

RS-232 Interfaces

3.3V High-Speed Opto-Isolated RS-232 Interface with RV1S9160A and ISL3232E

Abstract

This application note discusses the design of opto-isolated RS-232 interfaces for space constraint applications using the RV1S9160A opto-coupler, the smallest included in the latest Renesas family of digital high-speed optocouplers. For detailed information on the construction of opto-couplers, see [AN1991, Isolating RS-485 Interfaces with High-Speed Digital Optocouplers](#).

Related Literature

For a full list of related documents, visit our website:

- [ISL3232E](#), [RV1S9160A](#) device pages

1. Opto-Coupler Features

[Table 1](#) lists the features for the RV1S9x60A family of high-speed opto-couplers.

Table 1. Opto-Coupler Features

| Parameter | RV1S9060A | RV1S9160A | RV1S9960A |
|---|----------------------|----------------------|----------------------|
| Creepage Distance (minimum) | 8mm | 4.2mm | 14.5mm |
| Supply Range | 2.7V – 5.5V | 2.7V – 5.5V | 2.7V – 5.5V |
| Data Rate (minimum) | 15Mbps | 15Mbps | 15Mbps |
| Pulse Width Distortion (typical/maximum) | 2/20ns | 2/20ns | 2/20ns |
| Common-mode Transient Immunity (minimum/ typical) | 50/60kV/μs | 50/60kV/μs | 50/60kV/μs |
| Forward Current – I _{FHL} (minimum) | 2.2mA | 2.0mA | 3.8mA |
| Working Voltage (V _{IORM}) | 799V _{RMS} | 502V _{RMS} | 1131V _{RMS} |
| Isolation Voltage (V _{ISO}) | 5000V _{RMS} | 3750V _{RMS} | 7500V _{RMS} |
| Transient Overvoltage (V _{IOTM}) | 8000V _{PK} | 6000V _{PK} | 12000V _{PK} |
| Temperature Range | -40°C to +125°C | -40°C to +125°C | -40°C to +110°C |
| Insulation Classification | Reinforced | Basic | Reinforced |

2. LED Drive Circuit for Best Common-Mode Rejection

The opto-coupler LED is driven with a setting resistor, R_S, in series. The value of R_S is calculated using [Equation 1](#):

$$(EQ. 1) \quad R_S = \frac{V_{CC1} - V_F - V_{OL}}{I_F}$$

where V_F and I_F are the typical forward voltage and current of the LED, and V_{CC1} and V_{OL} the nominal supply voltage and typical output low-voltage of the driving source, which can be a logic gate or the general-purpose output of a local controller.

The RV1S9x90A datasheet specifies the minimum (3mA) and maximum (6mA) LED forward currents. The arithmetic means of these two currents define the typical value with I_{F-TYP} = 4.5mA. The I_F-versus-V_F characteristic in the opto-coupler datasheet depicts a typical forward voltage of V_F = 1.49V at this current. Therefore, for a nominal supply of V_{CC} = 3.3V and a typical V_{OL} of 0.25V for a standard logic output, the value for R_S is:

$$R_S = \frac{3.3V - 1.49V - 0.25V}{4.5mA} = 347\Omega$$

To improve the common-mode rejection and reducing the risk of output glitches, the common-mode impedance at the LED anode and cathode is balanced by splitting R_S into two resistors of equal value; in this case with $R_S/2 = 173\Omega$.

The next higher 5% standard value is 178Ω . Therefore, all current setting resistors in the following schematics use $R_S/2 = 178\Omega$. Because the output of the RV1S9160 opto-coupler turns low when the LED is on, and high when the LED is off, each coupler is driven from its cathode side.

3. Isolated RS-232 Interface

The interface in Figure 1 operates the RS-232 transceiver in full-duplex mode; the transceiver transmits and receives data at the same time. If the direction terminal DIR = H, the ISL3178E transmits data, if DIR = L, it receives data. See Figure 2 for corresponding waveforms. The ISL3232E is a 3.3V, 500kbps dual-channel driver and receiver circuit, available in a 4mmx5mm 16 Ld TSSOP package. Combined with the RV1S9160A opto-couplers they allow for a small footprint design, which is ideal for space constrained applications.

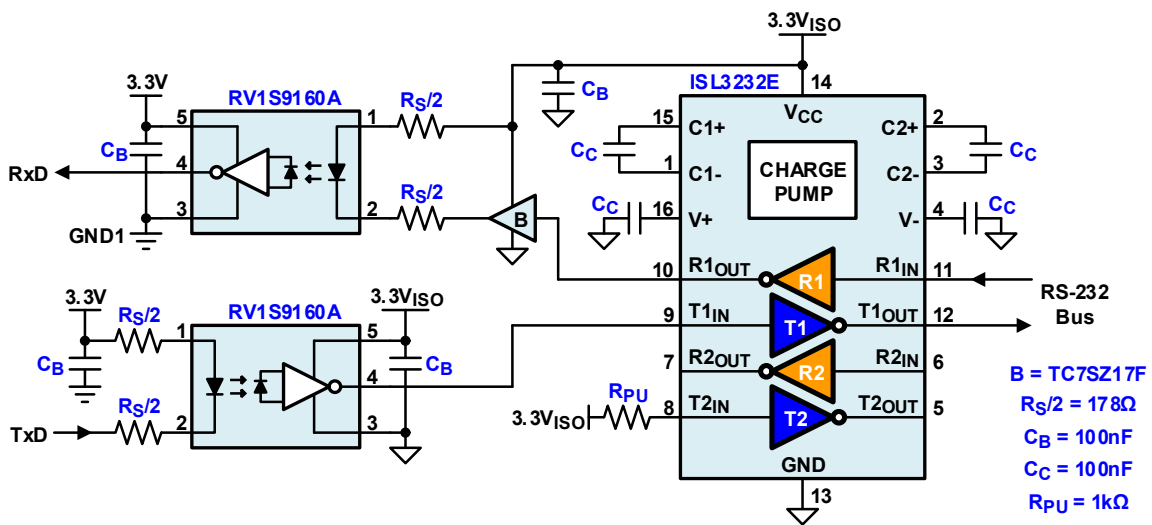


Figure 1. 3.75kV Isolated 500kbps RS-232 Interface

Note: The the RS-232 receiver output needs an external buffer to drive the opto-coupler. Also, unused transmitter inputs require an external pull-up or pull-down resistor, while unused receiver inputs can be left open as they are pulled down internally using a $5k\Omega$ resistor.

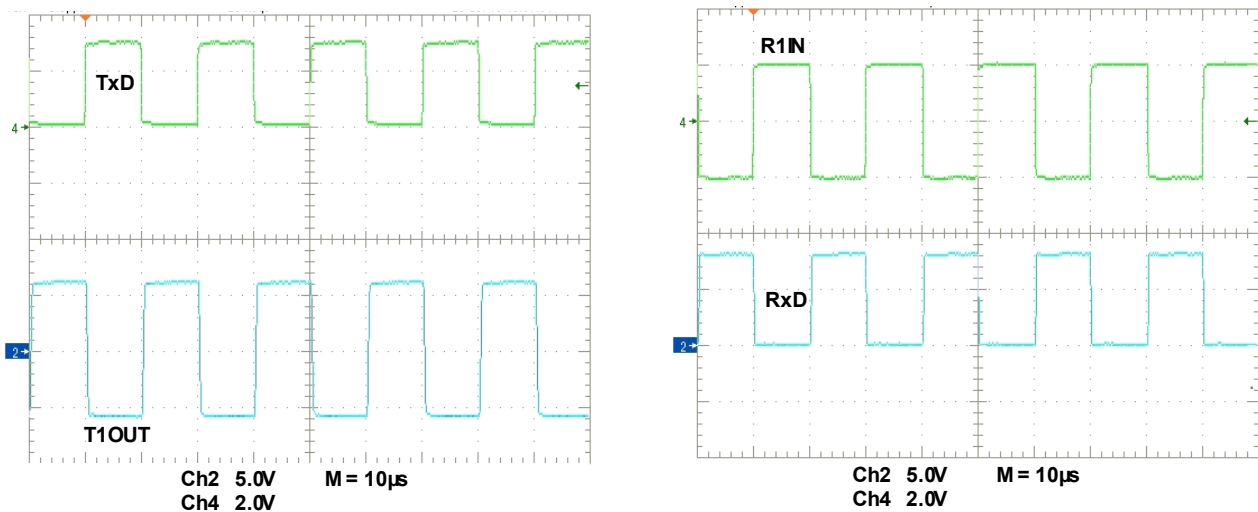


Figure 2. Signal Waveforms of the Circuit in Figure 1

4. Revision History

| Rev. | Date | Description |
|------|-----------|-----------------|
| 1.00 | Oct.29.19 | Initial release |

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