

LP3962/LP3965

1.5A Fast Ultra Low Dropout Linear Regulators

General Description

The LP3962/LP3965 series of fast ultra low-dropout linear regulators operate from a +2.5V to +7.0V input supply. Wide range of preset output voltage options are available. These ultra low dropout linear regulators respond very fast to step changes in load which makes them suitable for low voltage microprocessor applications. The LP3962/LP3965 are developed on a CMOS process which allows low quiescent current operation independent of output load current. This CMOS process also allows the LP3962/LP3965 to operate under extremely low dropout conditions.

Dropout Voltage: Ultra low dropout voltage; typically 38mV at 150mA load current and 380mV at 1.5A load current.

Ground Pin Current: Typically 5mA at 1.5A load current.

Shutdown Mode: Typically 15µA quiescent current when the shutdown pin is pulled low.

Error Flag: Error flag goes low when the output voltage drops 10% below nominal value (for LP3962).

SENSE: Sense pin improves regulation at remote loads. (For LP3965)

Precision Output Voltage: Multiple output voltage options are available ranging from 1.2V to 5.0V and adjustable (LP3965), with a guaranteed accuracy of $\pm 1.5\%$ at room temperature, and $\pm 3.0\%$ over all conditions (varying line, load, and temperature).

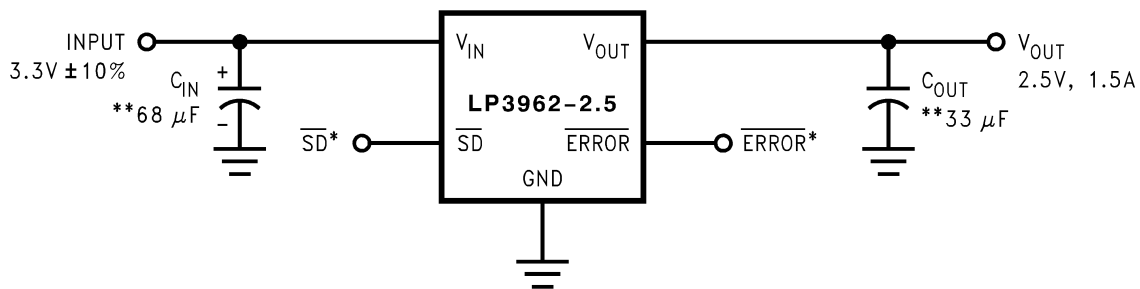
Features

- Ultra low dropout voltage
- Low ground pin current
- Load regulation of 0.04%
- 15µA quiescent current in shutdown mode
- Guaranteed output current of 1.5A DC
- Available in SOT-223, TO-263 and TO-220 packages
- Output voltage accuracy $\pm 1.5\%$
- Error flag indicates output status (LP3962)
- Sense option improves better load regulation (LP3965)
- Extremely low output capacitor requirements
- Overtemperature/overcurrent protection
- -40°C to $+125^{\circ}\text{C}$ junction temperature range

Applications

- Microprocessor power supplies
- GTL, GTL+, BTL, and SSTL bus terminators
- Power supplies for DSPs
- SCSI terminator
- Post regulators
- High efficiency linear regulators
- Battery chargers
- Other battery powered applications

Typical Application Circuits



*SD and ERROR pins must be pulled high through a 10kΩ pull-up resistor. Connect the ERROR pin to ground if this function is not used. See applications section for more information.

** See Application Hints.

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Ordering Information (Continued)**TABLE 1. Package Marking and Ordering Information** (Continued)

Output Voltage	Order Number	Description (Current, Option)	Package Type	Package Marking	Supplied As:
2.5	LP3965ESX-2.5	1.5A, SENSE	TO263-5	LP3965ES-2.5	Tape and Reel
1.8	LP3965ES-1.8	1.5A, SENSE	TO263-5	LP3965ES-1.8	Rail
1.8	LP3965ESX-1.8	1.5A, SENSE	TO263-5	LP3965ES-1.8	Tape and Reel
ADJ	LP3965ES-ADJ	1.5A, ADJ	TO263-5	LP3965ES-ADJ	Rail
ADJ	LP3965ESX-ADJ	1.5A, ADJ	TO263-5	LP3965ES-ADJ	Tape and Reel
5.0	LP3962ET-5.0	1.5A, Error Flag	TO220-5	LP3962ET-5.0	Rail
3.3	LP3962ET-3.3	1.5A, Error Flag	TO220-5	LP3962ET-3.3	Rail
2.5	LP3962ET-2.5	1.5A, Error Flag	TO220-5	LP3962ET-2.5	Rail
1.8	LP3962ET-1.8	1.5A, Error Flag	TO220-5	LP3962ET-1.8	Rail
5.0	LP3965ET-5.0	1.5A, SENSE	TO220-5	LP3965ET-5.0	Rail
3.3	LP3965ET-3.3	1.5A, SENSE	TO220-5	LP3965ET-3.3	Rail
2.5	LP3965ET-2.5	1.5A, SENSE	TO220-5	LP3965ET-2.5	Rail
1.8	LP3965ET-1.8	1.5A, SENSE	TO220-5	LP3965ET-1.8	Rail
ADJ	LP3965ET-ADJ	1.5A, ADJ	TO220-5	LP3965ET-ADJ	Rail

Absolute Maximum Ratings (Note 1)

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

Storage Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 5 sec.)	260°C
ESD Rating (Note 3)	2 kV
Power Dissipation (Note 2)	Internally Limited
Input Supply Voltage (Survival)	-0.3V to +7.5V
Shutdown Input Voltage (Survival)	-0.3V to $V_{IN}+0.3V$
Output Voltage (Survival), (Note 6), (Note 7)	-0.3V to +7.5V

I_{OUT} (Survival)	Short Circuit Protected
Maximum Voltage for \overline{ERROR} Pin	$V_{IN}+0.3V$
Maximum Voltage for SENSE Pin	$V_{OUT}+0.3V$

Operating Ratings

Input Supply Voltage (Operating), (Note 12)	2.5V to 7.0V
Shutdown Input Voltage (Operating)	-0.3V to $V_{IN}+0.3V$
Maximum Operating Current (DC)	1.5A
Operating Junction Temp. Range	-40°C to +125°C

Electrical Characteristics
LP3962/LP3965

Limits in standard typeface are for $T_J = 25^\circ\text{C}$, and limits in **boldface type** apply over the **full operating temperature range**. Unless otherwise specified: $V_{IN} = V_{O(NOM)} + 1V$, $I_L = 10\text{ mA}$, $C_{OUT} = 33\mu\text{F}$, $V_{SD} = V_{IN}-0.3V$.

Symbol	Parameter	Conditions	Typ (Note 4)	LP3962/5 (Note 5)		Units
				Min	Max	
V_O	Output Voltage Tolerance (Note 8)	$10\text{ mA} \leq I_L \leq 1.5\text{ A}$ $V_{OUT} + 1 \leq V_{IN} \leq 7.0\text{ V}$	0	-1.5 -3.0	+1.5 +3.0	%
V_{ADJ}	Adjust Pin Voltage (ADJ version)	$10\text{ mA} \leq I_L \leq 1.5\text{ A}$ $V_{OUT} + 1.5\text{ V} \leq V_{IN} \leq 7.0\text{ V}$	1.216	1.198 1.180	1.234 1.253	V
ΔV_{OL}	Output Voltage Line Regulation (Note 8)	$V_{OUT} + 1\text{ V} < V_{IN} < 7.0\text{ V}$,	0.02 0.06			%
$\Delta V_O / \Delta I_{OUT}$	Output Voltage Load Regulation (Note 8)	$10\text{ mA} < I_L < 1.5\text{ A}$	0.04 0.09			%
$V_{IN} - V_{OUT}$	Dropout Voltage (Note 10)	$I_L = 150\text{ mA}$	38		45 55	mV
		$I_L = 1.5\text{ A}$	380		450 550	
I_{GND}	Ground Pin Current In Normal Operation Mode	$I_L = 150\text{ mA}$	4		9 10	mA
		$I_L = 1.5\text{ A}$	5		14 15	
I_{GND}	Ground Pin Current In Shutdown Mode (Note 11)	$V_{SD} \leq 0.2\text{ V}$	15		25 75	μA
$I_{O(PK)}$	Peak Output Current	(Note 2)	2.5	2.0 1.7		A
SHORT CIRCUIT PROTECTION						
I_{SC}	Short Circuit Current		4.5			A
OVER TEMPERATURE PROTECTION						
Tsh(t)	Shutdown Threshold		165			$^\circ\text{C}$
Tsh(h)	Thermal Shutdown Hysteresis		10			$^\circ\text{C}$
SHUTDOWN INPUT						
V_{SDT}	Shutdown Threshold	Output = High	V_{IN}	$V_{IN}-0.3$		V
		Output = Low	0		0.2	

Electrical Characteristics

LP3962/LP3965 (Continued)

Limits in standard typeface are for $T_J = 25^\circ\text{C}$, and limits in **boldface type** apply over the **full operating temperature range**. Unless otherwise specified: $V_{IN} = V_{O(NOM)} + 1\text{V}$, $I_L = 10\text{ mA}$, $C_{OUT} = 33\mu\text{F}$, $V_{SD} = V_{IN} - 0.3\text{V}$.

Symbol	Parameter	Conditions	Typ (Note 4)	LP3962/5 (Note 5)		Units
				Min	Max	
T_{dOFF}	Turn-off delay	$I_L = 1.5\text{ A}$	20			μs
T_{dON}	Turn-on delay	$I_L = 1.5\text{ A}$	25			μs
I_{SD}	\overline{SD} Input Current	$V_{SD} = V_{IN}$	1			nA
ERROR FLAG COMPARATOR						
V_T	Threshold	(Note 9)	10	5	16	%
V_{TH}	Threshold Hysteresis	(Note 9)	5	2	8	%
$V_{EF(Sat)}$	Error Flag Saturation	$I_{sink} = 100\mu\text{A}$	0.02		0.1	V
T_d	Flag Reset Delay		1			μs
I_{lk}	Error Flag Pin Leakage Current		1			nA
I_{max}	Error Flag Pin Sink Current	$V_{Error} = 0.5\text{V}$ (over temp.)	1			mA
AC PARAMETERS						
PSRR	Ripple Rejection	$V_{IN} = V_{OUT} + 1.5\text{V}$ $C_{OUT} = 100\mu\text{F}$ $V_{OUT} = 3.3\text{V}$	60			dB
		$V_{IN} = V_{OUT} + 0.3\text{V}$ $C_{OUT} = 100\mu\text{F}$ $V_{OUT} = 3.3\text{V}$	40			
$\rho_{n(f)}$	Output Noise Density	$f = 120\text{Hz}$	0.8			μV
e_n	Output Noise Voltage (rms)	BW = 10Hz – 100kHz	150			μV (rms)
		BW = 300Hz – 300kHz	100			

Note 1: Absolute maximum ratings indicate limits beyond which damage to the device may occur. Operating ratings indicate conditions for which the device is intended to be functional, but does not guarantee specific performance limits. For guaranteed specifications and test conditions, see Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

Note 2: At elevated temperatures, devices must be derated based on package thermal resistance. The devices in TO220 package must be derated at $\theta_{JA} = 50^\circ\text{C/W}$ (with 0.5in², 1oz. copper area), junction-to-ambient (with no heat sink). The devices in the TO263 surface-mount package must be derated at $\theta_{JA} = 60^\circ\text{C/W}$ (with 0.5in², 1oz. copper area), junction-to-ambient. The devices in SOT223 package must be derated at $\theta_{JA} = 90^\circ\text{C/W}$ (with 0.5in², 1oz. copper area), junction-to-ambient.

Note 3: The human body model is a 100pF capacitor discharged through a 1.5k Ω resistor into each pin.

Note 4: Typical numbers are at 25°C and represent the most likely parametric norm.

Note 5: Limits are 100% production tested at 25°C. Limits over the operating temperature range are guaranteed through correlation using Statistical Quality Control (SQC) methods. The limits are used to calculate National's Average Outgoing Quality Level (AOQL).

Note 6: If used in a dual-supply system where the regulator load is returned to a negative supply, the LP396X output must be diode-clamped to ground.

Note 7: The output PMOS structure contains a diode between the V_{IN} and V_{OUT} terminals. This diode is normally reverse biased. This diode will get forward biased if the voltage at the output terminal is forced to be higher than the voltage at the input terminal. This diode can typically withstand 200mA of DC current and 1Amp of peak current.

Note 8: Output voltage line regulation is defined as the change in output voltage from the nominal value due to change in the input line voltage. Output voltage load regulation is defined as the change in output voltage from the nominal value due to change in load current. The line and load regulation specification contains only the typical number. However, the limits for line and load regulation are included in the output voltage tolerance specification.

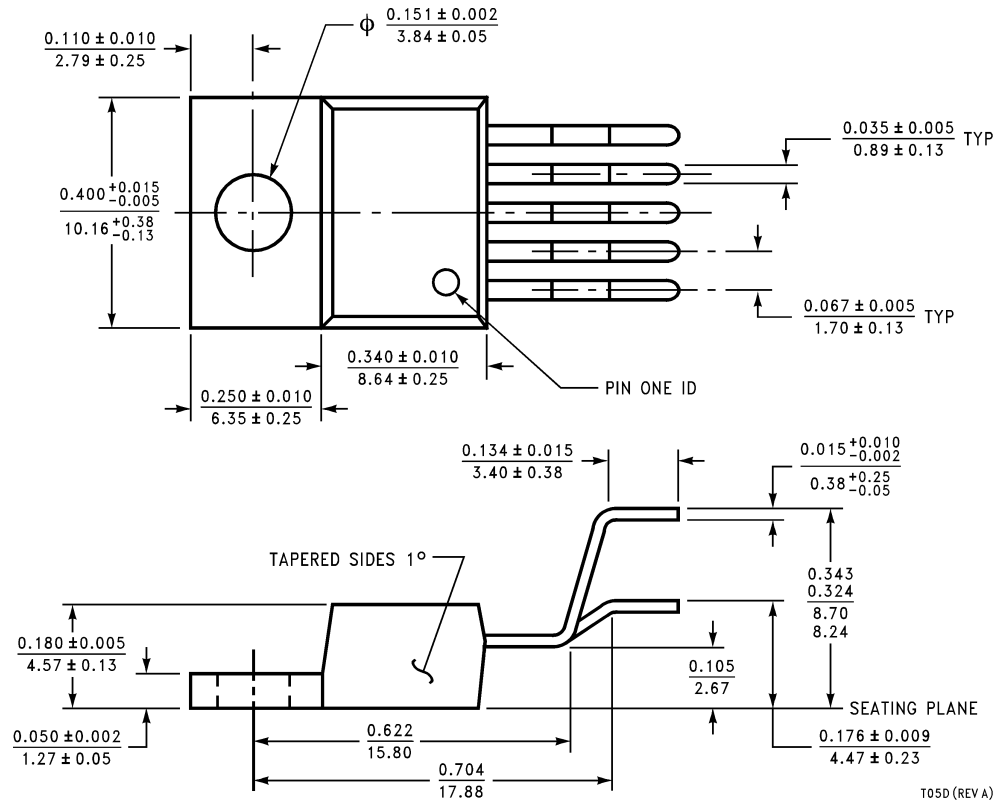
Note 9: Error Flag threshold and hysteresis are specified as percentage of regulated output voltage.

Note 10: Dropout voltage is defined as the minimum input to output differential voltage at which the output drops 2% below the nominal value. Dropout voltage specification applies only to output voltages of 2.5V and above. For output voltages below 2.5V, the drop-out voltage is nothing but the input to output differential, since the minimum input voltage is 2.5V.

Note 11: This specification has been tested for $-40^\circ\text{C} \leq T_J \leq 85^\circ\text{C}$ since the temperature rise of the device is negligible under shutdown conditions.

Note 12: The minimum operating value for V_{IN} is equal to either $[V_{OUT(NOM)} + V_{DROPOUT}]$ or 2.5V, whichever is greater.

Physical Dimensions inches (millimeters) unless otherwise noted



TO220 5-lead, Molded, Stagger Bend Package (TO220-5)
NS Package Number T05D
 For Order Numbers, refer to the "Ordering Information" section of this document.