

# 3.3V Low Power EIA/TIA-562 3-Driver/ 5-Receiver Transceiver

## FEATURES

- **Low Supply Current: 300 $\mu$ A**
- **Receivers 4 and 5 Kept Alive in Shutdown: 35 $\mu$ A**
- **ESD Protection:  $\pm 10$ kV**
- **Operates from a Single 3.3V Supply**
- **Uses Small Capacitors: 0.1 $\mu$ F**
- **Operates to 120kBaud**
- **Three-State Outputs are High Impedance When Off**
- **Output Overvoltage Does Not Force Current Back into Supplies**
- **EIA/TIA-562 I/O Lines Can Be Forced to  $\pm 25$ V Without Damage**
- **Flowthrough Architecture**

## APPLICATIONS

- Notebook Computers
- Palmtop Computers

## DESCRIPTION

The LTC<sup>®</sup>1350 is a 3-driver/5-receiver EIA/TIA-562 transceiver with very low supply current. In the no load condition, the supply current is only 300 $\mu$ A. The charge pump only requires four 0.1 $\mu$ F capacitors.

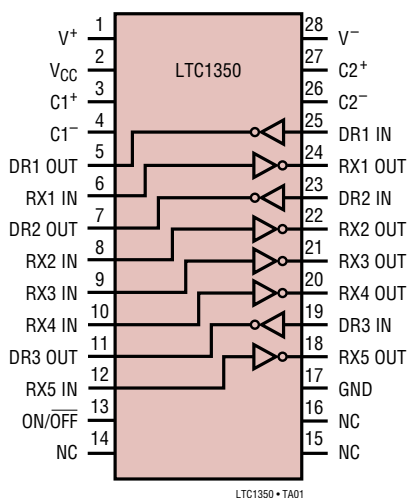
In Shutdown mode, two receivers are kept alive and the supply current is only 35 $\mu$ A. All RS232 outputs assume a high impedance state in Shutdown or with the power off.

The LTC1350 is fully compliant with all data rate and overvoltage EIA/TIA-562 specifications. The transceiver can operate up to 120kbaud with a 1000pF and 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.

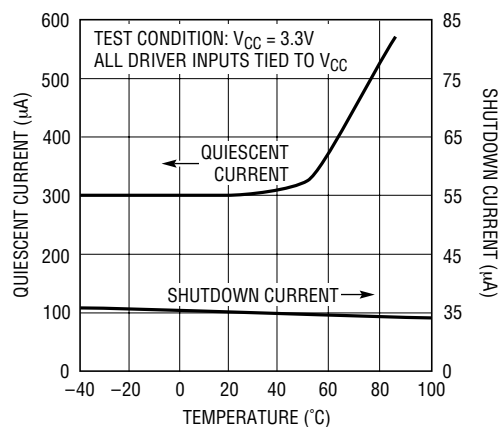
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## TYPICAL APPLICATION

**3-Drivers/5-Receivers with Shutdown**



**Quiescent and Shutdown Supply Current vs Temperature**



## ABSOLUTE MAXIMUM RATINGS

|                                      |                                  |
|--------------------------------------|----------------------------------|
| Supply Voltage ( $V_{CC}$ )          | 5V                               |
| Input Voltage                        |                                  |
| Driver                               | $-0.3V$ to $V_{CC} + 0.3V$       |
| Receiver                             | $-25V$ to $25V$                  |
| ON/OFF 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 (LTC1350C)                | $0^{\circ}C$ to $70^{\circ}C$    |
| Industrial (LTC1350I)                | $-40^{\circ}C$ to $85^{\circ}C$  |
| Storage Temperature Range            | $-65^{\circ}C$ to $150^{\circ}C$ |
| Lead Temperature (Soldering, 10 sec) | $300^{\circ}C$                   |

## PACKAGE/ORDER INFORMATION

| TOP VIEW                                                                                                                                                                                                                                                                            |              | ORDER PART NUMBER                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|--------------------------------------------------------------------------------|
| $V^+$ [1]                                                                                                                                                                                                                                                                           | [28] $V^-$   | LTC1350CG<br>LTC1350CNW<br>LTC1350CSW<br>LTC1350IG<br>LTC1350INW<br>LTC1350ISW |
| $V_{CC}$ [2]                                                                                                                                                                                                                                                                        | [27] $C2^+$  |                                                                                |
| $C1^+$ [3]                                                                                                                                                                                                                                                                          | [26] $C2^-$  |                                                                                |
| $C1^-$ [4]                                                                                                                                                                                                                                                                          | [25] DR1 IN  |                                                                                |
| DR1 OUT [5]                                                                                                                                                                                                                                                                         | [24] RX1 OUT |                                                                                |
| RX1 IN [6]                                                                                                                                                                                                                                                                          | [23] DR2 IN  |                                                                                |
| DR2 OUT [7]                                                                                                                                                                                                                                                                         | [22] RX2 OUT |                                                                                |
| RX2 IN [8]                                                                                                                                                                                                                                                                          | [21] RX3 OUT |                                                                                |
| RX3 IN [9]                                                                                                                                                                                                                                                                          | [20] RX4 OUT |                                                                                |
| RX4 IN [10]                                                                                                                                                                                                                                                                         | [19] DR3 IN  |                                                                                |
| DR3 OUT [11]                                                                                                                                                                                                                                                                        | [18] RX5 OUT |                                                                                |
| RX5 IN [12]                                                                                                                                                                                                                                                                         | [17] GND     |                                                                                |
| ON/OFF [13]                                                                                                                                                                                                                                                                         | [16] NC      |                                                                                |
| NC [14]                                                                                                                                                                                                                                                                             | [15] NC      |                                                                                |
| G PACKAGE 28-LEAD SSOP<br>NW PACKAGE 28-LEAD PDIP<br>SW PACKAGE 28-LEAD PLASTIC SO WIDE<br>$T_{JMAX} = 125^{\circ}C, \theta_{JA} = 96^{\circ}C/W$ (G)<br>$T_{JMAX} = 125^{\circ}C, \theta_{JA} = 56^{\circ}C/W$ (NW)<br>$T_{JMAX} = 125^{\circ}C, \theta_{JA} = 85^{\circ}C/W$ (SW) |              |                                                                                |

Consult LTC Marketing for parts specified with wider operating temperature ranges.

## DC ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range.  $V_{CC} = 3.3V$ ,  $C1 = C2 = C3 = C4 = 0.1\mu F$ , unless noted.

| PARAMETER                    | CONDITIONS                                            | MIN    | TYP  | MAX | UNITS      |
|------------------------------|-------------------------------------------------------|--------|------|-----|------------|
| <b>Any Driver</b>            |                                                       |        |      |     |            |
| Output Voltage Swing         | 3k to GND                                             | ● 3.7  | 4.5  |     | V          |
|                              | Positive                                              | ● -3.7 | -4.5 |     | V          |
| Logic Input Voltage Level    | Input Low Level ( $V_{OUT} = \text{High}$ )           | ● 2.0  | 1.4  | 0.8 | V          |
|                              | Input High Level ( $V_{OUT} = \text{Low}$ )           | ● 2.0  | 1.4  |     | V          |
| Logic Input Current          | $V_{IN} = V_{CC}$                                     | ●      |      | 5   | $\mu A$    |
|                              | $V_{IN} = 0V$                                         | ●      |      | -5  | $\mu A$    |
| Output Short-Circuit Current | $V_{OUT} = 0V$                                        | ±9     | ±10  |     | mA         |
| Output Leakage Current       | Shutdown (Note 3), $V_{OUT} = \pm 20V$                |        | 10   | 500 | $\mu A$    |
| <b>Any Receiver</b>          |                                                       |        |      |     |            |
| Input Voltage Thresholds     | Input Low Threshold                                   | ● 0.8  | 1.3  |     | V          |
|                              | Input High Threshold                                  | ● 0.8  | 1.7  | 2.4 | V          |
| Hysteresis                   |                                                       | ● 0.1  | 0.4  | 1   | V          |
| Input Resistance             | $V_{IN} = \pm 10V$                                    | 3      | 5    | 7   | k $\Omega$ |
| Output Voltage               | Output Low, $I_{OUT} = -1.6mA$ ( $V_{CC} = 3.3V$ )    | ● 3.0  | 0.2  | 0.4 | V          |
|                              | Output High, $I_{OUT} = 160\mu A$ ( $V_{CC} = 3.3V$ ) | ● 3.0  | 3.2  |     | V          |
| Output Short-Circuit Current | Sinking Current, $V_{OUT} = V_{CC}$                   | -3     | -20  |     | mA         |
| Output Leakage Current       | Shutdown (Note 3), $0V \leq V_{OUT} \leq V_{CC}$      | ●      | 1    | 10  | $\mu A$    |

## DC ELECTRICAL CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range.  $V_{CC} = 3.3V$ ,  $C1 = C2 = C3 = C4 = 0.1\mu F$ , unless noted.

| PARAMETER                     | CONDITIONS                                                                             |   | MIN | TYP  | MAX | UNITS   |
|-------------------------------|----------------------------------------------------------------------------------------|---|-----|------|-----|---------|
| <b>Power Supply Generator</b> |                                                                                        |   |     |      |     |         |
| $V^+$ Output Voltage          | $I_{OUT} = 0mA$                                                                        |   |     | 5.7  |     | V       |
|                               | $I_{OUT} = 5mA$                                                                        |   |     | 5.5  |     | V       |
| $V^-$ Output Voltage          | $I_{OUT} = 0mA$                                                                        |   |     | -5.3 |     | V       |
|                               | $I_{OUT} = -5mA$                                                                       |   |     | -5.0 |     | V       |
| Supply Rise Time              | Shutdown to Turn-On                                                                    |   |     | 0.2  |     | ms      |
| <b>Power Supply</b>           |                                                                                        |   |     |      |     |         |
| $V_{CC}$ Supply Current       | No Load (All Drivers $V_{IN} = V_{CC}$ )(Note 2) $0^\circ C \leq T_A \leq 70^\circ C$  | ● |     | 0.3  | 0.6 | mA      |
|                               | No Load (All Drivers $V_{IN} = 0$ )(Note 2) $0^\circ C \leq T_A \leq 70^\circ C$       | ● |     | 0.5  | 1.0 | mA      |
|                               | No Load (All Drivers $V_{IN} = V_{CC}$ )(Note 2) $0^\circ C \leq T_A \leq 85^\circ C$  | ● |     | 0.3  | 1.0 | mA      |
|                               | No Load (All Drivers $V_{IN} = V_{CC}$ )(Note 2) $-40^\circ C \leq T_A \leq 0^\circ C$ | ● |     | 0.3  | 1.5 | mA      |
|                               | No Load (All Drivers $V_{IN} = 0$ )(Note 2) $-40^\circ C \leq T_A \leq 85^\circ C$     | ● |     | 0.5  | 1.5 | mA      |
|                               | Shutdown (Note 3)                                                                      | ● |     | 35   | 50  | $\mu A$ |
| ON/OFF Threshold Low          |                                                                                        | ● |     | 1.4  | 0.8 | V       |
| ON/OFF Threshold High         |                                                                                        | ● | 2.0 | 1.4  |     | V       |

## AC CHARACTERISTICS

The ● denotes specifications which apply over the full operating temperature range.  $V_{CC} = 5V$ ,  $C1 = C2 = C3 = C4 = 0.1\mu F$ , unless noted.

| PARAMETER                                          | CONDITIONS               |   | MIN | TYP | MAX | UNITS      |
|----------------------------------------------------|--------------------------|---|-----|-----|-----|------------|
| Slew Rate                                          | $R_L = 3k, C_L = 51pF$   |   |     | 8   | 30  | V/ $\mu s$ |
|                                                    | $R_L = 3k, C_L = 1000pF$ |   | 3   | 5   |     | V/ $\mu s$ |
| Driver Propagation Delay<br>(TTL to EIA/TIA-562)   | $t_{HLD}$ (Figure 1)     | ● |     | 2   | 3.5 | $\mu s$    |
|                                                    | $t_{LHD}$ (Figure 1)     | ● |     | 2   | 3.5 | $\mu s$    |
| Receiver Propagation Delay<br>(EIA/TIA-562 to TTL) | $t_{HLR}$ (Figure 2)     | ● |     | 0.3 | 0.8 | $\mu s$    |
|                                                    | $t_{LHR}$ (Figure 2)     | ● |     | 0.3 | 0.8 | $\mu s$    |

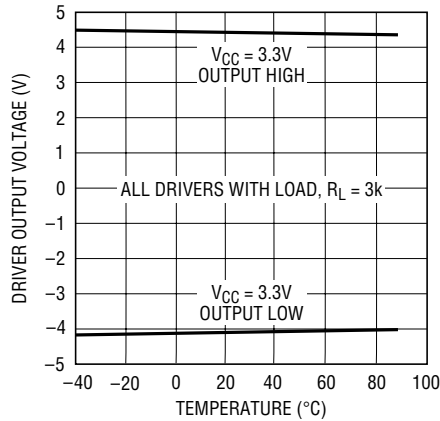
**Note 1:** Absolute Maximum Ratings are those values beyond which the life of the device may be impaired.

**Note 2:** Supply current is measured with driver and receiver outputs unloaded.

**Note 3:** Supply current measurement in Shutdown mode is performed with  $V_{ON/OFF} = 0V$ .

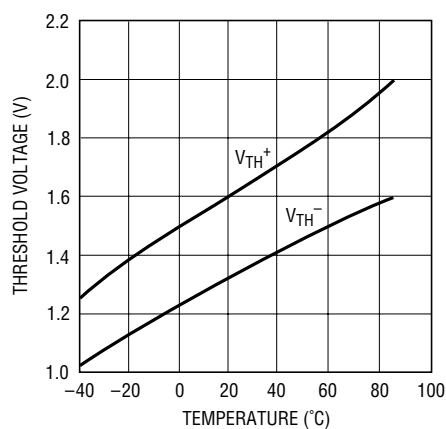
## TYPICAL PERFORMANCE CHARACTERISTICS

**Driver Output Voltage vs Temperature**



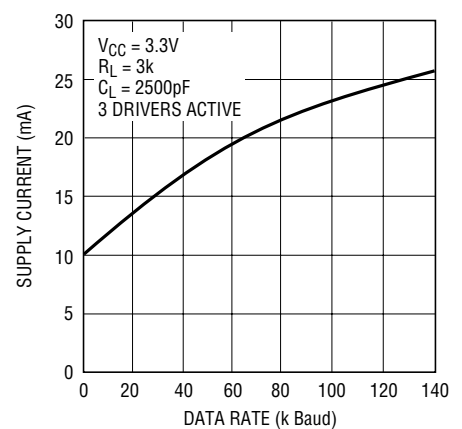
LTC1350 • TPC01

**Receiver Input Thresholds vs Temperature**



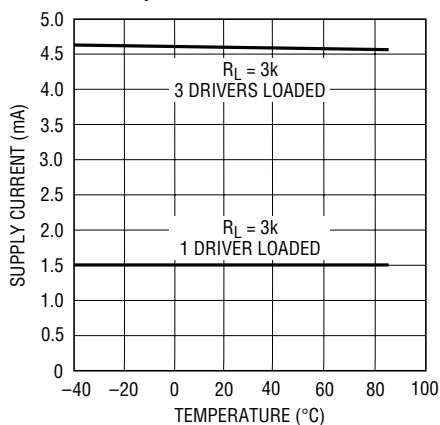
LTC1350 • TPC02

**Supply Current vs Data Rate**



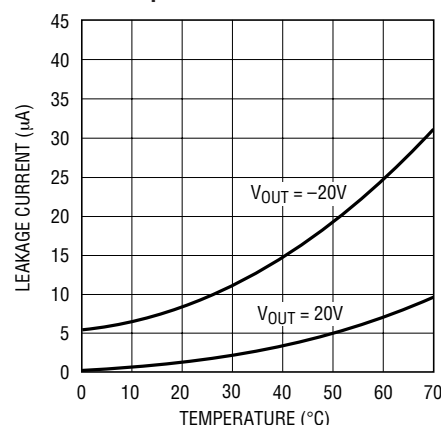
LTC1350 • TPC03

**VCC Supply Current vs Temperature**



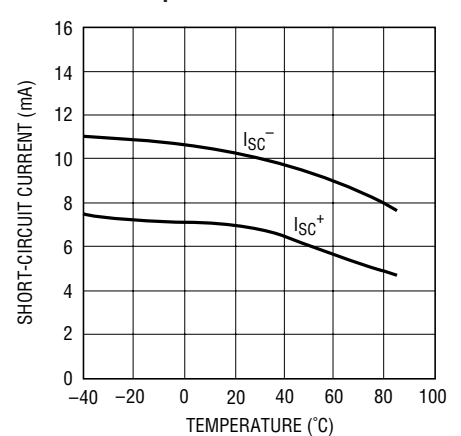
LTC1350 • TPC04

**Driver Leakage in Shutdown vs Temperature**



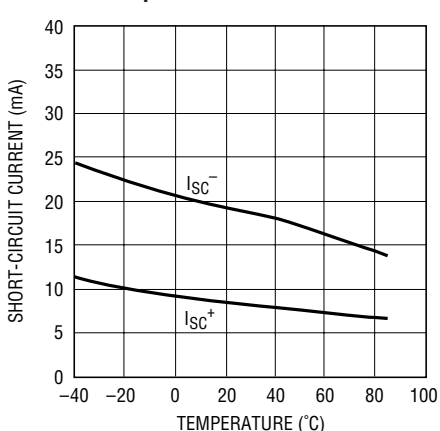
LTC1350 • TPC05

**Driver Short-Circuit Current vs Temperature**



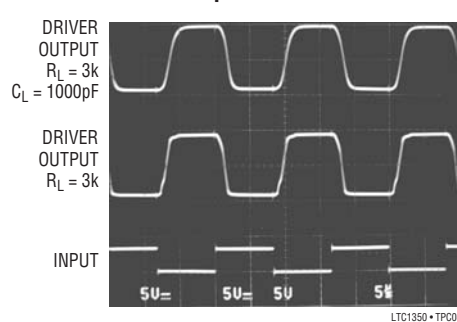
LTC1350 • TPC06

**Receiver Short-Circuit Current vs Temperature**



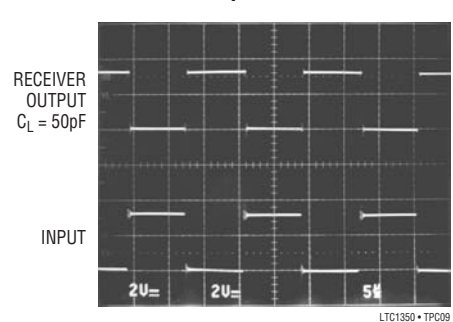
LTC1350 • TPC07

**Driver Output Waveforms**



LTC1350 • TPC08

**Receiver Output Waveform**



LTC1350 • TPC09

## PIN FUNCTIONS

**V<sub>CC</sub>**: 3.3V Input Supply Pin. Supply current is typically 35 $\mu$ A in the Shutdown mode. This pin should be decoupled with a 0.1 $\mu$ F ceramic capacitor.

**GND**: Ground Pin.

**ON/OFF**: TTL/CMOS Compatible Shutdown Pin. A logic low puts the device in the Shutdown mode with receivers 4 and 5 kept alive and the supply current equal to 35 $\mu$ A. All driver and other receiver outputs are in high impedance state. This pin cannot float.

**V<sup>+</sup>**: Positive Supply Output.  $V^+ \cong 2V_{CC} - 1V$ . This pin requires an external capacitor ( $C = 0.1\mu F$ ) for charge storage. The capacitor may be tied to ground or  $V_{CC}$ . With multiple devices, the  $V^+$  and  $V^-$  pins may be paralleled into common capacitors. For a large number of devices, increasing the size of the shared common storage capacitors is recommended to reduce ripple.

**V<sup>-</sup>**: Negative Supply Output.  $V^- \cong -(2V_{CC} - 1.3V)$ . This pin requires an external capacitor ( $C = 0.1\mu F$ ) for charge storage.

**C1<sup>+</sup>, C1<sup>-</sup>, C2<sup>+</sup>, C2<sup>-</sup>**: Commutating Capacitor Inputs. These pins require two external capacitors ( $C = 0.1\mu F$ ): 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 20 $\Omega$ .

**DR IN**: EIA/TIA-562 Driver Input Pins. Inputs are TTL/CMOS compatible. Inputs should not be allowed to float. Tie unused inputs to  $V_{CC}$ .

**DR OUT**: Driver Outputs at EIA/TIA-562 Voltage Levels. Outputs are in a high impedance state when in the Shutdown 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. Receiver 1, 2 and 3 outputs are in a high impedance state when in Shutdown mode to allow data line sharing. Receivers 4 and 5 are kept alive in Shutdown.

## SWITCHING TIME WAVEFORMS

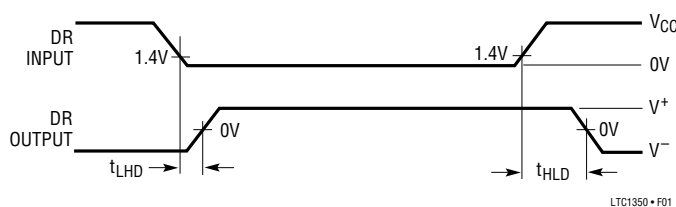


Figure 1. Driver Propagation Delay Timing

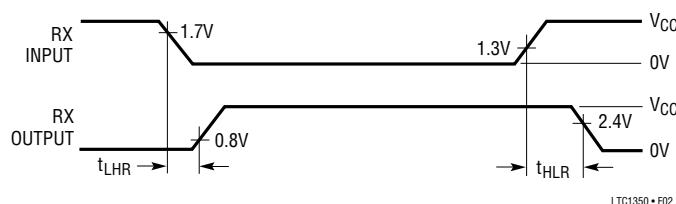
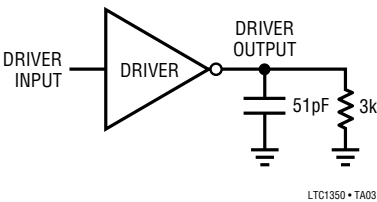


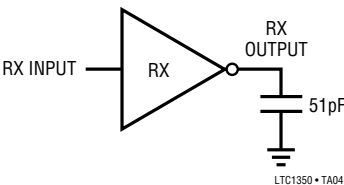
Figure 2. Receiver Propagation Delay Timing

TEST CIRCUITS

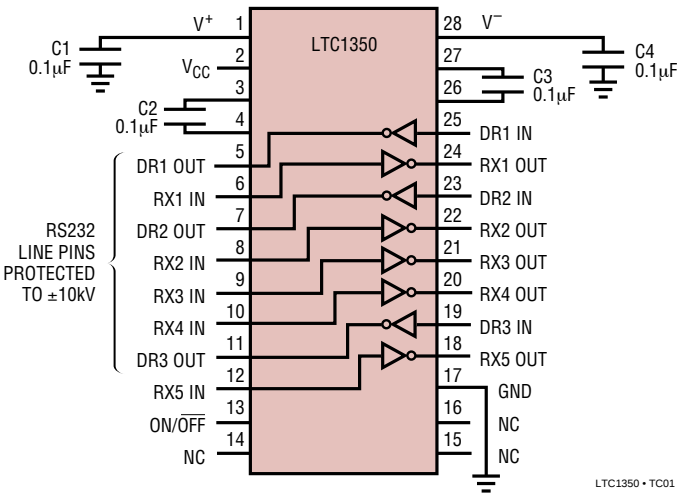
Driver Timing Test Load



Receiver Timing Test Load

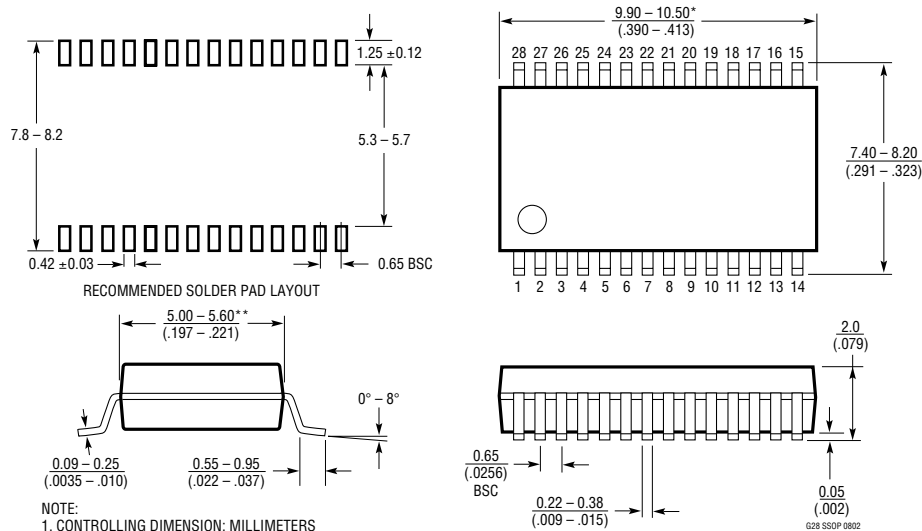


ESD Test Circuit



## PACKAGE DESCRIPTION

### G Package 28-Lead Plastic SSOP (5.3mm) (Reference LTC DWG # 05-08-1640)



NOTE:

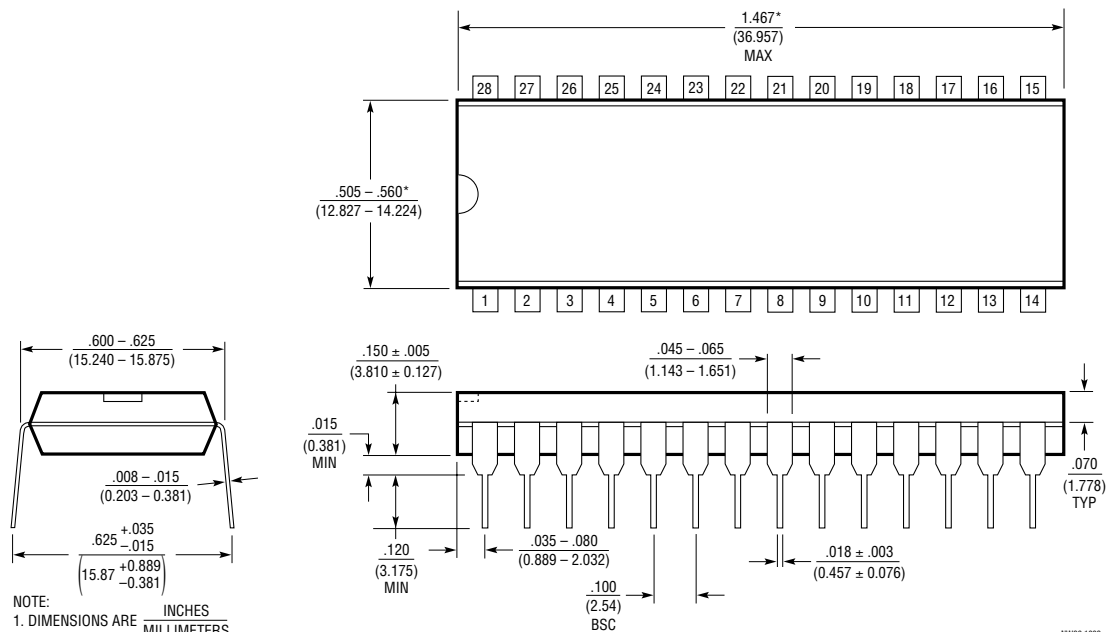
1. CONTROLLING DIMENSION: MILLIMETERS

2. DIMENSIONS ARE IN MILLIMETERS  
(INCHES)

3. DRAWING NOT TO SCALE

\*DIMENSIONS DO NOT INCLUDE MOLD FLASH. MOLD FLASH  
SHALL NOT EXCEED .152mm (.006") PER SIDE\*\*DIMENSIONS DO NOT INCLUDE INTERLEAD FLASH. INTERLEAD  
FLASH SHALL NOT EXCEED .254mm (.010") PER SIDE

### NW Package 28-Lead PDIP (Wide .600 Inch) (Reference LTC DWG # 05-08-1520)



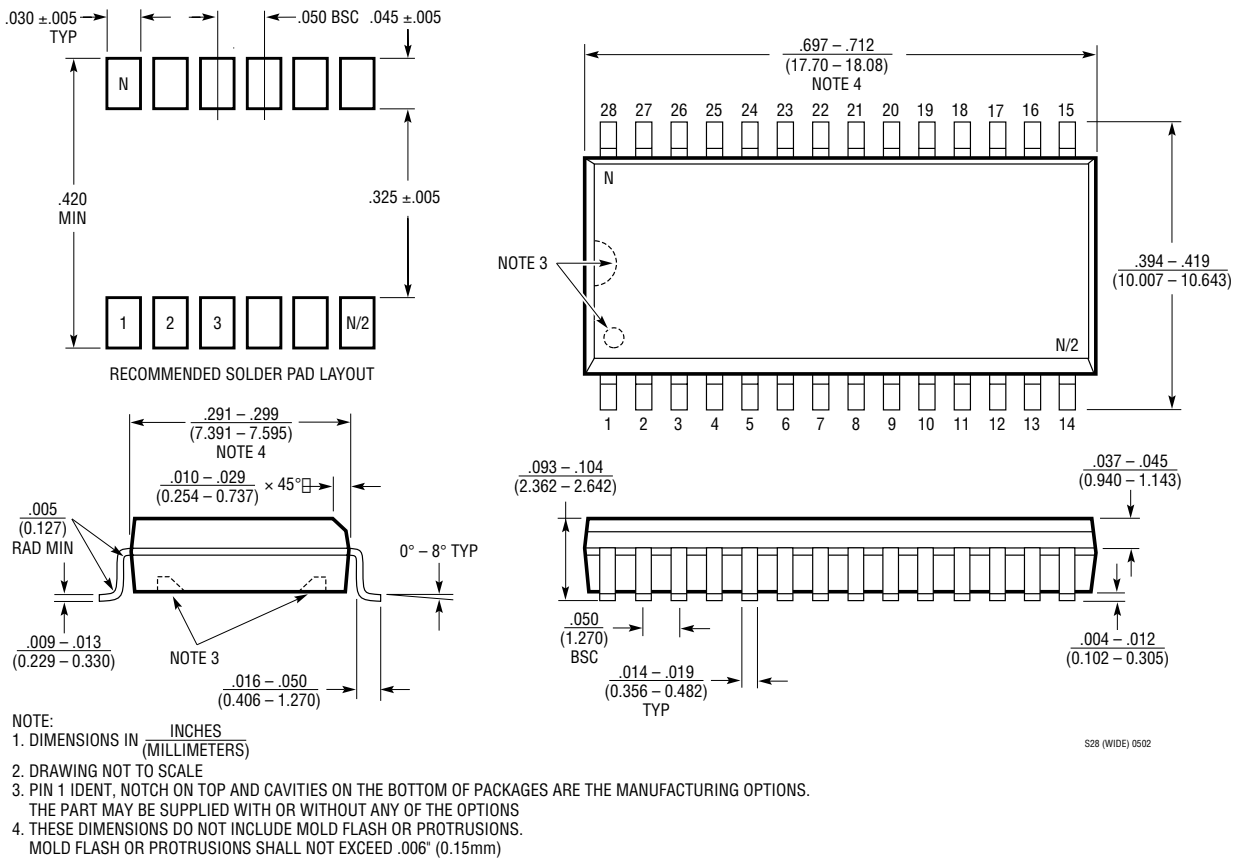
NOTE:

1. DIMENSIONS ARE INCHES  
MILLIMETERS\*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

NW28 1002

## PACKAGE DESCRIPTION

### SW Package 28-Lead Plastic Small Outline (Wide .300 Inch) (Reference LTC DWG # 05-08-1620)



S28 (WIDE) 0502

## RELATED PARTS

| PART NUMBER           | DESCRIPTION                                         | COMMENTS                                                           |
|-----------------------|-----------------------------------------------------|--------------------------------------------------------------------|
| LT <sup>®</sup> 1137A | 5V, 3 Driver, 5 Receiver RS232 Transceiver          | ±15kV ESD per IEC 1000-4                                           |
| LTC1327               | 3.3V, 3 Driver, 5 Receiver RS562 Transceiver        | 300μA Supply Current, 0.2μA in Shutdown                            |
| LTC1337               | 5V, 3 Driver, 5 Receiver RS232 Transceiver          | 300μA Supply Current, 1μA in Shutdown                              |
| LTC1348               | 3.3V to 5V, 3 Driver, 5 Receiver RS232 Transceiver  | True RS232 on 3.3V, 5 Receivers Active in Shutdown                 |
| LTC1385               | 3.3V, 2 Driver, 2 Receiver RS562 Transceiver        | 200μA Supply Current, 2 Receivers Active in Shutdown               |
| LTC1386               | 3.3V, 2 Driver, 2 Receiver RS562 Transceiver        | 200μA Supply Current, Narrow 16-Pin SO                             |
| LTC2844               | 3.3V, Software-Selectable Multiprotocol Transceiver | 4 Drivers, 4 Receivers for Control Signals Including LL            |
| LTC2845               | 3.3V, Software-Selectable Multiprotocol Transceiver | 5 Drivers, 5 Receivers for Control Signals Including LL, RL and TM |
| LTC2846               | 3.3V, Software-Selectable Multiprotocol Transceiver | 4 Drivers, 4 Receivers with Termination for Data/Clock             |