Optical Receiver Head Frequency Response

Receiver Head Detail:

Head unit 1

BPW34 2 * 10MΩ resistors / 1nF. Input FET 2N3820 (Id 5mA, Vd 5V) cascode with BC109 (Ic 0.5mA) , NE5532 buffer

Head Unit 2

SHA2030 2 * 10MΩ resistors / 1nF. Input FET 2N3819 (Id 5mA, Vd 5V) cascode with BC109 (Ic 0.5mA) , NE5532 buffer with frequency tailoring to maintain flatter frequency response.

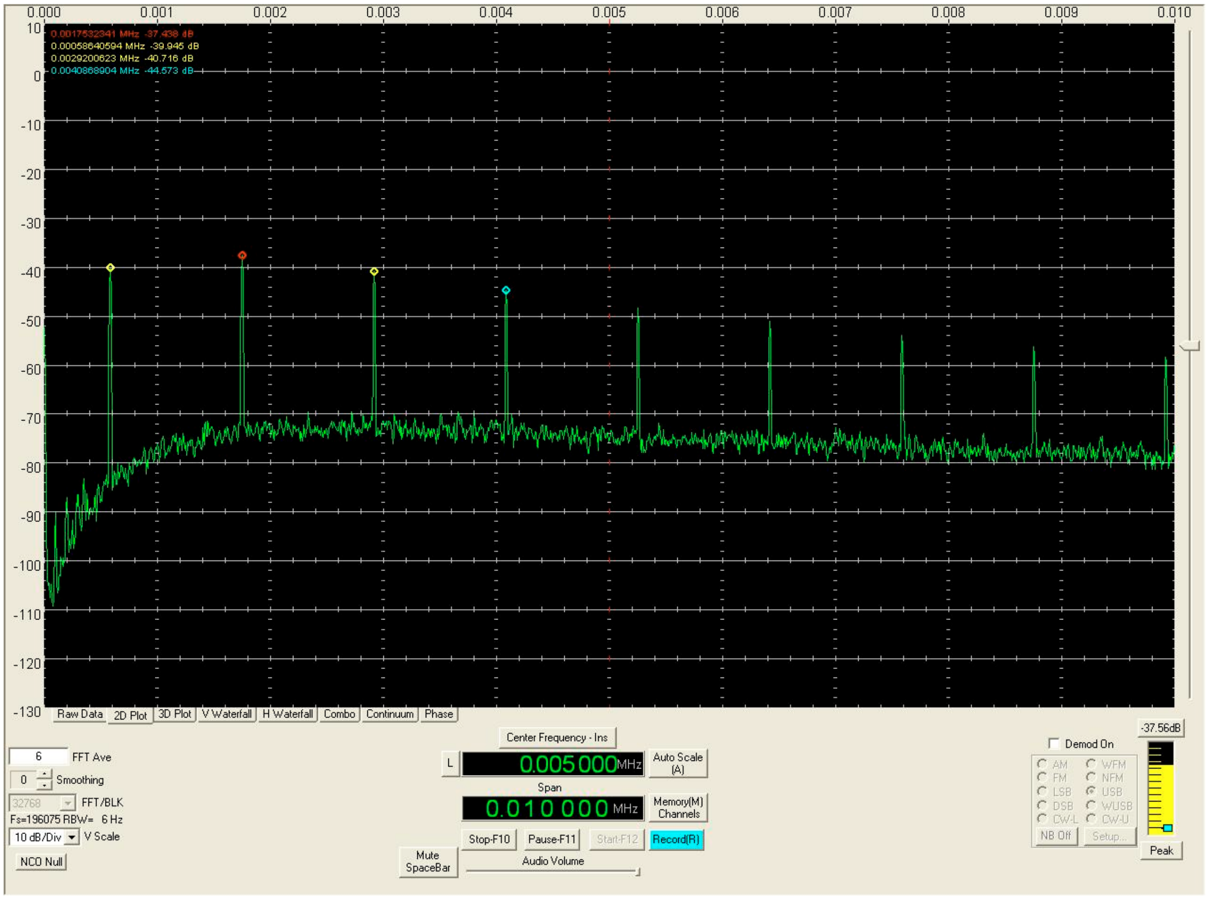
Test Bed

The receiver head unit under test was placed in one end of a 2.4 metre long piece of dark brown 50mm drain pipe. Two black socks (dirty, straight from the laundry bin !) were pushed in behind the module to exclude external light.

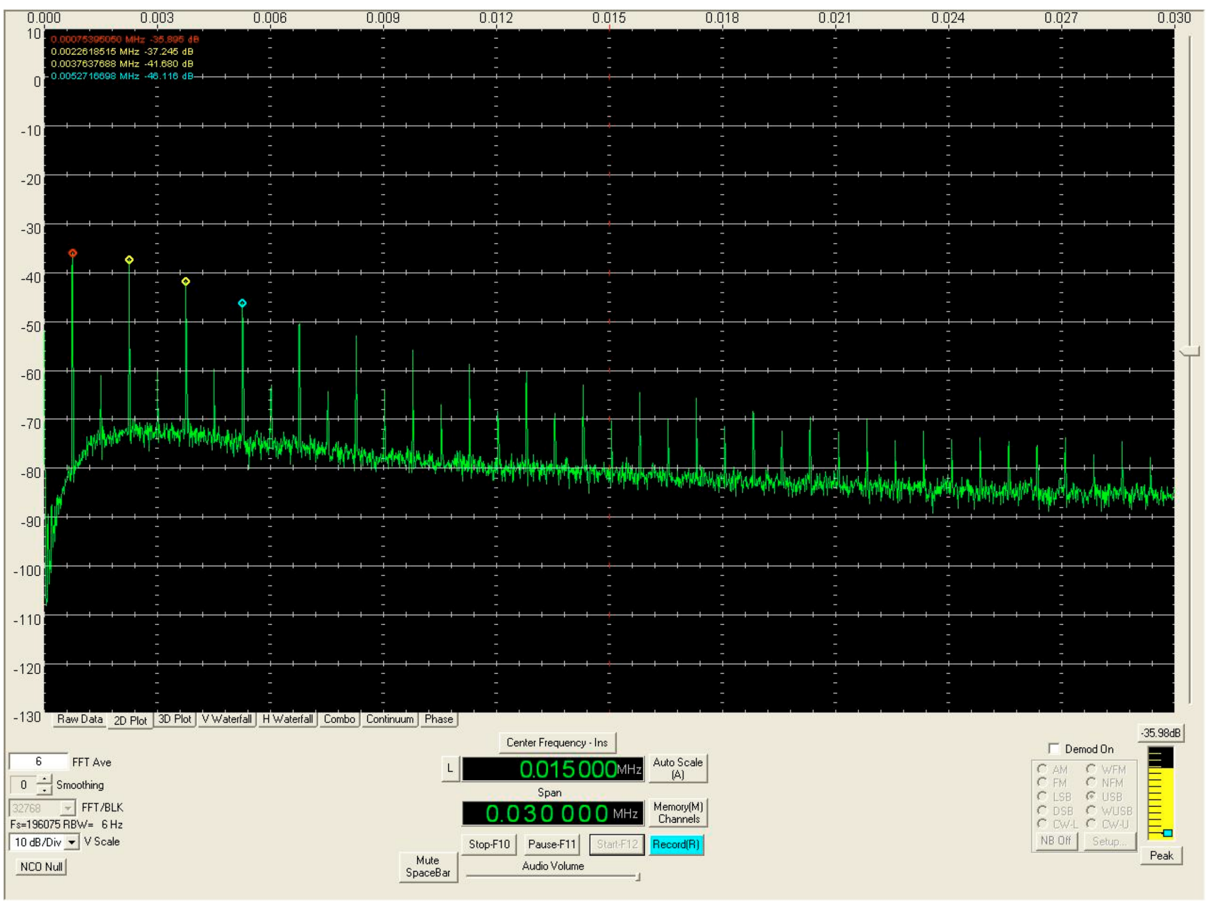
The Tx was formed by a 6V pk-pk square wave from a tunable oscillator through a 1.6k resistor to LED. An antiparallel diode across the LED prevented any reverse bias issues. The Tx was placed inside the tube at the other end and sealed by two more (also dirty) black socks. The S/N level for test was determined by inserting an optical attenuator in front of the Tx LED. This was made from 1, 2, 4 8 etc thicknesses of white handkerchief (clean, straight from the drawer). At 3dB per step, the 4 thickness / 9dB attenuator setting was chosen as optimum.

The Plots show Signal to Noise at the optical Rx output received on an SDR-IQ as the source was tuned over 3 to 125kHz

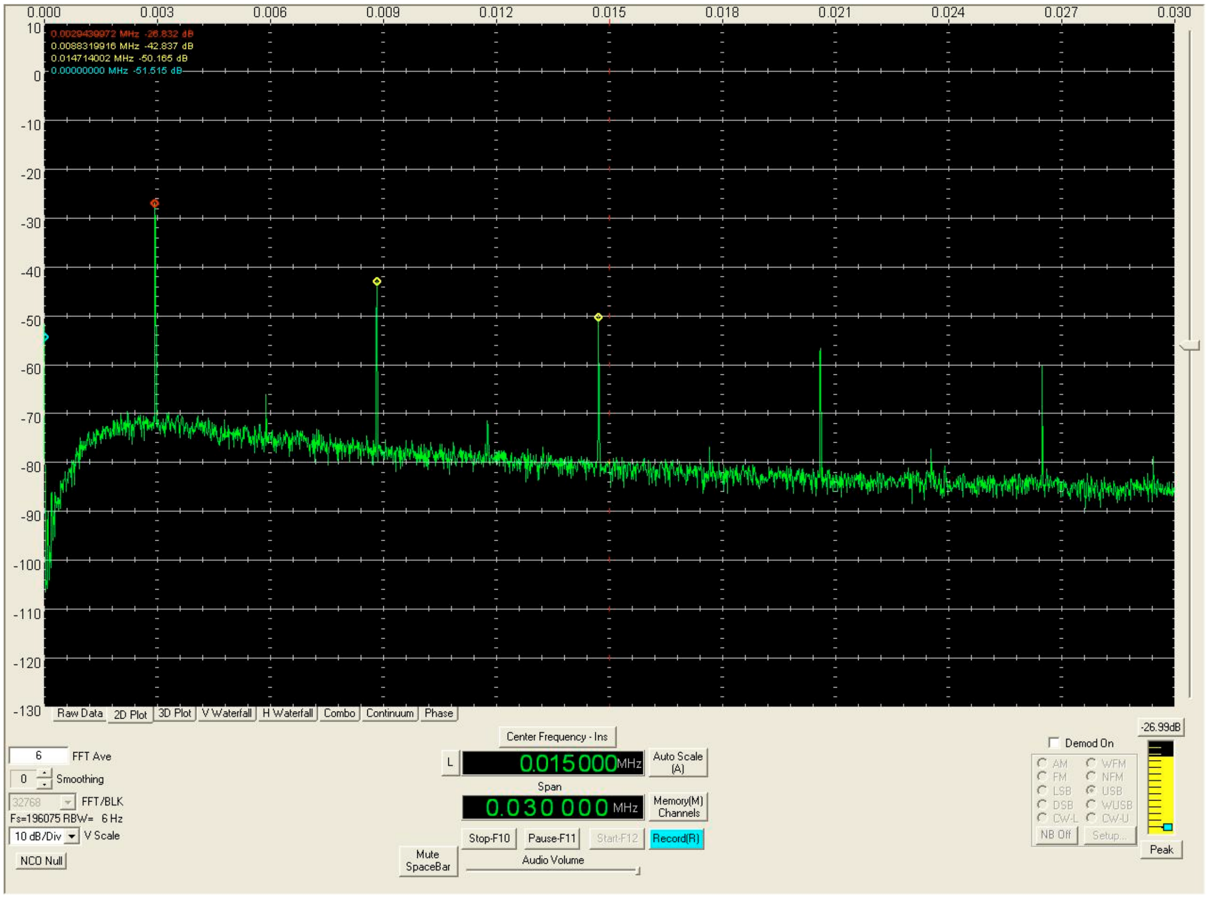
Receiver 1 Results...



600Hz

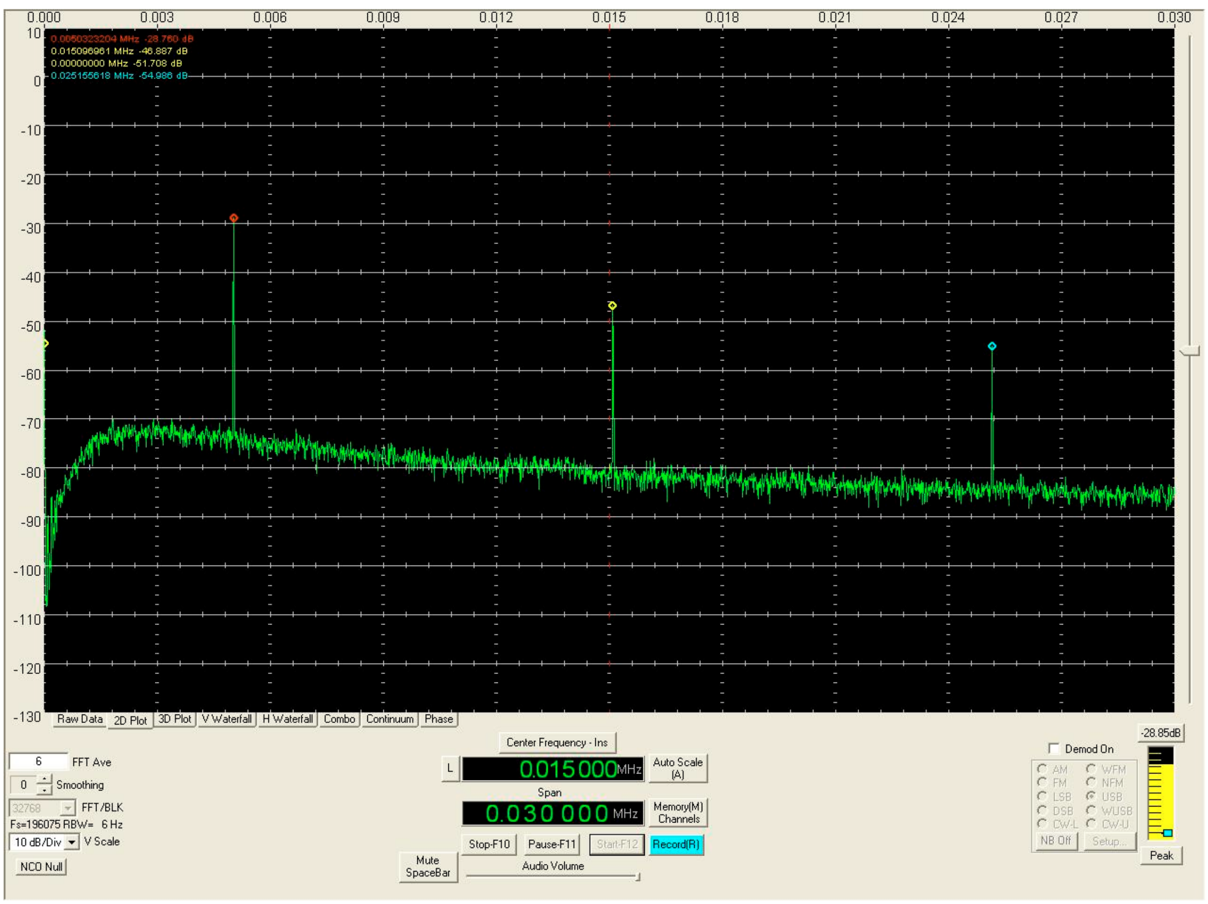


750Hz



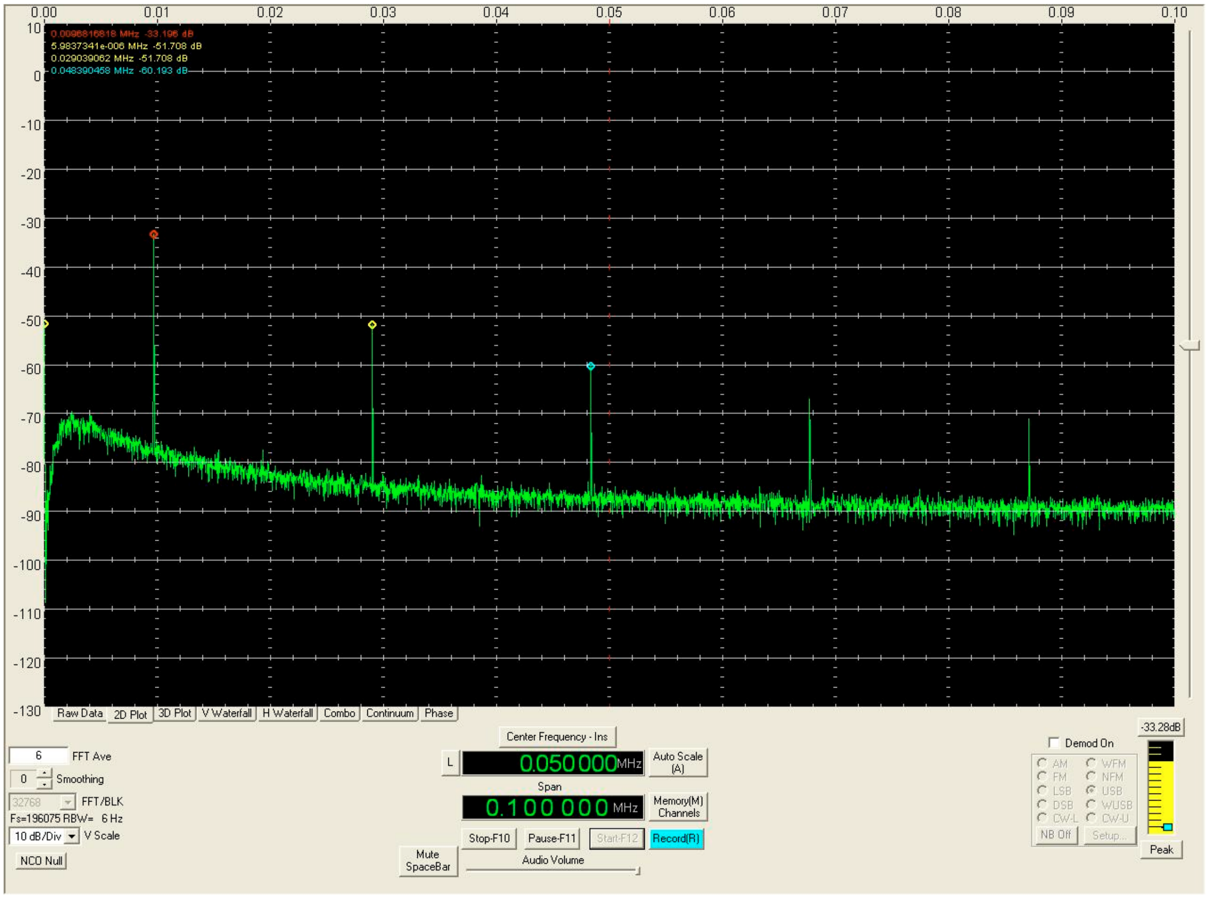
0.0029439972 MHz -26.832 dB
0.0088319916 MHz -42.837 dB
0.014714002 MHz -50.165 dB
0.00000000 MHz -51.515 dB
0.000 0.003 0.006 0.009 0.012 0.015 0.018 0.021 0.024 0.027 0.030
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.015000 MHz
Auto Scale (A)
Span
0.030 000 MHz
Memory(M) Channels
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
6 FFT Ave
0 Smoothing
32768 FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div V Scale
NCO Null
-26.99dB
Demod On
AM FM LSB DSB CW-L
WFM NFM USB WUSB CW-U
NB Off
Setup...
Peak

3kHz

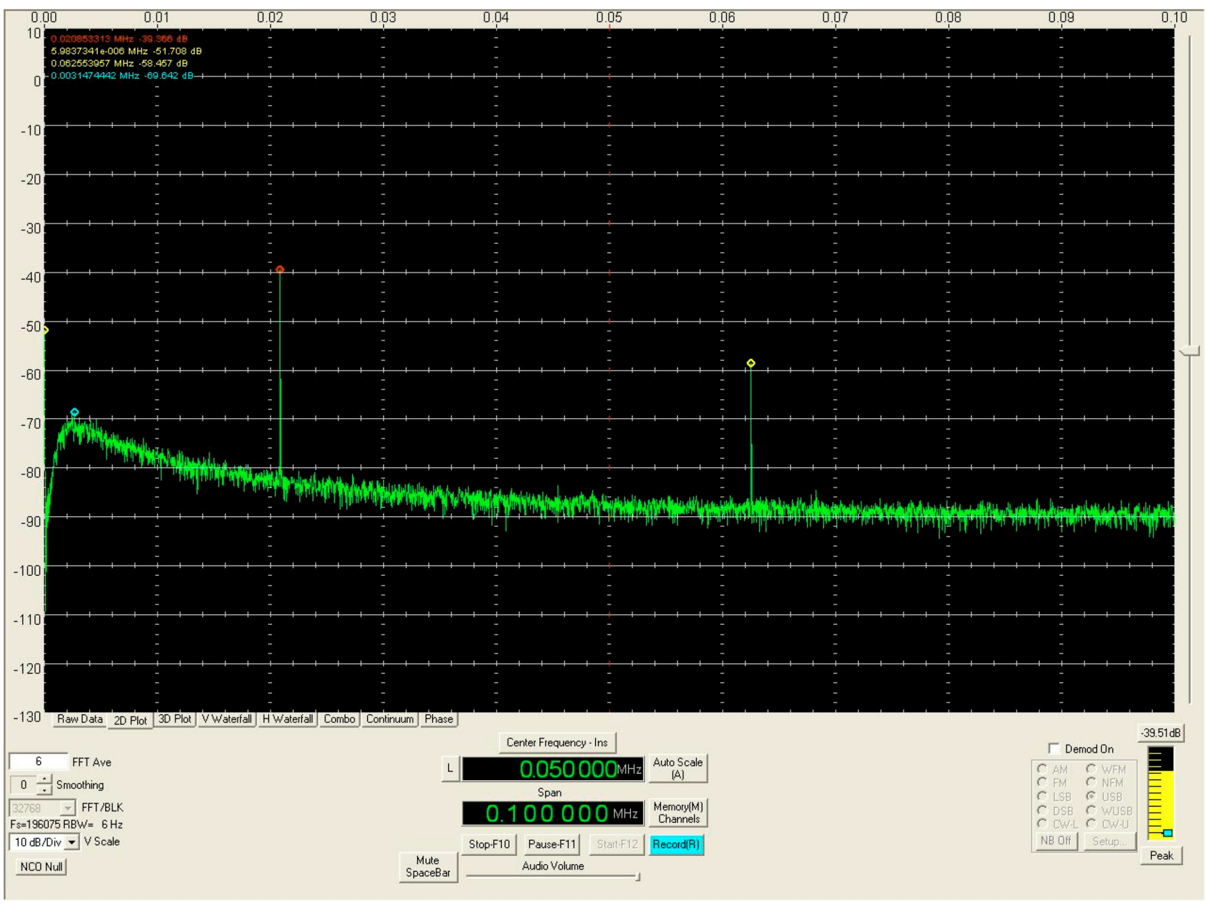


0.0050323204 MHz -28.760 dB
0.015096961 MHz -46.887 dB
0.00000000 MHz -51.708 dB
0.025155618 MHz -54.986 dB
0.000 0.003 0.006 0.009 0.012 0.015 0.018 0.021 0.024 0.027 0.030
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.015000 MHz
Auto Scale (A)
Span
0.030 000 MHz
Memory(M) Channels
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
6 FFT Ave
0 Smoothing
32768 FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div V Scale
NCO Null
-28.85dB
Demod On
AM FM LSB DSB CW-L
WFM NFM USB WUSB CW-U
NB Off
Setup...
Peak

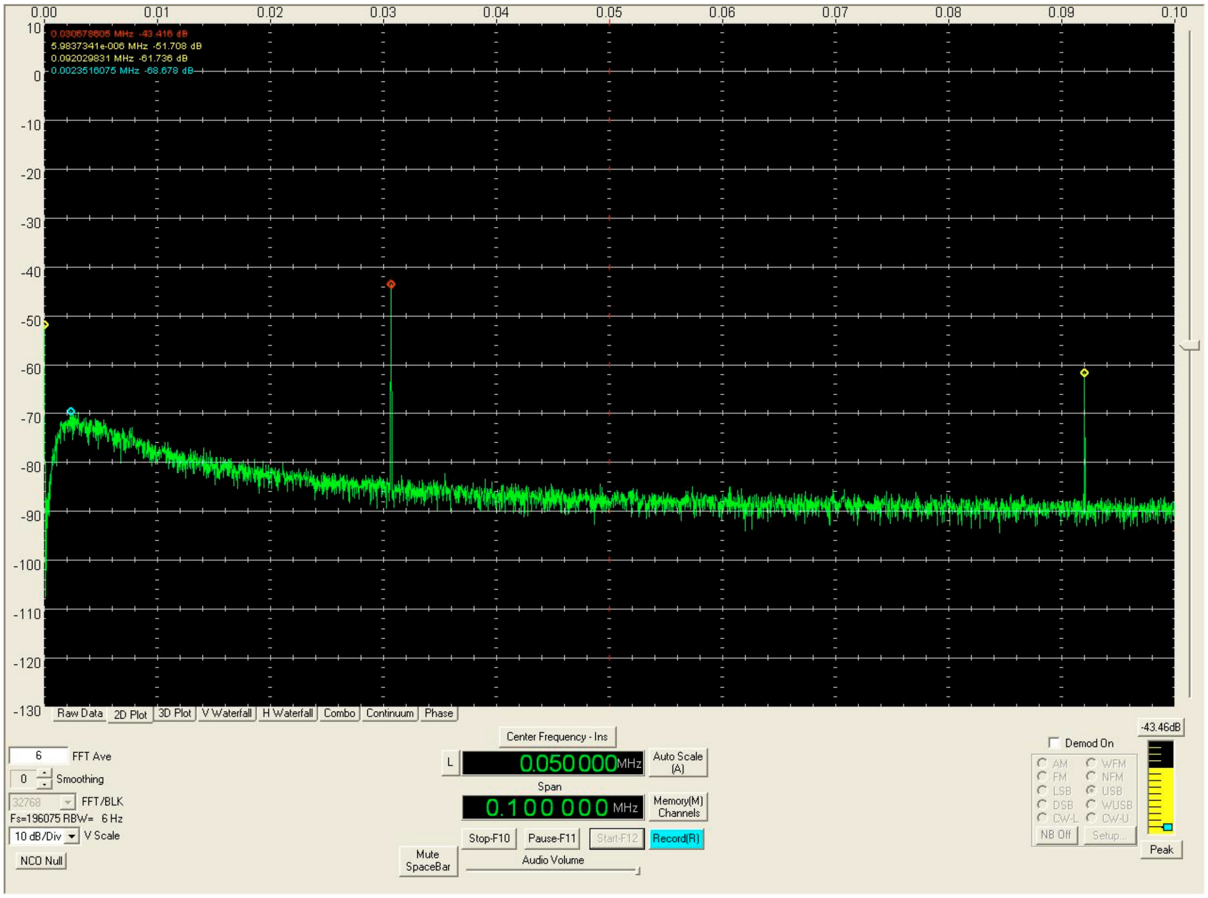
5kHz


0.0096816818 MHz -33.196 dB
5.9837341e-006 MHz -51.708 dB
0.029039062 MHz -51.708 dB
0.048390458 MHz -60.193 dB
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
6
FFT Ave
0
Smoothing
32768
FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div
V Scale
NCO Null
Center Frequency - Ins
L
0.050 000 MHz
Auto Scale (A)
Span
0.100 000 MHz
Memory(M) Channels
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
-33.28dB
Demod On
AM
FM
LSB
DSB
CW-L
WFM
NFM
USB
WUSB
CW-U
NB Off
Setup...
Peak

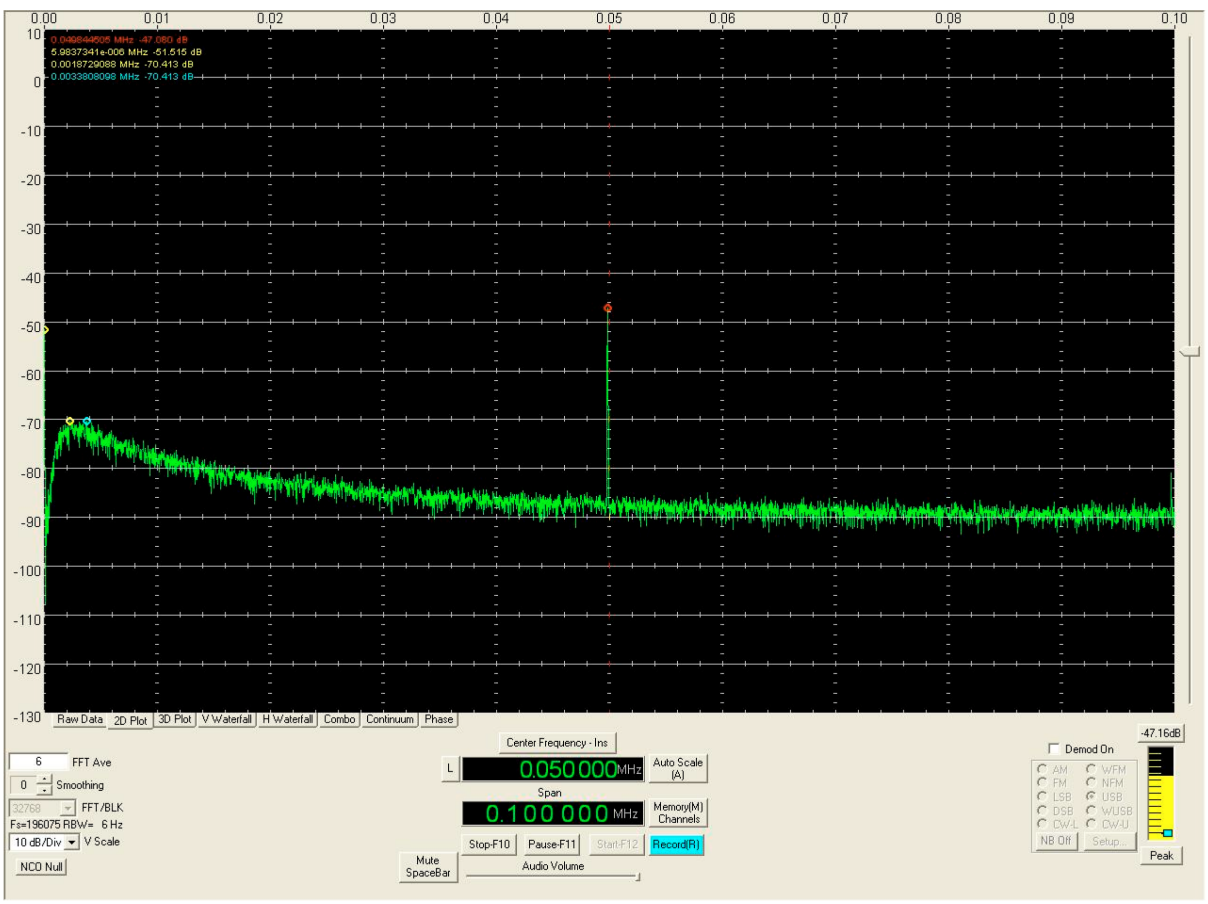
10kHz


0.020853313 MHz -39.366 dB
5.9837341e-006 MHz -51.708 dB
0.062553957 MHz -58.457 dB
0.0031474442 MHz -69.642 dB
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.10
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
6
FFT Ave
0
Smoothing
32768
FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div
V Scale
NCO Null
Center Frequency - Ins
L
0.050 000 MHz
Auto Scale (A)
Span
0.100 000 MHz
Memory(M) Channels
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
-39.51dB
Demod On
AM
FM
LSB
DSB
CW-L
WFM
NFM
USB
WUSB
CW-U
NB Off
Setup...
Peak

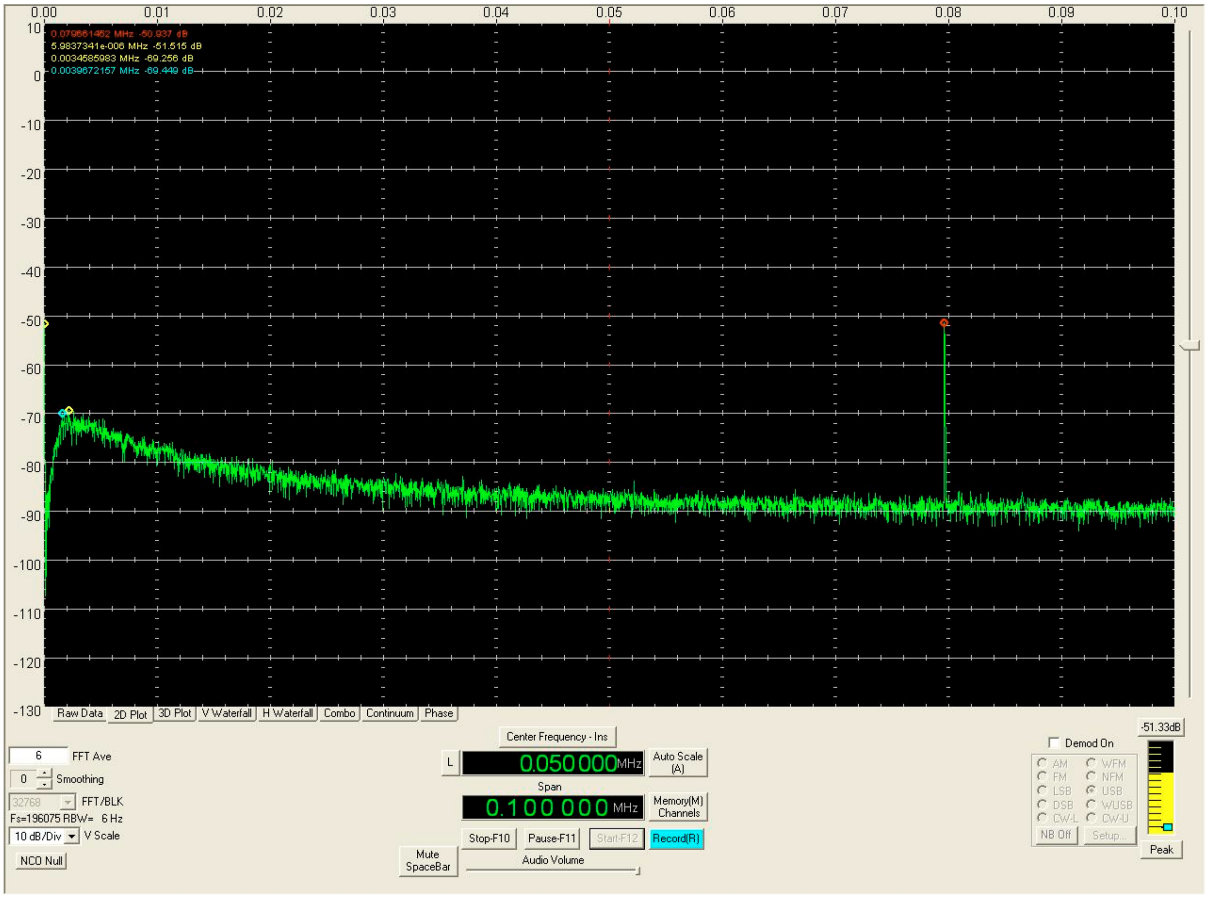
20kHz


0.030678605 MHz -43.416 dB
5.9837341e-006 MHz -51.708 dB
0.092029831 MHz -61.736 dB
0.0023516075 MHz -68.678 dB
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.050000 MHz
Auto Scale (A)
Span
0.100000 MHz
Memory(M) Channels
6
FFT Ave
0
Smoothing
32768
FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div
V Scale
NCO Null
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
Demod On
AM
FM
LSB
DSB
CW-L
WFM
NFM
USB
WUSB
CW-U
NB Off
Setup...
-43.46dB
Peak

30kHz

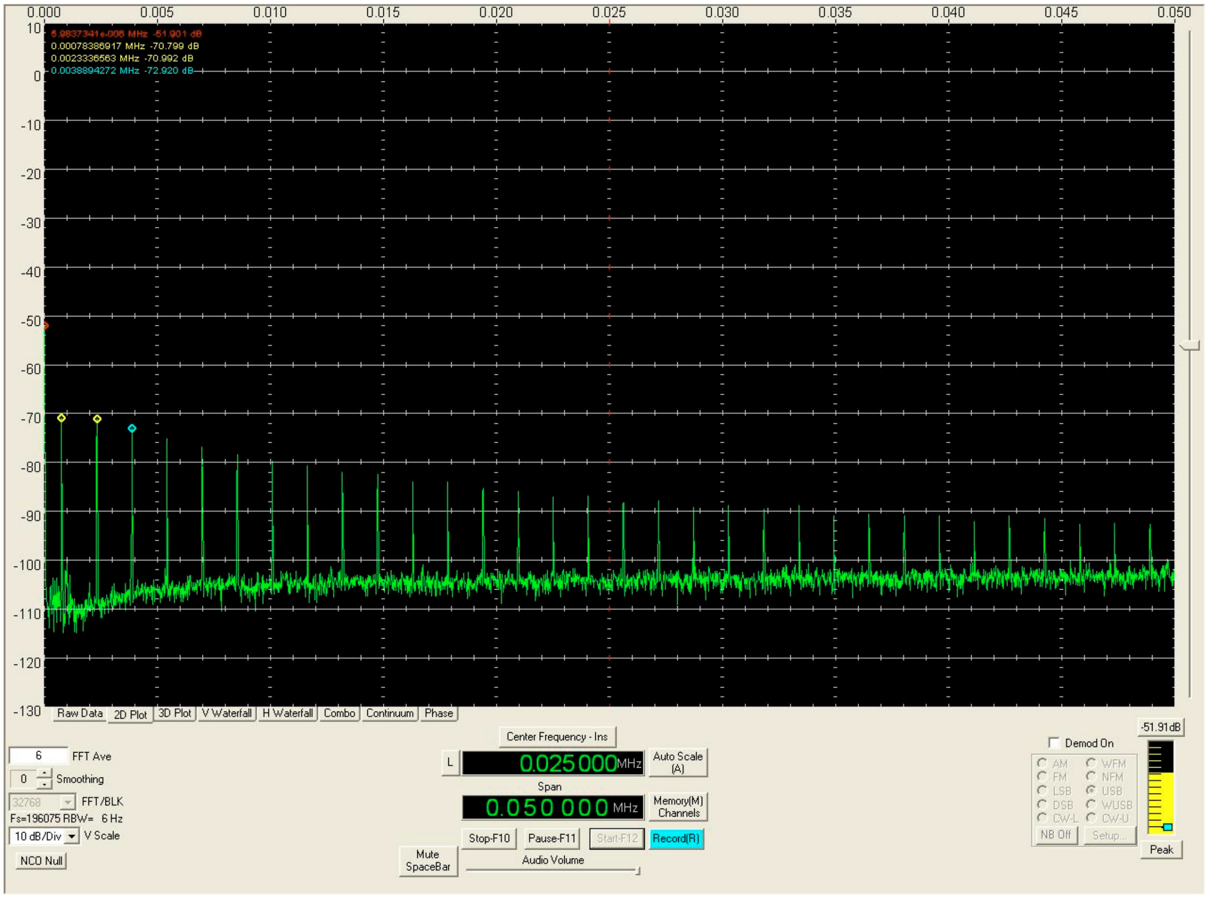

0.049844505 MHz -47.080 dB
5.9837341e-006 MHz -51.515 dB
0.0018729088 MHz -70.413 dB
0.0033808098 MHz -70.413 dB
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.050000 MHz
Auto Scale (A)
Span
0.100000 MHz
Memory(M) Channels
6
FFT Ave
0
Smoothing
32768
FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div
V Scale
NCO Null
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
Demod On
AM
FM
LSB
DSB
CW-L
WFM
NFM
USB
WUSB
CW-U
NB Off
Setup...
-47.16dB
Peak

50kHz

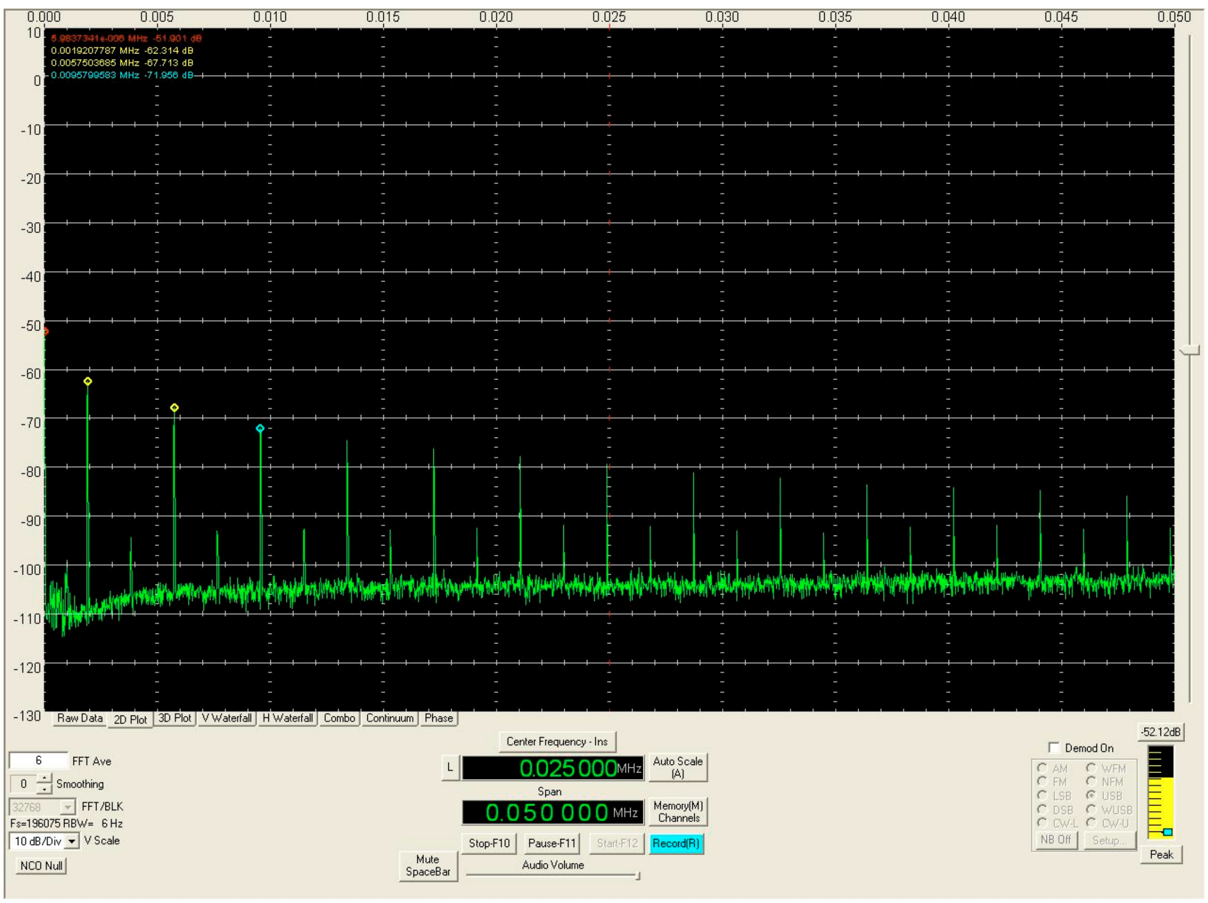

0.079661452 MHz -50.937 dB
5.9837341e-006 MHz -51.515 dB
0.0034585983 MHz -69.256 dB
0.0039672157 MHz -69.449 dB
0.00 0.01 0.02 0.03 0.04 0.05 0.06 0.07 0.08 0.09 0.10
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.050000 MHz
Auto Scale (A)
Span
0.100000 MHz
Memory(M) Channels
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
6 FFT Ave
0 Smoothing
32768 FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div V Scale
NCO Null
Demod On
AM
FM
LSB
DSB
CW-L
WFM
NFM
USB
WUSB
CW-U
NB Off
Setup...
-51.33dB
Peak

80kHz

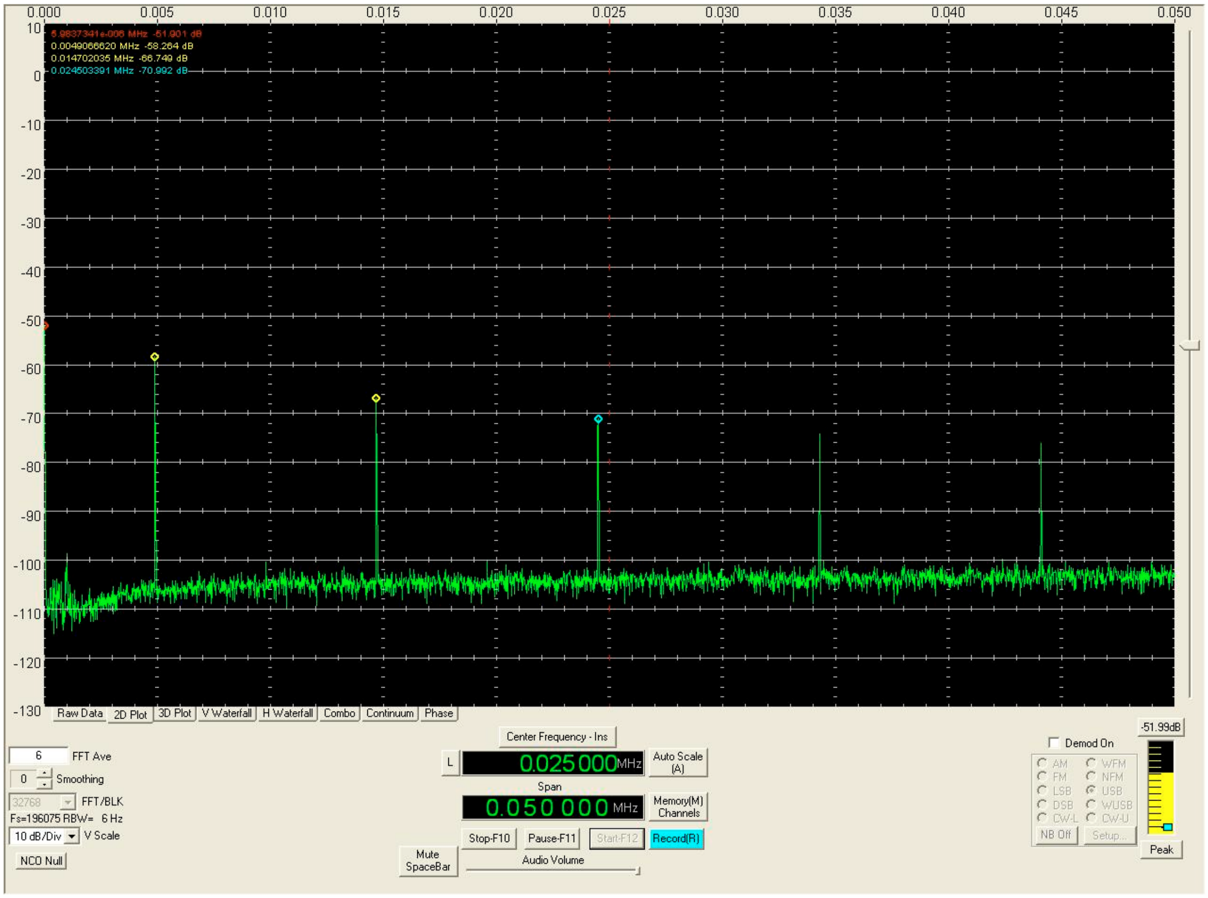
Receiver no. 2



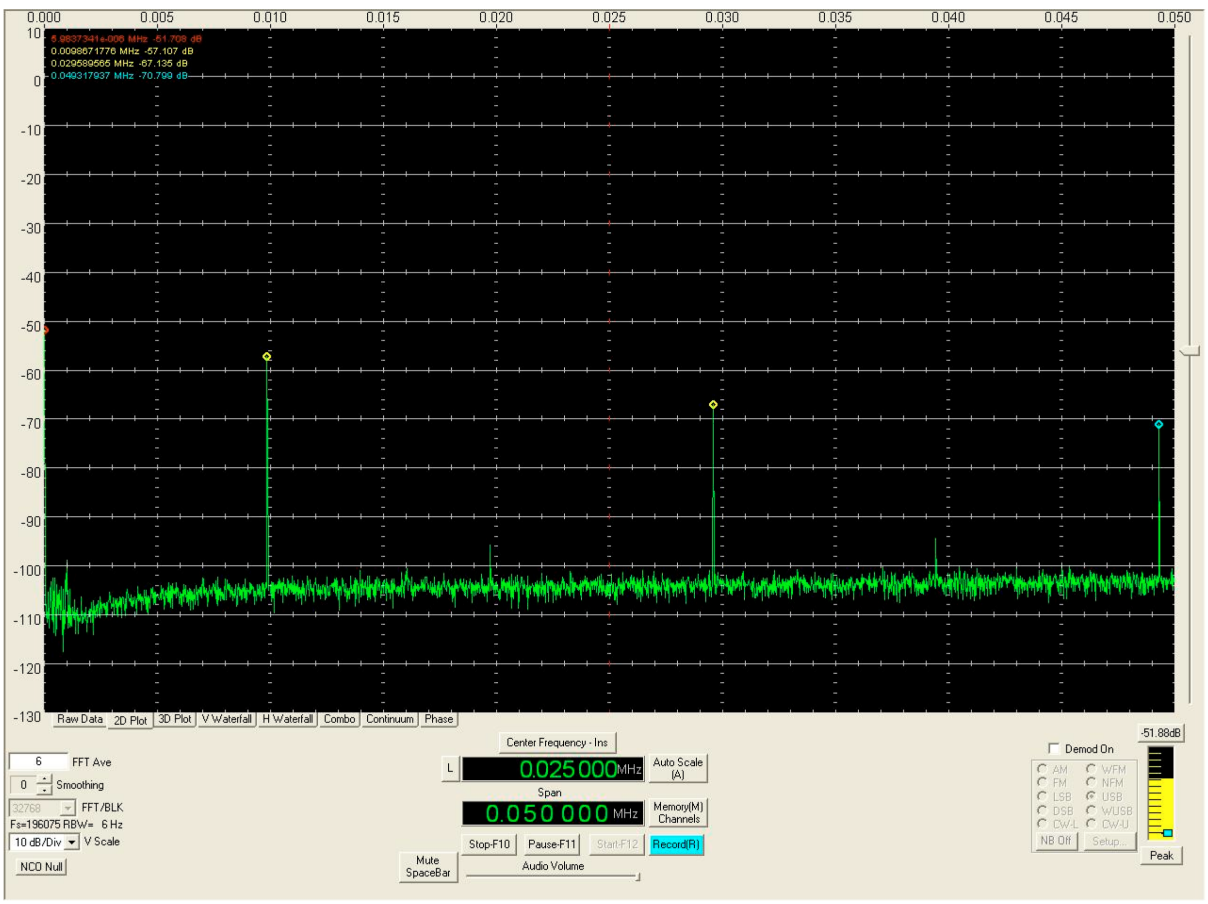
800Hz



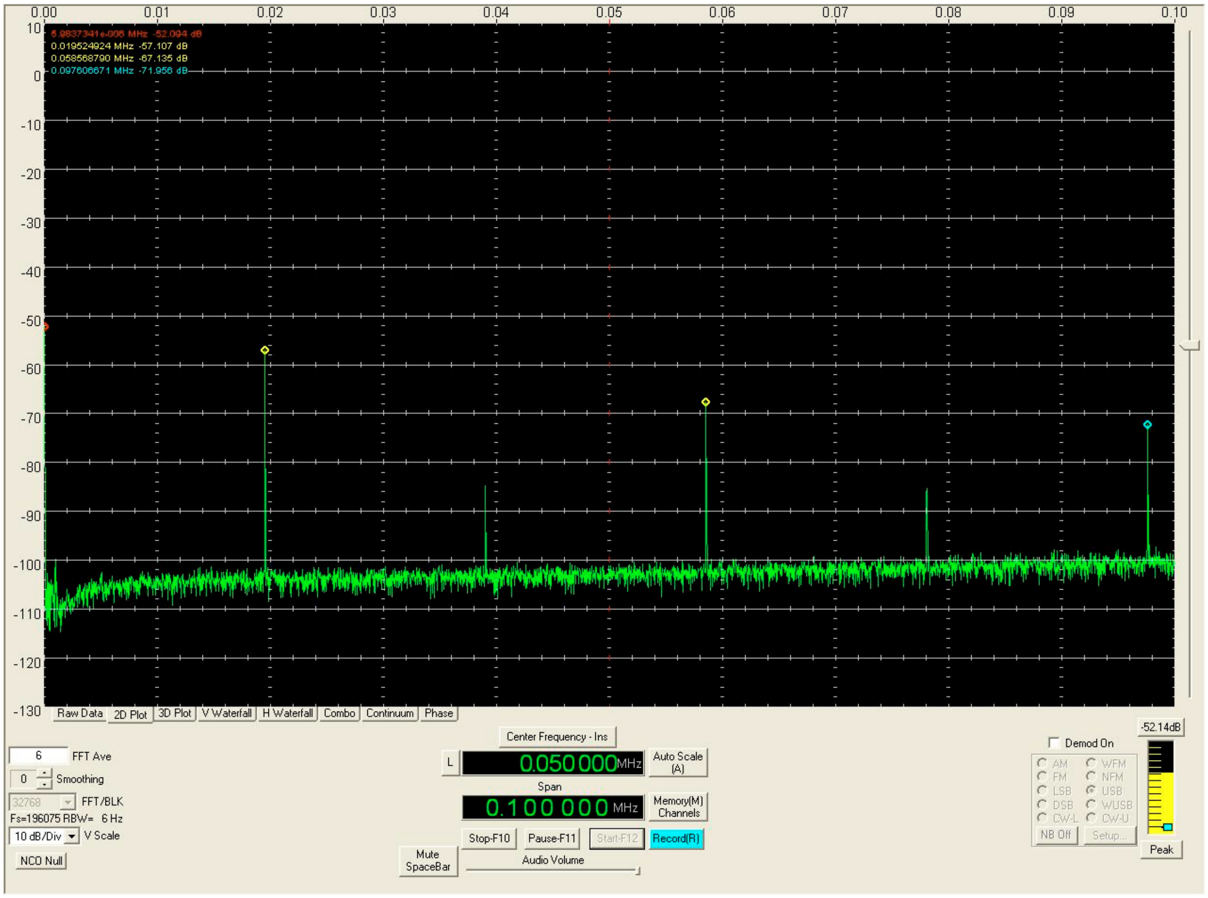
2kHz


5.9837341e-006 MHz -51.901 dB
0.0049066620 MHz -58.264 dB
0.014702035 MHz -66.749 dB
0.024503391 MHz -70.992 dB
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.025 000 MHz
Auto Scale (A)
Span
0.050 000 MHz
Memory(M) Channels
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
6 FFT Ave
0 Smoothing
32768 FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div V Scale
NCO Null
Demod On
AM
FM
LSB
DSB
CW-L
WFM
NFM
USB
WUSB
CW-U
NB Off
Setup...
-51.99dB
Peak

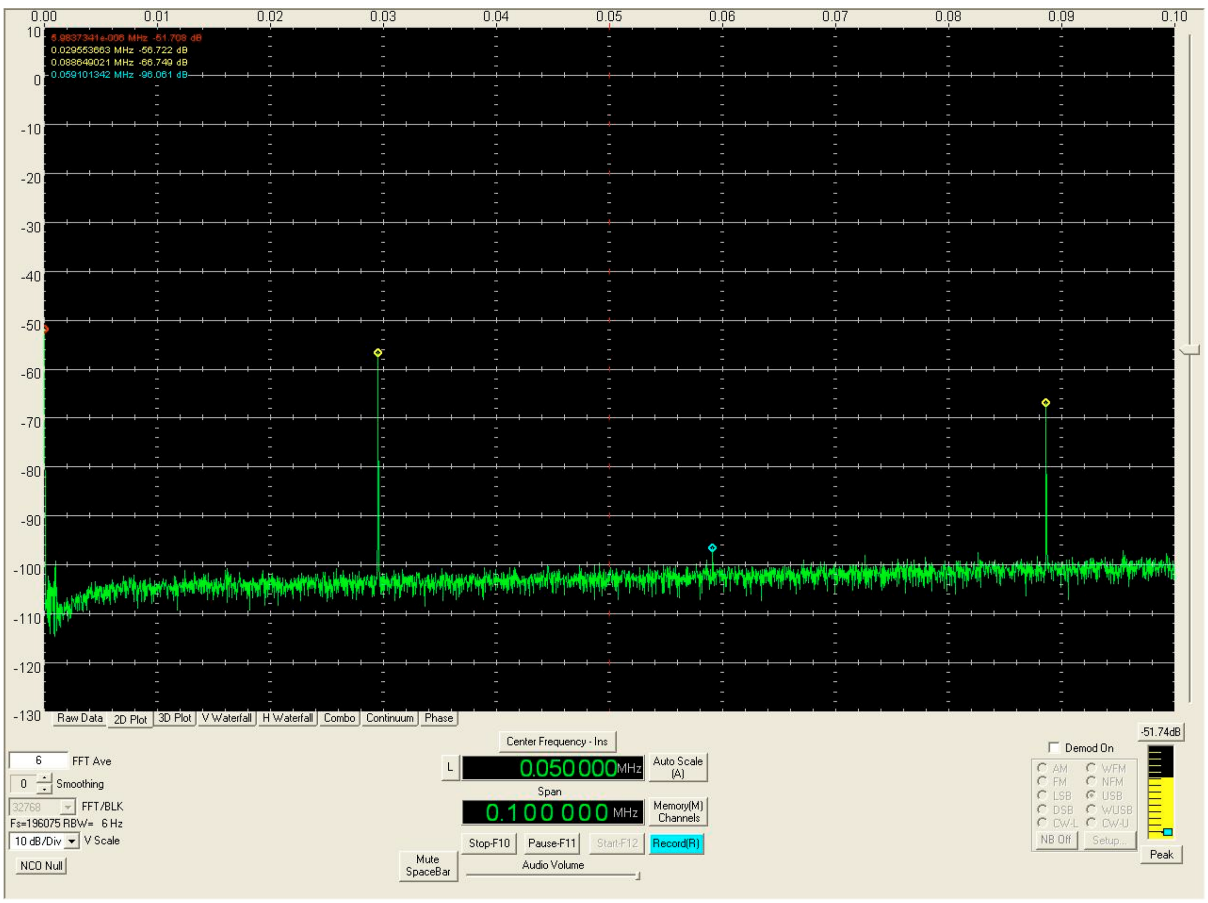
5kHz


5.9837341e-006 MHz -51.708 dB
0.0098671776 MHz -57.107 dB
0.029589565 MHz -67.135 dB
0.049317937 MHz -70.799 dB
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.025 000 MHz
Auto Scale (A)
Span
0.050 000 MHz
Memory(M) Channels
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
6 FFT Ave
0 Smoothing
32768 FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div V Scale
NCO Null
Demod On
AM
FM
LSB
DSB
CW-L
WFM
NFM
USB
WUSB
CW-U
NB Off
Setup...
-51.88dB
Peak

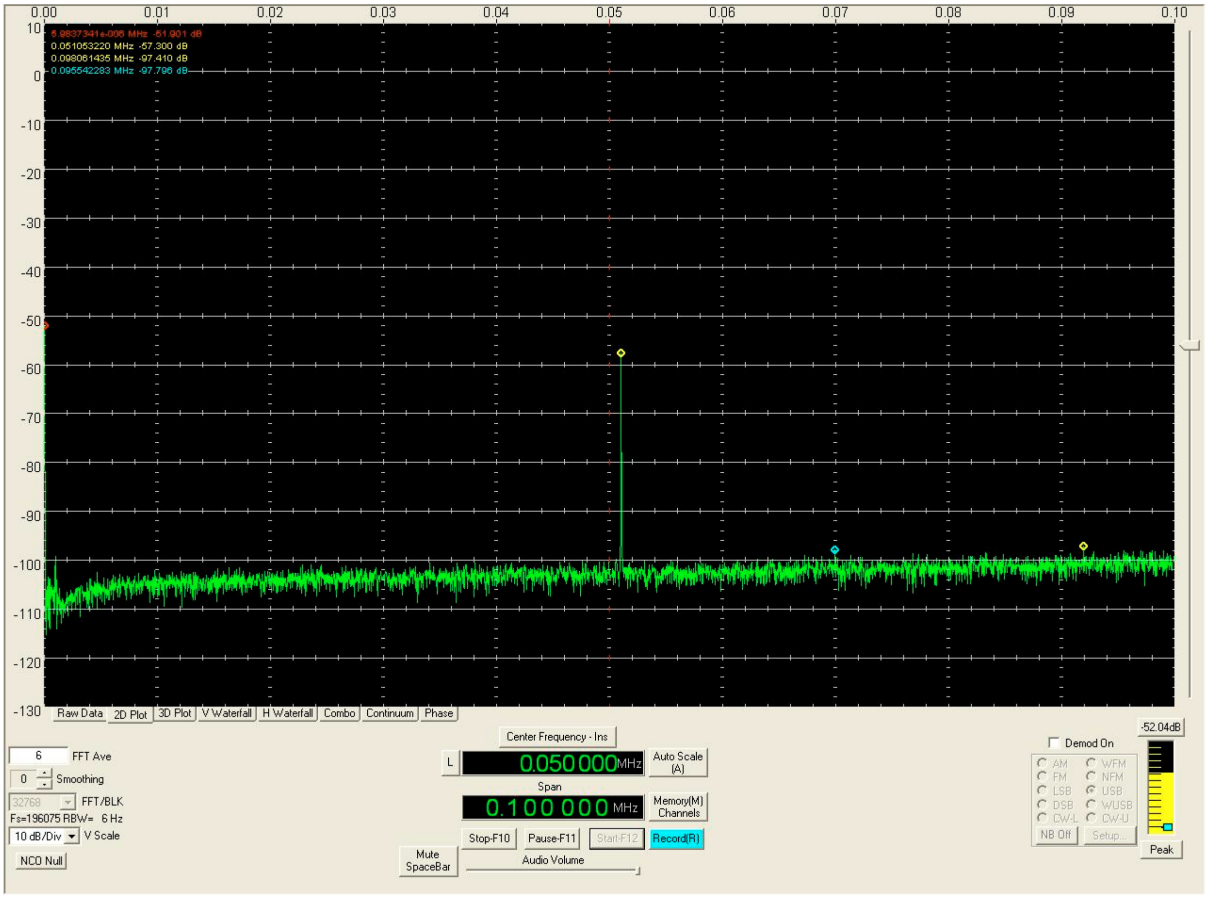
10kHz


5.9837341e-006 MHz -52.094 dB
0.019524924 MHz -57.107 dB
0.058568790 MHz -67.135 dB
0.097606671 MHz -71.956 dB
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.050 000 MHz
Auto Scale (A)
Span
0.100 000 MHz
Memory(M) Channels
FFT Ave
Smoothing
FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div
V Scale
NCO Null
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
Demod On
-52.14dB
Peak

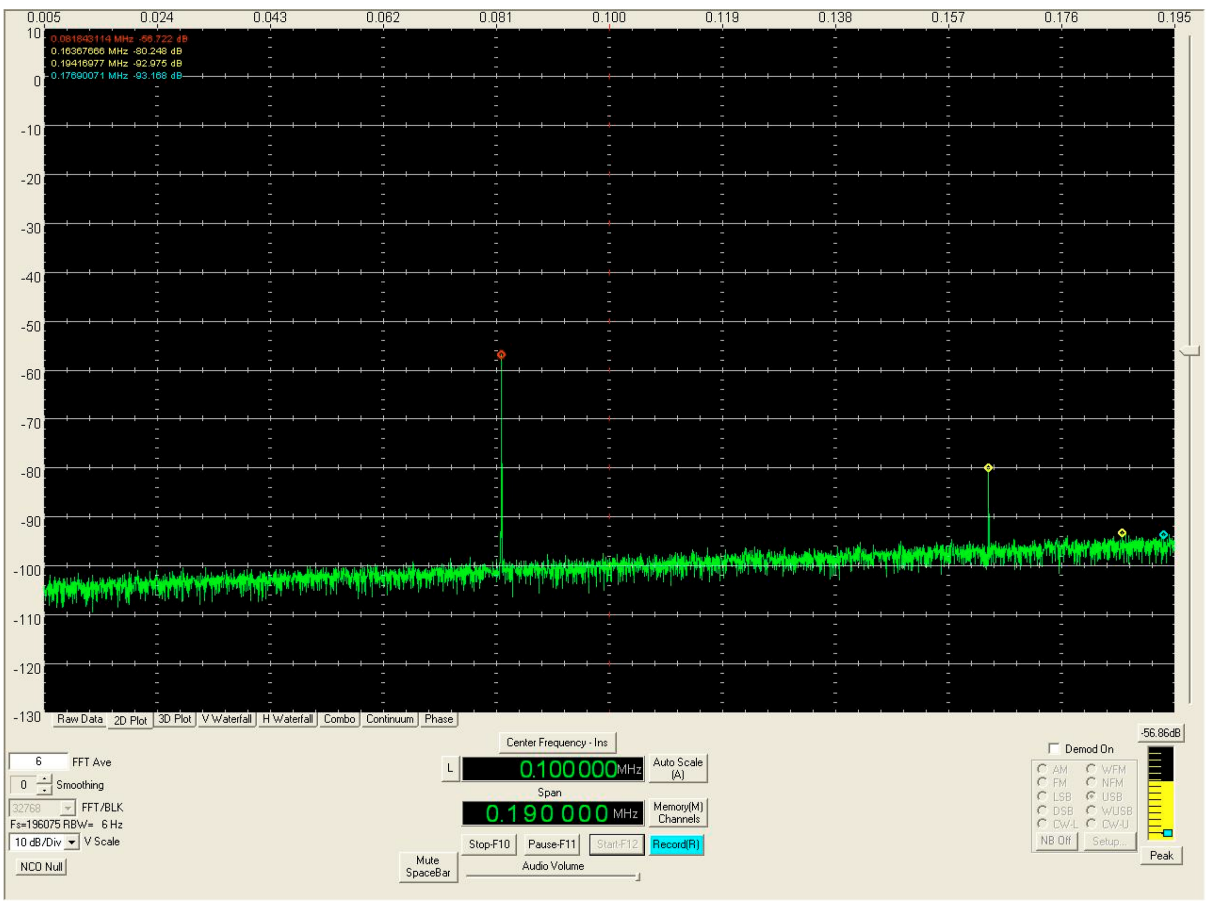
20kHz


5.9837341e-006 MHz -51.708 dB
0.029553663 MHz -56.722 dB
0.088649021 MHz -66.749 dB
0.059101342 MHz -96.061 dB
Raw Data
2D Plot
3D Plot
V Waterfall
H Waterfall
Combo
Continuum
Phase
Center Frequency - Ins
0.050 000 MHz
Auto Scale (A)
Span
0.100 000 MHz
Memory(M) Channels
FFT Ave
Smoothing
FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div
V Scale
NCO Null
Stop-F10
Pause-F11
Start-F12
Record(R)
Mute SpaceBar
Audio Volume
Demod On
-51.74dB
Peak

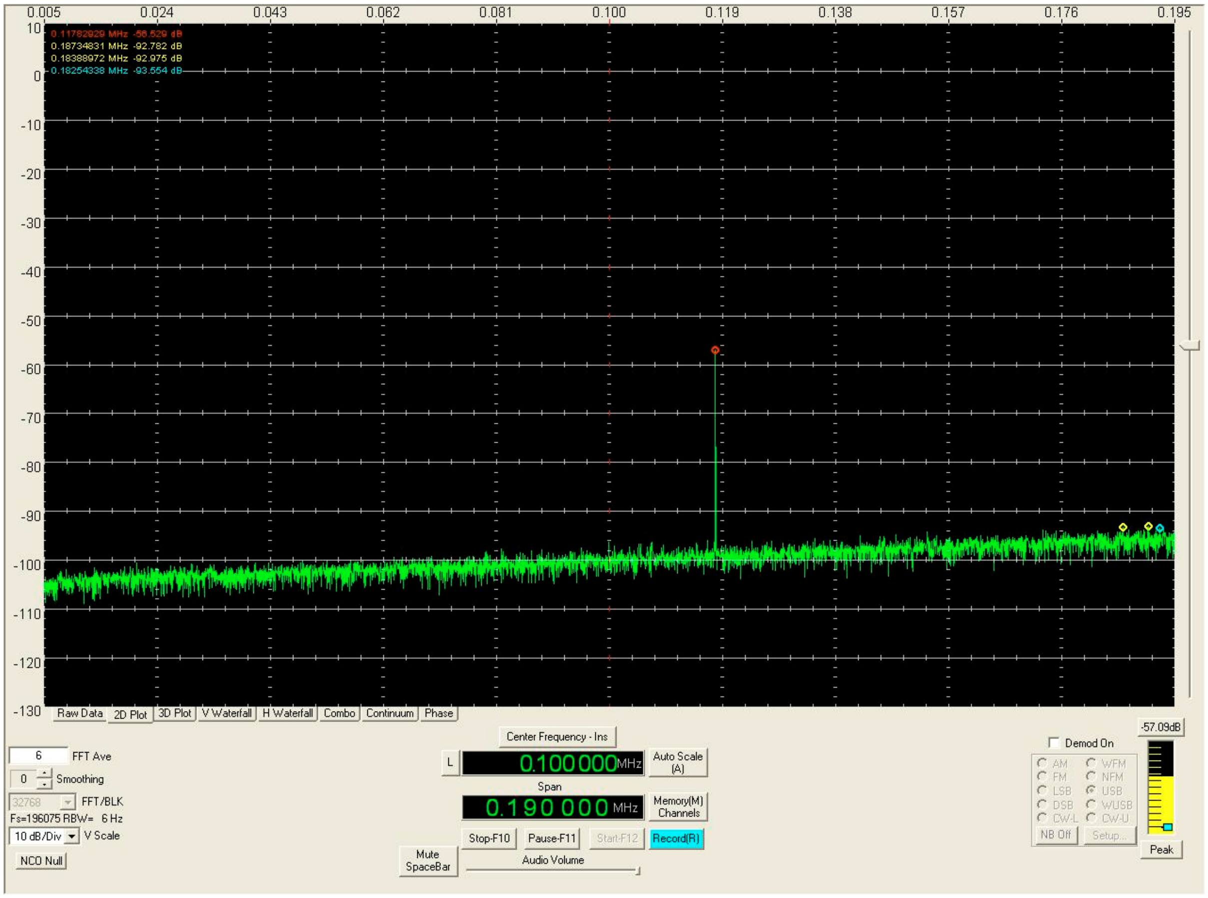
30kHz


5.9837341e-006 MHz -51.901 dB
0.051053220 MHz -57.300 dB
0.098061435 MHz -97.410 dB
0.095542283 MHz -97.796 dB
Center Frequency - Ins
0.050 000 MHz
Span
0.100 000 MHz
FFT Ave
Smoothing
FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div
V Scale
NCO Null
-52.04dB
Demod On
Peak

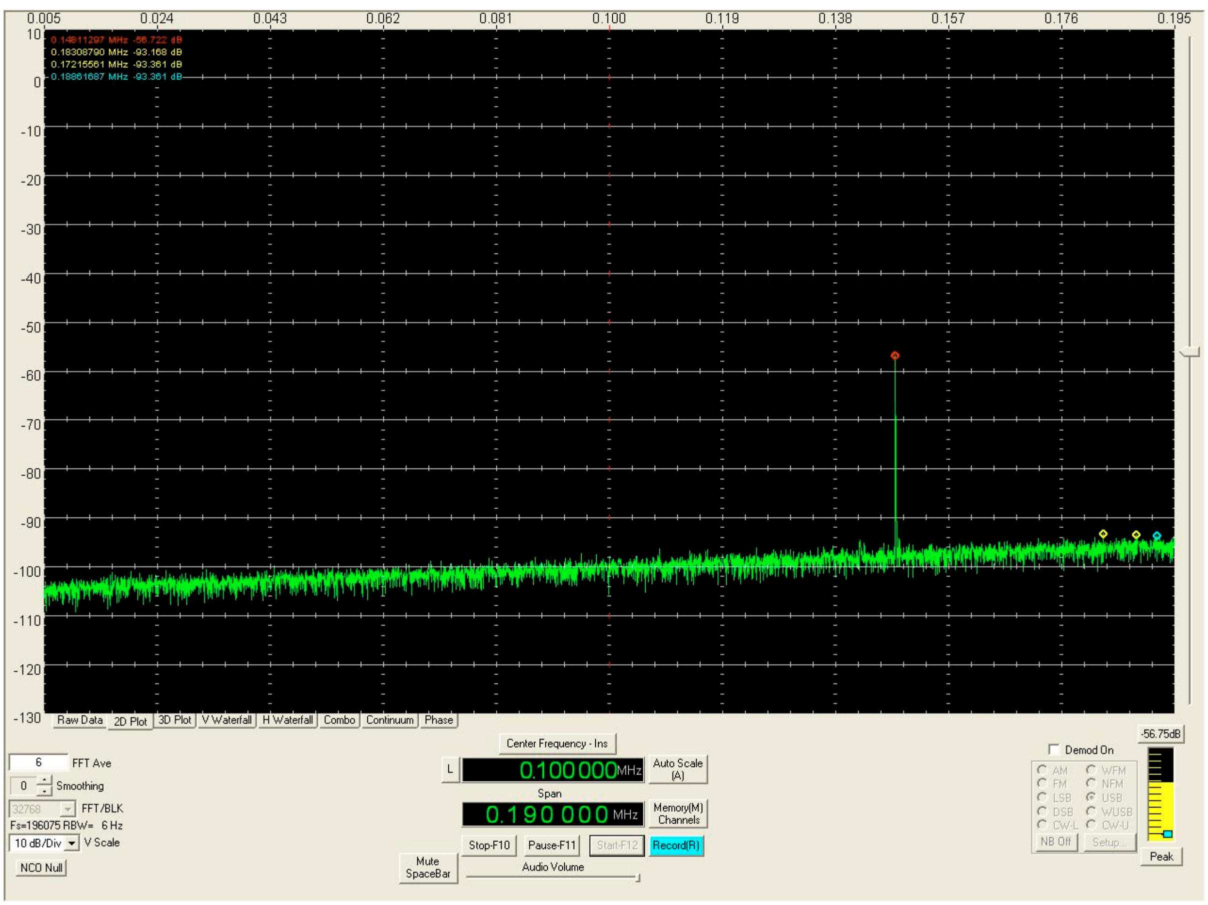
50kHz


0.081843114 MHz -56.722 dB
0.16367666 MHz -80.248 dB
0.19416977 MHz -92.975 dB
0.17690071 MHz -93.168 dB
Center Frequency - Ins
0.100 000 MHz
Span
0.190 000 MHz
FFT Ave
Smoothing
FFT/BLK
Fs=196075 RBW= 6 Hz
10 dB/Div
V Scale
NCO Null
-56.86dB
Demod On
Peak

80kHz



120kHz



150kHz

Conclusions

Receiver 1 (BPW34) started out at 43dB S/N at 600Hz and maintained this value up to around 20 – 30kHz At 50kHz the S/N has fallen to 40dB and at 80kHz, 37dB

Receiver 2 (SHA2030) was showing some interference in the region of a few 100Hz and the S/N rises from around 40dB at 800Hz to 47db at 5kHz. This S/N is maintained up to around 50kHz where it gently drops, reaching 40db at 150kHz.

This second batch of testing was made in a more scientific manner than the first quick roungh and ready estimate. The 2.4 m coupling distance completely removed the possibility of stray coupling, and external light was minimimised by using a light proof piece of drain pipe and black stuffing. A suitablel S/N was derived by a controlled attenuator and wide spacing rather than relying on a very low LED current.

However, results do near-enough – bear out my previous findings, albeit although in the first tests I may have been seeing a small amount of coupling at eh high frequences due to the close sapcing and gain roll-off up there.