

## Options and Solutions for a High Speed or Low Power Signal and Power Isolated RS-485 Fieldbus

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### INTRODUCTION

The Analog Devices, Inc., portfolio of *iCoupler*® digital isolators and RS-485 transceivers addresses two common needs in industrial applications: higher data rates and lower power operating modes.

Higher data rates, smaller RS-485 transceiver packages, and IEC 61000-4-2 ESD protection are required for high performance motor control encoder applications. The [ADM3065E/ADM3066E](#) 50 Mbps transceivers are available in space saving, 10-lead LFCSP packages and offer  $\pm 12$  kV contact and  $\pm 12$  kV air IEC 61000-4-2 ESD protection, which provide a reliable solution for EnDat encoders (see the [AN-1397 Application Note](#) for more information). Adding high speed robust signal and power isolation to the [ADM3065E/ADM3066E](#) is possible with the *isoPower*® [ADuM6401](#), or the *isoPower* [ADuM6000](#) and *iCoupler* [ADuM241D](#), as explained in this application note.

Lower power operating modes are in high demand for battery powered systems, downhole applications (for example, mining),

and process control systems that operate in 4 mA to 20 mA loops. Analog Devices offers a micropower digital isolator, the [ADuM1441](#), which consumes  $<23 \mu\text{A}$  of quiescent current in shutdown mode. The [ADM3483](#) 3.3 V, 250 kbps RS-485 transceiver offers extremely low quiescent current, with typically only 2 nA required for shutdown mode.

Figure 1 shows an isolated, robust, low power RS-485 solution for downhole applications. The [ADM3483](#) and [ADuM1441](#) together provide a robust low power link to the remote underground measurement node. The system interface card includes an ARM® Cortex® microcontroller unit (MCU), [ADuCM3027](#), and an integrated analog front end (AFE), [AD7124-4](#), for remote temperature and pressure measurements. Firmware updates to the system interface card are provided via the long distance RS-485 cabling, which is capable of low data rate transmission (for example, 9.6 kbps) over long distances of up to 1 km.

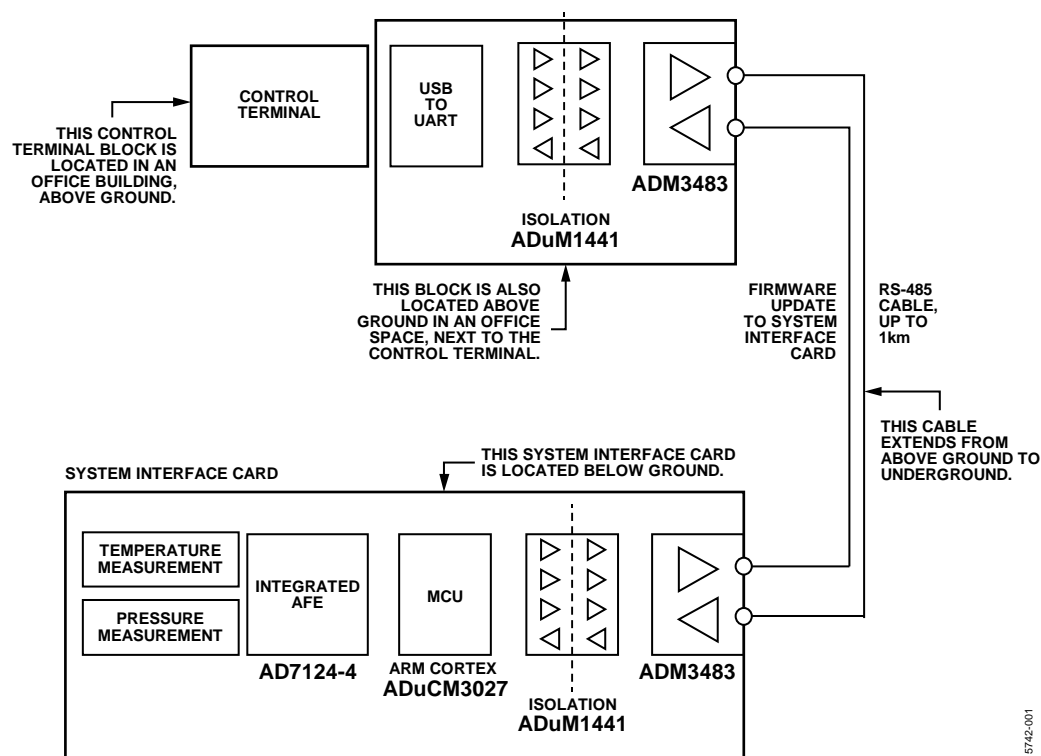


Figure 1. Robust, Low Power, Isolated RS-485 Solution for Downhole Applications

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REVISION HISTORY

7/2017—Revision 0: Initial Version

## ISOLATED HIGH SPEED RS-485

Galvanic isolation with reinforced insulation and 5 kV rms transient withstand voltage can be added to the [ADM3065E](#) using *iCoupler* and *isoPower* technology. The [ADuM6401](#) provides the required four channels of 5 kV rms signal isolation, operating at rates up to 25 Mbps together with an integrated dc-to-dc converter. The [ADuM6401](#) combines with the [ADM3065E](#), shown in Figure 2, with the  $V_{ISO}$  pin configured for 3.3 V by connecting the  $V_{SEL}$  pin to the  $GND_{ISO}$  pin and connecting a 5 V supply to the  $V_{DD1}$  pin. Operation at 3.3 V ensures that the [ADM3065E](#) remains within the load capability of the [ADuM6401](#), even at 25 Mbps.

Operation at 50 Mbps data rates with isolation of the [ADM3065E](#) can be implemented using the [ADuM241D](#) quad-channel digital isolator and the [ADuM6000](#) isolated dc-to-dc converter, as shown in Figure 3. The [ADuM241D](#) can operate at data rates of up to 150 Mbps, offering the precise timing required to fully support the [ADM3065E](#) at 50 Mbps.

Operation of the [ADM3065E](#) at 3.3 V allows operation at the 50 Mbps data rate.

If 5 V operation is desired, the  $V_{SEL}$  pin on the [ADuM6000](#) can be tied to  $V_{ISO}$ , and the maximum supported data rate becomes lower (for example, <10 Mbps). Refer to the [ADuM241D](#) and [ADuM6000](#) data sheets for more information.

The dc-to-dc converters in the [ADuM6401](#) and the [ADuM6000](#) *isoPower* devices provide regulated, isolated power to the [ADM3065E](#) (and the [ADuM241D](#)). These *isoPower* devices use high frequency switching elements to transfer power through their transformers. The user must meet emissions standards during printed circuit board (PCB) layout. See the [AN-0971 Application Note](#) for PCB layout recommendations.

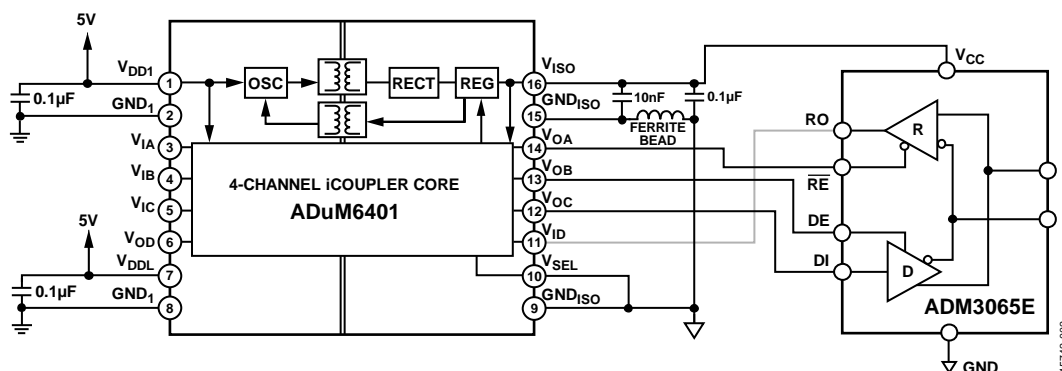


Figure 2. Signal and Power Isolated 25 Mbps RS-485 Solution (Simplified Diagram—All Connections Not Shown)

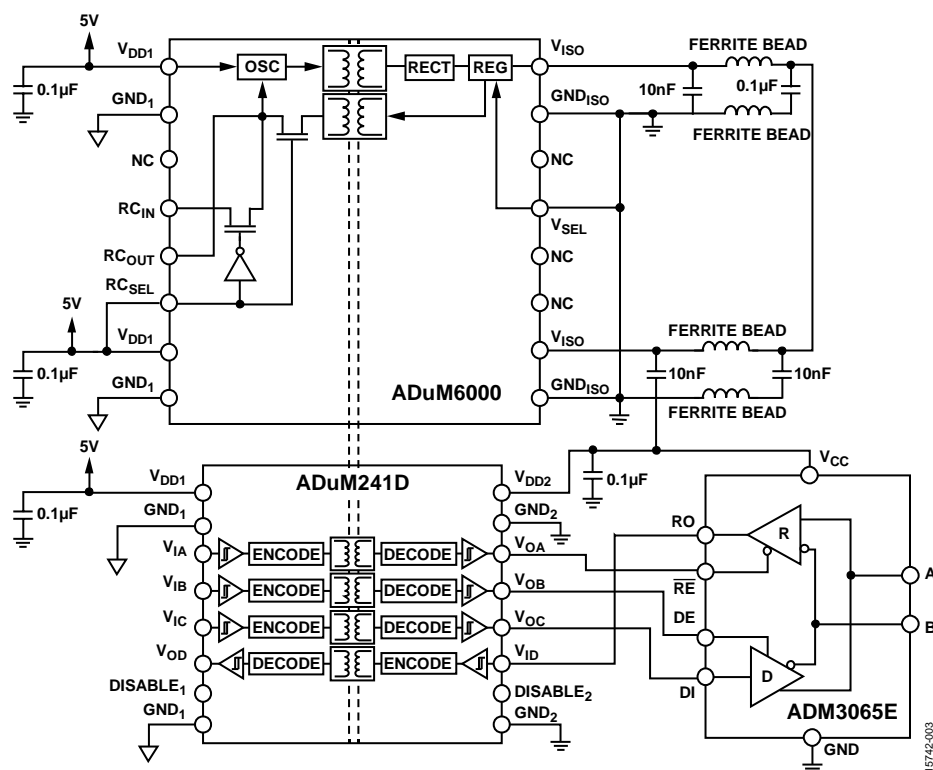


Figure 3. Signal and Power Isolated 50 Mbps RS-485 Solution (Simplified Diagram—All Connections Not Shown)

## ISOLATED LOW POWER RS-485

Figure 4 shows the combination of the **ADuM1441** micropower, quad-channel, digital isolator and the low power **ADM3483** half-duplex RS-485 transceiver.

When the **ADM3483** is operated in shutdown mode (driver enable  $\overline{DE}$  pin is low and receiver enable  $\overline{RE}$  pin is high), the quiescent supply current is typically only 2 nA, with a maximum 1  $\mu$ A specification. Figure 4 shows Pin 7 and Pin 10 of the **ADuM1441** tied to  $GND_1$  and  $GND_2$ , respectively. This means that the **ADuM1441** isolator operates with <23  $\mu$ A of quiescent current in shutdown mode with no active bus communication. Overall, this solution provides a low quiescent current of <24  $\mu$ A.

If Pin 7 and Pin 10 of the **ADuM1441** are wired directly to  $V_{DD1}$  and  $V_{DD2}$ , respectively, the **ADuM1441** operates with only 1.2  $\mu$ A of quiescent current. This is accomplished by a jumper connection on the PCB, which allows the user to connect Pin 7 to  $V_{DD1}$  or  $GND_1$ , and also Pin 10 to  $V_{DD2}$  or  $GND_2$ . Adding the 1.2  $\mu$ A of quiescent current from the **ADuM1441** to the **ADM3483** quiescent supply provides a fully isolated RS-485 node that consumes only 2  $\mu$ A of current in shutdown or standby mode. For normal isolator operation, Pin 7 and Pin 10 of the **ADuM1441** must be tied to  $GND_1$  and  $GND_2$ , respectively.

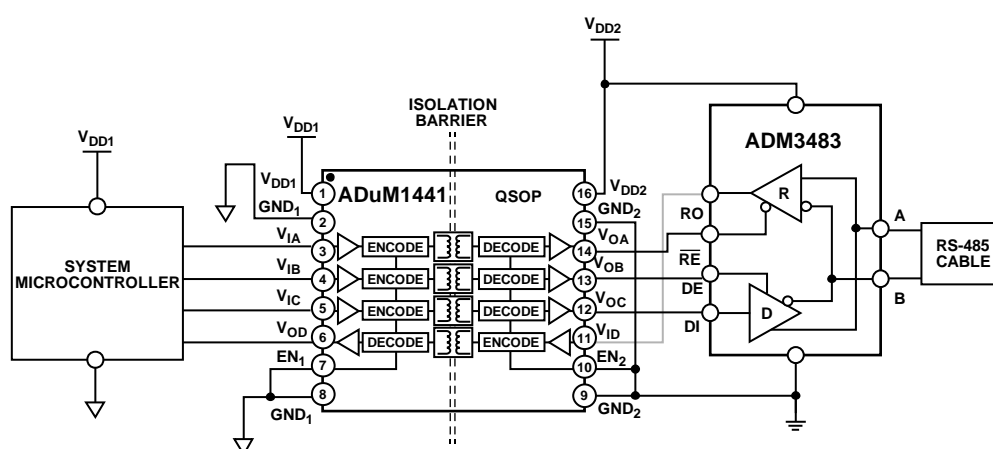


Figure 4. Low Power, Isolated, RS-485 Node