W-Band Frequency Extension Heads

And their comparison with the competition

Application Note **Revision: November 2009**

1.0 General

Farran Technology has developed a range of Frequency Extension products to satisfy the demand for extending the measurement capability of customer owned Vector Network Analysers to 170GHz. Offering full simultaneous 2-port s-parameter network analysis, they represent a robust independent alternative for Test and Measurement applications.

In order to benchmark the equipment, this application note will offer a comparison of Farran Technology **FEV-10-TR**, W-Band heads with those of one of our competitors. It will look at key parameters such as dynamic range, power range and stability.

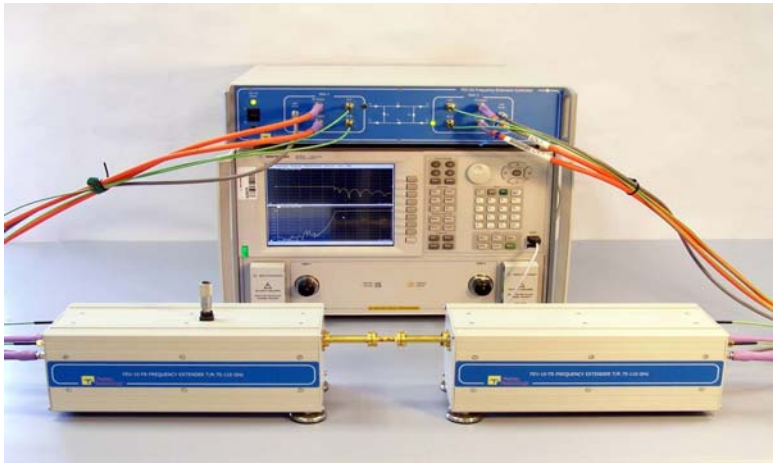

Figure 1: FEV-10-TR heads and controller with Agilent PNA

Applications

- Vector Network Analyser Frequency Extension

***NOTE:** Unit under test in the photograph is a High Pass Waveguide Filter with cut-off around 92GHz.

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2.0 Performance Test Results

The following table shows a direct comparison of Farran W band heads with those of a competitor for the operational parameters shown. The highlighted areas show how Farran heads have an improved specification over the competition's heads.

Operational Parameters	Competition Actual Test Results	Farran Technology FEV10-TR Actual Test Results
System Operating Frequency	75-110GHz	75-110GHz
Source Input Frequency	12.5 to 18.33GHz (X6)	12.5 to 18.33GHz (X6)
Source Input Power	+5dBm to +13dBm	0dBm to +13dBm
Test Port Output Power	-5dBm min. to +1dBm typ.	**+2dBm min., +4dBm typ.**
Test Port Input Power	+6dBm typ. input signal @ $P_{0.1dB}$	+6dBm typ. input signal @ $P_{0.1dB}$
Mixer LO Frequency	9.38 to 13.75GHz (X8)	9.38 to 13.75GHz (X8)
Mixer LO Drive	+5dBm to +13dBm	0dBm to +13dBm
Test Dynamic Range	80dB min. >90dB typ.	**100 dB min. 110dB typ.**
Magnitude and Phase Stability	±0.2dB and ±2°	**±0.05dB and ±0.5°**
Coupler Directivity	35dB min., >37dB typ.	**40dB min., 42dB typ.**

Figure 2: Comparison of operational parameters

It should be noted that the Farran FEV10-TR heads offer >100dB dynamic range. This test was conducted as a single sweep, with no averaging and no smoothing, in an IF bandwidth of 10Hz.
It is also noted that the magnitude and phase stability is nearly an order of magnitude better than the competition.

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3.0 Measurement of Amplitude Stability

The following measurements were made using the FEV10-TR heads with a PNA 8363C. With the heads back-to-back a plot of normalised S21 was taken after calibrating and allowing 2 hours for settling/drift. Agilent state that all stability measurements are guaranteed if the measurement is performed within ±1˚C of the calibration temperature. Either a manual attenuator (such as on the FEV10-TR-ATT) can be used to control the power on the PNA or alternatively the electronic power control (using power head and receiver calibration) can be used on the PNA-X. Further tests are shown later in this document for results with the PNA-X with up to 50dB of attenuation.

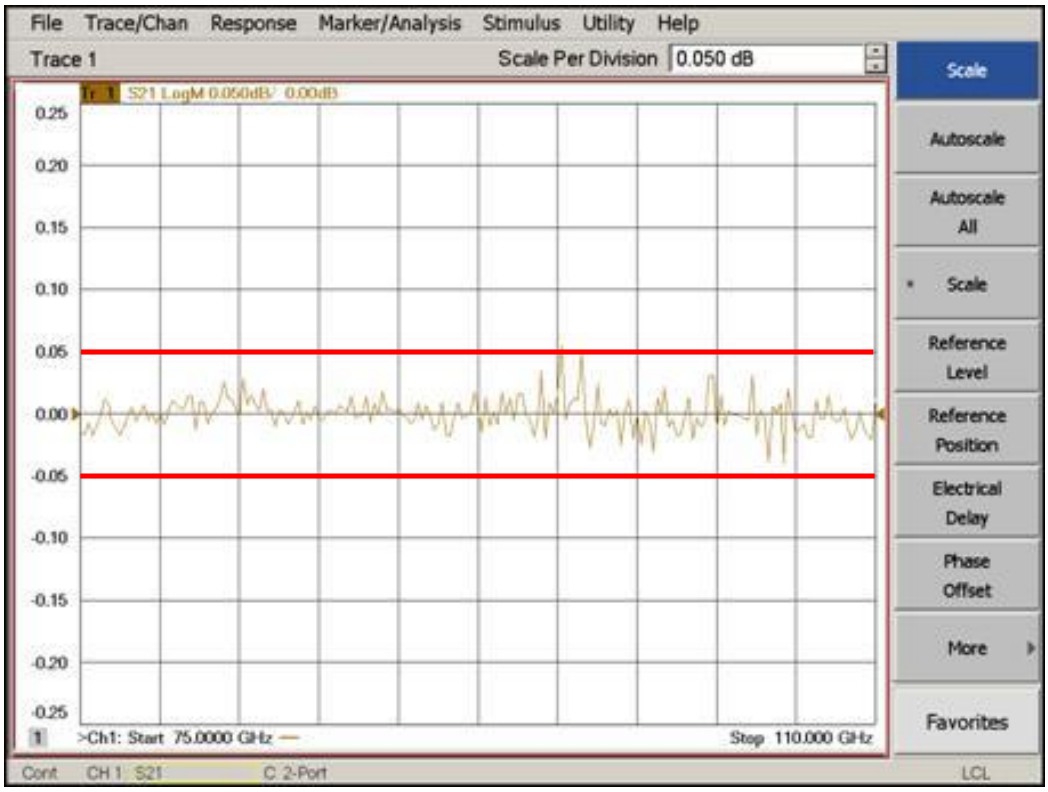

Figure 3: Plot of Full Band Amplitude Stability

Results show that over the full band, amplitude stability is within ±0.05dB after 2 hours.

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3.1 Measurement of Phase Stability

The following measurement was set up using the FEV10-TR heads with a PNA 8363C. With the heads back-to-back a plot of normalised S21 and S12 was taken after calibrating and allowing 2 hours settling/drift.

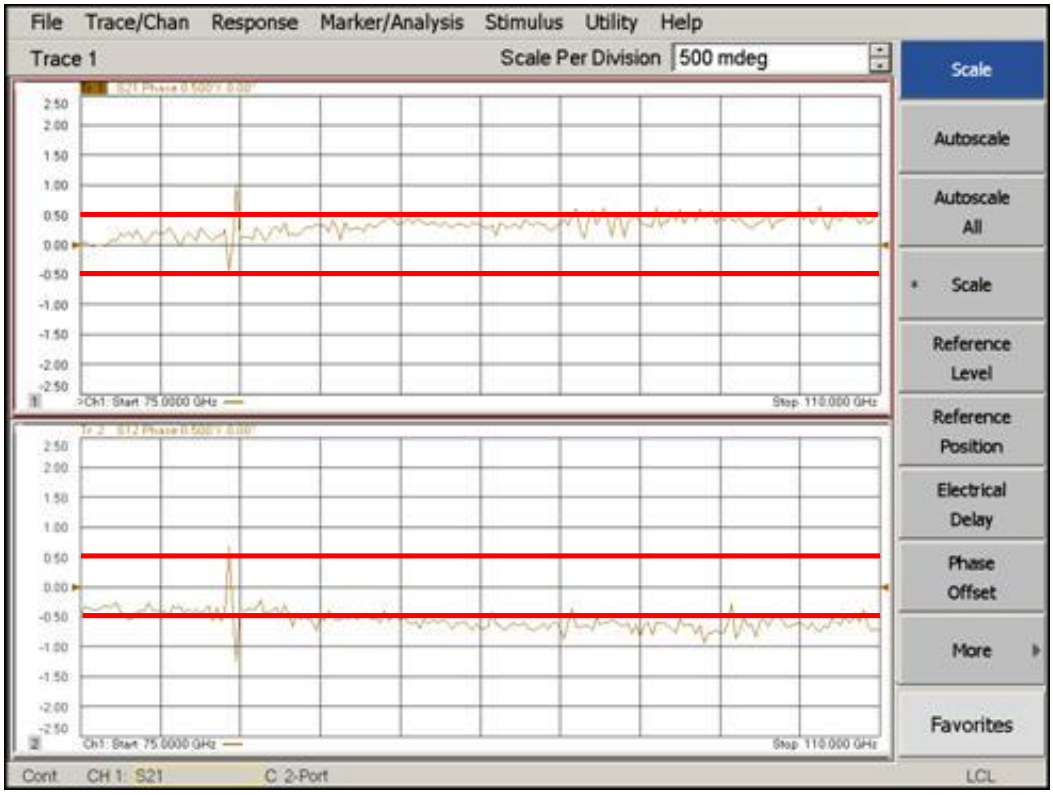

Figure 2: Plot of Full Band Phase Stability

Comments are much the same for phase as for magnitude. Results show that over the full band, phase stability is typically within ±0.5˚ after 2 hours.

3.2 Dynamic Range

With the heads calibrated, both ports of the FEV10-TR's are terminated with a suitable termination and a measurement of the noise floor is made. In this case measurements of S21 and S12 are made with no averaging or smoothing and an IF bandwidth of 10Hz.

Figure 5: Plot of Dynamic Range

Clearly it can be seen that the dynamic range across the band is greater than 100dB and typically in the region of -110dB.

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3.3 Electronic Power Control for -35dBm

Using the FEV10-TR heads and PNA-X (N5242A) with Firmware A.08.60), the system was calibrated using both HP W8486A power sensor and reference receiver levelling. The graph below shows electronic power sweep for an output power of -35dBm.

The minimum power level obtainable in this configuration is limited by the dynamic range of the FEV10-TR and error value (flatness) set by the user prior to calibration. In this case it was 0.5dB and the resultant sweep after calibration is shown in the plot below.

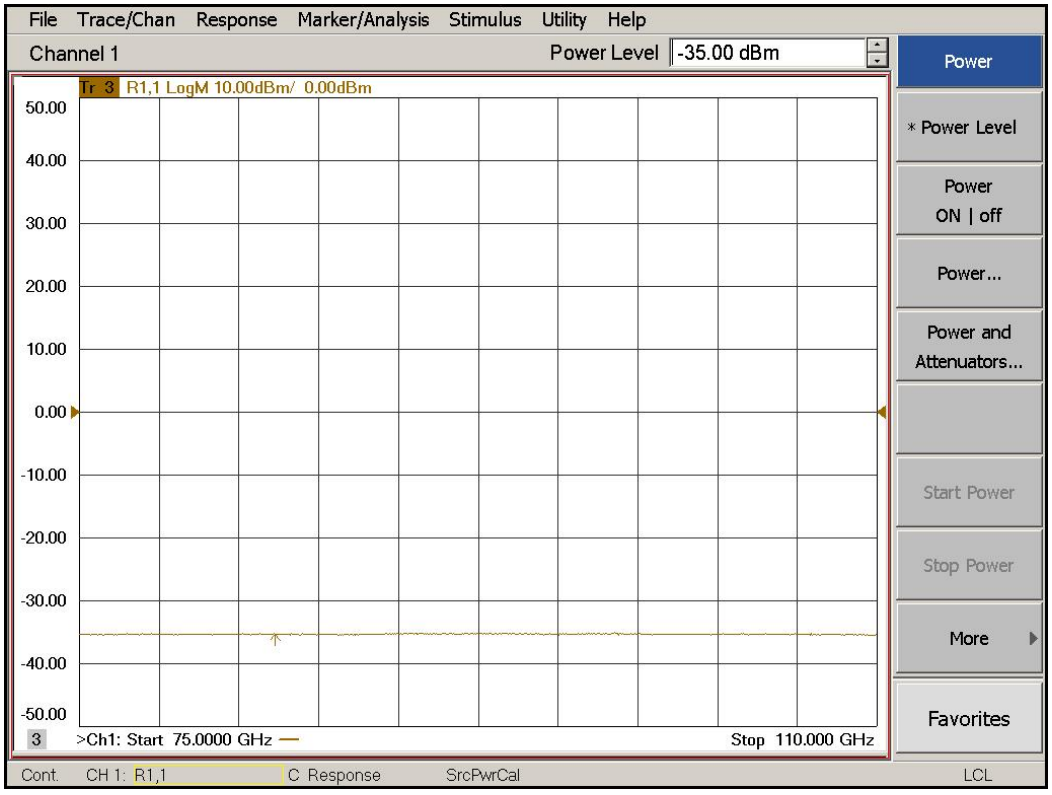

Figure 6: Plot of Power Calibration for -35dBm output power

Generally the lower the output power, the greater the power drift that would be expected. The above measurement was taken with an IF bandwidth of 100Hz and 801 data points.

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3.4 Electronic Power Control for -50dBm

Using the same set up as for the -35dBm test the graph below shows electronic power sweep for an output power of -50dBm.
The minimum power level obtainable in this configuration is limited by the dynamic range of the FEV10-TR and error value (flatness) set by the user prior to calibration. In this case it was 0.5dB and the resultant sweep after calibration is shown in the plot below.

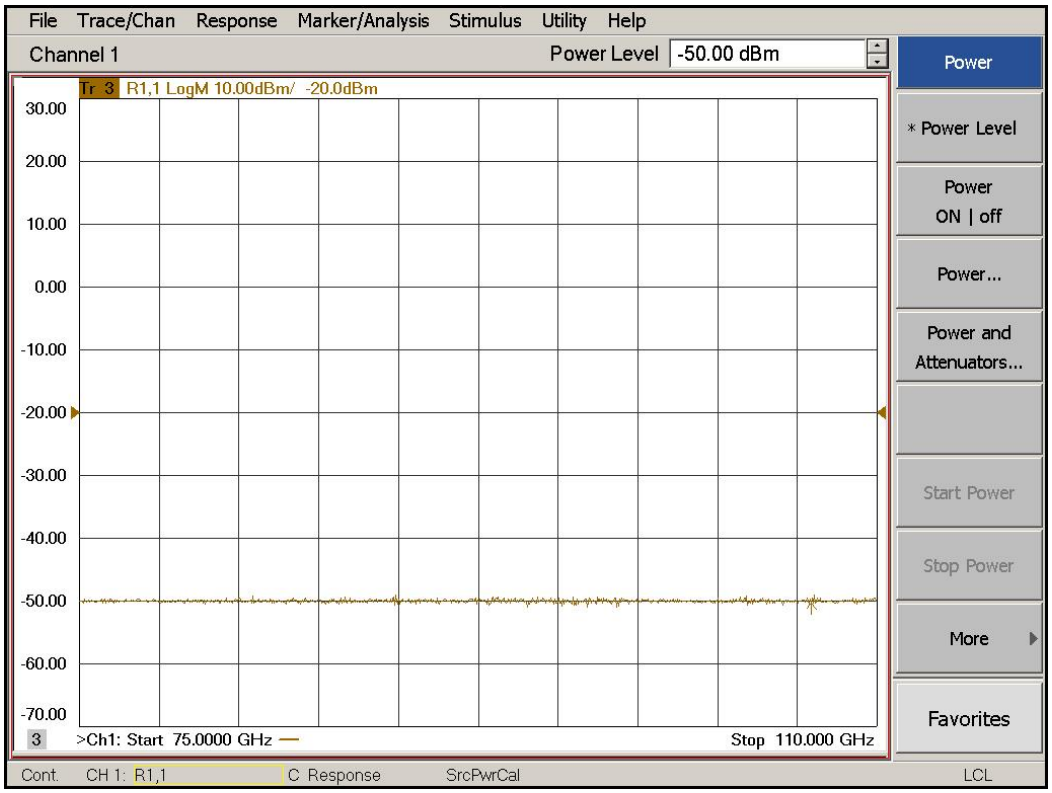

Figure 7: Plot of Power Calibration for -50dBm output power

Generally the lower the output power, the greater the power drift that would be expected. The above measurement was taken with an IF bandwidth of 100Hz and 801 data points.

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3.5 Uncalibrated Test Port Output Power

The following graph shows typical results from a FEV10-TR head showing the uncalibrated test port output power over the full W band.

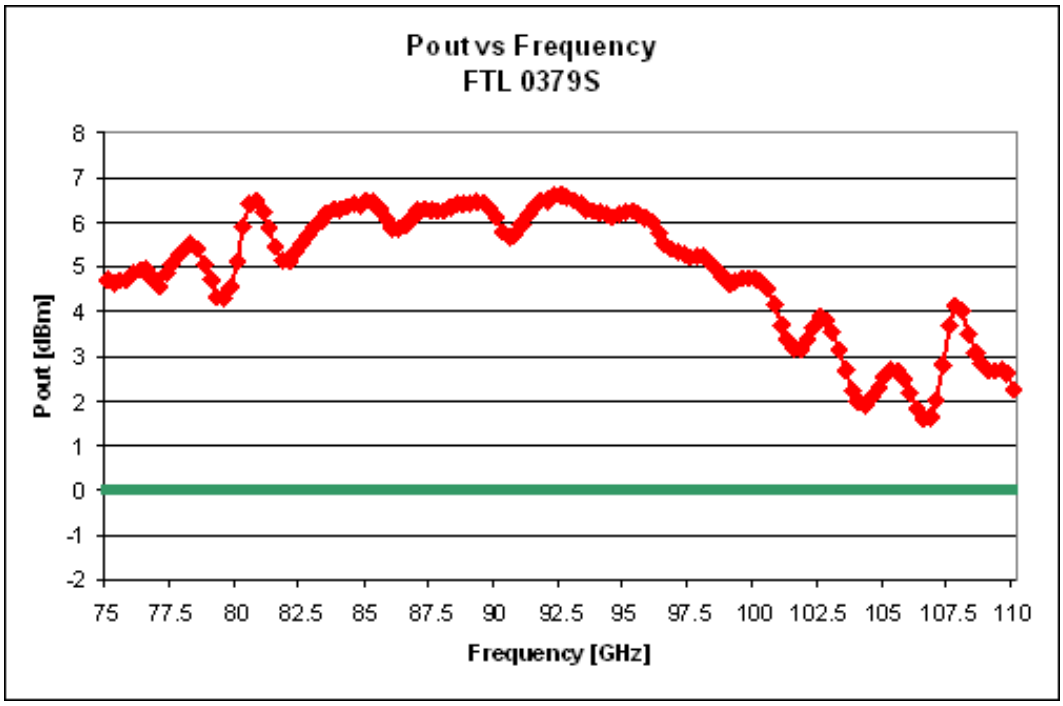

Figure 8: Plot of Uncalibrated Test Port Output Power

Conclusion

Results have been presented for a suite of tests performed using a mixture of prototype and production FEV10-TR heads with PNA or PNA-X VNA's in order that key operational parameters can be assessed. These were dynamic range, stability, output power and electronic power control. It can be concluded that the technical performance of the Farran Technology W-band heads is very good and in comparison to the competition perform extremely well. It has also been demonstrated that electronic power control can be used very effectively with the FEV10-TR heads.

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