

GENERAL DESCRIPTION

The SP335 is an advanced multiprotocol transceiver supporting RS-232, RS-485, and RS-422 serial standards. Integrated cable termination and multiple configuration modes allow all three protocols to be used interchangeably over a single cable or connector with no additional switching components. Full operation requires only four external charge pump capacitors.

The RS-485/RS-232 mode pin selects RS-485 mode when high, and RS-232 mode when low. In RS-485 mode, the TERM pin enables the differential 120Ω termination, and the HALF/FULL pin configures the transceiver as either half or full duplex.

The high speed drivers operate up to 20Mbps in RS-485/422 modes, and up to 1Mbps in RS-232 mode. All drivers can be slew limited to 250kbps in any mode to minimize electromagnetic interference (EMI) by setting the dedicated SLEW pin low.

All transmitter outputs and receiver inputs feature robust electrostatic discharge (ESD) protection to ±15kV IEC 61000-4-2 Airgap, ±15kV Human Body Model (HBM) and ±8kV IEC 61000-4-2 Contact. Each receiver output has full fail-safe protection to avoid system lockup, oscillation, or indeterminate states by defaulting to logic-high output level when the inputs are open, shorted, or terminated but undriven. No external biasing resistors are required.

The RS-232 receiver inputs include a 5kΩ pull-down to ground when in RS-232 mode. The RS-485/422 receiver inputs are high impedance (>96kΩ when termination is disabled), allowing up to 256 devices on a single communication bus (1/8th unit load).

The SP335 operates from a single power supply, either 3.3V or 5V, with low idle current. The shutdown mode consumes less than 1μA in low power standby operation with RS-232 receivers enabled.

ORDERING INFORMATION⁽¹⁾

| PART NUMBER | OPERATING TEMPERATURE RANGE | LEAD-FREE | PACKAGE | PACKAGE METHOD |
|-----------------|-----------------------------|--------------------|------------|----------------|
| SP335EER1-L | -40°C to +85°C | Yes ⁽²⁾ | 32-pin QFN | Tray |
| SP335EER1-L/TR | | | | Reel |
| SP335ECR1-L | 0°C to +70°C | | | Tray |
| SP335ECR1-L/TR | | | | Reel |
| SP335EER1-0A-EB | SP335E Evaluation Board | | | |

NOTES:

1. Refer to www.exar.com/SP335E for most up-to-date Ordering Information
2. Visit www.exar.com for additional information on Environmental Rating

FEATURES

- Pin-Selectable Cable Termination
- No External Resistors Required for RS-485/422 Termination or Biasing
- Robust ESD Protection:
 - ±15kV IEC 61000-4-2 Air Gap Discharge
 - ± 8kV IEC 61000-4-2 Contact Discharge
 - ±15kV Human Body Model (HBM)
- 20Mbps RS-485 and 1Mbps RS-232 Data Rates
- Pin-Selectable 250kbps Slew Limiting
- Single Supply Operation from 3V to 5.5V
- 1.65V to 5.5V Logic Interface V_L pin
- 2 Drivers, 2 Receivers RS-232/V.28
- 1 Driver, 1 Receiver RS-485/422
 - Full or Half Duplex Configuration
 - 1/8th Unit Load, up to 256 receivers on bus
- RS-485/422 Enhanced Receiver Fail-safe for open, shorted, or terminated but idle inputs
- 10nA Shutdown Supply Current (typical)
- Small 32 QFN package (5mm x 5mm)

TYPICAL APPLICATIONS

- Software Programmable Serial Ports (RS-232, RS-422, RS-485)
- Industrial and Single Board Computers
- Industrial and Process Control Equipment
- Point-Of-Sale Equipment
- HVAC Controls and Networking Equipment
- Building Security and Automation

ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections to the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability and cause permanent damage to the device.

| | |
|--|-------------------|
| Supply Voltage V_{CC} | -0.3V to 6.0V |
| Logic Interface Voltage V_L | $V_L \leq V_{CC}$ |
| Voltage at TTL Input Pins | -0.3V to 6.0V |
| Receiver Input Voltage (from Ground) | $\pm 18V$ |
| Driver Output Voltage (from Ground) | $\pm 18V$ |
| Short Circuit Duration, TX out to Ground | Continuous |
| Storage Temperature Range | -65°C to 150°C |
| Lead Temperature (soldering, 10s) | 300°C |
| Maximum Operating Junction Temperature, T_J | 125°C |
| Power Dissipation 32-pin 5x5 QFN (derate 26.0mW/°C above +70°C) | 1400mW |

CAUTION:

ESD (ElectroStatic Discharge) sensitive device. Permanent damage may occur on unconnected devices subject to high energy electrostatic fields. Unused devices must be stored in conductive foam or shunts. Personnel should be properly grounded prior to handling this device. The protective foam should be discharged to the destination socket before devices are removed.

ESD PROTECTION

| | | MIN. | TYP. | MAX. | UNITS | |
|---------------------------|--|------|----------|------|-------|------------------------|
| TX Output & RX Input Pins | | | ± 15 | | kV | IEC 61000-4-2 Airgap |
| | | | ± 8 | | kV | IEC 61000-4-2 Contact |
| | | | ± 15 | | kV | Human Body Model (HBM) |
| All Other Pins | | | ± 3 | | kV | Human Body Model (HBM) |

ELECTRICAL CHARACTERISTICS
UNLESS OTHERWISE NOTED:
 $V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_L = V_{CC} = 3.3V$, $T_A = +25^\circ C$.

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|--|---------------------------------------|------------------|------------|-----------------|---------|---|
| DC CHARACTERISTICS | | | | | | |
| I_{CC} | Supply Current (RS-232) | | 1 | 2.5 | mA | No load, Idle inputs, RS-485/RS-232 = 0V |
| I_{CC} | Supply Current (RS-485/422) | | 1.8 | 4.5 | mA | No load, Idle inputs, RS-485/RS-232 = V_{CC} |
| I_{CC} | Vcc Shutdown Current | | 0.01 | 1 | μA | $\overline{SHDN} = 0V$, Receiver inputs open or grounded |
| TRANSMITTER and LOGIC INPUTS (PINS 10 - 15, 20 - 22) | | | | | | |
| V_{IL} | Logic Input Voltage Low | | | $\frac{V_L}{3}$ | V | |
| V_{IH} | Logic Input Voltage High | $\frac{2V_L}{3}$ | | | V | |
| I_{INL} | Logic Input Leakage Current | | ± 0.01 | ± 1 | μA | |
| I_{INPD} | Logic Input Pulldown Current | | 10 | 50 | μA | \overline{RE} , TERM, & FD_TX_TERM $V_{IN} = V_L$ |
| V_{HYS} | Logic Input Hysteresis | | 200 | | mV | |
| RS-232 and RS-485/422 RECEIVER OUTPUTS (PINS 6 & 7) | | | | | | |
| V_{OL} | Receiver Output Voltage Low | | | 0.4 | V | $I_{OUT} = 1.5mA$ |
| V_{OH} | Receiver Output Voltage High | $V_L - 0.6$ | | | V | $I_{OUT} = -1.5mA$ |
| I_{OSS} | Receiver Output Short Circuit Current | | ± 20 | ± 85 | mA | $0 \leq V_O \leq V_L$ |
| I_{OZ} | Receiver Output Leakage Current | | ± 0.05 | ± 1 | μA | $0 \leq V_O \leq V_L$, Receivers disabled |

ELECTRICAL CHARACTERISTICS (Continued)

UNLESS OTHERWISE NOTED:

 $V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_{CC} = 3.3V$, $T_A = +25^\circ C$.

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|------------------------------|-----------|-----------|-----------|-----------|--|
| RS-232 SINGLE-ENDED RECEIVER INPUTS (PINS 18 & 19) | | | | | | |
| V_{IN} | Input Voltage Range | -15 | | +15 | V | |
| V_{IL} | Input Threshold Low | 0.6 | 1.2 | | V | $V_{CC} = 3.3V$ |
| | | 0.8 | 1.5 | | V | $V_{CC} = 5.0V$ |
| V_{IH} | Input Threshold High | | 1.5 | 2.0 | V | $V_{CC} = 3.3V$ |
| | | | 1.8 | 2.4 | V | $V_{CC} = 5.0V$ |
| V_{HYS} | Input Hysteresis | | 0.5 | | V | |
| R_{IN} | Input Resistance | 3 | 5 | 7 | $k\Omega$ | $-15V \leq V_{IN} \leq +15V$ |
| RS-232 SINGLE-ENDED TRANSMITTER OUTPUTS (PINS 3 & 4) | | | | | | |
| V_{OUT} | Output Voltage Swing | ± 5.0 | ± 5.5 | | V | Outputs loaded with $3k\Omega$ to Gnd |
| R_{OFF} | Output Power Off Impedance | 300 | 10M | | Ω | $V_{CC} = 0V$, $V_{OUT} = \pm 2V$ |
| I_{SC} | Output Short Circuit Current | | ± 30 | ± 60 | mA | $V_{OUT} = 0V$ |
| I_O | Output Leakage Current | | | ± 125 | μA | $\overline{SHDN} = 0V$, $V_{OUT} = \pm 9V$, $V_{CC} = 0V$ or $5.5V$ |

ELECTRICAL CHARACTERISTICS (Continued)
UNLESS OTHERWISE NOTED:
 $V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_{CC} = 3.3V$, $T_A = +25^\circ C$.

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|--|--|------|------|-----------|-----------|--|
| RS-485/422 DIFFERENTIAL RECEIVER INPUTS (A,B) | | | | | | |
| R_{IN} | Receiver Input Resistance | 96 | | | $k\Omega$ | Termination disabled, $-7V \leq V_{CM} \leq +12V$ |
| I_{IN} | Receiver Input Current | | | 125 | μA | $V_{IN} = +12V$ |
| | | | | -100 | μA | $V_{IN} = -7V$ |
| V_{TH} | Receiver Differential Threshold Voltage | -200 | -125 | -50 | mV | $-7V \leq V_{CM} \leq +12V$ |
| ΔV_{TH} | Receiver Input Hysteresis | | 25 | | mV | |
| R_{TERM} | Termination Resistance | 100 | 120 | 155 | Ω | Termination enabled, Figure 4 $-7V \leq V_{CM} \leq +12V$ |
| R_{TERM} | Termination Resistance | 100 | 120 | 140 | Ω | Termination enabled, Figure 4 $V_{CM} = 0V$ |
| RS-485/422 DIFFERENTIAL DRIVER OUTPUTS (Y, Z) | | | | | | |
| V_{OD} | Differential Driver Output | 1.5 | | V_{CC} | V | $R_L = 54\Omega$ (RS-485), Figure 5 |
| | | 1.5 | | V_{CC} | V | $-7V \leq V_{CM} \leq +12V$, Figure 6 |
| | | 2 | | V_{CC} | V | $R_L = 100\Omega$ (RS-422), Figure 5 |
| $ \Delta V_{OD} $ | Change In Magnitude of Differential Output Voltage | | | 0.2 | V | $R_L = 54\Omega$ or 100Ω , Figure 5 |
| V_{CM} | Driver Common Mode Output Voltage | | | 3 | V | $R_L = 54\Omega$ or 100Ω , Figure 5 |
| $ \Delta V_{CM} $ | Change In Magnitude of Common Mode Output Voltage | | | 0.2 | V | $R_L = 54\Omega$ or 100Ω , Figure 5 |
| I_{OSD} | Driver Output Short Circuit Current | | | ± 250 | mA | $-7V \leq V_Y$ or $V_Z \leq +12V$, Figure 7 |
| I_O | Driver Output Leakage Current | | | ± 125 | μA | $DE = 0V$ or $\overline{SHDN} = 0V$, V_Y or $V_Z = -7V$ or $+12V$, $V_{CC} = 0V$ or $5.5V$ |

TIMING CHARACTERISTICS

UNLESS OTHERWISE NOTED:

$V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_{CC} = 3.3V$, $T_A = +25^\circ C$.

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---|------|------|------|------------|---|
| ALL MODES | | | | | | |
| t_{ENABLE} | Enable from Shutdown | | 1000 | | ns | |
| $t_{SHUTDOWN}$ | Enable to Shutdown | | 1000 | | ns | |
| RS-232, DATA RATE = 250kbps ($\overline{SLEW} = 0V$), ONE TRANSMITTER SWITCHING | | | | | | |
| | Maximum Data Rate | 250 | | | kbps | $R_L = 3k\Omega$, $C_L = 1000pF$ |
| t_{RHL}, t_{RLH} | Receiver Propagation Delay | | 100 | | ns | $C_L = 150pF$, Figure 8 |
| $ t_{RHL}-t_{RLH} $ | Receiver Propagation Delay Skew | | | 100 | ns | |
| t_{DHL}, t_{DLH} | Driver Propagation Delay | | 1400 | | ns | $R_L = 3k\Omega$, $C_L = 2500pF$, Figure 9 |
| $ t_{DHL}-t_{DLH} $ | Driver Propagation Delay Skew | | | 600 | ns | |
| t_{SHL}, t_{SLH} | Transition Region Slew Rate from 3.0V to -3.0V or -3.0V to 3.0V | 6 | | 30 | V/ μs | $V_{CC} = +3.3V$, $R_L = 3k\Omega$ to $7k\Omega$, $C_L = 150pF$ to $2500pF$, $T_A = 25^\circ C$, Figure 9 |
| t_{SHL}, t_{SLH} | Transition Region Slew Rate from 3.0V to -3.0V or -3.0V to 3.0V | 4 | | 30 | V/ μs | $V_{CC} = +3.3V$, $R_L = 3k\Omega$ to $7k\Omega$, $C_L = 150pF$ to $2500pF$, Figure 9 |
| RS-232, DATA RATE = 1Mbps ($\overline{SLEW} = V_{CC}$), ONE TRANSMITTER SWITCHING | | | | | | |
| | Maximum Data Rate | 1 | | | Mbps | $R_L = 3k\Omega$, $C_L = 250pF$ |
| t_{RHL}, t_{RLH} | Receiver Propagation Delay | | 100 | | ns | $C_L = 150pF$, Figure 8 |
| $ t_{RHL}-t_{RLH} $ | Receiver Propagation Delay Skew | | | 100 | ns | |
| t_{DHL}, t_{DLH} | Driver Propagation Delay | | 300 | | ns | $R_L = 3k\Omega$, $C_L = 1000pF$, Figure 9 |
| $ t_{DHL}-t_{DLH} $ | Driver Propagation Delay Skew | | | 150 | ns | |
| t_{SHL}, t_{SLH} | Transition Region Slew Rate from 3.0V to -3.0V or -3.0V to 3.0V | 13 | | 150 | V/ μs | $V_{CC} = +3.3V$, $R_L = 3k\Omega$ to $7k\Omega$, $C_L = 150pF$ to $1000pF$, Figure 9 |
| t_{SHL}, t_{SLH} | Transition Region Slew Rate from 3.0V to -3.0V or -3.0V to 3.0V | 24 | | 150 | V/ μs | $V_{CC} = +3.3V$, $R_L = 3k\Omega$ to $7k\Omega$, $C_L = 150pF$ to $1000pF$, $T_A = 25^\circ C$, Figure 9 |

TIMING CHARACTERISTICS (Continued)
UNLESS OTHERWISE NOTED:
 $V_{CC} = +3.0V$ to $+5.5V$, $C1-C4 = 0.1\mu F$; $T_A = T_{MIN}$ to T_{MAX} . Typical values are at $V_{CC} = 3.3V$, $T_A = +25^\circ C$.

| SYMBOL | PARAMETERS | MIN. | TYP. | MAX. | UNITS | CONDITIONS |
|---|---------------------------------|------|------|------|-------|---|
| RS-485/RS-422, DATA RATE = 250kbps ($\overline{SLEW} = 0V$), ONE TRANSMITTER SWITCHING | | | | | | |
| | Maximum Data Rate | 250 | | | kbps | $R_L = 54\Omega$, $C_L = 50pF$ |
| t_{RPHL} , t_{RPLH} | Receiver Propagation Delay | | 50 | 150 | ns | $C_L = 15pF$, Figure 10 |
| $ t_{RPHL} - t_{RPLH} $ | Receiver Propagation Delay Skew | | | 10 | ns | |
| t_{DPHL} , t_{DPLH} | Driver Propagation Delay | | 500 | 1000 | ns | $R_L = 54\Omega$, $C_L = 50pF$, Figure 11 |
| $ t_{DPHL} - t_{DPLH} $ | Driver Propagation Delay Skew | | | 100 | ns | |
| t_{DR} , t_{DF} | Driver Rise and Fall Time | 300 | 650 | 1200 | ns | |
| RS-485/RS-422, DATA RATE = 20Mbps ($\overline{SLEW} = V_{CC}$), ONE TRANSMITTER SWITCHING | | | | | | |
| | Maximum Data Rate | 20 | | | Mbps | $R_L = 54\Omega$, $C_L = 50pF$ |
| t_{RPHL} , t_{RPLH} | Receiver Propagation Delay | | 50 | 150 | ns | $C_L = 15pF$, Figure 10 |
| $ t_{RPHL} - t_{RPLH} $ | Receiver Propagation Delay Skew | | | 10 | ns | |
| t_{DPHL} , t_{DPLH} | Driver Propagation Delay | | 30 | 100 | ns | $R_L = 54\Omega$, $C_L = 50pF$, Figure 11 |
| $ t_{DPHL} - t_{DPLH} $ | Driver Propagation Delay Skew | | | 10 | ns | |
| t_{DR} , t_{DF} | Driver Rise and Fall Time | | 10 | 20 | ns | |
| t_{RZH} , t_{RZL} | Receiver Output Enable Time | | | 200 | ns | $C_L = 15pF$, Figure 12 |
| t_{RHZ} , t_{RLZ} | Receiver Output Disable Time | | | 200 | ns | |
| t_{DZH} , t_{DZL} | Driver Output Enable Time | | | 1000 | ns | $R_L = 500\Omega$, $C_L = 50pF$, Figure 13 |
| t_{DZH} , t_{DLZ} | Driver Output Disable Time | | | 200 | ns | |

PIN DESCRIPTIONS

| Pin | Name | RS-232 | RS-485 Full Duplex | RS-485 Half Duplex |
|-----|-----------------------------------|---|---|----------------------|
| 1 | | | | |
| 2 | GND | Ground | | |
| 3 | T1OUT, B/Z | Transmitter 1 Output | Z Driver Neg Output | B/Z Neg Input/Output |
| 4 | T2OUT, A/Y | Transmitter 2 Output | Y Driver Pos Output | A/Y Pos Input/Output |
| 5 | | | | |
| 6 | R1OUT | Receiver 1 Output | X | X |
| 7 | R2OUT, RO | Receiver 2 Output | Receiver TTL Output | Receiver TTL Output |
| 8 | | | | |
| 9 | | | | |
| 10 | $\overline{\text{SHDN}}$ | Low power shutdown mode when low | | |
| 11 | $\overline{\text{SLEW}}$ | Data rate limited to 250kbps when low | | |
| 12 | FD_TX_TERM | X | 120Ω Y-Z termination enabled when both TERM and FD_TX_TERM are high | X |
| 13 | TERM | X | 120Ω A-B termination enabled when high | |
| 14 | $\overline{\text{RS-485/RS-232}}$ | 0 | 1 | 1 |
| 15 | $\overline{\text{HALF/FULL}}$ | X | 0 | 1 |
| 16 | | | | |
| 17 | GND | Ground | | |
| 18 | R2IN, A | Receiver 2 Input | A Pos Receiver Input | X |
| 19 | R1IN, B | Receiver 1 Input | B Neg Receiver Input | X |
| 20 | $\overline{\text{RE}}$ | X | Receiver enabled when low | |
| 21 | T2IN, DE | Transmitter 2 Input | Driver enabled when high | |
| 22 | T1IN, DI | Transmitter 1 Input | Driver TTL Input | |
| 23 | | | | |
| 24 | | | | |
| 25 | V- | Charge pump negative supply, 0.1μF from ground | | |
| 26 | C2- | Charge pump cap 2 negative lead | | |
| 27 | C2+ | Charge pump cap 2 positive lead, 0.1μF | | |
| 28 | V+ | Charge pump positive supply, 0.1μF to ground | | |
| 29 | C1+ | Charge pump cap 1 positive lead, 0.1μF | | |
| 30 | VL | Logic Supply for TTL Inputs and Outputs, $V_L = +1.65V$ to $+5.5V$ or tie to V_{CC} | | |
| 31 | VCC | Main Supply, $V_{CC} = +3.0V$ to $+5.5V$, bypass to ground with 1.0μF | | |
| 32 | C1- | Charge pump cap 1 negative lead | | |

SUGGESTED DB9 CONNECTOR PINOUT

| DB9 Pin | RS-232 | RS-485 Full Duplex | RS-485 Half Duplex |
|---------|--------|--------------------|--------------------|
| 1 | | | |
| 2 | RXD | RX+ | |
| 3 | TXD | TX- | Data- |
| 4 | | | |
| 5 | Ground | | |
| 6 | | | |
| 7 | RTS | TX+ | Data+ |
| 8 | CTS | RX- | |
| 9 | | | |

BLOCK DIAGRAMS

FIGURE 1. RS-232 MODE

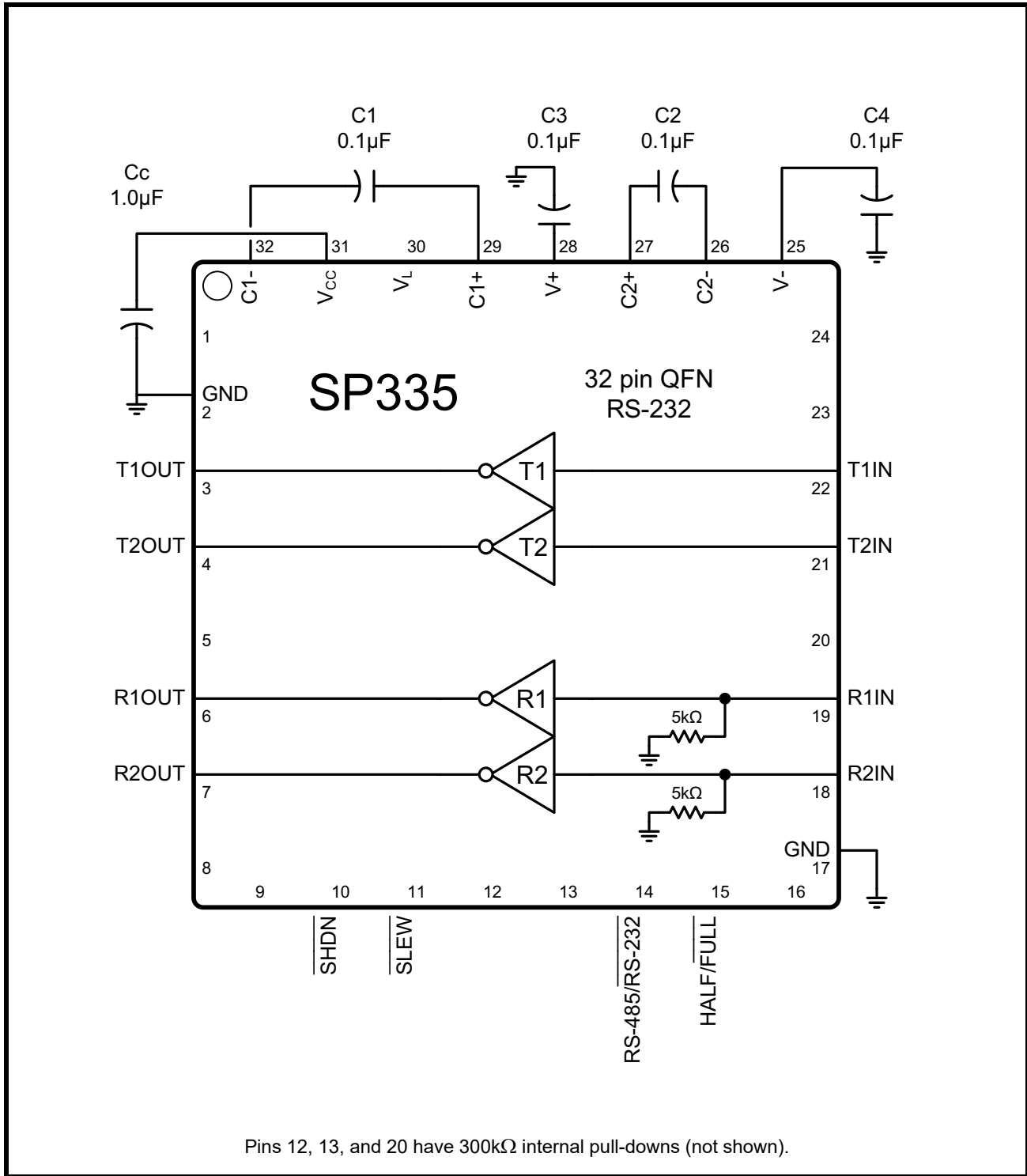


FIGURE 2. RS-485 FULL DUPLEX MODE

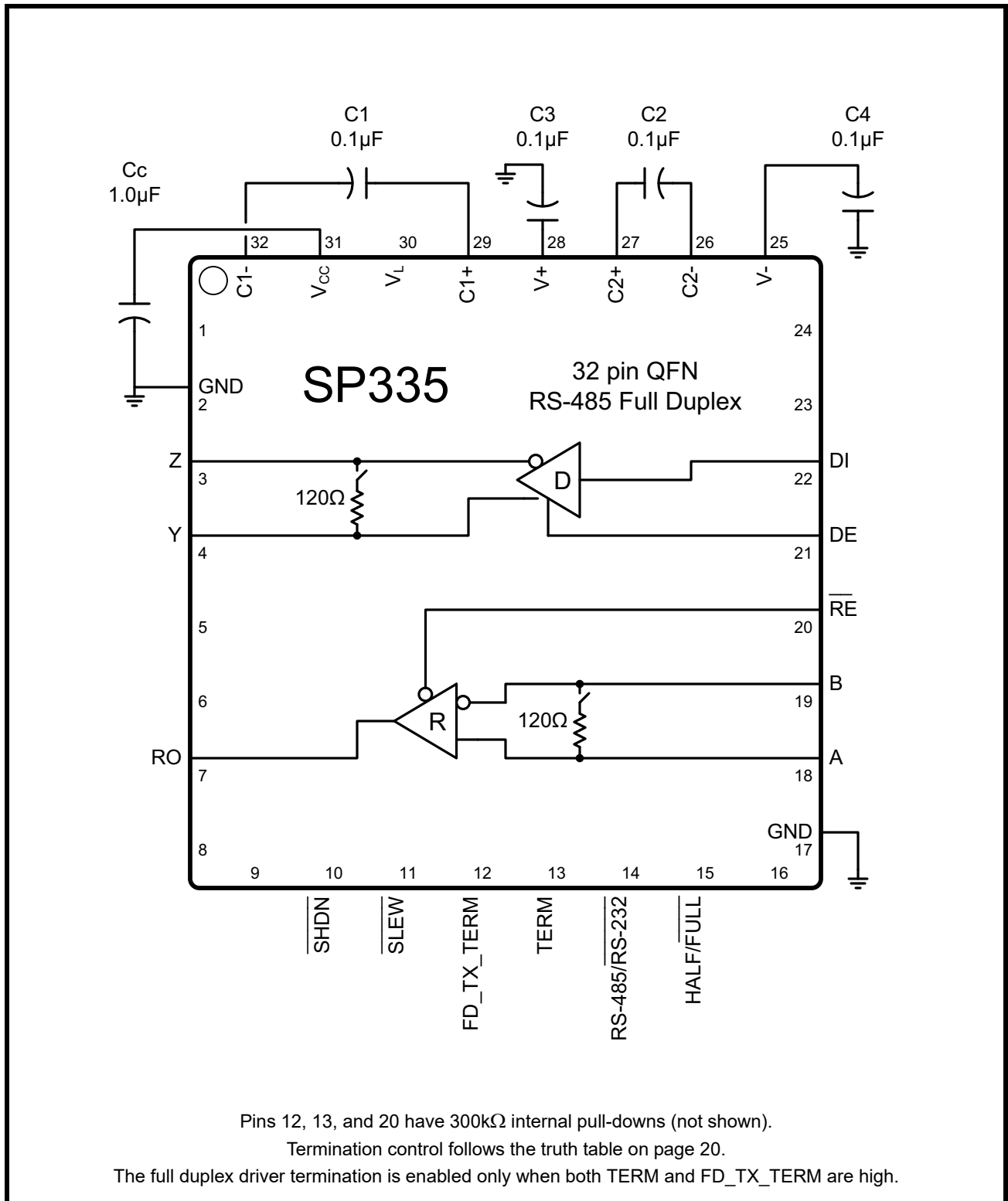
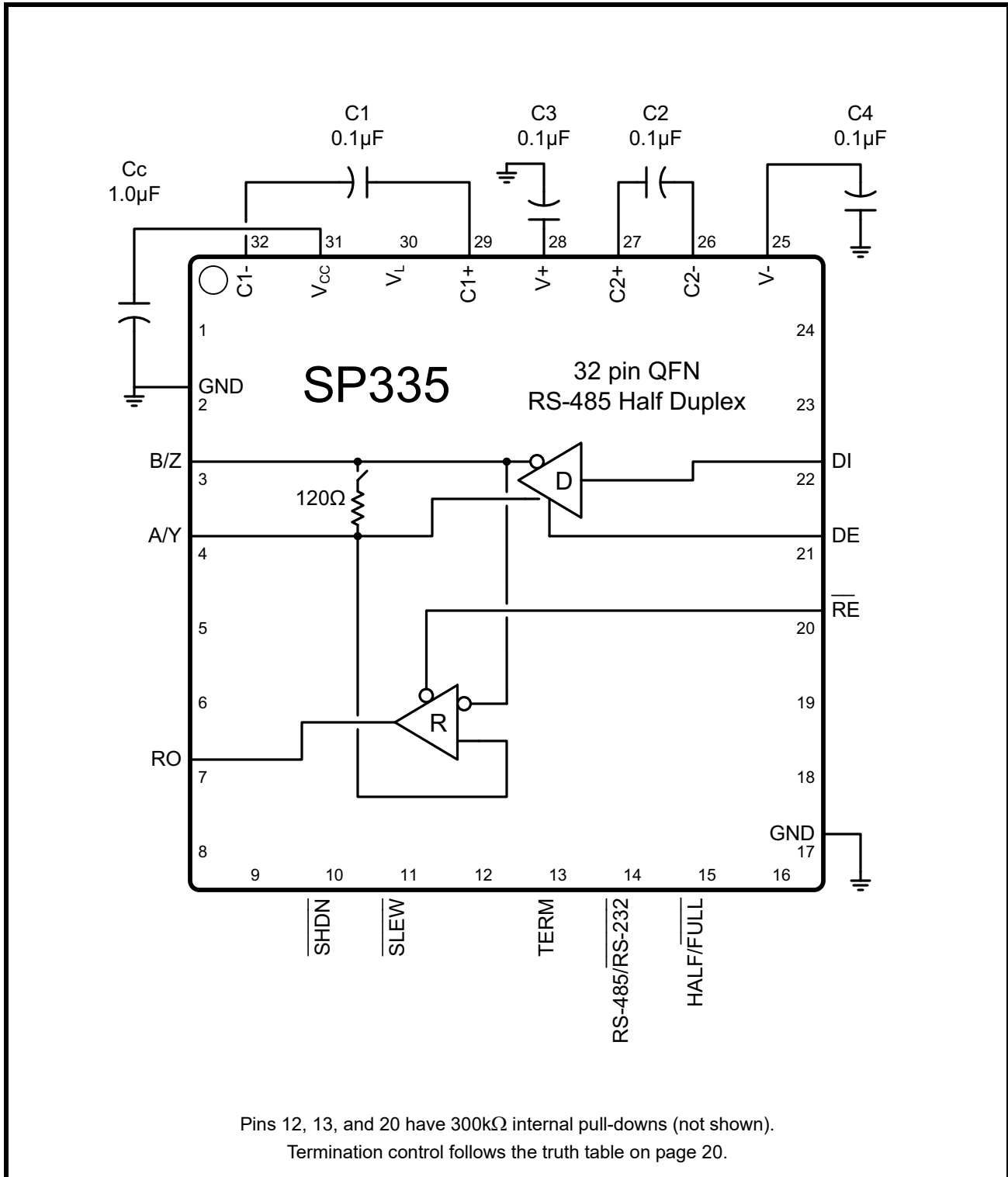


FIGURE 3. RS-485 HALF DUPLEX MODE



TEST CIRCUITS

FIGURE 4. RS-485/422 RECEIVER TERMINATION RESISTANCE

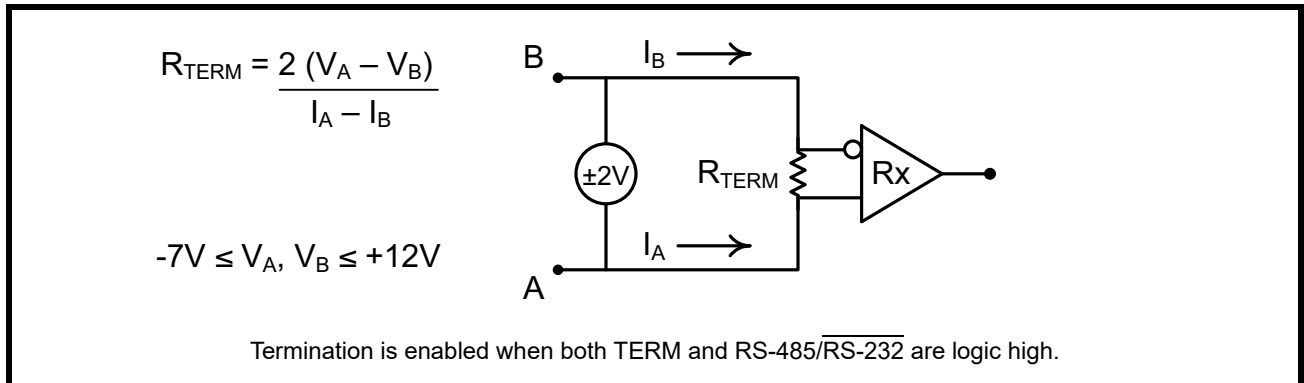


FIGURE 5. RS-485/422 DIFFERENTIAL DRIVER OUTPUT VOLTAGE

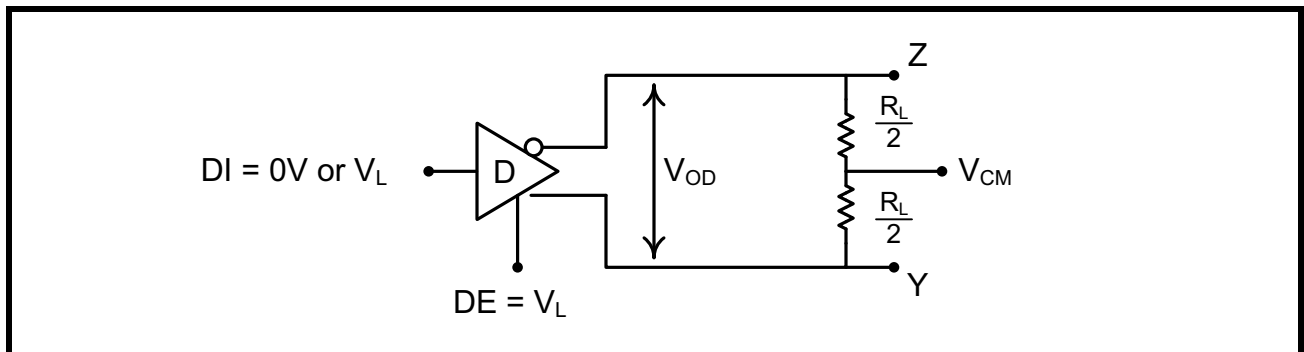


FIGURE 6. RS-485/422 DIFFERENTIAL DRIVER OUTPUT VOLTAGE OVER COMMON MODE

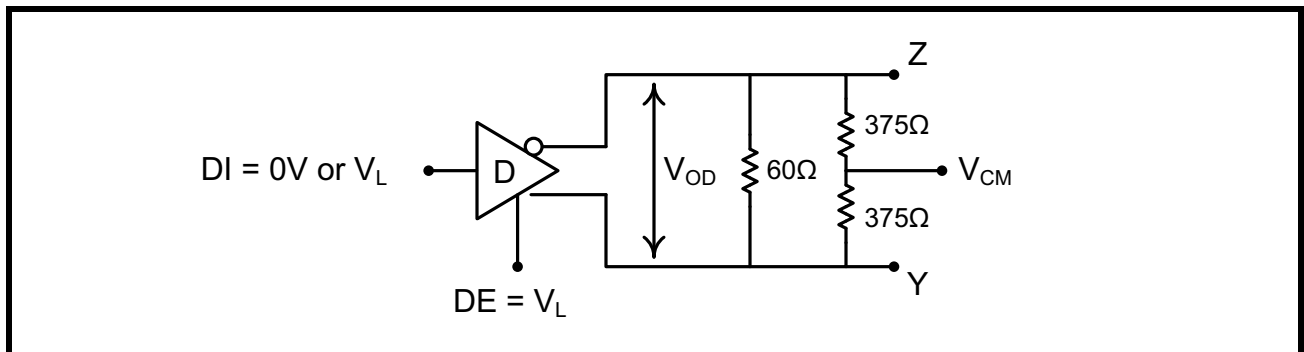


FIGURE 7. RS-485/422 DRIVER OUTPUT SHORT CIRCUIT CURRENT

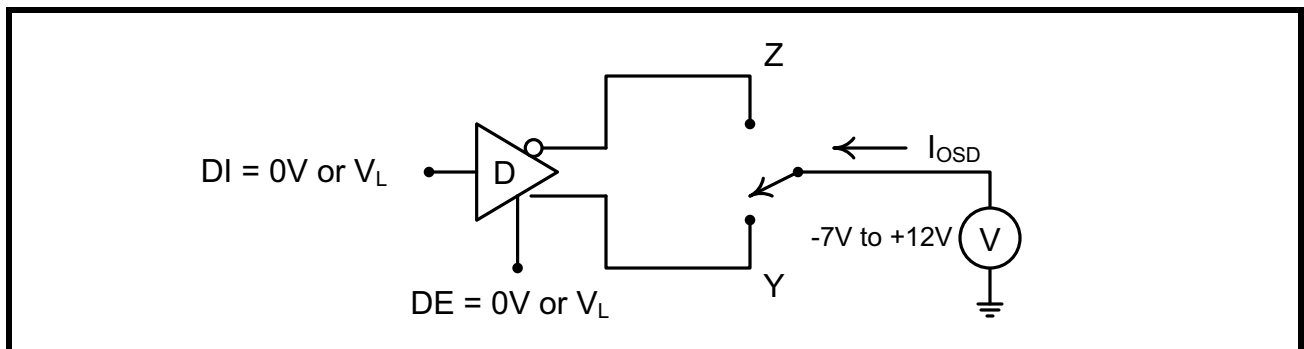


FIGURE 8. RS-232 RECEIVER PROPAGATION DELAY



FIGURE 9. RS-232 DRIVER PROPAGATION DELAY



FIGURE 10. RS-485/422 RECEIVER PROPAGATION DELAY

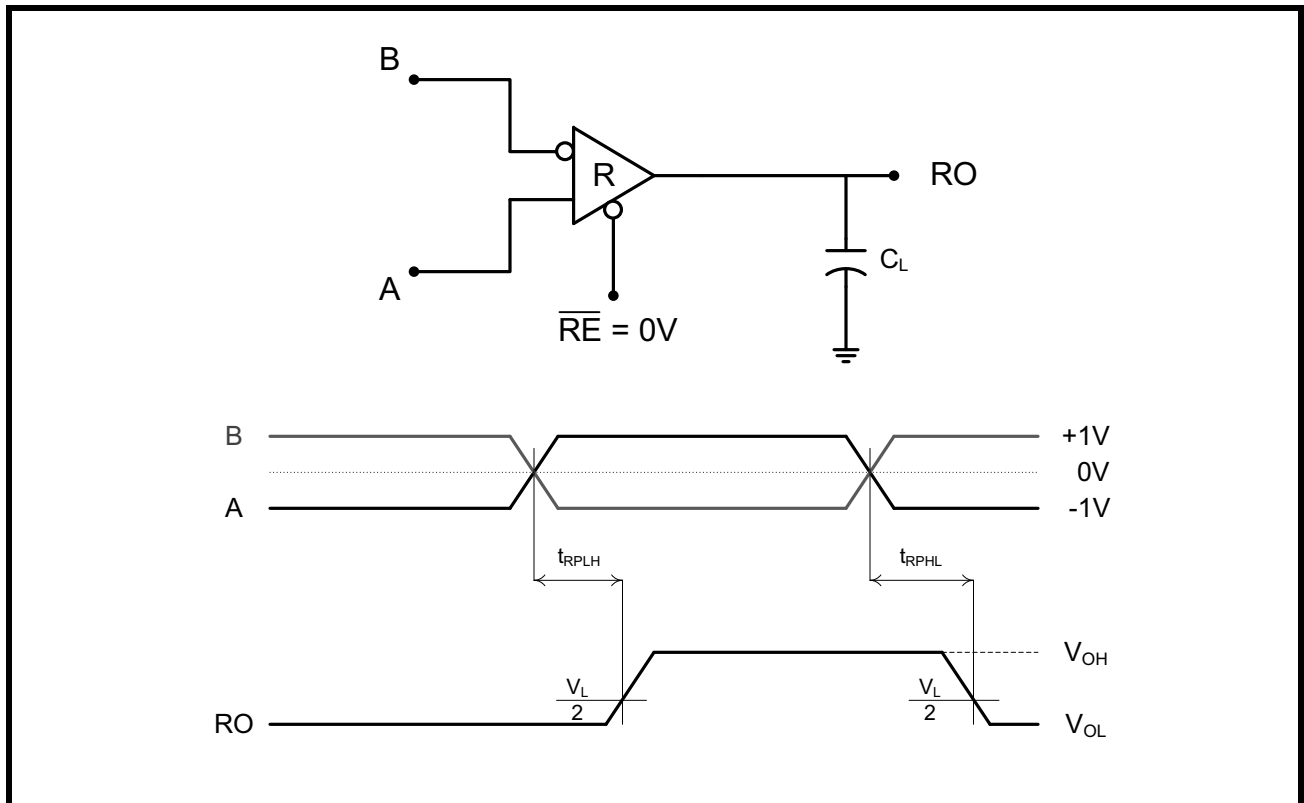


FIGURE 11. RS-485/422 DRIVER PROPAGATION DELAY AND RISE/FALL TIMES

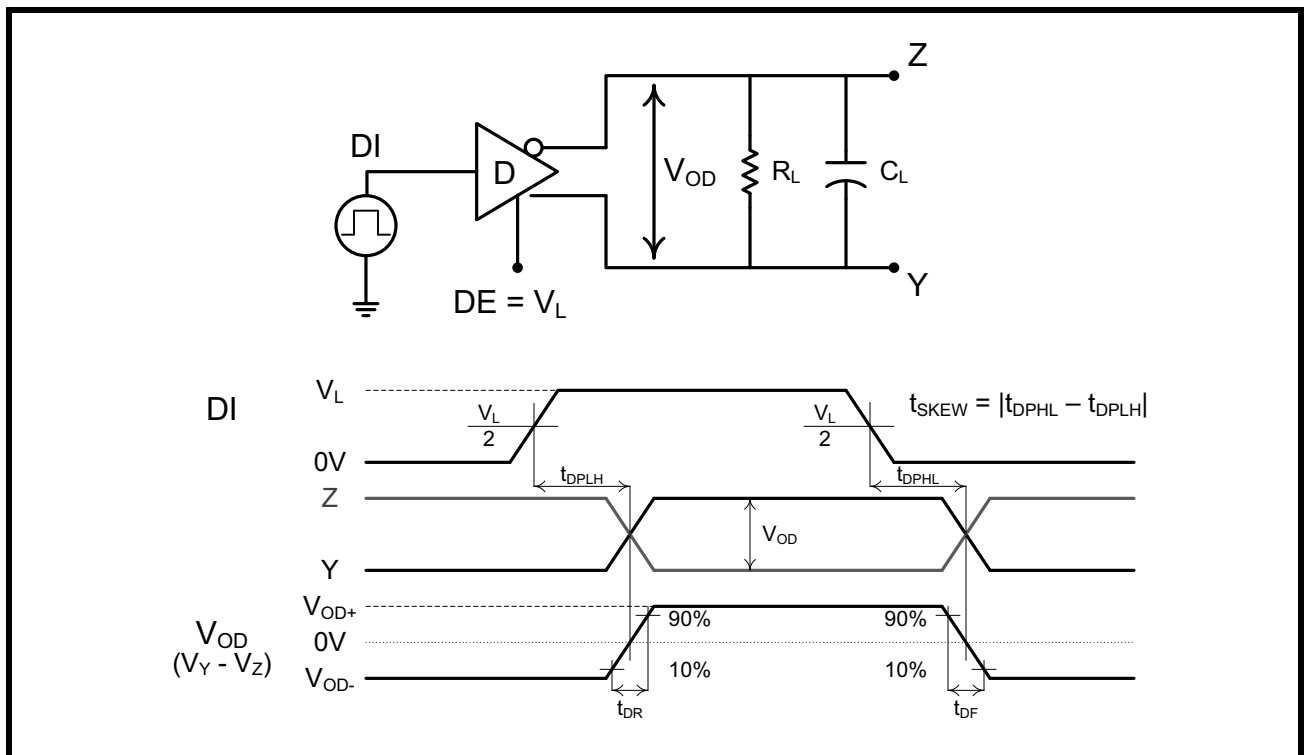
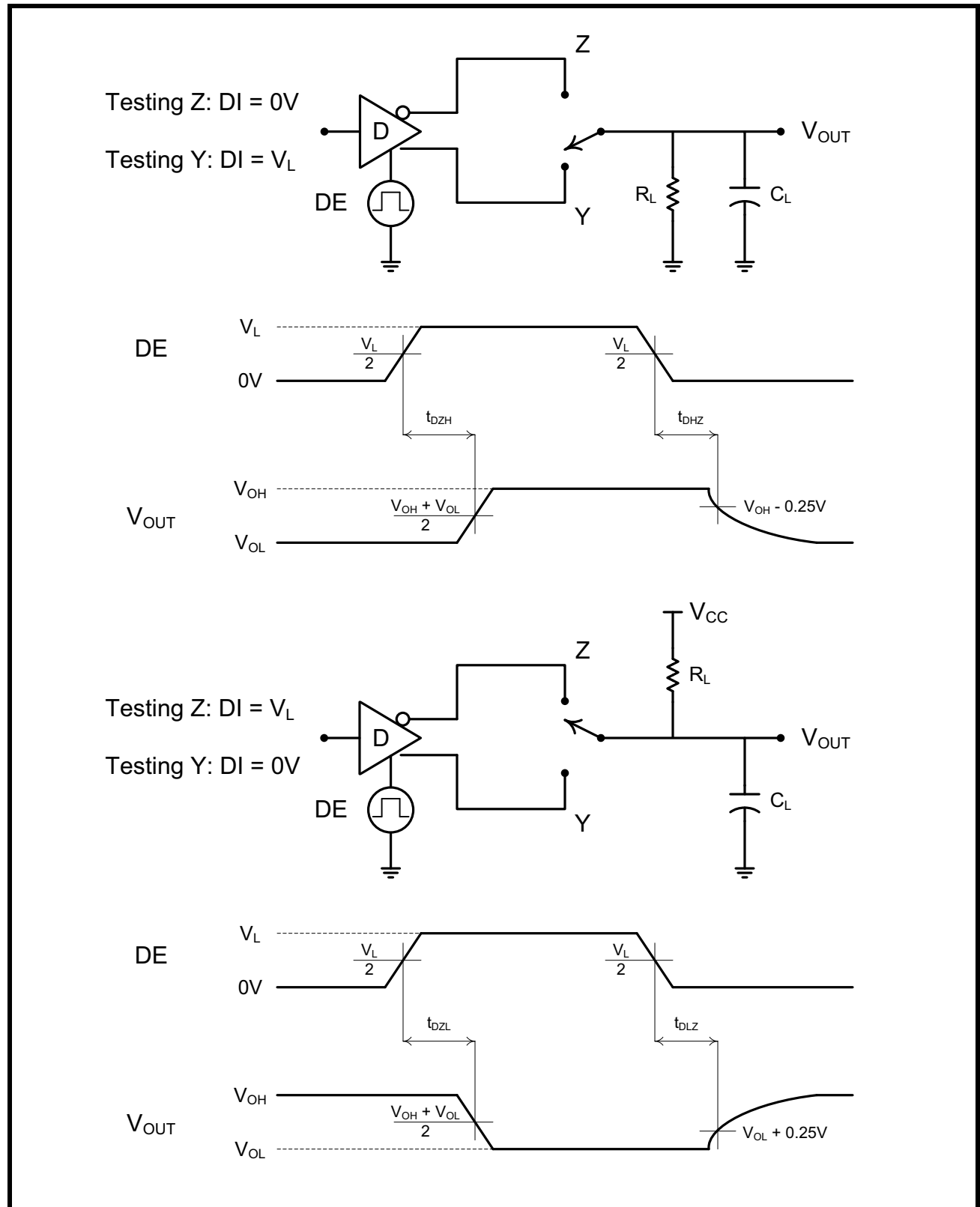


FIGURE 12. RS-485/422 RECEIVER OUTPUT ENABLE/DISABLE TIMES



FIGURE 13. RS-485/422 DRIVER OUTPUT ENABLE/DISABLE TIMES



PRODUCT SUMMARY

The SP335 is an advanced multiprotocol transceiver supporting RS-232, RS-485, and RS-422 serial standards. Integrated cable termination and multiple configuration modes allow all three protocols to be used interchangeably over a single cable or connector with no additional switching components. Full operation requires only four external charge pump capacitors.

INTERNALLY SWITCHED CABLE TERMINATION

Enabling and disabling the RS-485/422 termination resistor is one of the largest challenges system designers face when sharing a single connector or pair of lines across multiple serial protocols. A termination resistor may be necessary for accurate RS-485/422 communication, but must be removed when the lines are used for RS-232. SP335 provides an elegant solution to this problem by integrating the termination resistor and switching control, and allowing it to be switched in and out of the circuit with a single pin. No external switching components are required. Termination on the receiver inputs will be enabled if both TERM and RS-485/RS-232 are high.

ENHANCED FAILSAFE

The enhanced failsafe feature of the SP335 guarantees a logic-high receiver output when the receiver inputs are open, shorted, or terminated but idle/undriven. The enhanced failsafe interprets 0V differential as a logic high with a minimum 50mV noise margin, while maintaining compliance with the EIA/TIA-485 standard of $\pm 200\text{mV}$. No external biasing resistors are required, further easing the usage of multiple protocols over a single connector.

$\pm 15\text{kV}$ ESD PROTECTION

ESD protection structures are incorporated on all pins to protect against electrostatic discharges encountered during handling and assembly. The bus pins (driver outputs and receiver inputs) have extra protection structures, which have been tested up to $\pm 15\text{kV}$ without damage. These structures withstand high ESD in all states: normal operation, in shutdown, and when powered off.

ESD protection is tested in various ways. Exar uses the following methods to qualify the protection structures designed into SP335:

- $\pm 8\text{kV}$ using IEC 61000-4-2 Contact Discharge
- $\pm 15\text{kV}$ using IEC 61000-4-2 Airgap Discharge
- $\pm 15\text{kV}$ using the Human Body Model (HBM)

The IEC 61000-4-2 standard is more rigorous than HBM, resulting in lower voltage levels compared with HBM for the same level of ESD protection. Because IEC 61000-4-2 specifies a lower series resistance, the peak current is higher than HBM. The SP335 has passed both HBM and IEC 61000-4-2 testing without damage.

VARIABLE LOGIC LEVEL VOLTAGE

The SP335 includes a V_L pin, which reduces the logic level thresholds to interface with processors operating at reduced supply voltages. This pin should be connected to the supply voltage of the processor, or can be connected to V_{CC} for typical logic levels.

TRUTH TABLES
TABLE 1: RS-232 TX TRUTH TABLE

| INPUTS | | | OUTPUTS |
|--------|---------------|------------------|------------------------|
| SHDN | RS-485/RS-232 | DI/T1IN, DE/T2IN | Z(B)/T1OUT, Y(A)/T2OUT |
| 0 | X | X | 1/8th unit load |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | X | RS-485 Mode |

TABLE 2: RS-232 RX TRUTH TABLE

| INPUTS | | | OUTPUTS |
|--------|---------------|----------------|--|
| SHDN | RS-485/RS-232 | B/R1IN, A/R2IN | R1OUT, RO/R2OUT |
| X | 0 | 0 | 1 |
| X | 0 | 1 | 0 |
| X | 0 | Inputs open | 1 |
| X | 1 | X | R1OUT High-Z, RO/R2OUT in RS-485 Mode |

TABLE 3: RS-485/422 TX TRUTH TABLE

| INPUTS | | | | OUTPUTS | |
|--------------------------|---------------|---------|---------|-----------------|-----------------|
| $\overline{\text{SHDN}}$ | RS-485/RS-232 | DE/T2IN | DI/T1IN | Z(B)/T1OUT | Y(A)/T2OUT |
| 0 | X | X | X | 1/8th unit load | 1/8th unit load |
| 1 | 1 | 0 | X | 1/8th unit load | 1/8th unit load |
| 1 | 1 | 1 | 0 | 1 | 0 |
| 1 | 1 | 1 | 1 | 0 | 1 |
| X | 0 | X | X | RS-232 Mode | |

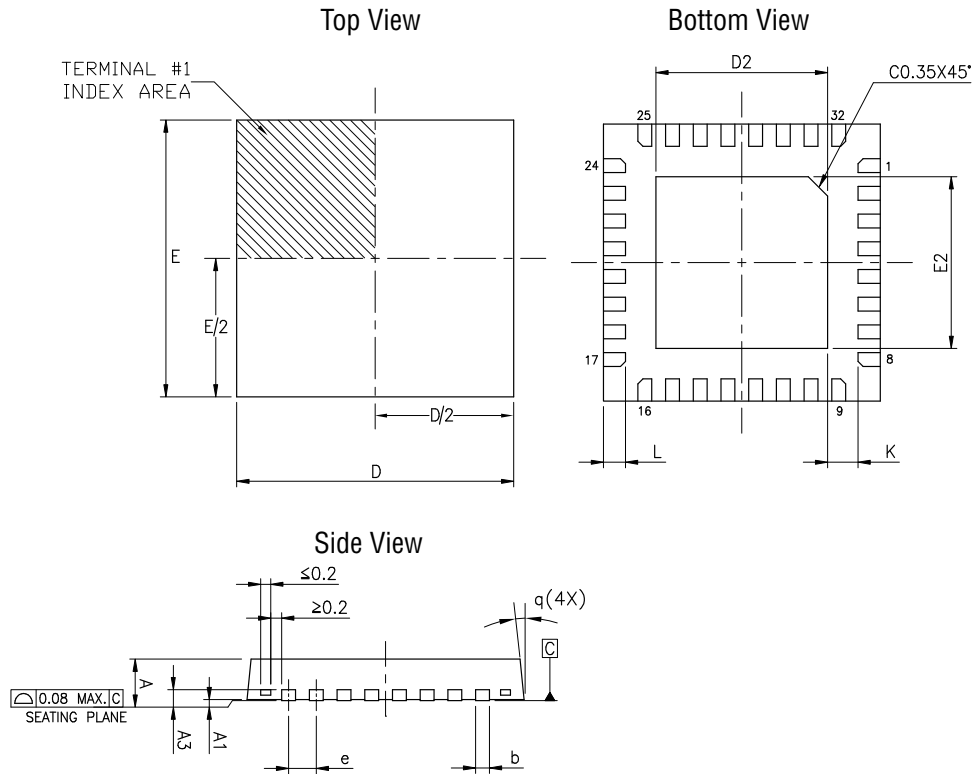
TABLE 4: RS-485/422 RX TRUTH TABLE

| INPUTS | | | | | | OUTPUT |
|---------------|--------------------------|-----------|------------------------|----------------------|----------------------|-------------|
| RS-485/RS-232 | $\overline{\text{SHDN}}$ | HALF/FULL | $\overline{\text{RE}}$ | (A-B) | (Y-Z) | RO/R2OUT |
| 1 | 0 | X | X | X | X | High-Z |
| 1 | 1 | 0 | 0 | $\geq -50\text{mV}$ | X | 1 |
| 1 | 1 | 0 | 0 | $\leq -200\text{mV}$ | X | 0 |
| 1 | 1 | 0 | 0 | Floating | X | 1 |
| 1 | 1 | 1 | 0 | X | $\geq -50\text{mV}$ | 1 |
| 1 | 1 | 1 | 0 | X | $\leq -200\text{mV}$ | 0 |
| 1 | 1 | 1 | 0 | X | Floating | 1 |
| 1 | 1 | X | 1 | X | X | High-Z |
| 0 | X | X | X | X | X | RS-232 Mode |

TABLE 5: RS-485/422 TERMINATION TRUTH TABLE

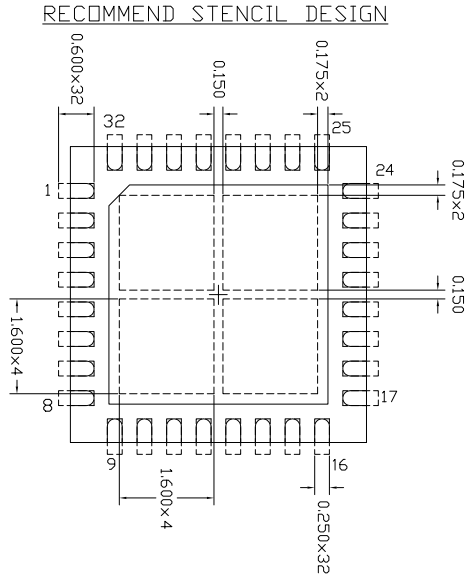
| FD_TX_TERM | TERM | RS-485/RS-232 | HALF/FULL | TX TERM | RX TERM |
|------------|--------|---------------|-----------|----------|------------|
| PIN 12 | PIN 13 | PIN 14 | PIN 15 | PINS 3-4 | PINS 18-19 |
| X | 0 | 1 | 0 | - | - |
| 0 | 1 | 1 | 0 | - | ON |
| 1 | 1 | 1 | 0 | ON | ON |
| X | 0 | 1 | 1 | - | - |
| X | 1 | 1 | 1 | ON | - |
| X | X | 0 | X | - | - |

The DE and $\overline{\text{RE}}$ pins have no effect on the termination setting in any mode.

PACKAGE DRAWINGS
FIGURE 14. QFN32 MECHANICAL DIMENSIONS


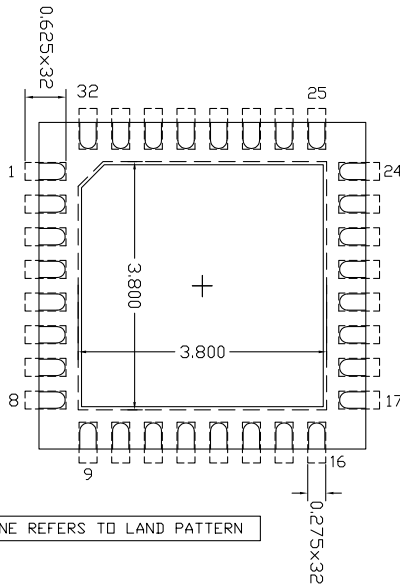
| SYMBOLS | DIMENSIONS IN MM (Control Unit) | | | DIMENSIONS IN INCH (Reference Unit) | | |
|---------|------------------------------------|------|------|--|-------|-------|
| | MIN | NOM | MAX | MIN | NOM | MAX |
| A | 0.80 | 0.90 | 1.00 | 0.032 | 0.035 | 0.039 |
| A1 | 0.00 | 0.02 | 0.05 | 0.000 | 0.001 | 0.002 |
| A3 | 0.20 | REF | | 0.008 | REF | |
| b | 0.18 | 0.25 | 0.30 | 0.007 | 0.010 | 0.012 |
| D | 5.00 BSC | | | 0.197 BSC | | |
| D2 | 3.50 | 3.65 | 3.80 | 0.138 | 0.144 | 0.150 |
| E | 5.00 BSC | | | 0.197 BSC | | |
| E2 | 3.50 | 3.65 | 3.80 | 0.138 | 0.144 | 0.150 |
| e | 0.50 BSC | | | 0.020 BSC | | |
| L | 0.35 | 0.40 | 0.45 | 0.014 | 0.016 | 0.018 |
| K | 0.20 | — | — | 0.008 | — | — |
| q | 0° | — | 14° | 0° | — | 14° |
| N | 32 | | | 32 | | |
| ND | 8 | | | 8 | | |
| NE | 8 | | | 8 | | |

FIGURE 15. QFN32 RECOMMENDED STENCIL DESIGN AND LAND PATTERN



- DASH LINE REFERS TO SOLDER STENCIL OPENING

RECOMMEND LAND PATTERN



- DASH LINE REFERS TO LAND PATTERN

REVISION HISTORY

| DATE | REVISION | DESCRIPTION |
|-------------|----------|--|
| Sept 2013 | 1.0.0 | Production Release |
| August 2017 | 1.0.1 | Update to MaxLinear logo. Updated format and ordering information table. Updated package drawing to reflect 32 pins on package for bottom and side view. |
| August 2017 | 1.0.2 | Added maximum operating junction temperature, page 2. |



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