

iGp12 Factory Test Results

Serial number: iGp12_0016

May 30, 2019

1 Test Procedures and Conditions

1.1 Common settings

All measurements are performed after the unit has been allowed to come to temperature with the ambient temperature of 24 ± 5 °C.

RF clock is set at the nominal frequency, as defined by `IGPF:TEST:RF_FREQ`.

1.2 ADC frequency response

Clock driven by HP8662A at 0 dBm level. ADC+ input is driven by HP8664A at -8 dBm. Set data acquisition length to 0.4 ms. Response is measured at 53 points between 10 MHz and 1.99 GHz as follows:

```
[amp,fr,RMS] = adc_fsweep_fast('TEST',linspace(10e6,1990e6,53));
```

Matlab figure window 2 is printed to `adc_fsweep.eps` and 3 dB bandwidth is recorded in `measurements.log`.

1.3 ADC performance

Clock driven by HP8664A at 0 dBm level. ADC+ input is connected to HP8662A via two Mini-Circuits SLP-21.4 filters in series. HP8662A is set to 2 dBm output level. Signal frequency is computed as

$$f_{\text{in}} = \lfloor \frac{20 \times 10^6}{f_{\text{bin}}} + 0.5 \rfloor f_{\text{bin}} \quad (1)$$

$$f_{\text{bin}} = \frac{f_{\text{clk}}}{N} \quad (2)$$

where N is the acquisition length (`IGPF:TEST:RECLLEN`). Data acquisition length set to 0.4 ms. ADC characterization is performed by the following function:

```
[sol,RMS,D,amp,f,x,x_fit,SNR,SINAD,SFDR] = adctest('TEST',10);
```

Matlab figure window 2 is printed to `SFDR.eps` and window 3 — to `adctest.eps`. Record average SFDR and SINAD, compute effective number of bits as $(\text{mean}(\text{SINAD}) - 1.76) / 6.02$.

Measure ADC signal level using HP4396A in the spectrum analyzer mode, then compute full-scale level by adding $20 * \log_{10}(2047.5 / \text{mean}(\text{amp}))$.

1.4 ADC step response

Signal source is SRS CG635 with `Q HIGH` set to 0.5 V and `Q LOW` to -0.5 V. Generator output is connected to the iGp12 via a 5 dB attenuator. Unused output of CG635 is terminated into $50\ \Omega$. Set CG635 to 36.001 MHz, data acquisition 0.4 ms and measure the step response:

```
[delay, val, x] = step_response('TEST', 36.001e6);
```

Print Matlab figure window 1 to `adc_tsweep.eps`. Record rise and fall times, overshoot and undershoot in `measurements.log`.

1.5 Transfer function measurements

Calibrate HP4396A in the network analyzer mode (using Mini-Circuits ZFSC-2-11-S+ splitter) for S_{21} measurements from 10 MHz to $0.98 \times f_{\text{clk}}$. Perform 4 transfer function measurements:

1.5.1 Feedthrough

DAC output turned off, measurement of the feedthrough. Averaging factor of 32, single display.

1.5.2 Direct

Feedback for all bunches on, first coefficient set to 32767 (use command `caput IGPF:TEST:CSET0 32767`). Averaging factor of 4, dual display (magnitude and delay), marker at -3 dB from the maximum gain.

1.5.3 Filter

Filter coefficients generated with gain of 0.1, phase of 0, frequency set to $1/N_{\text{taps}}$, maximum supported filter length. Dual display with magnitude and phase, port extension set to the delay measured earlier. Center frequency

at the revolution harmonic nearest to 15 MHz, revolution frequency span. Marker on the gain peak (upper sideband).

1.5.4 Downsampled filter

The same filter as above, processing downsampling set to 10. Frequency span of $f_{\text{ref}}/10$. Marker on the upper sideband gain peak.

1.6 DAC response

Configure drive for $f_{\text{clk}}/8$ or $f_{\text{clk}}/4$ square wave for all bunches, disable feedback. Connect DAC+ to SD-24 channel 0 and DAC- to 11801C trigger input. Record rise and fall times, peak-to-peak amplitude, overshoot and undershoot.

1.7 Instruments used

All instruments used for iGp12 testing are listed in Table 1.

Table 1: Instruments

| Model | Description | Serial № | Cal. date/certificate |
|---------------|------------------------------|------------|-----------------------|
| HP 8662A | Synthesized signal generator | 2232A01056 | 2011-08-11/1466327 |
| Agilent 8664A | Synthesized signal generator | 3744A02491 | 2011-08-11/1466394 |
| HP 4396A | Spectrum/network analyzer | 3241J00268 | 2011-08-11/1466348 |
| Tek11801C | Sampling scope mainframe | B030426 | 2011-08-11/1466413 |
| Tek SD-24 | 20 GHz TDR sampling head | B022559 | 2011-08-11/1466390 |
| SRS CG635 | Clock generator | 1459 | 2011-08-11/1466408 |

2 Measurements

Table 2: Measured parameters

| Parameter | Value |
|------------------------------|--------|
| Input -3 dB bandwidth (GHz) | 1.38 |
| Input full-scale level (dBm) | 1.5 |
| SFDR (dB) | 80.1 |
| SINAD (dB) | 60.0 |
| ENOB | 9.7 |
| Input rise time (ps) | 358.3 |
| Input fall time (ps) | 368.2 |
| Input overshoot (%) | 31.7 |
| Input undershoot (%) | 30.4 |
| Output rise time (ps) | 379 |
| Output fall time (ps) | 394 |
| Output amplitude (mVpp) | 840 |
| Output overshoot (%) | 17.8 |
| Output undershoot (%) | 20.0 |
| Group delay (ns) | 706.65 |

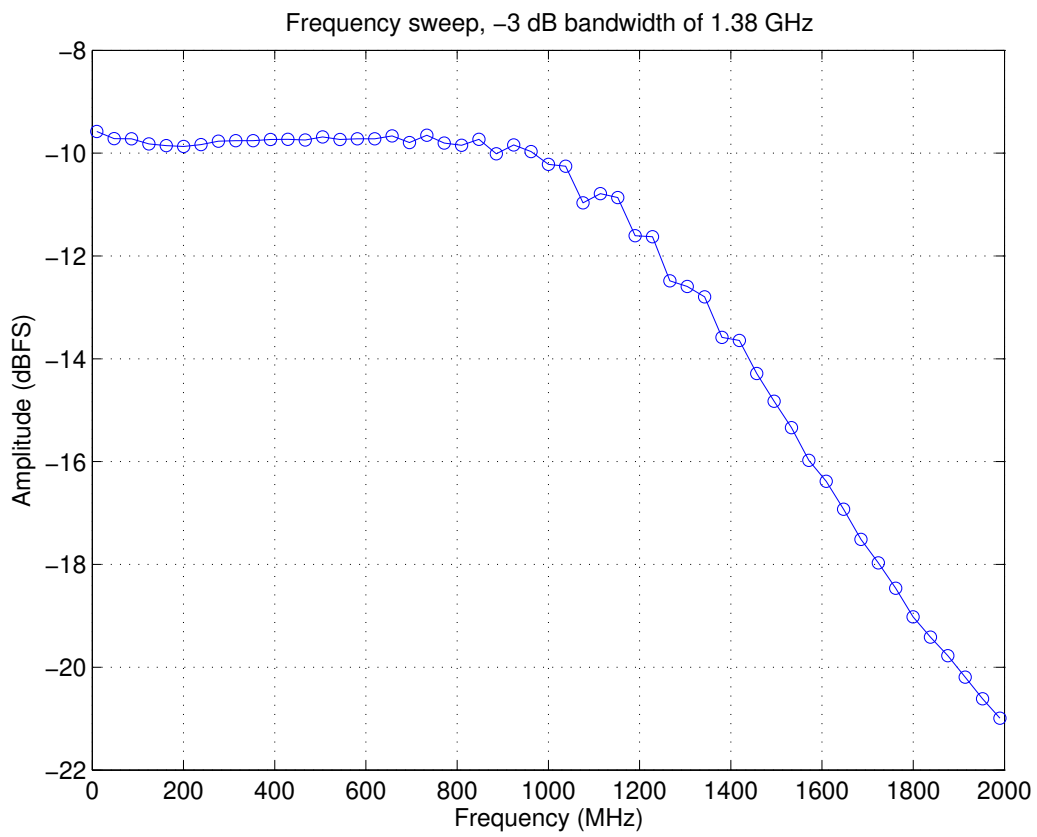


Figure 1: ADC frequency response

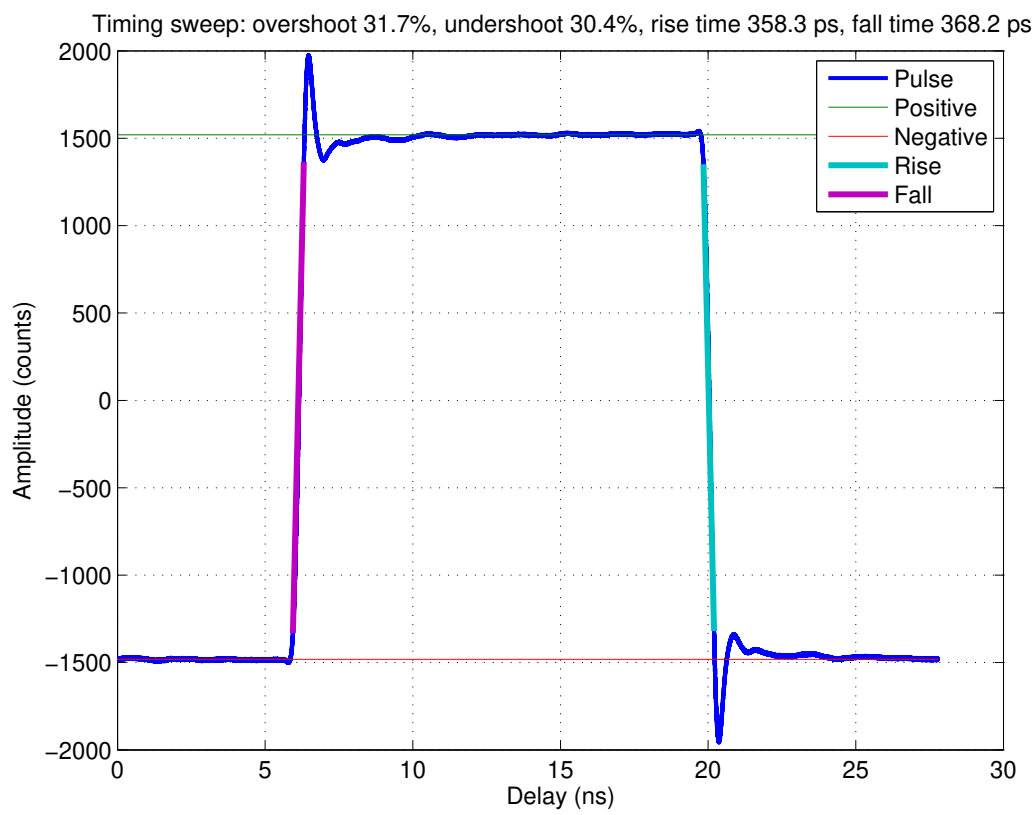


Figure 2: ADC step response

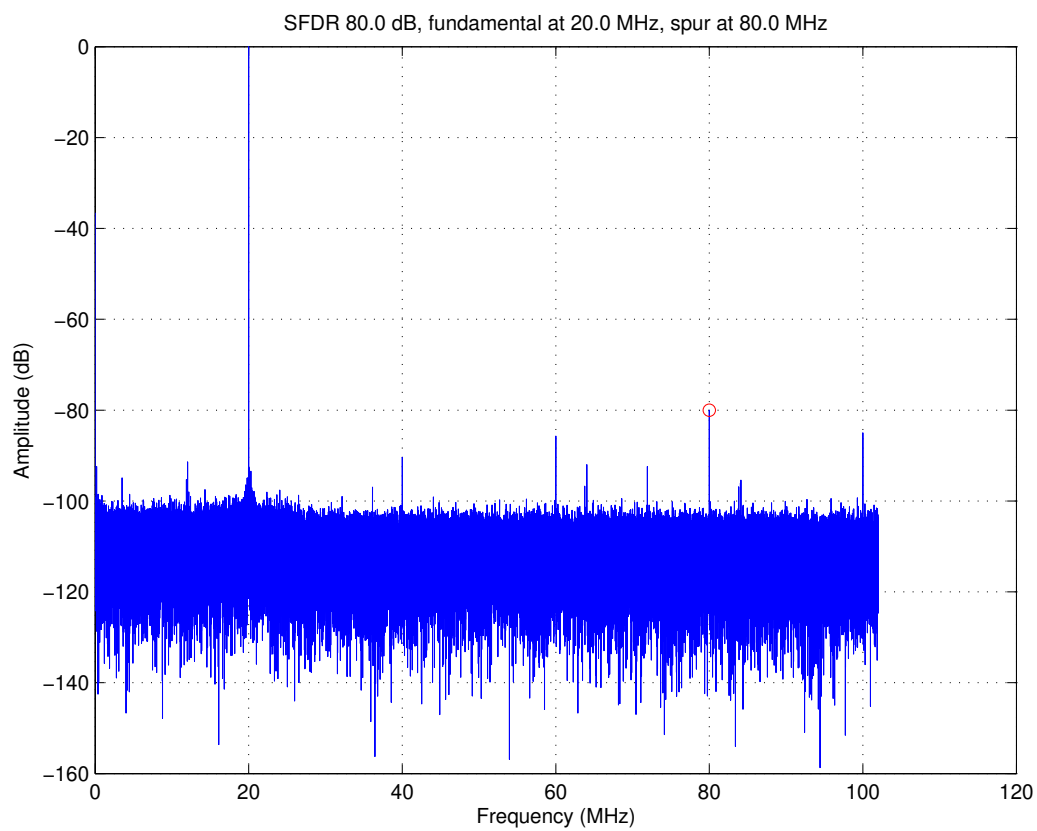


Figure 3: Spurious-free dynamic range

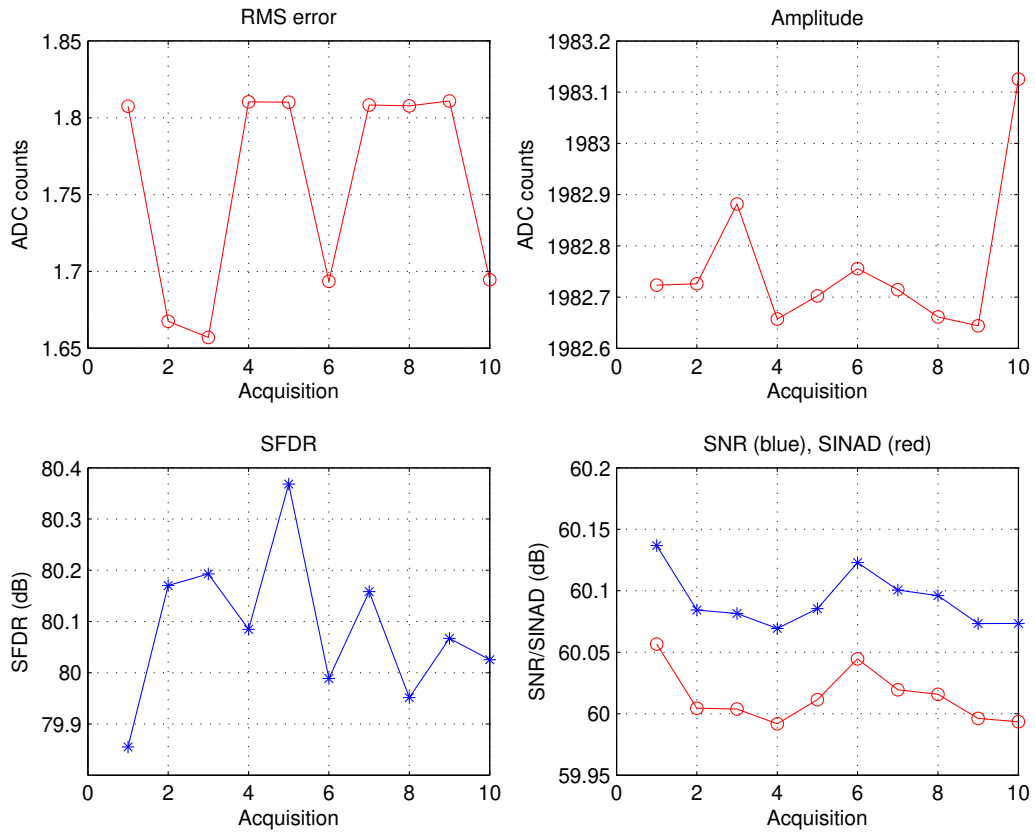


Figure 4: ADC tests: SNR, SFDR, SINAD, RMS error

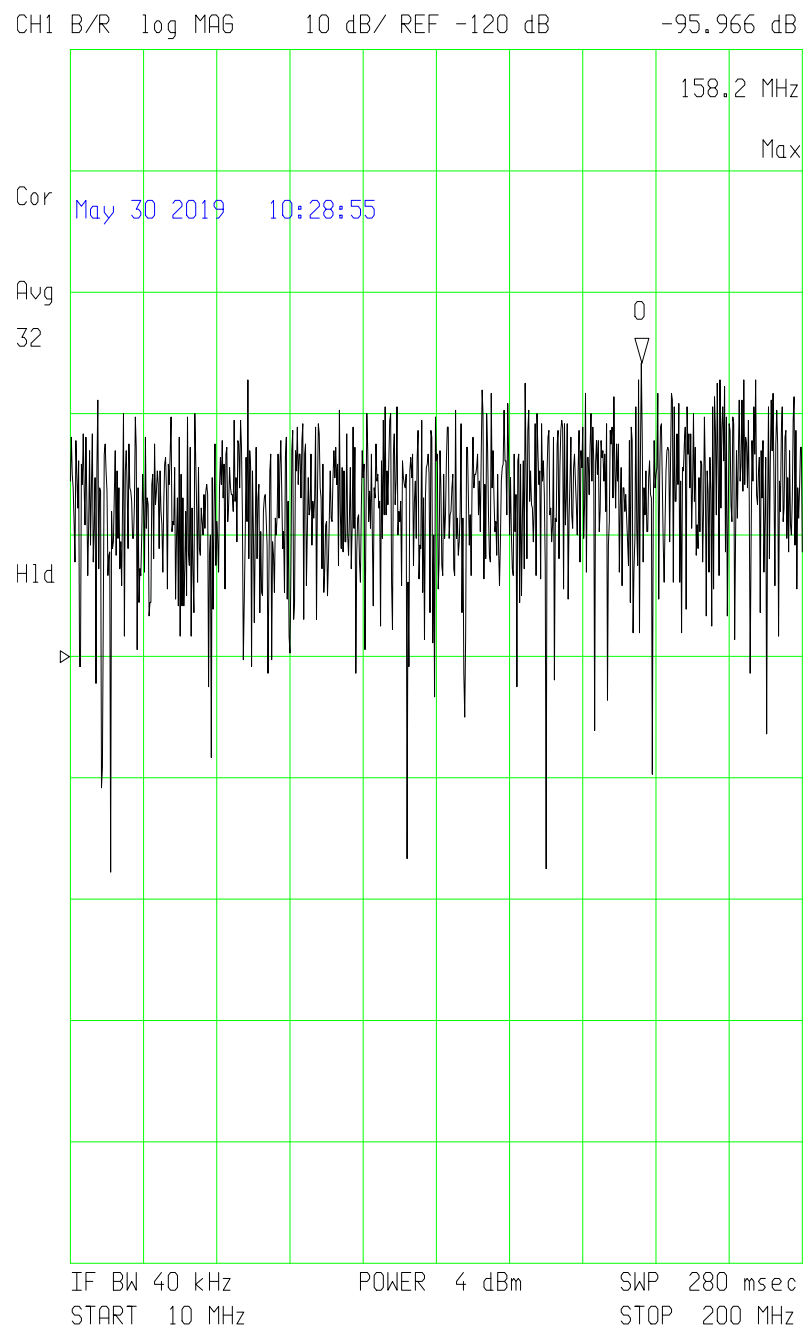


Figure 5: ADC to DAC coupling (feedback off)

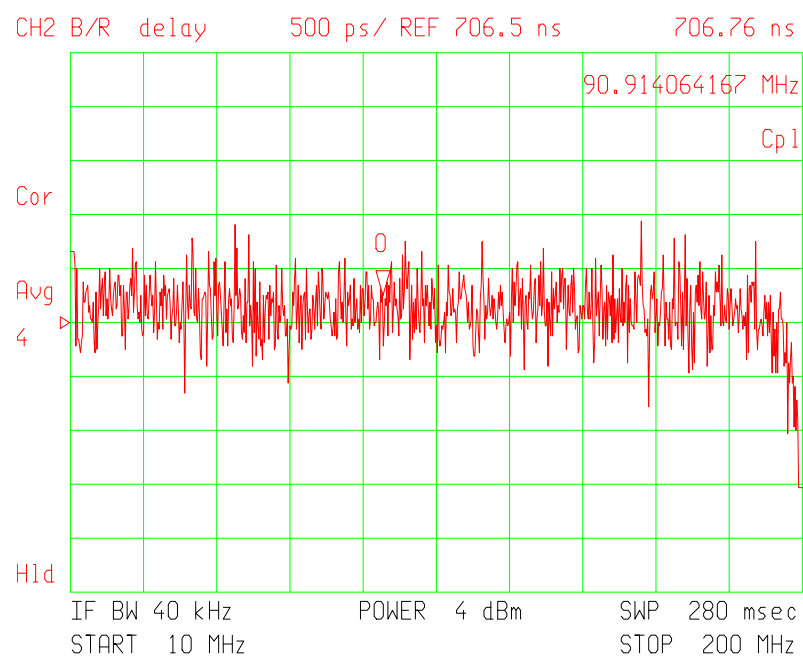
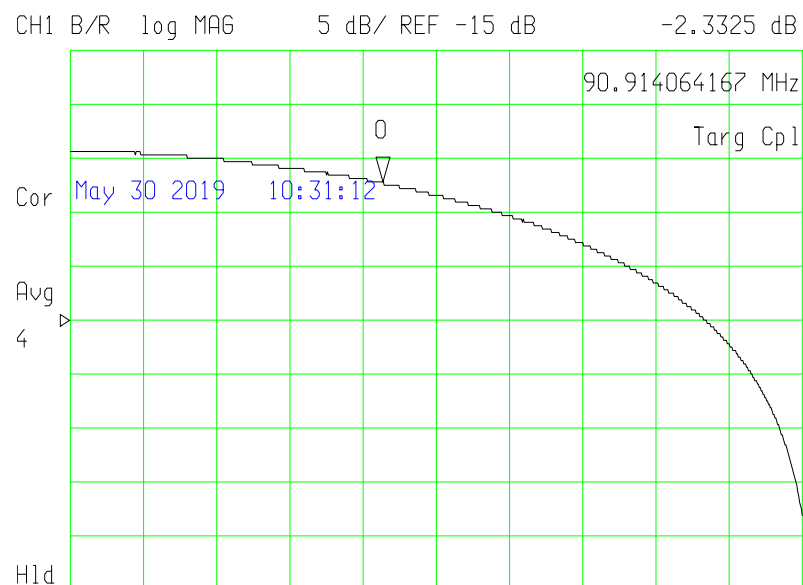


Figure 6: Through mode

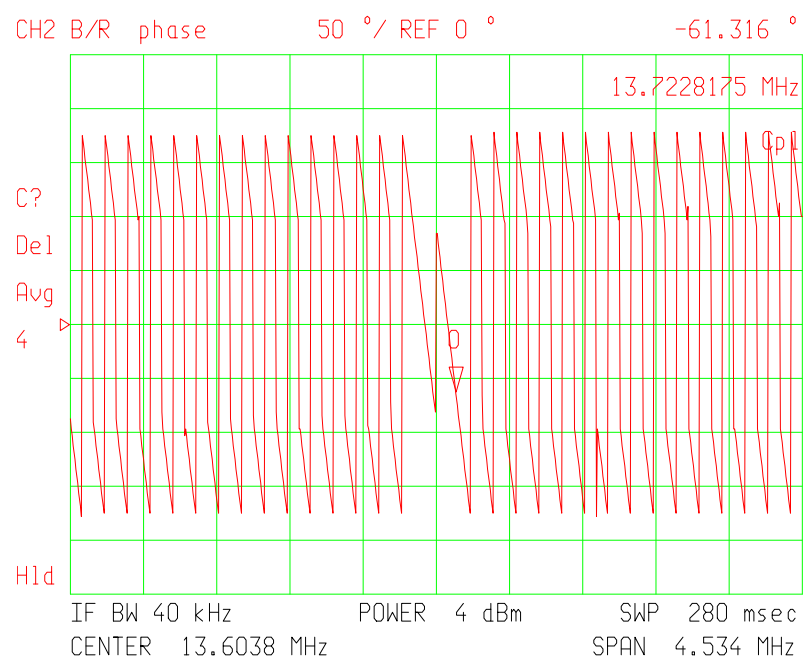
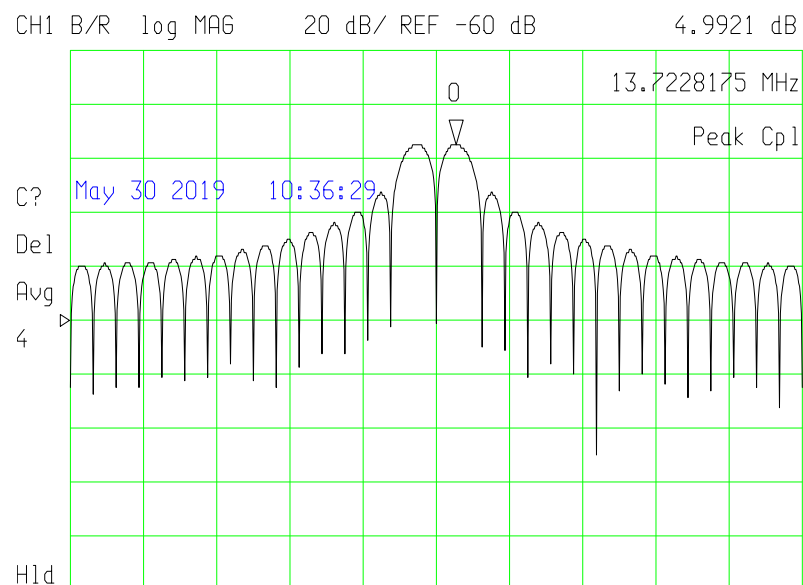


Figure 7: Filter, no downsampling

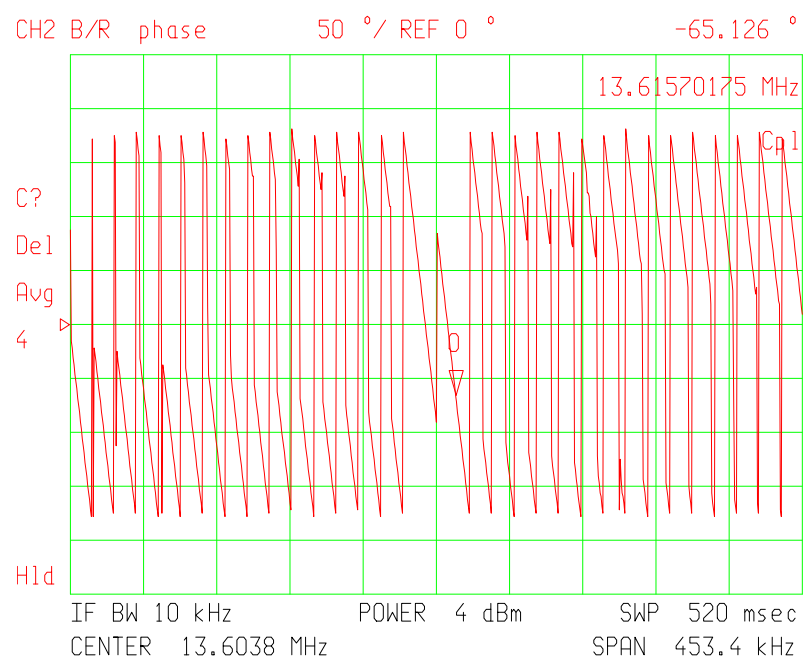
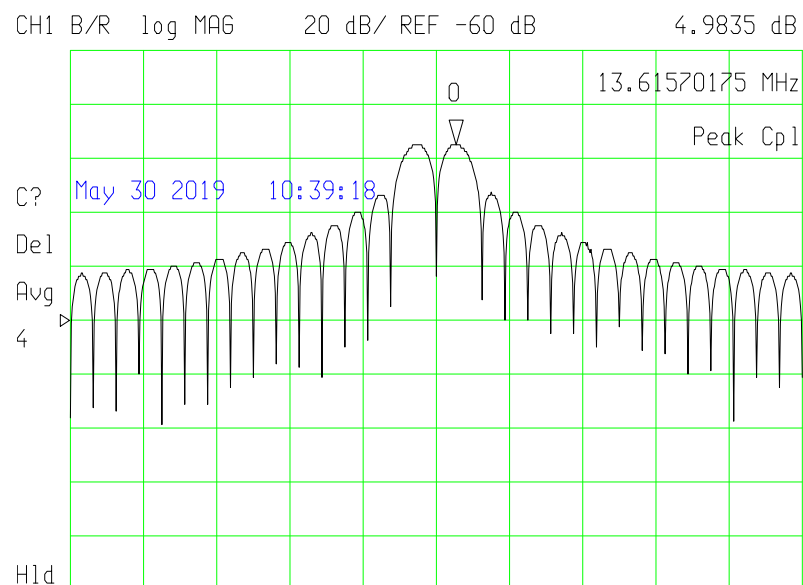


Figure 8: Filter, downsampling of 10