

FEATURES

- Pin Compatible with Most Bandgap Reference Applications, Including Ref 01, Ref 02, LM368, MC1400, and MC1404, with Greatly Improved Stability, Noise, and Drift
- Ultra Low Drift—2ppm/°C Max Slope
- Trimmed Output Voltage
- Operates in Series or Shunt Mode
- Output Sinks and Sources in Series Mode
- Very Low Noise < 1ppm p-p (0.1Hz to 10Hz)
- > 100dB Ripple Rejection
- Minimum Input-Output Differential of 1V
- 100% Noise Tested

APPLICATIONS

- A to D and D to A Converters
- Precision Regulators
- Digital Voltmeters
- Inertial Navigation Systems
- Precision Scales
- Portable Reference Standard

DESCRIPTION

The LT1021 is a precision reference with ultra low drift and noise, extremely good long term stability, and almost total immunity to input voltage variations. The reference output will both source and sink up to 10mA. Three voltages are available; 5V, 7V and 10V. The 7V and 10V units can be used as shunt regulators (two terminal zeners) with the same precision characteristics as the three terminal connection. Special care has been taken to minimize thermal regulation effects and temperature induced hysteresis.

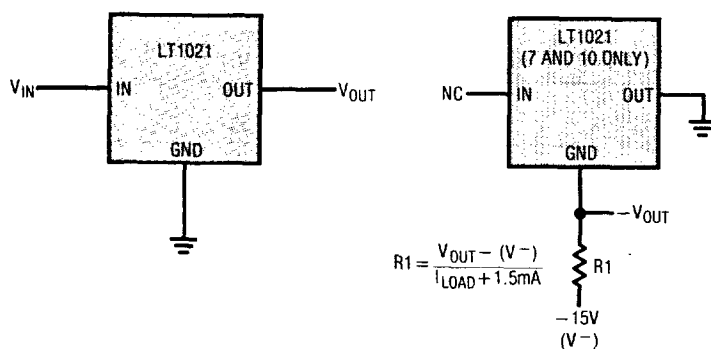
The LT1021 references are based on a buried zener diode structure which eliminates noise and stability problems associated with surface breakdown devices. Further, a subsurface zener exhibits better temperature drift and time stability than even the best band-gap references.

Unique circuit design makes the LT1021 the first IC reference to offer ultra low drift without the use of high power on-chip heaters.

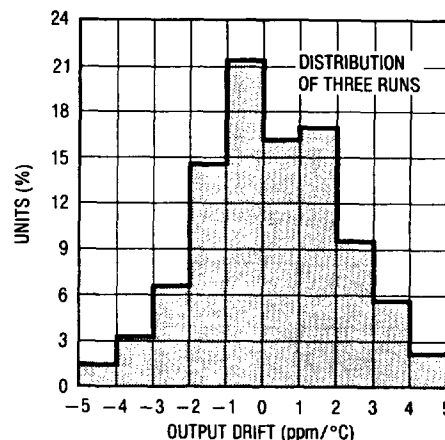
The LT1021-7 uses no resistive divider to set output voltage, and therefore exhibits the best long term stability and temperature hysteresis. The LT1021-5 and LT1021-10 are intended for systems requiring a precise 5V or 10V reference, with an initial tolerance as low as $\pm 0.05\%$.

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Basic Positive and Negative Connections



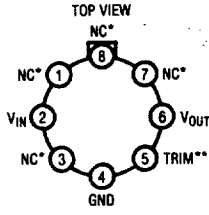
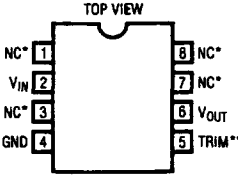
Typical Distribution of Temperature Drift—LT1021



ABSOLUTE MAXIMUM RATINGS

Input Voltage	40V
Input-Output Voltage Differential	35V
Output to Ground Voltage (Shunt Mode Current Limit)	
LT1021-5	10V
LT1021-7	10V
LT1021-10	16V
Trim Pin to Ground Voltage	
Positive	Equal to V_{OUT}
Negative	-20V
Output Short Circuit Duration	
$V_{IN} = 35V$	10 sec
$V_{IN} \leq 20V$	Indefinite
Operating Temperature Range	
LT1021 Mil	-55°C to 125°C
LT1021 Comm	0°C to 70°C
Storage Temperature Range	
All Devices	-65°C to 150°C
Lead Temperature (Soldering, 10 sec.)	300°C

PACKAGE/ORDER INFORMATION

		ORDER PART NUMBER		
 <p>METAL CAN H PACKAGE</p> <p>*CONNECTED INTERNALLY. DO NOT CONNECT EXTERNAL CIRCUITRY TO THESE PINS.</p> <p>**NO TRIM PIN ON LT1021-7. DO NOT CONNECT EXTERNAL CIRCUITRY TO PIN 5 ON LT1021-7.</p>	LT1021BMH-5	LT1021AMH-10		
	LT1021CMH-5	LT1021BMH-10		
	LT1021DMH-5	LT1021CMH-10		
	LT1021BCH-5	LT1021DMH-10		
	LT1021CCH-5	LT1021ACH-10		
	LT1021DCH-5	LT1021BCH-10		
		LT1021CCH-10		
		LT1021DCH-10		
		LT1021AMH-7		
		LT1021BMH-7		
	LT1021DMH-7			
	LT1021ACH-7			
	LT1021BCH-7			
	LT1021DCH-7			
 <p>PLASTIC DIP N8 PACKAGE</p> <p>*CONNECTED INTERNALLY. DO NOT CONNECT EXTERNAL CIRCUITRY TO THESE PINS.</p> <p>**NO TRIM PIN ON LT1021-7. DO NOT CONNECT EXTERNAL CIRCUITRY TO PIN 5 ON LT1021-7.</p>	LT1021BCN8-5			
	LT1021CCN8-5			
	LT1021DCN8-5			
		LT1021BCN8-7		
		LT1021DCN8-7		
		LT1021BCN8-10		
		LT1021CCN8-10		
		LT1021DCN8-10		

ELECTRICAL CHARACTERISTICS LT1021-5

$V_{IN} = 10V$, $I_{OUT} = 0$, $T_A = 25^\circ C$, Mil or Comm version, unless otherwise noted

PARAMETER	CONDITIONS	LT1021-5			UNITS
		MIN	TYP	MAX	
Output Voltage (Note 1)	LT1021C-5	4.9975	5.000	5.0025	V
	LT1021B-5, D-5	4.95	5.00	5.05	V
Output Voltage Temperature Coefficient (Note 2)	$T_{MIN} \leq T_J \leq T_{MAX}$ LT1021B-5		2	5	ppm/°C
	LT1021C-5, D-5		3	20	ppm/°C
Line Regulation (Note 3)	$7.2V \leq V_{IN} \leq 10V$		4	12	ppm/V
		•		20	ppm/V
	$10V \leq V_{IN} \leq 40V$	•	2	6	ppm/V
		•		10	ppm/V
Load Regulation (Sourcing Current)	$0 \leq I_{OUT} \leq 10mA$ (Note 3)		10	20	ppm/mA
		•		35	ppm/mA
Load Regulation (Sinking Current)	$0 \leq I_{OUT} \leq 10mA$ (Note 3)		60	100	ppm/mA
		•		150	ppm/mA
Supply Current			0.8	1.2	mA
		•		1.5	mA
Output Voltage Noise (Note 5)	$0.1Hz \leq f \leq 10Hz$		3		$\mu Vp-p$
	$10Hz \leq f \leq 1kHz$		2.2	3.5	$\mu Vrms$
Long Term Stability of Output Voltage (Note 6)	$\Delta t = 1000$ Hrs Non-Cumulative		15		ppm
Temperature Hysteresis of Output	$\Delta T = \pm 25^\circ C$		10		ppm

ELECTRICAL CHARACTERISTICS LT1021-7

V_{IN} = 12V, I_{OUT} = 0, T_A = 25°C, Mil or Comm version, unless otherwise noted

PARAMETER	CONDITIONS	LT1021-7			UNITS
		MIN	TYP	MAX	
Output Voltage (Note 1)		6.95	7.00	7.05	V
Output Voltage Temperature Coefficient (Note 2)	T _{MIN} ≤ T _J ≤ T _{MAX} LT1021A-7 LT1021B-7 LT1021D-7		1 2 3	2 5 20	ppm/°C ppm/°C ppm/°C
Line Regulation (Note 3)	8.5V ≤ V _{IN} ≤ 12V		1 2	4 8	ppm/V ppm/V
	12V ≤ V _{IN} ≤ 40V	●	0.5 1	2 4	ppm/V ppm/V
Load Regulation (Sourcing Current)	0 ≤ I _{OUT} ≤ 10mA (Note 3)	●	12	25	ppm/mA
		●		40	ppm/mA
Load Regulation (Shunt Mode)	1.2mA ≤ I _{SHUNT} ≤ 10mA (Notes 3, 4)	●	50	100	ppm/mA
		●		150	ppm/mA
Supply Current (Series Mode)		●	0.75	1.2	mA
Minimum Current (Shunt Mode)	V _{IN} is Open	●		1.5	mA
		●	0.7	1.0	mA
Output Voltage Noise (Note 5)	0.1Hz ≤ f ≤ 10Hz 10Hz ≤ f ≤ 1kHz		4		μVp-p
			2.5	4	μVrms
Long Term Stability of Output Voltage (Note 6)	Δt = 1000 Hrs Non-Cumulative		7		ppm
Temperature Hysteresis of Output	ΔT = ± 25°C		3		ppm

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ELECTRICAL CHARACTERISTICS LT1021-10

V_{IN} = 15V, I_{OUT} = 0, T_A = 25°C, Mil or Comm version, unless otherwise noted

PARAMETER	CONDITIONS	LT1021-10			UNITS	
		MIN	TYP	MAX		
Output Voltage (Note 1)	LT1021C-10 LT1021A-10, B-10, D-10		9.995	10.00	10.005	V
			9.95	10.00	10.05	V
Output Voltage Temperature Coefficient (Note 2)	T _{MIN} ≤ T _J ≤ T _{MAX} LT1021A-10 LT1021B-10 LT1021C-10, D-10		1	2	ppm/°C	
			2	5	ppm/°C	
Line Regulation (Note 3)	11.5V ≤ V _{IN} ≤ 14.5V		1	4	ppm/V	
		●		6	ppm/V	
	14.5V ≤ V _{IN} ≤ 40V	●	0.5	2	ppm/V	
		●		4	ppm/V	
Load Regulation (Sourcing Current)	0 ≤ I _{OUT} ≤ 10mA (Note 3)	●	12	25	ppm/mA	
		●		40	ppm/mA	
Load Regulation (Shunt Mode)	1.7mA ≤ I _{SHUNT} ≤ 10mA (Notes 3, 4)	●	50	100	ppm/mA	
		●		150	ppm/mA	
Series Mode Supply Current		●	1.2	1.7	mA	
Shunt Mode Minimum Current	V _{IN} is Open	●		2.0	mA	
		●	1.1	1.5	mA	
Output Voltage Noise (Note 5)	0.1Hz ≤ f ≤ 10Hz 0.1Hz ≤ f ≤ 1kHz		6		μVp-p	
			3.5	6	μVrms	
Long Term Stability of Output Voltage (Note 6)	Δt = 1000 Hrs Non-Cumulative		15		ppm	
Temperature Hysteresis of Output	ΔT = ± 25°C		5		ppm	

LT1021

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

Note 1: Output voltage is measured immediately after turn-on. Changes due to chip warm-up are typically less than 0.005%.

Note 2: Temperature coefficient is measured by dividing the change in output voltage over the temperature range by the change in temperature. Separate tests are done for hot and cold; T_{MIN} to 25°C, and 25°C to T_{MAX} . **Incremental slope is also measured at 25°C.** For the "A" version only, a box method is used from 0°C to 70°C with a height of $2\text{ppm}/^\circ\text{C} \times 70^\circ\text{C} = 140\text{ppm}$. Military "A" grades receive an additional -55°C to $+125^\circ\text{C}$ test to $\pm 5\text{ppm}/^\circ\text{C}$.

Note 3: Line and load regulation are measured on a pulse basis. Output changes due to die temperature change must be taken into account separately. Package thermal resistance is 150°C/W for TO-5 (H), and 130°C/W for N.

Note 4: Shunt mode regulation is measured with the input open. With the input-connected, shunt mode current can be reduced to 0mA. Load regulation will remain the same.

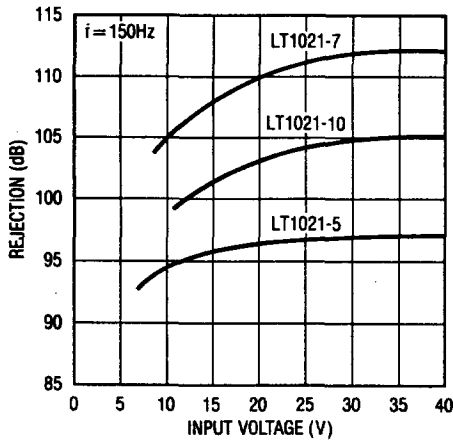
Note 5: RMS noise is measured with a single high pass filter at 10Hz and a 2-pole low pass filter at 1kHz. The resulting output is full wave rectified and then integrated for a fixed period, making the final reading an average as opposed to RMS. A correction factor of 1.1 is used to convert from average to RMS, and a second correction of 0.88 is used to correct for the non-ideal bandpass of the filters.

Peak-to-peak noise is measured with a single high pass filter at 0.1Hz and a 2-pole low pass filter at 10Hz. The unit is enclosed in a still-air environment to eliminate thermocouple effects on the leads. Test time is 10 seconds.

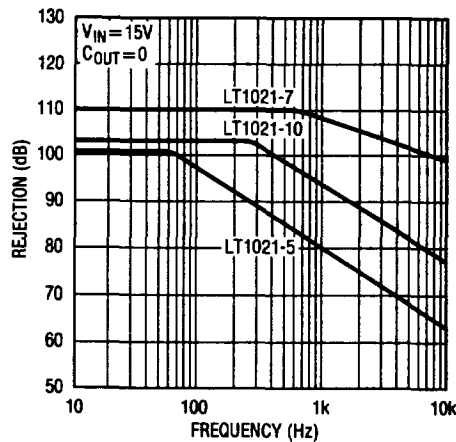
Note 6: Consult factory for units with long term stability data.

TYPICAL PERFORMANCE CHARACTERISTICS

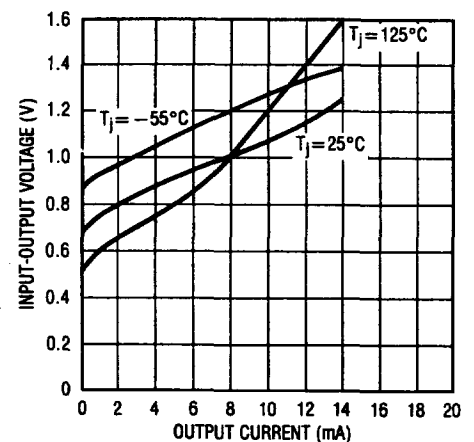
Ripple Rejection



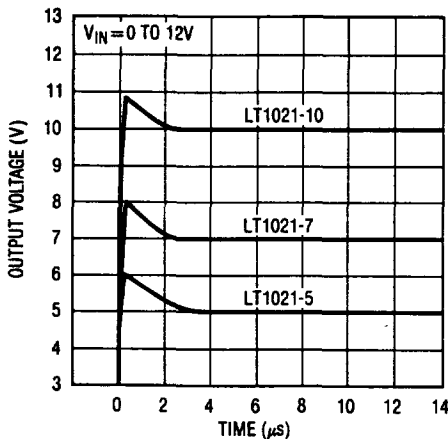
Ripple Rejection



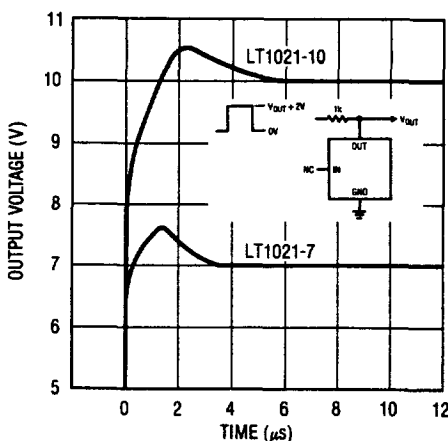
Minimum Input-Output Differential LT1021-7 and LT1021-10



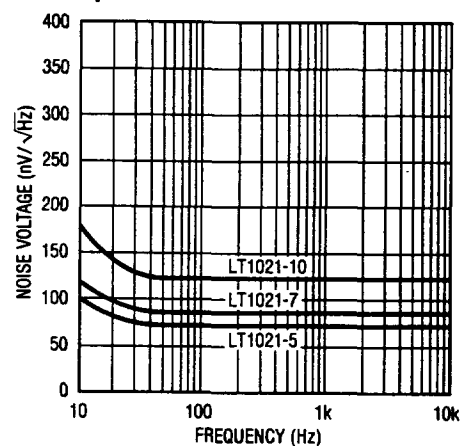
Start-Up (Series Mode)



Start-Up (Shunt Mode) LT1021-7 and LT1021-10

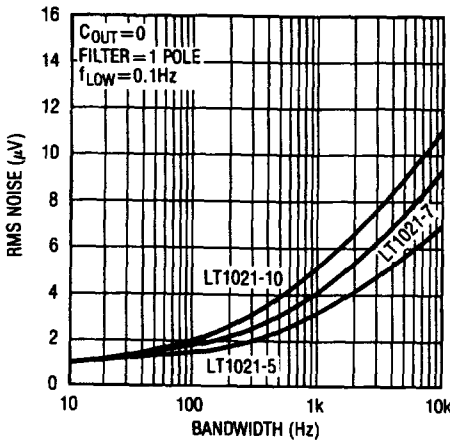


Output Voltage Noise Spectrum

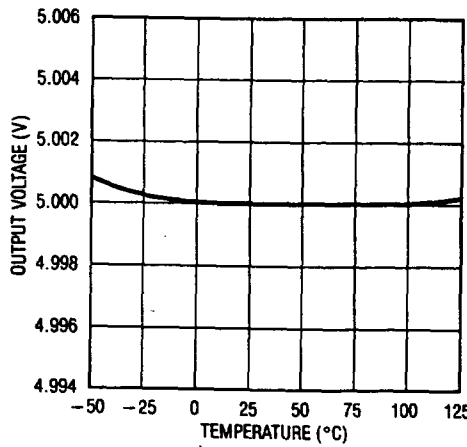


TYPICAL PERFORMANCE CHARACTERISTICS

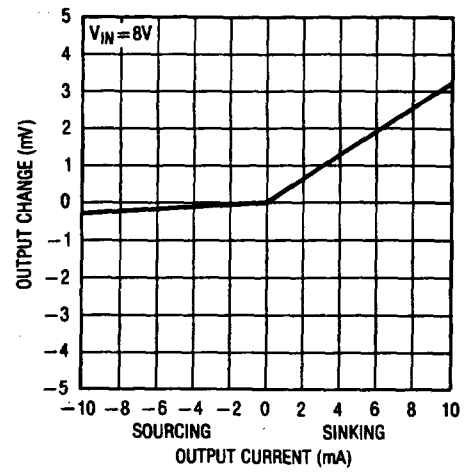
Output Voltage Noise



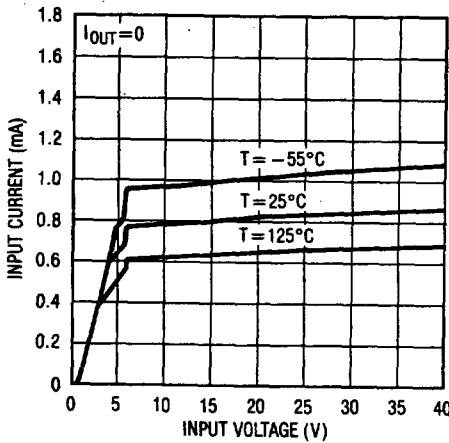
Output Voltage Temperature Drift LT1021-5



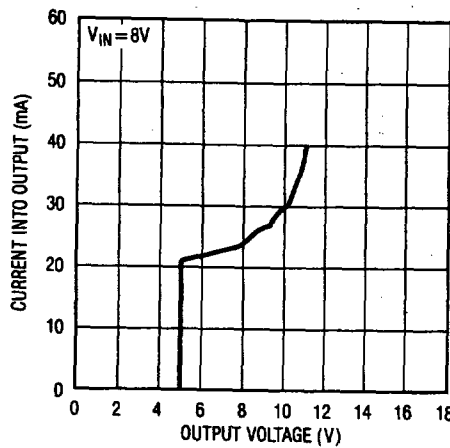
Load Regulation LT1021-5



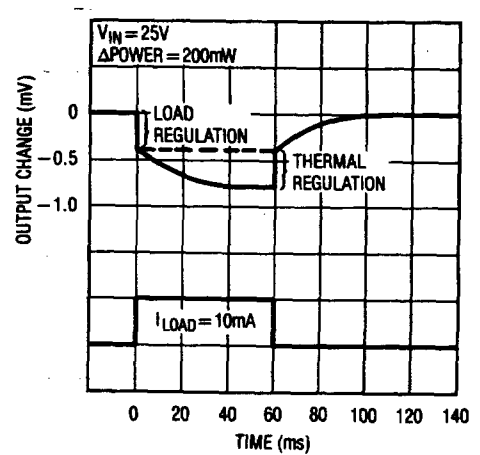
Quiescent Current LT1021-5



Sink Mode* Current Limit LT1021-5

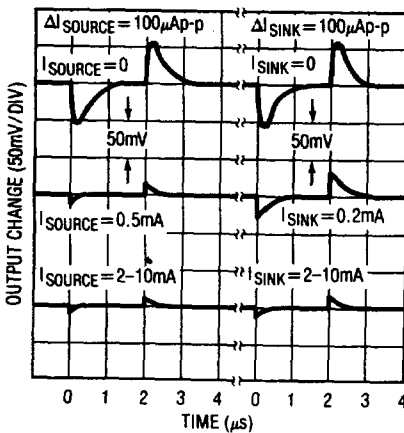


Thermal Regulation LT1021-5

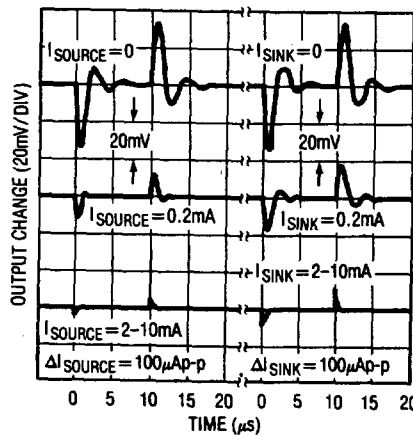


*NOTE THAT AN INPUT VOLTAGE IS REQUIRED FOR 5V UNITS.

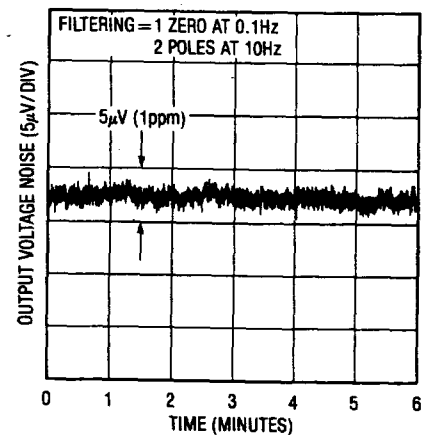
Load Transient Response LT1021-5, CLOAD = 0



Load Transient Response LT1021-5, CLOAD = 1000pF

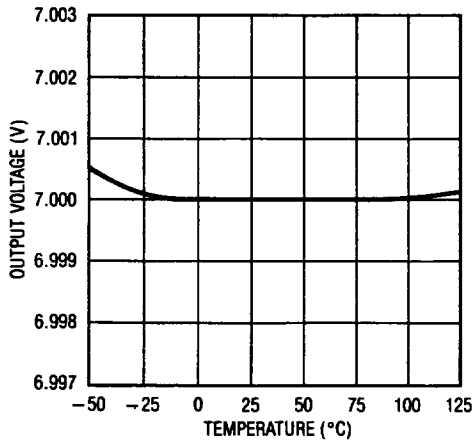


Output Noise 0.1Hz to 10Hz LT1021-5

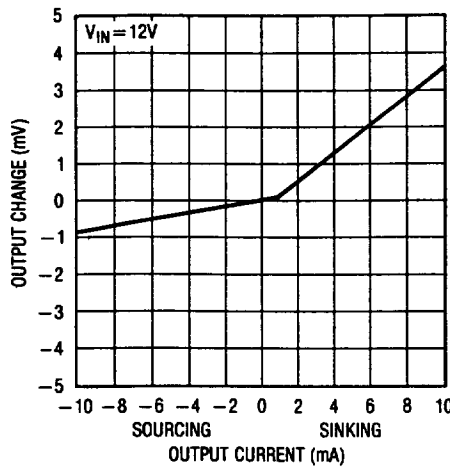


TYPICAL PERFORMANCE CHARACTERISTICS

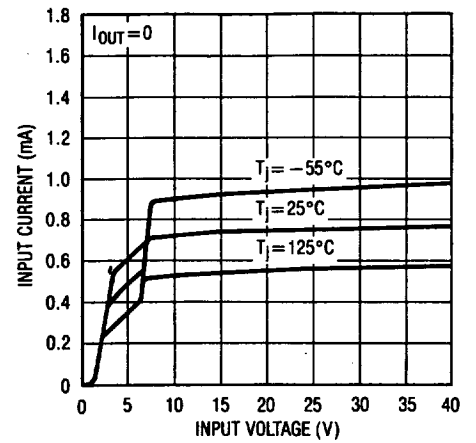
Output Voltage Temperature Drift LT1021-7



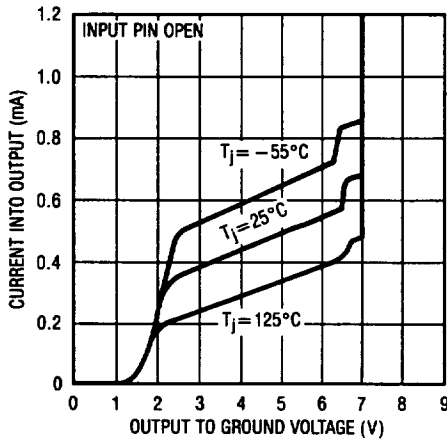
Load Regulation LT1021-7, 10



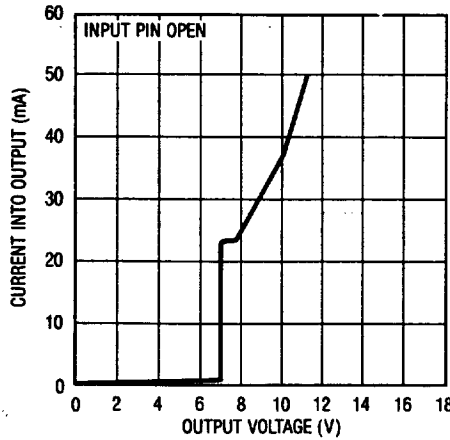
Quiescent Current LT1021-7



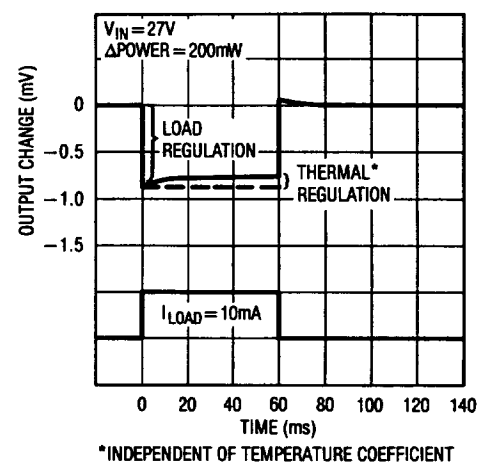
Shunt Characteristics LT1021-7



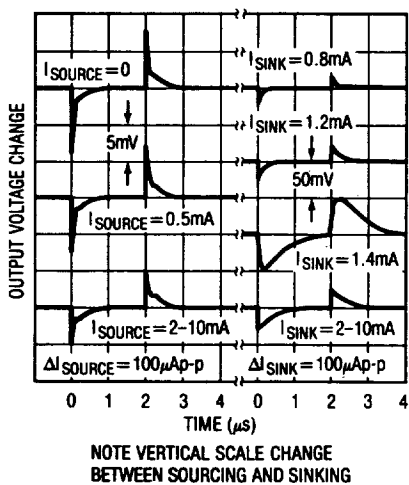
Shunt Mode Current Limit LT1021-7



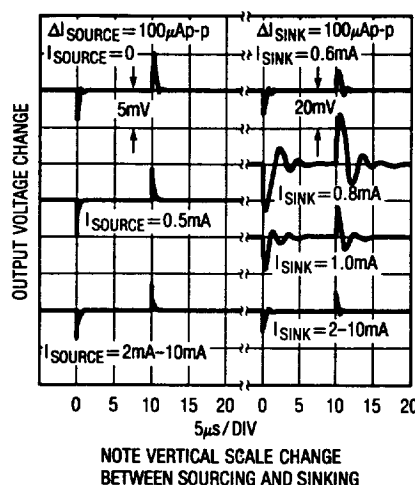
Thermal Regulation LT1021-7



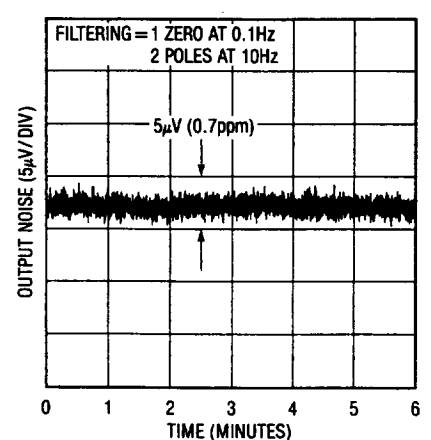
Load Transient Response LT1021-7, CLOAD = 0



Load Transient Response LT1021-7, CLOAD = 1000pF

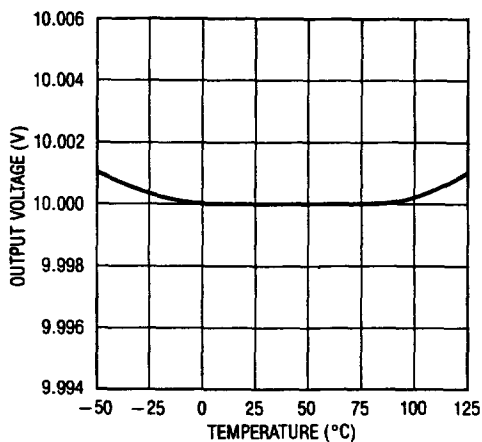


Output Noise 0.1Hz to 10Hz LT1021-7

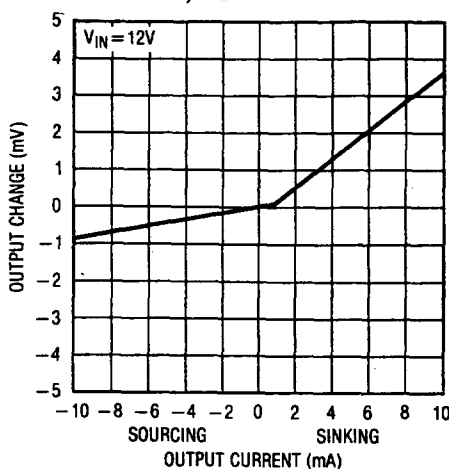


TYPICAL PERFORMANCE CHARACTERISTICS

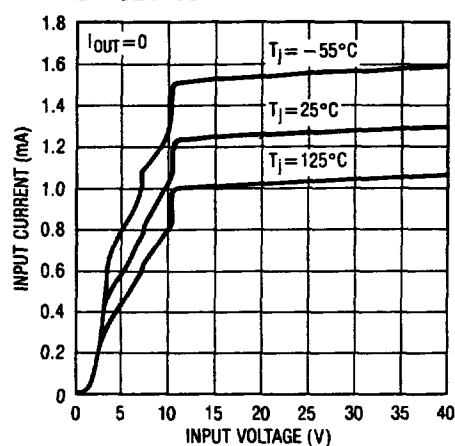
Output Voltage Temperature Drift LT1021-10



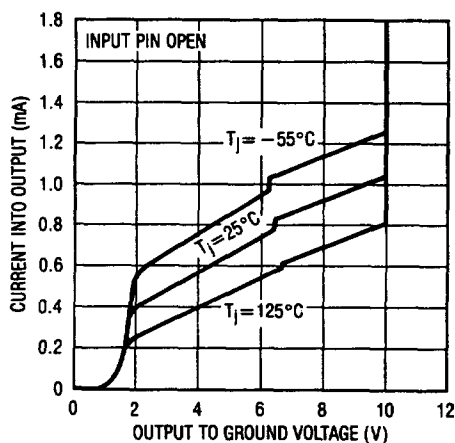
Load Regulation LT1021-7, 10



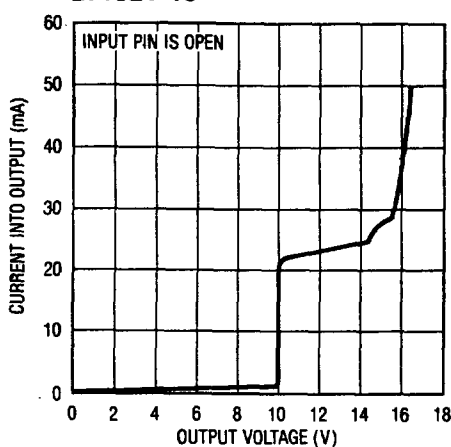
Input Supply Current LT1021-10



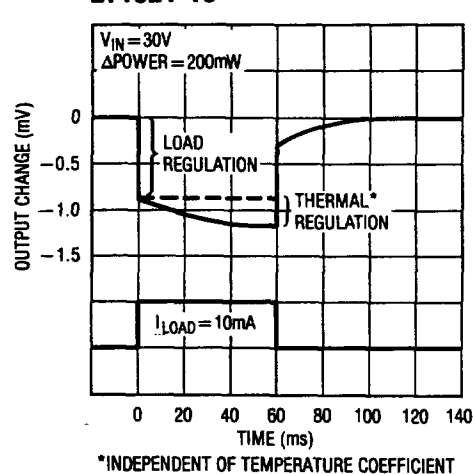
Shunt Characteristics LT1021-10



Shunt Mode Current Limit LT1021-10

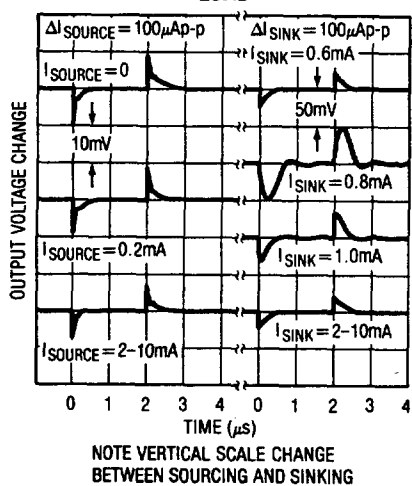


Thermal Regulation LT1021-10

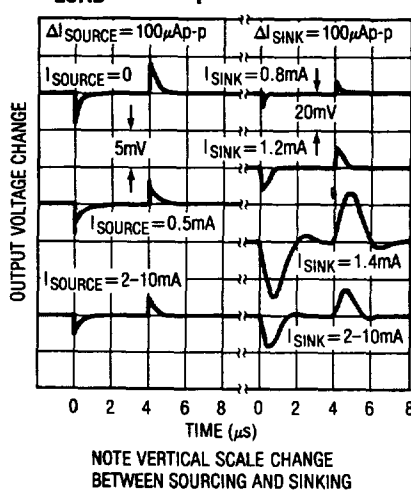


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Load Transient Response LT1021-10, CLOAD = 0



Load Transient Response LT1021-10, CLOAD = 1000pF



Output Noise 0.1Hz to 10Hz LT1021-10

