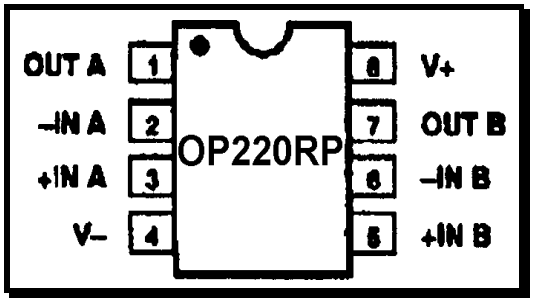
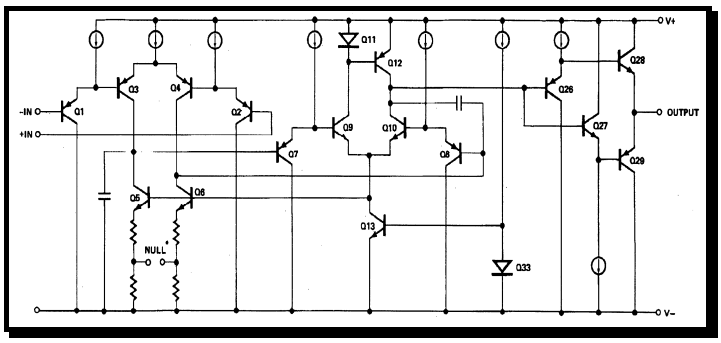
Preliminary

SEi - Radiation Hardened **OP220RP**

Dual Micropower Operational Amplifier





Features:

- RAD-PAK® technology hardened against natural space radiation
- Total dose hardness typical 100 krad (Si); dependent upon orbit
- Package:
  -8 pin RAD-PAK® flat pack
  -TO-99
- Excellent TCV_{OS} match
  - 21µV/°C max
- Low input offset voltage: 150µV max
- Low supply current: 100µA
- High PSRR = 3µV/V.
- Single-supply operation:
  - +5V to +30V
- Low input offset voltage drift:
  - 0.75µV/°C
- High open-loop gain:
  - 2000V/mV
- Low input bias current: 12 na
- Wide common-mode voltage range:
  - V- to within 1.5V of V+

SEi's OP220RP (RP for RAD-PAK®) monolithic dual operational amplifier microcircuit features a typical 100 kilorad (Si) total dose tolerance; dependent upon orbit. The OP220RP can be used either in single or dual supply operation. The OP220RP is this the first micropower precision dual operational amplifier. Individual amplifier features tight matching and temperature tracking between channels which provides high performance in instrumentation amplifier designs. It has extremely low input offset voltage drift, low noise voltage, and low bias current. The OP220RP is compensated and protected. Capable of surviving space environments, the OP220RP is ideal for satellite, spacecraft, and space probe missions. The patented radiation-hardened RAD-PAK® technology incorporates radiation shielding in the microcircuit package. It eliminates box shielding while providing required lifetime in orbit. This product is available with packaging and screening up to Class S.

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OP220RP ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Supply Voltage	V_{CC}	18	18	V
Differential Input Voltage			30	V
Input Voltage				Supply Voltage
Output Short-Circuit Duration				Indefinite
Storage Temperature Range	T_S	65	150	°C
Operating Temperature Range	T_A	55	125	°C

Note:
1. Absolute ratings apply to both DICE and packaged parts, unless otherwise noted.

OP220RP ELECTRICAL CHARACTERISTICS
at V_S=±2.5V to ±15V, T_A=+25°C, unless otherwise noted.

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
Input Offset Voltage	V_S=±2.5V to ±15V	V_{OS}		120	150	µV
Input Offset Current	V_{CM}=0	I_{OS}		0.15	1.5	nA
Input Bias Current	V_{CM}=0	I_B		12	20	nA
Input Voltage Range	V+=5V, V-=0V, V_S=±15V	IVR	0/3.5 -15/13.5			V
Common-Mode Rejection Ratio	V+=5V, V-=0V, 0V≤V_{CM}≤3.5V V_S=±15V, -15V≤V_{CM}≤13.5V	CMRR	90 95	100 100		dB
Power Supply Rejection Ratio	V_S=±2.5V to ±15V V-=0V, V+=5V to 30V	PSRR		3 6	10 18	µV/V
Large-Signal Voltgae Gain	V+=5V, V-=0V, R_L=100kΩ 1V≤V_O≤3.5V V_S=±15V, R_L=25kΩ V_O=±10V	A_{VO}	500 1000	1000 2000		V/mV
Output Voltage Swing	V+=5V, V-=0V R_L=10kΩ V_S=±15V, R_l =25kΩ	V_O	0.7/4 ±14			V
Slew Rate	R_L =25kΩ, (Note 1)	SR		0.05		V/µs
Bandwidth	A_{VCL}=+1, R_L=25kΩ	BW		200		kHz
Supply Current (Both Amplifiers)	V_S=±2.5V, No Load V_S=±15V, No Load	I_{SY}		100 140	115 170	µA

Matching Characteristics
at V_S=±15V, T_A=25°C, unless otherwise noted.

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
Input Offset Voltage Match		ΔVOS		150	300	µV
Average Noninverting Bias Current	V_{CM}=0	IB+		10	20	nA
Noninverting Offset Current	V_{CM}=0	IOS+		0.7	1.5	nA
Common-Mode Rejection Ratio Match (Note 1)	V_{CM}=-15V to +13.5V	ΔCMRR	92	100		dB
Power Supply Rejection Ratio Match (Note 2)	V_S=±2.5V to ±15V	ΔPSRR		6	14	µV/V

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OP220RP ELECTRICAL CHARACTERISTICS
at V_S=±2.5V to ±15V, -55°C≤T_A≤+125°C for OP220A

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
Average Input Offset Voltage Drift (Note 1)	V_S=±15V	TCV_{OS}		0.75	1.5	µV/°C
Input Offset Voltage		V_{OS}		200	300	µV
Input Offset Current	V_{CM}=0	I_{OS}		0.5	2	nA
Input Bias Current	V_{CM}=0	I_B		12	25	nA
Input Voltage Range	V+=5V, V-=0V, V_S=±15V	IVR	0/3.2 -15/13.2			V
Common-Mode Rejection Ratio	V+=5V, V-=0V, 0V≤V_{CM}≤3.2V V_S=±15V, -15V≤V_{CM}≤13.2V	CMRR	85 90	90 95		dB
Power Supply Rejection Ratio	V_S=±2.5V to ±15V V-=0V, V+=5V to 30V	PSRR		6 10	18 32	µV/V
Large-Signal Voltage Gain	V_S=±15V, R_L=50kΩ V_O=±10V	A_{VO}	500	1000		V/mV
Output Voltage Swing	V+=5V, V-=0V R_L=20kΩ V_S=±15V, R_L=50kΩ	V_O	0.9/3.8 ±13.8			V
Supply Current (Both Amplifiers)	V_S=±2.5V, No Load V_S=±15V, No Load	I_{SY}		135 190	170 250	µA

Notes:
1. Sample tested.

Matching Characteristics
at V_S=±15V, -55°C≤T_A≤+125°C for OP220A

PARAMETER	CONDITIONS	SYMBOL	MIN	TYP	MAX	UNIT
Input Offset Voltage Match		ΔVOS		250	500	µV
Input Offset Voltage Tracking	(Note 3)	TCΔVOS		1	2	µV/°C
Average Noninverting Bias Current	V_{CM}=0	IB+		10	25	nA
Average Drift of Noninverting Bias Current	V_{CM}=0 (Note 3)	TCIB+		15	25	pA/°C
Noninverting Offset Current	V_{CM}=0	IOS+		0.7	2	nA
Average Drift of Noninverting Offset Current	V_{CM}=0 (Note 3)	TCIOS+		7	15	pA/°C
Common-Mode Rejection Ratio Match (Note 1)	V_{CM}=-15V to +13V	ΔCMRR	87	98		dB
Power Supply Rejection Ratio Match (Note 2)	V_S=±2.5V to ±15V	ΔPSRR		10	26	µV/V

Notes:
1. ΔCMRR is 20 $\log_{10}$ V_{CM}/ΔCME, where V_{CM} is the voltage applied to both noninverting inputs and ΔCME is the difference in common-mode input-referred error.
2. ΔPSRR is Input-referred differential error / ΔV_S
3. Sample tested.

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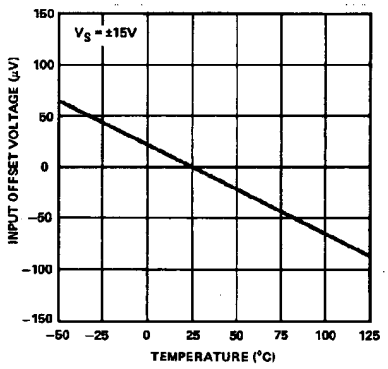
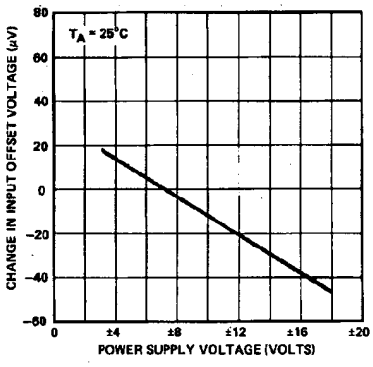
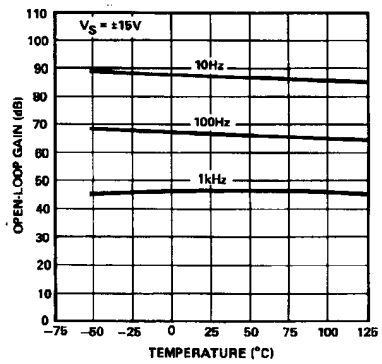
NORMALIZED OFFSET VOLTAGE vs TEMPERATURE



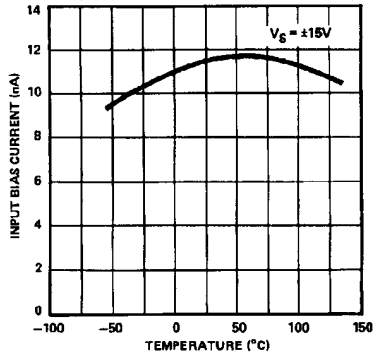
INPUT OFFSET VOLTAGE vs POWER SUPPLY VOLTAGE



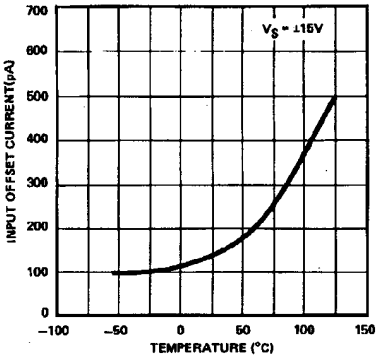
OPEN-LOOP GAIN vs TEMPERATURE



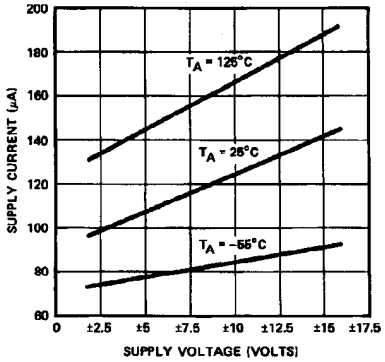
INPUT BIAS CURRENT vs TEMPERATURE



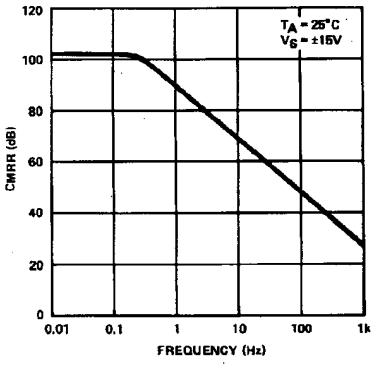
INPUT OFFSET CURRENT vs TEMPERATURE



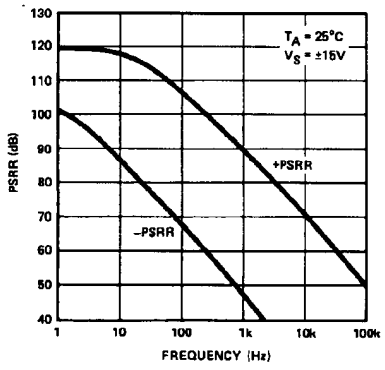
SUPPLY CURRENT vs SUPPLY VOLTAGE



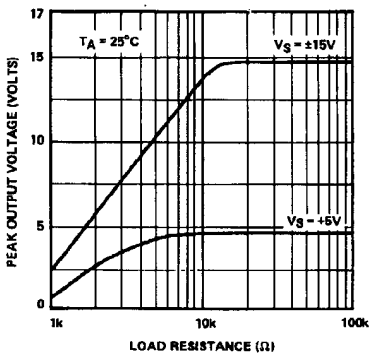
CMMR vs FREQUENCY



PSRR vs FREQUENCY



MAXIMUM OUTPUT VOLTAGE vs LOAD RESISTANCE



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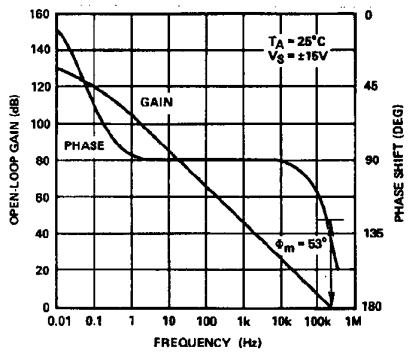
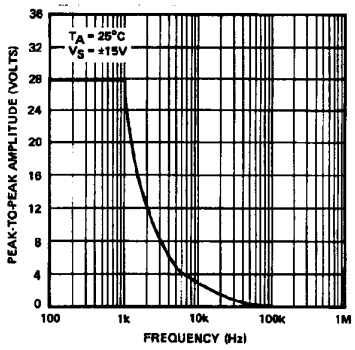
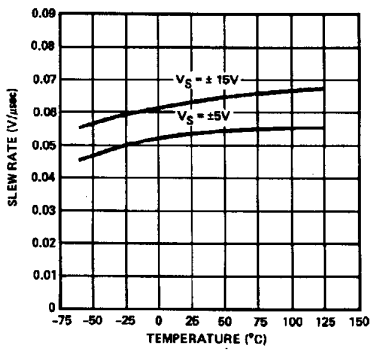
OPEN-LOOP VOLTAGE GAIN AND PHASE vs FREQUENCY



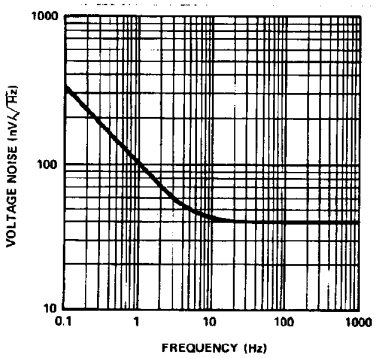
MAXIMUM OUTPUT SWING vs FREQUENCY



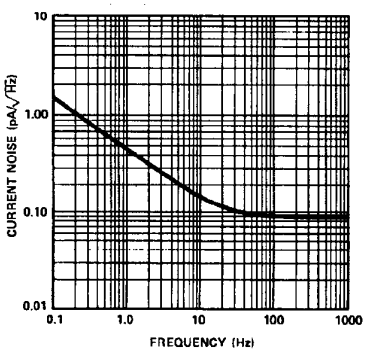
SLEW RATE vs TEMPERATURE



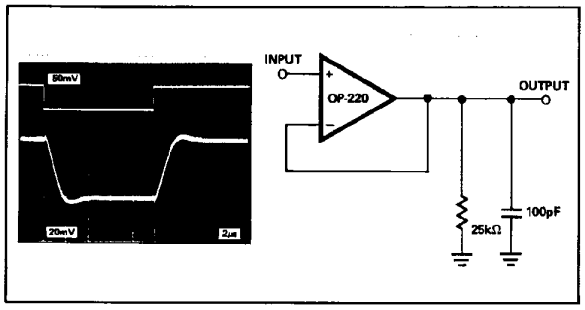
VOLTAGE NOISE DENSITY (e_n) vs FREQUENCY



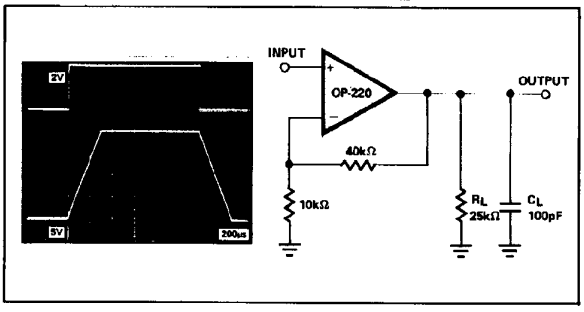
CURRENT NOISE DENSITY (i_n) vs FREQUENCY



SMALL-SIGNAL TRANSIENT RESPONSE



LARGE-SIGNAL TRANSIENT RESPONSE



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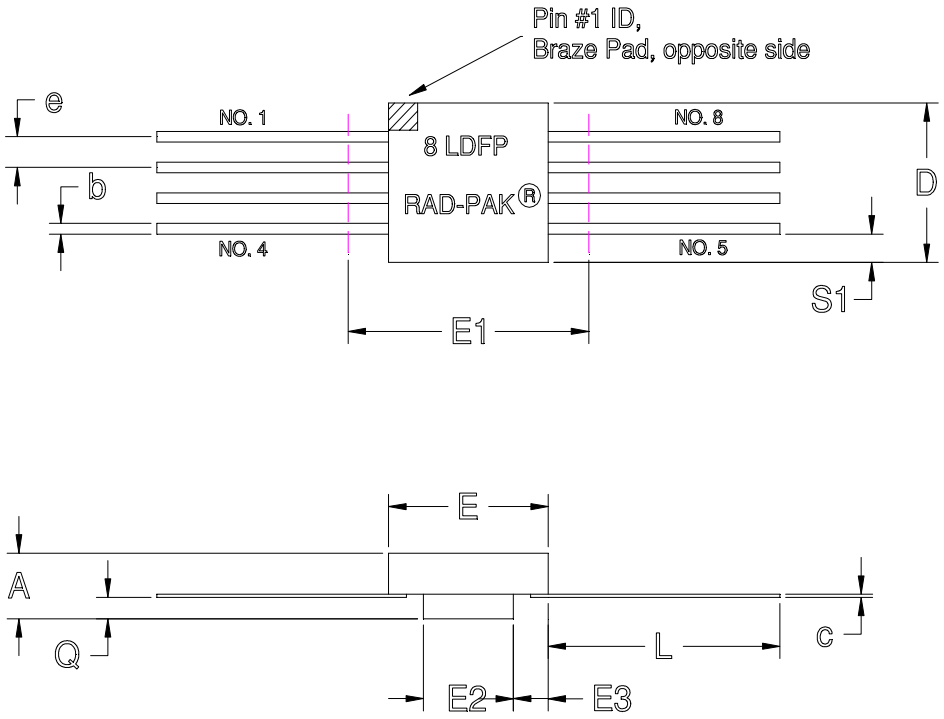

8 Pin RAD-PAK® Flat Package

SYMBOL	DIMENSION		
	MIN	NOM	MAX
A	0.119	0.132	0.145
b	0.010	0.017	0.022
c	0.004	0.005	0.009
D	0.250	0.255	0.260
E	0.250	0.255	0.260
E1	--	--	0.290
E2	0.125	0.175	--
E3	0.030	0.040	--
e	0.050 BSC		
L	0.338	0.348	0.358
Q	0.021	0.025	0.045
S1	0.005	0.019	--
N	8		

F8-01

Note: All dimensions in inches.

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