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Communication Networks

COMNET APPLICATION NOTE:

Extending Wiegand Access Control Networks Optically

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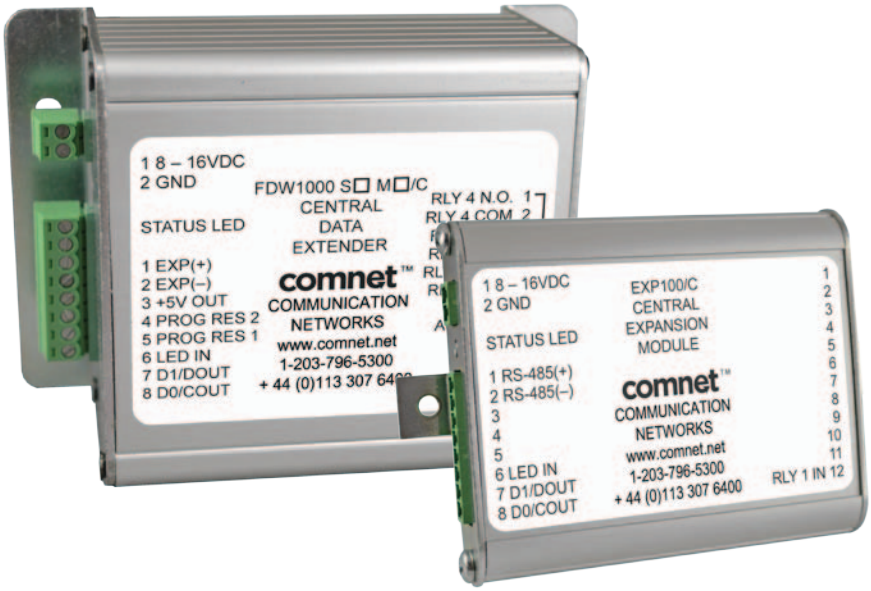


Extending Wiegand Access Control Networks Optically

Wiegand Technology: An Overview

In the early 1970s, engineer John R. Wiegand discovered that specially processed, ferromagnetic wire would generate a sharp uniform voltage pulse when passed through magnetic fields created by small permanent magnets. The Wiegand effect was first thought to be a commercially viable solution to better ignition systems for internal combustion engines of the day. That application was subsequently displaced by the modern and universally-accepted electronic ignition system.

Wiegand technology was later adapted to access control identification cards as an alternative to the then-popular magnetic stripe card format. An embedded Wiegand code strip, containing small pieces of this specially processed wire, is laminated under pressure to create a solid vinyl access control card. Any attempt to tamper with the code strip destroys the card, rendering it useless, and thereby making it highly secure.

By the late 1970s and early 1980s, Wiegand technology became the card technology of choice for access control applications. Wiegand ID cards do not wear out, are virtually impossible to counterfeit, they cannot be altered or duplicated, and they are essentially immune to external magnetic fields or RF interference, making them desirable for use in environments where high levels of electrical interference or strong magnetic fields may be present.

The card reader consists of a sealed unit containing permanent magnets and a pickup/reader head. When the card is passed through the reader, the wires generate a series of pulses, with one row representing binary 0's, and the other representing binary 1's. The reader transmits the data to the access control panel, where it is converted to a facility code and card identification number, which is checked against the access control database for security and controlled admission purposes.

The communications protocol used in conjunction with a Wiegand electrical interface is known as the Wiegand protocol. The Wiegand interface uses three wires, one being a common ground, and the remaining two are for data transmission and are usually referred to as DATA0 and DATA1. They may be alternately called out as Data Low and Data High. The voltage-high level is usually +5VDC, to accommodate long copper cable runs with minimal voltage loss (most Wiegand card reader equipment manufacturers publish a maximum copper distance limitation of 500 feet) from the card reader to the associated access control panel, which is typically located in a secure location. A major advantage of the Wiegand signaling format is that it supports very long copper cable runs, typically on the order of 500 feet, far longer than other electrical interface standards of its day allowed, such as RS-232

As the cost of the ID cards and their readers dropped, and other more popular data protocols (RS-422, RS-485, and Ethernet) gained in popularity in the access control market, Wiegand card swipe technology eventually began losing favor. The Wiegand interface is still used for many current production and legacy access control panel systems, and there is a large installed base of existing Wiegand cards, readers, and door/gate locking hardware, so the market for this equipment remains relatively strong.

Extending Wiegand Data Transmission Distances Optically: A Simple Solution

To support those applications for Wiegand data transmission through optical fiber, ComNet recently introduced a new product line of Wiegand data extenders and expansion modules. ComNet™ FDW1000 data extenders provide simple and seamless optical connectivity between one card reader and its associated door or gate locking hardware, to any Wiegand, MagStripe, or F/2F-based control panel. The connection is completely supervised and secure, and a pair of FDW1000 units will support a single locking gate or door and its card reader using only one optical fiber, thereby reducing the complexity of the optical cable plant and its attendant cost.

When used with the ComNet EXP-100 Expansion Module, up to 8 gates or doors and readers may be easily and seamlessly integrated onto the same network in a standard drop-and-repeat/daisy-chain topology. A service mode in the FDW1000 provides easy and fast set-up and configuration when the EXP-100 is used, and user selection of the reader formats (i.e., Wiegand, MagStripe, or F/2F) via DIP-switch setting is included.

An auxiliary I/O (input/output) interface is available for determining door, gate, and control panel status and signaling, and a simple dry relay contact interface provides the door strike or gate activation function.

The FDW1000 series are supplied as a remote unit (model FDW1000/R) for door or gate locations, and a central unit (model FDW1000/C) for control panel installation.

An LED fault-specific status indicator rapidly ascertains the operating status of the Wiegand data extender and the optical fiber link.

These units are environmentally-hardened for long-term, reliable operation in harsh industrial environments, with an operating temperature range of -40 to +75 degrees C. Further protection of the FDW1000 Wiegand Data Optical Extender is afforded by internal voltage transient/surge protection. Packaged in a rugged aluminum housing, their small size (4.5" x 3.1" x 2.0"H) makes these simple-to-install units ideal for use in those installations where space is at a premium, and the FDW1000 is designed for shelf/wall or surface mounting, or it may be DIN-rail mounted when used with the ComNet model DINBKT1 adaptor plate. It is not packaged in the ComFit housing, so mounting within the ComNet C1, C2 or C3 Card Cage units is not possible.

Figure 1 – Typical Copper Wire-Based Point-to-Point Wiegand Data Link 500' Distance Limitation

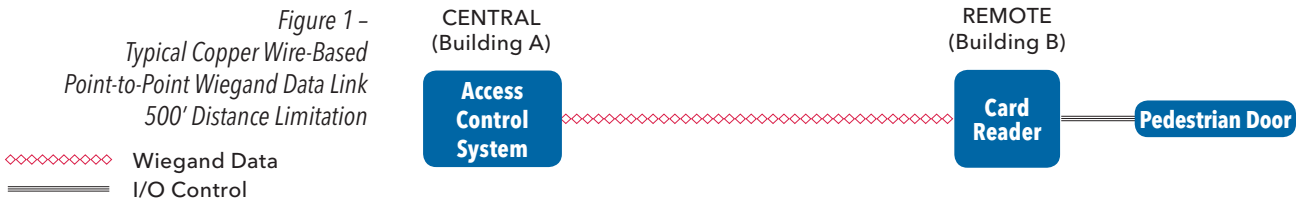


Figure 1 illustrates a basic copper wire-based point-to-point Wiegand link, for use with a single card reader and access control panel. Note that the copper limits the maximum usable transmission distance to 500 feet, and provides minimal immunity to induced electrical noise and interference. Even small amounts of electrical noise can result in data errors, with the result being unreliable or inconsistent door or gate operation.

For those Wiegand card reader applications where the copper wire distance limitation of 500 feet may be problematic, or in those environments where significant levels of electrical noise are present that may corrupt the data, fiber optic transmission is the ideal solution and remains the communications media of choice, due to its intrinsic immunity from external interference, and bandwidth that is essentially unaffected by distance. Using a single-conductor multimode optical fiber, distances of up to 3.5 km (2 miles) may be easily accommodated between a Wiegand control panel and compatible door/gate locking hardware. Distances of up to 40 km (24 miles) are supported when using a single-conductor of single-mode fiber, for those installations where extremely long transmission distances may be required.

Figure 2 – Typical Wiegand-Based Card Access System Point-to-Point Topology using Optical Fiber

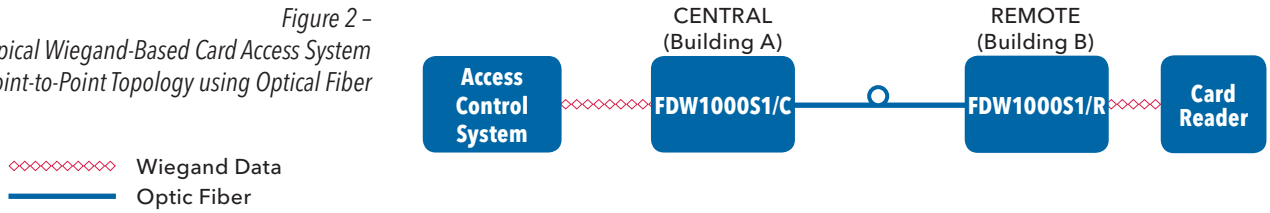


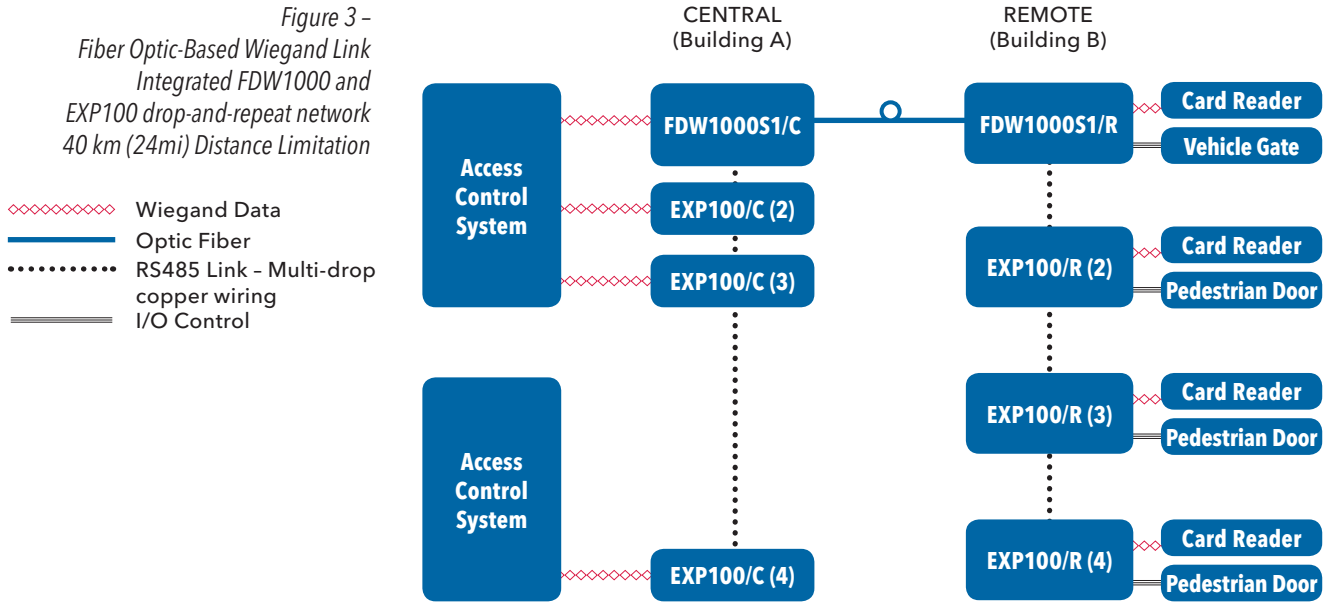
Figure 2 describes the same point-to-point Wiegand link, but the copper wiring connecting the access control system at central (building A), and the card reader and pedestrian door at the remote location (building B) has been replaced with a single-conductor of optical fiber. A pair of ComNet FDW1000 Optical Wiegand Extenders provide the electrical-to-optical interface.

In this application, the user may be assured of error-free Wiegand data in virtually any electrically-noisy operating environment, and at transmission distances far in excess of the 500 foot limitation imposed by copper. The extended operating temperature rating of -40 to +75 degrees C and voltage transient protection of the FDW1000 extenders ensure very high levels of reliability when these units are installed in nearly any out-of-plant application.

Creating a Wiegand Data Drop-and-Repeat Access Control Network

Many Wiegand access control networks require drop-and-repeat or daisy-chained communications, with multiple ID card readers connected to a remote access control panel. Typically, the communications media for this is copper, but as described earlier, a copper-based system will limit the maximum usable transmission distance to 500 feet, and will remain susceptible to the issues of electrical interference. When used with the ComNet FDW1000 series of fiber optic Wiegand extender modules, the ComNet EXP100 Expansion Module enables additional Wiegand, Magstripe, or F/2F-based control panels, readers, and associated door/gate hardware to be added to the network in a drop-and-repeat topology, and the distance between the central and remote locations may be optically extended to up to 24 miles (40 Km).

Figure 3 – Fiber Optic-Based Wiegand Link Integrated FDW1000 and EXP100 drop-and-repeat network 40 km (24mi) Distance Limitation



Up to 8 EXP100s can be daisy-chained together per channel (see figure 3) to easily and effectively create a Wiegand, Magstripe, or F/2F-based drop-and-repeat/ daisy-chain topology, and each EXP100 may be set to a unique address (1 thru 15) via DIP-switch selection. Only one DIP-switch is required to be set at time of installation. The EXP100 series are supplied as a remote unit (ComNet model EXP100/R) for door or gate locations, and a central unit (model EXP100/C) for control panel installation.

The EXP100 does not include an optical fiber interface; it utilizes a 2-wire RS-485 copper wire-based data interface to provide a secure, reliable, robust, and completely supervised connection, with excellent immunity to noise and interference in electrically noisy environments, due to the balanced, common-mode rejection provided by the RS-485 protocol. In very noisy environments, additional electrical noise rejection may be obtained by the use of shielded cable for the RS-485 circuit between EXP100s, and copper wire distances of up to 500 feet may be used between each of these expansion modules. An auxiliary I/O (input/output) interface is available for ascertaining door, gate, and control panel status and signaling. Central or remote operation is selected via a simple, user-selectable DIP switch.

Like the ComNet FDW1000 Extender Module, a dry relay contact interface provides reliable door strike or gate activation functions, and a LED fault-specific status indicator rapidly determines the operating status of the expansion module and the RS-485 data link. The EXP100 is packaged in a small form-factor (3.5" x 2.75" x 0.75" H) rugged aluminum housing, and is designed for shelf/wall or surface mounting, or it may be DIN-rail mounted when used with the ComNet model DINBKT1 adaptor plate. It is not packaged in the ComFit housing, so mounting within the ComNet C1, C2, or C3 Card Cage units is not possible. The extended operating temperature rating of -40° to +75°C, and voltage transient protection included within the EXP100 also ensure very high levels of reliability when these units are installed in nearly any out-of-plant environment.

Summary

Although the Wiegand interface has lost some degree of popularity over the years, having largely been replaced by the current generation of Ethernet-based card access control equipment, it is still in use in many current production and legacy access control panels, and there is still a large installed base of existing Wiegand cards and reader equipment.

For those applications where the normal Wiegand distance limitation of 500 feet through copper wire may be an issue, or the installation may be in an electrically noisy environment, the ComNet FDW1000 Wiegand Data Extender offers a simple-to-install and cost-effective solution of interfacing any Wiegand, Magstripe, or F/2F-based control panels, readers, and associated door/gate hardware to a fiber optic link, using only one conductor of fiber, and with the numerous advantages that optical communications offers to the user.

Where it is desired to connect multiple Wiegand card readers to a remote access control panel in a drop-and-repeat topology, the ComNet EXP100 expansion module used in conjunction with the FDW1000 series of fiber optic Wiegand extender modules, enables additional Wiegand, Magstripe, or F/2F-based control panels, readers, and associated door/gate hardware to be added to the network, using reliable and robust 2-wire RS-485 communications between the expansion module units.

ComNet offers an extensive line of environmentally hardened fiber optic and copper-based video and data transmission equipment as well as a line of Ethernet networking equipment that is uniquely designed to meet the needs of the Industrial Security, Intelligent Transportation, and industrial control markets.

Bruce Berman is responsible for directing and promoting the application of ComNet products in markets that can benefit from their use. In many cases he educates System Designers and customers on all levels about the benefits that ComNet products and technology bring to their projects. Berman has a Bachelor's Degree in Communications from the State University of New York at Geneseo.

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