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Options and Solutions for Partitioning Isolated Power in Isolated RS-485 Nodes

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Abstract

ADI's integrated RS-485 isolated transceiver portfolio offers the flexibility and performance to meet challenging system design requirements with significant advantages over the optocoupler approach.

Isolating signal and power in RS-485 nodes can present a design challenge in terms of achieving an optimum configuration that satisfies system requirements such as small form factor, lower power dissipation, data rates, EMI, and bill of materials cost. Traditional discrete solutions, such as optocouplers, have well documented issues relating to the lifetime burnout of the optocouplers and high power per channel isolation due to the inherent physics behind optocoupler technology. Additionally, the cost of optocoupler technology increases substantially as the data rates increase, and manufacturing complexity increases with increased component count. The implementation of discrete isolated DC-to-DC converters requires knowledge of transformer design, matching the other power components of the isolated DC-to-DC converter to the transformer. The design is susceptible to the parasitic resistance, inductance, and capacitance associated with these components. Fortunately, today there is a new breed of highly integrated isolated transceiver solutions that solves these design challenges.

Over the past seven years, ADI has developed a range of innovative integrated isolated RS-485 transceivers that combine ADI's advances in RS-485 interface technology with ADI's *i*Coupler® digital signal isolation technology, and, more recently, with ADI's *iso*Power® isolated DC-to-DC converter technology. These isolated transceiver products were designed for use in a wide variety of applications in harsh environments such as industrial automation, solar and wind energy, instrumentation, and power-line monitoring. Examples of some of the industrial communication protocols that use these families of products are PROFIBUS®, Interbus, Modbus, BacNet, etc.

This family of integrated isolated RS-485/RS-422 transceivers offers designers an optimal choice of integrated isolation based on the system partitioning of the power chain, in particular the isolated bus-side voltage supplies.

ADI's portfolio basically addresses three broad classifications for the partitioning of the power chain for isolated RS-485 nodes:

- A totally integrated signal and power isolated RS-485/RS-422 solution
- Integrated signal isolation and integrated transformer driver (partial power chain integration)
- Signal isolated RS-485/RS-422 transceivers that allow flexibility of choice of the source of the bus-side voltage power supply

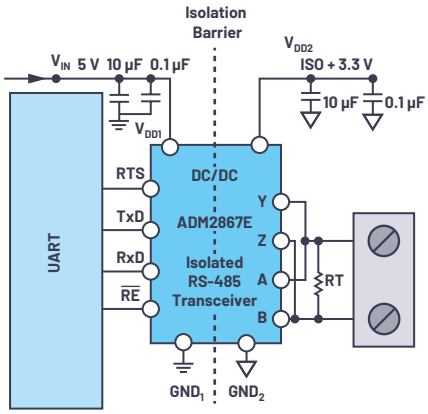

Figure 1. Typical RS-483/RS-422 isolation.

Figure 1 shows the compact configuration for ADI's ADM2867E, which is an integrated signal and power isolated RS-485 transceiver. This level of integration is enabled by ADI's *i*Coupler and *iso*Power isolation technologies that combine to deliver impressive benefits in ease of use, small form factor, and a lower input power for the given loads of RS-485, compared with more traditional approaches. The ADM2867E/ADM2582E signal and power isolated RS-485 transceivers are packaged in 20-lead wide body SOIC, which is the industry's smallest footprint solution available; they are also the industry's first signal and power isolated RS-485/RS-422 transceivers to provide such an integrated solution compatible with high volume surface-mount manufacturing technology. This option is ideal for customers under design time and small form factor constraints.

In 2007, ADI released the industry's first and smallest PROFIBUS-compliant signal isolated RS-485 transceiver with integrated transformer driver, the ADM2485, in 16-lead wide body SOIC. The ADM2485 is one of three isolated RS-485 transceivers that ADI offers with integrated transformer driver functionality. Figure 2 illustrates the ADM2485, driving the primary side of the transformer to deliver the isolated power to the bus-side circuitry.

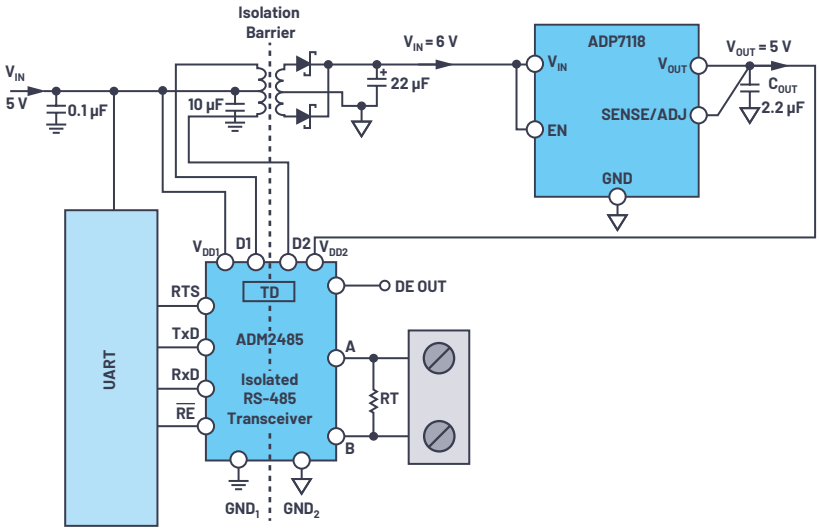

Figure 2. RS-485/RS-422 isolation with power.

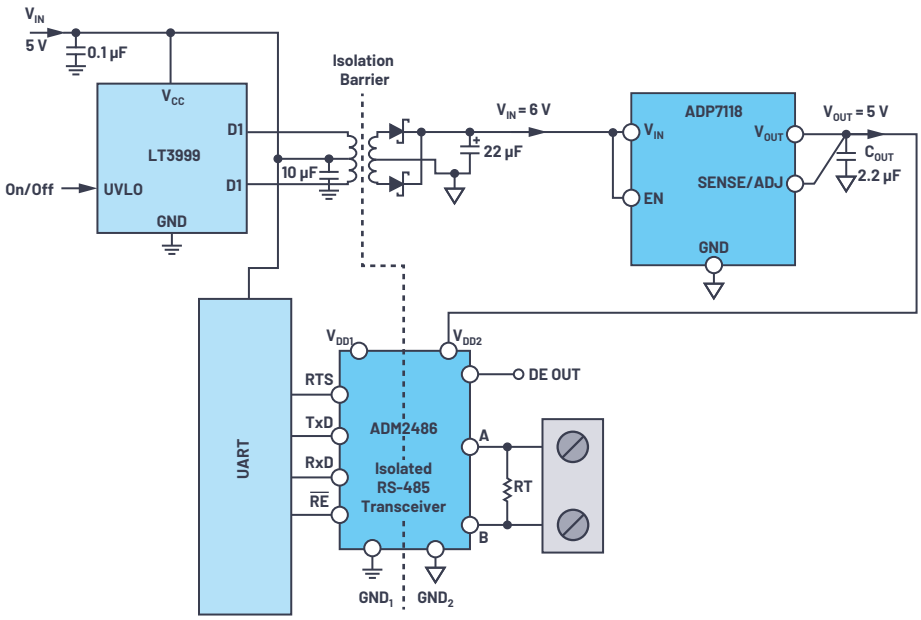

Figure 3. RS-485/RS-422 isolation with power and external ON/OFF possibility.

The configuration shown in Figure 2 offers high efficiency, at 81% typically for an input voltage supply of 5 V, for designs that have severe temperature constraints. The external transformer allows for a 500 kHz operation of the DC-to-DC converter, which provides a low EMI solution for designers constrained with very tight emissions requirements. The key trade-offs for system designers between the Figure 1 and Figure 2 solutions are more compact size and ease of use, vs. higher efficiency and a lower frequency emissions spectrum.

In typical programmable logic controller designs, there are a variety of isolated supplies required for the I/Os, as well as the communications ports. This leads to the requirement for custom supplies to generate multiple isolated supplies, such as ±15 V, 5 V, and 3.3 V supplies from the same transformer core. The optimum cost choice in this situation is to select an isolated RS-485 transceiver that has only the signal isolation integrated, like the ADM2486, isolated PROFIBUS-compliant RS-485 transceiver. This provides the flexibility to choose an existing 5 V or 3.3 V isolated supply, or to use a separate over-wind on the transformer to generate the bus-side isolation voltage. Figure 3 shows a simplified case of a discrete DC-to-DC converter to illustrate how this configuration works with the ADM2486 transceiver.

ADI's family of isolated RS-485/RS-422 transceivers also offers a variety of data rates up to 20 Mbps, up to 256 nodes on the bus, and half-duplex and full-duplex operation. Additionally, these integrated isolated RS-485 transceivers are all fully certified to UL and VDE with CSA certification available on request. They are 100% production tested up to 6800 V rms depending on the isolation products.

ADI's integrated RS-485 isolated transceiver portfolio offers the flexibility and performance to meet system design requirements while bringing many advantages over the optocoupler approach. The enabling *i*Coupler transformer technology has been in volume production since 2001, and with over 4 billion channels shipped, its reliability is proven. *i*Coupler has a lifetime of greater than 50 years and does not suffer from the traditional wear-out that is fundamental to the alternative optocoupler technology.

For more information on ADI's Isolated RS-485/RS-422 portfolio please visit analog.com/rs485.

About the Author

Keith Bennett is a system applications engineer in the Interface and Isolation Technology Group, where he helps architect the future of Analog Devices' isolated power products. Keith received his B.S.E.E. degree from Widener University in 1988. He joined Allied Signal Aerospace that same year, working on hybrid microelectronics and high frequency switching converters. In 1991 he relocated to Vermont to work for Dynapower Corporation, designing custom power conversion equipment. Industries served include electrochemical, battery formation, and particle physics applications. Keith joined Linear Technology (now part of ADI) in 2003. He subsequently served as applications engineer and design engineer for the Interface Products Group, where he was instrumental in establishing the isolated µModule® product line. He can be reached at keith.bennett@analog.com.