

Logic Diagram (One Amplifier)

### FEATURES:

- RAD-PAK® technology-hardened against natural space radiation
- Total dose hardness:
  - > 100 krad (Si), depending upon space mission
- Package:
  - 16 pin Rad-Pak® flat package
- Low offset voltage drift
  - 5 $\mu$  V/°C max (over -55 to +125°C)
- Low supply current (per amplifier) 20  $\mu$ A max
- High open-loop gain 700V/mV min

### DESCRIPTION:

Maxwell Technologies' OP490 monolithic quad operational amplifier microcircuit features a greater than 100 krad (Si) typical total dose tolerance, depending upon space mission. Using Maxwell's radiation-hardened RAD-PAK® packaging technology, the OP490 has an extremely low input offset voltage no less than 0.2 mV, guaranteed over the full military temperature range. The OP490 features low power consumption, drawing less than 20  $\mu$ A per amplifier.

Maxwell Technologies' patented RAD-PAK® packaging technology incorporates radiation shielding in the microcircuit package. It eliminates the need for box shielding while providing the required radiation shielding for a lifetime in orbit or space mission. In a GEO orbit, RAD-PAK® provides greater than 100 krad (Si) radiation dose tolerance. This product is available with screening up to Class S.

TABLE 1. PINOUT DESCRIPTION

PIN	SYMBOL	DESCRIPTION
1, 7, 10, 16	OUT A - D	Output Signal
2, 6, 11, 15	-IN A - D	Negative Input Signal
3, 5, 12, 14	+IN A - D	Positive Input Signal
8, 9	NC	Not Connected
4	V+	Positive Voltage
13	V-	Negative Voltage

TABLE 2. OP490 ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	MIN	MAX	UNIT
Supply Voltage	$V_{CC}$		$\pm 18$	V
Differential Input Voltage		(V-) - 20	(V+) + 20	V
Common-Mode Input Voltage		(V-) - 20	(V+) + 20	V
Output Short-Circuit Duration		Continuous		
Weight			2.65	Grams
Thermal Resistance	$T_{JC}$		3.35	$^{\circ}C/W$
Storage Temperature Range	$T_S$	-65	150	$^{\circ}C$
Operating Temperature Range	$T_A$	-55	125	$^{\circ}C$

TABLE 3. DELTA LIMITS

PARAMETER	VARIATION
ICC	$\pm 10\%$ of specified value in Table 4

TABLE 4. OP490 DC ELECTRICAL CHARACTERISTICS

( $V_S = \pm 15V$ ,  $T_A = -55$  TO  $125^{\circ}C$ , UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	TEST CONDITIONS	SUBGROUPS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$V_{OS}$		+25 $^{\circ}C$	1	---	0.2	mV
			-55 to 125 $^{\circ}C$	2, 3	--	0.4	
Input Offset Current	$I_{OS}$	$V_{CM} = 0V$	+25 $^{\circ}C$	1	---	0.4	nA
			-55 to 125 $^{\circ}C$	2, 3		1.5	
Input Bias Current	$I_B$	$V_{CM} = 0V$	+25 $^{\circ}C$	1	---	4.2	nA
			-55 to 125 $^{\circ}C$	2, 3		4.4	

TABLE 4. OP490 DC ELECTRICAL CHARACTERISTICS

( $V_S = \pm 15V$ ,  $T_A = -55$  TO  $125^\circ C$ , UNLESS OTHERWISE SPECIFIED)

PARAMETER	SYMBOL	TEST CONDITIONS	SUBGROUPS	MIN	TYP	MAX	UNITS	
Large Signal Voltage Gain	$A_{VO}$	$V_S = \pm 15V$ $R_L = 100 k\Omega$	+25°C	4	700	1200	--	V/mV
			-55 to 125°C	5, 6	225	400	--	
		$V_S = \pm 15V$ $R_L = 10 k\Omega$	+25°C	4	350	600	--	
			-55 to 125°C	5, 6	125	240	--	
		$V_S = \pm 15V$ $R_L = 2 k\Omega$	+25°C	4	125	250	--	
			-55 to 125°C	5, 6	50	110	--	
		$V_S = +5V$ $R_L = 100 k\Omega$	+25°C	4	--	400	--	
			-55 to 125°C	5, 6	--	200	--	
$V_S = +5V$ $R_L = 10 k\Omega$	+25°C	4	--	180	--			
	-55 to 125°C	5, 6	--	110	--			
Input Voltage Range <sup>1</sup>	IVR	$V_+ = +5V$ , $V_- = 0$ $V_S = \pm 15V$	1,2,3	0/4	--	--	V	
			1,2,3	-15/13.5	--	--		
Common Mode Rejection	CMR	$V_+ = +5V$ $0V < V_{CM} < 4$	25°C	4	--	110	--	dB
			-55 to 125°C	5, 6	--	108	--	
		$V_S = \pm 15V$ $15V < V_{CM} < 13$	25°C	4	100	130	--	
			-55 to 125°C		95	115	--	
Power Supply Rejection Ratio	PSRR		+25°C		---	1.0	5.6	$\mu V/V$
			-55 to 125°C	5, 6	--	3.2	10	
Output Voltage Swing	$V_O$	$V_S = \pm 15V$ $R_L = 10k\Omega$	25°C	4	-/-13.5	+/-14.2	---	V
			-55 to 125°C	5, 6	+/-13	+/-14	--	
			25°C	4	+/-10.5	+/-11.5	--	
			-55 to 125°C	5, 6	+/-10	+/-11	--	
	$V_{OH}$	$V_+ = 12V$ $R_L = 2 k\Omega$	25°C	4		4.2		
			-55 to 125°C	5, 6		4.1		
$V_{OL}$	$V_+ = 5$ $R_L = 10k\Omega$		4,5,6		100		$\mu V$	
Supply Current (All Amplifiers)	$I_{SY}$	VS=±15V No Load	+25°C	1	---	40	60	$\mu A$
			-55 to 125°C	2, 3	--	70	100	
		VS=±15V No Load	+25°C	1		60	80	
			-55 to 125°C	2, 3		90	120	
Slew Rate	SR	VS=±15V	+25°C	7	--	12	---	V/ms
Input Capacitance	$C_{IN}$		+25°C	1	---	3.2	---	pF
Capacitive Load Stability		AV = +1 No Oscillations	+25°C	1	---	650	---	pF

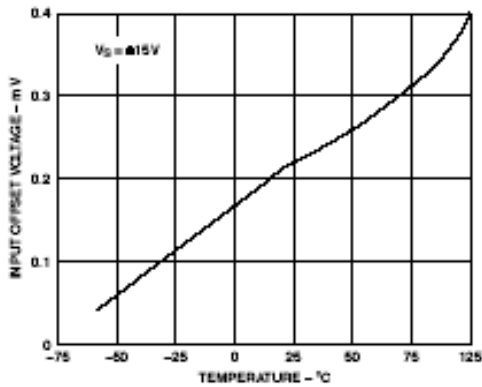
1. Guaranteed by CMR test.

TABLE 5. OP490 AC Electrical Characteristics

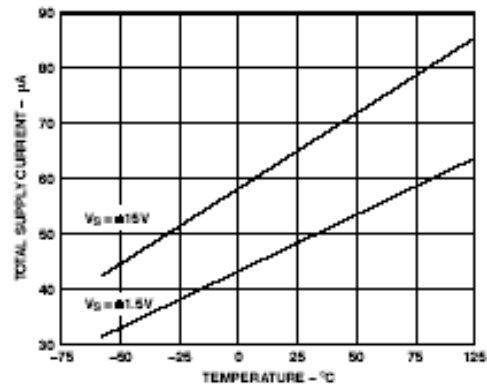
( $V_S = \pm 15V$ ,  $T_A = -55$  TO  $125^\circ C$ , UNLESS OTHERWISE SPECIFIED.)

PARAMETER	SYMBOL	Test Conditions		SUBGROUPS	MIN	TYP	MAX	UNIT
Input Noise Voltage	$e_{n\ p-p}$	0.1 Hz to 10 Hz	+25°C	7	---	3	---	$\mu V_{p-p}$
Input Resistance Differential Mode	$R_{IN}$	$V_S = \pm 15V$	+25°C	7	--	30	--	$M\Omega$
Input Resistance Common Mode	$R_{INCM}$	$V_S = \pm 15V$	+25°C	7	--	20	--	$G\Omega$
Gain Bandwidth Product	GBWP	$A_V = +1$	+25°C	4	--	500	---	kHz

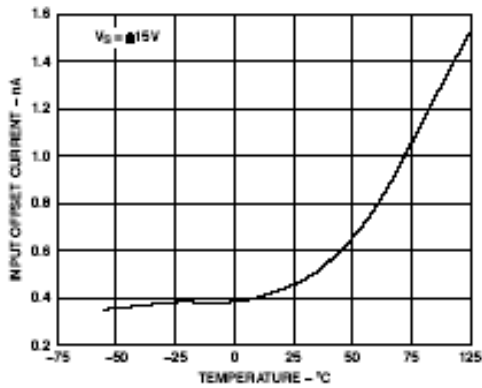
## OP490 TYPICAL OPERATING CHARACTERISTICS



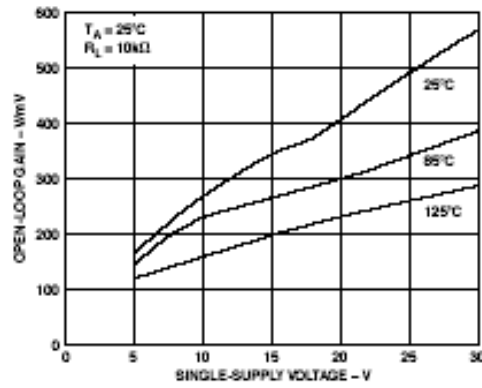
TPC 1. Input Offset Voltage vs. Temperature



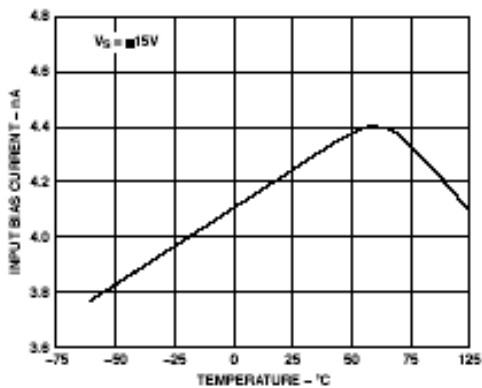
TPC 4. Total Supply Current vs. Temperature



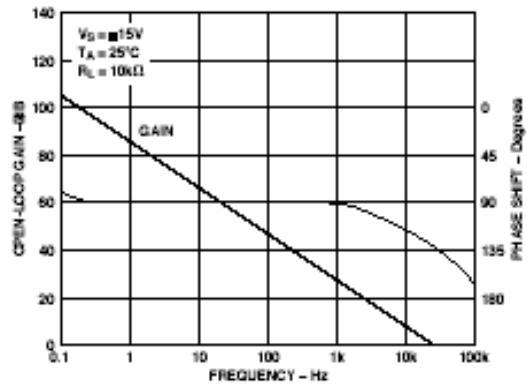
TPC 2. Input Offset Current vs. Temperature



TPC 5. Open-Loop Gain vs. Single-Supply Voltage

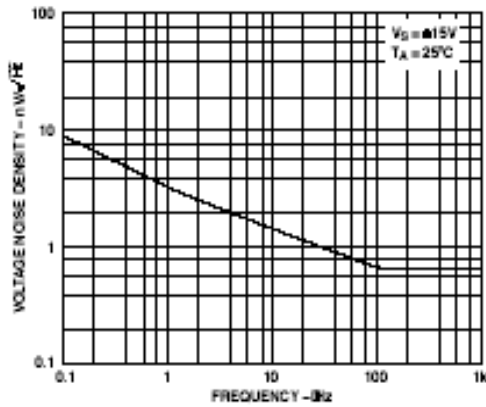


TPC 3. Input Bias Current vs. Temperature

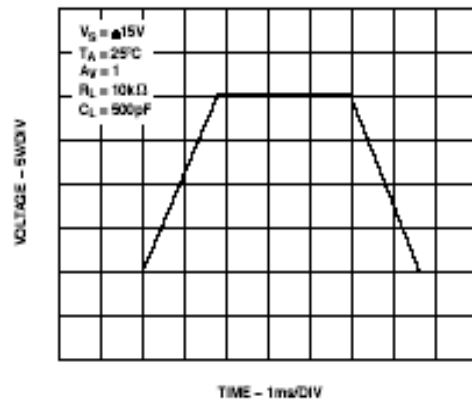


TPC 6. Open-Loop Gain and Phase Shift vs. Frequency

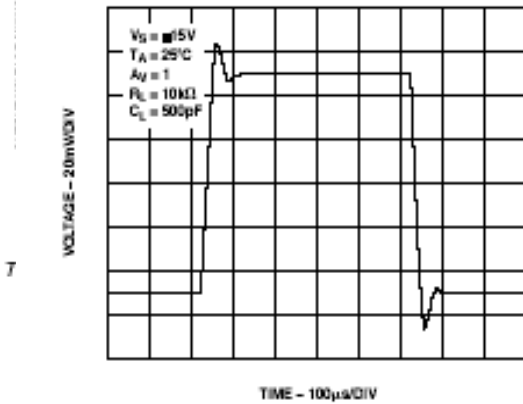
## OP490 TYPICAL OPERATING CHARACTERISTICS (CONTINUED)



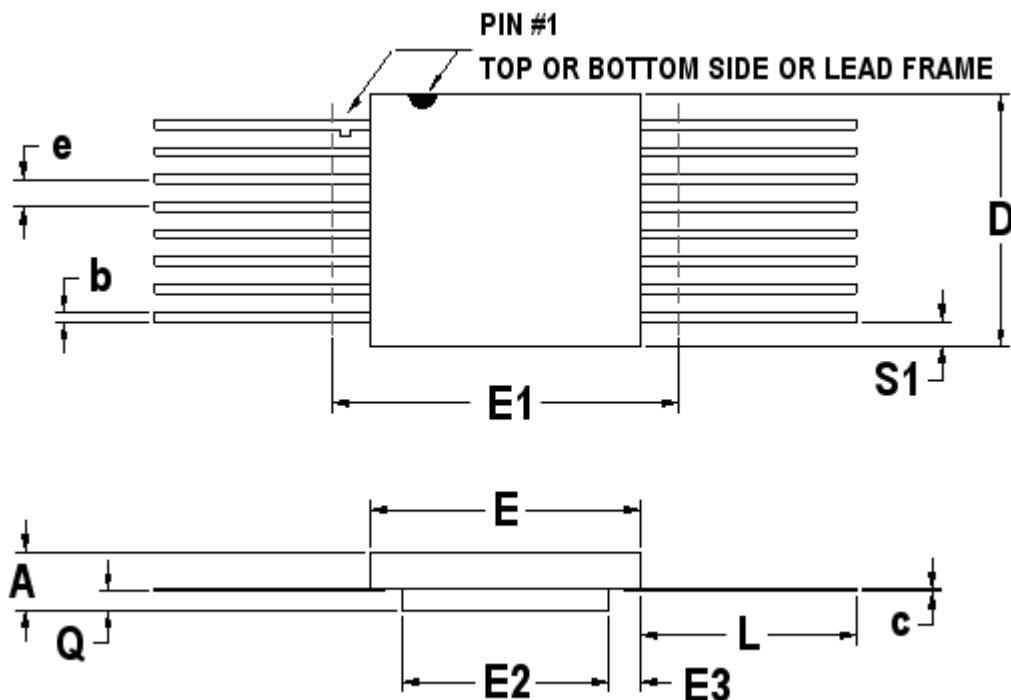
TPC 13. Current Noise Density vs. Frequency



TPC 15. Large-Signal Transient Response



TPC 14. Small-Signal Transient Response



16-PIN RAK-PAK® FLAT PACKAGE

SYMBOL	DIMENSION		
	MIN	NOM	MAX
A	0.115	0.135	0.150
b	0.015	0.017	0.022
c	0.004	0.005	0.009
D	--	0.415	0.440
E	0.245	0.280	0.285
E1	--	--	0.315
E2	0.1200	0.156	--
E3	0.030	0.062	--
e	0.050 BSC		
L	0.325	0.335	0.345
Q	0.020	0.033	0.045
S1	0.005	0.024	--
N	16		

Note: All dimensions in inches.

## Important Notice:

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