Interfacing a 5V RS-485 Transceiver to a 3V Microcontroller

Long-distance RS-485 networks often use 5V transceivers because of their large differential output voltages of up to ±3V. This voltage is twice the required minimum of ±1.5V specified in the RS-485 standard. Large-output voltage drives have multiple benefits, such as

- Providing high immunity against external noise
- Allowing for a large number of transceivers to be connected to the same bus
- Overcoming the signal loss of long-distance cables to provide crisp signals to remote receivers

Modern bus node designs, however, often use 3V-powered local controllers, whose logic levels might only sometimes be compatible with the bus transceiver. While the logic inputs of most 5V transceivers accept the logic output levels of 3V controllers, the receiver output of a 5V transceiver often exceeds the Absolute Maximum Ratings of 3V controllers.

To level-shift the receiver output (RO) of a 5V transceiver into the general purpose input (here denoted as RxD) of a 3V controller, Figure 1 provides a simple solution with just a Schottky diode and a pull-up resistor to the 3.3V controller supply.

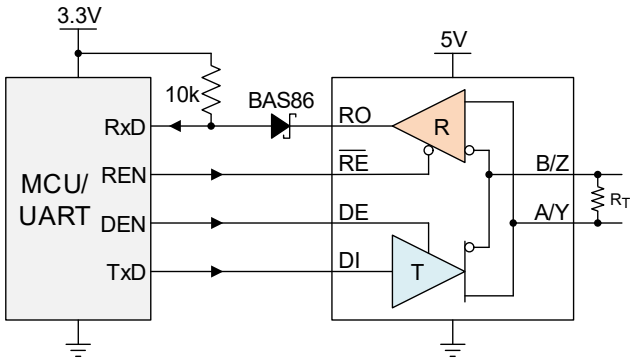

Figure 1. Interfacing a 5V Receiver Output to 3V MCU Input

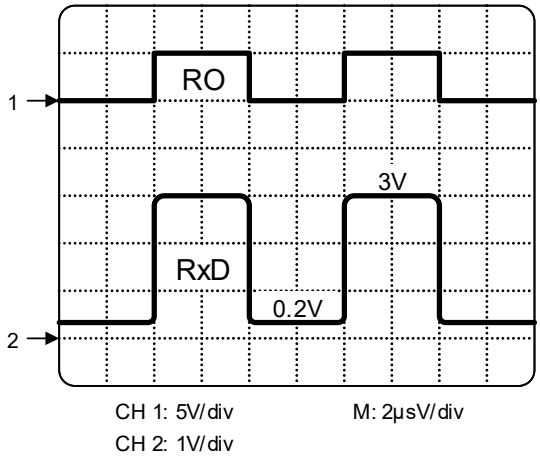

Figure 2. Timing of the RO-to-RxD Connection

When RO is high, the diode is reverse-biased, blocking any current flow from the receiver. In this case, the RxD input receives a logic high from the 3.3V supply using the 10k pull-up resistor.

When RO is low, the diode is forward-biased to ground. In this case, the RxD input receives a logic low that equals the diode forward voltage (V_{FW}). Depending on the value of the pull-up resistor, V_{FW} can be as high as 0.4V for a 1k resistor or 0.2V for a 10k resistor.

Use a low capacitance diode, such as BAS86 or BAS70, to avoid large switching transients at the RxD input. This solution works fine up to a few hundred kbps before signal edges become seriously round. But then again, most long-distance networks only operate in the 10 to 20kbps range.

Revision History

Revision	Date	Description
1.00	Oct 26, 2023	Initial release.

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Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan

www.renesas.com

Contact Information

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