

## FEATURES

- Low Supply Current: 500 $\mu$ A
- 0.2 $\mu$ A Supply Current in SHUTDOWN
- 50 $\mu$ A Supply Current in RECEIVER ALIVE Mode
- ESD Protection Over  $\pm 10$ kV
- Operates from a Single 5V Supply
- Uses Small Capacitors: 0.1 $\mu$ F
- Operates to 120k Baud
- Three-State Outputs Are High Impedance When Off
- Output Overvoltage Does Not Force Current Back into Supplies
- RS232 I/O Lines Can Be Forced to  $\pm 25$ V Without Damage
- Flowthrough Architecture

## APPLICATIONS

- Battery-Powered Modems
- Battery-Powered DCE
- Notebook Computers
- Palmtop Computers

## DESCRIPTION

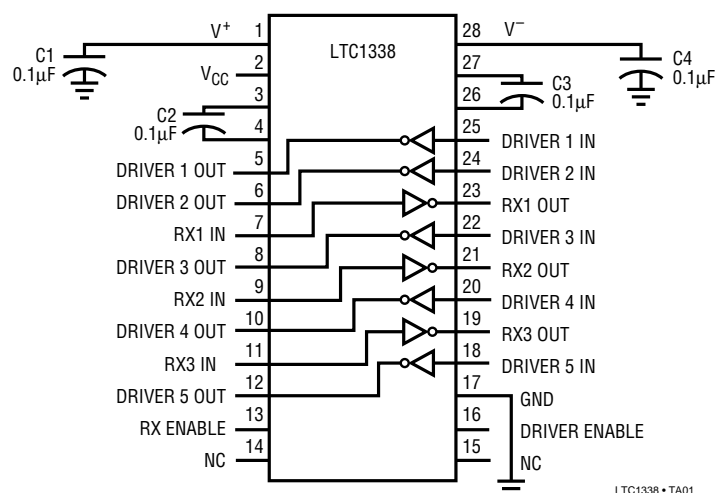
The LTC1338 is a 5-driver/3-receiver RS232 transceiver with very low supply current. In the no load condition, the supply current is only 500 $\mu$ A. The charge pump only requires four 0.1 $\mu$ F capacitors.

In SHUTDOWN mode, the supply current is further reduced to 0.2 $\mu$ A. In RECEIVER ALIVE mode, all three receivers are kept alive and the supply current is 50 $\mu$ A. All RS232 outputs assume a high impedance state in SHUTDOWN and with the power off.

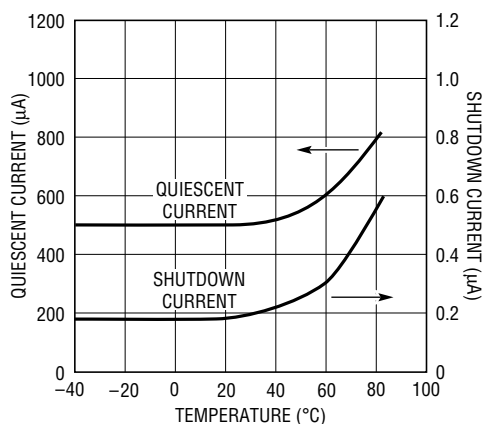
The LTC1338 is fully compliant with all data rate and overvoltage RS232 specifications. The transceiver can operate up to 120k baud with a 2500pF, 3k $\Omega$  load. Both driver outputs and receiver inputs can be forced to  $\pm 25$ V without damage, and can survive multiple  $\pm 10$ kV ESD strikes.

## TYPICAL APPLICATION

5-Drivers/3-Receivers with SHUTDOWN



Supply Current



TEST CONDITION:  
 $V_{CC} = 5V$ , ALL DRIVER INPUTS TIED TO  $V_{CC}$ .

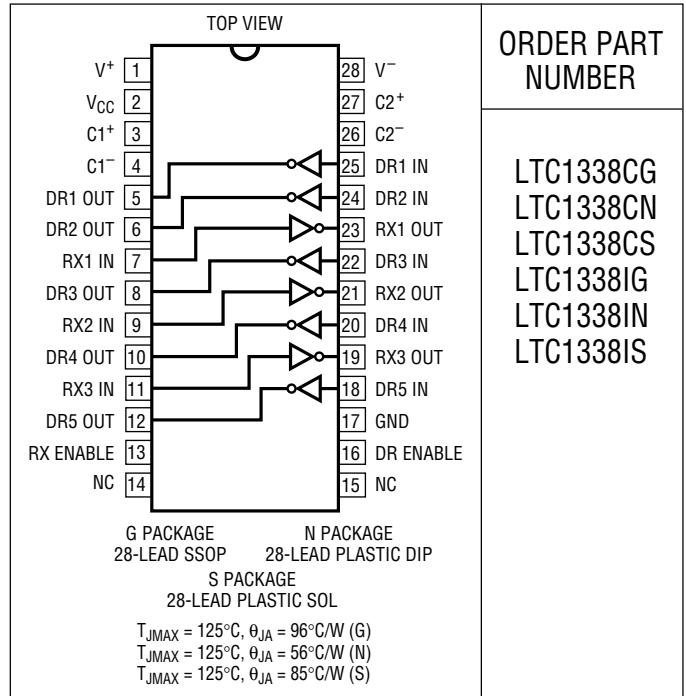
LTC1338 • TA02

## ABSOLUTE MAXIMUM RATINGS

(Note 1)

Supply Voltage ( $V_{CC}$ ) .....	6V
Input Voltage	
Driver .....	-0.3V to $V_{CC} + 0.3V$
Receiver .....	-25V to 25V
Driver/Receiver Enable Pin .....	-0.3V to $V_{CC} + 0.3V$
Output Voltage	
Driver .....	-25V to 25V
Receiver .....	-0.3V to $V_{CC} + 0.3V$
Short Circuit Duration	
$V^+$ .....	30 sec
$V^-$ .....	30 sec
Driver Output .....	Indefinite
Receiver Output .....	Indefinite
Operating Temperature Range	
Commercial (LTC1338C) .....	0°C to 70°C
Industrial (LTC1338I) .....	-40°C to 85°C
Storage Temperature Range .....	-65°C to 150°C
Lead Temperature (Soldering, 10 sec) .....	300°C

## PACKAGE/ORDER INFORMATION



## DC ELECTRICAL CHARACTERISTICS

$V_{CC} = 5V, C1 = C2 = C3 = C4 = 0.1\mu F$ , unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Any Driver</b>					
Output Voltage Swing	3k to GND	Positive Negative	5.0 -5.0	7.0 -6.5	V V
Logic Input Voltage Level	Input Low Level ( $V_{OUT} = \text{High}$ ) Input High Level ( $V_{OUT} = \text{Low}$ )		2.0	1.4 1.4	0.8 V V
Logic Input Current	$0 \leq V_{IN} \leq V_{CC}$				$\pm 5$ $\mu A$
Output Short-Circuit Current	$V_{OUT} = 0V$			$\pm 12$	mA
Output Leakage Current	SHUTDOWN, $V_{OUT} = \pm 20V$ (Note 3)			$\pm 10$ $\pm 500$	$\mu A$ $\mu A$
<b>Any Receiver</b>					
Input Voltage Thresholds	Input Low Threshold Input High Threshold		0.8 0.8	1.3 1.7	2.4 V V
Hysteresis			0.1	0.4	1 V
Input Resistance	$-10V \leq V_{IN} \leq 10V$		3	5	7 k $\Omega$
Output Voltage	Output Low, $I_{OUT} = -1.6mA$ ( $V_{CC} = 5V$ ) Output High, $I_{OUT} = 160\mu A$ ( $V_{CC} = 5V$ )		3.5	0.2 4.8	0.4 V V
Output Short-Circuit Current	Sinking Current, $V_{OUT} = V_{CC}$		-15	-40	mA
Output Leakage Current	SHUTDOWN, $0 \leq V_{OUT} \leq V_{CC}$ (Note 3)			1	10 $\mu A$
<b>Power Supply Generator</b>					
$V^+$ Output Voltage	$I_{OUT} = 0mA$ $I_{OUT} = 12mA$			8.0 7.5	V V
$V^-$ Output Voltage	$I_{OUT} = 0mA$ $I_{OUT} = -12mA$			-8.0 -7.0	V V
Supply Rise Time	SHUTDOWN to Turn-On			0.2	ms

## DC ELECTRICAL CHARACTERISTICS $V_{CC} = 5V, C1 = C2 = C3 = C4 = 0.1\mu F$ , unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
<b>Power Supply</b>					
$V_{CC}$ Supply Current	No Load (All Driver $V_{IN} = V_{CC}$ )(Note 2) $0^{\circ}C \leq T_A \leq 70^{\circ}C$		0.5	1.0	mA
	No Load (All Driver $V_{IN} = 0V$ )(Note 2) $0^{\circ}C \leq T_A \leq 70^{\circ}C$		1.0	1.5	mA
	No Load (All Driver $V_{IN} = V_{CC}$ )(Note 2) $-40^{\circ}C \leq T_A \leq 85^{\circ}C$		0.5	1.5	mA
	No Load (All Driver $V_{IN} = 0V$ )(Note 2) $-40^{\circ}C \leq T_A \leq 85^{\circ}C$		1.0	2.0	mA
	RECEIVER ALIVE Mode (Note 4)	●	50	80	$\mu A$
Supply Leakage Current ( $V_{CC}$ )	SHUTDOWN (Note 3)	●	0.2	10	$\mu A$
Driver/Receiver Enable Threshold Low		●	1.4	0.8	V
Driver/Receiver Enable Threshold High		●	2.0	1.4	V

## AC CHARACTERISTICS $V_{CC} = 5V, C1 = C2 = C3 = C4 = 0.1\mu F$ , unless otherwise noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Slew Rate	$R_L = 3k, C_L = 51pF$		8	30	V/ $\mu s$
	$R_L = 3k, C_L = 2500pF$	3	5		V/ $\mu s$
Driver Propagation Delay (TTL to RS232)	$t_{HLD}$ (Figure 1)	●	2	3.5	$\mu s$
	$t_{LHD}$ (Figure 1)	●	2	3.5	$\mu s$
Receiver Propagation Delay (RS232 to TTL)	$t_{HLR}$ (Figure 2)	●	0.3	0.8	$\mu s$
	$t_{LHR}$ (Figure 2)	●	0.2	0.8	$\mu s$

The ● denotes specifications which apply over the operating temperature range of  $0^{\circ}C$  to  $70^{\circ}C$  or  $-40^{\circ}C$  to  $85^{\circ}C$ .

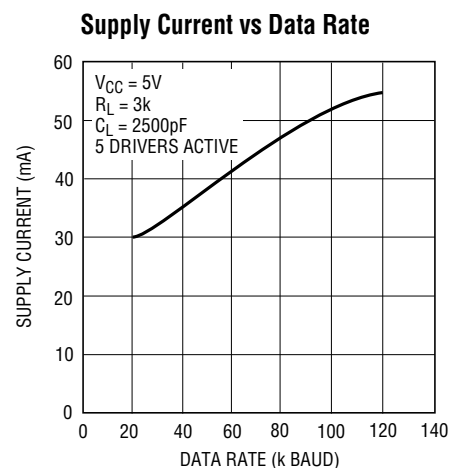
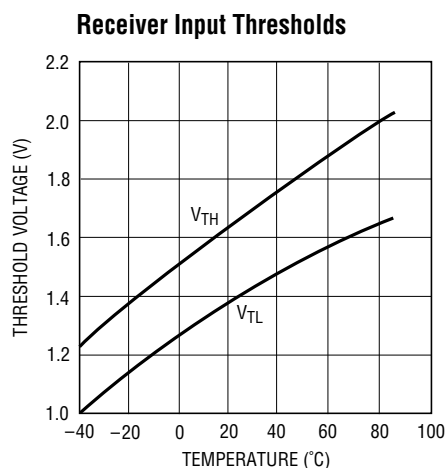
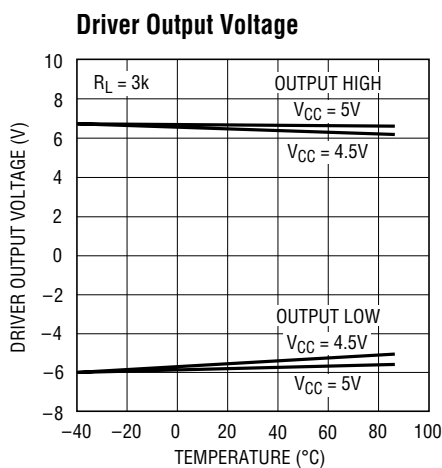
**Note 1:** Absolute maximum ratings are those values beyond which the life of the device may be impaired.

**Note 2:** Supply current is measured with driver and receiver outputs unloaded. The  $V_{DRIVER\ ENABLE}$  and  $V_{RECEIVER\ ENABLE} = V_{CC}$ .

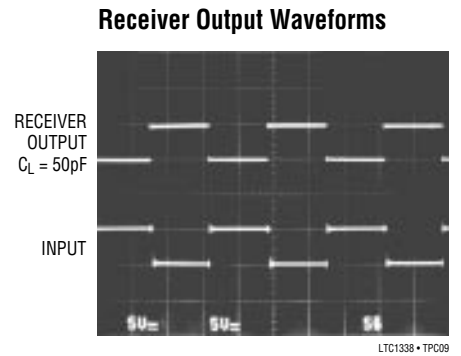
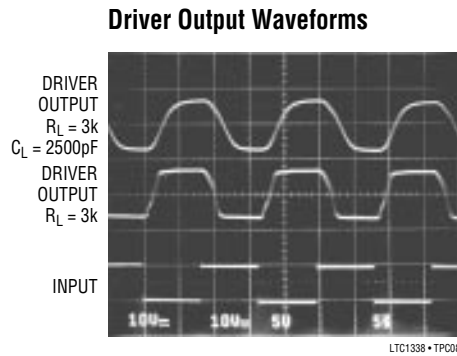
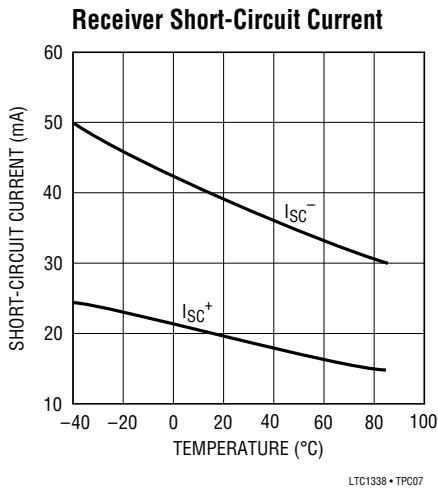
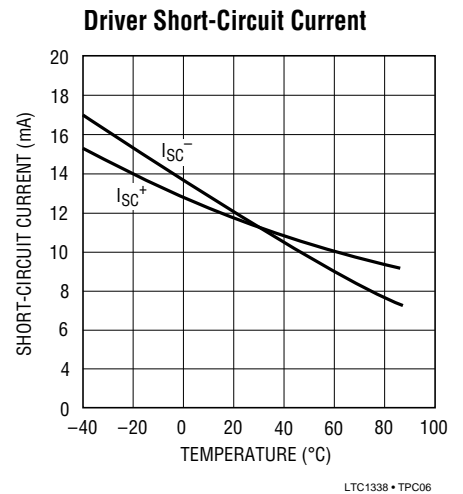
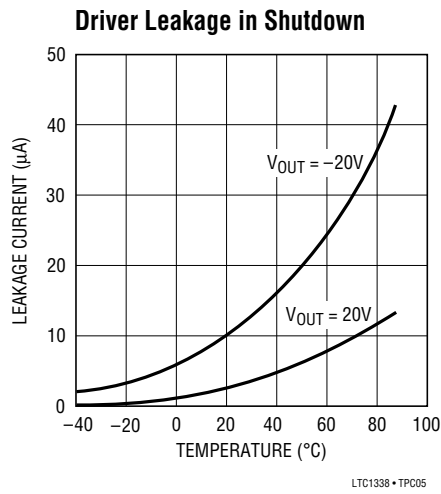
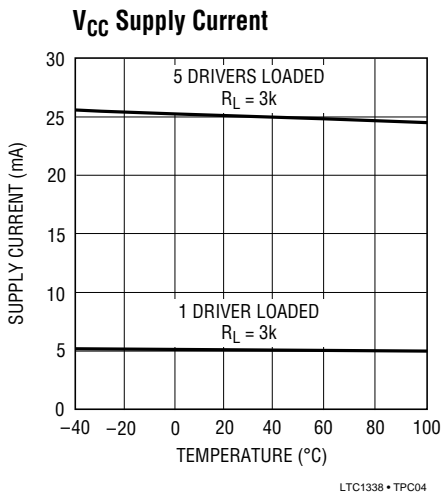
**Note 3:** Supply current and leakage current measurements in SHUTDOWN are performed with  $V_{DRIVER\ ENABLE}$  and  $V_{RECEIVER\ ENABLE} = 0V$ .

**Note 4:** Supply current measurement in RECEIVER ALIVE mode is performed with  $V_{DRIVER\ ENABLE} = 0V$  and  $V_{RECEIVER\ ENABLE} = V_{CC}$ .

## TYPICAL PERFORMANCE CHARACTERISTICS



## TYPICAL PERFORMANCE CHARACTERISTICS



## PIN FUNCTIONS

**V<sub>CC</sub>**: 5V Input Supply Pin. Supply current less than 0.2µA in the SHUTDOWN mode. This pin should be decoupled with a 0.1µF ceramic capacitor.

**GND**: Ground Pin.

**RECEIVER ENABLE**: TTL/CMOS Compatible Enable Pin. Refer to Table 1 for its functional description. This pin can not float.

**DRIVER ENABLE**: TTL/CMOS Compatible Enable Pin. Refer to Table 1 for its functional description. This pin can not float.

**V<sup>+</sup>**: Positive Supply Output (RS232 Drivers). V<sup>+</sup> ≅ 2V<sub>CC</sub> - 1V. This pin requires an external capacitor C = 0.1µF for

charge storage. The capacitor may be tied to ground or 5V. With multiple devices, the V<sup>+</sup> and V<sup>-</sup> pins may be paralleled into common capacitors. For large numbers of devices, increasing the size of the shared common storage capacitors is recommended to reduce ripple.

**V<sup>-</sup>**: Negative Supply Output (RS232 Drivers). V<sup>-</sup> ≅ 2V<sub>CC</sub> - 1.5V. This pin requires an external capacitor C = 0.1µF for charge storage.

**C1<sup>+</sup>, C1<sup>-</sup>, C2<sup>+</sup>, C2<sup>-</sup>**: Commutating Capacitor Inputs. These pins require two external capacitors C = 0.1µF: one from C1<sup>+</sup> to C1<sup>-</sup>, and another from C2<sup>+</sup> to C2<sup>-</sup>. To maintain charge pump efficiency, the capacitor's effective series resistance should be less than 20Ω.

## PIN FUNCTIONS

**DRIVER IN:** RS232 Driver Input Pins. Inputs are TTL/CMOS compatible. Inputs should not be allowed to float. Tie unused inputs to  $V_{CC}$ .

**DRIVER OUT:** Driver Outputs at RS232 Voltage Levels. Outputs are in a high impedance state when in SHUTDOWN, RECEIVER ALIVE mode or  $V_{CC} = 0V$ . The driver outputs are protected against ESD to  $\pm 10kV$  for human body model discharges.

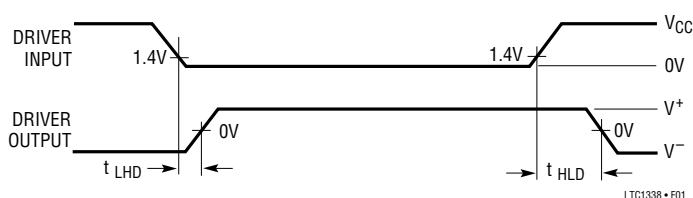
**RX IN:** Receiver Inputs. These pins can be forced to  $\pm 25V$  without damage. The receiver inputs are protected against ESD to  $\pm 10kV$  for human body model discharges. Each receiver provides 0.4V of hysteresis for noise immunity.

**RX OUT:** Receiver Outputs with TTL/CMOS Voltage Levels. Outputs are in a high impedance state when in SHUTDOWN or RECEIVER DISABLE mode to allow data line sharing.

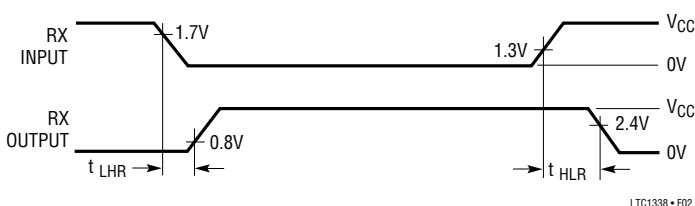
**Table 1. Functional Description**

MODE	RX ENABLE	DR ENABLE	DRIVERS	RECEIVERS	$I_{CC}$ ( $\mu A$ )(TYP)
SHUTDOWN	0	0	All driver outputs are high impedance.	All receiver outputs are high impedance.	0.2
Receiver Disable	0	1	All drivers alive.	All receiver outputs are high impedance.	500
RECEIVER ALIVE	1	0	All driver outputs are high impedance.	All receivers alive.	50
Normal	1	1	All drivers alive.	All receivers alive.	500

## SWITCHING TIME WAVEFORMS



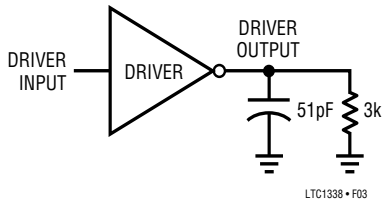
**Figure 1. Driver Propagation Delay Timing**



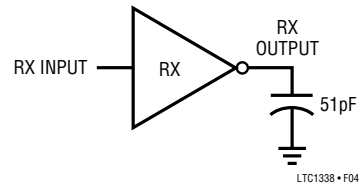
**Figure 2. Receiver Propagation Delay Timing**

TEST CIRCUITS

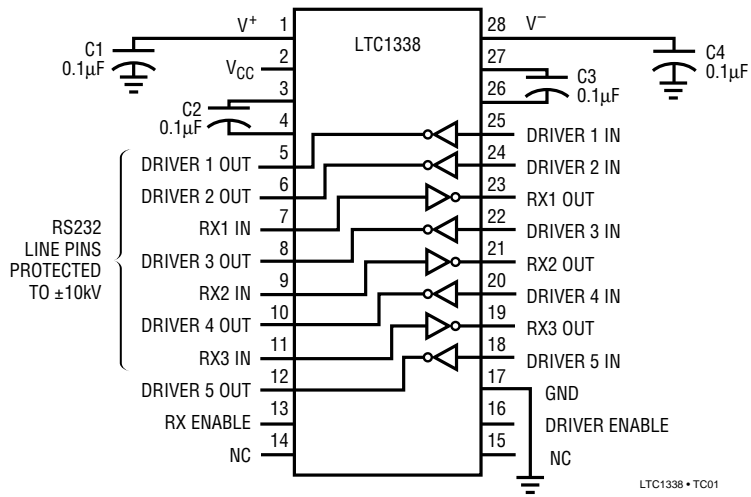
Driver Timing Test Load



Receiver Timing Test Load

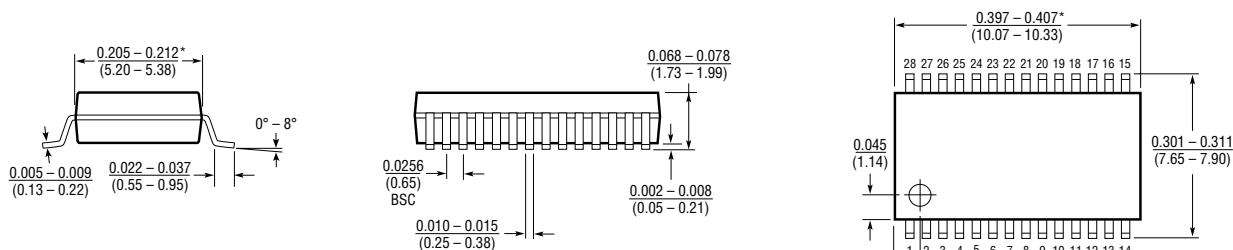


ESD Test Circuit



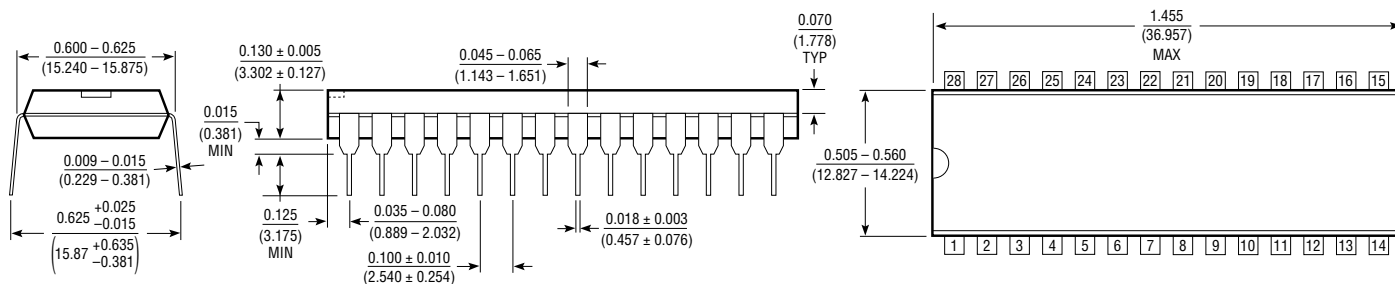
**PACKAGE DESCRIPTION** Dimensions in inches (millimeters) unless otherwise noted.

**G Package  
28-Lead SSOP**

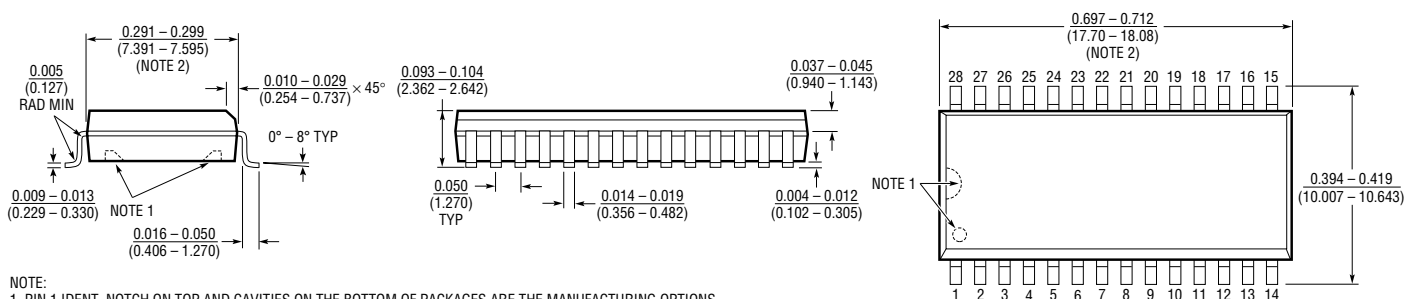


\*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 INCH (0.15mm).

**N Package  
28-Lead Plastic DIP**



**S Package  
28-Lead SOL**



NOTE:  
1. PIN 1 IDENT, NOTCH ON TOP AND CAVITIES ON THE BOTTOM OF PACKAGES ARE THE MANUFACTURING OPTIONS.  
THE PART MAY BE SUPPLIED WITH OR WITHOUT ANY OF THE OPTIONS.  
2. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 INCH (0.15mm).

## U.S. Area Sales Offices

### NORTHEAST REGION

#### Linear Technology Corporation

One Oxford Valley  
2300 E. Lincoln Hwy., Suite 306  
Langhorne, PA 19047  
Phone: (215) 757-8578  
FAX: (215) 757-5631

#### Linear Technology Corporation

266 Lowell St., Suite B-8  
Wilmington, MA 01887  
Phone: (508) 658-3881  
FAX: (508) 658-2701

### SOUTHEAST REGION

#### Linear Technology Corporation

17060 Dallas Parkway  
Suite 208  
Dallas, TX 75248  
Phone: (214) 733-3071  
FAX: (214) 380-5138

### CENTRAL REGION

#### Linear Technology Corporation

Chesapeake Square  
229 Mitchell Court, Suite A-25  
Addison, IL 60101  
Phone: (708) 620-6910  
FAX: (708) 620-6977

### SOUTHWEST REGION

#### Linear Technology Corporation

22141 Ventura Blvd.  
Suite 206  
Woodland Hills, CA 91364  
Phone: (818) 703-0835  
FAX: (818) 703-0517

### NORTHWEST REGION

#### Linear Technology Corporation

782 Sycamore Dr.  
Milpitas, CA 95035  
Phone: (408) 428-2050  
FAX: (408) 432-6331

## International Sales Offices

### FRANCE

#### Linear Technology S.A.R.L.

Immeuble "Le Quartz"  
58 Chemin de la Justice  
92290 Chatenay Malabry  
France  
Phone: 33-1-41079555  
FAX: 33-1-46314613

### KOREA

#### Linear Technology Korea Branch

Namsong Building, #505  
Itaewon-Dong 260-199  
Yongsan-Ku, Seoul  
Korea  
Phone: 82-2-792-1617  
FAX: 82-2-792-1619

### TAIWAN

#### Linear Technology Corporation

Rm. 801, No. 46, Sec. 2  
Chung Shan N. Rd.  
Taipei, Taiwan, R.O.C.  
Phone: 886-2-521-7575  
FAX: 886-2-562-2285

### GERMANY

#### Linear Technology GMBH

Untere Hauptstr. 9  
D-85386 Eching  
Germany  
Phone: 49-89-3197410  
FAX: 49-89-3194821

### SINGAPORE

#### Linear Technology Pte. Ltd.

101 Boon Keng Road  
#02-15 Kallang Ind. Estates  
Singapore 1233  
Phone: 65-293-5322  
FAX: 65-292-0398

### UNITED KINGDOM

#### Linear Technology (UK) Ltd.

The Coliseum, Riverside Way  
Camberley, Surrey GU15 3YL  
United Kingdom  
Phone: 44-276-677676  
FAX: 44-276-64851

### JAPAN

#### Linear Technology KK

5F YZ Bldg.  
4-4-12 Iidabashi, Chiyoda-Ku  
Tokyo, 102 Japan  
Phone: 81-3-3237-7891  
FAX: 81-3-3237-8010

## World Headquarters

#### Linear Technology Corporation

1630 McCarthy Blvd.  
Milpitas, CA 95035-7487  
Phone: (408) 432-1900  
FAX: (408) 434-0507

08/16/93