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Anritsu MS2035B VNA Stability Evaluation

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***Abstract*—The Anritsu handheld VNA/spectrum analyzer was tested for possible use in characterizing RF/Microwave components of low frequency radio telescope components in the field. It was found that the features of the instrument can be very helpful for field measurement, this includes light weight, long battery life, bright screen, touch screen, GPS and connectivity options. It was found that the instrument is very precise as seen in good repeatability of the measurement and very low trace noise.**

***Index Terms*— vector network analyzer, s-parameters measurement, UHF instrumentation.**

I. Introduction

THe high radio frequency interference level in big cities does not allow radio astronomy measurements. For this reason, radio astronomers needed to look in remote areas trying to find a clean spot to conduct better measurements without being affected by man made signals.

To do the required measurements, portable, and even handheld, test equipment are needed to characterize components of telescopes in the field. It is, for example, important to measure antennas in the field taking into account possible reflections of neighboring objects.

The Anritsu 2035B handheld VNA/Spectrum analyzer was tested in the lab. Most of the features of the instrument were explored and measurements were made to characterize the precision or repeatability of the instrument.

The accuracy of the instrument is related to the calibration and is believed to be very good.

This report is trying to investigate the trace noise and quantify it.

The standard deviation was chosen to quantify the variability in the measurement.

$$\sqrt{\frac{\sum (x-\bar{x})^2}{(n-1)}}$$

where x is the sample mean AVERAGE (number1,number2,…) and n is the sample size.

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II. Description of the Measurements

Port 1 of the VNA was calibrated at the type-N connector port using the Anritsu cal kit. The instrument was set to these settings:

- Start frequency: 10MHz
- Stop frequency: 1GHz
- Number of points: 991
- Port power: high
- IF BW: 500Hz
- AVG=1
- Cal method: SOL
- VNA was in battery mode

After calibration, a 50 ohm termination was connected to the port and 10 measurements of s11 were made. Both magnitude and phase were recorded with 3 averaging settings:

1. Measurement 1: averaging is set to 1 and 10 sweeps are triggered and data was saves in touchstone files.
2. Measurement 2: averaging is set to 10 and 10 sweeps are triggered and touchstone
3. Measurement 3: averaging is set to 100 and 10 sweep

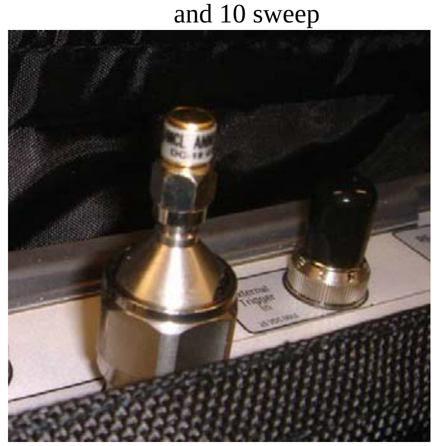
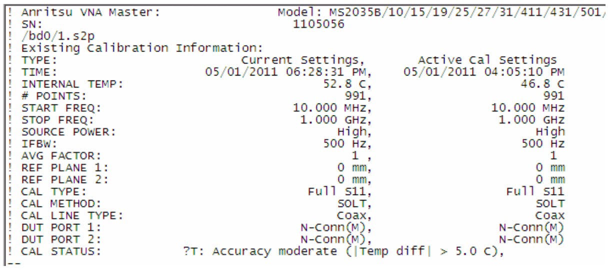


Fig1. the measurement setup showing a mini circuits termination connected to port1 through a type-N to SMA adapter.



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! Anritsu VNA Master:                    Model: MS2035B/10/15/19/25/27/31/411/431/501/
! SN:                                      1105056
! /bd0/1.s2p
! Existing Calibration Information:
! TYPE:                            Current Settings,        Active Cal Settings
! TIME:                        05/01/2011 06:28:31 PM,    05/01/2011 04:05:10 PM
! INTERNAL TEMP:                             52.8 C,                    46.8 C
! # POINTS:                                     991,                       991
! START FREQ:                          10.000 MHz,                10.000 MHz
! STOP FREQ:                             1.000 GHz,                 1.000 GHz
! SOURCE POWER:                               High,                      High
! IFBW:                                     500 Hz,                    500 Hz
! AVG FACTOR:                                    1 ,                         1
! REF PLANE 1:                                0 mm,                      0 mm
! REF PLANE 2:                                0 mm,                      0 mm
! CAL TYPE:                               Full S11,                  Full S11
! CAL METHOD:                                 SOLT,                      SOLT
! CAL LINE TYPE:                              Coax,                      Coax
! DUT PORT 1:                           N-Conn(M),                 N-Conn(M)
! DUT PORT 2:                           N-Conn(M),                 N-Conn(M)
! CAL STATUS:          ?T: Accuracy moderate (|Temp diff| > 5.0 C),
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Fig2. The header of touchstone files saved by the VNA showing instrument settings during calibration and during that particular measurement.

III. MEASUREMENT 1: 1 AVG FACTOR

Collected data is shown on Fig3 and Fig5. The standard deviation of the magnitude and phase data is shown on Fig4 and Fig6 respectively.

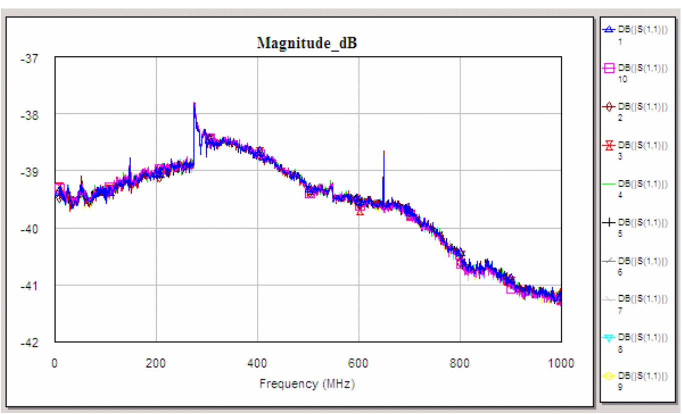

Fig3. S11 [dB] with AVG=1: 10 curves are plotted for AVG=1

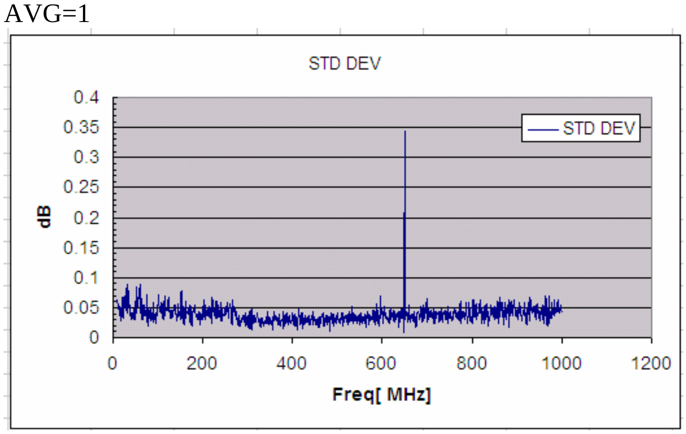

Fig4. STD dev (or RMS as called by engineers) of the S11 magnitude data shown on Fig1.

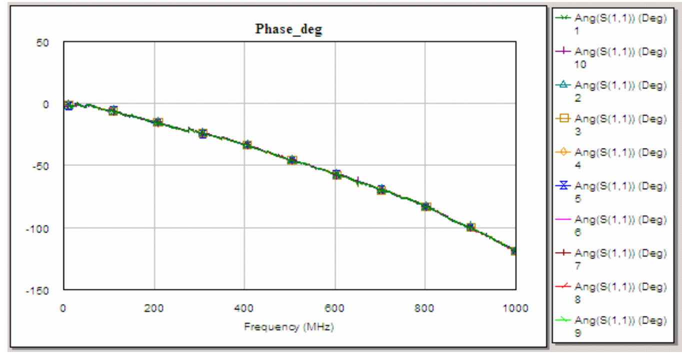

Fig5.S11 Phase [deg]: : 10 curves are plotted for AVG=1

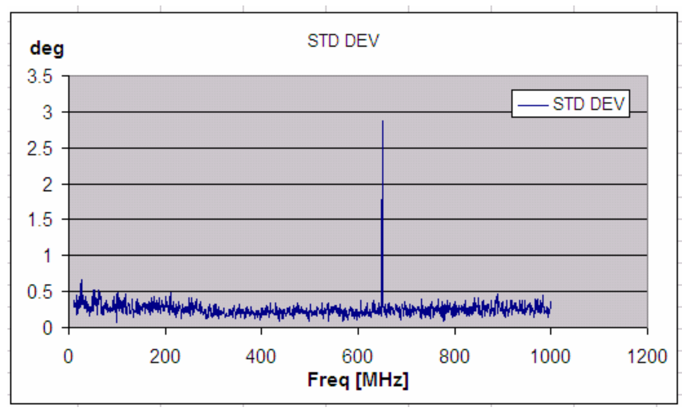

Fig6. std dev of the S11 phase data shown on Fig2.

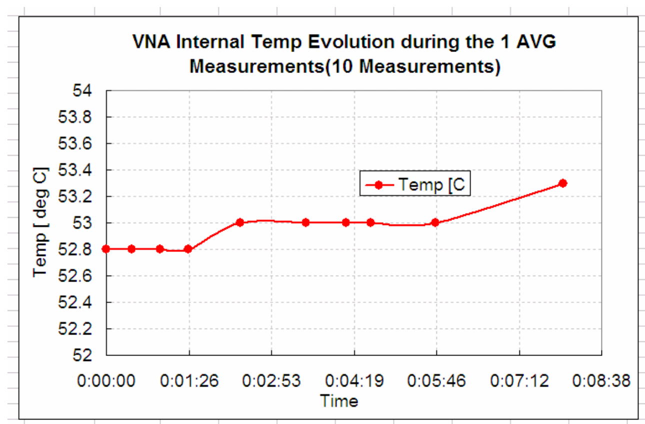

Fig7. Internal temperature of the instrument as recorded on the header of the touchstone file of each measurement. It is clear that the instrument was not given enough time to "warm up".

IV. MEASUREMENT 2: 10 AVG FACTOR

The averaging factor was set to 10. 10 measurements are done each one of them is the average of 10 sweeps.
Fig8 and Fig10 show collected data. And Fig

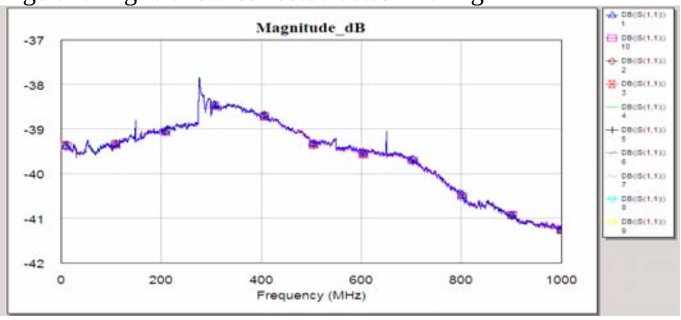

Fig8. S11 [dB] with AVG=1: 10 curves are plotted for AVG=10

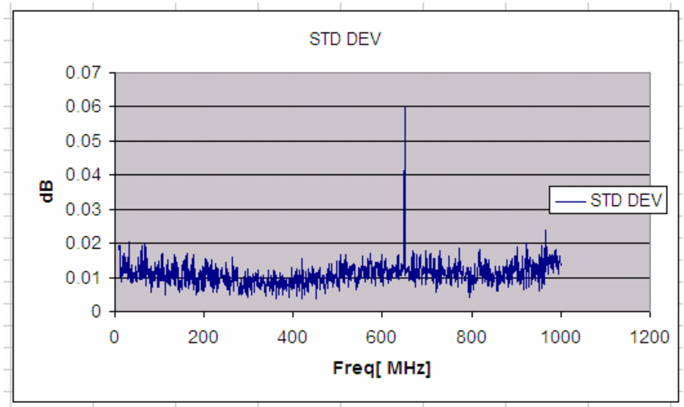

Fig9. STD dev (or RMS as called by engineers) of the S11 magnitude data shown on Fig8

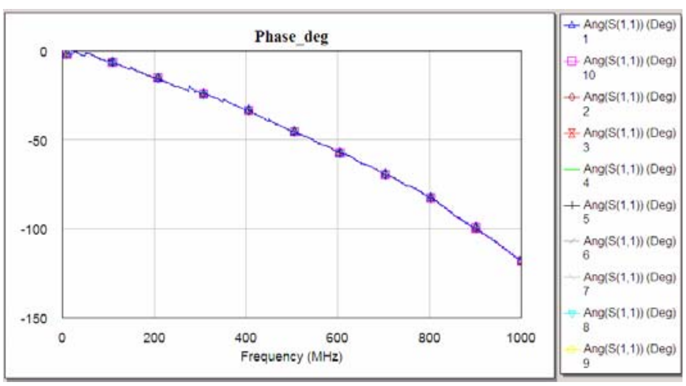

Fig10.S11 Phase [deg]: 10 curves are plotted for AVG=10

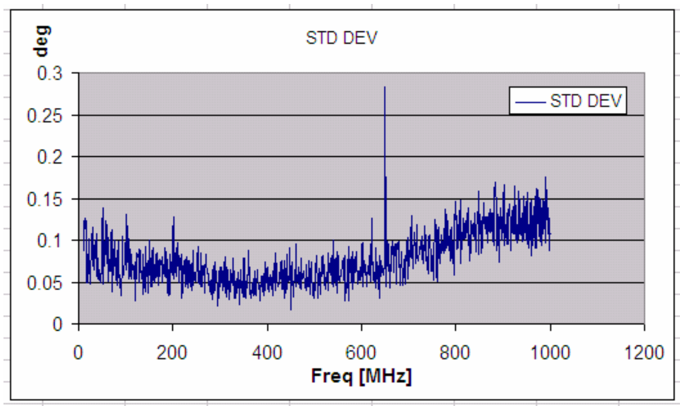

Fig11. std dev of the S11 phase data shown on Fig10.

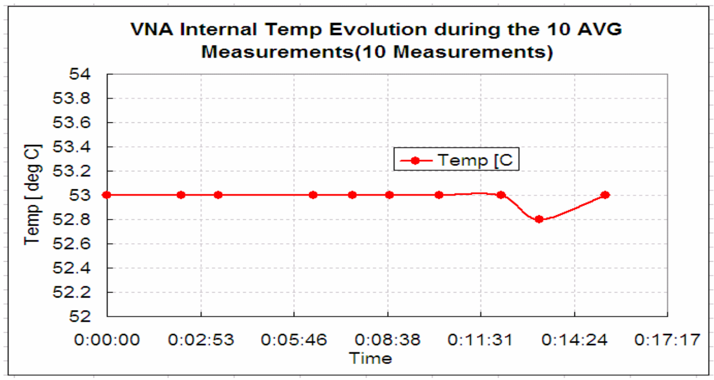

Fig12. Internal temperature of the instrument during measurement 2.

V. MEASUREMENT 3: 100 AVG FACTOR

The averaging factor was set to 100 sweeps. 10 measurements were made; each measurement is the average of 100 sweeps. Each measurement takes about 5 minutes considering the very large number of freq points and very narrow bandwidth of the IF filter.
Fig 13 and Fig15 show the collected data and Fig14 and Fig16 show the std deviation for the magnitude and phase data respectively.

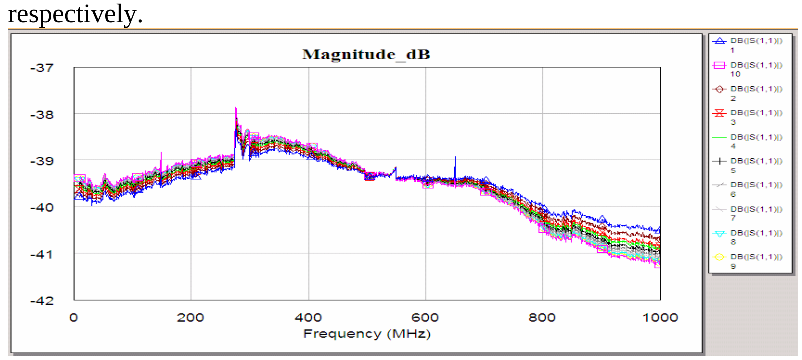

Fig 13. . S11 [dB] with AVG=1: 10 curves are plotted for AVG=100

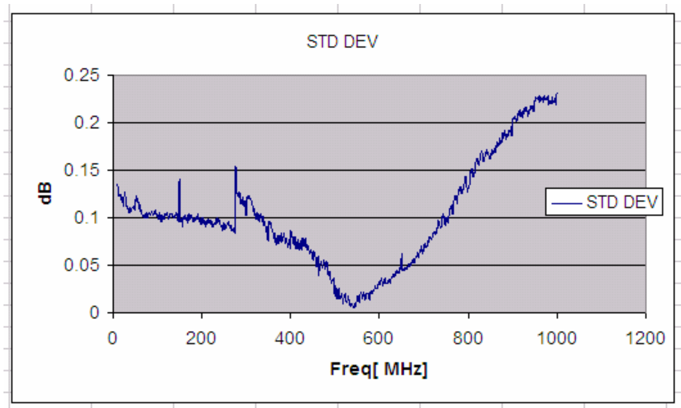

Fig14. STD dev (or RMS as called by engineers) of the S11 magnitude data shown on Fig13

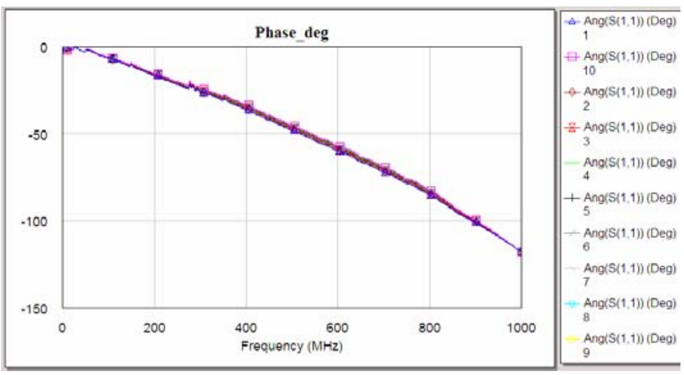

Fig15. S11 Phase [deg]: 10 curves are plotted for AVG=100

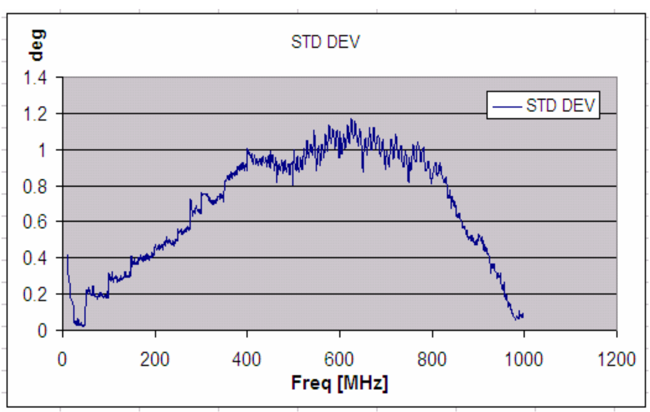

Fig16. std dev of the S11 phase data shown on Fig15.

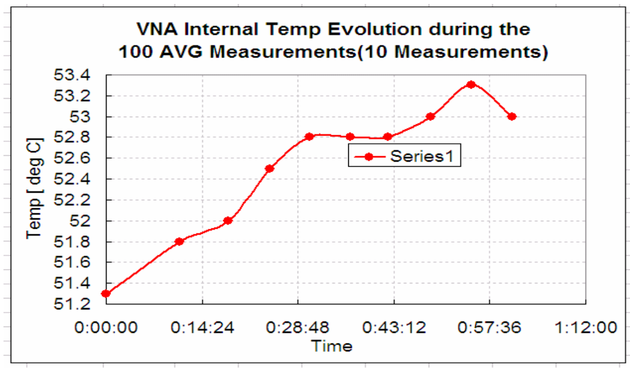

Fig17. Internal temperature of the instrument during measurement 3. This measurement was done just after calibration and the instrument did not have enough time to "warm up". For this reason the data of Measurement3 should be dismissed.

CONCLUSION & DISCUSSION

THE ANRITSU MS2035B SHOWED GOOD STABILITY AND LOW TRACE NOISE WHEN TESTED ON THE LAB EVEN IF THE MEASUREMENT WAS NOT DONE IN AN IDEAL CASE. IT IS IMPORTANT TO LET THE INSTRUMENT "WARM UP". THE VNA MONITORS ITS INTERNAL PHYSICAL TEMPERATURE AND RECORDS THE TEMPERATURE ON EACH TOUCH STONE FILE SAVED.

AKNOLWEDGEMENT

THE LOW FREQUENCY RADIOASTRONOMY AND EXPERIMENTAL COSMOLOGY GROUP WOULD LIKE TO THANK BRENT TREADWAY AND SEAN FLAVIN FROM ANRITSU FOR THE OPPORTUNITY TO EVALUATE THE MS2035B VNA.

REFERENCES

[1] Anritsu application notes/Instrument data sheets/useful conversation with Anritsu engineers.