

How to Calculate the Fiber Transmission Distance of an ICF-1170I CAN-to-fiber Media Converter

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Moxa is a leading provider of edge connectivity, industrial computing, and network infrastructure solutions for enabling connectivity for the Industrial Internet of Things (IIoT). With over 30 years of industry experience, Moxa has connected more than 57 million devices worldwide and has a distribution and service network that reaches customers in more than 70 countries. Moxa delivers lasting business value by empowering industries with reliable networks and sincere service. Information about Moxa’s solutions is available at www.moxa.com.

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This Tech Note applies to the following NPort device server models:

ICF-1170I-M-ST

ICF-1170I-M-ST-T

Why CAN Bus Communication Sometimes Fail

High baud-rate CAN-bus communications can fail when adding two ICF-1170 CAN-to-fiber media converters between a central site and remote site to extend CAN-bus communications of an existing CAN-bus network. The reason for this is due to the propagation delay.

The propagation delay segment exists because the CAN protocol allows for non-destructive arbitration between the nodes contending for access to the bus, and is required for in-frame acknowledgement.

In the case of non-destructive arbitration, more than one node may be transmitting in the arbitration field. Each transmitting node samples data from the bus in order to determine whether it has won the arbitration, and also to receive the arbitration field in case it loses the arbitration.

When each node samples each bit, the value sampled must be the logical superposition of the bit values transmitted by each of the nodes arbitrating for bus access. In the case of the acknowledged field, the transmitting node transmits a recessive bit but expects to receive a dominant bit, i.e., a dominant value must be sampled at the sample point(s).

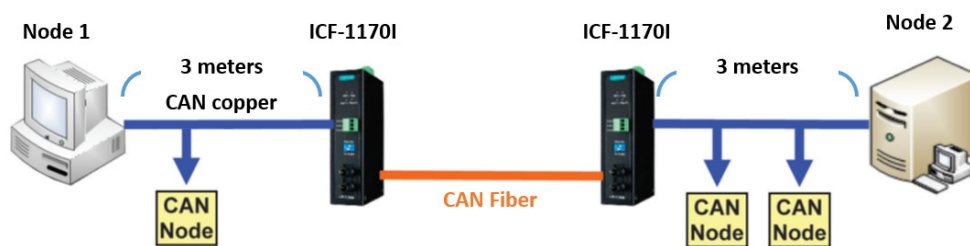
Therefore, the propagation delay segment exists to delay the earliest possible sample of the bit by a node until the transmitted bit values from all the transmitting nodes have reached all of the nodes.

The Maximum Fiber Transmission Distance of the ICF-1170I

Through testing, we have established the maximum fiber communication distance of the ICF-1170I. Please see the results below.

[Test Topology]

Data sent from Node 1 to Node 2



[Test Result]

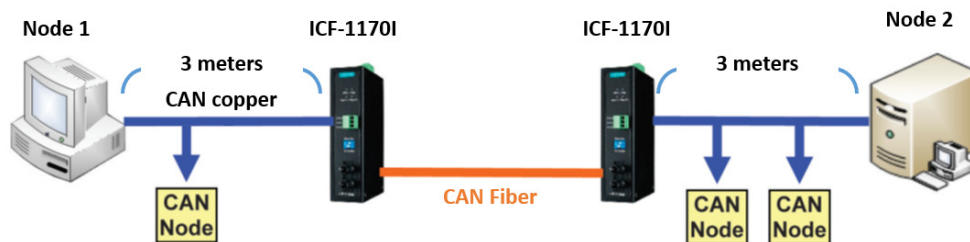
The maximum distance for CAN fiber transmissions is 2 km—depending on the data rate and the protocol used. This table below suggests the maximum fiber lengths at certain baud rates as per ISO-11899-2 while using no more than 3 meters of the CAN-bus cable in the CAN-bus network.

Baud Rate	Fiber Length
1000 kbps	10 m
500 kbps	100 m
250 kbps	250 m
125 kbps	400 m
50 kbps	1000 m
10 kbps	2000 m

Note: The transmission distance is limited by the signal rate, as stated in the ISO 11898-2 standard.

How to Calculate the Fiber Transmission Distance

In order to calculate the maximum fiber transmission distance between two ICF-1170 units, the overall propagation delay that will exist in the entire CAN-bus network needs to be calculated first.



Note 1: The ICF-1170I propagation delay is 200 ns.

Note 2: The signal delay time of the fiber optics and CAN bus is 5 m/ns.

Note 3: In CAN bus, a CAN-bus command is followed by an acknowledgement from the receiver. Thus the total propagation delay needs to be multiplied by 4 in order to take in to consideration the turnaround acknowledgement.

Example

If we assume the baud rate is 250 kbps, then the bit time will be calculated as follows:
 $1/250,000 = .000004$. In this case, the bit time would be 4 μ s. Let's also assume the maximum length of the existing CAN-bus cable between the CAN-bus nodes is 3 meters, and then calculate the propagation delay using the calculated bit time. Add the propagation delay of the cable and that of the ICF-1170 as shown below to determine the total amount of delay. You can then calculate the maximum theoretical fiber transmission distance between both ICF-1170Is.

1. The delay time of CAN bus cable length = $3\text{m} \times 5\text{m/ns}^{\text{Note2}} = 15\text{ ns}$.
2. ICF-1170I Propagation Delay is $200\text{ ns}^{\text{Note1}}$

Total delay time = $\{ 200\text{ns (ICF-1170I delay)} + 15\text{ns (CAN Bus delay)} \} \times 4^{\text{Note3}} = 860\text{ ns}$

→ Fiber Cable Distance < $(.000004 - .000000860) / .000000005 / 2 = 314\text{ meters}$.

So the maximum fiber transmission distance must be less than 314 m.