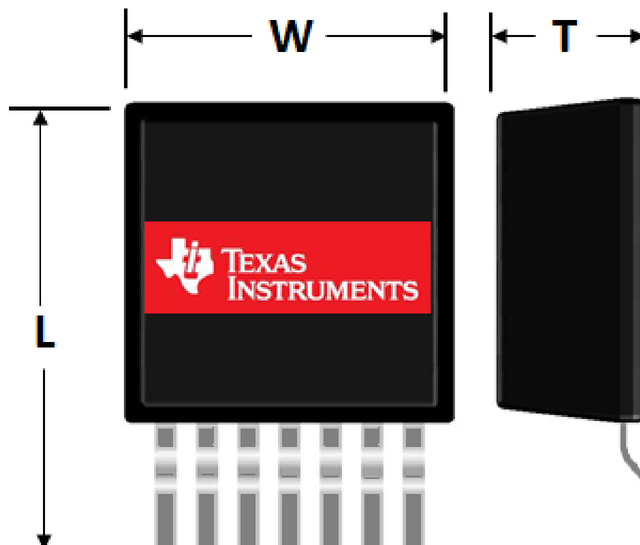
Design Summary LMZ1xxx & LMZ2xxx Power Module Family

Texas Instruments (TI) introduces LMZ1xxx and LMZ2xxx Power Module product family that is a complete power supply solution in a leaded gullwing style package outline. The NDW/NES/NDY packages meets or exceeds the requirements set forth in the European Union's RoHS and EU REACH legislation and are suitable for industry compliant Pb-Free soldering processes as defined by JEDEC. Each of the packages has an exposed ground pad that enhances thermal performance, while using plastic encapsulant and conventional copper lead frame technology for a robust effective solution. LMZxxx Power Modules are available in different quantity reel sizes following EIA-481 industry standard Tape and Reel format.
www.ti.com

Illustration of 7-NDW Package

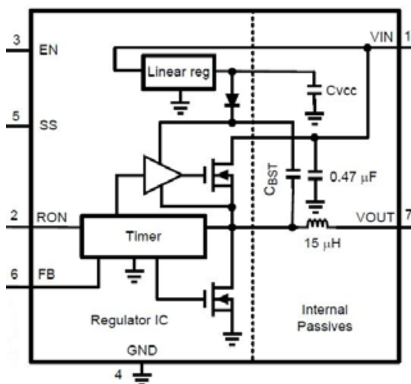


	7-NDW	9-NES	11-NDY
Total Number of Pins	7	9	11
Package Length (L) mm	13,77*	24,38*	17,79*
Package Width (W) mm	10,16*	20,0*	15,0*
Package Thickness (T) mm	4,67 Max	4,8*	5,9*
Pitch mm*	1,27	1,75	1,27
Lead Finish	Matte Sn	Matte Sn	Matte Sn
RoHS Compliant	Yes	Yes	Yes
Moisture Sensitivity Level (JEDEC)	Level 3 /245C	Level 3 /245C	Level 3 /245C

*Dimensions Illustrated as Nominal Values

Operation	Assembly Quick Start Checklist
Solder Paste	TI recommends the use of type 3 or finer solder paste when mounting the LMZ1xxx or LMZ2xxx Power Module devices.
Reflow Profile	Measure the peak reflow temperature by placing a fine gauge thermocouple (Type K) on top of the package body center.
	Ensure that the peak reflow temperature does not exceed 245C max. (240°C +/ -5°C) Exceeding the max temperature may damage the part.
	Reflow time within 5°C Peak Temp must not exceed 20 seconds and the reflow time above liquidus must not exceed 60 seconds.
	Minimizing the number of reflow cycles seen by the Power Module devices is recommended.
	Peak of 245C max is per JEDEC. See Moisture Sensitivity section for details.
Moisture Handling	LMZ1xxx and LMZ2xxx products are classified as MSL3and require special handling due to moisture sensitivity. MSL3 parts have a max floor life of 168 hours.
	Parts must be reflowed prior to the 168-hour floor life after removing form the moisture barrier bag. Parts must be baked out per Jedec recommendations once the 168-hour floor life has been exceeded. See Moisture Sensitivity section for details.

7-NDW Package Illustration

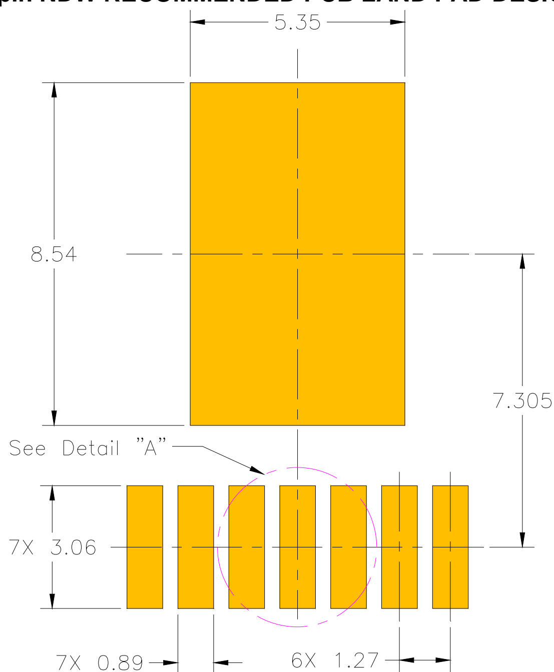


Example of 7-NDW typical block diagram, illustrating use of embedded passives within LMZxxx Power Module package.

PCB DESIGN GUIDELINES

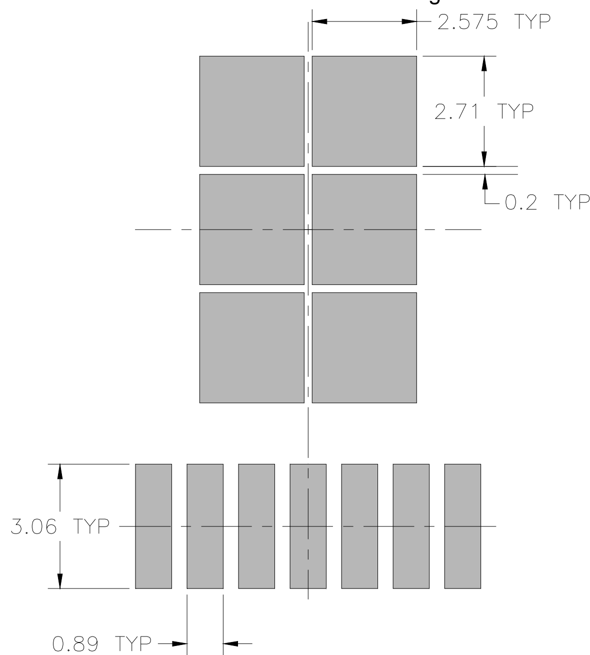
Although TI recommends NSMD (Non Solder Mask Defined) pads over SMD (Solder Mask Defined) pads when surface mounting LMZxxx Power Module package both can be utilized. NSDM allows tighter tolerance on copper etching and by design provides a larger solderable area due to the exposed edges free from solder mask, thus providing additional contact area to the PCB.

7 pin NDW RECOMMENDED PCB LAND PAD DESIGN



7 pin NDW RECOMMENDED STENCIL DESIGN

See note E "PCB Land Pad/Stencil Design Notes"



PCB Land Pad / Stencil Design Notes

(A) All dimensions are in millimeters.

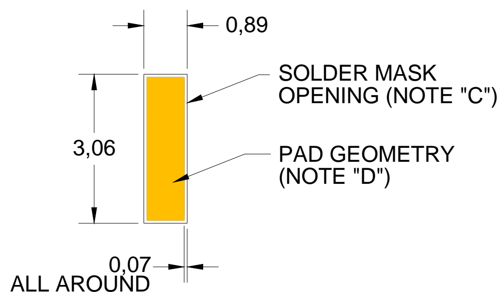
(B) Laser cutting apertures with trapezoidal walls and rounded corners will offer better paste release. Refer to IPC-7525 for stencil design considerations.

(C) Customers should contact their board fabrication site for recommended solder mask tolerances, via tenting recommendations for vias placed in thermal pad, and alternate stencil design.

(D) Publication IPC-7351 is an alternate information source for PCB land pattern designs.

(E) These drawings are subject to change without notice

PCB LAND PAD DETAIL "A"



Solder Paste

TI recommends the use of type 3 or finer solder paste when mounting the LMZxxx Power Module devices due to the following advantages:

- Contains flux to aid wetting of the solder to the PCB land.
- The adhesive/tacky properties of the paste will hold the component in place during manufacture.
- Paste by volume contains ~50% metal load typically and can be varied by print volume for calculating the amount of paste necessary to form a given solder joint. Power module packages are typically manufactured with printed thermal pad volumes between 50% and 80% by area to facilitate wetting of the periphery solder joints and also to maintain a standoff from the board surface.
- Paste contributes to the final volume of metal in the joint, and thus can be varied to give an optimum joint.
- Paste selection is normally driven by overall system assembly requirements. In general, the "no clean" compositions are preferred due to the difficulty in cleaning under the mounted components.

IR Reflow Profiles

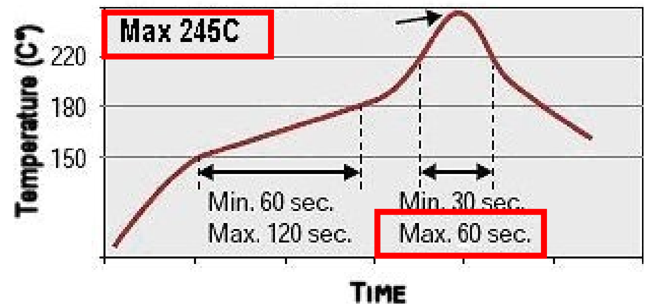
LMZxxx Power Module packages utilize a lead finish (Matte Sn) that is compatible with both lead and lead-free solder pastes.

- Measure peak reflow temperature using fine gauge thermocouple (Type K) located on top of the package body center.
- Ensure that the peak reflow temperature does not exceed 245C max. (240°C +/ -5°C)
- Time within 5°C Peak Temp not to exceed 20 seconds.
- Time above liquidus not to exceed 60 seconds.
- Minimizing the number of reflow cycles is recommended.
- Peak reflow temperature of 245C max is per JEDEC. See table below.

	Pb Free
Ramp Rate	3°C/sec. Max. *
Preheat	150 to 180°C
	60 to 120 sec.
Time Above Liquidus	217°C
	30 to 60 sec.
Peak Temp.	240°C +/ -5°C
Time Within 5°C Peak Temp.	10 to 20 sec.
Ramp Down Rate	6°C/sec. Max.

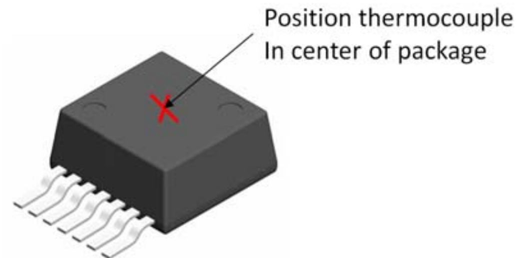
* No testing using a forced cool down of 6°C per second has been conducted

Recommended Temperature Profile For Sn-Ag-Cu Pb-Free Solder Paste



Time

*TI recommends following the solder paste supplier's recommendations to optimize flux activity and to achieve proper alloy melting temperatures within guidelines of J-STD-20. Figure above illustrates a range of temperatures that our packages are capable of withstanding without risk to package reliability however TI prefers parts to be processed with the lowest peak temperature possible while remaining below the components peak temperature rating as listed on the MSL label. The exact profile would depend on the maximum peak temperature for the component as rated on the MSL label, the solder paste manufacturer's recommendation, complexity of the PWB, and capability of the reflow equipment to be confirmed by the SMT assembly operation.



*Per IPC/JEDEC J-STD-020: standard for moisture/reflow sensitivity classification for non-hermetic solid state surface-mounted devices. Section 4 - classification / reclassification.

Table 4-2 Pb-free Process – Package Classification Reflow Temperatures

Package Thickness	Volume mm³ <350	Volume mm³ 350 - 2000	Volume mm³ >2000
≥2.5 mm	250 +0 °C *	245 +0 °C *	245 +0 °C *

Moisture Sensitivity Guidelines

- LMZxxx Parts are classified as MSL3 requiring special handling during assembly once removed from the original moisture sealed packaging.
- Parts must be reflowed prior to the 168 hour floor life after removing form the moisture barrier bag.
- If parts have exceeded the 168 hour floor life after removal then the parts must be baked per JEDEC standard (JSTD-033) as shown in the table below prior to reflow.
- Parts are available in a variety of quantities per reel to optimize the lot size per build. See ordering table located at the end of the datasheet.

The general guideline for the amount of time a component can be left out of the moisture sealed bag is shown below (Table 5-1 Moisture Classification level and Floor Life) as published in the JSTD-033. This assumes an ambient temperature and humidity less than or equal to 30C & 60% relative humidity. Another storage option is to use a dry box with relative humidity less than 10% as outlined in JSTD-033 which will stop the clock on the total floor life.

A visual indication to detect if a moisture sensitive component has been exposed to humidity due to an improperly sealed moisture barrier bag is the Humidity Indicator Card. The humidity indicator card uses a moisture reactive chemical where the blue (dry) color will transition to pink (wet) when exposed to moisture. For example In the case of LMZxxx 1&2 packages rated at MSL 3 the 5% can be pink but once the 10% no longer shows a solid blue the parts must be baked out due to excessive humidity exposure.

Once the devices are found to have exceeded the floor life the parts must be baked out to remove the excess moisture that has accumulated within the package. The table below illustrates the various times and temperatures required to remove moisture from the LMZxxx 1&2 packages.

Label examples and summary of information available.

Table 5-1 Moisture Classification Level and Floor Life

Level	Floor Life (out of bag) at factory ambient ≤30°C/60% RH or as stated
1	Unlimited at ≤30°C/85% RH
2	1 year
2a	4 weeks
3	168 hours

Bakeout times based on oven temperature. See JSTD-033 for additional details.

Package Body	Level	Bake @ 125°C		Bake @ 90°C ≤5% RH		Bake @ 40°C ≤5% RH	
		Exceeding Floor Life by >72 h	Exceeding Floor Life by ≤72 h	Exceeding Floor Life by >72 h	Exceeding Floor Life by ≤72 h	Exceeding Floor Life by >72 h	Exceeding Floor Life by ≤72 h
Thickness >2.0 mm ≤4.5 mm	2	48 hours	48 hours	10 days	7 days	79 days	67 days
	2a	48 hours	48 hours	10 days	7 days	79 days	67 days
	3	48 hours	48 hours	10 days	8 days	79 days	67 days
	4	48 hours	48 hours	10 days	10 days	79 days	67 days
	5	48 hours	48 hours	10 days	10 days	79 days	67 days
	5a	48 hours	48 hours	10 days	10 days	79 days	67 days

Note 1: Table 4-1 is based on worst-case molded lead frame SMD packages. Users may reduce the actual bake time if technically justified (e.g., absorption/desorption data, etc.). In most cases it is applicable to other nonhermetic surface mount SMD packages.

PACKAGE REPAIR GUIDELINES

- Reuse of a removed package is not recommended.
- Utilize a new package for the repair process (see package replacement procedure below).
- The new package should be kept dry and should not exceed stated floor life after dry pack has been opened. (Refer to MSL guideline section above)
- If failure analysis is required from TI we recommend returning the entire assembly with part mounted or a cutout of the section with the part still mounted. Please contact your local TI sales representative for shipping information.

LMZxxx Power Module Replacement Procedure:

A hot gas repair/rework station is strongly recommended for this process. (i.e. Air-Vac Engineering, Metcal, or Den-On Inst.)

- Bake PCB & package at 125°C for 48 hours prior to rework. See IPC/JEDEC J-STD-033 Bake Conditions for further information.
- Board preheat (bake is recommended)
- Reflow of component solder
- Vacuum removal of component
- Cleaning and preparation of PWB lands
- Screening of solder paste either onto the part or onto the board
- Placement and reflow of new component per IR reflow Guidelines
- Inspection of solder joints

See Texas Instruments Inc web site (http://www.ti.com) for the latest information on the LMZxxx Power Module package and product data sheet for specific applications.

QUESTIONS & ANSWERS

Q. Is package rework possible? Are tools available?
A. Yes, rework is possible, and there are several semi-automatic SMT rework machines and profiles available. However, TI does not guarantee the reliability of re-used packages. It is best to discard and replace any package that fails test.

Q. What alignment accuracy is possible?
A. Alignment accuracy for package is dependent upon board level pad tolerance, placement accuracy, and lead position tolerance. Nominal lead position tolerances are specified at ±50 microns. These packages are self aligning during solder reflow, so final alignment accuracy may be better than placement accuracy. To maximize the self-alignment effect of LMZxxx Power Module Package it is recommended that the maximum reflow temperature specified for the solder paste not be exceeded. A good guide is to subject the PCB to a temperature ramp not exceeding 4°C per second.

Q. What size land pad for these packages should I design on my board?
A. Pad size is the key to board-level reliability, and Texas Instruments strongly recommends following the land pattern design included in this design summary.

Q. Can the solder joints be inspected after reflow?
A. Many customers are achieving satisfactory results during process setup with lamographic X-ray techniques.

Q. What factors can increase LMZxxx Power Module assembly yields?
A. TI recommends the following
- Solder Paste Quality - Uniform viscosity and texture. Free from foreign material. Paste must be protected from drying out on the solder stencil.
- PCB Quality - Clean, flat, plated or coated solder land area. Attachment surface must be clean and free of solder mask residue.
- Placement Accuracy - LMZxxx Power Module packages have some ability to self-center as long as a major portion (more than 50 percent) of the lead finger is in contact with the solder paste covered land area on the board.
- A Solder Reflow Profile should be developed for each PCB type monitoring that the peak reflow temperature is not exceeded.
- Solder Volume is important to ensure optimum contact of all intended solder connections.
- Excess amount of solder paste during customer's board assembly may produce solder squeeze out and potential shorting. TI recommends optimizing the amount of solder paste on the bottom side by using a recommended stencil design.

Q. Is TI developing a RoHS version of LMZxxx Power Module?
A. Yes, Texas Instruments has developed the package to comply with all RoHS / lead-free environmental policies. Check with your local TI Field Sales representative for sample availability.

Q. Any EMI concerns for traces under the package and how can customers design their board to minimize EMI?
A. EMI can be controlled by minimizing any complex current loops on the PCB trace. Some helpful hints include:
- Solid ground and power planes can be used in the design. Partitioned ground and power planes must be avoided. These ground and power partitions may create complex current loops increasing radiation.
- Avoid right angles or "T" crosses on the trace. Right angles can cause impedance mismatch and increase trace capacitance causing signal degradation.
- Minimize power supply loops by keeping power and ground traces parallel and adjacent to each other. Significant package EMI can be reduced by using this method.

Q. What are the time requirements for floor life on these packages?
A. Moisture absorption is a significant factor in popcorn type defects during reflow. Since this package is classified as moisture level 3, the 1st and 2nd reflow have to be completed within 168 hours after opening the moisture barrier bag. If this time frame cannot be met, it is highly recommenced to bake the packages at 125C for 48 hours prior to reuse. IPC/JEDEC J-STD-33 provides additional information as to shelf life, floor life, & reworking MSL classified SMT devices.

Q. Can customers mount LMZxxx Power Modules packages on the bottom side of the PCB board?
A. Yes, they can and the ideal 2nd reflow profile is the same as the 1st (IR profile is recommended in this bulletin).

Q. Can this module be mounted by wave solder?
A. No, this package is designed for surface mount process with peak reflow temperature not to exceed 245° C. Immersing the part into a wave solder process is not recommended.

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