

# μA741, μA741Y GENERAL-PURPOSE OPERATIONAL AMPLIFIERS

SLOS094A – NOVEMBER 1970 – REVISED JANUARY 1992

- Short-Circuit Protection
- Offset-Voltage Null Capability
- Large Common-Mode and Differential Voltage Ranges
- No Frequency Compensation Required
- Low Power Consumption
- No Latch-Up
- Designed to Be Interchangeable With Fairchild μA741

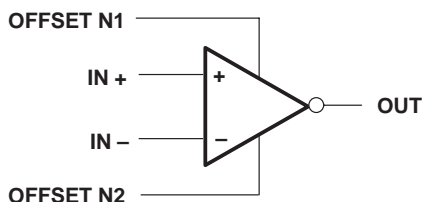
## description

The μA741 is a general-purpose operational amplifier featuring offset-voltage null capability.

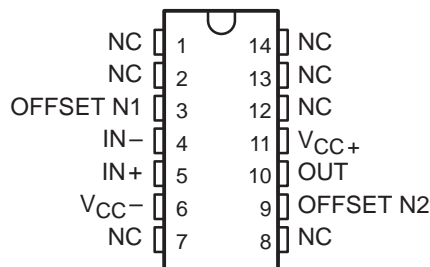
The high common-mode input voltage range and the absence of latch-up make the amplifier ideal for voltage-follower applications. The device is short-circuit protected and the internal frequency compensation ensures stability without external components. A low value potentiometer may be connected between the offset null inputs to null out the offset voltage as shown in Figure 2.

The μA741C is characterized for operation from 0°C to 70°C. The μA741I is characterized for operation from -40°C to 85°C. The μA741M is characterized for operation over the full military temperature range of -55°C to 125°C.

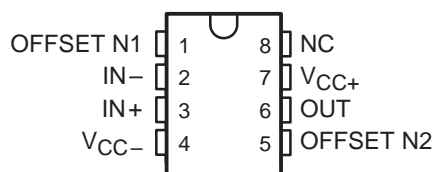
## symbol



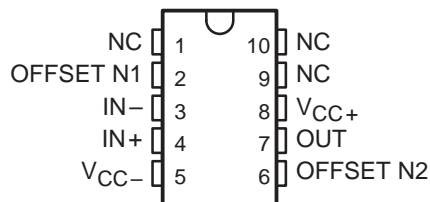
μA741M . . . J PACKAGE  
(TOP VIEW)



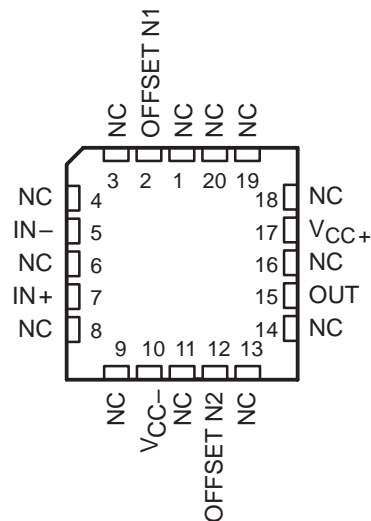
μA741M . . . JG PACKAGE  
μA741C, μA741I . . . D, P, OR PW PACKAGE  
(TOP VIEW)



μA741M . . . U PACKAGE  
(TOP VIEW)



μA741M . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS  
INSTRUMENTS**

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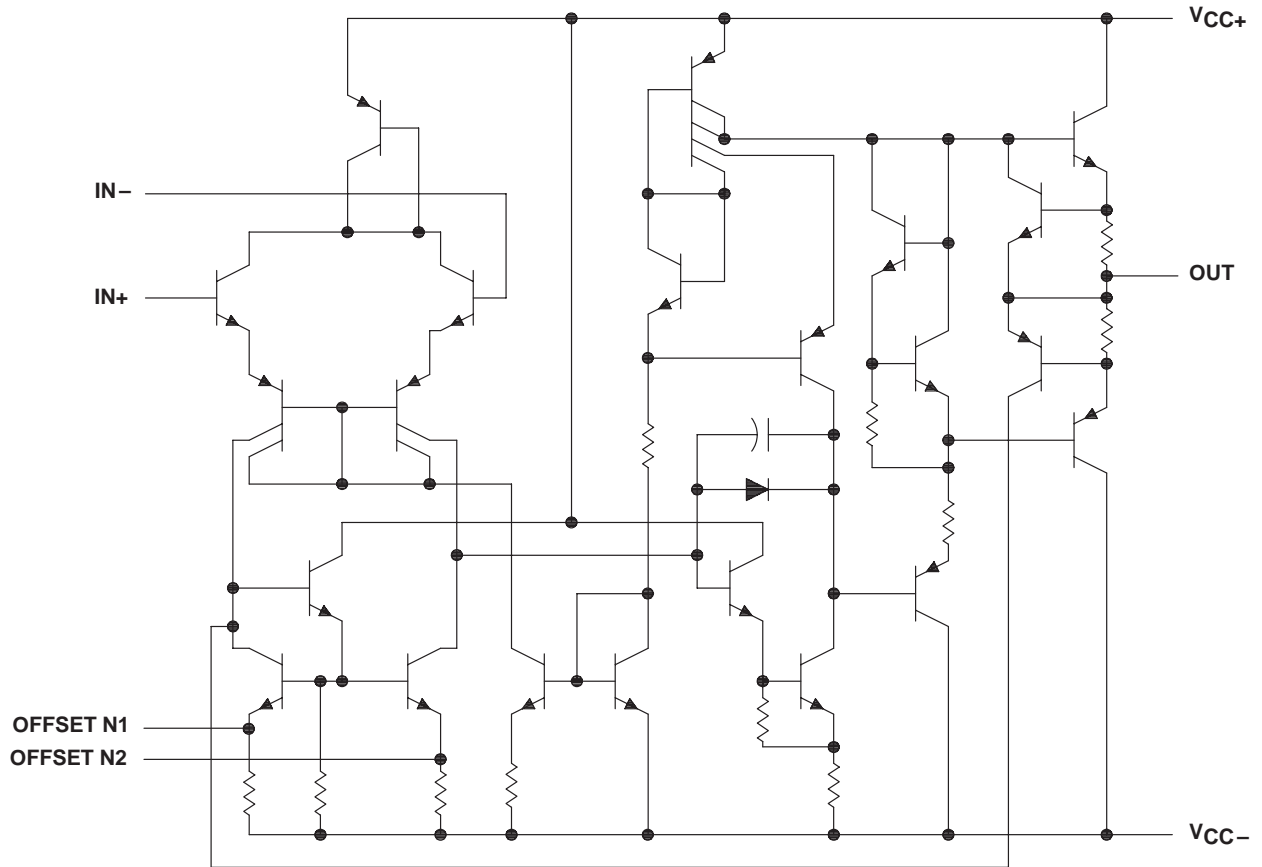
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## AVAILABLE OPTIONS

| T <sub>A</sub> | PACKAGED DEVICES  |                   |                 |                  |                 |            |               | CHIP FORM (Y) |
|----------------|-------------------|-------------------|-----------------|------------------|-----------------|------------|---------------|---------------|
|                | SMALL OUTLINE (D) | CHIP CARRIER (FK) | CERAMIC DIP (J) | CERAMIC DIP (JG) | PLASTIC DIP (P) | TSSOP (PW) | FLAT PACK (U) |               |
| 0°C to 70°C    | μA741CD           |                   |                 |                  | μA741CP         | μA741CPW   |               | μA741Y        |
| -40°C to 85°C  | μA741ID           |                   |                 |                  | μA741IP         |            |               |               |
| -55°C to 125°C |                   | μA741MFK          | μA741MJ         | μA741MJG         |                 |            | μA741MU       |               |

The D package is available taped and reeled. Add the suffix R (e.g., μA741CDR).

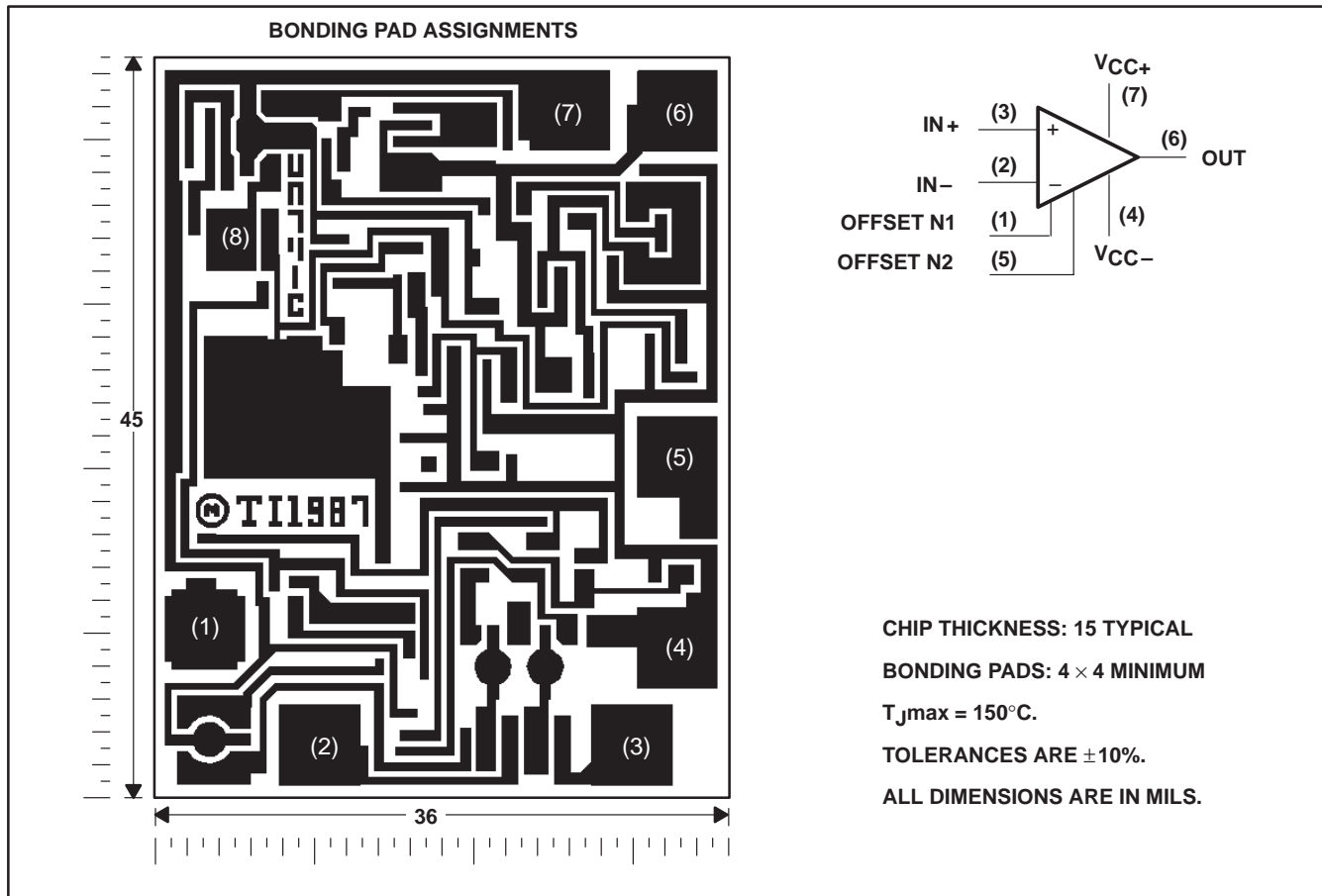
## schematic



| Component Count |    |
|-----------------|----|
| Transistors     | 22 |
| Resistors       | 11 |
| Diode           | 1  |
| Capacitor       | 1  |

### μA741Y chip information

This chip, when properly assembled, displays characteristics similar to the μA741C. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.



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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

|   | $\mu$ A741C                  | $\mu$ A741I | $\mu$ A741M | UNIT         |
|---|------------------------------|-------------|-------------|--------------|
| Supply voltage, $V_{CC+}$ (see Note 1)                                    | 18                           | 22          | 22          | V            |
| Supply voltage, $V_{CC-}$ (see Note 1)                                    | -18                          | -22         | -22         | V            |
| Differential input voltage, $V_{ID}$ (see Note 2)                         | $\pm 15$                     | $\pm 30$    | $\pm 30$    | V            |
| Input voltage, $V_I$ any input (see Notes 1 and 3)                        | $\pm 15$                     | $\pm 15$    | $\pm 15$    | V            |
| Voltage between offset null (either OFFSET N1 or OFFSET N2) and $V_{CC-}$ | $\pm 15$                     | $\pm 0.5$   | $\pm 0.5$   | V            |
| Duration of output short circuit (see Note 4)                             | unlimited                    | unlimited   | unlimited   |              |
| Continuous total power dissipation  | See Dissipation Rating Table |             |             |              |
| Operating free-air temperature range, $T_A$                               | 0 to 70                      | -40 to 85   | -55 to 125  | $^{\circ}$ C |
| Storage temperature range   | -65 to 150                   | -65 to 150  | -65 to 150  | $^{\circ}$ C |
| Case temperature for 60 seconds   | FK package                   |             | 260         | $^{\circ}$ C |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds              | J, JG, or U package          |             | 300         | $^{\circ}$ C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds              | D, P, or PW package          |             | 260         | $^{\circ}$ C |

<sup>†</sup> Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltage values, unless otherwise noted, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .  
 2. Differential voltages are at  $IN+$  with respect to  $IN-$ .  
 3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 15 V, whichever is less.  
 4. The output may be shorted to ground or either power supply. For the  $\mu$ A741M only, the unlimited duration of the short circuit applies at (or below) 125 $^{\circ}$ C case temperature or 75 $^{\circ}$ C free-air temperature.

DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^{\circ}$ C<br>POWER RATING | DERATING<br>FACTOR    | DERATE<br>ABOVE $T_A$ | $T_A = 70^{\circ}$ C<br>POWER RATING | $T_A = 85^{\circ}$ C<br>POWER RATING | $T_A = 125^{\circ}$ C<br>POWER RATING |
|---------|---|-----------------------|-----------------------|--------------------------------------|--------------------------------------|---------------------------------------|
| D       | 500 mW                                  | 5.8 mW/ $^{\circ}$ C  | 64 $^{\circ}$ C       | 464 mW                               | 377 mW                               | N/A                                   |
| FK      | 500 mW                                  | 11.0 mW/ $^{\circ}$ C | 105 $^{\circ}$ C      | 500 mW                               | 500 mW                               | 275 mW                                |
| J       | 500 mW                                  | 11.0 mW/ $^{\circ}$ C | 105 $^{\circ}$ C      | 500 mW                               | 500 mW                               | 275 mW                                |
| JG      | 500 mW                                  | 8.4 mW/ $^{\circ}$ C  | 90 $^{\circ}$ C       | 500 mW                               | 500 mW                               | 210 mW                                |
| P       | 500 mW                                  | N/A                   | N/A                   | 500 mW                               | 500 mW                               | N/A                                   |
| PW      | 525 mW                                  | 4.2 mW/ $^{\circ}$ C  | 25 $^{\circ}$ C       | 336 mW                               | N/A                                  | N/A                                   |
| U       | 500 mW                                  | 5.4 mW/ $^{\circ}$ C  | 57 $^{\circ}$ C       | 432 mW                               | 351 mW                               | 135 mW                                |



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**electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V (unless otherwise noted)**

| PARAMETER  | TEST CONDITIONS                  | $T_A$ †    | μA741C |     |     | μA741I, μA741M |     |      | UNIT |
|--|----------------------------------|------------|--------|-----|-----|----------------|-----|------|------|
|  |                                  |            | MIN    | TYP | MAX | MIN            | TYP | MAX  |      |
| $V_{IO}$ Input offset voltage  | $V_O = 0$                        | 25°C       |        | 1   | 6   |                | 1   | 5    | mV   |
|  |                                  | Full range |        |     | 7.5 |                |     | 6    |      |
| $\Delta V_{IO(adj)}$ Offset voltage adjust range                       | $V_O = 0$                        | 25°C       |        | ±15 |     |                | ±15 |      | mV   |
| $I_{IO}$ Input offset current  | $V_O = 0$                        | 25°C       |        | 20  | 200 |                | 20  | 200  | nA   |
|  |                                  | Full range |        |     | 300 |                |     | 500  |      |
| $I_{IB}$ Input bias current  | $V_O = 0$                        | 25°C       |        | 80  | 500 |                | 80  | 500  | nA   |
|  |                                  | Full range |        |     | 800 |                |     | 1500 |      |
| $V_{ICR}$ Common-mode input voltage range                              |                                  | 25°C       |        | ±12 | ±13 |                | ±12 | ±13  | V    |
|  |                                  | Full range |        |     | ±12 |                |     | ±12  |      |
| $V_{OM}$ Maximum peak output voltage swing                             | $R_L = 10$ kΩ                    | 25°C       |        | ±12 | ±14 |                | ±12 | ±14  | V    |
|  | $R_L \geq 10$ kΩ                 | Full range |        |     | ±12 |                |     | ±12  |      |
|  | $R_L = 2$ kΩ                     | 25°C       |        | ±10 | ±13 |                | ±10 | ±13  |      |
|  | $R_L \geq 2$ kΩ                  | Full range |        |     | ±10 |                |     | ±10  |      |
| $A_{VD}$ Large-signal differential voltage amplification               | $R_L \geq 2$ kΩ                  | 25°C       |        | 20  | 200 |                | 50  | 200  | V/mV |
|  | $V_O = \pm 10$ V                 | Full range |        |     | 15  |                |     | 25   |      |
| $r_i$ Input resistance   |                                  | 25°C       |        | 0.3 | 2   |                | 0.3 | 2    | MΩ   |
| $r_o$ Output resistance  | $V_O = 0$ , See Note 5           | 25°C       |        |     | 75  |                |     | 75   | Ω    |
| $C_i$ Input capacitance  |                                  | 25°C       |        |     | 1.4 |                |     | 1.4  | pF   |
| CMRR Common-mode rejection ratio                                       | $V_{IC} = V_{ICRmin}$            | 25°C       |        | 70  | 90  |                | 70  | 90   | dB   |
|  |                                  | Full range |        |     | 70  |                |     | 70   |      |
| $k_{SVS}$ Supply voltage sensitivity ( $\Delta V_{IO}/\Delta V_{CC}$ ) | $V_{CC} = \pm 9$ V to $\pm 15$ V | 25°C       |        | 30  | 150 |                | 30  | 150  | μV/V |
|  |                                  | Full range |        |     | 150 |                |     | 150  |      |
| $I_{OS}$ Short-circuit output current                                  |                                  | 25°C       |        | ±25 | ±40 |                | ±25 | ±40  | mA   |
| $I_{CC}$ Supply current  | $V_O = 0$ , No load              | 25°C       |        | 1.7 | 2.8 |                | 1.7 | 2.8  | mA   |
|  |                                  | Full range |        |     | 3.3 |                |     | 3.3  |      |
| $P_D$ Total power dissipation  | $V_O = 0$ , No load              | 25°C       |        | 50  | 85  |                | 50  | 85   | mW   |
|  |                                  | Full range |        |     | 100 |                |     | 100  |      |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range for the μA741C is 0°C to 70°C, the μA741I is -40°C to 85°C, and the μA741M is -55°C to 125°C.

NOTE 5: This typical value applies only at frequencies above a few hundred hertz because of the effects of drift and thermal feedback.

**operating characteristics,  $V_{CC\pm} = \pm 15$  V,  $T_A = 25^\circ$  C**

| PARAMETER                  | TEST CONDITIONS  | μA741C |     |     | μA741I, μA741M |     |     | UNIT |
|----------------------------|--|--------|-----|-----|----------------|-----|-----|------|
|                            |  | MIN    | TYP | MAX | MIN            | TYP | MAX |      |
| $t_r$ Rise time            | $V_I = 20$ mV, $R_L = 2$ kΩ,<br>$C_L = 100$ pF, See Figure 1 |        | 0.3 |     |                | 0.3 |     | μs   |
| Overshoot factor           |  |        |     | 5%  |                |     | 5%  |      |
| SR Slew rate at unity gain | $V_I = 10$ V, $R_L = 2$ kΩ,<br>$C_L = 100$ pF, See Figure 1  |        | 0.5 |     |                | 0.5 |     | V/μs |



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electrical characteristics at specified free-air temperature,  $V_{CC\pm} = \pm 15$  V,  $T_A = 25^\circ\text{C}$  (unless otherwise noted)

| PARAMETER                   |  | TEST CONDITIONS                  | $\mu$ A741Y |          |          | UNIT            |
|-----------------------------|--|----------------------------------|-------------|----------|----------|-----------------|
|                             |  |                                  | MIN         | TYP      | MAX      |                 |
| $V_{IO}$                    | Input offset voltage   | $V_O = 0$                        |             | 1        | 6        | mV              |
| $\Delta V_{IO(\text{adj})}$ | Offset voltage adjust range                                  | $V_O = 0$                        |             | $\pm 15$ |          | mV              |
| $I_{IO}$                    | Input offset current   | $V_O = 0$                        |             | 20       | 200      | nA              |
| $I_{IB}$                    | Input bias current   | $V_O = 0$                        |             | 80       | 500      | nA              |
| $V_{ICR}$                   | Common-mode input voltage range                              |                                  | $\pm 12$    | $\pm 13$ |          | V               |
| $V_{OM}$                    | Maximum peak output voltage swing                            | $R_L = 10\text{ k}\Omega$        | $\pm 12$    | $\pm 14$ |          | V               |
|                             |  | $R_L = 2\text{ k}\Omega$         | $\pm 10$    | $\pm 13$ |          |                 |
| $A_{VD}$                    | Large-signal differential voltage amplification              | $R_L \geq 2\text{ k}\Omega$      | 20          | 200      |          | V/mV            |
| $r_i$                       | Input resistance   |                                  | 0.3         | 2        |          | M $\Omega$      |
| $r_o$                       | Output resistance  | $V_O = 0$ , See Note 5           |             | 75       |          | $\Omega$        |
| $C_i$                       | Input capacitance  |                                  |             | 1.4      |          | pF              |
| CMRR                        | Common-mode rejection ratio                                  | $V_{IC} = V_{ICR\text{min}}$     | 70          | 90       |          | dB              |
| $k_{SVS}$                   | Supply voltage sensitivity ( $\Delta V_{IO}/\Delta V_{CC}$ ) | $V_{CC} = \pm 9$ V to $\pm 15$ V |             | 30       | 150      | $\mu\text{V/V}$ |
| $I_{OS}$                    | Short-circuit output current                                 |                                  |             | $\pm 25$ | $\pm 40$ | mA              |
| $I_{CC}$                    | Supply current   | $V_O = 0$ , No load              |             | 1.7      | 2.8      | mA              |
| $P_D$                       | Total power dissipation                                      | $V_O = 0$ , No load              |             | 50       | 85       | mW              |

† All characteristics are measured under open-loop conditions with zero common-mode voltage unless otherwise specified.

NOTE 5: This typical value applies only at frequencies above a few hundred hertz because of the effects of drift and thermal feedback.

operating characteristics,  $V_{CC\pm} = \pm 15$  V,  $T_A = 25^\circ\text{C}$

| PARAMETER |                         | TEST CONDITIONS   | $\mu$ A741Y |     |     | UNIT             |
|-----------|-------------------------|---|-------------|-----|-----|------------------|
|           |                         |   | MIN         | TYP | MAX |                  |
| $t_r$     | Rise time               | $V_I = 20\text{ mV}$ , $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ , See Figure 1 |             | 0.3 |     | $\mu\text{s}$    |
|           | Overshoot factor        |   |             | 5%  |     |                  |
| SR        | Slew rate at unity gain | $V_I = 10\text{ V}$ , $R_L = 2\text{ k}\Omega$ ,<br>$C_L = 100\text{ pF}$ , See Figure 1  |             | 0.5 |     | V/ $\mu\text{s}$ |



### PARAMETER MEASUREMENT INFORMATION

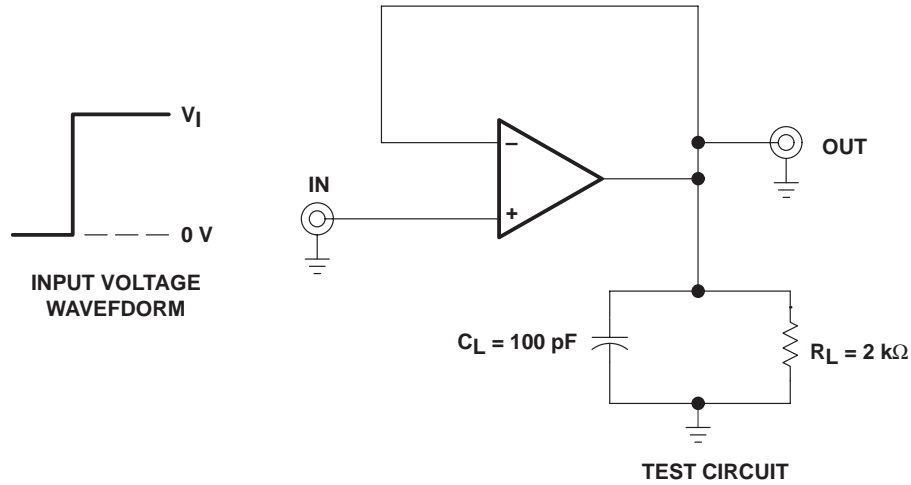


Figure 1. Rise Time, Overshoot, and Slew Rate

### APPLICATION INFORMATION

Figure 2 shows a diagram for an input offset voltage null circuit.

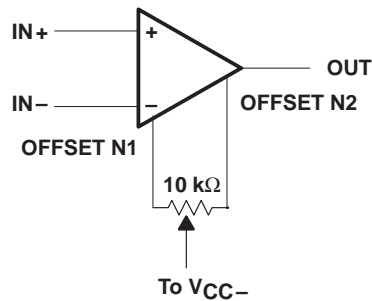


Figure 2. Input Offset Voltage Null Circuit

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## TYPICAL CHARACTERISTICS†

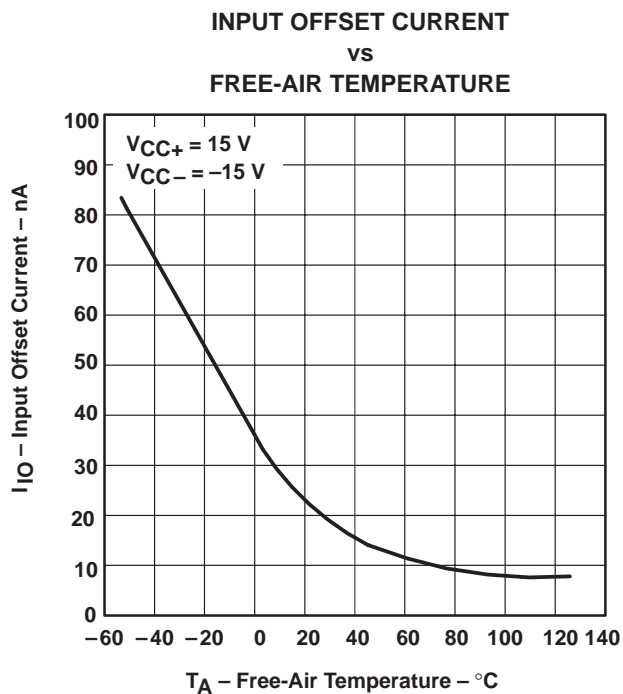


Figure 3

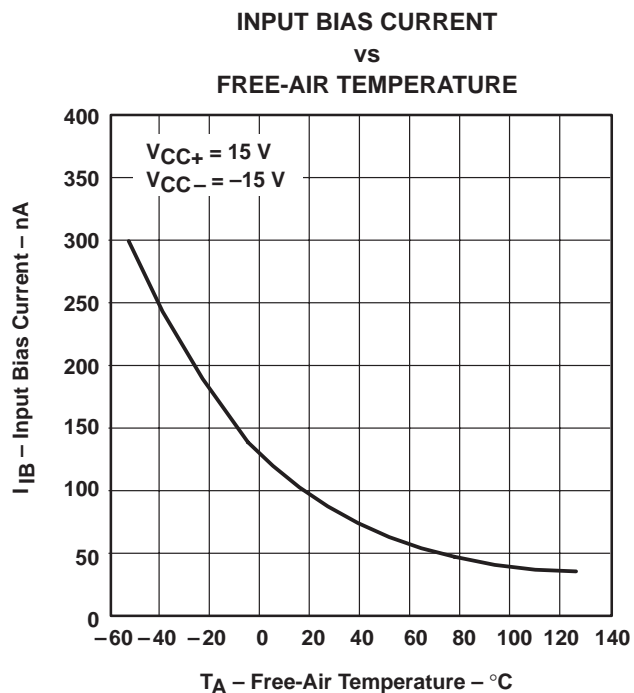


Figure 4

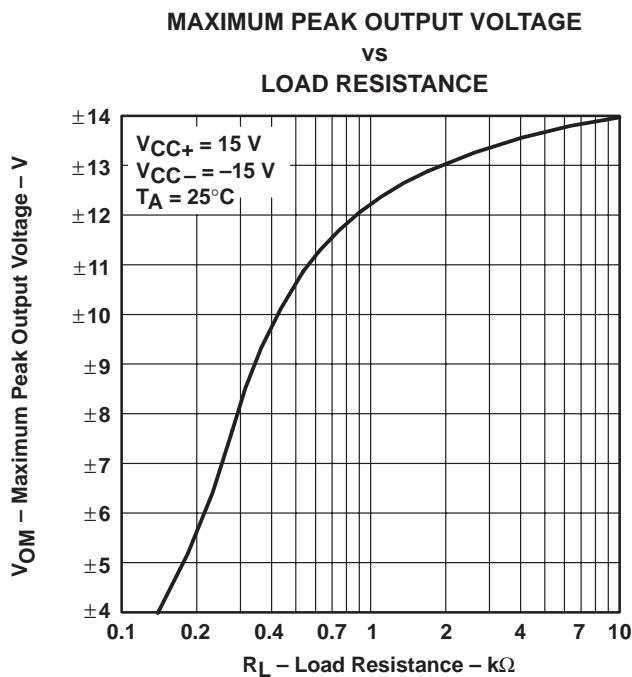


Figure 5

† Data at high and low temperatures are applicable only within the rated operating free-air temperature ranges of the various devices.



**TYPICAL CHARACTERISTICS**

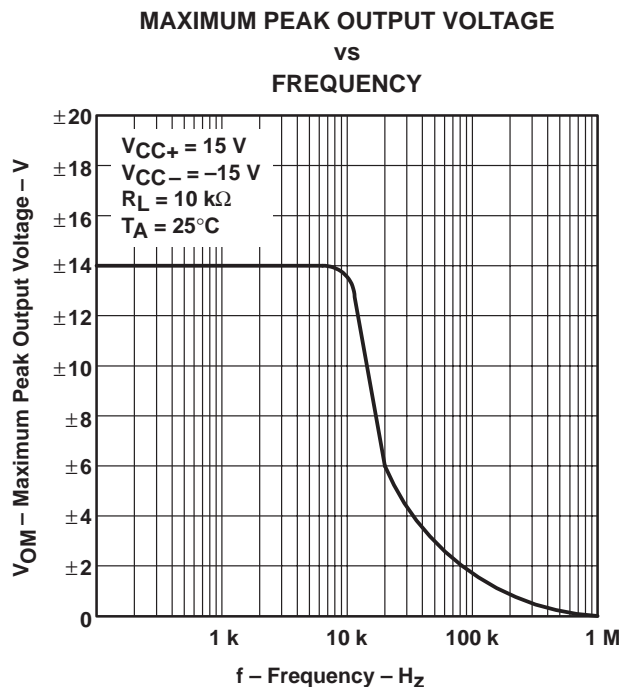


Figure 6

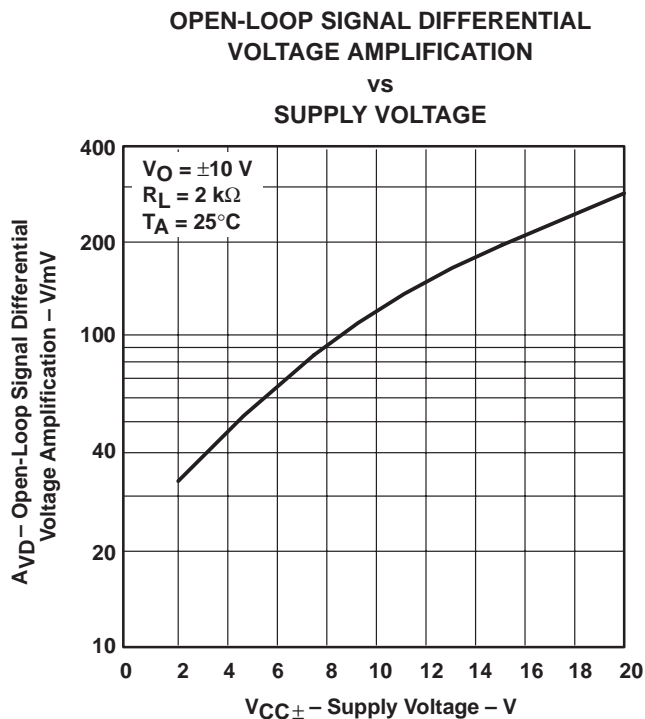


Figure 7

**OPEN-LOOP LARGE-SIGNAL DIFFERENTIAL  
VOLTAGE AMPLIFICATION  
vs  
FREQUENCY**

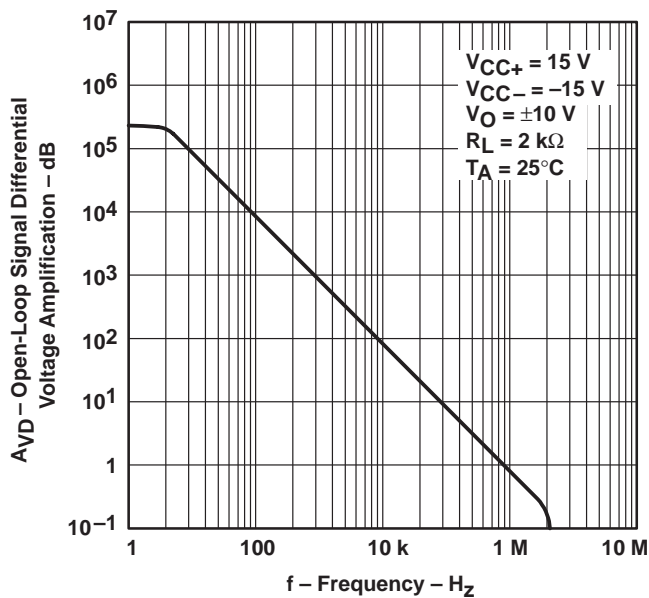


Figure 8

TYPICAL CHARACTERISTICS

COMMON-MODE REJECTION RATIO  
 VS  
 FREQUENCY

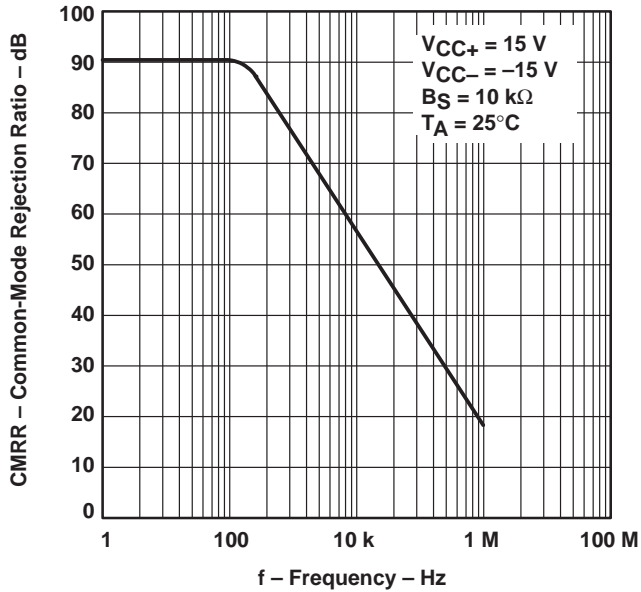


Figure 9

OUTPUT VOLTAGE  
 VS  
 ELAPSED TIME

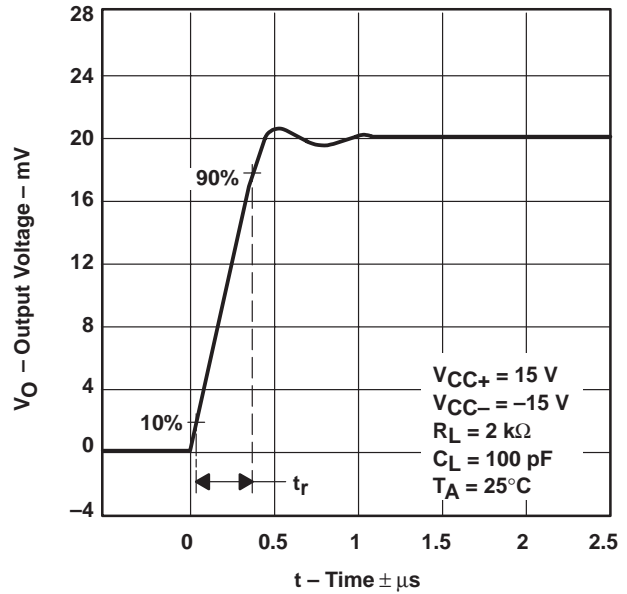


Figure 10

VOLTAGE-FOLLOWER  
 LARGE-SIGNAL PULSE RESPONSE

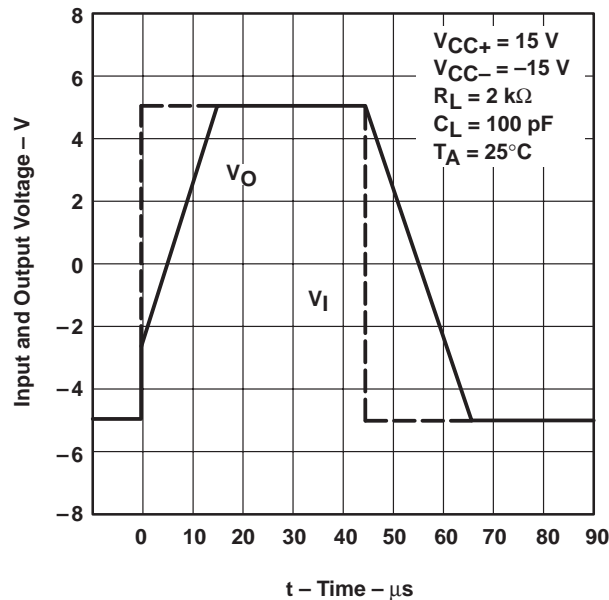


Figure 11

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