EXTRA APPLICATION INFO FOR THE LAN TEST PULSE GENERATOR

For determining impedance + velocity value + length measurement for an unknown cable.

1) With a known length (at least 1 to 5 meters):
Terminate with an adjustment (trimming) potentiometer, control range of 0 to 250 ohms. E.g. a 220 or 250 ohm trim potentiometer on a piece of PCB-clad with 2 short wires (max. 2 cm) with crocodile clamps.
Rotate till the echo pulses are gone.
Potentiometer value = Z of the cable. Up to a few ohm precision is possible.
Difference between 50 and 52 ohms coax highly measurable!
Also make a 100 ohm and 500 ohm terminate module.

2) With an accurately known cable length being tested the true shortening factor (velocity) will be known.
Measure the length accurately between the undamaged sheath!
The velocity is NOT always default to 0.66! Cable echo measurement can be done with open or shorted wires at the end. Do not connect a dummy.
More air in the plastic dielectricum gives a value more closely to 1.0. More (cheap) solid plastic gives a value sinking to 0.5 to 0.6. And teflon is different than polyethylene.
If an exact known length is tested than from the total echo duration (= 2x, return!) T it is easy to calculate the real velocity.

After that you can do this:

3) For example, with an open cable and thus a known shortening (velocity) factor:
Time in nanosecond on the scope display between generator and echo pulse = 2x (return) the pulse traveling time. Herewith the real length can be calculated exactly.
E.g. for an unknown cable length running through a building! If there is any damage you can see exactly where also! This gives a small (mini) echo.
With a standard pulse generator there must be estimated if the expected echo falls before or after the next generator pulse!!
With my pulse generator box with large delay the successive pulse represents an average of 1000 meters of cable traveling time!

After conversion of the measurement data:

For RG58, v = about 0.66
Total traveling time standard RG58 coaxial = 2x length in meters / velocity x light speed in meters/sec =

$T = 2.\ L\ /\ 0.66\ .\ 300\ .\ 10^{6}$ sec in traveling time.

And also for RG58:

Length in meters = velocity x light speed in m/sec x total pulse duration in sec / 2

$L = 0.66 \times 300 \times 10^{6} \times$ total pulse duration / 2

Length known, but the velocity of an unknown cable is not:

v = 2 x L in meters / light speed in m/sec x total traveling time in sec.

v = 2 x L in meters / 300 x 10^6 x total pulse traveling time in sec.

Example velocity:

48 m stranded (flexible) UTP CAT5E indicates 460 nsec echo

v = 2 x 48 / 300 x 10^6 x 460 x 10^{-9} = 0.6957

(measured Z = 102 ohms)

17.75 m solid UTP CAT5 gives 175 nsec echo

v = 2 x 17.75 / 300 x 10^6 x 175 x 10^{-9} = 0.676

(measured Z = 110 ohms)

Sample length:

A full reel RG58 gives on the scope an exactly 5 usec pulse echo duration. (So with return)

L = 0.66 x 300 x 10^6 x 5 x 10^{-6} / 2 = 495 meters

The full reel was before the cutting of a test piece estimated at 500 meters, so OK .....

Cheap standard 50 ohm stuff – RG58 with v = about 0.66 – gives with a T = echo pulse value in usec expressed:

L in meters = 0.66 . 300 . T / 2 = 99. T.

Roughly the length can be estimated in that case to be approximately 100 x T!
(And only for RG58 or equivalent with an approximate v = 0.66)