From line topology to star repeater

When a CAN system reaches some level of extent, a reasonable wiring scheme becomes an issue. Typically, nodes all over the machine have to be addressed from a central control cabinet.

As CAN is designed for a line topology system, integrators have to find a track through the system which does not violate their margins for length and costs. Seeing this problem, EMS Dr. Thomas Wünsche developed a concept for a CAN star repeater. The concept became a product, triggered by a customer who was in search of an improvement of the CAN wiring in their plastic film extrusion machine. In the beginning a fundamental analysis of the wiring possibilities was necessary. It became obvious that the wiring can be done in three fundamentally different ways.

Classic line topology

In the classic line topology all CAN nodes are connected to a single trunk. This method is wide-spread and has its value for small installations, based on its relatively low costs. Nevertheless there are serious disadvantages. The hole system will go down in case of a single failure like a broken line or a non functional node, sending a permanent dominant signal. Additionally, it is possible that there is a need to extend the system with the integration of further nodes. Usually this is not an easy task with an existing line topology. The length of the line may exceed the allowed maximum for the given bit rate when loops are introduced to connect the additional nodes. Some of these problems can be solved using standard repeaters.

Star-wiring with standard repeaters

Characteristic for star-wiring with standard repeaters is the connection of stub lines with CAN repeaters to one main trunk. In the stub segments, many nodes can be connected. This is a solution for some problems of the classic line topology. The use of repeaters permits long stubs, which can lead to a smaller total network. Furthermore the subsequent integration of further CAN nodes like sensors and actuators is eased. In addition the stability of the overall system is increased, because the breakdown of one segment has no effect on the communication of the remaining system.

Moreover the segmentation of the system simplifies trouble shooting, which increases the up-time of the station. Nevertheless this is still not the optimal solution. On one hand the maximum propagation delay of two repeaters has to be used when determining the effective maximum length within such a system. This can cause problems with the chosen bit rate for extended installations. On the other hand the costs for the use of many repeaters may exceed the given budget.

The customer of EMS Dr. Thomas Wünsche was using star wiring with standard repeaters. But costs let them search for alternatives. They found the solution in the star repeater CRep S8C. With the combination and implementation of the main trunk in a FPGA device, it became possible to integrate eight independent CAN segments in one device. This leads to the third possibility of wiring.

Star-wiring with star repeaters

With this method a CRep S8C becomes the central point of the star topology. In addition to the advantages discussed above for the star-wiring with standard repeaters, the use of a dedicated star repeater offers its own improvements. The most obvious one is the significant reduction of segment costs, because one star repeater can replace up to eight standard repeaters. Also the integration of the main trunk in the device reduces the propagation delay between two segments nearly by the factor of 2 compared to a system using standard repeaters. An additional advantage is the increased flexibility of the overall system. It is possible to cascade up to three Crep S8C, which leads to a maximum of 24 physical CAN segments. Every channel can be plugged with its own 3-pin pluggable terminal block. A terminating resistor is integrated for every channel. This enables the connection and disconnection of CAN nodes without changing the rest of the system.

Figure 1: The star repeater CRep S8C (Photo: EMS)

Star-wiring with star repeaters can be recommended for the following cases:

- If many CAN-nodes at different places of a system have to be connected;
- If line topology is not possible because of the expected extent of the system;
- If the network needs to be flexible for the addition of new nodes or segments;
- If parts of the system have to be available although segments of the system are permanently dominant.

Examples for this characteristics can be found in different branches such as mining, access control for e.g. camping sites, or construction of special machines. The company exhibits at the Embedded World fair in hall 1 / stand 640.

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CAN Newsletter Online

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UL-approved CAN infrastructure components

The repeater, segment coupler, and bridge for CANopen and DeviceNet transmissions from Phoenix Contact are now UL approved.

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CAN repeater with anti-noise circuit

HMS Industrial Networks now launches CAN repeaters under the Ixxat brand. These products enable coupling of two or more CAN network segments. The integrated galvanic isolation provides a built-in protection against over voltage and the anti-noise circuit of the units eliminates the effects of EMI (Electromagnetic Interference) like heavy noise on the CAN network.

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CAN repeaters with fiber-optic converters

Shenzhen Comark Technology (China) produces repeaters and hubs with fiber-optic converters for several industrial communication systems including CAN-based networks. The products support CANopen, DeviceNet or J1939 as well as proprietary bit-timing specifications.

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