

USING A SPECTRUM ANALYZER AS A DOWNCONVERTER FOR RF APPLICATIONS

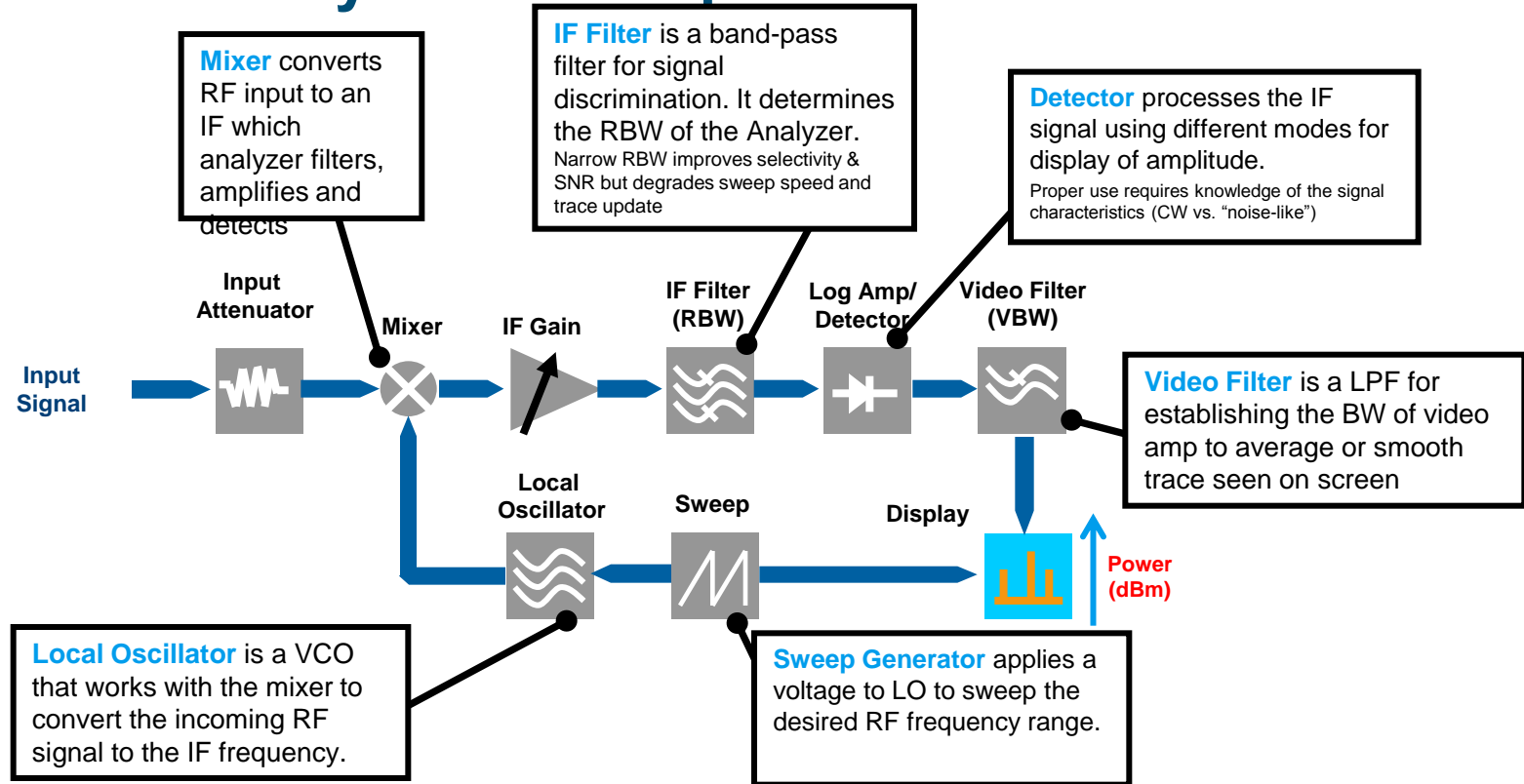
Greg Bonaguide WA1VUG
Microwave Update, April 14-15
Windsor Locks, CT

ROHDE & SCHWARZ

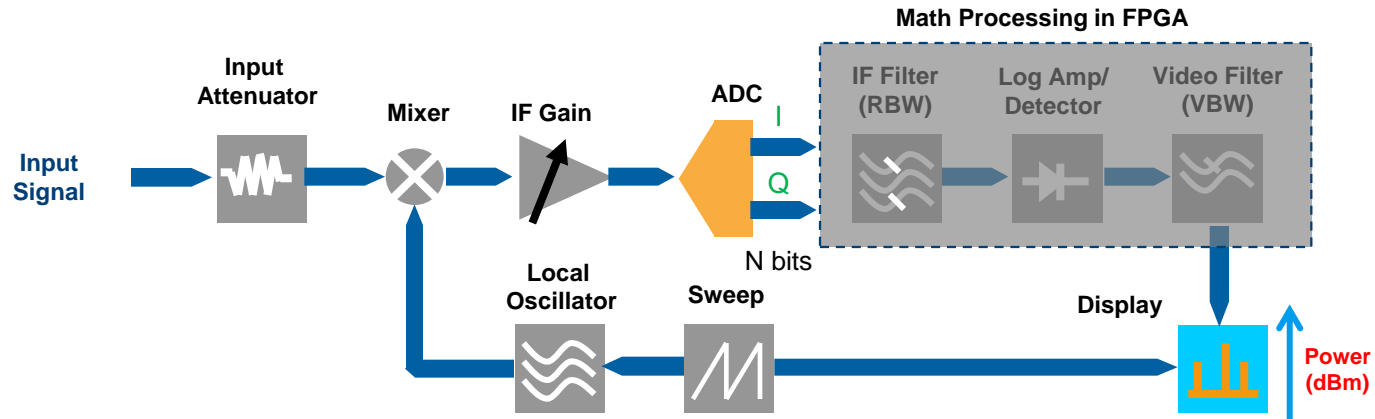
Make ideas real



Spectrum Analyzer “Conceptual” Architecture



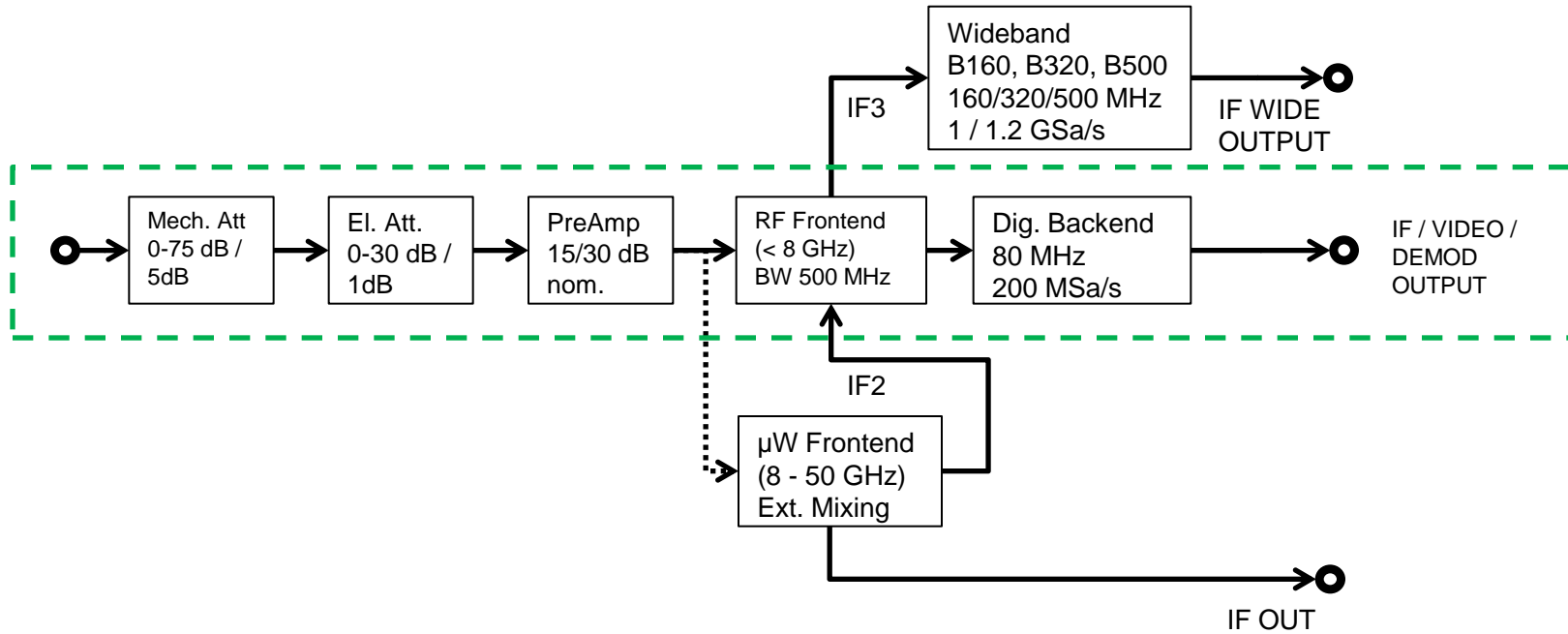
Spectrum Analyzer “Modern” Architecture



PHASOR DISPLAY ON A SIGNAL ANALYZER

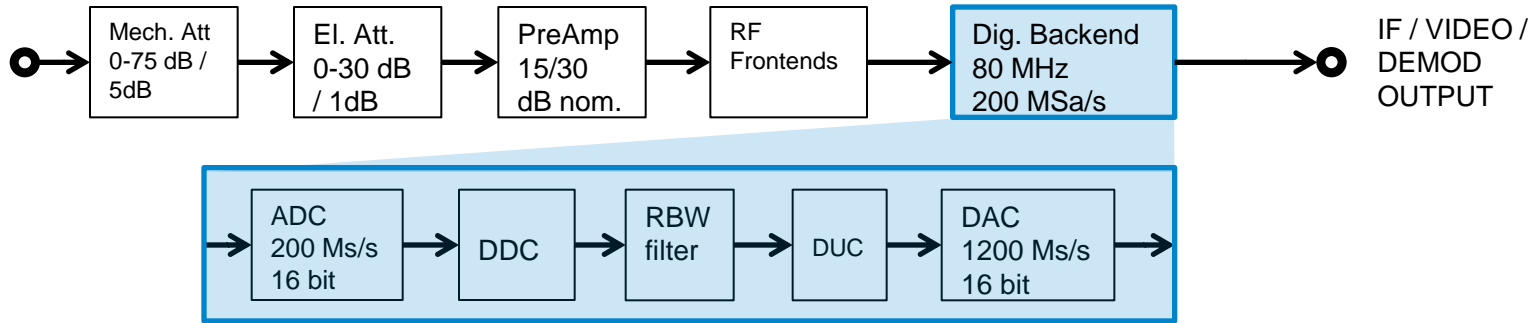


FSW BLOCK DIAGRAM



FSW – IF / Video / Demod Output

Details

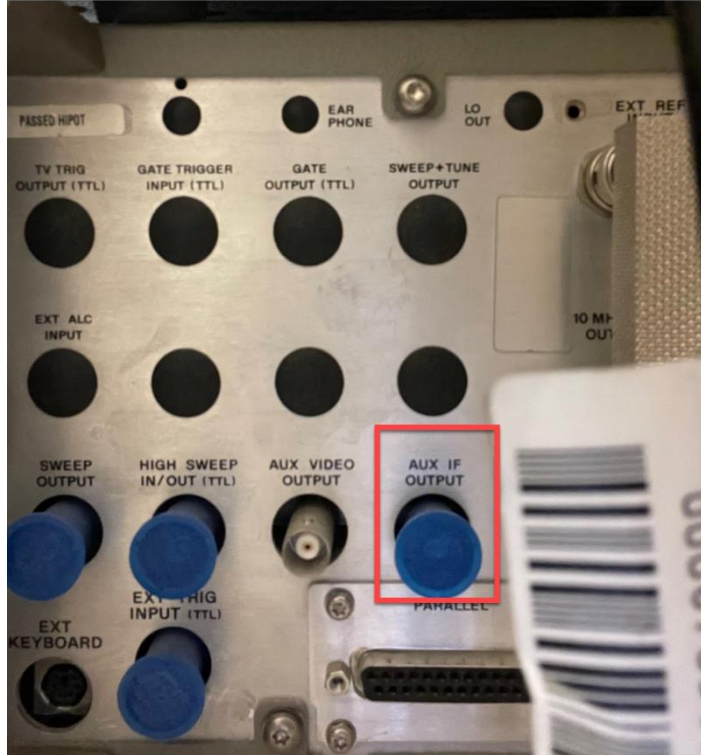


- ▶ Frequency selectable from $(0 \text{ Hz} + \text{RBW}/2)$ to $(240 \text{ MHz} - \text{RBW}/2)$
- ▶ Bandwidth equal to RBW setting in spectrum analyzer
- ▶ Full scale level depends on Reference level setting (digital IF gain)
- ▶ 0 dBm for full scale
- ▶ Similar to traditional IF output on FSU, hp8563, PSA etc.

IF OUT - HP



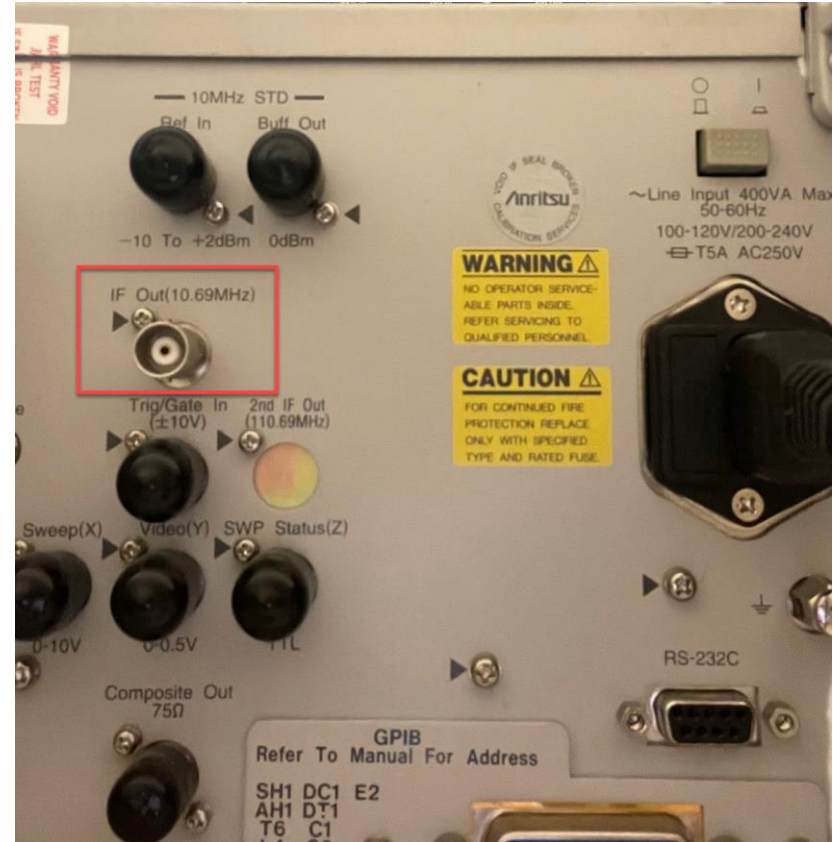
Zero Span: IF Out always available
IF Freq = 21.43 MHz
RBW must be > 100 kHz
Most stable with single sweep mode



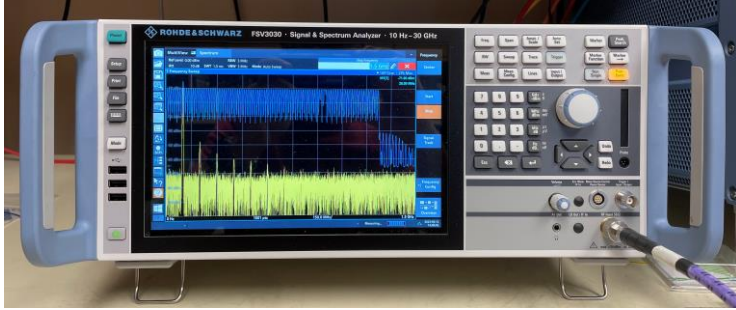
IF OUT - ANRITSU



Zero Span: IF Out always available
IF Freq = 10.864 MHz
RBW must be 3 MHz
Continuous or Single Sweep mode OK



IF OUT – R&S



Zero Span: IF Out always available
IF Freq = User-selectable
RBW must be 3 MHz
Cont.s or Single Sweep mode OK



BACKGROUND INFO

6.2.1.3 IF and video signal output

The measured IF signal or displayed video signal (i.e. the filtered and detected IF signal) can be provided at the IF output connector of the R&S FSV/A.

The **video output** is a signal of 1 V. It can be used, for example, to control demodulated audio frequencies.

The **IF output** is a signal of the measured level at a specified frequency.

Restrictions

Note the following restrictions for data output:

- IF and video output is only available in the time domain (zero span).
- For I/Q data, only IF output is available.
- IF output is not available if any of the following conditions apply:
 - The sample rate is larger than 200 MHz (upsampling)

TECHNICAL INFO (FROM THE DATASHEET)

R&S® FSV3-B5 and R&S® FSV3-B5E additional interfaces

IF output		
Connector		BNC female, 50 Ω
Bandwidth		equal to bandwidth setting
IF frequency		(50 kHz + $\frac{1}{2}$ RBW) to (53 MHz - $\frac{1}{2}$ RBW), selectable
Output level (gain versus RF input)	RF attenuation = 0 dB, RF preamplifier = off, span = 0 Hz	0 dB (nom.)

Video output		
Connector		BNC female, 50 Ω
Bandwidth		equal to bandwidth setting
Output scaling	log. display scale	logarithmic
	lin. display scale	linear
Output level	center frequency > 10 MHz, span = 0 Hz, signal at reference level and center frequency	1 V at 50 Ω load (nom.)

IF THE SCREEN GOES DARK, THERE'S ALWAYS SCPI !

R&S®FSVA3000/ R&S®FSV3000

Common measurement settings

Data input and output

IF Output State

Enables or disables output of the measured IF value at the "IF" output connector.

Remote command:

`OUTPut<up>:IF:STATe` on page 1096

IF Out Frequency

Defines or indicates the frequency at which the IF signal level is provided at the "IF" output connector if [IF Output State](#) is enabled.

For more information, see [Chapter 6.2.1.3, "IF and video signal output"](#), on page 342.

Remote command:

`OUTPut<up>:IF:IFFrequency` on page 1096

Video Output State

Enables or disables output of the displayed video signal (i.e. the filtered and detected IF signal) at the "Video" output connector.

Remote command:

`OUTPut<up>:VIDeo:STATe` on page 1097

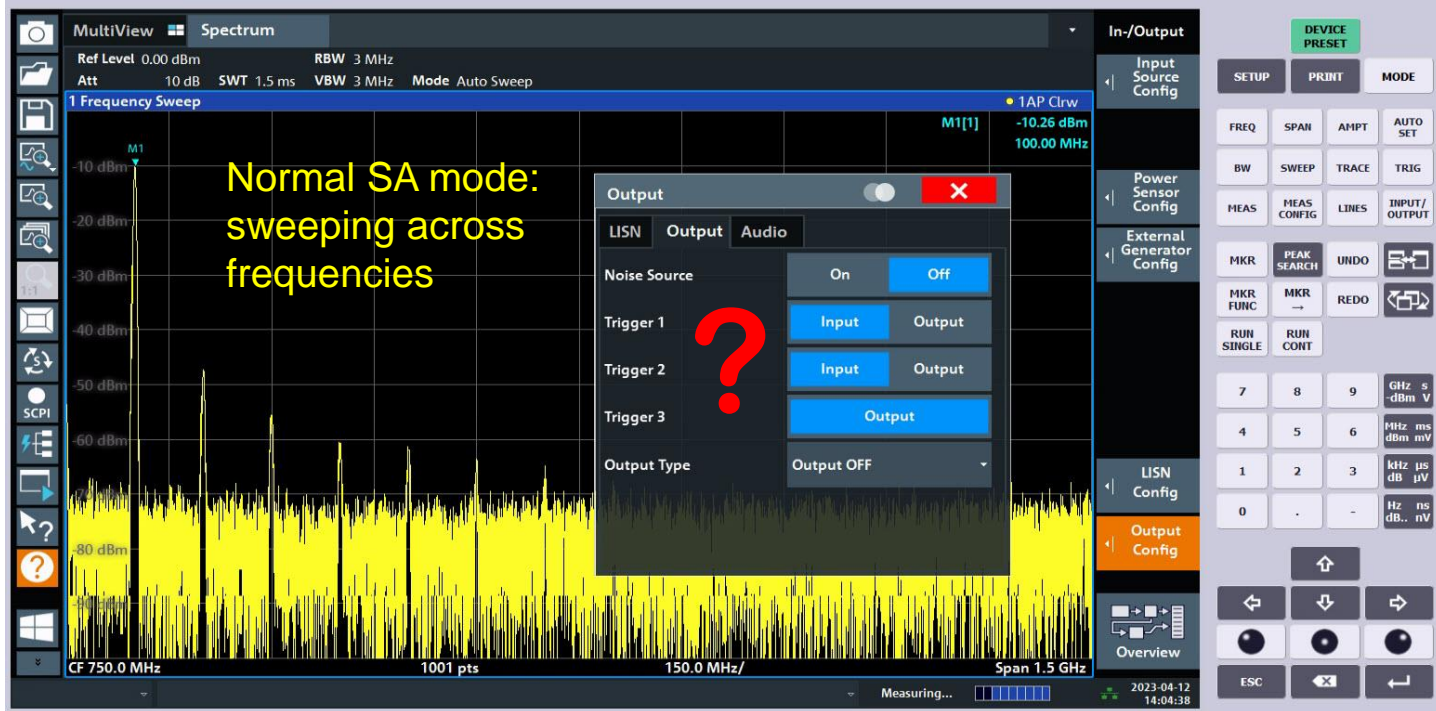
FOUR ISSUES WITH USING IF-OUT

- ▶ Getting the **IF Out** turned ON
- ▶ Down-conversion spurs (and what you can do about them)
- ▶ Setting the proper IF Level
- ▶ Consider IF Bandwidth (SA RBW – Resolution Bandwidth)

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GETTING THE IF OUT TO TURN ON: MIND THE MODE!



GETTING THE IF OUT TO TURN ON: MIND THE MODE!

MultiView Spectrum

Ref Level 0.00 dBm RBW 2 MHz

Att 10 dB SWT 1.01 ms VBW 2 MHz

1 Zero Span

M1 [1] -10.28 dBm
654.71 μ s

“Zero Span”
mode: like a fix-
tuned receiver

Output

LISN Output **IF/Video** Audio

IF Output

State On Off

Frequency 32.0 MHz

Video Output

State On Off

In-/Output

DEVICE PRESET

SETUP PRINT MODE

FREQ SPAN AMPT AUTO SET

BW SWEEP TRACE TRIG

MEAS MEAS CONFIG LINES INPUT/OUTPUT

MKR PEAK SEARCH UNDO

MKR FUNC MKR REDO

RUN SINGLE RUN CONT

7 8 9 GHz s -dBm V

4 5 6 MHz ms dBm mV

1 2 3 kHz μ s dB μ V

0 . - Hz ns dB.. nV

LISN Config

Output Config

Overview

CF 100.0 MHz 1001 pts 101.0 μ s/

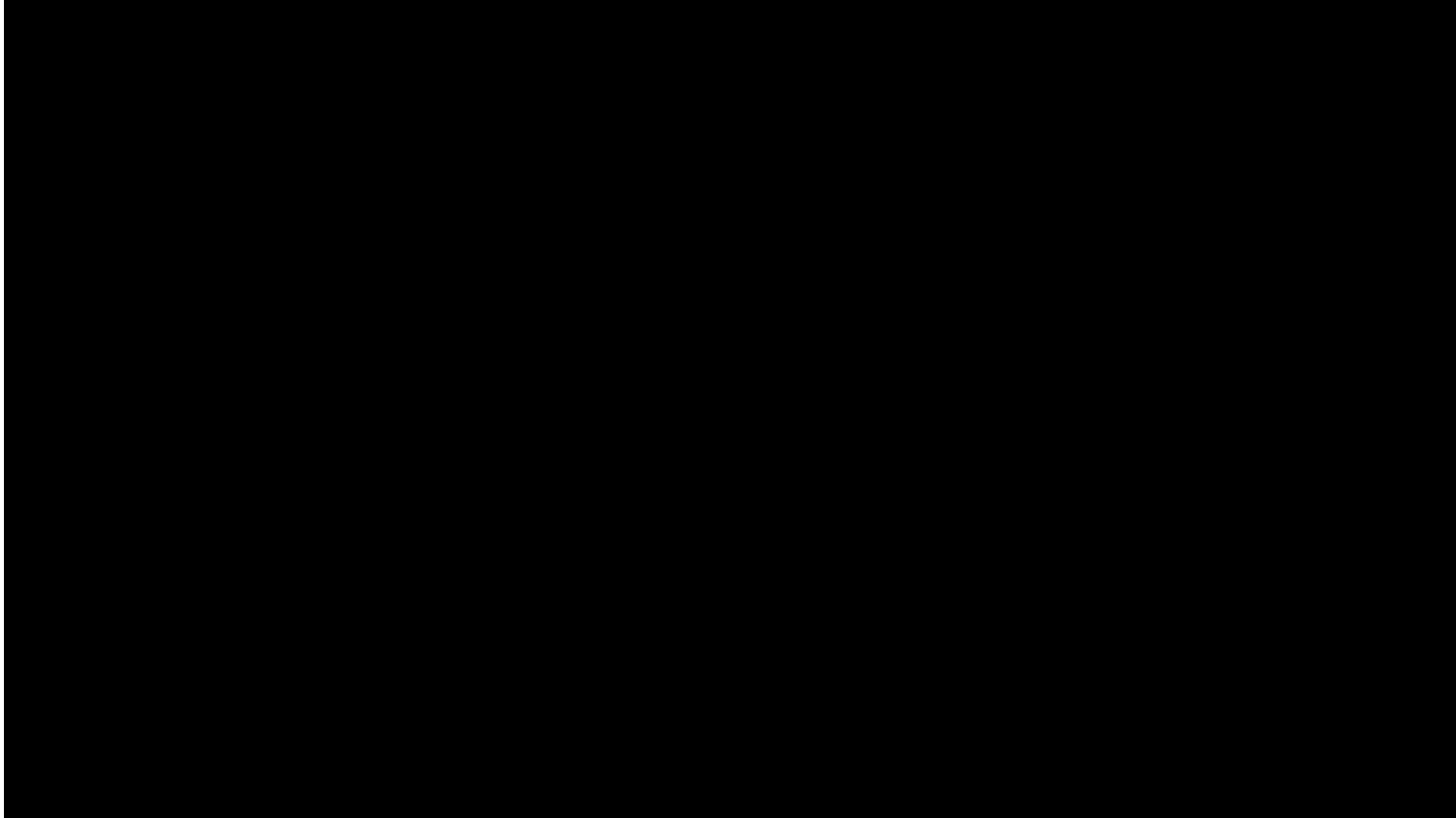
Measuring...

2023-04-12 14:05:29

FOUR ISSUES WITH USING IF-OUT

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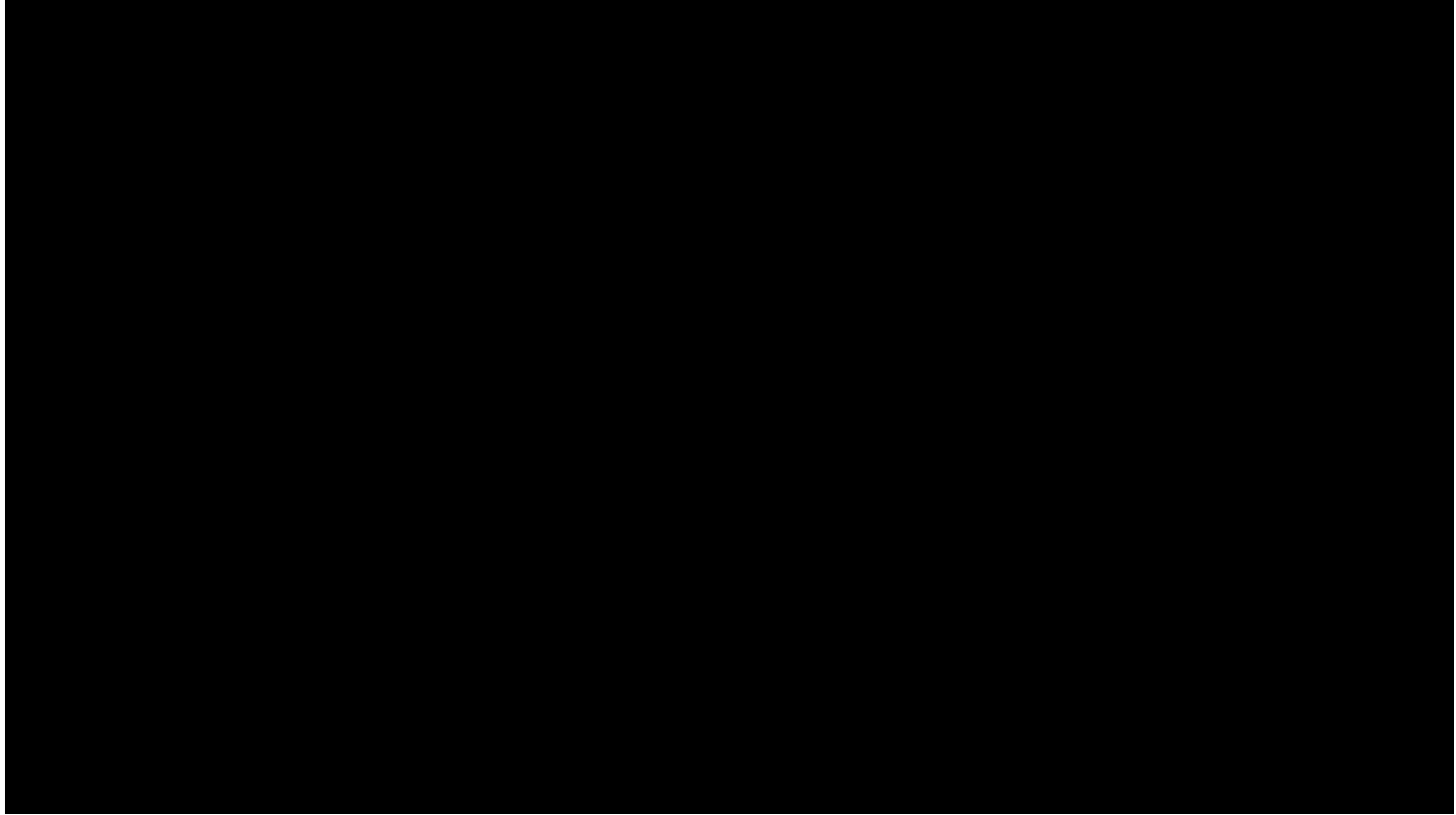
“IF-SHIFTING” TO AVOID SPURS



FOUR ISSUES WITH USING IF-OUT

- ▶ Getting the IF Out turned ON
- ▶ Down-conversion spurs (and what you can do about them)
- ▶ **Setting the proper IF Level**
- ▶ Consider IF Bandwidth (SA RBW – Resolution Bandwidth)

IF LEVEL AFFECTS ATTENUATORS WITH PREAMP

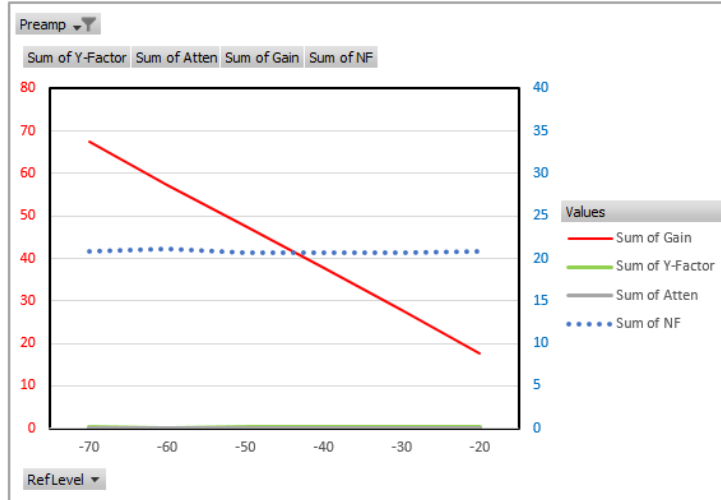


FSV3030 DOWNCONVERTER: PREAMP = 0 DB

Ref Level	Atten	Preamp	NF	Gain	Y-Factor
-20	0	0	20.79	17.67	0.15
-20	5	15	13.71	17.43	0.72
-20	20	30	24.77	17.10	0.06
-30	0	0	20.72	27.70	0.15
-30	0	15	8.05	27.55	2.21
-30	10	30	14.42	27.62	0.62
-40	0	0	20.73	37.71	0.15
-40	0	15	7.82	37.55	2.31
-40	0	30	4.42	37.52	4.02
-50	0	0	20.69	47.73	0.15
-50	0	15	7.75	47.56	2.34
-50	0	30	4.33	47.50	4.08
-60	0	0	21.07	57.27	0.14
-60	0	15	7.78	57.48	2.32
-60	0	30	4.31	57.43	4.09
-70	0	0	20.90	67.41	0.15
-70	0	15	7.81	67.44	2.31
-70	0	30	4.31	67.43	4.09

Preamp .Y

Row Labels	Sum of Y-Factor	Sum of Atten	Sum of Gain	Sum of NF
-70	0.15	0	67.41	20.9
-60	0.14	0	57.27	21.07
-50	0.15	0	47.73	20.69
-40	0.15	0	37.71	20.73
-30	0.15	0	27.7	20.72
-20	0.15	0	17.67	20.79
Grand Total	0.89	0	255.49	124.9

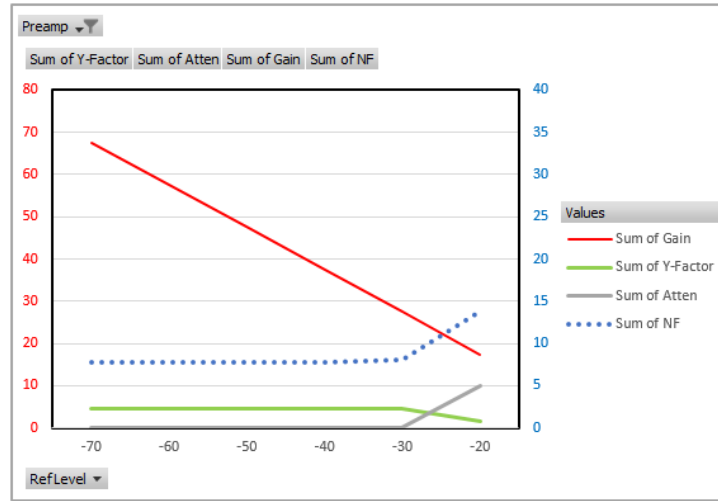


FSV3030 DOWNCONVERTER: PREAMP = 15 DB

Ref Level	Atten	Preamp	NF	Gain	Y-Factor
-20	0	0	20.79	17.67	0.15
-20	5	15	13.71	17.43	0.72
-20	20	30	24.77	17.10	0.06
-30	0	0	20.72	27.70	0.15
-30	0	15	8.05	27.55	2.21
-30	10	30	14.42	27.62	0.62
-40	0	0	20.73	37.71	0.15
-40	0	15	7.82	37.55	2.31
-40	0	30	4.42	37.52	4.02
-50	0	0	20.69	47.73	0.15
-50	0	15	7.75	47.56	2.34
-50	0	30	4.33	47.50	4.08
-60	0	0	21.07	57.27	0.14
-60	0	15	7.78	57.48	2.32
-60	0	30	4.31	57.43	4.09
-70	0	0	20.90	67.41	0.15
-70	0	15	7.81	67.44	2.31
-70	0	30	4.31	67.43	4.09

Preamp

Row Labels	Sum of Y-Factor	Sum of Atten	Sum of Gain	Sum of NF
-70	2.31	0	67.44	7.81
-60	2.32	0	57.48	7.78
-50	2.34	0	47.56	7.75
-40	2.31	0	37.55	7.82
-30	2.21	0	27.55	8.05
-20	0.72	5	17.43	13.71
Grand Total	12.21	5	255.01	52.92

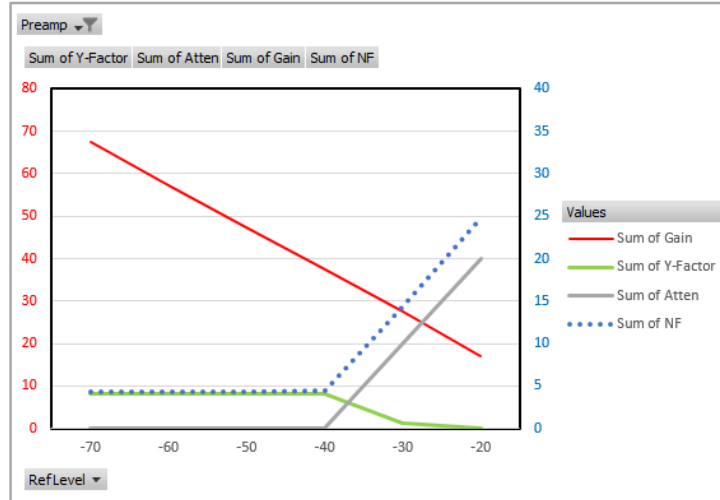


FSV3030 DOWNCONVERTER: PREAMP = 30 DB

Ref Level	Atten	Preamp	NF	Gain	Y-Factor
-20	0	0	20.79	17.67	0.15
-20	5	15	13.71	17.43	0.72
-20	20	30	24.77	17.10	0.06
-30	0	0	20.72	27.70	0.15
-30	0	15	8.05	27.55	2.21
-30	10	30	14.42	27.62	0.62
-40	0	0	20.73	37.71	0.15
-40	0	15	7.82	37.55	2.31
-40	0	30	4.42	37.52	4.02
-50	0	0	20.69	47.73	0.15
-50	0	15	7.75	47.56	2.34
-50	0	30	4.33	47.50	4.08
-60	0	0	21.07	57.27	0.14
-60	0	15	7.78	57.48	2.32
-60	0	30	4.31	57.43	4.09
-70	0	0	20.90	67.41	0.15
-70	0	15	7.81	67.44	2.31
-70	0	30	4.31	67.43	4.09

Preamp

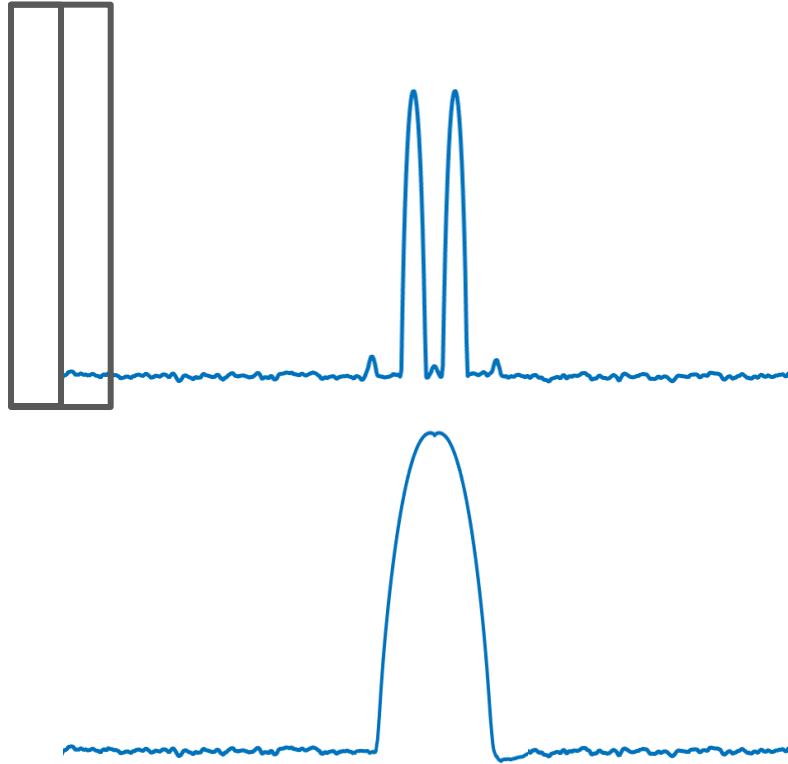
Row Labels	Sum of Y-Factor	Sum of Atten	Sum of Gain	Sum of NF
-70	4.09	0	67.43	4.31
-60	4.09	0	57.43	4.31
-50	4.08	0	47.5	4.33
-40	4.02	0	37.52	4.42
-30	0.62	10	27.62	14.42
-20	0.06	20	17.1	24.77
Grand Total	16.96	30	254.6	56.56



FOUR ISSUES WITH USING IF-OUT

- ▶ Getting the IF Out turned ON
- ▶ Down-conversion spurs (and what you can do about them)
- ▶ Setting the proper IF Level
- ▶ Consider IF Bandwidth (SA RBW – Resolution Bandwidth)

RBW – use to resolve closely-spaced signals

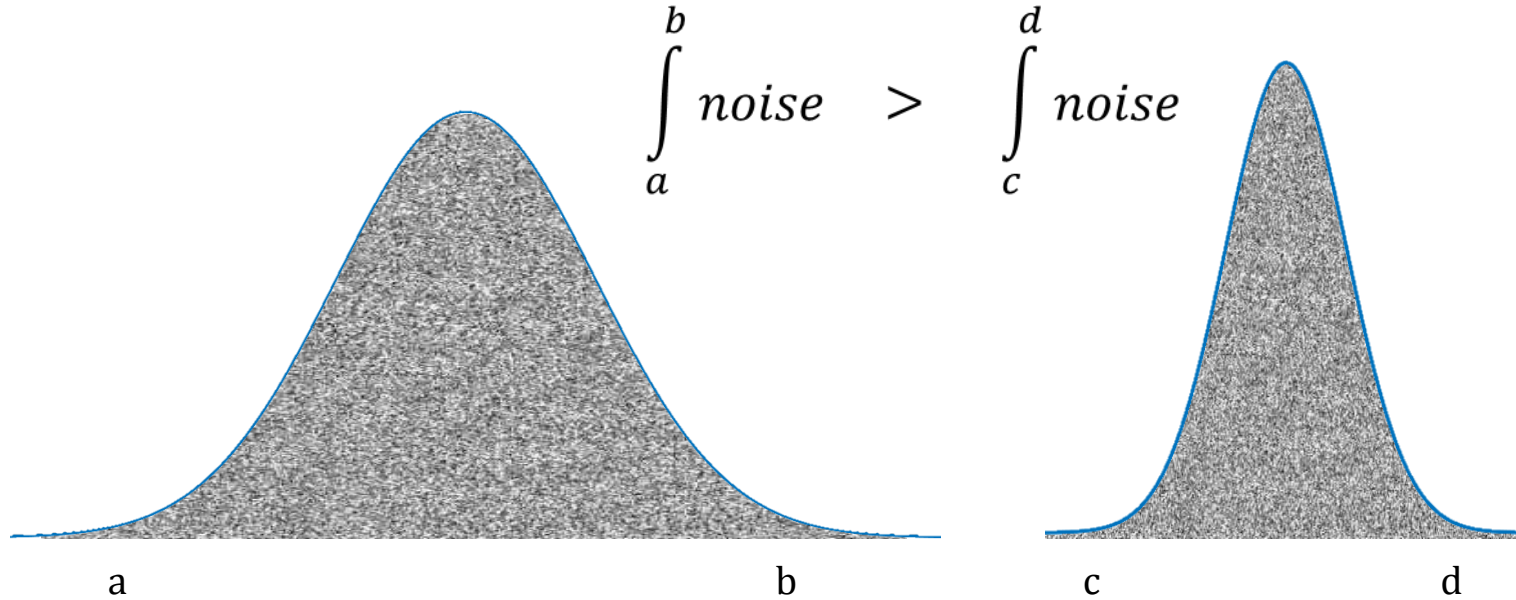


Resolution Bandwidth (RBW) – how it really works



Fixed IF
Frequency
(Gaussian
Frequency
Response)

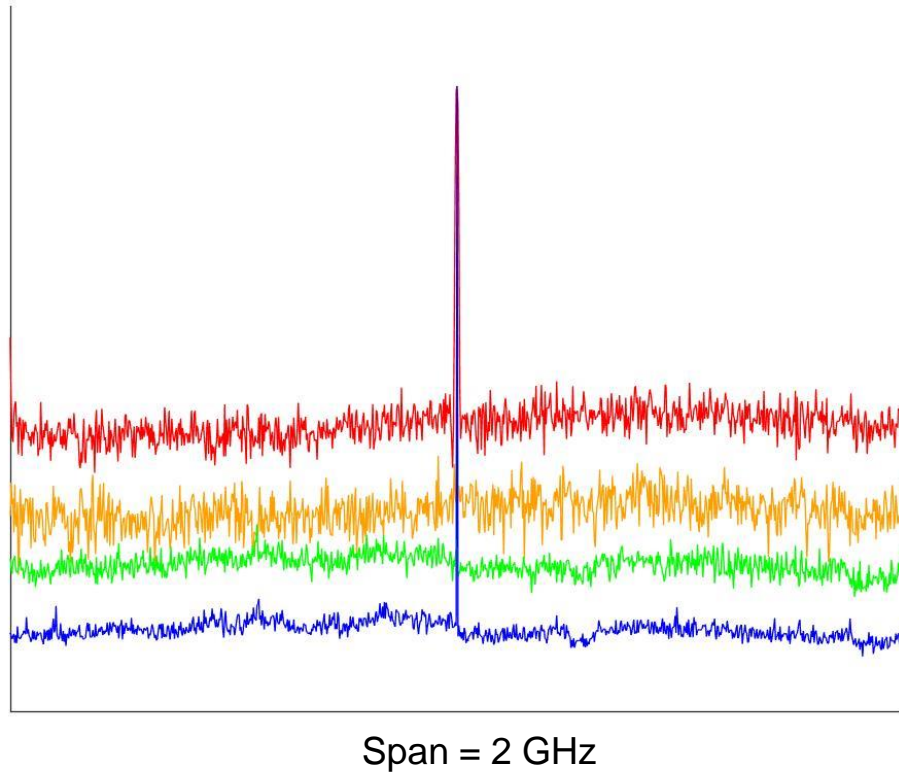
Why reducing RBW also reduces Noise Power



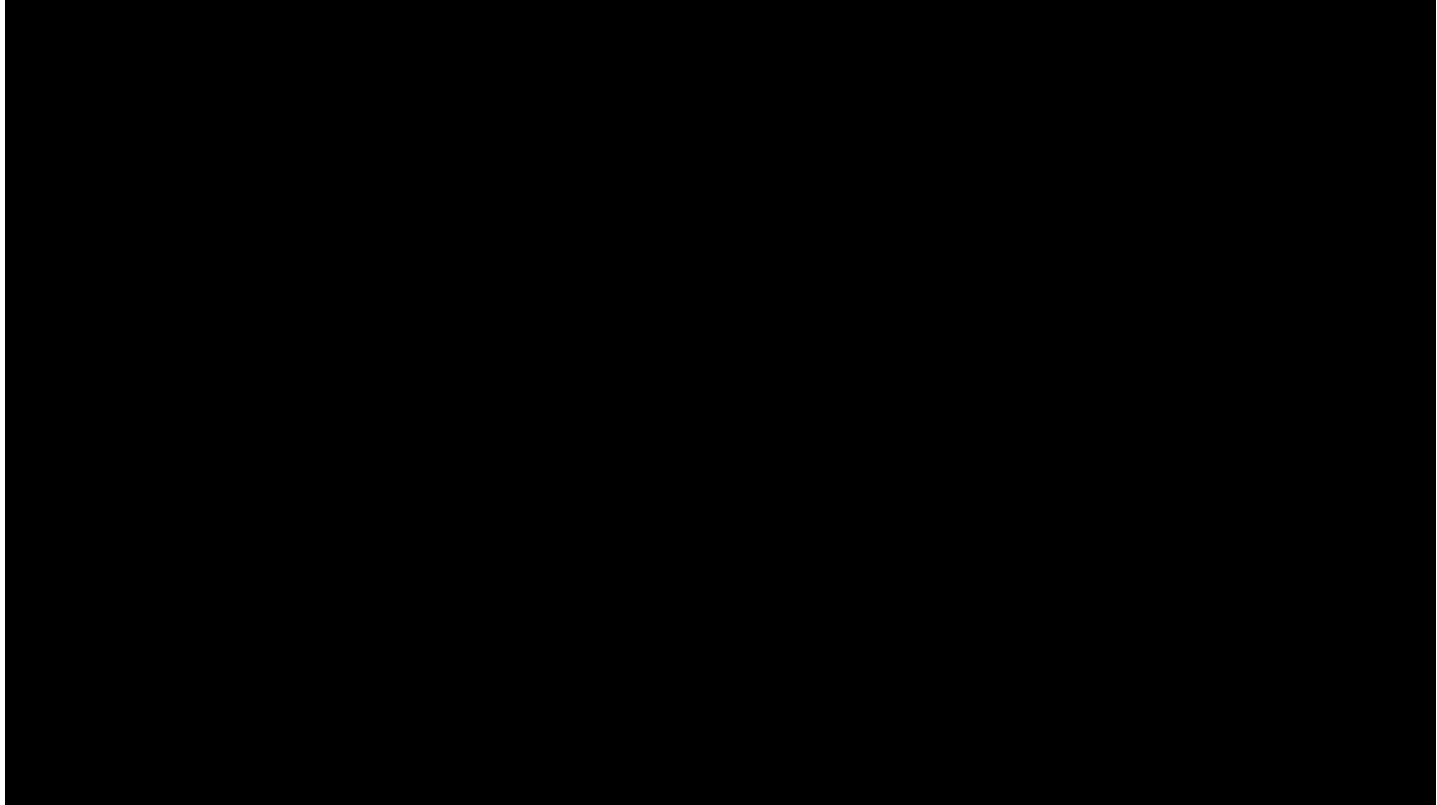
Effect of RBW on noise floor

Decreasing resolution bandwidth by a factor of 10 lowers the noise floor (DANL) by approximately 10 dB

RBW = 3 MHz	-73 dBm
RBW = 300 kHz	-84 dBm
RBW = 30 kHz	-93 dBm
RBW = 3 kHz	-104 dBm



SA RBW AFFECTS IF OUT BANDWIDTH



THANK YOU!

