# LINEAR TECHNOLOGY

## LTC1385

## 3.3V Low Power EIA/TIA-562 Transceiver

## FEATURES

- **Operates from a Single 3.3V Supply**
- **Low Supply Current: $I_{CC} = 200\mu A$**
- **$I_{CC} = 35\mu A$ in Driver Disable Mode**
- **$I_{CC} = 0.2\mu A$ in Shutdown Mode**
- **ESD Protection Over $\pm 10kV$**
- Uses Small Capacitors: $0.1\mu F$
- Operates to 120kBaud
- Output Overvoltage Does Not Force Current Back into Supplies
- EIA/TIA-562 I/O Lines Can Be Forced to $\pm 25V$ Without Damage
- Pin Compatible with LT1180A

## APPLICATIONS

- Notebook Computers
- Palmtop Computers

## DESCRIPTION

The LTC1385 is an ultra-low power, 2-driver/2-receiver EIA/TIA-562 transceiver which operates from a single 3.3V supply. The charge pump requires only four space-saving $0.1\mu F$ capacitors.

The transceiver operates in one of three modes: Normal, Driver Disable or Shutdown. In the Normal mode, $I_{CC}$ is only $200\mu A$ in the unloaded condition. In the Driver Disable mode, the charge pump is turned off, the driver outputs are forced into three-state, both receivers are kept active, and $I_{CC}$ drops to $35\mu A$. In the Shutdown mode, everything is turned off and $I_{CC}$ drops to $0.2\mu A$.

The LTC1385 is fully compliant with all data rate and overvoltage EIA/TIA-562 specifications. The transceiver can operate up to 120kbaud with a 1000pF, $3k\Omega$ load. Both driver outputs and receiver inputs can be forced to $\pm 25V$ without damage, and can survive multiple $\pm 10kV$ ESD strikes.

## TYPICAL APPLICATION

### 2-Drivers/2-Receivers with Shutdown and Driver Disable



LTC1385 • TA01
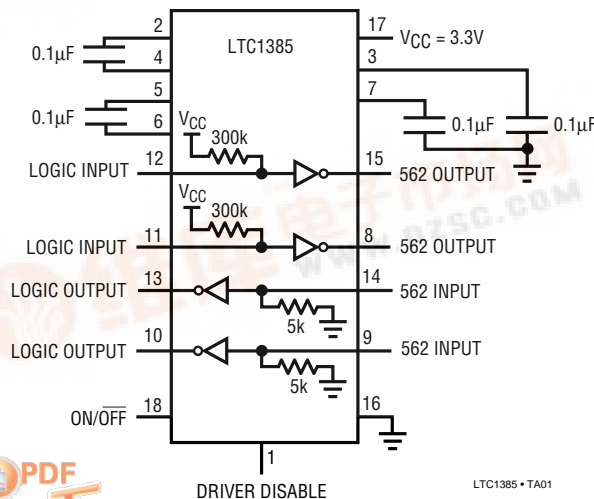
### Quiescent and Shutdown Supply Current vs Temperature
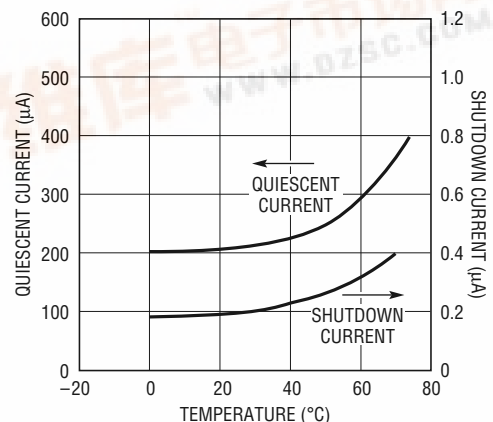


TEST CONDITION: $V_{CC} = 3.3V$

LTC1385 • TA02

# LTC1385

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage ($V_{CC}$) ................................................ 5V
Input Voltage
   Driver ........................................ −0.3V to $V_{CC}$ + 0.3V
   Receiver ........................................... −25V to 25V
   Digital Input .............................. −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 ................... 0°C to 70°C
Storage Temperature Range ............... −65°C to 150°C
Lead Temperature (Soldering, 10 sec) ................ 300°C

## PACKAGE/ORDER INFORMATION

| | | ORDER PART NUMBER |
|---|---|---|

**TOP VIEW**

G PACKAGE: 20-LEAD SSOP

| Pin | Name | Pin | Name |
|---|---|---|---|
| 1 | DRIVER DISABLE | 20 | ON/$\overline{OFF}$ |
| 2 | C1$^+$ | 19 | VCC |
| 3 | V$^+$ | 18 | GND |
| 4 | C1$^-$ | 17 | TR1 OUT |
| 5 | C2$^+$ | 16 | RX1 IN |
| 6 | C2$^-$ | 15 | RX1 OUT |
| 7 | V$^-$ | 14 | TR1 IN |
| 8 | TR2 OUT | 13 | TR2 IN |
| 9 | RX2 IN | 12 | RX2 OUT |
| 10 | NC | 11 | NC |

G PACKAGE
20-LEAD SSOP

$T_{JMAX}$ = 125°C, $\theta_{JA}$ = 135°C/W

ORDER PART NUMBER: LTC1385CG

**TOP VIEW**

N PACKAGE 18-LEAD PLASTIC DIP   S PACKAGE 18-LEAD PLASTIC SOL

| Pin | Name | Pin | Name |
|---|---|---|---|
| 1 | DRIVER DISABLE | 18 | ON/$\overline{OFF}$ |
| 2 | C1$^+$ | 17 | $V_{CC}$ |
| 3 | V$^+$ | 16 | GND |
| 4 | C1$^-$ | 15 | TR1 OUT |
| 5 | C2$^+$ | 14 | RX1 IN |
| 6 | C2$^-$ | 13 | RX1 OUT |
| 7 | V$^-$ | 12 | TR1 IN |
| 8 | TR2 OUT | 11 | TR2 IN |
| 9 | RX2 IN | 10 | RX2 OUT |

$T_{JMAX}$ = 125°C, $\theta_{JA}$ = 85°C/W

ORDER PART NUMBER: LTC1385CN  LTC1385CS

Consult factory for Industrial and Military grade parts.

## DC ELECTRICAL CHARACTERISTICS

$V_{CC}$ = 3.3V, C1 = C2 = C3 = C4 = 0.1$\mu$F, $V_{ON/\overline{OFF}}$ = $V_{CC}$, Driver Disable = $V_{CC}$, unless otherwise noted.

| PARAMETER | CONDITIONS | | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| **Any Driver** | | | | | | | |
| Output Voltage Swing | 3k to GND | Positive | ● | 3.7 | 4.5 | | V |
| | | Negative | ● | −3.7 | −4.5 | | V |
| Logic Input Voltage Level | Input Low Level ($V_{OUT}$ = High) | | ● | | 1.4 | 0.8 | V |
| | Input High Level ($V_{OUT}$ = Low) | | ● | 2.0 | 1.4 | | V |
| Logic Input Current | $V_{IN}$ = $V_{CC}$ | | ● | | | 5 | $\mu$A |
| | $V_{IN}$ = 0V | | ● | | −20 | −40 | $\mu$A |
| Output Short-Circuit Current | $V_{OUT}$ = 0V | | | | ±10 | | mA |
| Output Leakage Current | Shutdown or Driver Disable or $V_{CC}$ = 0V (Note 3,4), $V_{OUT}$ = ±20V | | ● | | ±10 | ±500 | $\mu$A |

# DC ELECTRICAL CHARACTERISTICS

$V_{CC}$ = 3.3V, C1 = C2 = C3 = C4 = 0.1μF, $V_{ON/\overline{OFF}}$ = $V_{CC}$, Driver Disable = $V_{CC}$, unless otherwise noted.

| PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **Any Receiver** | | | | | | |
| Input Voltage Thresholds | Input Low Threshold | ● | 0.8 | 1.3 | | V |
| | Input High Threshold | ● | | 1.7 | 2.4 | V |
| Hysteresis | | ● | 0.1 | 0.4 | 1.0 | V |
| Input Resistance | −10V ≤ $V_{IN}$ ≤ 10V | | 3 | 5 | 7 | kΩ |
| Output Voltage | Output Low, $I_{OUT}$ = −1.6mA ($V_{CC}$ = 3.3V) | ● | | 0.2 | 0.4 | V |
| | Output High, $I_{OUT}$ = 160μA ($V_{CC}$ = 3.3V) | ● | 3.0 | 3.2 | | V |
| Output Short-Circuit Current | Sinking Current, $V_{OUT}$ = $V_{CC}$ | | −5 | −20 | | mA |
| | Sourcing Current, $V_{OUT}$ = 0V | | 2 | 7 | | mA |
| Output Leakage Current | Shutdown (Note 4), 0V ≤ $V_{OUT}$ ≤ $V_{CC}$ | ● | | 1 | 10 | μA |
| **Power Supply Generator** | | | | | | |
| 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 or Driver Disable to Turn-On | | | 0.2 | | ms |
| **Power Supply** | | | | | | |
| $V_{CC}$ Supply Current | No Load (Note 2) | ● | | 0.2 | 0.5 | mA |
| Supply Leakage Current ($V_{CC}$) | Shutdown (Note 4) | ● | | 0.2 | 10 | μA |
| | Driver Disable (Note 3) | ● | | 35 | 50 | μA |
| Digital Input Threshold Low | | ● | | 1.4 | 0.8 | V |
| Digital Input Threshold High | | ● | 2.0 | 1.4 | | V |

# AC CHARACTERISTICS

$V_{CC}$ = 3.3V, C1 = C2 = C3 = C4 = 0.1μF, unless otherwise noted.

| PARAMETER | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Slew Rate | $R_L$ = 3k, $C_L$ = 51pF | | | 8 | 30 | V/μs |
| | $R_L$ = 3k, $C_L$ = 1000pF | | 3 | 5 | | V/μs |
| Driver Propagation Delay | $t_{HLD}$ (Figure 1) | ● | | 2 | 3.5 | μs |
| (TTL to EIA/TIA-562) | $t_{LHD}$ (Figure 1) | ● | | 2 | 3.5 | μs |
| Receiver Propagation Delay | $t_{HLR}$ (Figure 2) | ● | | 0.3 | 0.8 | μs |
| (EIA/TIA-562 to TTL) | $t_{LHR}$ (Figure 2) | ● | | 0.2 | 0.8 | μs |

The ● denotes specifications which apply over the operating temperature range 0°C ≤ $T_A$ ≤ 70°C.

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

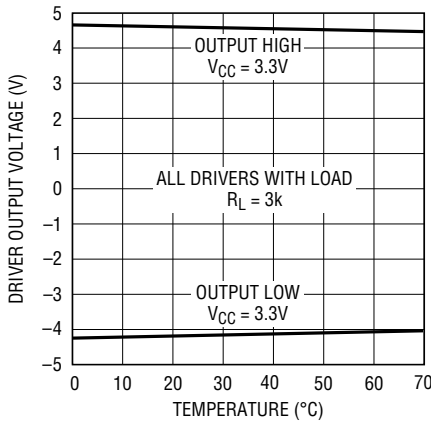**Note 2:** Supply current is measured with driver and receiver outputs unloaded.

**Note 3:** Measurements made in the Driver Disable mode are performed with $V_{DRIVER\ DISABLE}$ = GND and $V_{ON/\overline{OFF}}$ = $V_{CC}$.

**Note 4:** Measurements made in the Shutdown mode are performed with $V_{ON/\overline{OFF}}$ = 0V.
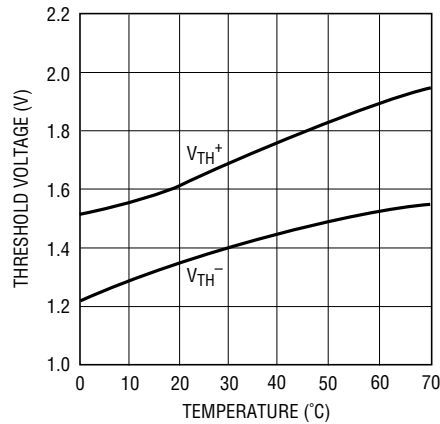
# LTC1385

# TYPICAL PERFORMANCE CHARACTERISTICS

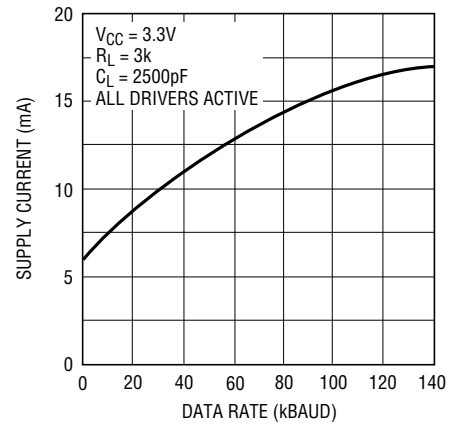### Driver Output Voltage vs Temperature



LTC1385 • TPC01

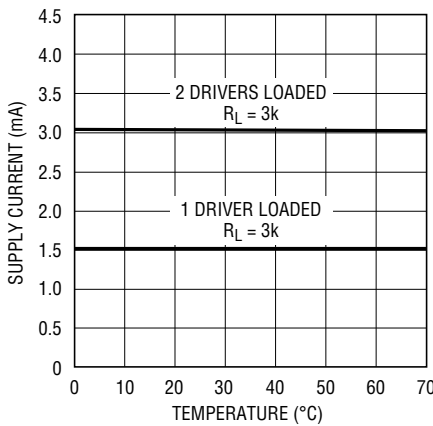### Receiver Input Thresholds vs Temperature



LTC1385 • TPC02

### Supply Current vs Data Rate
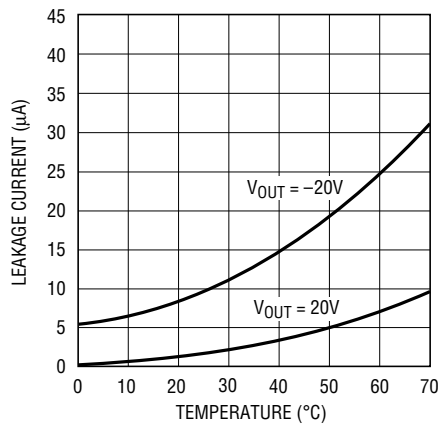


LTC1385 • TPC03

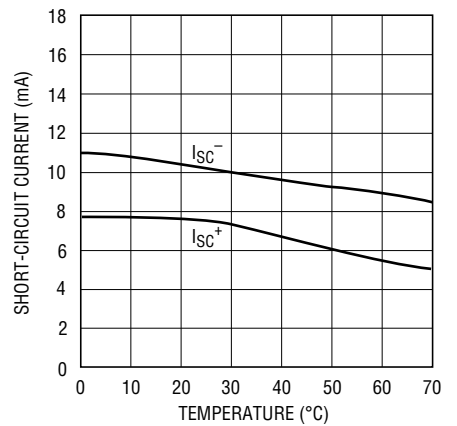### $V_{CC}$ Supply Current vs Temperature



LTC1385 • TPC04
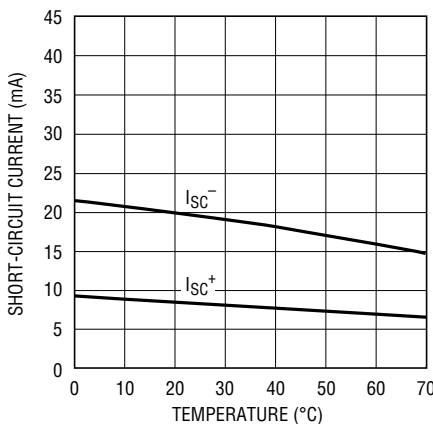
### Driver Leakage in Shutdown vs Temperature



LTC1385 • TPC05
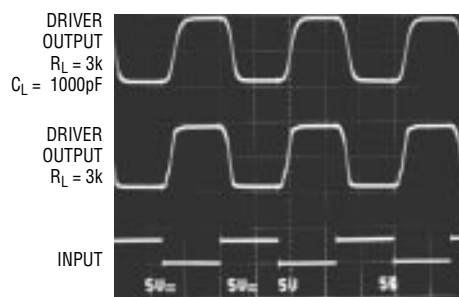
### Driver Short-Circuit Current vs Temperature



LTC1385 • TPC06

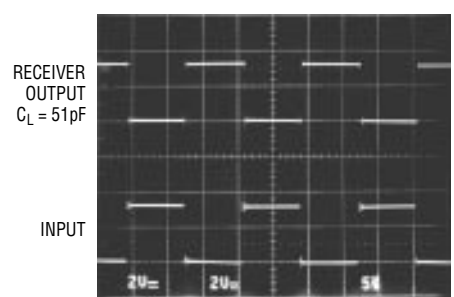### Receiver Short-Circuit Current vs Temperature



LTC1385 • TPC06

### Driver Output Waveforms



LTC1385 • TPC08

### Receiver Output Waveform



LTC1385 • TPC09

# PIN FUNCTIONS

**V$_{CC}$:** 3.3V Input Supply Pin. This pin should be decoupled with a 0.1µF ceramic capacitor.

**GND:** Ground Pin.

**ON/$\overline{OFF}$:** TTL/CMOS Compatible Shutdown Pin. A logic low puts the device in the Shutdown mode independent of the Driver Disable pin. The supply current drops to 0.2µA and all driver and receiver outputs are forced into three-state.

**DRIVER DISABLE:** TTL/CMOS Compatible Input Pin. With the ON/$\overline{OFF}$ pin held high, a logic low forces the part into the Driver Disable mode with the charge pump turned off and the driver outputs forced into three-state. Both receivers remain active and the supply current drops to 35µA. A logic high forces the part into the Normal mode.

**V$^+$:** Positive Supply Output (EIA/TIA-562 Drivers). V$^+ \cong 2V_{CC} - 1V$. This pin requires an external capacitor C = 0.1µF for charge storage. The capacitor may be tied to ground or V$_{CC}$. With multiple devices, the V$^+$ and V$^-$ pins may share a common capacitor. For a large number of devices, increasing the size of the shared common storage capacitors is recommended to reduce ripple.

**V$^-$:** Negative Supply Output (EIA/TIA-562 Drivers). V$^- \cong -(2V_{CC} - 1.3V)$. This pin requires an external capacitor C = 0.1µF for charge storage.

**C1$^+$, C1$^-$, C2$^+$, C2$^-$:** Commutating Capacitor Inputs. These pins require two external capacitors C = 0.1µF: one from C1$^+$ to C1$^-$, and another from C2$^+$ to C2$^-$. To maintain charge pump efficiency, the capacitor's effective series resistance should be less than 2Ω.

**TR IN:** EIA/TIA-562 Driver Input Pins. Inputs are TTL/CMOS compatible. The inputs of unused drivers can be left unconnected since 300k input pull-up resistors to V$_{CC}$ are included on chip. To minimize power consumption, the internal driver pull-up resistors are disconnected from V$_{CC}$ in the Shutdown mode.

**TR OUT:** Driver Outputs at EIA/TIA-562 Voltage Levels. Outputs are in a high impedance state when in the Shutdown or Driver Disable mode or V$_{CC}$ = 0V. The driver outputs are protected against ESD to ±10kV for human body model discharges.

**RX IN:** Receiver Inputs. These pins can be forced to ±25V without damage. The receiver inputs are protected against ESD to ±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 the Shutdown mode.
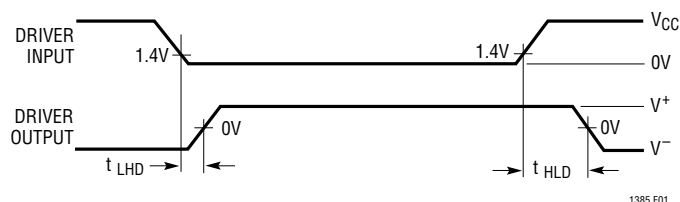
# SWITCHING TIME WAVEFORMS



Figure 1.  Driver Propagation Delay Timing
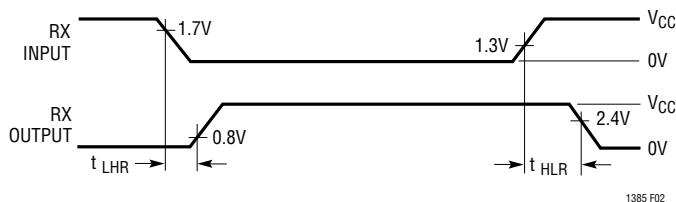


Figure 2.  Receiver Propagation Delay Timing

# TEST CIRCUITS

**Driver Timing Test Load**
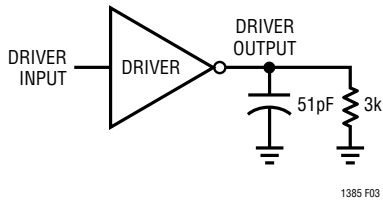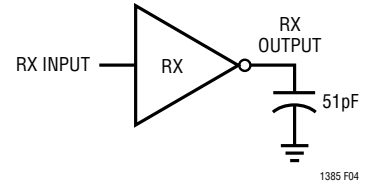
DRIVER INPUT — DRIVER — DRIVER OUTPUT

51pF    3k

1385 F03

**Receiver Timing Test Load**

RX INPUT — RX — RX OUTPUT

51pF

1385 F04

**ESD Test Circuit**

| 2 | LTC1385 | 17 $V_{CC}$ |
| 4 | | 3 |
| 0.1µF | | |
| 5 | | 7 |
| 6 $V_{CC}$ | | 0.1µF   0.1µF |

0.1µF

300k

LOGIC INPUT  12 — 15 562 OUTPUT

$V_{CC}$  300k

LOGIC INPUT  11 — 8 562 OUTPUT

LOGIC OUTPUT  13 — 14 562 INPUT

5k

LOGIC OUTPUT  10 — 9 562 INPUT

5k

ON/OFF  18

16

1

DRIVER DISABLE

RS562 LINE PINS PROTECTED TO ±10kV

1385 F05
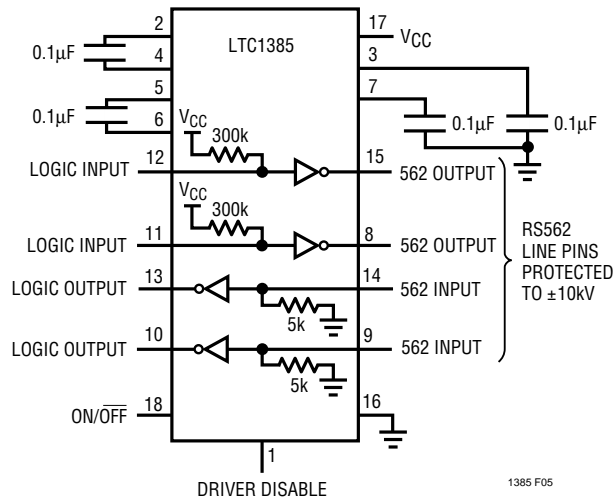
# PACKAGE DESCRIPTION

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

**G Package**
**20-Lead SSOP**
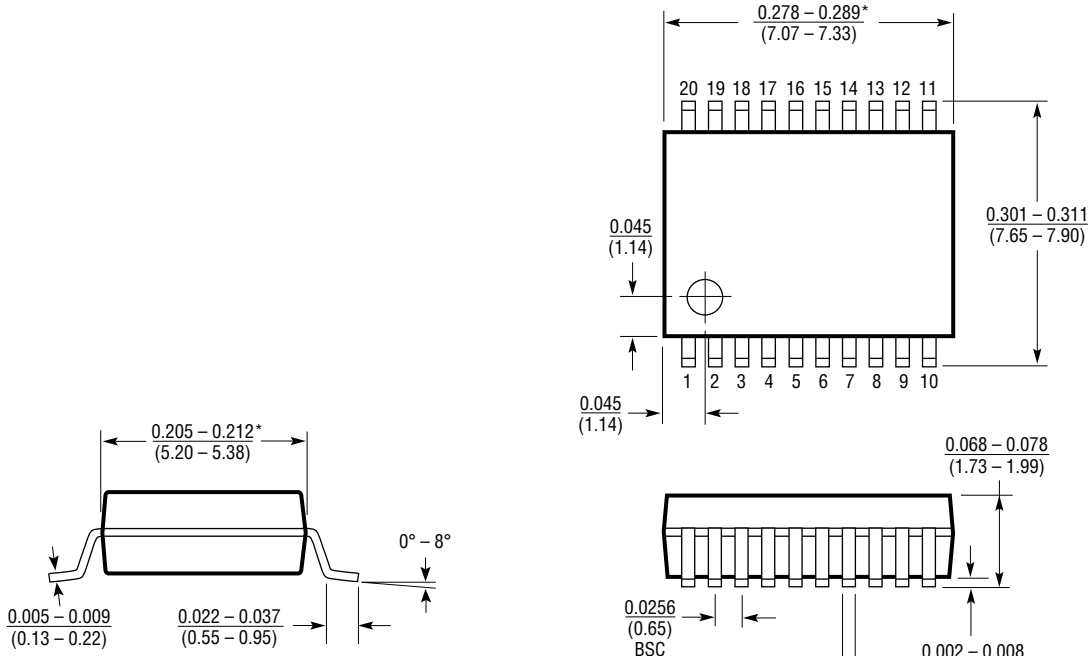
0.278 – 0.289*
(7.07 – 7.33)

20 19 18 17 16 15 14 13 12 11

0.045
(1.14)

0.301 – 0.311
(7.65 – 7.90)

1 2 3 4 5 6 7 8 9 10

0.045
(1.14)

0.205 – 0.212*
(5.20 – 5.38)

0° – 8°

0.005 – 0.009
(0.13 – 0.22)

0.022 – 0.037
(0.55 – 0.95)

0.068 – 0.078
(1.73 – 1.99)

0.0256
(0.65)
BSC

0.010 – 0.015
(0.25 – 0.38)

0.002 – 0.008
(0.05 – 0.21)

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

20SSOP 0294

**N Package**
**18-Lead Plastic DIP**

0.905
(22.860)
MAX

18 17 16 15 14 13 12 11 10

0.260 ± 0.010
(6.604 ± 0.254)

1 2 3 4 5 6 7 8 9

0.300 – 0.325
(7.620 – 8.255)

0.130 ± 0.005
(3.302 ± 0.127)

0.045 – 0.065
(1.143 – 1.651)

0.009 – 0.015
(0.229 – 0.381)

0.015
(0.381)
MIN

0.065
(1.651)
TYP

$0.325 {+0.025 \atop -0.015}$

$\left(8.255 {+0.635 \atop -0.381}\right)$

0.125
(3.175)
MIN

0.045 ± 0.015
(1.143 ± 0.381)

0.018 ± 0.003
(0.457 ± 0.076)

0.100 ± 0.010
(2.540 ± 0.254)

N18 0392

# LTC1385

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

**S Package**
**18-Lead Plastic SOL**



$$\frac{0.447 - 0.463}{(11.354 - 11.760)}$$ (NOTE 2)

18 17 16 15 14 13 12 11 10

SEE NOTE

$$\frac{0.394 - 0.419}{(10.007 - 10.643)}$$

1 2 3 4 5 6 7 8 9

$$\frac{0.291 - 0.299}{(7.391 - 7.595)}$$ (NOTE 2)

$$\frac{0.005}{(0.127)}$$ RAD MIN

$$\frac{0.010 - 0.029}{(0.254 - 0.737)} \times 45°$$

0° – 8° TYP

$$\frac{0.009 - 0.013}{(0.229 - 0.330)}$$

NOTE 1

$$\frac{0.016 - 0.050}{(0.406 - 1.270)}$$

$$\frac{0.093 - 0.104}{(2.362 - 2.642)}$$

$$\frac{0.037 - 0.045}{(0.940 - 1.143)}$$

$$\frac{0.050}{(1.270)}$$ TYP

$$\frac{0.014 - 0.019}{(0.356 - 0.482)}$$ TYP

$$\frac{0.004 - 0.012}{(0.102 - 0.305)}$$

SOL18 0392

NOTE:
1. PIN 1 IDENT, NOTCH ON TOP AND CAVITIES ON THE BOTTOM OF PACKAGES ARE THE MANUFACTURING OPTIONS.
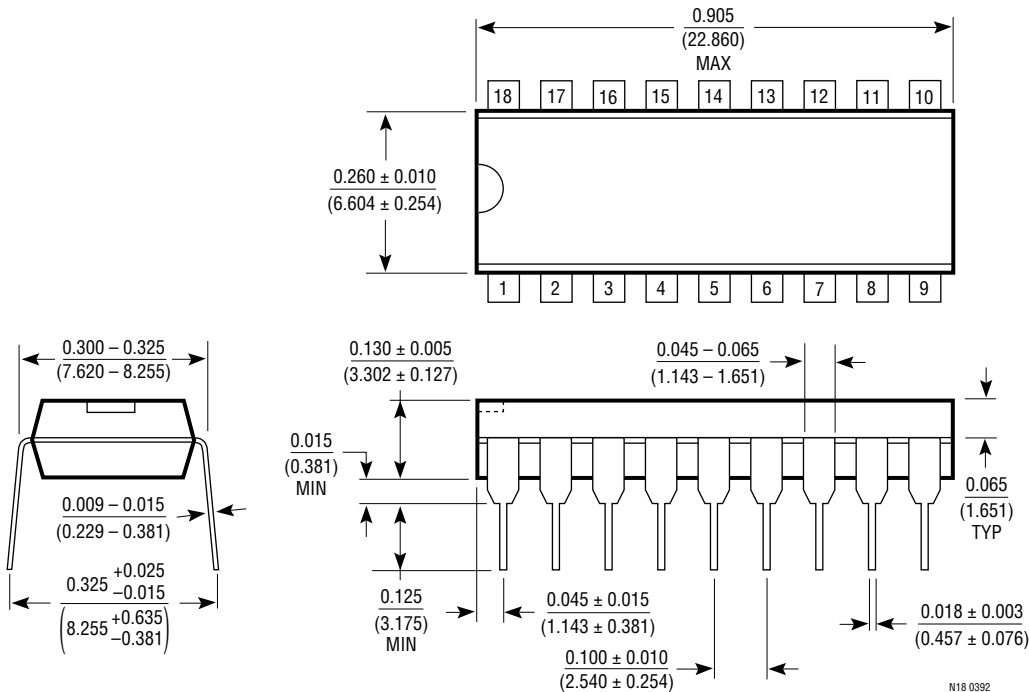   THE PART MAY BE SUPPLIED WITH OR WITHOUT ANY OF THE OPTIONS.

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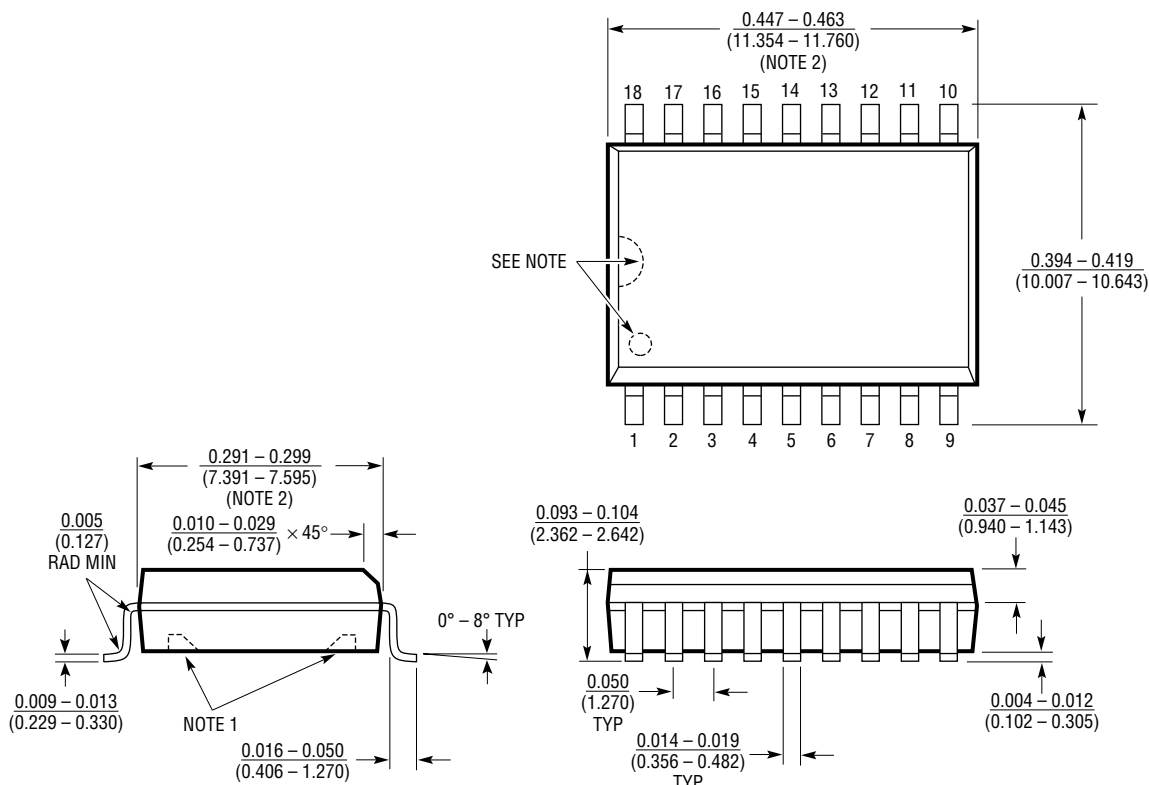   MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.006 INCH (0.15mm).