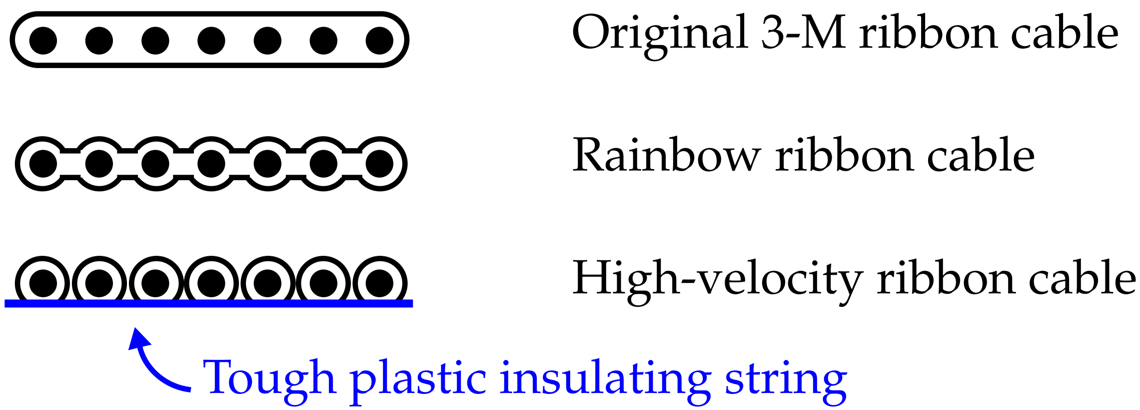
Ribbon Cables

A ribbon cable is any cable having multiple conductors bound together in a flat, wide strip.



Each dielectric configuration has different high-frequency characteristics.

All configurations support a parallel arrangement of wires running a precisely controlled separations.

This supports the easy insertion of **mass termination connectors**.

They are popular because they are cheap.

Also, the uniform separation makes them excellent transmission lines.

Ribbon Cable Signal Propagation

The rise time of a ribbon cable varies with the square of its length.

$$T_{10\text{-}90} = \frac{3L^2}{K}$$

K = constant dependent on cable, ft^2-GHz

L = length, ft

Reducing the length by 1/2, reduces rise time by 1/4, etc...

This is also true for coax and twisted pair.

This is true because the frequency response for any cable is determined by the cable's inductance, capacitance and resistance/length.

All cable types share the same basic frequency response shape.

$$|H(f)| = e^{-0.546\frac{[L^2 f]^{1/2}}{K}}$$

Only K differs for different cable types.

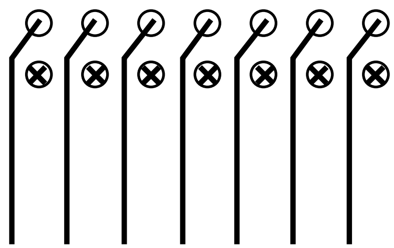
Ribbon Cable Signal Propagation

Shape invariance means, if K changes, you can compensate by modifying L.

In other words, you can get the *same response* using a long piece of coax or a short piece of ribbon cable.

Ribbon cable work very well at short distances.

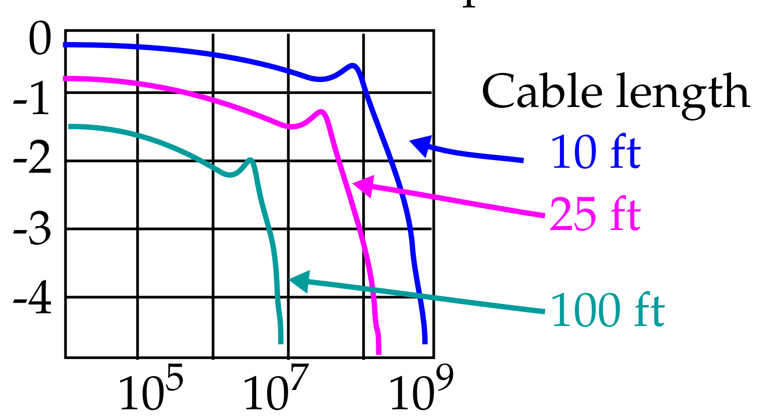
The response depends on the ground connection arrangement.



G-S-G arrangement

This arrangement yields a characteristic impedance between 80 and 100 Ω.

Freq response magnitude (dB)



Ribbon Cable Frequency Response

From the figure, a 10′ section produces an attenuation of less then 3.3 dB up to about 500 MHz.

The effective bandwidth varies with the **inverse square** of distance.

For ribbon cables less than 10 ft., the performance is very good.

At 100 ft., the 3.3-dB attenuation point occurs at 5 MHz, yielding a rise time of 100 ns.

Note the shape of the curves doesn’t change, they are only shifted.

The bumps occur because the cable terminations in the simulations were **not complex** (a resistor was used), and some mismatch occurred.

Also, resistive terminations cause cable resistance to introduce a DC attenuation, e.g., 100-ft response has a 1.5 dB attenuation at DC.

The cables dielectric impacts performance in two ways.

It controls signal *propagation velocity* and *attenuation*.

Ribbon Cable Frequency Response

Propagation velocity, in ft/ns, is **inversely proportional** to the *square root* of electric permittivity.

Cables with a dielectric surrounding the wires exhibit lower speed while cables on a thin, flat plastic sheet are high speed (air carries their field).

Attenuation depends on the **ratio** of *series resistance* to *cable impedance*.

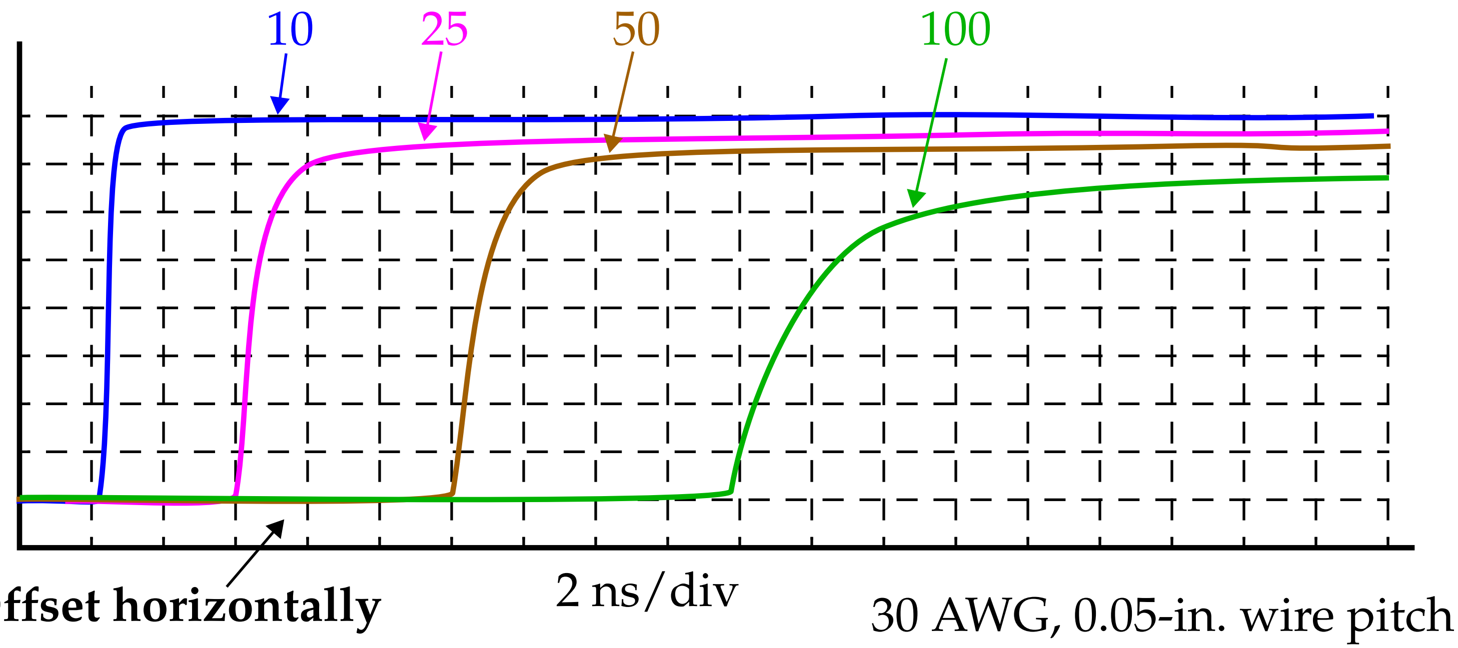
At high frequencies, skin effect causes series resistance to rise with the *square root* of frequency, and so follows attenuation.

Also, the **dielectric** influences attenuation by changing the cable's characteristic impedance.

Cables completely surrounded in a dielectric material exhibit *higher* effective permittivity, and more attenuation.

Ribbon Cable Rise Time

Rise time of 4 lengths of ribbon cables.



Rise time is proportional to the **square** of the length.

There is also a DC, resistive, attentuation.

To compute rise time given one value of attenuation, length and frequency.

$$K = \frac{L_0^2 F_0 (22.5)}{A_0^2}$$

Previous equation solved for K.

A_0 = attenuation, dB

Ribbon Cable Rise Time

Once K is known, then

$$T_{10\text{-}90} = \frac{3(L^2)}{K}$$

Crosstalk

Crosstalk in ribbon cables varies with the placement of grounds among the signal conductors.

Here, both inductive and capacitive crosstalk are present and are nearly equal.

This causes a large reverse coupling coefficient, but almost no forward coupling.