

μA741

FREQUENCY-COMPENSATED OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUIT

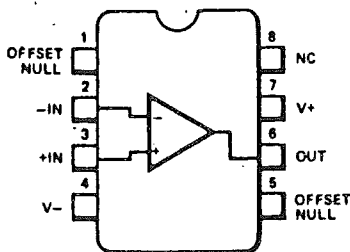
GENERAL DESCRIPTION — The μA741 is a high performance monolithic Operational Amplifier constructed using the Fairchild Planar* epitaxial process. It is intended for a wide range of analog applications. High common mode voltage range and absence of latch-up tendencies make the μA741 ideal for use as a voltage follower. The high gain and wide range of operating voltage provides superior performance in integrator, summing amplifier, and general feedback applications. Electrical characteristics of the μA741A and E are identical to MIL-M-38510/10101.

- 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

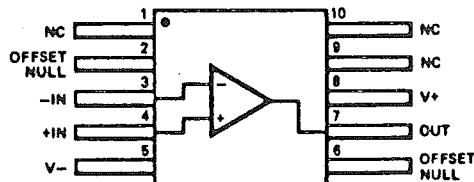
Supply Voltage	±22 V
μA741A, μA741, μA741E	±18 V
μA741C	
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
Molded and Hermetic DIP	670 mW
Mini DIP	310 mW
Flatpak	570 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Storage Temperature Range	
Metal Can, Hermetic DIP, and Flatpak	−65°C to +150°C
Mini DIP, Molded DIP	−55°C to +125°C
Operating Temperature Range	
Military (μA741A, μA741)	−55°C to +125°C
Commercial (μA741E, μA741C)	0°C to +70°C
Lead Temperature (Soldering)	300°C
Metal Can, Hermetic DIPs, and Flatpak (60 s)	260°C
Molded DIPs (10 s)	
Output Short Circuit Duration (Note 3)	Indefinite

8-LEAD MINIDIP
(TOP VIEW)
PACKAGE OUTLINES 6T 9T
PACKAGE CODES T R



TYPE	PART NO.
μA741C	μA741TC
μA741C	μA741RC

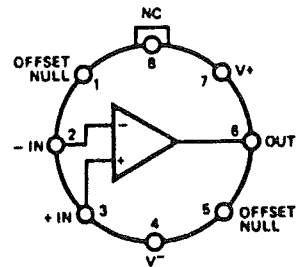
10-LEAD FLATPAK
(TOP VIEW)
PACKAGE OUTLINE 3F



TYPE	PART NO.
μA741A	μA741AFM
μA741	μA741FM

CONNECTION DIAGRAMS

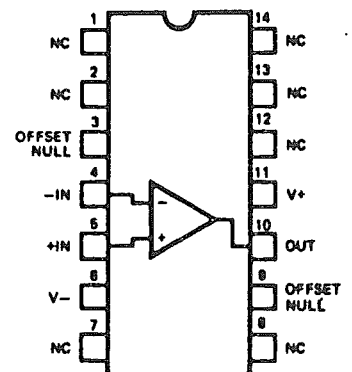
8-LEAD METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B



Note: Pin 4 connected to case

TYPE	PART NO.
μA741A	μA741AHM
μA741	μA741HM
μA741E	μA741EHC
μA741C	μA741HC

14-LEAD DIP
(TOP VIEW)
PACKAGE OUTLINE 6A, 9A



TYPE	PART NO.
μA741A	μA741ADM
μA741	μA741DM
μA741E	μA741EDC
μA741C	μA741DC
μA741C	μA741PC

Notes on following pages.

*Planar is a patented Fairchild process.

FAIRCHILD LINEAR INTEGRATED CIRCUITS • μ A741

μ A741A

ELECTRICAL CHARACTERISTICS ($V_S = \pm 15V$, $T_A = 25^\circ C$ unless otherwise specified)

PARAMETERS (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	$\mu V/^{\circ}C$
Input Offset Current				3.0	30	nA
Average Input Offset Current Drift					0.5	$nA/^{\circ}C$
Input Bias Current				30	80	nA
Power Supply Rejection Ratio		$V_S = +10, -20; V_S = +20, -10V, R_S = 50\Omega$		15	50	$\mu V/V$
Output Short Circuit Current			10	25	35	mA
Power Dissipation		$V_S = \pm 20V$		80	150	mW
Input Impedance		$V_S = \pm 20V$	1.0	6.0		M Ω
Large Signal Voltage Gain		$V_S = \pm 20V, R_L = 2k\Omega, V_{OUT} = \pm 15V$	50			V/mV
Transient Response (Unity Gain)	Rise Time			0.25	0.8	μs
	Overshoot			6.0	20	%
Bandwidth (Note 4)			.437	1.5		MHz
Slew Rate (Unity Gain)		$V_{IN} = \pm 10V$	0.3	0.7		V/ μs
The following specifications apply for $-55^{\circ}C \leq T_A \leq +125^{\circ}C$						
Input Offset Voltage					4.0	mV
Input Offset Current					70	nA
Input Bias Current					210	nA
Common Mode Rejection Ratio		$V_S = \pm 20V, V_{IN} = \pm 15V, R_S = 50\Omega$	80	95		dB
Adjustment For Input Offset Voltage		$V_S = \pm 20V$	10			mV
Output Short Circuit Current			10		40	mA
Power Dissipation	$V_S = \pm 20V$	$-55^{\circ}C$			165	mW
		$+125^{\circ}C$			135	mW
Input Impedance		$V_S = \pm 20V$	0.5			M Ω
Output Voltage Swing	$V_S = \pm 20V,$	$R_L = 10k\Omega$	± 16			V
		$R_L = 2k\Omega$	± 15			V
Large Signal Voltage Gain	$V_S = \pm 20V, R_L = 2k\Omega, V_{OUT} = \pm 15V$		32			V/mV
	$V_S = \pm 5V, R_L = 2k\Omega, V_{OUT} = \pm 2V$		10			V/mV

NOTES

- Rating applies to ambient temperatures up to $70^\circ C$. Above $70^\circ C$ ambient derate linearly at 6.3mW/ $^\circ C$ for the metal can, 8.3mW/ $^\circ C$ for the DIP and 7.1mW/ $^\circ C$ for the Flatpak.
- For supply voltages less than $\pm 15V$, the absolute maximum input voltage is equal to the supply voltage.
- Short circuit may be to ground or either supply. Rating applies to $+125^\circ C$ case temperature or $75^\circ C$ ambient temperature.
- Calculated value from: $BW(MHz) = \frac{0.35}{\text{Rise Time } (\mu s)}$

FAIRCHILD LINEAR INTEGRATED CIRCUITS • $\mu A741$

$\mu A741$

ELECTRICAL CHARACTERISTICS ($V_S = \pm 15$ V, $T_A = 25^\circ\text{C}$ unless otherwise specified)

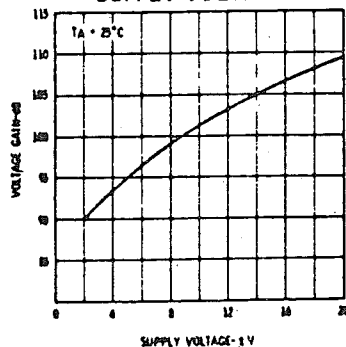
PARAMETERS (see definitions)	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leq 10$ k Ω		1.0	5.0	mV
Input Offset Current			20	200	nA
Input Bias Current			80	500	nA
Input Resistance		0.3	2.0		M Ω
Input Capacitance			1.4		pF
Offset Voltage Adjustment Range			± 15		mV
Large Signal Voltage Gain	$R_L \geq 2$ k Ω , $V_{OUT} = \pm 10$ V	50,000	200,000		
Output Resistance			75		Ω
Output Short Circuit Current			25		mA
Supply Current			1.7	2.9	mA
Power Consumption			50	85	mW
Transient Response (Unity Gain)	Rise time		0.3		μs
	Overshoot		5.0		%
Slew Rate	$R_L \geq 2$ k Ω		0.5		V/ μs

The following specifications apply for $-55^\circ\text{C} < T_A < +125^\circ\text{C}$:

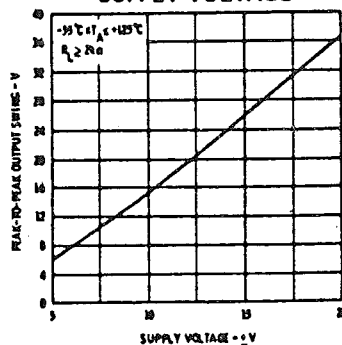
Input Offset Voltage	$R_S \leq 10$ k Ω		1.0	6.0	mV
Input Offset Current	$T_A = +125^\circ\text{C}$		7.0	200	nA
	$T_A = -55^\circ\text{C}$		85	500	nA
Input Bias Current	$T_A = +125^\circ\text{C}$		0.03	0.5	μA
	$T_A = -55^\circ\text{C}$		0.3	1.5	μA
Input Voltage Range		± 12	± 13		V
Common Mode Rejection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

TYPICAL PERFORMANCE CURVES FOR $\mu A741A$ AND $\mu A741$

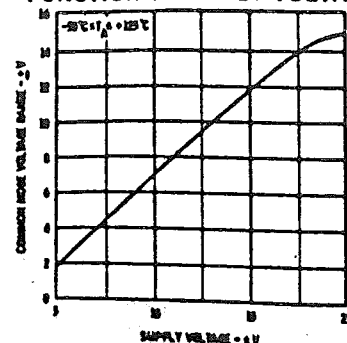
OPEN LOOP VOLTAGE GAIN
AS A FUNCTION OF
SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING
AS A FUNCTION OF
SUPPLY VOLTAGE



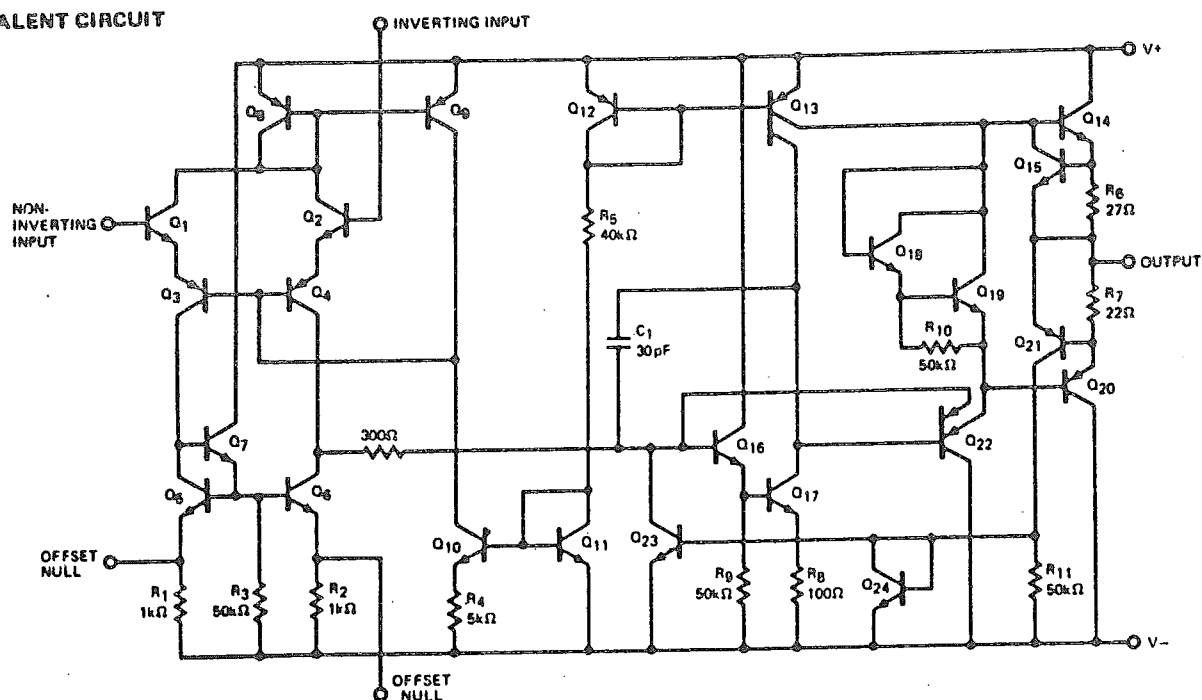
INPUT COMMON MODE
VOLTAGE RANGE AS A
FUNCTION OF SUPPLY VOLTAGE



$\mu A741E$ ELECTRICAL CHARACTERISTICS ($V_S = \pm 15V$, $T_A = 25^\circ C$ unless otherwise specified)

PARAMETERS (see definitions)	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S < 50\Omega$		0.8	3.0	mV
Average Input Offset Voltage Drift				15	$\mu V/^\circ C$
Input Offset Current			3.0	30	nA
Average Input Offset Current Drift				0.5	$nA/^\circ C$
Input Bias Current			30	80	nA
Power Supply Rejection Ratio	$V_S = +10, -20; V_S = +20, -10V, R_S = 50\Omega$		15	50	$\mu V/V$
Output Short Circuit Current		10	25	35	mA
Power Dissipation	$V_S = \pm 20V$		80	150	mW
Input Impedance	$V_S = \pm 20V$	1.0	6.0		M Ω
Large Signal Voltage Gain	$V_S = \pm 20V, R_L = 2k\Omega, V_{OUT} = \pm 15V$	50			V/mV
Transient Response	Rise Time		0.25	0.8	μs
(Unity Gain)	Overshoot		6.0	20	%
Bandwidth (Note 4)		.437	1.5		MHz
Slew Rate (Unity Gain)	$V_{IN} = \pm 10V$	0.3	0.7		V/ μs
The following specifications apply for $0^\circ C < T_A < 70^\circ C$					
Input Offset Voltage				4.0	mV
Input Offset Current				70	nA
Input Bias Current				210	nA
Common Mode Rejection Ratio	$V_S = \pm 20V, V_{IN} = \pm 15V, R_S = 50\Omega$	80	95		dB
Adjustment For Input Offset Voltage	$V_S = \pm 20V$	10			mV
Output Short Circuit Current		10		40	mA
Power Dissipation	$V_S = \pm 20V$			150	mW
Input Impedance	$V_S = \pm 20V$	0.5			M Ω
Output Voltage Swing	$V_S = \pm 20V, R_L = 10k\Omega$	± 16			V
	$R_L = 2k\Omega$	± 15			V
Large Signal Voltage Gain	$V_S = \pm 20V, R_L = 2k\Omega, V_{OUT} = \pm 15V$	32			V/mV
	$V_S = \pm 5V, R_L = 2k\Omega, V_{OUT} = \pm 2V$	10			V/mV

EQUIVALENT CIRCUIT



FAIRCHILD LINEAR INTEGRATED CIRCUITS • $\mu A741$

$\mu A741C$

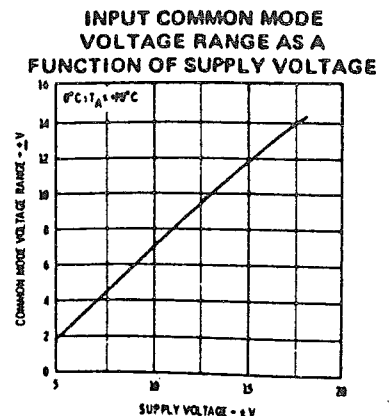
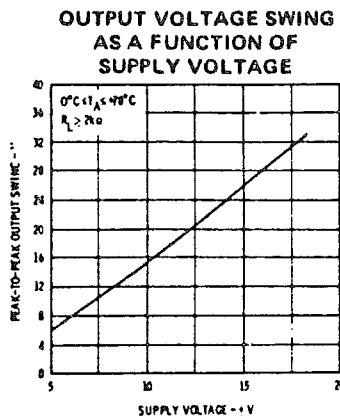
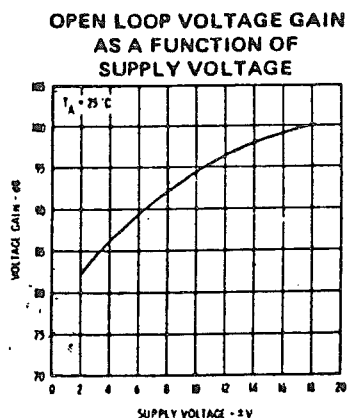
ELECTRICAL CHARACTERISTICS ($V_S = \pm 15\text{ V}$, $T_A = 25^\circ\text{C}$ unless otherwise specified)

PARAMETERS (see definitions)	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leq 10\text{ k}\Omega$		2.0	6.0	mV
Input Offset Current			20	200	nA
Input Bias Current			80	500	nA
Input Resistance		0.3	2.0		$M\Omega$
Input Capacitance			1.4		pF
Offset Voltage Adjustment Range			± 15		mV
Input Voltage Range		± 12	± 13		V
Common Mode Rejection Ratio	$R_S \leq 10\text{ k}\Omega$	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10\text{ k}\Omega$		30	150	$\mu\text{V/V}$
Large Signal Voltage Gain	$R_L \geq 2\text{ k}\Omega$, $V_{OUT} = \pm 10\text{ V}$	20,000	200,000		
Output Voltage Swing	$R_L \geq 10\text{ k}\Omega$	± 12	± 14		V
	$R_L \geq 2\text{ k}\Omega$	± 10	± 13		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	$V_{IN} = 20\text{ mV}$, $R_L = 2\text{ k}\Omega$, $C_L \leq 100\text{ pF}$	0.3		μs
	Overshoot		5.0		%
Slew Rate	$R_L \geq 2\text{ k}\Omega$		0.5		V/ μs

The following specifications apply for $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$:

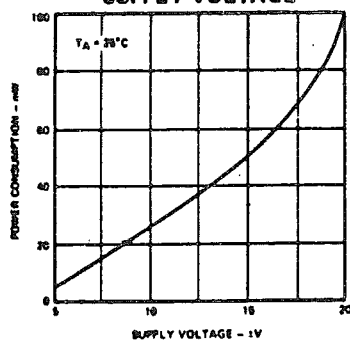
Input Offset Voltage				7.5	mV
Input Offset Current				300	nA
Input Bias Current				800	nA
Large Signal Voltage Gain	$R_L \geq 2\text{ k}\Omega$, $V_{OUT} = \pm 10\text{ V}$	15,000			
Output Voltage Swing	$R_L \geq 2\text{ k}\Omega$	± 10	± 13		V

TYPICAL PERFORMANCE CURVES FOR $\mu A741E$ AND $\mu A741C$

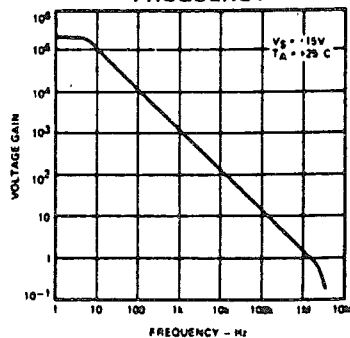


TYPICAL PERFORMANCE CURVES FOR $\mu A741A$, $\mu A741$, $\mu A741E$ AND $\mu A741C$

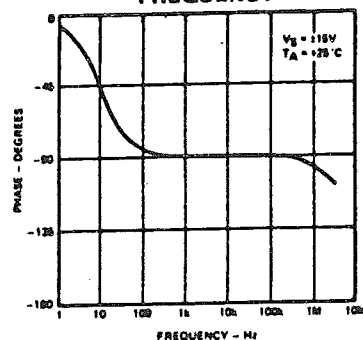
POWER CONSUMPTION
AS A FUNCTION OF
SUPPLY VOLTAGE



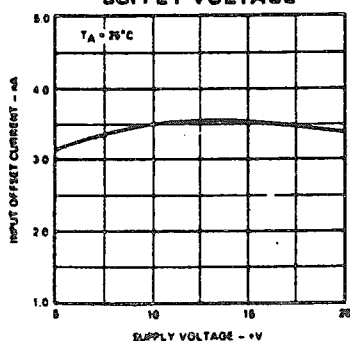
OPEN LOOP VOLTAGE GAIN
AS A FUNCTION OF
FREQUENCY



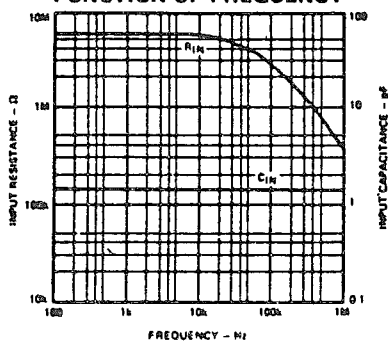
OPEN LOOP PHASE RESPONSE
AS A FUNCTION OF
FREQUENCY



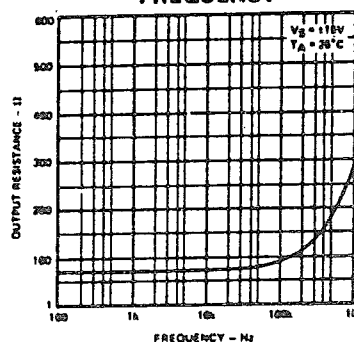
INPUT OFFSET CURRENT
AS A FUNCTION OF
SUPPLY VOLTAGE



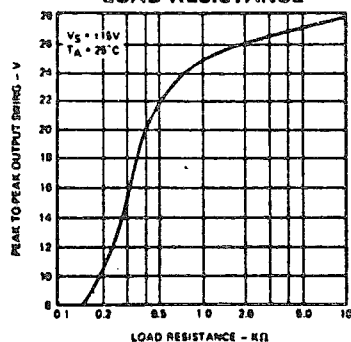
INPUT RESISTANCE AND
INPUT CAPACITANCE AS A
FUNCTION OF FREQUENCY



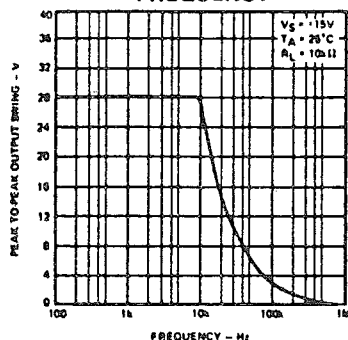
OUTPUT RESISTANCE
AS A FUNCTION OF
FREQUENCY



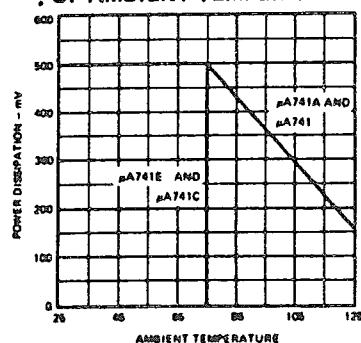
OUTPUT VOLTAGE SWING
AS A FUNCTION OF
LOAD RESISTANCE



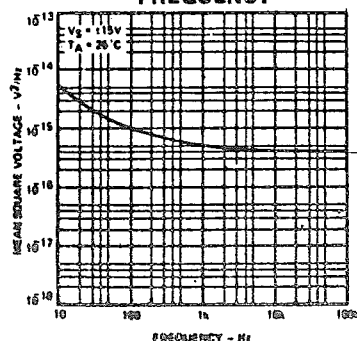
OUTPUT VOLTAGE SWING
AS A FUNCTION OF
FREQUENCY



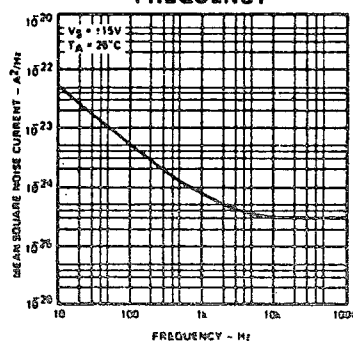
ABSOLUTE MAXIMUM POWER
DISSIPATION AS A FUNCTION
OF AMBIENT TEMPERATURE



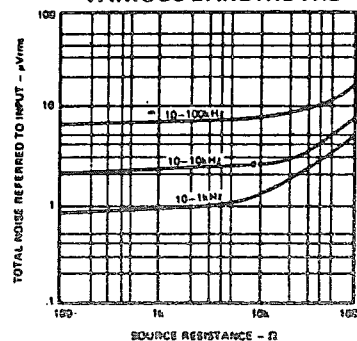
INPUT NOISE VOLTAGE
AS A FUNCTION OF
FREQUENCY



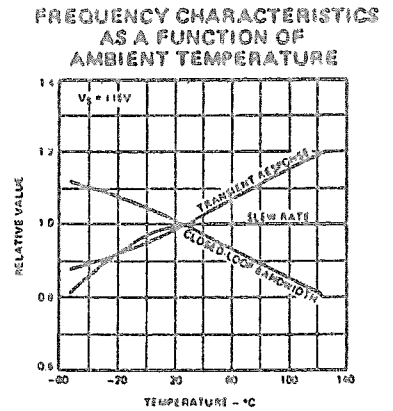
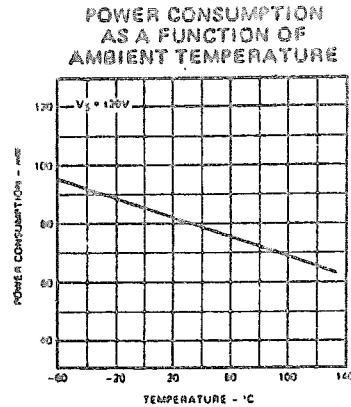
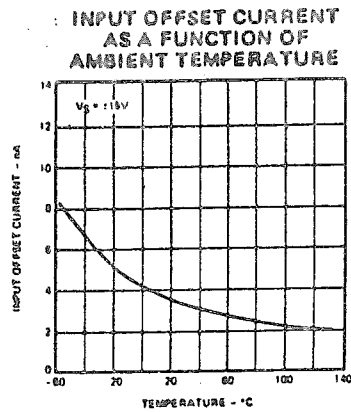
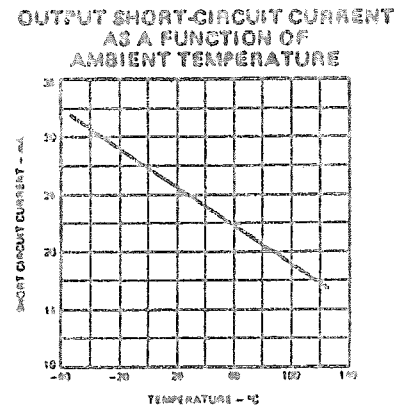
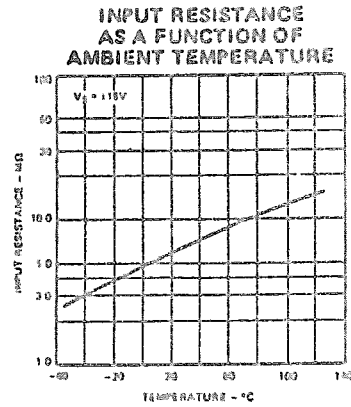
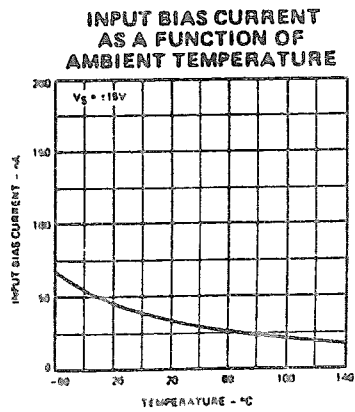
INPUT NOISE CURRENT
AS A FUNCTION OF
FREQUENCY



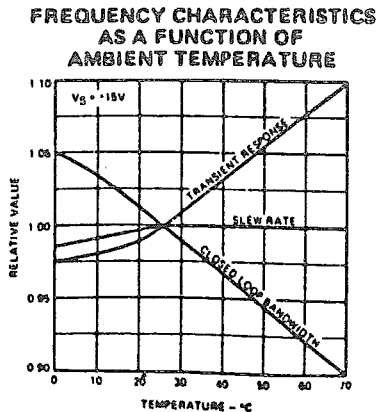
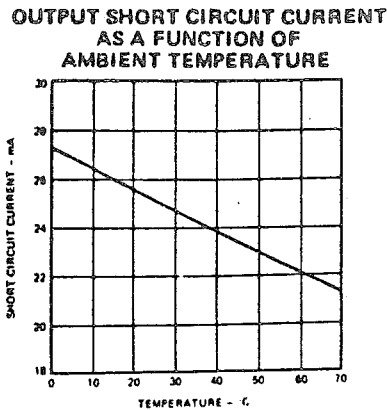
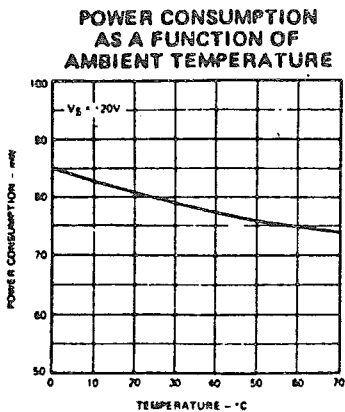
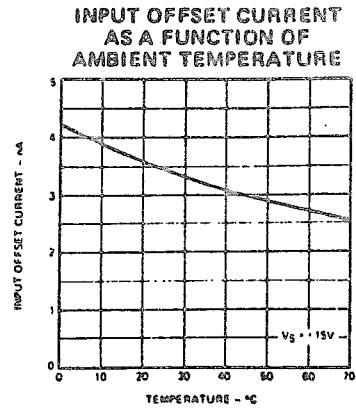
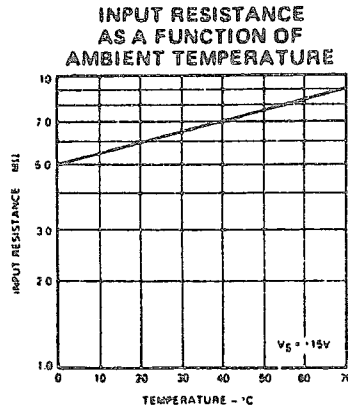
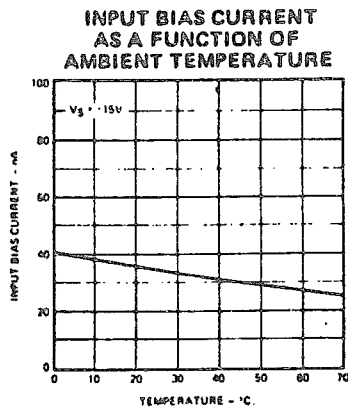
BROADBAND NOISE FOR
VARIOUS BANDWIDTHS



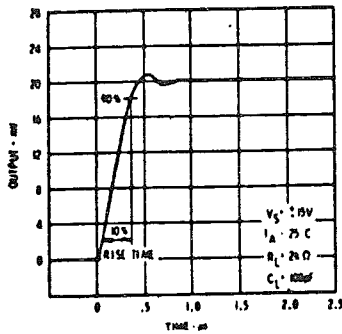
TYPICAL PERFORMANCE CURVES FOR $\mu A741A$ AND $\mu A741$



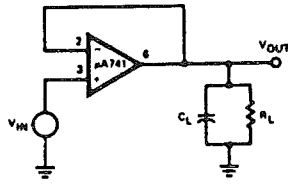
TYPICAL PERFORMANCE CURVES FOR $\mu A741E$ AND $\mu A741C$



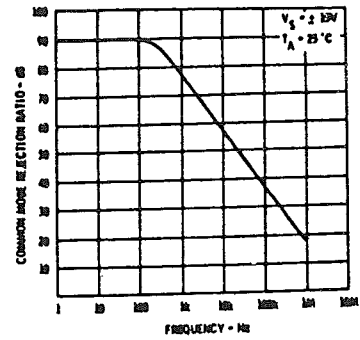
TRANSIENT RESPONSE



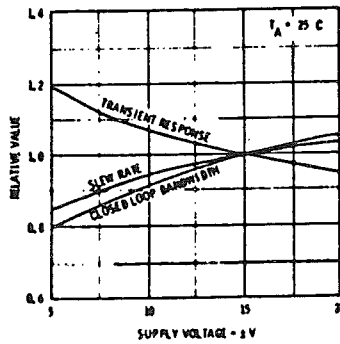
TRANSIENT RESPONSE TEST CIRCUIT



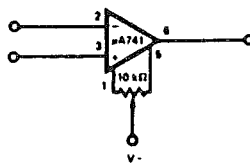
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



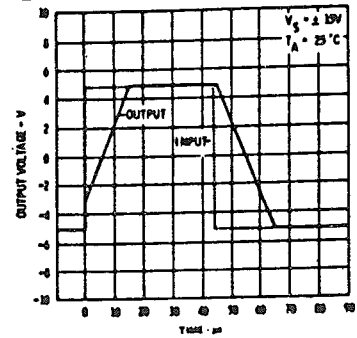
FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE



VOLTAGE OFFSET NULL CIRCUIT

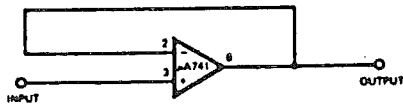


VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



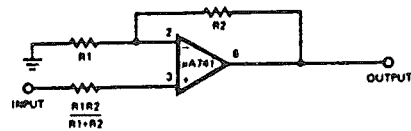
TYPICAL APPLICATIONS

UNITY-GAIN VOLTAGE FOLLOWER



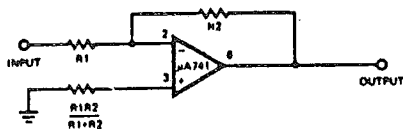
$R_{IN} = 400 M\Omega$
 $C_{IN} = 1 pF$
 $R_{OUT} < 1 \Omega$
B.W. = 1 MHz

NON-INVERTING AMPLIFIER



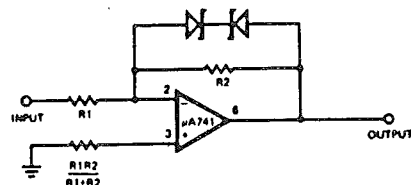
GAIN	R1	R2	BW	R_{IN}
10	1 k Ω	9 k Ω	100 kHz	400 M Ω
100	100 Ω	9.9 k Ω	10 kHz	280 M Ω
1000	100 Ω	99.9 k Ω	1 kHz	80 M Ω

INVERTING AMPLIFIER



GAIN	R1	R2	BW	R_{IN}
1	10 k Ω	10 k Ω	1 MHz	10 k Ω
10	1 k Ω	10 k Ω	100 kHz	1 k Ω
100	1 k Ω	100 k Ω	10 kHz	1 k Ω
1000	100 Ω	100 k Ω	1 kHz	100 Ω

CLIPPING AMPLIFIER

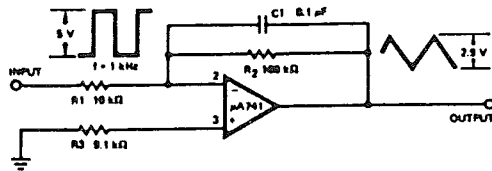


$$\frac{E_{OUT}}{E_{IN}} = \frac{R_2}{R_1} \text{ if } |E_{OUT}| < V_Z + 0.7 V$$

where V_Z = Zener breakdown voltage

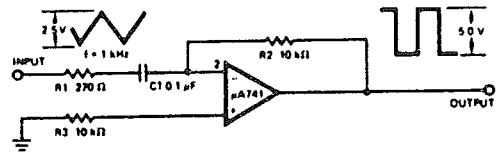
TYPICAL APPLICATIONS (Cont'd)

SIMPLE INTEGRATOR



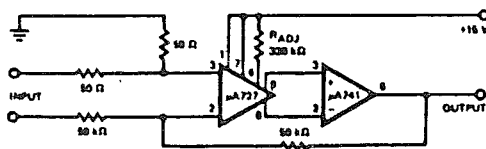
$$E_{OUT} = - \frac{1}{R_1 C_1} \int E_{IN} dt$$

SIMPLE DIFFERENTIATOR



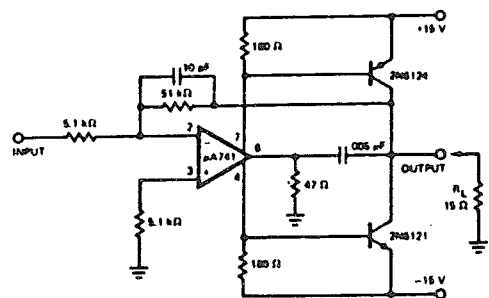
$$E_{OUT} = - R_2 C_1 \frac{dE_{IN}}{dt}$$

LOW DRIFT LOW NOISE AMPLIFIER

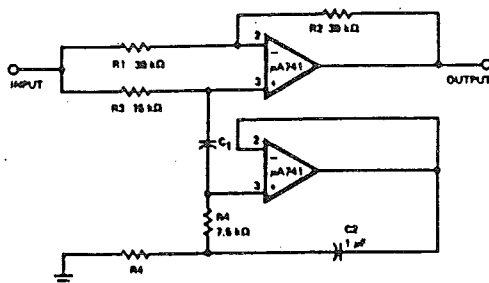


Voltage Gain = 10^3
Input Offset Voltage Drift = $0.6 \mu V/^{\circ}C$
Input Offset Current Drift = $2.0 pA/^{\circ}C$

HIGH SLEW RATE POWER AMPLIFIER



NOTCH FILTER USING THE $\mu A741$ AS A GYRATOR



Trim R3 such that

$$\frac{R_1}{R_2} = \frac{R_3}{2 R_4}$$

NOTCH FREQUENCY AS A FUNCTION OF C1

