

Galvanically Isolated LVDS Interfaces

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In this era of automation, digitization, and Industry 4.0, the transmission of signals and data is taking on an ever greater role. The networking of machines, systems, and even individual sensors taking place in these applications both on and off the production floor requires not only a stable infrastructure but also secure, fast, high precision, disturbance-free, high bandwidth transmission paths that may need to withstand extremely harsh environmental conditions, depending on the application. There are a number of different methods used for data transmission: wired, wireless, serial, and parallel. All approaches have their own advantages and disadvantages, which need to be weighed carefully against each other for each application case.

In contrast to wired systems, wireless technologies depend, for example, on a series of critical parameters, different components, and current environmental influences. An important aspect of radio communication is radio range, which is dependent on the location of the transmission and reception antennas, the transmission power, the condition of the local environment, and the frequency range. Thus, in the planning of radio transmission applications, the corresponding criteria, especially in relation to the range and thus the quality of the received signal, must be considered.

In the past, bandwidths of a few Mbps were adequate for applications such as interface converters or industrial backplanes. The partly necessary isolation of the different interfaces such as the serial peripheral interface (SPI) or RS-485 can still be realized with standard solutions. However, current trends such as Industry 4.0 and the Internet of Things (IoT) call for copious measurements and extremely complex control systems with higher data rates or bandwidths that, in turn, must be borne by the interfaces. Through these and other rising demands on the interfaces, such as additional safety in the form of higher dielectric strength, greater reliability, and lower space requirements, conventional solutions are no longer sufficient. Here, too, digital isolators represent the best solution because they not only satisfy the heightened demands for safety, performance, and reliability mentioned above but also offer integrated isolation and multiple inputs and outputs.

A common method used in signal transmission applications involves low voltage differential signaling (LVDS). This involves an established interface standard (TIA/EIA-644) for serial data transmission, which features a high noise immunity, apart from its extremely energy-saving properties and its high data rate potential of up to a few Gbps. These positive characteristics can be attributed to the internally used current control or limitation of the driver modules to a maximum of 3 mA. The signal's differential voltage is a mere 20 mV. However, it is subsequently amplified back to the logic level of 300 mV (differential) on the receiver side. This yields, among other things, extremely low electromagnetic interference (EMI) and extremely fast switching speeds.

LVDS interfaces are often used with control and regulating systems in which large data volumes must be sent between the electronic circuits or between short cable lengths. They are also used for synchronization of different components in a complete application by distributing the clock signals very rapidly to the respective components. Analog front ends (AFEs) in industrial measurement applications and control systems count among the typical applications for LVDS. However, they are also commonly used for realization of digital interfaces between multiple data nodes and in the transmission of video signals—for example, via HDMI.® Another aspect that should not be neglected is the possibility of galvanic isolation that LVDS circuits provide. Hence, they are also used wherever isolation of communication interfaces, such as in electronic circuits or backplanes, is required.

Backplanes are circuit boards with multiple connectors for accommodating various add-on board modules. This allows for easy plug and play extension of the base system to include additional assemblies. However, the add-on modules are often subjected to high voltage transients because, in many applications, they are in direct contact with components connected to the power distribution grid. The add-on modules are accordingly vulnerable to external events such as lightning strikes. Electrostatic discharge caused by human contact or internal capacitors that are suddenly charged, charged with

reverse polarity, or discharged when the add-on modules are plugged in or unplugged can also lead to high transients. Thus, a safely isolated interface is indispensable for the system. Otherwise, the connected assemblies could easily be damaged or users endangered if voltage transients occur. Functionally isolated communication interfaces are also favorable for industrial measuring instruments because isolated interfaces offer a floating ground, for example, between analog-to-digital converters and microcontrollers. This allows the measured signals to be isolated from influencing and interfering with or influences and interference from the rest of the application.

Diverse products for realizing isolated LVDS interfaces are already on the market. Analog Devices offers a very efficient and reliable solution with its isolated LVDS family consisting of [ADN4650](#), [ADN4651](#), and [ADN4652](#), which supports data rates of up to 600 Mbps and simultaneously also corresponds to the standard values of nonisolated LVDS interfaces. In comparison, standard digital isolators can reach just 150 Mbps. Very high data rates, despite existing isolation, are possible thanks to the *iCoupler*® technology. This involves a microelectromechanical systems (MEMS) reproduction of a transformer that enables simple, space-saving isolation of digital signals.

The LVDS family also offers very precise time characteristics, as well as extremely low jitter, also known as timing jitter. Jitter describes the variations in the rising and falling edges of the digital signals with respect to the ideal time reference. At high data rates, low jitter is extremely important because it takes just 1.6 ns to transmit one bit at 600 Mbps. Any jitter in the rising or falling edges of the signals must allow the analog-to-digital converter enough time for the actual high or low level so that sampling can be performed correctly. For the ADN465x family, jitter is typically 70 ps. The LVDS modules also offer two isolated LVDS channels, which form the transmission and the reception channel in the ADN4651. The channels in the ADN4652 are arranged inversely to the channels in the ADN4651, whereas the ADN4650 only offers transmission or reception channels, depending on the wiring. The ADN465x family works internally with a supply voltage of 2.5 V; industrial systems often, unfortunately, do not have this supply voltage, but rather often only 3.3 V, available. For this reason, low dropout voltage regulators (LDOs) enabling an external supply voltage of 3.3 V at the inputs are integrated into the ADN465x family. The supply to the module or its inputs and its isolated output side can, for example, be accomplished with the isolated [ADuM5000](#) dc-to-dc converter. This can selectively generate an isolated output voltage of either 5 V or 3.3 V with a maximum power output of 500 mW. This circuit configuration is shown in Figure 1.

In combination with the ADuM5000, this device family can meet the numerous demands placed on isolated LVDS interfaces in today's industrial applications. This highly integrated solution also meets all prerequisites for standardized bus communications. LVDS interfaces are frequently used in energy-saving applications. For this, the combination of the ADN4651 and the ADuM5000 represents an extremely power-saving alternative to traditional optocoupler solutions. The simultaneous isolation of several channels is often also required.

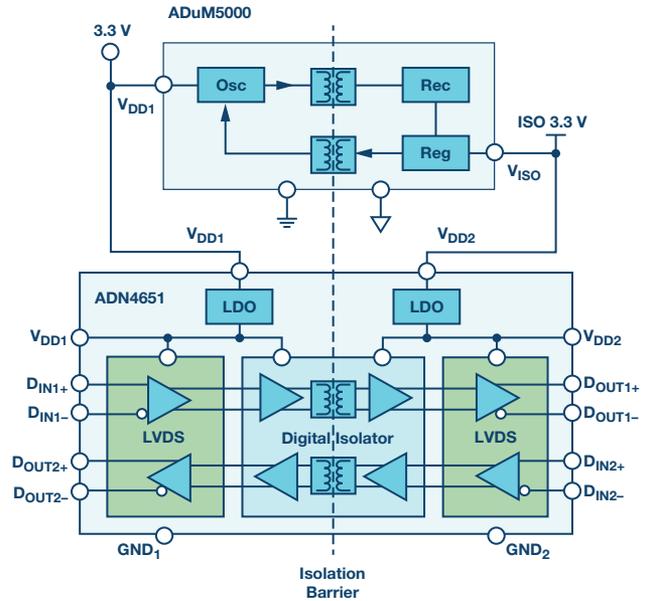


Figure 1. Isolated LVDS interface with ADN4651 and ADuM5000.

In LVDS applications, channels are used in parallel to maximize the throughput and, with it, the baud rate. The described circuit with the above-mentioned modules from Analog Devices offers one 4-channel isolator, two transmission channels, and two reception channels. This permits signal transmission by means of two complete transmission and reception channels on only one electronic assembly with simultaneously very high transmission rates.

The data rates of almost dc up to 600 Mbps can easily be reached with the ADN465x family provided that the specifications for the maximum pulse width distortion are adhered to. In addition, a few factors necessary for transmission of differential signals at high speeds must be taken into consideration in the layout. Thus, the input- and output-side traces should be matched and exhibit an approximate impedance of 50 Ω with respect to ground or 100 Ω between the signal lines. Furthermore, it is advisable to attach 100 Ω terminators to the LVDS inputs, as shown in Figure 2.

The cable length and the connector type also affect the maximum data rate. Lower data rates of up to 200 Mbps in combination with connectors for high data rates and shielded wire pairs even enable cable lengths of several meters.

The ADN4650/ADN4651/ADN4652 are signal isolated, LVDS buffers that operate at up to 600 Mbps with very low jitter. This combination with the ADuM5000 makes it ideal for high speed signal transmissions by being able to achieve 600 Mbps for short distances and 200 Mbps for up to several meters.

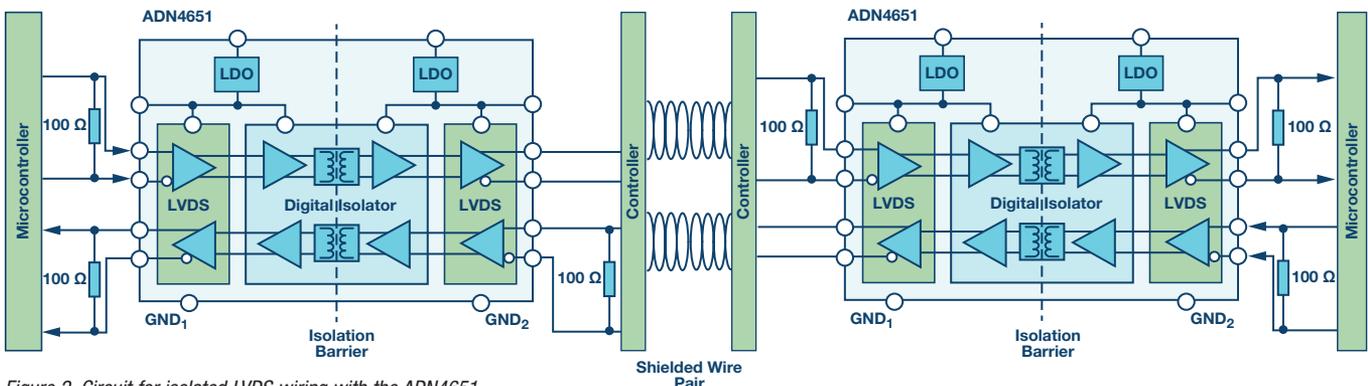


Figure 2. Circuit for isolated LVDS wiring with the ADN4651.

About the Author

Thomas Brand began his career at Analog Devices, Inc., in Munich in October 2015 as part of his master's thesis. From May 2016 to January 2017, he was part of a trainee program for field application engineers at Analog Devices. Afterward, in February 2017, he moved into the role as field applications engineer. Within this role, he is mainly responsible for large industrial customers. Furthermore, he specializes in the subject area of industrial Ethernet and supports-related matters in Central Europe.

He studied electrical engineering at the University of Cooperative Education in Mosbach before completing his postgraduate studies in international sales with a master's degree at the University of Applied Sciences in Constance. He can be reached at thomas.brand@analog.com.

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