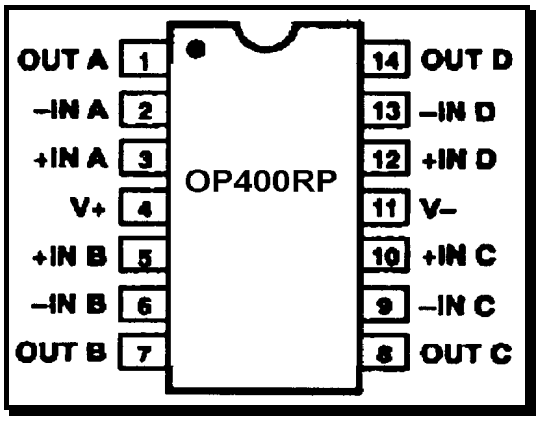
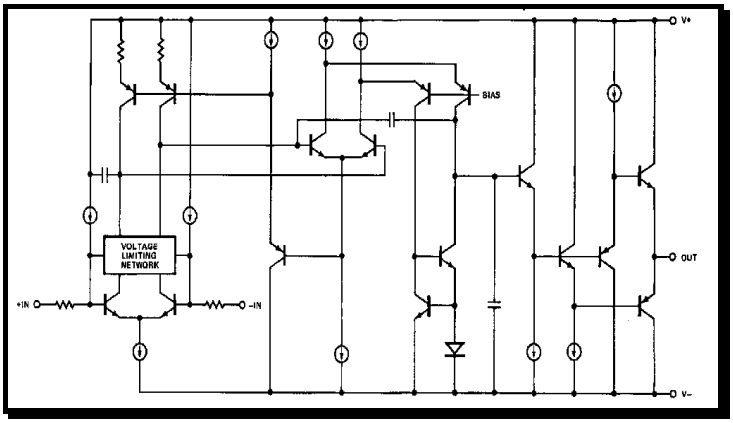
Preliminary

SEi - Radiation-Hardened **OP400RP**

Quad Low-Offset, Low-Power Operational Amplifier





Features:

- •RAD-PAK® technology-hardened against natural space radiation
- •Total dose hardness typical >100 krad (Si); dependent upon orbit
- •Package:
  - 14 pin RAD-PAK® flat package
  - 28 pin RAD-PAK® quad flat package
- • Low input offset voltage 150µV max
- • Low offset voltage drift
  - +1.2µV/°C max (over -55°C to +125°C)
- •Low supply current (per amplifier) 725µA max
- •High open-loop gain 5000V/mV min
- •Input bias current 3nA Max
- •Low noise voltage density 11nV per $\sqrt{Hz}$ at 1 kHz
- •Stable with large capacitive loads 10nF typ

SEi's OP400RP (RP for RAD-PAK®) monolithic quad operational amplifier microcircuit features a 100 kilorad (Si) typical total dose tolerance; dependent upon orbit. Using SEi's radiation-hardened RAD-PAK® packaging technology, the OP400RP has an extremely low input offset voltage no less than 150µV with a drift of under 1.2µV/°C, guaranteed over the full military temperature range. The OP400RP features low power consumption, drawing less than 725µA per amplifier. Capable of surviving space environments, the OP400RP 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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OP400RP ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Supply Voltage	V_{CC}		±20	V
Differential Input Voltage			±30	V
Input Voltage				Supply Voltage
Output Short-Circuit Duration				Continuous
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.

OP400RP ELECTRICAL CHARACTERISTICS
(V_S = ±15v, T_A = +25°C, unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
input Offset Voltage	V_{OS}	---	---	40	150	µV
Long Term Input Voltage Stability	---	---	---	0.1	---	µV/mo
Input Offset Current	I_{OS}	V_{CM} = 0V	---	0.1	1.0	nA
Input Bias Current	I_B	V_{CM} = 0V	---	0.75	3.0	nA
Input Noise Voltage	$e_{n\ p-p}$	0.1Hz to 10Hz	---	0.5	---	μV_{p-p}
Input Noise Voltage Density	e_n	f_O = 10Hz 1/ f_O = 1KHz 1/	--- ---	22 11	36 18	nV/$\sqrt{Hz}$
Input Noise Current	$i_{n\ p-p}$	0.1Hz to 10Hz	---	15	---	pA_{p-p}
Input Noise Current Density	in	f_O = 10Hz	---	0.6	---	pA/$\sqrt{Hz}$
Input Resistance Differential Mode	R_{IN}	---	---	10	---	MΩ
Input Resistance Common Mode	R_{INCM}	---	---	200	---	GΩ
Large Signal Voltage Gain	A_{VO}	V_O = ±10V R_L = 10kΩ R_L = 2kΩ	5000 2000	12000 3500	---	V/mV
Input Voltage Range	IVR	3/	±12	±13	---	v
Common Mode Rejection	CMR	V_{CM} = ±12V	120	140	---	dB
Power Supply Rejection Ratio	PSRR	V_S = ±3V to ±18V	---	0.1	1.8	µV/V
Output Voltage Swing	V_O	R_L = 10kΩ R_L = 2kΩ	±12 ±11	±12.6 ±12.2	---	V
Supply Current Per Amplifier	I_{SY}	No Load	---	600	725	µA
Slew Rate	SR	---	0.1	0.15	---	V/µs
Gain Bandwidth Product	GBWP	A_V = +1	---	500	---	kHz
Channel Separation	CS	V_O = 20V_{p-p} f_O = 10Hz 2/	123	135	---	dB
Input Capacitance	C_{IN}	---	---	3.2	---	pF
Capacitive Load Stability		A_V = +1 No Oscillations	---	10	---	nF

Notes:
1/ Sample tested.
2/ Guaranteed but not 100% tested.
3/ Guaranteed by CMR test.

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OP400RP ELECTRICAL CHARACTERISTICS

(V_S = ±15V, -55°C ≤ T_A ≤ 125°C unless otherwise specified.)

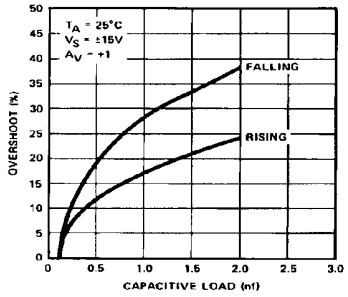
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNIT
Input Offset Voltage	V_{OS}	---	---	70	270	µV
Average Input Offset Voltage Drift	TCV_{OS}		---	0.3	1.2	µV/°C
Input Offset Current	I_{OS}	V_{CM} =0V	---	0.1	2.5	nA
Input Bias Current	I_B	V_{CM} =0V	---	1.3	5.0	nA
Large Signal Voltage Gain	A_{VO}	V_O = ± 10V R_L = 10kΩ R_L =2kΩ	3000 1000	9000 2300	--- ---	V/mV
Input Voltage Range	IVR	(Note 1)	±12	±12.5	---	V
Common Mode Rejection	CMR	V_{CM} = ±12V	115	130	---	dB
Power Supply Rejection Ratio	PSRR	V_S = ± 3V to ± 18V	---	0.2	3.2	µV/V
Output Voltage Swing	V_O	R_L =10kΩ R_L =2kΩ	±12 ± 11	±12.4 ±12	---	V
Supply Current Per Amplifier	I_{SY}	No Load	----	600	775	µA
Capacitive Load Stability		A_V =+1 No Oscillations	---	8	---	nF

Notes:

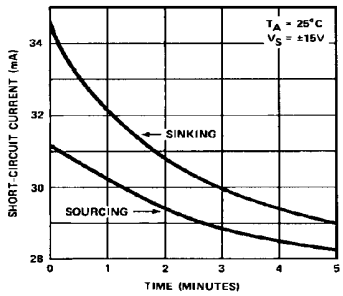
1. Guaranteed by design.

OP400RP TYPICAL PERFORMANCE CHARACTERISTICS

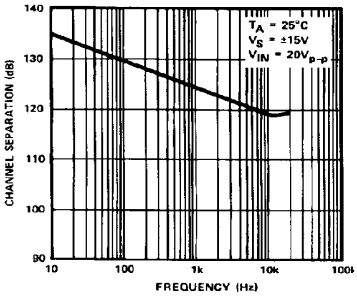
OVERSHOOT vs CAPACITIVE LOAD



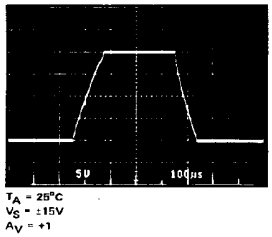
SHORT-CIRCUIT CURRENT vs TIME



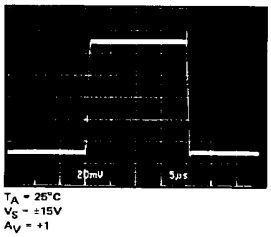
CHANNEL SEPARATION vs FREQUENCY



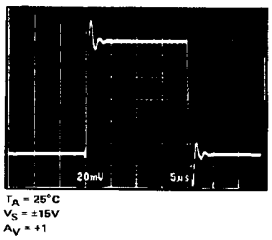
LARGE-SIGNAL TRANSIENT RESPONSE



SMALL-SIGNAL TRANSIENT RESPONSE



SMALL-SIGNAL TRANSIENT RESPONSE C_{LOAD} = 1nF



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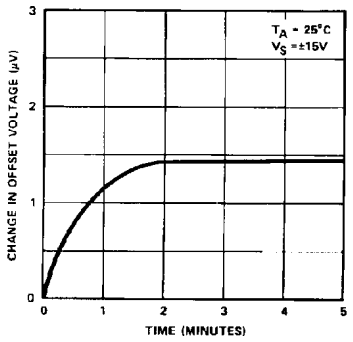
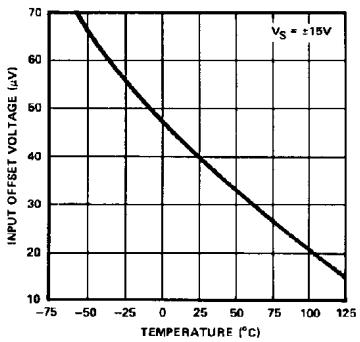
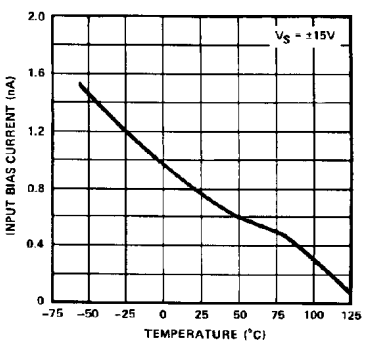
WARM-UP DRIFT



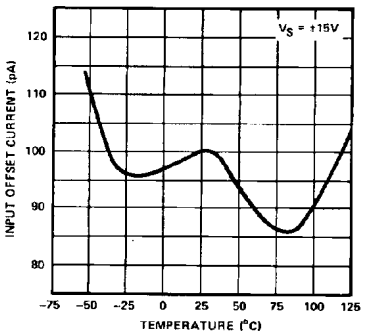
INPUT OFFSET VOLTAGE vs TEMPERATURE



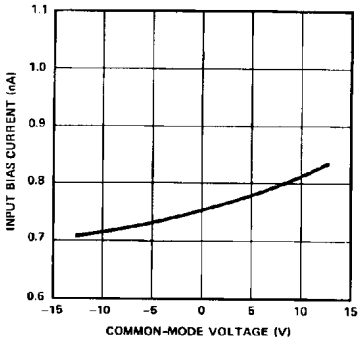
INPUT BIAS CURRENT vs TEMPERATURE



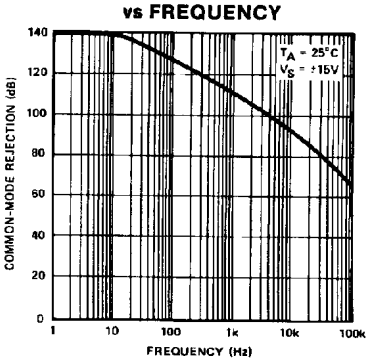
INPUT OFFSET CURRENT vs TEMPERATURE



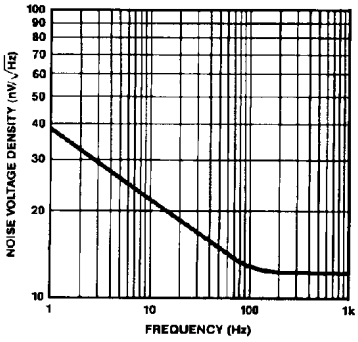
INPUT BIAS CURRENT vs COMMON-MODE VOLTAGE



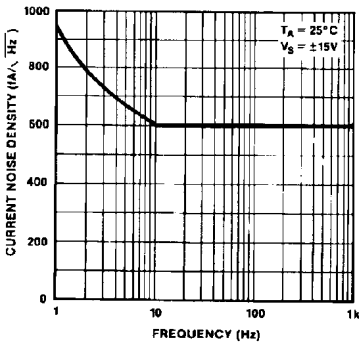
COMMON-MODE REJECTION vs FREQUENCY



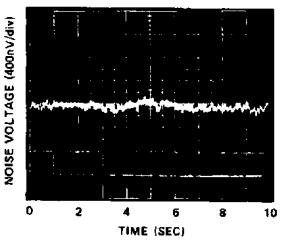
NOISE VOLTAGE DENSITY vs FREQUENCY



CURRENT NOISE DENSITY vs FREQUENCY



0.1Hz TO 10Hz NOISE



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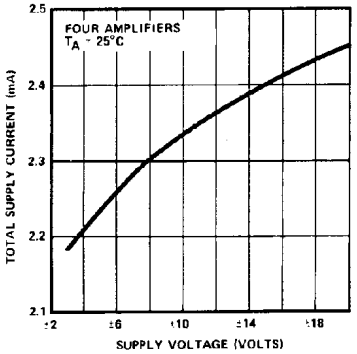
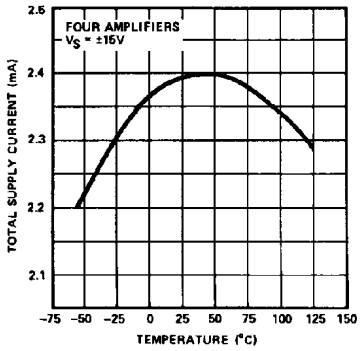
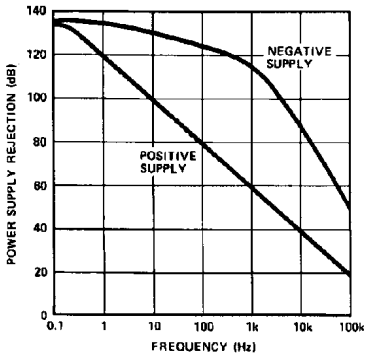
TOTAL SUPPLY CURRENT vs SUPPLY VOLTAGE



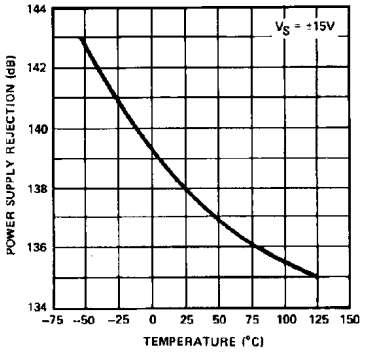
TOTAL SUPPLY CURRENT vs TEMPERATURE



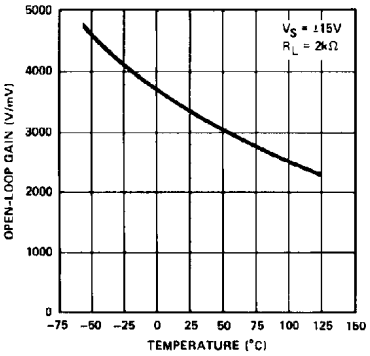
POWER SUPPLY REJECTION vs FREQUENCY



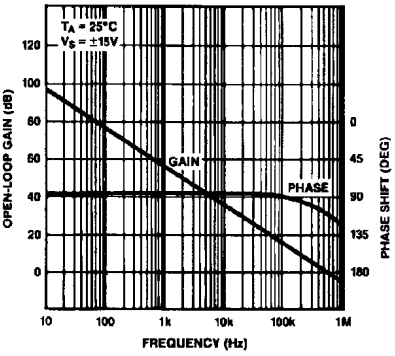
POWER SUPPLY REJECTION vs TEMPERATURE



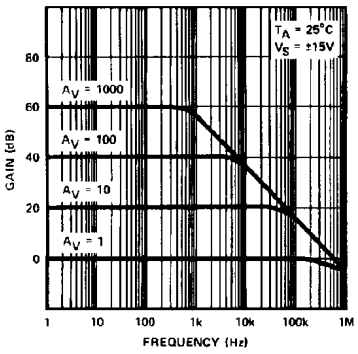
OPEN-LOOP GAIN vs TEMPERATURE



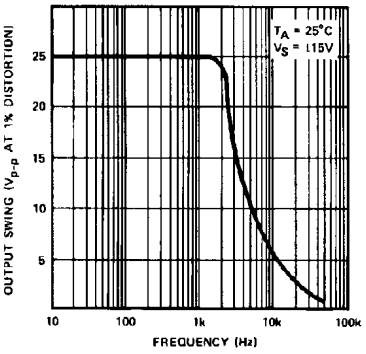
OPEN-LOOP GAIN AND PHASE SHIFT vs FREQUENCY



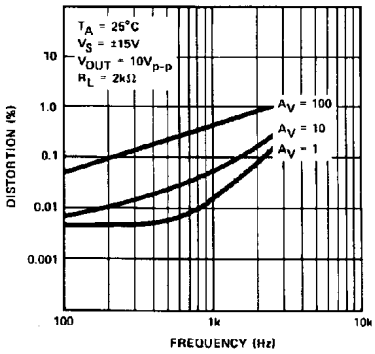
CLOSED-LOOP GAIN vs FREQUENCY



MAXIMUM OUTPUT SWING vs FREQUENCY



TOTAL HARMONIC DISTORTION vs FREQUENCY



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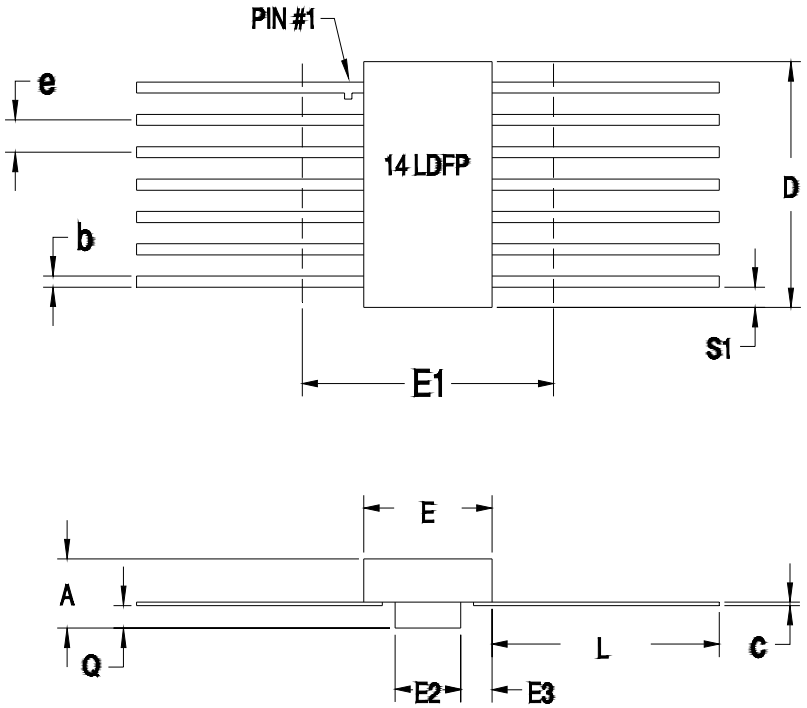

14 PIN FLAT PACKAGE

SYMBOL	DIMENSION		
	MIN	NOM	MAX
A	0.155	0.170	0.185
b	0.015	0.017	0.022
c	0.004	0.005	0.009
D	--	0.380	0.390
E	0.250	0.255	0.260
E1	--	--	0.290
E2	0.125	0.131	--
E3	0.030	0.062	--
e	0.050 BSC		
L	0.279	0.325	0.370
Q	0.026	0.045	0.055
S1	0.005	--	--
N	14		

F14-04

Note: All dimensions in inches.

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