

# Micropower Regulator and Comparator

## FEATURES

- 40 $\mu$ A Supply Current
- 125mA Output Current
- 2.5V Reference Voltage
- Reference Output Sources 1mA and Sinks 0.5mA
- Dual Output Comparator
- Comparator Sinks 10mA
- Dropout Detector
- 0.2V Dropout Voltage
- Thermal Limiting
- Electrical Shutdown

## APPLICATIONS

- Battery Systems
- Battery Backup System
- Portable Terminals
- Portable Instruments

## DESCRIPTION

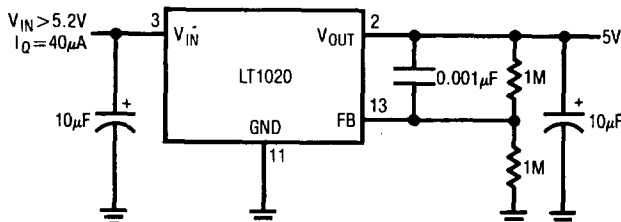
The LT1020 is a combination micropower positive regulator and free collector comparator on a single monolithic chip. With only 40 $\mu$ A supply current, the LT1020 can supply over 125mA of output current. Input voltage range is from 4.5V to 36V and dropout voltage is 0.6V at 125mA. Dropout voltage decreases with lower load currents. Also included on the chip is a class B output 2.5V reference that can either source or sink current. A dropout detector provides an output current to indicate when the regulator is about to drop out of regulation.

The dual output comparator can be used as a comparator for system or battery monitoring. For example, the comparator can be used to warn of low system voltage while the dropout detector shuts down the system to prevent abnormal operation. Frequency compensation of the comparator for amplifier applications can be obtained by adding external output capacitance. Dual output or positive and negative regulators can also be made.

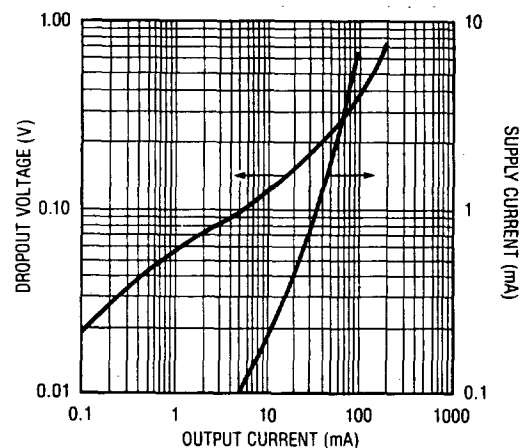
The 2.5V reference will source or sink current. This allows it to be used as a supply splitter or auxiliary output.

**4**

**5V Regulator**



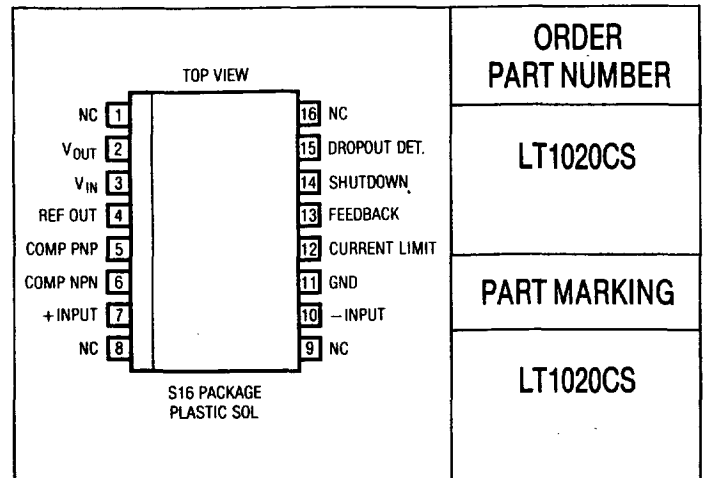
**Dropout Voltage and Supply Current**



## ABSOLUTE MAXIMUM RATINGS

Input Voltage .....	36V
NPN Collector Voltage .....	36V
PNP Collector Voltage .....	Supply – 36V
Output Short Circuit Duration .....	Indefinite
Power Dissipation .....	Internally Limited
Operating Temperature Range .....	0°C to 100°C
Storage Temperature Range .....	– 65°C to 150°C

## PACKAGE/ORDER INFORMATION

ELECTRICAL CHARACTERISTICS  $T_J = 25^\circ\text{C}$ 

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Reference</b>					
Reference Voltage	$4.5\text{V} \leq V_{IN} \leq 36\text{V}$	2.46	2.50	2.54	V
Line Regulation	$4.5\text{V} \leq V_{IN} \leq 36\text{V}$		0.01	0.015	%/V
Load Regulation	$-0.5\text{mA} \leq I_{REF} \leq 1\text{mA}$ , $V_{IN} = 12\text{V}$		0.2	0.3	%
Output Source Current	$V_{IN} = 5\text{V}$	1	4		mA
Output Sink Current	$V_{IN} = 5\text{V}$	0.5	2		mA
Temperature Stability			1		%
<b>Regulator</b>					
Supply Current	$V_{IN} = 6\text{V}$ , $I_{OUT} \leq 100\mu\text{A}$		45	80	$\mu\text{A}$
	$V_{IN} = 36\text{V}$ , $I_{OUT} \leq 100\mu\text{A}$		75	120	$\mu\text{A}$
	$V_{IN} = 12\text{V}$ , $I_{OUT} = 125\text{mA}$		11	20	mA
	$V_{IN} \leq 36\text{V}$ Shutdown		50		$\mu\text{A}$
Output Current	$(V_{IN} - V_{OUT}) \geq 1\text{V}$ , $V_{IN} \geq 6\text{V}$	125			mA
Load Regulation	$(V_{IN} - V_{OUT}) \geq 1\text{V}$ , $V_{IN} \geq 6\text{V}$		0.2	0.5	%
Line Regulation	$6\text{V} \leq V_{IN} \leq 36\text{V}$		0.01	0.015	%/V
Dropout Voltage	$I_{OUT} = 100\mu\text{A}$		0.02	0.05	V
	$I_{OUT} = 125\text{mA}$		0.4	0.65	V
Feedback Sense Voltage	$V_{IN} = 12\text{V}$	2.44	2.5	2.56	V
Dropout Detector Current	$\Delta V_{OUT} = -0.05\text{V}$	3	20		$\mu\text{A}$
Feedback Bias Current			15	40	nA
Minimum Load Current	$V_{IN} = 36\text{V}$		1	5	$\mu\text{A}$
Short Circuit Current	$V_{IN} = 36\text{V}$		250	360	mA
	Pin 11 and Pin 12 shorted, $V_{IN} = 4.5\text{V}$	3	30		mA
<b>Comparator</b>					
Offset Voltage	$0\text{V} \leq V_{CM} \leq 35\text{V}$ , $V_{IN} = 36\text{V}$		3	7	mV
Bias Current	$0\text{V} \leq V_{CM} \leq 35\text{V}$ , $V_{IN} = 36\text{V}$		15	40	nA
Offset Current	$0\text{V} \leq V_{CM} \leq 35\text{V}$ , $V_{IN} = 36\text{V}$		4	15	nA
Gain-NPN Pulldown	$\Delta V_{OUT} = 29\text{V}$ , $R_L = 20\text{k}$	2000	10000		V/V
Common Mode Rejection	$0\text{V} \leq V_{CM} \leq 35\text{V}$ , $V_{IN} = 36\text{V}$	80	94		dB

**ELECTRICAL CHARACTERISTICS**  $T_j = 25^\circ\text{C}$ 

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Comparator</b>					
Power Supply Rejection	$4.5\text{V} \leq V_S \leq 36\text{V}$	80	96		dB
Output Sink Current	$V_{IN} = 4.5\text{V}$	10	18		mA
NPN Saturation Voltage	$I_{OUT} = 1\text{mA}$		0.4	0.6	V
Output Source Current		60	200		$\mu\text{A}$
Input Voltage Range		0		$V_{IN} - 1$	V
Response Time			5		$\mu\text{s}$
Leakage Current (NPN)				2	$\mu\text{A}$

**ELECTRICAL CHARACTERISTICS**

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Reference						
Reference Voltage	$4.5\text{V} \leq V_{\text{IN}} \leq 36\text{V}$	●	2.40	2.50	2.55	V
Line Regulation	$4.5\text{V} \leq V_{\text{IN}} \leq 36\text{V}$	●		0.01	0.02	%/V
Load Regulation	$-0.5\text{mA} \leq I_{\text{REF}} \leq 1\text{mA}$ , $V_{\text{IN}} = 12\text{V}$	●		0.3	0.4	%
Output Source Current	$V_{\text{IN}} = 5\text{V}$	●	1			mA
Output Sink Current	$V_{\text{IN}} = 5\text{V}$	●	0.5			mA
Regulator						
Supply Current	$V_{\text{IN}} = 6\text{V}$ , $I_{\text{OUT}} \leq 100\mu\text{A}$	●		65	95	$\mu\text{A}$
	$V_{\text{IN}} = 36\text{V}$ , $I_{\text{OUT}} \leq 100\mu\text{A}$	●		85	120	$\mu\text{A}$
	$V_{\text{IN}} = 12\text{V}$ , $I_{\text{OUT}} = 125\text{mA}$	●		11	20	mA
Output Current	$(V_{\text{IN}} - V_{\text{OUT}}) \geq 1\text{V}$ , $V_{\text{IN}} \geq 6\text{V}$	●	125			mA
Load Regulation	$(V_{\text{IN}} - V_{\text{OUT}}) \geq 1\text{V}$ , $V_{\text{IN}} \geq 6\text{V}$	●			1	%
Line Regulation	$6\text{V} \leq V_{\text{IN}} \leq 36\text{V}$	●			0.02	%/V
Dropout Voltage	$I_{\text{OUT}} = 100\mu\text{A}$	●			0.06	V
	$I_{\text{OUT}} = 125\text{mA}$	●			0.85	V
Feedback Sense Voltage	$V_{\text{IN}} = 12\text{V}$	●	2.38	2.5	2.57	V
Dropout Detector Current	$\Delta V_{\text{OUT}} = -0.05\text{V}$	●	3			$\mu\text{A}$
Feedback Bias Current		●			50	nA
Minimum Load Current	$V_{\text{IN}} = 36\text{V}$	●			50	$\mu\text{A}$
Short Circuit Current	$V_{\text{IN}} = 36\text{V}$	●		240	360	mA
	Pin 11 and Pin 12 shorted, $V_{\text{IN}} = 4.5\text{V}$	●	2.5	30		mA
Comparator						
Offset Voltage	$0\text{V} \leq V_{\text{CM}} \leq 35\text{V}$ , $V_{\text{IN}} = 36\text{V}$	●			10	mV
Bias Current	$0\text{V} \leq V_{\text{CM}} \leq 35\text{V}$ , $V_{\text{IN}} = 36\text{V}$ (Note 1)	●		15	60	nA
Offset Current	$0\text{V} \leq V_{\text{CM}} \leq 35\text{V}$ , $V_{\text{IN}} = 36\text{V}$	●			20	nA
Gain-NPN Pulldown	$\Delta V_{\text{OUT}} = 29\text{V}$ , $R_{\text{L}} = 20\text{k}$	●	1000			V/V
Common Mode Rejection	$0\text{V} \leq V_{\text{CM}} \leq 35\text{V}$ , $V_{\text{IN}} = 36\text{V}$	●	80			dB
Power Supply Rejection	$4.5\text{V} \leq V_{\text{S}} \leq 36\text{V}$	●	80			dB
Output Sink Current	$V_{\text{IN}} = 4.5\text{V}$	●	5	10		mA
Output Source Current		●	40	120		$\mu\text{A}$
Input Voltage Range		●	0		$V_{\text{IN}} - 1$	V
Leakage Current (NPN)	$V_{\text{IN}} = 36\text{V}$	●			8	$\mu\text{A}$

The ● denotes the specifications which apply over full operating temperature range.

Note 1: For  $0\text{V} \leq V_{CM} \leq 0.1\text{V}$  and  $T > 85^\circ\text{C}$  I bias max is 100nA.

## PIN FUNCTIONS

Pins 1, 8, 9, 16—No internal connection.

Pin 2—**Regulator Output.** Main output, requires  $10\mu\text{F}$  output capacitor. Can be shorted to  $V_{\text{IN}}$  or ground without damaging device.

Pin 3—**Input Supply.** Bypass with  $10\mu\text{F}$  cap. Must always be more positive than ground.

Pin 4—**Reference.** 2.5V can source or sink current. May be shorted to ground or up to 5V. Voltages in excess of 5V can damage the device.

Pin 5—**Comparator PNP Output.** Pull up current source for the comparator. May be connected to any voltage from  $V_{\text{IN}}$  to 36V more negative than  $V_{\text{IN}}$  (operates below ground). Short circuit protected. For example, if  $V_{\text{IN}}$  is 6V then pin 5 will operate to  $-30\text{V}$ .

Pin 6—**Comparator NPN Output.** May be connected to any voltage from ground to 36V more positive than ground (operates above  $V_{\text{IN}}$ ). Short circuit protected.

Pins 7, 10—**Comparator Inputs.** Operates from ground to  $V_{\text{IN}} - 1\text{V}$ . Comparator inputs will withstand 36V even with  $V_{\text{IN}}$  of 0V.

Pin 11—**Ground.**

Pin 12—**Current Limit.** Connecting this pin to ground decreases the regulator current limit to 3mA min. Leave open when not used.

Pin 13—**Feedback.** This is the feedback point of the regulator. When operating, it is nominally at 2.5V. Optimum source resistance is 200k to 500k. The feedback pin should not be driven below ground or more positive than 5V.

Pin 14—**Shutdown.** Logic high turns the regulator output off. Shutdown threshold is 1.4V and impedance is  $65\text{k}\Omega$ .

Pin 15—**Dropout Detector.** This pin acts like a current source from  $V_{\text{IN}}$  which turns on when the output transistor goes into saturation. The magnitude of the current depends on the magnitude of the output current and the input-output voltage differential. Pin current ranges from  $5\mu\text{A}$  to about  $300\mu\text{A}$ .