

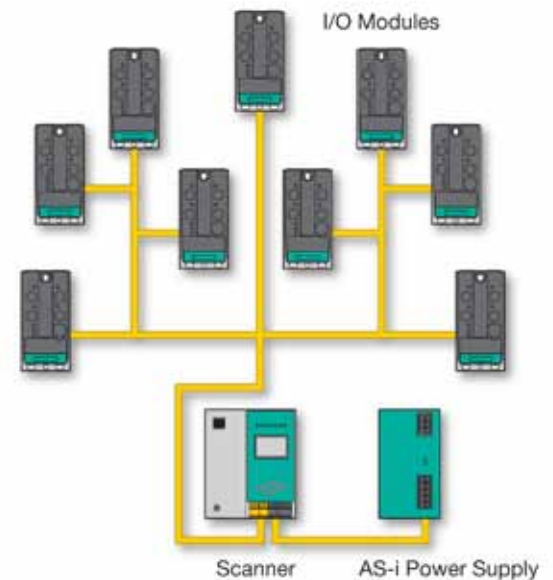
All industrial networks, including AS-Interface, PROFIBUS, DeviceNet, and Ethernet, have cable length restrictions, topology restrictions, or both. These limitations could be based on baud rate, wire gauge, or the type of network transceivers used. As machines get bigger, networks are pushed to the limit, while new and better technologies try and extend the networks even farther.

AS-Interface is one of the only networks that has no topology restriction. It can be laid in a trunk-line, drop-line topology or star configuration. It is usually referred to as a tree topology because network cable can be branched in many directions. The one network infrastructure limitation that AS-Interface has is its length—100 m. AS-Interface was designed to support 62 nodes, one master, and 100 m of cable. Up to two repeaters can be connected in series if larger networks are required.

People often ask, “Why 100 m?” It is clearly not a firm limit, but it is in the specification. The network isn’t going to be completely unstable at 101 m and may work at 150 m without any problems. The 100-meter limit has enough of a safety margin in it to allow a tree-type topology, slightly out-of-specification components, and noise. It is a safe working number that will allow most networks to work without fault. One can exceed the limit, but network analyzers should be used to make sure that communication integrity has not been compromised.

Some networks put a strict limitation on topology, allowing them to be extended much farther. If networks can lower the baud rate, a longer network can be achieved. For example, PROFIBUS has a daisy-chain type network topology. If it is run at 9600 Bit/s, then 1200 m of cable can be run. The same network at 12 Mbit/s would have a cable length of 100 m. This assumes the use of good-quality PROFIBUS certified type A cable with termination at both ends. DeviceNet also has a variable baud rate selection from 125 kBit/s up to 500 kBit/s. This network puts tight restrictions on the length of the drop connections, thickness of the trunk cable, and overall length of the network. AS-Interface, on the other hand, can’t lower its baud rate to extend the

trunk line. It has a fixed transfer speed of 166.66 kBit/s. Very long cable lengths that are achieved with PROFIBUS and other networks are not possible conventionally with AS-Interface.



A normal AS-Interface network has a maximum cable length of 100 m and no termination. Because of the design of the network, a “tree topology” can be used to run cable anywhere required by the application.

One thing that AS-Interface does not have compared to all other networks is termination. Because of the network design, the relatively low baud rate of the system, and the 100-meter limit there is no need for it, so termination wasn’t an integral design criteria when AS-Interface was being developed. Usually reflections are a problem when the length of the cable starts exceeding $\frac{1}{4}$ of the wavelength of a given network. Because the wavelength of AS-Interface is over 1000 m, there has never been a problem. “AS-Interface is a real bus system that copes with reflections and, therefore, topology is not limited,” says Frank Ebert of Pepperl+Fuchs GmbH.

New developments in AS-Interface have challenged this limit. Network extensions patented by Bihl + Wiedemann and sold by many manufacturers have pushed the network length to 300 m per segment, with a total network length of 1500 m possible when using repeaters. Yes, termination isn't in the AS-Interface specification, but with a little planning and network analysis these lengths can be achieved.

When long networks of 1500 m are built, certain features like topology, power supply placement, and repeater use must be optimized. This ensures that the network operates at top performance.

Network Layout

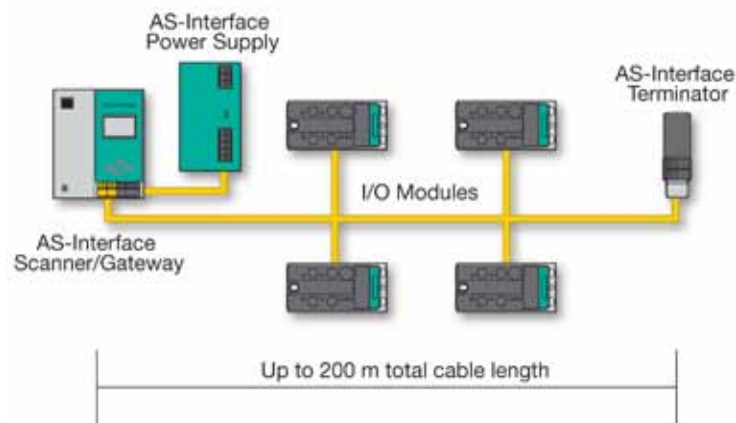
To push the AS-Interface network from 100 m to 300 m, the drops must be kept short or eliminated. Star-type networks or networks with long drop cables will still have open ends even after termination. These open ends will cause reflections and could make termination ineffective.

Termination Type

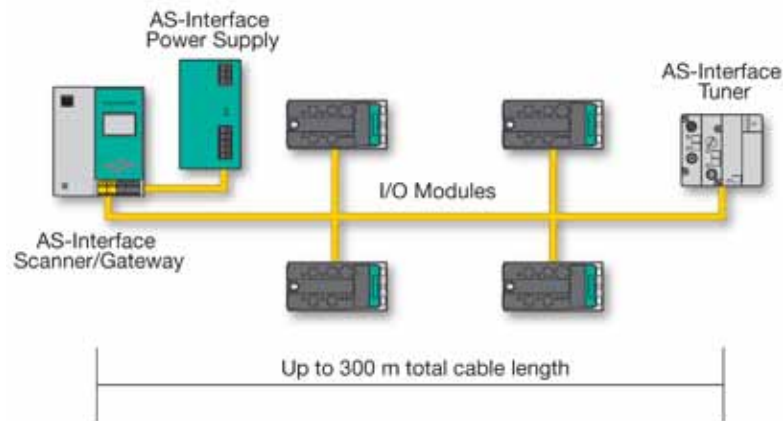
There are a couple types of terminations that can be used. The first is the "terminator."

It has a fixed impedance that will work under most circumstances and can extend the network up to 200 m. Different network components and different cable types mean different termination values may be required if one wants to extend the network farther—up to 300 m. For these situations, a "tuner" was developed.

The tuner was developed on the basis that as long as communication is without fault and there are few or no retries, then the network is working properly. This device requires that a teach-in phase be performed after the network is installed. During this time, the Tuner is dynamically changing the termination values trying to find the optimal settings. When the network retries are minimized, the tuning is complete and the impedance values are locked in. LED indicators show network stability so that re-teaching can be performed if new devices are added or cable has been rerouted.



A 200 m AS-Interface network can be built with a power supply at one end and termination at the other. A "linear network" is required for best performance.



A 300 m AS-Interface network can be built with a power supply at one end and a tuner at the other. A "linear network" is used for best performance and a tune in procedure is performed in configuration mode after all AS-Interface nodes and gateway are attached to the network.

Repeater Selection

The specification limits the number of repeaters that can be used on the network to two in series and that has not changed. This limitation is caused by a combination of propagation delay of cable, slave synchronization, and repeater delay times. If the time is longer than 63 μ s, the AS-Interface scanner must retry. Long networks could have cable lengths as long as 900 m, which would extend the propagation delay time from 3.6 μ s to 11 μ s. To compensate for this extra delay time, advanced repeaters were developed to cut the normal repeater delay time from 14 μ s to 9 μ s. This time savings is enough for the AS-Interface node to respond in time for even the longest designed networks. Advanced repeaters are required when termination is used.

Network termination is a great way to extend an existing AS-Interface network. However, it will not help against installations with poor network wiring, out-of-spec. AS-Interface cable, nonconformance tested devices, or extreme noise sources close to network components are used. A network analyzer should be used to help troubleshoot and pinpoint network issues and to verify that termination was effective in extending the network. The proper network layout and the use of AS-Interface specification components will assure error-free networks for years to come.



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