SOFTWARE TO MAKE A SOFTWARE DEFINED RADIO (SDR) INTO A VECTOR NETWORK ANALYZER (VNA)

INVENTOR:

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Using Software Defined Radios (SDR) to Power Vector Network Analyzers (VNA)

This idea is to use a SDR as the RF engine to power a VNA. Attached with this disclosure also find reading material and slides on conventional VNAs and S-parameters.

SDRs input and output a digital stream of I (in-phase) and Q (quadrature) voltages from a controller/processor to source or receive RF (radio frequency) signals. The processor may be a laptop, a tablet, a cell phone, or other dedicated device. The controller may be headless or contain user input-output and a display. Communications between the controller and the SDR may be USB, high speed serial, Ethernet, or any other method. Power to the SDR can optionally be provided by a communications cable. The VNA can be remotely located, for example at a headend, fiber node, or cell tower.

The operating system employed may be Android, Windows, MAC, IOS or Linus. Or the software can be an executable run from a microprocessor.

The VNA typically needs to have its RF components calibrated for precision measurement of S-parameters on a device under test (DUT). Calibration results are stored for future use.

The VNA will have an ability to sweep a test frequency range which is within the range of the SDR.

The VNA will also have an ability to sweep RF power, which are used for testing nonlinear distortion.

The VNA may also have its transmit power calibrated so swept power is uniform.

The VNA may also employ linear amplifiers on the transmit output to increase power, or on the receiver input to improve sensitivity.

The VNA can have its swept test signal as uniform frequency steps, log steps, continuous sweep, or generate a continuous broadband signal, such as a chirp, a stepped chirp, a Zadoff-Chu sequence, or any desired reference signal. Dwell time at each frequency can be adjusted to reduce noise, or test frequencies can be “stepped over” to avoid interference with communications signals. IF signal bandwidth can be dynamically adjusted.

The controller may have an optional ability to run custom programs or test sequences. Thus, a tech at a cell tower would likely run different diagnostic routines than a tech at a fiber node or hub site.

Fig. 1 is a block diagram of a prior-art VNA taken from the Agilent training slides.

Fig. 2 is a block diagram of a VNA using a SDR, which may be a Pluto device from Analog Devices. The device may be a 1-transmit and 1-receive channel, or the SDR may utilize multiple channels. The source comes from a TX port on the SDR. The 3-way switch may be manual, computer controller, solid state electronic, or accomplished by moving coaxial connectors. Ports that are not connected should be terminated.

A Nano VNA is a low cost VNA that can be evaluated for comparable basic functionality.

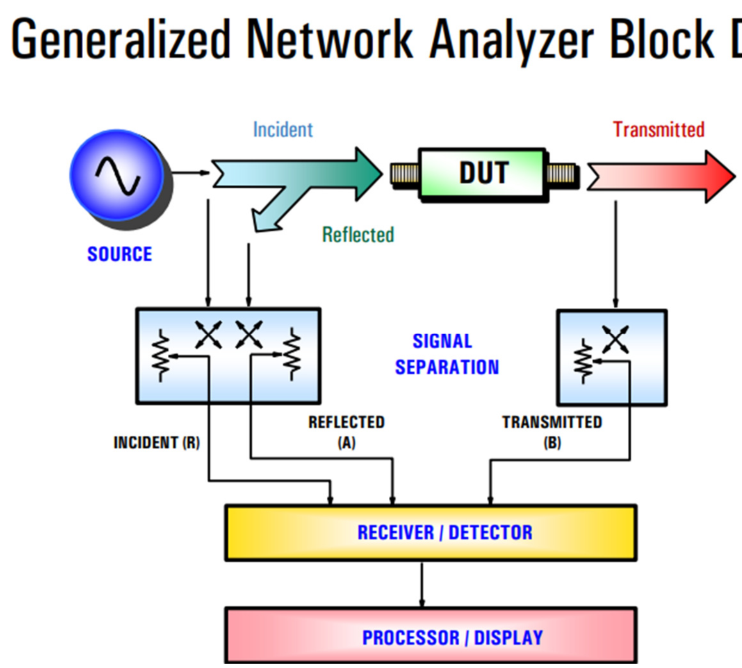

Fig. 1 Conventional VNA

Calibration kit should be supplied which includes cables, plus an open, short, termination, and thru connector. Calibration can be done by manually moving connectors, or automatic with switching under computer control. Calibration can entail more or less steps depending on the test being performed, as described in the accompanying Agilent slide stack. The block diagram of Fig. 2 gives S11 and S21. If the S22 and S12 parameters are needed, the DUT can be turned around by exchanging input and output connectors.

The tester can use a return loss bridge to measure reflections, or it can use a simple 50 or 75 ohm splitter for low cost applications.

Fig. 3 is a heterodyne converter that may optionally be used to extend the frequency range of the SDR. In this example, a 105 MHz transmit test signal is down converted to 5MHz to test a device, and them upconverted back to 105MHz for the receiver. Filters may optionally be used to protect the receiver and/or the DUT from image frequencies. If the SDR has two transmit channels, one transmit channel can be used as the 100 MHz local oscillator.

Fig. 4 is a flow diagram that a cable technician might use. The test that can be chosen are transmission tests when both ends of a cable are co-located, return loss tests on field components or lab components, TDR (time domain reflectometer) tests on cable lines, shielding isolation tests on coax cable or houses using sheath current induction tests, or amplifier tests, including group delay.

The SDR can also be used as a vector network analyzer (VNA) by not using the transmitter, or as a sweep generator by not using the receiver.

The device’s controller can be upgraded with new software with bug fixes and new features, and the FPGA (field programmable gate array) inside the SDR can be re-programmed if desired.

The economics of building a test device are very attractive for cable operators.

Ham radio operators can also use these devices, primarily for antenna testing.

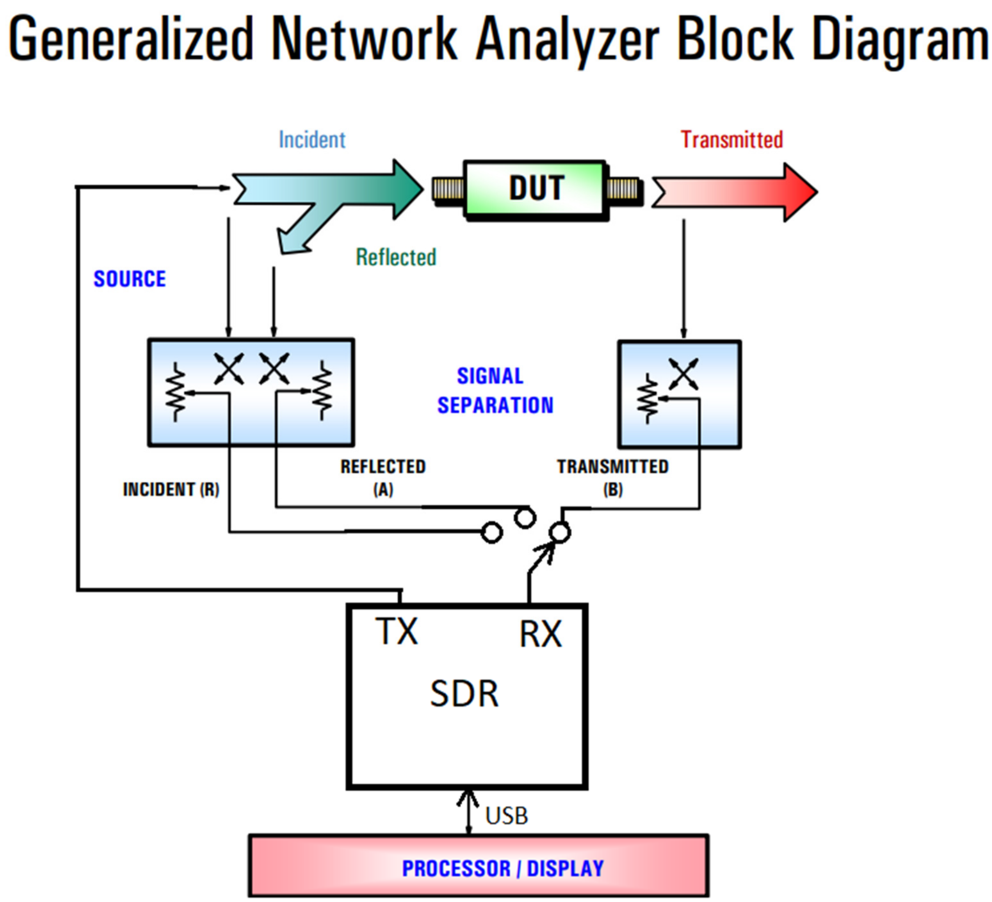

Fig. 2 VNA Employing an SDR

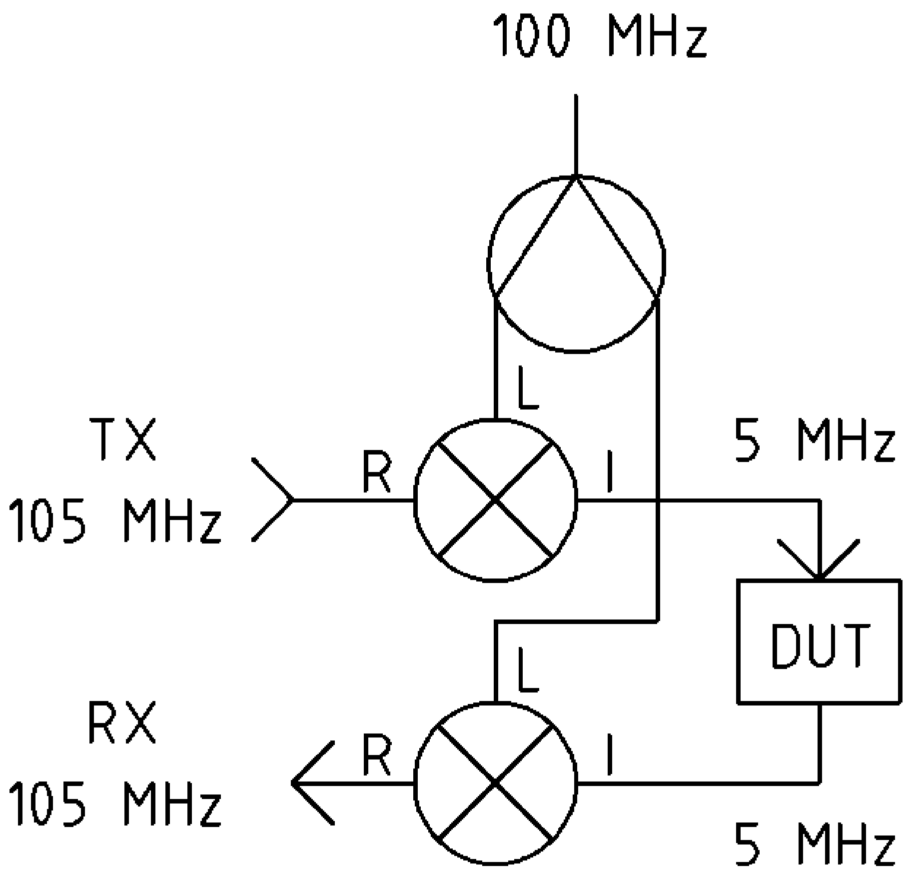

Fig. 3 A heterodyned converter to extend the frequency range of the SDR

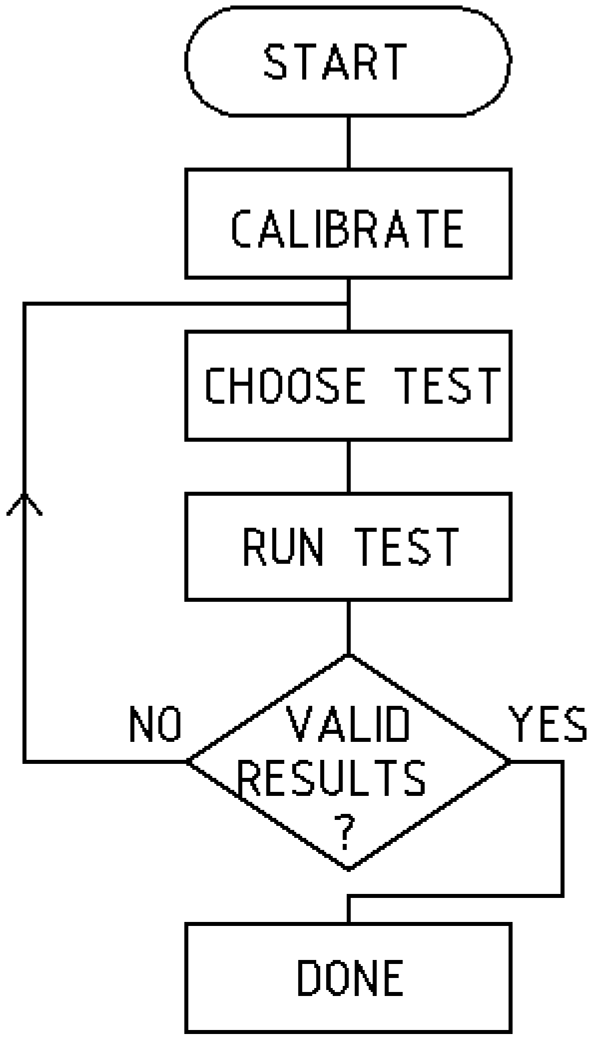

Fig. 4 Flow diagram that a field technician might use.