

Fieldbus 301

Network wiring fundamentals

- Overview
- A fieldbus advantage
- Basic segment design
- Wire types and segment lengths
- Total segment length
- Mixing wire types on a segment
- Spur length

Overview

What are the rules for wiring a fieldbus network?

Many aspects of a FOUNDATION fieldbus network are similar to a traditional analog control network. You'll still need wire, power, field devices, I/O cards, and possibly intrinsic safety barriers. There are a few new components, such as terminators. And there are differences in how you put the pieces together. But different doesn't mean harder. In this case, different means better.

This course focuses on wiring, which is the backbone of the fieldbus network — and one of the most visible changes to the traditional system.

Hint: As you go through the topics in this course, watch for answers to these questions:

- *Does existing plant wire need to be replaced to use FOUNDATION fieldbus?*
- *What's the difference between a branch layout and a tree layout?*
- *Can you mix wire types on a segment?*

A fieldbus advantage

Wire isn't very expensive — if you're connecting a couple of instruments a few yards away.

But put in a few miles of wire to connect hundreds — or even thousands — of individual devices across a plant, and you're talking about a major expense. Especially when you include the labor required to install the wire, as well as conduits and cable trays. Not to mention documenting every wire and connection, then keeping up with changes.

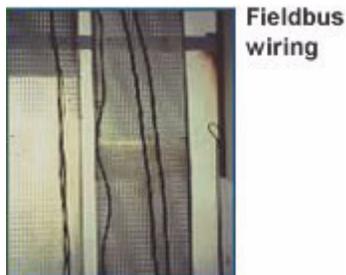
You get the picture.



These are the costs that FOUNDATION fieldbus and PlantWeb architecture are designed to reduce.

- Digital communication enables several devices to share the same cable, vastly reducing the total amount of wire required.
- FOUNDATION fieldbus H1 can work on standard plant wiring, so you can even use wires that are already available.
- If you do need to add wiring, either for new construction or for a capacity increase, available wiring and cable options make the job easier and the results more reliable.

And all of that translates into a lot less cost.

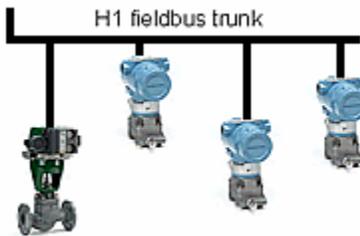


Basic segment design

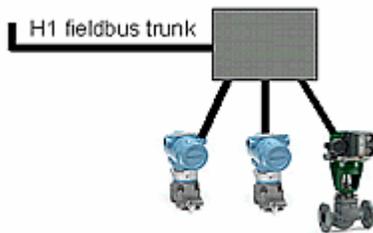
Conventional analog installations have a dedicated pair of wires connecting each field device to a host system. FOUNDATION fieldbus installations use a single twisted-pair cable — also called

a bus or trunk — to connect multiple devices. The cable, connected devices, and supporting components are called a segment.

Devices connect to the fieldbus either individually or in groups. If they connect through individual spurs branching off the main trunk, the result is called a **branch** layout or topology



A bus with spurs connected to the trunk in close groups is called a **tree** layout.



A single segment can have both branches and trees, as long as a few rules are followed for total segment length, length of drops, total device count, and segment current draw.

Key segment limits	Typical values
Maximum of 32 devices per segment without a repeater	4 to 16 devices per segment
Maximum of 240 devices per segment with a repeater	
Each device must draw at least 8 mA from the segment	15 to 25 mA power consumption for a two-wire device 8.5 mA for a four-wire device 400 mA typical segment limit
Voltage range 9-32 Vdc	24 Vdc

Wire types and segment lengths

The length of a total fieldbus segment depends on the type of wire you're using.

For example, the maximum wire length is 1900 meters (6232 feet) if typical instrument grade wire — individually shielded twisted pairs — is used. The maximum length drops to 200 meters (656 feet) if you're using just two wires with no shield and not twisted.

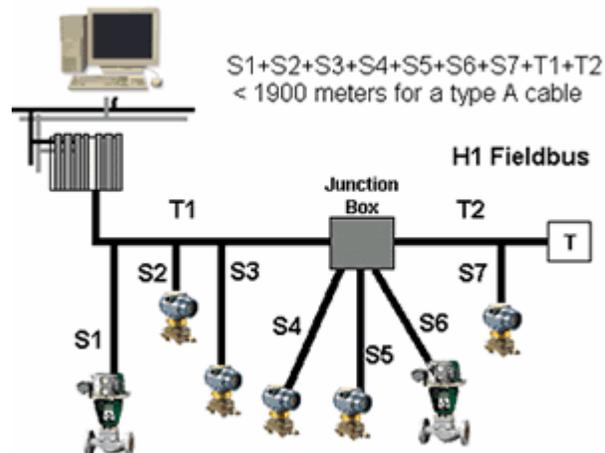
The table below provides examples of wire types and allowable segment lengths.

Type	Description	Size	Maximum length
A	Individual shielded, twisted pair	#18 AWG (0.8 mm ²)	1900 m (6232 ft.)
B	Multiple-twisted-pair with overall shield	#22 AWG (0.32 mm ²)	1200 m (3936 ft.)
C	Multiple-twisted-pair without shield	#26 AWG (0.13 mm ²)	400 m (1312 ft.)
D	Two wires with no shield and not twisted	#16 AWG (1.25 mm ²)	200 m (656 ft.)

Total length segment

Total segment length is determined by adding the length of all the sections of the segment. The total segment length must be within the maximum allowed for the wire type(s) used.

The diagram provides an example.



The total segment length is the sum of the lengths of all the spurs (S1 through S7), plus the length of the main cables, or trunks (T1 and T2). For type A wire, the total must be less than 1900 meters.

Mixing wire types on a segment

You can use different wire types on the same FOUNDATION fieldbus segment — as long as you follow the rules about how much of each type can coexist on the segment.

To find the maximum length of each wire type on a segment, first calculate the following ratio for each wire:

$$\frac{\text{Length of individual wire}}{\text{Max. length for wire type}}$$

(For maximum lengths for each wire type, see the previous topic, "Wire types and segment length.")

Then add the ratios for all the individual wires in the segment. If the sum of the ratios is less than 1.0 (or 100%), the wire combinations and lengths are acceptable.

Here's an example:

A segment has 2000 feet (610 meters) of type A shielded twisted pair wire and 400 feet (122 meters) of type D non-shielded, non-twisted pair. Is this combination acceptable?

$\frac{2000 \text{ ft A}}{6232 \text{ ft max}} = 0.32$	$\frac{400 \text{ ft D}}{656 \text{ ft max}} = 0.61$
$0.32 + 0.61 = 0.93 \text{ or } 93\%$	

The sum of 0.93 or 93% is less than 1.0 or 100%. So this is an acceptable wire combination.

Spur length

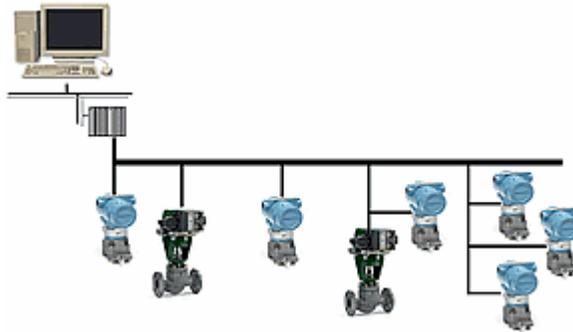
The maximum length of a spur depends on

- the total number of devices on the spur, and
- the total number of devices on the segment

Total devices on segment	Devices per spur		
	1	2	3
1-12	120 m	90 m	60 m
13-14	90 m	60 m	30 m
15-18	60 m	30 m	1 m

Note that a spur can have up to three devices.

For example, the diagram below shows a segment with a total of eight devices. Reading across the "1-12" row in the table, that means the spurs with one device can each be 120 meters long, the spur with two devices can be 90 meters, and the spur with three devices can be 60 meters.



Practical pointer

Some suppliers offer automated segment design tools that take all these rules into consideration. These tools make FOUNDATION fieldbus segment design quick and easy.