



May 2003

LP3983

Micropower, Low Quiescent Current, CMOS Voltage Regulator in micro SMD Package

General Description

The LP3983 is a fixed voltage low current regulator.

The LP3983 is ideally suited to standby type applications in battery powered equipment, it allows the lifetime of the battery to be maximized. The device can be controlled via an Enable(disable) control and can thus be used by the system to further extend the battery lifetime by reducing the power consumption to virtually zero.

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

For output voltages other than those stated and alternative package options, please contact your local NSC sales office.

Features

- Miniature 5 pin package
- Logic Controlled Enable
- No Noise Bypass Capacitor Required
- Stable with Low ESR Ceramic Capacitors
- Fast turn ON
- Short Circuit Protection

Package

- Tiny 5 Pin micro SMD 828µm by 1387µm

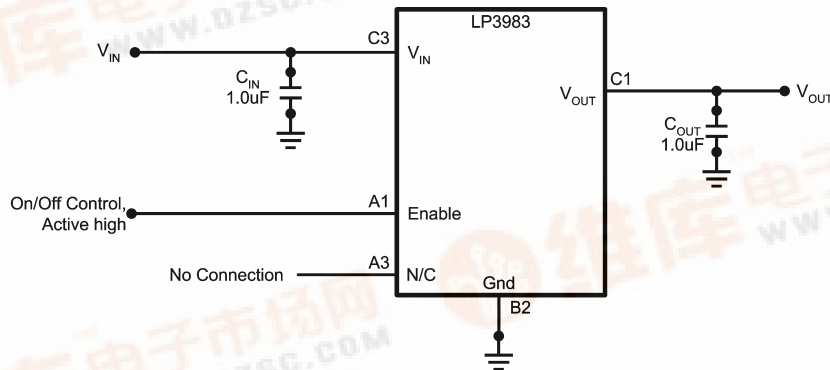
Key Specifications

■ Input Voltage Range	2.5 to 6.0V
■ Output Voltages	1.6, 1.8, & 2.5
■ Output Current	5mA
■ Output Capacitors	1µF Low ESR
■ Virtually Zero I _Q (Disabled)	1.0µA
■ Low I _Q (Enabled)	14µA
■ PSRR	10dB
■ Fast Start Up	170µs

Applications

- GSM Portable Phones
- CDMA Cellular Handsets
- Bluetooth Devices
- Portable Information Appliances

Typical Application Circuit

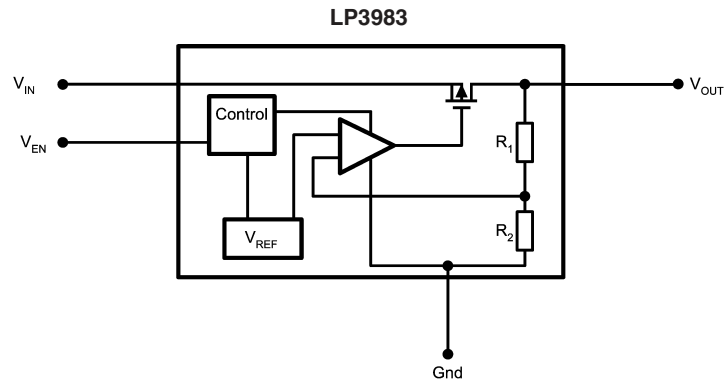


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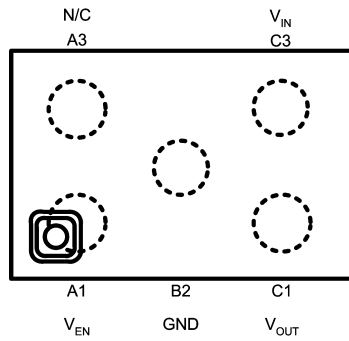
Block Diagram



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Connection Diagrams

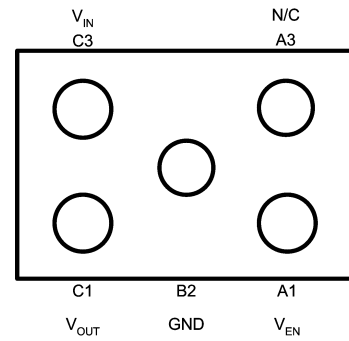
5 Pin micro SMD Package



20057603

Top View
See NS Package Number TLA05

5 Pin micro SMD Package



20057604

Bottom View
See NS Package Number TLA05

Pin Descriptions

Name	Pin No.	Name and Function
V _{EN}	A1	Enable Input Logic, Enables regulator when $\geq 1.2V$. Disables regulator when $\leq 0.5V$
GND	B2	Common Ground
V _{OUT}	C1	Voltage Output. Connect this Output to the Load Circuit.
V _{IN}	C3	Unregulated supply Input.
N/C	A3	No Connection. There should be no electrical connection made to this pin.

Ordering Information

TL refers as 0.300mm bump size with package height of 0.6mm

Output Voltage (V)	Grade	LP3983 Supplied as 250 Units, Tape and Reel	LP3983 Supplied as 3000 Units, Tape and Reel
1.6	STD	LP3983ITL-1.6	LP3983ITLX-1.6
1.8	STD	LP3983ITL-1.8	LP3983ITLX-1.8
2.5	STD	LP3983ITL-2.5	LP3983ITLX-2.5

* Please contact National Semiconductor for availability

Absolute Maximum Ratings (Notes 1,

Machine Model

100V

2)

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

V_{IN}	-0.3 to 6.5V
V_{EN}	-0.3 to ($V_{IN} + 0.3V$) to 6.5V(max)
V_{OUT}	-0.3V to ($V_{IN} + 0.3V$) to 6.5V(max)
Junction Temperature	150°C
Storage Temperature	-65°C to +150°C
Pad Temperature (Soldering, 10 sec.)	265°C
ESD (Note 4)	
Human Body Model	2KV

Operating Ratings (Notes 1, 2)

V_{IN} (Note 9)	$V_{IN(MIN)}$ to 6V
V_{EN}	0 to 6.0V
Recommended Load Current	0 to 5mA
Junction Temperature	-40°C to +125°C
Ambient Temperature (Note 3)	-40°C to +119°C

Thermal Properties (Note 3)

Junction to Ambient Thermal Resistance (θ_{JA})	255°C/W
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Electrical Characteristics

Unless otherwise specified: $V_{EN} = 1.8V$, $V_{IN} = V_{OUT(nom)} + 1.0V$, $C_{IN} = 1.0 \mu F$, $I_{OUT} = 1.0mA$, $C_{OUT} = 1.0 \mu F$. Typical values and limits appearing in standard typeface are for $T_J = 25^\circ C$. Limits appearing in **boldface type** apply over the entire junction temperature range for operation, -40°C to +125°C. (Note 10) (Note 11)

Symbol	Parameter	Conditions	Typ	Limit		Units
				Min	Max	
ΔV_{OUT}	Output Voltage Tolerance	$I_{OUT} = 0mA$ to 5mA		-55	+55	mV from $V_{OUT(nom)}$
				-96	+96	% of $V_{OUT(nom)}$
				- 6	+6	
PSRR	Power Supply Rejection Ratio	$V_{IN} = V_{OUT(nom)} + 1V$, $f \leq 10$ kHz, $I_{OUT} = 1mA$	10			dB
I_Q	Quiescent Current	$I_{OUT} = 50\mu A$, $V_{IN} = 4.2V$ $V_{EN} = 0.4V$, $V_{IN} = 4.2V$			21	μA
				1	3	
I_{SC}	Short Circuit Current Limit (Note 7)	Output Grounded	28		35	mA
I_{OUT}	Maximum Output Current	(Note 6)		5		mA

Logic Control Characteristics

I_{EN}	Maximum Input Current at V_{EN} input	$V_{EN} = 0.4$ and $V_{IN} = 6.0V$	0.02			μA
V_{IL}	Logic Low Input Threshold	$V_{IN} = V_{IN(MIN)}$ to 6.0V			0.5	V
V_{IH}	Logic High Input Threshold	$V_{IN} = V_{IN(MIN)}$ to 6.0V		1.2		V

Timing Characteristics

T_{ON}	Turn on Time (Note 7)	(Note 8)	170		250	μs
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Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may 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: The maximum ambient temperature ($T_{A(max)}$) is dependent on the maximum operating junction temperature ($T_{J(max-op)} = 125^\circ C$), 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 4: The human body model is 100pF discharged through a 1.5k Ω resistor into each pin. The machine model is a 200pF capacitor discharged directly into each pin.

Note 5: 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 6: The device maintains the regulated output voltage without load.

Electrical Characteristics (Continued)

Note 7: This electrical specification is guaranteed by design.

Note 8: Time from $V_{EN} = 1.2V$ to $V_{OUT} = 95\%$ of $V_{OUT(NOM)}$

Note 9: The minimum V_{IN} is dependant on the device output option.

For $V_{OUT(NOM)} \leq 2.7V$, $V_{IN(MIN)}$ will equal 2.5V. For $V_{OUT(NOM)} > 2.7V$, $V_{IN(MIN)}$ will equal $V_{OUT(NOM)} + 200mV$.

Note 10: All limits are guaranteed. All electrical characteristics having room-temperature limits are tested during production with $T_J = 25^\circ C$ 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 11: The target output voltage which is labelled $V_{OUT(NOM)}$ is the desired voltage option.

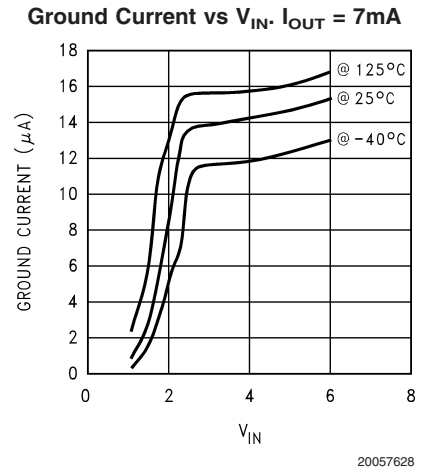
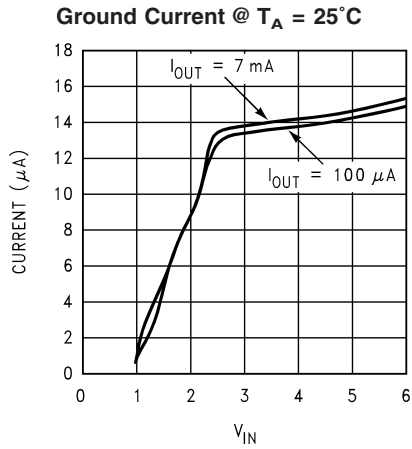
Output Capacitor, Recommended Specifications

Symbol	Parameter	Conditions	Value	Limit		Units
				Min	Max	
C _o	Output Capacitor	Capacitance(Note 12)	1.0	0.75		μF
		ESR		5	500	m Ω

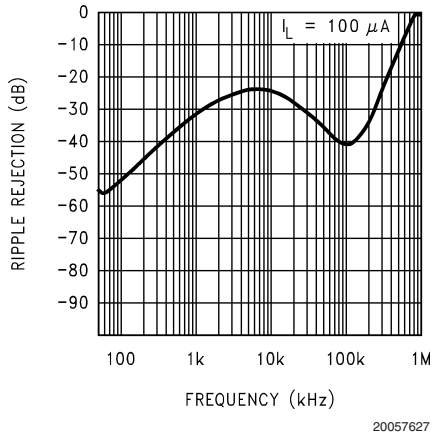
Note 12: The capacitor tolerance should be $\pm 25\%$ or better over the temperature range. Capacitor types recommended are X7R, Y5V, and Z5U.

Typical Performance Characteristics

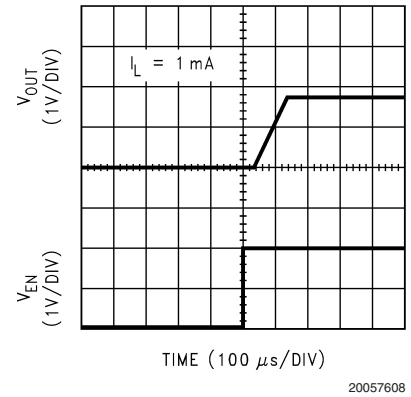
Unless otherwise specified, $C_{IN} = C_{OUT} = 1 \mu F$ Ceramic, $V_{IN} = V_{OUT(nom)} + 1.0V$, $T_A = 25^\circ C$, Enable pin is tied to V_{IN} .



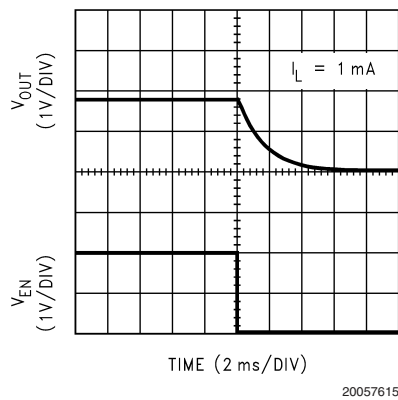
Ripple Rejection ($C_{IN} = C_{OUT} = 1\mu F$, $I_L = 100\mu A$)



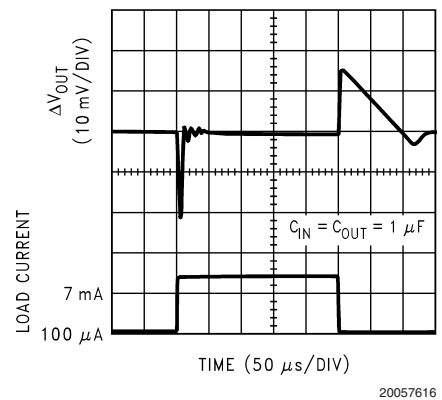
Start Up Time. $V_{OUT} = 1.8V$



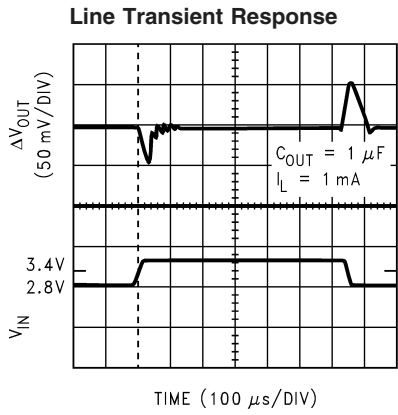
Turn-Off Time. $V_{OUT} = 1.8V$



Load Transient Response. $V_{OUT} = 1.8V$



Typical Performance Characteristics Unless otherwise specified, $C_{IN} = C_{OUT} = 1 \mu\text{F}$ Ceramic, $V_{IN} = V_{OUT(nom)} + 1.0\text{V}$, $T_A = 25^\circ\text{C}$, Enable pin is tied to V_{IN} . (Continued)



Application Hints

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 IC, 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 and ambient air.

As stated in note 3 in the electrical specification section, the allowable power dissipation for the device in a given package can be calculated using the equation

$$P_D = (T_J - T_A)/\theta_{JA}$$

With a $\theta_{JA} = 255^\circ\text{C/W}$, the device in the micro SMD package returns a value of 392mW with a maximum junction temperature of 125°C and an ambient temperature of 25°C . The actual power dissipation across the device can be represented by the following equation;

$$P_D = (V_{IN} - V_{OUT}) * I_{OUT}$$

This establishes the relationship between the power dissipation allowed due to thermal considerations, the voltage drop across the device, and the continuous current capability of the device. These two equations should be used to determine the optimum operating conditions for the device in the application.

EXTERNAL CAPACITORS

In common with most low-dropout regulators, the LP3983 requires external capacitors to ensure stable operation. The LP3983 is specifically designed for portable applications requiring minimum board space and smallest components. These capacitors must be correctly selected for good performance.

INPUT CAPACITOR

An input capacitor is required for stability. It is recommended that a 1.0 μF capacitor be connected between the LP3983 input pin and ground (this capacitance value may be increased without limit).

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

Important: 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 guaranteed by the manufacturer to have a surge current rating sufficient for the application.

There are no requirements for the **ESR** (Equivalent Series Resistance) on the input capacitor, but tolerance and temperature coefficient must be considered when selecting the capacitor to ensure the capacitance will be $\approx 1\mu\text{F}$ over the entire operating temperature range.

OUTPUT CAPACITOR

The LP3983 is designed specifically to work with very small ceramic output capacitors. A ceramic capacitor (dielectric types Z5U, Y5V or X7R), recommended value 2.2 μF and with ESR between 5m Ω to 500m Ω , is suitable in the LP3983 application circuit.

For this device the output capacitor should be connected between the VOUT pin and ground.

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

NO-LOAD STABILITY

The LP3983 will remain stable and in regulation with no external load. This is specially important in CMOS RAM keep-alive applications.

CAPACITOR CHARACTERISTICS

The LP3983 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 1 μF to 4.7 μF range, ceramic capacitors are the smallest, least expensive and have the lowest ESR values (which makes them best for eliminating high frequency noise). The ESR of a typical 1 μF ceramic capacitor is in the range of 20 m Ω to 40 m Ω , which easily meets the ESR requirement for stability by the LP3983.

The temperature performance of ceramic capacitors varies by type. Larger value ceramic capacitors may be manufactured with Z5U or Y5V temperature characteristics, which results in the capacitance dropping by more than 50% as the temperature goes from 25°C to 85°C .

A better choice for temperature coefficient in a ceramic capacitor is X7R, which holds the capacitance within $\pm 15\%$ over the temperature range. 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 1 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. It should also be noted that the ESR of a typical tantalum will increase about 2:1 as the temperature goes from 25°C down to -40°C , so some guard band must be allowed.

ENABLE OPERATION

The LP3983 may be switched ON or OFF by a logic input at the ENABLE pin, V_{EN} . A high voltage at this pin will turn the device on. When the enable pin is low, the regulator output is off and the device typically consumes $< 1\mu\text{A}$. If the application does not require the shutdown feature, the V_{EN} pin should be tied to V_{IN} to keep the regulator output permanently on. To ensure proper operation, the signal source used to drive the V_{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} .

MICRO SMD MOUNTING

The micro SMD package requires specific mounting techniques which are detailed in National Semiconductor Application Note (AN-1112).

Referring to the section *Surface Mount Technology (SMT) Assembly Considerations*, it should be noted that the pad style which must be used with the 5 pin package is NSMD (non-solder mask defined) type.

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

Application Hints (Continued)

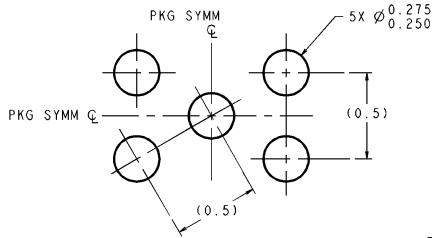
MICRO SMD LIGHT SENSITIVITY

Exposing the micro SMD device to direct sunlight may cause mis-operation of the device. Light sources such as Halogen lamps can effect electrical performance if brought near to the device.

Light with wavelengths in the red and infra-red part of the spectrum have the most detrimental effect thus the fluores-

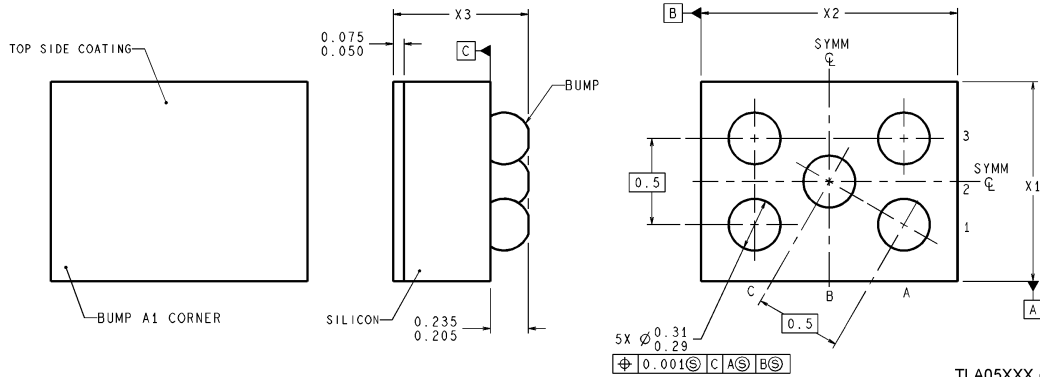
cent lighting used inside most buildings has very little effect on the output voltage of the device. Tests carried out on a micro SMD test board showed a negligible effect on the regulated output voltage when brought within 1cm of a fluorescent lamp. A deviation of less than 0.1% from nominal output voltage was observed.

Physical Dimensions inches (millimeters) unless otherwise noted



DIMENSIONS ARE IN MILLIMETERS

LAND PATTERN RECOMMENDATION



**micro SMD, 5 Bump, Package (TLA05)
NS Package Number TLA05ADA**

The dimensions for X1, X2 and X3 are given as:

- X1 = 1006 +/- 0.03mm**
- X2 = 1438 +/- 0.03mm**
- X3 = 0.600 +/- 0.075mm**

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