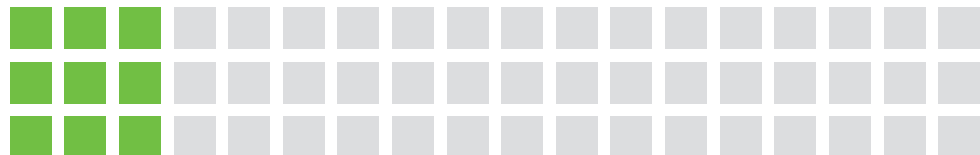


# TRAILER CONNECTORS

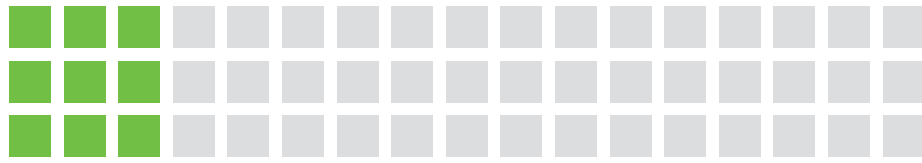
Development Guidance for Next Generation Connector Systems



WHITE PAPER



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## Introduction

Heavy-duty on-road vehicles account for about one-fourth of transportation-sector greenhouse gas (GHG) emissions and fuel consumption. The trend of this proportion is projected to increase nearly 20% by 2030. To reduce fuel consumption and climate-warming pollution, in Europe the EU Commission has already set the goal of 60% reduction in carbon dioxide emission by 2050. This goal will put a very high requirement on driving and fuel consumption efficiency. One solution to achieve this goal is the fully automatic coupling system (FACS).

By conventional coupling and uncoupling of truck and trailer the driver must leave the cabinet to handle the brake lines and electrical cables. Through the fully automatic coupling system the coupling could be simplified, since the driver can stay in cabinet when the connections are made. This can improve the driver's productivity and reduces the coupling time up to 20 minutes. The FACS system also reduces risk of injury since the driver doesn't need to climb on the vehicle to finish the connection.

In the future when electric-driven heavy-duty vehicles become more and more popular, the requirements for tractor trailer will become higher. Some tractor trailers will have their own battery management system, electric powertrain, braking and brake energy regeneration system. For

autonomous driving the trailer will also need more cameras and sensors. All these requests require a high-speed data exchange. The standard trailer connectors which are currently being used will hardly meet these requirements. Therefore new trailer connector standards need to also consider this market demand.

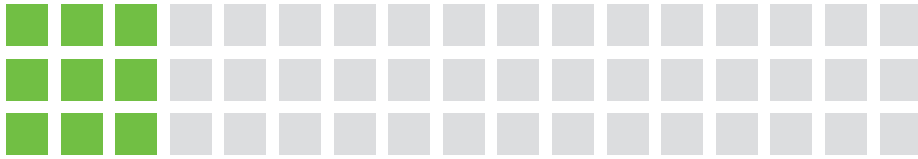
The purpose of this paper is to look at the current Littelfuse trailer connector family and provide a recommendation for the future development of trailer connectors which can meet the requirement of the FACS system and autonomous driving electric vehicles. The remainder of this paper is organized into the following sections:

Section 2 introduces trailer connectors and provides an overview of the current Littelfuse trailer connector product family.

Section 3 provides the requirement and goals of new trailer connectors that can support a fully automatic coupling system. This section also offers a recommendation on next generation trailer connector designs.

Section 4 summarizes this white paper and identifies next steps in the future work of this space.





## Trailer Connectors and the Littelfuse Portfolio

The trailer connector is an electrical connector with multiple pins, used for the electrical connection between a vehicle and a trailer or caravan. The trailer connector serves as the main supply of electrical control for the trailer, such as lighting or management of other consumers of power.

The Littelfuse trailer connector product line covers 12V and 24V DC electric sockets, plugs, and spiral coils for industrial and agricultural trailers, trolleys, and caravans. This includes ABS and ADR-style plugs and sockets that operate in the 12V (13-Pin) and 24V DC (15-Pin) ranges.

### 7-Pin Sockets & Plugs 12V, ISO 1724 / ISO 3732

The range consists of a N (Normal) version complying to ISO 1724, which is generally used for standard applications, and a S (Supplementary) version complying to ISO 3732 to be used for additional connections.



Figure 1: 7-Pin Socket 12V, ISO 1724 / ISO 3732

### 13-Pin Sockets & Plugs 12V, ISO 11446 (DIN 72570)

In a single connector, this new system accommodates all connections required by the prior 7-Pin 12V DC system (both type N and S). Advantages are greater mechanical resistance, higher weather-resistance and a more reliable and safer electrical connection.



Figure 3: 13-Pin Socket 12V, ISO 11446 (DIN 72570)

### 7-Pin Sockets & Plugs 24V, ISO 1185 / ISO 3731

The system consists of a N (Normal) version according to ISO 1185, generally used for standard applications, and a S (Supplementary) version according to ISO 3731 used for additional connections.

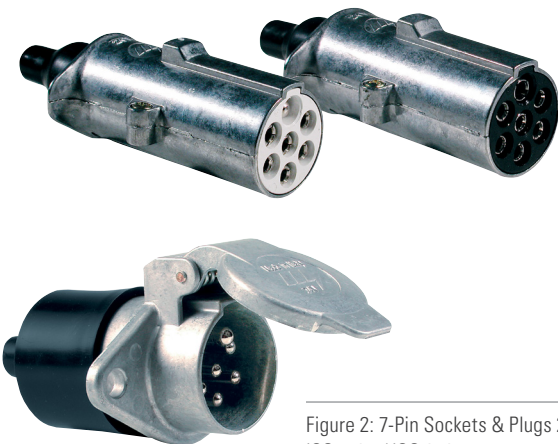


Figure 2: 7-Pin Sockets & Plugs 24V, ISO 1185 / ISO 3731

### 15-Pin Sockets & Plugs 24V, ISO/DIS 12098

In a single connector, this new system accommodates all connections required by the prior 24V DC 7-Pin system (both type N and S). Advantages are greater mechanical resistance, higher weather-resistance as well as a more reliable and safer electrical connection. The 15-Pin sockets and plugs fully comply to the technical requirements of ADR/GGVs norms regarding vehicles transporting hazardous goods.



Figure 4: 15-Pin Sockets & Plugs 24V, ISO/DIS 12098

## Sockets & Plugs ABS / EBS 12/24V, ISO 7638-1 / ISO7638-2

These products are used to connect the ABS/EBS braking system between a tractor and trailer, for both 12V and 24V DC electrical systems. The ABS/EBS system conforms to ISO/DIN 7638, which is compulsory on all vehicles weighing over 3.5 tons. The technical specifications of the materials used conform to ADR/GGVS requirements for vehicles transporting hazardous goods.



Figure 5: Sockets & Plugs ABS/EBS 12/24V, ISO 7638-1 / ISO7638-2



## 2-Pin Sockets & Plugs ISO 4165 / DIN 72591

These connectors are used for the electrical connection of inspection lights, beacons, and other accessories on vehicles with either 12V or 24V DC electrical systems. Contacts are made of brass with 6.3 mm screw or spade terminals.

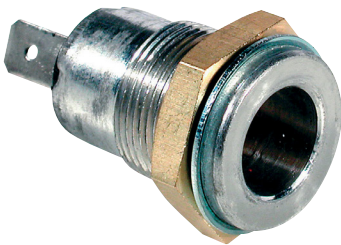


Figure 6: 2-Pin Sockets ISO 4165 / DIN 72591

## 3-Pin Sockets & Plugs DIN 9680

These connectors are mainly used for agricultural vehicles and trailers, for various types of additional connections. Two contacts made of 25A nickel-plated brass with double 6.3 mm spade terminals and an additional 5A contact with 3.5 mm spade terminal.

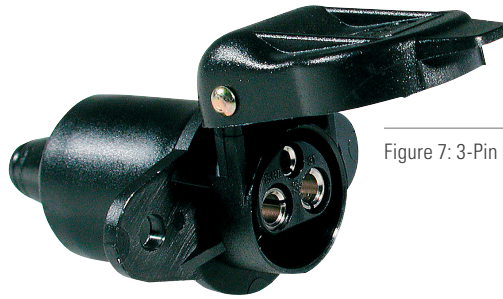


Figure 7: 3-Pin Socket DIN 9680

## 2, 7 & 13-Pin Tractor Trailer Connectors SAE J560a/b

2, 7, or 13-Pin trailer connectors are SAE J560a/b rated and are used for 12V and 24V DC electrical connections of turn lights, brake lights, lamps, and AUX/ABS power on vehicles. 7-Pin terminals accept up to 10AWG cable, 2-Pin accept up to 6AWG, and all ground terminals accept up to 8WG.

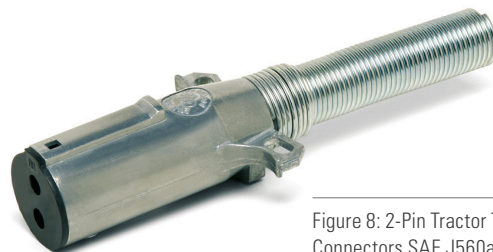


Figure 8: 2-Pin Tractor Trailer Connectors SAE J560a/b



Figure 9: 7-Pin Tractor Trailer Connectors SAE J560a/b



Figure 10: 13-Pin Tractor Trailer Connectors SAE J560a/b

## IBBC- Implement Bus Breakaway Connector ISO 11783-2

The Implement Bus Breakaway Connector (IBBC) is an innovative connector for CAN based implement systems. The IBBC makes it possible to connect and power all implements and systems that require ISOBUS communication. The necessary electronics to enable communication on a highly intelligent level are fully integrated. The IBBC maintains full compatibility with ISO 11783-2 standard ensuring communication is implemented within a tractor or construction vehicle.



Figure 11 Implement Bus Breakaway Connector ISO 11783-2

## Design and Requirements for New Trailer Connectors

Today's trailer connector is used to build up a "one way" connection between a vehicle and trailer. This can enable the transition of electrical energy, control systems for lighting, braking or other functions, and compressed air from vehicle to the trailer. However, these conventional coupling systems requires a manual operation from the driver to connect the electrical and pneumatic supply lines between the truck and trailer. This manual operation incurs downtime for coupling and uncoupling the connectors. During the coupling and uncoupling, the driver needs to leave the cabin and stay in the "danger area" to finish the operation, such like stay under the semitrailer or climb on the vehicle. These operations lead to a high risk of injury of drivers.

With modern automatic coupling systems the trailer connector will get more complex. The new trailer connector is designed to eliminate the expensive coil hoses and cables. It reduces the space between truck and trailer, simplifying the design for the skirt and fairings, enabling improved aerodynamic performance. The fully automatic coupling system with integrated new trailer connector can bring many advantages particularly in port and warehouse which has the simpler traffic situation than street traffic. Additionally it can improve the driver's productivity, reduces the waiting time, and avoid injury to the driver.

### Technical requirement of the trailer connector.

- The connector should support 12V, 24V, 48V DC or even higher voltage to cover the need of extension of future technology.

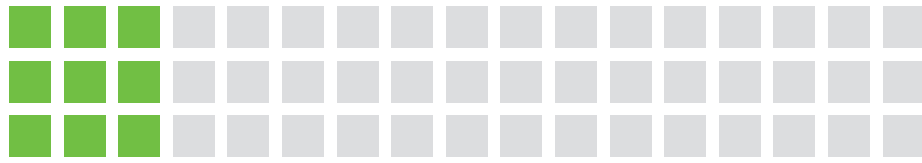
- For the electric vehicle the connector should enable the two-way power supply, as the trailer will have its own battery and power train. The power supply and braking energy regeneration can be implemented now only from tractor to trailer but in the future, it will also be reversed.
- The future "smart trailer" will require more interchange of data communication between vehicle and trailer. The connector should therefore support CAN communication. Two CAN network buses are required, one for the braking control and a second one for system diagnostic or auxiliary devices. The communication should be able from both forward and back ward. This can allow the trailer can send the control signal back to the vehicle.
- Autonomous driving systems will require more information about the status of a trailer: the distance to the obstacle or other road users, status of trailer's health, status of braking and road situation etc. Most of this information will be detected through cameras and sensors, which will require high speed real time data transmission. The connector should support the high data transfer rate by at least 1Mb or ethernet standard. Optional wireless or 5G data transmission shall be investigated when there is demand for such application.

- To eliminate the coil hoses and cables, to save cost and keep the connection interface compact, the connector should be integrated into a housing in both vehicle and trailer sides. The connector will be used to transmit electrical power, electrical control signals and compressed air between vehicle and trailer, and should therefore include both electrical and pneumatic interfaces. All the electrical contact and pneumatic connection between vehicle and trailer should be coupled through the single connector to enable the automatic coupling. During the coupling and uncoupling, the electrical cables and plastic airlines are continually connected to the connector and not be utilized during the operation, this can avoid the material fatigue and reduce the damage of the cables and lines.
- In automatic coupling, guiding pins will be required as part of the metal housing to help the connector fix into the right position. Ideally the coupling of the connector and the housing should be at the same time. Alternatively, the coupling of the connector and housing can be separated to avoid the physical damage of the connector that can occur if a crash force is experienced during coupling.
- On the vehicle side, it is recommended to place the male/female connector under the fifth wheel. On the trailer side, it is recommended to place the female/male connector in the surrounding area of the king pin. The housing should be designed to allow a light rotation and offset during the coupling, so that the male and female connector can be fixed in the right position through the guide pin.
- The connector is designed to have at least 100,000 mechanical life cycles. It should be easy to maintain and should contain a module design of the electrical contact and pneumatic connection. In case of a physical damage during the operation, the damaged modules can be replaced through new modules.
- The housing of the connector should include a protective cover. The cover should prevent foreign debris and liquid from entering the connector. The protection through the housing and cover should ensure the performance of the coupling and uncoupling by extreme weather conditions.
- The connector should achieve IP69K sealing in both coupled and uncoupled states. Resistance against corrosion, thermal shock and mechanical vibration should fulfill requirements according to ISO 4091 and ISO 16750.
- The next generation of connectors and the existing standard connector system will coexist for a long period of time. Normally the trailer will have a much longer service life than the vehicle. Therefore it will take a very long time to eliminate the existing trailer connector. The new generation system should be compatible to the existing trailer connector and provide a possibility for the adaption. It should be ensured that there is no performance degrade when the new connector system be connected to the existing trailer or vehicle.

## Conclusion

This white paper introduces the future needs of trailer connector products, and provides Littelfuse's guidance on development and strategy in light of these changes. In summary, trailer connector products should support the future needs of the tractor trailer vehicles and industry; the new generation of connector products should fulfill the following design needs:

- Support fully automatic coupling/uncoupling systems.
- Suitable for electric vehicle and autonomous driving to improve the driver's productivity and safety.
- Enable high speed two ways communication between vehicle and trailer.
- To eliminate the coil hoses and cables.
- Enable the interface with future wireless connections to support the smart trailer concept.
- Enable the communication with the trailer's own battery management, power train and brake systems.
- Compact design to enable all the connections between a vehicle and trailer to occur via a single trailer connector. Reduce the space between vehicle and trailer to improve aerodynamic performance.
- Provide an interface to connect to the existing trailer connector system.



## Notes

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