LP3990-Q1 150-mA Linear Voltage Regulator for Digital Applications

1 Features

- Qualified for Automotive Applications
- AEC-Q100 Qualified With the Following Results
  - Device Temperature Grade 1: –40°C to +125°C Ambient Operating Temperature Range
- Input Voltage Range: 2 V to 6 V
- 1% Voltage Accuracy at Room Temperature
- Output Voltage Range: 0.8 V to 3.3 V
- Output Current: 150 mA
- Logic Controlled Enable
- Thermal-Overload and Short-Circuit Protection
- Virtually Zero I_Q (Disabled), < 10 nA
- Very Low I_Q (Enabled): 43 µA
- Low Output Noise: 150 μV_{RMS}
- PSRR: 55 dB at 1 kHz
- Fast Start-Up: 105 µs
- Stable with Ceramic Capacitor
- Output Stable - Capacitors, 1 µF
- No Noise Bypass Capacitor Required

2 Applications

- Infotainment
- Instrumentation
- Body Electronics

3 Description

The LP3990-Q1 regulator is designed to meet the requirements of portable, battery-powered systems providing an accurate output voltage, low-noise, and low-quiescent current. The LP3990-Q1 will provide a 0.8-V output from the low input voltage of 2 V at up to a 150-mA load current. When switched into shutdown mode via a logic signal at the enable pin (EN), the power consumption is reduced to virtually zero.

The LP3990-Q1 is designed to be stable with space-saving ceramic capacitors with values as low as 1 µF.

Performance is specified for a –40°C to +125°C junction temperature range.

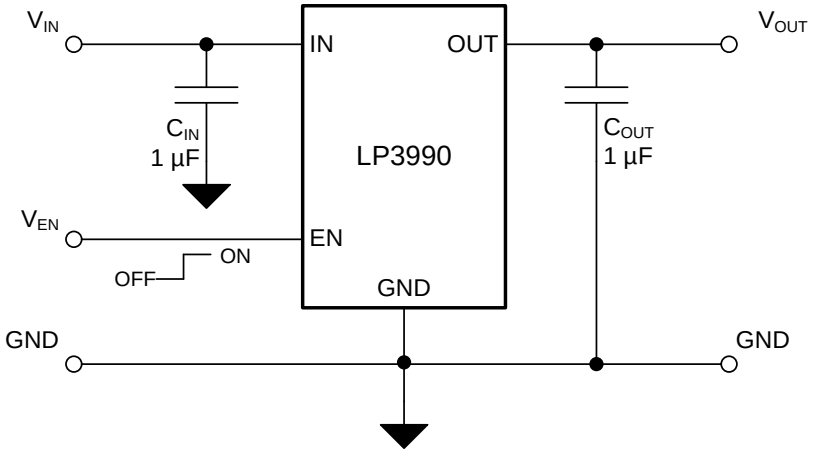
For output voltage options please refer to package option addendum (POA) or contact the Texas Instruments Sales Office.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE
LP3990-Q1	DSBGA (4)	1.324 mm x 1.045 mm (MAX)

(1) For all available packages, see the orderable addendum at the end of the data sheet.

Simplified Schematic



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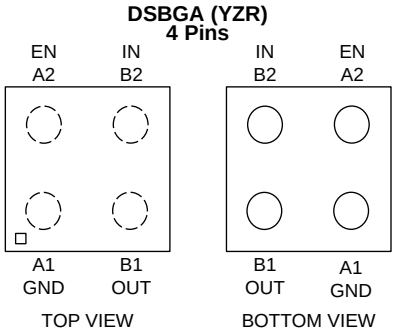
4 Revision History

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

Changes from Original (October 2014) to Revision A	Page
• Changed "For output voltages other than 0.8 V, 1.2 V, 1.35 V, 1.5 V, 1.8 V, 2.5 V, 2.8 V, or 3.3 V, please contact the Texas Instruments sales office." to "For output voltage options please refer to package option addendum (POA) or contact the Texas Instruments Sales Office."	1
• Changed *Handling Ratings* to *ESD Ratings* table	4
• Added introductory sentence for *Design Requirements*	11

5 Pin Configuration and Functions



Pin Functions

PIN		I/O	DESCRIPTION
NO.	NAME		
A1	GND	—	Common ground.
A2	EN	I	Enable Input; Enables the regulator when ≥ 0.95 V. Disables the Regulator when ≤ 0.4 V. Enable Input has 1-MΩ (typical) pulldown resistor to GND.
B1	OUT	O	Voltage output. A 1-µF low-ESR capacitor must be connected to this pin. Connect this output to the load circuit.
B2	IN	I	Voltage supply Input. A 1-µF capacitor must be connected at this input.

6 Specifications

6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)(2)(3)

	MIN	MAX	UNIT
Input voltage	–0.3	6.5	V
Output voltage	–0.3	See(4)	V
ENABLE input voltage	–0.3	6.5	V
Continuous power dissipation internally limited	See(5)		
Storage temperature range , T_{stg}	–65	150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) If Military/Aerospace specified devices are required, contact the TI Sales Office/Distributors for availability and specifications.
(3) All voltages are with respect to the potential at the GND pin.
(4) The lower of V_{IN} + 0.3 V or 6.5 V.
(5) Internal thermal shutdown circuitry protects the device from permanent damage.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002(1)	±2000	V
		Charged-device model (CDM), per AEC Q100-011	±1500	

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

6.3 Recommended Operating Conditions

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

	MIN	NOM	MAX	UNIT
Input voltage, V_{IN}	2		6	V
Enable input voltage, V_{EN}	0		V_{IN}	V
Junction temperature, T_J(1)	–40		125	°C

(1) $T_{J\text{-}MAX} = (T_{A\text{-}MAX} + (R_{\theta JA} \times P_{D\text{-}MAX}))$.

6.4 Thermal Information

THERMAL METRIC(1)		LP3990 YZR (DSBGA) 4 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	188.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	1.0	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	105.3	°C/W
ψ_{JT}	Junction-to-top characterization parameter	0.7	°C/W
ψ_{JB}	Junction-to-board characterization parameter	105.2	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

6.5 Electrical Characteristics

Unless otherwise noted, V_{EN} = 950 mV, V_{IN} = V_{OUT} + 1 V or V_{IN} = 2 V, whichever is higher. C_{IN} = 1 µF, I_{OUT} = 1 mA, C_{OUT} = 0.47 µF.(1)(2)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_{IN}	Input voltage	See(3)		2		6	V
ΔV_{OUT}	Output voltage tolerance	I_{LOAD} = 1 mA, T_J = 25°C		–1%		1%	
		Over full line and load regulation		–2.5%		2.5%	
	Line regulation error	V_{IN} = ($V_{OUT(NOM)}$ + 1 V) to 6 V		0.1	0.02	0.1	%/V
	Load regulation error	I_{OUT} = 1 mA to 150 mA	V_{OUT} = 0.8 V to 1.95 V	–0.005	0.002	0.005	%/mA
			V_{OUT} = 2 V to 3.3 V	–0.002	0.0005	0.002	
V_{DO}	Dropout voltage	I_{OUT} = 150 mA, see(4)(5)			120	200	mV
I_{LOAD}	Load current	T_J = 25°, see(5)(6)		0			µA
I_Q	Quiescent current	V_{EN} = 950 mV, I_{OUT} = 0 mA			43	80	µA
		V_{EN} = 950 mV, I_{OUT} = 150 mA			65	120	
		V_{EN} = 0.4 V (output disabled), T_J = 25°C			0.002	0.2	
I_{SC}	Short circuit current limit	See(7)			550	1000	mA
I_{OUT}	Maximum output current			150			
PSRR	Power Supply Rejection Ratio	f = 1 kHz, I_{OUT} = 1 mA to 150 mA			55		dB
		f = 10 kHz, I_{OUT} = 150 mA			35		
e_η	Output noise voltage(5)	BW = 10 Hz to 100 kHz	V_{OUT} = 0.8 V		60		μV_{RMS}
			V_{OUT} = 1.5 V		125		
			V_{OUT} = 3.3 V		180		
$T_{SHUTDOWN}$	Thermal shutdown junction temperature	Junction temperature (T_J) rising until the output is disabled			155		°C
		Hysteresis			15		
ENABLE CONTROL CHARACTERISTICS							
I_{EN}(8)	Maximum input current at EN pin	V_{EN} = 0 V (Output is disabled) T_J = 25°C			0.001	0.1	µA
		V_{EN} = 6 V		2.5	6	10	
V_{IL}	Low input threshold	V_{IN} = 2 V to 6 V V_{EN} falling from ≥ V_{IH} until the output is disabled				0.4	V
V_{IH}	High input threshold	V_{IN} = 2 V to 6 V V_{EN} rising from ≤ V_{IL} until the output is enabled		0.95			

(1) All voltages are with respect to the device GND terminal, unless otherwise stated.
(2) Minimum and Maximum limits are ensured through test, design, or statistical correlation over the operating junction temperature range (T_J) of –40°C to 125°C, unless otherwise stated. Typical values represent the most likely parametric norm at T_J = 25°C, and are provided for reference purposes only.
(3) $V_{IN(MIN)}$ = $V_{OUT(NOM)}$ + 0.5 V, or 2 V, whichever is higher.
(4) Dropout voltage is voltage difference between input and output at which the output voltage drops to 100 mV below its nominal value. This parameter applies only for output voltages above 2 V.
(5) This electrical specification is verified by design.
(6) The device maintains the regulated output voltage without the load.
(7) Short-circuit current is measured with V_{OUT} pulled to 0 V and V_{IN} worst case = 6 V.
(8) ENABLE pin has 1-MΩ (typical) resistor connected to GND.

6.6 Output Capacitor, Recommended Specifications

See(1)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
C_{OUT}	Output capacitance	Capacitance(2)	0.7(3)	1	500	µF
		ESR	5			mΩ

(1) Unless otherwise specified, values and limits apply for T_J = 25°C.
(2) The full operating conditions for the application must be considered when selecting a suitable capacitor to ensure that the minimum value of capacitance is always met. Recommended capacitor type is X7R. However, dependent on application, X5R, Y5V, and Z5U can also be used. (See *Detailed Design Procedure*.)
(3) Limit applies over the full operating junction temperature range (T_J) of −40°C to 125°C.

6.7 Timing Requirements

				MIN	NOM(1)	MAX(2)	UNIT
T_{ON}	Turnon time(3)	From V_{EN} ↑ V_{IH} to V_{OUT} 95% level ($V_{IN(MIN)}$) to 6 V)	V_{OUT} = 0.8 V		80	150	µs
			V_{OUT} = 1.5 V		105	200	
			V_{OUT} = 3.3 V		175	250	
Transient response	Line transient response (ΔV_{OUT})	T_{rise} = T_{fall} = 30 µs(3), ΔV_{IN} = 600 mV			8	16	mV (pk-pk)
	Load transient response (ΔV_{OUT})	T_{rise} = T_{fall} = 1 µs(3), I_{OUT} = 1 mA to 150 mA C_{OUT} = 1 µF			55	100	mV

(1) Nominal values apply for T_J = 25°C.
(2) Maximum limits apply over the full operating junction temperature (T_J) range of −40°C to 125°C.
(3) This electrical specification is verified by design.

6.8 Typical Characteristics

Unless otherwise specified, C_{IN} = 1-µF ceramic, C_{OUT} = 0.47-µF ceramic, V_{IN} = $V_{OUT(NOM)}$ + 1 V, T_A = 25°C, $V_{OUT(NOM)}$ = 1.5 V; V_{EN} = V_{IN}.

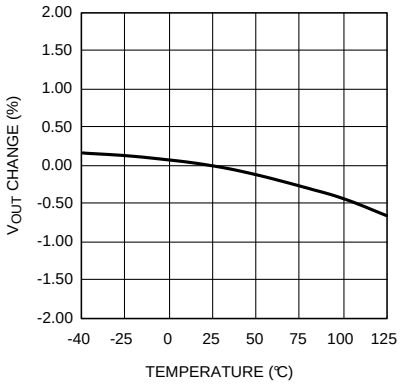


Figure 1. Output Voltage Change vs Temperature

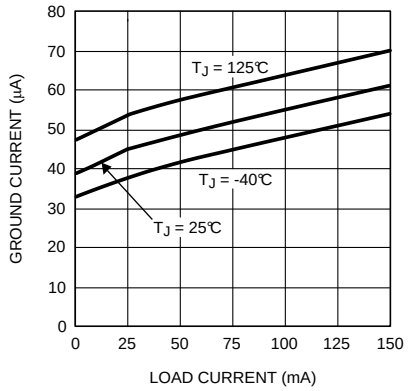
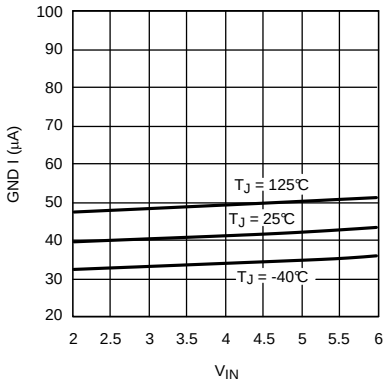
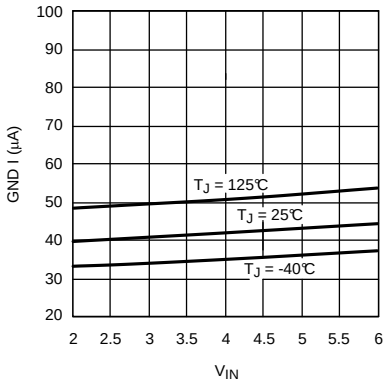


Figure 2. Ground Current vs Load Current



I_{LOAD} = 0 mA

Figure 3. Ground Current vs V_{IN}

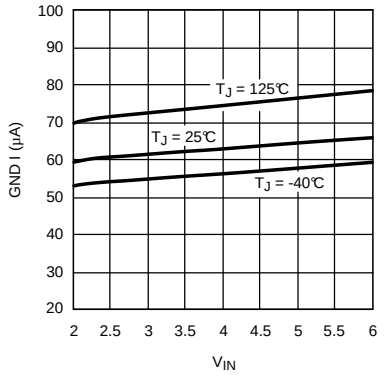


I_{LOAD} = 1 mA

Figure 4. Ground Current vs V_{IN}

Typical Characteristics (continued)

Unless otherwise specified, C_{IN} = 1-µF ceramic, C_{OUT} = 0.47-µF ceramic, V_{IN} = $V_{OUT(NOM)}$ + 1 V, T_A = 25°C, $V_{OUT(NOM)}$ = 1.5 V; V_{EN} = V_{IN}.



I_{LOAD} = 150 mA

Figure 5. Ground Current vs V_{IN}

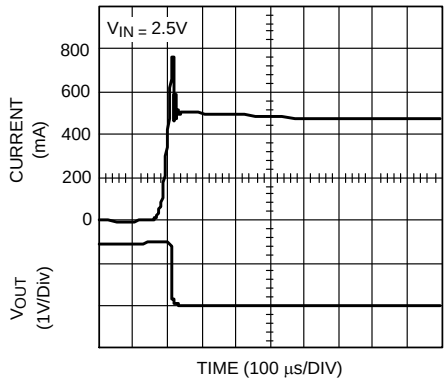


Figure 6. Short Circuit Current

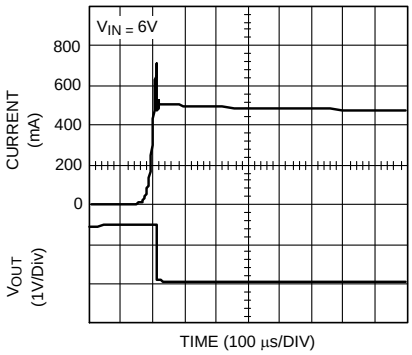


Figure 7. Short Circuit Current

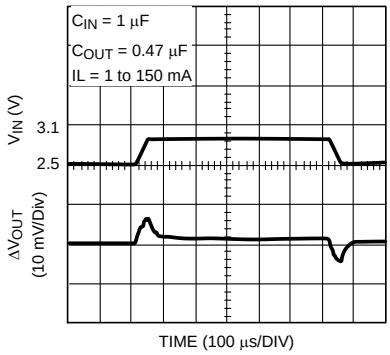


Figure 8. Line Transient

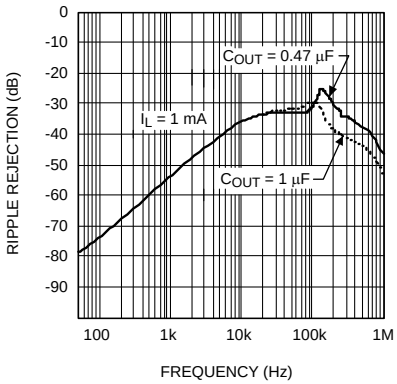


Figure 9. Power Supply Rejection Ratio

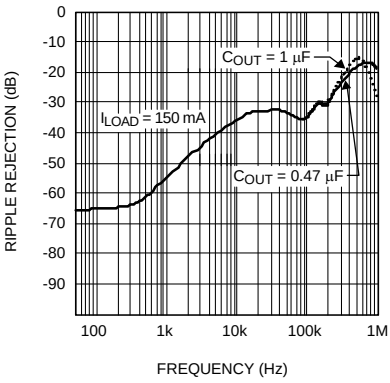


Figure 10. Power Supply Rejection Ratio

Typical Characteristics (continued)

Unless otherwise specified, C_{IN} = 1-µF ceramic, C_{OUT} = 0.47-µF ceramic, V_{IN} = $V_{OUT(NOM)}$ + 1 V, T_A = 25°C, $V_{OUT(NOM)}$ = 1.5 V; V_{EN} = V_{IN}.

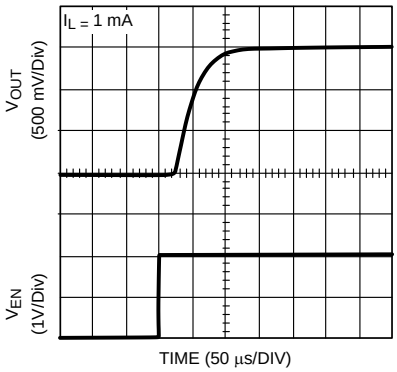


Figure 11. Enable Start-Up Time

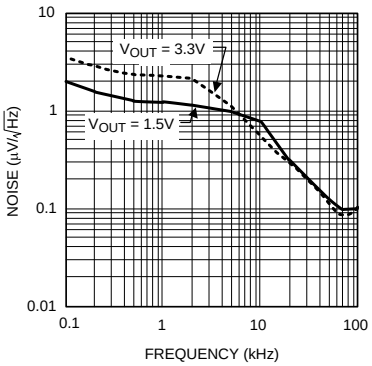


Figure 12. Noise Density

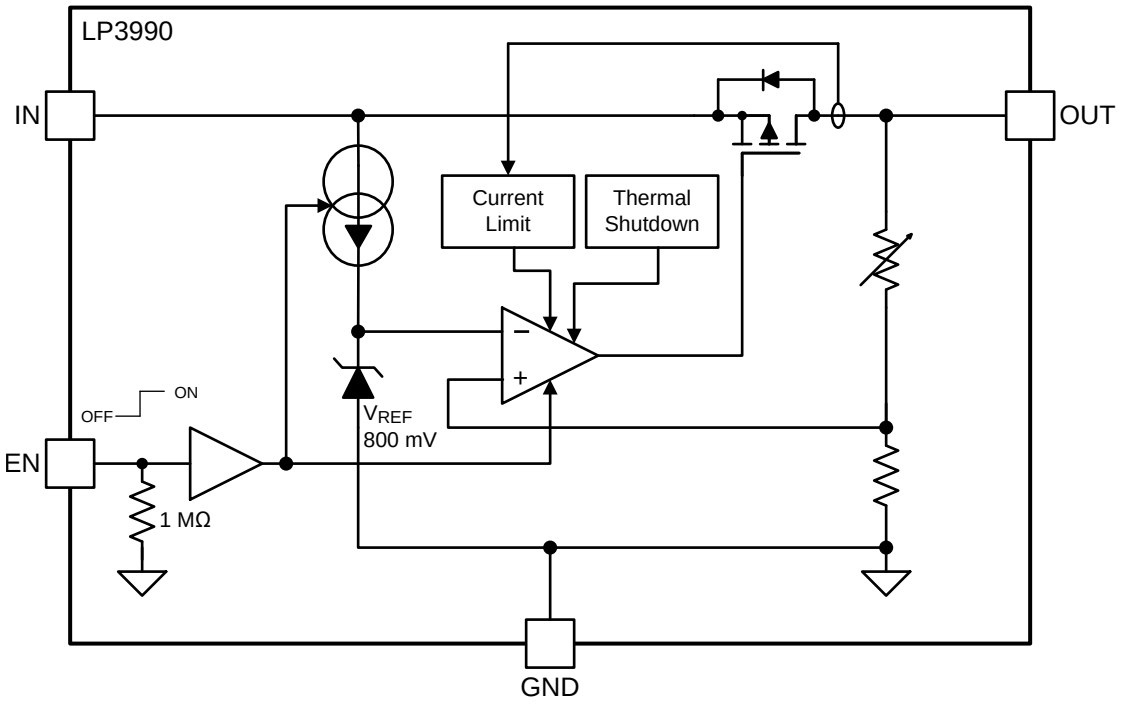
7 Detailed Description

7.1 Overview

The LP3990-Q1 is designed to meet the requirements of portable, battery-powered digital systems providing an accurate output voltage with fast start-up. When disabled via a low logic signal at the enable pin (EN), the power consumption is reduced to virtually zero.

The device is designed to perform with a single 1-µF input capacitor and a single 1-µF ceramic output capacitor.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Enable (EN)

The LP3990-Q1 Enable (EN) pin is internally held low by a 1-MΩ resistor to GND. The EN pin voltage must be higher than the V_{IH} threshold to ensure that the device is fully enabled under all operating conditions. The EN pin voltage must be lower than the V_{IL} threshold to ensure that the device is fully disabled. If the EN pin is left open the LP3990-Q1 output is disabled.

7.3.2 Thermal Overload Protection (T_{SD})

Thermal Shutdown disables the output when the junction temperature rises to approximately 155°C which allows the device to cool. When the junction temperature cools to approximately 140°C, the output circuitry enables. Based on power dissipation, thermal resistance, and ambient temperature, the thermal protection circuit may cycle on and off. This thermal cycling limits the dissipation of the regulator and protects it from damage as a result of overheating.

The Thermal Shutdown circuitry of the LP3990-Q1 has been designed to protect against temporary thermal overload conditions. The Thermal Shutdown circuitry was not intended to replace proper heat-sinking. Continuously running the LP3990-Q1 device into thermal shutdown may degrade device reliability.

7.4 Device Functional Modes

7.4.1 Enable (EN)

The LP3990-Q1 EN pin is internally held low by a 1-MΩ resistor to GND. The EN pin voltage must be higher than the V_{IH} threshold to ensure that the device is fully enabled under all operating conditions.

7.4.2 Minimum Operating Input Voltage (V_{IN})

The LP3990-Q1 does not include any dedicated UVLO circuitry. The LP3990-Q1 internal circuitry is not fully functional until V_{IN} is at least 2 V. The output voltage is not regulated until $V_{IN} \geq (V_{OUT} + V_{DO})$, or 2 V, whichever is higher.

8 Application and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The LP3990-Q1 is a linear voltage regulator for digital applications designed to be stable with space-saving ceramic capacitors as small as 1 µF.

8.2 Typical Application

Figure 13 shows the typical application circuit for the LP3990-Q1. The input and output capacitances may need to be increased above the 1 µF shown for some applications.

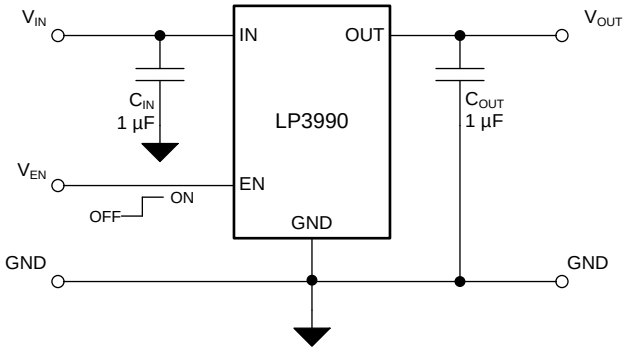


Figure 13. LP3990-Q1 Typical Application

8.2.1 Design Requirements

For typical design parameters, see Table 1.

Table 1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Input voltage range	2 V to 6 V
Output voltage	1.8 V
Output current	100 mA
Output capacitor range	1 µF
Input/output capacitor ESR range	5 mΩ to 500 mΩ

8.2.2 Detailed Design Procedure

To begin the design process, determine the following:

- Available input voltage range
- Output voltage needed
- Output current needed
- Input and output capacitors

8.2.2.1 Power Dissipation and Device Operation

The permissible power dissipation for any package is a measure of the capability of the device to pass heat from the power source, the junctions of the device, to the ultimate heat sink, the ambient environment. Thus, the power dissipation is dependent on the ambient temperature and the thermal resistance across the various interfaces between the die junction and ambient air.

The maximum allowable power dissipation for the device in a given package can be calculated using Equation 1:

$$P_{D\text{-}MAX} = ((T_{J\text{-}MAX} - T_A) / R_{\theta JA}) \quad (1)$$

The actual power being dissipated in the device can be represented by Equation 2:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} \quad (2)$$

Equation 1 and Equation 2 establish the relationship between the maximum power dissipation allowed due to thermal consideration, the voltage drop across the device, and the continuous current capability of the device. Equation 1 and Equation 2 should be used to determine the optimum operating conditions for the device in the application.

In applications where lower power dissipation (P_D) and/or excellent package thermal resistance ($R_{\theta JA}$) is present, the maximum ambient temperature ($T_{A\text{-}MAX}$) may be increased.

In applications where high power dissipation and/or poor package thermal resistance is present, the maximum ambient temperature ($T_{A\text{-}MAX}$) may have to be derated. $T_{A\text{-}MAX}$ is dependent on the maximum operating junction temperature ($T_{J\text{-}MAX\text{-}OP}$ = 125°C), the maximum allowable power dissipation in the device package in the application ($P_{D\text{-}MAX}$), and the junction-to ambient thermal resistance of the part/package in the application ($R_{\theta JA}$), as given by Equation 3:

$$T_{A\text{-}MAX} = (T_{J\text{-}MAX\text{-}OP} - (R_{\theta JA} \times P_{D\text{-}MAX})) \quad (3)$$

Alternately, if $T_{A\text{-}MAX}$ can not be derated, the P_D value must be reduced. This can be accomplished by reducing V_{IN} in the $V_{IN} - V_{OUT}$ term as long as the minimum V_{IN} is met, or by reducing the I_{OUT} term, or by some combination of the two.

8.2.2.2 External Capacitors

In common with most regulators, the LP3990-Q1 requires external capacitors for regulator stability. The LP3990-Q1 is specifically designed for portable applications requiring minimum board space and smallest components. These capacitors must be correctly selected for good performance.

8.2.2.3 Input Capacitor

An input capacitor is required for stability. It is recommended that a 1-µF capacitor be connected between the LP3990-Q1 IN pin and GND pin (this capacitance value may be increased without limit).

This capacitor must be located a distance of not more than 1 cm from the IN pin and returned to a clean analogue ground. Any good quality ceramic, tantalum, or film capacitor may be used at the input.

Important: To ensure stable operation it is essential that good PCB design practices are employed to minimize ground impedance and keep input inductance low. If these conditions cannot be met, or if long leads are used to connect the battery or other power source to the LP3990-Q1, then it is recommended that the input capacitor is increased. Also, tantalum capacitors can suffer catastrophic failures due to surge current when connected to a low-impedance source of power (like a battery or a very large capacitor). If a tantalum capacitor is used at the input, it must be ensured by the manufacturer to have a surge current rating sufficient for the application.

There are no requirements for the equivalent series resistance (ESR) on the input capacitor, but tolerance and temperature coefficient must be considered when selecting the capacitor to ensure the capacitance remains approximately 1 µF over the entire operating temperature range.

8.2.2.4 Output Capacitor

The LP3990-Q1 is designed specifically to work with very small ceramic output capacitors. A 1-µF ceramic capacitor (temperature types Z5U, Y5V or X7R/X5R) with ESR between 5 mΩ to 500 mΩ, is suitable in the LP3990-Q1 application circuit.

For this device the output capacitor must be connected from the OUT pin to the GND pin.

It is also possible to use tantalum or film capacitors at the device output, but these are not as attractive for reasons of size and cost (see *Capacitor Characteristics*).

The output capacitor must meet the requirement for the minimum value of capacitance and also have an ESR value that is within the range 5 mΩ to 500 mΩ for stability.

8.2.2.5 No-Load Stability

The LP3990-Q1 remains stable and in regulation with no external load. This is an important consideration in some circuits, for example CMOS RAM keep-alive applications.

8.2.2.6 Capacitor Characteristics

The LP3990-Q1 is designed to work with ceramic capacitors on the output to take advantage of the benefits they offer. For capacitance values in the range of 0.47 µF to 4.7 µF, ceramic capacitors are the smallest, least expensive and have the lowest ESR values, thus making them best for eliminating high frequency noise. The ESR of a typical 1-µF ceramic capacitor is in the range of 20 mΩ to 40 mΩ, which easily meets the ESR requirement for stability for the LP3990-Q1.

For both input and output capacitors, careful interpretation of the capacitor specification is required to ensure correct device operation. The capacitor value can change greatly, depending on the operating conditions and capacitor type.

In particular, the output capacitor selection must take account of all the capacitor parameters, to ensure that the specification is met within the application. The capacitance can vary with DC bias conditions as well as temperature and frequency of operation. Capacitor values also show some decrease over time due to aging. The capacitor parameters are also dependant on the particular case size, with smaller sizes giving poorer performance figures in general. As an example, Figure 14 shows a typical graph comparing different capacitor case sizes in a Capacitance vs. DC Bias plot. As shown in Figure 14, increasing the DC Bias condition can result in the capacitance value falling below the minimum value given in the recommended capacitor specifications table (0.7 µF in this case). Note that the graph shows the capacitance out of spec for the 0402 case size capacitor at higher bias voltages. It is therefore recommended that the capacitor manufacturers' specifications for the nominal value capacitor are consulted for all conditions, as some capacitor sizes (for example, 0402) may not be suitable in the actual application.

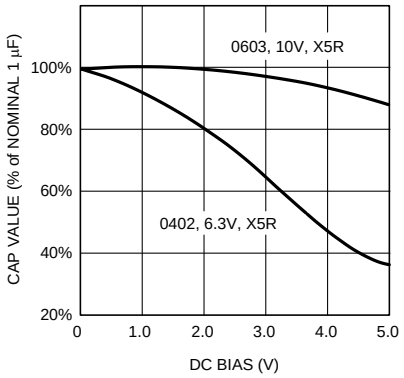


Figure 14. Typical Variation In Capacitance vs DC Bias

Capacitance of the ceramic capacitor can vary with temperature. The capacitor type X7R, which operates over a temperature range of –55°C to 125°C, only varies the capacitance to within ±15%. The capacitor type X5R has a similar tolerance over a reduced temperature range of –55°C to 85°C. Many large value ceramic capacitors, larger than 1 µF are manufactured with Z5U or Y5V temperature characteristics. Their capacitance can drop by more than 50% as the temperature varies from 25°C to 85°C. Therefore, X7R and X5R types are recommended over Z5U and Y5V in applications where the ambient temperature changes significantly above or below 25°C.

Tantalum capacitors are less desirable than ceramic for use as output capacitors because they are more expensive when comparing equivalent capacitance and voltage ratings in the 0.47-µF to 4.7-µF range.

Another important consideration is that tantalum capacitors have higher ESR values than equivalent size ceramics. This means that while it may be possible to find a tantalum capacitor with an ESR value within the stable range, it would have to be larger in capacitance (which means bigger and more costly) than a ceramic capacitor with the same ESR value. The ESR of a typical tantalum increases about 2:1 as the temperature goes from 25°C down to –40°C, so some guard band must be allowed.

8.2.2.7 Enable Control

The LP3990-Q1 features an active high Enable pin, EN, which turns the device on when pulled high. When not enabled the regulator output is off and the device typically consumes 2 nA.

If the application does not require the enable switching feature, the EN pin must be tied to V_{IN} to keep the regulator output permanently on.

To ensure proper operation, the signal source used to drive the EN input must be able to swing above and below the specified turn-on/off voltage thresholds listed in the *Electrical Characteristics* section under V_{IL} and V_{IH}.

An internal 1-MΩ pull-down resistor ties the EN input to ground, ensuring that the device remains off if the EN pin is left open circuit.

8.2.3 Application Curves

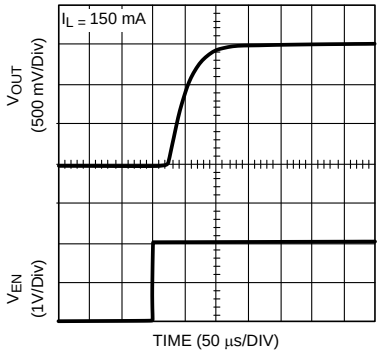


Figure 15. Enable Start-Up Time

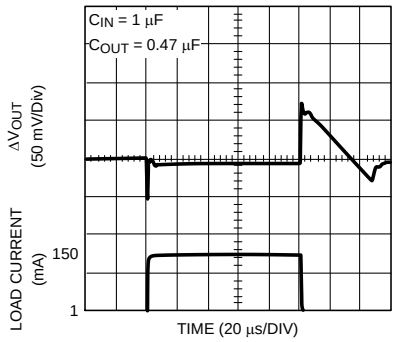


Figure 16. Load Transient

9 Power Supply Recommendations

This device is designed to operate from an input supply voltage range of 2 V to 6 V. The input supply must be well regulated and free of spurious noise. To ensure that the LP3990-Q1 output voltage is well regulated, the input supply must be at least V_{OUT} + 0.5 V, or 2 V, whichever is higher. A minimum capacitor value of 1-µF is required to be within 1 cm of the IN pin.

10 Layout

10.1 Layout Guidelines

The dynamic performance of the LP3990-Q1 is dependant on the layout of the PCB. PCB layout practices that are adequate for typical LDOs may degrade the load regulation, PSRR, noise, or transient performance of the LP3990-Q1.

Best performance is achieved by placing C_{IN} and C_{OUT} on the same side of the PCB as the LP3990-Q1, and as close to the package as is practical. The ground connections for C_{IN} and C_{OUT} must be back to the LP3990-Q1 ground pin using as wide, short copper traces as is practical.

Connections using long trace lengths, narrow trace widths, or connections through vias must be avoided. These add parasitic inductances and resistance that results in inferior performance especially during transient conditions.

Layout Guidelines (continued)

A Ground Plane, either on the opposite side of a two-layer PCB, or embedded in a multi-layer PCB, is strongly recommended. This Ground Plane provides a circuit reference plane to assure accuracy.

10.2 Layout Example

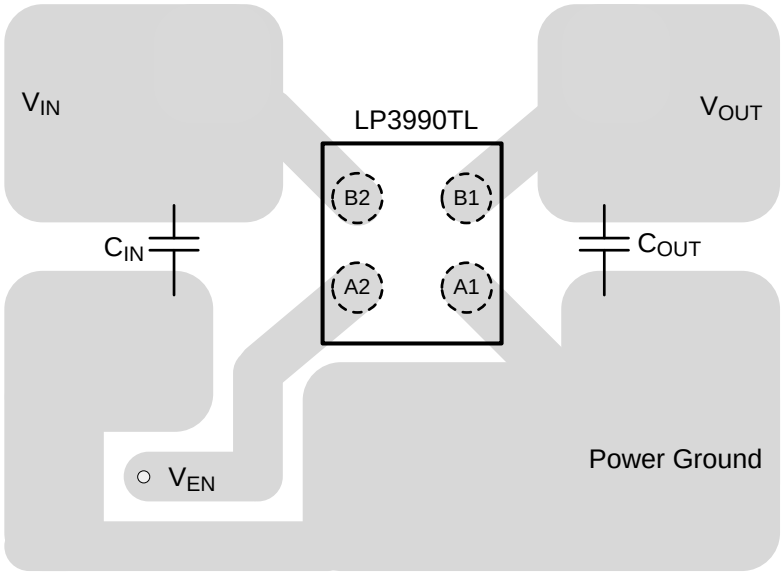


Figure 17. LP3990-Q1 DSBGA Layout

10.3 DSBGA Mounting

The DSBGA package requires specific mounting techniques, which are detailed in TI Application Note *DSBGA Wafer Level Chip Scale Package* (SNVA009).

For best results during assembly, alignment ordinals on the PC board may be used to facilitate placement of the DSBGA device.

10.4 DSBGA Light Sensitivity

Exposing the DSBGA device to direct light may affect the operation of the device. Light sources, such as halogen lamps, can affect electrical performance, if placed in close proximity to the device.

The wavelengths that have the most deterimental effect are reds and infra-reds, which means the fluorescent lighting used inside most buildings has little effect on performance.

11 Device and Documentation Support

11.1 Documentation Support

11.1.1 Related Documentation

For related documentation, see the following:

AN-1112 DSBGA Wafer Level Chip Scale Package (SNVA009)

11.2 Community Resources

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.

TI E2E™ Online Community ***TI's Engineer-to-Engineer (E2E) Community.*** Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support ***TI's Design Support*** Quickly find helpful E2E forums along with design support tools and contact information for technical support.

11.3 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

11.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

11.5 Glossary

SLYZ022 — *TI Glossary*.

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

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

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)
LP3990QTLX-1.2Q1	Active	Production	DSBGA (YZR) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 125	
LP3990QTLX-1.2Q1.A	Active	Production	DSBGA (YZR) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 125	
LP3990QTLX-1.8Q1	Active	Production	DSBGA (YZR) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 125	
LP3990QTLX-1.8Q1.A	Active	Production	DSBGA (YZR) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 125	
LP3990QTLX-2.8Q1	Active	Production	DSBGA (YZR) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 125	
LP3990QTLX-2.8Q1.A	Active	Production	DSBGA (YZR) | 4	3000 | LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 125	

(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.

OTHER QUALIFIED VERSIONS OF LP3990-Q1 :

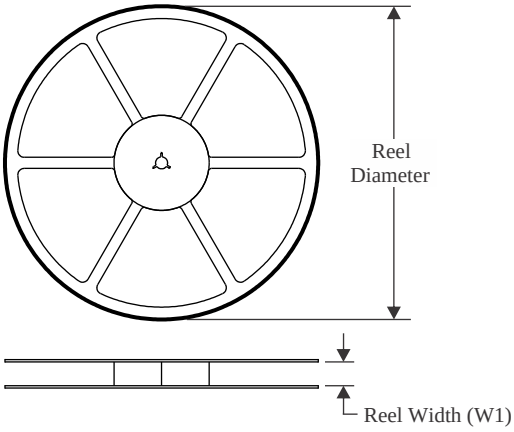
- Catalog : LP3990

NOTE: Qualified Version Definitions:

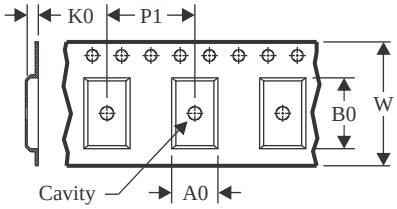
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

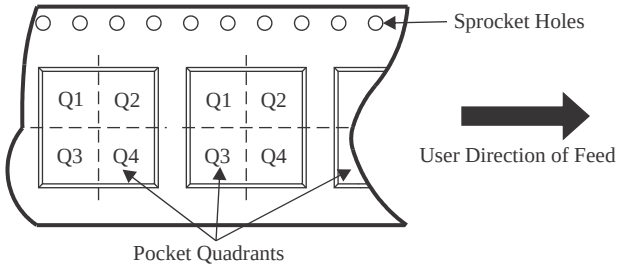


TAPE DIMENSIONS



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

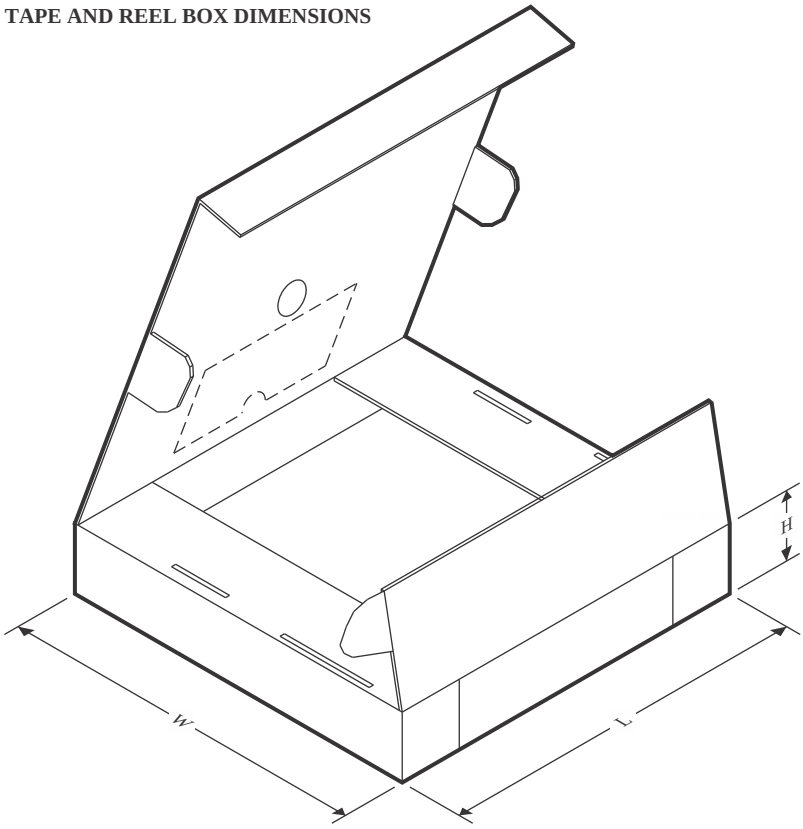
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
LP3990QTLX-1.2Q1	DSBGA	YZR	4	3000	178.0	8.4	1.09	1.35	0.76	4.0	8.0	Q1
LP3990QTLX-1.8Q1	DSBGA	YZR	4	3000	178.0	8.4	1.09	1.35	0.76	4.0	8.0	Q1
LP3990QTLX-2.8Q1	DSBGA	YZR	4	3000	178.0	8.4	1.09	1.35	0.76	4.0	8.0	Q1

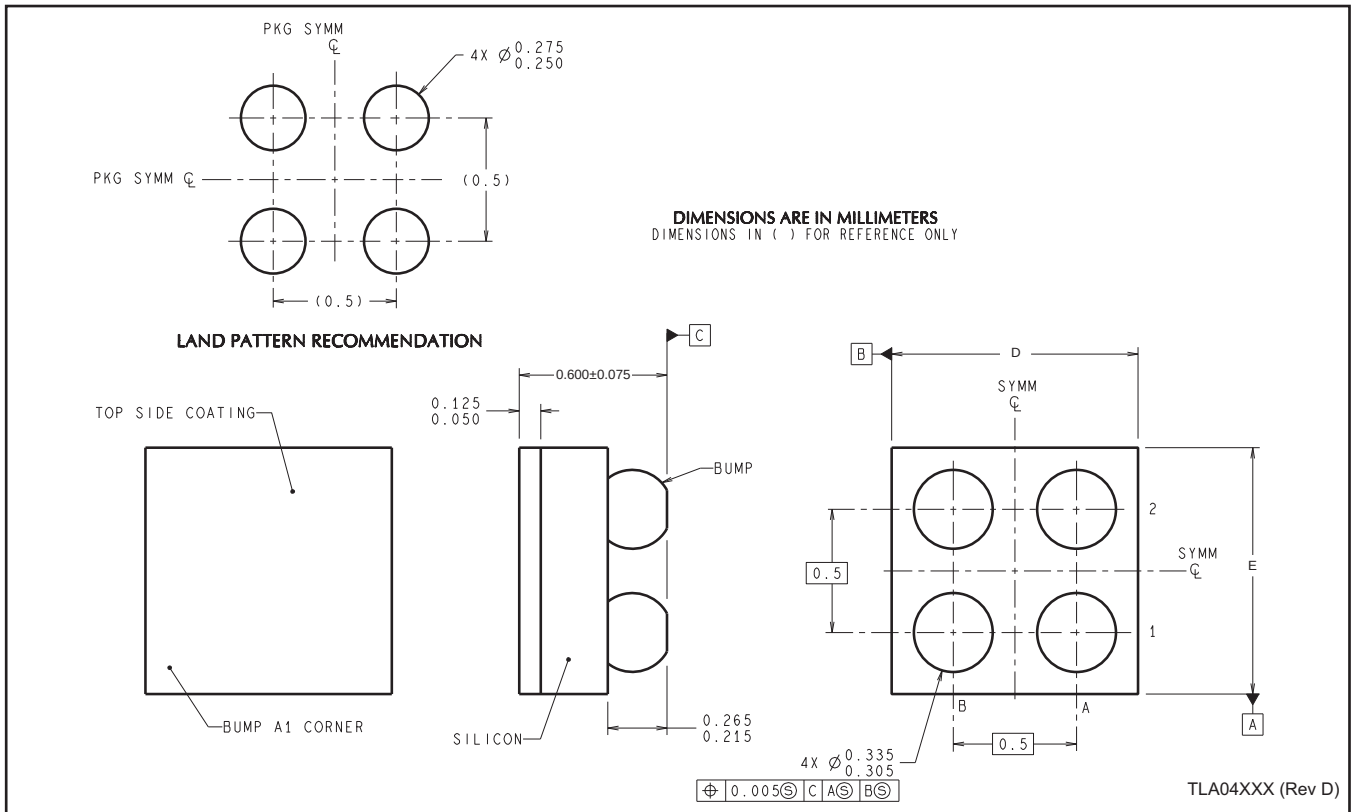
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
LP3990QTLX-1.2Q1	DSBGA	YZR	4	3000	208.0	191.0	35.0
LP3990QTLX-1.8Q1	DSBGA	YZR	4	3000	208.0	191.0	35.0
LP3990QTLX-2.8Q1	DSBGA	YZR	4	3000	208.0	191.0	35.0

YZR0004



D: Max = 1.324 mm, Min =1.263 mm

E: Max = 1.045 mm, Min =0.984 mm

4215042/A 12/12

NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
B. This drawing is subject to change without notice.

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