Measurement of Phase Switch Effects on AM-ing of IF Signals (revised)

filename:
AMing_2007sep7

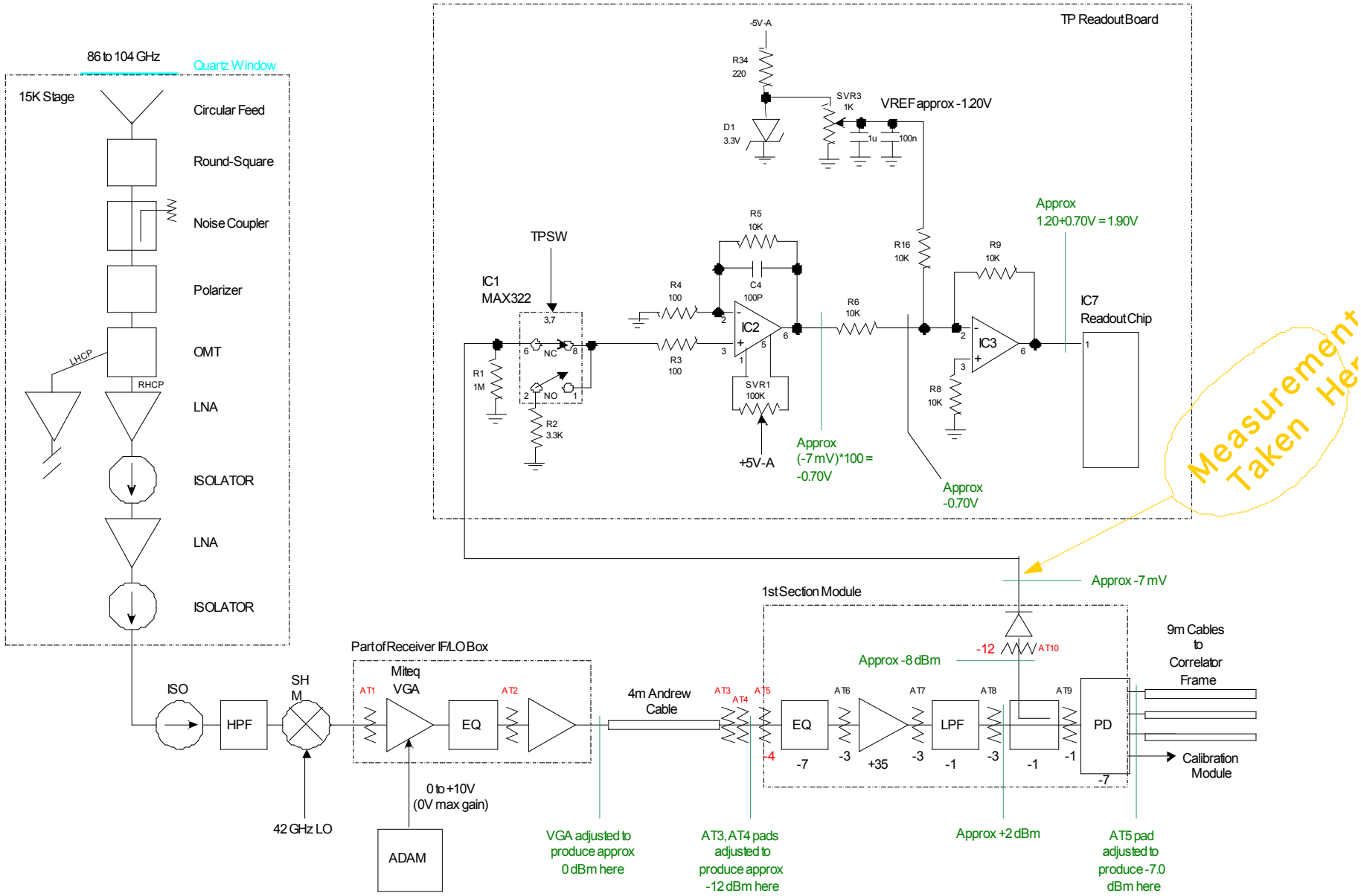
Sept 7, 2007

D. Kubo, P. Altamirano,
P. Oshiro

Test Description

- Measurements taken on Friday August 31 (HST), during the day with the shelter closed. Was a windy day so the shelter temperature was relatively cool (comfortable).
- Absorbers installed over all 7 receiver feeds.
- Converged VGAs successfully for IF2, IF1 kept to stock 0V control voltage.
- A portable Fluke oscilloscope was used to characterize the output from the 1st Section Krytar power detector, see pages 7 through 13.
  - Channel A represents detector output
  - Channel B represents TTL phase switch trigger
- Design goal for input power to detector is -20 dBm (approx -7 mV output).

Functional Block



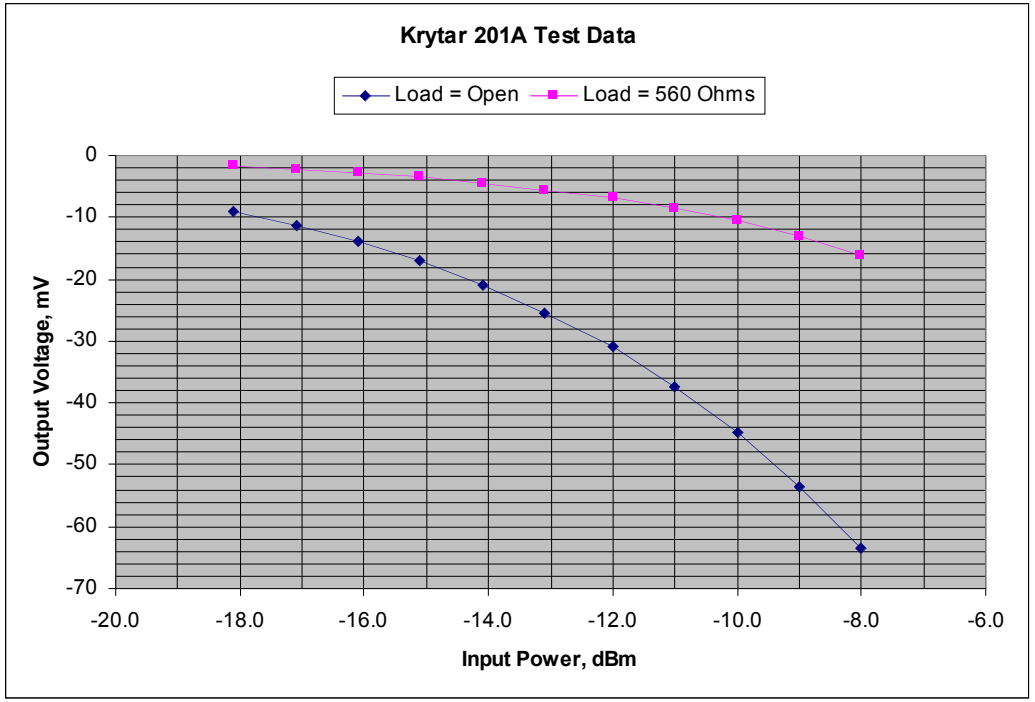
Krytar Detector Characterization

- One Krytar detector was characterized to quantify amplitude of AMing
- The output of the detector sees a 1 MOhm load so we will use the open circuit load condition (blue trace on graph)
- Output voltage vs input power is:

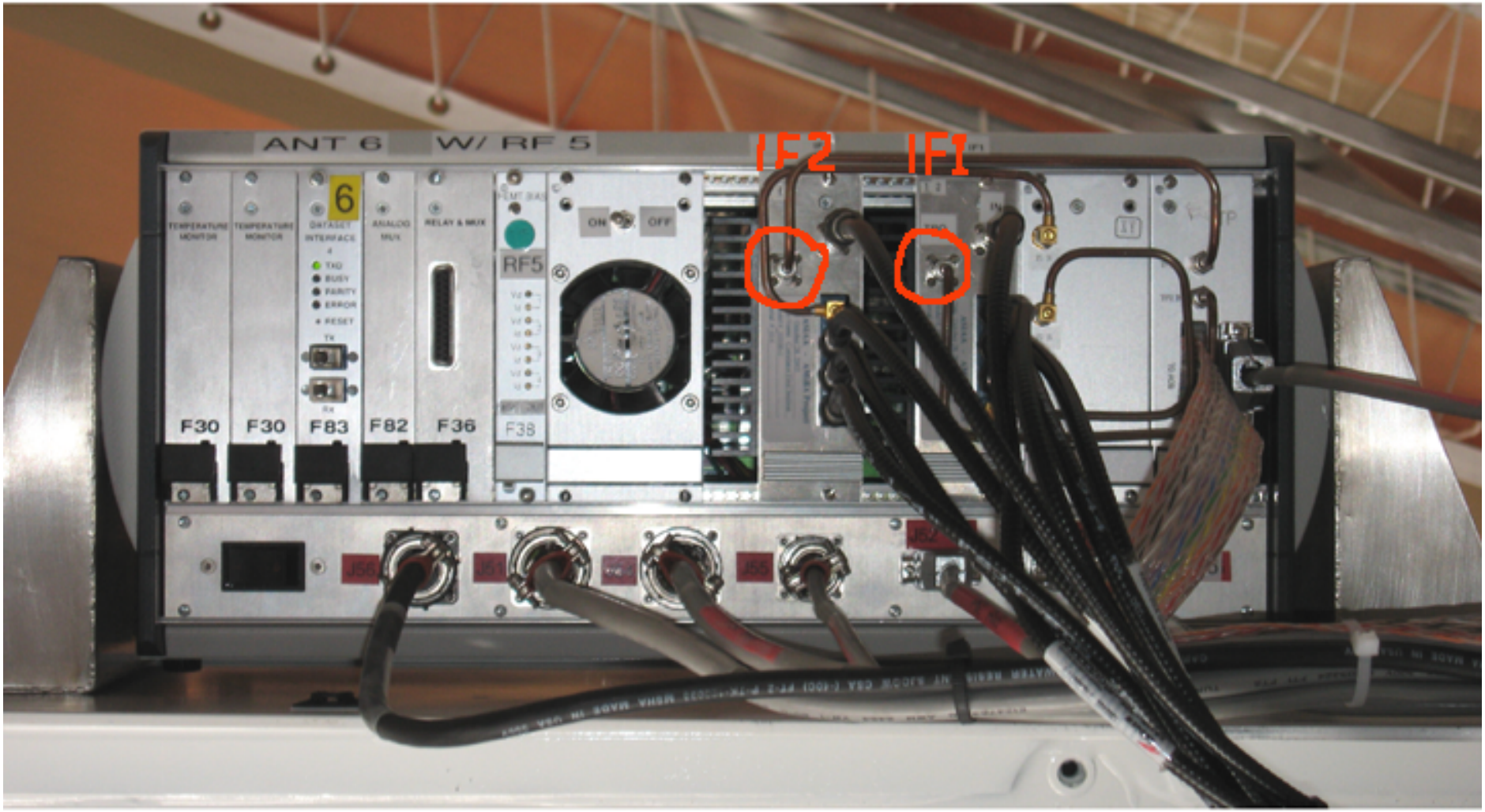
  P(mW) = 10^-5*x^2 - 0.0016*x - 0.0004
  where x = detector output in mV

  This was used to map voltage to power (to characterize amplitude of AMing in dB)

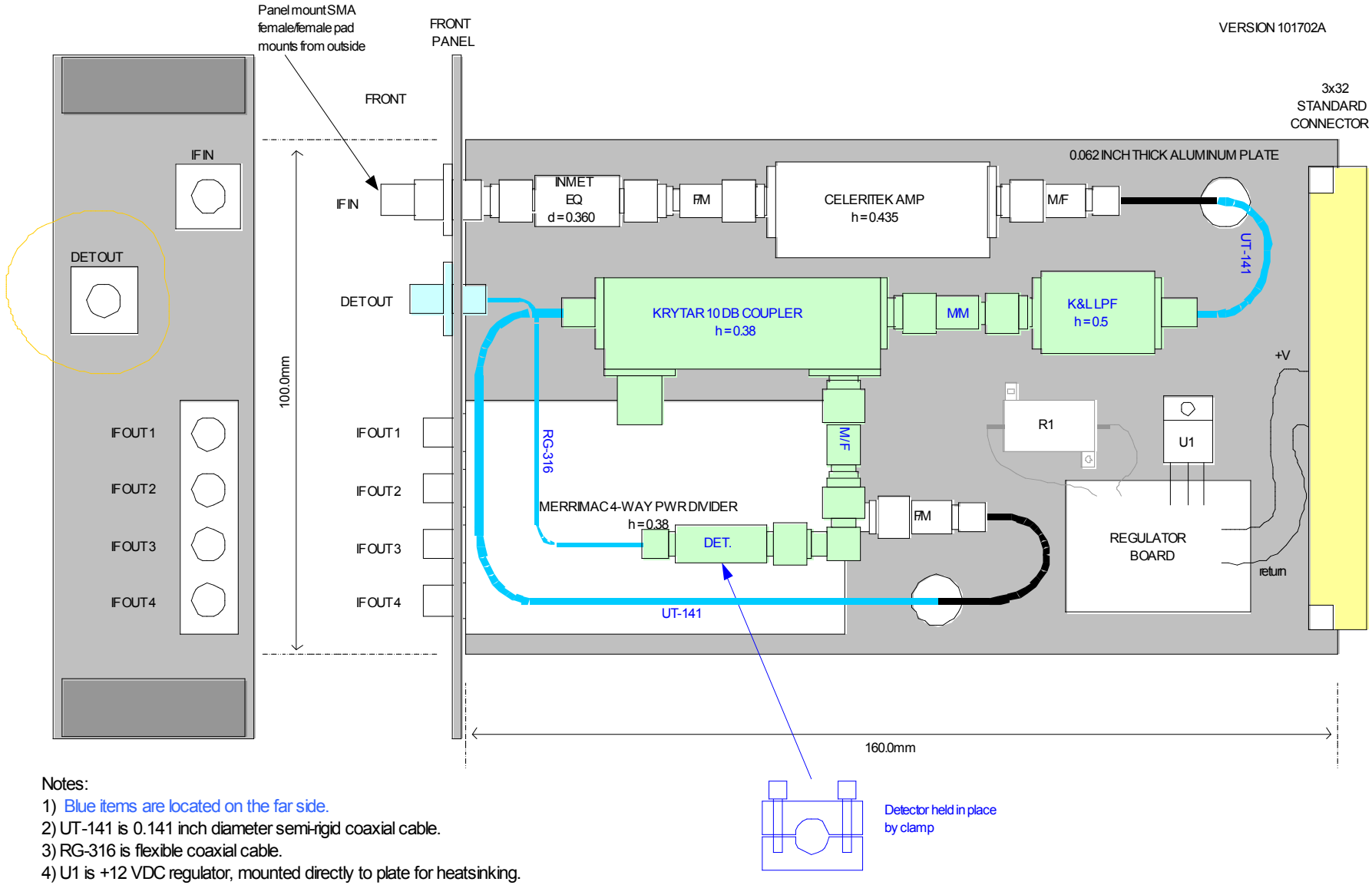
- Note that this detector produces a negative voltage output, the stronger the IF power the more negative the output voltage.



Measurement Locations



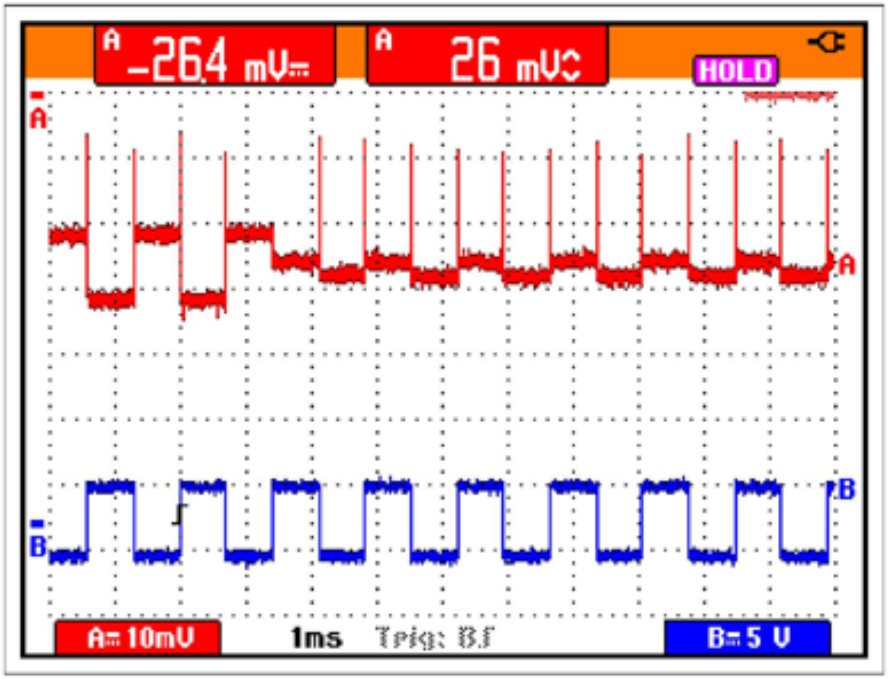
1st Section Module



Notes:

1) Blue items are located on the far side.
2) UT-141 is 0.141 inch diameter semi-rigid coaxial cable.
3) RG-316 is flexible coaxial cable.
4) U1 is +12 VDC regulator, mounted directly to plate for heatsinking.
5) R1 is 5W power resistor, mounted directly to plate for heatsinking.

Antenna 1 (left IF1, right IF2)



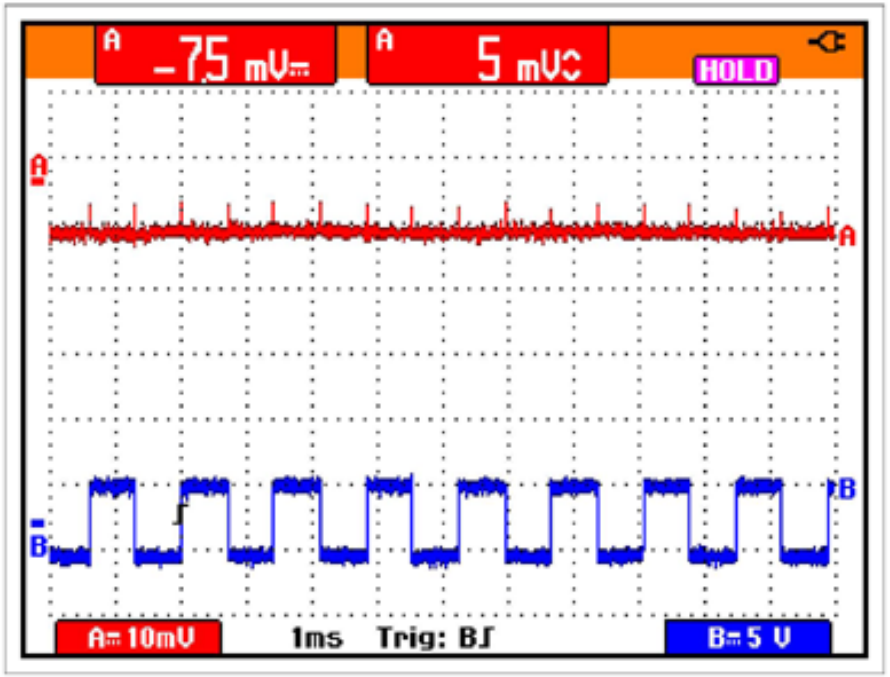
Upper trace: A1-IF1

*Average pwr = -13.1 dBm

*AM = 1.9 dB (ignoring narrow spikes)

*Narrow spikes are probably associated to transition times of PIN switches

Lower trace: TTL phase switch



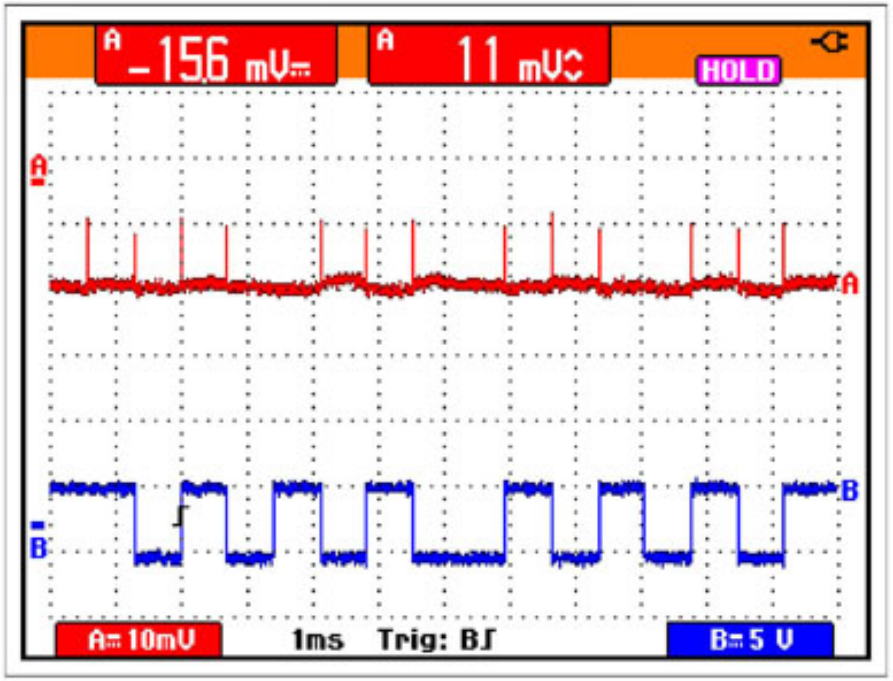
Upper trace: A1-IF2

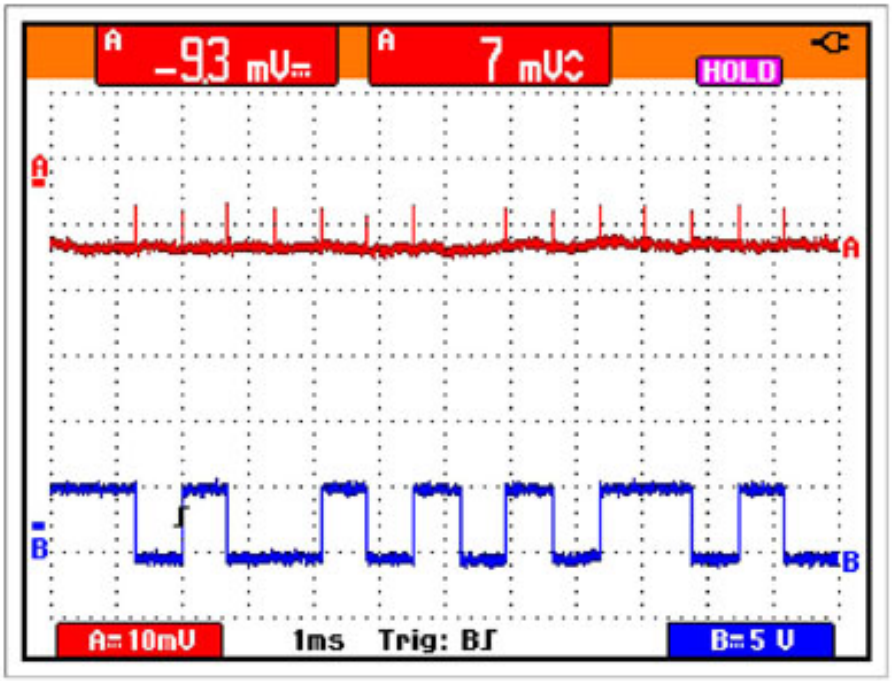
*Average pwr = -19.1 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch

Antenna 2 (left IF1, right IF2)





Upper trace: A2-IF1

*Average pwr = -15.7 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch (accidentally reversed IF1 w/ IF2)

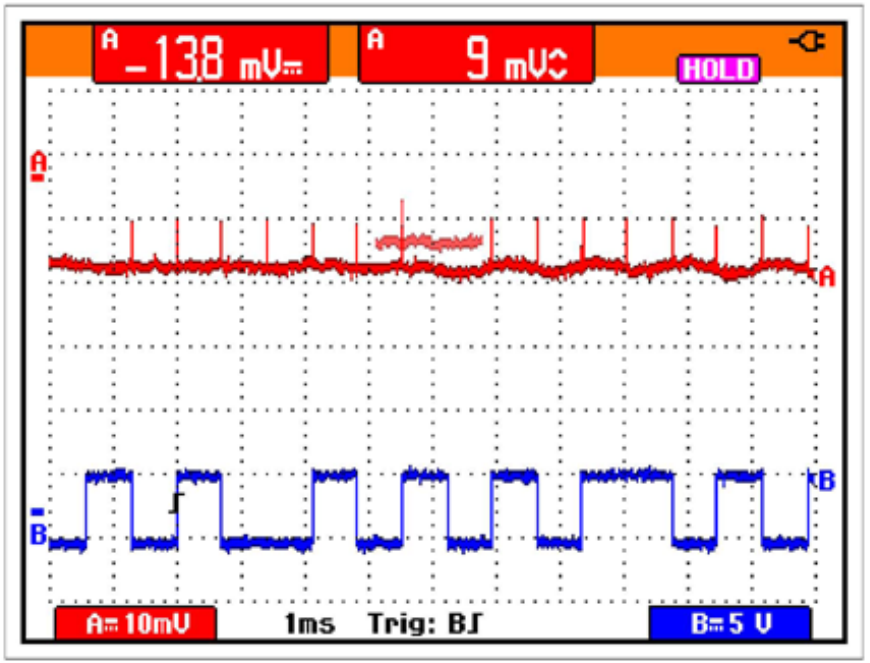
Upper trace: A2-IF2

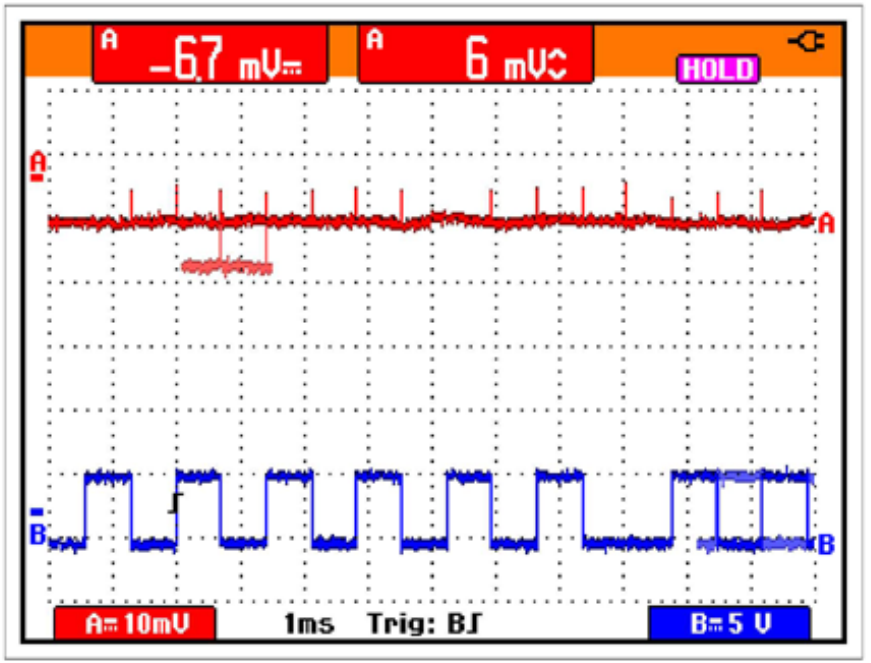
*Average pwr = -18.1 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch (accidentally reversed IF1 w/ IF2)

Antenna 3 (left IF1, right IF2)





Upper trace: A3-IF1

*Average pwr = -16.3 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch (accidentally reversed IF1 w/ IF2)

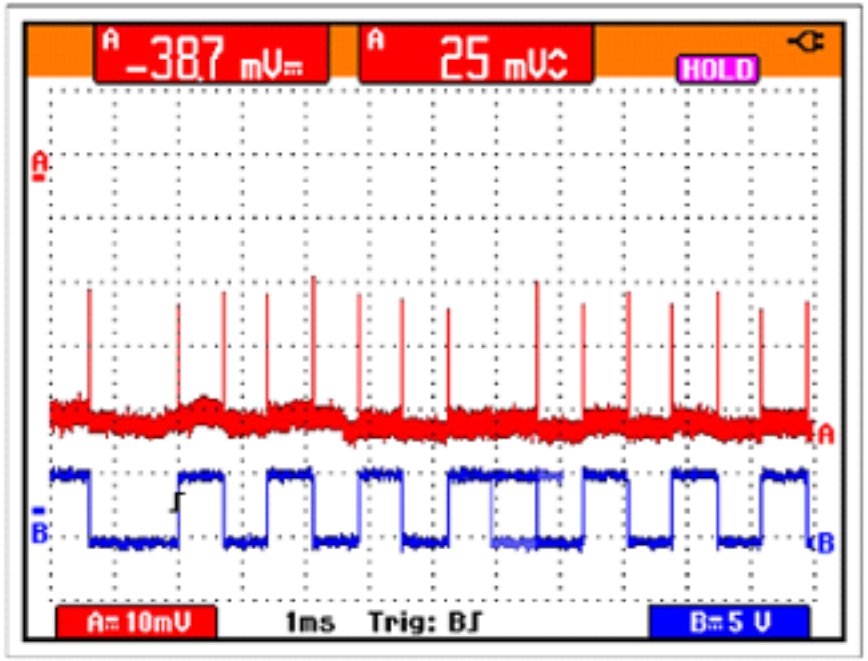
Upper trace: A3-IF2

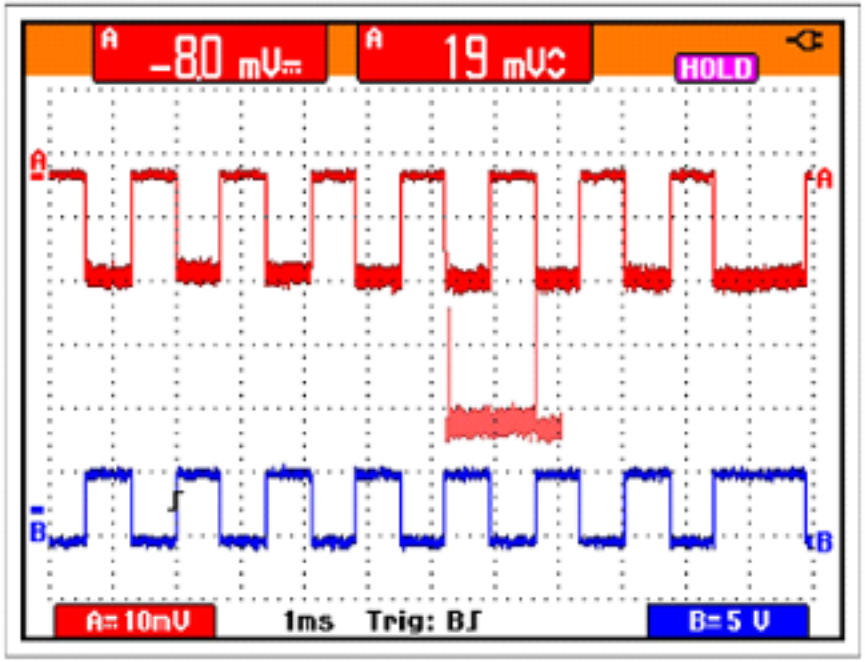
*Average pwr = -19.7 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch (accidentally reversed IF1 w/ IF2)

Antenna 4 (left IF1, right IF2)





Upper trace: A4-IF1

*Average pwr = -11.2 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch

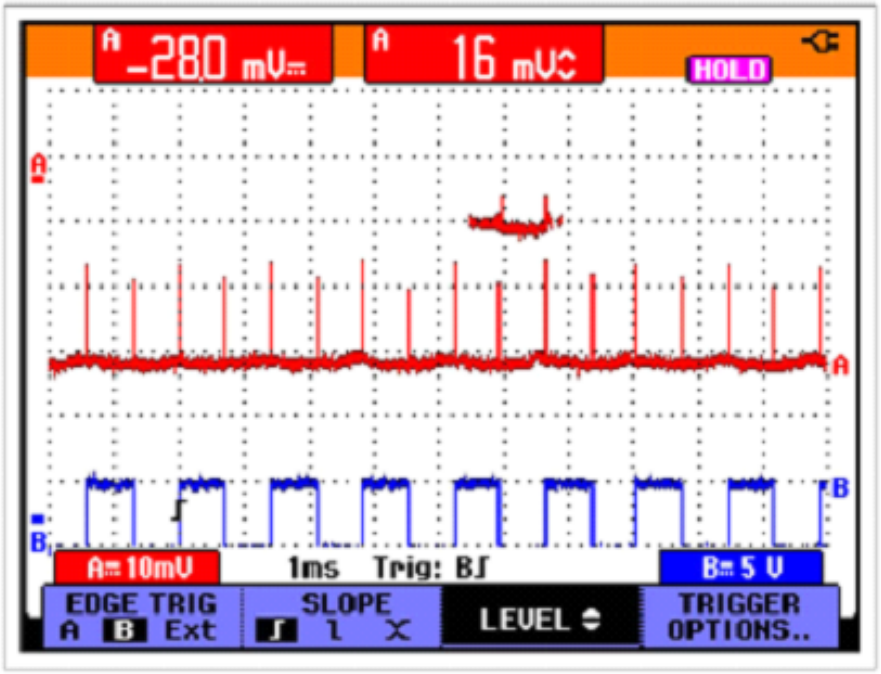
Upper trace: A4-IF2

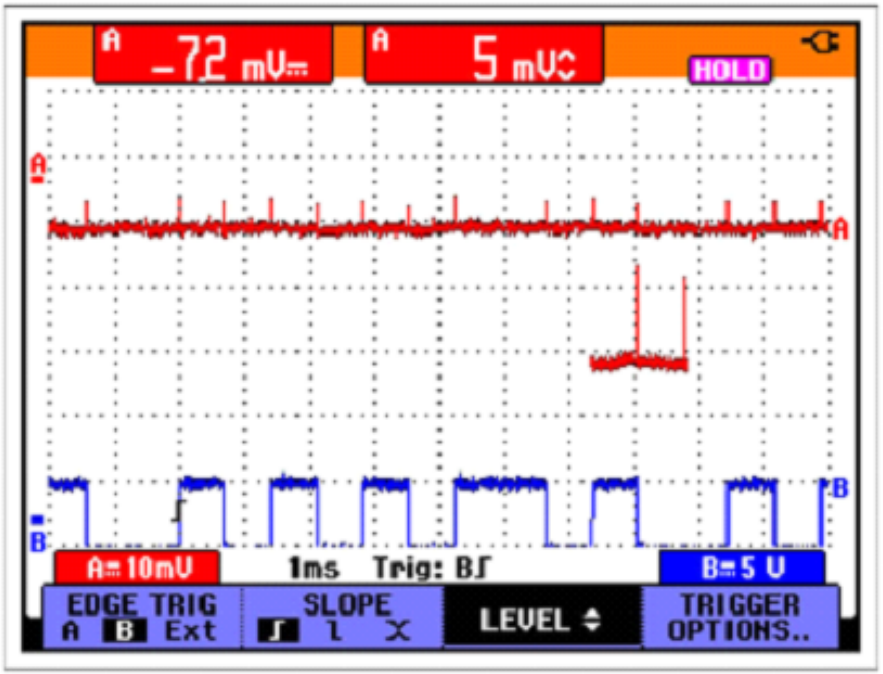
*Average pwr = -18.8 dBm

*AM = 3.4 dB

Lower trace: TTL phase switch

Antenna 5 (left IF1, right IF2)





Upper trace: A5-IF1

*Average pwr = -12.8 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch

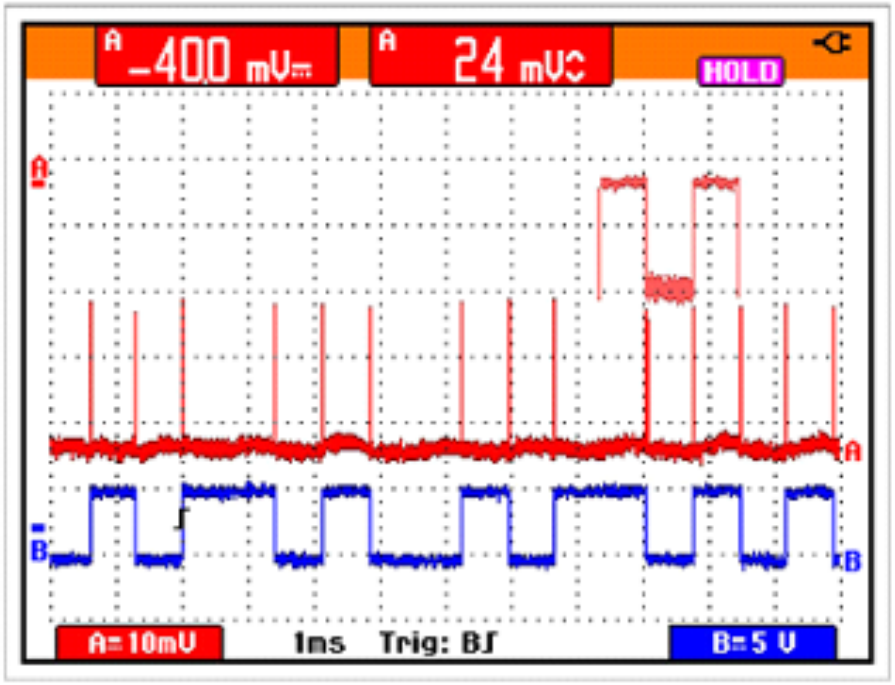
Upper trace: A5-IF2

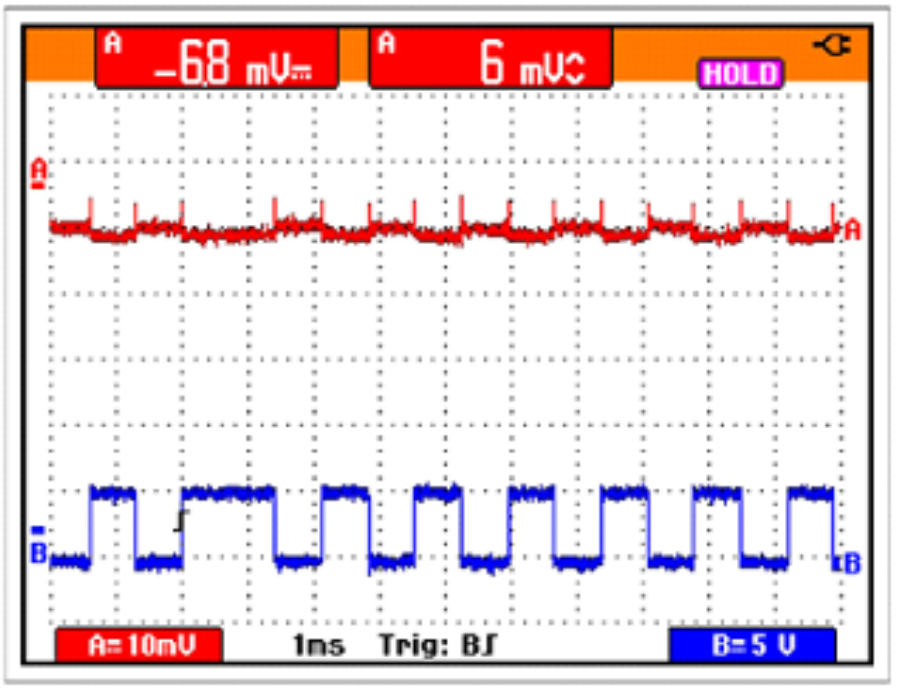
*Average pwr = -19.3 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch

Antenna 6 (left IF1, right IF2)





Upper trace: A6-IF1

*Average pwr = -11.0 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch

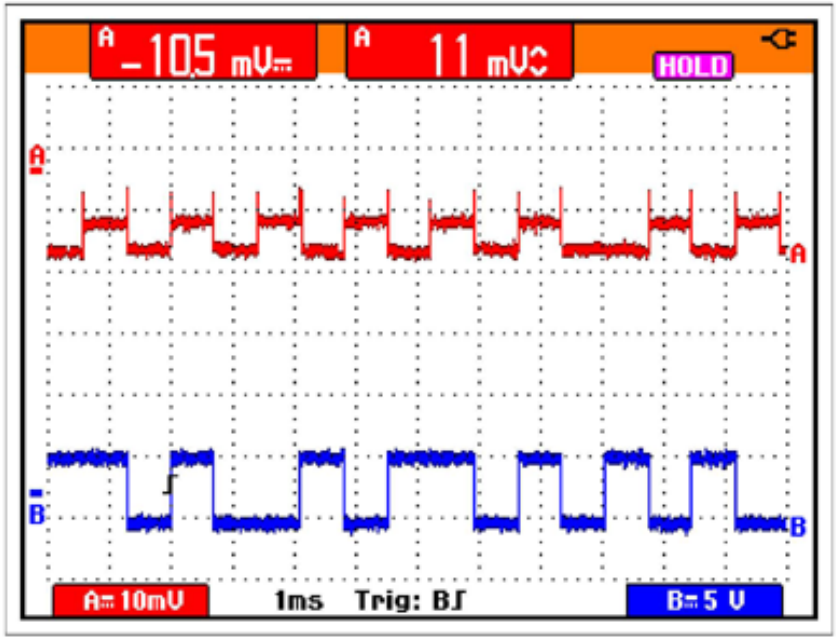
Upper trace: A6-IF2

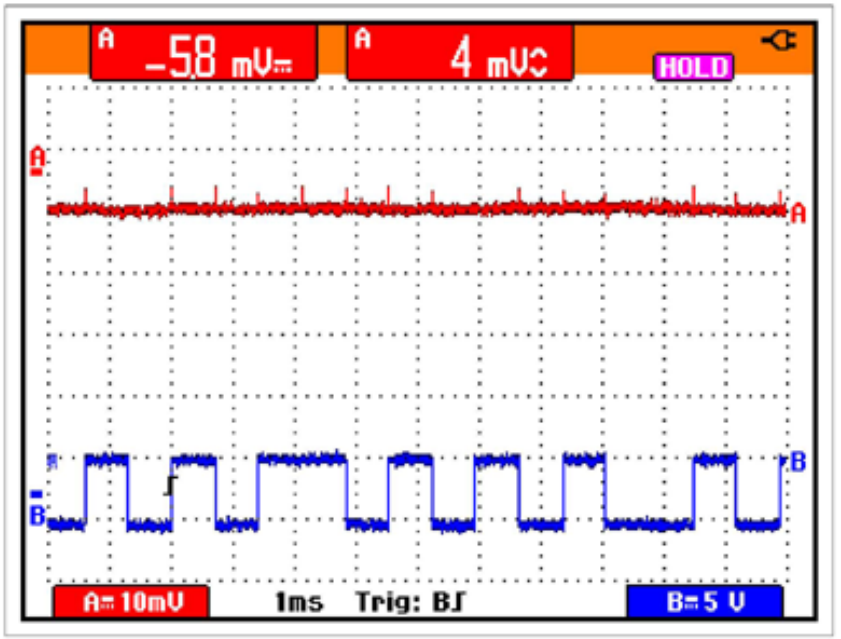
*Average pwr = -19.6 dBm

*AM = ~0.1 dB (ignoring narrow spikes)

Lower trace: TTL phase switch

Antenna 7 (left IF1, right IF2)





Upper trace: A7-IF1

*Average pwr = -17.6 dBm

*AM = 0.4 dB (ignoring narrow spikes)

Lower trace: TTL phase switch (accidentally reversed IF1 w/ IF2)

Upper trace: A7-IF2

*Average pwr = -20.4 dBm

*AM = ~0 dB (ignoring narrow spikes)

Lower trace: TTL phase switch (accidentally reversed IF1 w/ IF2)

Summary

- A1-IF1 exhibited 2 levels of AM-ing which we happened to catch on the oscilloscope as it was transitioning (page 7). This was the only antenna with this indication.
- The narrow upward going spikes were characterized to be ~1 usec in duration. I believe this is related directly to the transition times of the PIN switches used to provide the phase switch function. I.e., each time the phase is changed there is probably no LO power for a duration of 0.5 to 1 usec.
- Here is a summary table of the power levels and AM-ing for each of the 14 channels:
  - Note that the design goal power to the detector is -20 dBm
  - And of course the desired amount of AM-ing is 0 dB

ANTENNA	IF1		IF2	
	PWR	AM	PWR	AM
1	-13.1	1.9	-19.1	0.0
2	-15.7	0.0	-18.1	0.0
3	-16.3	0.0	-19.7	0.0
4	-11.2	0.0	-18.8	3.4
5	-12.8	0.0	-19.3	0.0
6	-11.0	0.0	-19.6	0.1
7	-17.6	0.4	-20.4	0.0

- Poor AM-ing is seen on A1-IF1, A4-IF2 and A7-IF1
- It is nice to see the IF2 power values to be relatively close to the target of -20 dBm which indicates that the tune VGA routine is working.
- Observed DC offsets (> 10k counts):
  - Aug 27: 1L-2L, 1L-7L, 2L-7L, 4R-6R (no absorber)
  - Aug 28: 1L-2L, 1L-5L, 1L-7L, 2L-7L, 3L-4L, 6L-7L, 3R-4R, 6R-7R (no absorber)
  - Aug 29: 1L-2L, 1L-3L, 1L-7L, 2L-7L, 3L-4L, 6L-7L, 3R-4R (no absorber)
  - Aug 30: 1L-2L, 1L-3L, 1L-6L, 1L-7L, 2L-7L, 4L-7L, 5L-7L, 6L-7L (absorbers installed, tune VGAs)

Summary (continued)

- I think it's safe to say that the observed baselines with offsets >10k counts matches fairly well with the observed AM-ing. Exceptions to this are the 3L-4L offsets seen on Aug 28 & 29.

- SHORT TERM PLANS:
  - We have already begun our investigations with the adjustments of the LO attenuators and have found a definite correlation between LO drive to the SHMs (sub-harmonic mixers) and the AM-ing.
    - Preliminary tests on 2 antennas have shown that driving the SHM's with more LO power reduces the AM-in, and reduced AM-ing corresponds to reduced DC offsets
  - The LO attenuators were originally adjusted for maximum Y-factor at the output of the IF/LO module. We of course want to maintain a maximum Y-factor through the system.
    - We are currently investigating the relationship between the LO drive and Y-factor.