

Using Isolated RS-485 in DMX512 Lighting Applications

By Hein Marais

Introduction

The western theatrical age started in Greece circa 500 B.C. Open-air theatres used the sun as their main lighting source, but often added lanterns to indicate nighttime scenes. These early lighting applications have evolved into the more complex systems available today.

Modern lighting equipment includes dimmers, flashing lights, moving lights, colored lights, and gobos¹ (GOes Before Optics). These lighting systems are often controlled over long distances—up to 4000 feet—using the [DMX512 communications protocol](#).²

What is DMX512?

DMX512 is a standard developed by the [Entertainment Services and Technology Association](#) (ESTA).³ This standard describes a method of digital data transmission between controllers and controlled lighting equipment and accessories, including dimmers and related equipment. The physical electrical interface is specified by [EIA/TIA-485](#),⁴ also known as RS-485.

The DMX512 standard, which specifies an 8-bit asynchronous serial protocol and 250-kbps data rate, is designed to carry repetitive control data from a single controller to one or multiple receivers. The control data on the primary link consists of up to 513 slots that are sent in packets over a balanced transmission line.

Information, in an 8-bit format, is sent sequentially to the various nodes. Values range from 0 to 255, where 0 indicates the *off* condition and 255 indicates the *on* condition. A *break* condition lasting two frames indicates the start of a sequence of 512 values. A high level for at least 8 μs indicates the start of the first byte.

Discrete DMX512 System Configuration

A DMX512 port consists of four signals (Data1+, Data1-, Data2+, and Data2-) plus a common reference. The primary data link is formed by Data1+ and Data1-. An optional secondary data link is formed by Data2+ and Data2-. The paired links are configured as a bidirectional half-duplex RS-485 communications network.

The DMX512 standard specifies a system using ground-referenced transmitting devices and isolated receiving devices. The receiving devices are isolated to protect expensive lighting equipment from harmful current surges.

Figure 1 shows a discrete implementation of an isolated DMX512 receiver. An isolated power supply is generated by a transformer driver driving the primary side of a transformer. The output of the transformer is rectified and regulated to create an isolated 5-V supply. The data and control signals for the RS-485 transceiver are isolated using optical isolation.

The [ADM485](#) RS-485 transceiver converts a control signal received on the A and B pins into a serial output on the RxD pin. This signal is optically isolated and connected to the UART input of the [ADuC7020](#) precision analog microcontroller. The ADuC7020 software decodes the message and outputs logic-level signals to a digital-to-analog converter (DAC). The [ADTL084](#) JFET-input op amps buffer the DAC outputs to provide 0 V to 10 V signals.

The ADuC7020 software sends a response to indicate that the message was received correctly. This signal is optically isolated from the ADM485, which outputs a signal on the A and B pins.

DMX512 System Configuration Using the ADM2487E

Figure 2 shows a simpler, more integrated, isolated DMX512 receiver using the [ADM2487E](#) isolated RS-485 transceiver. An on-chip oscillator outputs a pair of square waves that drive an external transformer to provide the 3.3-V isolated power required by the bus side. The logic side of the device is powered with a

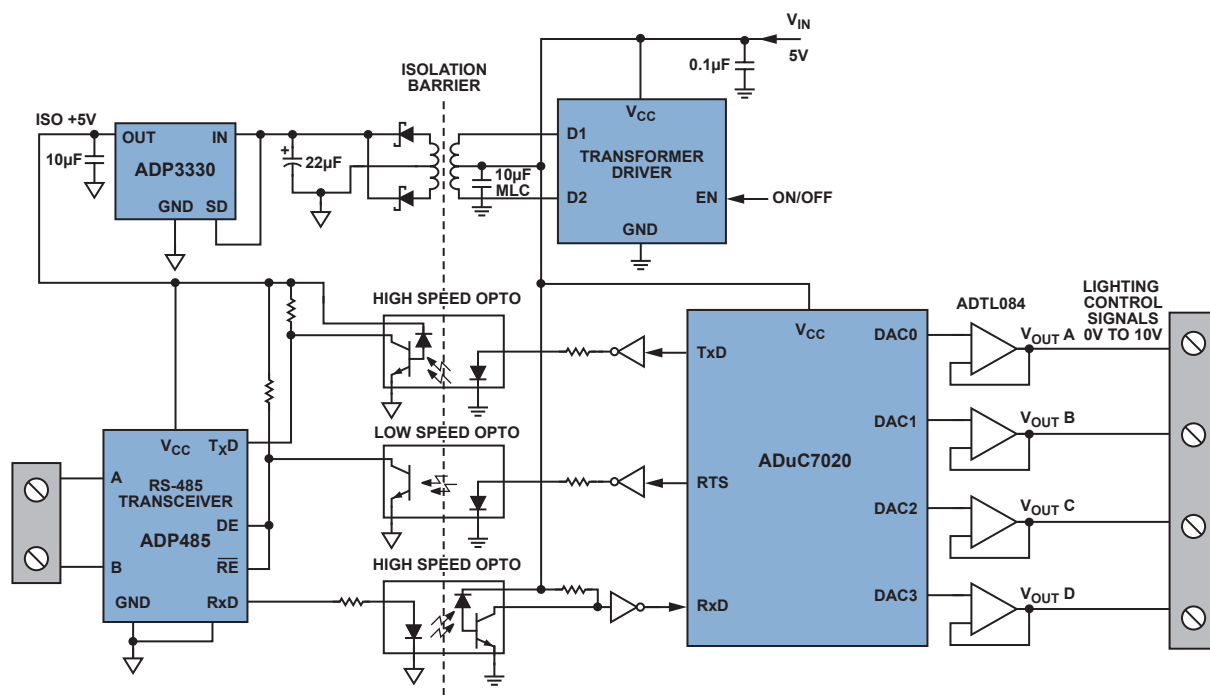


Figure 1. Discrete DMX512 receiver block diagram.

3.3-V or 5-V supply. The ADM2487E employs *iCoupler*^{®5} digital isolation technology to combine a 3-channel isolator, a 3-state differential line driver, and a differential input receiver into a single package. TXD, RXD, DE, and \overline{RE} pins connect directly to the ADuC7020 UART.

The ADM2487E transceiver, suitable for half-duplex or full-duplex communication on multipoint transmission lines, operates with data rates up to 500 kbps. It provides 2.5-kV rms isolation—certified to Underwriters Laboratory (UL) and VDE standards—and ± 15 -kV ESD protection.

For half-duplex operation, the transmitter outputs and receiver inputs share the same transmission line by externally linking transmitter output Pin Y to receiver input Pin A, and transmitter output Pin Z to receiver input Pin B. Designed for balanced transmission lines, the ADM2487E complies with TIA/EIA 485 A-98 and ISO 8482⁶:1993 standards.

Current-limiting and thermal shutdown features protect against output short circuits and situations where bus contention might cause excessive power dissipation. Fully specified over the -40°C to $+85^{\circ}\text{C}$ industrial temperature range, the ADM2487E is available in a 16-lead, wide-body SOIC package.

The ADM2487E features an open- and short-circuit fail-safe receiver input design, eliminating the need for external biasing resistors. The low-input-current receiver design ($125\ \mu\text{A}$) enables up to 256 nodes to be connected on the same bus.

Replacing the discrete DMX512 receiver implementation with the ADM2487E implementation provides a space-saving, more robust, more reliable system.

Why Is Isolation Important?

Sudden voltage surges between two or more interconnected circuits can cause damage to expensive equipment. Electrical isolation is designed to protect expensive equipment from these voltage surges. Because of the distance between nodes, DMX512 transmitters and receivers require different power supplies. This will increase the impedance of the earth ground, making it more likely that ground currents from other sources will find their way into the link's ground wire. Isolating the link reduces or even eliminates these problems. Galvanic isolation, shown in Figure 3, is required if there is no guarantee that the potentials at the earth grounds of different nodes in the system are within the common-mode range of the receiver.

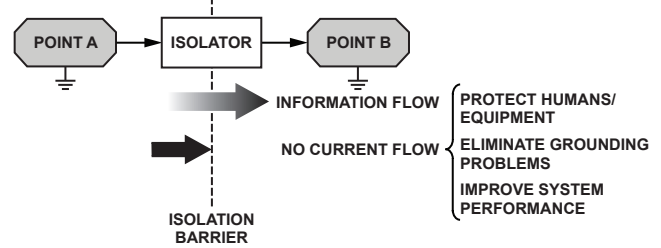


Figure 3. Galvanic isolation allows information flow, prevents ground-current flow.

The ADM2487E integrates galvanic isolation with the transceiver to create robust protection against harmful current surges. An ideal solution to implement an isolated DMX512 receiver, it will reduce the overall form factor, improve reliability, and increase robustness.

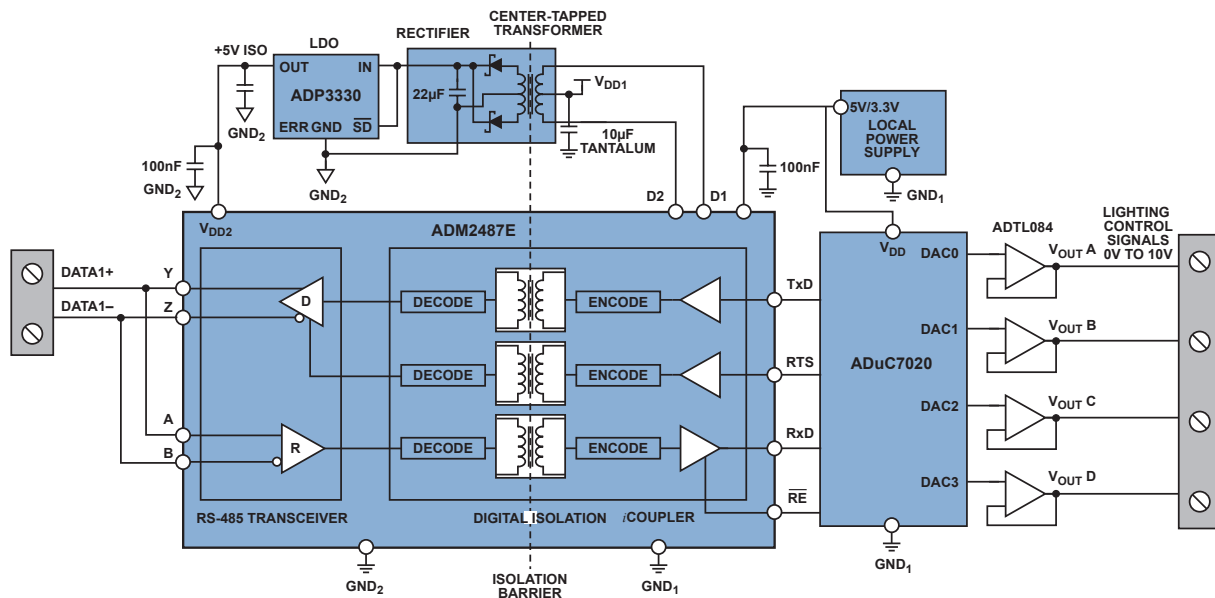


Figure 2. ADM2487E DMX512 receiver block diagram.

References

(Information on all ADI components can be found at www.analog.com)

¹ [http://en.wikipedia.org/wiki/Gobo_\(lighting\)](http://en.wikipedia.org/wiki/Gobo_(lighting))

² <http://en.wikipedia.org/wiki/DMX512>

³ http://en.wikipedia.org/wiki/Entertainment_Services_and_Technology_Association

⁴ <http://en.wikipedia.org/wiki/EIA-485>

⁵ www.analog.com/en/interface/digital-isolators/products/CU_over_iCoupler_Digital_Isolation/fca.html

⁶ www.iso.org/iso/catalogue_detail.htm?csnumber=20954

Further Reading

ANSI E1.11 – 2008 Entertainment Technology - USITT DMX512-A, Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories

USITT DMX512, DMX512/1990, DMX512-A

Application Note, AN-960: RS-485/RS-422 Circuit Implementation Guide

Author

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graduated from the University of Stellenbosch, South Africa, in 2001 with a bachelors degree in electronics. He started his career in the South African Air Force working on electronic warfare systems. In 2003, he joined Grintek Communication Systems, where he was involved in the design of software and hardware for military radios. In 2007, Hein joined ADI, where he is currently a product applications engineer for the High Speed Interconnect Group, working on RS-485 and LVDS products.

