

# TL601, TL604, TL607, TL610 P-MOS ANALOG SWITCHES

SLAS042 – D2161, JUNE 1976 — REVISED OCTOBER 1986

- Switch  $\pm 10$ -V Analog Signals
- TTL Logic Capability
- 5-to 30-V Supply Ranges
- Low ( $100 \Omega$ ) On-State Resistance
- High ( $10^{11} \Omega$ ) Off-State Resistance
- 8-Pin Functions

## description

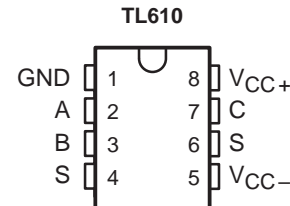
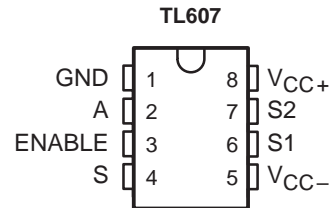
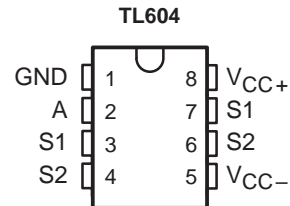
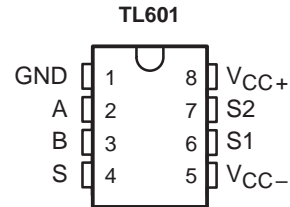
The TL601, TL604, TL607, and TL610 are a family of monolithic P-MOS analog switches that provide fast switching speeds with high  $r_{off}/r_{on}$  ratio and no offset voltage. The p-channel enhancement-type MOS switches accept analog signals up to  $\pm 10$  V and are controlled by TTL-compatible logic inputs. The monolithic structure is made possible by BI-MOS technology, which combines p-channel MOS with standard bipolar transistors.

These switches are particularly useful in military, industrial, and commercial applications such as data acquisition, multiplexers, A/D and D/A converters, MODEMS, sample-and-hold systems, signal multiplexing, integrators, programmable operational amplifiers, programmable voltage regulators, crosspoint switching networks, logic interface, and many other analog systems.

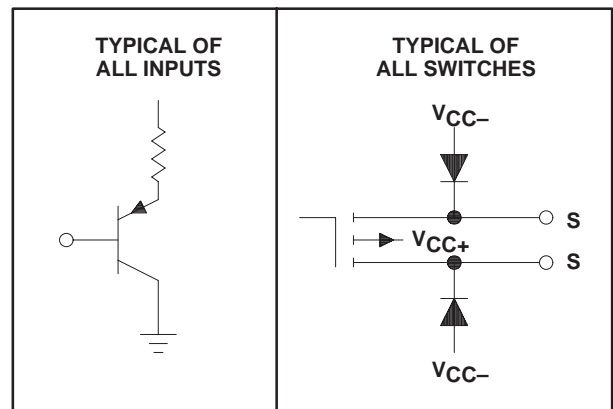
The TL601 is an SPDT switch with two logic control inputs. The TL604 is a dual complementary SPST switch with a single control input. The TL607 is an SPDT switch with one logic control input and one enable input. The TL610 is an SPST switch with three logic control inputs. The TL610 features a higher  $r_{off}/r_{on}$  ratio than the other members of the family.

The TL601C, TL604C, TL607C, and TL610C are characterized for operation from  $0^\circ\text{C}$  to  $70^\circ\text{C}$ , the TL601I, TL604I, TL607I, and TL610I are characterized for operation from  $-25^\circ\text{C}$  to  $85^\circ\text{C}$ , and the TL601M, TL604M, TL607M, and TL610M are characterized for operation over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ .

### JG OR P PACKAGE (TOP VIEW)



## schematics of inputs and outputs



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

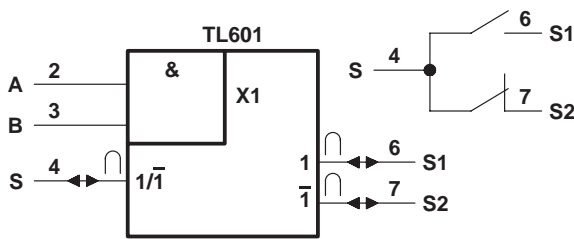
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1986, Texas Instruments Incorporated

# TL601, TL604, TL607, TL610 P-MOS ANALOG SWITCHES

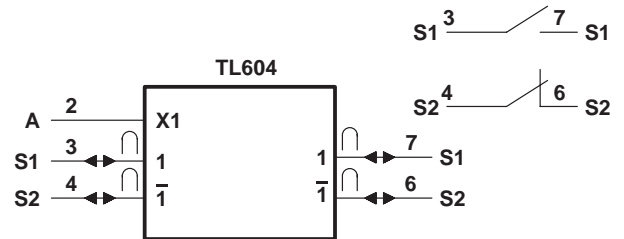
D2161, JUNE 1976 — REVISED OCTOBER 1986

## logic symbols† and switch diagrams



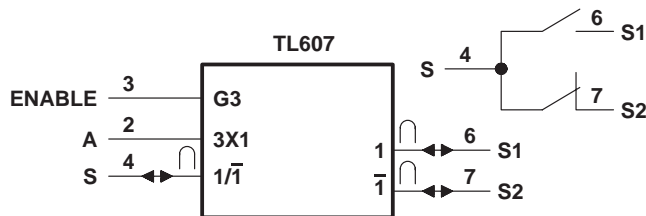
FUNCTION TABLE

| INPUTS |   | ANALOG SWITCHES |             |
|--------|---|-----------------|-------------|
| A      | B | S1              | S2          |
| L      | X | Off (open)      | On (closed) |
| X      | L | Off (open)      | On (closed) |
| H      | H | On (closed)     | Off (open)  |



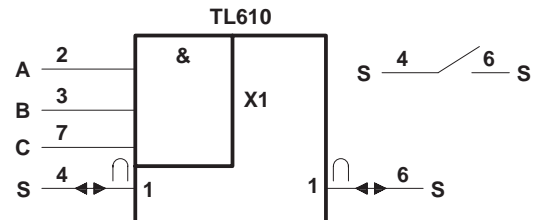
FUNCTION TABLE

| INPUT | ANALOG SWITCHES |             |
|-------|-----------------|-------------|
| A     | S1              | S2          |
| H     | On (closed)     | Off (open)  |
| L     | Off (open)      | On (closed) |



FUNCTION TABLE

| INPUTS |        | ANALOG SWITCHES |             |
|--------|--------|-----------------|-------------|
| A      | ENABLE | S1              | S2          |
| X      | L      | Off (open)      | Off (open)  |
| L      | H      | Off (open)      | On (closed) |
| H      | H      | On (closed)     | Off (open)  |

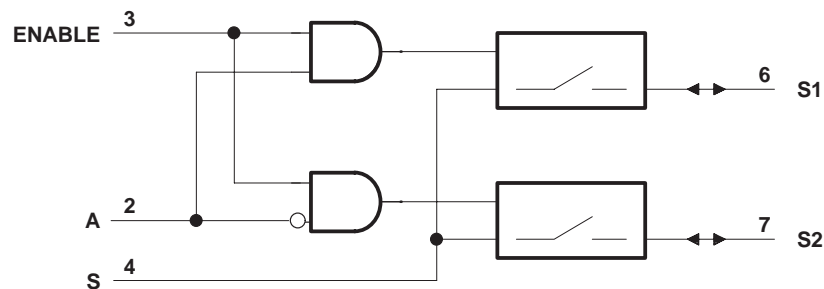


FUNCTION TABLE

| INPUTS |   |   | ANALOG SWITCHES |
|--------|---|---|-----------------|
| A      | B | C | S               |
| L      | X | X | Off (open)      |
| X      | L | X | Off (open)      |
| X      | X | L | Off (open)      |
| X      | H | H | On (closed)     |

† These symbols are in accordance with ANSI/IEEE Std 91-1984.

## TL607 logic diagram (positive logic)



# TL601, TL604, TL607, TL610 P-MOS ANALOG SWITCHES

D2161, JUNE 1976 — REVISED OCTOBER 1986

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

|  |                |
|--|----------------|
| Supply voltage, $V_{CC+}$ (see Note 1)                                   | 30 V           |
| Supply voltage, $V_{CC-}$  | -30 V          |
| $V_{CC+}$ to $V_{CC-}$ supply voltage differential                       | 35 V           |
| Control input voltage  | $V_{CC+}$      |
| Switch off-state voltage   | 30 V           |
| Switch on-state current  | 10 mA          |
| Operating free-air temperature range:                                    |                |
| TL601C, TL604C, TL607C, TL610C   | 0°C to 70°C    |
| TL601I, TL604I, TL607I, TL610I   | -25°C to 85°C  |
| TL601M, TL604M, TL607M, TL610M   | -55°C to 125°C |
| Storage temperature range  | -65°C to 150°C |
| Lead temperature (1,6 mm) 1/16 inch from case for 60 seconds: JG package | 300°C          |
| Lead temperature (1,6 mm) 1/16 inch from case for 10 seconds: P package  | 260°C          |

NOTE 1: All voltage values are with respect to network ground terminal.

## recommended operating conditions

|   | TL601C, TL604C<br>TL607C, TL610C |     |           | TL601I, TL604I<br>TL607I, TL610I |     |           | TL601M, TL604M<br>TL607M, TL610M |     |           | UNIT |
|---|----------------------------------|-----|-----------|----------------------------------|-----|-----------|----------------------------------|-----|-----------|------|
|   | MIN                              | TYP | MAX       | MIN                              | TYP | MAX       | MIN                              | TYP | MAX       |      |
| Supply voltage, $V_{CC+}$ (see Figure 1)                          | 5                                | 10  | 25        | 5                                | 10  | 25        | 5                                | 10  | 25        | V    |
| Supply voltage, $V_{CC-}$ (see Figure 1)                          | -5                               | -20 | -25       | -5                               | -20 | -25       | -5                               | -20 | -25       | V    |
| $V_{CC+}$ to $V_{CC-}$ supply voltage differential (see Figure 1) | 15                               |     | 30        | 15                               |     | 30        | 15                               |     | 30        | V    |
| High-level control input voltage, $V_{IH}$                        | 2                                |     | 5.5       | 2                                |     | 5.5       | 2                                |     | 5.5       | V    |
| Low-level control input voltage, $V_{IL}$                         | All inputs                       |     |           | 0.8                              |     |           | 0.8                              |     |           |      |
| Voltage at any analog switch (S) terminal                         | $V_{CC-} + 8$                    |     | $V_{CC+}$ | $V_{CC-} + 8$                    |     | $V_{CC+}$ | $V_{CC-} + 8$                    |     | $V_{CC+}$ | V    |
| Switch on-state current   | 10                               |     |           | 10                               |     |           | 10                               |     |           | mA   |
| Operating free-air temperature, $T_A$                             | 0                                |     | 70        | 25                               |     | 85        | -55                              |     | 125       | °C   |

# TL601, TL604, TL607, TL610 P-MOS ANALOG SWITCHES

D2161, JUNE 1976 — REVISED OCTOBER 1986

electrical characteristics over recommended operating free-air temperature range,  $V_{CC+} = 10\text{ V}$ ,  $V_{CC-} = -20\text{ V}$ , analog switch test current = 1 mA (unless otherwise noted)

| PARAMETER                                    | TEST CONDITIONS†   | TL6 __ C                   |                |       | TL6 __ M<br>TL6 __ I |      |                  | UNIT           |             |
|--|--|----------------------------|----------------|-------|----------------------|------|------------------|----------------|-------------|
|  |  | MIN                        | TYP‡           | MAX   | MIN                  | TYP‡ | MAX              |                |             |
| $I_{IH}$ High-level input current            | $V_I = 5.5\text{ V}$                                       |                            | 0.5            | 10    |                      | 0.5  | 10               | $\mu\text{A}$  |             |
| $I_{IL}$ Low-level input current             | $V_I = 0.4\text{ V}$                                       |                            | -50            | -250  |                      | -50  | -250             | $\mu\text{A}$  |             |
| $I_{off}$ Switch off-state current           | $V_{I(sw)} = -10\text{ V}$ ,<br>See Note 2                 | $T_A = 25^\circ\text{C}$   |                | -500  |                      | -400 |                  | $\rho\text{A}$ |             |
|  |  | $T_A = \text{MAX}^\dagger$ |                | -10   | -20                  |      | -50              | -100           | $\text{nA}$ |
| $r_{on}$ Switch on-state resistance          | $V_{I(sw)} = 10\text{ V}$ ,<br>$I_{O(sw)} = -1\text{ mA}$  | TL601<br>TL604<br>TL607    |                | 75    | 200                  |      | 55               | 100            | $\Omega$    |
|  |  | TL610                      |                | 40    | 100                  |      | 40               | 80             |             |
|  | $V_{I(sw)} = -10\text{ V}$ ,<br>$I_{O(sw)} = -1\text{ mA}$ | TL601<br>TL604<br>TL607    |                | 220   | 600                  |      | 220              | 400            |             |
|  |  | TL610                      |                | 120   | 300                  |      | 120              | 300            |             |
| $r_{off}$ Switch off-state resistance        |  |                            | 20             |       | 20                   |      | $\text{G}\Omega$ |                |             |
| $C_{on}$ Switch on-state input capacitance   | $V_{I(sw)} = 0\text{ V}$ , $f = 1\text{ MHz}$              |                            | 16             |       | 16                   |      | $\text{pF}$      |                |             |
| $C_{off}$ Switch off-state input capacitance | $V_{I(sw)} = 0\text{ V}$ , $f = 1\text{ MHz}$              |                            | 8              |       | 8                    |      | $\text{pF}$      |                |             |
| $I_{CC+}$ Supply current from $V_{CC+}$      | Logic input(s) at 5.5 V,<br>All switch terminals open      |                            | TL601<br>TL604 | 5     | 10                   |      | 5                | 10             | $\text{mA}$ |
|  |  | ENABLE high                | TL607          | 5     | 10                   |      | 5                | 10             |             |
|  |  | ENABLE low                 |                | 3     | 5                    |      | 3                | 5              |             |
|  |  |                            | TL610          | 5     | 10                   |      | 5                | 10             |             |
| $I_{CC-}$ Supply current from $V_{CC-}$      | Logic input(s) at 5.5 V, All switch terminals open         |                            | TL601<br>TL604 | -1.2  | -2.5                 |      | -1.2             | -2.5           | $\text{mA}$ |
|  |  | ENABLE high                | TL607          | -2.5  | -5                   |      | -2.5             | -5             |             |
|  |  | ENABLE low                 |                | -0.05 | -0.5                 |      | -0.05            | -0.5           |             |
|  |  |                            | TL610          | -1.2  | -2.5                 |      | -1.2             | -2.5           |             |

† MAX is  $70^\circ\text{C}$  for C-suffix types,  $85^\circ\text{C}$  for I-suffix types, and  $125^\circ\text{C}$  for M-suffix types.

‡ All typical values are at  $T_A = 25^\circ\text{C}$  except for  $I_{off}$  at  $T_A = \text{MAX}$ .

NOTE 2: The other terminal of the switch under test is at  $V_{CC+} = 10\text{ V}$ .

switching characteristics,  $V_{CC+} = 10\text{ V}$ ,  $V_{CC-} = -20\text{ V}$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER                      | TEST CONDITIONS  | MIN | TYP | MAX | UNIT        |
|--------------------------------|--|-----|-----|-----|-------------|
| $t_{off}$ Switch turn-off time | $R_L = 1\text{ k}\Omega$ , $C_L = 35\text{ pF}$ , See Figure 2 |     | 400 | 500 | $\text{ns}$ |
| $t_{on}$ Switch turn-on time   |  |     | 100 | 150 |             |



PARAMETER MEASUREMENT INFORMATION

Figure 1 shows power supply boundary conditions for proper operation of the TL601 Series. The range of operation for supply  $V_{CC+}$  from 5 V to 25 V is shown on the vertical axis. The range of  $V_{CC-}$  from -5 V to -25 V is shown on the horizontal axis. A recommended 30-V maximum voltage differential from  $V_{CC+}$  to  $V_{CC-}$  governs the maximum  $V_{CC+}$  for a chosen  $V_{CC-}$  (or vice versa). A minimum recommended difference of 15 V from  $V_{CC+}$  to  $V_{CC-}$  and the boundaries shown in Figure 1 allow the designer to select the proper combinations of the two supplies.

The designer-selected  $V_{CC+}$  supply value for a chosen  $V_{CC-}$  supply value limits the maximum input voltage that can be applied to either switch terminal; that is, the input voltage should be between  $V_{CC-} + 8$  V and  $V_{CC+}$  to keep the on-state resistance within specified limits.

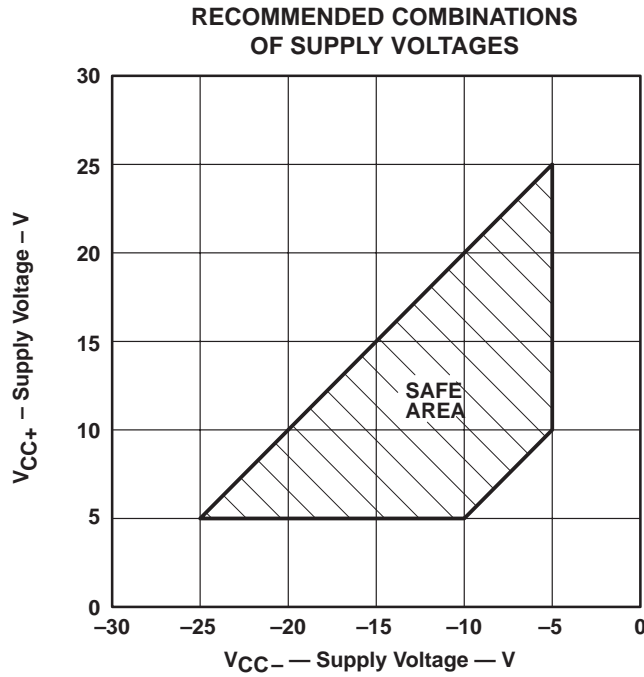
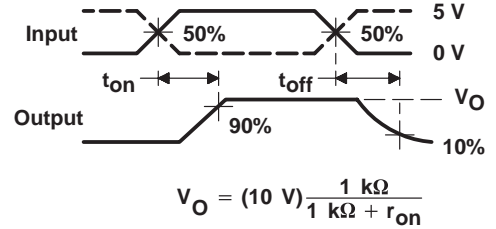
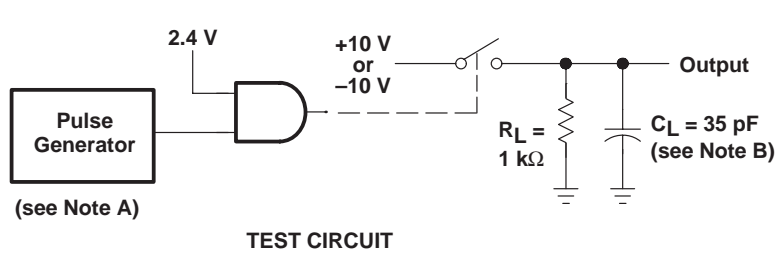


Figure 1

# TL601, TL604, TL607, TL610 P-MOS ANALOG SWITCHES

D2161, JUNE 1976 — REVISED OCTOBER 1986

## PARAMETER MEASUREMENT INFORMATION



NOTES: A. The pulse generator has the following characteristics:  $Z_O = 50 \Omega$ ,  $t_r \geq 15 \text{ ns}$ ,  $t_f \geq 15 \text{ ns}$ ,  $t_w = 500 \text{ ns}$ .  
B.  $C_L$  includes probe and jig capacitance.

Figure 2

## TYPICAL CHARACTERISTICS

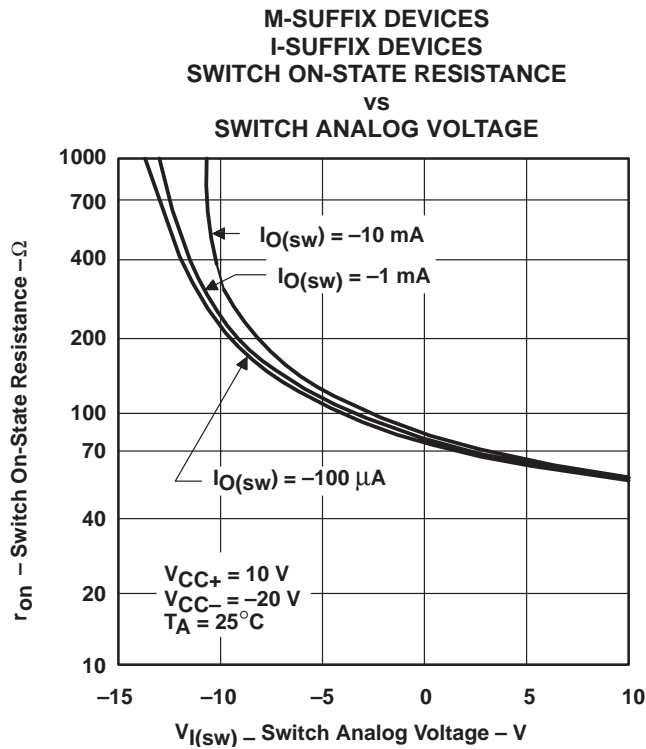


Figure 3

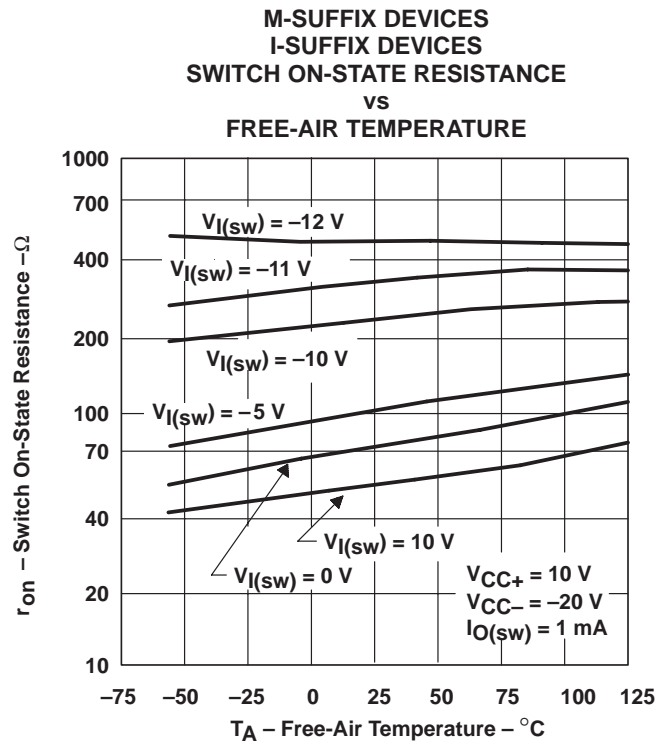


Figure 4

**PACKAGING INFORMATION**

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| TL601CP          | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                      |
| TL601IP          | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                      |
| TL604CP          | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                      |
| TL607CP          | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                      |
| TL610CP          | OBSOLETE              | PDIP         | P               | 8    |             | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

P (R-PDIP-T8)

PLASTIC DUAL-IN-LINE



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Falls within JEDEC MS-001

For the latest package information, go to [http://www.ti.com/sc/docs/package/pkg\\_info.htm](http://www.ti.com/sc/docs/package/pkg_info.htm)





## IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

| <b>Products</b>  |  | <b>Applications</b> |  |
|------------------|--|---------------------|--|
| Amplifiers       | <a href="http://amplifier.ti.com">amplifier.ti.com</a>             | Audio               | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                   |
| Data Converters  | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     | Automotive          | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>         |
| DSP              | <a href="http://dsp.ti.com">dsp.ti.com</a>                         | Broadband           | <a href="http://www.ti.com/broadband">www.ti.com/broadband</a>           |
| Interface        | <a href="http://interface.ti.com">interface.ti.com</a>             | Digital Control     | <a href="http://www.ti.com/digitalcontrol">www.ti.com/digitalcontrol</a> |
| Logic            | <a href="http://logic.ti.com">logic.ti.com</a>                     | Military            | <a href="http://www.ti.com/military">www.ti.com/military</a>             |
| Power Mgmt       | <a href="http://power.ti.com">power.ti.com</a>                     | Optical Networking  | <a href="http://www.ti.com/opticalnetwork">www.ti.com/opticalnetwork</a> |
| Microcontrollers | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> | Security            | <a href="http://www.ti.com/security">www.ti.com/security</a>             |
|                  |  | Telephony           | <a href="http://www.ti.com/telephony">www.ti.com/telephony</a>           |
|                  |  | Video & Imaging     | <a href="http://www.ti.com/video">www.ti.com/video</a>                   |
|                  |  | Wireless            | <a href="http://www.ti.com/wireless">www.ti.com/wireless</a>             |

Mailing Address: Texas Instruments  
Post Office Box 655303 Dallas, Texas 75265