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Mesuring the Impedance of a Coax Using an SWR Analyser

- Calculate the required frequency (F in MHz), which is related to the cable length L in feet :

F = 185 / L (This is approximately the quarter wavelength frequency)

- Connect the cable to the SWR analyzer and terminate the other end with a 50 ohms load.

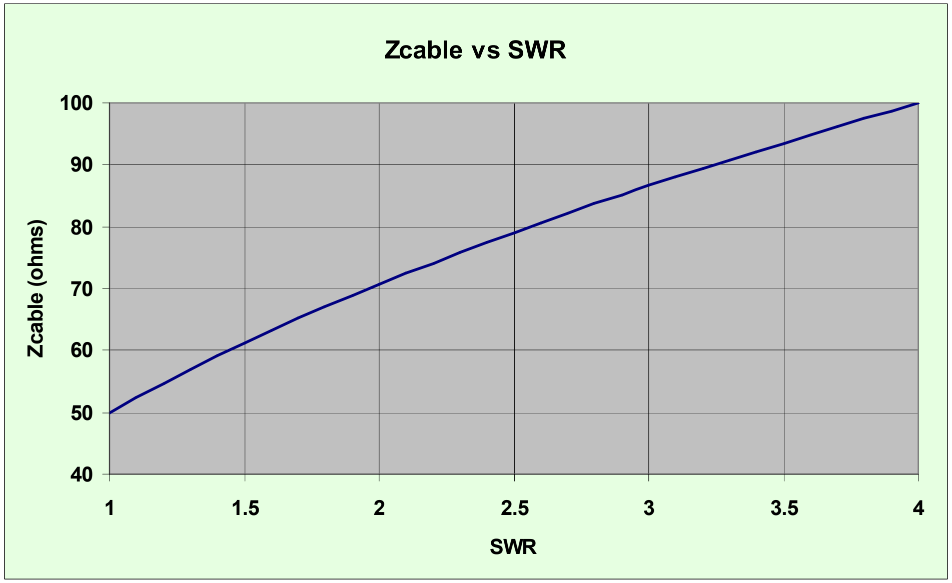
- Measure the SWR. If you get 1:1, then the cable impedance is 50 ohms.
  If the SWR is above 1:1, change the frequency to <u>maximize</u> the SWR reading.

- Calculate Zcable at the frequency where the SWR is maximum, or use the graph below:

$$Zcable = 50 * \sqrt{SWR}$$

Exemple: SWR = 2.25 gives Zcable = 75 ohms

- NOTE: This technique is valid for Zcable >= 50 ohms.



Computing the cable impedance Zo with an L-C meter:

Quick and easy !

$$Zo = 31.62 * \sqrt{\frac{L_{(nH)\ short}}{C_{(pF)\ open}}}$$

L is measured with the line end shorted
C is measured with the line end open

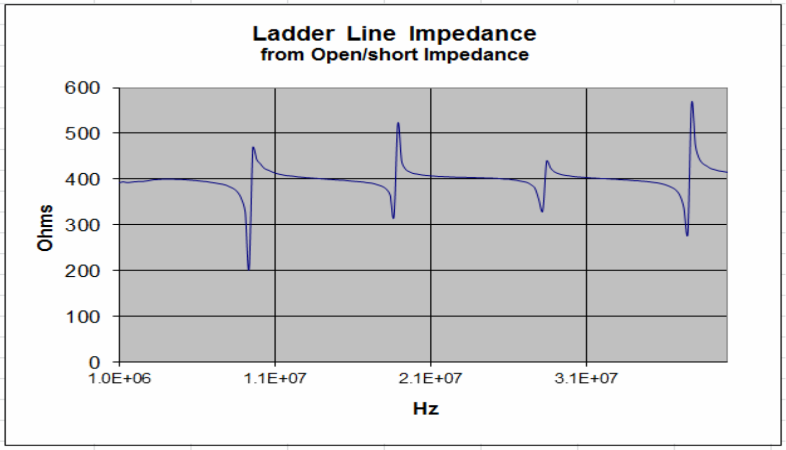
The cable length should be less than 1 % of the wavelength at the test frequency.
So, if using the AADE L-C meter, the cable length should be under 12 feet.
If measuring at 100 KHz, the cable length should be under 80 feet.

Computing the cable impedance Zo with a VNA:

Computing the cable impedance as:

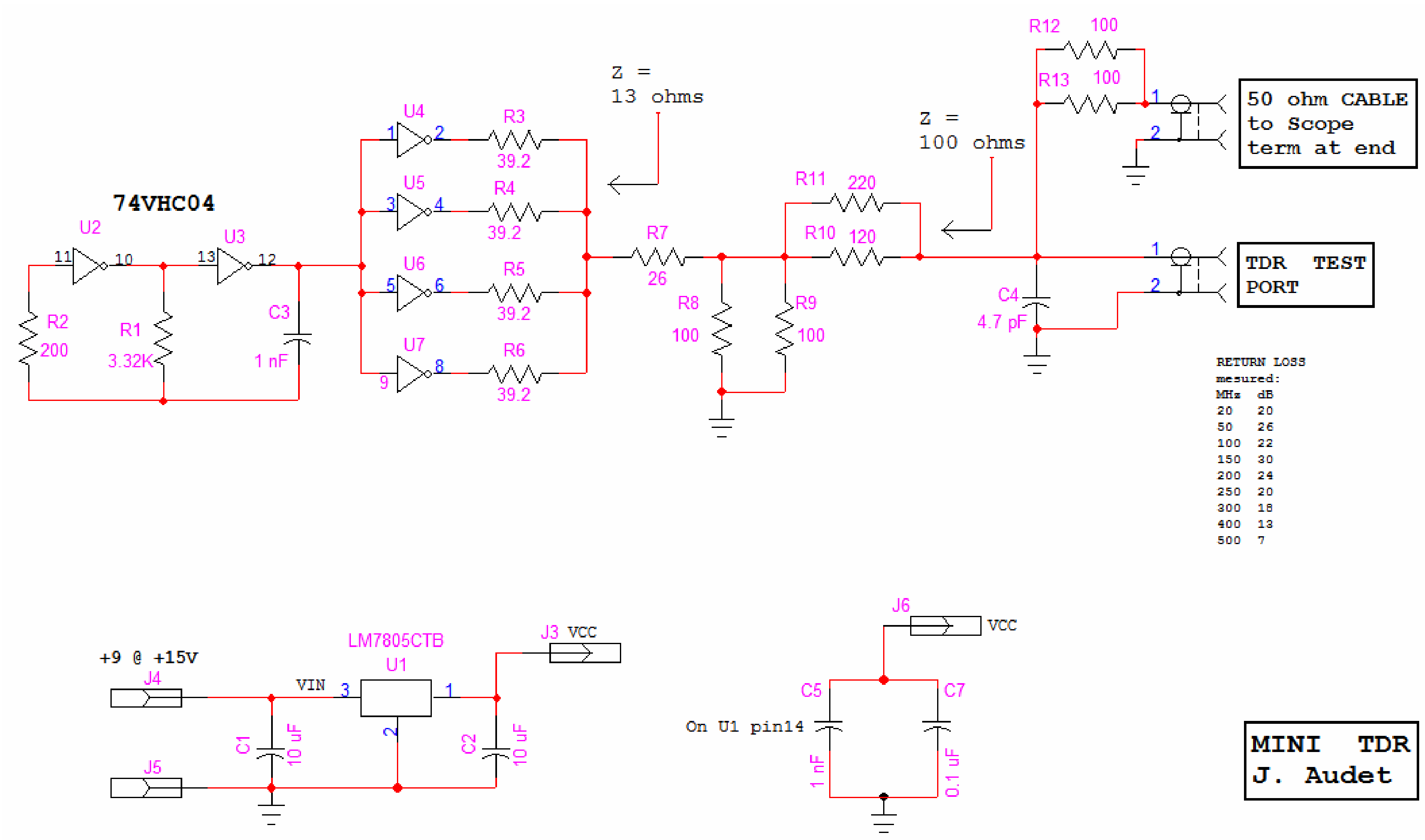
$$Zo = \sqrt{Zopen \times Zshort}$$

Measure the complex impedances Zopen and Zshort with a VNA.
Perform the calculation on the left.
Contact me for an Excel spreadsheet that does these calculations.
The best frequency to use is around 45 degrees line length.
See: http://ve2azx.net/technical/Degrees-Length.pdf
Zo calculated will have a complex value, ie a small amount of negative reactance. This is normal.



Example of Zo magnitude measurement on a ladder line.
A 4:1 balun was used to improve the accuracy of impedance measurements (derived from S11).
The peaks occur at line lenghts which are multiples of 90 degrees. These errors are caused by inaccuracies in measuring extreme values of impedance.

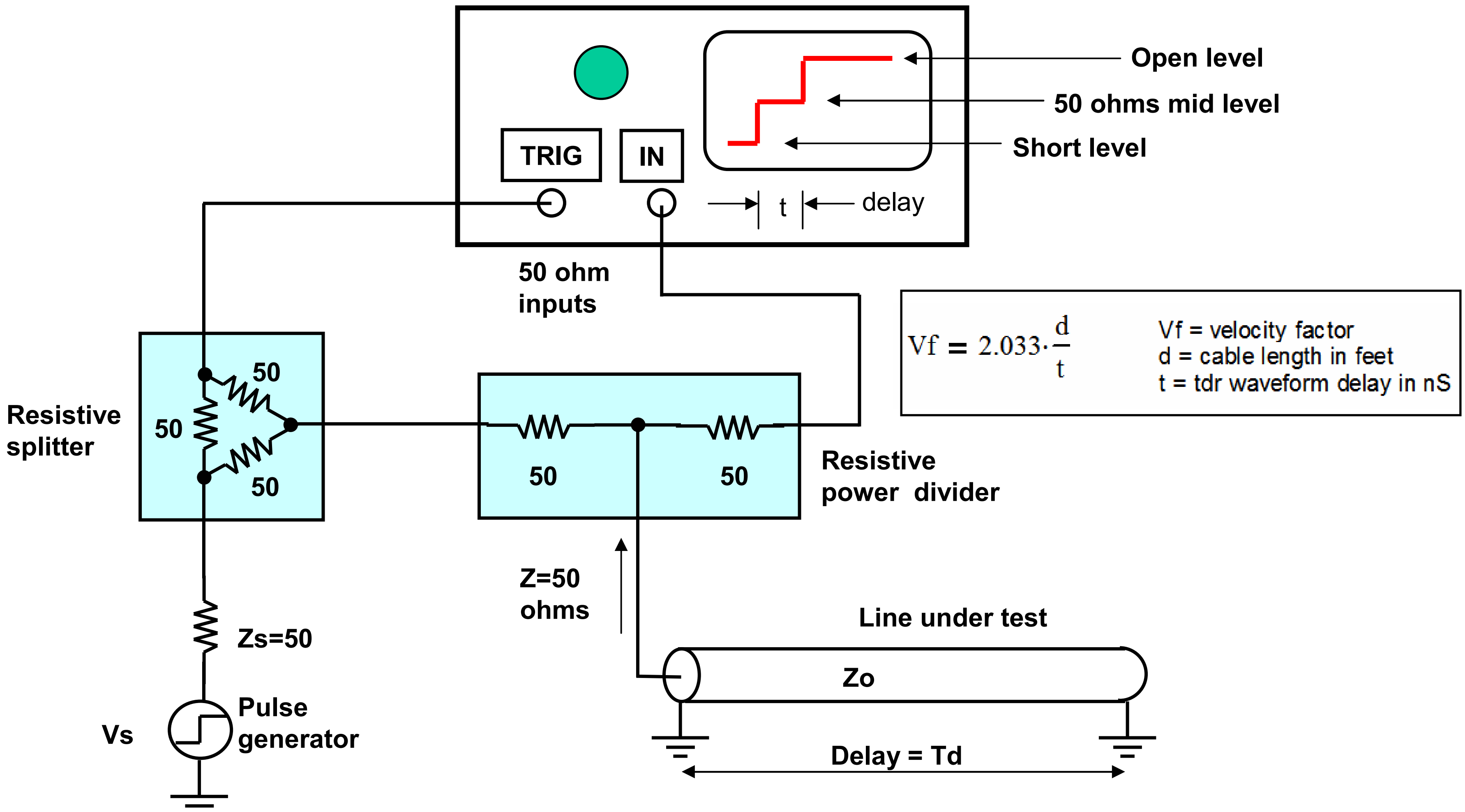
Computing the cable impedance Zo with a TDR:



MHz	dB
20	20
50	26
100	22
150	30
200	24
250	20
300	18
400	13
500	7

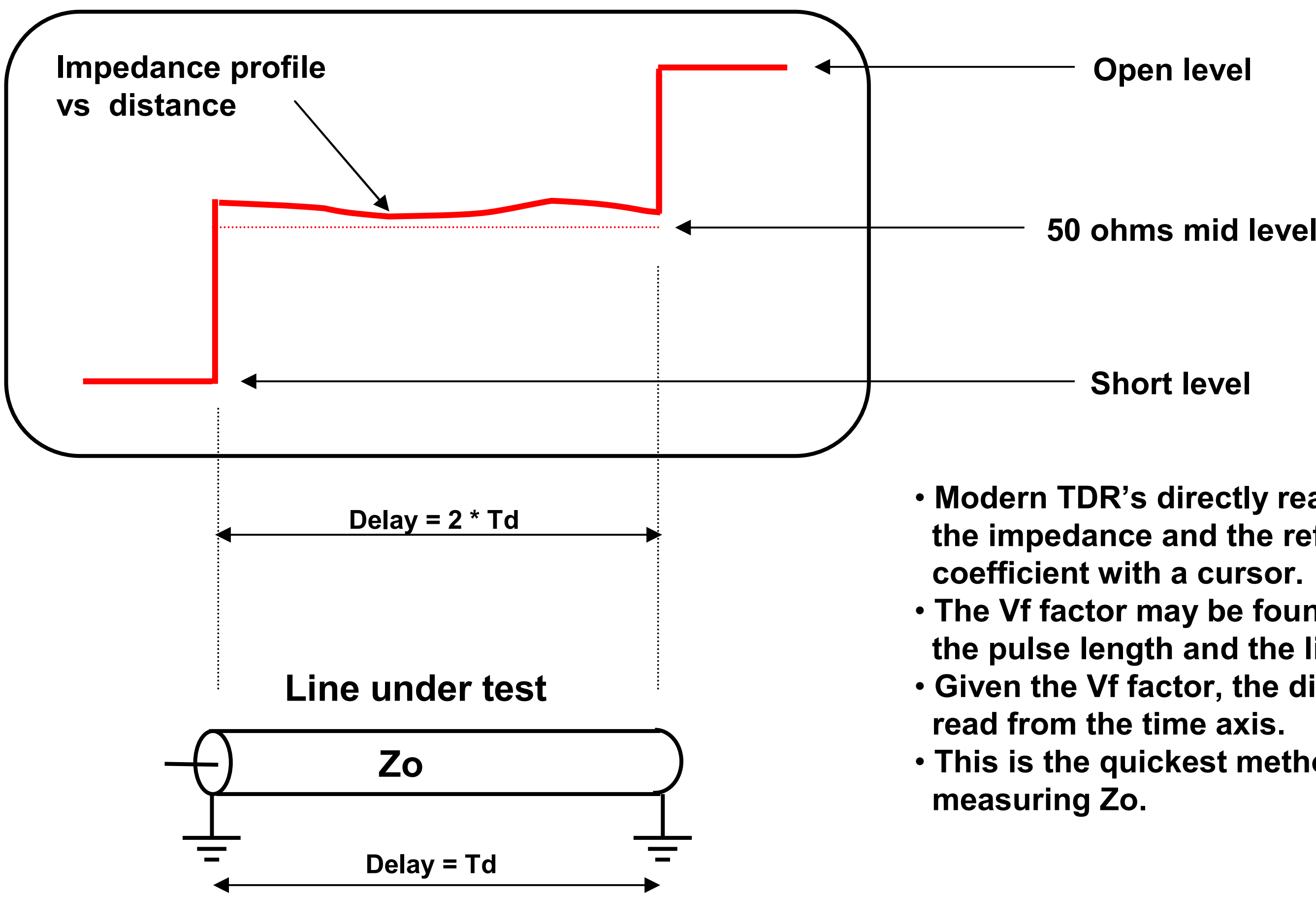
Use your pulse generator to make your TDR

A basic TDR - Time Domain Reflectometer



TDR - Measurements

Time Domain Reflectometer - Impedance measurements

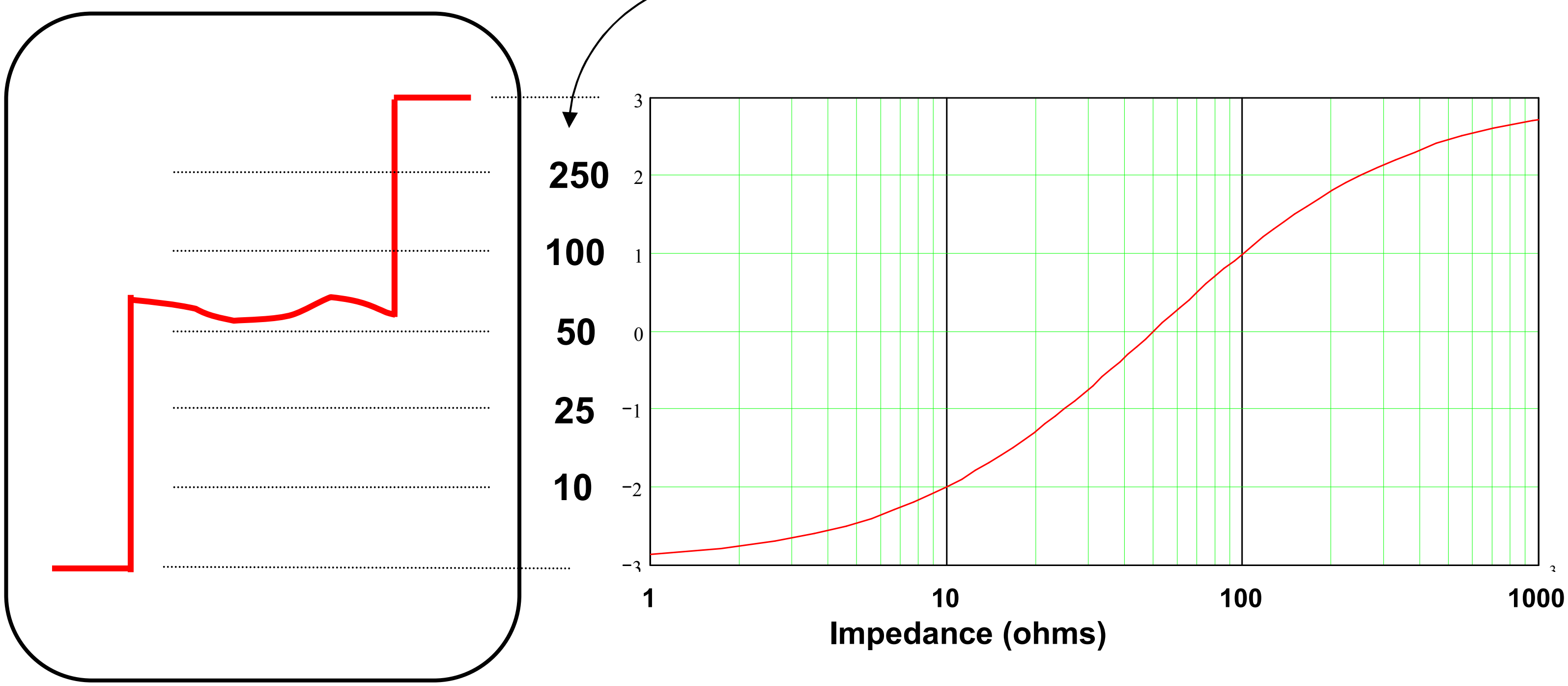


- Modern TDR's directly read the impedance and the reflection coefficient with a cursor.
- The Vf factor may be found from the pulse length and the line length.
- Given the Vf factor, the distance is read from the time axis.
- This is the quickest method for measuring Zo.

TDR Impedance Measurements

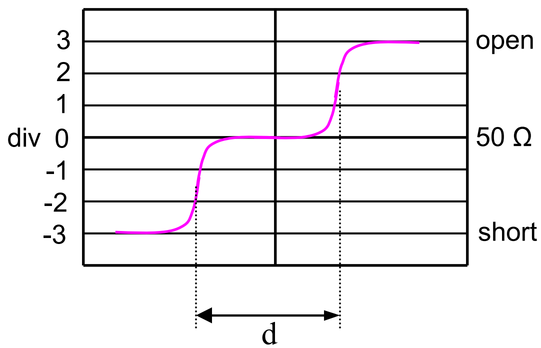
Reading the Impedance value

Line impedance



Transmission Lines - Measurements

$$Z = Z_0 \cdot \frac{(3 + div)}{(3 - div)}$$



$$Vf = 2.033 \cdot \frac{d}{t}$$

Vf = velocity factor
d = distance in feet
t = tdr waveform delay in nS

# divisions above 50Ω	Ohms	**# divisions below 50Ω**	Ohms
0	50	-1.5	16.7
0.1	53.4	-1.4	18.2
0.2	57.1	-1.3	19.8
0.3	61.1	-1.2	21.4
0.4	65.4	-1.1	23.2
0.5	70	-1	25
0.6	75	-0.9	26.9
0.7	80.4	-0.8	28.9
0.8	86.4	-0.7	31.1
0.9	92.9	-0.6	33.3
1	100	-0.5	35.7
1.1	107.9	-0.4	38.2
1.2	116.7	-0.3	40.9
1.3	126.5	-0.2	43.8
1.4	137.5	-0.1	46.8
1.5	150	0	50