LMZ31520 QFNパッケージ、3V～14.5V入力の20A電源モジュール

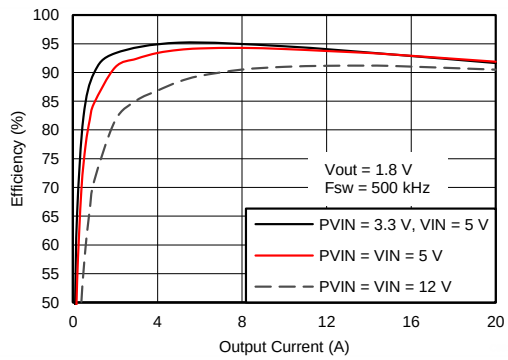
1 特長

- 完全に統合された電源ソリューション、ディスクリート設計より小型
- 15mm×16mm×5.8mmのパッケージ・サイズ
  - LMZ31530とピン互換
- 超高速の負荷ステップ応答
- 最高96%の効率
- 0.6V～3.6Vの広い範囲で出力電圧を設定可能、リファレンス精度1%
- オプションの分割電源レールにより最低3Vの入力電圧で動作
- スイッチング周波数を選択可能(300kHz～850kHz)
- スロー・スタートを選択可能
- 過電流制限を変更可能
- パワー・グッド出力
- 出力電圧のシーケンシング
- 過熱保護機能
- プリバイアス出力によるスタートアップ
- 動作温度範囲: -40℃～85℃
- 強化された熱特性: 8.6℃/W
- EN55022 Class Aの放射要件に準拠
  - シールド付きインダクタを内蔵
- WEBENCH® Power Designerにより、LMZ31520を使用するカスタム設計を作成

2 アプリケーション

- ブロードバンドおよび通信インフラストラクチャ
- DSPおよびFPGAのポイント・オブ・ロード・アプリケーション
- 高密度の電源システム

効率

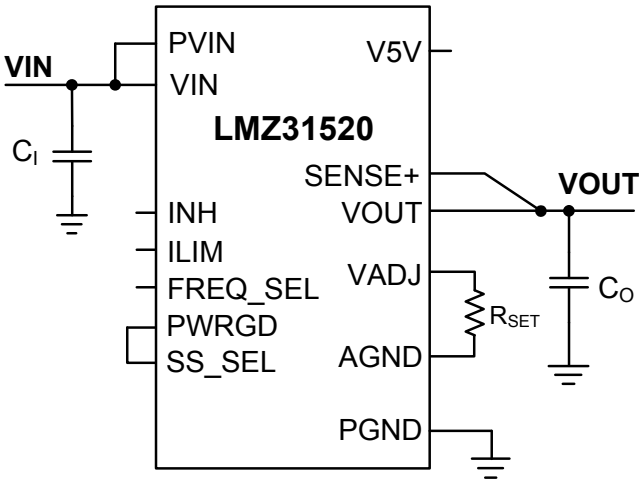


3 概要

LMZ31520パワー・モジュールは、20AのDC-DCコンバータをパワーMOSFET、シールド付きインダクタ、およびパッシブ部品とともに低プロファイルのQFNパッケージに実装した、使いやすい統合電源ソリューションです。外付け部品は3個しか使用せず、ループ補償や磁気部品の選択プロセスも不要になります。

15mm×16mm×5.8mmのQFNパッケージは、プリント基板に簡単にハンダ付けでき、コンパクトなポイント・オブ・ロード(POL)設計が可能です。95%を超える効率と非常に高速な負荷ステップ応答を特徴とし、8.6℃/Wの熱インピーダンスによって優れた消費電力特性を実現します。LMZ31520は、ディスクリートPOL設計と同等の柔軟性および機能セットを備え、幅広い範囲のICやシステムへの電力供給に理想的です。先進のパッケージング技術により、標準のQFN実装/試験手法に対応した堅牢で信頼性の高い電源ソリューションが得られます。

アプリケーション概略図



4 Specifications

4.1 Absolute Maximum Ratings(1)

over operating temperature range (unless otherwise noted)

		VALUE		UNIT
		MIN	MAX	
Input Voltage	VIN, PVIN	–0.3	20	V
	INH, VADJ, PWRGD, PWRGD_PU, ILIM, FREQ_SEL, SS_SEL, V5V	–0.3	7	V
Output Voltage	PH	–1	25	V
	PH 10ns Transient	–2	27	
	VOUT	–0.3	6	V
V_{DIFF} (GND to exposed thermal pad)			±200	mV
Operating Junction Temperature		–40	125(2)	°C
Storage Temperature		–55	150	°C
Peak Reflow Case Temperature(3)			245(4)	°C
Maximum Number of Reflows Allowed(3)			3(4)	
Mechanical Shock	Mil-STD-883D, Method 2002.3, 1 msec, 1/2 sine, mounted		250	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) See the temperature derating curves in the Typical Characteristics section for thermal information.
(3) For soldering specifications, refer to the *Soldering Requirements for BQFN Packages* application note.
(4) 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
PV_{IN}	Input Switching Voltage	3	14.5	V
V_{IN}	Input Bias Voltage	4.5	14.5	V
V_{OUT}	Output Voltage	0.6	3.6	V
f_{SW}	Switching Frequency	300	850	kHz

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4.3 Thermal Information

THERMAL METRIC(1)			LMZ31520 RLG 72 PINS	UNIT
θ_{JA}	Junction-to-ambient thermal resistance(2)	Natural Convection	8.6	°C/W
$\theta_{JA(100LFM)}$	Junction-to-ambient thermal resistance(3)	100 LFM	7.8	°C/W
ψ_{JT}	Junction-to-top characterization parameter(4)		1.6	°C/W
ψ_{JB}	Junction-to-board characterization parameter(5)		4.2	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report (SPRA953).
(2) The junction-to-ambient thermal resistance, θ_{JA}, applies to devices soldered directly to a 100 mm x 100 mm, 6-layer PCB with 1 oz. copper and natural convection cooling. Additional airflow reduces θ_{JA}.
(3) The junction-to-ambient thermal resistance, θ_{JA}, applies to devices soldered directly to a 100 mm x 100 mm, 6-layer PCB with 1 oz. copper and 100 LFM forced air cooling. Additional airflow reduces θ_{JA}.
(4) 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.
(5) 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

LMZ31520		UNIT
Weight		4.96 grams
Flammability	Meets UL 94 V-O	
MTBF Calculated reliability	Per Bellcore TR-332, 50% stress, T_A = 40°C, ground benign	26.5 MHrs

4.5 Electrical Characteristics

T_A = -40°C to 85°C, VIN = 12 V, VOUT = 1.8 V, I_{OUT} = 20A
C_{IN} = 2x 22 µF ceramic & 330 µF bulk, C_{OUT} = 4x 100 µF ceramic (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I_{OUT}	Output current		0		20	A
V_{IN}	Input bias voltage range	Over I_{OUT} range	4.5		14.5	V
P_{VIN}	Input switching voltage range	Over I_{OUT} range	3.0(1)		14.5	V
UVLO	VIN Undervoltage lockout	V_{IN} Increasing	4.0	4.2	4.33	V
		Hysteresis		0.25		
$V_{OUT(adj)}$	Output voltage adjust range	Over I_{OUT} range	0.6		3.6	V
V_{OUT}	Set-point voltage tolerance	I_{OUT} = 20 A, FCCM mode			±1.0% (2)	
	Temperature variation	-40°C ≤ T_A ≤ +85°C		±0.25%		
	Load regulation	Over I_{OUT} range		+0.3%		
	Total output voltage variation	Includes set-point, load, and temperature variation			±1.8% (2)	
	Line regulation	P_{VIN} ±10%		±0.1%		
		Over P_{VIN} range		±0.5%		

(1) The minimum PVIN voltage is 3.0V or (V_{OUT}+ 1.1V), whichever is greater. See VIN and PVIN Input Voltage for more details.
(2) 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.

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Electrical Characteristics (continued)

T_A = -40°C to 85°C, VIN = 12 V, VOUT = 1.8 V, I_{OUT} = 20A
C_{IN} = 2x 22 µF ceramic & 330 µF bulk, C_{OUT} = 4x 100 µF ceramic (unless otherwise noted)

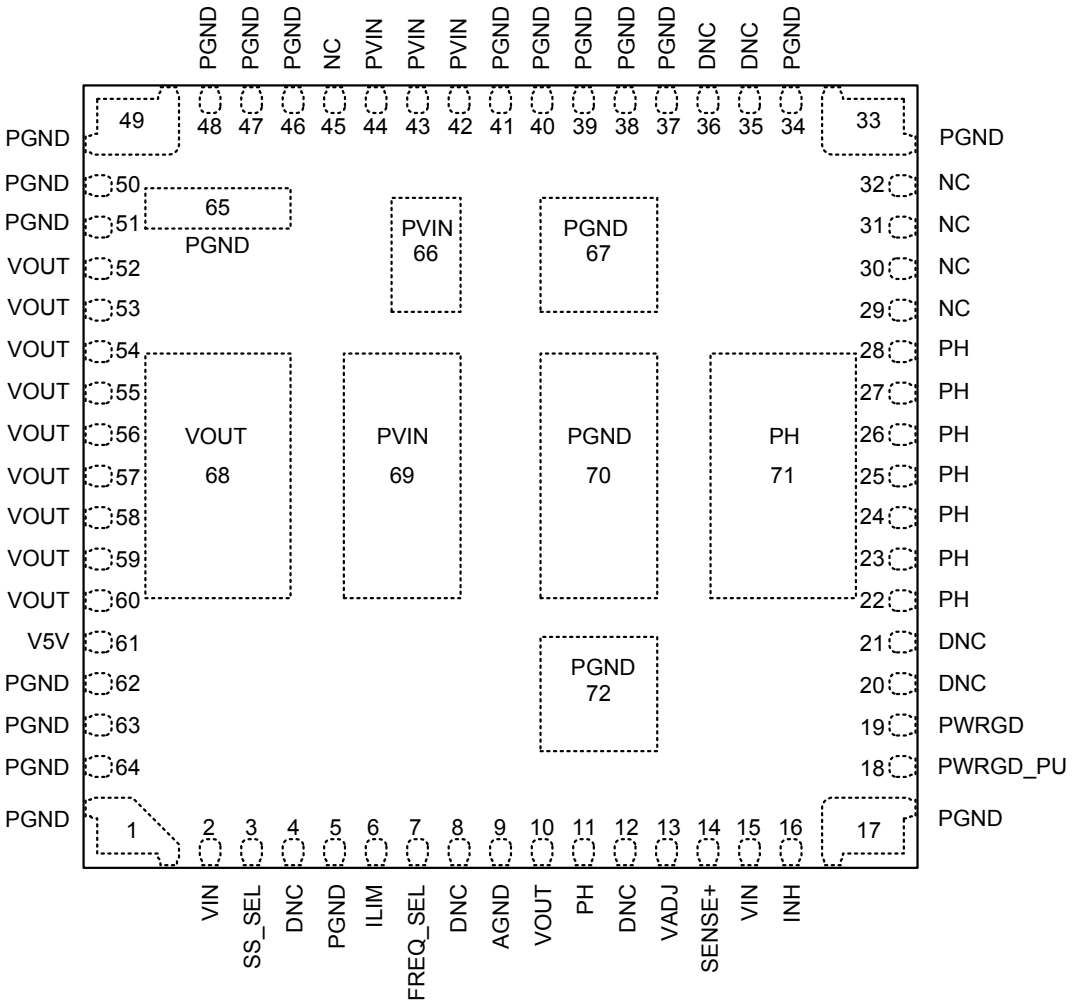
PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
η	Efficiency	P_{VIN} = V_{IN} = 12 V, I_O = 15 A	V_{OUT} = 3.3 V, f_{SW} = 500kHz		94		%
			V_{OUT} = 1.8 V, f_{SW} = 500kHz		92		
			V_{OUT} = 1.2 V, f_{SW} = 500kHz		88		
			V_{OUT} = 0.9 V, f_{SW} = 500kHz		86		
			V_{OUT} = 0.6 V, f_{SW} = 500kHz		82		
		P_{VIN} = V_{IN} = 5 V, I_O = 15 A	V_{OUT} = 3.3 V, f_{SW} = 500kHz		96		%
			V_{OUT} = 1.8 V, f_{SW} = 500kHz		94		
			V_{OUT} = 1.2 V, f_{SW} = 500kHz		91		
			V_{OUT} = 0.9 V, f_{SW} = 500kHz		88		
			V_{OUT} = 0.6 V, f_{SW} = 500kHz		85		
	Output voltage ripple	20 MHz bandwith			1%		VOUT
I_{LIM}	Current limit threshold				30		A
	Transient response	2.5 A/µs load step from 25 to 75% $IOUT_{(max)}$	Recovery time		25		µs
			VOUT over/undershoot		25		mV
V_{INH}	Inhibit Control	Inhibit High Voltage		1.8		Open (3)	V
		Inhibit Low Voltage		-0.3		0.6	V
$I_{IN(stby)}$	VIN standby current	INH pin to AGND	V_{IN} = 5 V		0.5	0.7	mA
			V_{IN} = 12 V		1.2	1.5	mA
Power Good	PWRGD Thresholds	V_{OUT} rising	Good		95		%
			Fault		115		
		V_{OUT} falling	Fault		90		
			Good		110		
	PWRGD Low Voltage	I(PWRGD) = 2 mA			0.2	0.3	V
f_{SW}	Switching frequency	FREQ_SEL pin OPEN, I_{OUT} = 10 A		470	520	570	kHz
f_{SEL}	Frequency Select (4)	66 kΩ resistor between FREQ_SEL pin and PGND			300		kHz
		FREQ_SEL pin connected to V5V (pin 61)			850		kHz
	Thermal Shutdown	Thermal shutdown			145		°C
		Thermal shutdown hysteresis			10		°C
C_{IN}	External input capacitance		Ceramic	44 (5)	94		µF
			Non-ceramic		330		
C_{OUT}	External output capacitance			100 (6)	400	5000	µF

(3) This pin has an internal pull-up to approximately 0.4 x V_{IN}. If this pin is left open circuit, the device operates when a valid input voltage is applied. A small, low-leakage (<300nA) MOSFET is recommended for control.
(4) See the Frequency Select section for more information on selecting the frequency.
(5) A minimum of 44 µF (2x 22 µF) of external ceramic capacitance is required across the input (PVIN/VIN and PGND connected) for proper operation. Locate the capacitor close to the device. See Table 3 for more details. When operating with split VIN and PVIN rails, place 4.7 µF of ceramic capacitance directly at the VIN pin to PGND.
(6) A minimum of 100 µF of ceramic capacitance is required at the output. Locate the capacitance close to the device. Adding additional capacitance close to the load improves the response of the regulator to load transients and reduces ripple. See Table 3 for more details.

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5 Device Information

RLG PACKAGE
(TOP VIEW)



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Pin Functions

TERMINAL		DESCRIPTION
NAME	NO.	
AGND	9	This pin is connected internally to the power ground of the device. This pin should only be used as the zero volt ground reference for connecting the voltage setting resistor (R_{SET}). Do not connect AGND to PGND. See Layout Recommendations.
DNC	4	Do Not Connect. Do not connect these pins to AGND, 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.
	8	
	12	
	20	
	21	
	35	
	36	
FREQ_SEL	7	Frequency Select pin. Leave this pin open (floating) to select 500 kHz (typ) operating frequency. Connect this pin to V5V pin to select 850 kHz (typ) operating frequency. Connect a 66 kΩ resistor between this pin and PGND to select 300 kHz (typ) operating frequency. See Table 2 for more info.
ILIM	6	Current limit setting pin. Connecting a resistor between this pin and PGND sets the current limit. When left open, refer to the Electrical Characterization table for current limit value.
INH	16	Inhibit pin. Use an open drain or open collector logic device to ground this pin to control the INH function.
NC	29	Not Connected. These pins are internally isolated from any signal and all other pins. Each pin must be soldered to a pad on the PCB. These pins can be left isolated, connected to one another, or connected to any signal on the PCB.
	30	
	31	
	32	
	45	
PGND	1	This is the return current path for the power stage of the device. Connect these pins to the load and to the bypass capacitors associated with VIN and VOUT. Pads 65, 67, 70, and 72 should be connected to PCB ground planes 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 device.
	5	
	17	
	33	
	34	
	37	
	38	
	39	
	40	
	41	
	46	
	47	
	48	
	49	
	50	
	51	
	62	
	63	
	64	
	65	
	67	
	70	
	72	

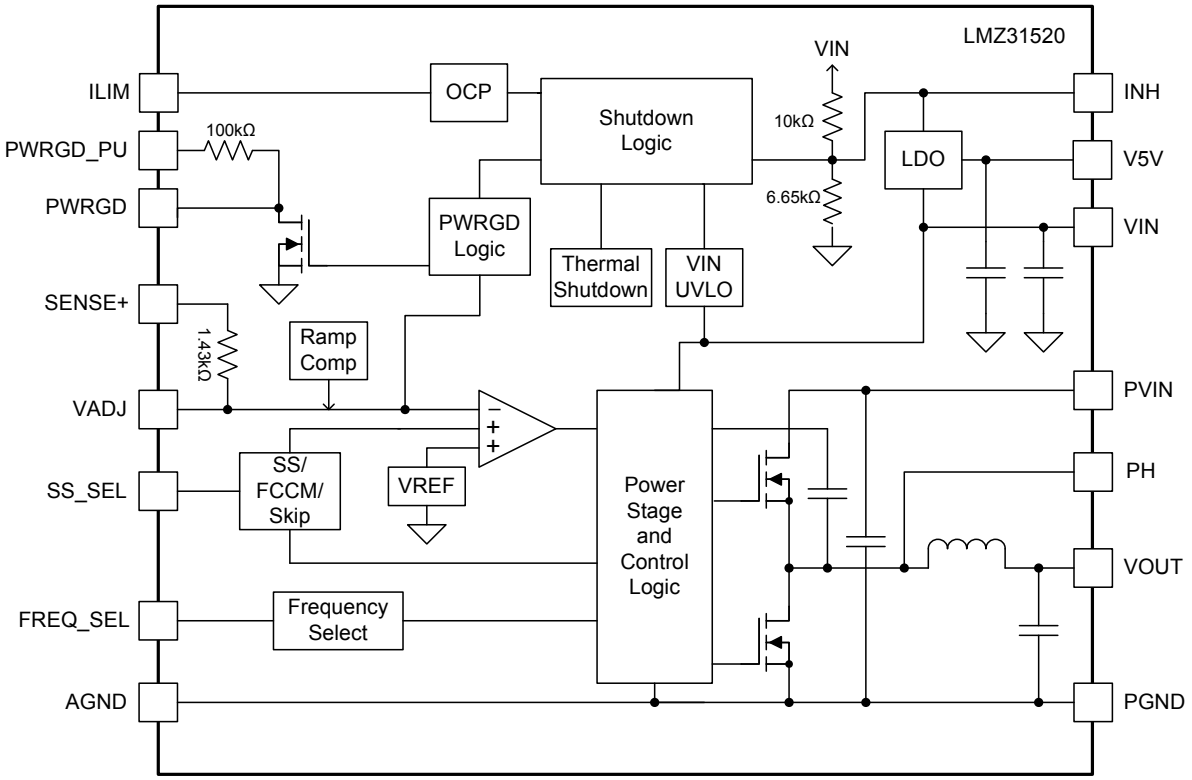
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Pin Functions (continued)

TERMINAL		DESCRIPTION
NAME	NO.	
PH	11	Phase switch node. Do not place any external component on these pins or tie them to a pin of another function. Connect these pins using a copper area beneath pad 71.
	22	
	23	
	24	
	25	
	26	
	27	
	28	
	71	
PVIN	42	Input switching voltage pin. This pin supplies voltage to the power switches of the converter.
	43	
	44	
	66	
	69	
PWRGD	19	Power Good flag pin. This open drain output asserts low if the output voltage is more than approximately ±6% out of regulation.
PWRGD_PU	18	Power Good pull-up pin. This pin is connected to a 100kΩ resistor which is tied to the PWRGD pin internally. Connect this pin to V5V or to any voltage between 1.3V and 6.5V.
SENSE+	14	Remote sense connection. Connect this pin to VOUT at the load for improved regulation. This pin must be connected to VOUT at the load, or at the module pins.
SS_SEL	3	Slow-start select pin. Connect a resistor between this pin and PWRGD (or PGND) to select the slow-start time. See the SS_SEL section of the datasheet for slow-start times and corresponding resistor values. Connect the SS_SEL pin to PGND to select Auto-skip Eco-mode or to the PWRGD pin (pin 19) to select FCCM.
V5V	61	5V regulator pin. This regulator supplies the internal circuitry.
VADJ	13	Output voltage adjust pin. Connecting a resistor between this pin and AGND sets the output voltage.
VIN	2	Input bias voltage pins. Supplies the control circuitry of the power converter.
	15	
VOUT	10	Output voltage. These pins are connected to the internal output inductor. Connect these pins to the output load and connect external bypass capacitors between these pins and PGND.
	52	
	53	
	54	
	55	
	56	
	57	
	58	
	59	
	60	
	68	

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Functional Block Diagram



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6 Typical Characteristics (PVIN = 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 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 six-layer PCB with 1 oz. copper. Applies to Figure 4 and Figure 5.

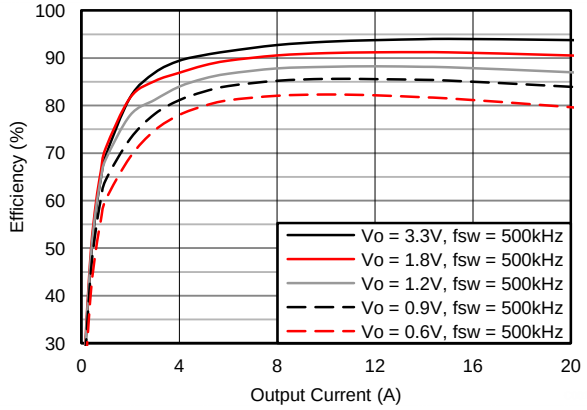


Figure 1. Efficiency vs. Output Current

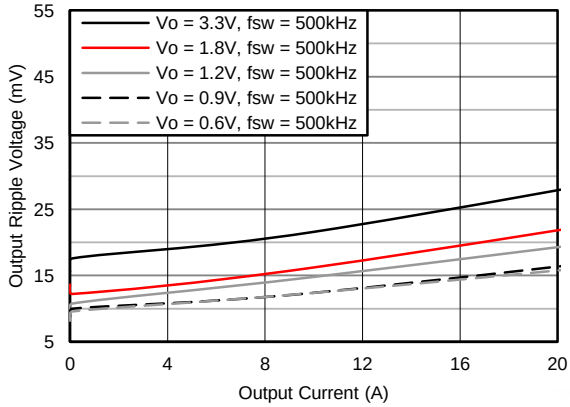


Figure 2. Voltage Ripple vs. Output Current

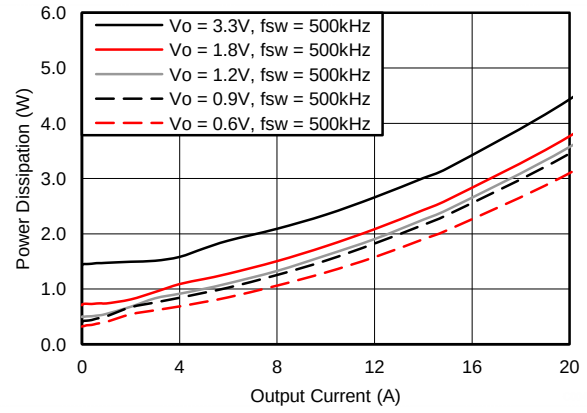


Figure 3. Power Dissipation vs. Output Current

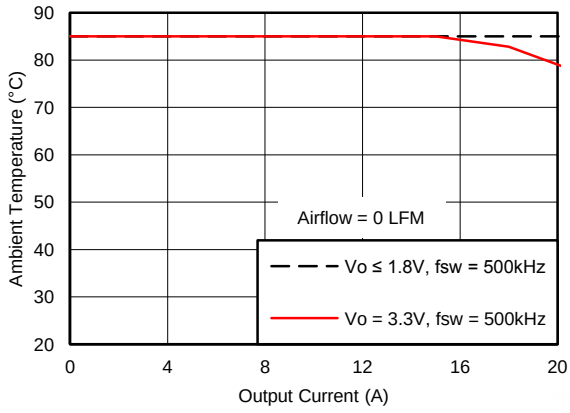


Figure 4. Safe Operating Area (0 LFM)

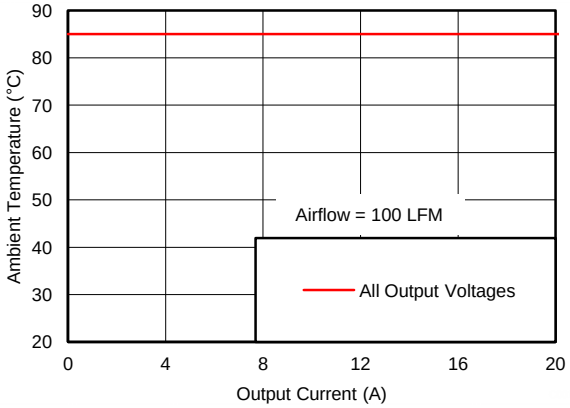


Figure 5. Safe Operating Area (100 LFM)

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7 Typical Characteristics (PVIN = 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 6, Figure 7, and Figure 8. 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 six-layer PCB with 1 oz. copper. Applies to Figure 9.

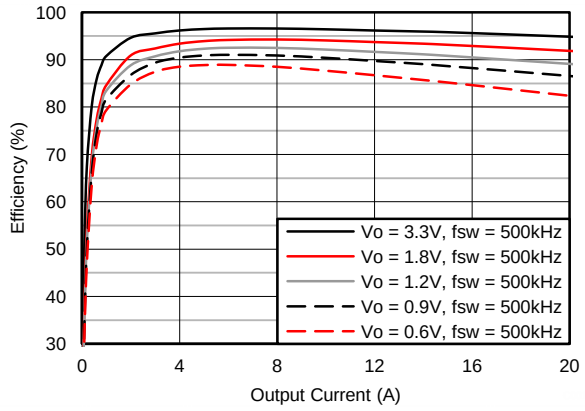


Figure 6. Efficiency vs. Output Current

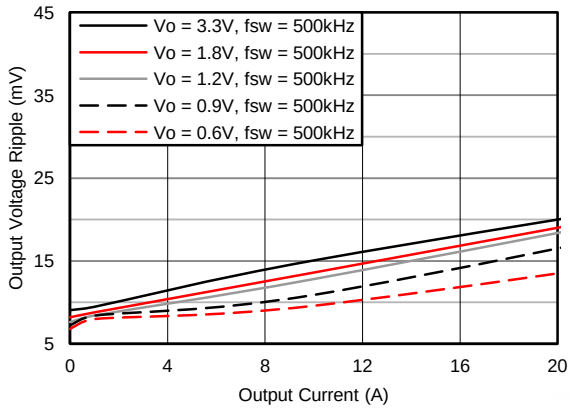


Figure 7. Voltage Ripple vs. Output Current

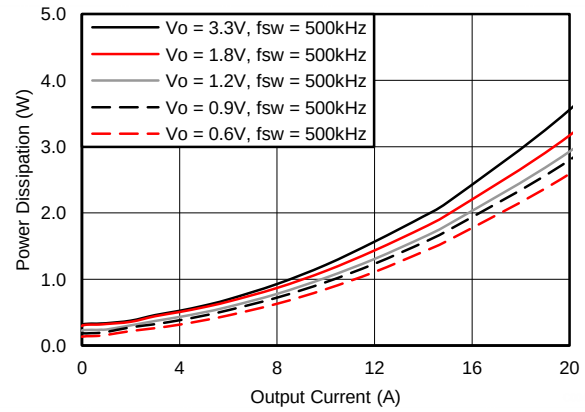


Figure 8. Power Dissipation vs. Output Current

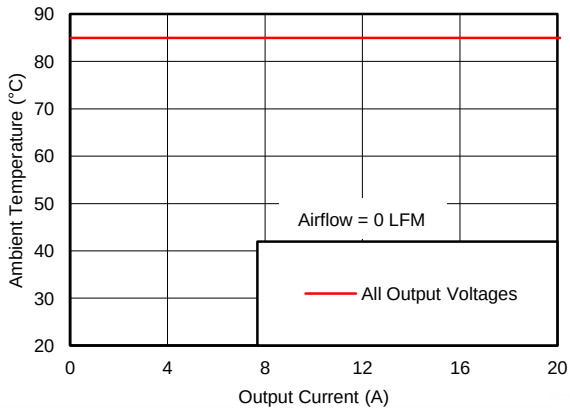


Figure 9. Safe Operating Area (0 LFM)

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8 Application Information

8.1 Adjusting the Output Voltage

The VADJ control sets the output voltage of the LMZ31520. The output voltage adjustment range is from 0.6V to 3.6V. The adjustment method requires the addition of R_{SET}, which sets the output voltage, and the connection of SENSE+ to VOUT. The R_{SET} resistor must be connected directly between the VADJ (pin 13) and AGND (pin 9). The SENSE+ pin (pin 14) must be connected to VOUT either at the load for improved regulation or at VOUT of the device.

The LMZ31520 relies on a precision trimmed 0.6 V reference for the feedback voltage regulation and operates by regulating the valley of the voltage ripple appearing at the VADJ pin. The voltage ripple is a function of the input voltage and the output voltage, therefore the R_{SET} resistor will change based on the input voltage. Table 1 gives the calculated external R_{SET} resistor for a number of common bus voltages for PVIN of 12 V, 5 V, and 3.3 V. The recommended switching frequency is 500 kHz which can be configured by leaving the FREQ_SEL pin open. To adjust the frequency, see Table 2.

Table 1. R_{SET} Resistor Values

	R_{SET} (Ω)				R_{SET} (Ω)		
V_{OUT} (V)	PVIN = 12 V	PVIN = 5 V	PVIN = 3.3 V	V_{OUT} (V)	PVIN = 12 V	PVIN = 5 V	PVIN = 3.3 V
0.60	open	open	open	2.15	566	563	560
0.65	18787	18681	18588	2.20	548	545	542
0.70	9024	8993	8966	2.25	532	528	525
0.75	5939	5923	5908	2.30	516	513	510
0.80	4427	4416	4406	2.35	502	498	495
0.85	3529	3521	3513	2.40	488	484	481
0.90	2934	2927	2921	2.45	475	471	468
0.95	2511	2505	2500	2.50	462	459	456
1.00	2195	2190	2185	2.55	451	447	444
1.05	1950	1945	1941	2.60	439	436	433
1.10	1754	1749	1745	2.65	429	425	422
1.15	1594	1589	1586	2.70	419	415	412
1.20	1460	1456	1453	2.75	409	405	402
1.25	1348	1344	1341	2.80	400	396	393
1.30	1251	1248	1244	2.85	391	387	384
1.35	1168	1164	1161	2.90	382	379	375
1.40	1095	1091	1088	2.95	374	370	367
1.45	1031	1027	1024	3.00	367	363	359
1.50	973	970	968	3.05	359	355	352
1.55	922	919	916	3.10	352	348	345
1.60	876	873	870	3.15	345	341	338
1.65	834	831	828	3.20	339	335	331
1.70	797	793	790	3.25	332	328	325
1.75	762	759	756	3.30	326	322	318
1.80	730	727	724	3.35	320	316	312
1.85	701	698	695	3.40	315	310	307
1.90	674	671	668	3.45	309	305	301
1.95	650	646	643	3.50	304	300	296
2.00	626	623	620	3.55	299	294	291
2.05	605	602	599	3.60	294	289	286
2.10	585	581	578				

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8.2 Frequency Select

The LMZ31520 switching frequency can be selected from several values as shown in Table 2. To select a switching frequency, a resistor (R_{FREQ}) must be connected between the FREQ_SEL pin and either PGND or V5V (pin 61) as shown in Table 2. For all output voltages, the recommended switching frequency is 500 kHz which can be configured by leaving the FREQ_SEL pin open. Table 2 also shows the output voltage range for each frequency.

Table 2. Frequency Selection

Frequency Select (kHz)	R_{FREQ} (kΩ)	Connect To	V_{OUT} RANGE (V)	
			MIN	MAX
300	66	PGND	0.6	3.6
400	498	PGND	0.6	3.6
500	open	-	0.6	3.6
650	745	V5V	0.8	3.6
750	188	V5V	1.0	3.6
850	short	V5V	1.2	3.6

8.3 Capacitor Recommendations for the LMZ31520 Power Supply

8.3.1 Capacitor Technologies

8.3.1.1 Electrolytic, Polymer-Electrolytic Capacitors

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

8.3.1.2 Ceramic Capacitors

The performance of ceramic capacitors is most effective 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.

8.3.1.3 Tantalum, Polymer-Tantalum Capacitors

Polymer-tantalum type capacitors are recommended for applications where the ambient operating temperature is less than 0°C. The Panasonic 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.

8.3.1.4 Input Capacitor

The LMZ31520 requires a minimum input capacitance of 44 µF of ceramic type. The voltage rating of input capacitors must be greater than the maximum input voltage. The input RMS ripple current is a function of the output current and the duty cycle for any application. The input capacitor must be rated for the application's RMS ripple current. Table 3 includes a preferred list of capacitors by vendor.

8.3.1.5 Output Capacitor

The required output capacitance of the LMZ31520 can be comprised of either all ceramic capacitors, or a combination of ceramic and bulk capacitors. The required output capacitance must include at least 100 µF of ceramic type. When adding additional non-ceramic bulk capacitors, low-ESR devices like the ones recommended in Table 3 are required. The required capacitance above the minimum is determined by actual transient deviation requirements. See Table 4 for typical transient response values for several output voltage, input voltage and capacitance combinations. Table 3 includes a preferred list of capacitors by vendor.

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Capacitor Recommendations for the LMZ31520 Power Supply (continued)

Table 3. Recommended Input/Output Capacitors (1)

VENDOR	SERIES	PART NUMBER	CAPACITOR CHARACTERISTICS		
			WORKING VOLTAGE (V)	CAPACITANCE (µF)	ESR (2) (mΩ)
Murata	X5R	GRM32ER61E226K	25	22	2
TDK	X5R	C3216X5R1E476M	25	47	2
TDK	X5R	C3216X5R1C476M	16	47	2
Murata	X5R	GRM32ER61C476M	16	47	2
TDK	X5R	C3225X5R0J107M	6.3	100	2
Murata	X5R	GRM32ER60J107M	6.3	100	2
TDK	X5R	C3225X5R0J476K	6.3	47	2
Murata	X5R	GRM32ER60J476M	6.3	47	2
Panasonic	EEH-ZA	EEH-ZA1E101XP	25	100	30
Kemet	T520	T520V107M010ASE025	10	100	25
Panasonic	POSCAP	6TPE100MI	6.3	100	25
Panasonic	POSCAP	2R5TPE220M7	2.5	220	7
Kemet	T530	T530D227M006ATE006	6.3	220	6
Kemet	T530	T530D337M006ATE010	6.3	330	10
Panasonic	POSCAP	2TPF330M6	2.0	330	6
Panasonic	POSCAP	6TPE330MFL	6.3	330	15

(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 @ 100kHz, 25°C.

8.4 Transient Response

The LMZ31520 is designed to have an ultra-fast load step response with minimal output capacitance. Table 4 shows the voltage deviation and recovery time for several different transient conditions. Several transient waveforms are shown in Application Curves (1).

Table 4. Output Voltage Transient Response

C_{IN1} = 3 x 47 µF CERAMIC						
V_{OUT} (V)	V_{IN} (V)	C_{OUT1} Ceramic	C_{OUT2} BULK	VOLTAGE DEVIATION (mV)		RECOVERY TIME (µs)
				5 A LOAD STEP, (1 A/µs)	10 A LOAD STEP, (1 A/µs)	
0.6	5	500 µF	-	8	15	35
	12	500 µF	-	8	15	35
0.9	5	500 µF	-	8	15	40
		500 µF	470 µF	6	12	40
	12	500 µF	-	8	20	40
		500 µF	470 µF	7	16	40
1.2	5	500 µF	-	10	20	40
		500 µF	330 µF	8	15	40
	12	500 µF	-	10	20	40
		500 µF	330 µF	8	16	40
1.8	5	500 µF	-	10	20	40
		500 µF	330 µF	8	16	40
	12	500 µF	-	10	20	40
		500 µF	330 µF	8	16	45
3.3	5	500 µF	-	12	25	50
	12	500 µF	-	12	25	50

(1) Device configured for FCCM mode of operation, (pin 3 connected to pin 19).

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8.5 Application Curves (1)

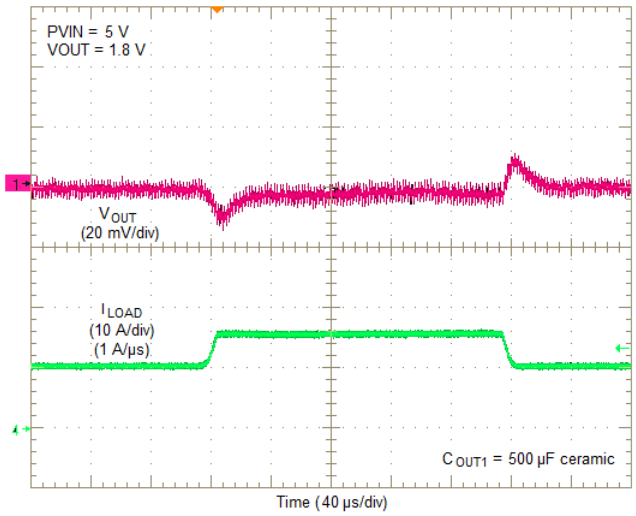


Figure 10. PVIN = 5V, VOUT = 1.8V, 5A Load Step

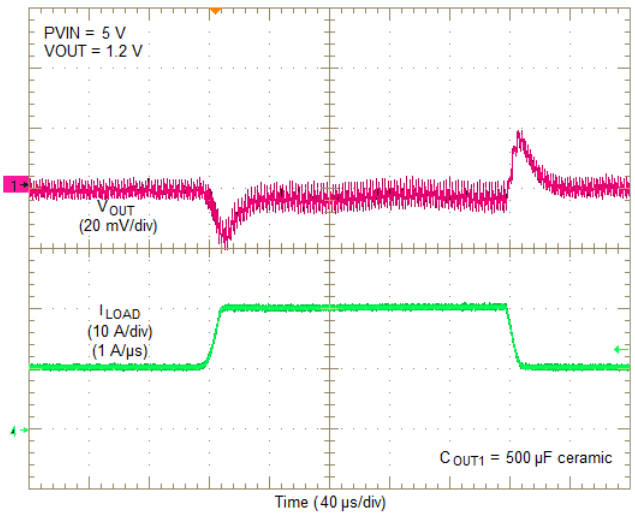


Figure 11. PVIN = 5V, VOUT = 1.2V, 10A Load Step

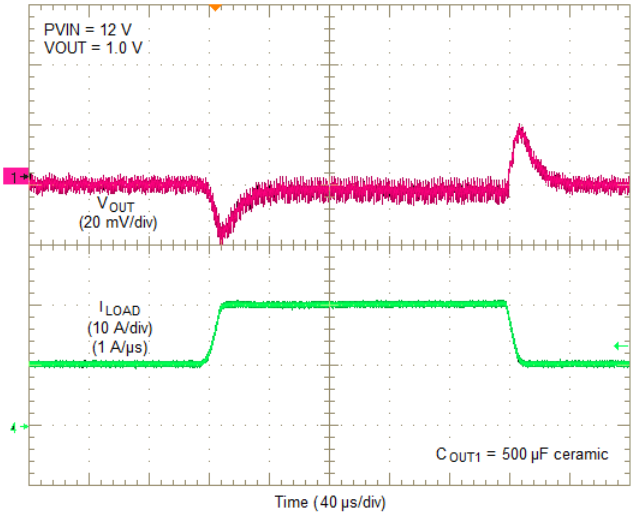


Figure 12. PVIN = 12V, VOUT = 1.0V, 10A Load Step

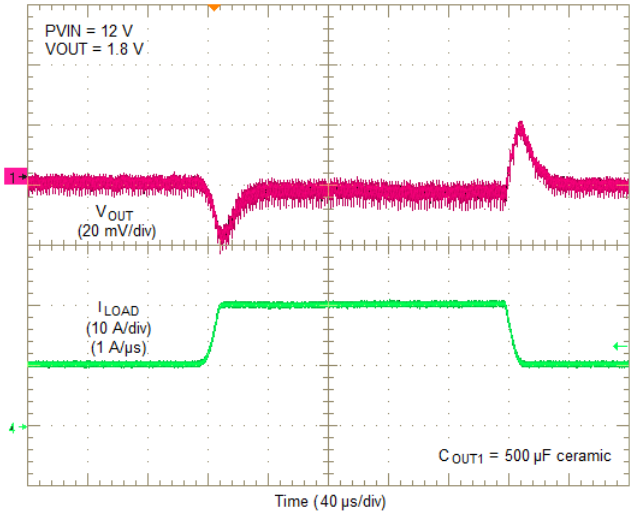


Figure 13. PVIN = 12V, VOUT = 1.8V, 10A Load Step

(1) Device configured for FCCM mode of operation, (pin 3 connected to pin 19).

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8.6 Application Schematics

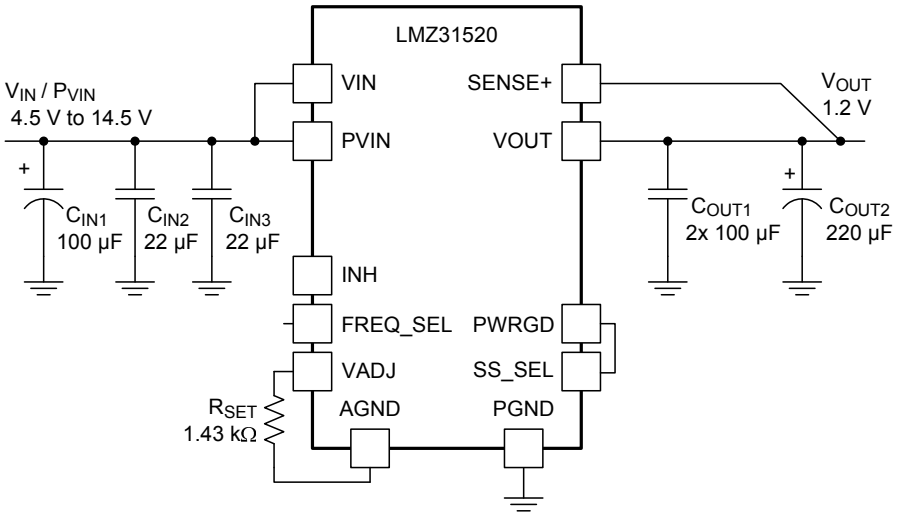


Figure 14. Typical Schematic
PVIN = VIN = 4.5 V to 14.5 V, VOUT = 1.2 V

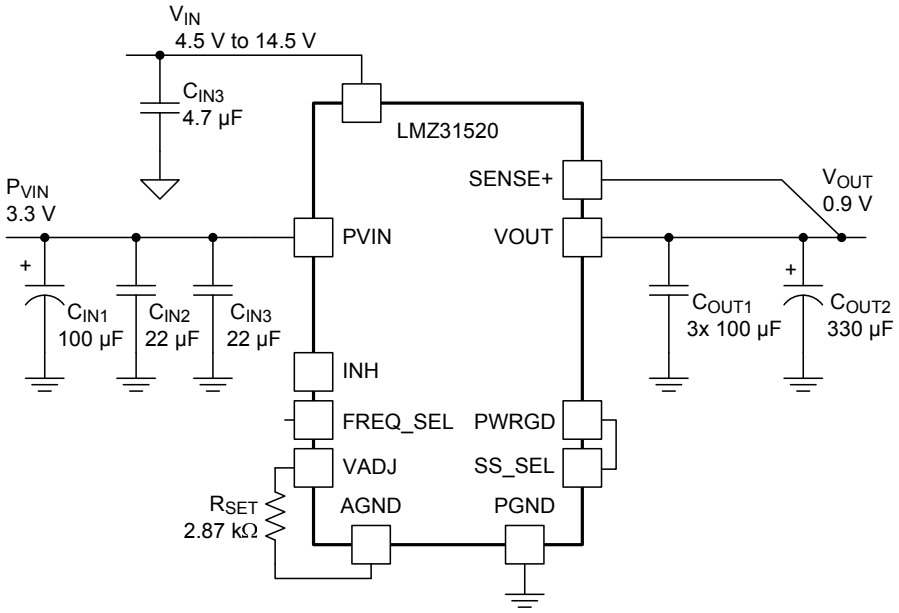


Figure 15. Typical Schematic
PVIN = 3.3 V, VIN = 4.5 V to 14.5 V, VOUT = 0.9 V

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8.7 Custom Design With WEBENCH® Tools

Click here to create a custom design using the LMZ31520 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.

8.8 VIN and PVIN Input Voltage

The LMZ31520 allows for a variety of applications by using the VIN and PVIN pins together or separately. The VIN voltage supplies the internal control circuits of the device. The PVIN voltage provides the input voltage to the power converter system.

If tied together, the input voltage for the VIN pin and the PVIN pin can range from 4.5 V to 14.5 V. If using the VIN pin separately from the PVIN pin, the VIN pin must be greater than 4.5 V, and the PVIN pin can range from as low as 3.0 V to 14.5 V. When operating from a split rail, it is recommended to supply VIN from 5 V to 12 V, for best performance.

8.9 3.3 V PVIN Operation

Applications operating from a PVIN of 3.3 V must provide at least 4.5 V for VIN. It is recommended to supply VIN from 5 V to 12 V, for best performance. See application note, SNVA692 for help creating 5 V from 3.3 V using a small, simple charge pump device.

8.10 Power Good (PWRGD)

The PWRGD pin is an open drain output. Once the voltage on the SENSE+ pin is between 90% and 115% of the set voltage, the PWRGD pin pull-down is released and the pin floats. The recommended pull-up resistor value is between 10 kΩ and 100 kΩ to a voltage source that is less than 7 V. An internal 100 kΩ pull-up resistor is provided internal to the device between the PWRGD pin (pin 19) and PWRGD_PU pin (pin 18). The PWRGD_PU pin can be connected to a voltage source less than 7 V or connected directly to V5V (pin 61), which is an internal 5V regulator. The PWRGD pin is in a defined state once VIN is greater than 1.0 V. The PWRGD pin is pulled low when the voltage on SENSE+ is lower than 90% or greater than 115% of the nominal set voltage. Also, the PWRGD pin is pulled low if the input UVLO or thermal shutdown is asserted or the INH pin is pulled low.

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8.11 Slow Start (SS_SEL)

Connecting the SS_SEL pin to PWRGD or PGND sets the slow start interval of approximately 0.7 ms. The connection to either PWRGD or PGND determines the mode of the LMZ31520 as decribed in Auto-Skip Eco-mode™ / Forced Continuous Conduction Mode. Adding a resistor between SS_SEL pin and PWRGD or PGND increases the slow start time. Increasing the slow start time will reduce inrush current.Table 5 shows a resistor connected between SS_SEL pin and PWRGD to select FCCM and Figure 17 shows a resistor between SS_SEL pin and PGND to select Auto-skip mode. See Table 5 below for SS resistor values and timing interval.

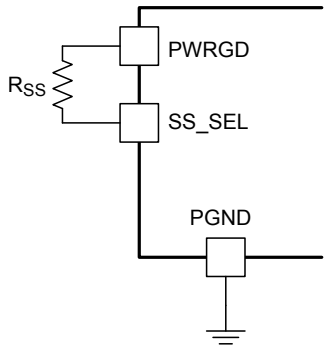


Figure 16. Slow-Start Resistor (R_{SS}) in FCCM

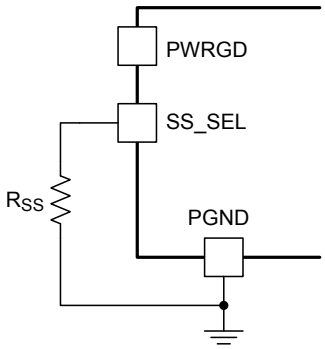


Figure 17. Slow-Start Resistor (R_{SS}) in Auto-skip Mode

Table 5. Slow-Start Resistor Values and Slow-Start Time

R_{SS} (kΩ)	short	61.9	161	436
SS Time (msec)	0.7	1.4	2.8	5.6

8.12 Auto-Skip Eco-mode™ / Forced Continuous Conduction Mode

Auto-skip Eco-mode or Forced Continuous Conduction Mode (FCCM) can be selected using the SS_SEL pin (pin 3). Connect the SS_SEL pin to PGND to select Auto-skip Eco-mode or to the PWRGD pin to select FCCM.

In Auto-skip Eco-mode, the LMZ31520 automatically reduces the switching frequency at light load conditions to maintain high efficiency. In FCCM, the controller keeps continuous conduction mode in light load condition and the switching frequency is kept almost constant over the entire load range. Transient performance is best in FCCM.

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8.13 Power-Up Characteristics

When configured as shown in the front page schematic, the LMZ31520 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. Figure 18 shows the start-up waveforms for a LMZ31520, operating from a 5-V input (PVIN=VIN) and with the output voltage adjusted to 1.8 V. Figure 19 shows the start-up waveforms for a LMZ31520 starting up into a pre-biased output voltage. The waveforms were measured with a 15-A constant current load.

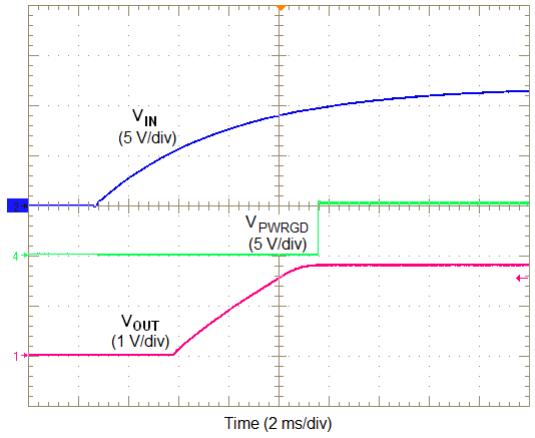


Figure 18. Start-Up Waveforms

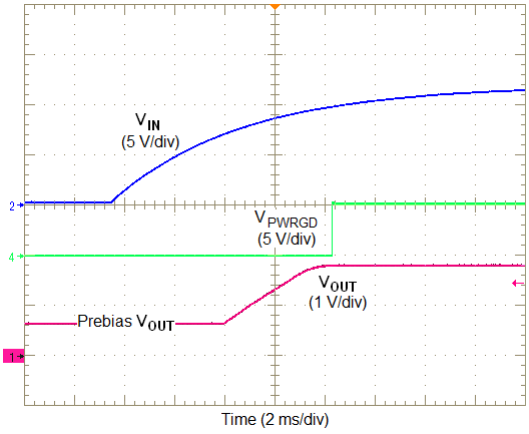


Figure 19. Start-up into Pre-bias

8.14 Pre-Biased Start-Up

The LMZ31520 has been designed to prevent the low-side MOSFET from discharging a pre-biased output. During pre-biased startup, the low-side MOSFET does not turn on until the high-side MOSFET has started switching. The high-side MOSFET does not start switching until the slow start voltage exceeds the voltage on the VADJ pin. Refer to Figure 19.

8.15 Remote Sense

The SENSE+ pin must be connected to V_{OUT} at the load, or at the device pins.

Connecting the SENSE+ pin to V_{OUT} at the load improves the load regulation performance of the device by allowing it to compensate for any I-R voltage drop between its output pins and the load. An I-R drop is caused by the high output current flowing through the small amount of pin and trace resistance. This should be limited to a maximum of 300 mV.

NOTE

The remote sense feature is not designed to compensate for the forward drop of nonlinear or frequency dependent components that may be placed in series with the converter output. Examples include OR-ing diodes, filter inductors, ferrite beads, and fuses. When these components are enclosed by the SENSE+ connection, they are effectively placed inside the regulation control loop, which can adversely affect the stability of the regulator.

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8.16 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, use an open drain/collector device, or a suitable logic gate to interface with the pin.

Figure 20 shows the typical application of the inhibit function. The Inhibit control has its own internal pull-up to VIN potential. An open-collector or open-drain device is recommended to control this input.

Turning Q1 on applies a low voltage to the inhibit control (INH) pin and disables the output of the supply, shown in Figure 21. If Q1 is turned off, the supply executes a soft-start power-up sequence, as shown in Figure 22. A regulated output voltage is produced within 2 ms. The waveforms were measured with a 5-A constant current load.

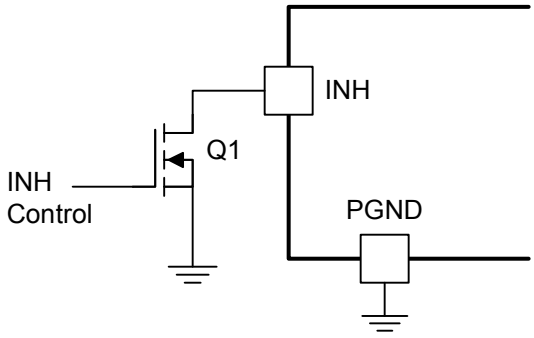


Figure 20. Typical Inhibit Control

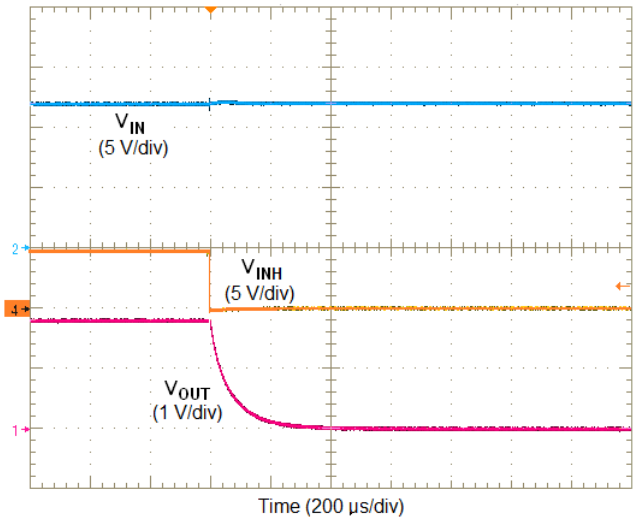


Figure 21. Inhibit Turn-Off

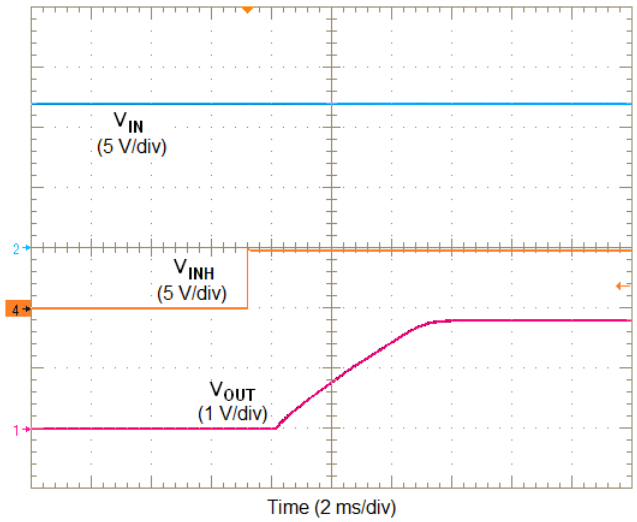


Figure 22. Inhibit Turn-On

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8.17 Overcurrent Protection

For protection against load faults, the LMZ31520 incorporates cycle-by-cycle overcurrent limiting control. The inductor current is monitored during the OFF state and the controller maintains the OFF state during the period in that the inductor current is larger than the overcurrent trip level. In cycle-by-cycle mode, applying a load that exceeds the regulator's overcurrent threshold limits the output current and reduces the output voltage as shown in Figure 23. If the overcurrent condition remains and the output voltage drops below 70% of the set-point, the LMZ31520 shuts down. Following shutdown, the module periodically attempts to recover by initiating a soft-start power-up as shown in Figure 23. This is described as a hiccup mode of operation, whereby the module continues in a cycle of successive shutdown and power up until the load fault is removed. During this period, the average current flowing into the fault is significantly reduced which reduces power dissipation. Once the fault is removed, the module automatically recovers and returns to normal operation as shown in Figure 24.

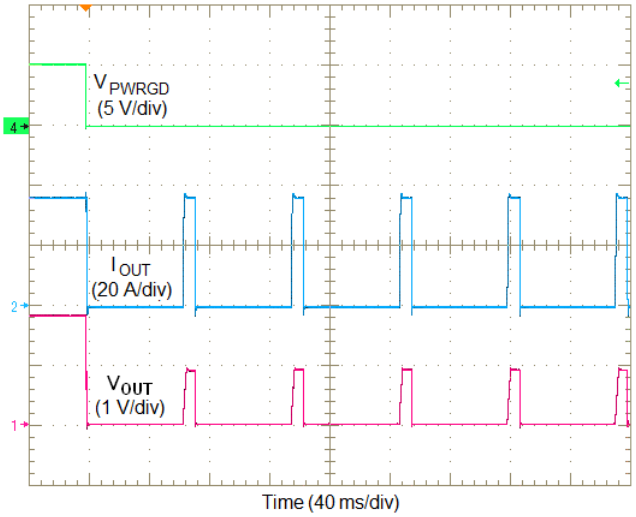


Figure 23. Typical Overcurrent Limiting

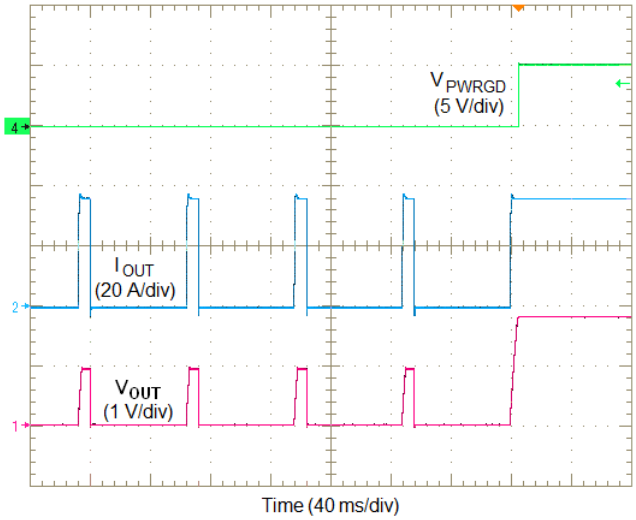


Figure 24. Typical Removal of Overcurrent

8.18 Current Limit (ILIM) Adjust

The current limit of this device can be adjusted lower by connecting a resistor, R_{ILIM}, between the ILIM pin (pin 6) and PGND. To adjust the typical current limit threshold, as listed in the electrical characteristics table, refer to Table 6.

Table 6. Current Limit Adjust Resistor

Current Limit Reduction	R_{ILIM} (kΩ)
10 %	715
20 %	383
30 %	243

8.19 Thermal Shutdown

The internal thermal shutdown circuitry forces the device to stop switching if the junction temperature exceeds 145°C typically. The device reinitiates the power up sequence when the junction temperature drops below 135°C typically.

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8.20 Layout Considerations

To achieve optimal electrical and thermal performance, an optimized PCB layout is required. Figure 25 thru Figure 30, shows a typical PCB layout. Some considerations for an optimized layout are:

- Use large copper areas for power planes (PVIN, VOUT, and PGND) to minimize conduction loss and thermal stress.
- Place ceramic input and output capacitors close to the device pins to minimize high frequency noise.
- Locate additional output capacitors between the ceramic capacitor and the load.
- Keep AGND and PGND separate from one another. AGND should only be used as the return for R_{SET}.
- Place R_{SET}, R_{FREQ}, and R_{SS} as close as possible to their respective pins.
- Use multiple vias to connect the power planes to internal layers.

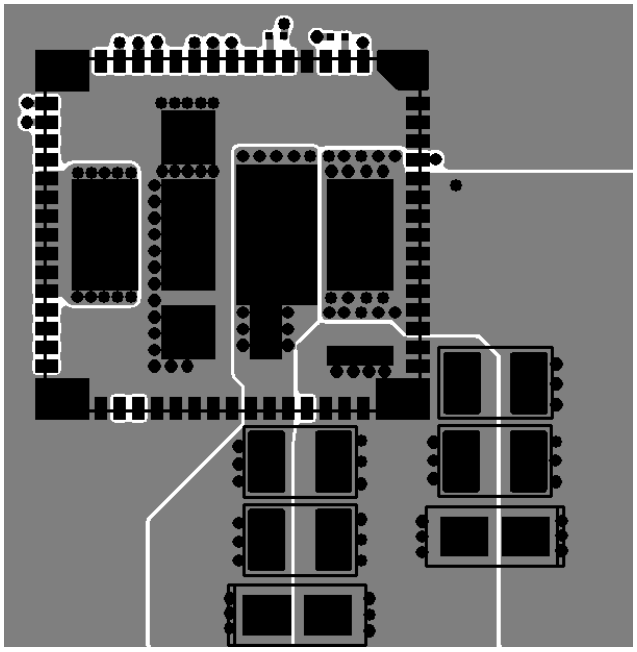


Figure 25. Typical Top Layer Layout

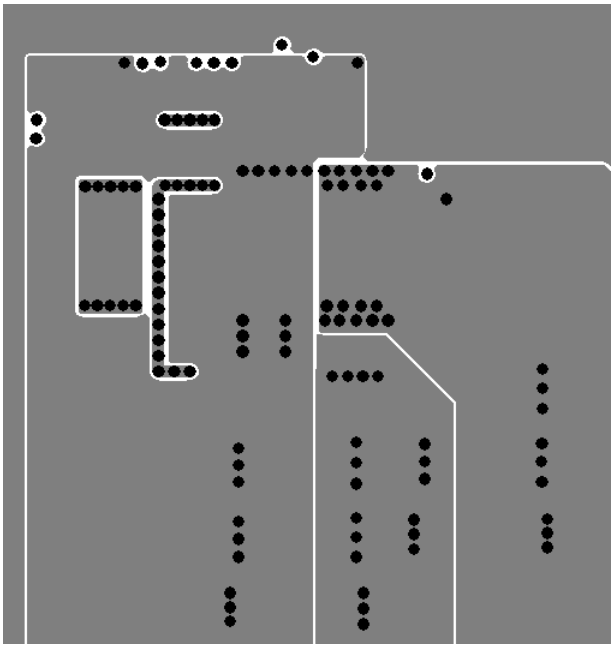


Figure 26. Typical Layer 2 Layout

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Layout Considerations (continued)

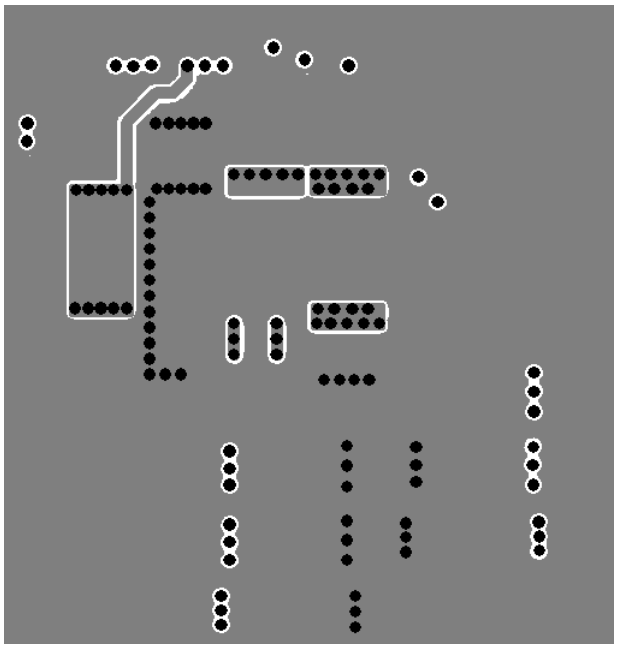


Figure 27. Typical Layer 3 Layout

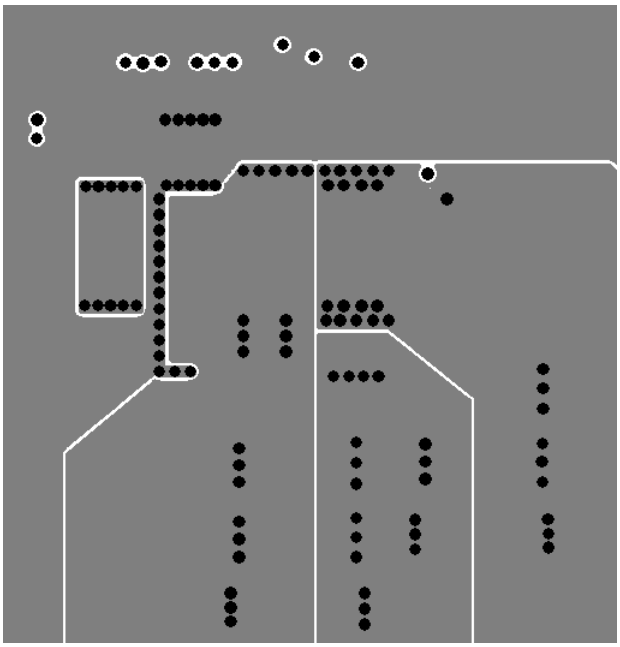


Figure 28. Typical Layer 4 Layout

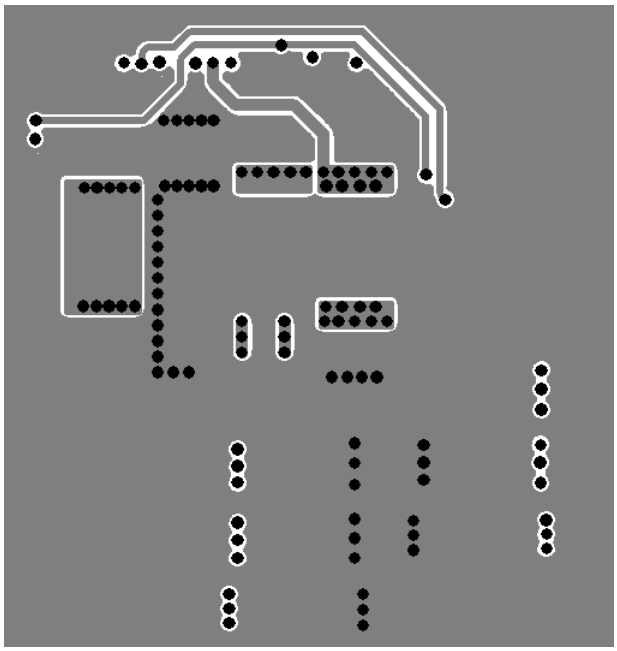


Figure 29. Typical Layer 5 Layout

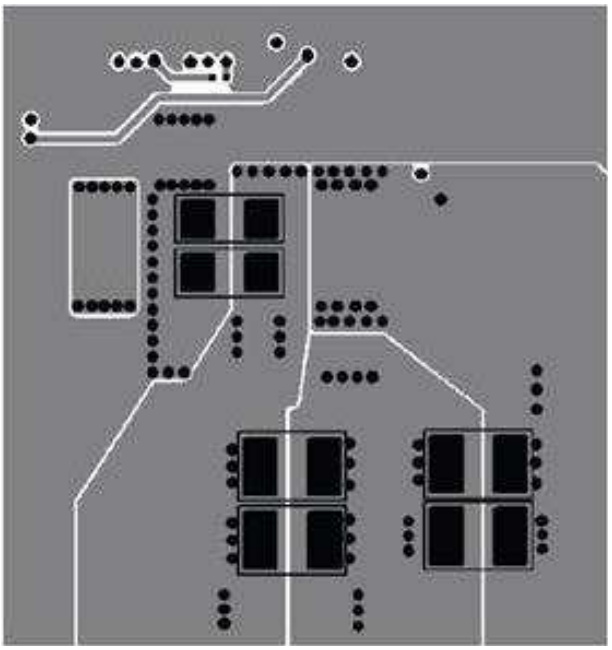


Figure 30. Typical Bottom Layer Layout

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8.21 EMI

The LMZ31520 is compliant with EN55022 Class A radiated emissions. Figure 31 and Figure 32 show typical examples of radiated emissions plots for the LMZ31520 operating from 5V and 12V respectively. Both graphs include the plots of the antenna in the horizontal and vertical positions.

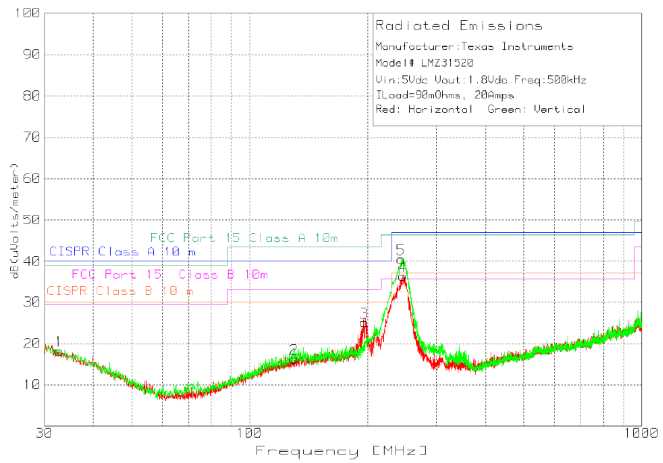


Figure 31. Radiated Emissions 5-V Input, 1.8-V Output, 20-A Load (EN55022 Class A)

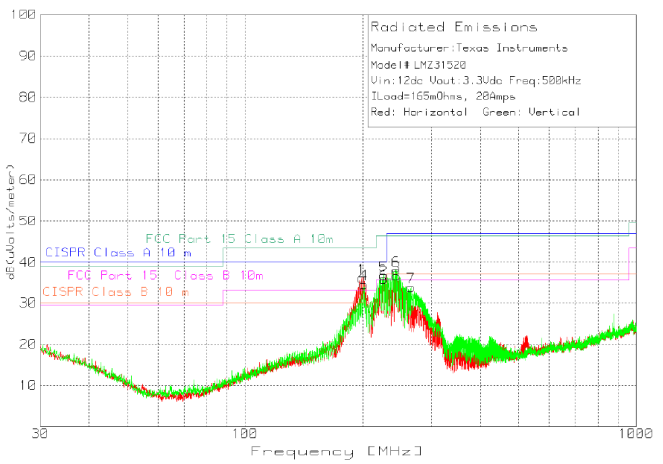


Figure 32. Radiated Emissions 12-V Input, 3.3-V Output, 20-A Load (EN55022 Class A)

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9 Revision History

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

Changes from Revision D (April 2018) to Revision E — **Page**

- Updated PCB Typical Bottom Layer Layout 21

Changes from Revision C (June 2017) to Revision D — **Page**

- LMZ31520用のWEBENCH®設計リンクを追加..... 1
- Increased the peak reflow temperature and maximum number of reflows to JEDEC specifications for improved manufacturability..... 2
- 「デバイス・サポート」セクションを追加 25
- 「メカニカル、パッケージ、および注文情報」セクションを追加..... 26

Changes from Revision B (December 2013) to Revision C — **Page**

- Added peak reflow and maximum number of reflows information 2

Changes from Revision A (December 2013) to Revision B — **Page**

- Added additional capacitors to the recommended capacitor table..... 13

Changes from Original (October 2013) to Revision A — **Page**

- ステータスをプレビューから量産に 変更..... 1

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10 デバイスおよびドキュメントのサポート

10.1 デバイス・サポート

10.1.1 開発サポート

10.1.1.1 WEBENCH®ツールによるカスタム設計

ここをクリックすると、WEBENCH® Power Designerにより、LMZ31520デバイスを使用するカスタム設計を作成できます。

1. 最初に、入力電圧(V_{IN})、出力電圧(V_{OUT})、出力電流(I_{OUT})の要件を入力します。
2. オプティマイザのダイヤルを使用して、効率、占有面積、コストなどの主要なパラメータについて設計を最適化します。
3. 生成された設計を、テキサス・インスツルメンツが提供する他の方式と比較します。

WEBENCH Power Designerでは、カスタマイズされた回路図と部品リストを、リアルタイムの価格と部品の在庫情報と併せて参照できます。

通常、次の操作を実行可能です。

- 電気的なシミュレーションを実行し、重要な波形と回路の性能を確認する。
- 熱シミュレーションを実行し、基板の熱特性を把握する。
- カスタマイズされた回路図やレイアウトを、一般的なCADフォーマットで出力する。
- 設計のレポートをPDFで印刷し、設計を共有する。

WEBENCHツールの詳細は、www.ti.com/WEBENCHでご覧になれます。

10.2 ドキュメントのサポート

10.2.1 関連資料

関連資料については、以下を参照してください。

『BQFNパッケージのハンダ付け要件』

10.3 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の隅にある「*通知を受け取る*」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

10.4 コミュニティ・リソース

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's Terms of Use.

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設計サポート ***TIの設計サポート*** **役に立つE2Eフォーラムや、設計サポート・ツールをすばやく見つけることができます。技術サポート用の連絡先情報も参照できます。**

10.5 商標

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10.6 静電気放電に関する注意事項

すべての集積回路は、適切なESD保護方法を用いて、取扱いと保存を行うようにして下さい。

静電気放電はわずかな性能の低下から完全なデバイスの故障に至るまで、様々な損傷を与えます。高精度の集積回路は、損傷に対して敏感であり、極めてわずかなパラメータの変化により、デバイスに規定された仕様に適合しなくなる場合があります。

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10.7 Glossary

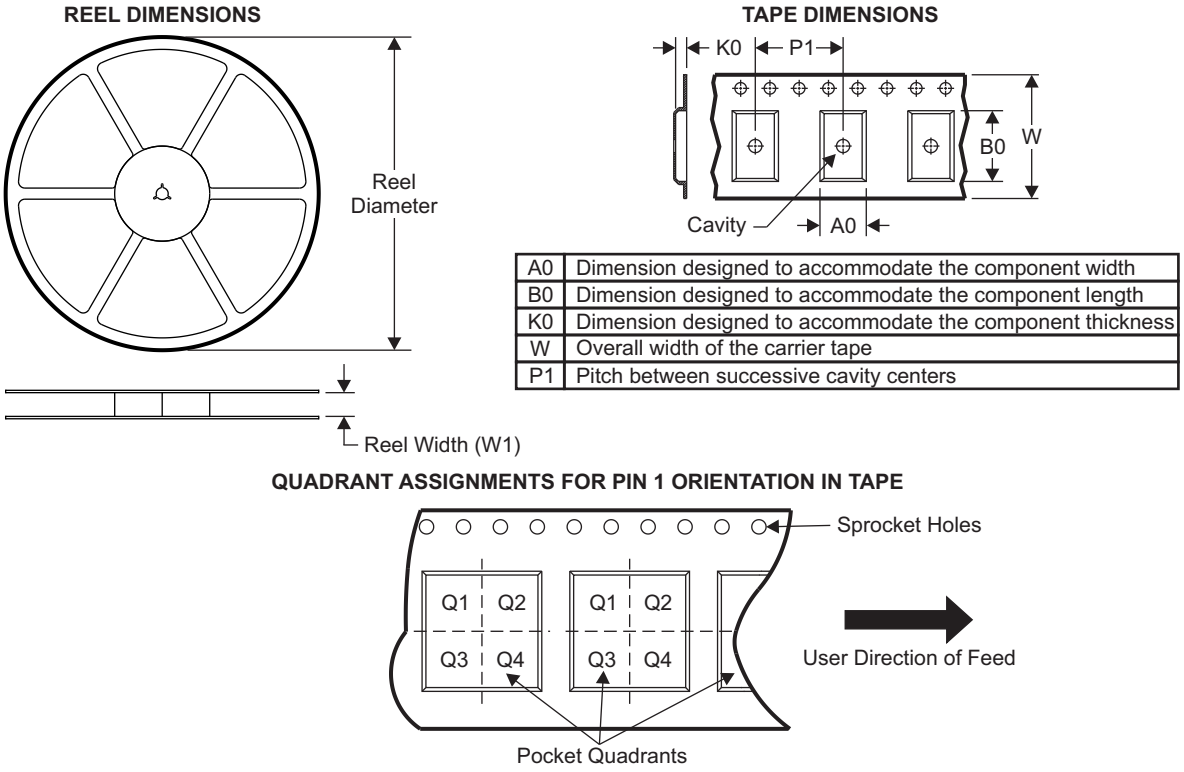
SLYZ022 — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

11 メカニカル、パッケージ、および注文情報

以降のページには、メカニカル、パッケージ、および注文に関する情報が記載されています。この情報は、そのデバイスについて利用可能な最新のデータです。このデータは予告なく変更されることがあり、ドキュメントが改訂される場合もあります。本データシートのブラウザ版を使用されている場合は、画面左側の説明をご覧ください。

11.1 Tape and Reel Information

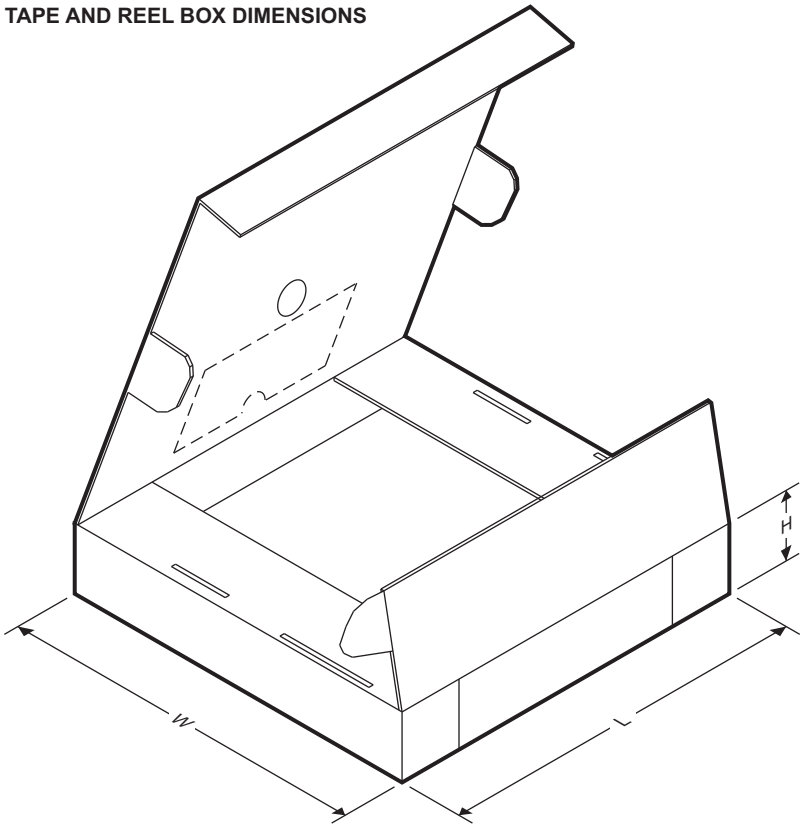


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
LMZ31520RLGT	BQFN	RLG	72	250	330.0	24.4	15.35	16.35	6.1	20.0	24.0	Q1

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TAPE AND REEL BOX DIMENSIONS



Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMZ31520RLGT	BQFN	RLG	72	250	383.0	353.0	58.0

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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)
LMZ31520RLGT	Active	Production	BQFN (RLG) | 72	250 | SMALL T&R	Exempt	NIPDAU	Level-3-245C-168 HR	-40 to 85	LMZ31520
LMZ31520RLGT.A	Active	Production	BQFN (RLG) | 72	250 | SMALL T&R	Exempt	NIPDAU	Level-3-245C-168 HR	-40 to 85	LMZ31520
LMZ31520RLGTG4	Active	Production	BQFN (RLG) | 72	250 | SMALL T&R	Yes	NIPDAU	Level-3-245C-168 HR	-40 to 85	LMZ31520
LMZ31520RLGTG4.A	Active	Production	BQFN (RLG) | 72	250 | SMALL T&R	Yes	NIPDAU	Level-3-245C-168 HR	-40 to 85	LMZ31520
LMZ31520RLGTG4.B	Active	Production	BQFN (RLG) | 72	250 | SMALL T&R	Yes	NIPDAU	Level-3-245C-168 HR	-40 to 85	LMZ31520

(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.

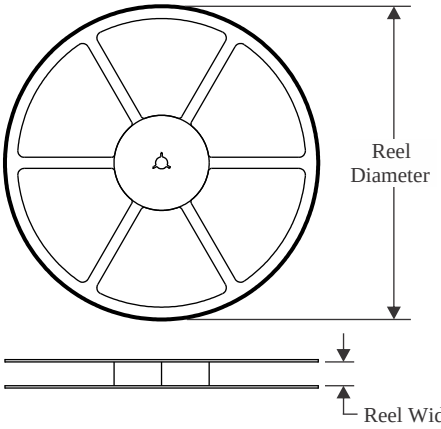
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

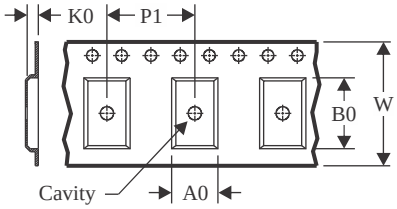
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

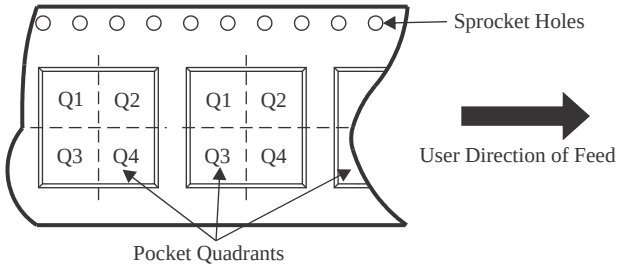


TAPE DIMENSIONS



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

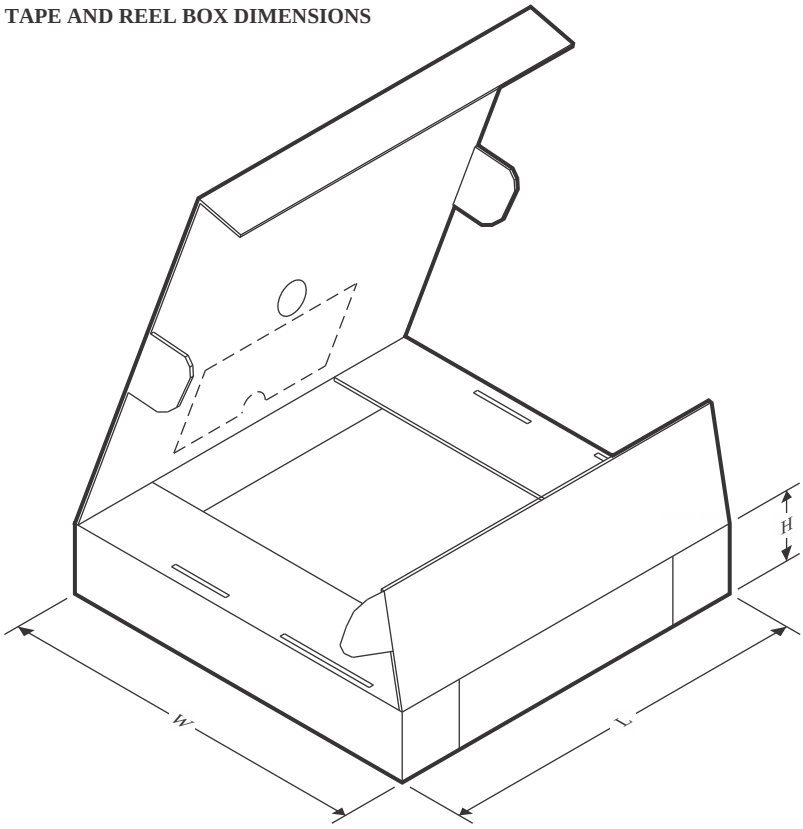
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LMZ31520RLGT	BQFN	RLG	72	250	330.0	24.4	15.35	16.35	6.1	20.0	24.0	Q1
LMZ31520RLGTG4	BQFN	RLG	72	250	330.0	24.4	15.35	16.35	6.1	20.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

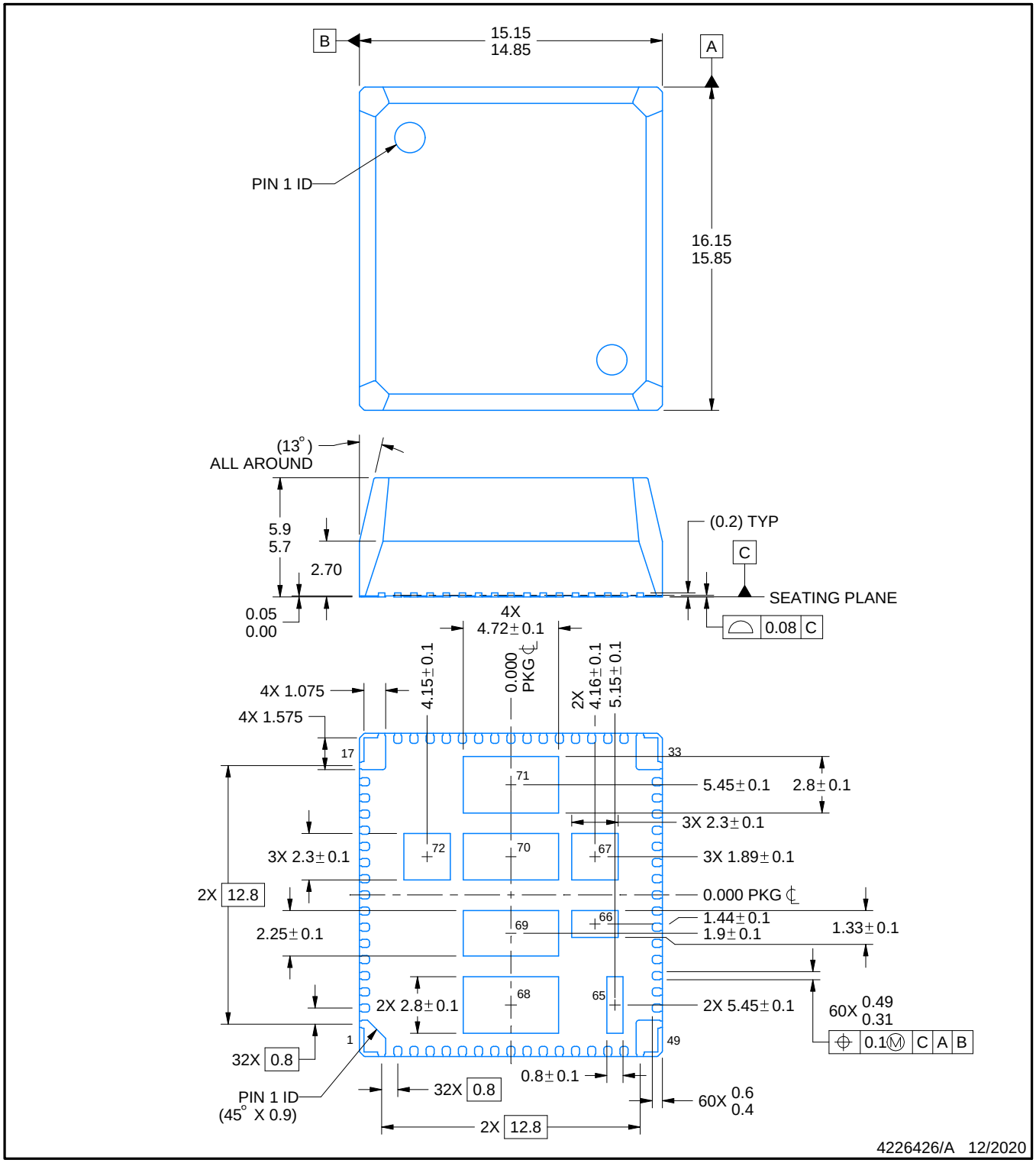
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LMZ31520RLGT	BQFN	RLG	72	250	383.0	353.0	58.0
LMZ31520RLGTG4	BQFN	RLG	72	250	383.0	353.0	58.0

PACKAGE OUTLINE

RLG0072A

B4QFN - 5.9 mm max height

EXTREMELY THICK QUAD FLATPACK - NO LEAD



NOTES:

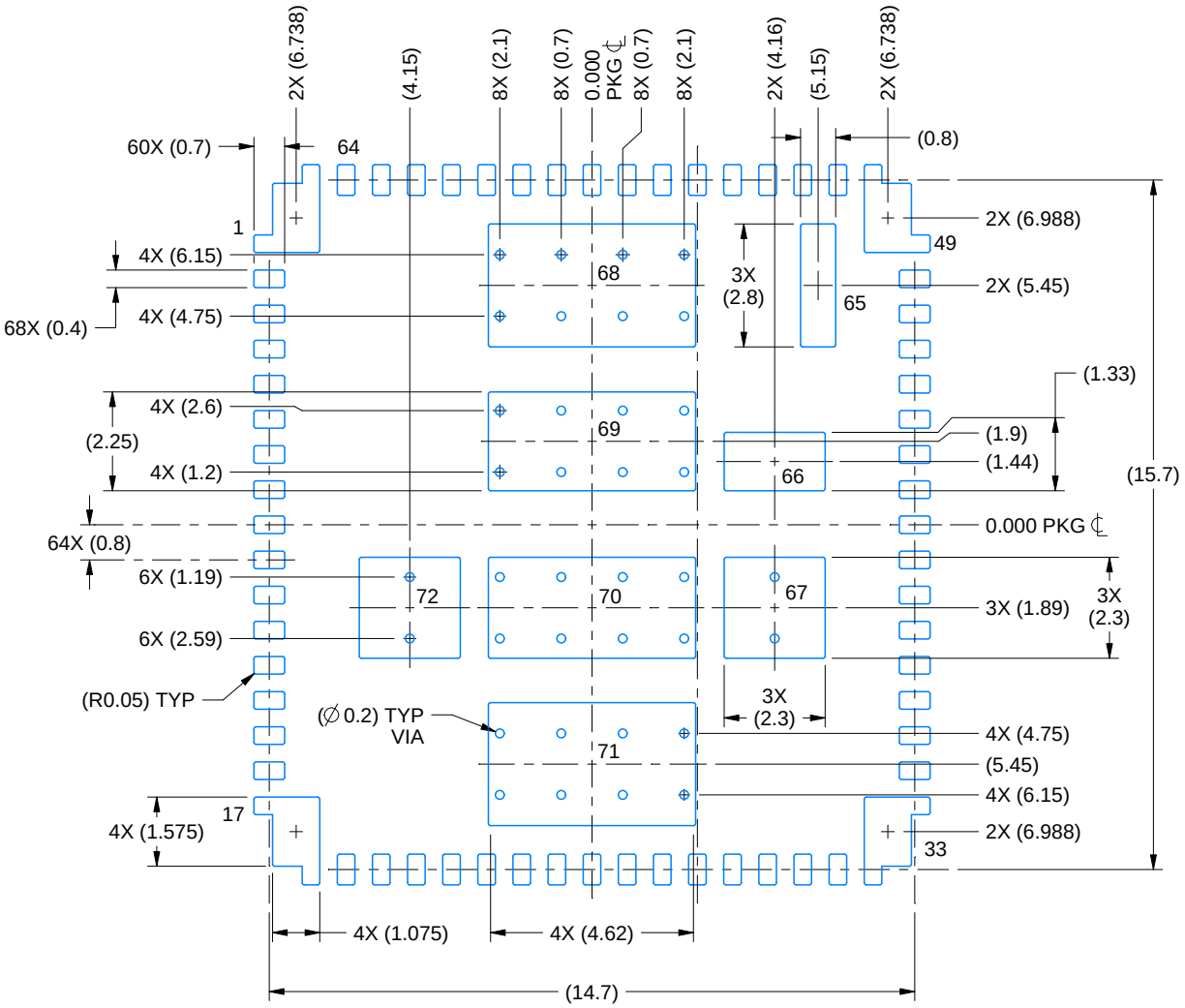
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pads must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

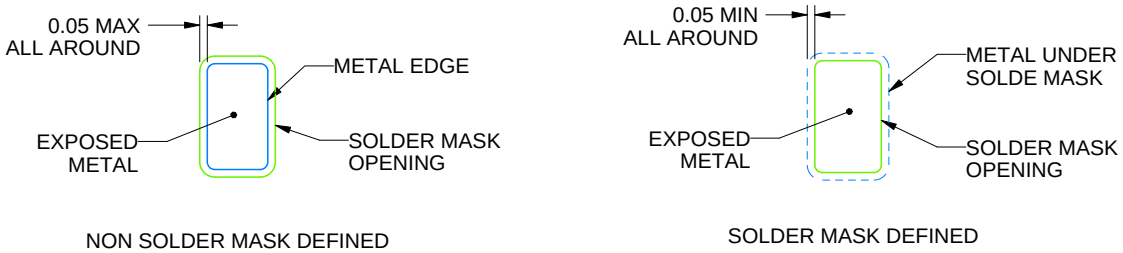
RLG0072A

B4QFN - 5.9 mm max height

EXTREMELY THICK QUAD FLATPACK - NO LEAD



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 6X



SOLDER MASK DETAILS

4226426/A 12/2020

NOTES: (continued)

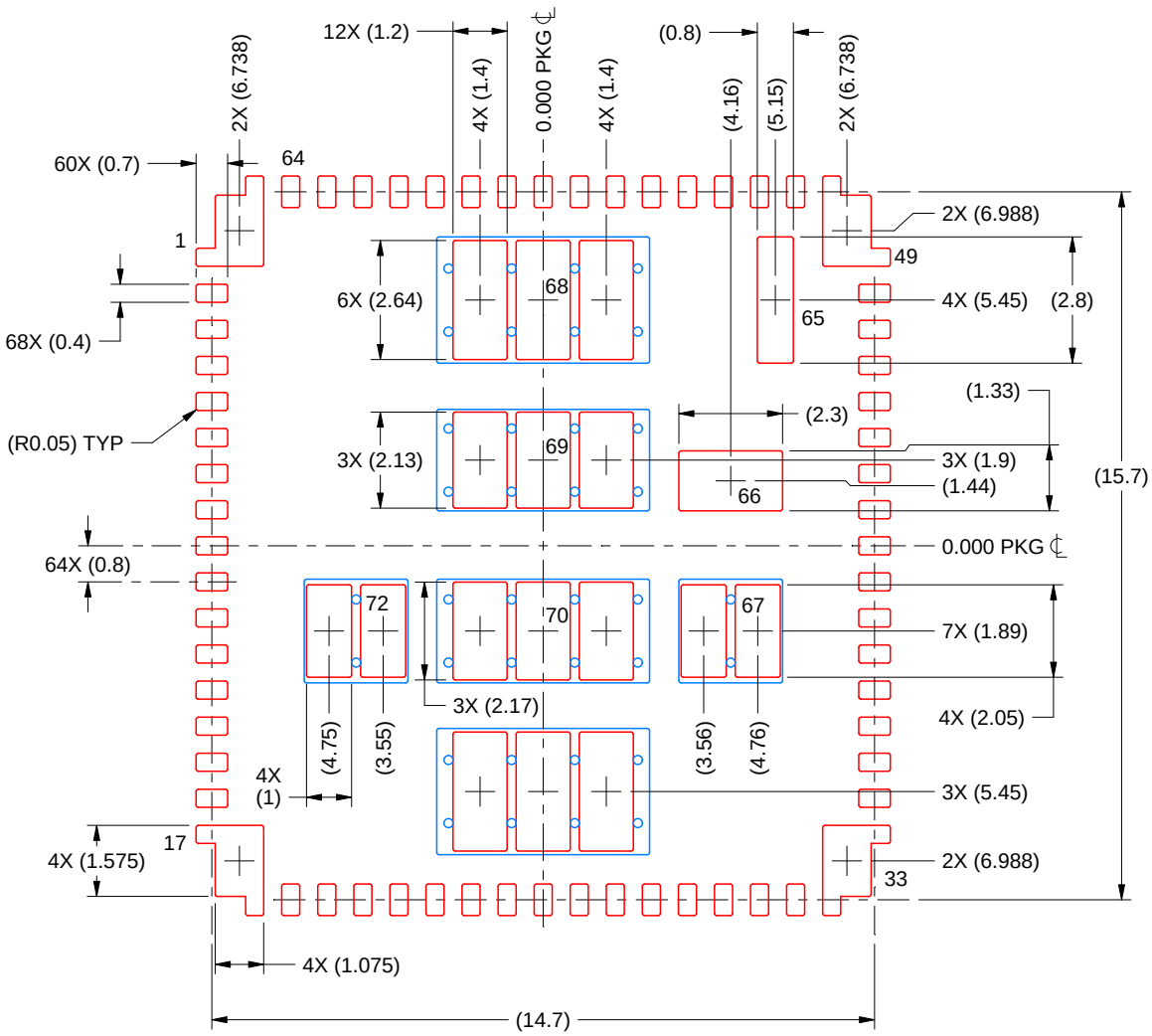
4. This package is designed to be soldered to the thermal pads on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations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

EXAMPLE STENCIL DESIGN

RLG0072A

B4QFN - 5.9 mm max height

EXTREMELY THICK QUAD FLATPACK - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
PADS 67 & 72: 78%
PADS 68 & 71: 73%
PADS 69 & 70: 74%
SCALE: 6X

4226426/A 12/2020

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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最終更新日：2025 年 10 月