μA747

DUAL FREQUENCY-COMPENSATED OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

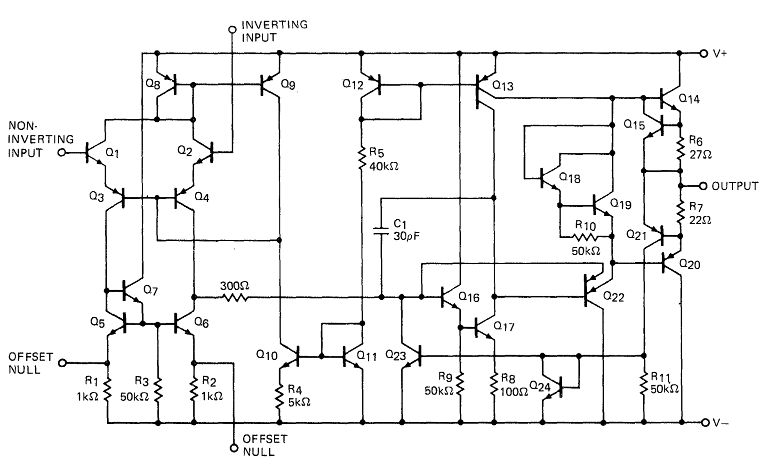
GENERAL DESCRIPTION — The μA747 is a pair of high performance monolithic Operational Amplifiers constructed using the Fairchild Planar* epitaxial process. They are intended for a wide range of analog applications where board space or weight are important. High common mode voltage range and absence of latch-up make the μA747 ideal for use as a voltage follower. The high gain and wide range of operating voltage provides superior performance in integrator, summing amplifier, and general feedback applications. The μA747 is short circuit protected and requires no external components for frequency compensation. The internal 6 dB/octave roll-off insures stability in closed loop applications. For single amplifier performance, see μA741 data sheet.

- **NO FREQUENCY COMPENSATION REQUIRED**
- **SHORT CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **LOW POWER CONSUMPTION**
- **NO LATCH-UP**

ABSOLUTE MAXIMUM RATINGS

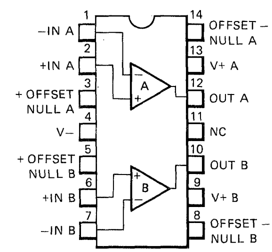
Supply Voltage	
Military (μA747A, μA747, μA747E)	±22 V
Commercial (μA747C)	±18 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
DIP	670 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Voltage betweeen Offset Null and V−	±0.5 V
Storage Temperature Range	−65°C to +150°C
Operating Temperature Range	
Military (μA747A, μA747)	−55° C to +125°C
Commercial (μA747E, μA747C)	0°C to 70°C
Pin Temperature (Soldering 60 s)	300°C
Output Short Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT (1/2 μA747)



Notes on following pages.

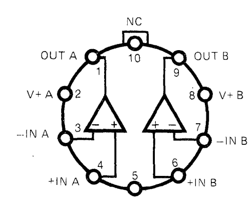
CONNECTION DIAGRAMS
14-PIN DIP
(TOP VIEW)
PACKAGE OUTLINE 7A 9A
PACKAGE CODE D P



ORDER INFORMATION

TYPE	PART NO.
μA747A	μA747ADM
μA747	μA747DM
μA747E	μA747EDC
μA747C	μA747DC
μA747C	μA747PC
μA747−I	μA747−IDM
μA747−IC	μA747−IDC

10-PIN METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5N
PACKAGE CODE H



ORDER INFORMATION

TYPE	PART NO.
μA747A	μA747AHM
μA747	μA747HM
μA747E	μA747EHC
μA747C	μA747HC
μA747−I	μA747−IHM
μA747−IC	μA747−IHC

NOTE:
V+A is internally connected to V+B for μA747A, μA747, μA747E, and μA747C. They are not internally connected for μA747-I and μA747-IC.

*Planar is a patented Fairchild process.

μA747A

ELECTRICAL CHARACTERISTICS: ±5 V ⩽ V_S ⩽ ±20 V, T_A = 25°C unless otherwise specified.

CHARACTERISTICS		CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage		R_S ⩽ 50Ω		0.8	3.0	mV
Average Input Offset Voltage Drift					15	μV/°C
Input Offset Current				3.0	30	nA
Average Input Offset Current Drift		T_A = 25°C to +125°C			0.2	nA/°C
		T_A = −55°C to +25°C			0.5	nA/°C
Input Bias Current				30	80	nA
Power Supply Rejection Ratio		V_S = +10 to +20, −20; V_S = +20, −10 to −20, R_S = 50 Ω		15	50	μV/V
Common Mode Rejection Ratio		V_S = ±20 V, V_{IN} = ±15 V, R_S = 50 Ω	80	95		dB
Adjustment for Input Offset Voltage		V_S = ±20 V	10			mV
Output Short Circuit Current			10	25	40	mA
Power Dissipation		V_S = ±20 V per Channel		80	150	mW
Input Impedance		V_S = ±20 V	1.0	6		MΩ
Large Signal Voltage Gain		V_S = ±20 V, R_L = 2 kΩ, V_{OUT} = ±15 V	50			V/mV
Transient Response (Unity Gain)	Rise Time			0.25	0.8	μs
	Overshoot			6.0	20	%
Bandwidth (Note 4)			0.437	1.5		MHz
Slew Rate (Unity Gain)		V_{IN} = ±10 V	0.3	0.7		V/μs
The following specifications apply for −55°C ⩽ T_A ⩽ +125°C						
Input Offset Voltage					4.0	mV
Input Offset Current					70	nA
Input Bias Current					210	nA
Output Short Circuit Current			10		40	mA
Power Dissipation		V_S = ±20 V, −55°C			165	mW
		V_S = ±20 V, +125°C			135	mW
Input Impedance		V_S = ±20 V	0.5			MΩ
Output Voltage Swing		V_S = ±20 V, R_L = 10 kΩ	±16			V
		R_L = 2 kΩ	±15			V
Large Signal Voltage Gain		V_S = ±20 V, R_L = 2 kΩ, V_{OUT} = ±15 V	32			V/mV
		V_S = ± 5 V, R_L = 2 kΩ, V_{OUT} = ± 2 V	10			V/mV
Channel Separation		V_S = ±20 V	100			dB

NOTES:
1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for the Metal Can, 8.3 mW/°C for the DIP.
2. For supply voltages less than ±15 V, the absolute maximum input voltage is equal to the supply voltage.
3. Short circuit may be to ground or either supply. Rating applies to +125°C case temperature or 75°C ambient temperature.
4. Calculated value from: $BW\ (MHz) = \frac{0.35}{RISE\ TIME\ (\mu s)}$

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μA747

ELECTRICAL CHARACTERISTICS: Each Amplifier (V_S = ±15 V, T_A = 25°C unless otherwise specified)

CHARACTERISTICS (see definitions)		CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		1.0	5.0	mV
Input Offset Current				20	200	nA
Input Bias Current				80	500	nA
Input Resistance			0.3	2.0		MΩ
Input Capacitance				1.4		pF
Offset Voltage Adjustment Range				±15		mV
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	50,000	200,000		V/V
Output Resistance				75		Ω
Output Short-Circuit Current				25		mA
Supply Current				1.7	2.8	mA
Power Consumption				50	85	mW
Transient Response (Unity Gain)	Rise time	V_{IN} = 20 mV, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
	Overshoot			5.0		%
Slew Rate		$R_L \geq 2$ kΩ		0.5		V/μs
Channel Separation				120		dB

The following specifications apply for $-55°C \leq T_A \leq +125°C$.

Input Offset Voltage	$R_S \leq 10$ kΩ		1.0	6.0	mV
Input Offset Current	T_A = +125°C		7.0	200	nA
	T_A = −55°C		85	500	nA
Input Bias Current	T_A = +125°C		0.03	0.5	μA
	T_A = −55°C		0.3	1.5	μA
Input Voltage Range		±12	±13		V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10$ kΩ		30	150	μV/V
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000			V/V
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±14		V
	$R_L \geq 2$ kΩ	±10	±13		V
Supply Current	T_A = +125°C		1.5	2.5	mA
	T_A = −55°C		2.0	3.3	mA
Power Consumption	T_A = +125°C		45	75	mW
	T_A = −55°C		60	100	mW

μA747C

ELECTRICAL CHARACTERISTICS: Each Amplifier (V_S = ±15 V, T_A = 25°C unless otherwise specified)

CHARACTERISTICS (see definitions)	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leq 10$ kΩ		1.0	6.0	mV
Input Offset Current			20	200	nA
Input Bias Current			80	500	nA
Input Resistance		0.3	2.0		MΩ
Input Capacitance			1.4		pF
Offset Voltage Adjustment Range			±15		mV
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000	200,000		V/V
Output Resistance			75		Ω
Output Short-Circuit Current			25		mA
Supply Current			1.7	2.8	mA
Power Consumption			50	85	mW
Transient Response (Unity Gain) — Rise time	V_{IN} = 20 mV, R_L = 2 kΩ, $C_L \leq 100$ pF		0.3		μs
Transient Response (Unity Gain) — Overshoot			5.0		%
Slew Rate	$R_L \geq 2$ kΩ		0.5		V/μs
Channel Separation			120		dB

The following specifications apply for 0°C ≤ T_A ≤ +70°C.

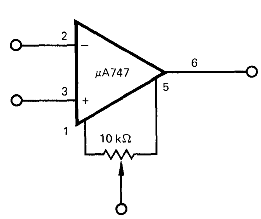
CHARACTERISTICS	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leq 10$ kΩ		1.0	7.5	mV
Input Offset Current			7.0	300	nA
Input Bias Current			0.03	0.8	μA
Input Voltage Range		±12	±13		V
Common Mode Rejection Ratio	$R_S \leq 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10$ kΩ		30	150	μV/V
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, V_{OUT} = ±10 V	15,000			V/V
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±14		V
	$R_L \geq 2$ kΩ	±10	±13		V
Supply Current			2.0	3.3	mA
Power Consumption			60	100	mW

μA747E

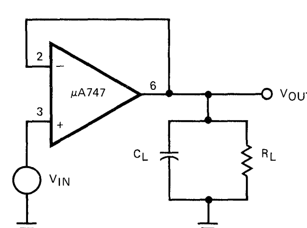
ELECTRICAL CHARACTERISTICS: $\pm5\ V \leq V_S \leq \pm20\ V$, $T_A = 25°C$ unless otherwise specified.

CHARACTERISTICS (see definitions)		CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage		$R_S \leq 50\Omega$		0.8	3.0	mV
Average Input Offset Voltage Drift					15	μV/°C
Input Offset Current				3	30	nA
Average Input Offset Current Drift		$T_A = 25°C$ to $70°C$			0.2	nA/°C
		$T_A = 0°C$ to $25°C$			0.5	nA/°C
Input Bias Current				30	80	nA
Power Supply Rejection Ratio		$V_S = +10, -20$; $V_S = +20\ V, -10\ V$; $R_S = 50\ \Omega$		15	50	μV/V
Common Mode Rejection Ratio		$V_S = \pm20\ V$, $V_{IN} = \pm15\ V$; $R_S = 50\ \Omega$	80	95		dB
Adjustment for Input Offset Voltage		$V_S = \pm20\ V$	10			mV
Output Short Circuit Current			10	25	35	mA
Power Dissipation		$V_S = \pm20\ V$		80	150	mW
Input Impedance		$V_S = \pm20\ V$	1.0	6		MΩ
Large Signal Voltage Gain		$V_S = \pm20\ V$, $R_L = 2\ k\Omega$, $V_{OUT} = \pm15\ V$	50			V/mV
Transient Response (Unity Gain)	Rise Time			0.25	0.8	μs
	Overshoot			6	20	%
Bandwidth (Note 4)			0.437	1.5		MHz
Slew Rate (Unity Gain)		$V_{IN} = \pm10\ V$	0.3	0.7		V/μs
The following specifications apply for $0°C \leq T_A \leq 70°C$						
Input Offset Voltage					4.0	mV
Input Offset Current					70	nA
Input Bias Current					210	nA
Output Short Circuit Current			10		40	mA
Power Dissipation		$V_S = \pm20\ V$			165	mW
Input Impedance		$V_S = \pm20\ V$	0.5			MΩ
Output Voltage Swing		$V_S = \pm20\ V$, $R_L = 10\ k\Omega$	±16			V
		$R_L = 2\ k\Omega$	±15			V
Large Signal Voltage Gain		$V_S = \pm20\ V$, $R_L = 2\ k\Omega$, $V_{OUT} = \pm15\ V$	32			V/mV
		$V_S = \pm\ 5\ V$, $R_L = 2\ k\Omega$, $V_{OUT} = \pm\ 2\ V$	10			V/mV
Channel Separation		$V_S = \pm20\ V$	100			dB

VOLTAGE OFFSET NULL CIRCUIT

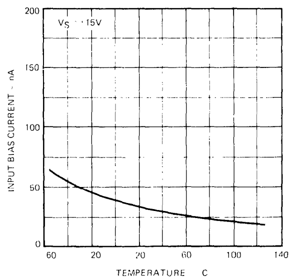


TRANSIENT RESPONSE TEST CIRCUIT

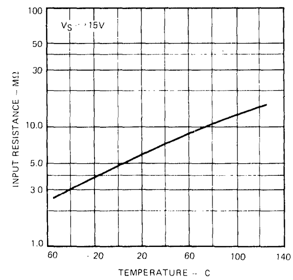


TYPICAL PERFORMANCE CURVES FOR μA747A AND μA747

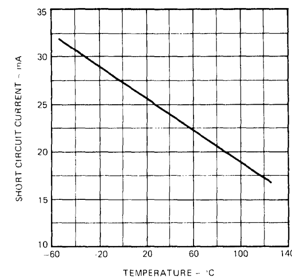
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



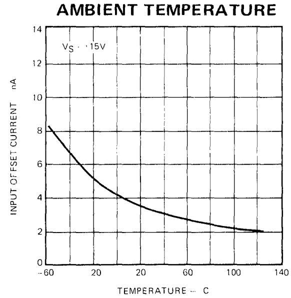
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



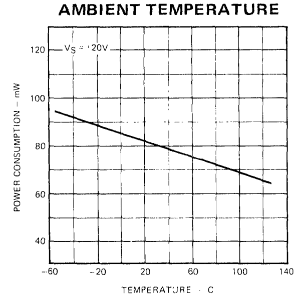
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



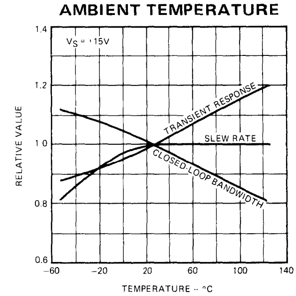
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE

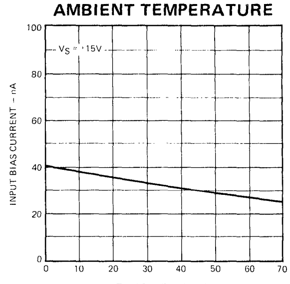


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

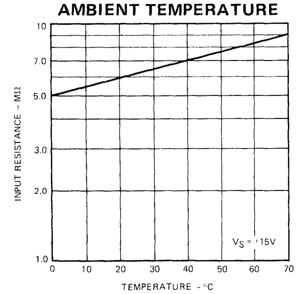


TYPICAL PERFORMANCE CURVES FOR μA747E AND μA747C

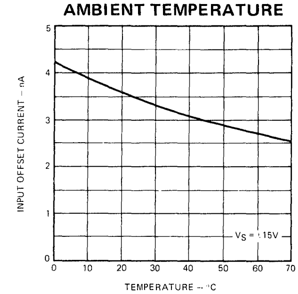
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



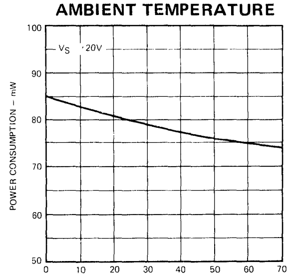
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



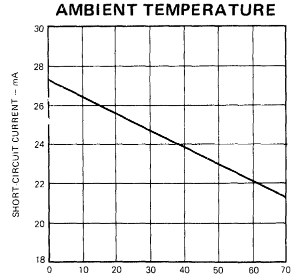
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



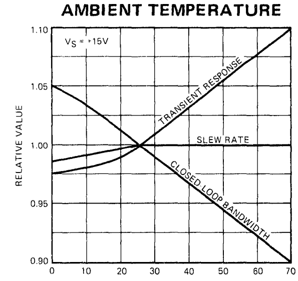
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



OUTPUT SHORT CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE



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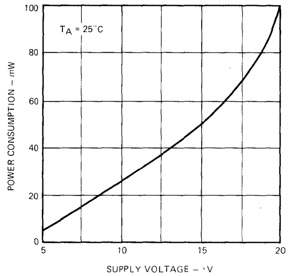
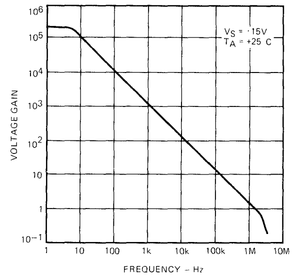
TYPICAL PERFORMANCE CURVES FOR μA747A, μA747C, μA747 AND μA747E

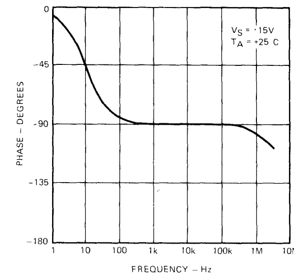
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



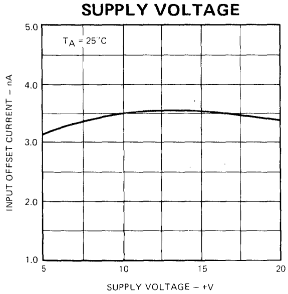
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



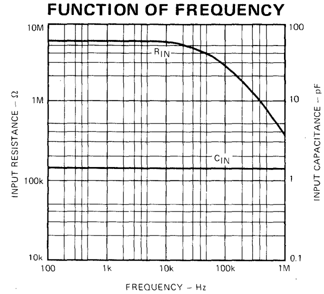
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



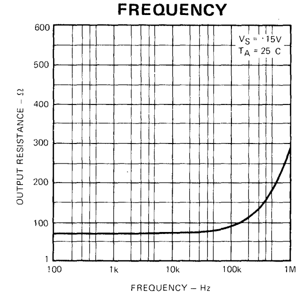
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



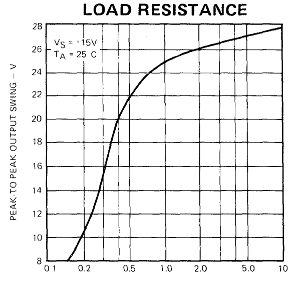
INPUT RESISTANCE AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



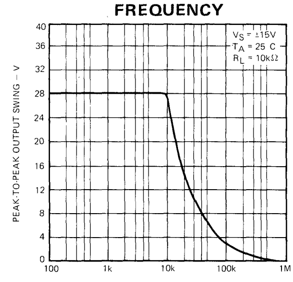
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY



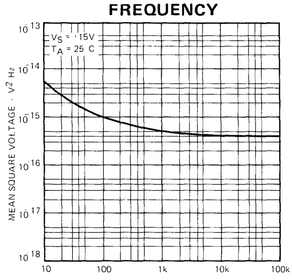
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



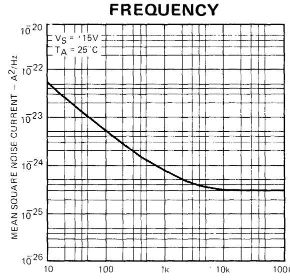
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



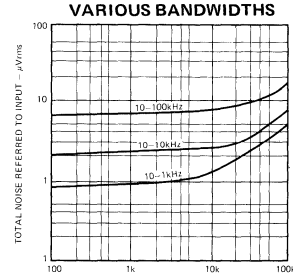
INPUT NOISE VOLTAGE DENSITY AS A FUNCTION OF FREQUENCY



INPUT NOISE CURRENT DENSITY AS A FUNCTION OF FREQUENCY

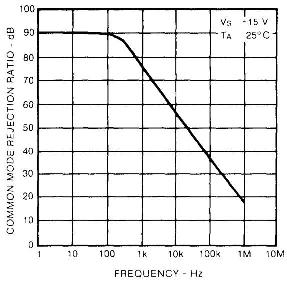


BROADBAND NOISE FOR VARIOUS BANDWIDTHS

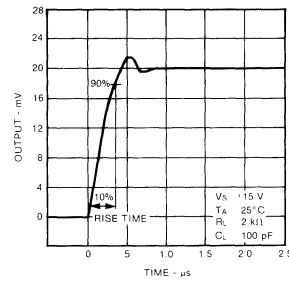


TYPICAL PERFORMANCE CURVES (Each Amplifier) FOR μA747 AND μA747C

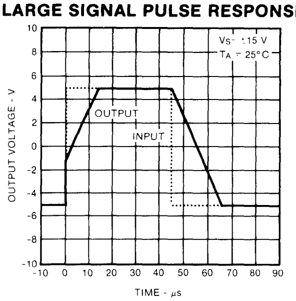
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



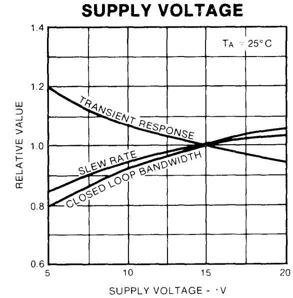
TRANSIENT RESPONSE



VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE

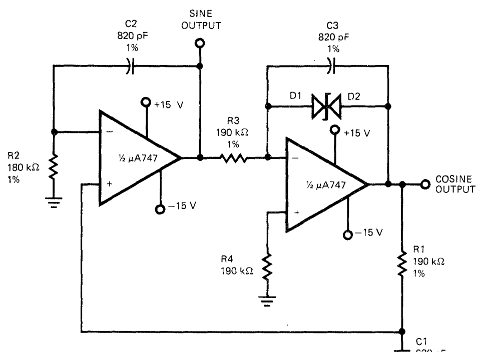


FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE



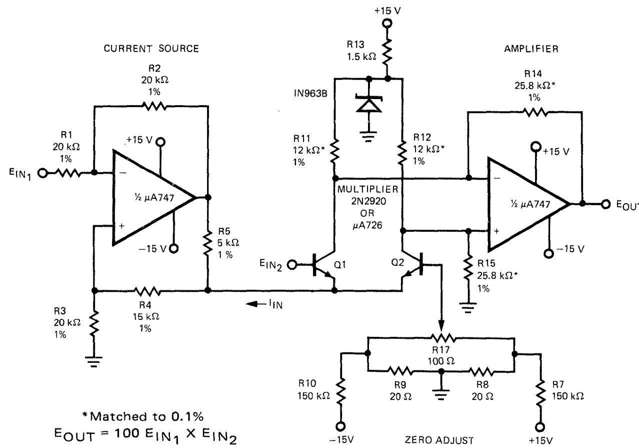
TYPICAL APPLICATIONS

QUADRATURE OSCILLATOR



$$f = \frac{1}{2\pi\sqrt{C2R2C3R3}} \quad (R1C1 = R2C2)$$

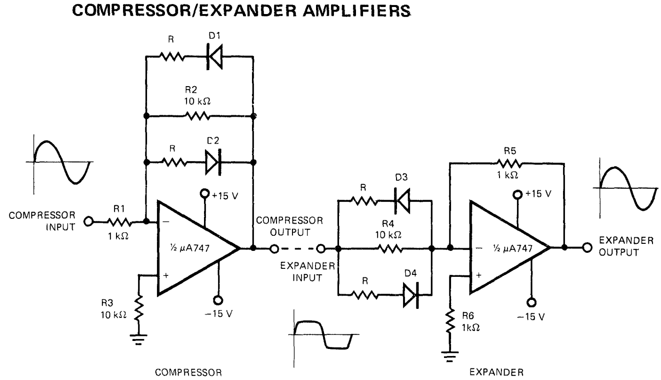
ANALOG MULTIPLIER



*Matched to 0.1%

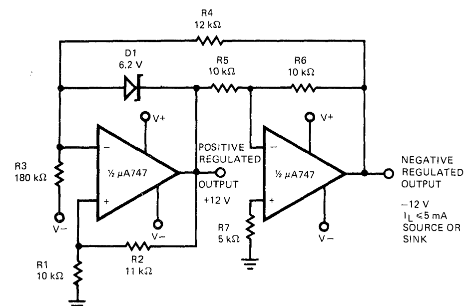
$E_{OUT} = 100\ E_{IN_1} \times E_{IN_2}$

COMPRESSOR/EXPANDER AMPLIFIERS



MAXIMUM COMPRESSION EXPANSION RATIO = R1/R (10 kΩ > R ⩾ 0)
NOTE: DIODES D1 THROUGH D4 ARE MATCHED FD666 OR EQUIVALENT

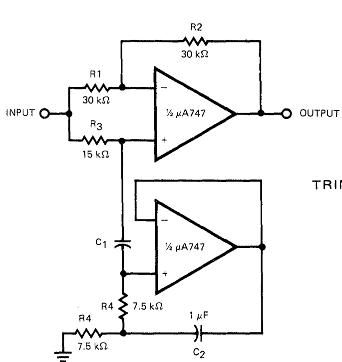
TRACKING POSITIVE AND NEGATIVE VOLTAGE REFERENCES



POSITIVE OUTPUT = $V_{D1} \times \frac{R1 + R2}{R2}$

NEGATIVE OUTPUT = −POSITIVE OUTPUT × $\frac{R6}{R5}$

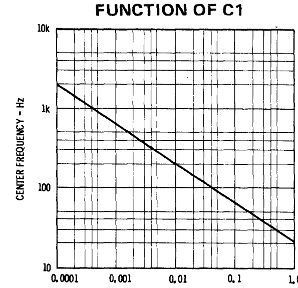
NOTCH FILTER USING THE μA747 AS A GYRATOR



TRIM R3 SUCH THAT

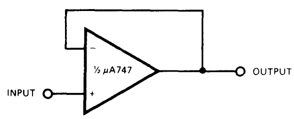
$$\frac{R1}{R2} = \frac{R3}{2\ R4}$$

NOTCH FREQUENCY AS A FUNCTION OF C1



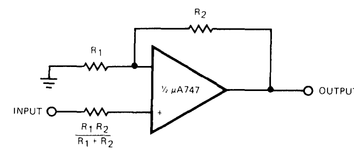
TYPICAL APPLICATIONS

UNITY-GAIN VOLTAGE FOLLOWER



R_{IN} = 400 MΩ
C_{IN} = 1 pF
R_{OUT} << 1 Ω
B W = 1 MHz

NON-INVERTING AMPLIFIER



GAIN	R_1	R_2	B.W.	R_{IN}
10	1 kΩ	9 kΩ	100 kHz	400 MΩ
100	100 Ω	9.9 kΩ	10 kHz	280 MΩ
1000	100 Ω	99.9 kΩ	1 kHz	80 MΩ

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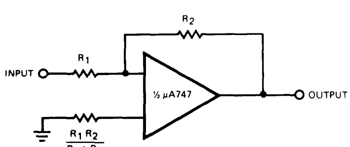
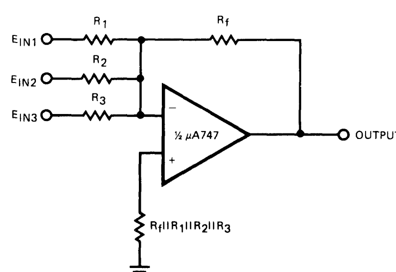
INVERTING AMPLIFIER



GAIN	R_1	R_2	B W	R_{IN}
1	10 kΩ	10 kΩ	1 MHz	10 kΩ
10	1 kΩ	10 kΩ	100 kHz	1 kΩ
100	1 kΩ	100 kΩ	10 kHz	1 kΩ
1000	100 Ω	100 kΩ	1 kHz	100 Ω

WEIGHTED AVERAGING AMPLIFIER



$$-E_{OUT} = E_{IN1}\left(\frac{R_f}{R_1}\right) + E_{IN2}\left(\frac{R_f}{R_2}\right) + E_{IN3}\left(\frac{R_f}{R_3}\right)$$