National Semiconductor

LP38856
3A Fast-Response High-Accuracy LDO Linear Regulator with Enable

General Description

The LP38856 is a high-current, fast-response regulator which can maintain output voltage regulation with an extremely low input to output voltage drop. Fabricated on a CMOS process, the device operates from two input voltages: V_{BIAS} provides power for the internal bias and control circuits, as well as drive for the gate of the N-MOS power transistor, while V_{IN} supplies power to the load. The use of an external bias rail allows the part to operate from ultra low V_{IN} voltages. Unlike bipolar regulators, the CMOS architecture consumes extremely low quiescent current at any output load current. The use of an N-MOS power transistor results in wide bandwidth, yet minimum external capacitance is required to maintain loop stability.

The fast transient response of this device makes it suitable for use in powering DSP, Microcontroller Core voltages and Switch Mode Power Supply post regulators. The LP38856 is available in TO-220 and TO-263 5-Lead packages.

Dropout Voltage: 240 mV (typical) at 3A load current.

Low Ground Pin Current: 14 mA (typical) at 3A load current.

Shutdown Current: 1 µA (typical) $I_{IN(GND)}$ when EN pin is low.

Precision Output Voltage: ±1.0% for T_J = 25°C and ±2.0% for 0°C ≤ T_J ≤ +125°C, across all line and load conditions

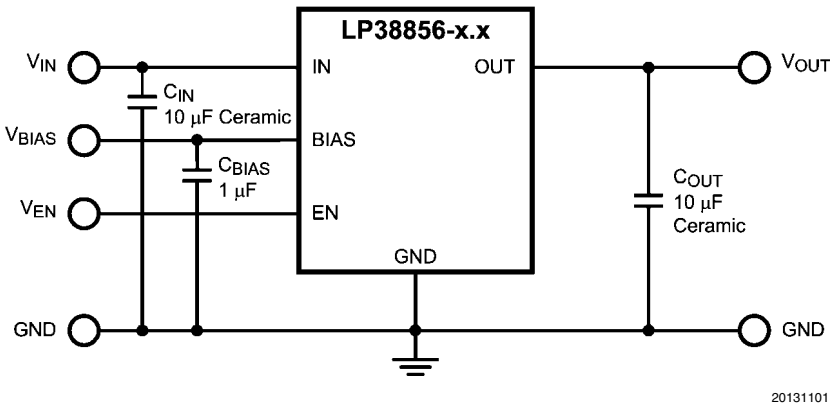
Features

- Standard V_{OUT} values of 0.8V and 1.2V
- Wide V_{BIAS} Supply operating range of 3.0V to 5.5V
- Stable with 10 µF ceramic capacitors
- Dropout voltage of 240 mV (typical) at 3A load current
- Precision Output Voltage across all line and load conditions:
  - — ±1.0% for T_J = 25°C
  - — ±2.0% for 0°C ≤ T_J ≤ +125°C
  - — ±3.0% for -40°C ≤ T_J ≤ +125°C
- Over-Temperature and Over-Current protection
- Available in 5 lead TO-220 and TO-263 packages
- Custom V_{OUT} values between 0.8V and 1.2V are available
- -40°C to +125°C Operating Temperature Range

Applications

- ASIC Power Supplies In:
  - Desktops, Notebooks, and Graphics Cards, Servers
  - Gaming Set Top Boxes, Printers and Copiers
- Server Core and I/O Supplies
- DSP and FPGA Power Supplies
- SMPS Post-Regulator

Typical Application Circuit

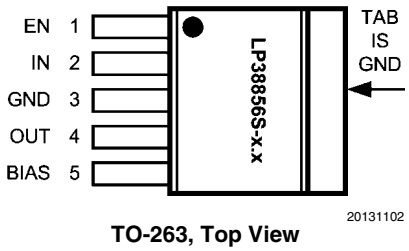


Ordering Information

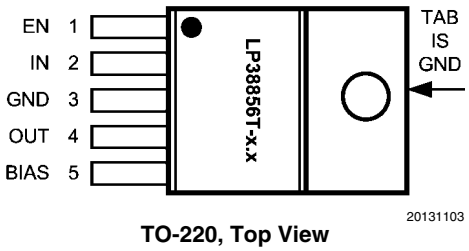
V_{OUT} *	Order Number	Package Type	Package Drawing	Supplied As
0.8V	LP38856S-0.8	TO263-5	TS5B	Rail of 45
	LP38856SX-0.8	TO263-5	TS5B	Tape and Reel of 500
	LP38856T-0.8	TO220-5	T05D	Rail of 45
1.2V	LP38856S-1.2	TO263-5	TS5B	Rail of 45
	LP38856SX-1.2	TO263-5	TS5B	Tape and Reel of 500
	LP38856T-1.2	TO220-5	T05D	Rail of 45

* For custom V_{OUT} values between 0.8V and 1.2V please contact the National Semiconductor Sales Office.

Connection Diagrams



TO-263, Top View



TO-220, Top View

Pin Descriptions

TO220–5 and TO263–5 Packages

Pin #	Pin Symbol	Pin Description
1	EN	The device Enable pin.
2	IN	The unregulated input voltage pin
3	GND	Ground
4	OUT	The regulated output voltage pin
5	BIAS	The supply for the internal control and reference circuitry
TAB	TAB	The TAB is a thermal connection that is physically attached to the backside of the die, and is used as a thermal heat-sink connection. See the Application Information section for details

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 seconds	260°C
ESD Rating	
Human Body Model (Note 2)	±2 kV
Power Dissipation (Note 3)	Internally Limited
V_{IN} Supply Voltage (Survival)	−0.3V to +6.0V
V_{BIAS} Supply Voltage (Survival)	−0.3V to +6.0V
V_{EN} Voltage (Survival)	−0.3V to +6.0V
V_{OUT} Voltage (Survival)	−0.3V to +6.0V
I_{OUT} Current (Survival)	Internally Limited
Junction Temperature	−40°C to +150°C

Operating Ratings (Note 1)

V_{IN} Supply Voltage	$(V_{OUT} + V_{DO})$ to V_{BIAS}
V_{BIAS} Supply Voltage	3.0V to 5.5V
V_{EN} Enable Input Voltage	0.0V to V_{BIAS}
I_{OUT}	0 mA to 3.0A
Junction Temperature Range (Note 3)	−40°C to +125°C

Electrical Characteristics

Unless otherwise specified: $V_{IN} = V_{OUT(NOM)} + 1V$, $V_{BIAS} = 3.0V$, $I_{OUT} = 10$ mA, $C_{IN} = C_{OUT} = 10$ µF, $C_{BIAS} = 1$µF, $V_{EN} = V_{BIAS}$. Limits in standard type are for $T_J = 25°C$ only; limits in **boldface type** apply over the junction temperature (T_J) range of -40°C to +125°C. Minimum and Maximum limits are guaranteed through test, design, or statistical correlation. Typical values represent the most likely parametric norm at $T_J = 25°C$, and are provided for reference purposes only.

Symbol	Parameter	Conditions	MIN	TYP	MAX	Units
V_{OUT}	Output Voltage Tolerance	$V_{OUT(NOM)} + 1V \le V_{IN} \le V_{BIAS}$, $3.0V \le V_{BIAS} \le 5.5V$, $10\text{ mA} \le I_{OUT} \le 3.0A$	-1.0 **-3.0**	0.0	+1.0 **+3.0**	%
		$V_{OUT(NOM)} + 1V \le V_{IN} \le V_{BIAS}$, $3.0V \le V_{BIAS} \le 5.5V$, $10\text{ mA} \le I_{OUT} \le 3.0A$, $0°C \le T_J \le 125°C$	-2.0	0	+2.0	
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation, V_{IN} (Note 4)	$V_{OUT(NOM)} + 1V \le V_{IN} \le V_{BIAS}$	-	0.04	-	%/V
$\Delta V_{OUT}/\Delta V_{BIAS}$	Line Regulation, V_{BIAS} (Note 4)	$3.0V \le V_{BIAS} \le 5.5V$	-	0.10	-	%/V
$\Delta V_{OUT}/\Delta I_{OUT}$	Output Voltage Load Regulation (Note 5)	$10\text{ mA} \le I_{OUT} \le 3.0A$	-	0.2	-	%/A
V_{DO}	Dropout Voltage $V_{IN} - V_{OUT}$ (Note 6)	$I_{OUT} = 3.0A$	-	240	300 **450**	mV
$I_{GND(IN)}$	Ground Pin Current Drawn from V_{IN} Supply	LP38856-0.8 $10\text{ mA} \le I_{OUT} \le 3.0A$	-	7.0	8.5 **9.0**	mA
		LP38856-1.2 $10\text{ mA} \le I_{OUT} \le 3.0A$	-	11	12 **15**	
		$V_{EN} \le 0.5V$	-	1.0	10 **300**	µA
$I_{GND(BIAS)}$	Ground Pin Current Drawn from V_{BIAS} Supply	$10\text{ mA} \le I_{OUT} \le 3.0A$	-	3.0	3.8 **4.5**	mA
		$V_{EN} \le 0.5V$	-	100	170 **200**	µA
UVLO	Under-Voltage Lock-Out Threshold	V_{BIAS} rising until device is functional	2.20 **2.00**	2.45	2.70 **2.90**	V
$UVLO_{(HYS)}$	Under-Voltage Lock-Out Hysteresis	V_{BIAS} falling from UVLO threshold until device is non-functional	60 **50**	150	300 **350**	mV
I_{SC}	Output Short-Circuit Current	$V_{IN} = V_{OUT(NOM)} + 1V$, $V_{BIAS} = 3.0V$, $V_{OUT} = 0.0V$	-	6.2	-	A

Symbol	Parameter	Conditions	MIN	TYP	MAX	Units
ENABLE Pin						
I_{EN}	ENABLE pin Current	$V_{EN} = V_{BIAS}$	-	0.01	-	µA
		V_{EN} = 0.0V, V_{BIAS} = 5.5V	-19 **-13**	-30	-40 **-51**	
$V_{EN(ON)}$	Enable Voltage Threshold	V_{EN} rising until Output = ON	1.00 **0.90**	1.25	1.50 **1.55**	V
$V_{EN(HYS)}$	Enable Voltage Hysteresis	V_{EN} falling from $V_{EN(ON)}$ until Output = OFF	50 **30**	100	150 **200**	mV
t_{OFF}	Turn-OFF Delay Time	$R_{LOAD} \times C_{OUT} << t_{OFF}$	-	20	-	µs
t_{ON}	Turn-ON Delay Time	$R_{LOAD} \times C_{OUT} << t_{ON}$	-	15	-	
AC Parameters						
PSRR (V_{IN})	Ripple Rejection for V_{IN} Input Voltage	$V_{IN} = V_{OUT}$ +1V, f = 120 Hz	-	80	-	dB
		$V_{IN} = V_{OUT}$ + 1V, f = 1 kHz	-	65	-	
PSRR (V_{BIAS})	Ripple Rejection for V_{BIAS} Voltage	$V_{BIAS} = V_{OUT}$ + 3V, f = 120 Hz	-	58	-	dB
		$V_{BIAS} = V_{OUT}$ + 3V, f = 1 kHz	-	58	-	
e_n	Output Noise Density	f = 120 Hz	-	1	-	µV/√Hz
	Output Noise Voltage	BW = 10 Hz – 100 kHz	-	150	-	µV (rms)
		BW = 300 Hz – 300 kHz	-	90	-	
Thermal Parameters						
T_{SD}	Thermal Shutdown Junction Temperature		-	160	-	°C
$T_{SD(HYS)}$	Thermal Shutdown Hysteresis		-	10	-	
θ_{JA}	Thermal Resistance, Junction to Ambient(Note 3)	TO220-5	-	60	-	°C/W
		TO263-5	-	60	-	
θ_{JC}	Thermal Resistance, Junction to Case(Note 3)	TO220-5	-	3	-	
		TO263-5	-	3	-	

Note 1: Absolute maximum ratings indicate limits beyond which damage to the component may occur. Operating ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications, see Electrical Characteristics. Specifications do not apply when operating the device outside of its rated operating conditions.

Note 2: The Human Body Model (HBM) is a 100 pF capacitor discharged through a 1.5k resistor into each pin. Test method is per JESD22-A114. The HBM rating for device pin 1 (EN) is ±1.5 kV.

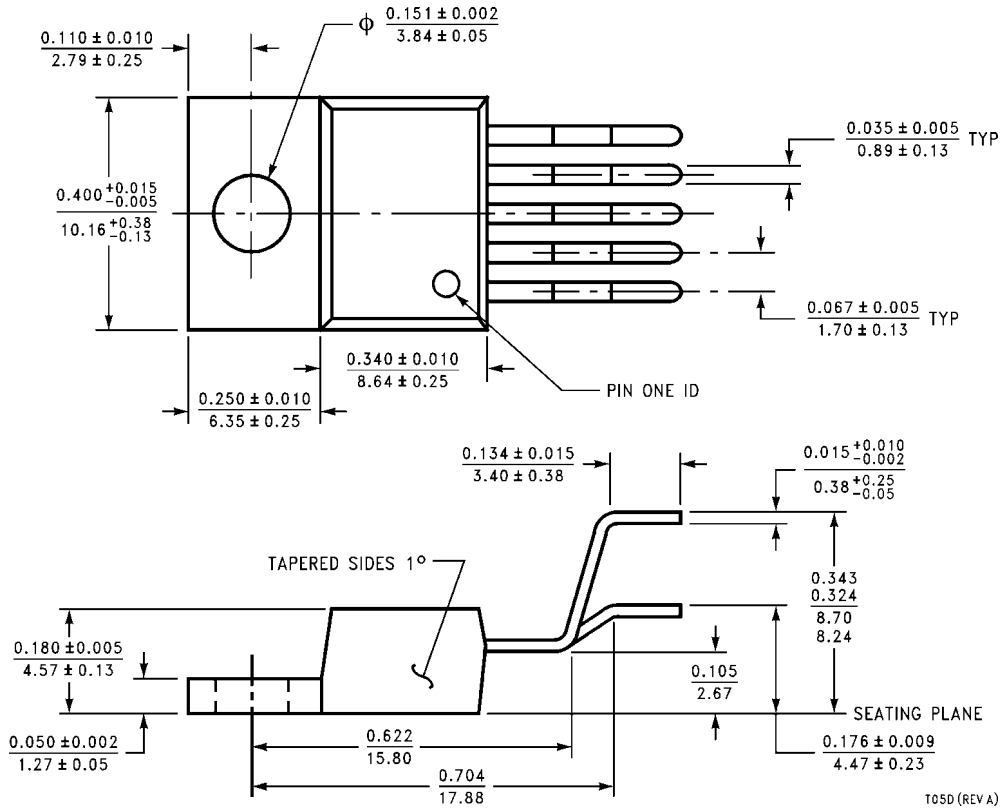
Note 3: Device power dissipation must be de-rated based on device power dissipation (T_D), ambient temperature (T_A), and package junction to ambient thermal resistance (θ_{JA}). Additional heat-sinking may be required to ensure that the device junction temperature (T_J) does not exceed the maximum operating rating. See the Application Information section for details.

Note 4: Output voltage line regulation is defined as the change in output voltage from nominal value resulting from a change in input voltage.

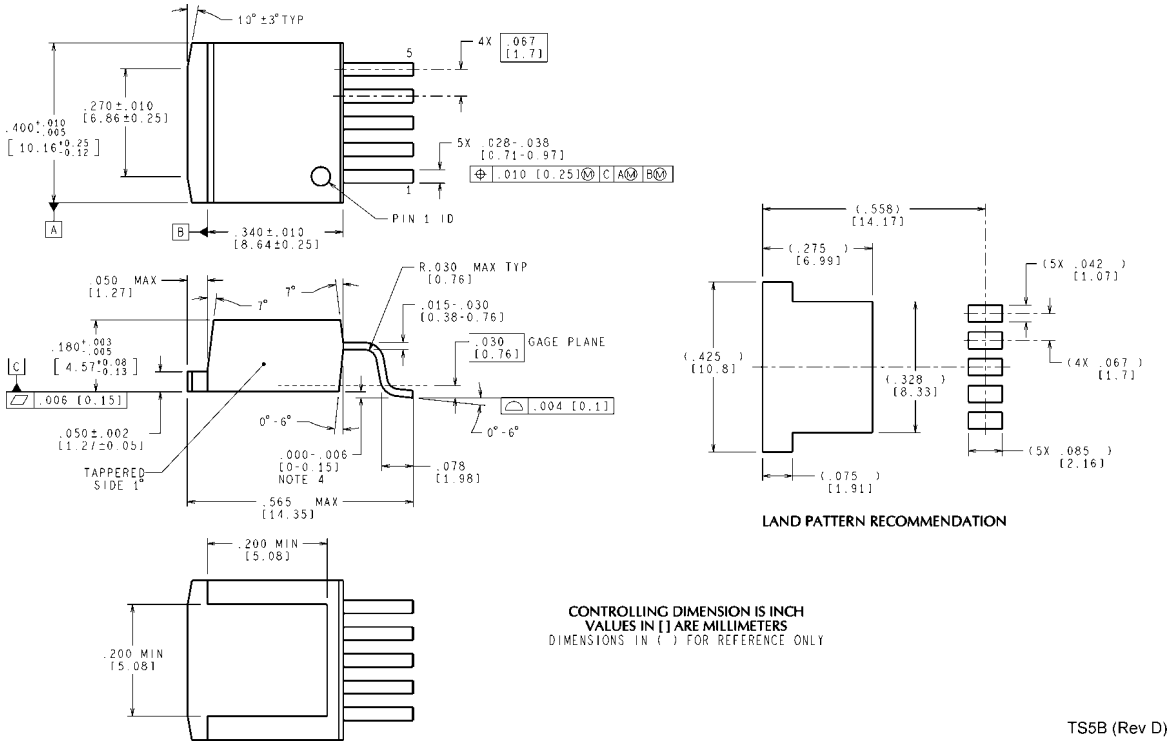
Note 5: Output voltage load regulation is defined as the change in output voltage from nominal value as the load current increases from no load to full load.

Note 6: Dropout voltage is defined the as input to output voltage differential (V_{IN} - V_{OUT}) where the input voltage is low enough to cause the output voltage to drop no more than 2% from the nominal value

Physical Dimensions inches (millimeters) unless otherwise noted



TO220 5-lead, Molded, Stagger Bend Package (TO220-5)
NS Package Number T05D



TO263 5-Lead, Molded, Surface Mount Package (TO263-5)
NS Package Number TS5B