EXPERIMENT NO.1

TITLE: INTERPRETATION OF DATA SHEETS AND CHARACTERISTICS OF AN OP-AMP.

OBJECTIVES:

1. To extract from data sheets some of the basic op-amp characteristics such as typical applications, absolute maximum ratings, connection diagram and electrical characteristics.
2. To define the terms input offset voltage, input offset current, CMRR, Large Signal Voltage Gain and slew rate & state their typical values for 741C.

LAB REQUIREMENT:

Datasheet of op-amp IC 741.

INTERPRETATION OF A TYPICAL SET OF DATA SHEETS:

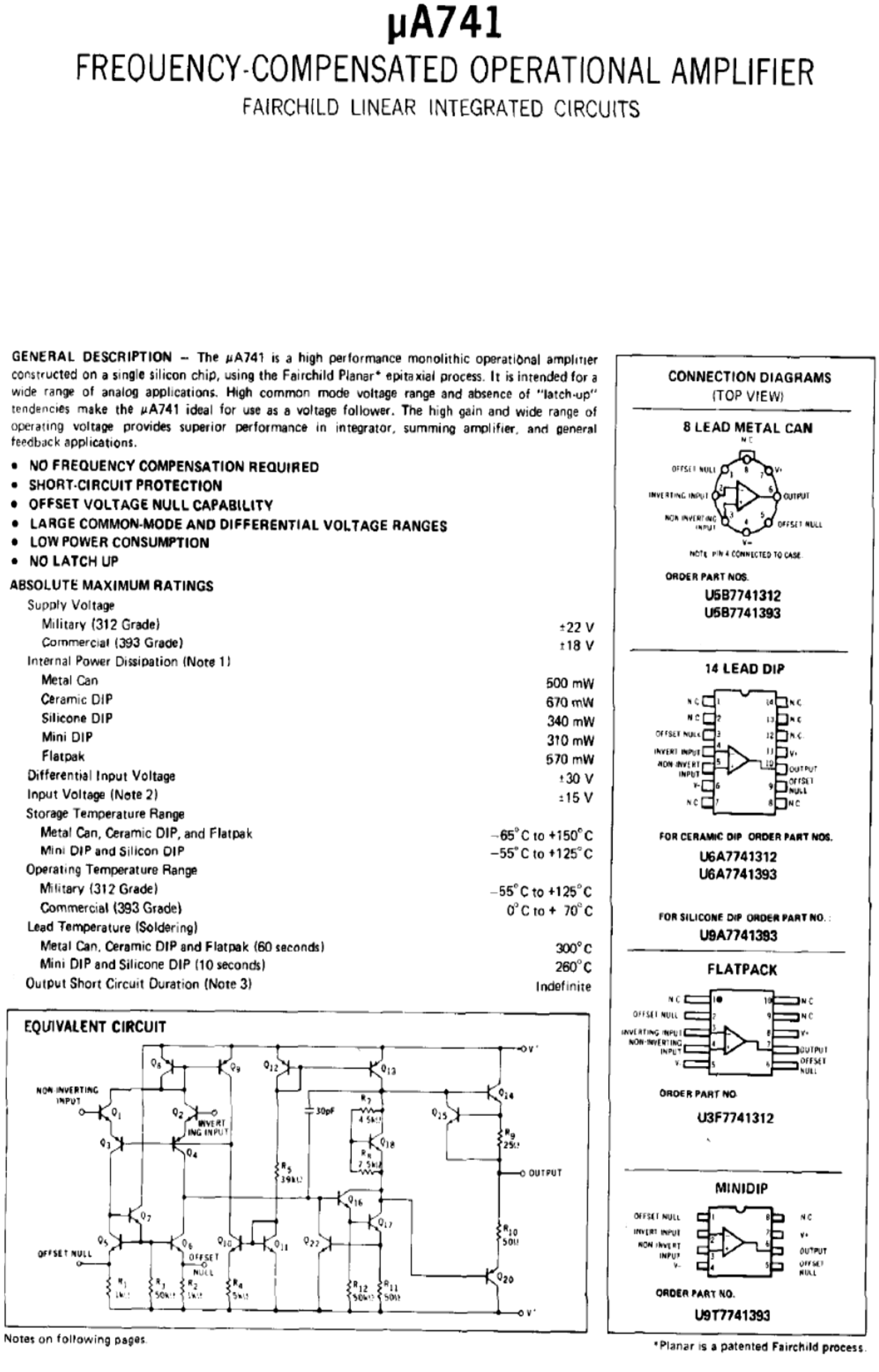
Manufacturers supply datasheets for the IC they produce. These data sheets provide wealth of information: absolute maximum ratings, intended applications, performance limitation, pin diagrams, equivalent circuits of the devices and more. To get the most use out of these data sheets, we must be able to interpret properly the information presented in them. Proper interpretation of the data sheet not only help you to understand the characteristics of op-amp but should also help you to select proper op-amp for a desired application.

How to read the data sheets of op-amp IC μA741?

With reference to the data sheets of op-amp IC μA741, information on the data sheets is broken down into following groups:

1. At the top of the datasheet is a device number and brief description of the basic types of the device such as frequency compensated op-amp, low power op-amp or low cost programmable op-amp.
2. A general description is given that includes the construction process of the device, intended applications and list of main features.
3. Absolute maximum ratings for the proper operation of the device are then specified. These values are limiting values of the device which should not be exceeded.
4. Pin configuration, package types and order information is given.
5. The internal schematic diagram is shown.
6. Electrical Characteristics and parameter values under specific conditions are also given.
7. Typical Performance curve such as voltage gain v/s supply voltage, output voltage swing as a function of frequency and power consumption as a function of temperature are provided.
8. Finally, typical applications and test circuits for the device are illustrated.

DATASHEET OF OP-AMP IC µA741:



µA741

FREQUENCY-COMPENSATED OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

GENERAL DESCRIPTION – The µA741 is a high performance monolithic operational amplifier constructed on a single silicon chip, 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	
Military (312 Grade)	±22 V
Commercial (393 Grade)	±18 V
Internal Power Dissipation (Note 1)	
Metal Can	500 mW
Ceramic DIP	670 mW
Silicone DIP	340 mW
Mini DIP	310 mW
Flatpak	570 mW
Differential Input Voltage	±30 V
Input Voltage (Note 2)	±15 V
Storage Temperature Range	
Metal Can, Ceramic DIP, and Flatpak	−65°C to +150°C
Mini DIP and Silicon DIP	−55°C to +125°C
Operating Temperature Range	
Military (312 Grade)	−55°C to +125°C
Commercial (393 Grade)	0°C to + 70°C
Lead Temperature (Soldering)	
Metal Can, Ceramic DIP and Flatpak (60 seconds)	300°C
Mini DIP and Silicone DIP (10 seconds)	260°C
Output Short Circuit Duration (Note 3)	Indefinite

EQUIVALENT CIRCUIT

Notes on following pages.

CONNECTION DIAGRAMS
(TOP VIEW)

8 LEAD METAL CAN

NOTE: PIN 4 CONNECTED TO CASE.

ORDER PART NOS.
U5B7741312
U5B7741393

14 LEAD DIP

FOR CERAMIC DIP ORDER PART NOS.
U6A7741312
U6A7741393

FOR SILICONE DIP ORDER PART NO.:
U9A7741393

FLATPACK

ORDER PART NO.
U3F7741312

MINIDIP

ORDER PART NO.
U9T7741393

*Planar is a patented Fairchild process.

393 GRADE

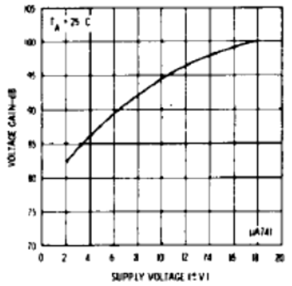
ELECTRICAL CHARACTERISTICS ($V_S = \pm 15$ V, $T_A = 25°C$ unless otherwise specified)

PARAMETERS (see definitions)	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10$ kΩ		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	$R_S \leq 10$ 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, $V_{out} = \pm 10$ V	20,000	200,000		
Output Voltage Swing	$R_L \geq 10$ kΩ	±12	±14		V
	$R_L \geq 2$ kΩ	±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)	$V_{in} = 20$ mV, $R_L = 2$ kΩ, $C_L \leq 100$ pF				
Risetime			0.3		μs
Overshoot			5.0		%
Slew Rate	$R_L \geq 2$ kΩ		0.5		V/μs
The following specifications apply for $0°C \leq T_A \leq +70°C$:					
Input Offset Voltage				7.5	mV
Input Offset Current				300	nA
Input Bias Current				800	nA
Large-Signal Voltage Gain	$R_L \geq 2$ kΩ, $V_{out} = \pm 10$ V	15,000			
Output Voltage Swing	$R_L \geq 2$ kΩ	±10	±13		V

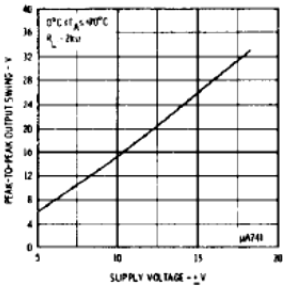
TYPICAL PERFORMANCE CURVES

393 GRADE

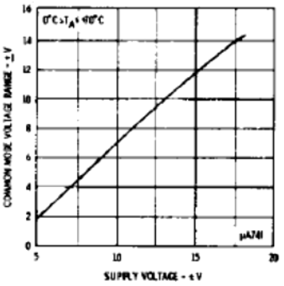
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE

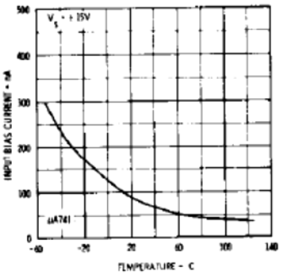


NOTES

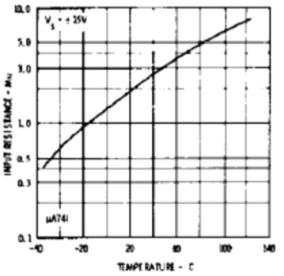
1. Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for the Metal Can, 8.3 mW/°C for the Ceramic DIP, 6.3 mW/°C for the Silicone DIP, 5.6 mW/°C for the Mini DIP and 7.1 mW/°C for the Flatpak.
2. For supply voltages less than ±15 V, the absolute maximum 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[illegible] ambient temperature.

TYPICAL PERFORMANCE CURVES (312 GRADE)

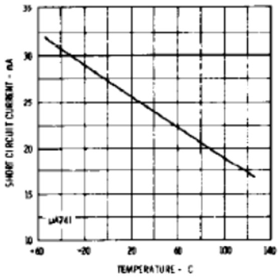
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



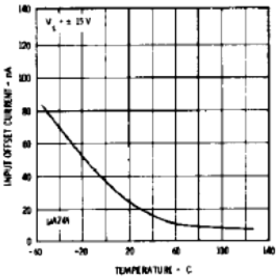
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



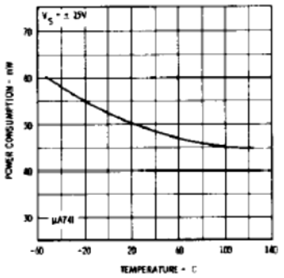
OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



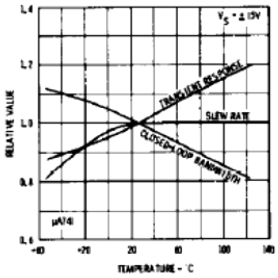
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE

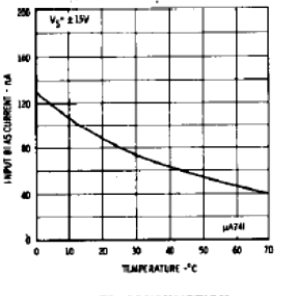


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

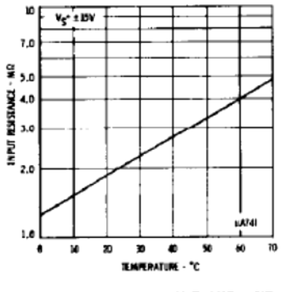


(393 GRADE)

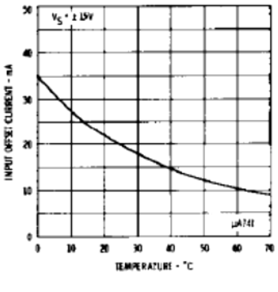
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



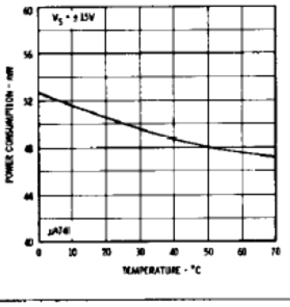
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



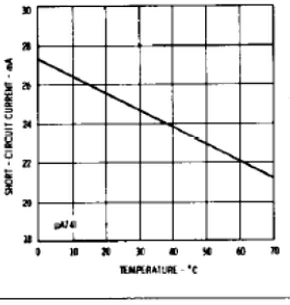
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



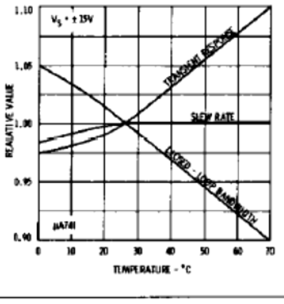
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



OUTPUT SHORT-CIRCUIT CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE

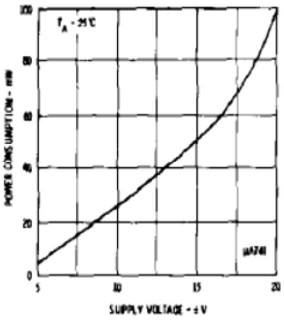


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

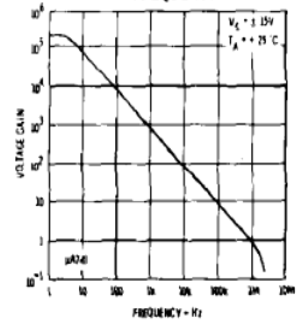


TYPICAL PERFORMANCE CURVES (312 AND 393 GRADES)

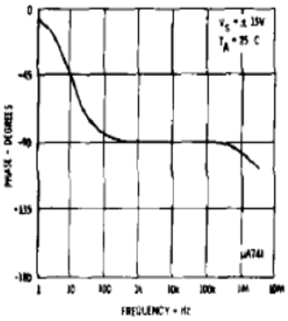
POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



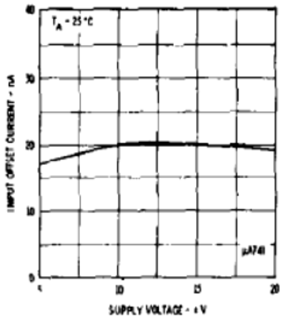
OPEN LOOP VOLTAGE GAIN AS A FUNCTION OF FREQUENCY



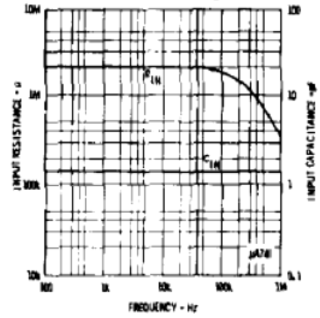
OPEN LOOP PHASE RESPONSE AS A FUNCTION OF FREQUENCY



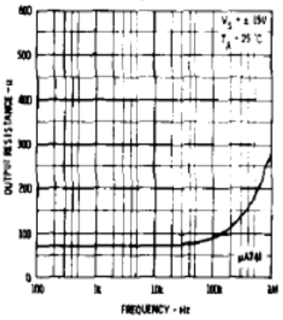
INPUT OFFSET CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



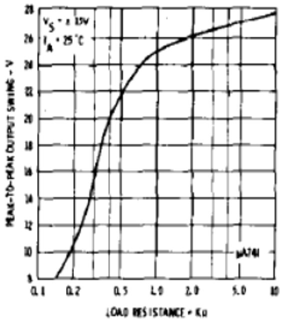
INPUT RESISTANCE AND INPUT CAPACITANCE AS A FUNCTION OF FREQUENCY



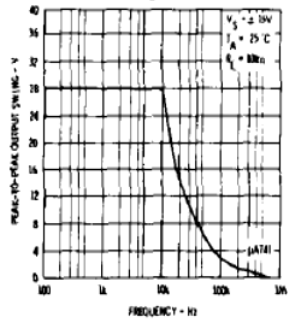
OUTPUT RESISTANCE AS A FUNCTION OF FREQUENCY



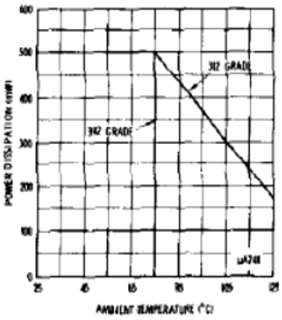
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



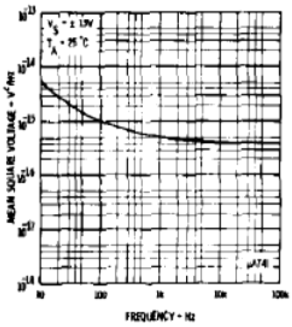
OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY



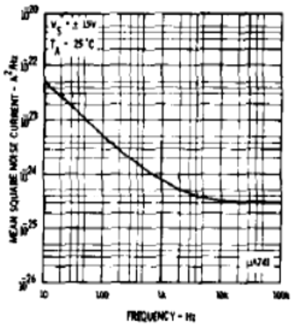
ABSOLUTE MAXIMUM POWER DISSIPATION AS A FUNCTION OF AMBIENT TEMPERATURE



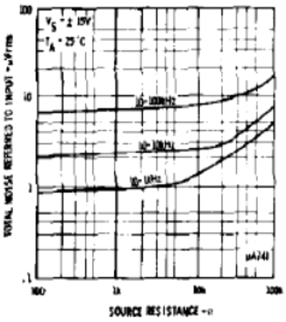
INPUT NOISE VOLTAGE AS A FUNCTION OF FREQUENCY



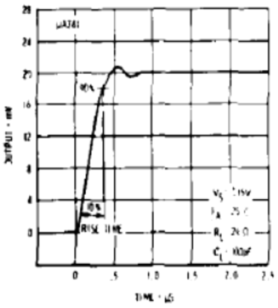
INPUT NOISE CURRENT AS A FUNCTION OF FREQUENCY



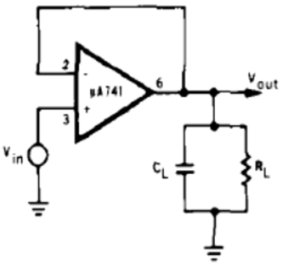
BROADBAND NOISE FOR VARIOUS BANDWIDTHS



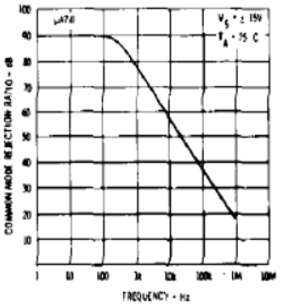
TRANSIENT RESPONSE



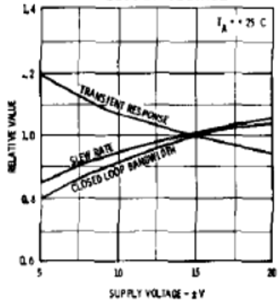
TRANSIENT RESPONSE TEST CIRCUIT



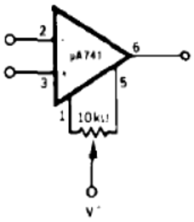
COMMON MODE REJECTION RATIO AS A FUNCTION OF FREQUENCY



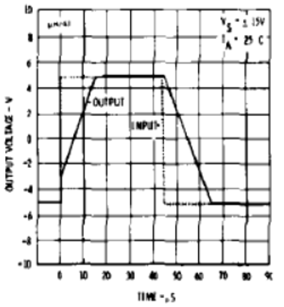
FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE



VOLTAGE OFFSET NULL CIRCUIT

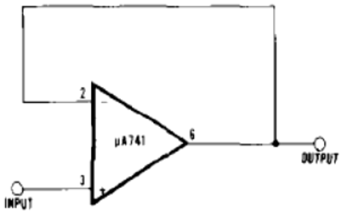


VOLTAGE FOLLOWER LARGE-SIGNAL PULSE RESPONSE



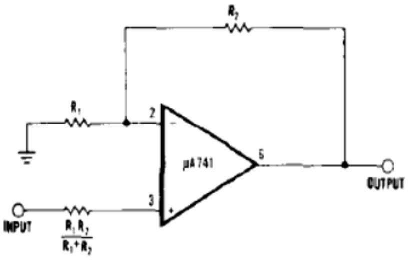
TYPICAL APPLICATIONS

UNITY-GAIN VOLTAGE FOLLOWER



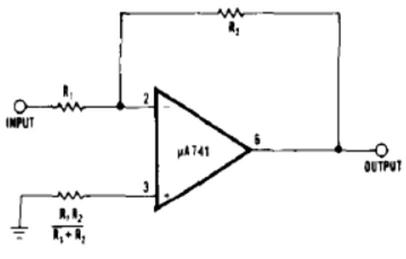
R_{IN} — 400 MΩ
C_{IN} = 1 pF
R_{OUT} << 1 Ω
B.W. = 1 MHz

NON-INVERTING AMPLIFIER



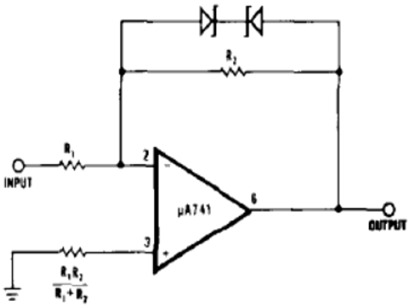
GAIN	R_1	R_2	B.W.	R_{IN}
10	1 kΩ	9 kΩ	100 kHz	400 MΩ
100	100 Ω	9.9 kΩ	10 kHz	280 MΩ
1000	100 Ω	99.9 kΩ	1 kHz	80 MΩ

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

CLIPPING AMPLIFIER

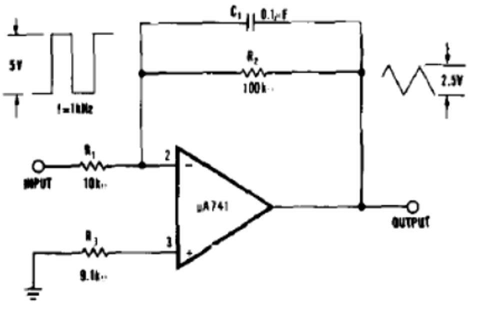


$$\frac{E_{out}}{E_{IN}} - \frac{R_2}{R_1} \text{ if } |E_{out}| \leq V_Z + 0.7\ \text{V}$$

where V_Z – Zener breakdown voltage

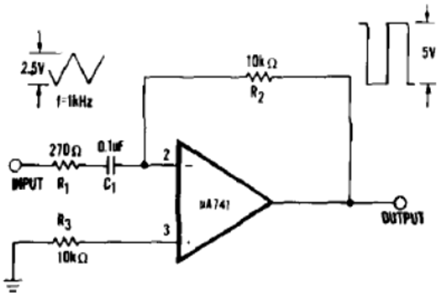
TYPICAL APPLICATIONS

SIMPLE INTEGRATOR



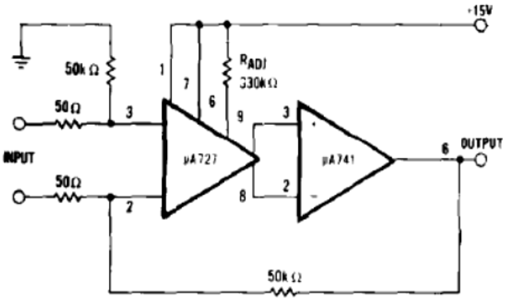
$$E_{out} = -\frac{1}{R_1C_1}\int E_{IN}dt$$

SIMPLE DIFFERENTIATOR



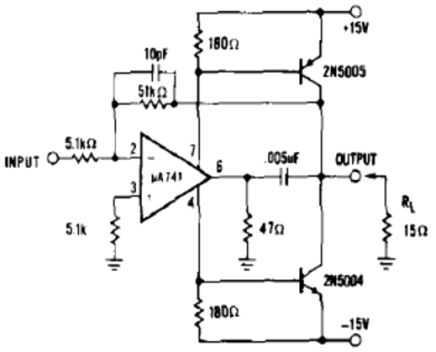
$$E_{out} = -R_2C_1\frac{dE_{IN}}{dt}$$

LOW DRIFT LOW NOISE AMPLIFIER

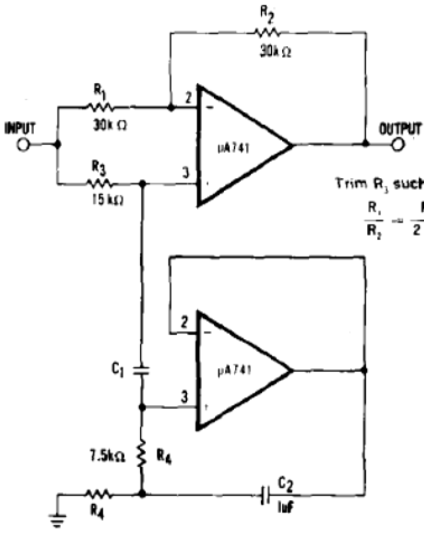


Voltage Gain = 10^3
Input Offset Voltage Drift = 0.6 μV/°C
Input Offset Current Drift = 2.0 pA/°C

HIGH SLEW RATE POWER AMPLIFIER

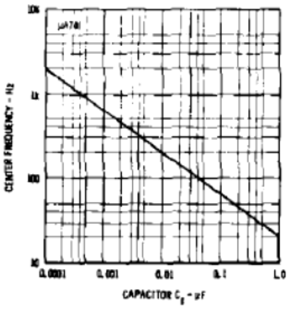


NOTCH FILTER USING THE μA741 AS A GYRATOR



Trim R_3 such that
$$\frac{R_1}{R_2} = \frac{R_3}{2R_4}$$

NOTCH FREQUENCY AS A FUNCTION OF C_1



Following points can be outlined from the data sheets of op-amp IC µA741-

1. The Fairchild 741 is ______________________________op-amp.
2. The 741 is a monolithic IC constructed by a special process called '___________________________'. It is suited for____applications.
3. The features of the 741 are as follows:

____

____

____

4. Absolute maximum ratings are specified for ______________________________

____

____

5. The 741 ia available in all three packages:______________________________
6. The equivalent circuit diagram illustrates______________________________
7. For IC 741C, two sets of electrical specifications are given i.e. One set applies at__________________________, whereas the other set applies to the commercial temperature range from______________________.
8. The electrical parameters mentioned in the data sheets are applicable at supply voltages of ____________________________________.

Definitions of Electrical Parameters & their typical values for 741C:

1. **Input Offset Voltage:**

____

____

____

2. **Input Offset Current:**

____

____

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3. **CMRR:**

4. **Large Signal Voltage Gain:**

5. **Slew Rate:**

EVALUATION(FOR TEACHER):

Excellent/Good/Average/Poor