VNA Project

- Open Source Vector Network Analyzer
- Low-cost, simple hardware
- Software released under GNU GPL
- Uses USB to interface to host
- Target software downloaded by host
- Target processor is Cypress EZUSB (8051 with additions)
  - Written in C with Keil tools.
- Host is Windows 98 – Windows XP
  - Written in Microsoft C++ .NET 1.1.
A Few VNA Applications

• **S21**
  - Filter transmittance
  - Attenuators (flatness, delay)
  - Power splitters
  - Baluns
  - Phasing networks
  - Crystals, resonances, impedances
  - Amplifier gain, delay
  - Cable electrical length, velocity factor

• **S11**
  - Antenna measurements
  - Complex load impedance
  - Power splitters, diplexers
  - Filter return loss
  - Amplifier return loss
  - Cable impedance
Kit proved to be too difficult for TAPR – 8 fine lead pitch surface mount parts.
  – Steve Bible hand-assembled these on the 10 beta units.
  – Does not scale well for kits!
TenTec is selling assembled & tested unit.
  – Including cables, attenuators, etc.
Bare circuit boards will be available from TAPR.
  – Need to be an SMT expert to build it yourself
Software, parts list, schematic, etc. available at:
ftp://ftp.tapr.org/pub/n5eg
R3 Circuit Board - Integrated Preamplifier
Software Enhancements Added

• Added Time Domain Reflectometer (TDR) display mode
  – Useful for:
    • Locating cable fault distance(s).
    • Determining Cable Velocity Factor (VF).
• TDR synthesized from S11 frequency sweep
  – Inverse Fast Fourier Transform of wideband reflection sweep.
  – Key issue is time resolution. Limited by the upper frequency of the VNA: 120 MHz.
  – 120 MHz $\rightarrow$ 8.25 nanoseconds.
  – Trick used to double resolution:
    • Extrapolate low and negative frequency data from sweep.
    • Doubles resolution $\rightarrow$ 4.125 nanoseconds.
  – Cable reflection doubles delay $\rightarrow$ 2.06 nanoseconds.
    • Velocity factor 0.66 converts to about 1.3 feet resolution.
    • Can visually interpolate between points of the IFFT for better than this.
TDR resolution enhancement

Actual S11 Measurement of Cable

DC
Low frequency limit of VNA

Negative Frequency, MHz.
Positive Frequency, MHz.

Magnitude
Phase

Extrapolation
Complex conjugate

Doubles effective frequency sweep range
Interpolation

Start Frequency: 585,935
Stop Frequency: 120,116,675
Tx Level, dB: 0
Ref. Level, dB: 0
TDR Setup

- Sets start and stop time of display (zoom).
- Fixture Calibration determines the reference plane.
- Guess required for cable velocity factor.
- If distance to short or open is known then VF of the cable can be determined.
Signal Generator Application

- Existing hardware provides for reference clock to be strapped ‘External’
- SIGGEN R1.0 application available on TAPR website
  - Different downloadable image than VNA – automatically handled.
  - Different host image than VNA – automatically handled.
  - Source code and binary windows installer available.
- Allows using:
  - GPS-derived external 10,000,000,000 Hz. reference clock,
  - or other external reference in the range of 5-75 MHz
- Provides micro-hertz resolution and finer granularity amplitude setting.
- Contains analog phase-meter for comparing phase of external input to the synthesized frequency.
  - Useful for monitoring coarse behavior of test inputs compared to the synthesized reference.
External Ref Clock

External Reference Clock input
Signal Generator

Phase ofRecv W.R.T. Source

Frequency

10,000,000.00000000

Level

0.00
Resources

- Current parts list, build docs, schematic, updated source code, help files, Windows binary executable, *this presentation*
  ftp://ftp.tapr.org/pub/n5eg

- TenTec Website
  http://www.tentec.com

- TAPR Website
  http://www.tapr.org