
- **Adjustable Output Voltage**
  - 0.8V to 21V Range
  - 2% Accuracy
- **Soft-Start and Enable Function**
- **Built-in Thermal, Over Current and Output Short Circuit Protection**
- **RoHS Compliant, "Green"/Halogen Free 8-Pin SOIC Package**
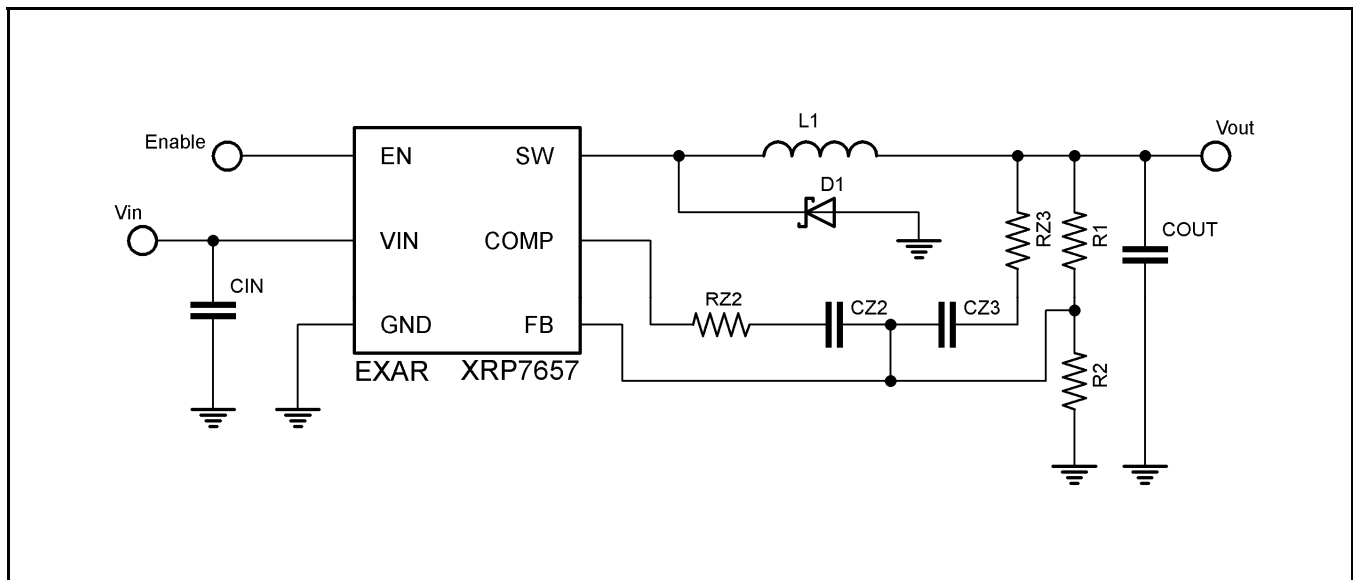
TYPICAL APPLICATION DIAGRAM

Fig. 1: XRP7657 Application Diagram

ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

V_{IN} ....-0.3V to 30V
COMP, FB pin voltage....................................-0.3V to 6V
SW, EN pin voltage..................................... -0.3V to V_{IN}
Storage Temperature............................. -65°C to 150°C
Power Dissipation .... Internally Limited
Junction Temperature T_J......................................150°C
Lead Temperature (Soldering, 10 sec) ....260°C
ESD Rating (HBM - Human Body Model)....................2kV

OPERATING RATINGS

Input Voltage Range V_{IN}..............................4.75V to 25V
Output Voltage Range V_{OUT}...........................0.8V to 21V
Junction Temperature T_J Range.................-40°C to 125°C
Thermal Resistance θ_{JA}
(junction to ambient, no heat sink, free air) ....100°C/W

ELECTRICAL SPECIFICATIONS

Specifications with standard type are for an Ambient Temperature of T_A = 25°C only; limits applying over the full Operating Junction Temperature range are denoted by a "●". Minimum and Maximum limits are guaranteed through test, design, or statistical correlation. Typical values represent the most likely parametric norm at T_A = 25°C, and are provided for reference purposes only. Unless otherwise indicated, V_{IN} = 12V, V_{OUT} = 5V, T_A= 25°C.

Parameter	Min.	Typ.	Max.	Units		Conditions
Input Voltage V_{IN}	4.75		25			
Shutdown Quiescent Current I_{SHDN}		44	60	µA		V_{EN}=0.4V
Quiescent Current I_Q		1.3	2.5	mA		V_{EN}=2.0V, V_{FB}=1.3V
Feedback Voltage V_{FB}	0.784	0.800	0.816	V		V_{IN}=5V to 25V
Feedback Bias Current I_{FB}		-0.1	-0.5	µA		V_{FB}=1.3V
Switch Current Limit I_{LIM}	2.5	3.4		A		
Oscillator Frequency f_{OSC}	336	420	504	kHz		
Oscillator Frequency f_{OSC1}		40		kHz		V_{FB}=0.52V, Current limit activated or short circuit protection mode
Error Amplifier Voltage Gain G_V		1000		V/V		
Error Amplifier Transconductance G_S		700		µA/V		
EN Pin Threshold High V_H	1.5			V		
EN Pin Threshold Low V_L			0.7	V		
EN Pin Input Leakage Current I_{EN}		-5	-10	µA		V_{EN}=2.5V
Internal PMOS ON Resistance $R_{DS(ON)}$		130	150	mΩ		V_{IN}= V_{EN}=12V, V_{FB}=0.65V, I_{OUT}=12A
Maximum Duty Cycle D_{MAX}			100	%		V_{FB}=0.65V, I_{SW}=0.1A
Thermal Shutdown T_{OTSD}		155		°C		
Thermal Shutdown Hysteresis T_{HYS}		20		°C		

BLOCK DIAGRAM
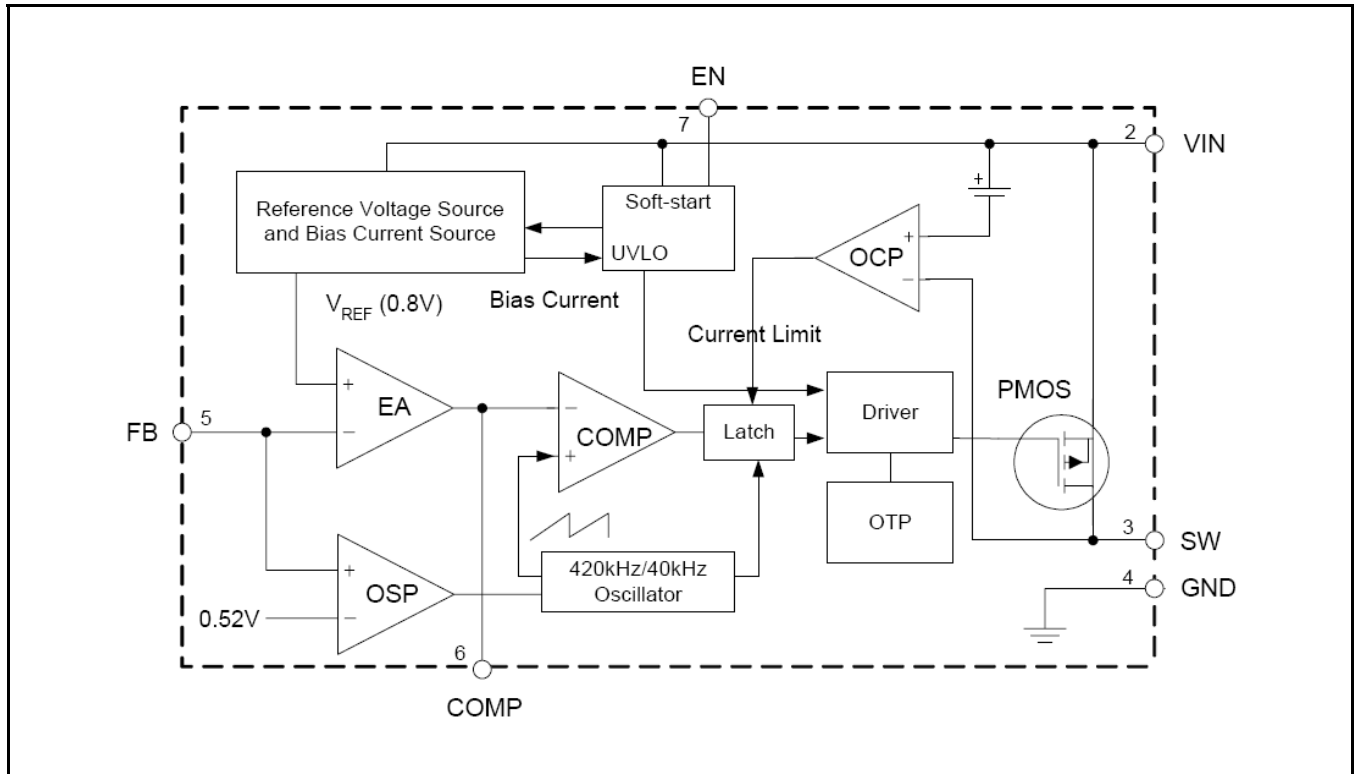
Fig. 2: XRP7657 Block Diagram

PIN ASSIGNMENT
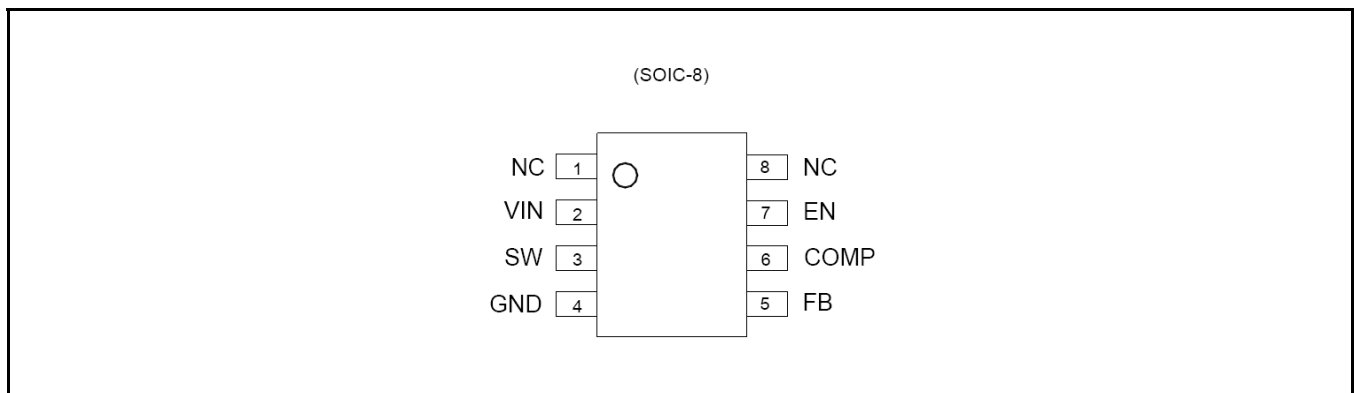
Fig. 3: XRP7657 Pin Assignment

PIN DESCRIPTION

Name	Pin Number	Description
NC	1	No connect
VIN	2	Supply Voltage Input Pin. Bypass VIN to GND with a suitable large capacitor to eliminate noise on the input
SW	3	Power Switch Output Pin. SW is the switch node that supplies power to the output
GND	4	Ground signal pin
FB	5	Feedback Pin. Through an external resistor divider network, FB senses the output voltage and regulates it. To prevent current limit run away in a short circuit fault condition, the frequency feedback comparator lowers the oscillator frequency to 40kHz when the FB voltage is below 0.52V. The feedback threshold voltage is 0.8V
COMP	6	Compensation Pin. This pin is the output of the error amplifier. Frequency compensation is done at this pin by connecting a series RC to ground (parallel a C if necessary)
EN	7	Enable Pin. Drive EN pin high to turn on the device, drive it low to turn off.Default of this pin is high level.
NC	8	No connect

ORDERING INFORMATION

Part Number	Junction Temperature Range	Marking	Package	Packing Quantity	Note 1	Note 2
XRP7657EDTR-F	-40°C≤T_A≤+125°C	XRP7657E YYWW X	SOIC8	2.5K/Tape & Reel	RoHS Compliant Halogen Free	
XRP7657EVB	XRP7657 Evaluation Board					

"YY" = Year – "WW" = Work Week – "X" = Lot Number

TYPICAL PERFORMANCE CHARACTERISTICS

All data taken at V_{IN}=12V, V_{OUT}=5V, T_A=25°C, unless otherwise specified - Schematic and BOM from Application Information section of this datasheet.
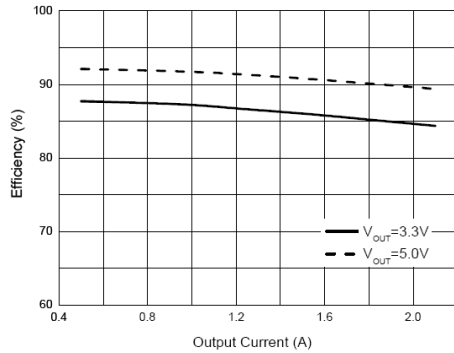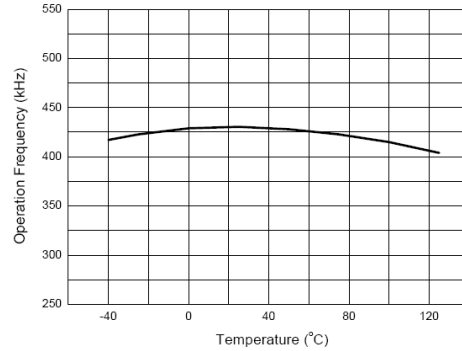
Fig. 4: Efficiency vs. Output Current

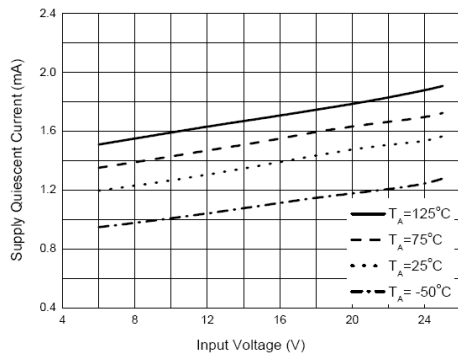Fig. 5: Operation Frequency vs. Temperature
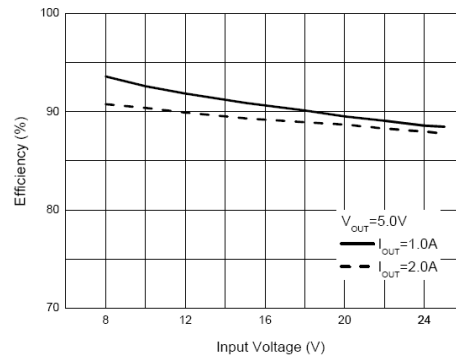
Fig. 6: Supply Quiescent Current vs. Input Voltage
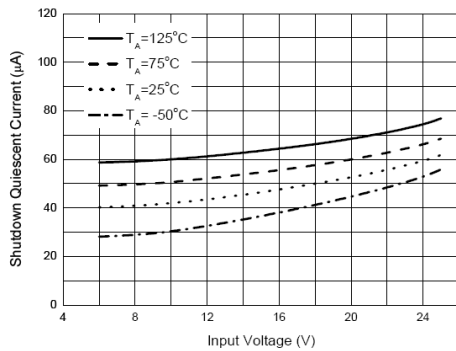
Fig. 7: Efficiency vs. Input Voltage

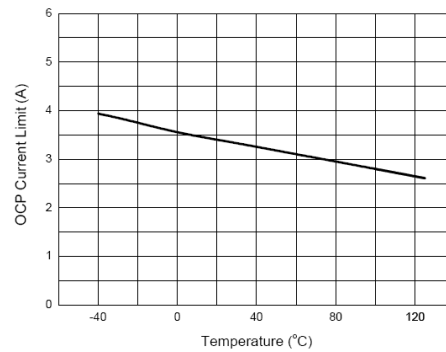Fig. 8:Shutdown Quiescent Current vs. Input Voltage

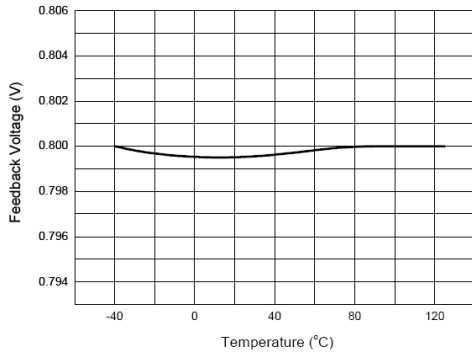Fig. 9: OCP Current Limit vs. Temperature

Fig. 10: Feedback Voltage vs. Temperature
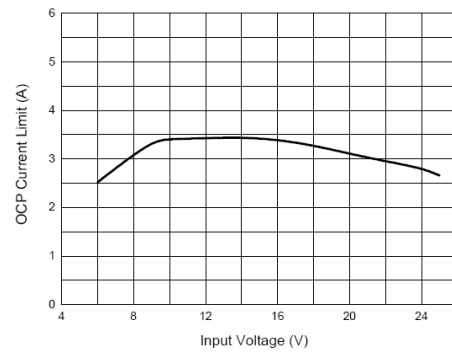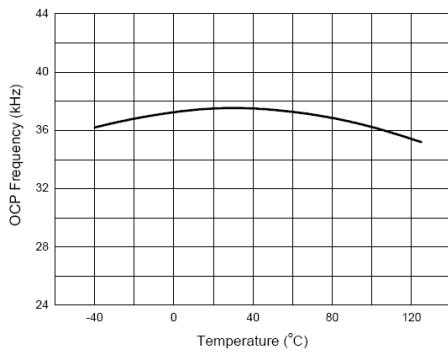

Fig. 11: OCP Current Limit vs. Input Voltage

Fig. 12: OCP Frequency vs. Temperature

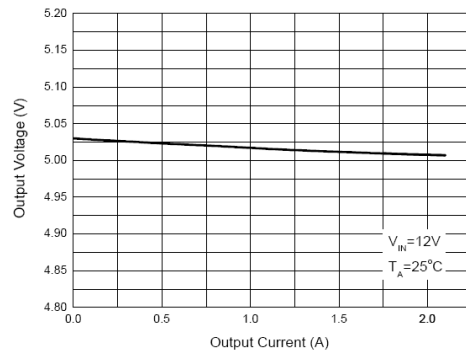Fig. 13: Output Voltage vs. Output Current

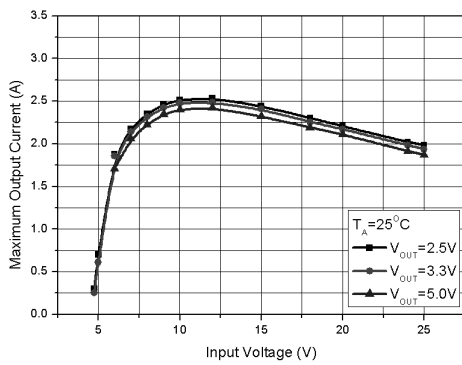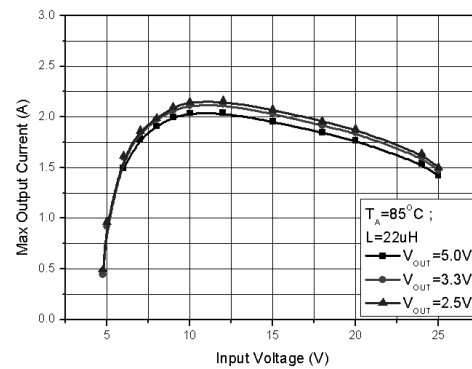Fig. 14: Output Current vs. Input voltage (T_A=25°C)

Fig. 15: Output Current vs. Input Voltage (T_A=85°C)

APPLICATION INFORMATION

THEORY OF OPERATION

XRP7657 is a non-synchronous voltage mode PWM buck regulator featuring an integrated P-channel switching FET. Using a PFET enables the regulator to operate at 100% duty cycle. Additional features include preset switching frequency of 420kHz and preset soft-start. Safety features include under-voltage lock-Out (UVLO), over-current protection (OCP), over-temperature protection (OVP) and short-circuit protection.

TYPICAL APPLICATION SCHEMATICS
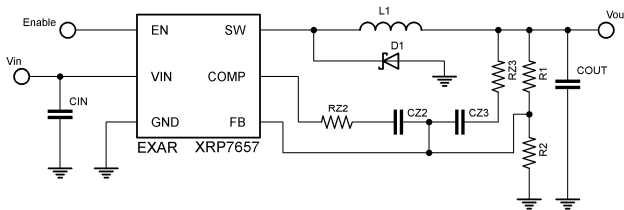
SETTING THE OUTPUT VOLTAGE

Output voltage V_{OUT} is set by placing a resistor divider between output of the regulator and feedback pin. Resistors R_1 and R_2 are calculated from the following equation:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right)$$

Where V_{REF} is the reference voltage set internally at 0.8V nominal.

ENABLE SIGNAL

The Enable pin can be used to turn the regulator on and off. Pulling the Enable below 0.7V puts the regulator in shutdown mode with a corresponding quiescent current of less than 60µA. If Enable is not going to be used it should be tied to V_{IN}.

SELECTING DIODE D1

D1 must be a Schottky diode and selected for Voltage rating V_R, current rating I_F and power rating P. The voltage rating should be greater than V_{IN} in order to block the input voltage when the internal PFET is on. As a rule of thumb D1 voltage rating should be 50% larger than V_{IN}. A simplified rule for current rating is to select a diode capable of conducting the converter's output current.

SELECTING INDUCTOR L1

L1 should have saturation current rating I_{SAT} greater than the converter output current. As a rule of thumb I_{SAT} should be twice the output current.

The inductance value can be calculate from the following equation:

$$L = (V_{IN} - V_{OUT}) \times \left(\frac{V_{OUT}}{V_{IN}}\right) \times \left(\frac{1}{f}\right) \times \left(\frac{1}{\Delta_{IL}}\right)$$

Where:

V_{IN} is converter input voltage

V_{OUT} is converter output voltage

f is the nominal switching frequency, 420kHz

Δ_{IL} is the peak to peak inductor current ripple usually set to 30% of I_{OUT}

OUTPUT CAPACITOR SELECTION

Either ceramic or ALEL capacitors can be used. Select the output capacitor for voltage rating, capacitance and Equivalent Series Resistance (ESR). Nominally the voltage rating is selected to be twice as large as the output voltage. Select the capacitance to satisfy the specification for output voltage overshoot/undershoot caused by current step load. A steady-state output current I_{OUT} corresponds to inductor stored energy of ½ x L x I_{OUT}^2. A sudden decrease in I_{OUT} forces the energy surplus in L to be absorbed by C_{OUT}. This causes an overshoot in output voltage that is corrected by power switch reduced duty cycle. Use the following equation to calculate C_{OUT}:

$$C_{OUT} = L \times \left(\frac{I_2{}^2 - I_1{}^2}{V_{OUTS}{}^2 - V_{OUT}{}^2} \right)$$

Where:

I_2 is the load step high current

I_1 is the load step low current

V_{OUTS} is output voltage including overshoot

V_{OUT} is steady-state output voltage

INPUT CAPACITOR SELECTION

Ceramic capacitors are recommended since they have low ESR and low ESL. Therefore they are more effective in providing the pulsating input current required by the buck converter. Voltage rating of the capacitor should be at least 50% higher than the converter input voltage. See following design examples for required value of C_{IN}.

COMPENSATION

A type-III compensation is used to stabilize the loop. A detailed explanation of calculating component values for type-III compensations is given in EXAR's application note ANP-16. Compensation was calculated based on a cross-over frequency (f_C) of 40kHz and ramp voltage of 0.5V. Component Cp, which is mentioned in ANP-16, has not been used here.

## TYPICAL APPLICATIONS

24V TO 5V – 2A POINT OF LOAD CONVERTER
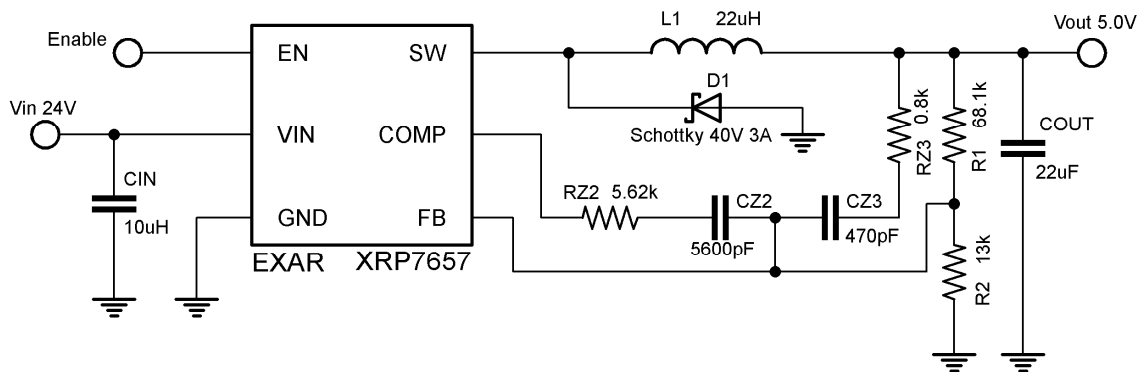
Ref.	Qty	Manufacturer	Part Number	Size	Description
U1	1	EXAR	XRP7657	SOIC-8	2A 25V Non-synchronous Buck Regulator
D1	1	Central Semicon.	CMSH3-40MA	SMA	Schotkky, 40V, 3A
L1	1	Cooper Bussmann	DR74-220	7.6x7.6mm	22uH Coil 2.4A 48.9mOhm
C_{IN}	1	Murata Corp.	GRM32ER61E106K	1210	Ceramic Cap 10µF, 25V,X5R,1210
C_{OUT}	1	Murata Corp.	GRM31CR61C226M	1206	Ceramic Cap 22µF, 16V,X5R, 1206
CZ3	1	Murata Corp.	GRM188R71H471K	0603	Ceramic Cap 470pF, 50V,X7R, 0603
CZ2	1	Murata Corp.	GRM188R71H562K	0603	Ceramic Cap 5600pF, 50v,X7R,0603
R1	1	Panasonic	ERJ-3EKF6812V	0603	Res 68.1k Ohm, 1%, 0603, SMD
R2	1	Panasonic	ERJ-3EKF1302V	0603	Res 13k Ohm, 1%, 0603 SMD
RZ3	1	Panasonic	ERJ-3EKF0801V	0603	Res 0.8k Ohm, 1%, 0603 SMD
RZ2	1	Panasonic	ERJ-3EKF5621V	0603	Res 5.62k Ohm, 1%, 0603 SMD

12V TO 3.3V – 2A POINT OF LOAD CONVERTER
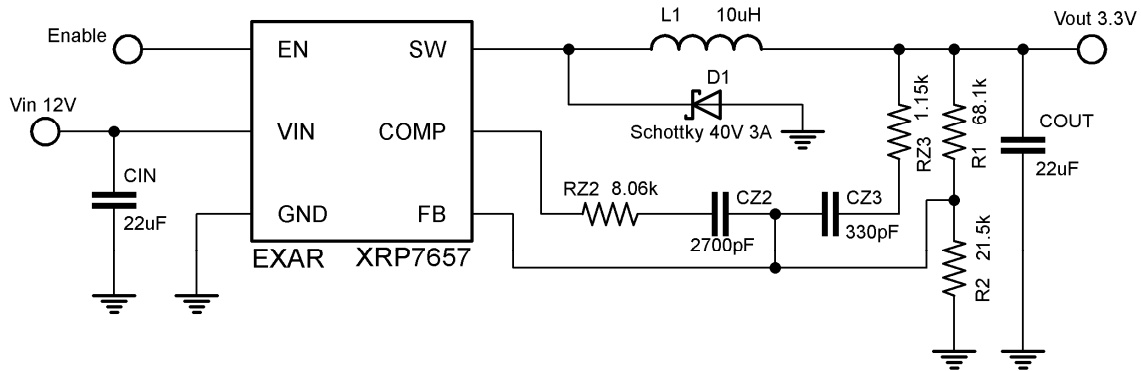
Ref.	Qty	Manufacturer	Part Number	Size	Description
U1	1	EXAR	XRP7657	SOIC-8	2A 25V Non-synchronous Buck Regulator
D1	1	Central Semicon.	CMSH3-40MA	SMA	Schotkky, 40V, 3A
L1	1	Cooper Bussmann	DR74-100	7.6x7.6mm	10uH Coil 2.4A 48.9mOhm
C_{IN}	1	Murata Corp.	GRM32ER61E226K	1210	Ceramic Cap 22µF, 25V,X5R,1210
C_{OUT}	1	Murata Corp.	GRM31CR61C226M	1206	Ceramic Cap 22µF, 16V,X5R, 1206
CZ3	1	Murata Corp.	GRM188R71H331K	0603	Ceramic Cap 330pF, 50V,X7R, 0603
CZ2	1	Murata Corp.	GRM188R71H272K	0603	Ceramic Cap 2700pF, 50v,X7R,0603
R1	1	Panasonic	ERJ-3EKF6812V	0603	Res 68.1k Ohm, 1%, 0603, SMD
R2	1	Panasonic	ERJ-3EKF2152V	0603	Res 21.5k Ohm, 1%, 0603 SMD
RZ3	1	Panasonic	ERJ-3EKF1151V	0603	Res 1.15k Ohm, 1%, 0603 SMD
RZ2	1	Panasonic	ERJ-3EKF8061V	0603	Res 8.06k Ohm, 1%, 0603 SMD

PACKAGE SPECIFICATION

SOIC-8
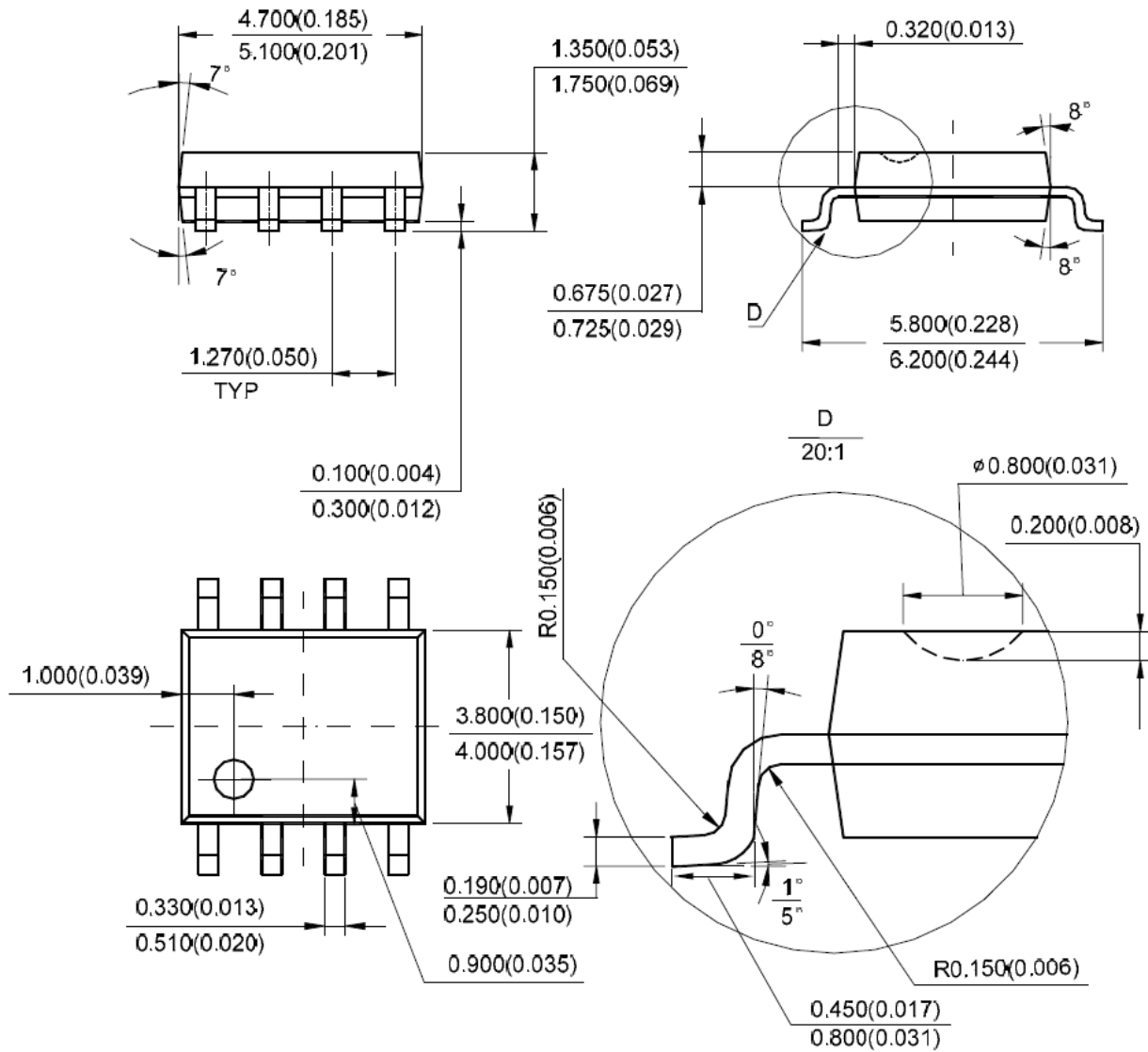
REVISION HISTORY

Revision	Date	Description
1.0.0	09/25/2009	Initial Release of Datasheet
2.0.0	02/18/2011	Maximum Quiescent Current I_Q set to 2.5mA

FOR FURTHER ASSISTANCE

Email: customersupport@exar.com

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EXAR CORPORATION

HEADQUARTERS AND SALES OFFICES

48720 Kato Road

Fremont, CA 94538 – USA

Tel.: +1 (510) 668-7000

Fax: +1 (510) 668-7030

www.exar.com

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