µA741

FREQUENCY-COMPENSATED OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

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.

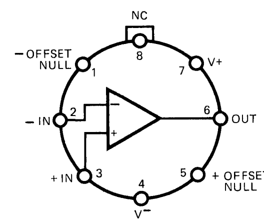
- **NO FREQUENCY COMPENSATION REQUIRED**
- **SHORT CIRCUIT PROTECTION**
- **OFFSET VOLTAGE NULL CAPABILITY**
- **LARGE COMMON MODE AND DIFFERENTIAL VOLTAGE RANGES**
- **LOW POWER CONSUMPTION**
- **NO LATCH-UP**

ABSOLUTE MAXIMUM RATINGS

Supply Voltage	
µA741A, µA741, µA741E	±22 V
µA741C	±18 V
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
Pin Temperature (Soldering)	
Metal Can, Hermetic DIPs, and Flatpak (60 s)	300°C
Molded DIPs (10 s)	260°C
Output Short Circuit Duration (Note 3)	Indefinite

CONNECTION DIAGRAMS

8-PIN METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5B
PACKAGE CODE H

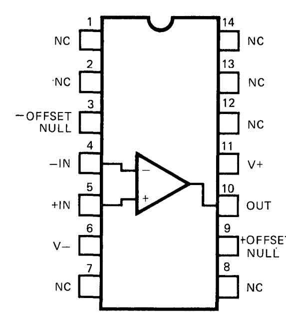


Note: Pin 4 connected to case

ORDER INFORMATION

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

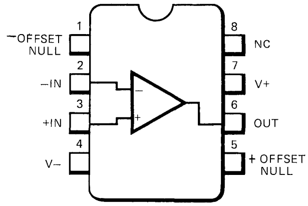
14-PIN DIP
(TOP VIEW)
PACKAGE OUTLINES 6A, 9A
PACKAGE CODES D P



ORDER INFORMATION

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

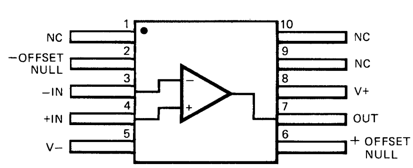
8-PIN MINI DIP
(TOP VIEW)
PACKAGE OUTLINES 6T 9T
PACKAGE CODES R T



ORDER INFORMATION

TYPE	PART NO.
µA741C	µA741TC
µA741C	µA741RC

10-PIN FLATPAK
(TOP VIEW)
PACKAGE OUTLINE 3F
PACKAGE CODE F



ORDER INFORMATION

TYPE	PART NO.
µA741A	µA741AFM
µA741	µA741FM

Notes on following pages.

*Planar is a patented Fairchild process.

μA741A

ELECTRICAL CHARACTERISTICS: $V_S = \pm 15$ 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					3.0	30	nA
Average Input Offset Current Drift						0.5	nA/°C
Input Bias Current					30	80	nA
Power Supply Rejection Ratio		V_S = +20, −20; V_S = −20, +10V, $R_S = 50\Omega$			15	50	μV/V
Output Short Circuit Current				10	25	40	mA
Power Dissipation		$V_S = \pm 20V$			80	150	mW
Input Impedance		$V_S = \pm 20V$		1.0	6.0		MΩ
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 $-55°C \leq T_A \leq +125°C$							
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°C			165	mW
			+125°C			135	mW
Input Impedance		$V_S = \pm 20V$		0.5			MΩ
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
		$V_S = \pm 5V$, $R_L = 2k\Omega$, $V_{OUT} = \pm 2$ V		10			V/mV

NOTES

1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3mW/°C for the metal can, 8.3mW/°C for the DIP and 7.1mW/°C for the Flatpak.
2. For supply voltages less than ±15V, 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: $BW(MHz) = \frac{0.35}{\text{Rise Time } (\mu s)}$

μA741

ELECTRICAL CHARACTERISTICS: V_S = ±15 V, T_A = 25°C unless otherwise specified.

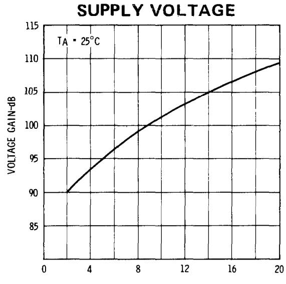
CHARACTERISTICS (see definitions)	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leq 10\ k\Omega$		1.0	5.0	mV
Input Offset Current			20	200	nA
Input Bias Current			80	500	nA
Input Resistance		0.3	2.0		MΩ
Input Capacitance			1.4		pF
Offset Voltage Adjustment Range			±15		mV
Large Signal Voltage Gain	$R_L \geq 2\ k\Omega$, V_{OUT} = ±10 V	50,000	200,000		
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	V_{IN} = 20 mV, R_L = 2 kΩ, $C_L \leq 100$ pF		5.0		%
Slew Rate	$R_L \geq 2\ k\Omega$		0.5		V/μs

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

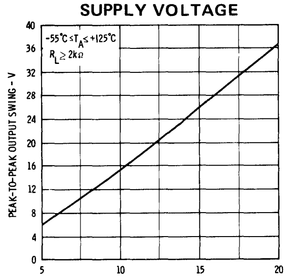
CHARACTERISTICS	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leq 10\ k\Omega$		1.0	6.0	mV
Input Offset Current	T_A = +125°C		7.0	200	nA
	T_A = −55°C		85	500	nA
Input Bias Current	T_A = +125°C		0.03	0.5	μA
	T_A = −55°C		0.3	1.5	μA
Input Voltage Range		±12	±13		V
Common Mode Rejection Ratio	$R_S \leq 10\ k\Omega$	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10\ k\Omega$		30	150	μV/V
Large Signal Voltage Gain	$R_L \geq 2\ k\Omega$, V_{OUT} = ±10 V	25,000			
Output Voltage Swing	$R_L \geq 10\ k\Omega$	±12	±14		V
	$R_L \geq 2\ k\Omega$	±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

TYPICAL PERFORMANCE CURVES FOR μA741A AND μA741

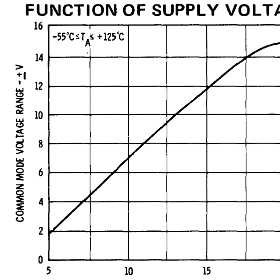
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



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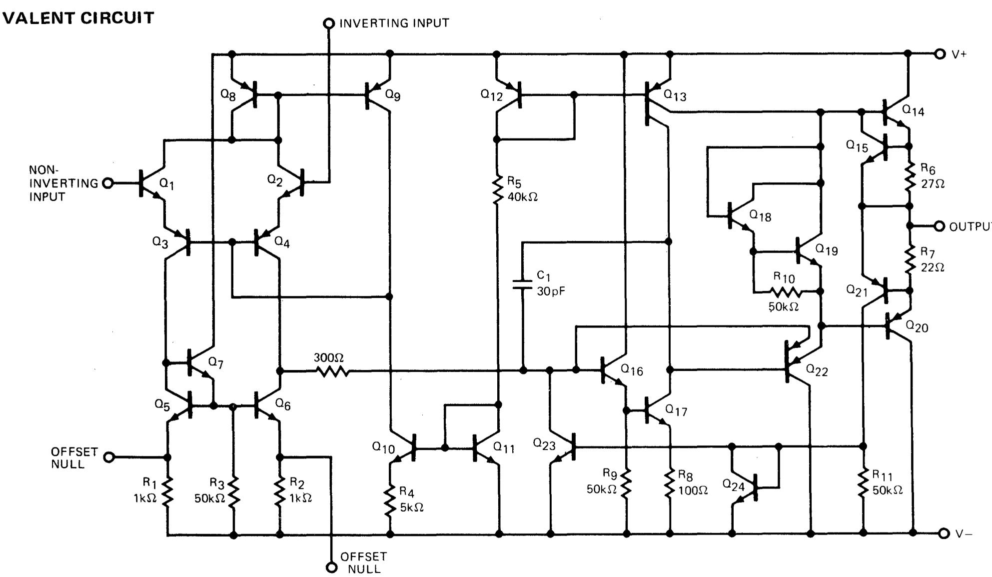
μA741E

ELECTRICAL CHARACTERISTICS: V_S = ±15 V, T_A = 25°C unless otherwise specified.

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

EQUIVALENT CIRCUIT



μA741C

ELECTRICAL CHARACTERISTICS: V_S = ±15 V, T_A = 25°C unless otherwise specified.

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

The following specifications apply for $0^\circ C \leqslant T_A \leqslant +70^\circ C$:

	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage				7.5	mV
Input Offset Current				300	nA
Input Bias Current				800	nA
Large Signal Voltage Gain	$R_L \geqslant 2\ k\Omega$, V_{OUT} = ±10 V	15,000			
Output Voltage Swing	$R_L \geqslant 2\ k\Omega$	±10	±13		V

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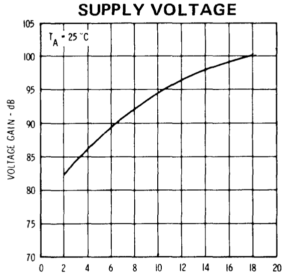
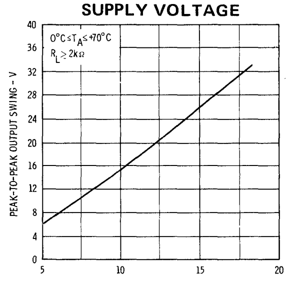
TYPICAL PERFORMANCE CURVES FOR μA741E AND μA741C

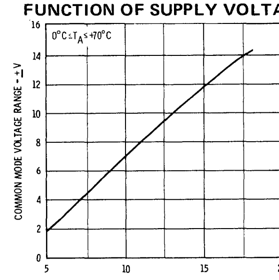
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE

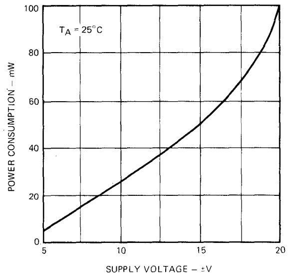


INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE

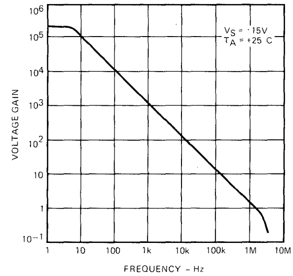


TYPICAL PERFORMANCE CURVES FOR μA741A, μA741, μA741E AND μA741C

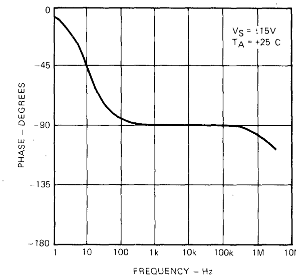
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



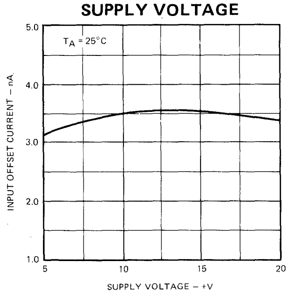
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



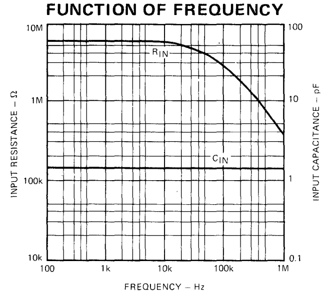
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



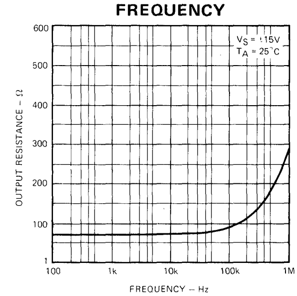
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



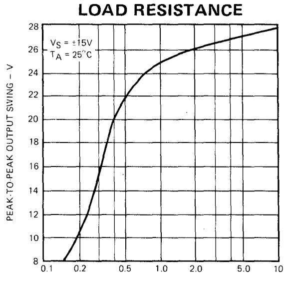
INPUT RESISTANCE AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



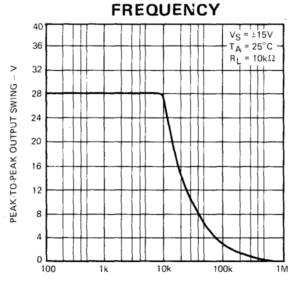
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY



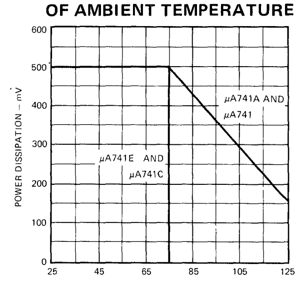
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



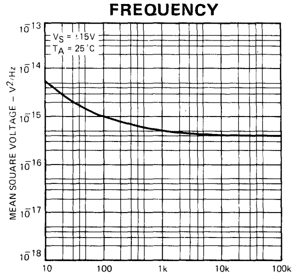
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



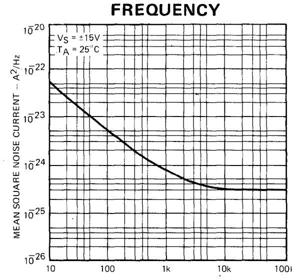
ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



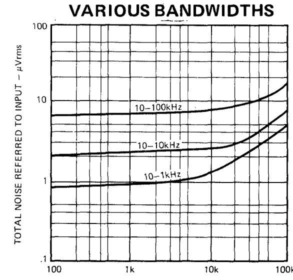
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY

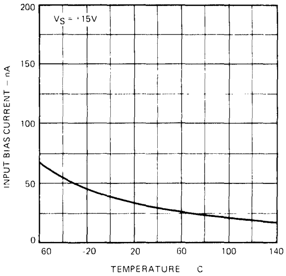


BROADBAND NOISE FOR VARIOUS BANDWIDTHS

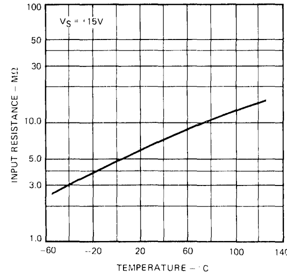


TYPICAL PERFORMANCE CURVES FOR μA741A AND μA741

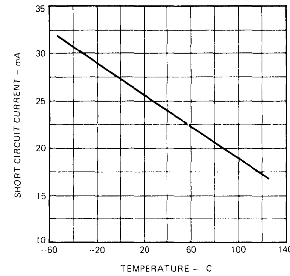
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



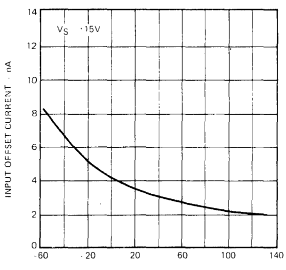
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



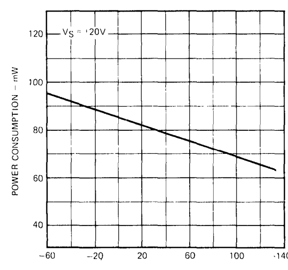
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



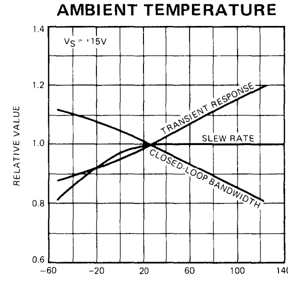
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE

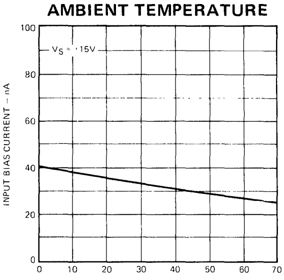


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

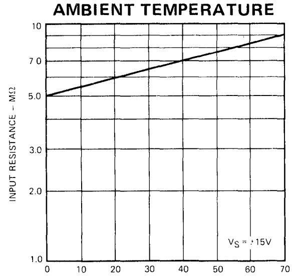


TYPICAL PERFORMANCE CURVES FOR μA741E AND μA741C

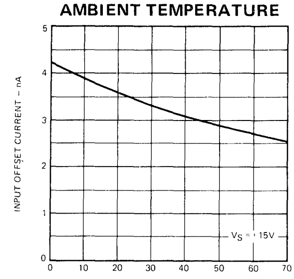
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



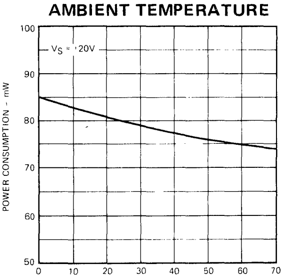
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



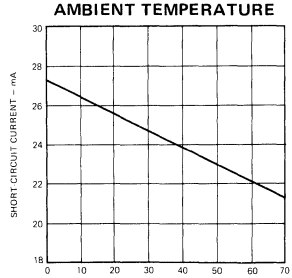
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



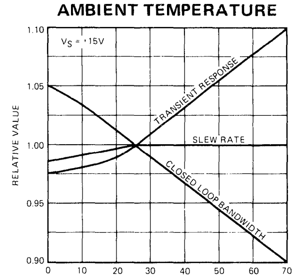
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



OUTPUT SHORT CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

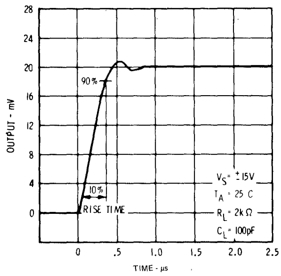


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

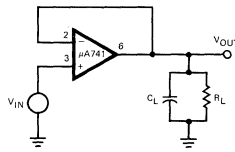


5

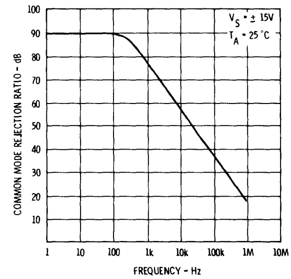
TRANSIENT RESPONSE



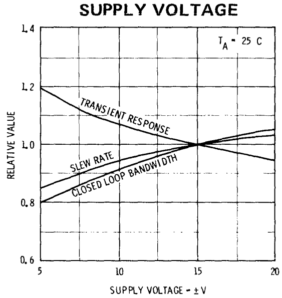
TRANSIENT RESPONSE TEST CIRCUIT



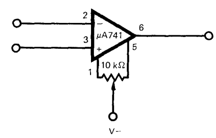
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



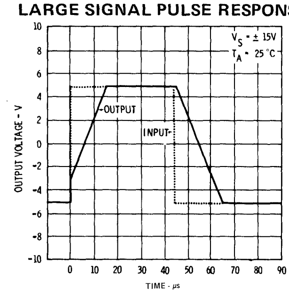
FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE



VOLTAGE OFFSET NULL CIRCUIT

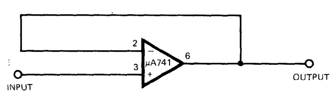


VOLTAGE FOLLOWER LARGE SIGNAL PULSE RESPONSE



TYPICAL APPLICATIONS

UNITY-GAIN VOLTAGE FOLLOWER



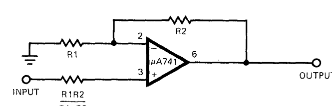
$R_{IN} = 400\ M\Omega$

$C_{IN} = 1\ pF$

$R_{OUT} << 1\ \Omega$

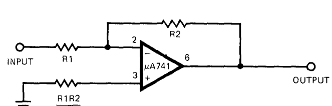
B.W. = 1 MHz

NON-INVERTING AMPLIFIER



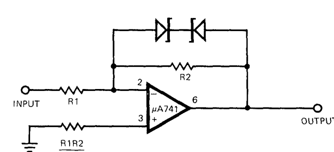
GAIN	R1	R2	B W	R_{IN}
10	1 kΩ	9 kΩ	100 kHz	400 MΩ
100	100 Ω	9.9 kΩ	10 kHz	280 MΩ
1000	100 Ω	99.9 kΩ	1 kHz	80 MΩ

INVERTING AMPLIFIER



GAIN	R1	R2	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

CLIPPING AMPLIFIER

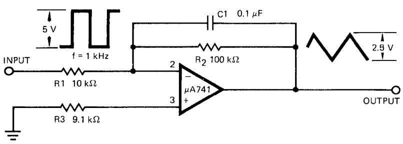


$$\frac{E_{OUT}}{E_{IN}} = \frac{R2}{R1} \text{ if } |E_{OUT}| \leq V_Z + 0.7\ V$$

where V_Z = Zener breakdown voltage

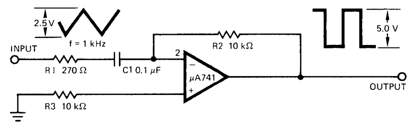
TYPICAL APPLICATIONS (Cont'd)

SIMPLE INTEGRATOR



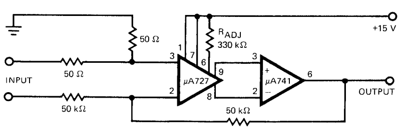
$$E_{OUT} = -\frac{1}{R_1C_1}\int E_{IN}dt$$

SIMPLE DIFFERENTIATOR



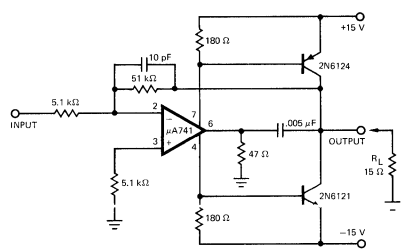
$$E_{OUT} = -R2C\frac{dE_{IN}}{dt}$$

LOW DRIFT LOW NOISE AMPLIFIER

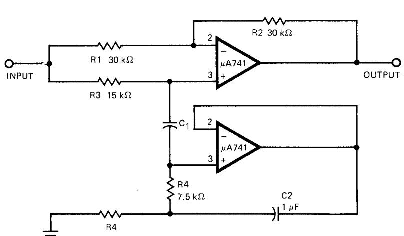


Voltage Gain = 10^3
Input Offset Voltage Drift = 0.6 μV/°C
Input Offset Current Drift = 2.0 pA/°C

HIGH SLEW RATE POWER AMPLIFIER



NOTCH FILTER USING THE μA741 AS A GYRATOR



Trim R3 such that

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

NOTCH FREQUENCY AS A FUNCTION OF C_1