*Click here for production status of specific part numbers.*

# MAX33250E/ MAX33251E

# 600V Isolated 2Tx/2Rx and 1Tx/1Rx RS-232 Transceiver with ±15kV ESD and Integrated Capacitors

## General Description

The MAX33250E and MAX33251E are isolated 2Tx/2Rx and 1Tx/1Rx RS-232 transceivers, respectively, with a galvanic isolation of $600V_{RMS}$ (60sec) between the logic UART side and field side. The isolation barrier protects the logic UART side from electrical transient strikes from the field side. It also breaks ground loops and large differences in ground potentials between the two sides that can potentially corrupt the receiving and sending of data. The MAX33250E and MAX33251E conform to the EIA/TIA-232E standard and operate at data rates up to 1Mbps.

The isolated RS-232 transceivers have integrated charge pumps and an inverter to eliminate the need for a high positive and negative voltage supply. Both devices also have integrated charge pump and inverter capacitors to help further reduce PCB space. The supply pin $V_{CCA}$ on the UART logic side operates from a dual voltage supply from +3V to +5.5V. $V_{CCB}$ also operates from +3V to +5.5V, simplifying power requirements and enabling level translation between the two voltages. The transmitters and receivers on the field side of these devices are rated for ±15kV of ESD HBM protection, suitable for applications where RS-232 cables are frequently worked on.

Both are available in a 12-pin, 6mm x 6mm LGA package and operate over the -40ºC to +85ºC temperature range.

## Applications

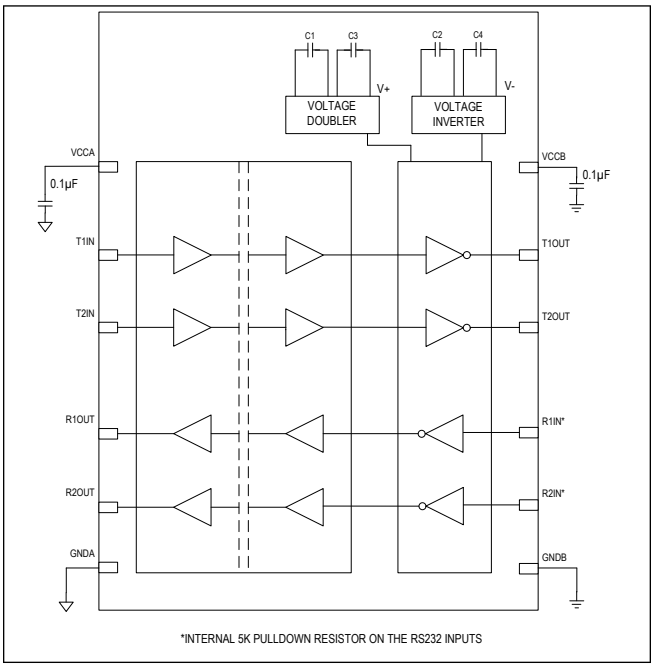
- Diagnostics Equipment
- POS Systems
- Industrial Equipment
- GPS Equipment
- Communication Systems
- Medical Equipment

## Benefits and Features

- High Integration Saves Space and Simplifies Designs
  - Integrated Charge Pumps and Inverter Eliminates Extra Power Supplies
  - Four Internal Capacitors Saves PCB Space
  - Integrated Isolator Saves Up to 63% Versus a Discrete Solution
- Integrated Protection for Robust Communications
  - $600V_{RMS}$ Withstand Isolation Voltage for 60 Seconds ($V_{ISO}$)
  - $200V_{RMS}$ Working Voltage for >50 years ($V_{IOWM}$)
  - Integrated ±15kV ESD Human Body Model (HBM)

***Ordering Information* appears at end of data sheet.**

## Simplified Block Diagram



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## Absolute Maximum Ratings

$V_{CCA}$ to GNDA ..... -0.3V to +6V
$V_{CCB}$ to GNDB ..... -0.3V to +6V
T_IN to GNDA ..... -0.3V to +6V
T_OUT to GNDB ..... ±13.2V
R_IN to GNDB ..... ±25V
R_OUT to GNDA ..... -0.3V to +6V
Short-Circuit Duration (T_OUT to GNDB) ..... Continuous
Short-Circuit Duration (R_OUT to GNDA) ..... Continuous
Side A ($V_{CCA}$, T1IN, T2IN, R1OUT, R2OUT) to GNDA ESD ±2kV
Side B ($V_{CCB}$) to GNDB ESD ..... ±2kV
Side B (T1OUT, T2OUT, R1IN, R2IN) to GNDB ESD HBM ±15kV
Continuous Power Dissipation (Single Layer Board) ($T_A$ = +70°C, derate 10mW/°C above +70°C.) ..... 510mW
Continuous Power Dissipation (Multilayer Board) ($T_A$ = +70°C, derate 10mW/°C above +70°C.) ..... 700mW
Operating Temperature Range ..... -40°C to +85°C

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## Package Information

### LGA-12

| | |
|---|---|
| Package Code | L1266M+1 |
| Outline Number | 21-100222 |
| Land Pattern Number | 90-100078 |
| **Thermal Resistance, Single-Layer Board:** | |
| Junction-to-Ambient ($\theta_{JA}$) | 157°C/W |
| Junction-to-Case Thermal Resistance ($\theta_{JC}$) | 31°C/W |
| **Thermal Resistance, Four-Layer Board:** | |
| Junction-to-Ambient ($\theta_{JA}$) | 115°C/W |
| Junction-to-Case Thermal Resistance ($\theta_{JC}$) | 31°C/W |

For the latest package outline information and land patterns (footprints), go to *www.maximintegrated.com/packages*. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

Package thermal resistances were obtained using the method described in JEDEC specification JESD51-7, using a four-layer board. For detailed information on package thermal considerations, refer to *www.maximintegrated.com/thermal-tutorial*.

## Electrical Characteristics

($V_{CCA}$ - $V_{GNDA}$ = 3.0V to 5.5V, $V_{CCB}$ - $V_{GNDB}$ = 3.0V to 5.5V, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CCA}$ - $V_{GNDA}$ = 3.3V, $V_{CCB}$ - $V_{GNDB}$ = 3.3V, $V_{GNDA}$ = $V_{GNDB}$, and $T_A$ = +25°C. (Note 1), Limits are 100% tested at $T_A$ = +25°C. Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Specifications marked "GBD" are guaranteed by design and not production tested.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| **POWER** | | | | | | |
| Supply Voltage | $V_{CCA}$, $V_{CCB}$ | | 3.0 | | 5.5 | V |
| Supply Current | $I_{CCA}$ | $V_{CCA}$ = 5V, R_IN and T_IN idle | | | 12 | mA |
| | | $V_{CCA}$ = 3.3V, R_IN and T_IN idle | | | 10 | |
| | $I_{CCB}$ | $V_{CCB}$ = 5V, R_IN and T_IN idle, no load | | | 12 | |
| | | $V_{CCB}$ = 3.3V, R_IN and T_IN idle, no load | | | 10 | |
| Undervoltage-Lockout Threshold | $V_{UVLO}$ | $V_{CCA}$ - $V_{GNDA}$ (Note 2) | | 2.0 | | V |
| Undervoltage-Lockout Hysteresis | $V_{UVLOHYS}$ | $V_{CCA}$ - $V_{GNDA}$ (Note 2) | | 0.1 | | V |
| **INPUT INTERFACE (T_IN, R_IN)** | | | | | | |
| Input Low Voltage | $V_{IL}$ | T_IN relative to GNDA | | | 0.8 | V |
| | | R_IN relative to GNDB, $T_A$ = 25ºC, $V_{CC}$ = 3.3V | | | 0.6 | |
| | | R_IN relative to GNDB, $T_A$ = 25ºC, $V_{CC}$ = 5V | | | 0.8 | |
| Input High Voltage | $V_{IH}$ | T_IN relative to GNDA | 0.7 x $V_{CCA}$ | | | V |
| | | R_IN relative to GNDB, $V_{CCB}$ = 3.3V and 5V, $T_A$ = 25°C | 2.4 | | | |
| Transmitter Input Hysteresis | | (T_IN) | | 0.5 | | V |
| Receiver Input Hysteresis | | (R_IN) | | 0.5 | | V |
| Transmitter Input Leakage | | (T_IN) | | | ±1 | µA |
| Input Resistance (R_IN) | | $T_A$ = 25ºC | 3 | 5 | 7 | kΩ |
| **RECEIVER OUTPUT INTERFACE (R_OUT)** | | | | | | |
| Output Low Voltage | $V_{OL}$ | R_OUT relative to GNDA, sink current = 4mA | | | 0.8 | V |
| Output High Voltage | $V_{OH}$ | R_OUT relative to GNDA, source current = 4mA | $V_{CCA}$ - 0.4 | | | V |
| Output Short-Circuit Current | | | | | ±110 | mA |
| **TRANSMITTER OUTPUT (T_OUT)** | | | | | | |
| Output Voltage Swing | | T_OUT loaded with 3kΩ to GNDB | ±5 | | | V |

## Electrical Characteristics (continued)

($V_{CCA}$ - $V_{GNDA}$ = 3.0V to 5.5V, $V_{CCB}$ - $V_{GNDB}$ = 3.0V to 5.5V, $T_A$ = $T_{MIN}$ to $T_{MAX}$, unless otherwise noted. Typical values are at $V_{CCA}$ - $V_{GNDA}$ = 3.3V, $V_{CCB}$ - $V_{GNDB}$ = 3.3V, $V_{GNDA}$ = $V_{GNDB}$, and $T_A$ = +25°C. (Note 1), Limits are 100% tested at $T_A$ = +25°C. Limits over the operating temperature range and relevant supply voltage range are guaranteed by design and characterization. Specifications marked "GBD" are guaranteed by design and not production tested.)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Output Resistance | | $V_{CCB}$ = 0V, transmitters = ±2V | 300 | 10M | | Ω |
| Output Short-Circuit Current | | | | | ±70 | mA |
| Output Leakage Current | | $V_{CCB}$ = 0V, $V_{OUT}$ = ±12V | | | ±25 | µA |
| **ESD AND ISOLATION PROTECTION** | | | | | | |
| ESD for R_IN, T_OUT | | IEC 61000-4-2 Air Discharge | | ±12 | | kV |
| | | IEC 61000-4-2 Contact Discharge | | ±6 | | |
| | | ESD Human Body Model JEDEC JS-001-2014 | | ±15 | | |
| Isolation Voltage | $V_{ISO}$ | t = 60s (Note 3) | | 600 | | $V_{RMS}$ |
| Working Isolation Voltage | $V_{IOWM}$ | > 50 years (Note 3) | | 200 | | $V_{RMS}$ |
| **TIMING CHARACTERISTICS** | | | | | | |
| Maximum Data Rate | | $V_{CCB}$ = 5V, $R_L$ = 3kΩ, $C_L$ = 1000pF | 1000 | | | kbps |
| Receiver Propagation Delay | $t_{PHL}$, $t_{PLH}$ | R_IN to R_OUT, $C_L$ = 150pF | | 0.15 | | µs |
| Transmitter Skew | $\lvert t_{PHL} - t_{PLH} \rvert$ (Note 4) | | | 35 | | ns |
| Receiver Skew | $\lvert t_{PHL} - t_{PLH} \rvert$ | | | 60 | | ns |
| Transition-Region Slew Rate | | $V_{CCA}$ = $V_{CCB}$ = 3.3V, $T_A$ = +25C, $R_L$ = 3k to 7k, $C_L$ = 150pF to 1000pF, measured from +3V to -3V or -3V to +3V | 24 | | 150 | V/µs |

**Note 1:** All units are production tested at $T_A$ = 25°C. Specifications over temperature are guaranteed by design. All voltages of side A are referenced to GNDA. All voltages of side B are referenced to GNDB.

**Note 2:** The undervoltage lockout threshold and hysteresis guarantee that the outputs are in a known state when the supply voltage dips.

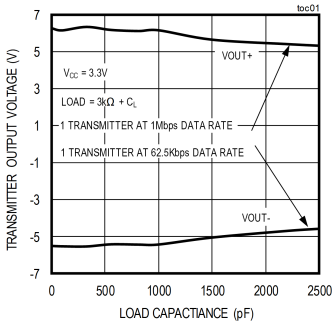
**Note 3:** The isolation is guaranteed by design and not production tested.

**Note 4:** Transmitter skew is measured at the transmitter zero cross points.

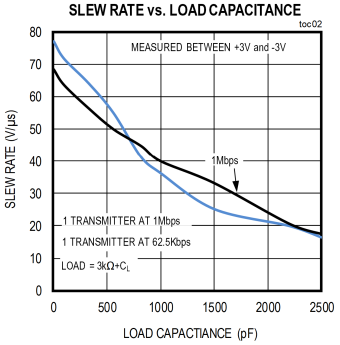
## Typical Operating Characteristics

($V_{DD}$ = 5V, $V_L$ = 3.3V, $R_L$ = 60Ω, $C_L$ = 15pF, $T_A$ = +25°C, unless otherwise noted.)

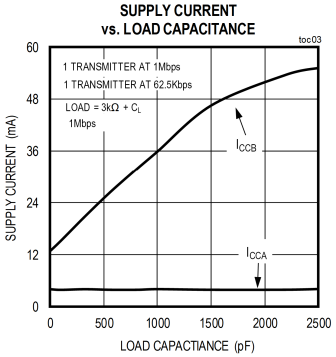
TRANSMITTER OUTPUT VOLTAGE vs. LOAD CAPACITANCE



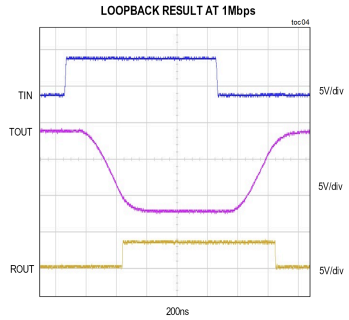

SLEW RATE vs. LOAD CAPACITANCE



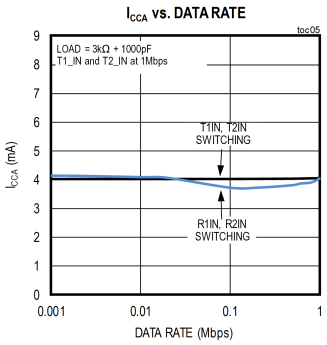

SUPPLY CURRENT vs. LOAD CAPACITANCE



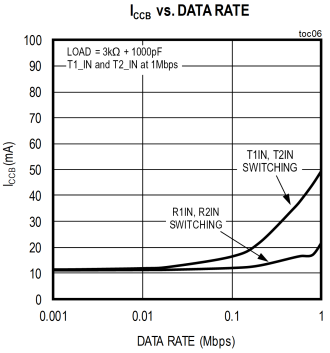

LOOPBACK RESULT AT 1Mbps




ICCA vs. DATA RATE

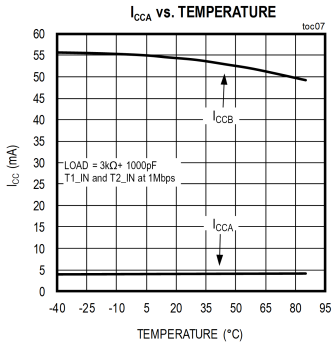


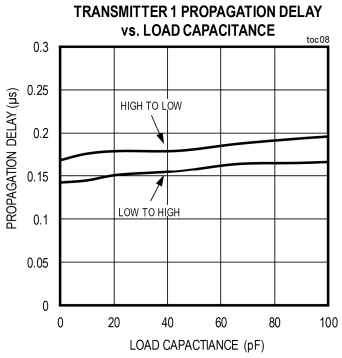

ICCB vs. DATA RATE

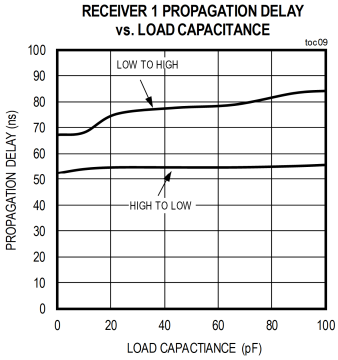


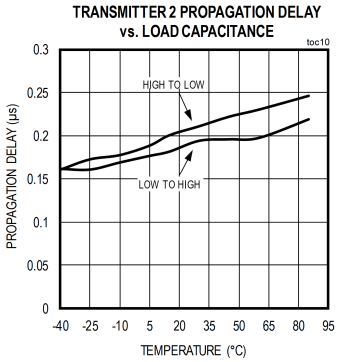
## Typical Operating Characteristics (continued)

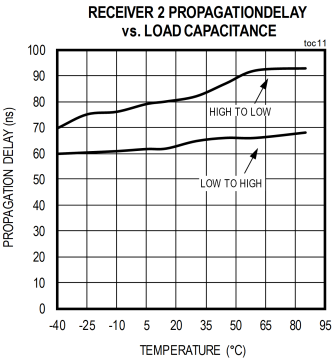
($V_{DD}$ = 5V, $V_L$ = 3.3V, $R_L$ = 60Ω, $C_L$ = 15pF, $T_A$ = +25°C, unless otherwise noted.)

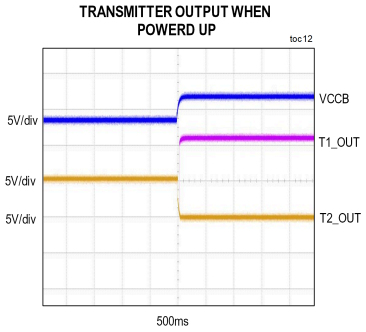


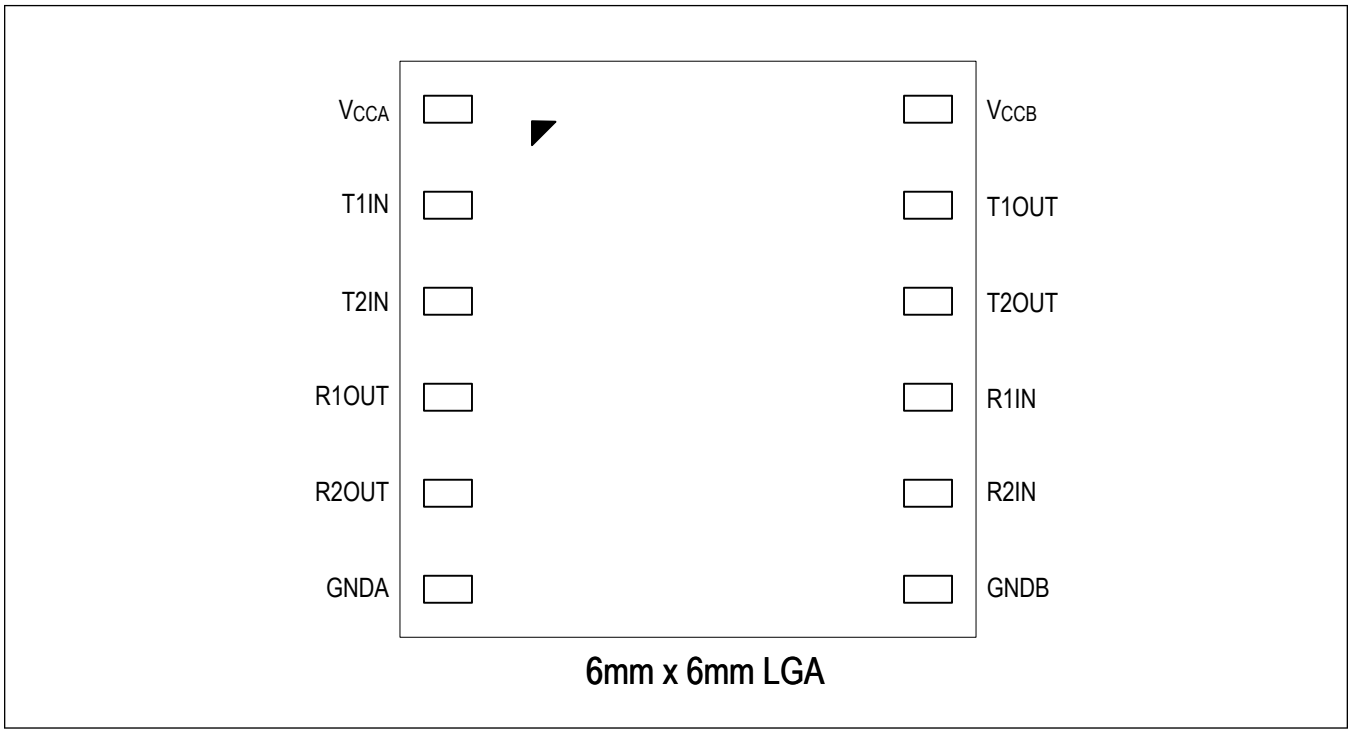



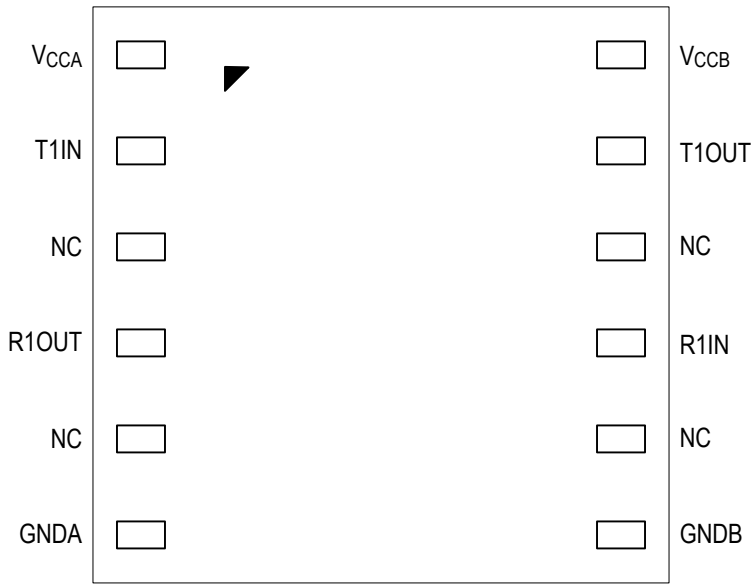



## Pin Configurations

**MAX33250E**



**MAX33251E**




6mm x 6mm LGA

## Pin Description

| PIN | | NAME | FUNCTION |
|---|---|---|---|
| MAX33250E | MAX33251E | | |
| 1 | 1 | $V_{CCA}$ | Supply Voltage of Logic Side A. Bypass $V_{CCA}$ with a 0.1µF ceramic capacitor to GNDA |
| 2 | 2 | T1IN | TTL/CMOS Transmitter Input 1 |
| 3 | --- | T2IN | TTL/CMOS Transmitter Input 2 |
| 4 | 4 | R1OUT | TTL/CMOS Receiver Output 1 |
| 5 | --- | R2OUT | TTL/CMOS Receiver Output 2 |
| 6 | 6 | GNDA | Ground for Logic Side A |
| 7 | 7 | GNDB | Ground for Field Side B |
| 8 | --- | R2IN | RS-232 Receiver Input 2 |
| 9 | 9 | R1IN | RS-232 Receiver Input 1 |
| 10 | --- | T2OUT | RS-232 Transmitter Output 2 |
| 11 | 11 | T1OUT | RS-232 Transmitter Output 1 |
| 12 | 12 | $V_{CCB}$ | Supply Voltage of Logic Side B. Bypass $V_{CCB}$ with a 0.1µF ceramic capacitor to GNDB |

## Detailed Description

The MAX33250E and MAX33251E are 1Mbps, $600V_{RMS}$ isolated RS-232 transceivers. The MAX33250E has 2 transmitters and 2 receivers (2Tx/2Rx), and the MAX33251E has 1 transmitter and 1 receiver (1Tx/1Rx). The isolation is provided by Maxim's proprietary insulation material that can withstand $600V_{RMS}$ for 60 seconds. The MAX33250E and MAX33251E conform to the EIA/TIA-232 standard and operates at data rates up to 1Mbps over the temperature range of -40ºC to 85ºC.

### Digital Isolation

The MAX33250E and MAX33251E provide galvanic isolation and protection for digital signals from the local microcontroller's logic UART port (primary side) to the field lines (secondary side). A capacitive design is utilized where the insulation material for the isolation barrier is rated for $600V_{RMS}$ withstand voltage ($V_{ISO}$) for 60 seconds. The same material can also be exposed to a differential of $200V_{RMS}$ of working voltage ($V_{IOWM}$) for more than 50 years, providing longevity for many different types of end equipment. The isolation barrier also breaks ground loops and level translation for two different systems where it could potentially create inadvertent or misinterpret data signals.

### Dual Charge Pump Voltage Converter and Inverter

Both parts have internal RS-232 power supplies that consist of a regulated dual charge pump that provides output voltages of +5.5V (doubling charge pump) and -5.5V (inverting charge pump), over the +3.0V to +5.5V range. Each charge pump is internally connected to a pair of flying capacitors and a pair of reservoir capacitors to generate the internal V+ and V- supplies, as shown in *Typical Application Diagram*.

### Startup and Undervoltage Lockout

The $V_{CCA}$ and $V_{CCB}$ supplies are both internally monitored for undervoltage conditions. Undervoltage events can occur during power-up, power-down, or during normal operation due to a dip in either power supply line. When an undervoltage event is detected on either of the supplies, all outputs on both sides are automatically controlled, regardless of the status of the inputs.

## Table 1. Output Control Truth Table

| INPUTS | $V_{CCA}$ | $V_{CCB}$ | RxOUT | TxOUT |
|---|---|---|---|---|
| RxIN = 1 | Undervoltage | Powered | High | --- |
| RxIN = 0 | Undervoltage | Powered | Follows $V_{CCA}$ | --- |
| TxIN = 1 | Undervoltage | Powered | — | Low |
| TxIN = 0 | Undervoltage | Powered | — | Low |
| RxIN = 1 | Powered | Undervoltage | High | --- |
| RxIN = 0 | Powered | Undervoltage | High | --- |
| TxIN = 1 | Powered | Undervoltage | — | *Low |
| TxIN = 0 | Powered | Undervoltage | — | *Low |

**TxOUT will be out of compliance with the RS-232 specification as $V_{CCB}$ falls below 2.9V.*

### RS-232 Transmitters

The transmitters are inverting level translators that convert CMOS-logic levels from the UART or equivalent output port to +5V EIA/TIA-232 levels. The two devices guarantee 1Mbps with worst-case loads of 3kΩ in parallel with 1000pF, providing compatibility with PC-to-PC communication software. Transmitters can be paralleled to drive multiple receivers.

### RS-232 Receivers

The receivers convert RS-232 signals to CMOS-logic output levels to the UART or equivalent input port. The devices feature inverting outputs that always remain active.

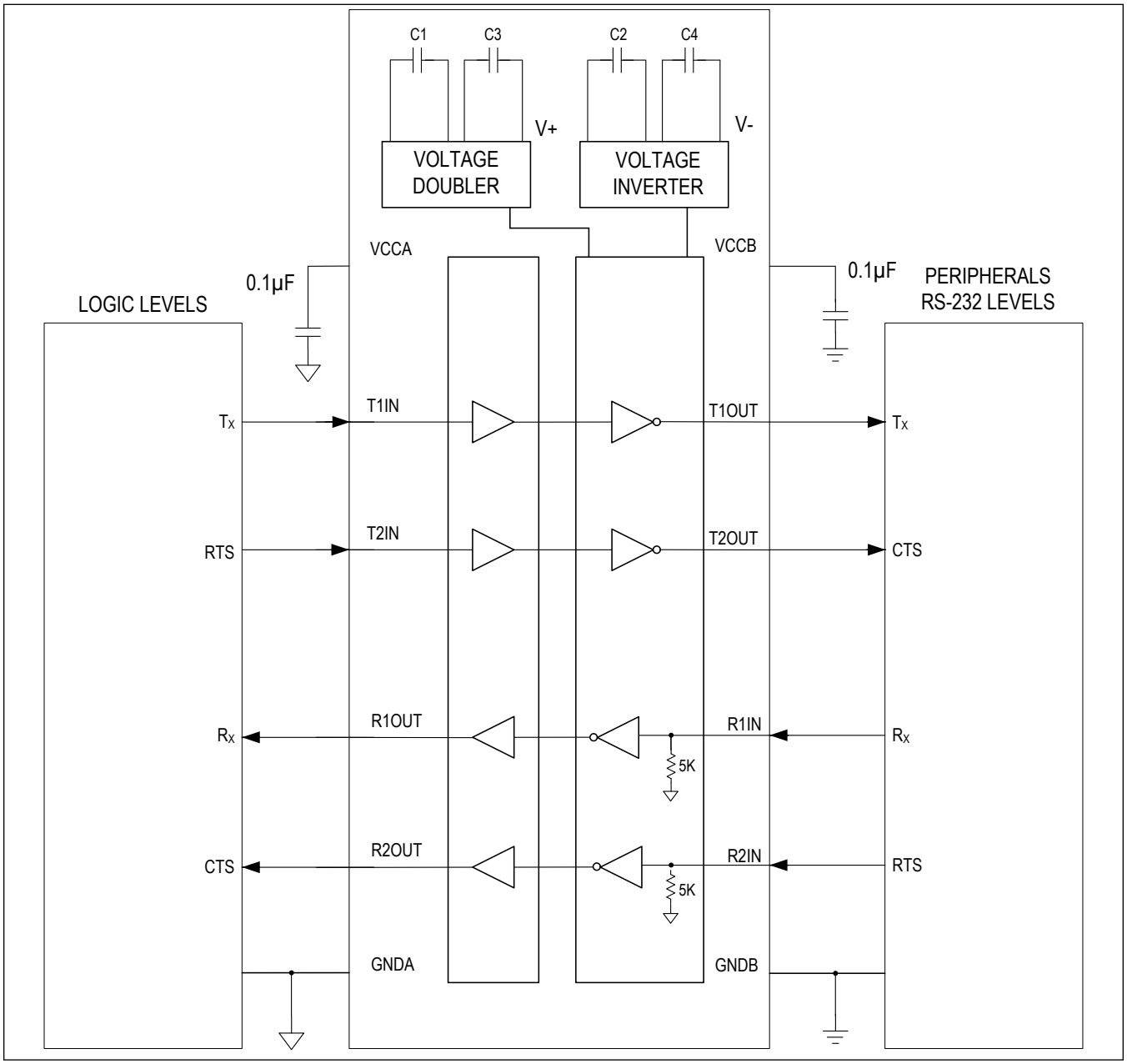
### Power Supply Decoupling

To reduce ripple and the chance of introducing data errors, bypass $V_{CCA}$ and $V_{CCB}$ with 0.1µF ceramic capacitors to GNDA and GNDB, respectively. Place the bypass capacitors as close to the power-supply input pins as possible.

## Insulation and Safety Characteristics

| PARAMETER | SYMBOL | CONDITIONS | VALUE | UNIT |
|---|---|---|---|---|
| **IEC INSULATION AND SAFETY RELATED FOR SPECIFICATIONS** | | | | |
| External Tracking (Creepage) | CPG | IEC 60664-1 | 4.4 | mm |
| External Air Gap (Clearance) | CLR | IEC 60664-1 | 4.4 | mm |
| Minimum Internal Gap | | Insulation Thickness | 0.0026 | mm |
| Tracking Resistance (Comparative Tracking Index) | CTI | IEC 112/VDE 030 Part 1 | 175 | V |
| Insulation Resistance Across Barrier | $R_{ISO}$ | | 1 | GΩ |
| Capacitance Across Isolation Barrier | $C_{IO}$ | f = 1MHz | 12 | pF |
| **VDE IEC INSULATION CHARACTERISTICS** | | | | |
| Surge Isolation Voltage | $V_{IOSM}$ | IEC 60747-17, section 5.3.1.6 and 5.4.6 for basic insulation | 1 | $kV_{PEAK}$ |
| Repetitive Peak Isolation Voltage | $V_{IORM}$ | IEC 60747-17, section 5.3.1.3 | 282 | $kV_{PEAK}$ |
| Rated Transient Isolation Voltage | $V_{IOTM}$ | IEC 60747-17, section 5.3.1.4 | 850 | $kV_{PEAK}$ |
| Safety Limiting Temperature | $T_S$ | IEC 60747-17, section 7.2.1 | 150 | °C |
| Safety Limiting Side A Power Dissipation | $P_{SA}$ | IEC 60747-17, section 7.2.1 | 0.75 | W |
| Safety Limiting Side B Power Dissipation | $P_{SB}$ | IEC 60747-17, section 7.2.1 | 0.75 | W |
| Apparent Charge Method | $q_{pd}$ | IEC 60747-17, section 7.4 method a and b | 5 | pC |
| Overvoltage Category | | IEC 60664-1, single or three phase 50V DC or AC | I,II | — |
| Overvoltage Category | | IEC 60664-1, single or three phase 100V DC or AC | I | — |
| Climatic Category | | | 40/125/21 | — |
| Pollution Degree | | DIN VDE 0110 | 2 | — |

## Typical Application Circuit



## Ordering Information

| PART NUMBER | TEMPERATURE RANGE | CHANNEL-CONFIGURATION | DATA RATE | PIN-PACKAGE |
|---|---|---|---|---|
| MAX33250EELC+ | -40°C to +85°C | 2 Transmitters, 2 Receivers | 1Mbps | 12 (6mm x 6mm) LGA |
| MAX33251EELC+ | -40°C to +85°C | 1 Transmitter, 1 Receiver | 1Mbps | 12 (6mm x 6mm) LGA |

*+Denotes a lead(Pb)-free/RoHS-compliant package.*

*T = Tape-and-reel.*

## Revision History

| REVISION NUMBER | REVISION DATE | DESCRIPTION | PAGES CHANGED |
|---|---|---|---|
| 0 | 9/18 | Initial release | — |
| 1 | 11/18 | Updated *Ordering Information* | 13 |

For pricing, delivery, and ordering information, please visit Maxim Integrated's online storefront at https://www.maximintegrated.com/en/storefront/storefront.html.

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Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

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