采用 QFN 封装且具有 4.5V 至 40V 输入的 LMZ34002 15W 负输出电源模块

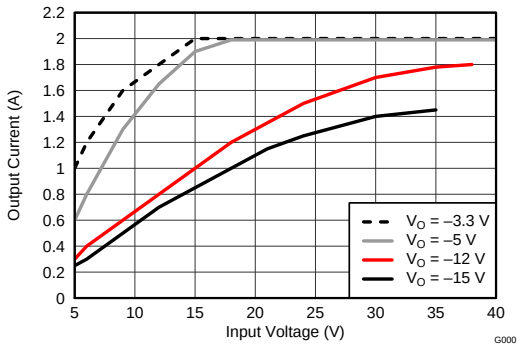
1 特性

- 完整的集成式电源解决方案可实现小尺寸和扁平设计
- 4.5V 至 40V 的宽输入电压范围
- 可调节输出电压范围为 –3V 至 –17V
- 输出电流高达 2A
- 45V 浪涌能力
- 与外部时钟同步
- 可调慢速启动
- 可编程欠压锁定 (UVLO)
- 输出过流保护
- 过热保护
- 运行温度范围：-40°C 至 +85°C
- 增强的热性能：14°C/W
- 符合 EN55022 B 类辐射标准
  - 集成屏蔽式电感器
- 如需设计帮助，请访问 http://www.ti.com.cn/product/cn/lmz34002
- 使用 LMZ34002 并借助 WEBENCH® 电源设计器创建定制设计方案

2 应用

- 工业和电机控制
- 自动测试设备
- 音频/视频中的双极放大器
- 高密度电源系统

安全工作电流

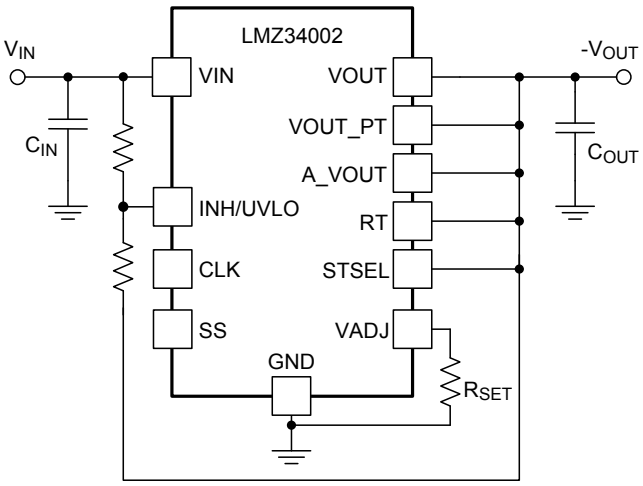


3 说明

LMZ34002 SIMPLE SWITCHER® 电源模块是一款易于使用的负输出电压电源模块，它在一个小外形尺寸的 QFN 封装内整合了一个带有屏蔽式电感器的 15W 直流/直流转换器和无源器件。此整体电源解决方案仅需五个外部组件，并省去了环路补偿和磁性元件选择过程。

9×11×2.8mm QFN 封装可轻松焊接到印刷电路板上，并且可凭借较少的组件和出色的功率耗散能力实现紧凑的设计。LMZ34002 提供离散设计的灵活性和特性集并且非常适合为多种 IC 和要求负输出电压的模拟电路供电。先进的封装技术可提供一个与标准 QFN 贴装和测试技术兼容的稳健耐用且可靠的电源解决方案。

简化应用



An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

4 Specifications

4.1 Absolute Maximum Ratings(1)

over operating temperature range (unless otherwise noted)

		MIN	MAX	UNIT
Input Voltage	VIN	–0.3	45	V
	INH/UVLO	–0.3	5(2)	V
	VADJ	–0.3	3(2)	V
	SS	–0.3	3(2)	V
	STSEL	–0.3	3(2)	V
	RT	–0.3	3.6(2)	V
	CLK	–0.3	3.6(2)	V
Output Voltage	PH	–0.6	45	V
	PH 10ns Transient	–2	45	V
	VOUT	–0.6	VIN(2)	V
V_{DIFF} (VOUT to exposed thermal pad)			±200	mV
Source Current	INH/UVLO		100	µA
Sink Current	SS		200	µA
Operating Junction Temperature		–40	105(3)	°C
Storage Temperature		–65	150	°C
Peak Reflow Case Temperature(4)			250(5)	°C
Maximum Number of Reflows Allowed(4)			3(5)	
Mechanical Shock	Mil-STD-883D, Method 2002.3, 1 ms, 1/2 sine, mounted		1500	G
Mechanical Vibration	Mil-STD-883D, Method 2007.2, 20-2000Hz		20	

(1) Stresses beyond those listed under absolute maximum ratings may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) This voltage rating is referenced to A_VOUT, not GND.
(3) See the temperature derating curves in the Typical Characteristics section for thermal information.
(4) For soldering specifications, refer to the *Soldering Requirements for BQFN Packages* application note.
(5) Devices with a date code prior to week 14 2018 (1814) have a peak reflow case temperature of 240°C with a maximum of one reflow.

4.2 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V_{IN}	Input Voltage	4.5	40	V
V_{OUT}	Output Voltage	–3	–17	V

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4.3 Thermal Information

THERMAL METRIC(1)		LMZ34002 RKG 41 PINS	UNIT
θ_{JA}	Junction-to-ambient thermal resistance(2)	14	°C/W
ψ_{JT}	Junction-to-top characterization parameter(3)	3.3	°C/W
ψ_{JB}	Junction-to-board characterization parameter(4)	6.8	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* (SPRA953) application report.
(2) The junction-to-ambient thermal resistance, θ_{JA}, applies to devices soldered directly to a 100 mm x 100 mm double-sided PCB with 1 oz. copper and natural convection cooling. Additional airflow reduces θ_{JA}.
(3) The junction-to-top characterization parameter, ψ_{JT}, estimates the junction temperature, T_J, of a device in a real system, using a procedure described in JESD51-2A (sections 6 and 7). $T_J = \psi_{JT} * Pdis + T_T$; where Pdis is the power dissipated in the device and T_T is the temperature of the top of the device.
(4) The junction-to-board characterization parameter, ψ_{JB}, estimates the junction temperature, T_J, of a device in a real system, using a procedure described in JESD51-2A (sections 6 and 7). $T_J = \psi_{JB} * Pdis + T_B$; where Pdis is the power dissipated in the device and T_B is the temperature of the board 1mm from the device.

4.4 Package Specifications

LMZ34002		UNIT
Weight		0.9 grams
Flammability	Meets UL 94 V-O	
MTBF Calculated reliability	Per Bellcore TR-332, 50% stress, T_A = 40°C, ground benign	31.7 MHrs

4.5 Electrical Characteristics

-40°C ≤ T_A ≤ +85°C, V_{IN} = 12 V, V_{OUT} = –5 V, I_{OUT} = 2 A
C_{IN} = 2 × 2.2 µF ceramic, C_{OUT} = 2 × 47 µF ceramic (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
I_{OUT}	Output current	Over input voltage and output voltage range		0(1)		2(2)	A
V_{IN}	Input voltage range	Over output current range		4.5		40(3)	V
UVLO	V_{IN} Undervoltage lockout	Rising only, R_{UVLO1} = 174 kΩ, R_{UVLO2} = 63.4 kΩ			4.5		V
$V_{OUT(adj)}$	Output voltage adjust range	Over output current range		–3		–17(3)	V
V_{OUT}	Set-point voltage tolerance	T_A = 25°C, I_{OUT} = 100 mA				2.0% (4)	
	Temperature variation	–40°C ≤ T_A ≤ +85°C			±0.5%	±1%	
	Line regulation	Over input voltage range			±0.1%		
	Load regulation	From 100 mA to $I_{OUT(max)}$			±0.4%		
	Total output voltage variation	Includes set-point, line, load, and temperature variation				3% (4)	
η	Efficiency	V_{IN} = 24 V	V_{OUT} = –12 V, I_{OUT} = 1.0 A		85%		
			V_{OUT} = –5.0 V, I_{OUT} = 1.0 A		81%		
			V_{OUT} = –3.3 V, I_{OUT} = 1.0 A		77%		
		V_{IN} = 12 V	V_{OUT} = –12 V, I_{OUT} = 0.6 A		86%		
			V_{OUT} = –5.0 V, I_{OUT} = 1.0 A		81%		
			V_{OUT} = –3.3 V, I_{OUT} = 1.0 A		78%		
	Output voltage ripple	20 MHz bandwith, 100 mA ≤ I_{OUT} ≤ $I_{OUT(max)}$			1%		V_{OUT}
I_{LIM}	Current limit threshold				3 (5)		A
	Transient response	1.0 A/µs load step from 25 to 75% $I_{OUT(max)}$	Recovery time		500		µs
			V_{OUT} over/undershoot		80		mV

(1) This device can regulate V_{OUT} down to 0 A, however the ripple may increase due to pulse-skipping at light loads. See *Light-Load Behavior* for more information. See *No-Load Operation* when operating at 0 A.
(2) The maximum current is dependant on V_{IN} and V_{OUT}, see Figure 33.
(3) The sum of V_{IN} + $|V_{OUT}|$ must not exceed 50 V.
(4) The stated limit of the set-point voltage tolerance includes the tolerance of both the internal voltage reference and the internal adjustment resistor. The overall output voltage tolerance will be affected by the tolerance of the external R_{SET} resistor.
(5) This product is not designed to endure a sustained (> 5 sec) over-current condition.

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Electrical Characteristics (continued)

-40°C ≤ T_A ≤ +85°C, V_{IN} = 12 V, V_{OUT} = –5 V, I_{OUT} = 2 A
C_{IN} = 2 × 2.2 µF ceramic, C_{OUT} = 2 × 47 µF ceramic (unless otherwise noted)

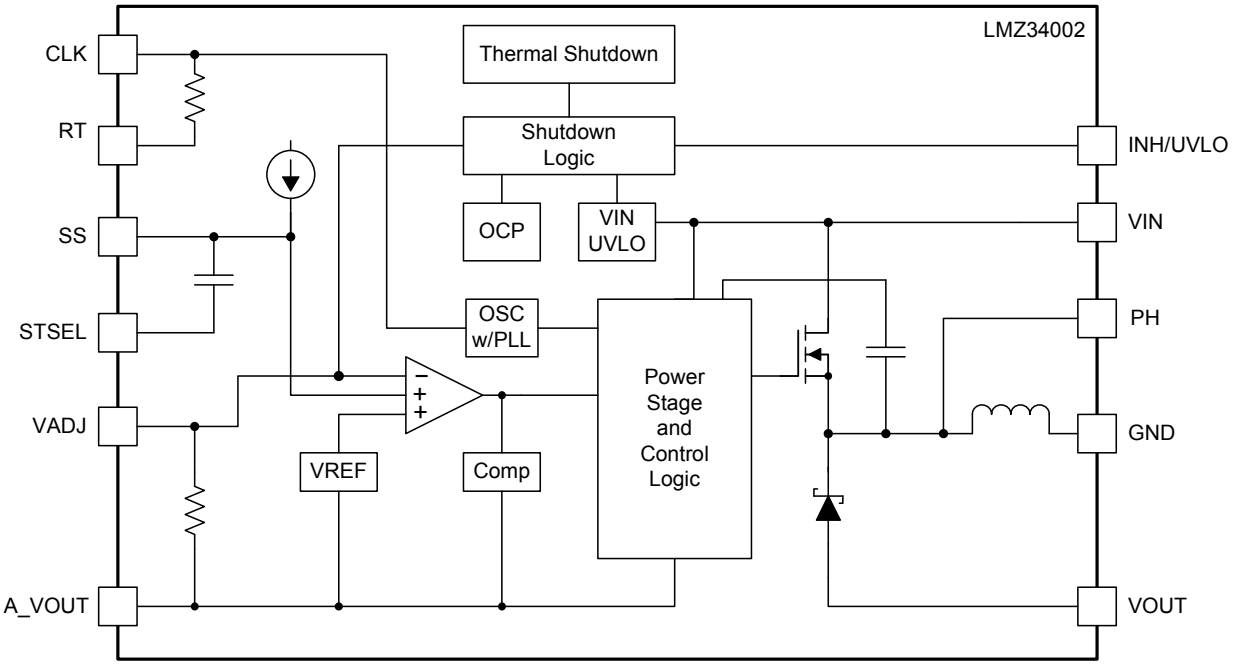
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{INH}	Inhibit threshold voltage	INH with respect to A_VOUT		1.15	1.25	1.36 (6)	V
I_{INH}	INH Input current	V_{INH} < 1.15 V			–0.9		µA
		V_{INH} > 1.36 V			–3.8		µA
$I_{I(stby)}$	Input standby current	INH pin to A_VOUT			1.3	4	µA
f_{SW}	Switching frequency	RT pin to A_VOUT		700	800	900	kHz
f_{CLK}	Synchronization frequency		R_{RT} = 0 Ω	700 (7)		900 (7)	kHz
			R_{RT} = 93.1 kΩ	400 (7)		600 (7)	kHz
V_{CLK-H}	CLK High-Level Threshold	With respect to A_VOUT			1.9	2.2	V
V_{CLK-L}	CLK Low-Level Threshold	With respect to A_VOUT		0.5	0.7		V
D_{CLK}	CLK Duty cycle			25%	50%	75%	
	Thermal Shutdown	Thermal shutdown			180		°C
		Thermal shutdown hysteresis			15		°C
C_{IN}	External input capacitance		Ceramic	4.7 (8)	10		µF
			Non-ceramic		22		
C_{OUT}	External output capacitance			100 (9)		430 (9)	µF

(6) If this pin is left open circuit, the device operates when input power is applied. An external level-shifter is required to interface with this pin. See *Output On/Off Inhibit (INH)* for further guidance.
(7) The synchronization frequency is dependant on V_{IN} and V_{OUT} as shown in *Switching Frequency*. R_{RT} must be either 0 Ω or 93.1kΩ.
(8) A minimum of 4.7 µF of ceramic external capacitance is required across the input (VIN and PGND connected) for proper operation. Locate the capacitor close to the device. See Table 1 for more details.
(9) The amount of required capacitance must include at least 2 x 47 µF ceramic capacitor (or 4 x 22 µF). Locate the capacitance close to the device. Adding additional capacitance close to the load improves the response of the regulator to load transients. See Table 1 for more details. See *Inrush Current* section when adding additional output capacitance.

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5 Device Information

Functional Block Diagram

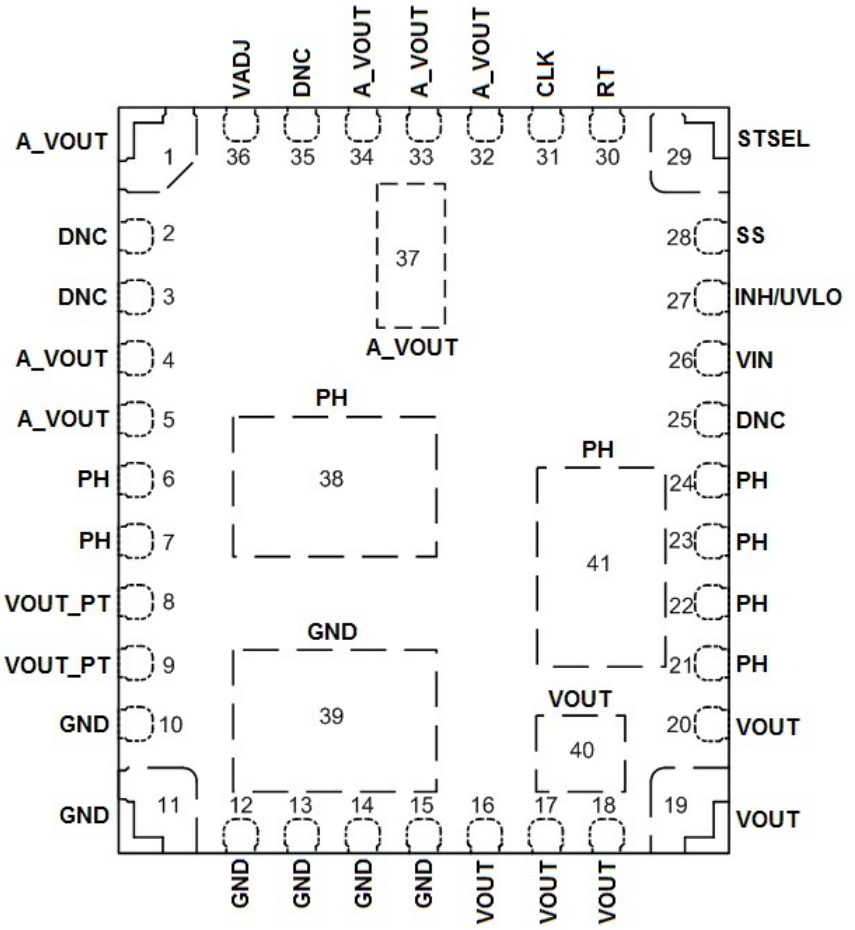


Pin Functions

TERMINAL		DESCRIPTION
NAME	NO.	
VIN	26	Input voltage. This pin supplies all power to the converter. Connect this pin to the input supply and connect bypass capacitors between this pin and GND.
VOUT	16	Negative output voltage with respect to GND. Connect these pins to the output load and connect external bypass capacitors between these pins and GND. Pad 40 should be connected to PCB VOUT planes using multiple vias for good thermal performance.
	17	
	18	
	19	
	20	
	40	
GND	10	This is the return current path for the power stage of the device. These pins are connected to the internal output inductor. Connect these pins to the load and to the bypass capacitors associated with VIN and VOUT.
	11	
	12	
	13	
	14	
	15	
	39	
PH	6	Phase switch node. Do not place any external component on these pins or tie them to a pin of another function.
	7	
	21	
	22	
	23	
	24	
	38	
	41	
VOUT_PT	8	VOUT and A_VOUT Connection Point. Connect VOUT to A_VOUT at these pins as shown in the Layout Considerations section. These pins are not connected to internal circuitry, and are not connected to one other.
	9	
DNC	2	Do Not Connect. Do not connect these pins to GND, to another DNC pin, or to any other voltage. These pins are connected to internal circuitry. Each pin must be soldered to an isolated pad.
	3	
	25	
	35	
A_VOUT	1	These pins are connected to the internal analog reference (A_VOUT) of the device. This node should be treated as the negative voltage reference for the analog control circuitry. Pad 37 should be connected to the PCB A_VOUT plane using multiple vias for good thermal performance. Not all pins are connected together internally. All pins must be connected together externally with a copper plane or pour directly under the module. Connect A_VOUT to VOUT at a single point (VOUT_PT; pins 8 & 9). See Layout Recommendations.
	4	
	5	
	32	
	33	
	34	
	37	
RT	30	Switching frequency adjust pin. To operate at the recommended free-running frequency, connect this pin to A_VOUT. Connecting a resistor between this pin and A_VOUT will reduce the switching frequency. See Switching Frequency section.
CLK	31	Use this pin to synchronize to an external clock. If unused, isolate this pin from any other signal.
INH/UVLO	27	Inhibit and UVLO adjust pin. Use an external level-shifter device to ground this pin to control the INH function. A resistor divider between this pin, A_VOUT, and VIN sets the UVLO voltage.
SS	28	Slow-start pin. Connecting an external capacitor between this pin and A_VOUT adjusts the output voltage rise time.
STSEL	29	Slow-start select. Connect this pin to A_VOUT to enable the internal SS capacitor.
VADJ	36	Connecting a resistor between this pin and GND sets the output voltage. A dedicated GND sense line connected at the load will improve regulation at the load. See Figure 48 in the Layout Considerations section.

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RKG PACKAGE
(TOP VIEW)



6 Typical Characteristics (VIN = 5 V)

The electrical characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the converter. Applies to Figure 1, Figure 2, and Figure 3. The temperature derating curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures. Derating limits apply to devices soldered directly to a 100 mm × 100 mm, 4-layer, double-sided PCB with 1 oz. copper. Applies to Figure 4, Figure 5, and Figure 6.

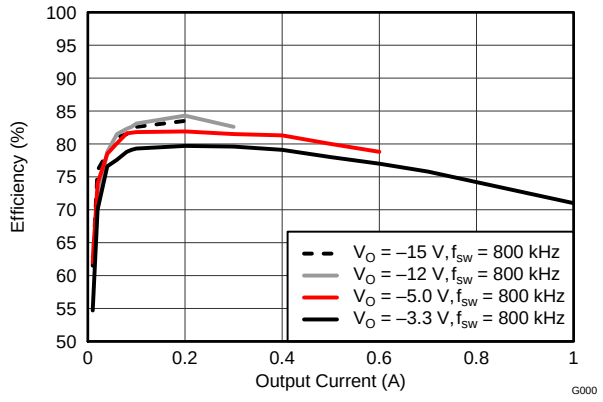


Figure 1. Efficiency vs. Output Current

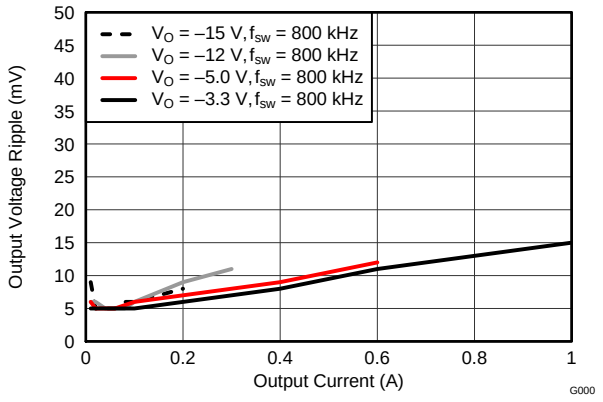


Figure 2. Voltage Ripple vs. Output Current

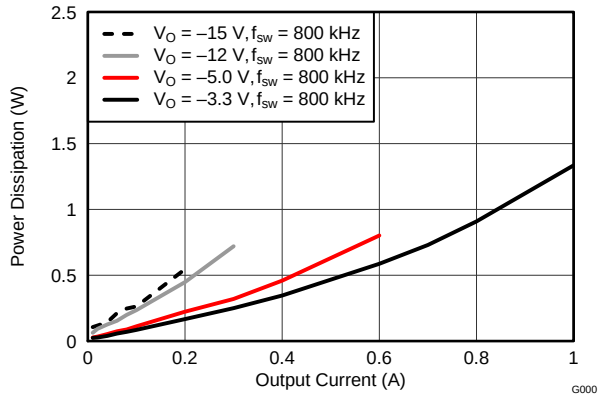


Figure 3. Power Dissipation vs. Output Current

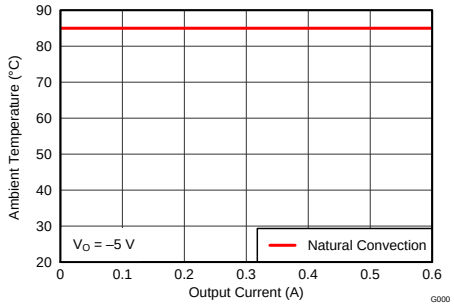


Figure 4. Safe Operating Area

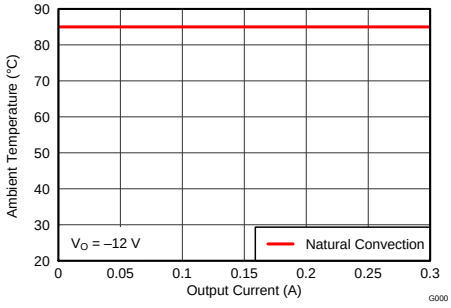


Figure 5. Safe Operating Area

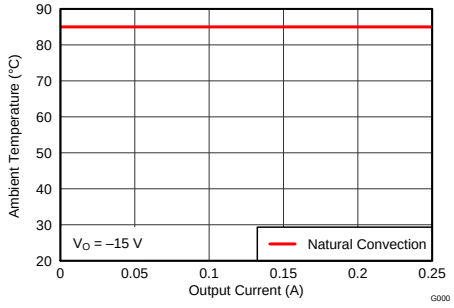


Figure 6. Safe Operating Area

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7 Typical Characteristics (VIN = 12 V)

The electrical characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the converter. Applies to Figure 7, Figure 8, and Figure 9. The temperature derating curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures. Derating limits apply to devices soldered directly to a 100 mm × 100 mm, 4-layer, double-sided PCB with 1 oz. copper. Applies to Figure 10, Figure 11, and Figure 12.

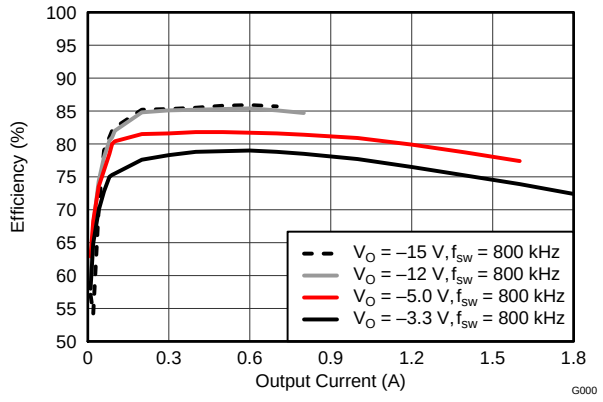


Figure 7. Efficiency vs. Output Current

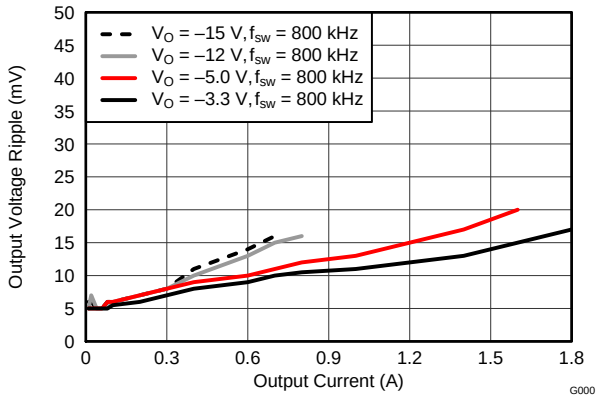


Figure 8. Voltage Ripple vs. Output Current

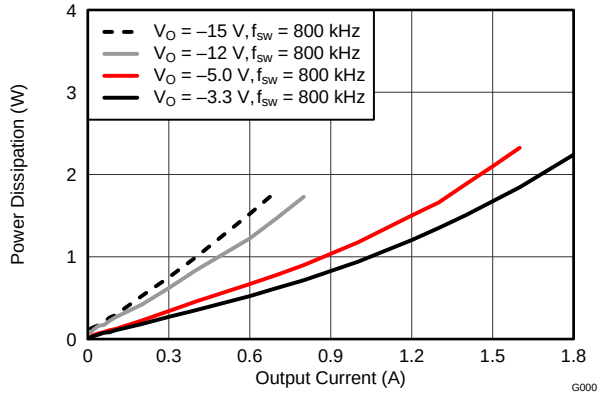


Figure 9. Power Dissipation vs. Output Current

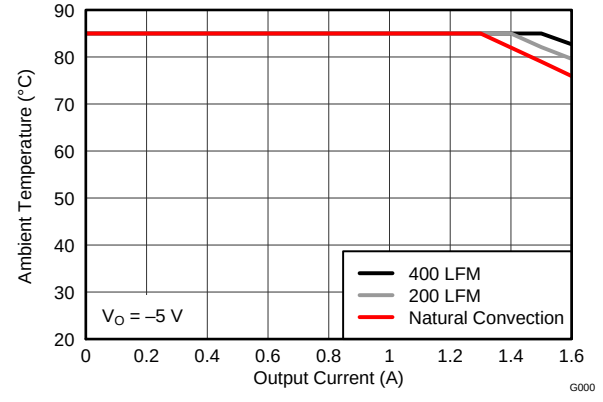


Figure 10. Safe Operating Area

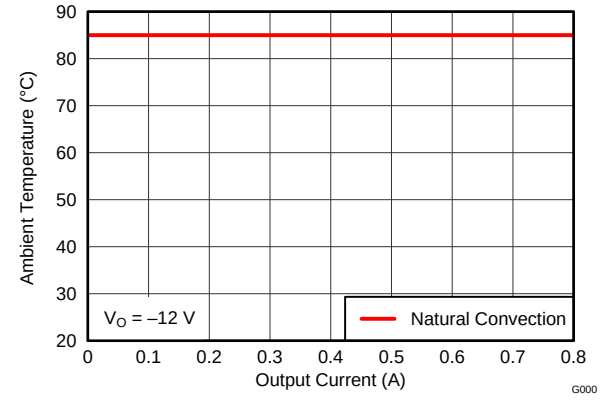


Figure 11. Safe Operating Area

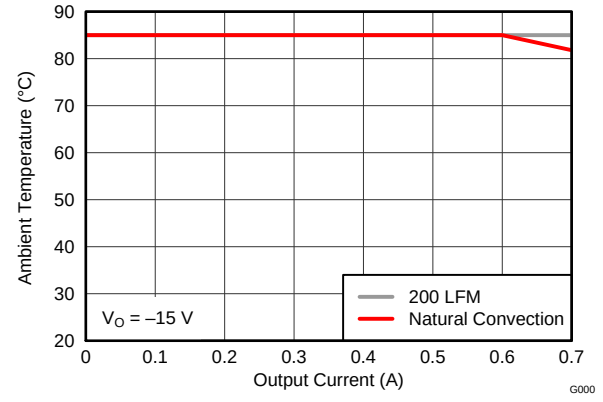


Figure 12. Safe Operating Area

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8 Typical Characteristics (VIN = 24 V)

The electrical characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the converter. Applies to Figure 13, Figure 14, and Figure 15. At light load the output voltage ripple may increase due to pulse skipping. See Light-Load Behavior for more information. Applies to Figure 14. The temperature derating curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures. Derating limits apply to devices soldered directly to a 100 mm × 100 mm, 4-layer, double-sided PCB with 1 oz. copper. Applies to Figure 16, Figure 17, and Figure 18.

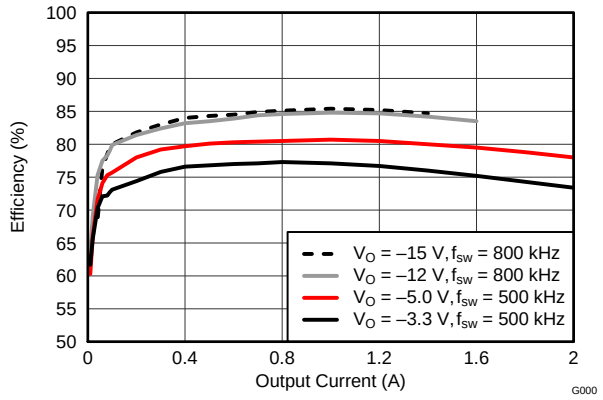


Figure 13. Efficiency vs. Output Current

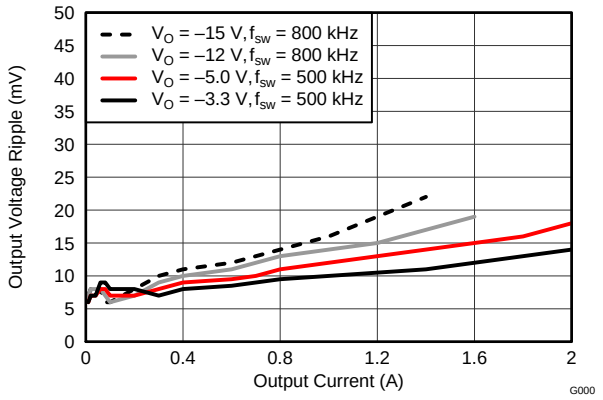


Figure 14. Voltage Ripple vs. Output Current

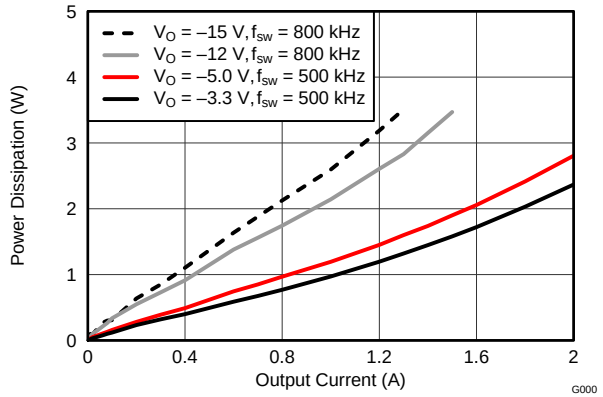


Figure 15. Power Dissipation vs. Output Current

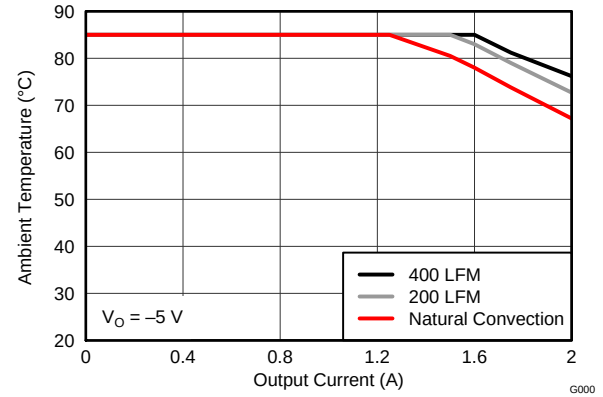


Figure 16. Safe Operating Area

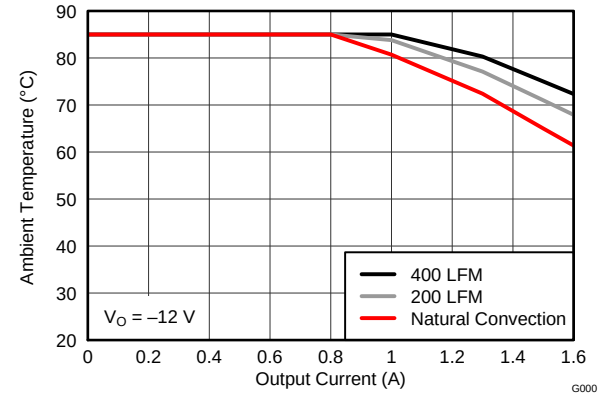


Figure 17. Safe Operating Area

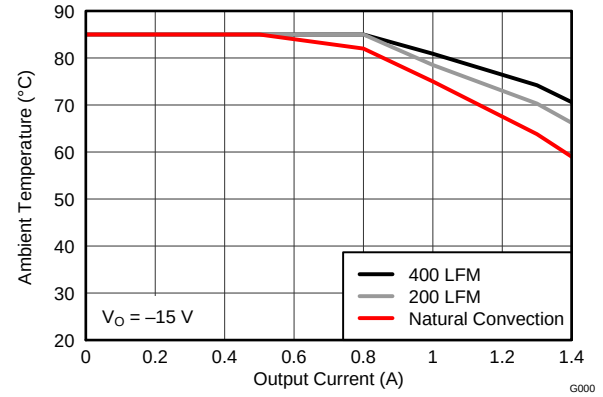


Figure 18. Safe Operating Area

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9 Typical Characteristics (VIN = 36 V)

The electrical characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the converter. Applies to Figure 19, Figure 20, and Figure 21. At light load the output voltage ripple may increase due to pulse skipping. See Light-Load Behavior for more information. Applies to Figure 20. The temperature derating curves represent the conditions at which internal components are at or below the manufacturer's maximum operating temperatures. Derating limits apply to devices soldered directly to a 100 mm × 100 mm, 4-layer, double-sided PCB with 1 oz. copper. Applies to Figure 22, Figure 23, and Figure 24.

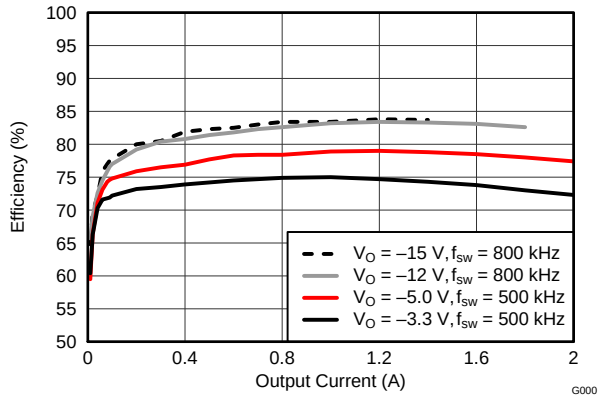


Figure 19. Efficiency vs. Output Current

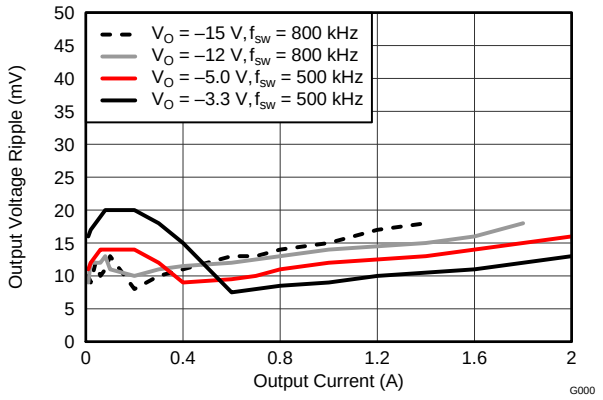


Figure 20. Voltage Ripple vs. Output Current

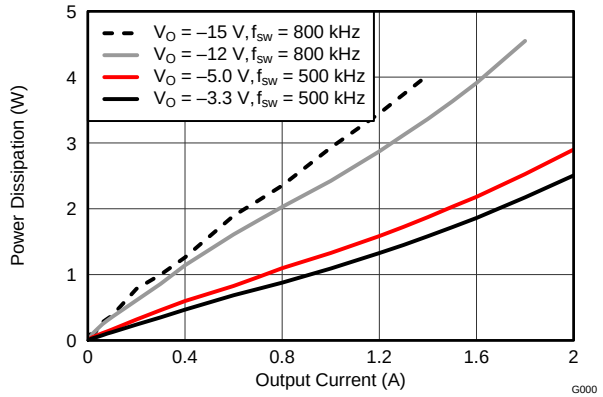


Figure 21. Power Dissipation vs. Output Current

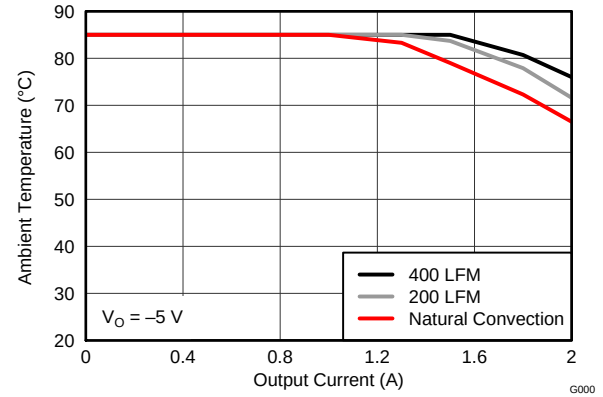


Figure 22. Safe Operating Area

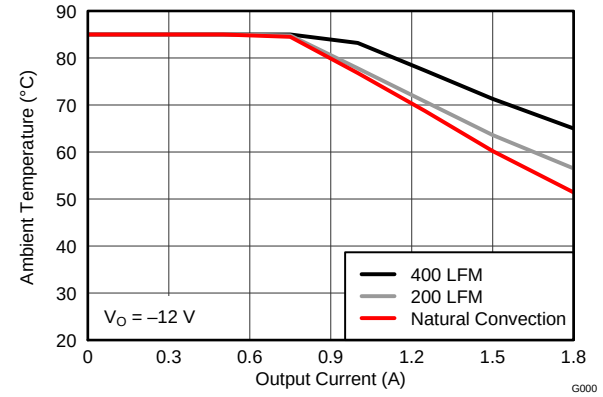


Figure 23. Safe Operating Area

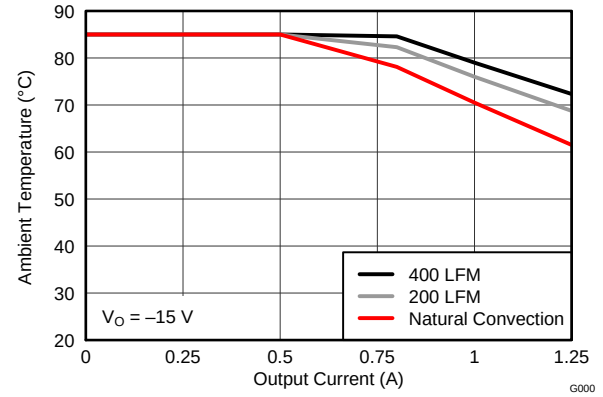


Figure 24. Safe Operating Area

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10 Typical Characteristics (Bode Plots)

The electrical characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the converter.

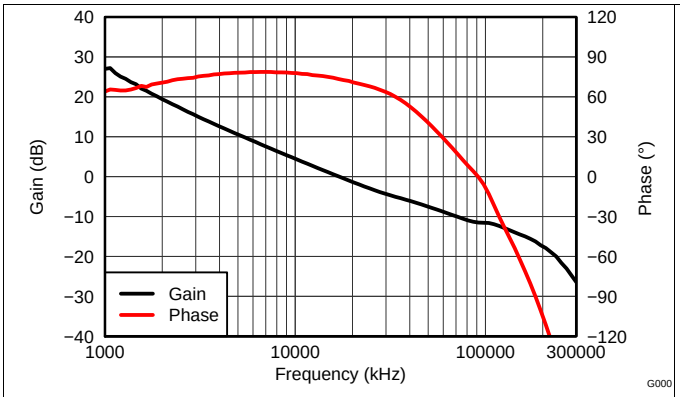


Figure 25. V_{IN}= 5 V, V_{OUT}= –5 V, I_{OUT}= 0.6 A, C_{OUT}= 4 x 22µF ceramic, f_{SW}= 800 kHz

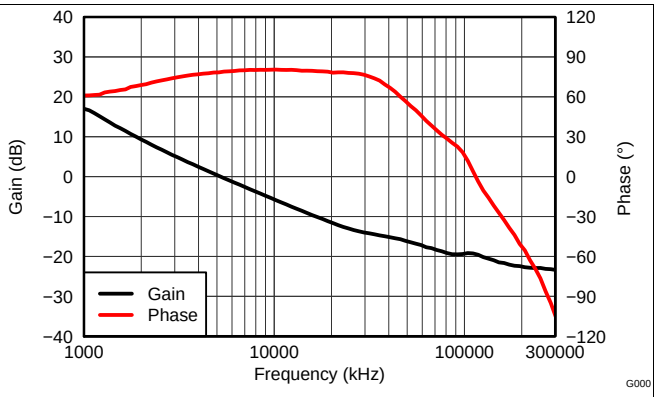


Figure 26. V_{IN}= 5 V, V_{OUT}= –12 V, I_{OUT}= 0.3 A, C_{OUT}= 4 x 22 µF ceramic, f_{SW}= 800 kHz

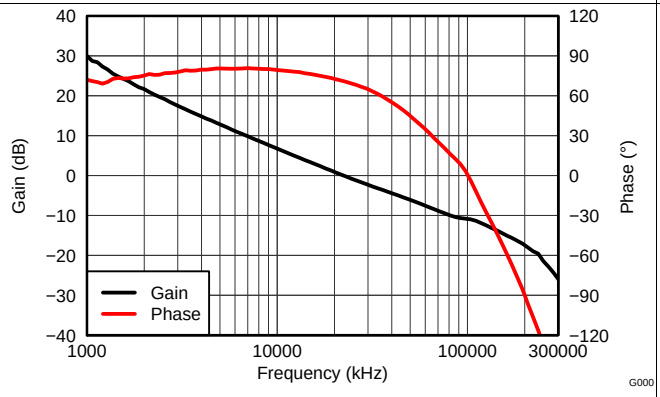


Figure 27. V_{IN}= 12 V, V_{OUT}= –5 V, I_{OUT}= 1.6 A, C_{OUT}= 4 x 22 µF ceramic, f_{SW}= 800 kHz

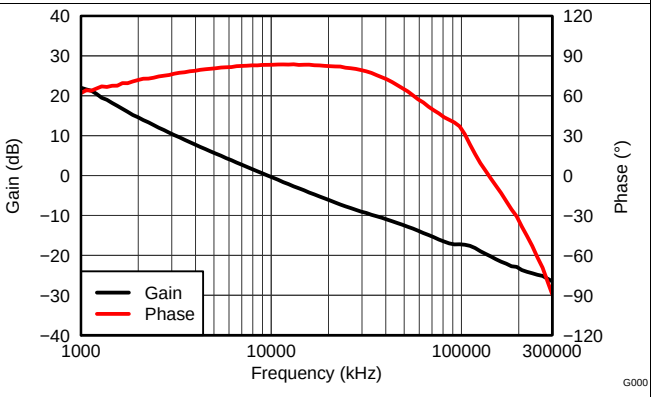


Figure 28. V_{IN}= 12 V, V_{OUT}= –12 V, I_{OUT}= 0.8 A, C_{OUT}= 4 x 22 µF ceramic, f_{SW}= 800 kHz

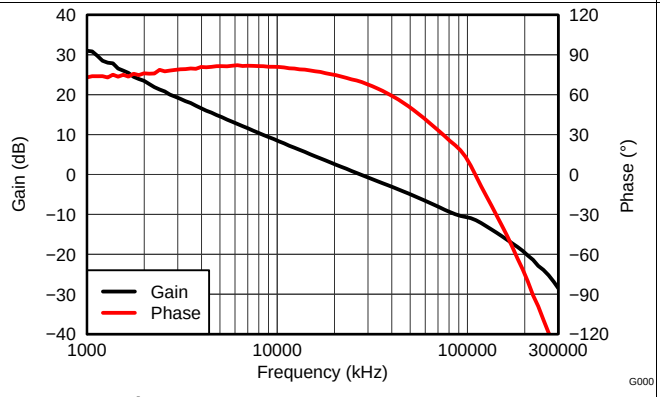


Figure 29. V_{IN}= 24 V, V_{OUT}= –5 V, I_{OUT}= 2.0 A, C_{OUT}= 4 x 22 µF ceramic, f_{SW}= 500 kHz

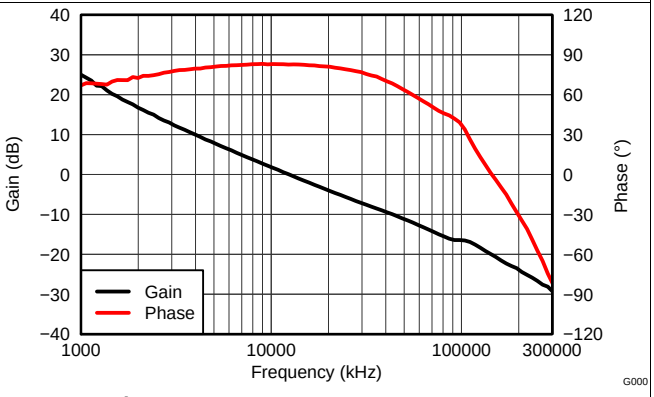


Figure 30. V_{IN}= 24 V, V_{OUT}= –12 V, I_{OUT}= 1.5 A, C_{OUT}= 4 x 22 µF ceramic, f_{SW}= 800 kHz

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Typical Characteristics (Bode Plots) (continued)

The electrical characteristic data has been developed from actual products tested at 25°C. This data is considered typical for the converter.

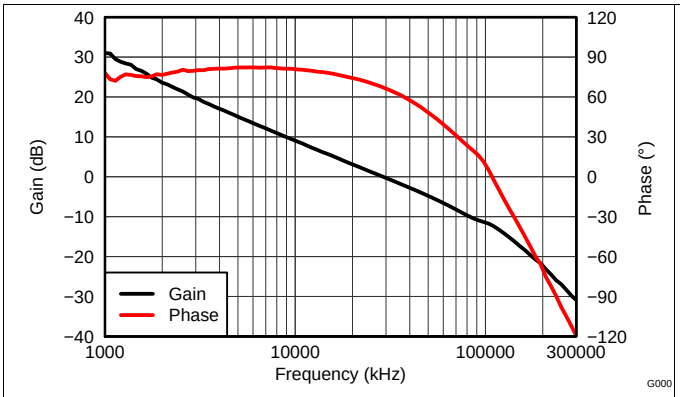


Figure 31. V_{IN}= 36 V, V_{OUT}= −5 V, I_{OUT}= 2.0 A, C_{OUT}= 4 x 22 µF ceramic, f_{SW}= 500 kHz

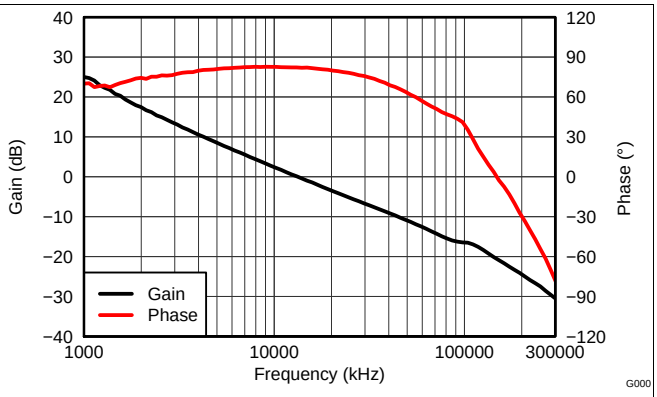


Figure 32. V_{IN}= 36 V, V_{OUT}= −12 V, I_{OUT}= 1.8 A, C_{OUT}= 4 x 22 µF ceramic, f_{SW}= 800 kHz

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11 Capacitor Recommendations for the LMZ34002 Power Supply

11.1 Capacitor Technologies

11.1.1 Electrolytic, Polymer-Electrolytic Capacitors

When using electrolytic capacitors, high-quality, computer-grade electrolytic capacitors are recommended. Polymer-electrolytic type capacitors are recommended for applications where the ambient operating temperature is less than 0°C. The Sanyo OS-CON capacitor series is suggested due to the lower ESR, higher rated surge, power dissipation, ripple current capability, and small package size. Aluminum electrolytic capacitors provide adequate decoupling over the frequency range of 2 kHz to 150 kHz, and are suitable when ambient temperatures are above 0°C.

11.1.2 Ceramic Capacitors

The performance of aluminum electrolytic capacitors is less effective than ceramic capacitors above 150 kHz. Multilayer ceramic capacitors have a low ESR and a resonant frequency higher than the bandwidth of the regulator. They can be used to reduce the reflected ripple current at the input as well as improve the transient response of the output.

11.1.3 Tantalum, Polymer-Tantalum Capacitors

Polymer-tantalum type capacitors are recommended for applications where the ambient operating temperature is less than 0°C. The Sanyo POSCAP series and Kemet T530 capacitor series are recommended rather than many other tantalum types due to their lower ESR, higher rated surge, power dissipation, ripple current capability, and small package size. Tantalum capacitors that have no stated ESR or surge current rating are not recommended for power applications.

11.2 Input Capacitor

The LMZ34002 requires a minimum input capacitance of 4.7 µF of ceramic type. The voltage rating of input capacitors must be greater than the maximum input voltage. The ripple current rating of the capacitor must be at least 450 mArms. Table 1 includes a preferred list of capacitors by vendor.

11.3 Output Capacitor

The required output capacitance of the LMZ34002 can be comprised of either all ceramic capacitors, or a combination of ceramic and bulk capacitors. The required output capacitance must include at least 2 × 47 µF of ceramic type (or 4 × 22 µF). The voltage rating of output capacitors must be greater than the output voltage. When adding additional non-ceramic bulk capacitors, low-ESR devices like the ones recommended in Table 1 are required. Additional capacitance above the required minimum is determined by actual transient deviation requirements. Table 1 includes a preferred list of capacitors by vendor.

Table 1. Recommended Input/Output Capacitors(1)

VENDOR	SERIES	PART NUMBER	CAPACITOR CHARACTERISTICS		
			WORKING VOLTAGE (V)	CAPACITANCE (µF)	ESR (2) (mΩ)
Murata	X5R	GRM31CR61H225KA88L	50	2.2	2
TDK	X5R	C3216X5R1H475K	50	4.7	2
Murata	X5R	GRM32ER61E226K	16	22	2
TDK	X5R	C3225X5R0J476K	6.3	47	2
Murata	X5R	GRM32ER60J476M	6.3	47	2
Sanyo	POSCAP	16TQC68M	16	68	50
Sanyo	POSCAP	6TPE100MI	6.3	100	25
Kemet	T530	T530D227M006ATE006	6.3	220	6

(1) **Capacitor Supplier Verification, RoHS, Lead-free and Material Details**
Consult capacitor suppliers regarding availability, material composition, RoHS and lead-free status, and manufacturing process requirements for any capacitors identified in this table.
(2) Maximum ESR @ 100 kHz, 25°C.

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12 Application Information

12.1 Adjusting the Output Voltage

The LMZ34002 is designed to provide output voltages from –3 V to –17 V. The output voltage is determined by the value of R_{SET}, which must be connected between the VADJ pin (Pin 36) and GND. Table 2 gives the standard external R_{SET} resistor for a number of common bus voltages.

Table 2. Standard R_{SET} Resistor Values for Common Output Voltages

OUTPUT VOLTAGE V_{OUT} (V)	–3.3	–5.0	–8.0	–12.0	–15.0
R_{SET} (kΩ)	31.6	52.3	90.9	140	178

For other output voltages the value of R_{SET} can be calculated using the following formula, or simply selected from the range of values given in Table 3.

$$R_{SET} = 10 \times \left(\frac{|V_{OUT}|}{0.798} - 1 \right) \ (k\Omega) \quad (1)$$

Table 3. Standard R_{SET} Resistor Values

V_{OUT} (V)	R_{SET} (kΩ)		V_{OUT} (V)	R_{SET} (kΩ)		V_{OUT} (V)	R_{SET} (kΩ)
–3.0	27.4		–7.5	84.5		–12.5	147
–3.3	31.6		–8.0	90.9		–13.0	154
–3.5	34.0		–8.5	97.6		–13.5	158
–4.0	40.2		–9.0	102		–14.0	165
–4.5	46.4		–9.5	110		–14.5	174
–5.0	52.3		–10.0	115		–15.0	178
–5.5	59.0		–10.5	121		–15.5	187
–6.0	64.9		–11.0	127		–16.0	191
–6.5	71.5		–11.5	133		–16.5	196
–7.0	78.7		–12.0	140		–17.0	205

12.2 Safe Operating Current

The amount of output current that can safely be delivered by the LMZ34002 depends on the input voltage and the output voltage. Figure 33 shows the maximum output current for four standard output voltages over input voltage.

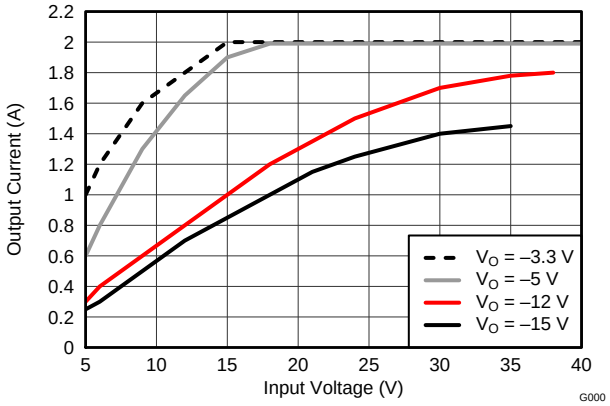


Figure 33. Safe Operating Current

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12.3 Application Schematics

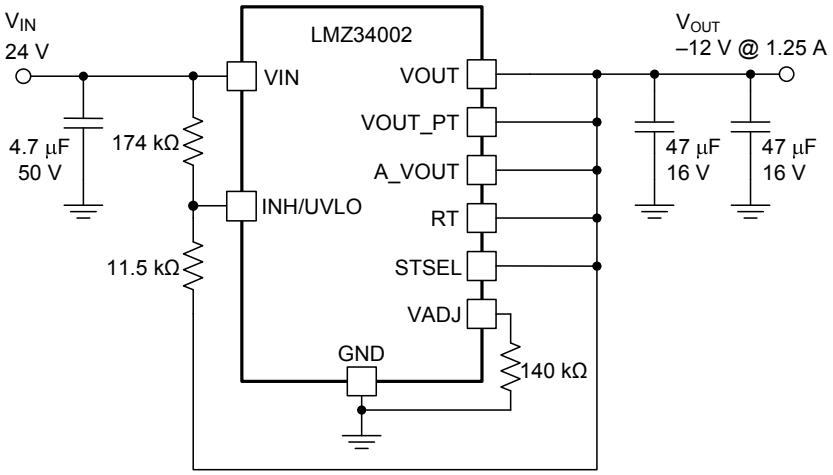


Figure 34. Typical Schematic
V_{IN} = 24 V, V_{OUT} = –12 V

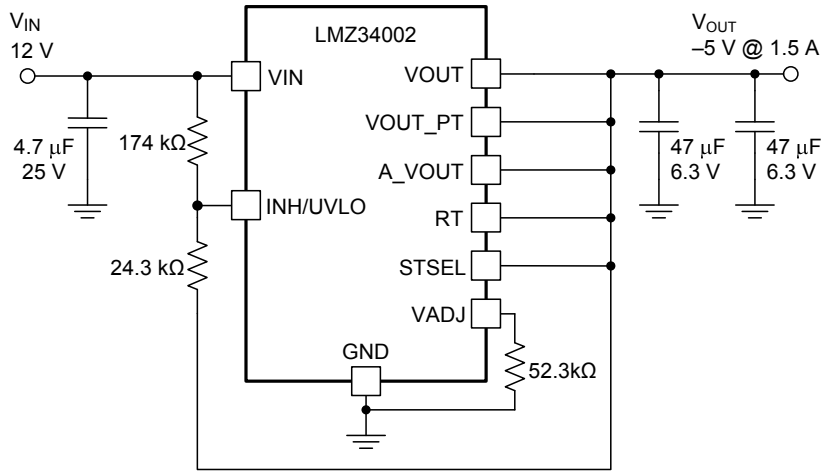


Figure 35. Typical Schematic
V_{IN} = 12 V, V_{OUT} = –5 V

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12.4 Custom Design With WEBENCH® Tools

Click here to create a custom design using the LMZ34002 device with the WEBENCH® Power Designer.

1. Start by entering the input voltage (V_{IN}), output voltage (V_{OUT}), and output current (I_{OUT}) requirements.
2. Optimize the design for key parameters such as efficiency, footprint, and cost using the optimizer dial.
3. Compare the generated design with other possible solutions from Texas Instruments.

The WEBENCH Power Designer provides a customized schematic along with a list of materials with real-time pricing and component availability.

In most cases, these actions are available:

- Run electrical simulations to see important waveforms and circuit performance
- Run thermal simulations to understand board thermal performance
- Export customized schematic and layout into popular CAD formats
- Print PDF reports for the design, and share the design with colleagues

Get more information about WEBENCH tools at www.ti.com/WEBENCH.

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12.5 Input Voltage

The LMZ34002 operates over the input voltage range of 4.5 V to 40 V. The maximum input voltage is 40 V, however, the sum of V_{IN} + $|V_{OUT}|$ must not exceed 50 V.

See the Undervoltage Lockout (UVLO) Threshold section of this datasheet for more information.

12.6 Undervoltage Lockout (UVLO) Threshold

At turn-on, the V_{ON} UVLO threshold determines the input voltage level where the device begins power conversion. R_{UVLO1} and R_{UVLO2} set the turn-on threshold as shown in Figure 36. The UVLO threshold is not present during the power-down sequence. Applications requiring a turn-off threshold must monitor the input voltage with external circuitry and shut-down using the INH control (see Output On/Off Inhibit (INH)).

The V_{ON} UVLO threshold must be set to at least 4.5 V to insure proper start-up and reduce current surges on the host input supply as the voltage rises. If possible, it is recommended to set the UVLO threshold to appproximantely 80 to 85% of the minimum expected input voltage.

Use Equation 2 and Equation 3 to calculate the values of R_{UVLO1} and R_{UVLO2}. V_{ON} is the voltage threshold during power-up when the input voltage is rising. Table 4 lists standard resistor values for R_{UVLO1} and R_{UVLO2} for adjusting the V_{ON} UVLO threshold for several input voltages.

$$R_{UVLO1} = \frac{0.5}{2.9 \times 10^{-3}} \left(k\Omega\right) \tag{2}$$

$$R_{UVLO2} = \frac{1.25}{\left(\frac{\left(V_{ON} - 1.25\right)}{R_{UVLO1}}\right) + 0.9 \times 10^{-3}} \left(k\Omega\right) \tag{3}$$

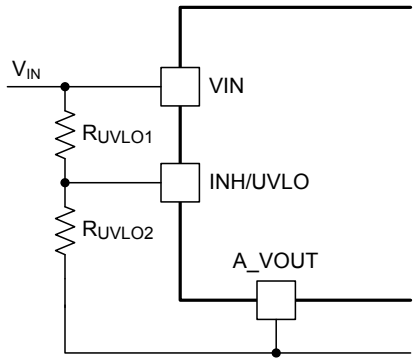


Figure 36. Adjustable VIN UVLO

Table 4. Standard Resistor Values to set V_{ON} UVLO Threshold

V_{ON} THRESHOLD (V)	4.5	5.0	6.5	8.0	9.0	10.0	15.0	20.0	30.0
R_{UVLO1} (kΩ)	174	174	174	174	174	174	174	174	174
R_{UVLO2} (kΩ)	63.4	56.2	40.2	31.6	27.4	24.3	15.8	11.5	7.50

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12.7 Power-Up Characteristics

When configured as shown in the application schematics, the LMZ34002 produces a regulated output voltage following the application of a valid input voltage. During the power-up, internal soft-start circuitry slows the rate that the output voltage rises, thereby limiting the amount of in-rush current that can be drawn from the input source. The soft-start circuitry introduces a short time delay from the point that a valid input voltage is recognized. Figure 37 shows the start-up waveforms for a LMZ34002, operating from a 12 V input and the output voltage adjusted to –5 V. The waveform were measured with a 1.5-A constant current load.

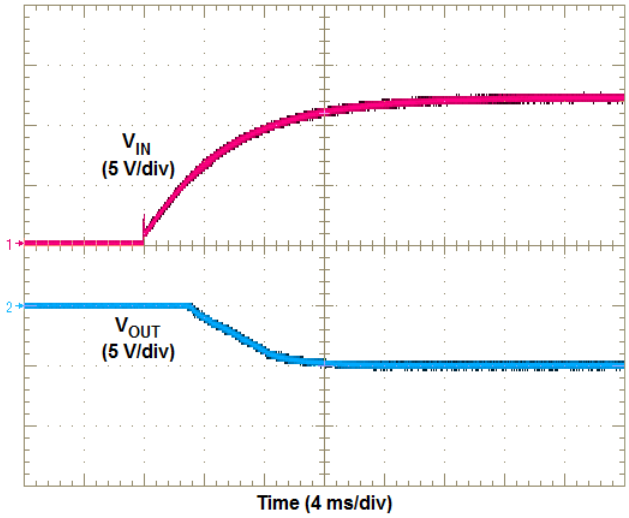


Figure 37. Start-Up Sequence

12.8 Light-Load Behavior

The LMZ34002 is a non-synchronous converter. One of the characteristics of non-synchronous operation is that as the output load current decreases, a point is reached where the energy delivered by a single switching pulse is more than the load can absorb. This energy causes the output voltage to rise slightly. This rise in output voltage is sensed by the feedback loop and the device responds by skipping one or more switching cycles until the output voltages falls back to the set point. At very light loads or no load, many switching cycles are skipped. The observed effect during this pulse skipping mode of operation is an increase in the peak to peak ripple voltage, and a decrease in the ripple frequency. The amount of load current when pulse skipping begins is a function of the input voltage, the output voltage, and the switching frequency.

12.9 No-Load Operation

When operating at no load or very light load and the input voltage is removed, the output voltage discharges very slowly. If the input voltage is re-applied before the output voltage discharges, the slow-start circuit does not activate and the amount of inrush current is extremely large and may cause an over-current condition. To avoid this condition the output voltage must be allowed to discharge before re-applying the input voltage. Applying a 50-mA to 100-mA minimum load helps discharge the output voltage. Additionally, monitoring the input voltage with a supervisor and shuting-down using the INH control (see Output On/Off Inhibit (INH)) activates the internal slow-start circuit.

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12.10 Switching Frequency

The recommended switching frequency of the LMZ34002 is 800 kHz. To operate at the recommended switching frequency, connect the RT pin (Pin 30) to A_VOUT (at pin 32).

It is recommended to adjust the switching frequency in applications with both, higher input voltage (> 18V) and lower output voltage (< –8V). For these applications, improved operating performance can be obtained by decreasing the operating frequency to 500 kHz by adding a resistor, R_{RT} of 93.1 kΩ between the RT pin and A_VOUT as shown in Figure 38. Figure 39 shows the recommended switching frequency over input voltage and output voltage.

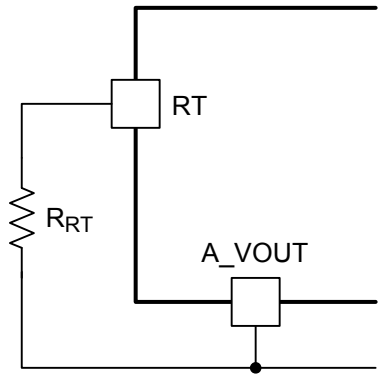


Figure 38. R_{RT} Resistor Placement

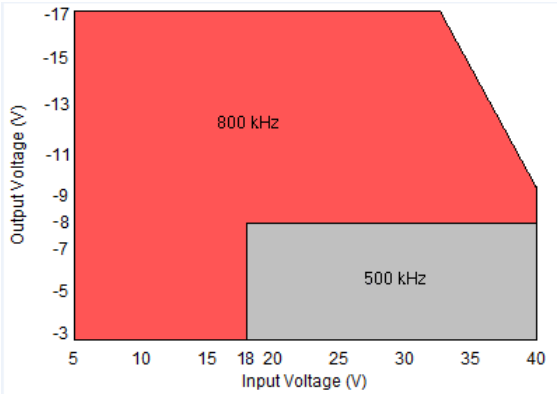


Figure 39. Recommended Switching Frequency

Table 5. Standard Resistor Values For Setting Switching Frequency

f_{SW} (kHz)	500	800
R_{RT}(kΩ)	93.1	0 (short)

12.11 Synchronization (CLK)

An internal phase locked loop (PLL) allows synchronization from 700 kHz to 900 kHz for 800 kHz applications, or 400 kHz to 600 kHz for 500 kHz applications. See Figure 39 to determine switching frequency based on input voltage and output voltage. To implement the synchronization feature, connect a square wave clock signal to the RT/CLK pin with a duty cycle between 25% to 75%. The clock signal amplitude must transition lower than 0.5 V and higher than 2.2 V. The start of the switching cycle is synchronized to the falling edge of RT/CLK pin. In applications requiring CLK mode, configure the device as shown in Figure 40 (800 kHz) and Figure 41 (500kHz).

Before the external clock is present, the device works in RT mode where the switching frequency is set by the R_{RT} resistor. When the external clock is present, the CLK mode overrides the RT mode. The first time the CLK pin is pulled above the RT/CLK high threshold (2.2 V), the device switches from RT mode to CLK mode and the CLK pin becomes high impedance as the PLL starts to lock onto the frequency of the external clock. It is not recommended to switch from CLK mode back to RT mode because the internal switching frequency drops to 100 kHz first before returning to the switching frequency set by the RT resistor.

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Synchronization (CLK) (continued)

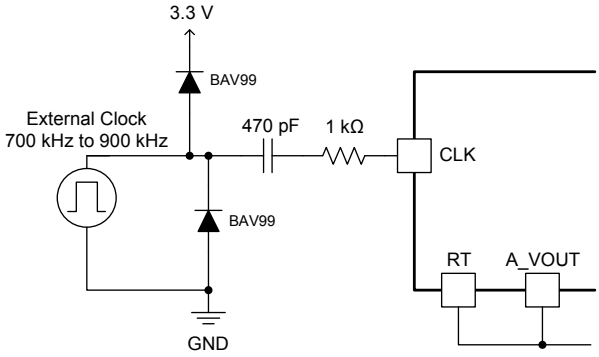


Figure 40. CLK Configuration (800 kHz Typ)

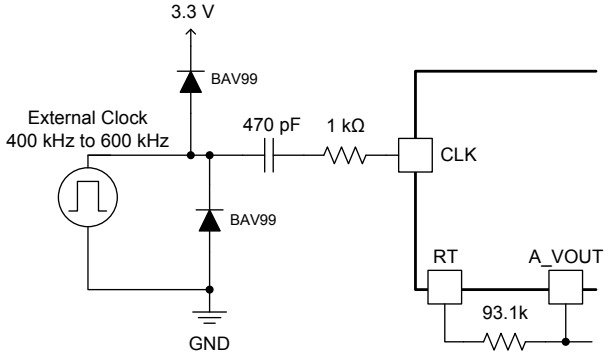


Figure 41. CLK Configuration (500 kHz Typ)

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12.12 Output On/Off Inhibit (INH)

The INH pin provides electrical on/off control of the device. Once the INH pin voltage exceeds the threshold voltage, the device starts operation. If the INH pin voltage is pulled below the threshold voltage, the regulator stops switching and enters low quiescent current state.

The INH pin has an internal pull-up current source, allowing the user to float the INH pin for enabling the device. If an application requires controlling the INH pin, an external level-shifter is required to interface with the pin because in a positive-to-negative buck-boost supply, the INH pin is referenced to VOUT, not GND. Adding a level-shifter (U1) as shown in Figure 42, allows the INH control to be refernced to GND. A recommended level-shifter part # is DCX144EH-7 from Diodes Inc.

Pulling the input of U1 to GND applies a low voltage to the inhibit control pin and disables the output of the supply, shown in Figure 43. Releasing the input of U1 enables the device, which executes a soft-start power-up sequence, as shown in Figure 44. The device produces a regulated output voltage within 10 ms. The waveforms were measured with a 1.5-A constant current load.

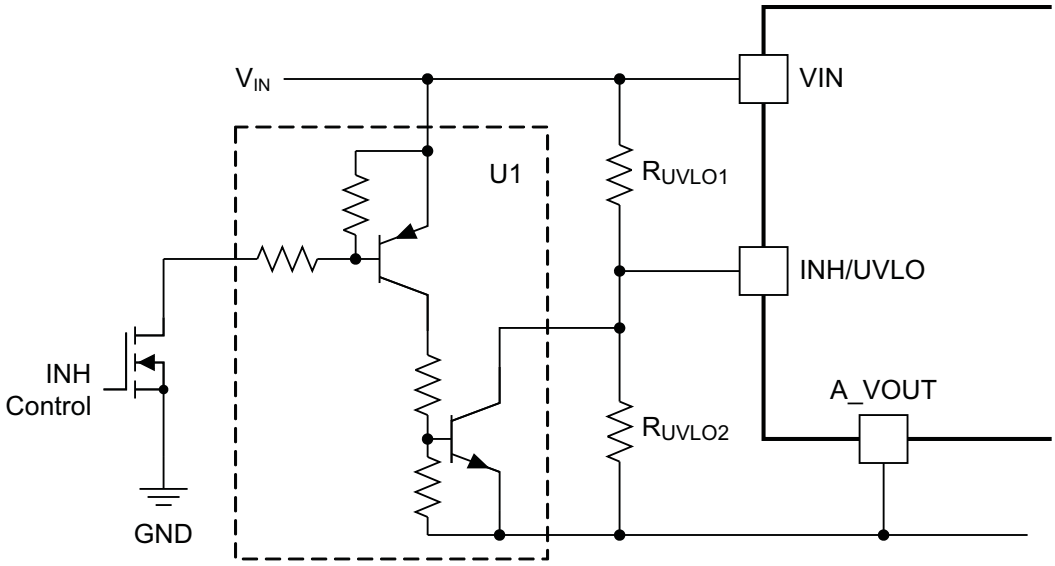


Figure 42. Typical Inhibit Control

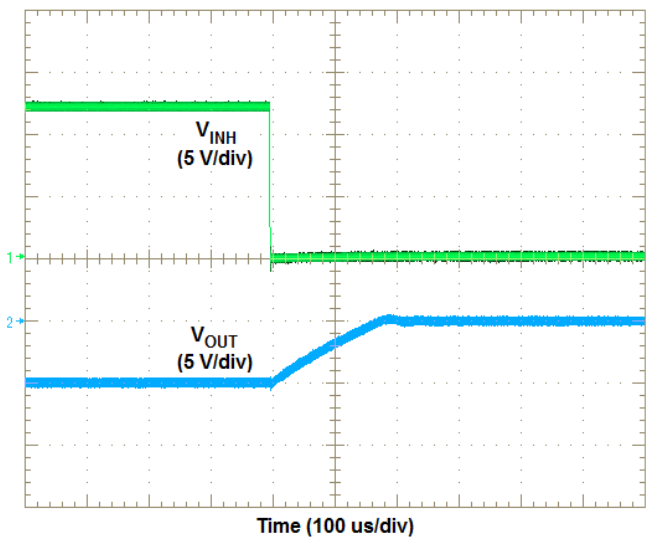


Figure 43. Inhibit Turn-Off

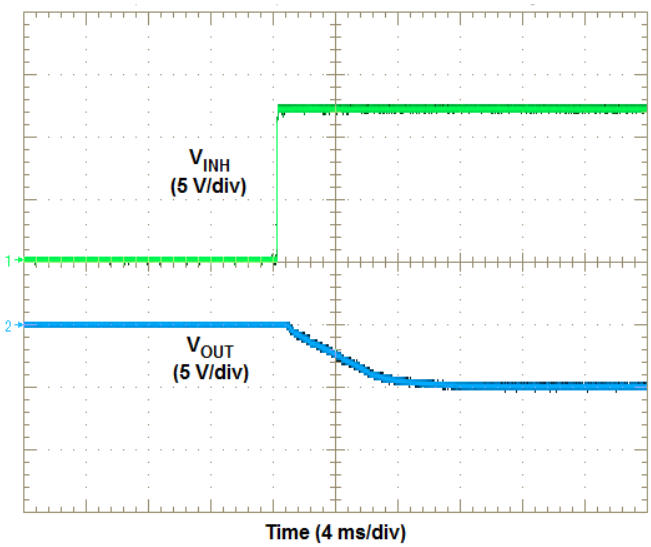


Figure 44. Inhibit Turn-On

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12.13 Slow-Start Circuit (SS)

Connecting the STSEL pin (Pin 29) to A_VOUT while leaving SS pin (Pin 28) open, enables the internal SS capacitor with a slow-start interval of approximately 10 ms. Adding additional capacitance between the SS pin and A_VOUT increases the slow-start time. Figure 45 shows an additional SS capacitor connected to the SS pin and the STSEL pin connected to A_VOUT. See Table 6 below for SS capacitor values and timing interval.

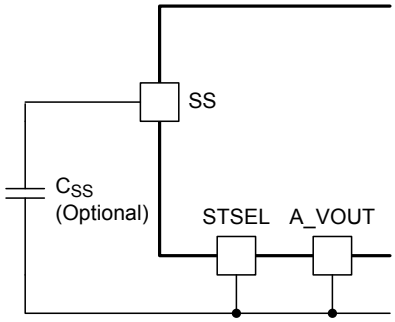


Figure 45. Slow-Start Capacitor (C_{SS}) and STSEL Connection

Table 6. Slow-Start Capacitor Values and Slow-Start Time

C_{SS} (nF)	open	10	15	22
SS Time (ms)	10	15	17	20

12.14 Inrush Current

During turn-on, as the LMZ34002 performs a slow-start sequence, an inrush current is induced as the output capacitors charge up. The inrush current is in addition to the DC input current. The amount of inrush current depends on the input voltage, output voltage and amount of output capacitance. Table 7 shows the typical inrush current for the input voltage, output voltage and the amount of output capacitance. Increasing the slow-start capacitor reduces the inrush current by slowing down the ramp of the output voltage. See Slow-Start Circuit (SS).

Table 7. Typical Inrush Current

Output Capacitance →		100 µF ceramic	200 µF (1)	320 µF (1)	430 µF (1)
VIN (V)	VOUT (V)	Inrush Current (A)			
5	–3.3	0.1	0.1	0.1	0.1
	–5	0.1	0.2	0.2	0.3
	–12	0.3	0.8	1.2	1.8
	–15	0.4	1.3	2.5	3.6
12	–3.3	0.1	0.1	0.1	0.1
	–5	0.1	0.1	0.1	0.2
	–12	0.2	0.4	0.6	0.8
	–15	0.3	0.5	0.9	1.3
24	–3.3	0.1	0.1	0.1	0.1
	–5	0.1	0.1	0.2	0.2
	–12	0.2	0.2	0.3	0.5
	–15	0.3	0.3	0.5	0.7
36	–3.3	0.2	0.2	0.2	0.2
	–5	0.2	0.2	0.2	0.2
	–12	0.2	0.3	0.4	0.4

(1) This amount of capacitance includes the required 100 µF of ceramic capacitance with additional bulk capacitance.

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12.15 Input to Output Coupling Capacitor

Adding an input to output coupling capacitor (C_{IO}) across VIN to VOUT as shown in Figure 46 can help reduce output voltage ripple and improve transient response. A typical value for C_{IO} is 2.2 µF ceramic with a voltage rating greater than the sum of VIN + |VOUT|.

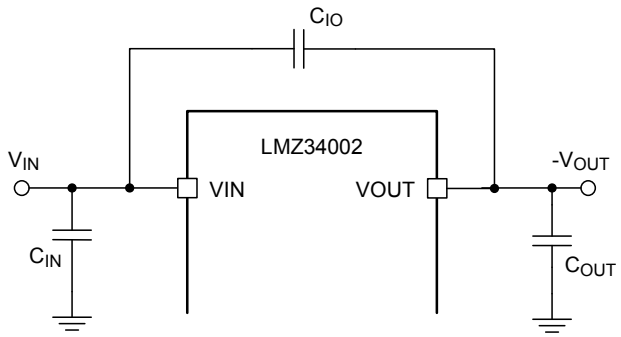


Figure 46. Input to Output Coupling Capacitor

12.16 Overcurrent Protection

For protection against load faults, the LMZ34002 incorporates cycle-by-cycle current limiting. During an overcurrent condition the output current is limited and the output voltage is reduced. If the output voltage drops more than 25%, the switching frequency is lowered to reduce power dissipation within the device. When the overcurrent condition is removed, the output voltage returns to the established voltage.

The LMZ34002 is not designed to endure a sustained short circuit condition. The use of an output fuse, voltage supervisor circuit, or other overcurrent protection circuit is recommended.

12.17 Thermal Shutdown

The internal thermal shutdown circuitry forces the device to stop switching if the junction temperature exceeds 180°C typically. The device reinitiates the power up sequence when the junction temperature drops below 165°C typically.

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12.18 Layout Considerations

To achieve optimal electrical and thermal performance, an optimized PCB layout is required. Figure 47 through Figure 50 show four layers of a typical PCB layout. Some considerations for an optimized layout are:

- Use large copper areas for power planes (VIN, VOUT, and GND) to minimize conduction loss and thermal stress.
- Place ceramic input and output capacitors close to the module pins to minimize high frequency noise.
- Locate additional output capacitors between the ceramic capacitor and the load.
- Place a dedicated A_VOUT copper area beneath the LMZ34002.
- Isolate the PH copper area from the GND copper area using the VOUT copper area.
- Connect the VOUT and A_VOUT copper areas at one point; at pins 8 & 9.
- Place R_{SET}, R_{RT}, and C_{SS} as close as possible to their respective pins.
- Use multiple vias to connect the power planes to internal layers.
- Use a dedicated sense line to connect R_{SET} to GND near the load for best regulation.

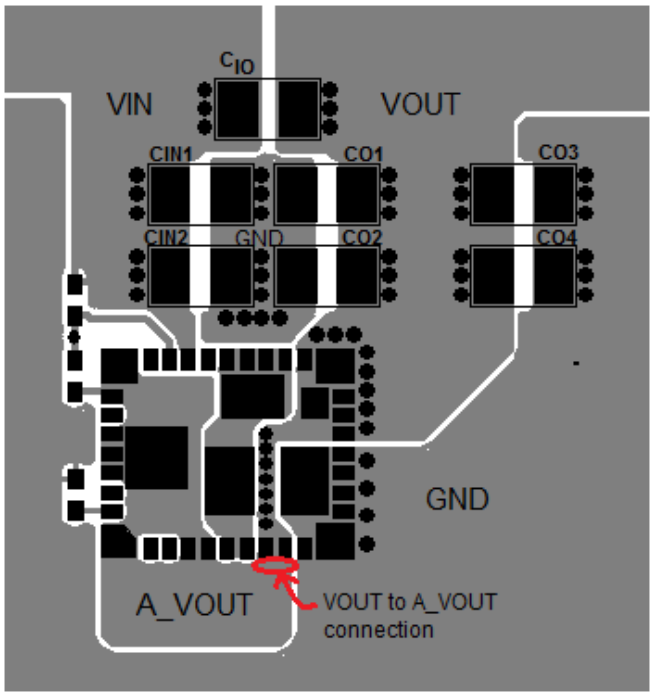


Figure 47. Typical Top-Layer Recommended Layout

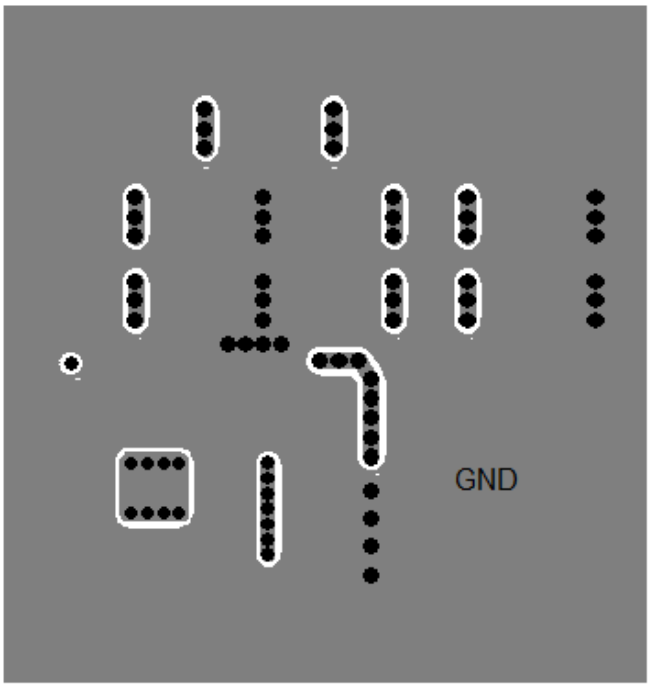


Figure 48. Typical GND-Layer Recommended Layout

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Layout Considerations (continued)

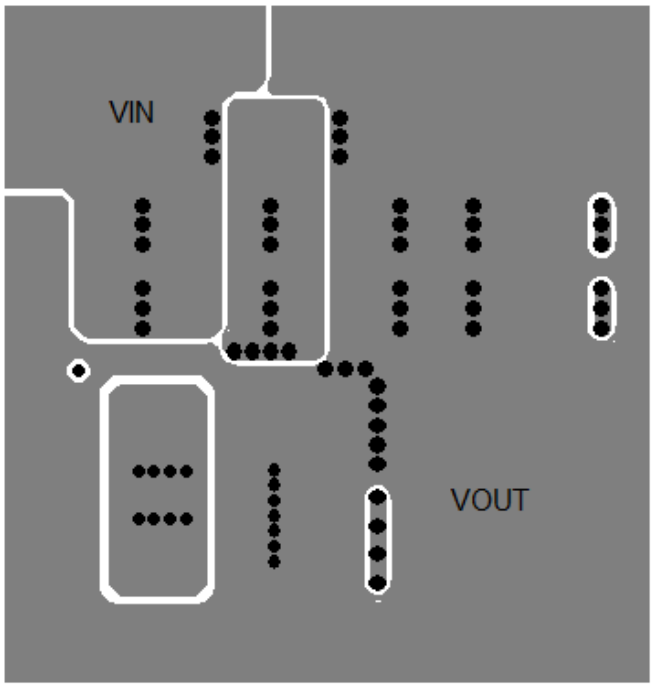


Figure 49. Typical VOUT-Layer Recommended Layout

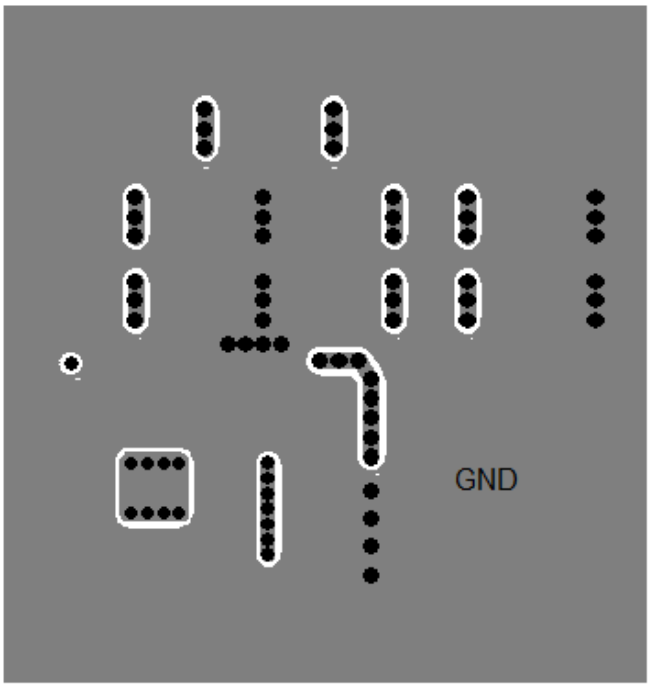


Figure 50. Typical Bottom-Layer Recommended Layout

12.19 EMI

The LMZ34002 complies with EN55022 Class B radiated emissions. Figure 51 shows a typical example of radiated emissions plots for the LMZ34002. The graph includes the plot of the antenna in the horizontal and vertical positions.

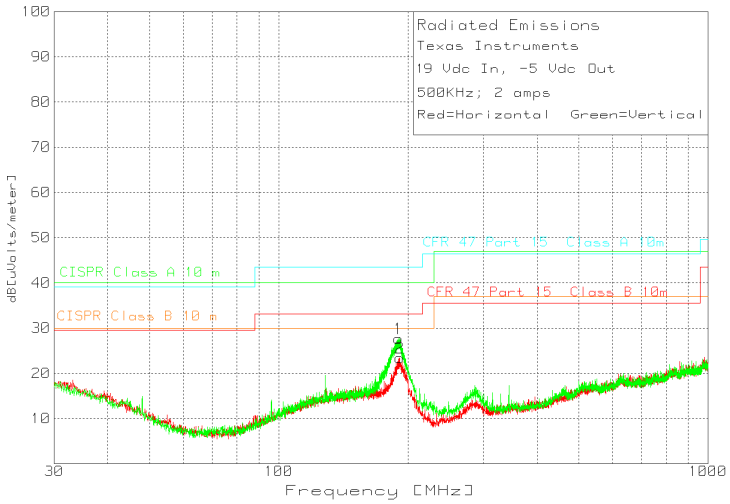


Figure 51. Radiated Emissions 19-V Input, -5-V Output, 2-A Load (EN55022 Class B)

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13 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (June 2017) to Revision C **Page**

- 添加 LMZ34002 的 WEBENCH® 设计链接 1
- Increased the peak reflow temperature and maximum number of reflows to JEDEC specifications for improved manufacturability 2
- 添加器件支持 部分 28

Changes from Revision A (September 2013) to Revision B **Page**

- Added peak reflow and maximum number of reflows information 2

Changes from Original (JULY 2013) to Revision A **Page**

- Changed incorrect R_{SET} value for -5.5 V_{OUT} in Table 3. 15

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14 器件和文档支持

14.1 器件支持

14.1.1 开发支持

14.1.1.1 使用 WEBENCH® 工具创建定制设计

单击此处，使用 LMZ34002 器件并借助 WEBENCH® 电源设计器创建定制设计方案。

1. 首先键入输入电压 (V_{IN})、输出电压 (V_{OUT}) 和输出电流 (I_{OUT}) 要求。
2. 使用优化器拨盘优化关键参数设计，如效率、封装和成本。
3. 将生成的设计与德州仪器 (TI) 的其他解决方案进行比较。

WEBENCH 电源设计器可提供定制原理图以及罗列实时价格和组件供货情况的物料清单。

在多数情况下，可执行以下操作：

- 运行电气仿真，观察重要波形以及电路性能
- 运行热性能仿真，了解电路板热性能
- 将定制原理图和布局方案导出至常用 CAD 格式
- 打印设计方案的 PDF 报告并与同事共享

有关 WEBENCH 工具的详细信息，请访问 www.ti.com.cn/WEBENCH。

14.2 文档支持

14.2.1 相关文档

请参阅如下相关文档：

BQFN 封装的焊接要求 (SLTA069)

14.3 接收文档更新通知

要接收文档更新通知，请导航至 TI.com.cn 上的器件产品文件夹。单击右上角的*通知我* 进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

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设计支持 ***TI 参考设计支持*** **可帮助您快速查找有帮助的 E2E 论坛、设计支持工具以及技术支持的联系信息。**

14.5 商标

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WEBENCH is a registered trademark of Texas Instruments.
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14.6 静电放电警告

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ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

14.7 术语表

SLYZ022 — *TI 术语表*。

这份术语表列出并解释术语、缩写和定义。

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15 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请参阅左侧的导航栏。

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PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
LMZ34002RKGR	Active	Production	B1QFN (RKG) | 41	500 | LARGE T&R	Exempt	NIPDAU	Level-3-250C-168 HR	-40 to 85	(54260, LMZ34002)
LMZ34002RKGR.A	Active	Production	B1QFN (RKG) | 41	500 | LARGE T&R	Exempt	NIPDAU	Level-3-250C-168 HR	-40 to 85	(54260, LMZ34002)
LMZ34002RKGT	Active	Production	B1QFN (RKG) | 41	250 | SMALL T&R	Exempt	NIPDAU	Level-3-250C-168 HR	-40 to 85	(54260, LMZ34002)
LMZ34002RKGT.A	Active	Production	B1QFN (RKG) | 41	250 | SMALL T&R	Exempt	NIPDAU	Level-3-250C-168 HR	-40 to 85	(54260, LMZ34002)
LMZ34002RKGTG4	Active	Production	B1QFN (RKG) | 41	250 | SMALL T&R	Yes	NIPDAU	Level-3-250C-168 HR	-40 to 85	LMZ34002
LMZ34002RKGTG4.A	Active	Production	B1QFN (RKG) | 41	250 | SMALL T&R	Yes	NIPDAU	Level-3-250C-168 HR	-40 to 85	LMZ34002
LMZ34002RKGTG4.B	Active	Production	B1QFN (RKG) | 41	250 | SMALL T&R	Yes	NIPDAU	Level-3-250C-168 HR	-40 to 85	LMZ34002

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

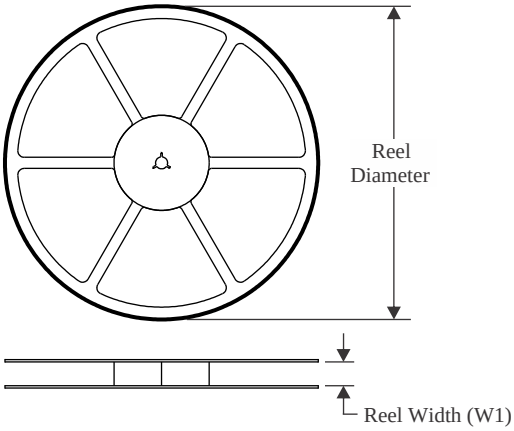
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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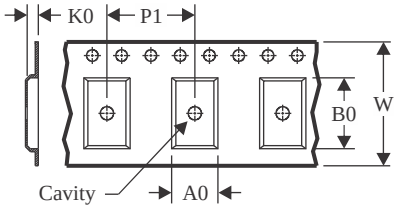
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

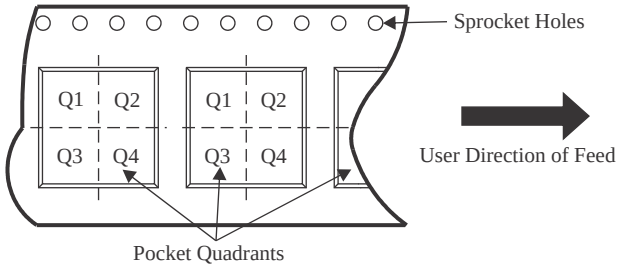


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

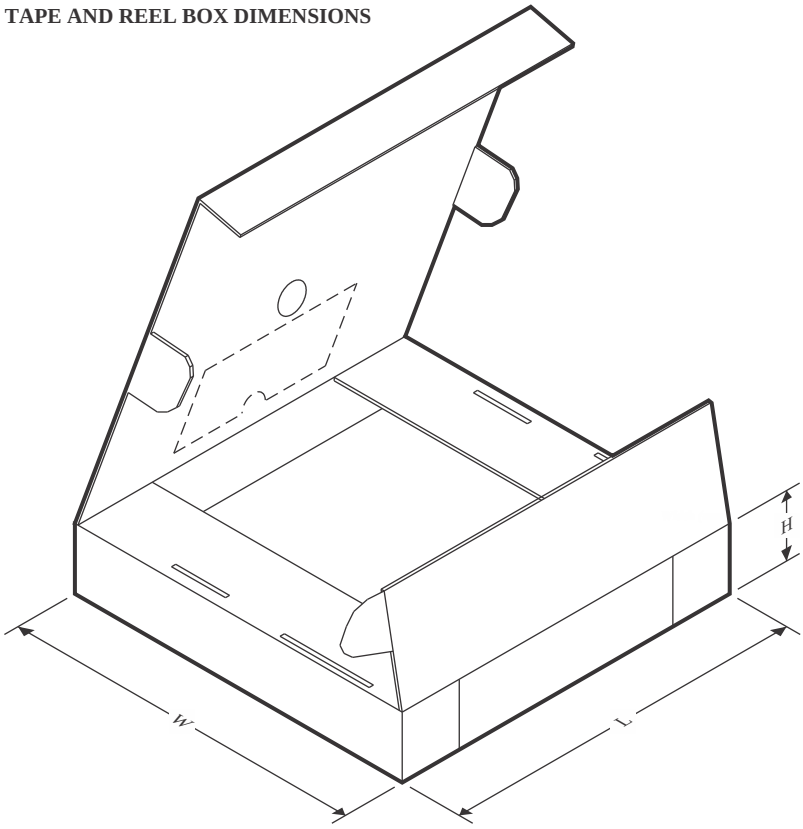
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
LMZ34002RKGR	B1QFN	RKG	41	500	330.0	24.4	9.35	11.35	3.1	16.0	24.0	Q1
LMZ34002RKGT	B1QFN	RKG	41	250	330.0	24.4	9.35	11.35	3.1	16.0	24.0	Q1
LMZ34002RKGTG4	B1QFN	RKG	41	250	330.0	24.4	9.35	11.35	3.1	16.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

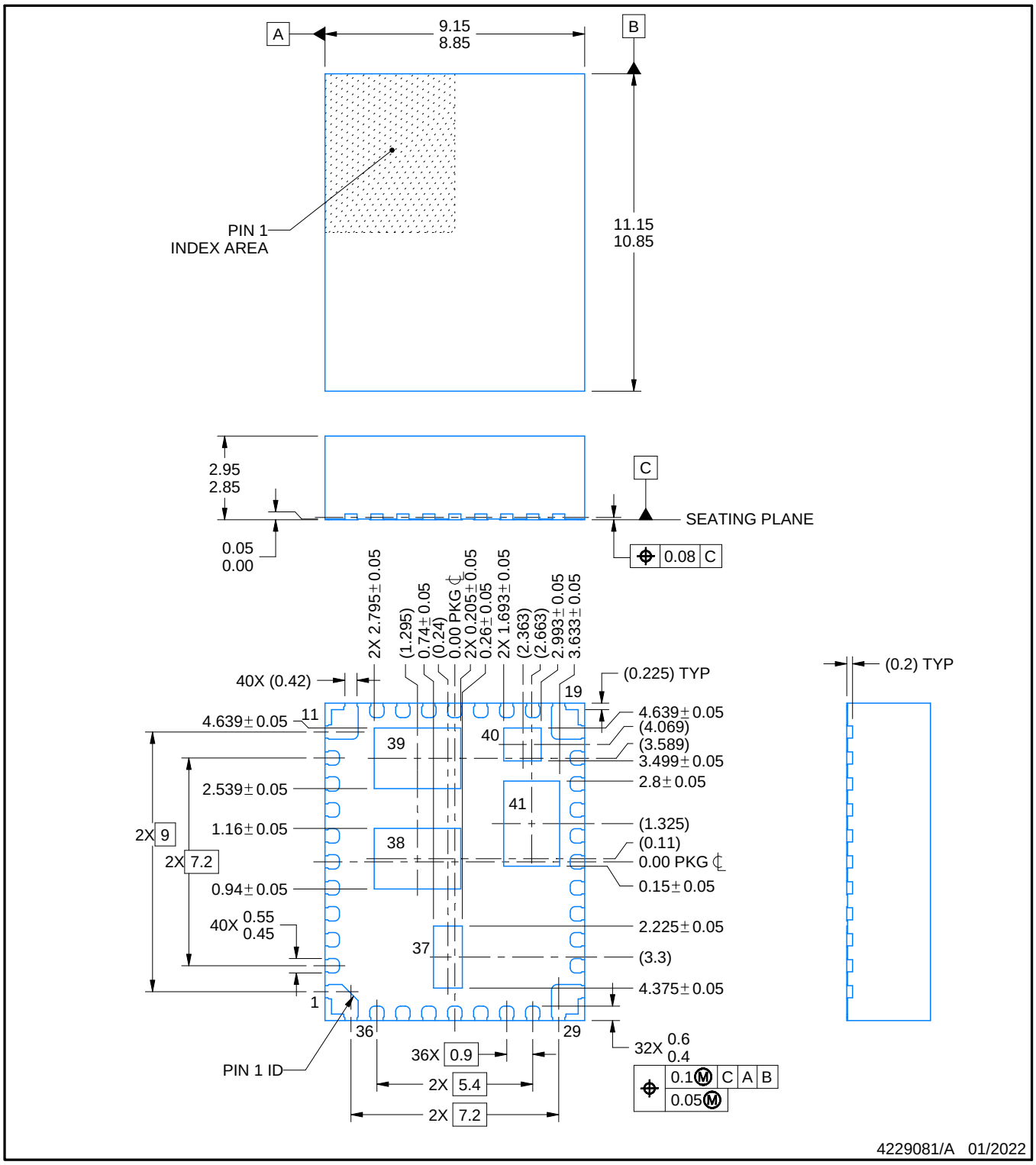
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMZ34002RKGR	B1QFN	RKG	41	500	383.0	353.0	58.0
LMZ34002RKGT	B1QFN	RKG	41	250	383.0	353.0	58.0
LMZ34002RKGTG4	B1QFN	RKG	41	250	383.0	353.0	58.0

PACKAGE OUTLINE

RKG0041A

B1QFN - 2.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



NOTES:

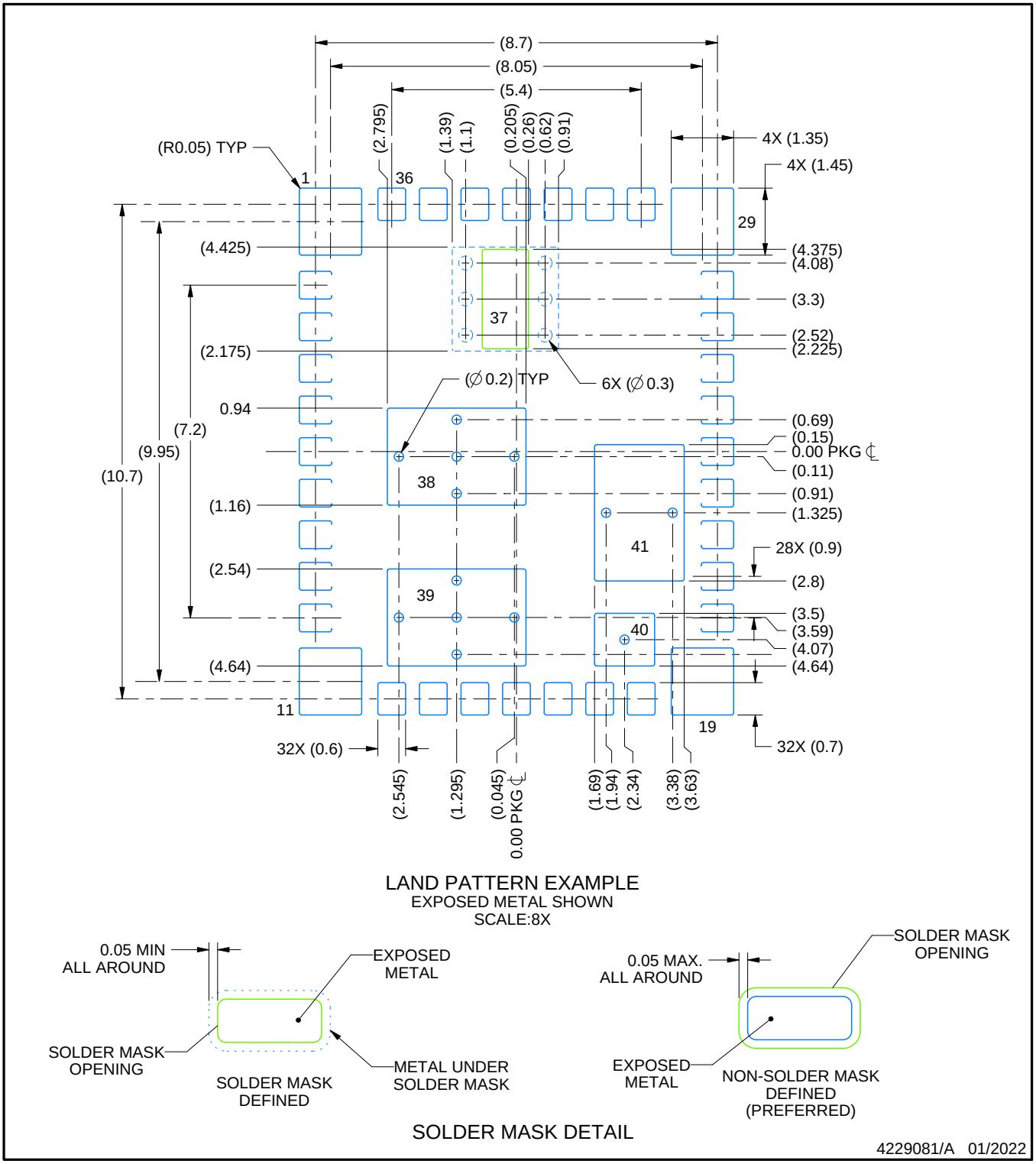
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pads must be soldered to the printed circuit board for optimal thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

RKG0041A

B1QFN - 2.8 mm max height

PLASTIC QUAD FLATPACK - NO LEAD



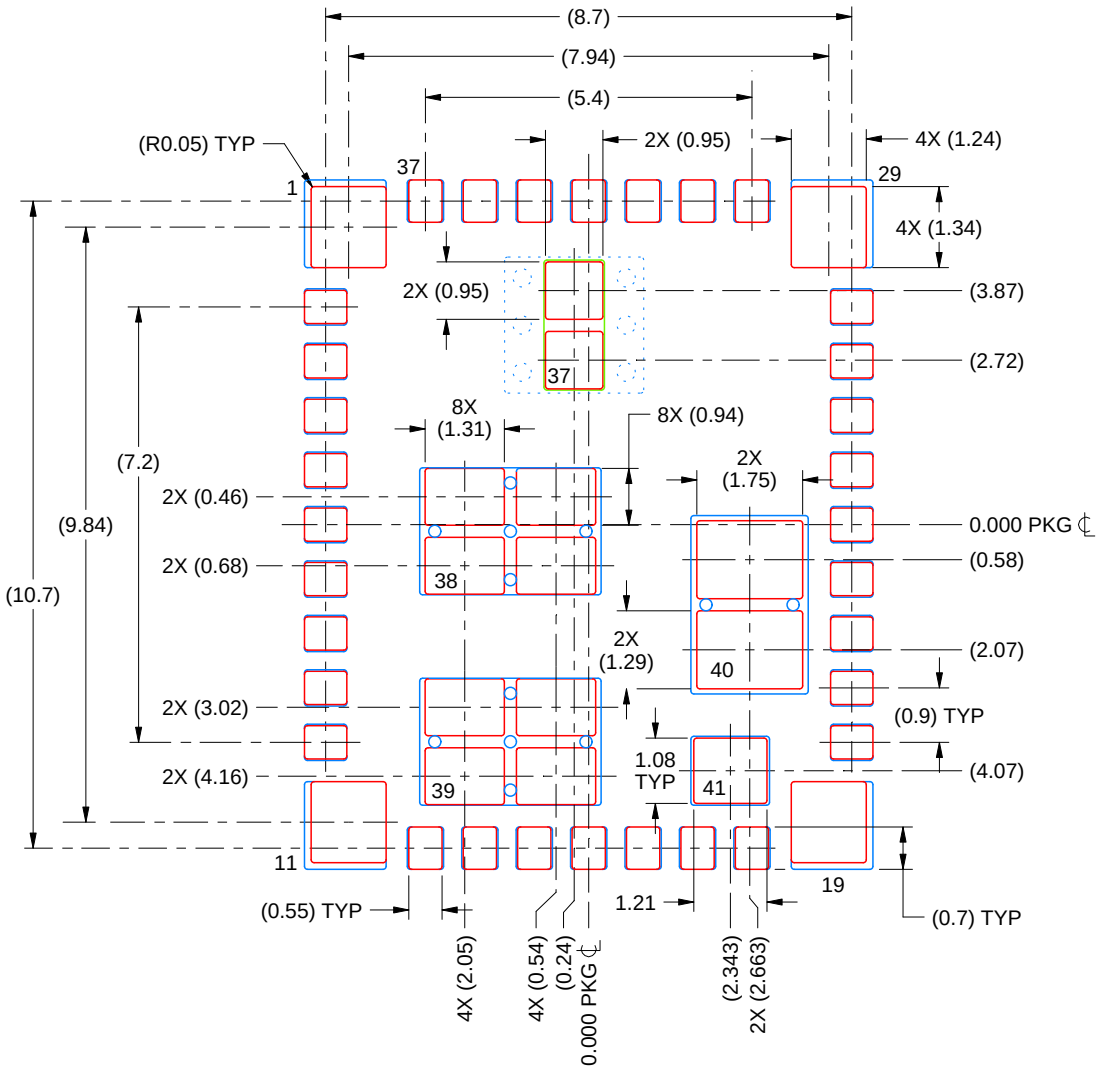
LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X

SOLDER MASK DETAIL

4229081/A 01/2022

NOTES: (continued)

4. This package designed to be soldered to a thermal pads on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.



SOLDER PASTE EXAMPLE

BASED ON 0.1 mm STENCIL THICKNESS

4229081/A 01/2022

NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.

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最后更新日期：2025 年 10 月