Dual Precision Operational Amplifier

DESCRIPTION

The RH1013M is the first precision dual operational amplifier which directly upgrades designs in the industry standard 8-pin DIP LM158/MC1558/OP-221 pin configuration. Low offset voltage (300µV max), low drift (≤2.5µV/°C), low offset current (≤1.5nA), and high gain (1.2 million min) combine to make the RH1013M two truly precision amplifers in one package.

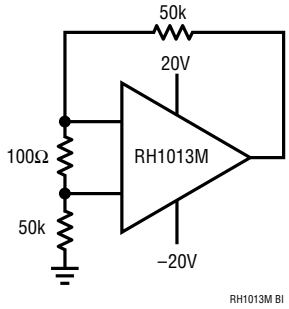
The wafer lots are processed to Linear Technology's in-house Class S flow to yield circuits usable in stringent military applications.

ABSOLUTE MAXIMUM RATINGS

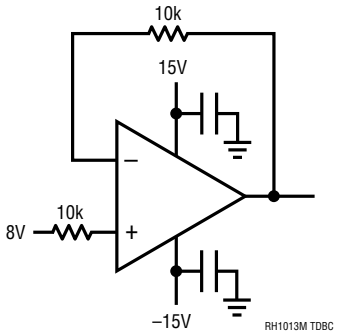
Supply Voltage ..... ±22V
Differential Input Voltage ..... ±30V
Input Voltage ..... Equal to Positive Supply Voltage
..... 5V Below Negative Supply Voltage
Output Short-Circuit Duration ..... Indefinite
Operating Temperature Range ..... –55°C to 125°C
Storage Temperature Range ..... –65°C to 150°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

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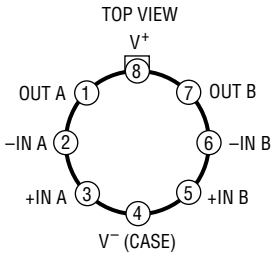
BURN-IN CIRCUIT



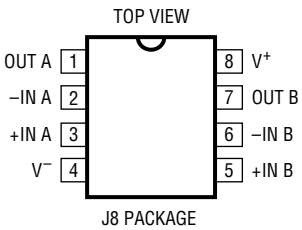
TOTAL DOSE BIAS CIRCUIT



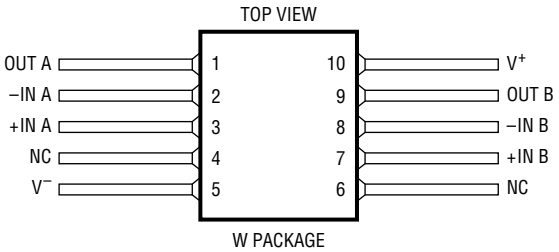
PACKAGE/ORDER INFORMATION



H PACKAGE
8-LEAD TO-5 METAL CAN



J8 PACKAGE
8-LEAD CERAMIC DIP



W PACKAGE
10-LEAD CERPAC

TABLE 1: ELECTRICAL CHARACTERISTICS (Pre-Irradiation)

V_S = ±15V, V_{CM} = 0V, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	NOTES	T_A = 25°C MIN	TYP	MAX	SUB-GROUP	−55°C ≤ T_A ≤ 125°C MIN	TYP	MAX	SUB-GROUP	UNITS
V_{OS}	Input Offset Voltage					300	1			550	2,3	µV
			2			450	1			750	3	µV
		V_{CM} = 0.1V								750	2	µV
$\frac{\Delta V_{OS}}{\Delta Temp}$	Average Tempco of Offset Voltage		1							2.5		µV/°C
$\frac{\Delta V_{OS}}{\Delta Time}$	Long Term V_{OS} Stability				0.5							µV/Mo
I_{OS}	Input Offset Current					10	1			20	2,3	nA
			2			10	1			20	2,3	nA
I_B	Input Bias Current					30	1			45	2,3	nA
			2			50	1			120	2,3	nA
e_n	Input Noise Voltage	0.1Hz to 10Hz			0.55							μV_{P-P}
	Input Noise Voltage	f_O = 10Hz			24							nV/√Hz
	Density	f_O = 1000Hz			22							nV/√Hz
i_n	Input Noise Current Density	f_O = 10Hz			0.07							pA/√Hz
R_{IN}	Input Resistance	Differential	1	70								MΩ
		Common Mode			4							GΩ
A_{VOL}	Large-Signal Voltage Gain	V_O = ±10V, R_L ≥ 2k		1.2			4	0.25			5,6	V/µV
		V_O = ±10V, R_L ≥ 600Ω		0.5			4					V/µV
		V_O = 5mV to 4V, R_L = 500Ω	2		1							V/µV
	Input Voltage Range		1	13.5								V
			1	–15.0								V
			1,2	3.5								V
			1,2	0								V
CMRR	Common-Mode Rejection	V_{CM} = 13.5V, –15V		97			1					dB
	Ratio	V_{CM} = 13V, –14.9V						94			2,3	dB
PSRR	Power Supply Rejection Ratio	V_S = ±2V to ±18V		100			1	97			2,3	dB
	Channel Separation	V_O = ±10V, R_L = 2k		120			1					dB
V_{OUT}	Output Voltage Swing	R_L ≥ 2k		±12.5			4	±11.5			5,6	V
		Output Low, No Load	2			25	4					mV
		Output Low, 600Ω to GND	2			10	4			18	5,6	mV
		Output Low, I_{SINK} = 1mA	2			350	4					mV
		Output High, No Load	2	4.0			4					V
		Output High, 600Ω to GND	2	3.4			4	3.1			5,6	V
SR	Slew Rate			0.2			4					V/µs
I_S	Supply Current	Per Amplifier				0.55	1			0.70	2,3	mA
			2			0.50	1			0.65	2,3	mA

TABLE 1A: ELECTRICAL CHARACTERISTICS (Post-Irradiation)

V_S = ±15V, V_{CM} = 0V, T_A = 25°C, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	NOTES	10KRAD(Si) MIN	10KRAD(Si) MAX	20KRAD(Si) MIN	20KRAD(Si) MAX	50KRAD(Si) MIN	50KRAD(Si) MAX	100KRAD(Si) MIN	100KRAD(Si) MAX	200KRAD(Si) MIN	200KRAD(Si) MAX	UNITS
V_{OS}	Input Ofset Voltage				450		450		600		750		900	µV
			2		600		600		750		900			µV
I_{OS}	Input Offset Current				10		10		15		20		25	nA
			2		10		10		15		20			nA
I_B	Input Bias Current				60		75		100		175		250	nA
			2		80		100		125		200			nA
	Input Voltage Range		1	13.5		13.5		13.5		13.5		13.5		V
			1	–15.0		–15.0		–15.0		–15.0		–15.0		V
			2	3.5		3.5		3.5		3.5				V
			2	0		0		0		0				V
CMRR	Common-Mode Rejection Ratio	V_{CM} = 13V, – 15V		97		97		94		90		86		dB
PSRR	Power Supply Rejection Ratio	V_S = ±10V to ±18V		100		98		94		86		80		dB
A_{VOL}	Large-Signal Voltage Gain	R_L ≥ 10k, V_O = ±10V		500		200		100		50		25		V/mV
V_{OUT}	Maximum Output Voltage	R_L ≥ 10k		±12.5		±12.5		±12.5		±12.5		±12.5		V
	Swing	Output Low, No Load	2		25		30		40		50			mV
		Output Low, 600Ω to GND	2		10		10		10		10			mV
		Output Low, I_{SINK} = 1mA	2		0.6		0.8		1.0		1.6			V
		Output High, No Load	2	4.0		4.0		4.0		4.0				V
		Output High, 600Ω to GND	2	3.4		3.2		3.0		2.8				V
SR	Slew Rate	R_L ≥ 10k		0.13		0.12		0.11		0.07		0.01		V/µs
I_S	Supply Current	Per Amplifier			0.55		0.55		0.55		0.55		0.55	mA
			2		0.50		0.50		0.50		0.50			mA

Note 1: Guaranteed by design, characterization, or correlation to other tested parameters..

Note 2: Specification applies for V_S^+ = 5V, V_S^- = 0V, V_{CM} = 0V, V_{OUT} = 1.4V.

TABLE 2: ELECTRICAL TEST REQUIREMENTS

MIL-STD-883 TEST REQUIREMENTS	SUBGROUP
Final Electrical Test Requirements (Method 5004)	1*,2,3,4,5,6
Group A Test Requirements (Method 5005)	1,2,3,4,5,6
Group B and D for Class S, and Group C and D for Class B End Point Electrical Parameters (Method 5005)	1,2,3

* PDA applies to subgroup 1. See PDA Test Notes.

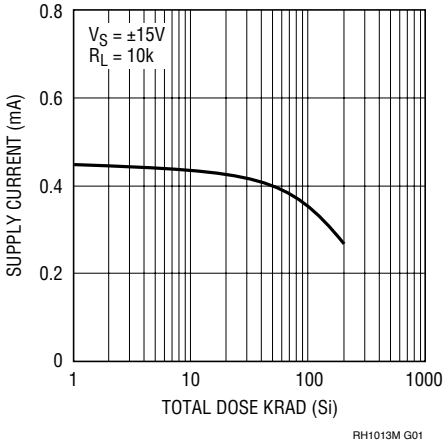
PDA Test Notes

The PDA is specified as 5% based on failures from group A, subgroup 1, tests after cooldown as the final electrical test in accordance with method 5004 of MIL-STD-883. The verified failures of group A, subgroup 1, after burn-in divided by the total number of devices submitted for burn-in in that lot shall be used to determine the percent for the lot.

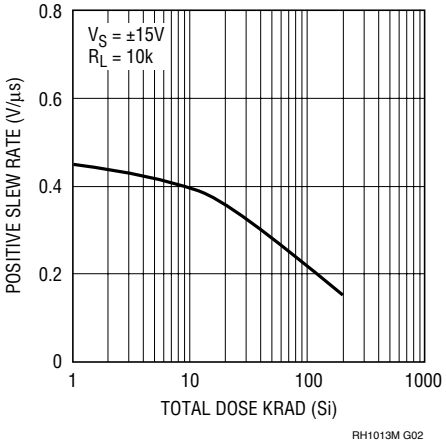
Linear Technology Corporation reserves the right to test to tighter limits than those given.

TYPICAL PERFORMANCE CHARACTERISTICS

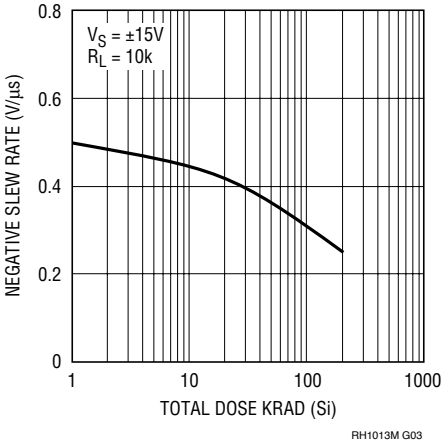
Supply Current (Per Amplifier)



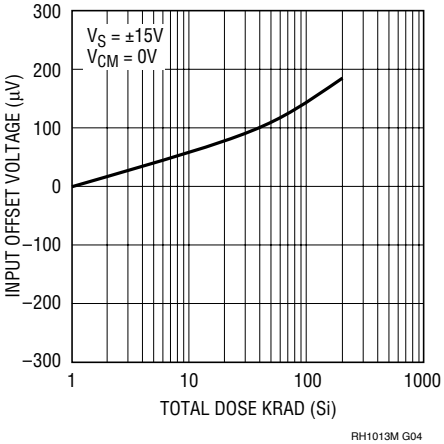
Positive Slew Rate



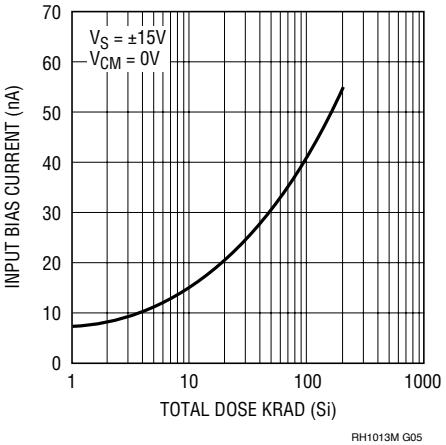
Negative Slew Rate



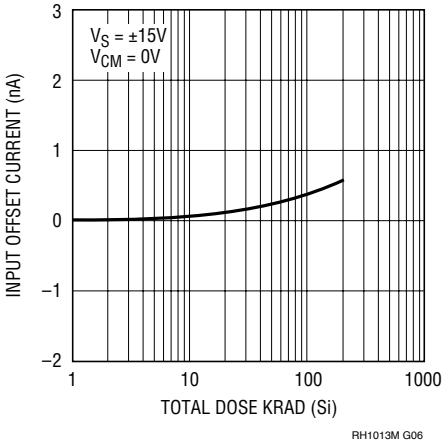
Input Offset Voltage



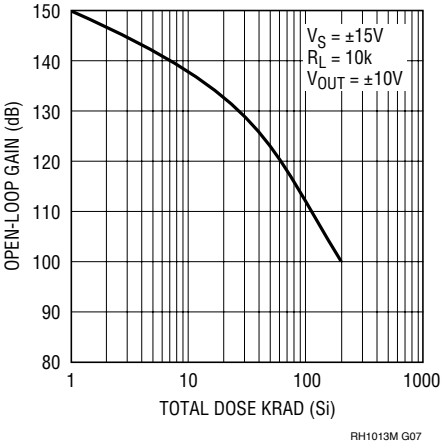
Input Bias Current



Input Offset Current

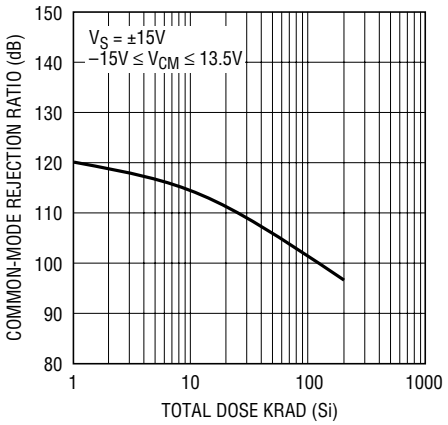


Open-Loop Gain

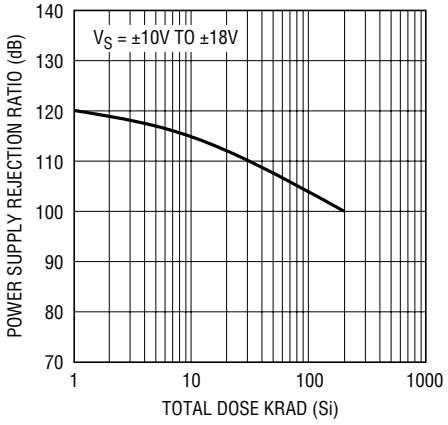


TYPICAL PERFORMANCE CHARACTERISTICS

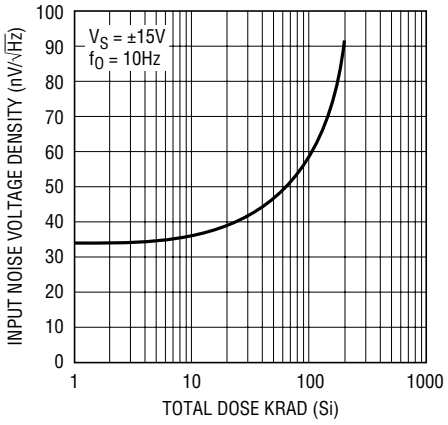
Common-Mode Rejection Ratio



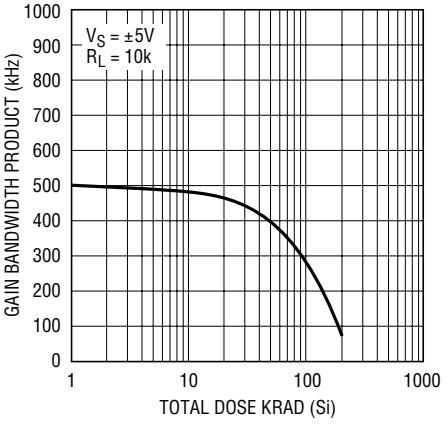
Power Supply Rejection Ratio



Input Noise Voltage Density



Gain Bandwidth Product



LINEAR TECHNOLOGY

Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.

Rad Hard

This table provides example specifications for our Rad Hard products. For complete Rad Hard data sheets, contact 1-800-4-LINEAR.

DEVICE	SYMBOL	CONDITIONS	10Krad (Si) MIN	10Krad (Si) MAX	20Krad (Si) MIN	20Krad (Si) MAX	50Krad (Si) MIN	50Krad (Si) MAX	80Krad (Si) MIN	80Krad (Si) MAX	100Krad (Si) MIN	100Krad (Si) MAX	200Krad (Si) MIN	200Krad (Si) MAX	UNITS	PACKAGE OPTIONS
RH07	V_{OS} I_{OS}			90 2.8		150 4		200 8				250 12		300 20	µV nA	J8, H
RH27C	V_{OS} I_{OS}			100 75		130 75		180 90				280 120		400 180	µV nA	H, W
RH37C	V_{OS} I_{OS}			100 75		130 75		180 90				280 120		400 180	µV nA	H, W
RH101A	V_{OS} I_{OS}			2 10		2 10		2 10				2 10		3 20	mV nA	H, W
RH108A	V_{OS} I_{OS}			0.5 0.2		0.5 0.2		0.5 0.2		1.0 0.2					mV nA	H, W
RH117	V_{REF}	$3V \le (V_{IN} - V_{OUT}) \le 40V$ $10mA \le I_{OUT} \le I_{MAX}$, $P \le P_{MAX}$	1.20	1.30	1.20	1.30	1.20	1.30			1.20	1.30			V	H, K
RH118	V_{OS} SR	$V_S = \pm15V$, $A_V = 1$	50	4	50	4	50	4			50	4	50	10	mV V/µs	H, W
RH119	V_{OS} I_{OS}			4 75		4 100		4 150				4 300		8 500	mV nA	H, J, W
RH129	V_Z $\Delta V_Z/\Delta TEMP$	 RH129A RH129B RH129C	6.7	7.2 10 20 50	6.7	7.2 10 20 50	6.7	7.2 10 20 50			6.7	7.2 15 25 55	6.7	7.2 20 30 60	V ppm/°C ppm/°C ppm/°C	H
RH137	V_{REF}	$\lvert V_{IN} - V_{OUT} \rvert \le 5V$, $I_{OUT} = 10mA$ $3V \le \lvert V_{IN} - V_{OUT} \rvert \le 40\ V$ $10mA \le I_{OUT} \le I_{MAX}$, $P \le P_{MAX}$	–1.225 –1.2	–1.275 –1.3	–1.225 –1.2	–1.275 –1.3	–1.225 –1.2	–1.275 –1.3			–1.225 –1.2	–1.275 –1.3	–1.22 –1.2	–1.23 –1.3	V V	K, H
RH1009	V_Z $\Delta V_Z/\Delta I_Z$		2.495	2.505 6	2.495	2.505 6	2.495	2.505 8			2.495	2.505 10	2.495	2.505 12	V mV	H
RH1011	V_{OS} I_{OS}			1.5 4		1.5 4		1.5 4				1.5 20		2 50	mV nA	H, J8, W
RH1013	V_{OS} I_{OS}			450 10		450 10		600 15				750 20		900 25	µV nA	H, J8, W
RH1014	V_{OS} I_{OS}			450 10		450 10		600 15				750 20		900 25	µV nA	J, W
RH1021-5	V_{OUT} TCV_{OUT}	RH1021CM-5 RH1021BM-5, DM-5 RH1021BM-5 RH1021CM-5, DM-5	4.9975 4.95	5.0025 5.05 5 20	4.995 4.945	5.005 5.055 5 20	4.993 4.942	5.007 5.058 5 20			4.9925 4.94	5.008 5.06 7 22	4.99 4.935	5.01 5.065 10 25	V V ppm/°C ppm/°C	H
RH1021-7	V_{OUT} TCV_{OUT}	 RH1021BM-7 RH1021DM-7	6.95	7.05 5 20	6.95	7.05 5 20	6.95	7.05 5 20			6.94	7.06 7 22	6.93	7.07 10 25	V ppm/°C ppm/°C	H
RH1021-10	V_{OUT} TCV_{OUT}	RH1021CM-10 RH1021BM-10, DM-10 RH1021BM-10 RH1021CM-10, DM-10	9.995 9.95	10.005 10.05 5 20	9.99 9.945	10.01 10.055 5 20	9.987 9.942	10.013 10.06 5 20			9.985 9.98	10.015 10.06 7 22	9.98 9.935	10.02 10.065 10 25	V V ppm/°C ppm/°C	H
RH1056A	V_{OS} I_{OS}			180 ±10		180 ±50		250 ±150				450 ±250		450 ±350	µV pA	H, W
RH1078	V_{OS}			350		500		650	75k	800		1000			µV	H, J8, W
	I_{OS}			2		18		13	75k	18		23			nA	J, W
RH1086	V_{REF} Dropout V	$I_{OUT} = 10mA$ $10mA \le I_{OUT} \le I_{FULL\ LOAD}$ $1.5V \le (V_{IN} - V_{OUT}) \le 15V$ $\Delta V_{REF} = 1\%$, $I_{OUT} = 1.5A$ (K) $\Delta V_{REF} = 1\%$, $I_{OUT} = 0.5A$ (H)		1.258 1.271 1.5		1.257 1.269 1.51		1.253 1.265 1.52				1.247 1.260 1.55		1.241 1.253 1.575	V V V	H, K

I.D. No. 66-11-1013 Rev. E 0103

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