



Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

## I. INTRODUCTION

S-band receivers are the most frequent to fail the Tsys criteria on the stress test. This is likely due to incorrect Tcals, and possibly RFI, but the switched power system was inspected to rule out problems with the noise diode power injection. This is also an opportunity to search for the rev G Cal boards, which have an over-damped Cal signal.

All antennas, with the exception of EA17 which is in the ABB, were surveyed on 5/6/15. One second of data was collected from the T304/T305 Total Power Detectors (TPDs) at a sample rate of 500Hz. Plots of this data can be found in the subsequent sections of this report.

Since this is not a frequently performed test, other issues have been identified based on the data collected. Where excessive noise was present in any IF, an FFT was performed in Matlab to analyze the frequency components present.

## 2. SUMMARY

Antenna	Cal Power (R / L, dBm)	TPD Survey Notes	Stress Test Notes – 5/6/15 I305UT (S-band Tsys spec: 25-35K)
EA01	0.45 / 0.45	All IFs OK. Low amplitude 60Hz oscillation on all IFs.	Tsys <b>low</b> on RCP (15-16K)
EA02	0.50 / 0.50	IFs A, B, D OK. <b>Ramp</b> visible on IFC on T304 input; not visible on T305 output. Likely a problem with the RF TPD in this T304. Note – same effect is visible in other bands.	Tsys OK.
EA03	0.20 / 0.20	All IFs OK. Moderate amplitude 60Hz oscillation on all IFs.	Tsys <b>High</b> all IFs (55-55K)
EA04	0.35 / 0.40	All IFs OK.	Tsys OK.
EA05	0.20 / 0.20	All IFs OK. Moderate amplitude 60Hz oscillation on all IFs.	Tsys <b>High</b> all IFs (57-59K)
EA06	0.45 / 0.50	All IFs OK. Low amplitude 60Hz oscillation on all IFs.	Tsys OK.
EA07	0.25 / 0.25	Moderate amplitude 60Hz oscillation on all IFs.	Tsys <b>High</b> all IFs (71-99K)
EA08	0.35 / 0.35	Moderate amplitude 60Hz oscillation on all IFs.	Tsys <b>High</b> all IFs (49-52K)
EA09	0.45 / 0.50	Moderate amplitude <b>~82Hz</b> oscillation on RCP. Note – not present in other bands. X band has 60Hz noise. C is quiet.	Tsys OK.
EA10	0.55 / 0.50	Low amplitude 60Hz oscillation on all IFs.	Tsys <b>Low</b> all IFs (13-14K)
EA11	0.35 / 0.35	<b>Very high</b> amplitude 60Hz oscillation on all IFs. Note – other bands look better. E.g., X band has low amplitude	Tsys OK.



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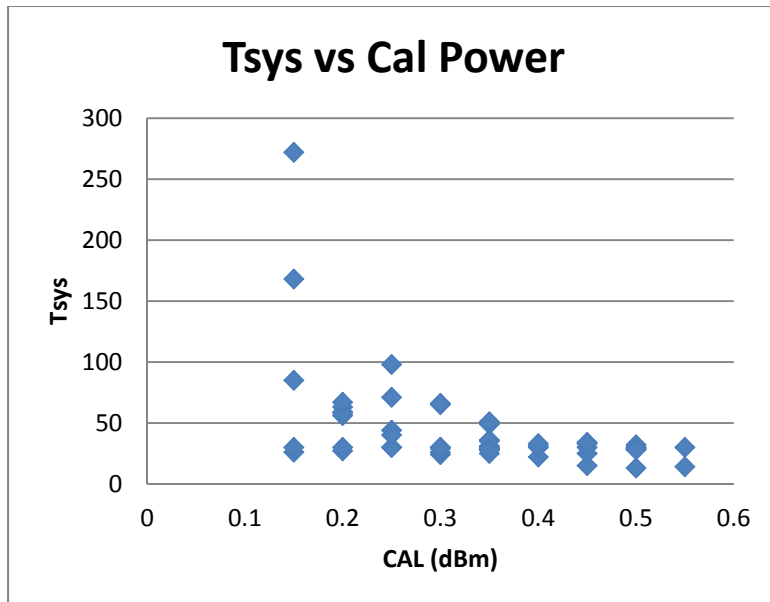
Antenna	Cal Power (R / L, dBm)	TPD Survey Notes	Stress Test Notes – 5/6/15 I305UT (S-band Tsys spec: 25-35K)
		60Hz oscillation.	
EA12	0.15 / 0.15	Moderate amplitude 60Hz oscillation on all IFs.	Tsys <b>High</b> all IFs (165-280K)
EA13	0.40 / 0.40	Low amplitude 60Hz oscillation on all IFs.	Tsys OK.
EA14	0.30 / 0.30	Low amplitude 60Hz oscillation on all IFs.	Tsys OK.
EA15	0.30 / 0.35	Low amplitude 60Hz oscillation on all IFs.	Tsys OK.
EA16	0.25 / 0.25	Moderate amplitude 60Hz oscillation on all IFs.	Tsys OK.
EA17			
EA18	0.40 / 0.45	Moderate amplitude 60Hz oscillation on all IFs.	Tsys OK.
EA19	0.35 / 0.35	Low amplitude 60Hz oscillation on all IFs. Shows a little gain instability in IFs B and D. Perhaps a wandering L302-2.	Tsys OK.
EA20	0.30 / 0.35	Low amplitude 60Hz oscillation on all IFs.	Tsys <b>High</b> all IFs (64-67K)
EA21	0.30 / 0.30	Low amplitude 60Hz oscillation on all IFs.	Tsys OK.
EA22	0.35 / 0.35		Tsys OK.
EA23	0.50 / 0.55		Tsys OK.
EA24	0.15 / 0.20	Moderate amplitude 60Hz oscillation on all IFs.	Tsys OK.
EA25	0.15 / 0.20	<b>High</b> amplitude 60Hz oscillation on all IFs.	Tsys <b>High</b> all IFs (65-91K)
EA26	0.35 / 0.35		Tsys OK. <sup>1</sup>
EA27	0.25 / 0.25	Moderate amplitude 60Hz oscillation on all IFs. Shows a little gain instability.	Tsys <b>High</b> all IFs (39-44K)
EA28	0.15 / 0.20	Moderate amplitude 60Hz oscillation on all IFs.	Tsys OK.

Tsys failures are consistent across stress tests. The same antennas are flagged in December (no S-band receivers replaced since last fall), when environmental temperatures were lower and the array was in C-configuration. Strongest correlation between Tsys value is with the Cal signal power (low power; high Tsys). However, the correlation is weak as is evident in the following figure.

<sup>1</sup> IF C failed the test on 5/6/15, with a Tsys of 45K. However, this appears to be an anomaly. Previous and subsequent reports are within specification.



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Most antennas show some degree of 60Hz noise. While irksome, it does not appear to affect system gains or Tsys in the stress test. Not clear if this is gain modulation or amplitude modulation. May be mechanically coupled (microphonics) or electrically coupled. Need to determine the effect on long-term system linearity (if any) before deciding on any corrective action.

Antenna 9 differs from others in that the noise present in RCP is not 60Hz, but closer to 82-83Hz. Source is unknown. May be noise of a higher frequency that is aliased down to this frequency. Noise is not present in all bands at this antenna - X-band had 60Hz noise and C-band was quiet.

Antenna 19 and 27 show a little gain instability or other low-frequency oscillation. Should be investigated further.

In regards to the rev G Cal boards, there are no rev G boards in use on S-band receivers at this time (confirming what Craig H. had previously indicated).

### 2.1. Questions

- What is the intended CAL input power? How tightly is this set in the lab?
  - Craig: 2-3K of noise, equivalent to 0.1-0.2dBm of noise power at the receiver.
  - Hard to explain the variability seen in RF power injected, as measured at the T304 input.
- Source of the ~82Hz noise?
  - Scott-T? Refrigerator?
  - Microphonics?
- Importance of/interest in addressing 60Hz noise?
- Insights into the failing Tsys tests?



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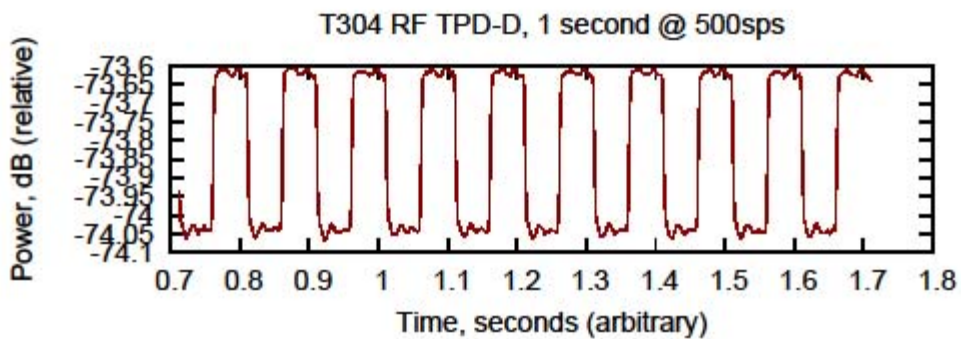
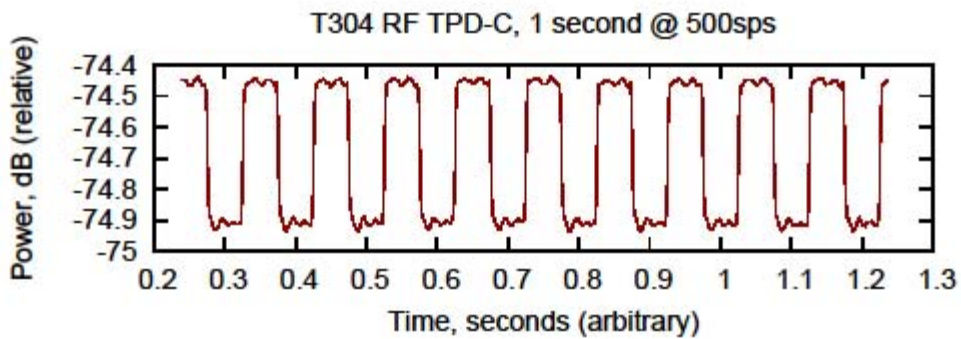
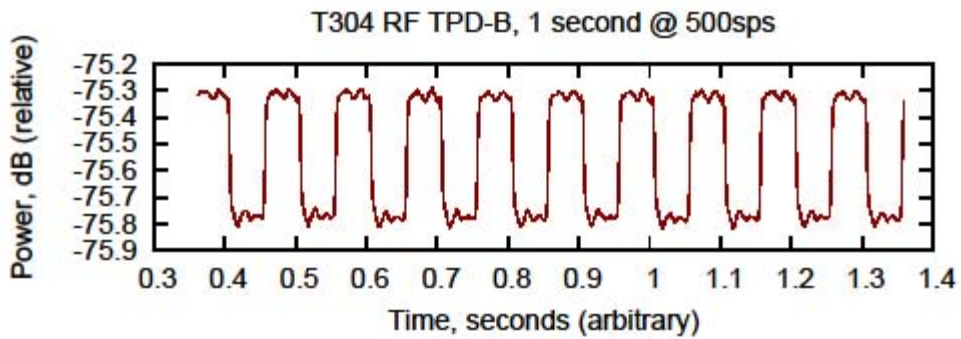
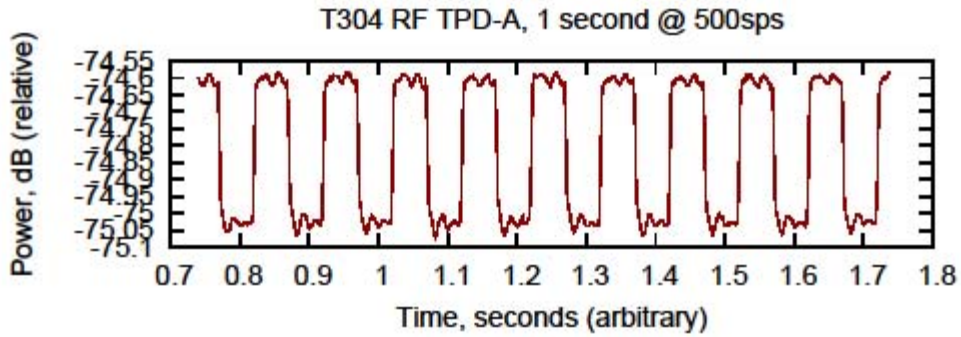
## 2.2. *Follow-up Work*

- Inspect & repair RF TPD in T304/T305 (IFC) in EA02.
- Inspect stability of L302-2 in EA19. (Re-run test for EA19)
- Inspect gain stability of EA27 (Re-run test for EA27)
- Re-run tests with refrigerators off and compare results.
- Re-run test with CAL switching off and compare results.
- Perform similar test in all other bands (maintenance day activity).
  - Find Rev G cal boards.
  - Determine if other bands are similarly polluted by 60Hz noise.
- Discuss impact of 60Hz noise with scientific staff. Solicit input.
  - Baseline plan is to only address worst cases as a low-priority task.
- Compare SonofSOIDA and SOIDA rack calibration in S-band.



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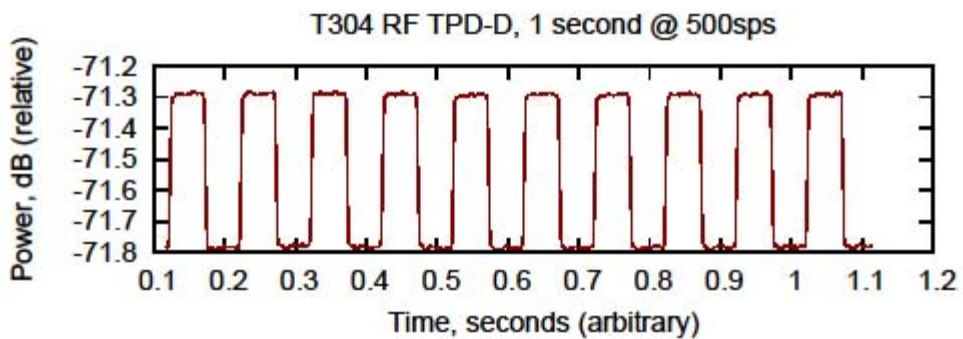
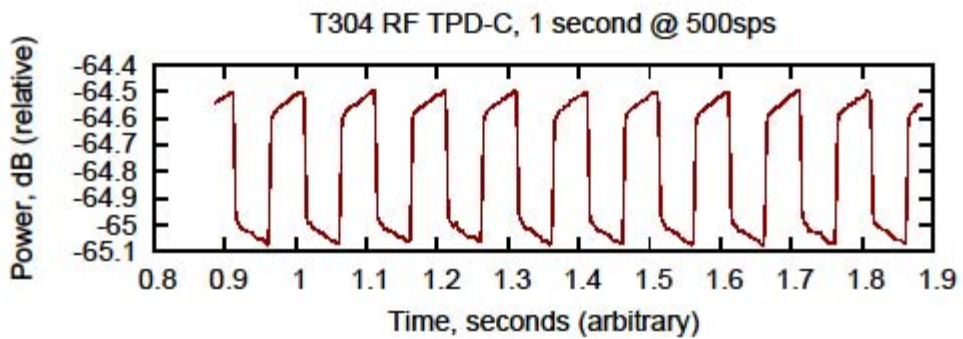
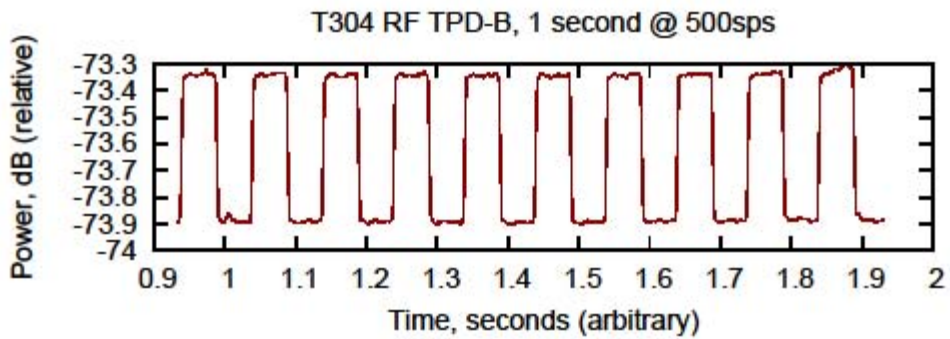
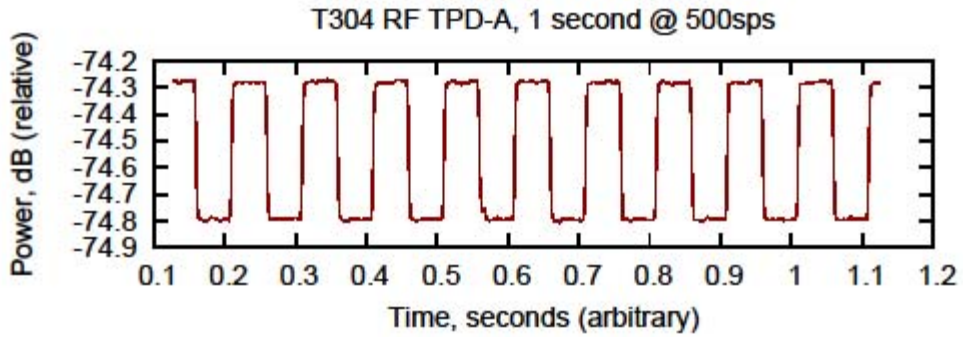
### 3. EA01





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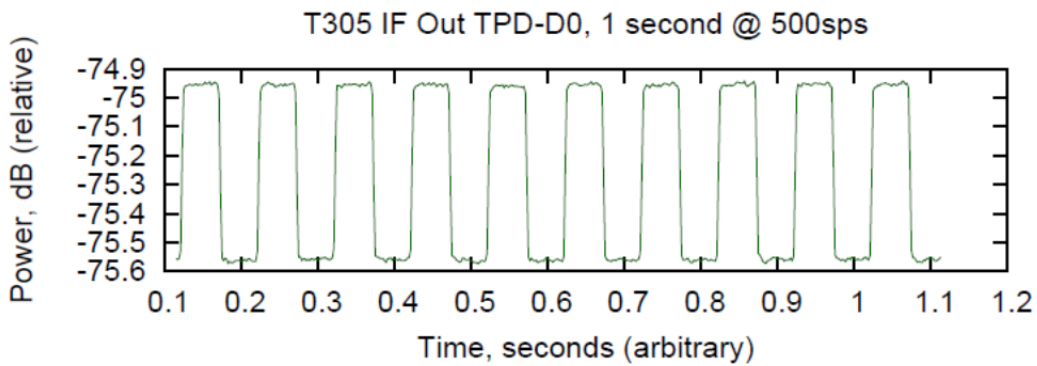
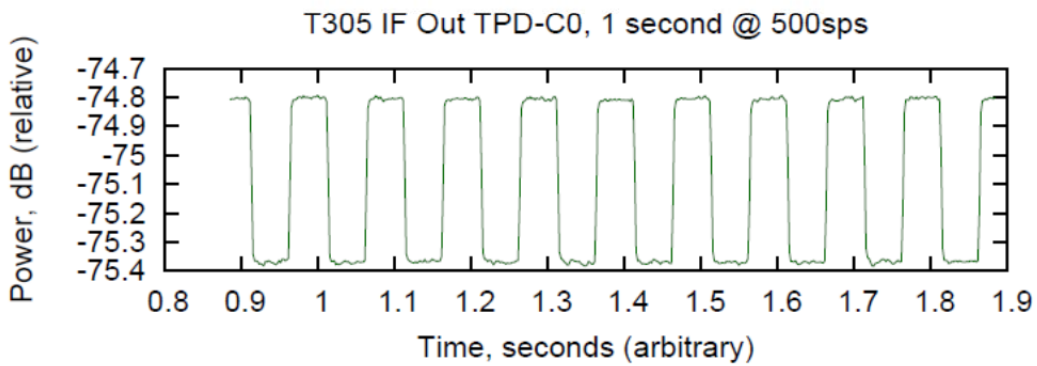
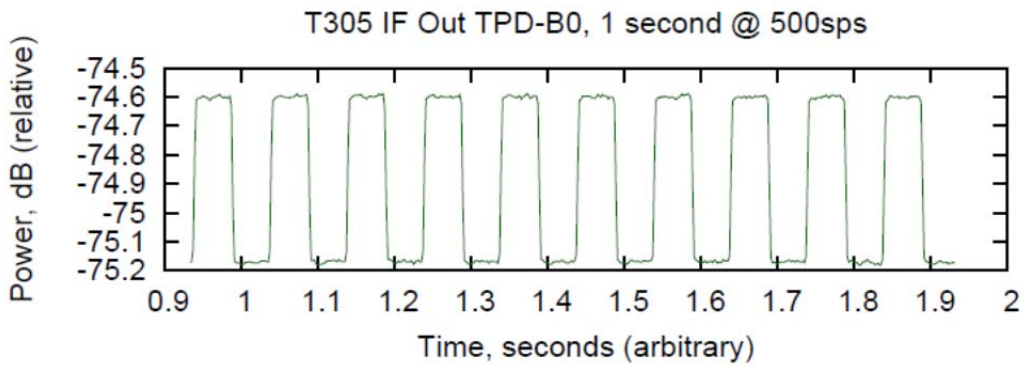
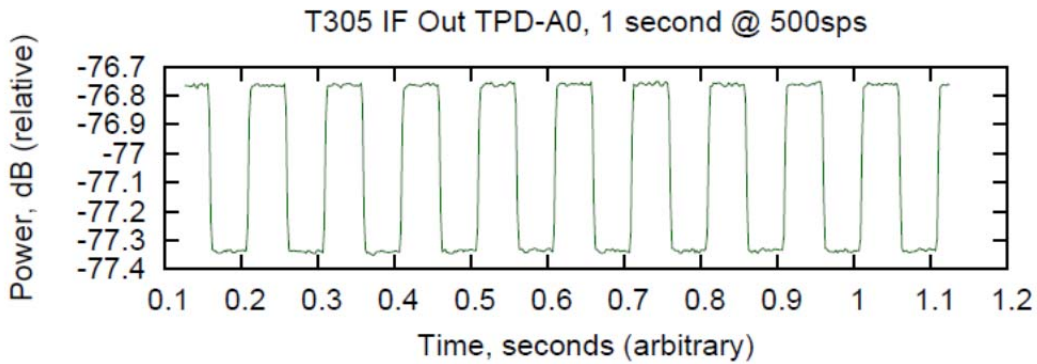
4. EA02





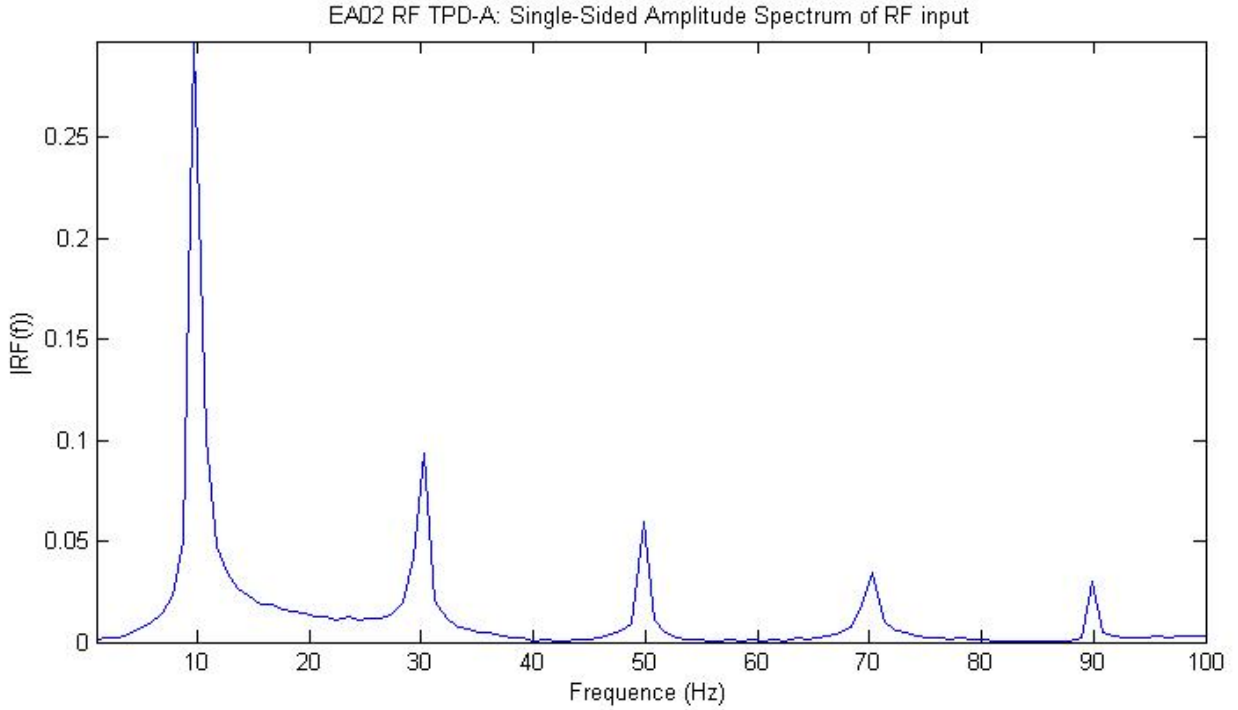


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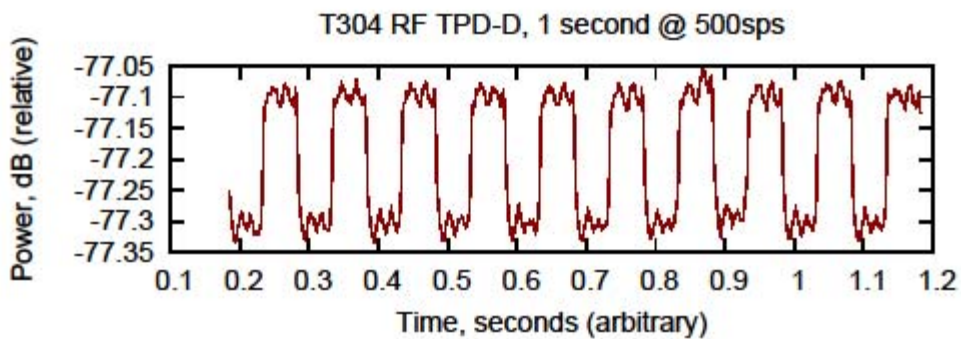
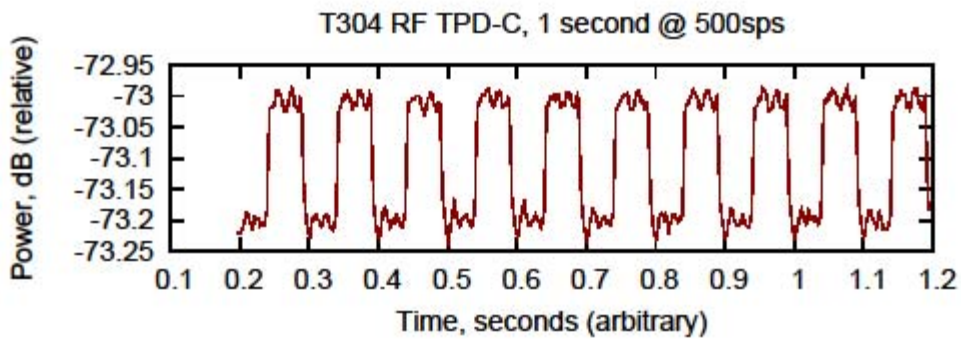
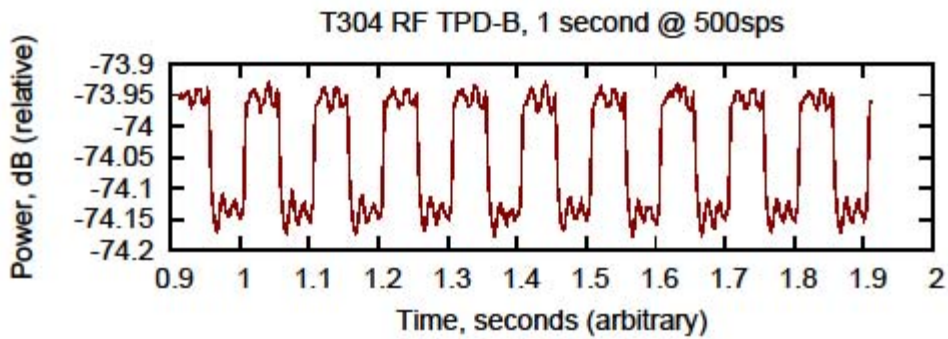
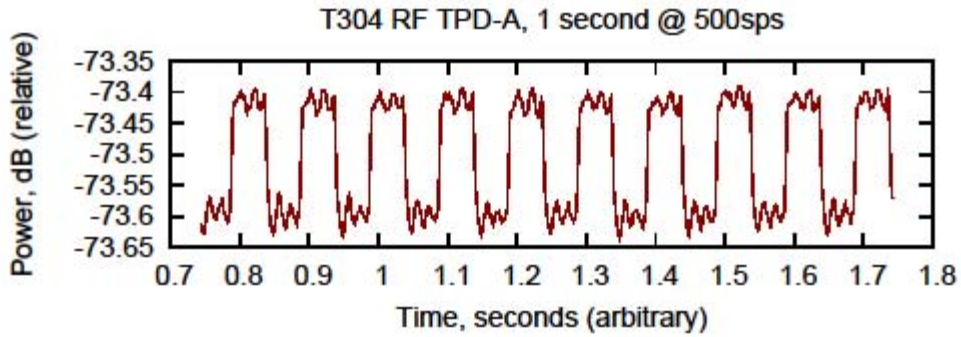
When analyzing the single-sided amplitude spectrum of the RF input, the 10Hz component and its odd harmonics (30Hz, 50Hz, 70Hz and 90Hz) are due to the square wave CAL injection (a square wave is composed of its natural frequency and all odd harmonics). EA02 shows very little noise, and no 60Hz noise, so it is included here for reference.





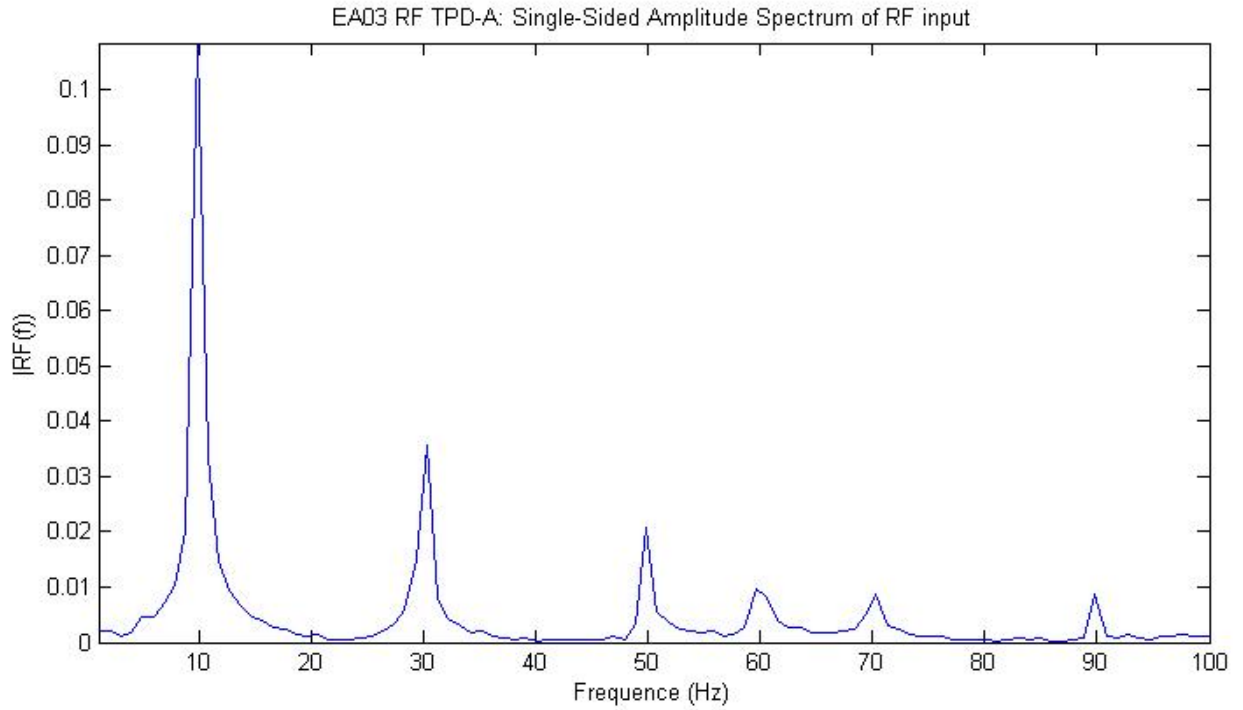
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5. EA03





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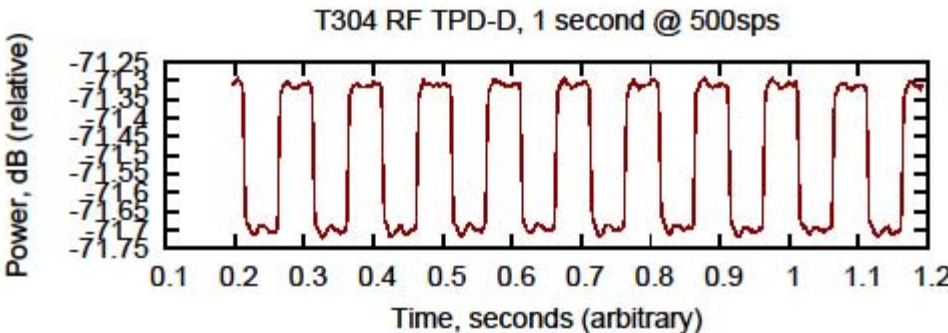
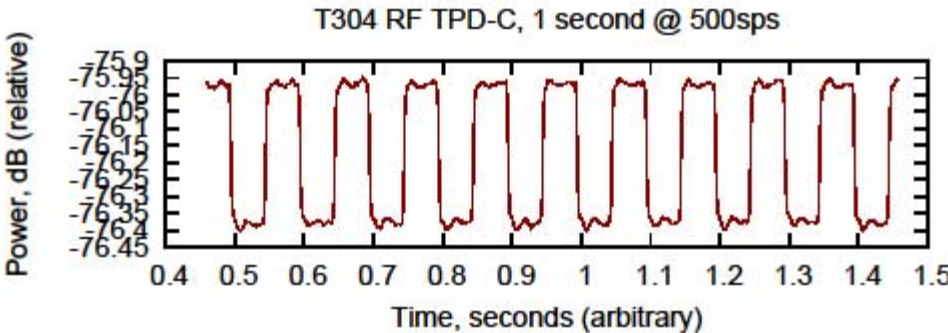
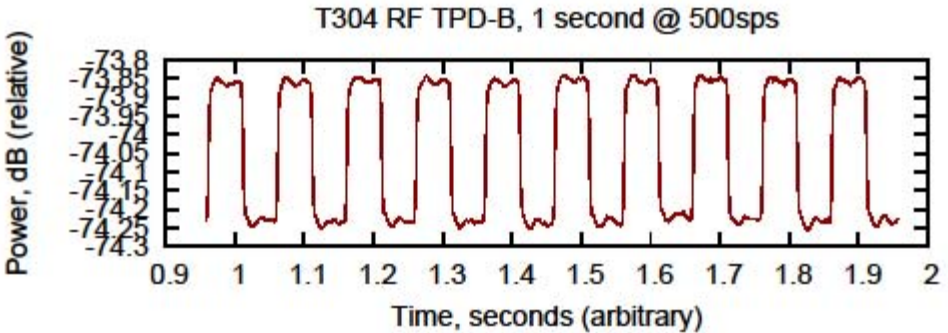
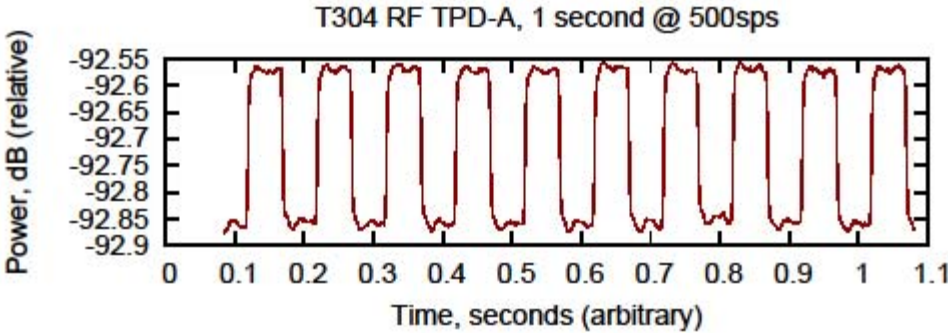


As mentioned previously, the 10Hz component and its odd harmonics (30Hz, 50Hz, 70Hz and 90Hz) are due to the square wave CAL injection. The 60Hz component is unwanted noise in the RF, which appears to be coupled from an AC power supply.



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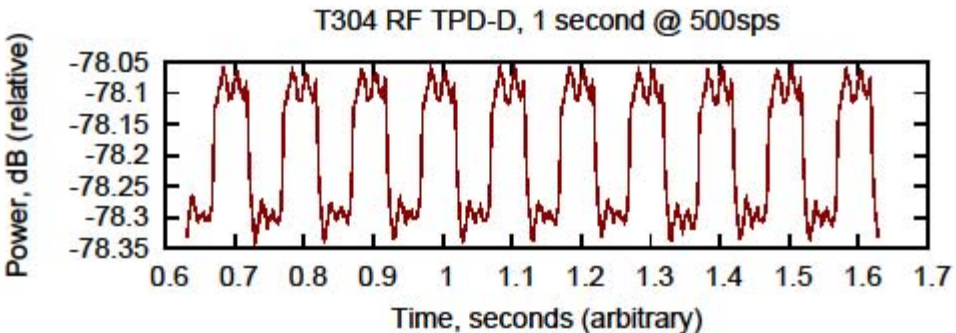
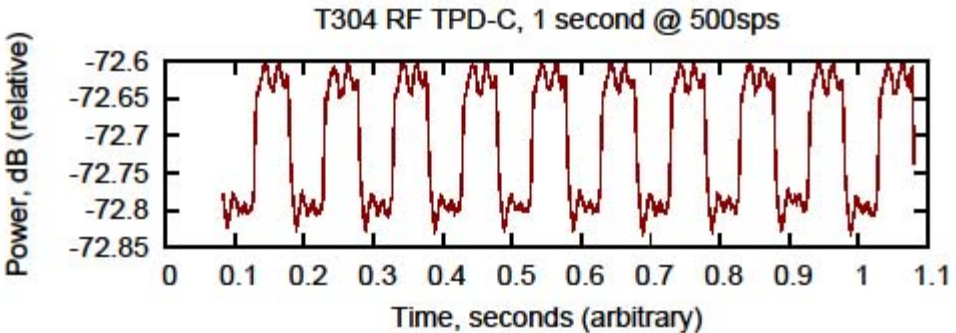
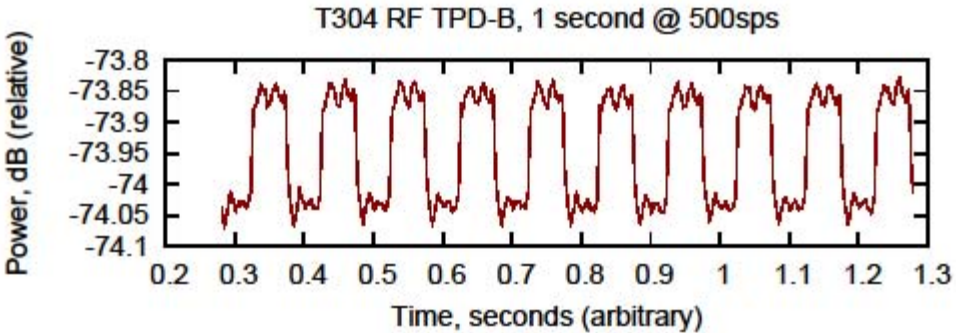
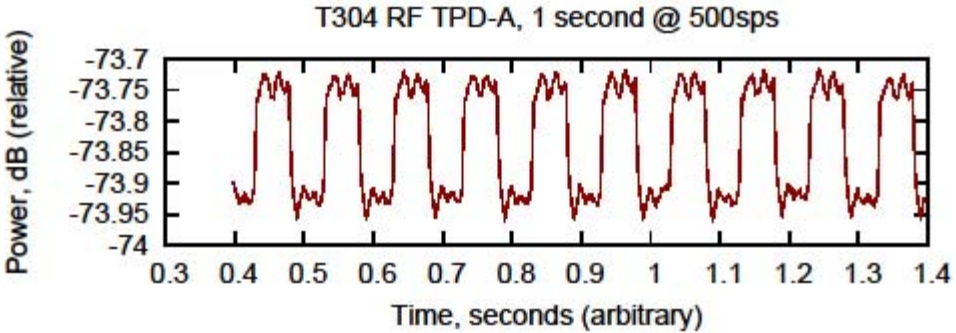
6. EA04





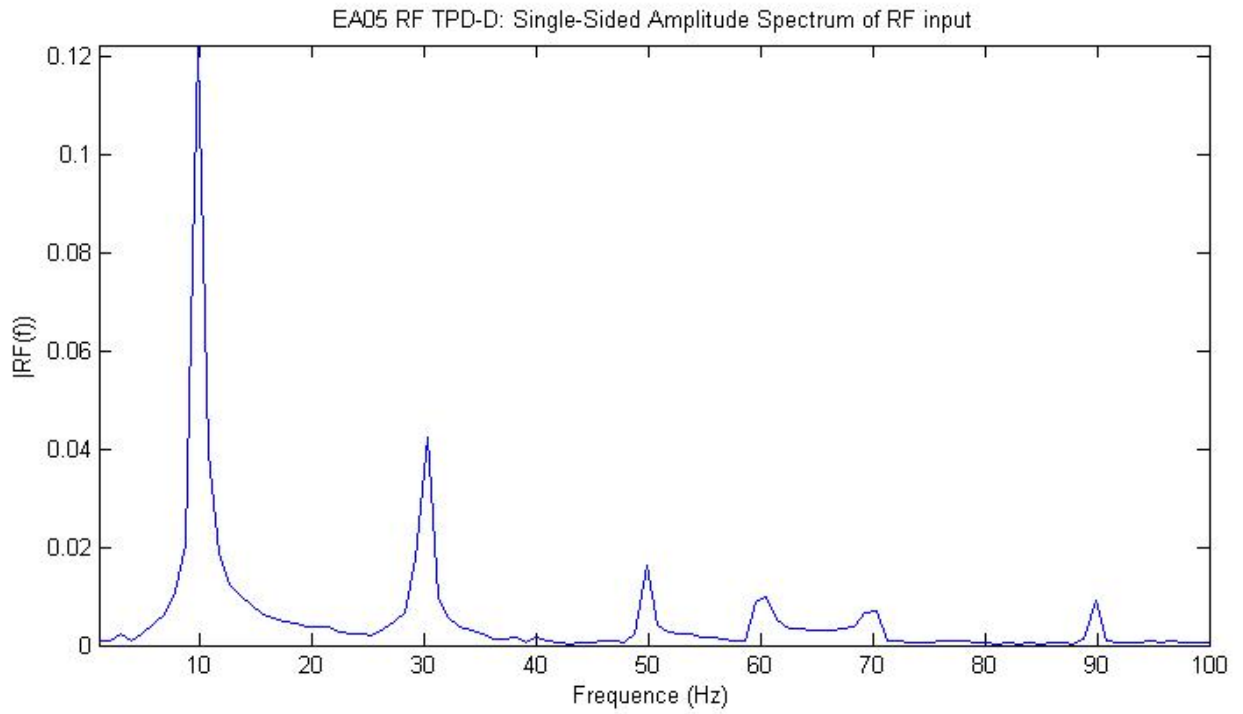
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7. EA05





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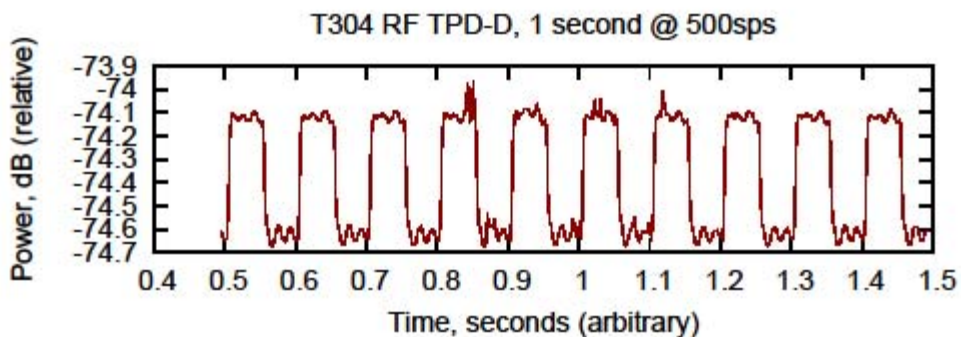
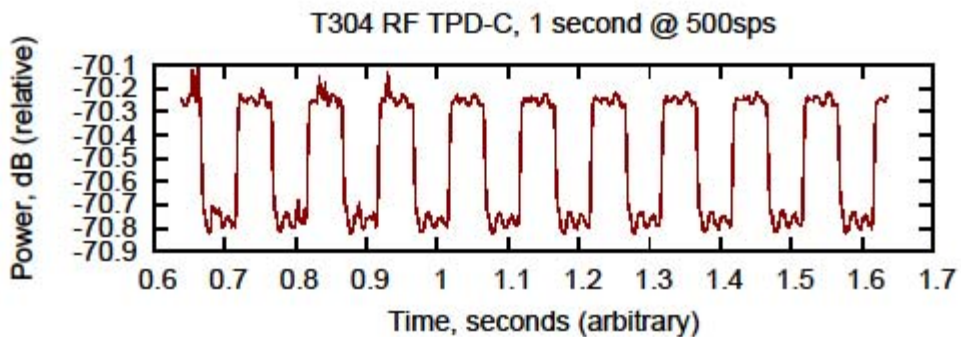
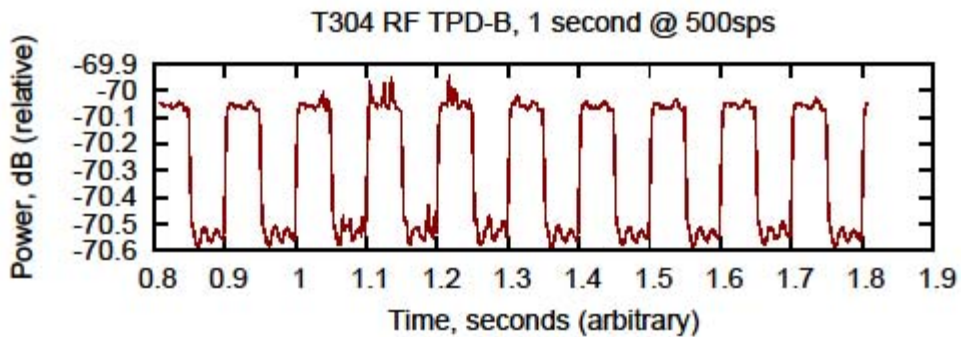
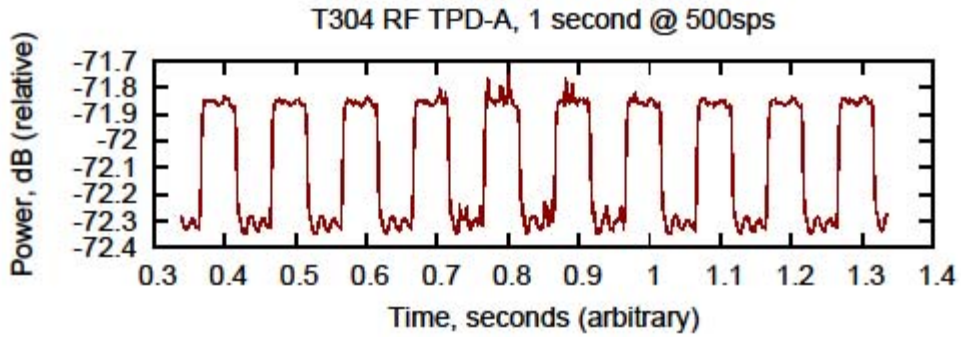






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8. EA06

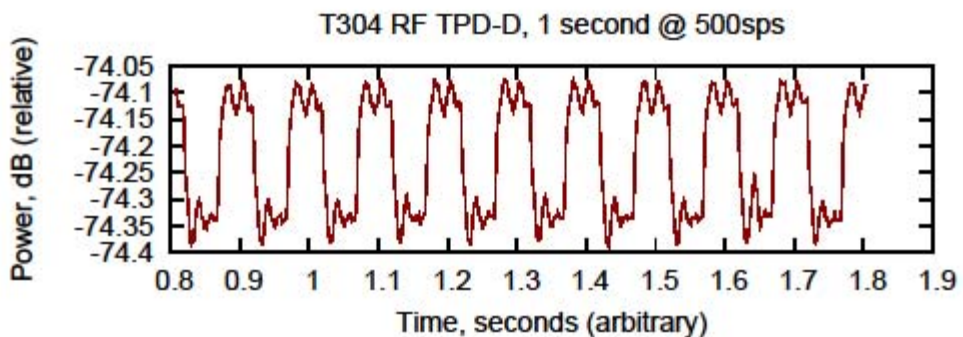
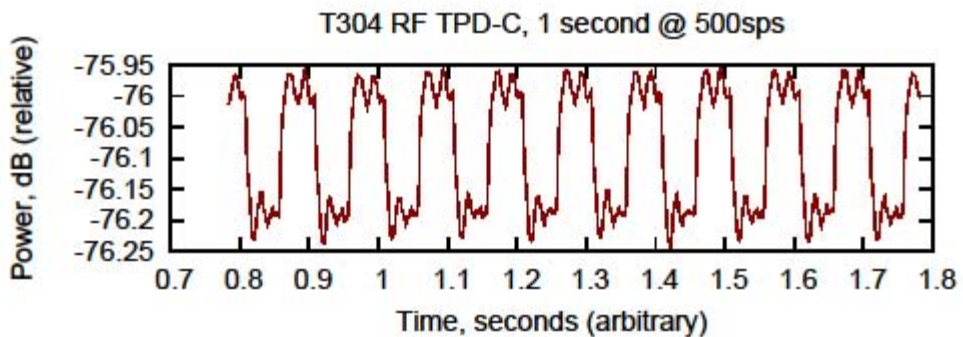
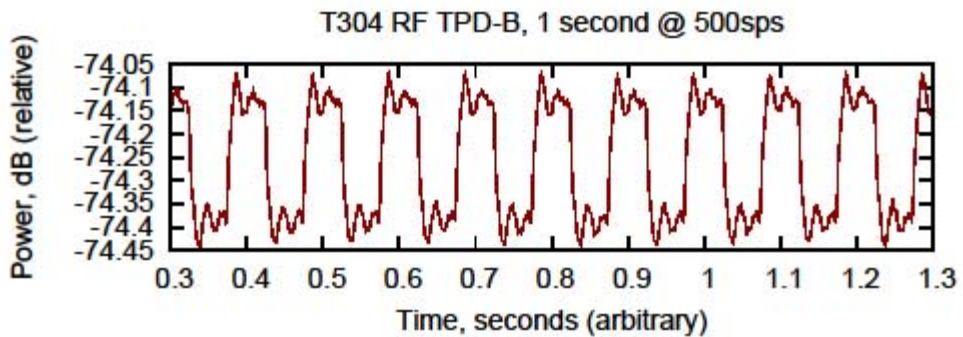
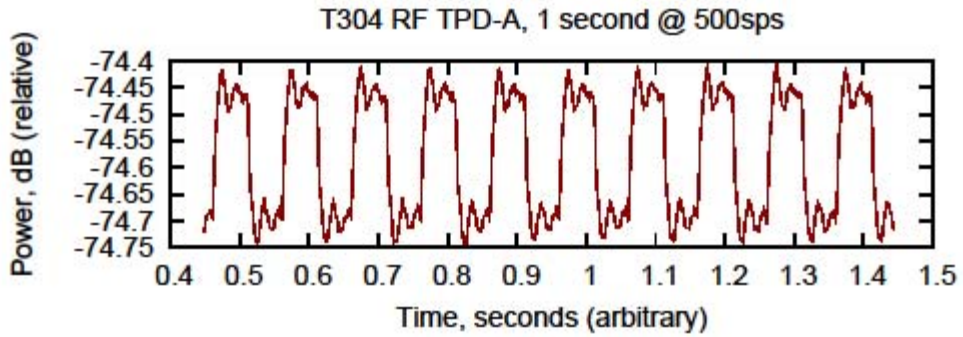






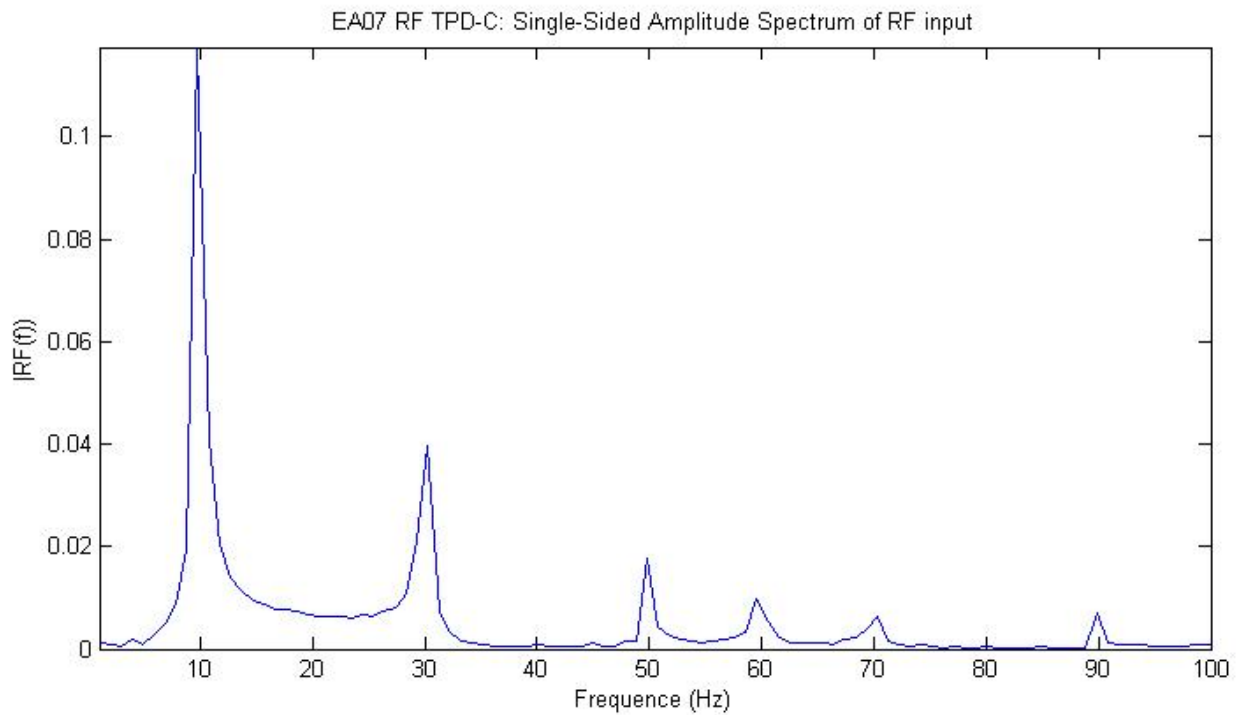
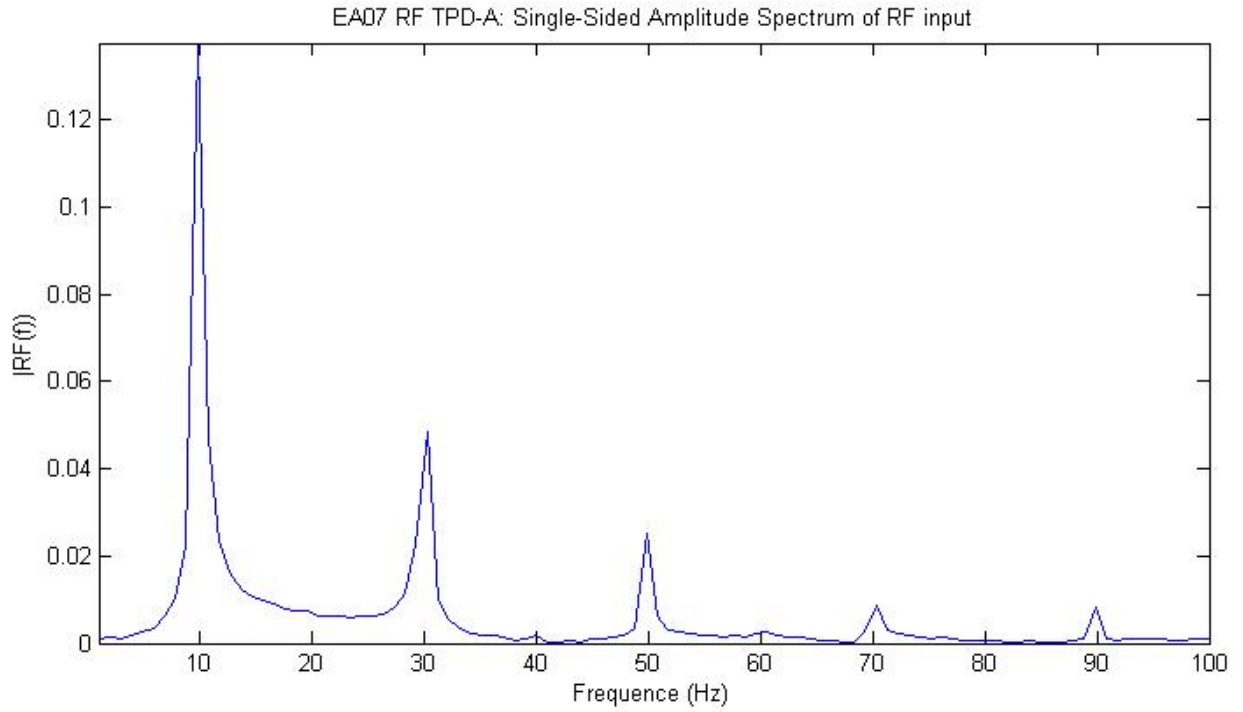
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9. EA07





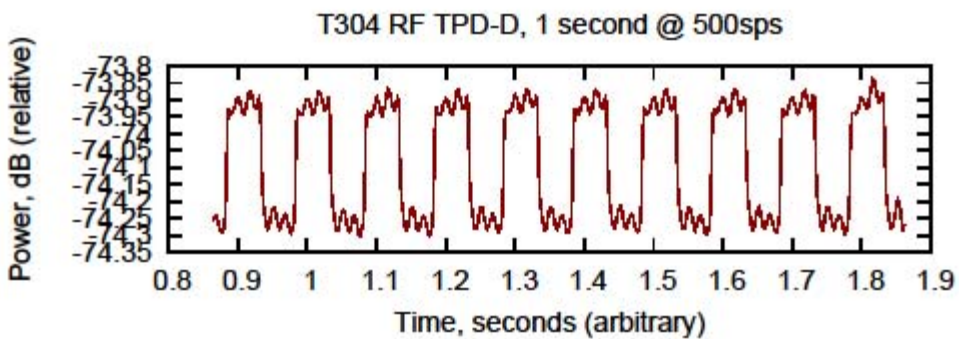
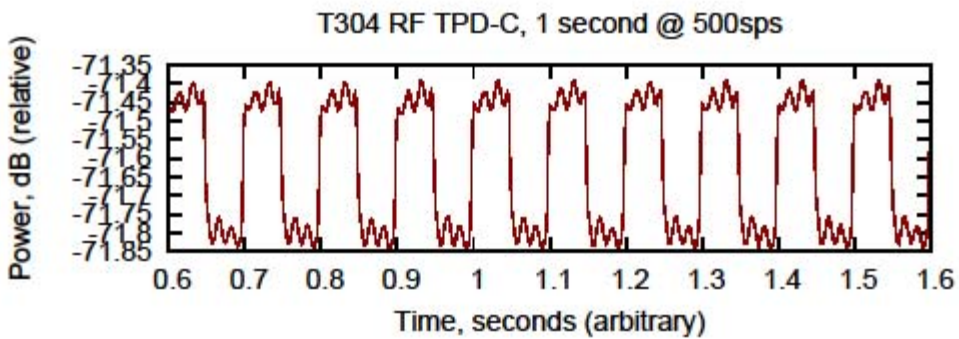
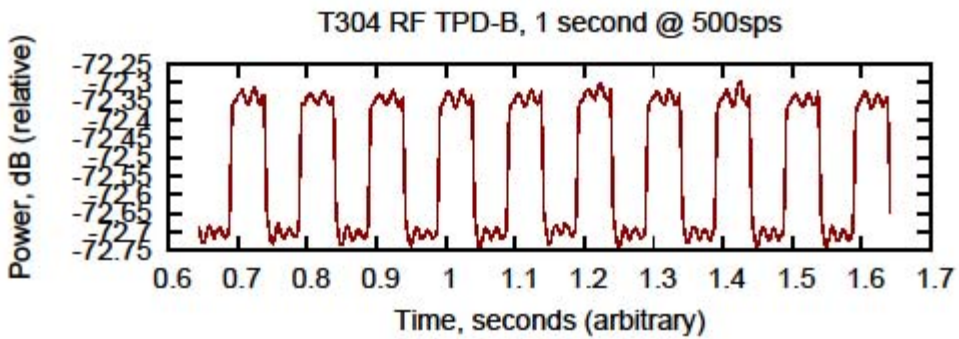
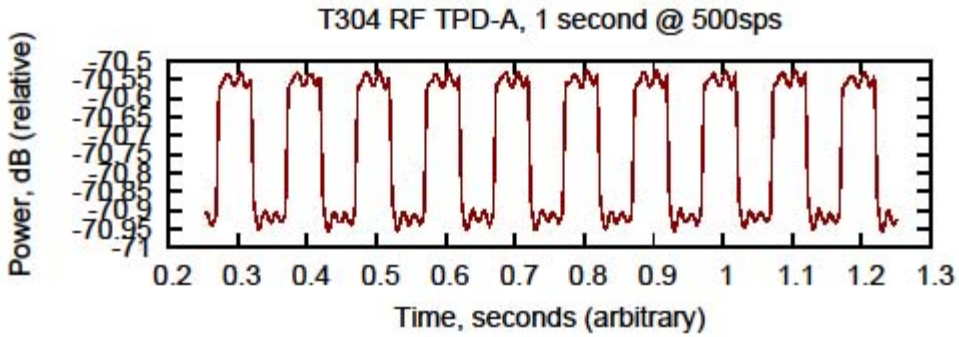
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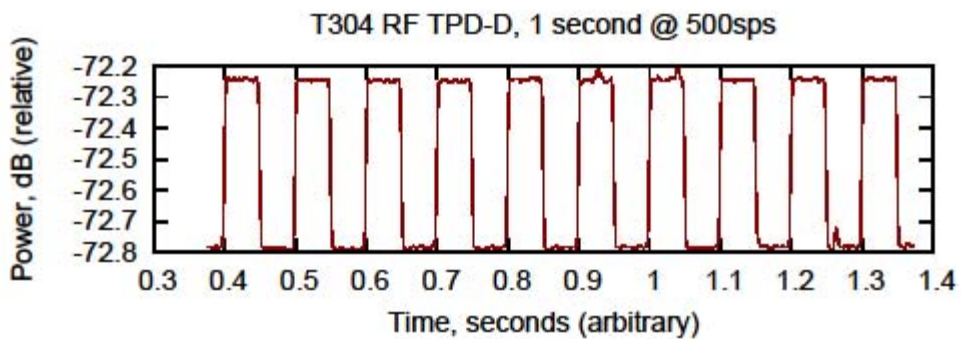
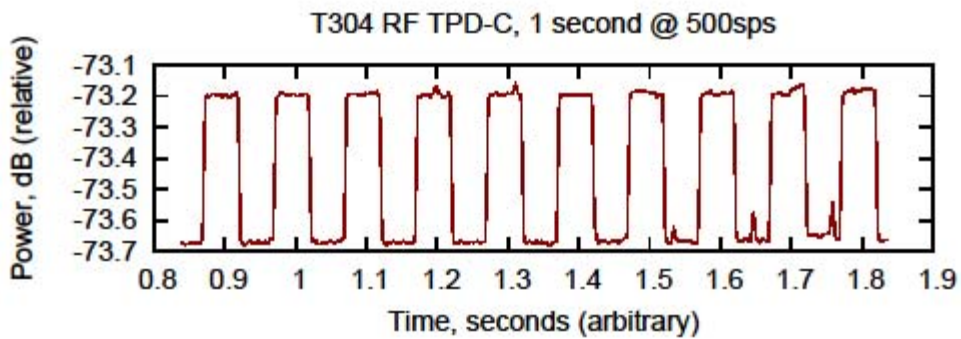
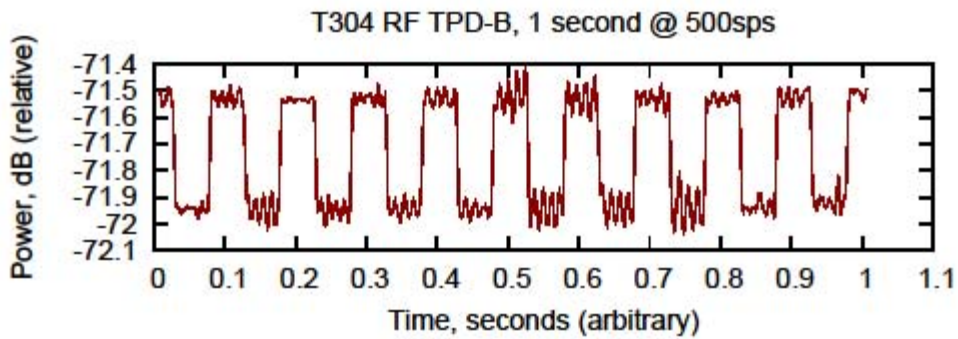
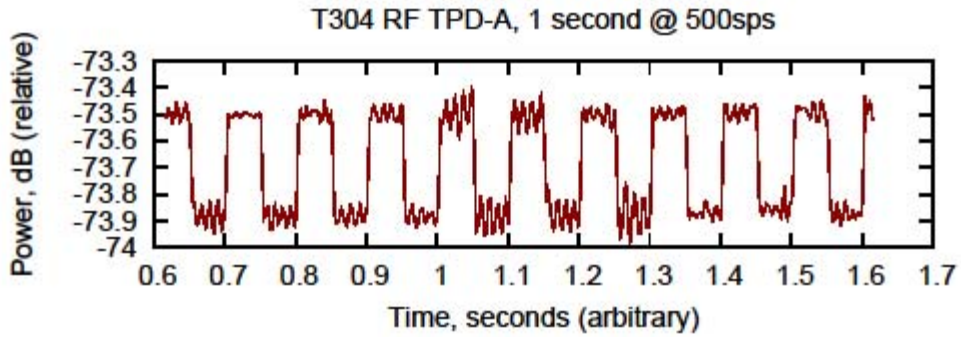
10. EA08





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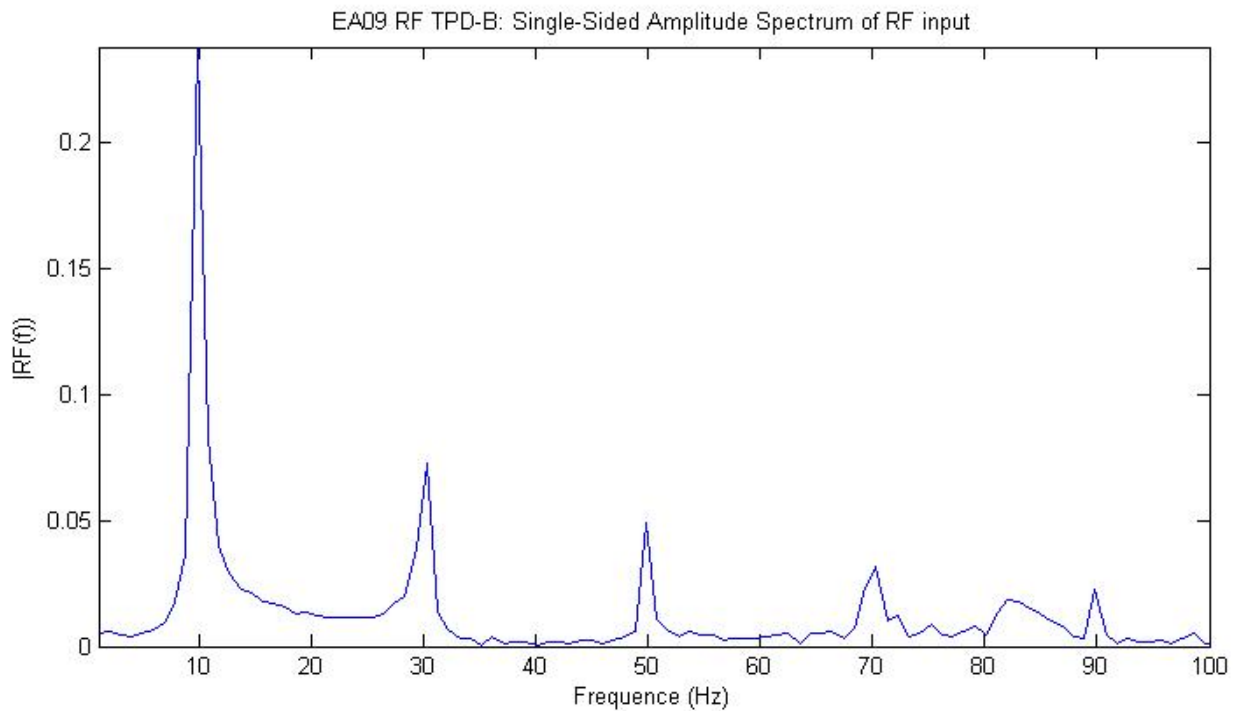
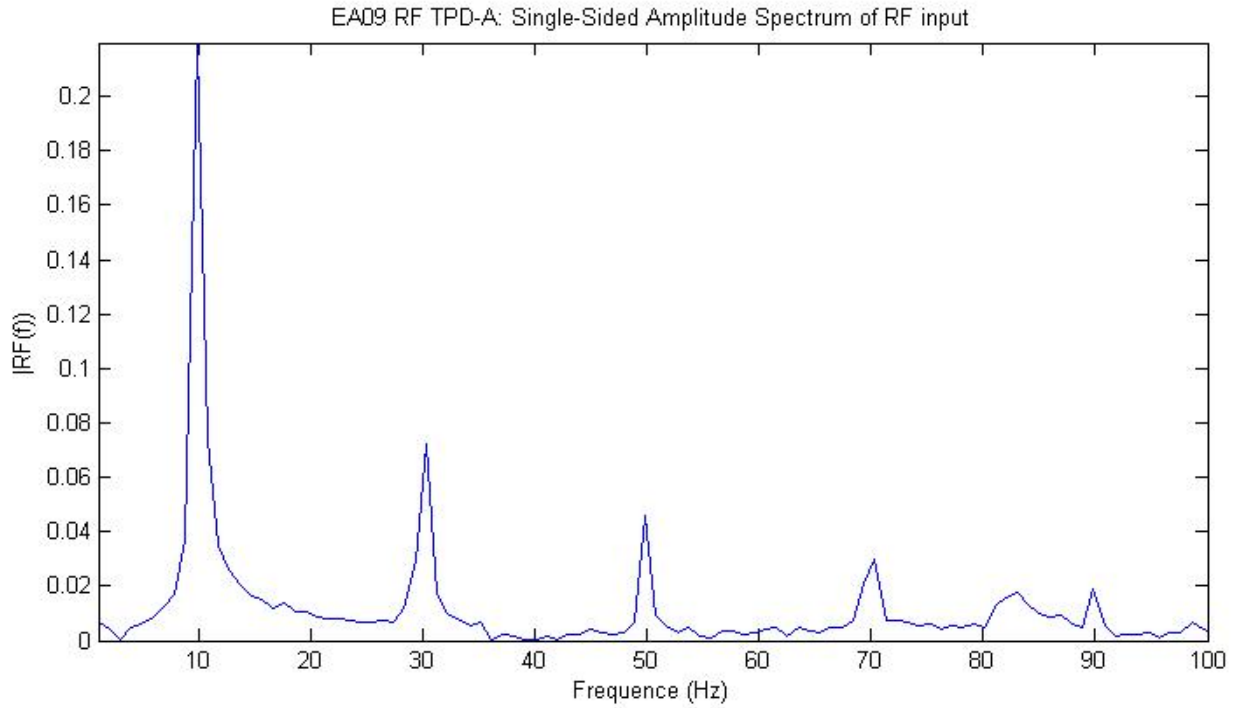
II. EA09







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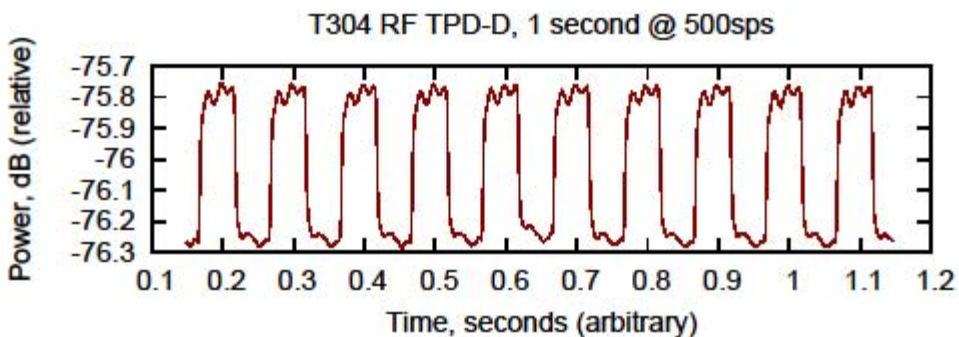
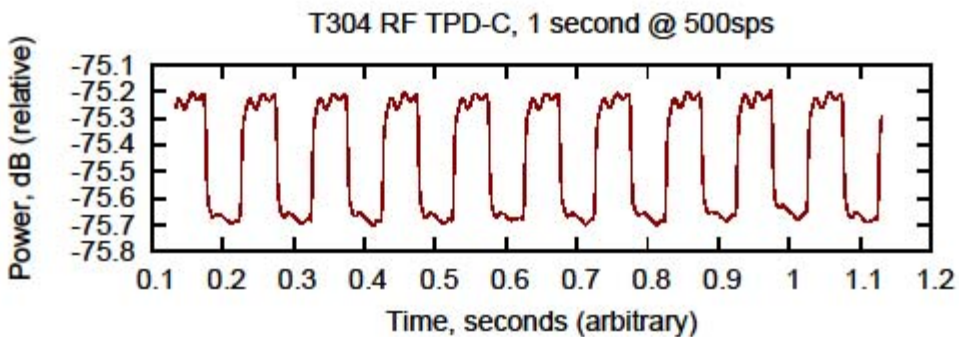
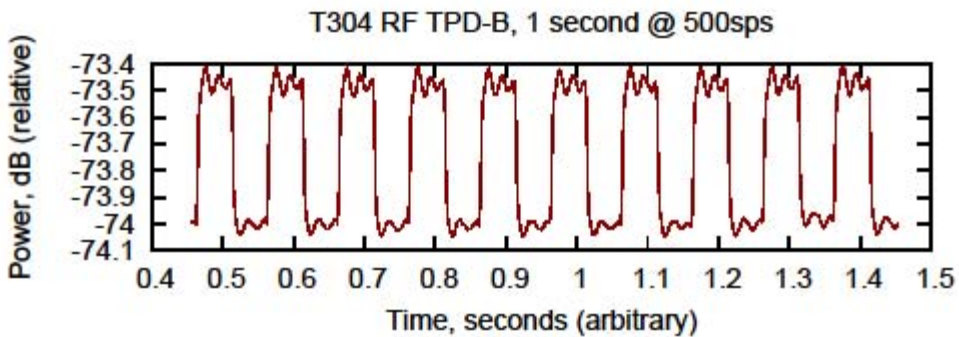
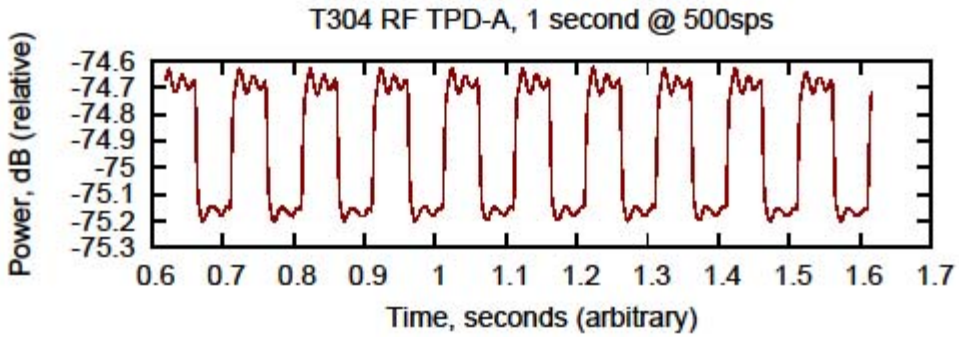


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12. EA10

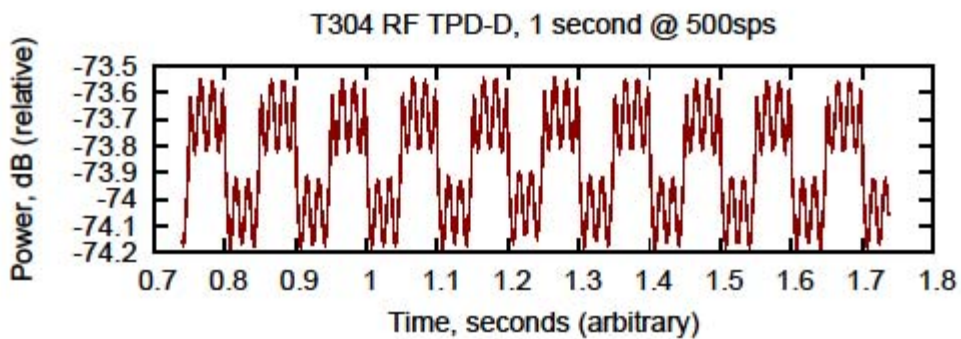
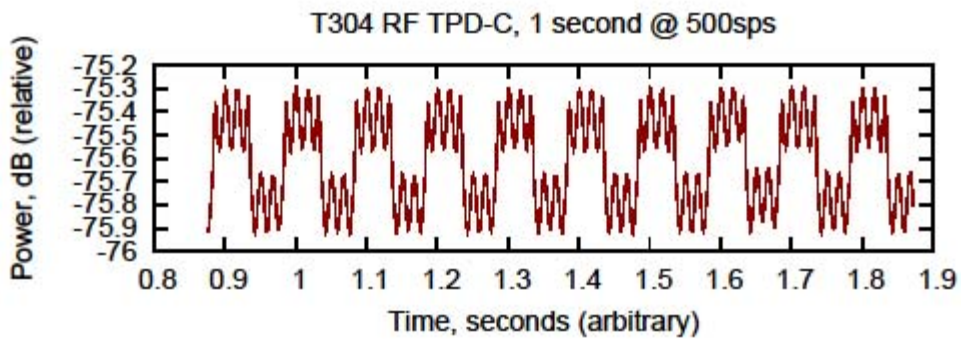
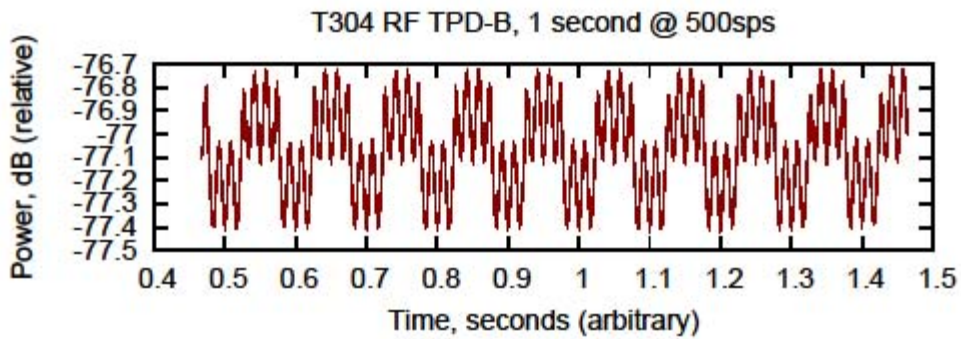
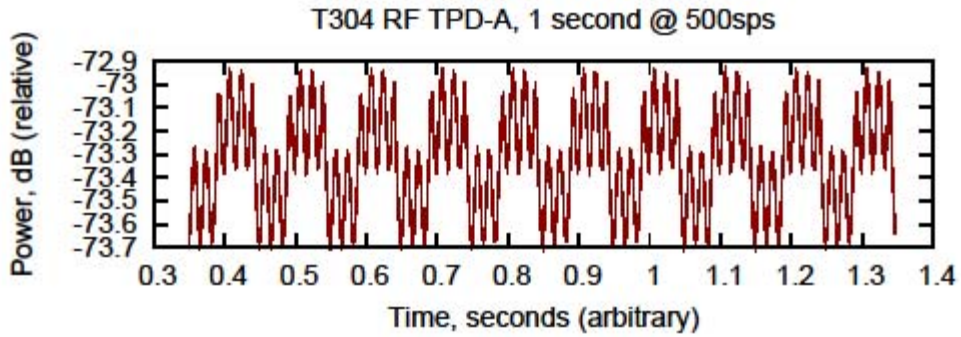






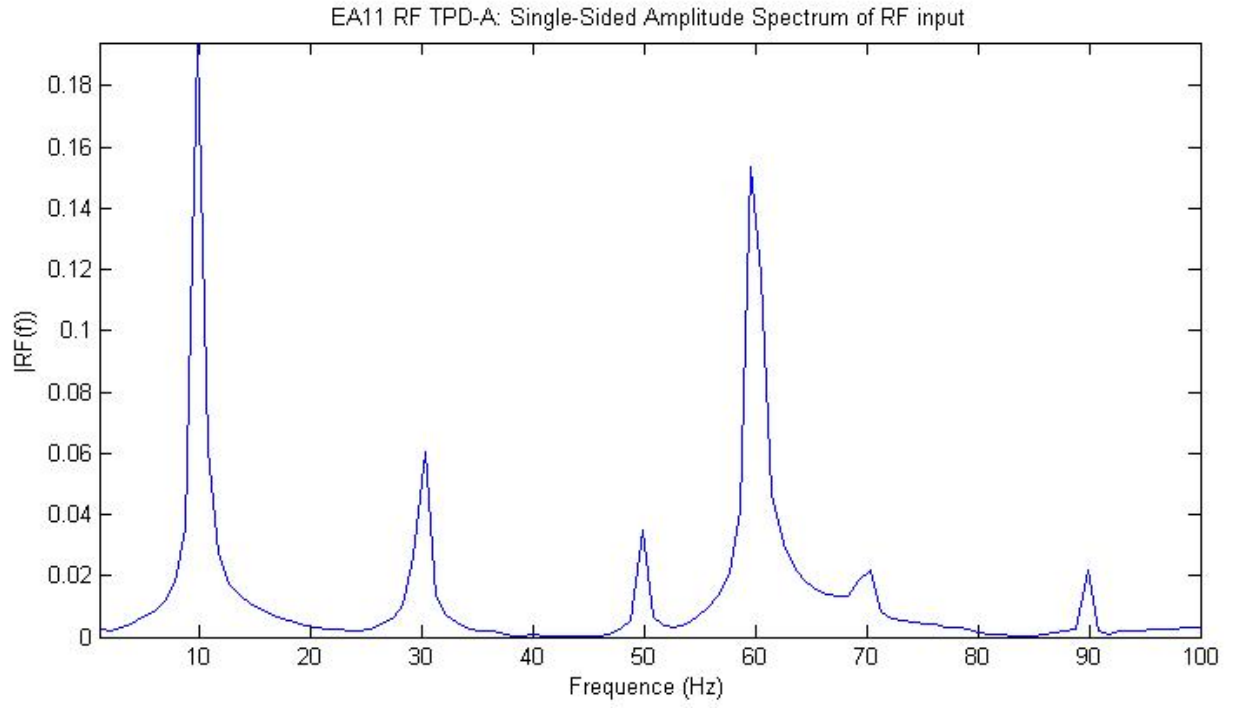
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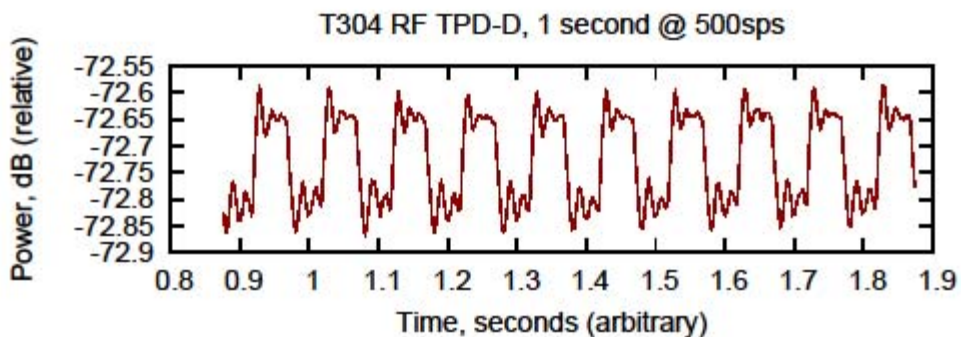
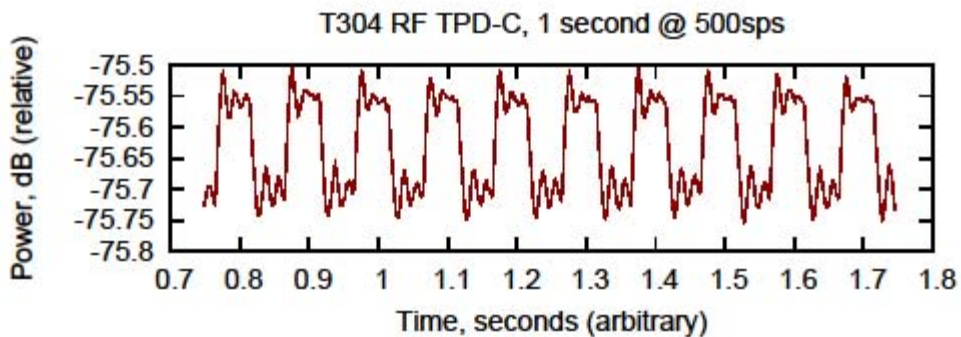
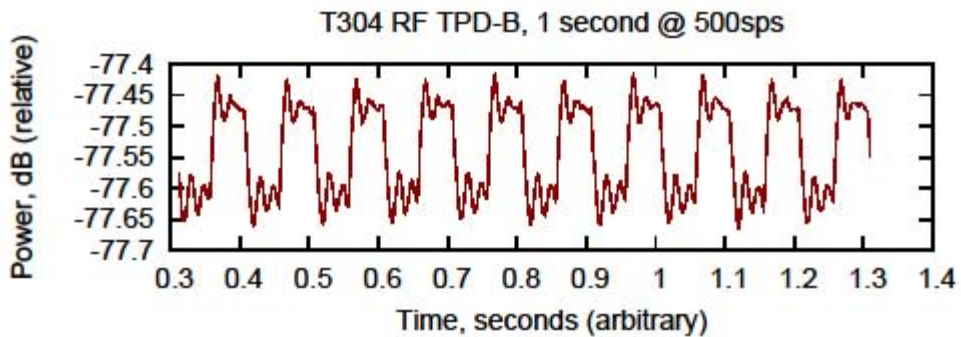
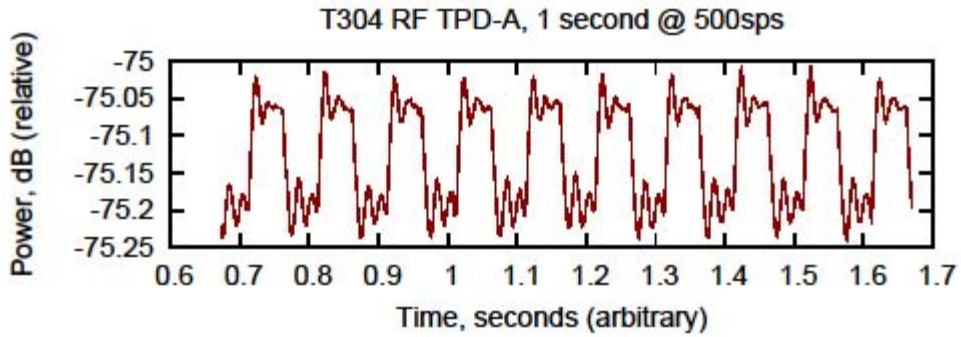
Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3





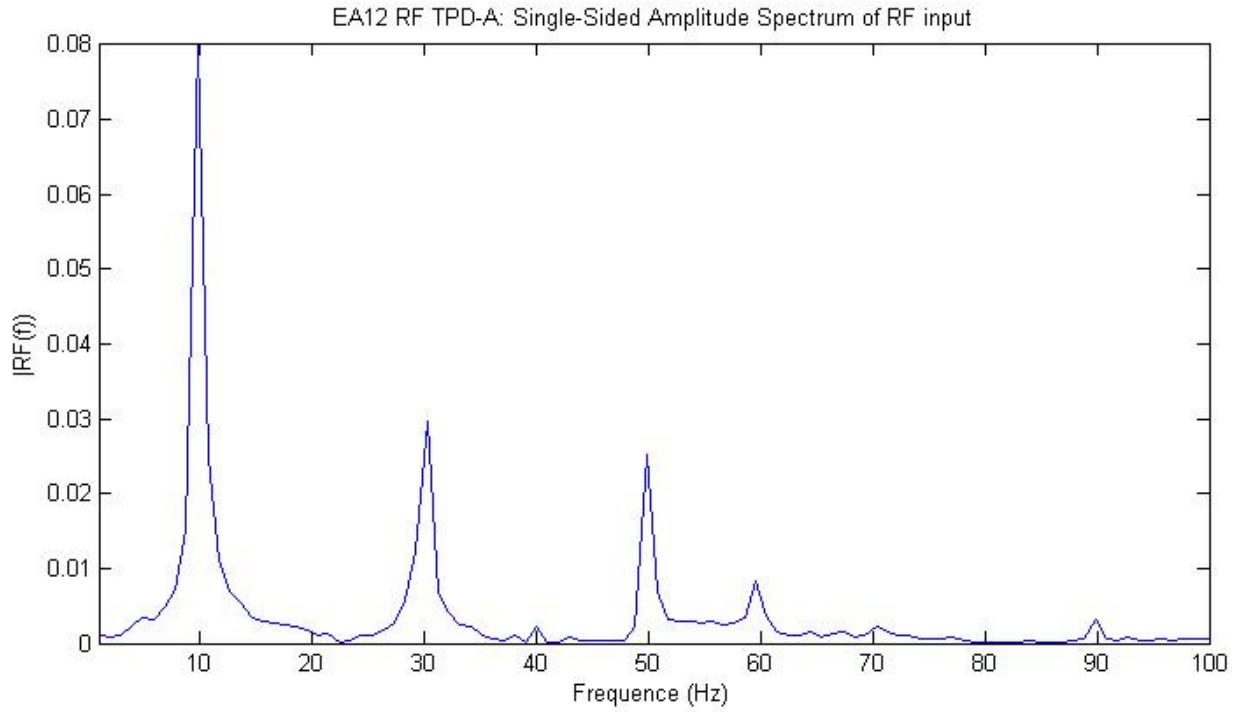
Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

14. EA12





Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

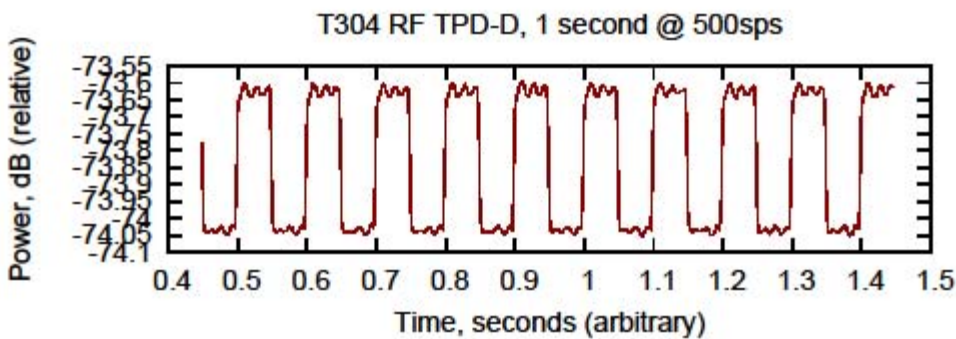
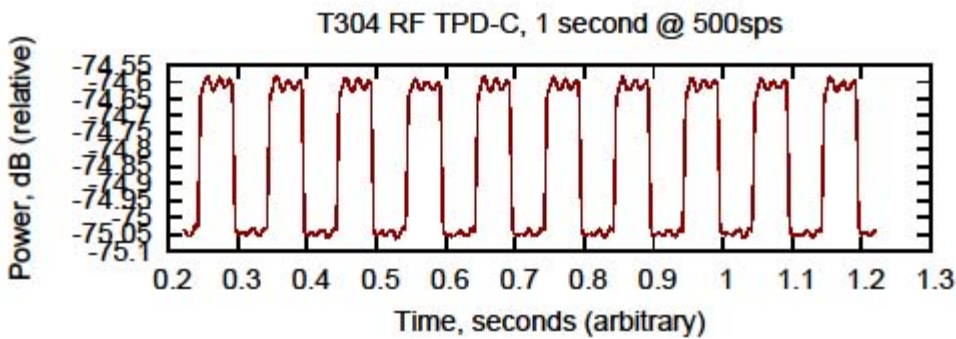
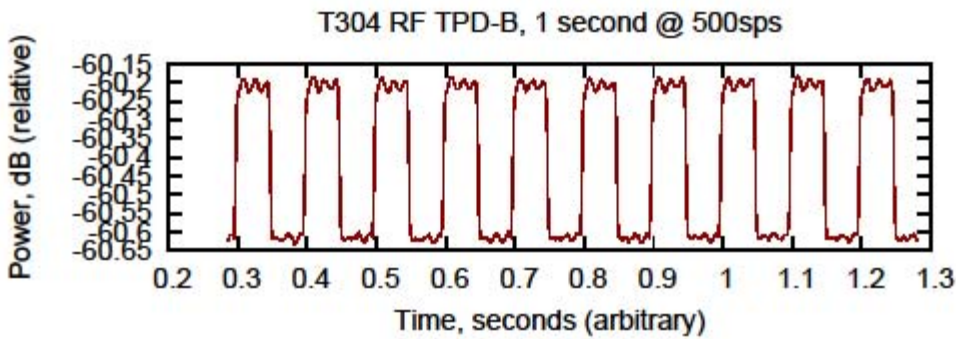
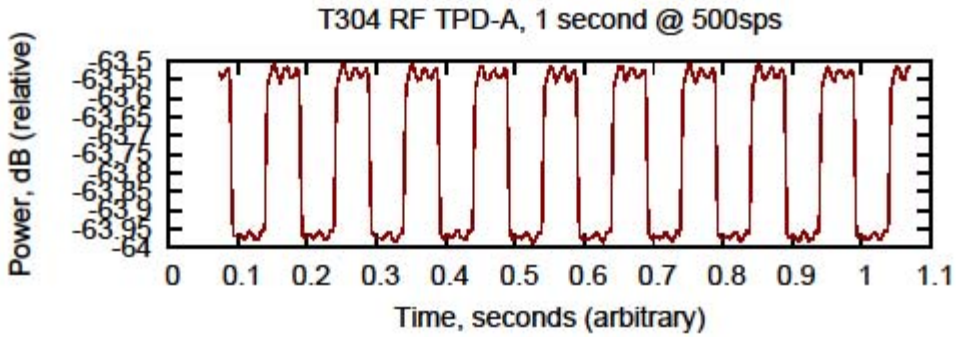






Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

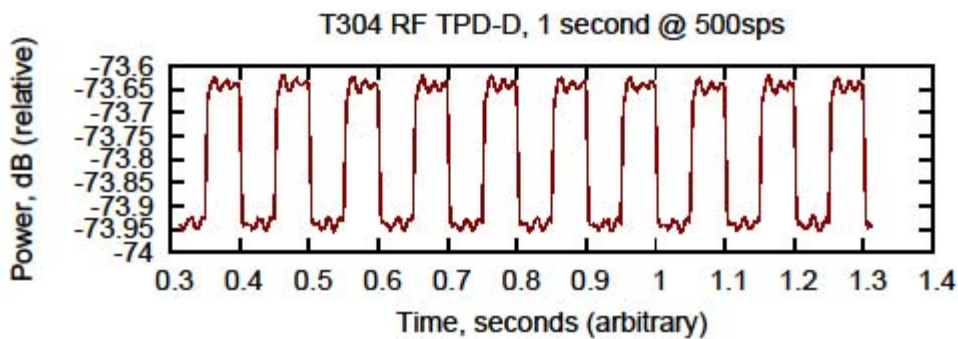
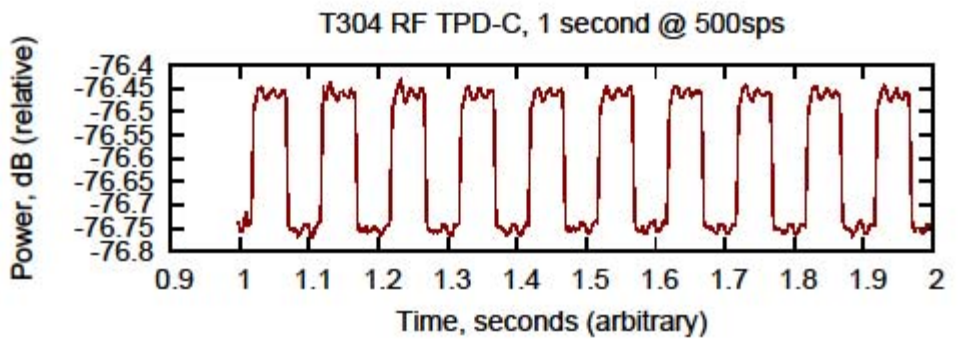
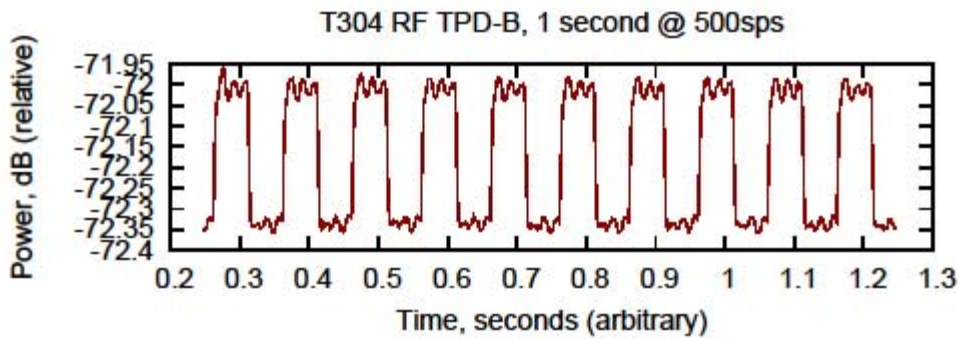
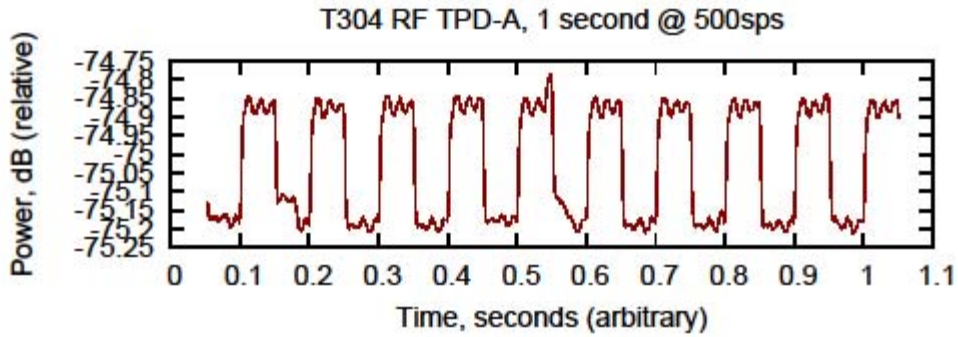
15. EA13





Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

16. EA14

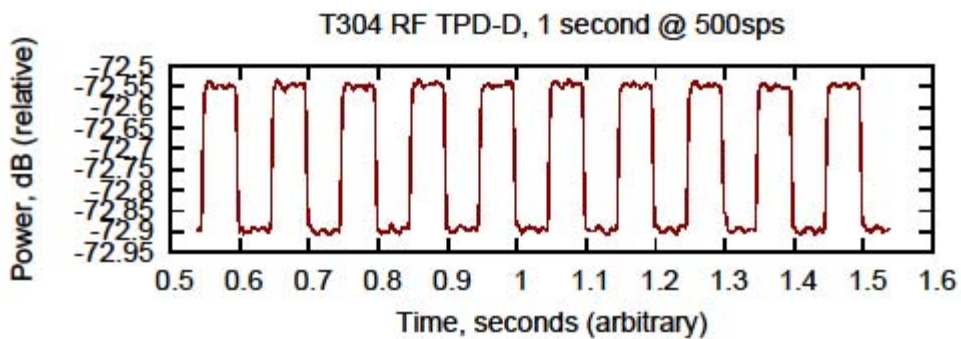
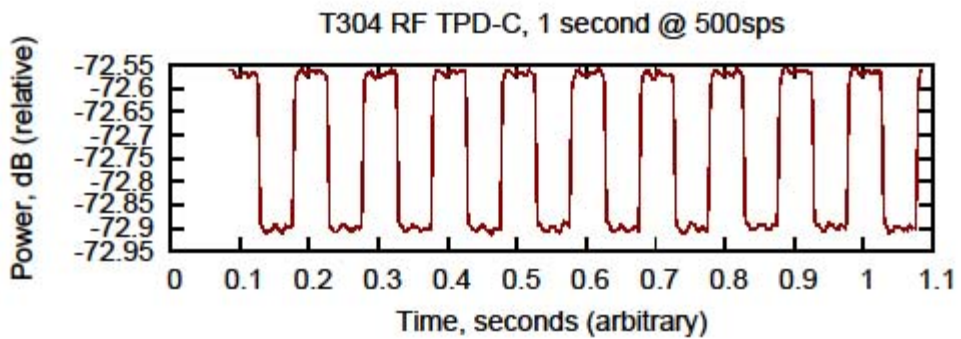
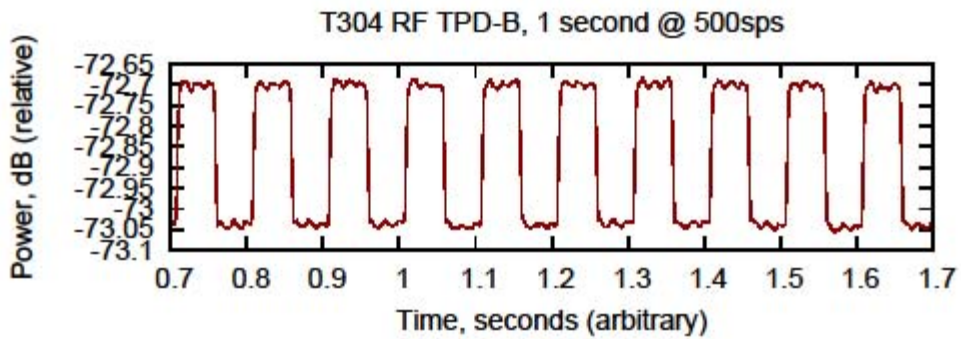
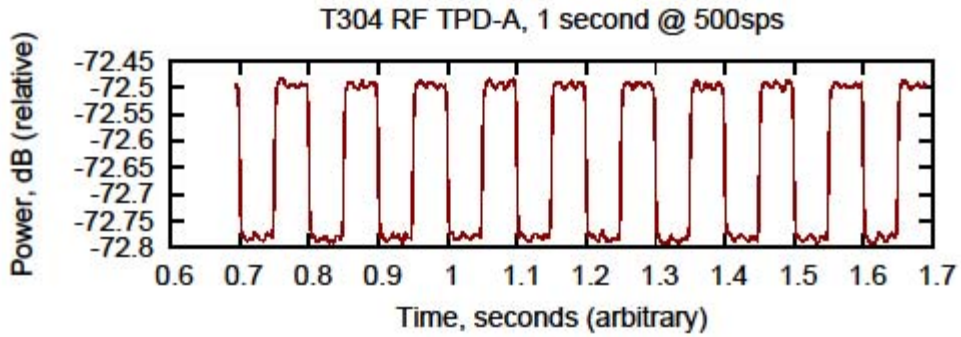






Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

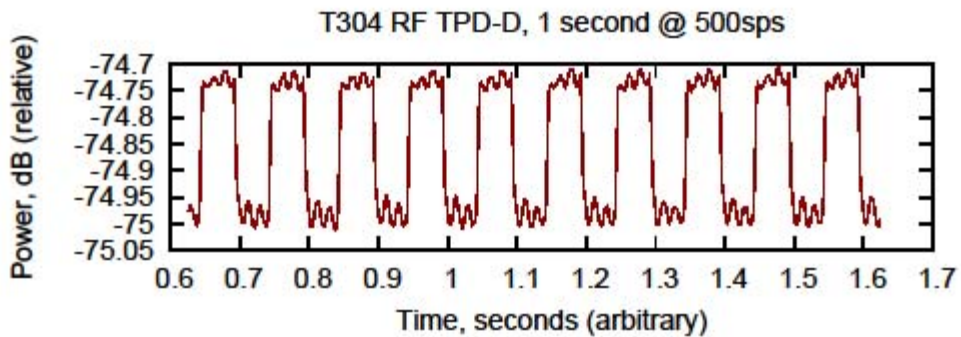
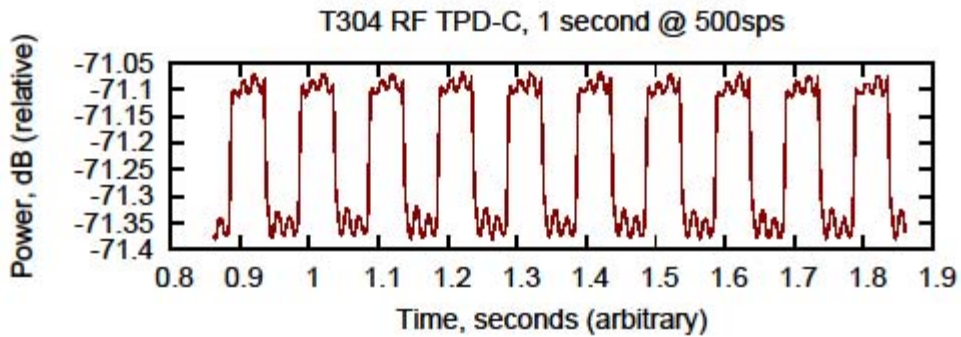
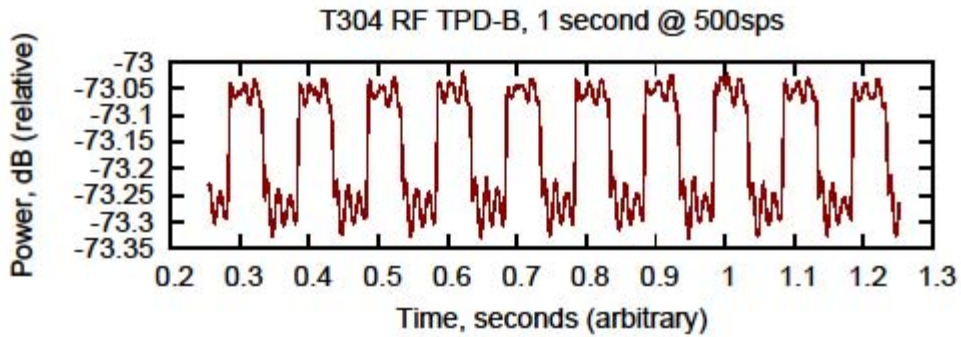
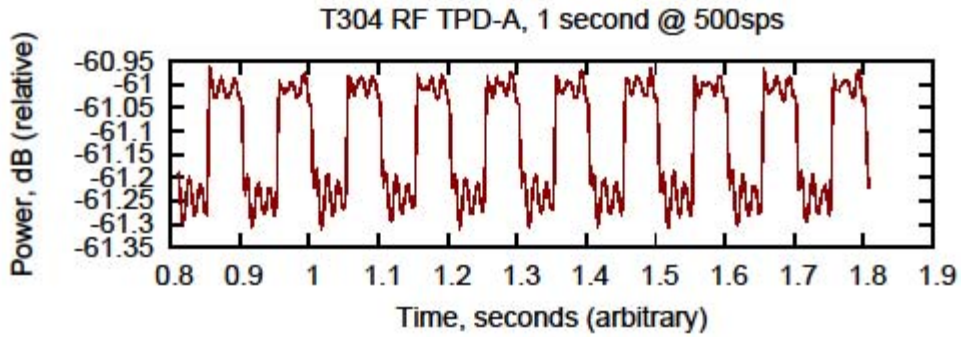
17. EA15





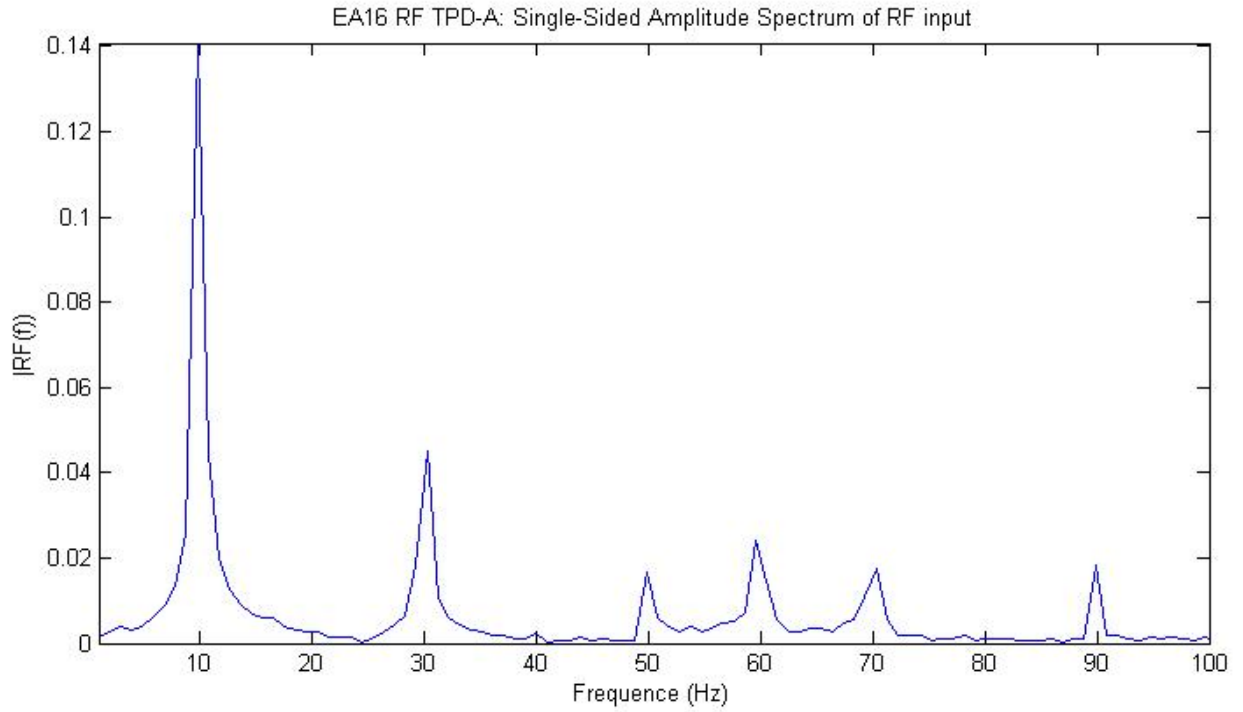
Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

18. EA16





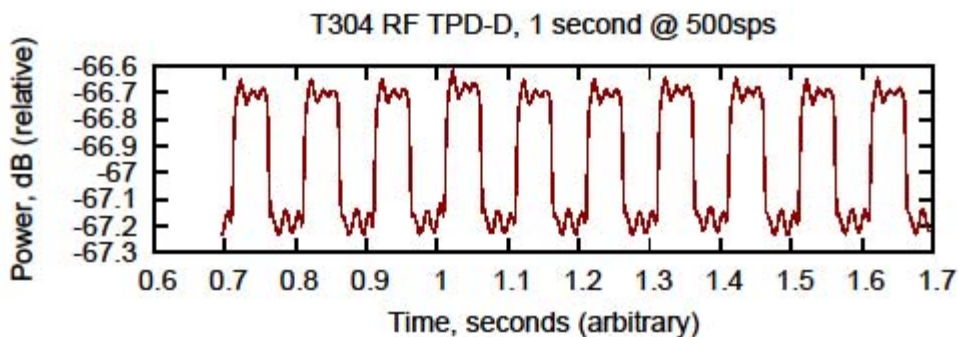
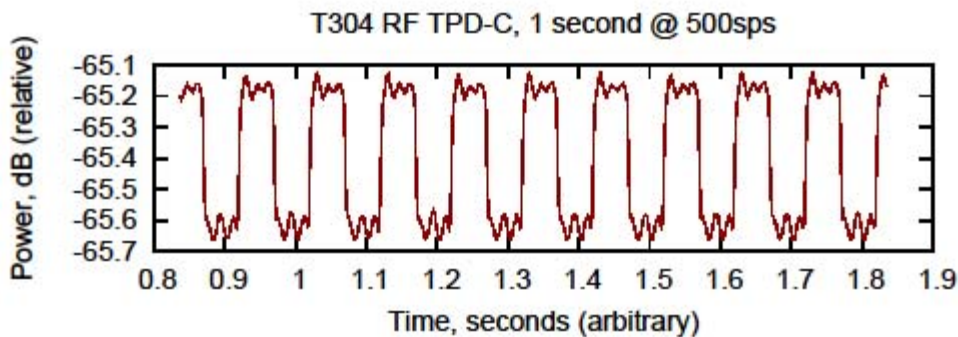
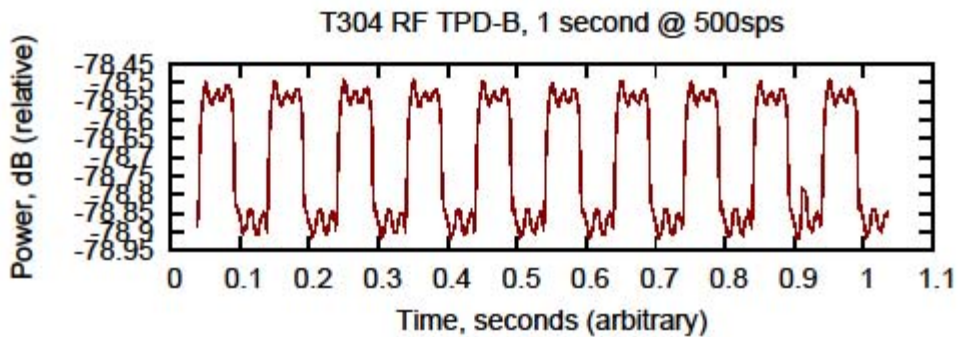
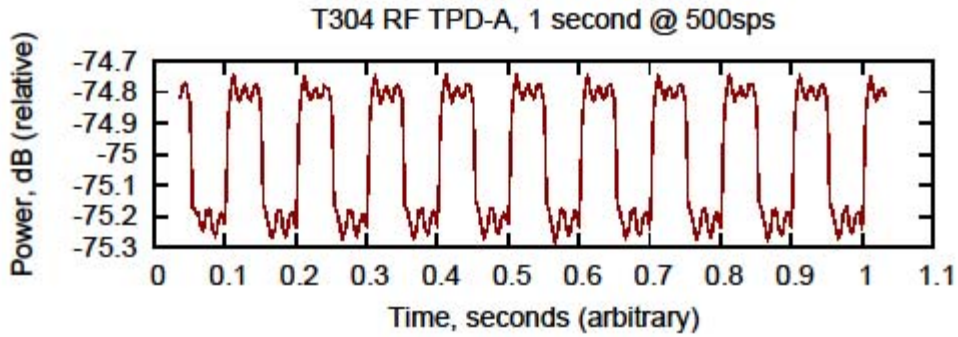
Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3





Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

19. EA18

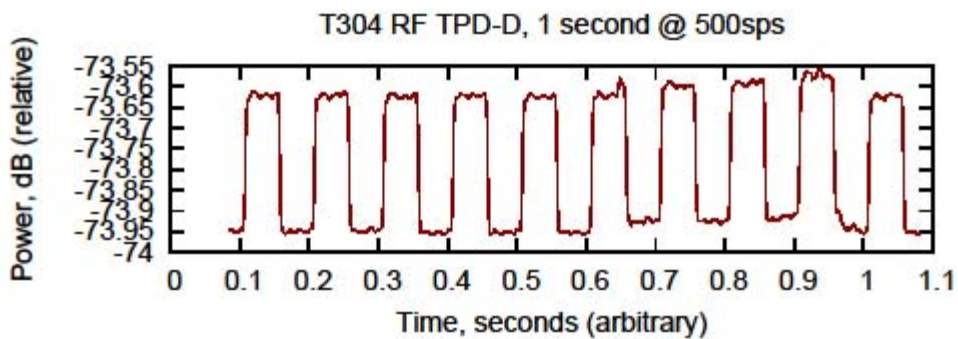
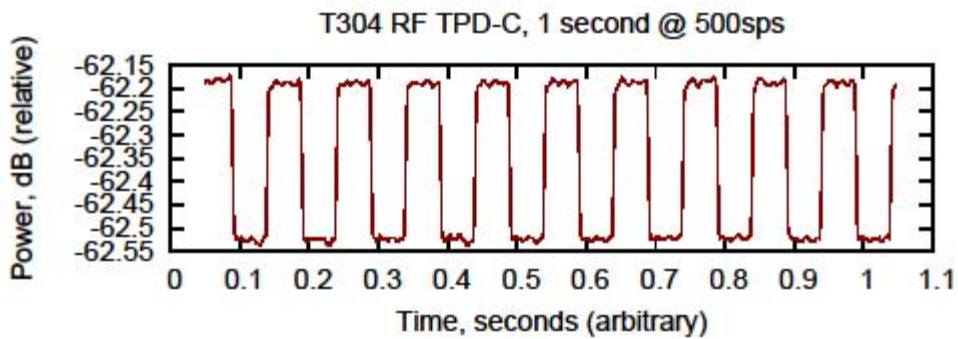
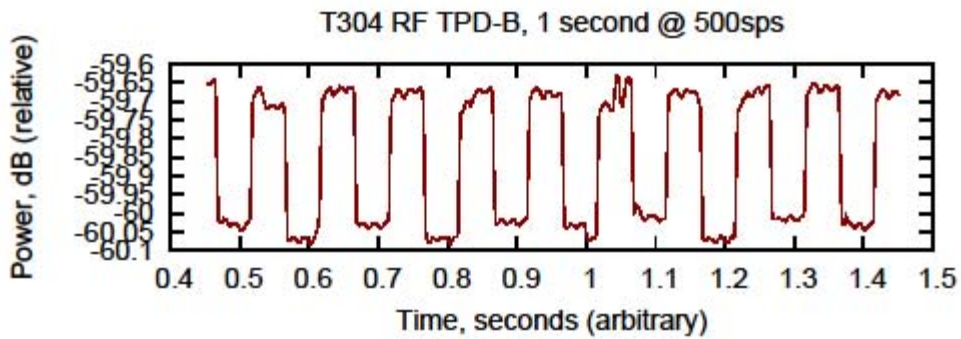
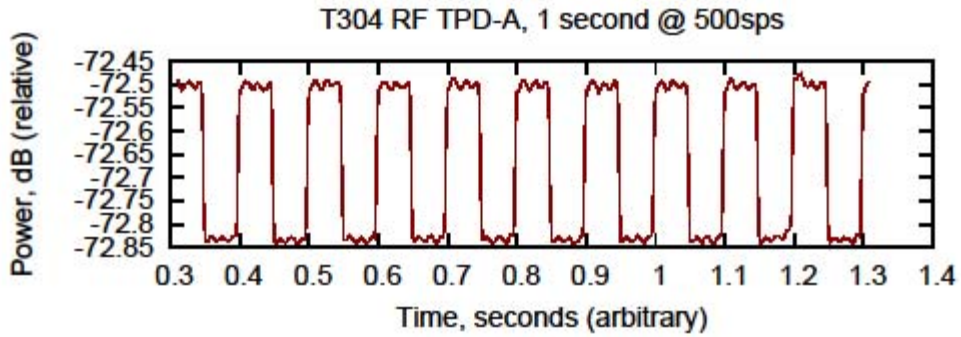






Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

20. EA19

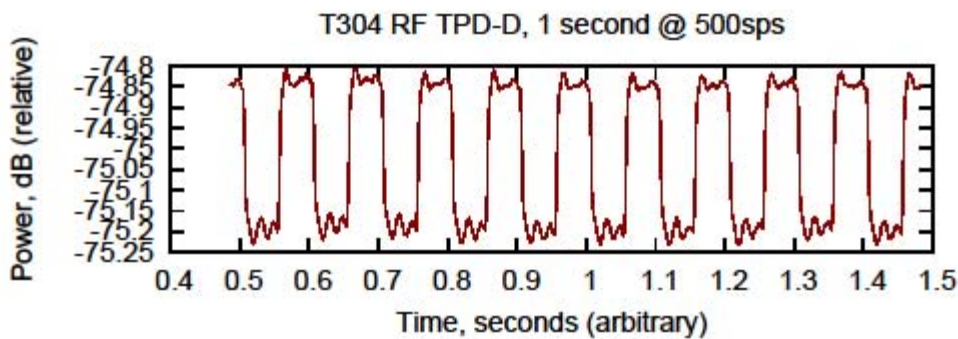
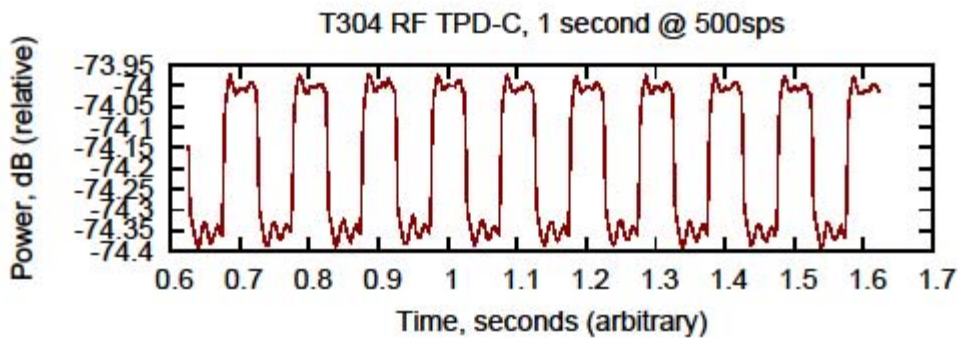
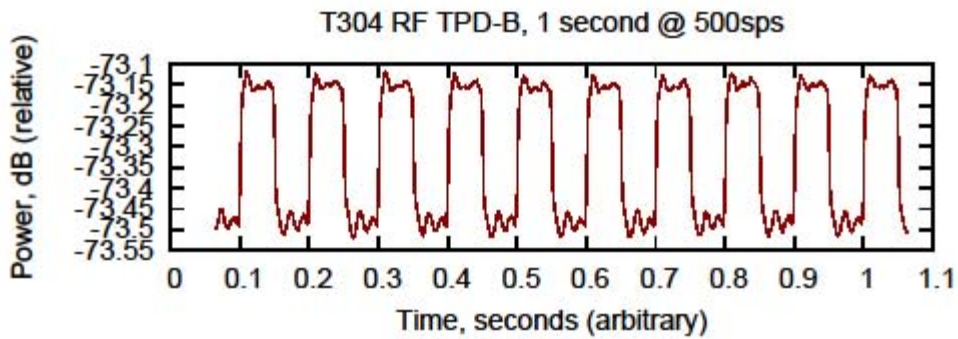
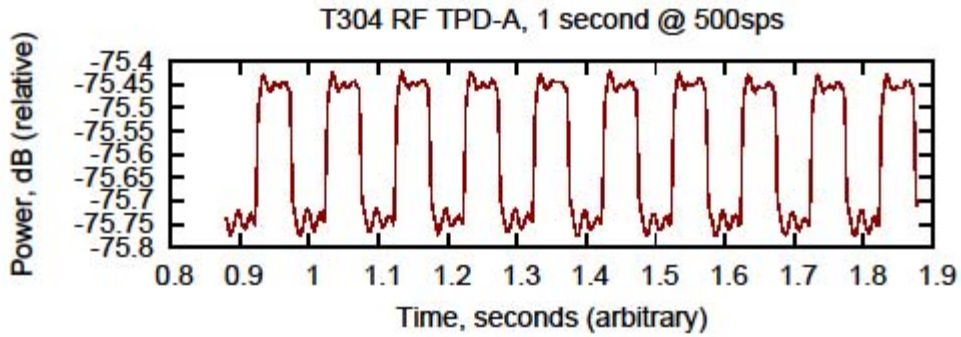






Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

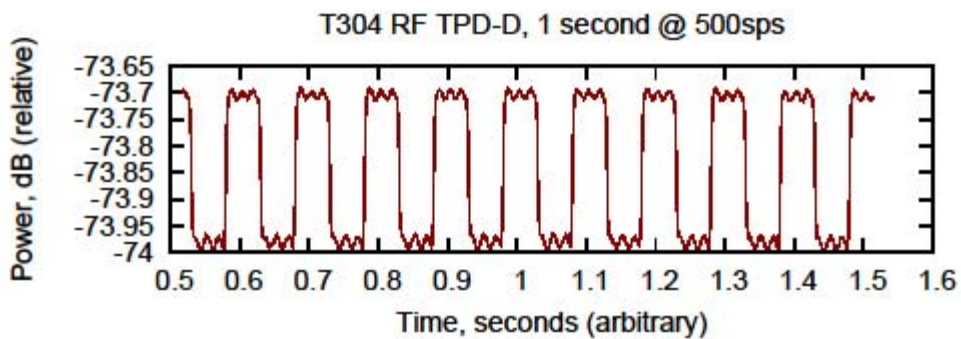
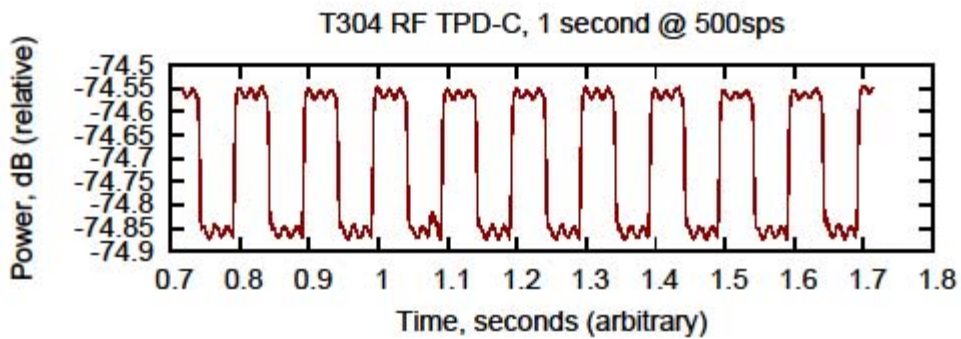
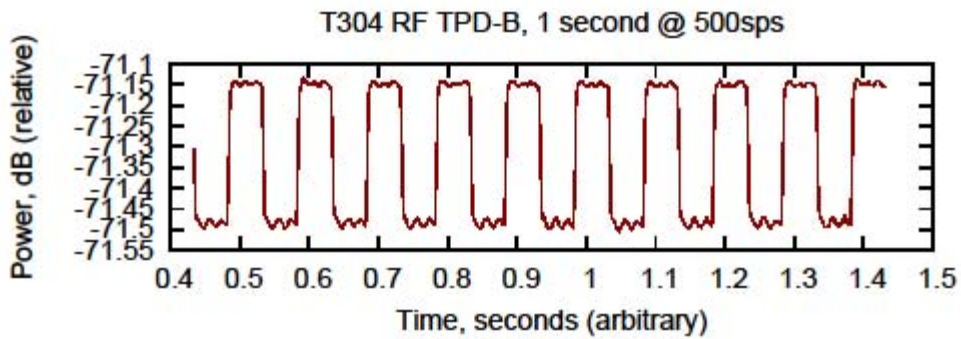
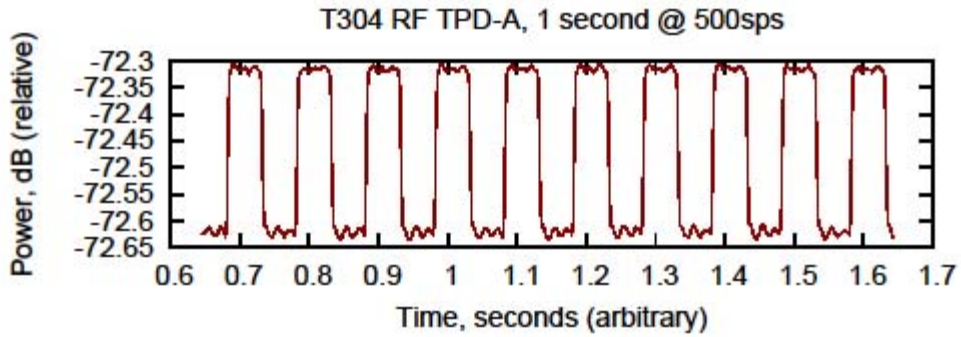
21. EA20





Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

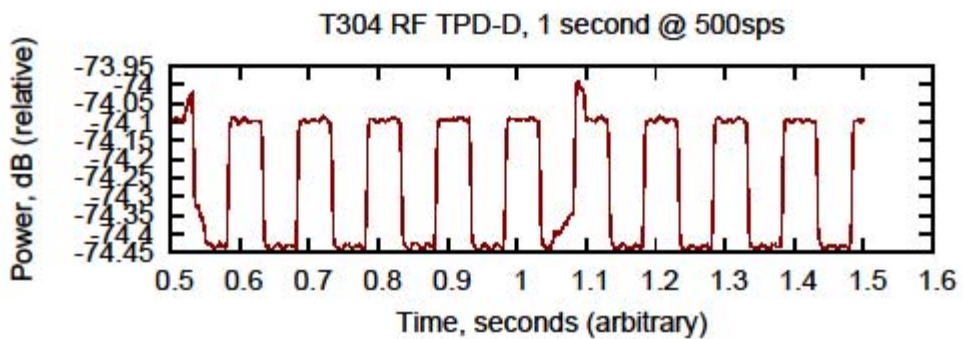
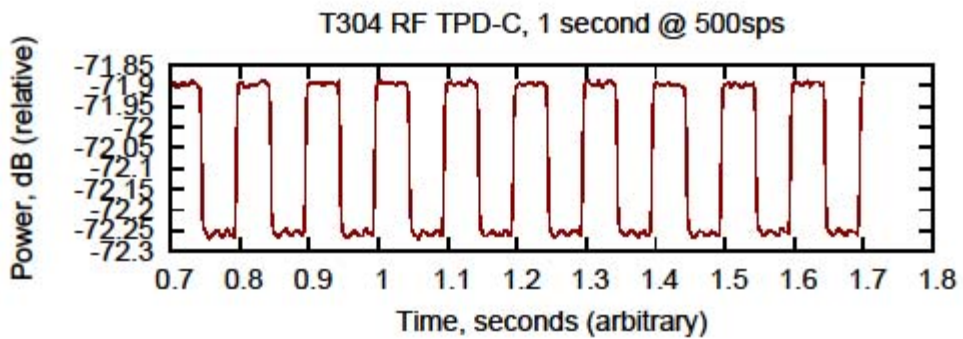
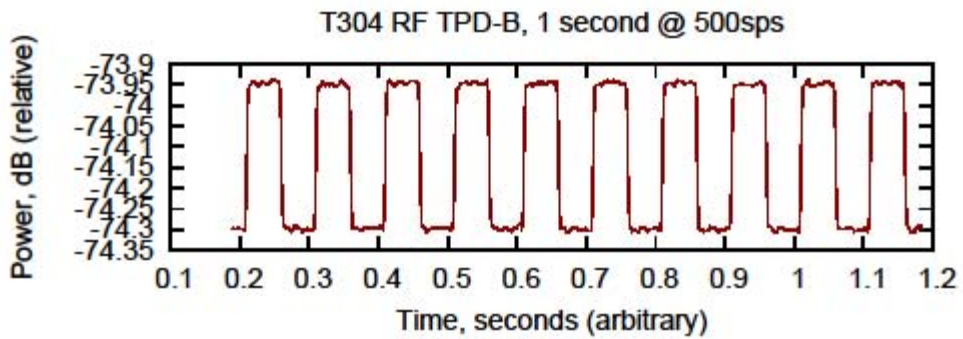
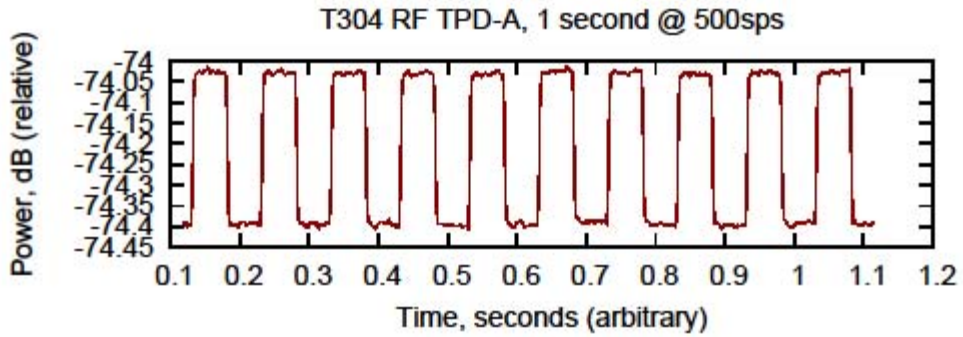
22. EA2I





Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

23. EA22

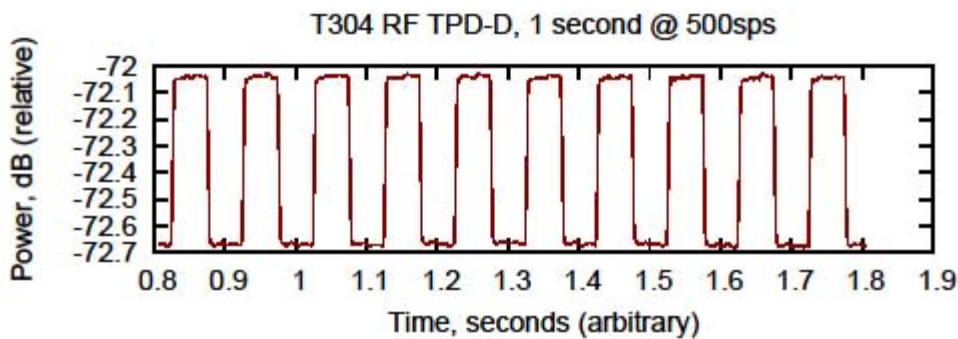
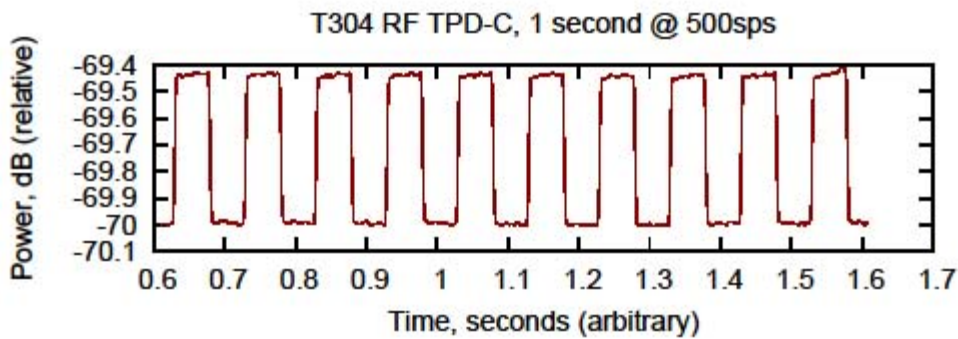
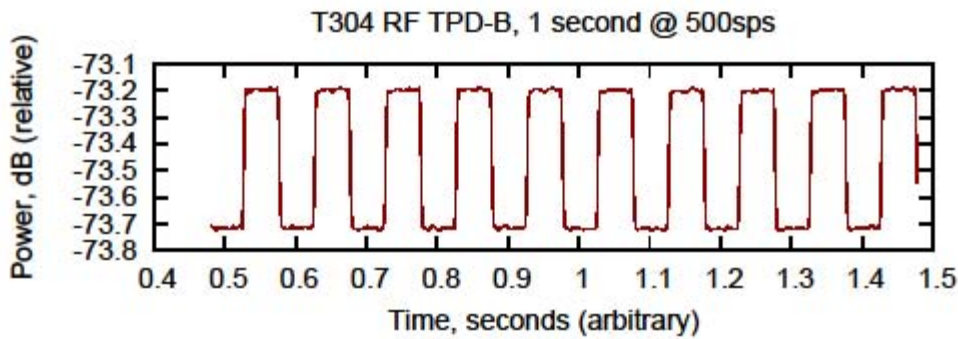
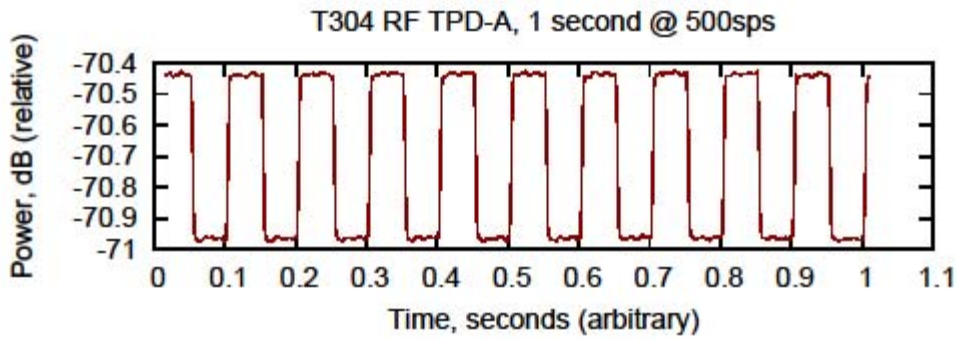






Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

24. EA23

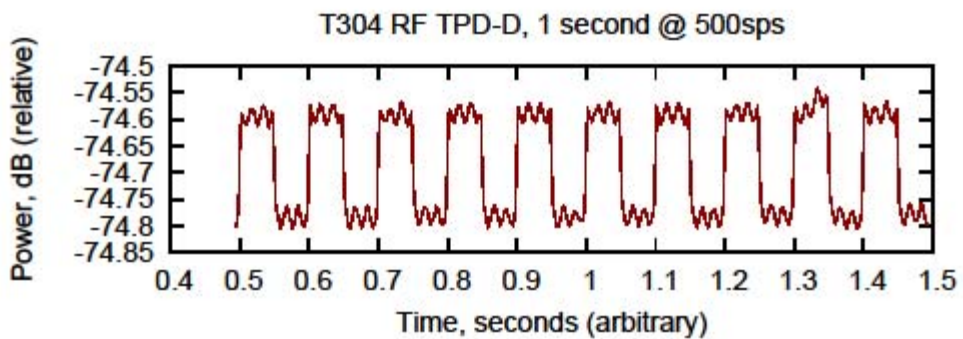
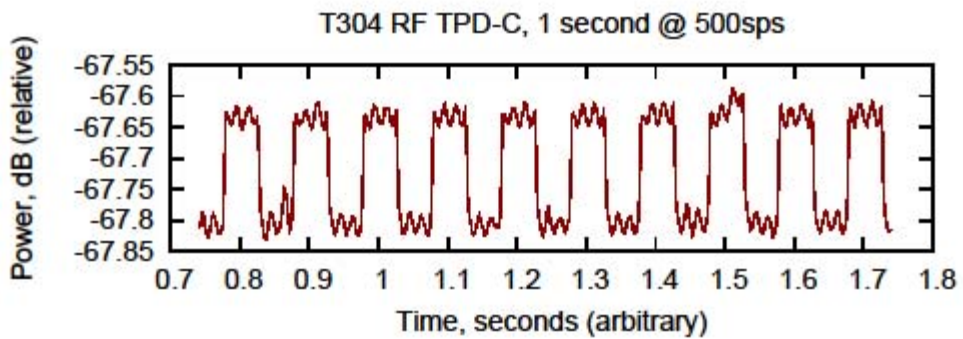
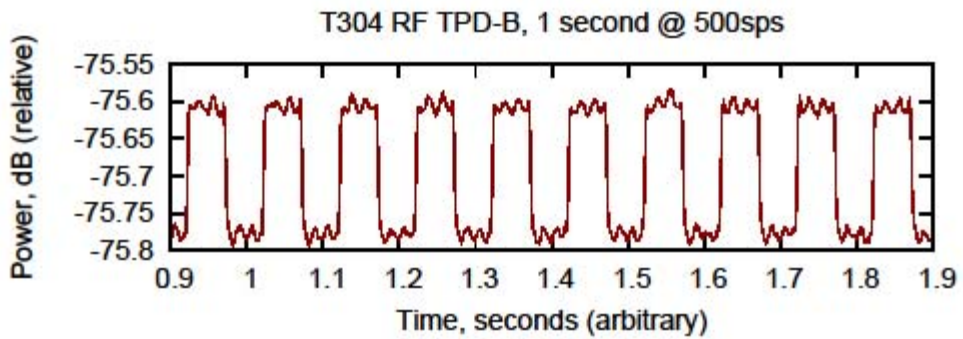
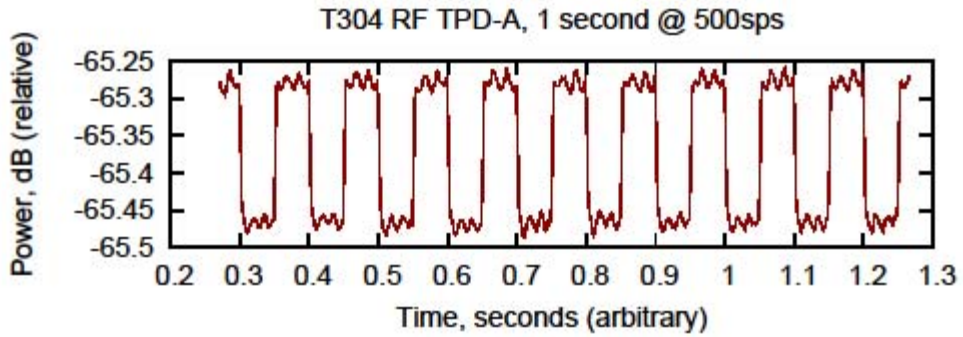






Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

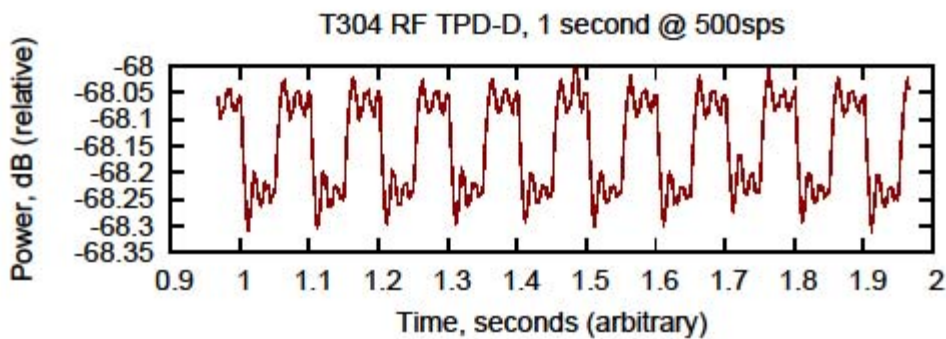
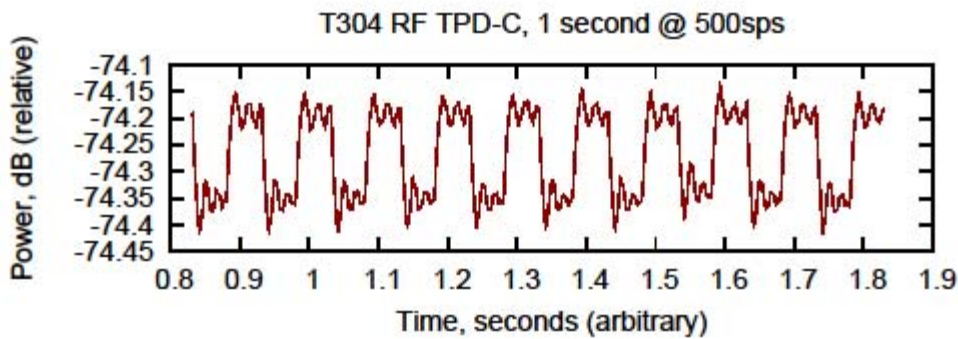
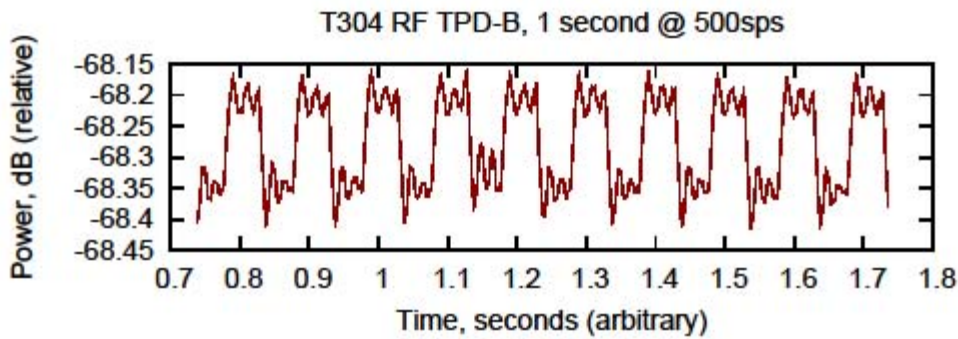
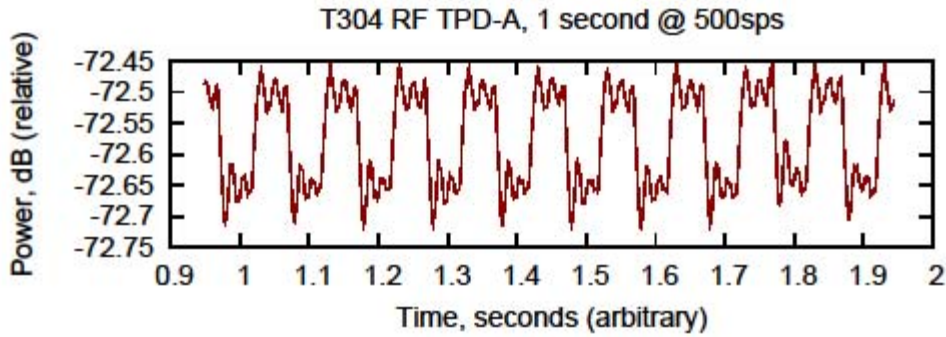
25. EA24





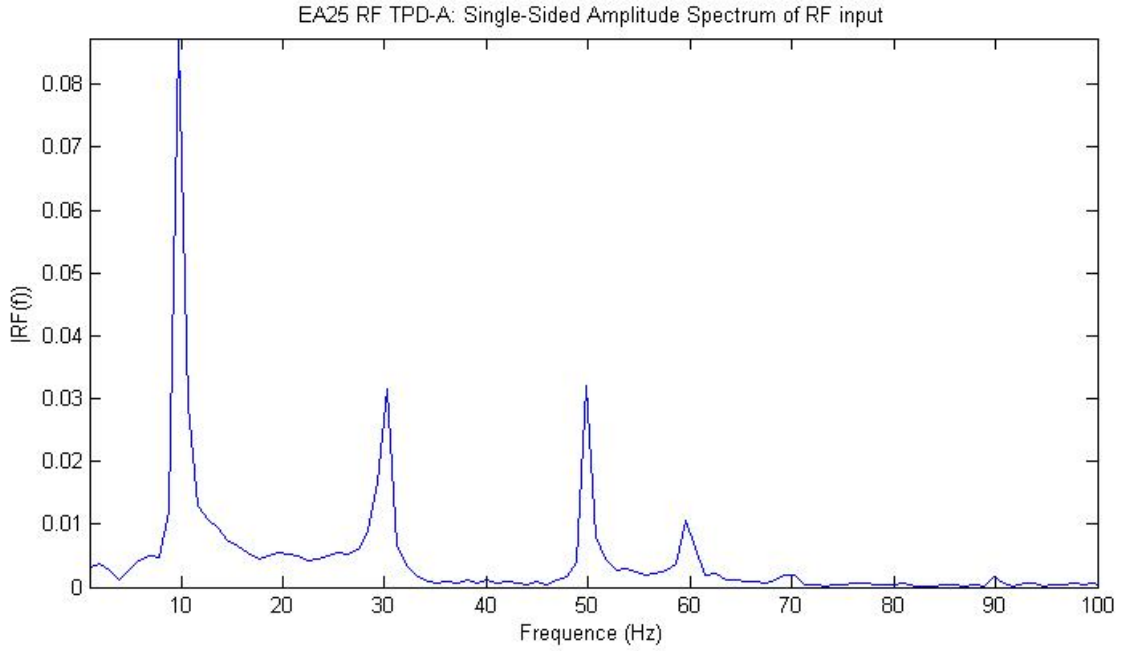
Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

26. EA25





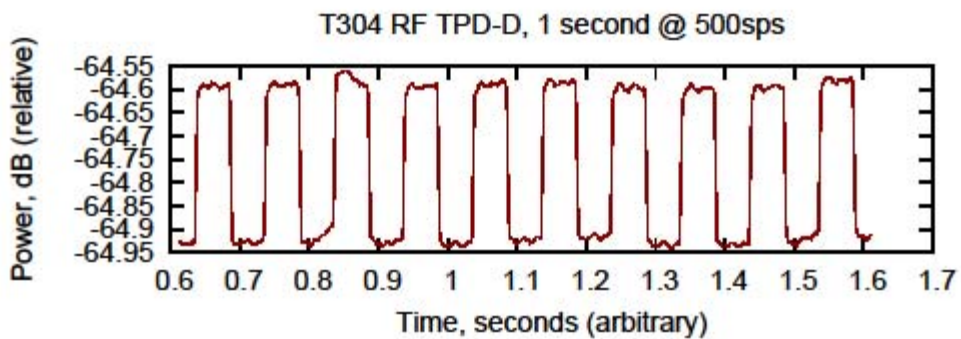
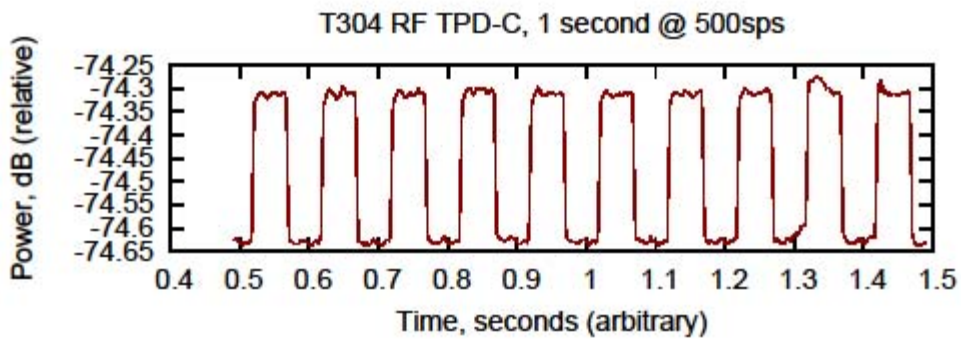
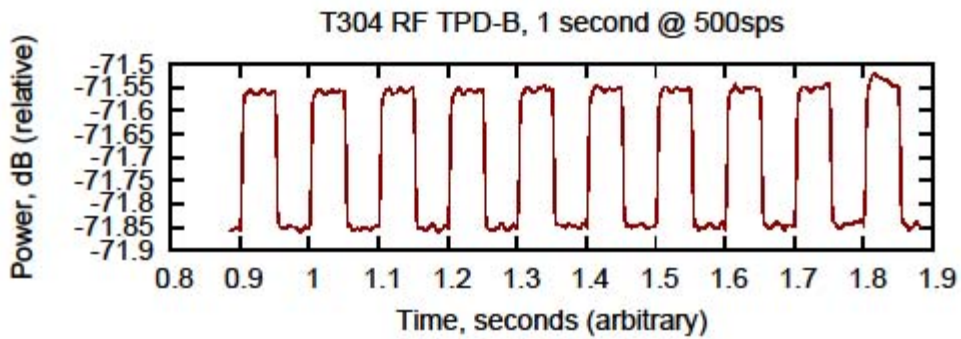
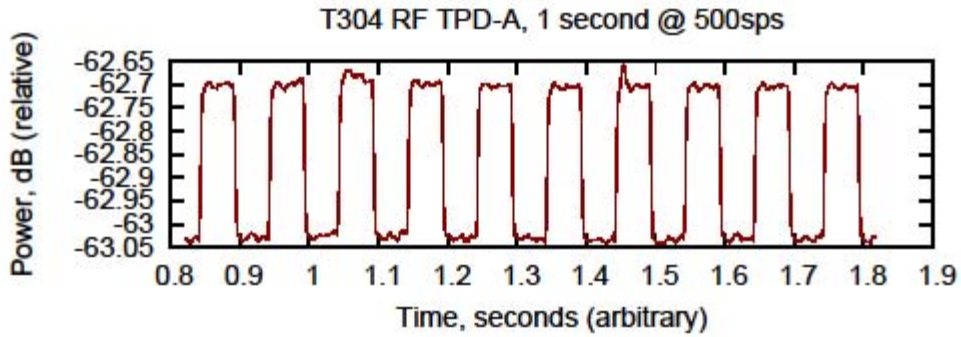
Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3





Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

27. EA26

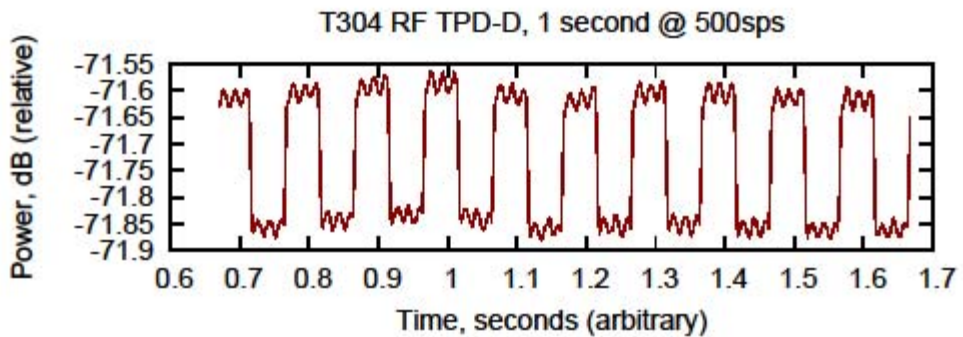
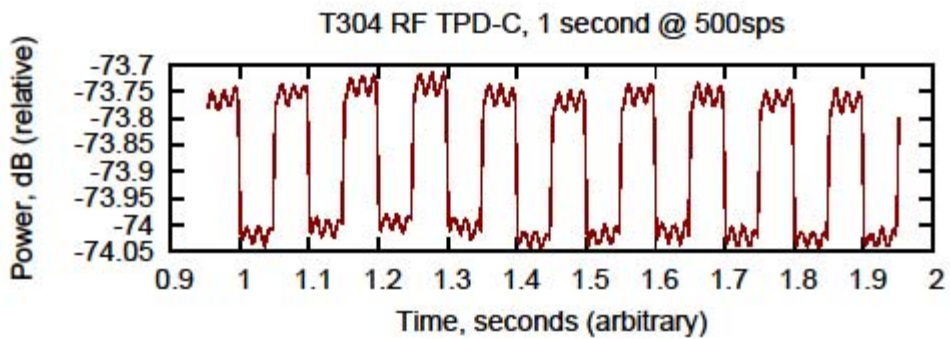
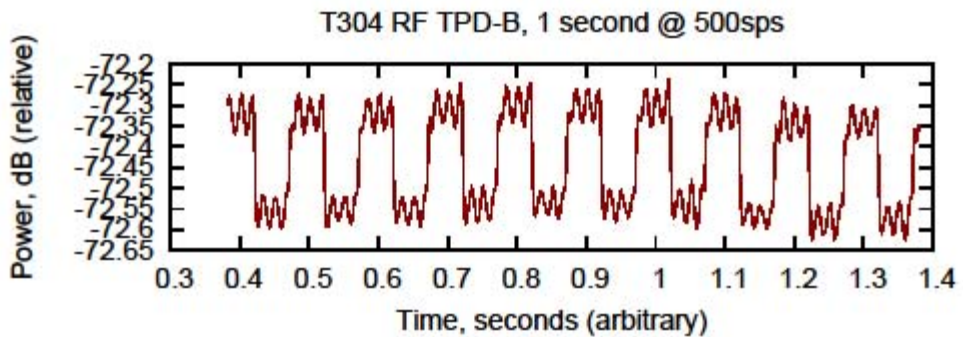
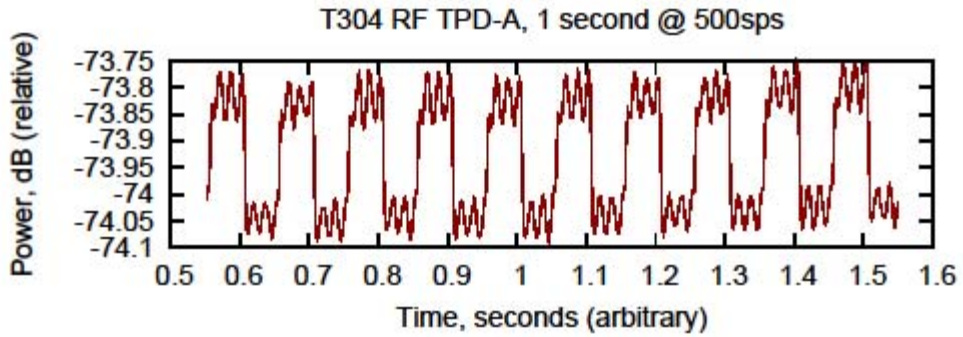






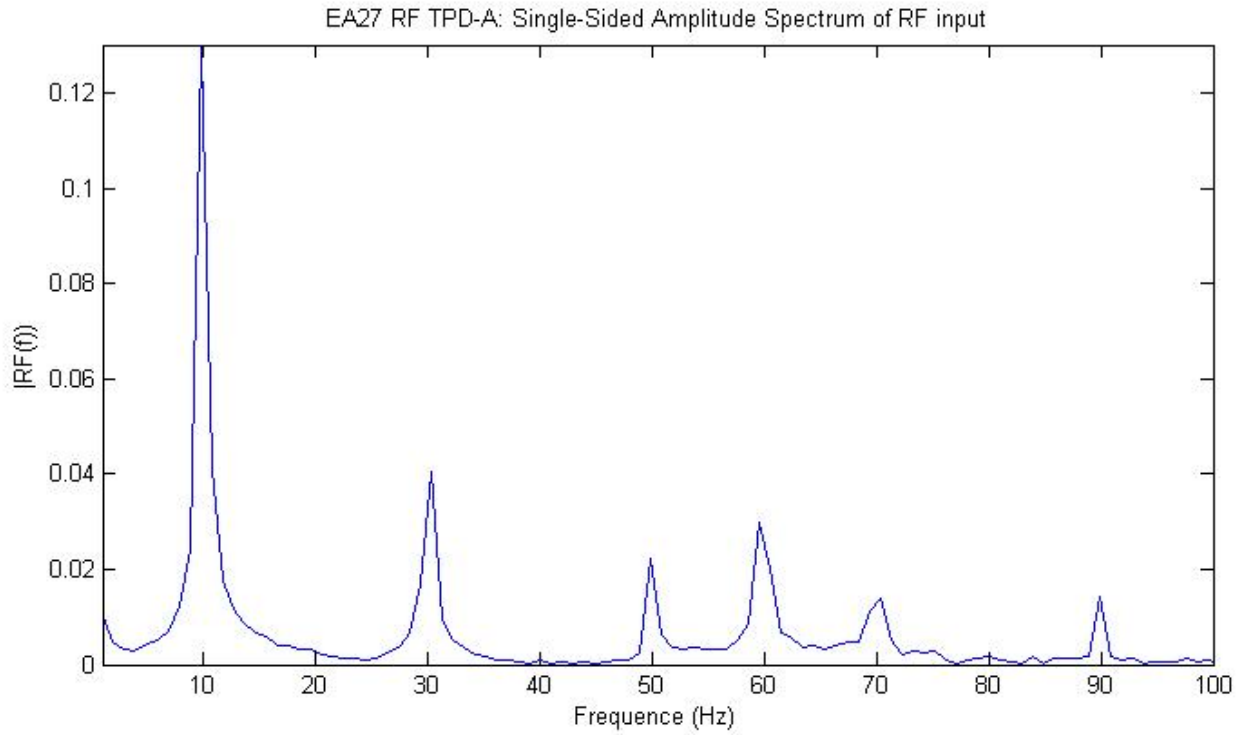
Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

28. EA27





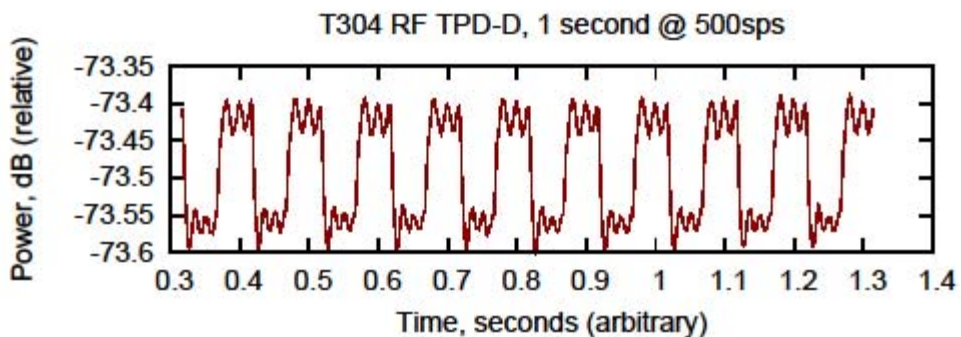
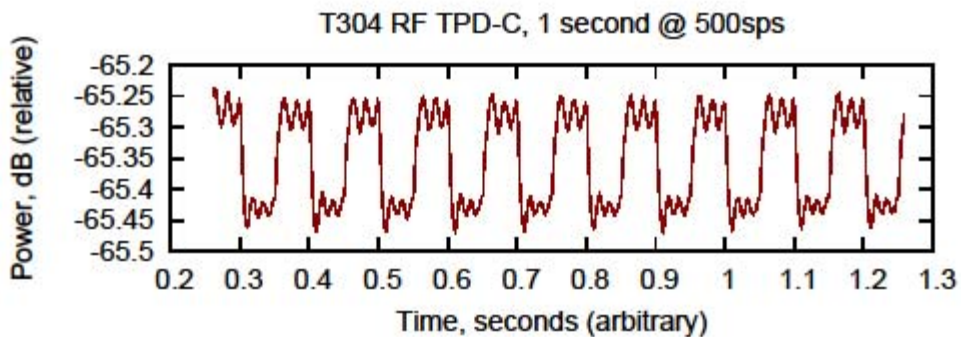
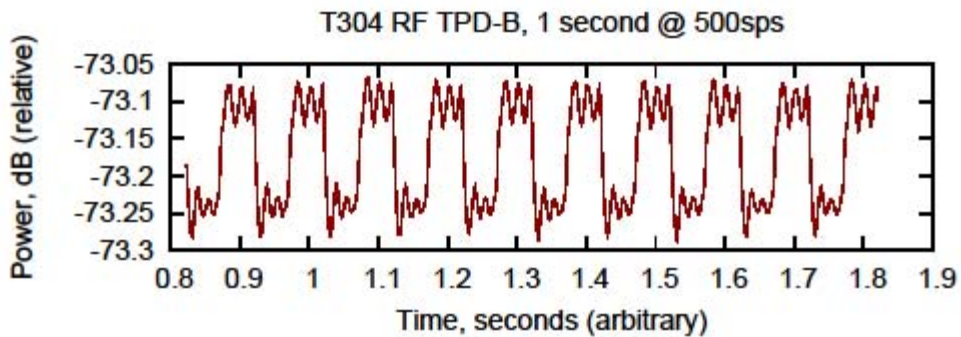
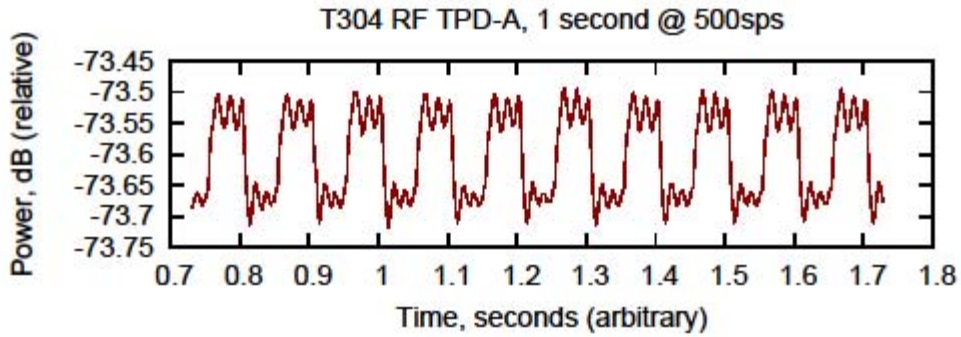
Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3





Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

29. EA28





Title: S-Band Total Power Detector Survey (5/6/15)	Date: 5/8/15
Authors: Selina	Version: 0.3

