

# 3.3V 20Mbps RS485/RS422 Transceivers with Integrated Switchable Termination

## FEATURES

- Integrated, Logic-Selectable 120Ω Termination Resistor
- 3.3V Supply Voltage
- 20Mbps Maximum Data Rate
- No Damage or Latchup Up to ±25kV HBM
- High Input Impedance Supports 256 Nodes (C-, I-Grade)
- Operation Up to 125°C (H-Grade)
- Guaranteed Failsafe Receiver Operation Over the Entire Common Mode Range
- Current Limited Drivers and Thermal Shutdown
- Delayed Micropower Shutdown: 5μA Maximum (C-, I-Grade)
- Power Up/Down Glitch-Free Driver Outputs
- Low Operating Current: 370μA Typical in Receive Mode
- Compatible with TIA/EIA-485-A Specifications
- Available in 10-Pin 3mm × 3mm DFN, 12-Pin 4mm × 3mm DFN and 16-Pin SSOP Packages

## APPLICATIONS

- Low Power RS485/RS422 Transceiver
- Level Translator
- Backplane Transceiver

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## DESCRIPTION

The [LTC®2854](#) and [LTC2855](#) are low power, 20Mbps RS485/RS422 transceivers operating on 3.3V supplies. The receiver includes a logic-selectable 120Ω termination, one-eighth unit load supporting up to 256 nodes per bus (C-, I-Grade), and a failsafe feature that guarantees a high output state under conditions of floating or shorted inputs.

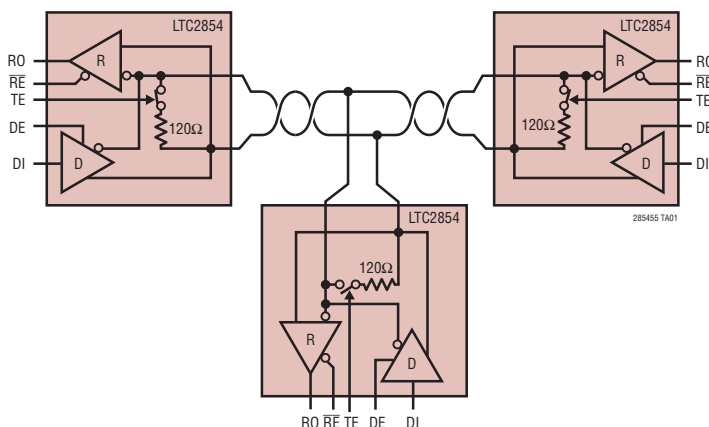
The driver maintains a high output impedance over the entire common mode range when disabled or when the supply is removed. Excessive power dissipation caused by bus contention or a fault is prevented by current limiting all outputs and by a thermal shutdown.

Enhanced ESD protection allows the LTC2854 to withstand ±25kV (human body model) and the LTC2855 to withstand ±15kV on the transceiver interface pins without latchup or damage.

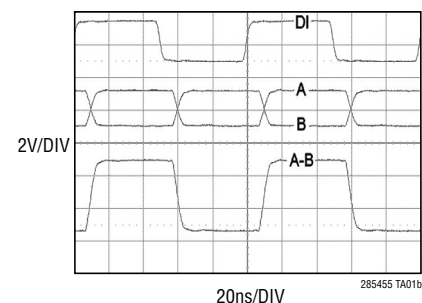
## PRODUCT SELECTION GUIDE

| PART NUMBER | DUPLEX | PACKAGE         |
|-------------|--------|-----------------|
| LTC2854     | HALF   | DFN-10          |
| LTC2855     | FULL   | SSOP-16, DFN-12 |

## TYPICAL APPLICATION



LTC2854 at 20Mbps into 54Ω



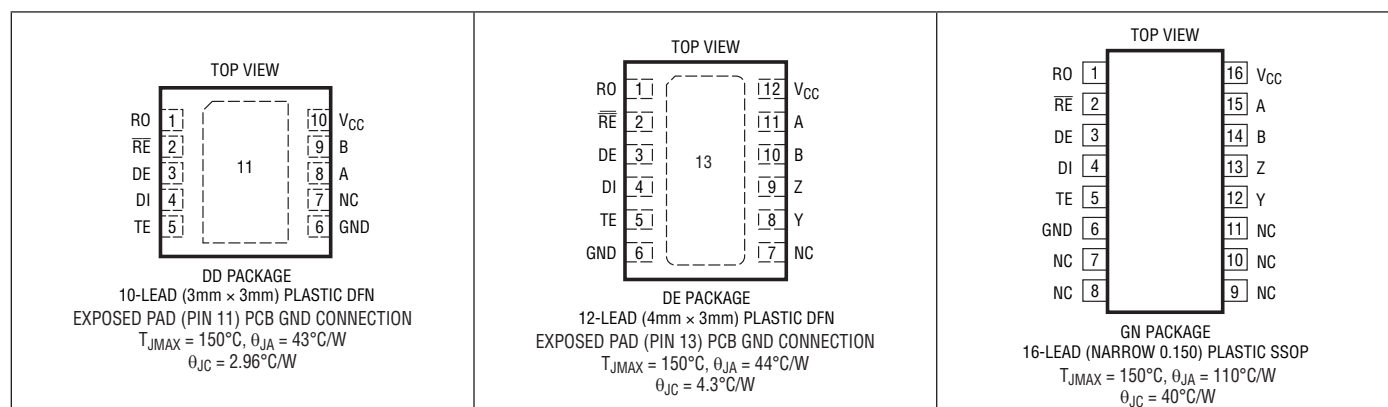
# LTC2854/LTC2855

## ABSOLUTE MAXIMUM RATINGS (Note 1)

Supply Voltage ( $V_{CC}$ ) ..... -0.3V to 7V  
 Logic Input Voltages ( $\overline{RE}$ , DE, DI, TE) ..... -0.3V to 7V  
 Interface I/O:  
   A, B, Y, Z ..... ( $V_{CC}$  -15V) to +15V  
   (A-B) or (B-A) with Terminator Enabled ..... 6V  
 Receiver Output Voltage (RO) ..... -0.3V to ( $V_{CC}$  +0.3V)

Operating Temperature (Note 4)  
 LTC2854C, LTC2855C ..... 0°C to 70°C  
 LTC2854I, LTC2855I ..... -40°C to 85°C  
 LTC2854H, LTC2855H ..... -40°C to 125°C  
 Storage Temperature Range ..... -65°C to 150°C  
 Lead Temperature (Soldering, 10 sec)  
   GN Package ..... 300°C

## PIN CONFIGURATION



## ORDER INFORMATION

| LEAD FREE FINISH  | TAPE AND REEL    | PART MARKING* | PACKAGE DESCRIPTION                 | TEMPERATURE RANGE |
|-------------------|------------------|---------------|-------------------------------------|-------------------|
| LTC2854CDD#PBF    | LTC2854CDD#TRPBF | LCQG          | 10-Lead (3mm × 3mm) Plastic DFN     | 0°C to 70°C       |
| LTC2854IDD#PBF    | LTC2854IDD#TRPBF | LCQG          | 10-Lead (3mm × 3mm) Plastic DFN     | -40°C to 85°C     |
| LTC2854HDD#PBF    | LTC2854HDD#TRPBF | LCQG          | 10-Lead (3mm × 3mm) Plastic DFN     | -40°C to 125°C    |
| LTC2855CDE#PBF    | LTC2855CDE#TRPBF | 2855          | 12-Lead (4mm × 3mm) Plastic DFN     | 0°C to 70°C       |
| LTC2855IDE#PBF    | LTC2855IDE#TRPBF | 2855          | 12-Lead (4mm × 3mm) Plastic DFN     | -40°C to 85°C     |
| LTC2855HDE#PBF    | LTC2855HDE#TRPBF | 2855          | 12-Lead (4mm × 3mm) Plastic DFN     | -40°C to 125°C    |
| LTC2855CGN#PBF    | LTC2855CGN#TRPBF | 2855          | 16-Lead (Narrow 0.150) Plastic SSOP | 0°C to 70°C       |
| LTC2855IGN#PBF    | LTC2855IGN#TRPBF | 2855I         | 16-Lead (Narrow 0.150) Plastic SSOP | -40°C to 85°C     |
| LTC2855HGN#PBF    | LTC2855HGN#TRPBF | 2855H         | 16-Lead (Narrow 0.150) Plastic SSOP | -40°C to 125°C    |
| LEAD BASED FINISH | TAPE AND REEL    | PART MARKING* | PACKAGE DESCRIPTION                 | TEMPERATURE RANGE |
| LTC2854CDD        | LTC2854CDD#TR    | LCQG          | 10-Lead (3mm × 3mm) Plastic DFN     | 0°C to 70°C       |
| LTC2854IDD        | LTC2854IDD#TR    | LCQG          | 10-Lead (3mm × 3mm) Plastic DFN     | -40°C to 85°C     |
| LTC2854HDD        | LTC2854HDD#TR    | LCQG          | 10-Lead (3mm × 3mm) Plastic DFN     | -40°C to 125°C    |
| LTC2855CDE        | LTC2855CDE#TR    | 2855          | 12-Lead (4mm × 3mm) Plastic DFN     | 0°C to 70°C       |
| LTC2855IDE        | LTC2855IDE#TR    | 2855          | 12-Lead (4mm × 3mm) Plastic DFN     | -40°C to 85°C     |
| LTC2855HDE        | LTC2855HDE#TR    | 2855          | 12-Lead (4mm × 3mm) Plastic DFN     | -40°C to 125°C    |
| LTC2855CGN        | LTC2855CGN#TR    | 2855          | 16-Lead (Narrow 0.150) Plastic SSOP | 0°C to 70°C       |
| LTC2855IGN        | LTC2855IGN#TR    | 2855I         | 16-Lead (Narrow 0.150) Plastic SSOP | -40°C to 85°C     |
| LTC2855HGN        | LTC2855HGN#TR    | 2855H         | 16-Lead (Narrow 0.150) Plastic SSOP | -40°C to 125°C    |

Consult LTC Marketing for parts specified with wider operating temperature ranges. \*The temperature grade is identified by a label on the shipping container.

For more information on lead free part marking, go to: <http://www.linear.com/leadfree/>

For more information on tape and reel specifications, go to: <http://www.linear.com/tapeand reel/>

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# ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V}$  unless otherwise noted (Note 2).

| SYMBOL           | PARAMETER                                                                                 | CONDITIONS                                                                                                                                                                                                                         | MIN         | TYP      | MAX                              | UNITS                          |
|------------------|-------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|----------|----------------------------------|--------------------------------|
| <b>Driver</b>    |                                                                                           |                                                                                                                                                                                                                                    |             |          |                                  |                                |
| $ V_{OD} $       | Differential Driver Output Voltage                                                        | $R = \infty$ , $V_{CC} = 3\text{V}$ (Figure 1)<br>$R = 27\Omega$ , $V_{CC} = 3\text{V}$ (Figure 1)<br>$R = 50\Omega$ , $V_{CC} = 3.13\text{V}$ (Figure 1)                                                                          | ●<br>●<br>● | 1.5<br>2 | $V_{CC}$<br>$V_{CC}$<br>$V_{CC}$ | V<br>V<br>V                    |
| $\Delta V_{OD} $ | Change in Magnitude of Driver Differential Output Voltage for Complementary Output States | $R = 27\Omega$ or $R = 50\Omega$ (Figure 1)                                                                                                                                                                                        | ●           |          | 0.2                              | V                              |
| $V_{OC}$         | Driver Common Mode Output Voltage                                                         | $R = 27\Omega$ or $R = 50\Omega$ (Figure 1)                                                                                                                                                                                        | ●           |          | 3                                | V                              |
| $\Delta V_{OC} $ | Change in Magnitude of Driver Common Mode Output Voltage for Complementary Output States  | $R = 27\Omega$ or $R = 50\Omega$ (Figure 1)                                                                                                                                                                                        | ●           |          | 0.2                              | V                              |
| $I_{OZD}$        | Driver Three-State (High Impedance) Output Current on Y and Z                             | $DE = 0\text{V}$ , (Y or Z) = $-7\text{V}$ , $12\text{V}$ (LTC2855)<br>H-Grade                                                                                                                                                     | ●<br>●      |          | $\pm 10$<br>$\pm 50$             | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{OSD}$        | Maximum Driver Short-Circuit Current                                                      | $-7\text{V} \leq (\text{Y or Z}) \leq 12\text{V}$ (Figure 2)                                                                                                                                                                       | ●           | 180      | $\pm 250$<br>300                 | $\text{mA}$<br>$\text{mA}$     |
| <b>Receiver</b>  |                                                                                           |                                                                                                                                                                                                                                    |             |          |                                  |                                |
| $I_{IN}$         | Receiver Input Current (A, B)                                                             | $DE = TE = 0\text{V}$ , $V_{CC} = 0\text{V}$ or $3.3\text{V}$ , $V_{IN} = 12\text{V}$ (Figure 3) (C-, I-Grade)<br>$DE = TE = 0\text{V}$ , $V_{CC} = 0\text{V}$ or $3.3\text{V}$ , $V_{IN} = -7\text{V}$ , (Figure 3) (C-, I-Grade) | ●<br>●      |          | 125                              | $\mu\text{A}$<br>$\mu\text{A}$ |
|                  |                                                                                           | $DE = TE = 0\text{V}$ , $V_{CC} = 0\text{V}$ or $3.3\text{V}$ , $V_{IN} = 12\text{V}$ (Figure 3) (H-Grade)<br>$DE = TE = 0\text{V}$ , $V_{CC} = 0\text{V}$ or $3.3\text{V}$ , $V_{IN} = -7\text{V}$ , (Figure 3) (H-Grade)         | ●<br>●      |          | 250<br>-145                      | $\mu\text{A}$<br>$\mu\text{A}$ |
| $R_{IN}$         | Receiver Input Resistance                                                                 | $\overline{RE} = V_{CC}$ or $0\text{V}$ , $DE = TE = 0\text{V}$ , $V_{IN} = -7\text{V}$ , $-3\text{V}$ , $3\text{V}$ , $7\text{V}$ , $12\text{V}$ (Figure 3) (C-, I-Grade)                                                         | ●           | 96       | 125                              | $\text{k}\Omega$               |
|                  |                                                                                           | $\overline{RE} = V_{CC}$ or $0\text{V}$ , $DE = TE = 0\text{V}$ , $V_{IN} = -7\text{V}$ , $-3\text{V}$ , $3\text{V}$ , $7\text{V}$ , $12\text{V}$ (Figure 3) (H-Grade)                                                             | ●           | 48       | 125                              | $\text{k}\Omega$               |
| $V_{TH}$         | Receiver Differential Input Threshold Voltage                                             | $-7\text{V} \leq B \leq 12\text{V}$                                                                                                                                                                                                | ●           |          | $\pm 0.2$                        | V                              |
| $\Delta V_{TH}$  | Receiver Input Hysteresis                                                                 | $B = 0\text{V}$                                                                                                                                                                                                                    |             | 25       |                                  | mV                             |
| $V_{OH}$         | Receiver Output HIGH Voltage                                                              | $I(RO) = -4\text{mA}$ , $A-B = 200\text{mV}$ , $V_{CC} = 3\text{V}$                                                                                                                                                                | ●           | 2.4      |                                  | V                              |
| $V_{OL}$         | Receiver Output LOW Voltage                                                               | $I(RO) = 4\text{mA}$ , $A-B = -200\text{mV}$ , $V_{CC} = 3\text{V}$                                                                                                                                                                | ●           |          | 0.4                              | V                              |
| $I_{OZR}$        | Receiver Three-State (High Impedance) Output Current on RO                                | $\overline{RE} = V_{CC}$ , $0\text{V} \leq RO \leq V_{CC}$                                                                                                                                                                         | ●           |          | $\pm 1$                          | $\mu\text{A}$                  |
| $I_{OSR}$        | Receiver Short-Circuit Current                                                            | $0\text{V} \leq RO \leq V_{CC}$                                                                                                                                                                                                    | ●           |          | $\pm 85$                         | $\text{mA}$                    |
| $R_{TERM}$       | Receiver Input Terminating Resistor                                                       | $TE = V_{CC}$ , $V_{AB} = 2\text{V}$ , $V_B = -7\text{V}$ , $0\text{V}$ , $10\text{V}$ (Figure 8)                                                                                                                                  | ●           | 108      | 120                              | 156<br>$\Omega$                |
| <b>Logic</b>     |                                                                                           |                                                                                                                                                                                                                                    |             |          |                                  |                                |
| $V_{IH}$         | Logic Input High Voltage                                                                  | $V_{CC} = 3.6\text{V}$                                                                                                                                                                                                             | ●           | 2        |                                  | V                              |
| $V_{IL}$         | Logic Input Low Voltage                                                                   | $V_{CC} = 3\text{V}$                                                                                                                                                                                                               | ●           |          | 0.8                              | V                              |
| $I_{INL}$        | Logic Input Current                                                                       |                                                                                                                                                                                                                                    | ●           | 0        | $\pm 10$                         | $\mu\text{A}$                  |
| <b>Supplies</b>  |                                                                                           |                                                                                                                                                                                                                                    |             |          |                                  |                                |
| $I_{CCS}$        | Supply Current in Shutdown Mode                                                           | $DE = 0\text{V}$ , $\overline{RE} = V_{CC}$ , $TE = 0\text{V}$ (C-, I-Grade)<br>(H-Grade)                                                                                                                                          | ●<br>●      | 0<br>0   | 5<br>15                          | $\mu\text{A}$<br>$\mu\text{A}$ |
| $I_{CCR}$        | Supply Current in Receive Mode                                                            | $DE = 0\text{V}$ , $\overline{RE} = 0\text{V}$ , $TE = 0\text{V}$                                                                                                                                                                  | ●           | 370      | 900                              | $\mu\text{A}$                  |

## ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V}$ ,  $T_E = 0\text{V}$  unless otherwise noted (Note 2).

| SYMBOL                 | PARAMETER                                                    | CONDITIONS                                                                                              | MIN | TYP | MAX  | UNITS         |
|------------------------|--------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|-----|-----|------|---------------|
| $I_{\text{CCT}}$       | Supply Current in Transmit Mode                              | No Load, $\text{DE} = V_{\text{CC}}$ , $\overline{\text{RE}} = V_{\text{CC}}$ , $\text{TE} = 0\text{V}$ | ●   | 450 | 1000 | $\mu\text{A}$ |
| $I_{\text{CCTR}}$      | Supply Current with Both Driver and Receiver Enabled         | No Load, $\text{DE} = V_{\text{CC}}$ , $\overline{\text{RE}} = 0\text{V}$ , $\text{TE} = 0\text{V}$     | ●   | 450 | 1000 | $\mu\text{A}$ |
| $I_{\text{CCTERM}}$    | Supply Current in Termination Mode                           | $\text{DE} = 0\text{V}$ , $\overline{\text{RE}} = V_{\text{CC}}$ , $\text{TE} = V_{\text{CC}}$          | ●   | 110 | 180  | $\mu\text{A}$ |
| $I_{\text{CCTERM R}}$  | Supply Current in Receive and Termination Mode               | $\text{DE} = 0\text{V}$ , $\overline{\text{RE}} = 0\text{V}$ , $\text{TE} = V_{\text{CC}}$              | ●   | 450 | 950  | $\mu\text{A}$ |
| $I_{\text{CCTERM T}}$  | Supply Current in Transmit and Termination Mode              | $\text{DE} = V_{\text{CC}}$ , $\overline{\text{RE}} = V_{\text{CC}}$ , $\text{TE} = V_{\text{CC}}$      | ●   | 470 | 1000 | $\mu\text{A}$ |
| $I_{\text{CCTERM TR}}$ | Supply Current with Driver, Receiver and Termination Enabled | $\text{DE} = V_{\text{CC}}$ , $\overline{\text{RE}} = 0\text{V}$ , $\text{TE} = V_{\text{CC}}$          | ●   | 470 | 1000 | $\mu\text{A}$ |

### ESD Protection

|  |                                     |                                                                              |  |                      |          |
|--|-------------------------------------|------------------------------------------------------------------------------|--|----------------------|----------|
|  | ESD Protection for RS485/RS422 Pins | A, B on LTC2854, Human Body Model<br>Y, Z, A, B on LTC2855, Human Body Model |  | $\pm 25$<br>$\pm 15$ | kV<br>kV |
|--|-------------------------------------|------------------------------------------------------------------------------|--|----------------------|----------|

## SWITCHING CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at  $T_A = 25^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V}$ ,  $T_E = 0\text{V}$  unless otherwise noted (Note 2).

| SYMBOL                                                           | PARAMETER                                                                  | CONDITIONS                                                                                                                                                                              | MIN | TYP | MAX     | UNITS         |
|------------------------------------------------------------------|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|---------|---------------|
| <b>Driver</b>                                                    |                                                                            |                                                                                                                                                                                         |     |     |         |               |
| $f_{\text{MAX}}$                                                 | Maximum Data Rate                                                          | Note 3                                                                                                                                                                                  | ●   | 20  |         | Mbps          |
| $t_{\text{PLHD}}, t_{\text{PHLD}}$                               | Driver Input to Output                                                     | $R_{\text{DIFF}} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)                                                                                                                          | ●   | 10  | 50      | ns            |
| $\Delta t_{\text{PD}}$                                           | Driver Input to Output Difference<br>$ t_{\text{PLHD}} - t_{\text{PHLD}} $ | $R_{\text{DIFF}} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)                                                                                                                          | ●   | 1   | 6       | ns            |
| $t_{\text{SKEWD}}$                                               | Driver Output Y to Output Z                                                | $R_{\text{DIFF}} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)                                                                                                                          | ●   | 1   | $\pm 6$ | ns            |
| $t_{\text{RD}}, t_{\text{FD}}$                                   | Driver Rise or Fall Time                                                   | $R_{\text{DIFF}} = 54\Omega$ , $C_L = 100\text{pF}$ (Figure 4)                                                                                                                          | ●   | 4   | 12.5    | ns            |
| $t_{\text{ZLD}}, t_{\text{ZHD}}, t_{\text{LZD}}, t_{\text{HZD}}$ | Driver Enable or Disable Time                                              | $R_L = 500\Omega$ , $C_L = 50\text{pF}$ , $\overline{\text{RE}} = 0$ (Figure 5)                                                                                                         | ●   |     | 70      | ns            |
| $t_{\text{ZHSD}}, t_{\text{ZLSD}}$                               | Driver Enable from Shutdown                                                | $R_L = 500\Omega$ , $C_L = 50\text{pF}$ , $\overline{\text{RE}} = V_{\text{CC}}$ (Figure 5)                                                                                             | ●   |     | 8       | $\mu\text{s}$ |
| $t_{\text{SHDN}}$                                                | Time to Shutdown                                                           | $R_L = 500\Omega$ , $C_L = 50\text{pF}$<br>( $\text{DE} = \downarrow$ , $\overline{\text{RE}} = V_{\text{CC}}$ ) or ( $\text{DE} = 0$ , $\overline{\text{RE}} \uparrow$ )<br>(Figure 5) | ●   |     | 100     | ns            |
| <b>Receiver</b>                                                  |                                                                            |                                                                                                                                                                                         |     |     |         |               |
| $t_{\text{PLHR}}, t_{\text{PHLR}}$                               | Receiver Input to Output                                                   | $C_L = 15\text{pF}$ , $V_{\text{CM}} = 1.5\text{V}$ , $ V_{\text{AB}}  = 1.5\text{V}$ , $t_{\text{R}}$ and $t_{\text{F}} < 4\text{ns}$ (Figure 6)                                       | ●   | 50  | 70      | ns            |
| $t_{\text{SKEWR}}$                                               | Differential Receiver Skew<br>$ t_{\text{PLHR}} - t_{\text{PHLR}} $        | $C_L = 15\text{pF}$ (Figure 6)                                                                                                                                                          | ●   | 1   | 6       | ns            |
| $t_{\text{RR}}, t_{\text{FR}}$                                   | Receiver Output Rise or Fall Time                                          | $C_L = 15\text{pF}$ (Figure 6)                                                                                                                                                          | ●   | 3   | 12.5    | ns            |
| $t_{\text{ZLR}}, t_{\text{ZHR}}, t_{\text{LZR}}, t_{\text{HZR}}$ | Receiver Enable/Disable                                                    | $R_L = 1\text{k}$ , $C_L = 15\text{pF}$ , $\text{DE} = V_{\text{CC}}$ (Figure 7)                                                                                                        | ●   |     | 50      | ns            |
| $t_{\text{ZHSR}}, t_{\text{ZLSR}}$                               | Receiver Enable from Shutdown                                              | $R_L = 1\text{k}$ , $C_L = 15\text{pF}$ , $\text{DE} = 0\text{V}$ (Figure 7)                                                                                                            | ●   |     | 8       | $\mu\text{s}$ |
| $t_{\text{RTEN}}, t_{\text{RTZ}}$                                | Termination Enable or Disable Time                                         | $V_{\text{B}} = 0\text{V}$ , $V_{\text{AB}} = 2\text{V}$ , $\overline{\text{RE}} = V_{\text{CC}}$ , $\text{DE} = 0\text{V}$<br>(Figure 8)                                               | ●   |     | 100     | $\mu\text{s}$ |

**Note 1:** Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime. High temperatures degrade operating lifetimes. Operating lifetime is derated at temperatures greater than  $105^\circ\text{C}$ .

**Note 2:** All currents into device pins are positive; all currents out of device pins are negative. All voltages are referenced to device ground unless otherwise specified.

**Note 3:** Maximum data rate is guaranteed by other measured parameters and is not tested directly.

**Note 4:** This IC includes overtemperature protection that is intended to protect the device during momentary overload conditions. Overtemperature protection activates at a junction temperature exceeding  $150^\circ\text{C}$ . Continuous operation above the specified maximum operating junction temperature may result in device degradation or failure.

# TEST CIRCUITS

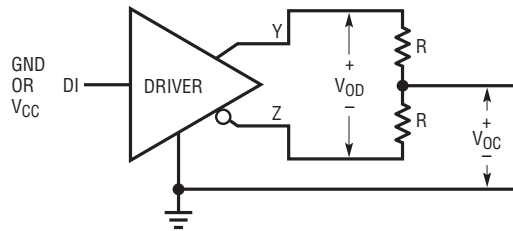


Figure 1. Driver DC Characteristics

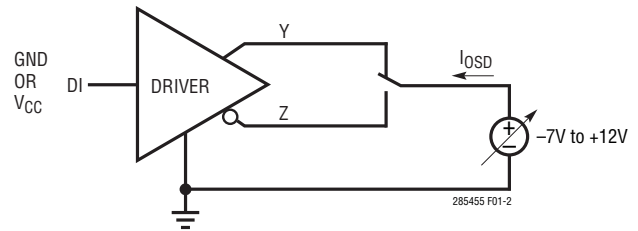


Figure 2. Driver Output Short-Circuit Current

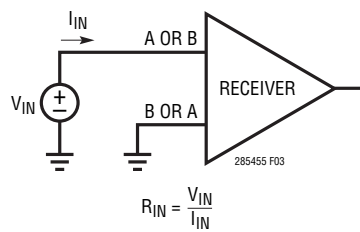


Figure 3. Receiver Input Current and Input Resistance

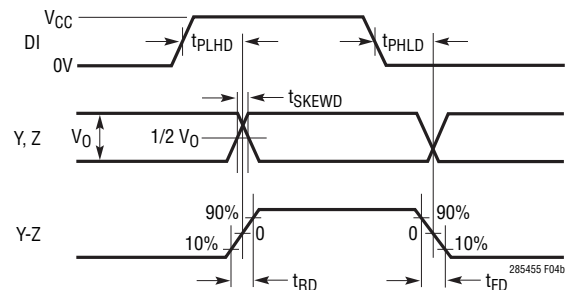
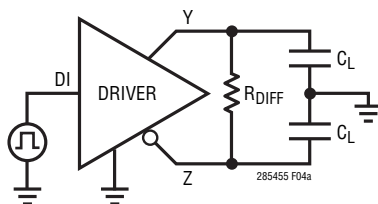


Figure 4. Driver Timing Measurement

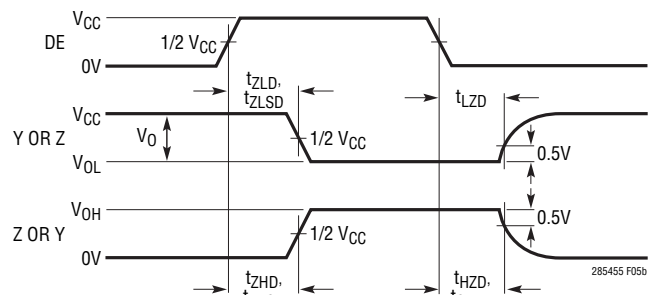
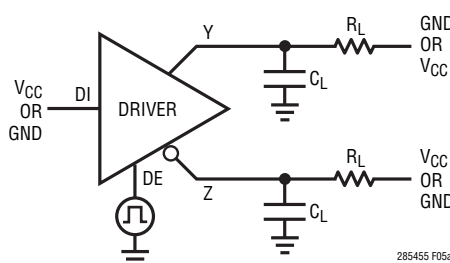


Figure 5. Driver Enable and Disable Timing Measurements

## TEST CIRCUITS

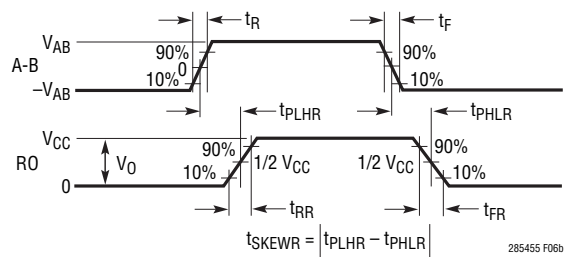
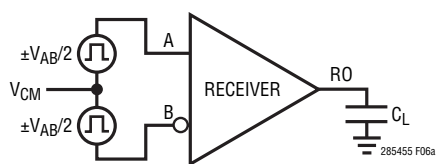


Figure 6. Receiver Propagation Delay Measurements

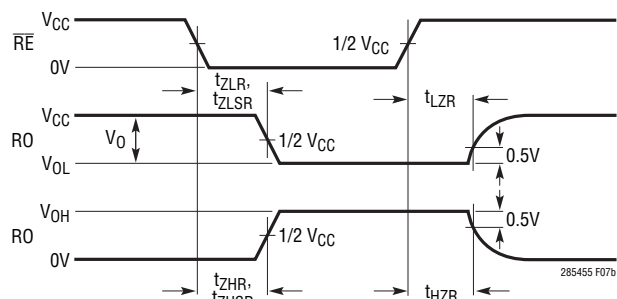
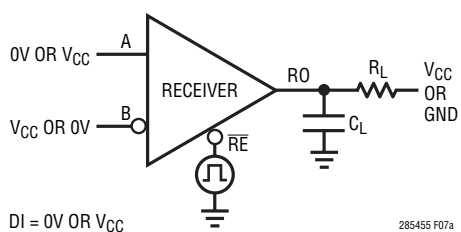


Figure 7. Receiver Enable and Disable Timing Measurements

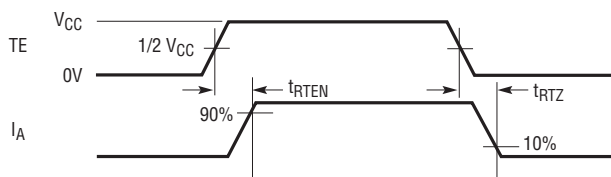
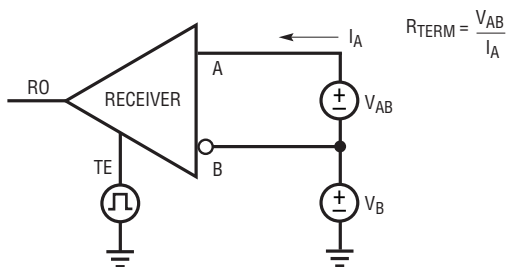
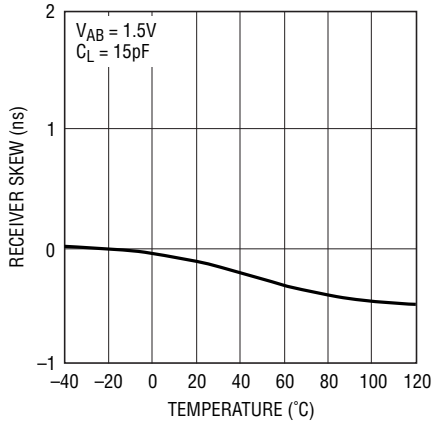


Figure 8. Termination Resistance and Timing Measurements

# TYPICAL PERFORMANCE CHARACTERISTICS

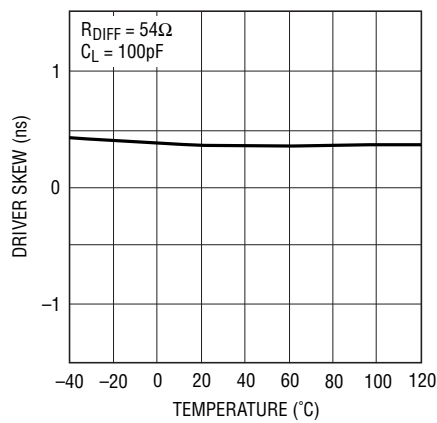
$T_A = 25^\circ\text{C}$ ,  $V_{CC} = 3.3\text{V}$ , unless otherwise noted.

### Receiver Skew vs Temperature



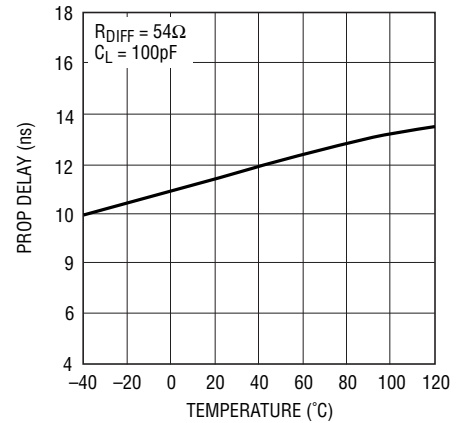
285455 G01

### Driver Skew vs Temperature



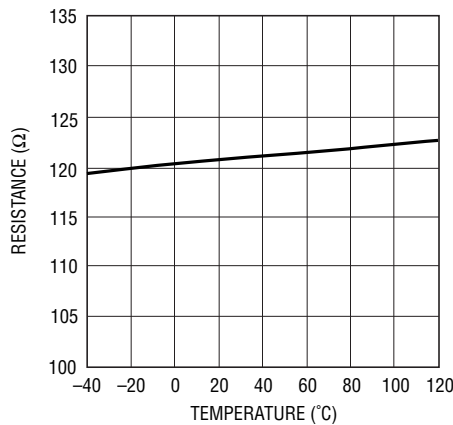
285455 G02

### Driver Propagation Delay vs Temperature



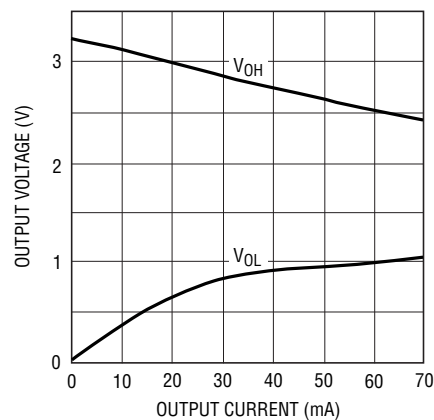
285455 G03

### R\_TERM vs Temperature



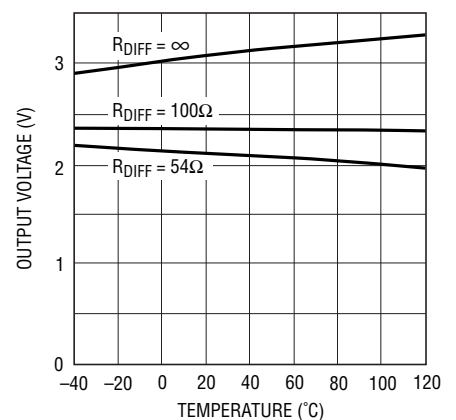
285455 G04

### Driver Output Low/High Voltage vs Output Current



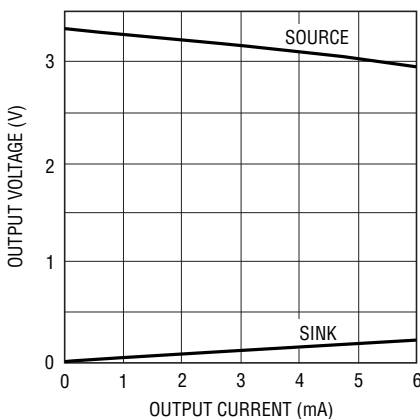
285455 G05

### Driver Differential Output Voltage vs Temperature



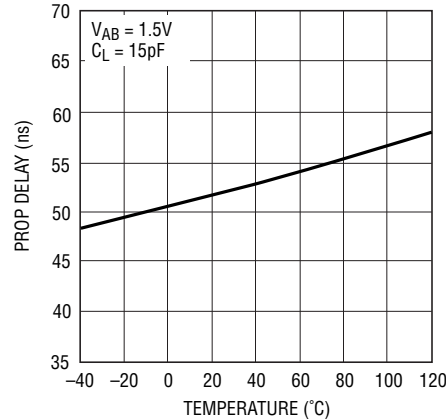
285455 G06

### Receiver Output Voltage vs Output Current (Source and Sink)



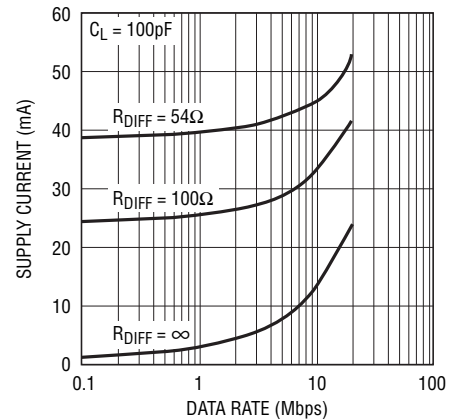
285455 G07

### Receiver Propagation Delay vs Temperature



285455 G08

### Supply Current vs Data Rate



285455 G09

285455fc

## PIN FUNCTIONS (DD/DE/GN)

**RO (Pin 1):** Receiver Output. If the receiver output is enabled ( $\overline{RE}$  low) and  $A > B$  by 200mV, then RO will be high. If  $A < B$  by 200mV, then RO will be low. If the receiver inputs are open, shorted, or terminated without a signal, RO will be high.

**$\overline{RE}$  (Pin 2):** Receiver Enable. A low enables the receiver. A high input forces the receiver output into a high impedance state.

**DE (Pin 3):** Driver Enable. A high on DE enables the driver. A low input will force the driver outputs into a high impedance. If  $\overline{RE}$  is high with DE and TE low, the part will enter a low power shutdown state.

**DI (Pin 4):** Driver Input. If the driver outputs are enabled (DE high), then a low on DI forces the driver positive output low and negative output high. A high on DI, with the driver outputs enabled, forces the driver positive output high and negative output low.

**TE (Pin 5):** Internal Termination Resistance Enable. A high input will connect a termination resistor (120 $\Omega$  typical) between pins A and B.

**GND (Pins 6,11/6,13/6):** Ground. Pins 11 and 13 are backside thermal pad, connected to Ground.

**Y (Pins NA/8/12):** Positive Driver Output for LTC2855.

**Z (Pins NA/9/13):** Negative Driver Output for LTC2855.

**B (Pins 9/10/14):** Negative Receiver Input (and Negative Driver Output for LTC2854).

**A (Pins 8/11/15):** Positive Receiver Input (and Positive Driver Output for LTC2854).

**V<sub>CC</sub> (Pins 10/12/16):** Positive Supply.  $V_{CC} = 3.0V < V_{CC} < 3.6V$ . Bypass with 0.1 $\mu$ F ceramic capacitor.



## APPLICATIONS INFORMATION

### Driver

The driver provides full RS485/RS422 compatibility. When enabled, if DI is high, Y-Z is positive for the full-duplex device (LTC2855) and A-B is positive for the half-duplex device (LTC2854).

When the driver is disabled, both outputs are high-impedance. For the full-duplex LTC2855, the leakage on the driver output pins is guaranteed to be less than  $10\mu\text{A}$  over the entire common mode range of  $-7\text{V}$  to  $+12\text{V}$ . On the half-duplex LTC2854, the impedance is dominated by the receiver input resistance,  $R_{\text{IN}}$ .

### Driver Overvoltage and Overcurrent Protection

The driver outputs are protected from short-circuits to any voltage within the Absolute Maximum range of ( $V_{\text{CC}} - 15\text{V}$ ) to  $+15\text{V}$ . The typical peak current in this condition does not exceed  $180\text{mA}$ .

If a high driver output is shorted to a voltage just above  $V_{\text{CC}}$ , a reverse current will flow into the supply. When this voltage exceeds  $V_{\text{CC}}$  by about  $1.4\text{V}$ , the reverse current turns off. Preventing the driver from turning off with outputs shorted to output voltages just above  $V_{\text{CC}}$  keeps the driver active even for receiver loads that have a positive common mode with respect to the driver—a valid condition.

The worst-case peak reverse short-circuit current can be as high as  $300\text{mA}$  in extreme cold conditions. If this current cannot be absorbed by the supply, a  $3.6\text{V}$  Zener diode can be added in parallel with the supply to sink this current.

All devices also feature thermal shutdown protection that disables the driver and receiver in case of excessive power dissipation (see Note 4).

### Receiver and Failsafe

With the receiver enabled, when the absolute value of the differential voltage between the A and B pins is greater than  $200\text{mV}$ , the state of RO will reflect the polarity of (A-B).

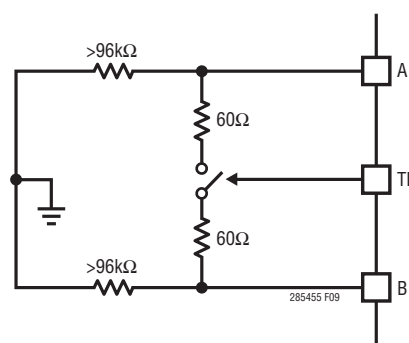
The LTC2854/LTC2855 have a failsafe feature that guarantees the receiver output to be in a logic-high state when

the inputs are either shorted, left open, or terminated (externally or internally), but not driven. This failsafe feature is guaranteed to work for inputs spanning the entire common mode range of  $-7\text{V}$  to  $+12\text{V}$ .

The receiver output is internally driven high (to  $V_{\text{CC}}$ ) or low (to ground) with no external pull-up needed. When the receiver is disabled the RO pin becomes High-Z with leakage of less than  $\pm 1\mu\text{A}$  for voltages within the supply range.

### Receiver Input Resistance

The receiver input resistance from A or B to ground is guaranteed to be greater than  $96\text{k}\Omega$  (C-, I-Grade) when the termination is disabled. This is 8X higher than the requirements for the RS485 standard and thus this receiver represents a one-eighth unit load. This, in turn, means that 8X the standard number of receivers, or 256 total, can be connected to a line without loading it beyond what is called out in the RS485 standard. The receiver input resistance from A or B to ground on high temperature H-Grade parts is greater than  $48\text{k}\Omega$  providing a one-quarter unit load. The input resistance of the receivers is unaffected by enabling/disabling the receiver and by powering/unpowering the part. The equivalent input resistance looking into A and B is shown in Figure 9. The termination resistor cannot be enabled by TE if the device is unpowered or in thermal shutdown mode.



**Figure 9. Equivalent Input Resistance into A and B (on the LTC2854, Valid if Driver is Disabled)**

## APPLICATIONS INFORMATION

### Switchable Termination

Proper cable termination is very important for good signal fidelity. If the cable is not terminated with its characteristic impedance, reflections will result in distorted waveforms.

The LTC2854/LTC2855 are the first 3.3V RS485/RS422 transceivers to offer integrated switchable termination resistors on the receiver input pins. This provides the advantage of being able to easily change, through logic control, the line termination for optimal performance when configuring transceiver networks.

When the TE pin is high, the termination resistor is enabled and the differential resistance from A to B is  $120\Omega$ . Figure 10 shows the I/V characteristics between pins A and B with the termination resistor enabled and disabled. The resistance is maintained over the entire RS485 common mode range of  $-7V$  to  $+12V$  as shown in Figure 11.

The integrated termination resistor has a high frequency response which does not limit performance at the maximum specified data rate. Figure 12 shows the magnitude and phase of the termination impedance vs frequency.

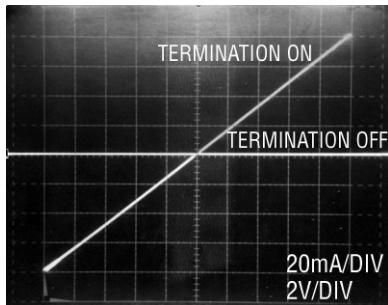


Figure 10. Curve Trace Between A and B with Termination Enabled and Disabled

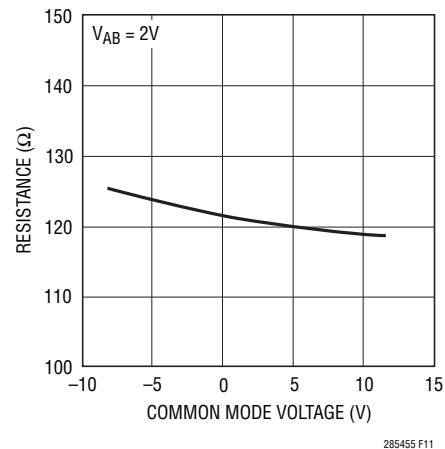


Figure 11. Typical Resistance of the Enabled Terminator vs Voltage on B Pin

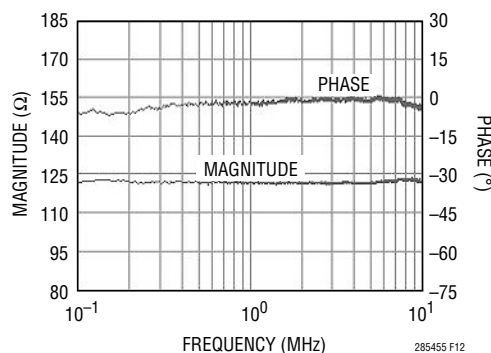


Figure 12. Termination Magnitude and Phase vs Frequency

## APPLICATIONS INFORMATION

### Supply Current

The unloaded static supply currents in the LTC2854/LTC2855 are very low—typically under 500 $\mu$ A for all modes of operation. In applications with resistively terminated cables, the supply current is dominated by the driver load. For example, when using two 120 $\Omega$  terminators with a differential driver output voltage of 2V, the DC current is 33mA, which is sourced by the positive voltage supply. This is true whether the terminators are external or internal such as in the LTC2854/LTC2855. Power supply current increases with toggling rate due to capacitive loading and this term can increase significantly at high data rates. Figure 13 shows supply current vs data rate for two different capacitive loads for the circuit configuration of Figure 4.

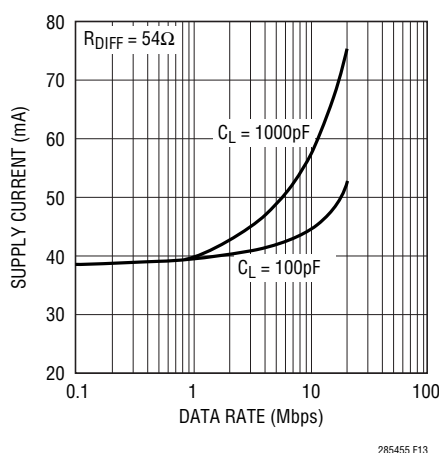


Figure 13. Supply Current vs Data Rate

### High Speed Considerations

A ground plane layout is recommended for the LTC2854/LTC2855. A 0.1 $\mu$ F bypass capacitor less than one-quarter inch away from the V<sub>CC</sub> pin is also recommended. The PC board traces connected to signals A/B and Z/Y (LTC2855) should be symmetrical and as short as possible to maintain good differential signal integrity. To minimize capacitive effects, the differential signals should be separated by more than the width of a trace and should not be routed on top of each other if they are on different signal planes.

Care should be taken to route outputs away from any sensitive inputs to reduce feedback effects that might cause noise, jitter, or even oscillations. For example, in the full

duplex LTC2855, DI and A/B should not be routed near the driver or receiver outputs.

The logic inputs of the LTC2854/LTC2855 have 150mV of hysteresis to provide noise immunity. Fast edges on the outputs can cause glitches in the ground and power supplies which are exacerbated by capacitive loading. If a logic input is held near its threshold (typically 1.5V), a noise glitch from a driver transition may exceed the hysteresis levels on the logic and data input pins causing an unintended state change. This can be avoided by maintaining normal logic levels on the pins and by slewing inputs through their thresholds by faster than 1V/ $\mu$ s when transitioning. Good supply decoupling and proper line termination also reduces glitches caused by driver transitions.

### Cable Length vs Data Rate

For a given data rate, the maximum transmission distance is bounded by the cable properties. A typical curve of cable length vs data rate compliant with the RS485/RS422 standards is shown in Figure 14. Three regions of this curve reflect different performance limiting factors in data transmission. In the flat region of the curve, maximum distance is determined by resistive losses in the cable. The downward sloping region represents limits in distance and data rate due to AC losses in the cable. The solid vertical line represents the specified maximum data rate in the RS485/RS422 standards. The dashed lines at 20Mbps show the maximum data rates of the LTC2854/LTC2855.

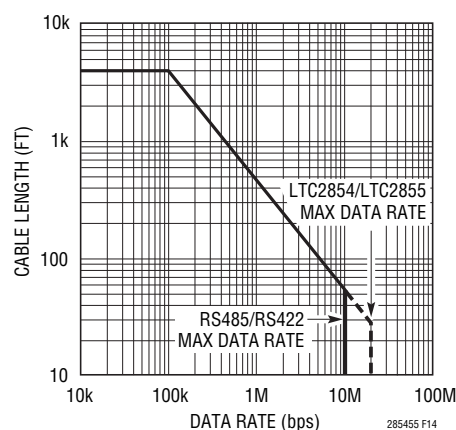
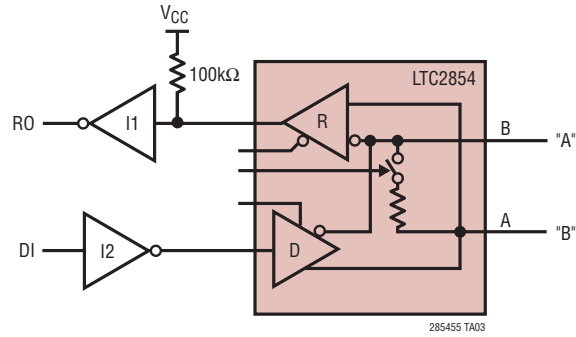


Figure 14. Cable Length vs Data Rate (RS485/RS422 Standards Shown in Vertical Solid Line)

## TYPICAL APPLICATION

### Failsafe "0" Application (Idle State = Logic "0")

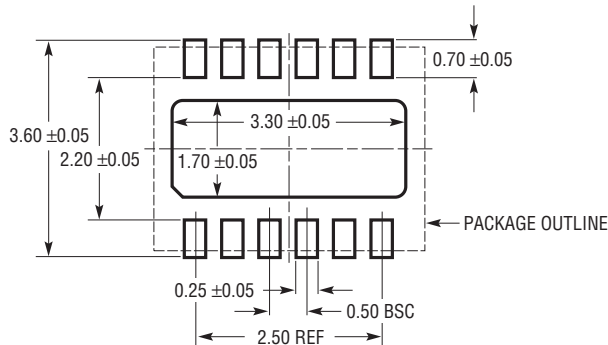




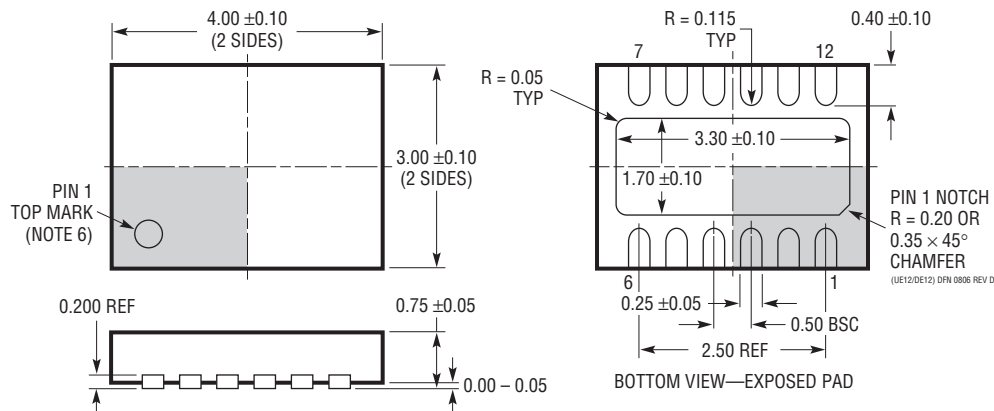
## PACKAGE DESCRIPTION

Please refer to <http://www.linear.com/designtools/packaging/> for the most recent package drawings.

### DE/UE Package 12-Lead Plastic DFN (4mm × 3mm) (Reference LTC DWG # 05-08-1695 Rev D)



RECOMMENDED SOLDER PAD PITCH AND DIMENSIONS  
APPLY SOLDER MASK TO AREAS THAT ARE NOT SOLDERED



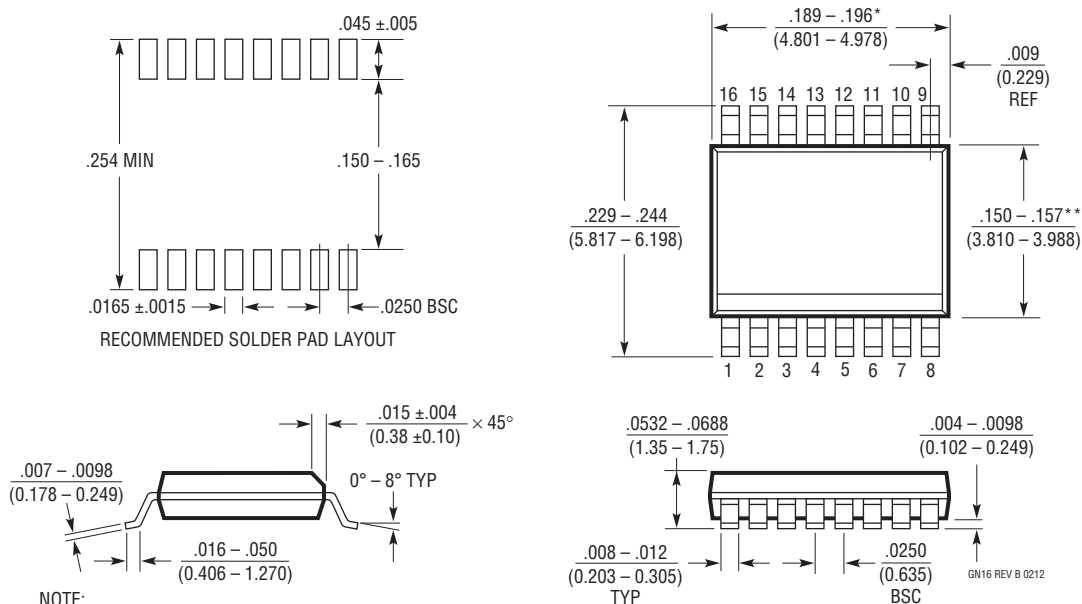
#### NOTE:

1. DRAWING PROPOSED TO BE A VARIATION OF VERSION (WGED) IN JEDEC PACKAGE OUTLINE M0-229
2. DRAWING NOT TO SCALE
3. ALL DIMENSIONS ARE IN MILLIMETERS
4. DIMENSIONS OF EXPOSED PAD ON BOTTOM OF PACKAGE DO NOT INCLUDE MOLD FLASH. MOLD FLASH, IF PRESENT, SHALL NOT EXCEED 0.15mm ON ANY SIDE
5. EXPOSED PAD SHALL BE SOLDER PLATED
6. SHADED AREA IS ONLY A REFERENCE FOR PIN 1 LOCATION ON THE TOP AND BOTTOM OF PACKAGE

## PACKAGE DESCRIPTION

Please refer to <http://www.linear.com/designtools/packaging/> for the most recent package drawings.

### GN Package 16-Lead Plastic SSOP (Narrow .150 Inch) (Reference LTC DWG # 05-08-1641 Rev B)

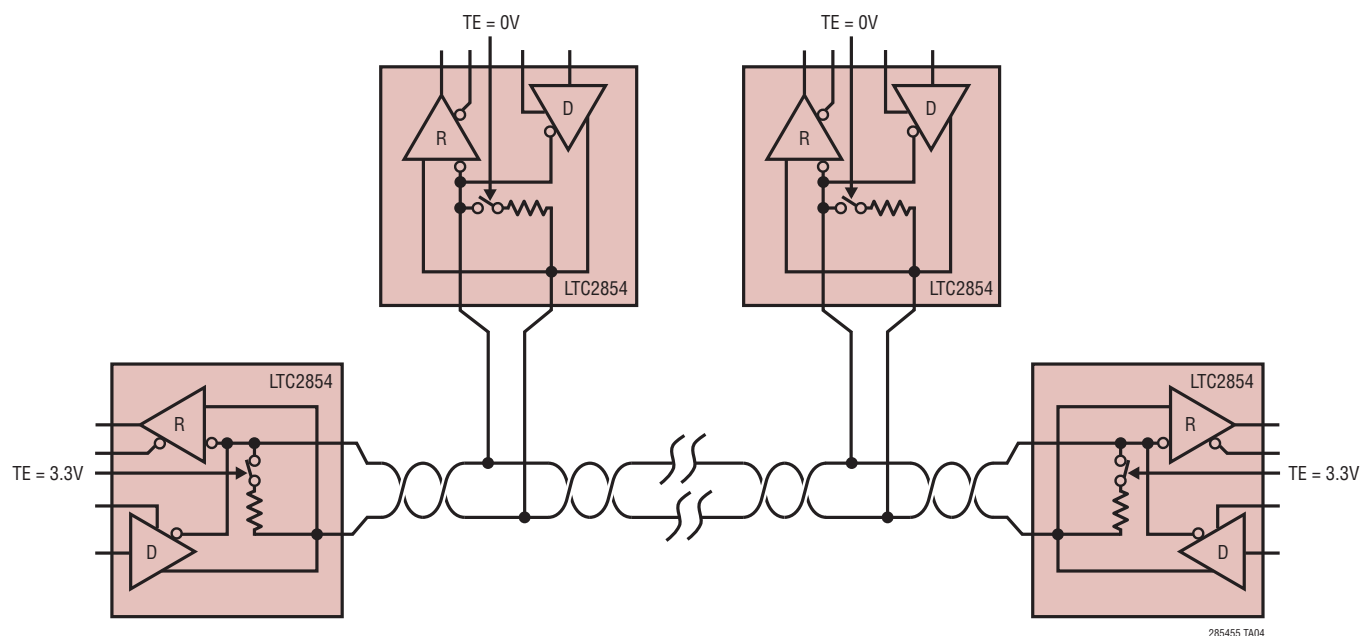


## REVISION HISTORY

| REV | DATE  | DESCRIPTION                                     | PAGE NUMBER |
|-----|-------|-------------------------------------------------|-------------|
| C   | 06/15 | Added H-grade<br>Updated DD Package description | 1-18<br>14  |

## TYPICAL APPLICATION

Multi-Node Network with End Termination Using the LTC2854



## RELATED PARTS

| PART NUMBER                             | DESCRIPTION                                                          | COMMENTS                                                       |
|-----------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------|
| <a href="#">LTC485</a>                  | Low Power RS485 Interface Transceiver                                | $I_{CC} = 300\mu A$ (Typ)                                      |
| <a href="#">LTC491</a>                  | Differential Driver and Receiver Pair                                | $I_{CC} = 300\mu A$                                            |
| <a href="#">LTC1480</a>                 | 3.3V Ultralow Power RS485 Transceiver                                | 3.3V Operation                                                 |
| <a href="#">LTC1483</a>                 | Ultralow Power RS485 Low EMI Transceiver                             | Controlled Driver Slew Rate                                    |
| <a href="#">LTC1485</a>                 | Differential Bus Transceiver                                         | 10Mbps Operation                                               |
| <a href="#">LTC1487</a>                 | Ultralow Power RS485 with Low EMI, Shutdown and High Input Impedance | Up to 256 Transceivers on the Bus                              |
| <a href="#">LTC1520</a>                 | 50Mbps Precision Quad Line Receiver                                  | Channel-to-Channel Skew 400ps (Typ)                            |
| <a href="#">LTC1535</a>                 | Isolated RS485 Full-Duplex Transceiver                               | 2500V <sub>RMS</sub> Isolation in Surface Mount Package        |
| <a href="#">LTC1685</a>                 | 52Mbps RS485 Transceiver with Precision Delay                        | Propagation Delay Skew 500ps (Typ)                             |
| <a href="#">LT1785</a>                  | 60V Fault Protected RS485 Transceiver                                | 60V Tolerant, 15kV ESD                                         |
| <a href="#">LTC2856/LTC2857/LTC2858</a> | 20Mbps and Slew Rate-Limited, 15kV RS485/RS422 Transceiver           | Up to 256 Transceivers on the Bus                              |
| <a href="#">LTC2859/LTC2861</a>         | 20Mbps RS485 Transceiver with Integrated Switchable Termination      | 5V Integrated, Switchable, 120Ω Termination Resistor, 15kV ESD |