



Connecting Systems with Solutions

Testing Standards for your Safety: 1000BASE-T1

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The automation of truck driving functions is a development that will significantly change the way trucks are driven in the foreseeable future. The path to autonomous driving will gradually progress through partial automation of driving functions first. Many driver assistance systems are already in use today, especially in the automotive and trucking sector, supporting drivers in tasks like parking or increasing safety through automatic vehicle-to-vehicle distance control. In many countries, governments support this trend by investing in trucking test projects like building special smart highway sections where these technologies can be tested and improved.



Currently, the trucking industry often uses two CAN connections with a 125 kbit/s data rate. Some of the messages transmitted here are relevant to ECE R 13 and already have latency requirements, making it difficult to further increase the data bus load. CAN data rate between the tractor and trailer is insufficient for some sensor systems like external environment detection and mapping for highly automated driving functions. The use of communication systems with higher data rates and low latency will soon replace or complement the current CAN data transmission. 1000BASE-T1 Ethernet is the data transmission standard that will help the trucking industry in this task.

Because the reliability of truck-trailer signal transmissions is very critical, validation and testing of 1000BASE-T1 Ethernet connectors, cables and modules must be very rigorous. Have you ever wondered what engineers have to do to make data systems work properly? This whitepaper explains some of the technical details and testing methodologies employed by the industry.

1000BASE-T1: Functional Operational Criteria

In 1000BASE-T1 networks, signal quality is evaluated using the Signal Quality Indicator (SQI) on a scale of 0 to 7, with higher values indicating better reception. SQI is calculated based on Mean Squared Error (MSE) values determined by microchip transceivers. While not all analog bit errors lead to logical errors, SQI values are linked to bit error rates as per OPEN ALLIANCE standards. Monitoring involves assessing link stability, communication errors, and signal quality using SQI.

For the transmissions, the following metrics are monitored:

- Link interruptions
- Communication errors
- Signal quality based on SQI

The immunity of 1000BASE-T1 systems against narrowband radiated disturbances (1 MHz to 1000 MHz) is tested using the Bulk Current Injection (BCI) measurement method. Interferences are coupled using a coupling clamp at various points in the cable harness, which can be as long as 40 m for best proximity to real operating conditions.



Test Equipment Setup

Testing is conducted using different microchip solutions from leading global chip manufacturers.

Signal Quality (SQI)

It is very important that any data wiring harness complies with both the data protocol specification requirements and the truck/trailer manufacturer guidelines. One such requirement can be using capacitors for connecting the data connector metal shield to the printed circuit board system ground to lower the electromagnetic noise of the modules and cables.

Tests also include reference measurements on the test bench in a lab environment, as well as tests under various temperatures to gauge the influence of the temperature on system performance. Data channels are tested at -40°C, 23°C, and 85°C in a temperature chamber to ensure safe operation of the data link in any climate.

Disturbance Immunity (BCI)

This measurement places the data channel on two measurement tables, with Table 1 connected to ground representing the tractor chassis and Table 2 disconnected from the ground representing the trailer. The connection between the tables is made through a spiral cable. Power is supplied to the communication nodes at the harness on Table 1. Unused data or power wires are terminated with the 50 Ω resistors on both ends of the cable harness.

In total, four BCI coupling points are selected, where interference is coupled across all lines at the connectors to the coiled cable and at the communication nodes.

Test Results Evaluation

No product being tested can exhibit any errors above the thresholds set by IEEE 802.3 applicable standards; however, potential influences on the MSE values (analog error rate at the receiver chip) due to the injected interference can be tolerated to a certain degree.

Summary

1000BASE-T1 Ethernet data channels have been thoroughly tested and evaluated by many truck, trailer and components manufacturers around the world both in lab setups and under real operating conditions. At ERICH JAEGER, we work tirelessly to ensure the full functionality of any Ethernet connection we produce up to 40 m, which covers most of the standard trucking applications.





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