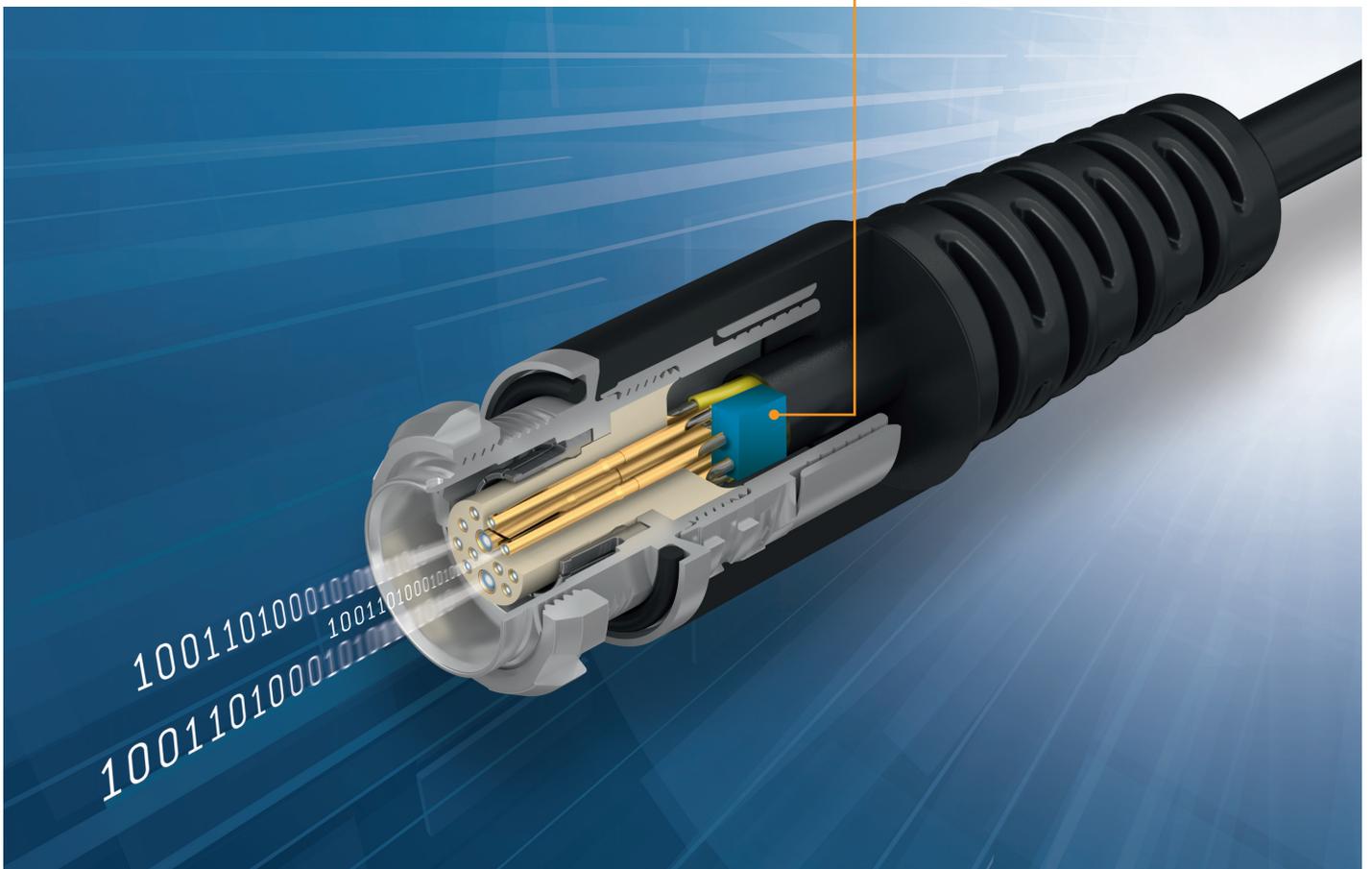


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CONNECTORS WITH INTEGRATED **EEPROMS**



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INTRODUCTION

Connector systems with integrated microchips such as EEPROMs (Electrically Erasable Programmable Read-Only Memory) offer an easy pairing of devices and connectors, real-time connection status, mating cycle count and electronic device identification.

Based on realized custom specific projects this features an off-the-shelf solution that allows system designers an easy method of serialization, valuable space savings as well as time and cost savings with the physical labeling of connectors or cable assemblies.

The overmolded sealed cable assembly connects an EEPROM underneath the overmold or potting to the contacts of ruggedized standard or custom specific connectors.

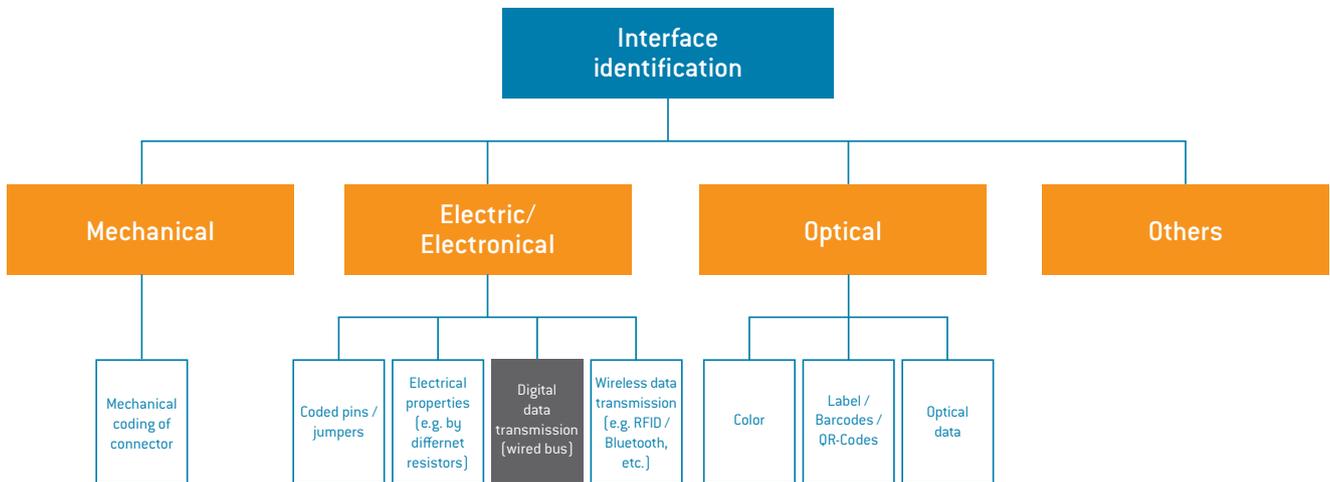
Connected EEPROM devices provide a highly secured data transfer and can be used for a wide range of applications that require electronic security checks to establish a connection, including accessory or PCB identification, sensor calibration and data storage. This integrated solution also allows easy security code storage and can facilitate the customization of application programs such as transmitter codes and appliance settings.

INTEGRATED SMART SOLUTIONS – FOR THE MARKET NEEDS

The need for identification of connected equipment is steadily growing. Increasing number of product variants and accessories, results in increased safety requirements,

additional documentation needs and predictive maintenance as well as service options.

Identifying of interfaces can be performed in various forms:

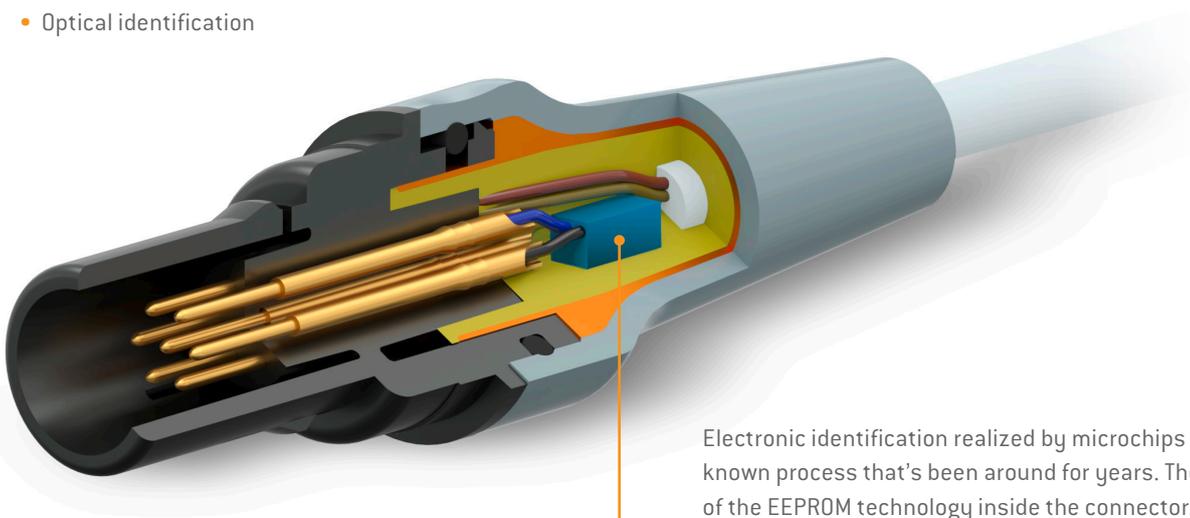


Possibilities for identification:

- Mechanical coding of mated connectors – only proper equipment fits to the receptacle
- Electric coding of mated connectors – by resistors and jumpers a limited number of partners can be identified by its electrical properties
- Electronic identification by wired bus or wireless (e.g. RFID/Bluetooth or similar)
- Optical identification

Characteristics of various ways of identification:

- Mechanical coding – robust, high variety of versions
- Electric coding – robust, reduced variety of versions, costly due to additional contacts
- Electronic identification – robust, 2 additional pins, microcontroller required, nearly unlimited number of IDs, additional memory capabilities lead to broad range of applications



Integrated memory chip inside the connector

Electronic identification realized by microchips is a well-known process that's been around for years. The integration of the EEPROM technology inside the connector, which only requires one additional wire, provides many advantages for customers and users.

Power is fed to the microchip via the signal line. In many cases the ground line can be shared with the ground contact or the shield of the cable.

1. Medical market

International regulatory schemes within the medical market impact technologies for devices all the way down to the component level. Connectivity products for medical applications require consistent performance and reliability. Today, medical device designers are selecting materials and components with much more foresight to ensure product performance, safety and regulatory compliance. Risk management and documentation have become mandatory.

The emphasis on increased product safety is an ever increasing effort not only in product design, component selection, testing, and quality inspection but also during the whole product life cycle. Correct product configuration, safe operating limits, accurately timed services, exchange of components and timely disposal of products at end of life are all factored in at the product design stage.

Connectors with integrated memories are supporting the shift to design safer and smarter products. Safety can be brought to the next level by including identity and memory at a component level for sensors, cables, handheld devices etc.

The obvious benefits are increased safety functions such as preventing the use of expired or invalid products, prevention of misconfigurations, operation within specific device limits but also a fully automated documentation.



Ever increasing requirements in medical applications can be met efficiently by self-identifying connectors and components.

2. Military and security market

Military equipment and devices require a fast and secure information flow with no malfunctions or interruptions in communication systems. A highly reliable and robust connection for high-tech products ensures the highest security level as the standard. Identification of connected equipment is a big advantage for users within this field. A system which requires no color or mechanical coding allows connectors to be plugged into any receptacle of the equipment, while the system electronically configures itself in the correct way. Valuable time will be saved and operator's attention can be focused on where it's really needed.

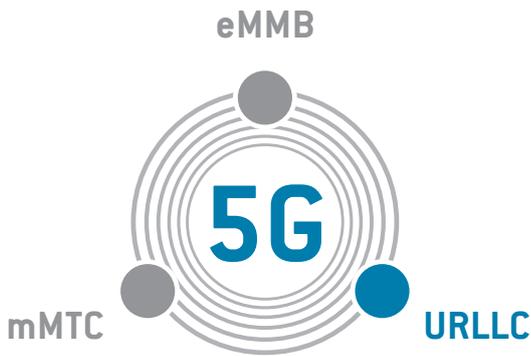
Another application in the field of military and security are vehicles. Within joint development projects a reliable identification of components is essential. Prevention of misconfigurations becomes simple, when controlled by any component connected – from a complex system to a simple cable. Connectors with integrated chips can help identify any component that is connected, configure the system, identify non-authorized equipment and manage service as well as the lifetime of the components.



Time is essential – self-identifying connectors, universal receptacles in combination with electronic configuration management can be a lifesaver.

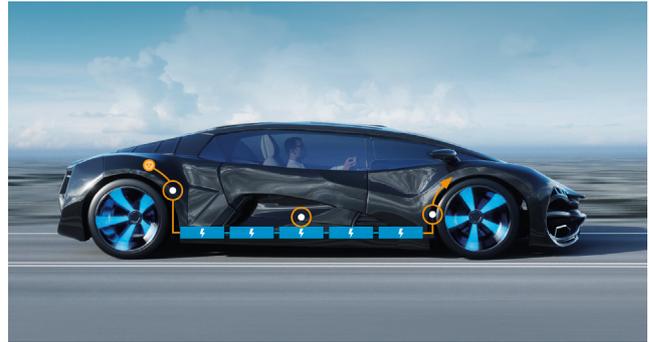
3. Test and measurement market

For test and measurement applications, precision is significant. Future communication technologies like Enhanced Mobile Broadband (eMBB), Massive Machine Type Communications (mMTC) and Ultra-Reliable Low Latency Communications (URLLC) drives the market where connector systems have to guarantee the precise transfer of measurement data all times.



Fifth generation of cellular communication

The requirements and the growing demand for tracking data like accuracy of the measurements, calibration values and surveillance of operations within specific device limits are getting trivial. Documentation of complex, configurable systems become more and more demanding at the same time.



Efficient development and testing of eMobility solutions by using EEPROM components

Test and measurement demands within the eMobility sector have evolved in the past years. Testing of components in this field has to meet new and different requirements than the conventional tests in the development of combustion engine vehicles. The interaction of manifold components such as electric motors, inverters, batteries, actors, sensors, etc. in different configurations needs to be tested in relation to performance and proper functionality. Conventional electrical measurement technology takes it into account by galvanically isolated measuring electronics, sensors and special insulated connectors and cables. Using integrated EEPROMs allows accurate measurement of more and more complex testing set-ups with higher accuracy, better documentation and ensuring right testing configurations with less effort.



The wide range of the identification is matched with the various needs in the field of test and measurement.

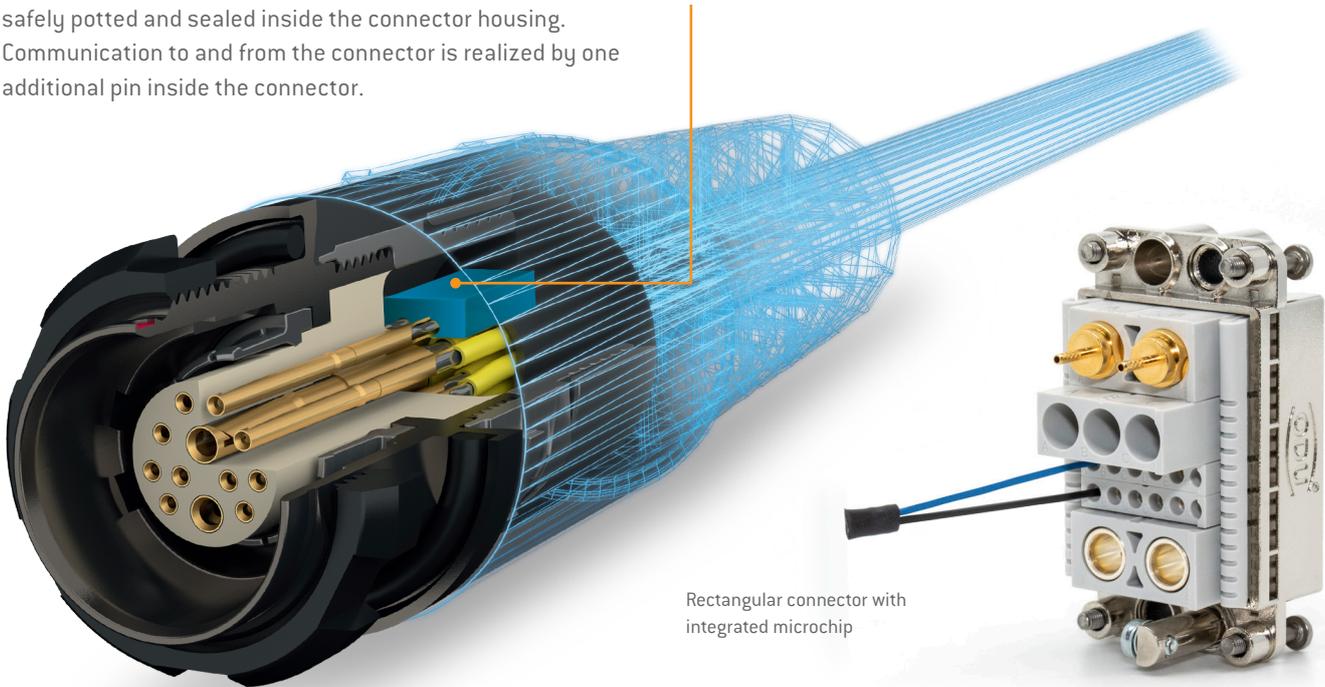
TECHNOLOGY – KNOWLEDGE UNVEILS THE FULL POTENTIAL

Cable assembly solutions with integrated chips retain identity and memory. With both features, a wide range of functionalities can be realized. Aside pure identification of interconnected equipment, many other options will be possible:

Inside the connectors, a single microchip is enclosed, safely potted and sealed inside the connector housing. Communication to and from the connector is realized by one additional pin inside the connector.

Power to the microchip is provided via the signal line, a concept known as parasitic power transfer. By this, additional weight and size will be reduced to a minimum.

A microchip inside the connector provide identity and memory to your application.

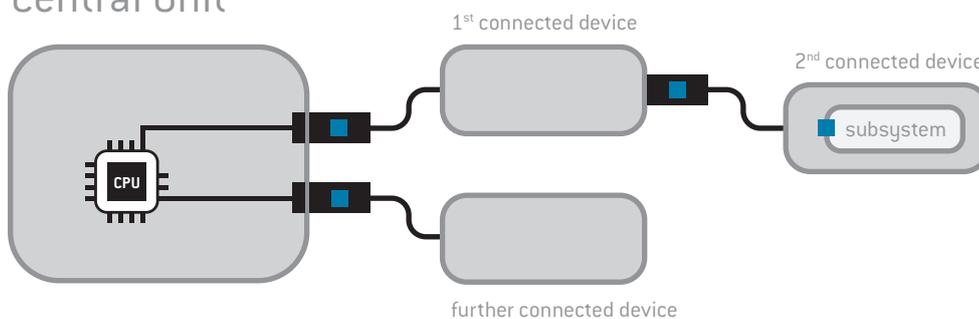


Rectangular connector with integrated microchip

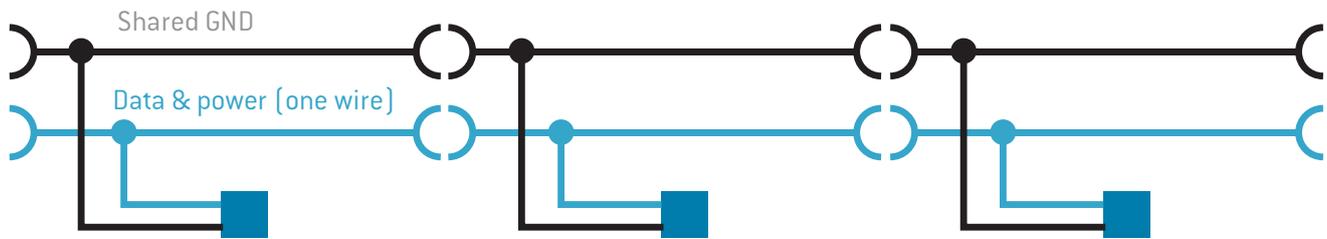
Employed bus protocols to communicate with the microchips are similar to I²C protocol, however at lower data rates and with only one shared data/power line. Identity is given by a unique 64 bit ROM that is permanently lasered to the microchip. Additionally 1 to 4 kBit of memory can be used to save device specific data.

Additional safety functionalities are available, such as write protection or EEPROM-emulation mode. The bus protocol also enables addressing multiple connectors/devices on the same bus while distances can exceed 100 m depending on bus network topology and number of microchips connected to the bus.

Central Unit



Application example for connectors with integrated EEPROM in a system. Connectors are diagrammed by black boxes, EEPROMs by blue boxes.



Schematic view of bus with multiple connectors/EEPROMs along the bus. Beside the ground wire (GND) only one additional wire is needed (in Blue – shared data & power line).

The application's central control unit – a microcontroller, an industrial PC, industrial controller or similar – addresses the connector via a standard digital I/O line. Read/write voltage ranges from 2.8 to 5.25 V. Standard libraries are available and can be integrated into existing software easily. Once integrated, a universe of possibilities opens up to bring applications to the next level:

Identification

Simple identification is done by reading the connector's unique 64 bit ID. This ID can be connected to lists of approved products, or locally provided (stored) on the device or via IoT-connectivity linked to real time data.

Product tracking

By linking the ID to online data, a real time status of the specific connector can be provided. Enriched with further data from the application device this allows to track products around the globe, record application specific use of devices, connections done by users, frequency of use, etc.

Real time product release/status

By giving back a status of the product to the device, enhanced safety options can be considered. E.g., a call back action could be displayed on the application device and callbacks could be limited to affected products.

Product piracy

IDs can also be used to hinder or at least uncover product piracy. Or by the simple existence of an ID to identify duplicate products in use.

Documentation

With reading the IDs of connected devices the documentation of a system configuration can be automated. Interest is high especially in medical and measurement applications with ever increasing requirements in proper documentation.

The internal memory introduces additional options. Memory up to 1 kBit offers reasonable space for information of the connector itself and the connected devices. Data could be used to store:

- Information about the kind of device connected (e.g. sensor, actor, display, etc.)
- Operating data (e.g. allowed voltage, power, temperature, etc.)
- Calibration data for connected sensors and measurement systems
- Production data – lot number, lot size, factory, versions
- Operation records – number of use cycles, minimum/maximum values seen during operation, number of mating cycles, total hours of operation, etc.
- Logical data – information to configure the overall system
- Product data – general information, weblink to manual and spare part orders, etc.

More complex functionalities can be implemented:

- ⊕ **PRODUCT VALIDITY** – by date and by use
- ⊕ **PREDICTIVE MAINTENANCE** – information about due service or expected replacements
- ⊕ **ENHANCED PRODUCT SAFETY** – prevention of misuse, wrong configurations, etc.
- ⊕ **ONE CONNECTOR FITS ALL PORTS** – electronic system configuration, just plug into any available port and the system will set up itself

Many further functionalities and applications are possible, e.g. on the same bus, digital sensors can be included, e.g. for measuring the temperatures.

CONCLUSION

Connectors with integrated EEPROMs are the solution of choice to make products safer, more reliable and intelligent. Today many applications face ever-growing demands in safety, performance, documentation and ease of use. To meet these requirements, components can be an efficient and clever solution when integrated into cable assemblies. This white paper shows how connectors with identity and memory contribute to create better products.

Smart functionality is realized by adding microchips to the connectors that communicate via a single wire to the central controller. Due to this and its small form factor, integration is possible for most of ODU's product range. Smart functionalities can be integrated, no matter if the connector is circular or rectangular. Based on the small size of the EEPROM and the need of one additional pin, the size of the connector remains the same.

AUTHOR



Rudolf Weidenspointner is Product Manager for Cable Assemblies at ODU. He is responsible for new product developments, market-driven and future-oriented solutions.

The integrated EEPROM solution sector is particular focus of his market research next to the areas Medical, Test and measurement and Military and security. While talking to many customers in this area Rudolf found out that integrated solutions are becoming more and more important.

FIND OUT MORE

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