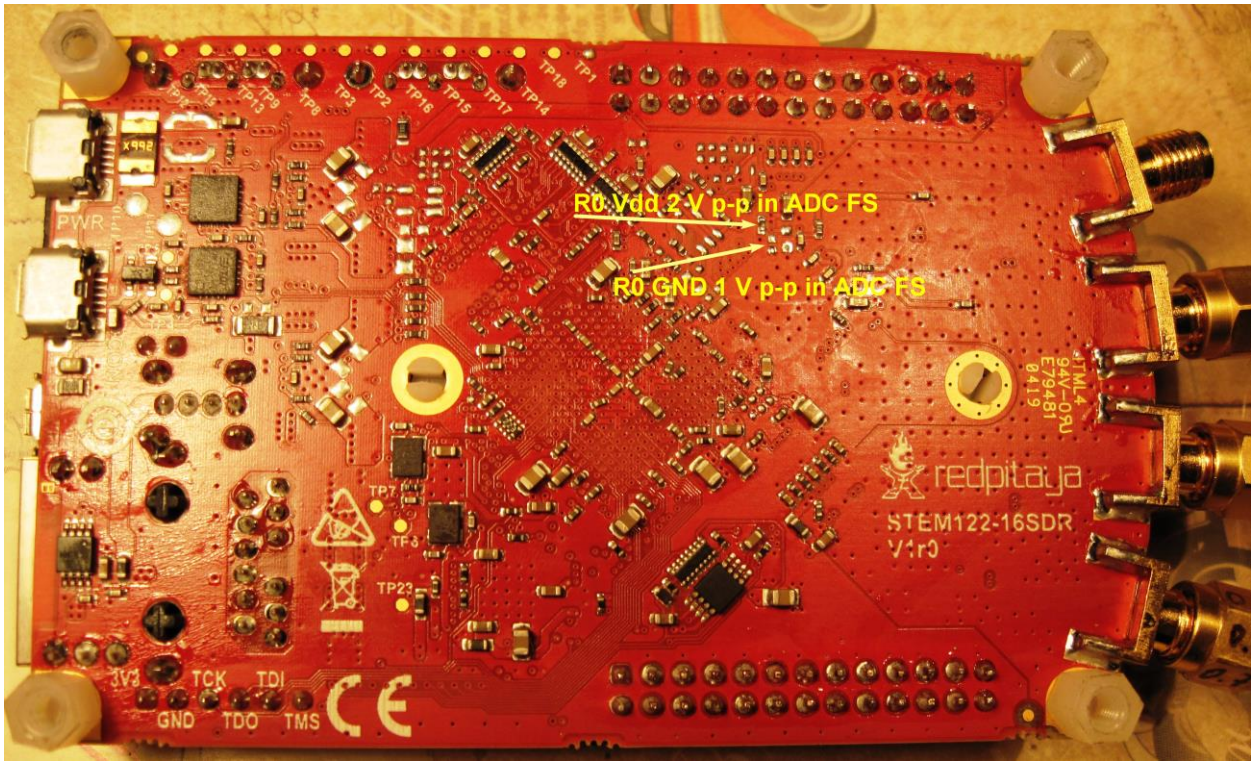
STEMlab 122.88-16 SDR (Red Pitaya 16-bit)

All the measurements were done using PowerSDR mRX PS v3.4.9 and the firmware by Pavel Demin.

One small modification was done by changing the position of the jumper connected to the SENSE pin of the ADC chip. After this modification, the ADC input range is set to 2 V peak-to-peak.

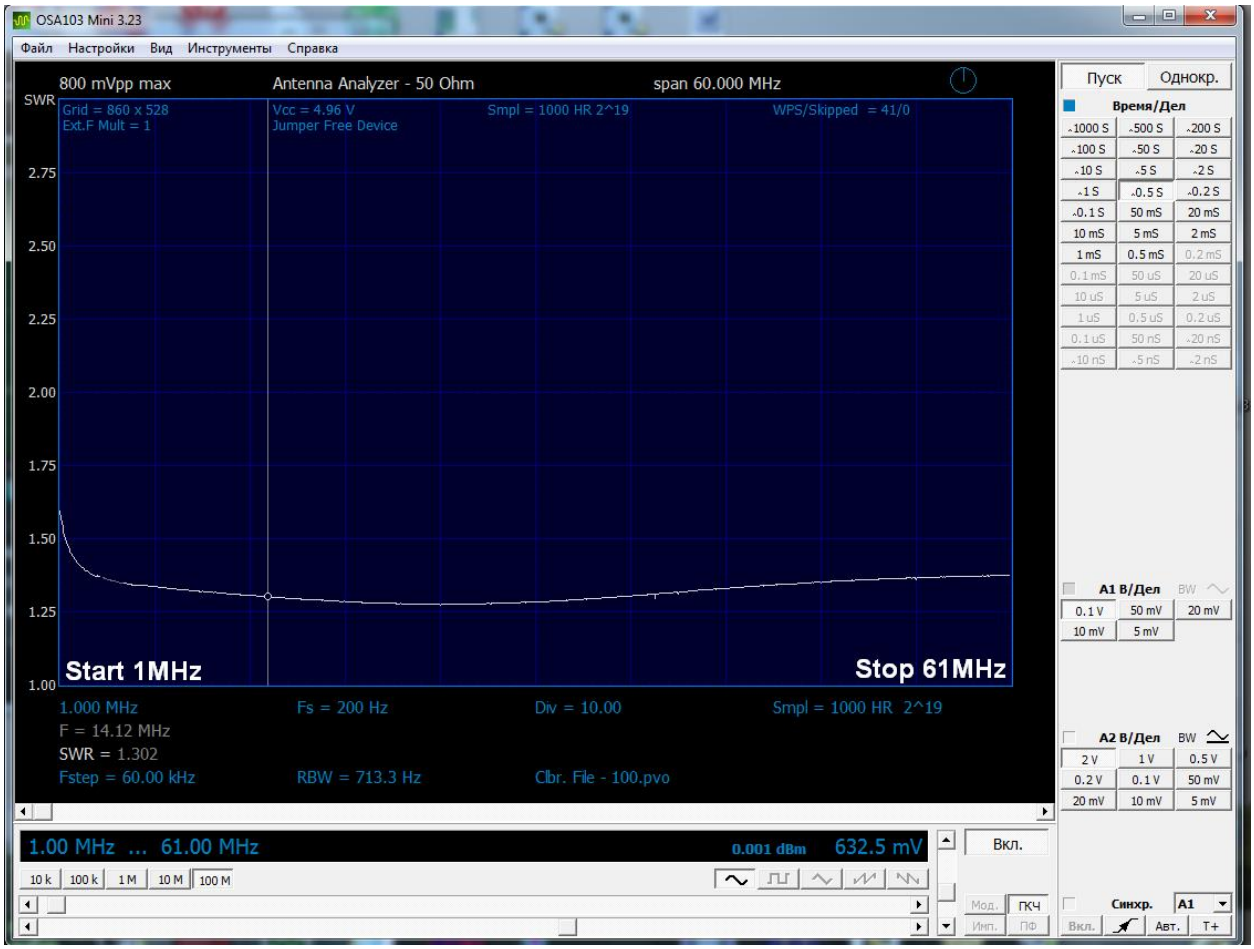


After this modification, the dynamic range is increased by 6 dB, the sensitivity does not change.

SENSE, Vpp	1	2
MDS, dBm	-124	-124
DR, dB	121	**127**

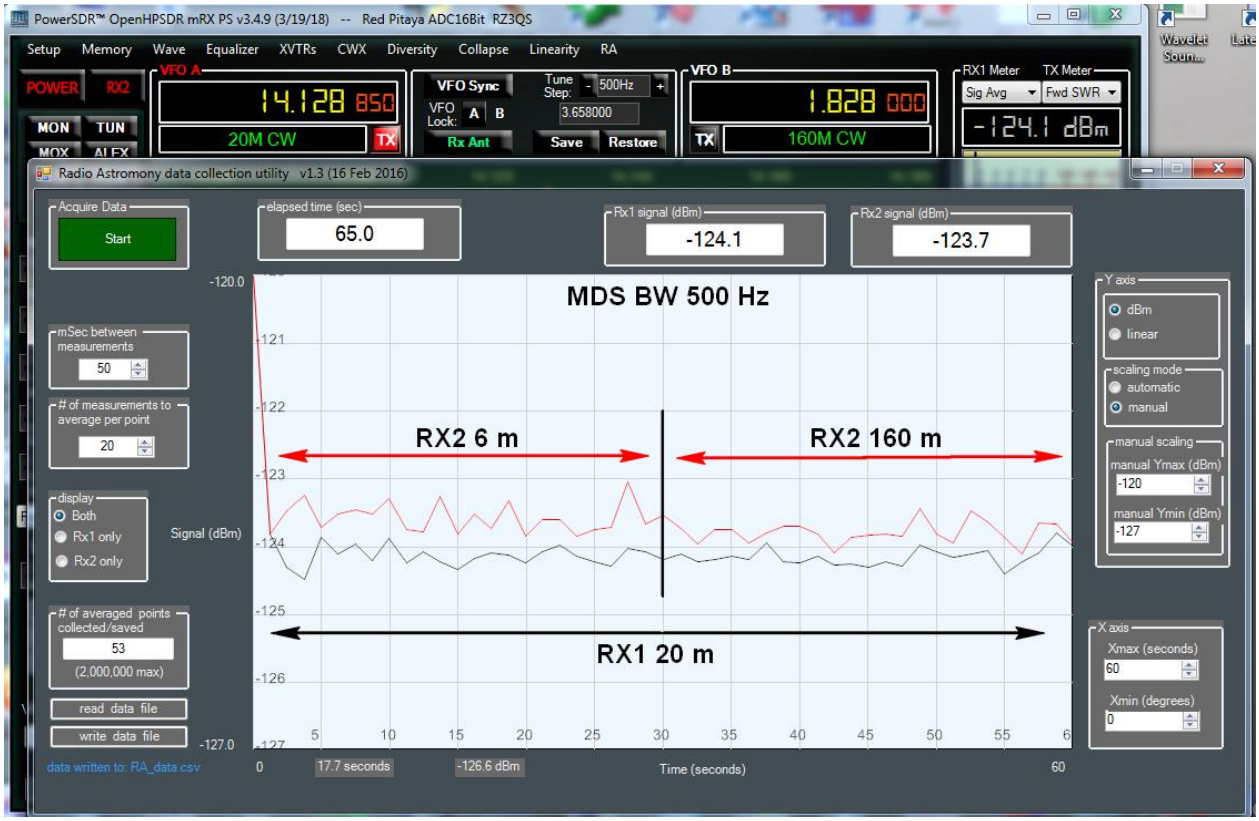
The receiver is based on a dual channel ADC (LTC2185).

SWR at the RF inputs is around 1.3 over the HF range.

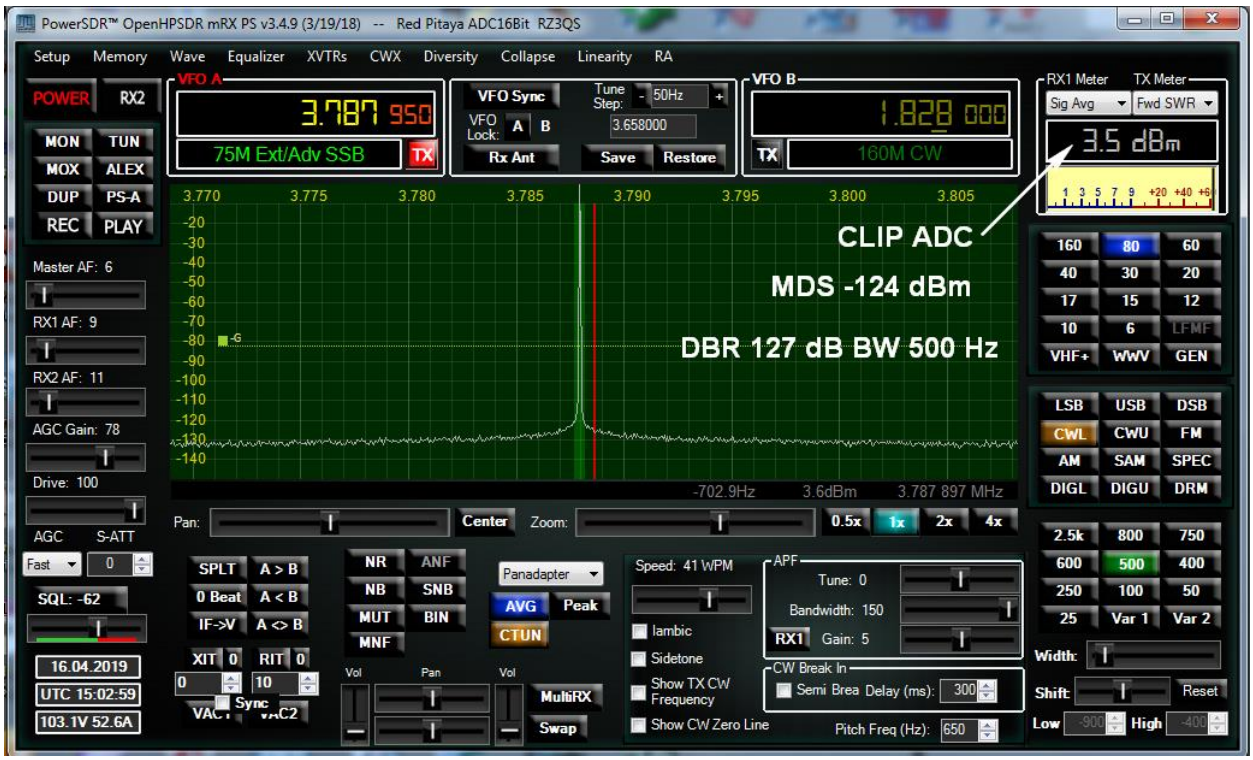


Noise floor in the 500 Hz band is -124 dBm.

The variation of the noise floor over the HF range is minimal.

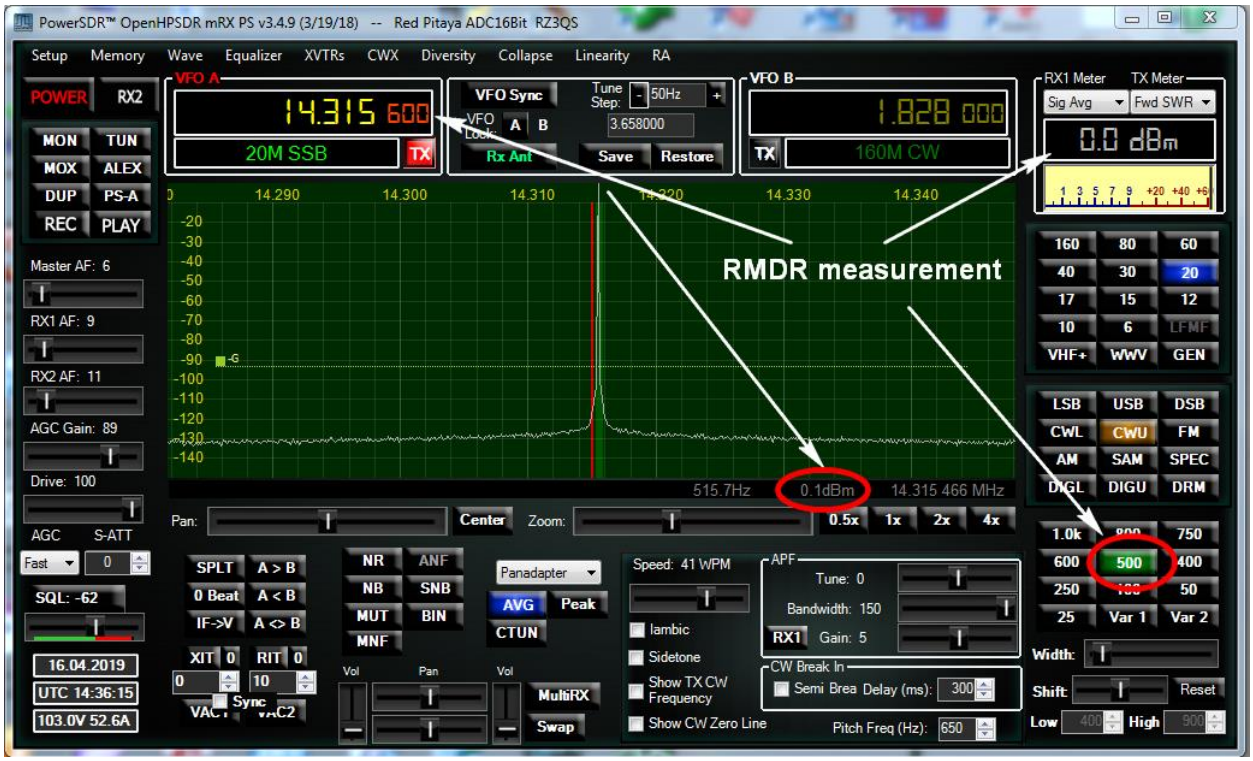


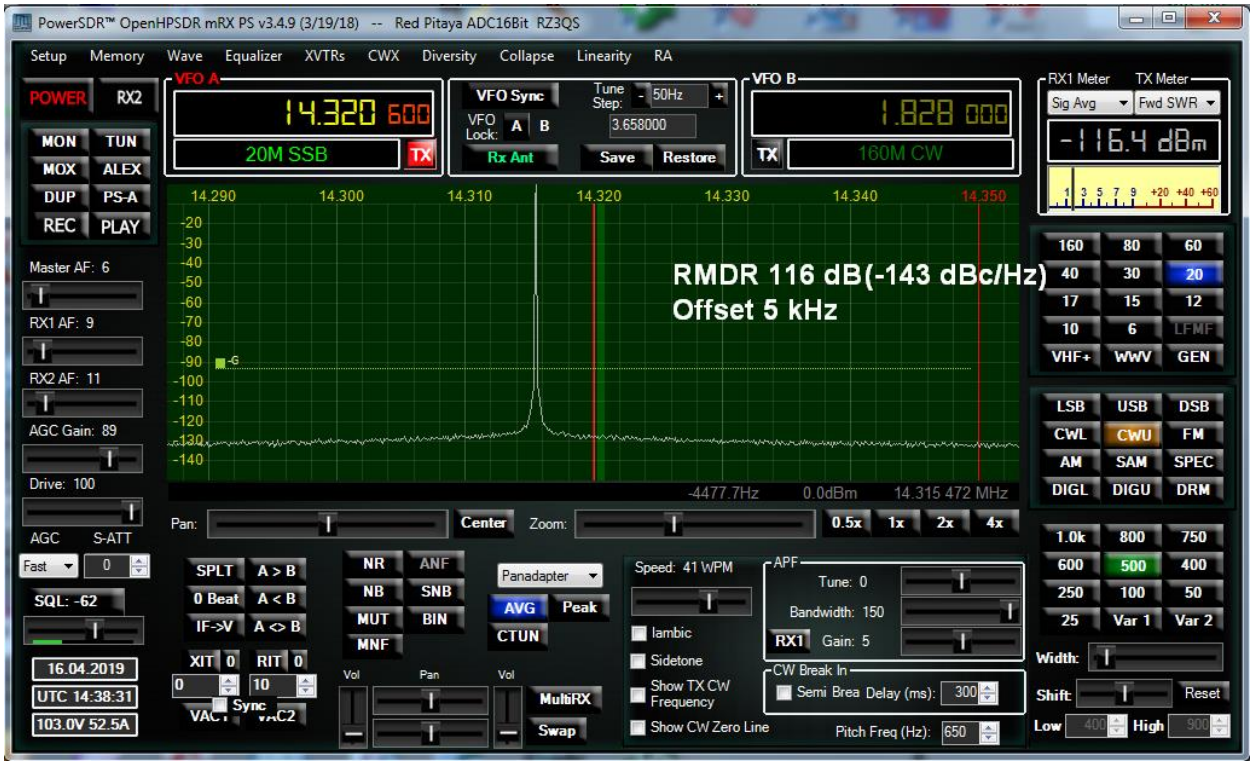
Blocking dynamic range (BDR).

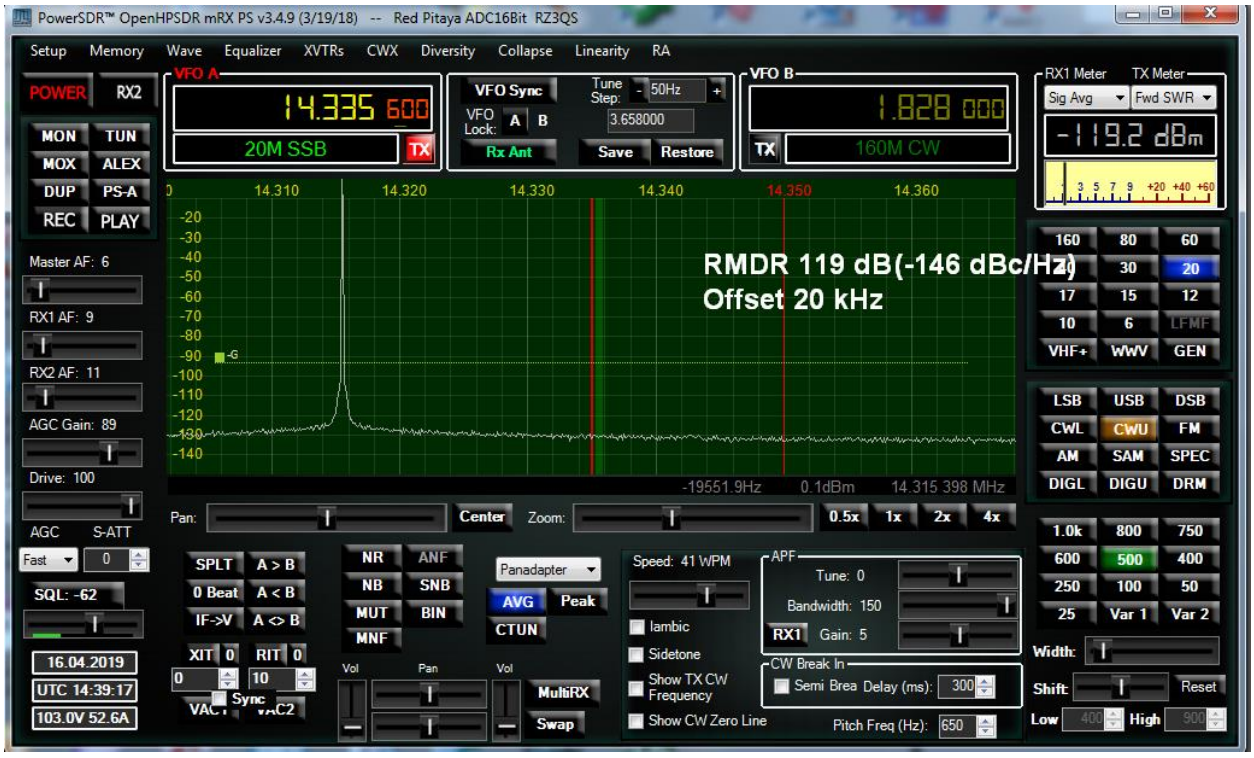


Reciprocal mixing dynamic range (RMDR).

Measured 2, 5, 20 kHz from an unmodulated carrier.



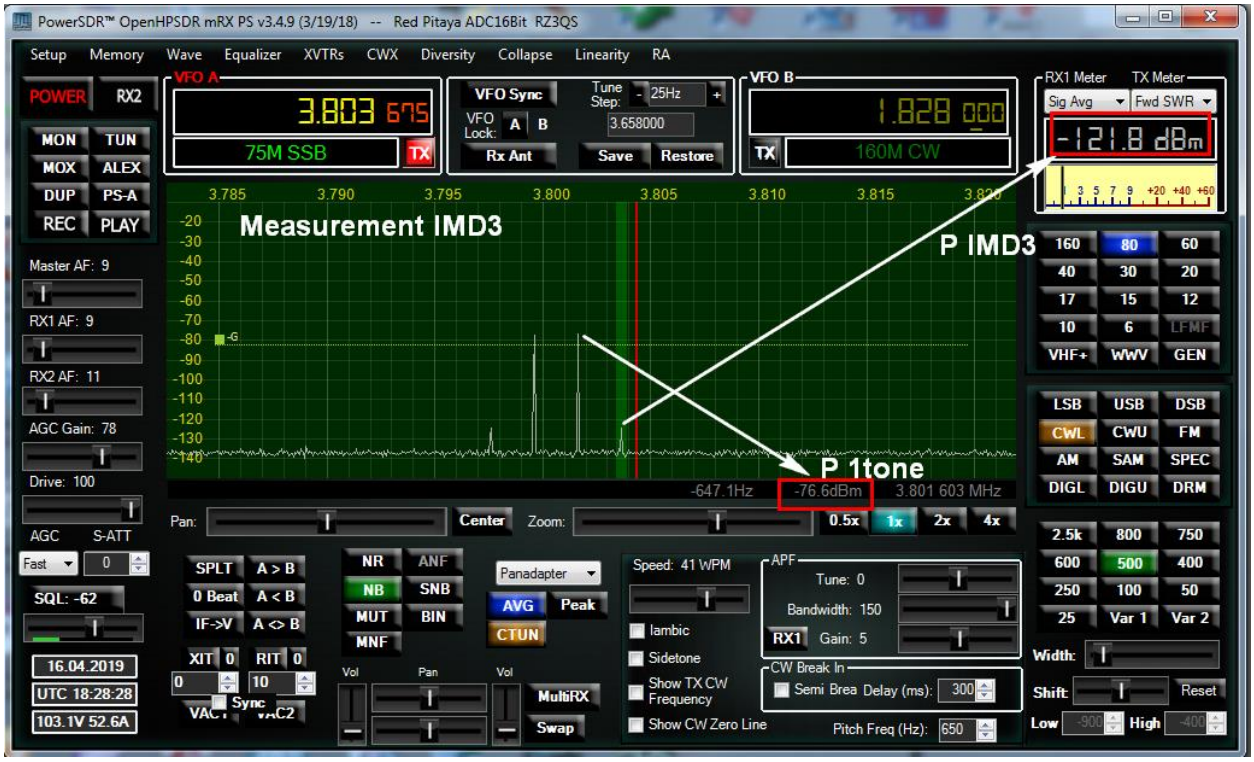

PowerSDR™ OpenHPSDR mRX PS v3.4.9 (3/19/18) -- Red Pitaya ADC16Bit RZ3QS
Setup Memory Wave Equalizer XVTRs CWX Diversity Collapse Linearity RA
POWER RX2
VFO A
14.320 600
20M SSB
VFO Sync
VFO Lock: A B
Tune Step: 50Hz
3.658000
Rx Ant Save Restore
VFO B
1.828 000
160M CW
RX1 Meter TX Meter
Sig Avg Fwd SWR
-116.4 dBm
MON TUN
MOX ALEX
DUP PS-A
REC PLAY
RMDR 116 dB(-143 dBc/Hz)
Offset 5 kHz
-4477.7Hz 0.0dBm 14.315 472 MHz
Master AF: 6
RX1 AF: 9
RX2 AF: 11
AGC Gain: 89
Drive: 100
AGC S-ATT
SQL: -62
16.04.2019
UTC 14:38:31
103.0V 52.5A
Pan: Center Zoom: 0.5x 1x 2x 4x
SPLT A > B
0 Beat A < B
IF->V A <> B
XIT 0 RIT 0
Sync
NR ANF
NB SNB
MUT BIN
MNF
Panadapter
AVG Peak
CTUN
Vol Pan Vol
MultiRX
Swap
Speed: 41 WPM
Iambic
Sidetone
Show TX CW Frequency
Show CW Zero Line
APF
Tune: 0
Bandwidth: 150
RX1 Gain: 5
CW Break In
Semi Brea Delay (ms): 300
Pitch Freq (Hz): 650
160 80 60
40 30 20
17 15 12
10 6 LFMF
VHF+ WWV GEN
LSB USB DSB
CWL CWU FM
AM SAM SPEC
DIGL DIGU DRM
1.0k 800 750
600 500 400
250 100 50
25 Var 1 Var 2
Width:
Shift: Reset
Low 400 High 900

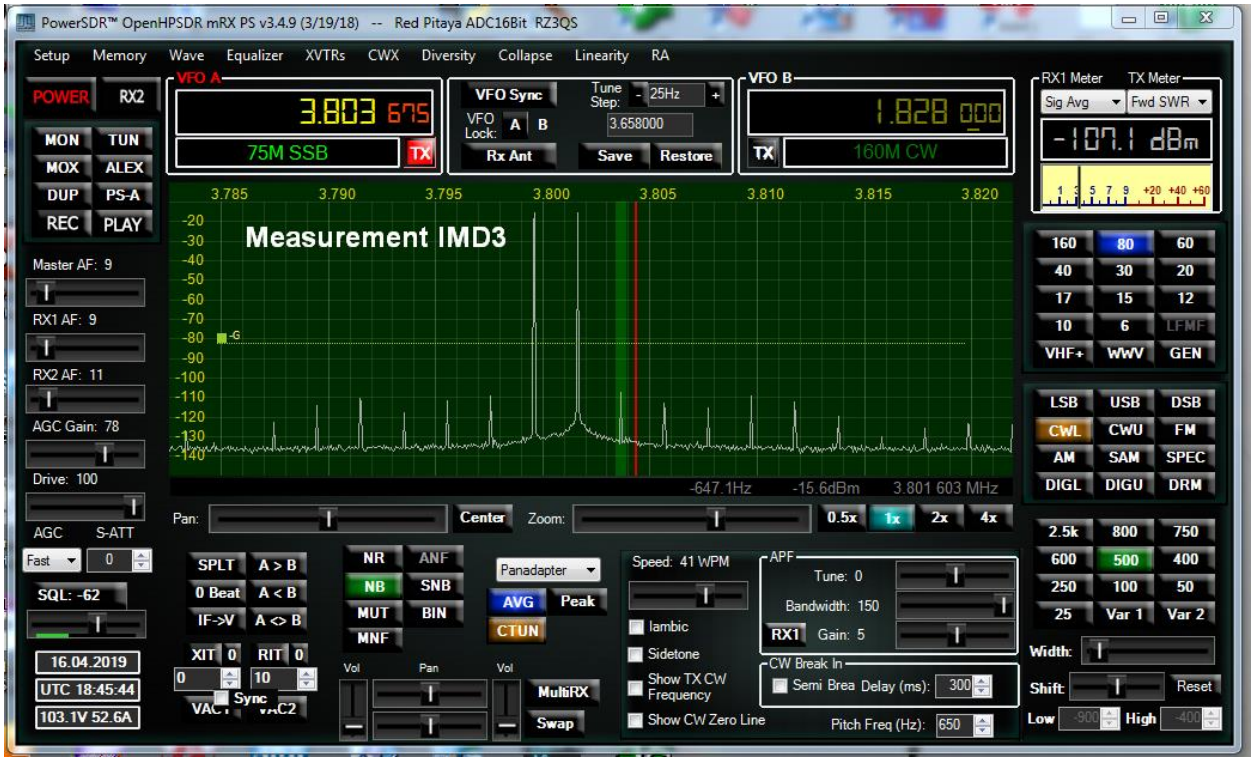

PowerSDR™ OpenHPSDR mRX PS v3.4.9 (3/19/18) -- Red Pitaya ADC16Bit RZ3QS
Setup Memory Wave Equalizer XVTRs CWX Diversity Collapse Linearity RA
POWER RX2
VFO A
14.335 600
20M SSB
VFO Sync
VFO Lock: A B
Tune Step: 50Hz
3.658000
Rx Ant Save Restore
VFO B
1.828 000
160M CW
RX1 Meter TX Meter
Sig Avg Fwd SWR
-119.2 dBm
MON TUN
MOX ALEX
DUP PS-A
REC PLAY
RMDR 119 dB(-146 dBc/Hz)
Offset 20 kHz
-19551.9Hz 0.1dBm 14.315 398 MHz
Master AF: 6
RX1 AF: 9
RX2 AF: 11
AGC Gain: 89
Drive: 100
AGC S-ATT
SQL: -62
16.04.2019
UTC 14:39:17
103.0V 52.6A
Pan: Center Zoom: 0.5x 1x 2x 4x
SPLT A > B
0 Beat A < B
IF->V A <> B
XIT 0 RIT 0
Sync
NR ANF
NB SNB
MUT BIN
MNF
Panadapter
AVG Peak
CTUN
Vol Pan Vol
MultiRX
Swap
Speed: 41 WPM
Iambic
Sidetone
Show TX CW Frequency
Show CW Zero Line
APF
Tune: 0
Bandwidth: 150
RX1 Gain: 5
CW Break In
Semi Brea Delay (ms): 300
Pitch Freq (Hz): 650
160 80 60
40 30 20
17 15 12
10 6 LFMF
VHF+ WWV GEN
LSB USB DSB
CWL CWU FM
AM SAM SPEC
DIGL DIGU DRM
1.0k 800 750
600 500 400
250 100 50
25 Var 1 Var 2
Width:
Shift: Reset
Low 400 High 900

Two-tone third-order intermodulation distortion (IMD3).

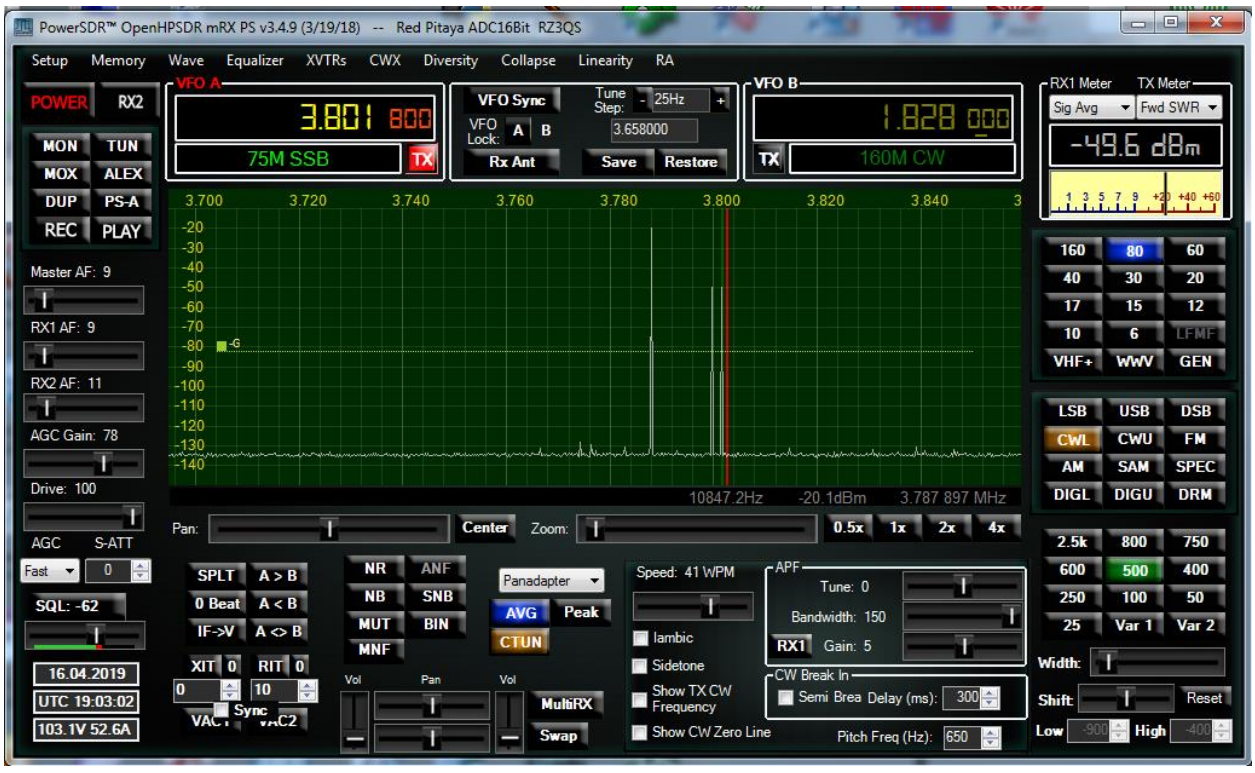
The following table shows the results of measurements carried out at the power levels of two tones in the range from -76 dBm to -4 dBm with a step of 6 dBm.

P 1 tone, dBm	P IMD3, dBm	IMD3, dBc
-76	-121	45
-70	-118	48
-64	-120	56
-58	-123	65
-52	-122	70
-46	-113	67
-40	-112	66
-34	-115	81
-28	-108	80
-22	-108	86
-16	-107	91
-10	-95	85
-4	-80	76



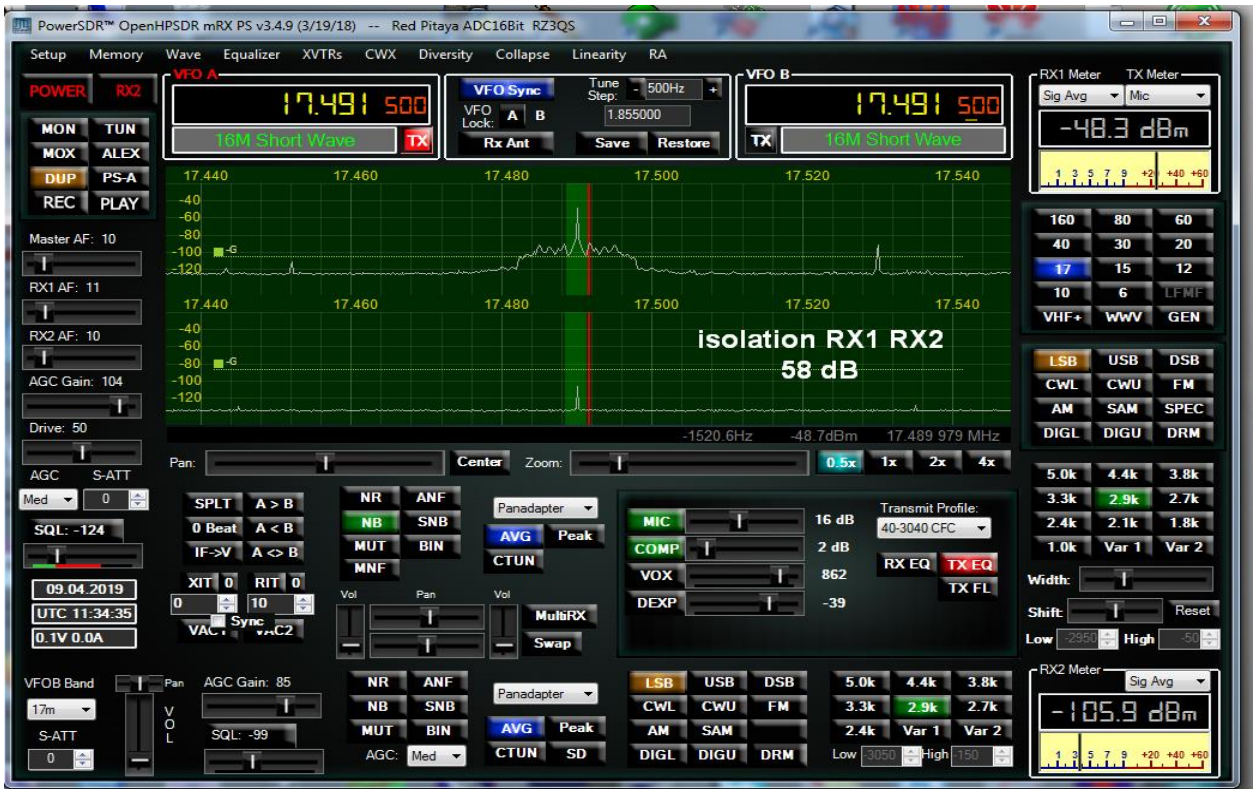


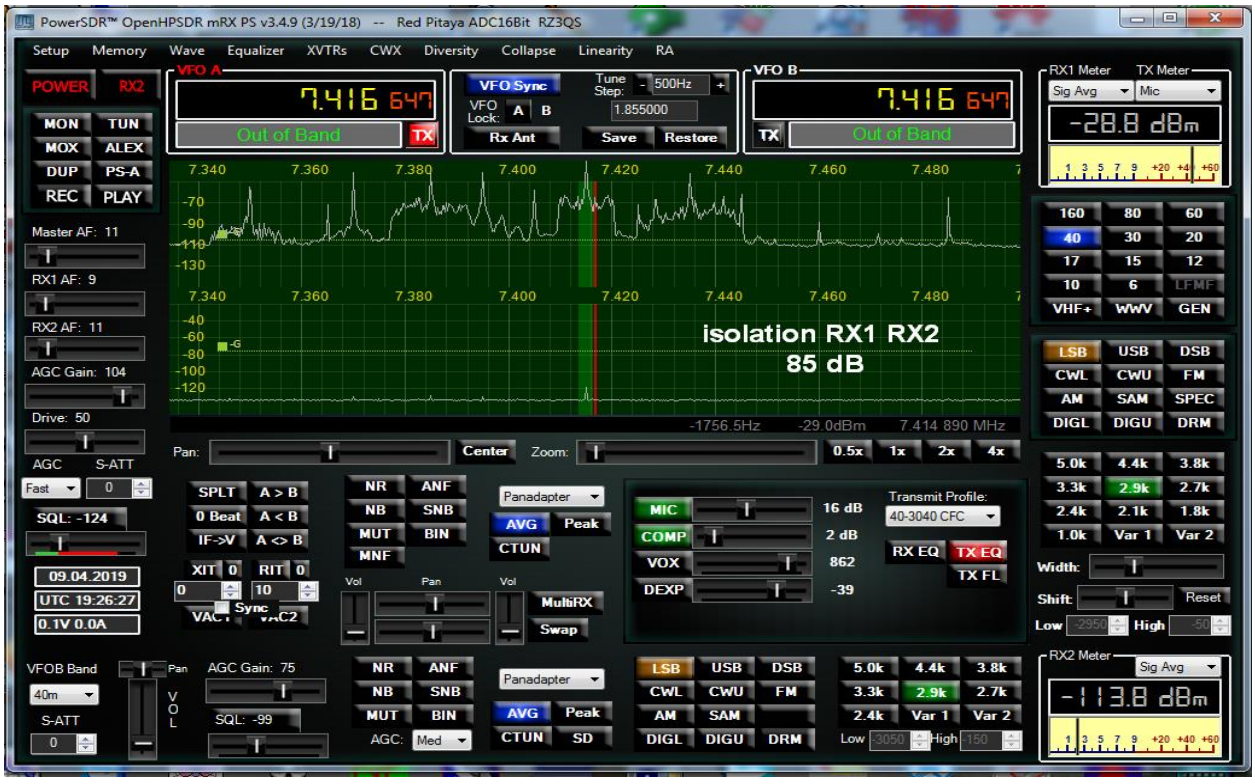
In the real signal from the antenna there are noises and signals from various stations. The presence of the noise in the signal from the antenna smooths the ADC transfer function and reduces the signal distortion caused by the digitization. This effect can be illustrated by adding a third tone to the two-tone test signal.



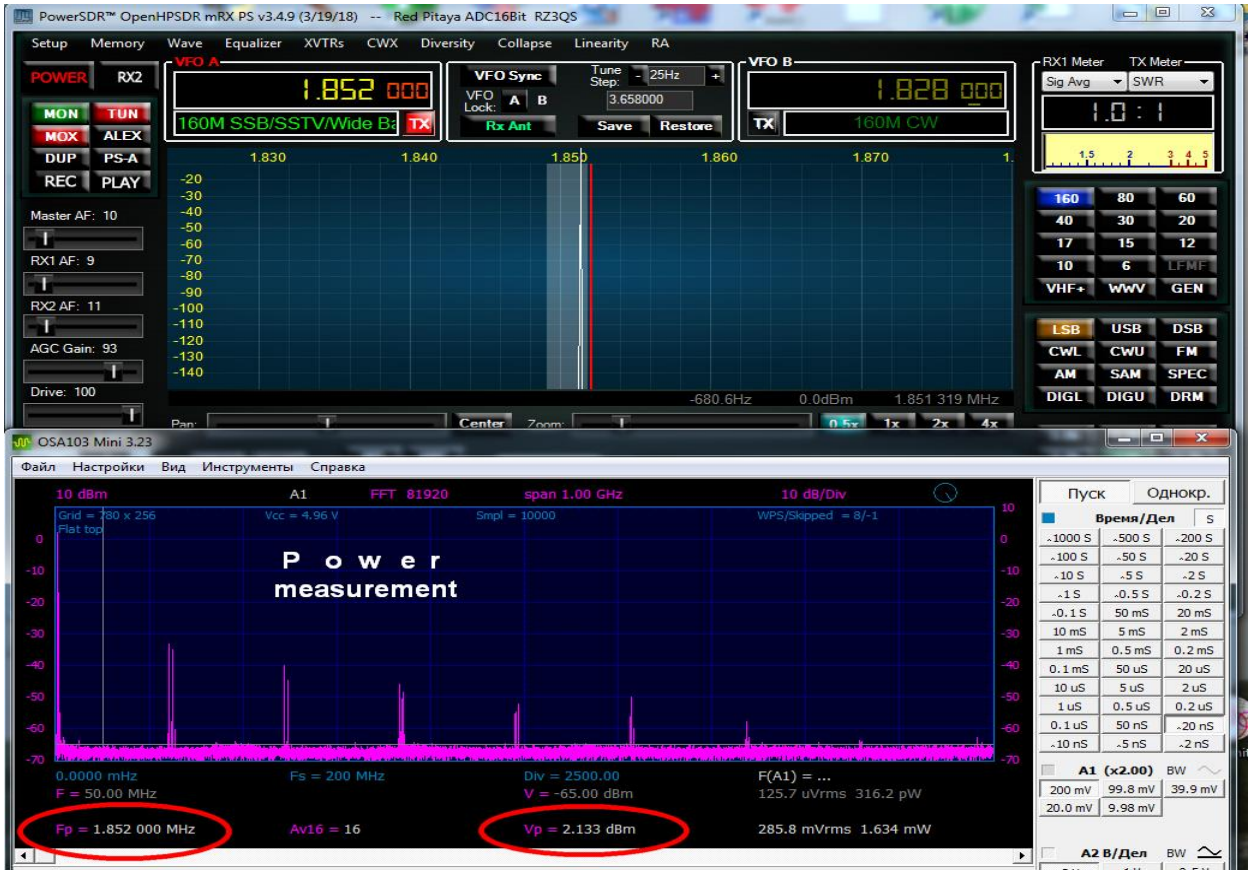
Crosstalk between IN1 and IN2.

IN1 is connected to an antenna. IN2 is connected to a 50 Ohm terminator.

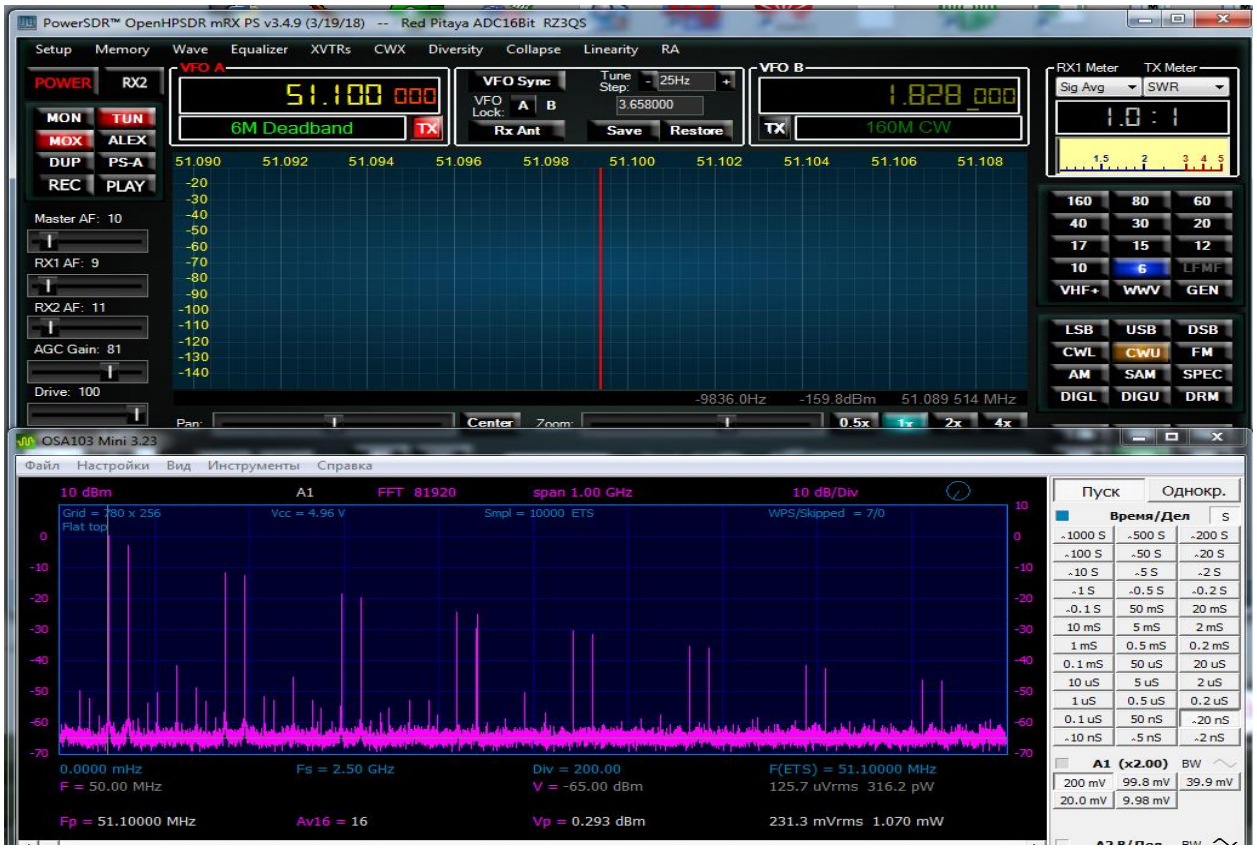




Output signal level.



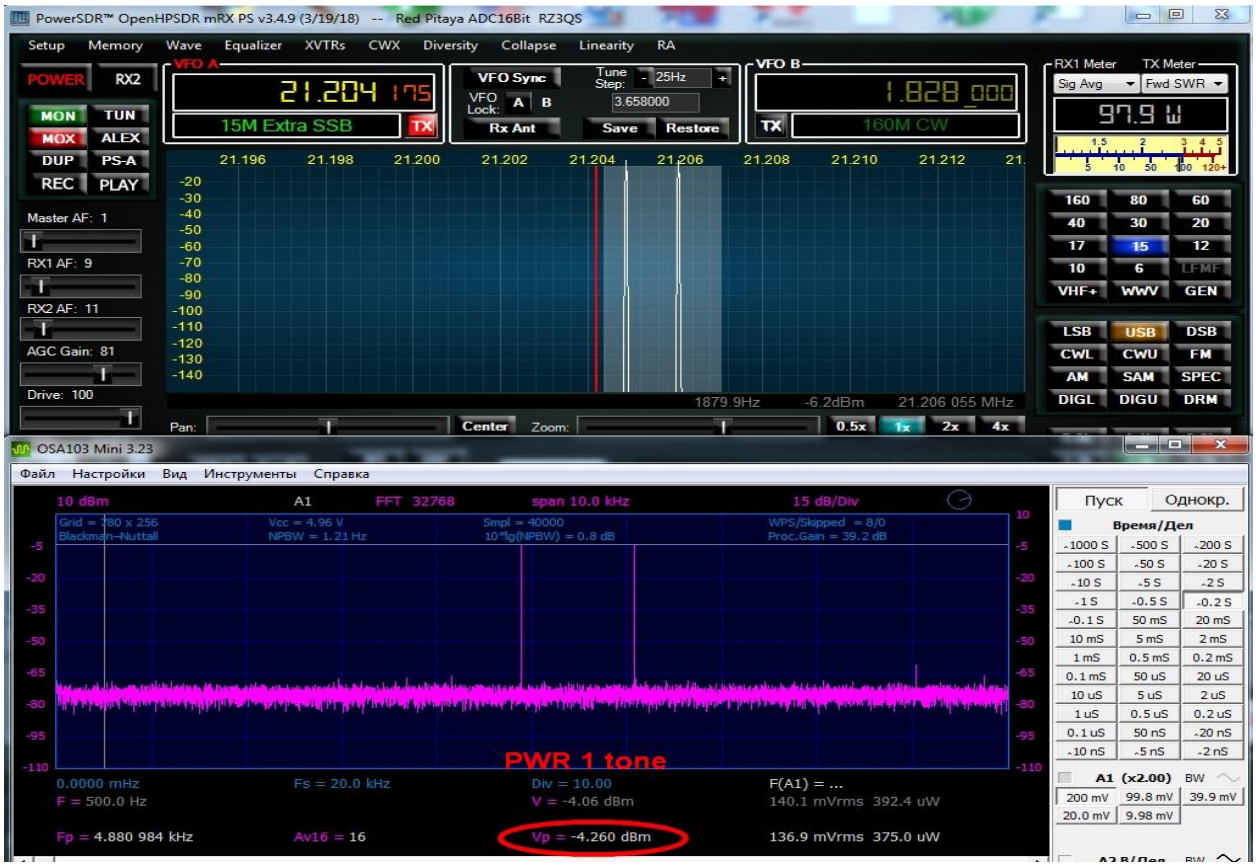
PowerSDR™ OpenHPSDR mRX PS v3.4.9 (3/19/18) -- Red Pitaya ADC16Bit RZ3QS
Setup Memory Wave Equalizer XVTRs CWX Diversity Collapse Linearity RA
VFO A 28.470 000
10M SSB
VFO Sync
Tune Step: 25Hz
3.658000
Rx Ant Save Restore
VFO B 1.828 000
160M CW
RX1 Meter TX Meter
Sig Avg SWR
1.0 : 1
POWER RX2
MON TUN
MOX ALEX
DUP PS-A
REC PLAY
Master AF: 10
RX1 AF: 9
RX2 AF: 11
AGC Gain: 89
Drive: 100
160 80 60
40 30 20
17 15 12
10 6 LFMF
VHF+ WWV GEN
LSB USB DSB
CWL CWU FM
AM SAM SPEC
DIGL DIGU DRM
28.450 28.460 28.470 28.480 28.490
594.9Hz 0.0dBm 28.470 595 MHz
Pan: Center Zoom: 0.5x 1x 2x 4x
OSA103 Mini 3.23
Файл Настройки Вид Инструменты Справка
10 dBm A1 FFT 81920 span 1.00 GHz 10 dB/Div
Grid = 780 x 256 Vcc = 4.96 V Smpl = 10000 ETS WPS/Skipped = 8/-1
Flat top
Пуск Однокр.
Время/Дел
0.0000 mHz Fs = 2.50 GHz Div = 200.00 F(ETS) = 28.47000 MHz
F = 50.00 MHz V = -65.00 dBm 125.7 uVrms 316.2 pW
Fp = 28.47000 MHz Av16 = 16 Vp = 2.174 dBm 287.2 mVrms 1.650 mW
A1 (x2.00) BW
A2 В/Дел BW


PowerSDR™ OpenHPSDR mRX PS v3.4.9 (3/19/18) -- Red Pitaya ADC16Bit RZ3QS
Setup Memory Wave Equalizer XVTRs CWX Diversity Collapse Linearity RA
VFO A 51.100 000
6M Deadband
VFO Sync
Tune Step: 25Hz
3.658000
Rx Ant Save Restore
VFO B 1.828 000
160M CW
RX1 Meter TX Meter
Sig Avg SWR
1.0 : 1
POWER RX2
MON TUN
MOX ALEX
DUP PS-A
REC PLAY
Master AF: 10
RX1 AF: 9
RX2 AF: 11
AGC Gain: 81
Drive: 100
160 80 60
40 30 20
17 15 12
10 6 LFMF
VHF+ WWV GEN
LSB USB DSB
CWL CWU FM
AM SAM SPEC
DIGL DIGU DRM
51.090 51.092 51.094 51.096 51.098 51.100 51.102 51.104 51.106 51.108
-9836.0Hz -159.8dBm 51.089 514 MHz
Pan: Center Zoom: 0.5x 1x 2x 4x
OSA103 Mini 3.23
Файл Настройки Вид Инструменты Справка
10 dBm A1 FFT 81920 span 1.00 GHz 10 dB/Div
Grid = 780 x 256 Vcc = 4.96 V Smpl = 10000 ETS WPS/Skipped = 7/0
Flat top
Пуск Однокр.
Время/Дел
0.0000 mHz Fs = 2.50 GHz Div = 200.00 F(ETS) = 51.10000 MHz
F = 50.00 MHz V = -65.00 dBm 125.7 uVrms 316.2 pW
Fp = 51.10000 MHz Av16 = 16 Vp = 0.293 dBm 231.3 mVrms 1.070 mW
A1 (x2.00) BW

Transmitter IMD3.

Peak envelope power (PEP) is 2 dBm.

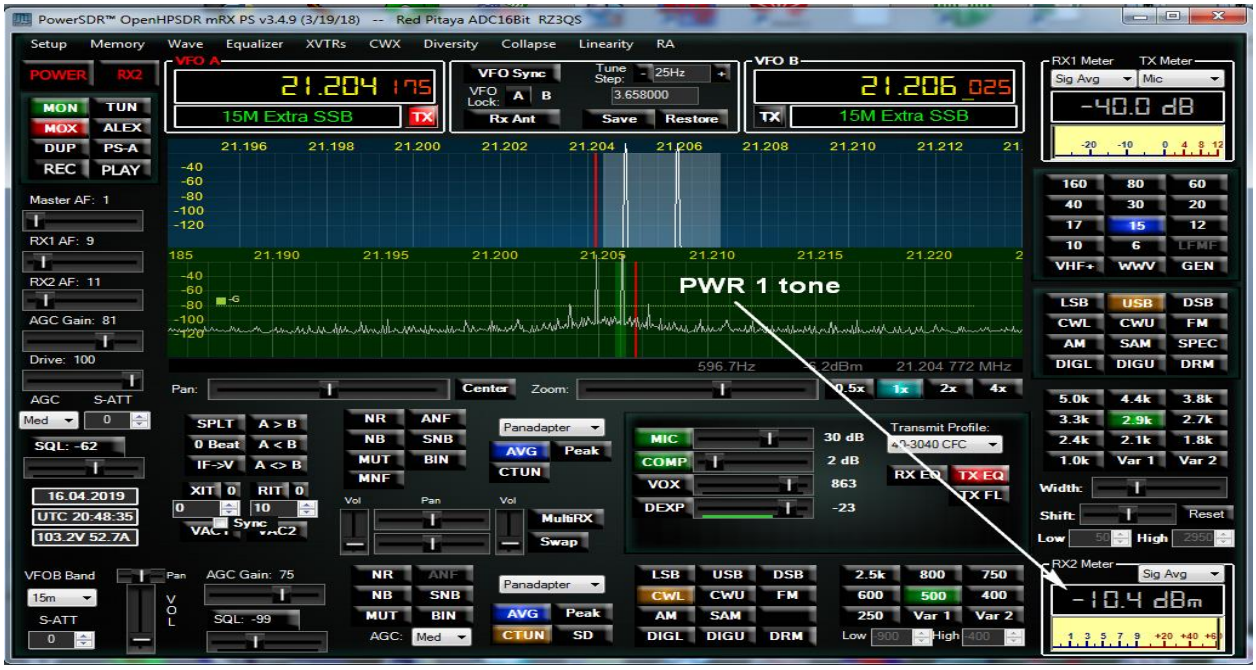
OSA103 mini shows the power of one tone.



Transmitter IMD3 precisely measured using PowerSDR mRX PS.

The transmitter signal is connected to IN2.

Transmitter IMD3 is 68 dBc.



Yevgeni
73 de RZ3QS