National Semiconductor

LP3991
300mA Linear Voltage Regulator for Digital Applications

General Description

Operating from a minimum input voltage of 1.65V, the LP3991 regulator has been designed to provide fixed stable output voltages for load currents up to 300mA. This device is suitable where accurate, low voltages are required from low input voltage sources and is therefore suitable for post regulation of switched mode regulators. In such applications, significant improvements in performance and EMI can be realized, with little reduction in overall efficiency. The LP3991 will provide fixed outputs as low as 1.2V from a wide input range of 1.65V to 4.0V Using the enable pin, the device may be controlled to provide a shutdown state, in which negligible supply current is drawn.

The LP3991 is designed to be stable with space saving ceramic capacitors as small as 0402 case size.

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

For output voltage options please contact your local NSC sales office.

Features

- Operation from 1.65V to 4.0V Input
- 1% accuracy at room temperature
- Output Voltage from 1.2V to 2.8V
- 125mV Dropout at 300mA load
- 50µA Quiescent Current at 1mA Load
- Inrush Current controlled to 600mA
- PSRR 65dB at 1kHz
- 100µs Start-Up time for 1.5V V_{OUT}
- Stable with Ceramic Capacitors as small as 0402
- Thermal-Overload and Short-Circuit Protection

Package

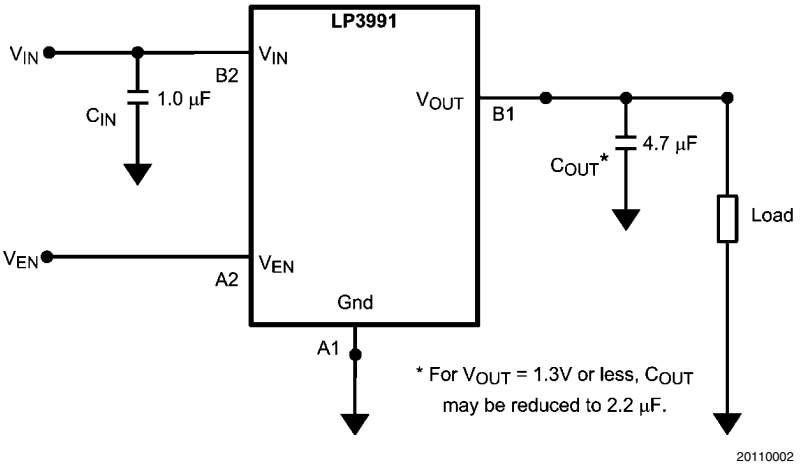
4 pin micro SMD (0.963mm x 1.446mm)

For other package options contact your NSC sales office.

Applications

- Post DC/DC Regulator
- Battery Operated Devices
- Hand-Held Information Appliances

Typical Application Circuit



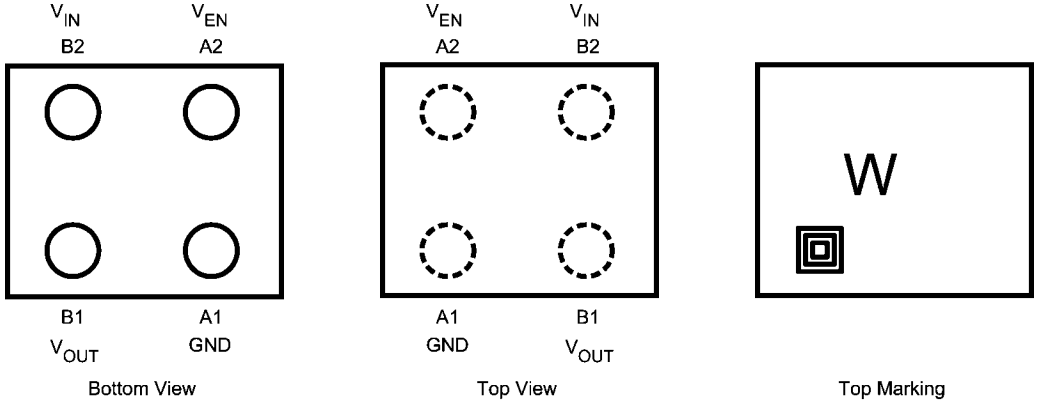
Pin Descriptions

Packages

Pin No.	Symbol	Name and Function
B1	V_{OUT}	Voltage output. A Low ESR Ceramic Capacitor should be connected from this pin to GND. (See Application Information) Connect this output to the load circuit.
A1	GND	Common Ground. Connect to Pad.
A2	V_{EN}	Enable Input; Enables the Regulator when ≥ 0.95V. Disables the Regulator when ≤ 0.4V. Enable Input has an internal 1.2MΩ pull-down resistor to GND.
B2	V_{IN}	Voltage Supply Input. A 1.0µF capacitor should be connected from this pin to GND.

Connection Diagram

4 Bump Thin Micro SMD, Large Bump



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See NS package number TLA04

Ordering Information (4-Bump Micro SMD)

Only available as Lead Free.

Output Voltage (V)	Grade	LP3991 Supplied as 1000 Units, Tape and Reel	LP3991 Supplied as 3000 Units, Tape and Reel
0.8	STD	LP3991TL-0.8	LP3991TLX-0.8
1.2	STD	LP3991TL-1.2	LP3991TLX-1.2
1.3	STD	LP3991TL-1.3	LP3991TLX-1.3
1.5	STD	LP3991TL-1.5	LP3991TLX-1.5
1.55	STD	LP3991TL-1.55	LP3991TLX-1.55
1.7	STD	LP3991TL-1.7	LP3991TLX-1.7
1.8	STD	LP3991TL-1.8	LP3991TLX-1.8
2.0	STD	LP3991TL-2.0	LP3991TLX-2.0
2.5	STD	LP3991TL-2.5	LP3991TLX-2.5
2.8	STD	LP3991TL-2.8	LP3991TLX-2.8
3.0	STD	LP3991TL-3.0	LP3991TLX-3.0

* Contact your local NSC Sales Office for availability

Absolute Maximum Ratings

(Notes 1, 2)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

V_{IN}, V_{OUT}, Pins: Voltage to GND	-0.3 to 6.5V
V_{EN} Pin: Voltage to GND	-0.3 to (V_{IN} + 0.3V) to 6.5V (max)
Junction Temperature	150°C
Lead/Pad Temp. (Note 3)	
Micro SMD	260°C
Storage Temperature	-65 to 150°C
Continuous Power Dissipation (Note 4)	Internally Limited
ESD (Note 5)	
Human Body Model	2KV
Machine Model	200V

Operating Ratings (Note 1)

Input Voltage Range	1.65 to 4.0V
Recommended Load Current	300mA
Junction Temperature	-40°C to 125°C
Ambient Temperature T_ARange (Note 6)	-40°C to 85°C

Thermal Properties (Note 1)

Junction To Ambient Thermal Resistance(Note 7)	
θ_{JA} JEDEC Board (Note 8)	88°C/W
θ_{JA} 4 Layer Board	160°C/W

Electrical Characteristics

Unless otherwise noted, V_{EN} =950mV, V_{IN} = V_{OUT} + 0.5V, or 1.8V, whichever is higher. C_{IN} = 1µF, I_{OUT} = 1.0mA, C_{OUT} =4.7µF.

Typical values and limits appearing in normal type apply for T_A = 25°C. Limits appearing in **boldface** type apply over the full junction temperature range for operation, –40 to +125°C. (Note 9)

Symbol	Parameter	Conditions		Typ	Limit		Units
					Min	Max	
V_{IN}	Input Voltage	(Note 10)			1.65	3.6	V
		(Note 16)				4.0	
ΔV_{OUT}	Output Voltage Tolerance	V_{IN} = $V_{IN(NOM)}$ to 3.6V I_{LOAD} = 1 to 300mA			-1.0 **-3.0**	1.0 **3.0**	%
			Temperature (T_J)= -25°C to +85°C		-2.5	2.5	
	Line Regulation Error	V_{IN} = $V_{OUT(NOM)}$ +0.5V to 3.6V, I_{OUT} = 1mA 0.8V ≤ V_{OUT} ≤ 2.8V		0.05		**1**	%/V
	Load Regulation Error	I_{OUT} = 1mA to 300mA		10		**60**	µV/mA
V_{DO}	Dropout Voltage(Note 11)	1.8 ≤ V_{OUT} ≤ 2.5V	I_{OUT} = 150mA	55		**90**	mV
			I_{OUT} = 300mA	110		**180**	
		V_{OUT} > 2.5V	I_{OUT} = 150mA	40		**80**	
			I_{OUT} = 300mA	75		**160**	
I_{LOAD}	Minimum Load Current	(Note 12)			0		mA
I_Q	Quiescent Current	V_{EN} = 950mV, I_{OUT} = 0mA		50		**100**	µA
		V_{EN} = 950mV, I_{OUT} = 300mA		120		**225**	
		V_{EN} = 0.4V		0.001		**1.0**	
I_{SC}	Short Circuit Current Limit	V_{IN} = 3.6V (Note 13)		550		**900**	mA
I_{OUT}	Maximum Output Current				**300**		mA
PSRR	Power Supply Rejection Ratio (Note 14)	f = 1kHz, I_{OUT} = 1mA to 300mA		65			dB
e_n	Output noise Voltage (Note 14)	BW = 10Hz to 100kHz, V_{IN} = 4.2V, C_{OUT} = 4.7µF		280			μV_{RMS}
$T_{SHUTDOWN}$	Thermal Shutdown	Temperature		160			°C
		Hysteresis		20			

Electrical Characteristics con't.

Unless otherwise noted, V_{EN} =950mV, V_{IN} = V_{OUT} + 0.5V, or 1.8V, whichever is higher. C_{IN} = 1µF, I_{OUT} = 1.0mA, C_{OUT} =4.7µF.

Typical values and limits appearing in normal type apply for T_A = 25°C. Limits appearing in **boldface** type apply over the full junction temperature range for operation, −40 to +125°C. (Note 9)

Symbol	Parameter	Conditions		Typ	Limit		Units
					Min	Max	
Enable Control Characteristics							
I_{EN} (Note 15)	Maximum Input Current at V_{EN} Input	V_{EN} = 0V, V_{IN} = 3.6V		0.001			µA
		V_{EN} = V_{IN} = 3.6V		3		**5.5**	
V_{IL}	Low Input Threshold	V_{IN} = 1.65V to 3.6V				**0.4**	V
V_{IH}	High Input Threshold	V_{IN} = 1.65V to 3.6V			**0.95**		V
Timing Characteristics							
T_{ON}	Turn On Time (Note 14)	To 95% Level $V_{IN(MIN)}$ to 3.6V	V_{OUT} ≤ 2.0V	100			µs
			V_{OUT} > 2.0V	140			
	Line Transient Response $\lvert\delta V_{OUT}\rvert$	T_{rise} = T_{fall} = 30µs (Note 14) δV_{IN} = 600mV		6			mV (pk - pk)
Transient Response	Load Transient Response $\lvert\delta V_{OUT}\rvert$	T_{rise} = T_{fall} = 1µs (Note 14)	I_{OUT} = 0 mA to 300mA	140			mV
			I_{OUT} = 1mA to 300mA	110			
			I_{OUT} = 300mA to 1mA	80			
			I_{OUT} = 0mA to 200mA	110			
			I_{OUT} = 1mA to 200mA	80			
			I_{OUT} = 200mA to 1mA	60			
			I_{OUT} = 0mA to 150mA	100			
			I_{OUT} = 1mA to 150mA	70			
			I_{OUT} = 150mA to 1mA	50			
	Overshoot on Start-up			0		**2**	%
I_{IR}	In-Rush Current (Note 14)			600		**1000**	mA

Note 1: Absolute Maximum Ratings are limits beyond which damage can occur. Operating Ratings are conditions under which operation of the device is guaranteed. Operating Ratings do not imply guaranteed performance limits. For guaranteed performance limits and associated test conditions, see the Electrical Characteristics tables.

Note 2: All Voltages are with respect to the potential at the GND pin.

Note 3: For further information on these packages please refer to the following application notes,AN-1112 Micro SMD Wafer Level Chip Scale Package.

Note 4: Internal thermal shutdown circuitry protects the device from permanent damage.

Note 5: The human body model is 100pF discharged through a 1.5kΩ resistor into each pin. The machine model is a 200pF capacitor discharged directly into each pin.

Note 6: The maximum ambient temperature ($T_{A(max)}$) is dependant on the maximum operating junction temperature ($T_{J(max-op)}$ = 125°C), the maximum power dissipation of the device in the application ($P_{D(max)}$), and the junction to ambient thermal resistance of the part / package in the application (θ_{JA}), as given by the following equation: $T_{A(max)} = T_{J(max-op)} - (\theta_{JA} \times P_{D(max)})$.

Note 7: Junction to ambient thermal resistance is dependant on the application and board layout. In applications where high maximum power dissipation is possible, special care must be paid to thermal dissipation issues in board design.

Note 8: Full details can be found in JESD61-7

Note 9: All limits are guaranteed. All electrical characteristics having room-temperature limits are tested during production at T_J = 25°C or correlated using Statistical Quality Control methods. Operation over the temperature specification is guaranteed by correlating the electrical characteristics to process and temperature variations and applying statistical process control.

Note 10: $V_{IN(MIN)} = V_{OUT(NOM)}$ + 0.5V or 1.65V, whichever is greater. (See post DC/DC convertor example in application information section).

Note 11: Dropout voltage is voltage difference between input and output at which the output voltage drops to 100mV below its nominal value. This parameter is only specified for output voltages above 1.8V.

Note 12: The device maintains the regulated output voltage without a load.

Note 13: Short circuit current is measured with V_{OUT} pulled to 0V.

Note 14: This electrical specification is guaranteed by design.

Note 15: Enable Pin has an internal 1.2MΩ typical, resistor connected to GND.

Note 16: The device will operate with input voltages up to 4.0V. However special care should be taken in relation to thermal dissipation and the need to derate the maximum allowable ambient temperature. See (Notes 6, 7)

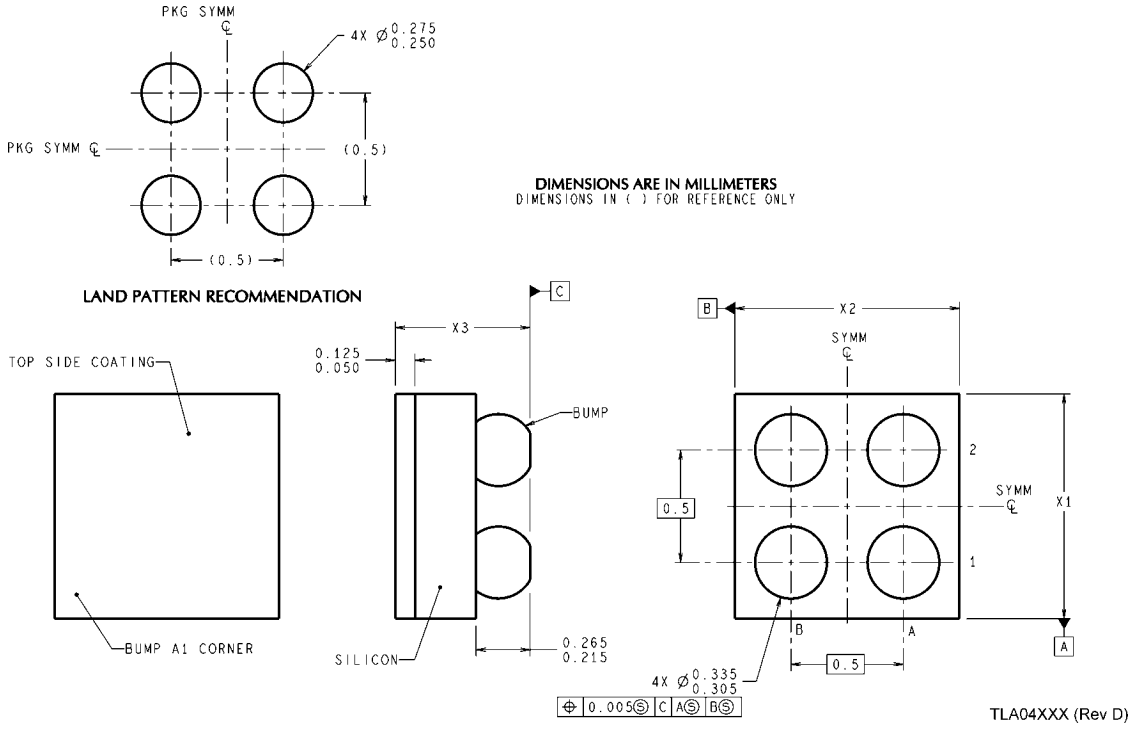
Output Capacitor, Recommended Specifications

	Parameter	Conditions		Typ	Limit		Units
					Min	Max	
C_{OUT}	Output Capacitor	Capacitance (Note 17)	$V_{OUT} \geq 1.5V$	4.7	**2**		µF
			$V_{OUT} < 1.5V$ (Note 18)	2.2	**1.6**		
		ESR			**5**	**500**	mΩ

Note 17: The capacitor tolerance should be 30% or better over temperature. The full operating conditions for the application should be considered when selecting a suitable capacitor to ensure that the minimum value of capacitance is always met. Recommended capacitor type is X7R or X5R. (See capacitor section in Applications Hints)

Note 18: On lower voltage options, 2.2µF output capacitor may be used but some degradation in load transient (10 -15%) can be expected, compared to a 4.7µF.

Physical Dimensions inches (millimeters) unless otherwise noted



4 Bump Thin micro SMD, Large Bump
NS Package Number TLA04ZTA
The Dimensions for X1, X2 and X3 as given as:
X1 = 0.963mm ± 0.030mm
X2 = 1.446mm ± 0.03mm
X3 = 0.60mm ± 0.075mm