

*How to Build a Quiet Station

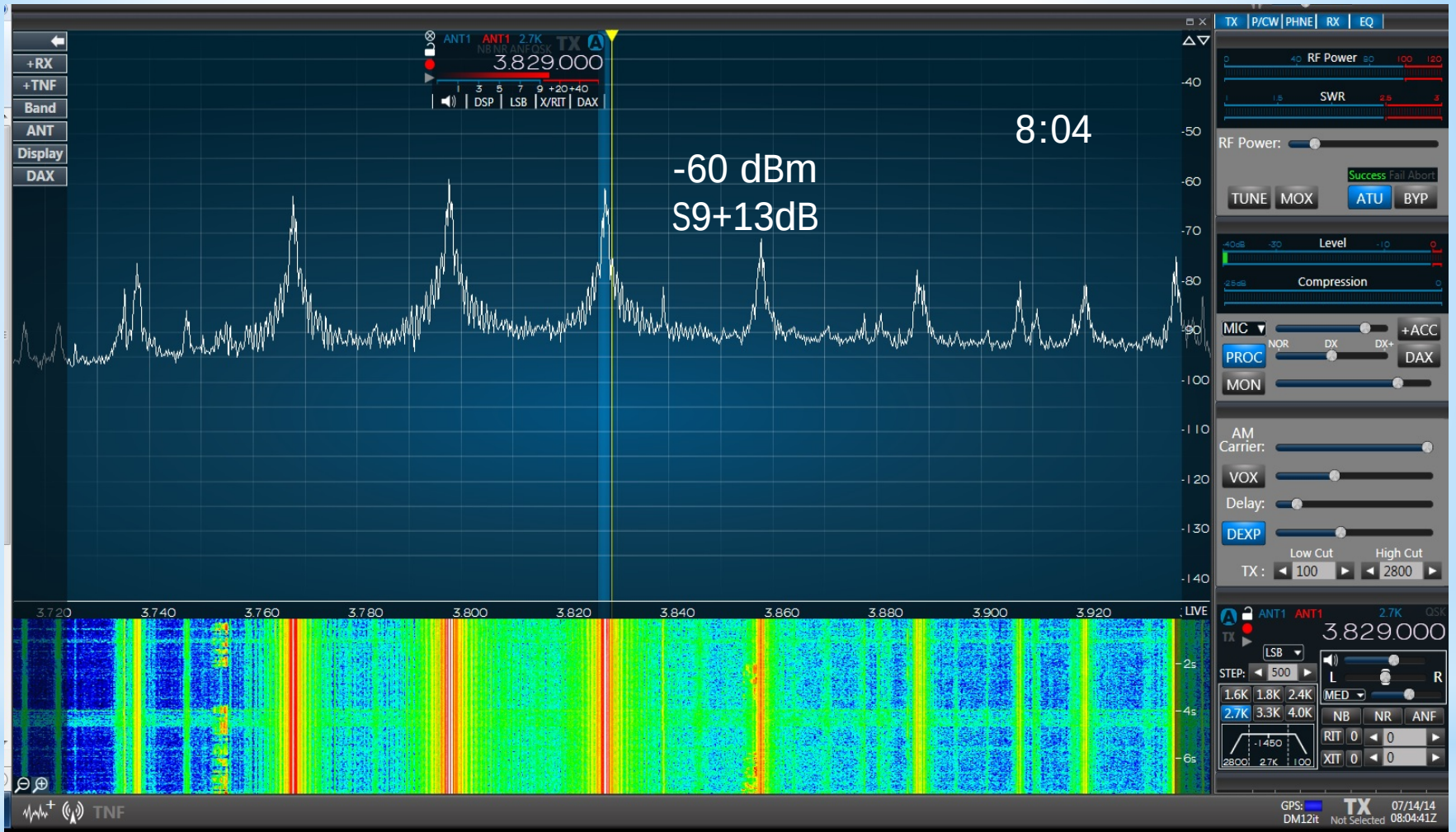
Howard White PhD, P.Eng. KY6LA

*WHY QUIET?

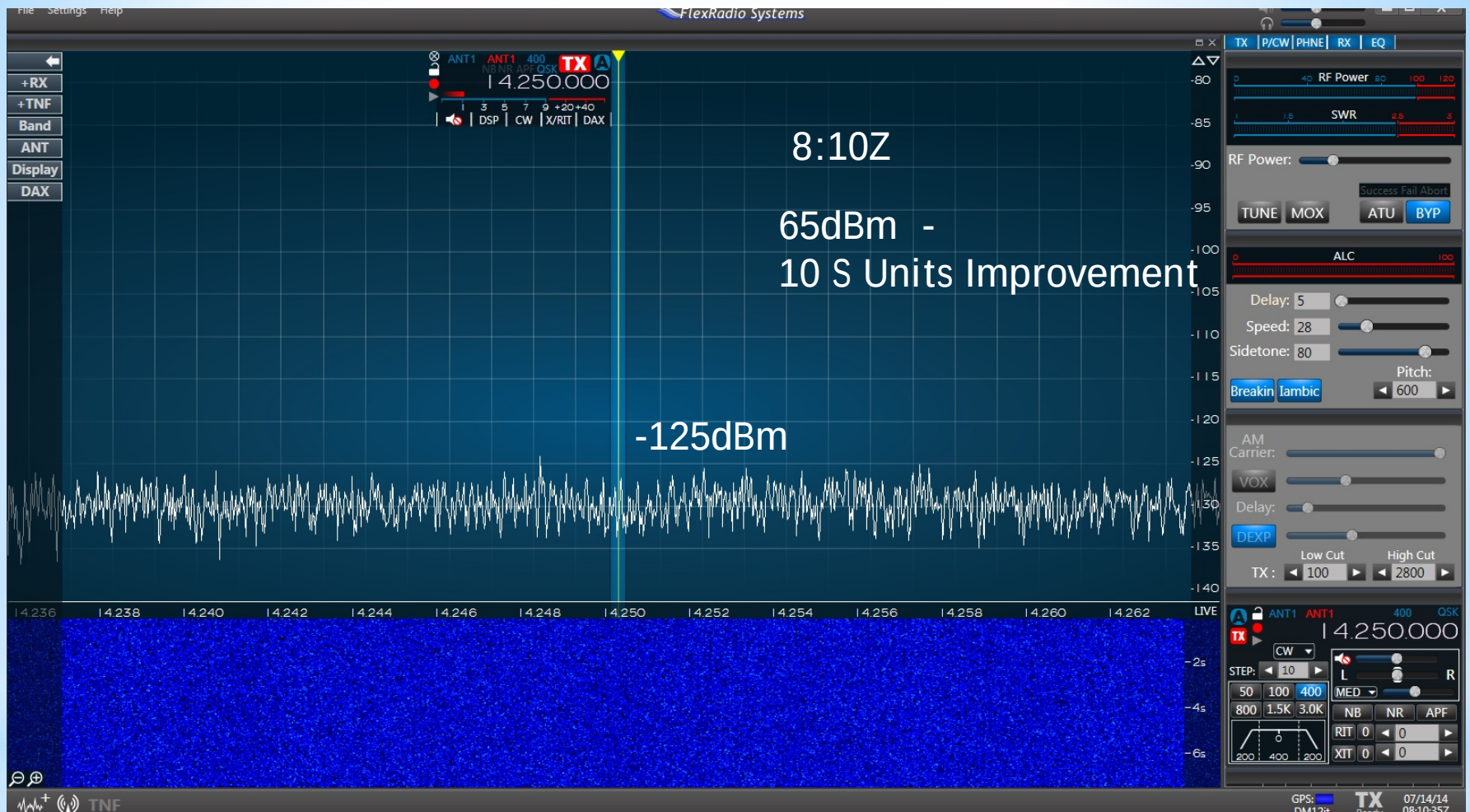
- * Hear the Weak Stations – More Mults
- * Weak Stations Hear YOU – More DX
- * Reduce your FATIGUE
 - * Contests
 - * Dxing
- * First to Spot FT5ZM

- * Noisy vs Quiet Station
- * Definitions
- * Measurement
- * Ground
- * AC Power
- * DC Power
- * Internet and Computers
- * Ferrites
- * Receiving
- * Transmitting

*Topics



***Noisy Station- S9+10dB**



*Quiet Station - S1



*Big Antenna's Help

*Legacy Radios

- * 1928 Technology... Superhetrodyne
- * Use Analog Circuitry

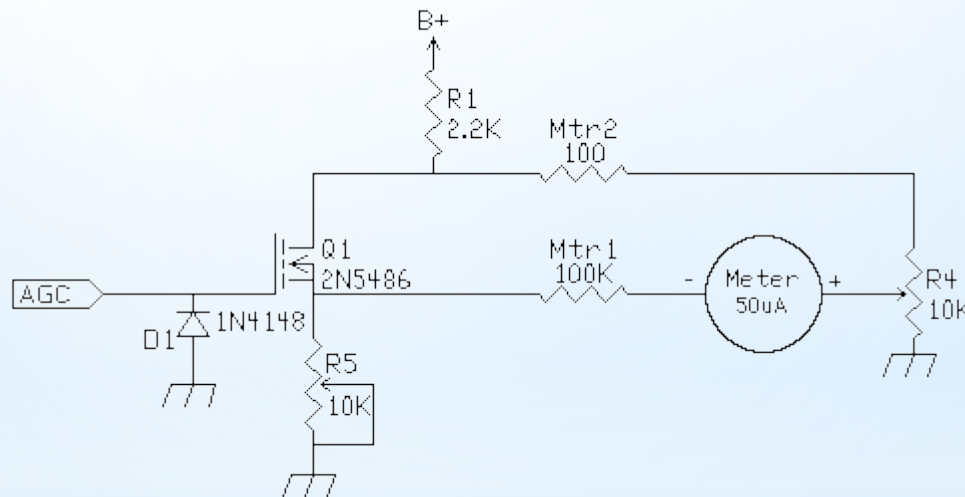
*Modern Radios

- * 21st Century Technology – Software Defined Radio (SDR)
- * Use Digital Circuitry and Software
- * Software = **MATH**
- * If you own a Cell Phone, you own a Modern Radio

*Definitions

* Legacy Radios - S Units

- * S9 is supposed to be $50\mu\text{V}$ @ 50Ω (usually NOT)
- * Each S Unit is supposed to be 6 dB (usually NOT)



* Definitions



***S-Meters LIE!!!!**

**Not Calibrated
Not Consistent**

*Modern Radios - dBm

- * Power ratio in [decibels](#) (dB) of the measured power referenced to one [milliwatt](#) (mW)
- * ACCURATE Absolute measure of signal power
- * $S9 = -73\text{dBm}$
- * $S0 = -127\text{dBm}$
- * Absolute Zero = -143dBm

*Definitions

* “ALL legacy and
Modern Radios hear
TOO MUCH”

* Rob Sherwood

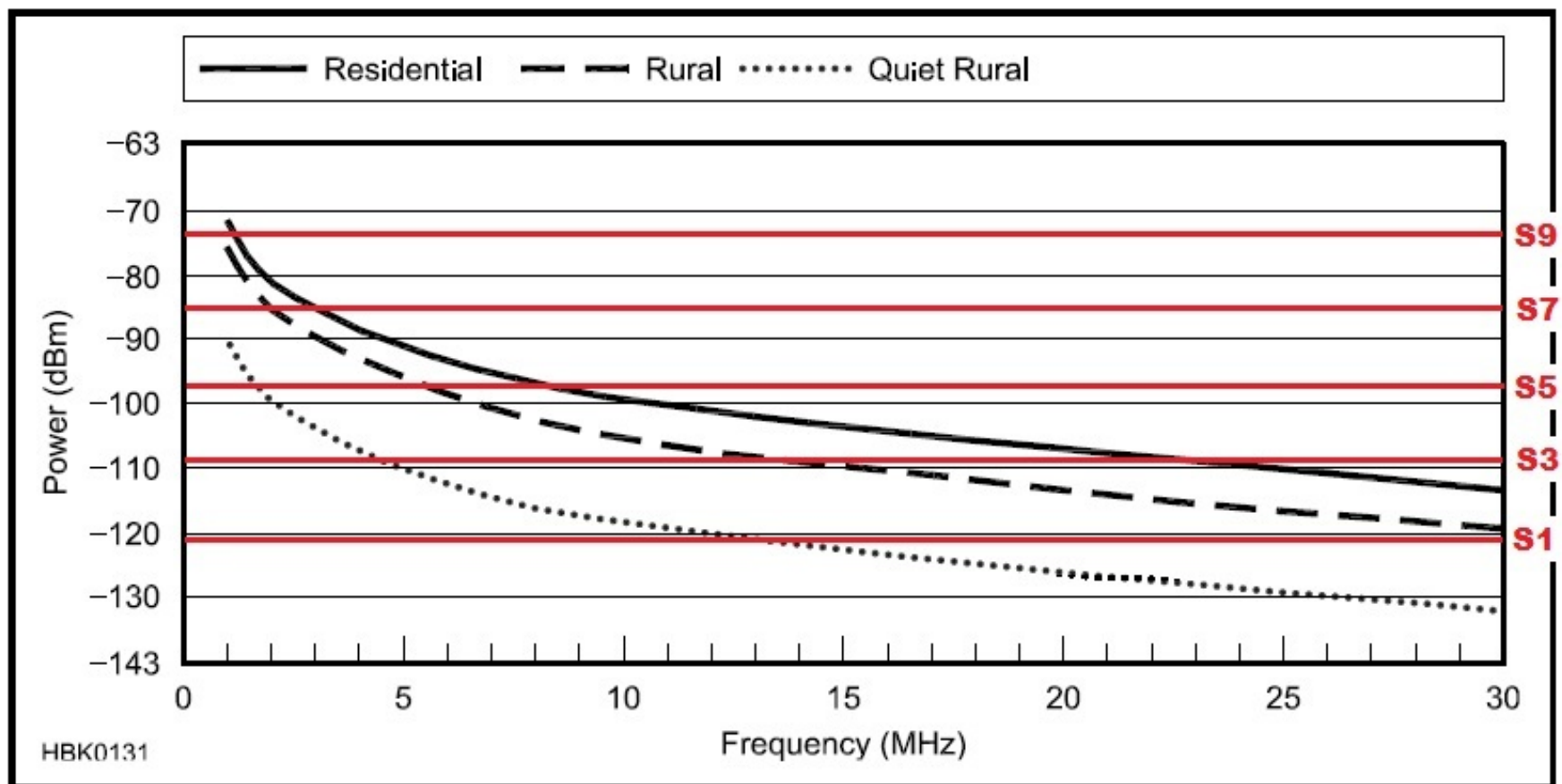


Fig 19.37 — Typical noise levels versus frequency for various environments.
 (Man-made noise in a 500-Hz bandwidth, from Rec. ITU-R P.372.7, *Radio Noise*)

Propagation of Radio Signals 19.31

***S-Meter to dBm**

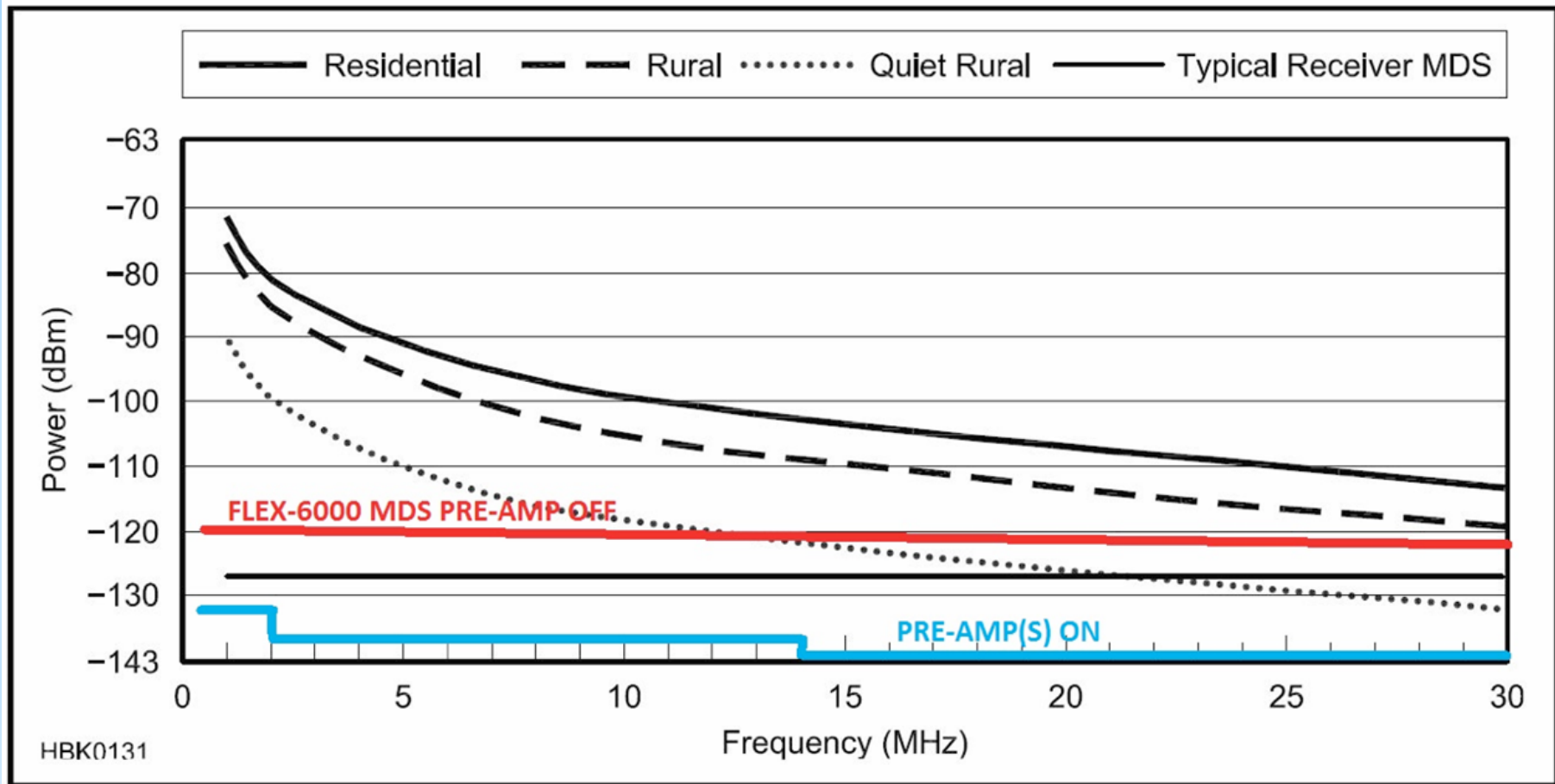


Fig 19.37 — Typical noise levels versus frequency for various environments. (Man-made noise in a 500-Hz bandwidth, from Rec. ITU-R P.372.7, *Radio Noise*)



Minimum Discernable Signal vs. Mother Nature & Man

*MFJ-852 Line Noise Meter



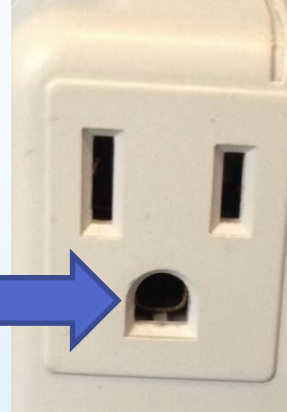
*Measurement

- *The first place to clean up your station noise
 - * Good **RF** Ground
 - * SHORT - Very close to the station
 - * Big Ground Bus
 - * Low RF Impedance Ground Leads
 - * SINGLE POINT GROUND for all equipment

***Grounds**

*Power Protection Ground is NOT RF Ground

NOT RF GROUND



*Grounds

*Tower Protection Ground is NOT RF Ground

NOT RF GROUND



***Grounds**

- * 3 - 8' x 1/2" ground rod @ 4' Apart
- * Connected by 1/2' Copper Pipe Ground Bus
- * 1/2" Copper Pipe Ground Bus into House



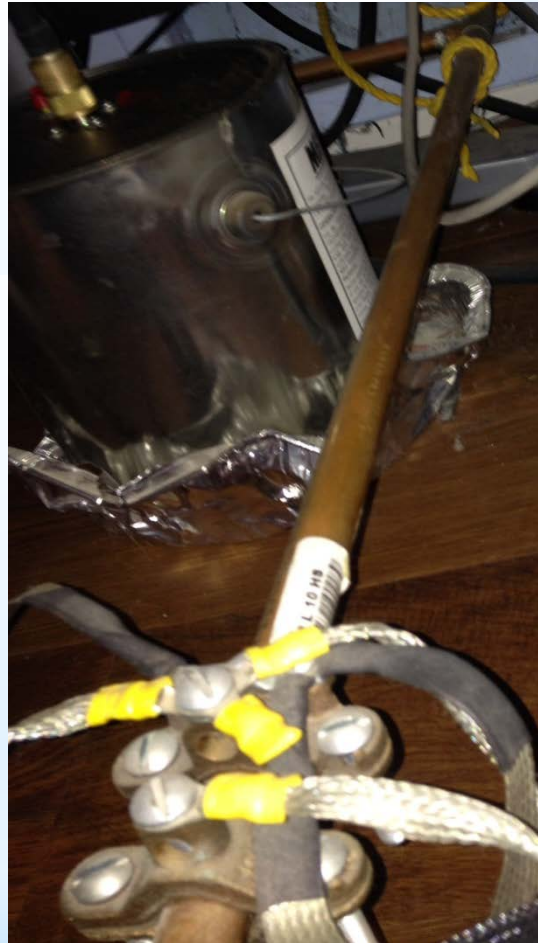
*RF Ground

- *Ground Bus into House ½" Copper Pipe
- *Soldered – so Not lightning protection



***RF Ground**

*Internal Ground Bus



*Grounds

*Single Point Ground



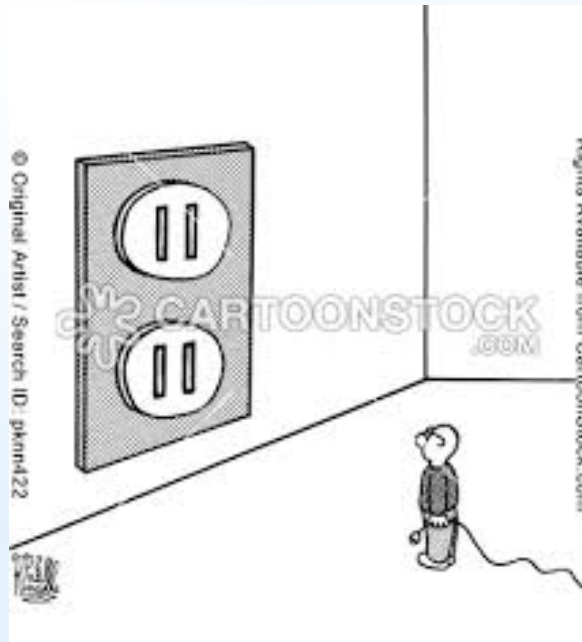
*Grounds

- *MFJ-931 Artificial Ground
- *For those who are not Near Ground



*Grounds

- * Naked AC Power is Noisy
- * Do Not Use Naked Power



***Naked AC Power**

- *Every AC Power Cable Near Your Radio needs Line Filtering
- ***MOST** UPS are good inexpensive filters



*AC Power

*Some UPS are Noisy Too.. So sniff them



*AC Power

- *DC Power can be very quiet power
- *Most Switching DC Power Supplies are Noisy
- *Linear DC Power Supplies are Much Quieter
- *BATTERY DC POWER is almost Noise Free

*Run **EVERYTHING** From DC Power

*DC Power

* Battery Tenders - Float Chargers are Very NOISY



DO NOT USE

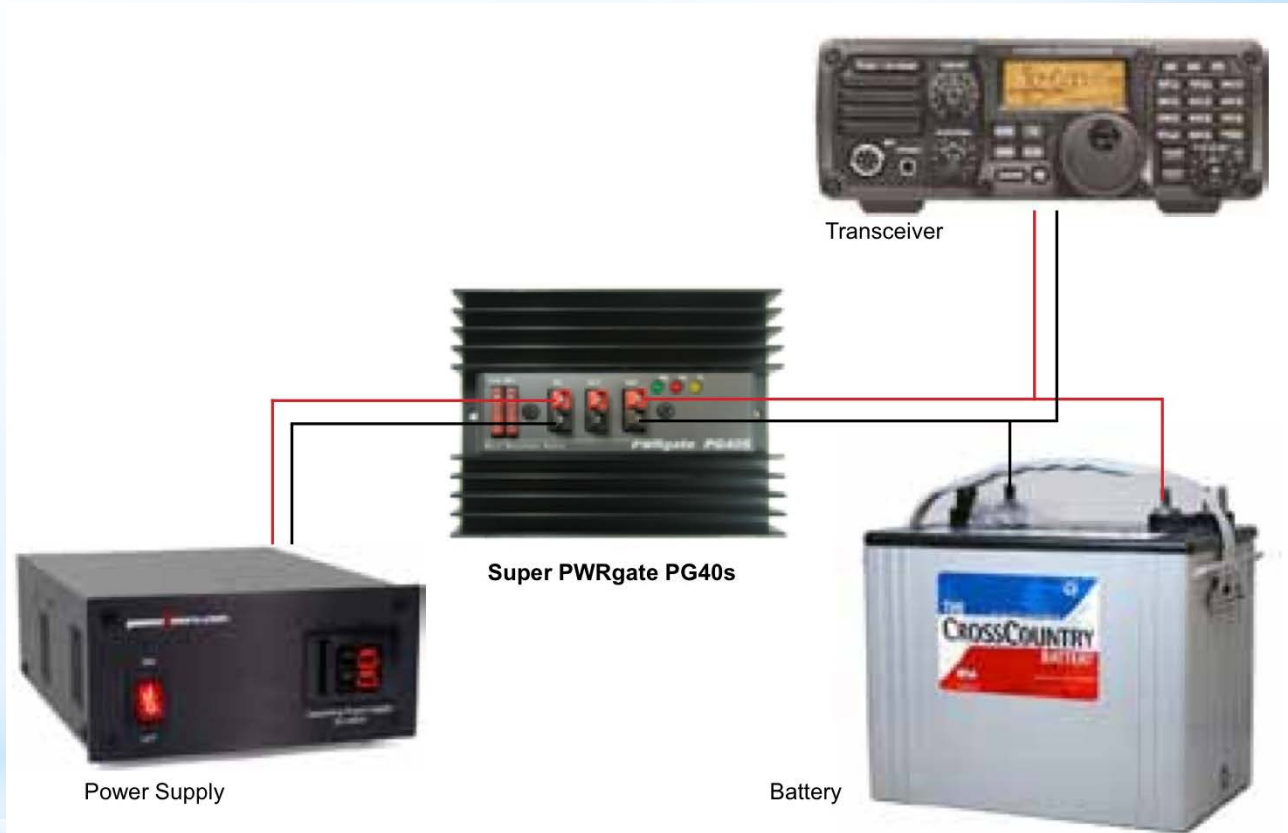
* **DC Power**

*Battery Backup DC Power - Good



*DC Power

*Battery DC Powered – Best



*DC Power

*Wall Warts are the Enemy of Quiet Radios



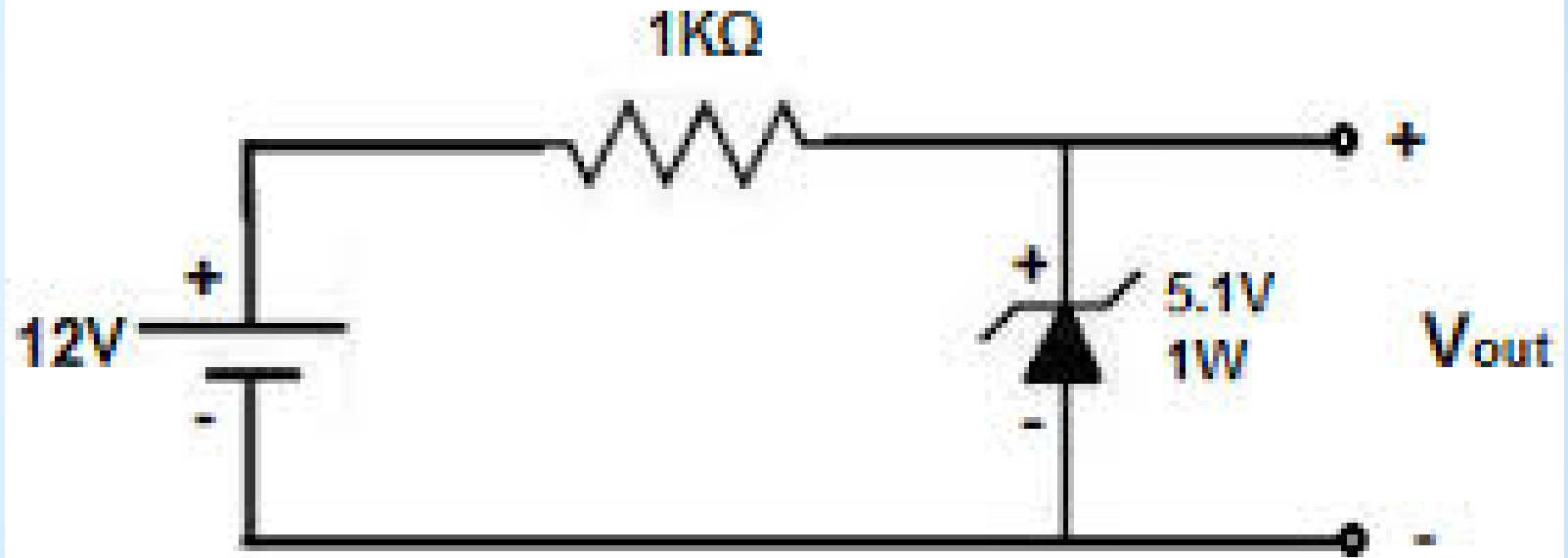
DO NOT USE

***DC Power**



*12v DC POWER BUS

Zener Diode Voltage Regulator Circuit



***5V DC Power Bus**



*5V DC Power Bus



*DC Power - Batteries

- * DC Battery Power
 - * Routers,
 - * Switches,
 - * WiFi
- * Use CAT-6 Cabling
- * Connect to single point RF Ground

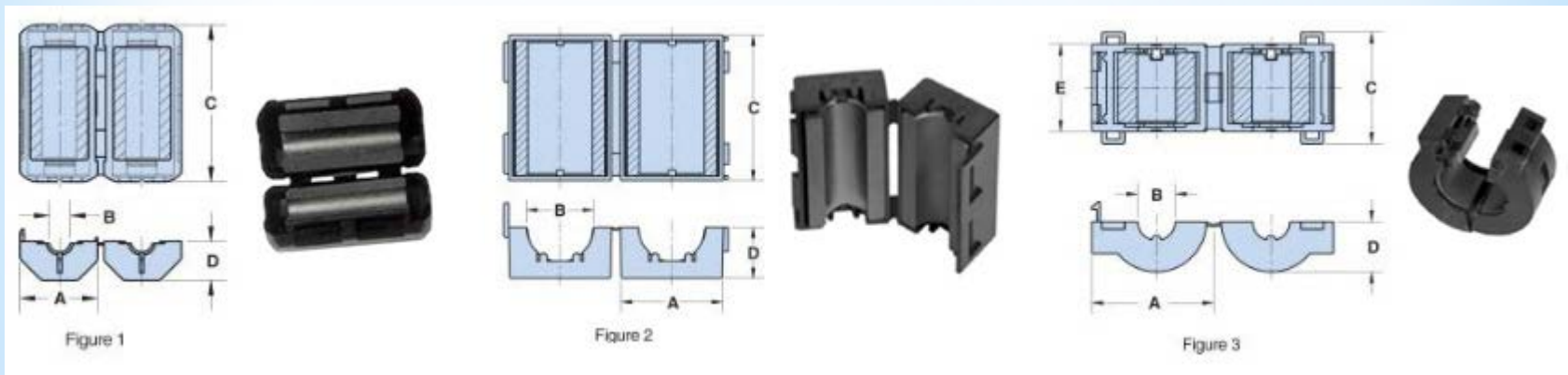
***Internet**

- *Change the PC power supply to a better EMI blocking one
- *UPS filter on the PC mains
- *Ferrites on everything coming into or going out of the PC and monitors
- *Shielded monitor cables (DVI seems to work best)
- *Build a shielded enclosure for the monitor power supplies, if they're external, with ferrites on the ins and outs.
- *Ground the enclosure. -Single point shack ground
- *Ensure that all metal to metal cabinet, etc., connections are really metal-to-metal, not paint-to-paint.
- *Move your PC away from the rig, and especially away from DC and antenna leads

***Computer**

*When in doubt – Use More **Type 31** Ferrites

*You can never have too many Ferrites



***Ferrites**

*Dirty Little Secret



Don't tell N6KI

*Receiving

*Legacy Radios add:

*Distortion to the received signals

*5 to 15 dBm of Crud to the received signals

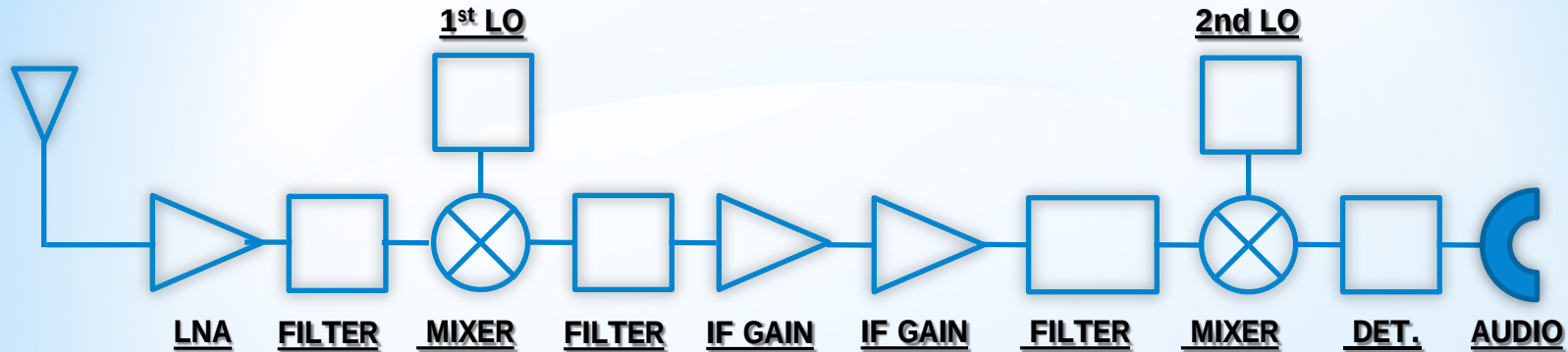
*Or 1 -2 S Units of Noise+Distortion to the received signals

***Receiving**

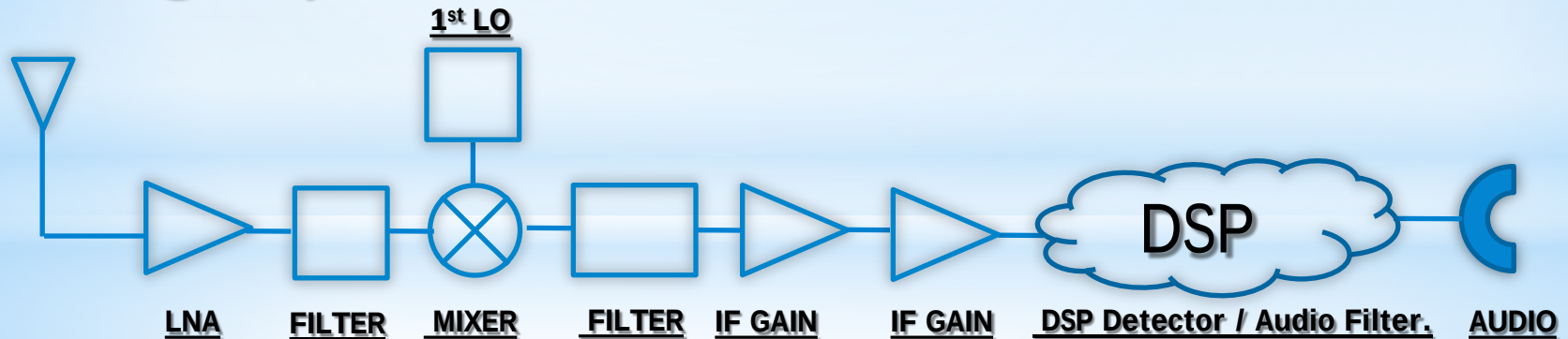
- *Multi-conversion a.k.a. Superhetrodyne 1928 – Legacy
 - *Your car radio, your TV, any older scanner you have
 - *Most every Kenwood, Icom, Ten-Tec, Elecraft and Yaesu on the market today
- *Direct Conversion 2000 – Modern
 - *FLEX-5000, FLEX-3000, FLEX1500, Elecraft KX3, Elad FDM-Duo
- *Direct Sampling a.k.a wideband 2009 – Modern
 - *FLEX-6000, HPSDR, ANAN-100, SUNSDR-2

*Radio RF/IF Architecture

Multi-Stage HW Receiver Chain - 1928



Legacy HW/DSP Receiver Chain - 1980

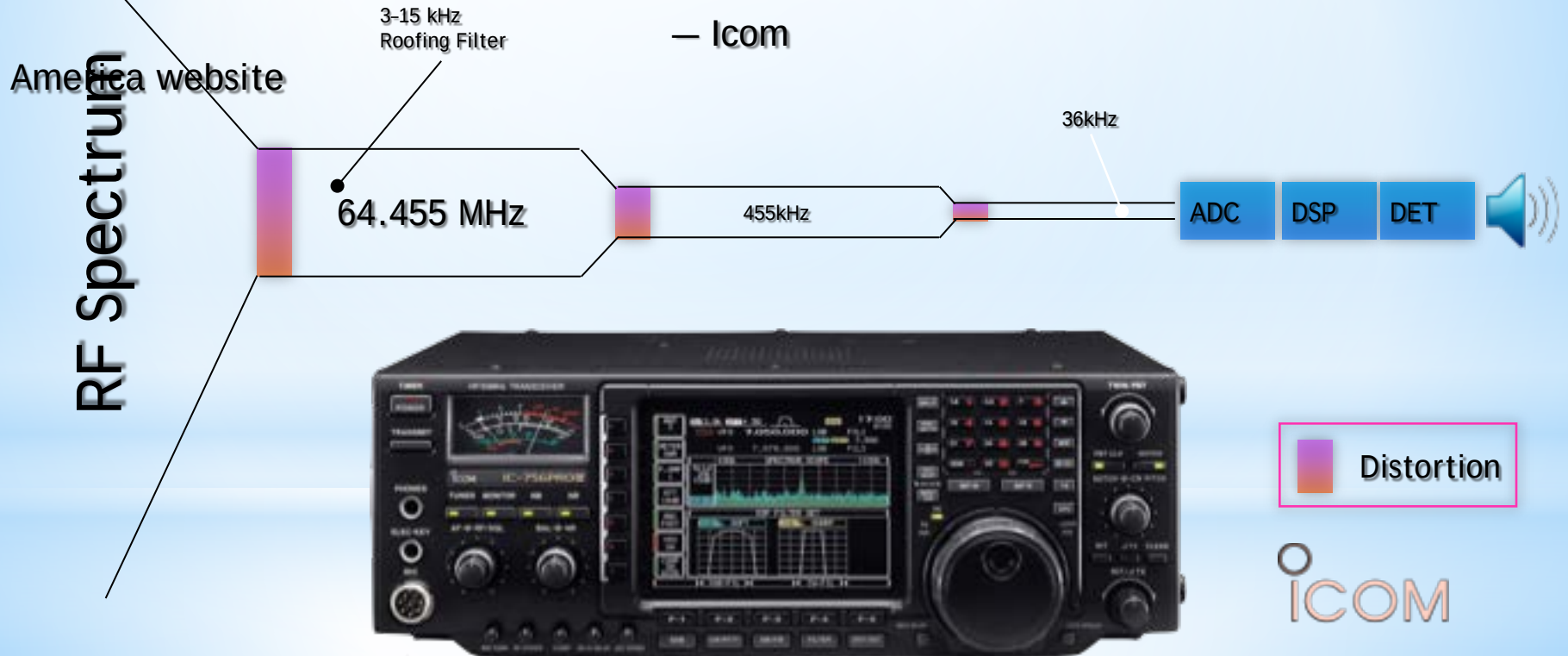




Multi-Conversion

On the IC-7600:

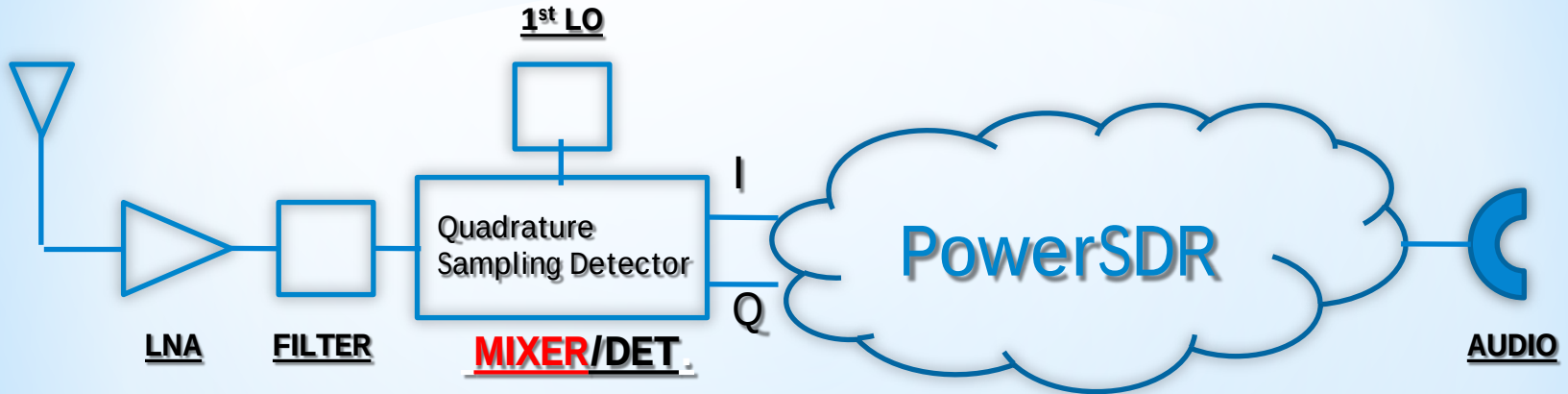
“When compared to a typical triple-conversion system, the double conversion system is more difficult to implement but it dramatically reduces signal distortion and provides a high-fidelity RF signal to the DSP processor.”



- + Adjacent band signal rejection: operate in harsh signal conditions
- + Common, well-accepted design: works well
- Distortion introduced in each stage of filtering and mixing
- Noise (CRUD) amplified at each stage
- Only signals in the final IF can be tuned
- Limited view of spectrum
- For best filtering, requires expensive crystal filters (multiple)

Multi-Conversion **The good and bad**

MODERN RADIO - 2000 TECHNOLOGY - 2nd Generation SDR



***“QSD” Direct Conversion Chain**

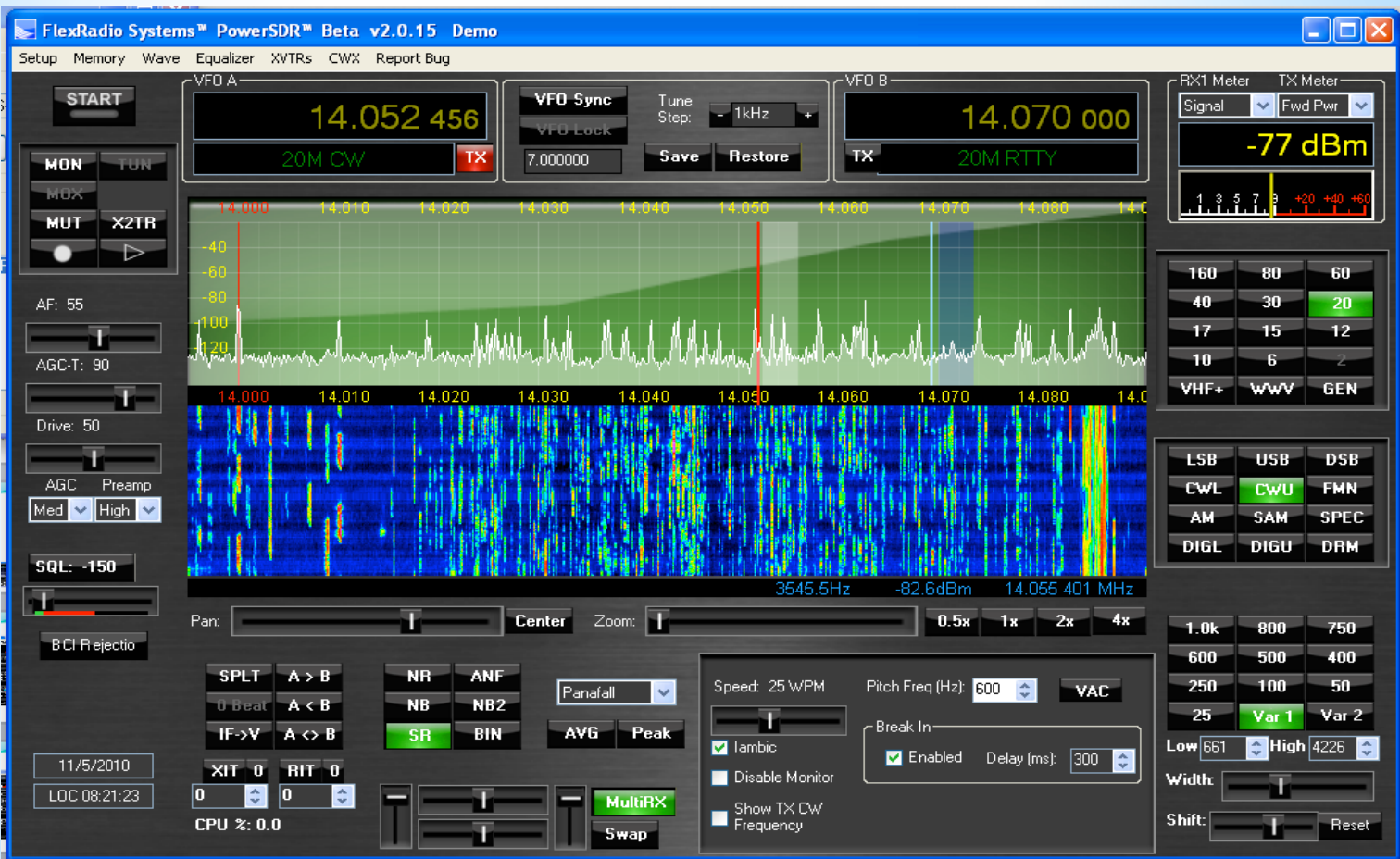


Direct Conversion



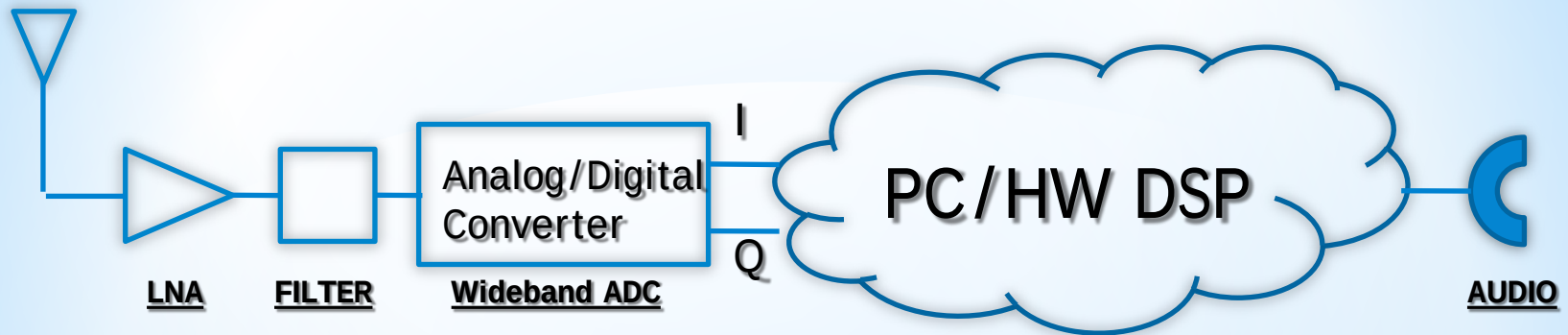
- + Distortion minimized with only one mixer:
clear signal — sounds better, less fatigue (less in-band distortion) - Noise amplified by only 1 stage
- + Can show 192kHz of realtime spectrum:
wide panadapter view
- + Low power, high dynamic range:
interference mitigation
- Image rejection difficult (balanced IQ mixer, WBIR)
- Better, but still limited view of spectrum

Direct Conversion **The good and not-so-good**



*Direct Conversion

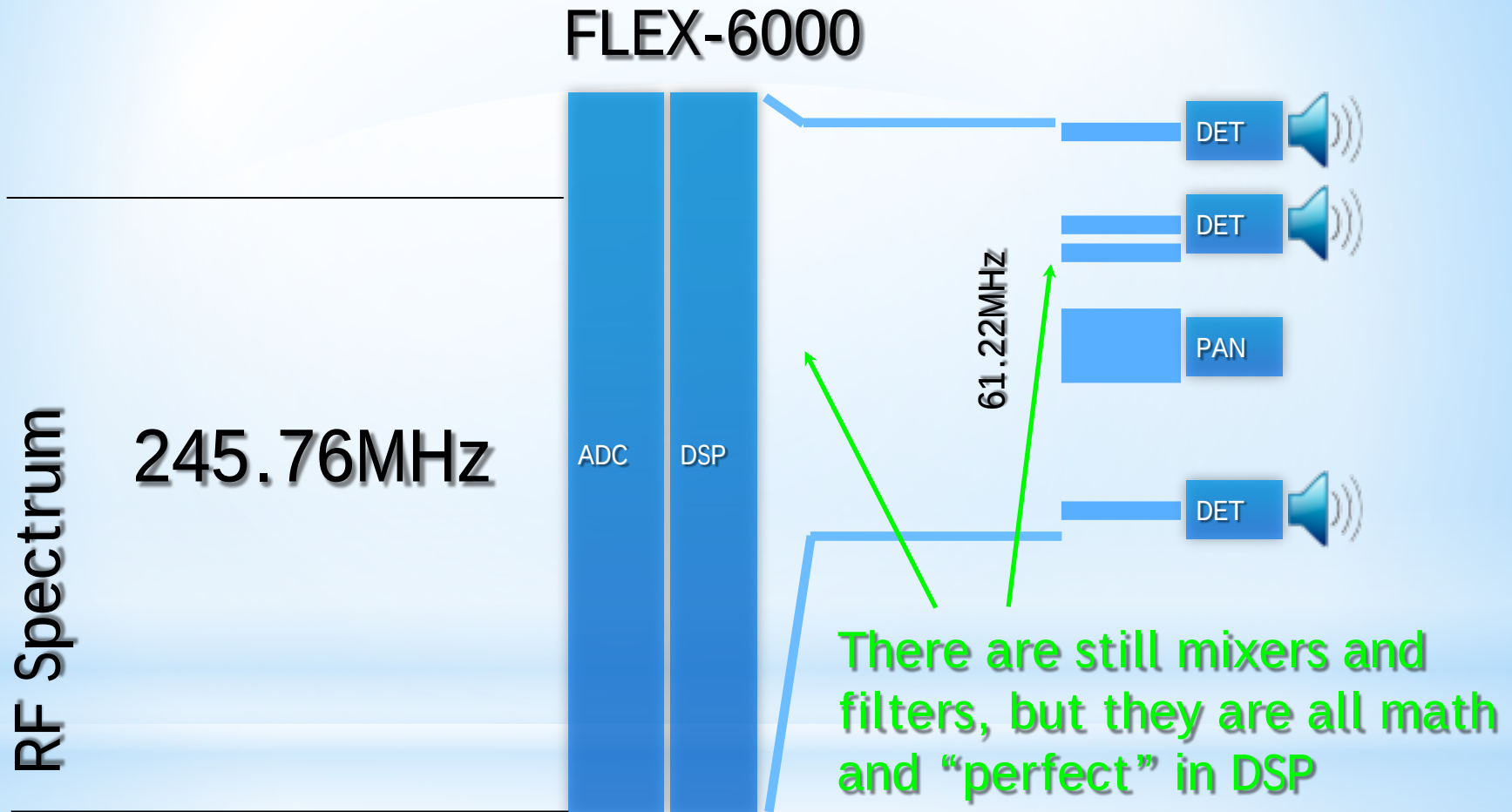
MODERN RADIO - 2009+ TECHNOLOGY - 3rd Generation SDR



*Direct Sampling Converter Chain



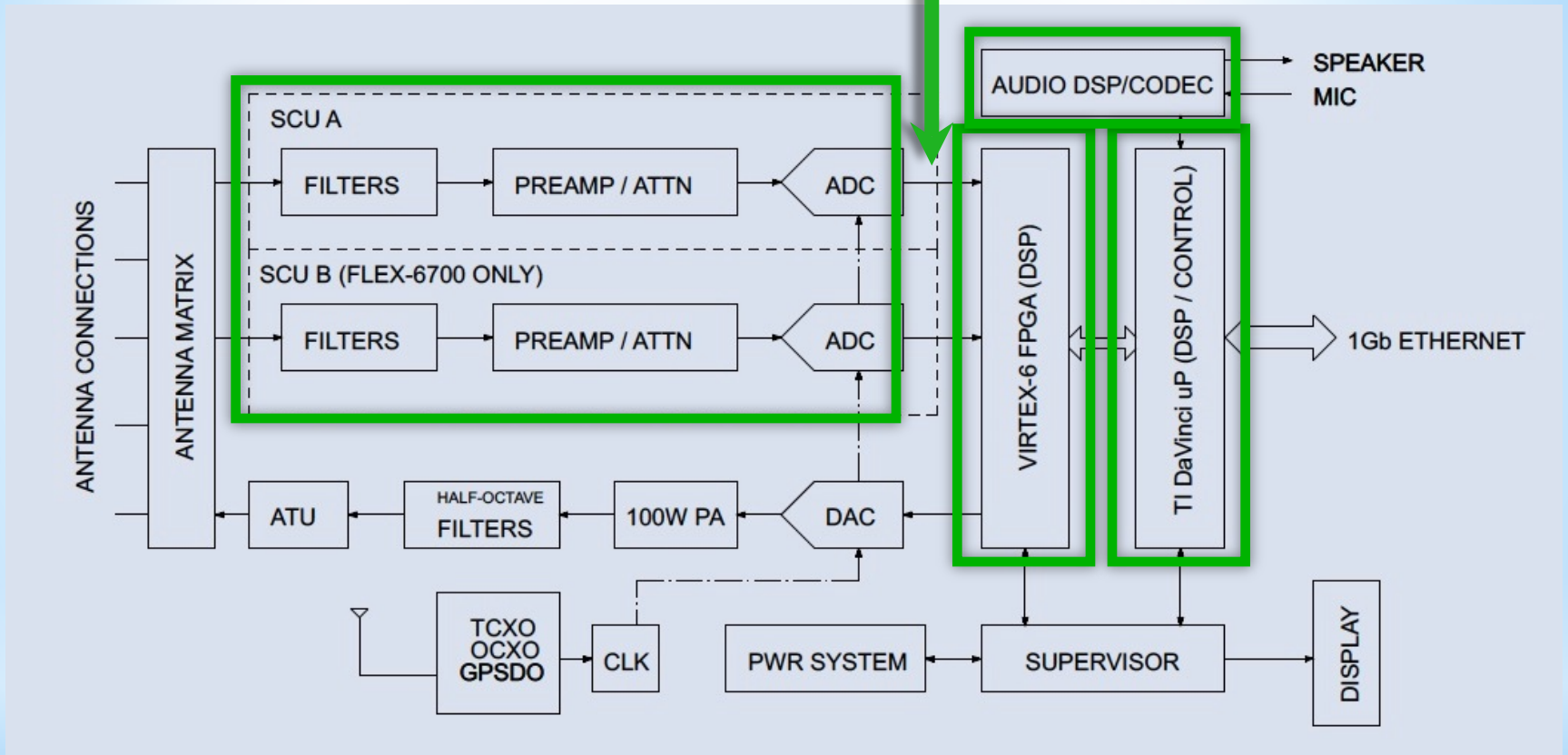
Direct Sampling



- + **Distortion minimized (ADC @ antenna):**
best signal clarity
- + n-Receivers, n-Panadapters and varying widths see more bands, more receivers
- + **Extremely high dynamic range: operate in worst conditions - IP3 +50db +125db Dynamic Range or better**
- + **Extreme flexibility through reprogrammability**
(ultimate SDR): future benefits
- **Technically challenging to design and write software**

***Direct Sampling Benefits**

7.9Gbps + 1Gbps



51



3rd Generation SDR Architecture



FLEX-6000 Series



ANAN-200



SUNSDR-2

*3rd Generation Direct Sampled SDR

*Enough with the Techno-nerd Stuff.

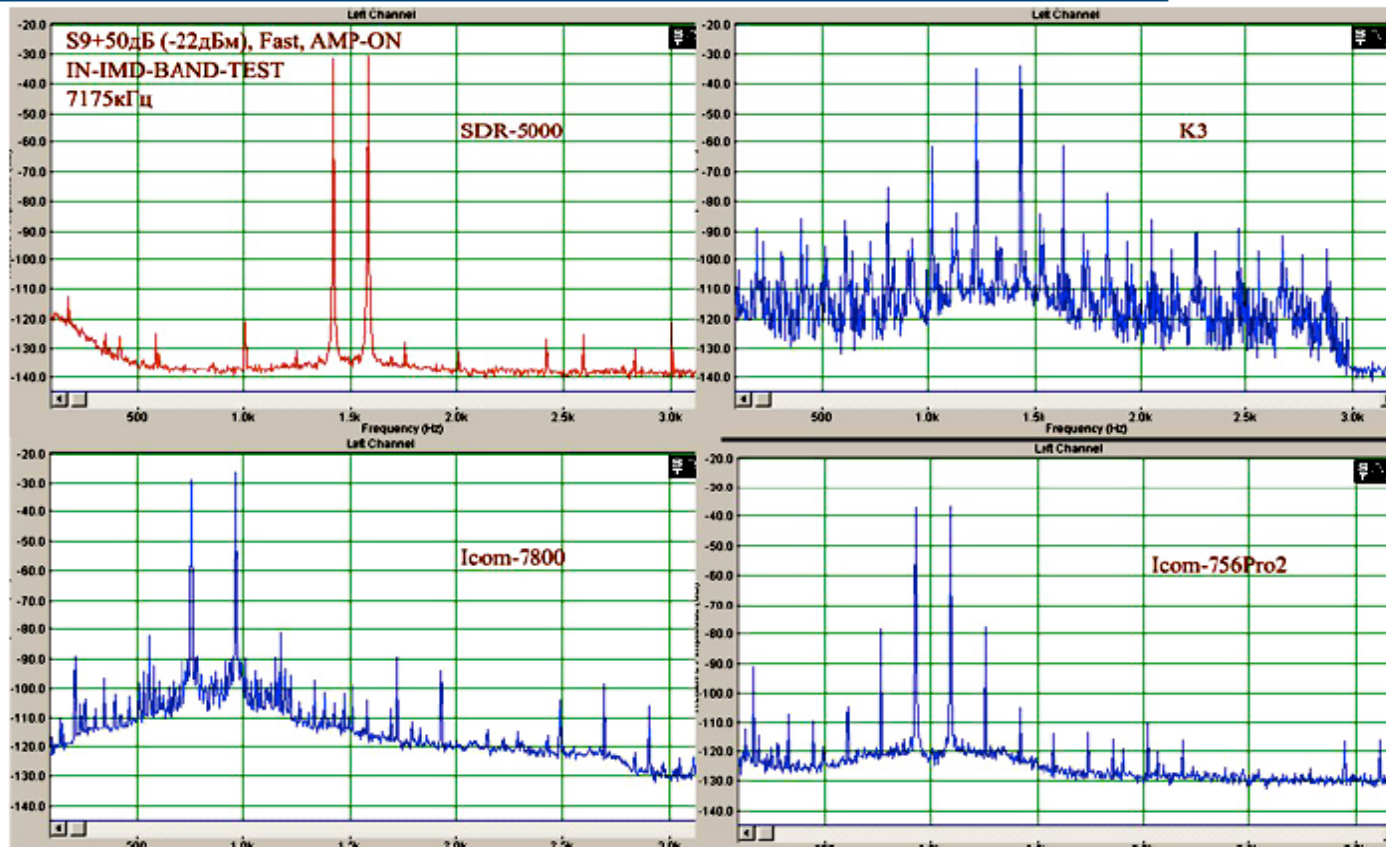
*Yes Modern Radios are 5 generations beyond 1928

***What about the real world?**

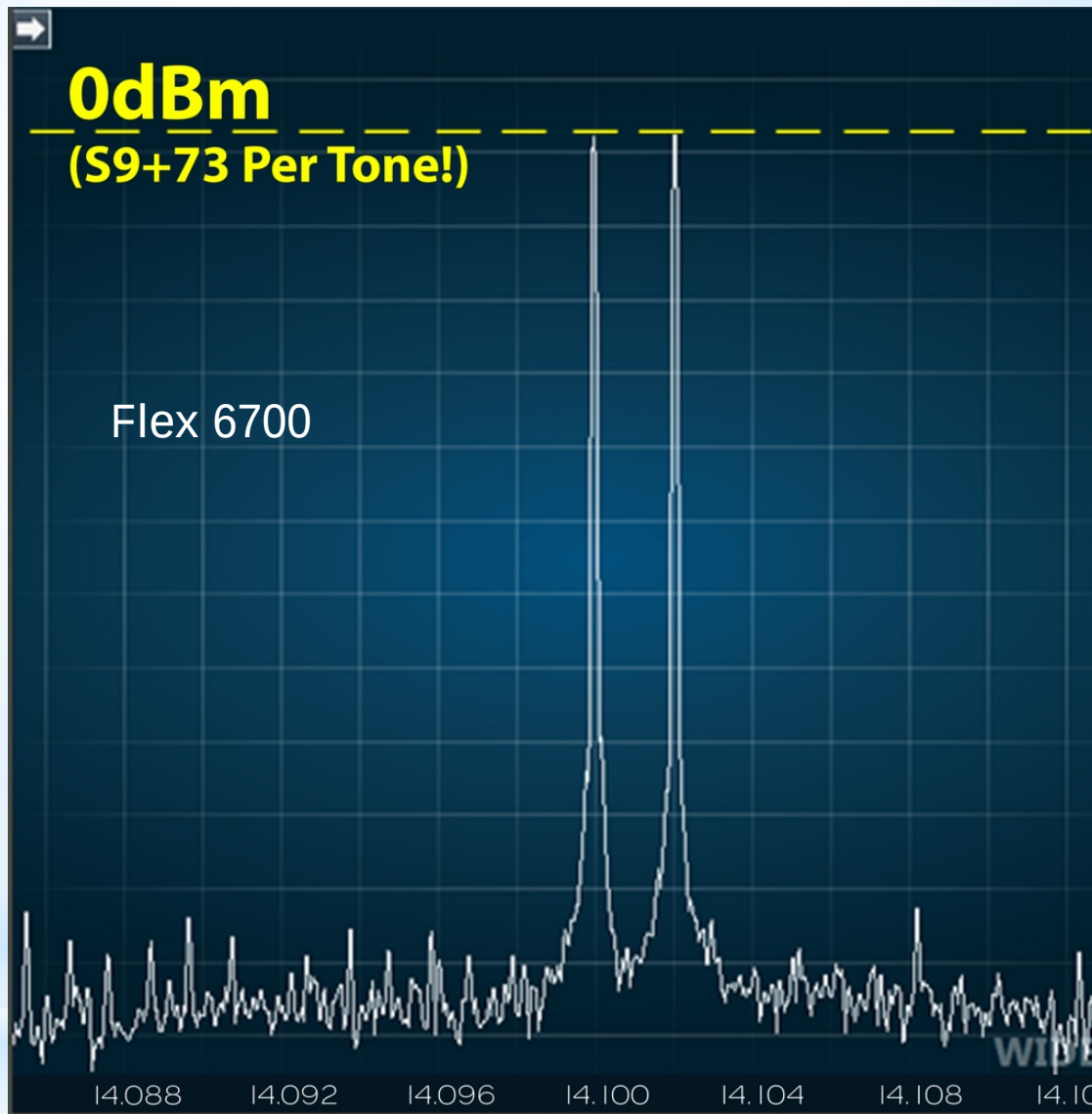
S9+50 (-22dBm)

Sherwood Engineering

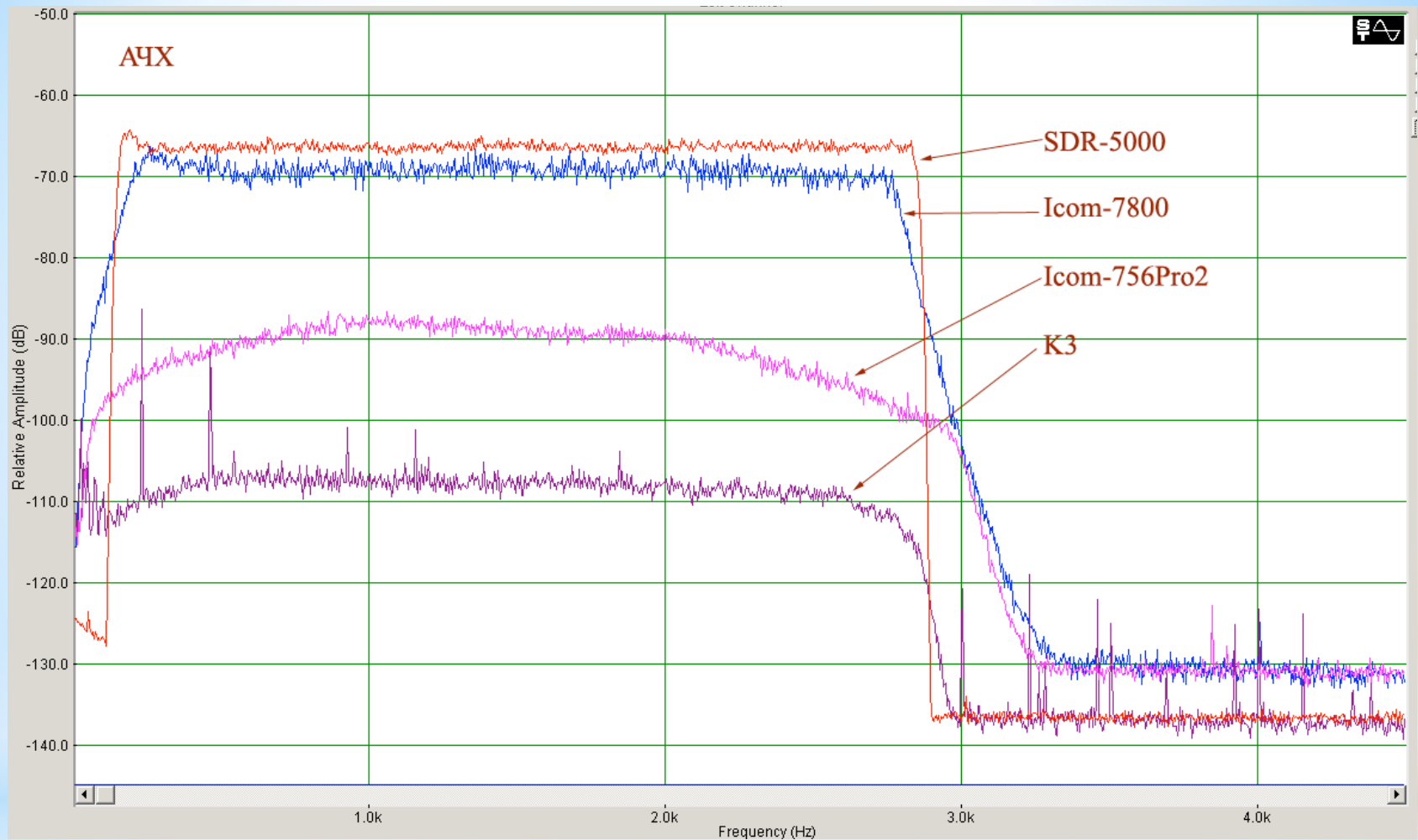
Data from UR5LAM on 4 Transceivers



*Modern vs Legacy

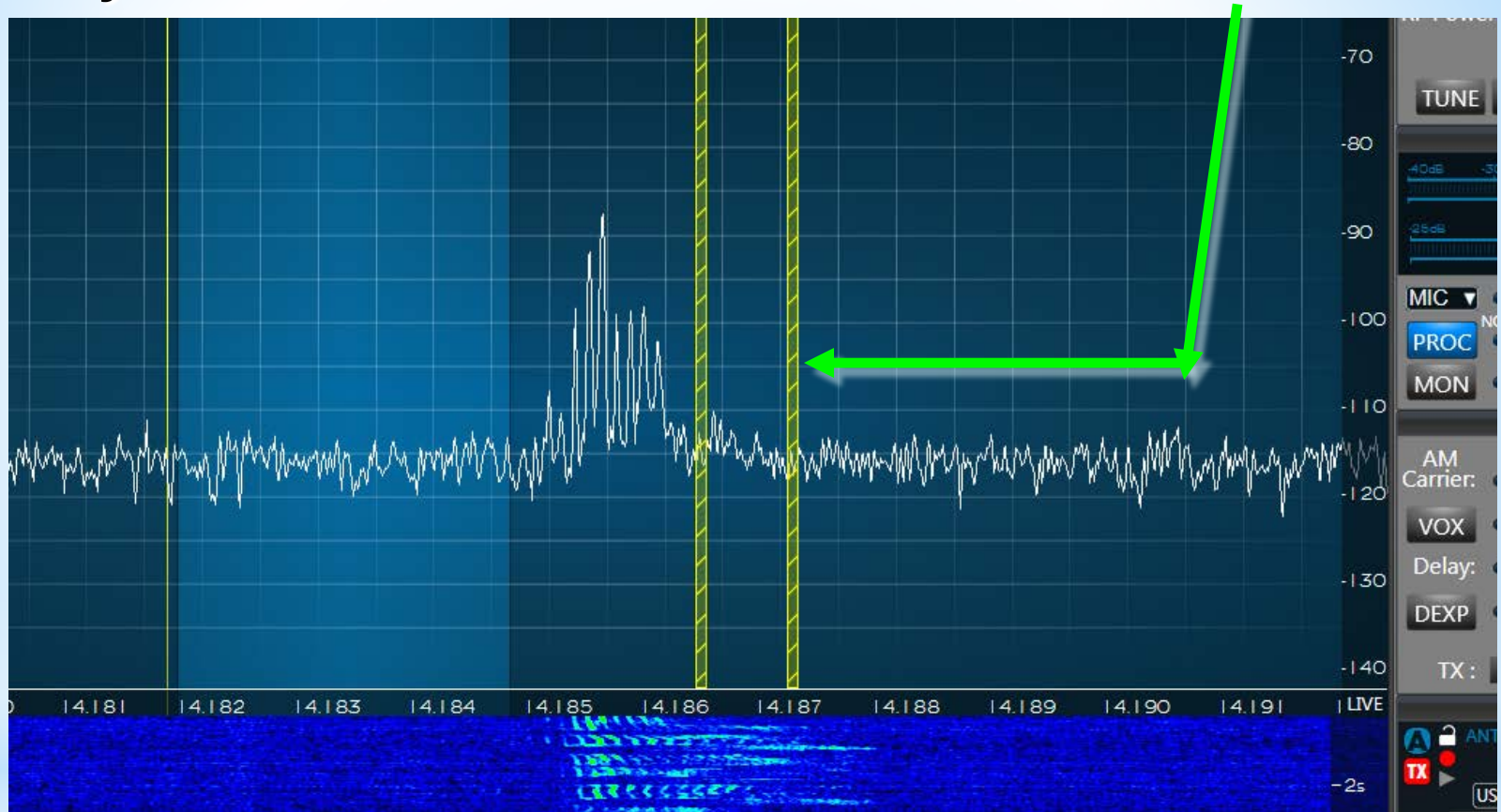


***Dynamic Range**



*Brick Wall Filters

As you tune, the TNF follows *RF*, not *IF/Audio*



* ∞ Tracking Notch Filters

Legacy Radio Arrangement



Analog to Digital to Analog
adds 6dB distortion

SDR Radio Arrangement

WA3IHV JT65 Real World Example

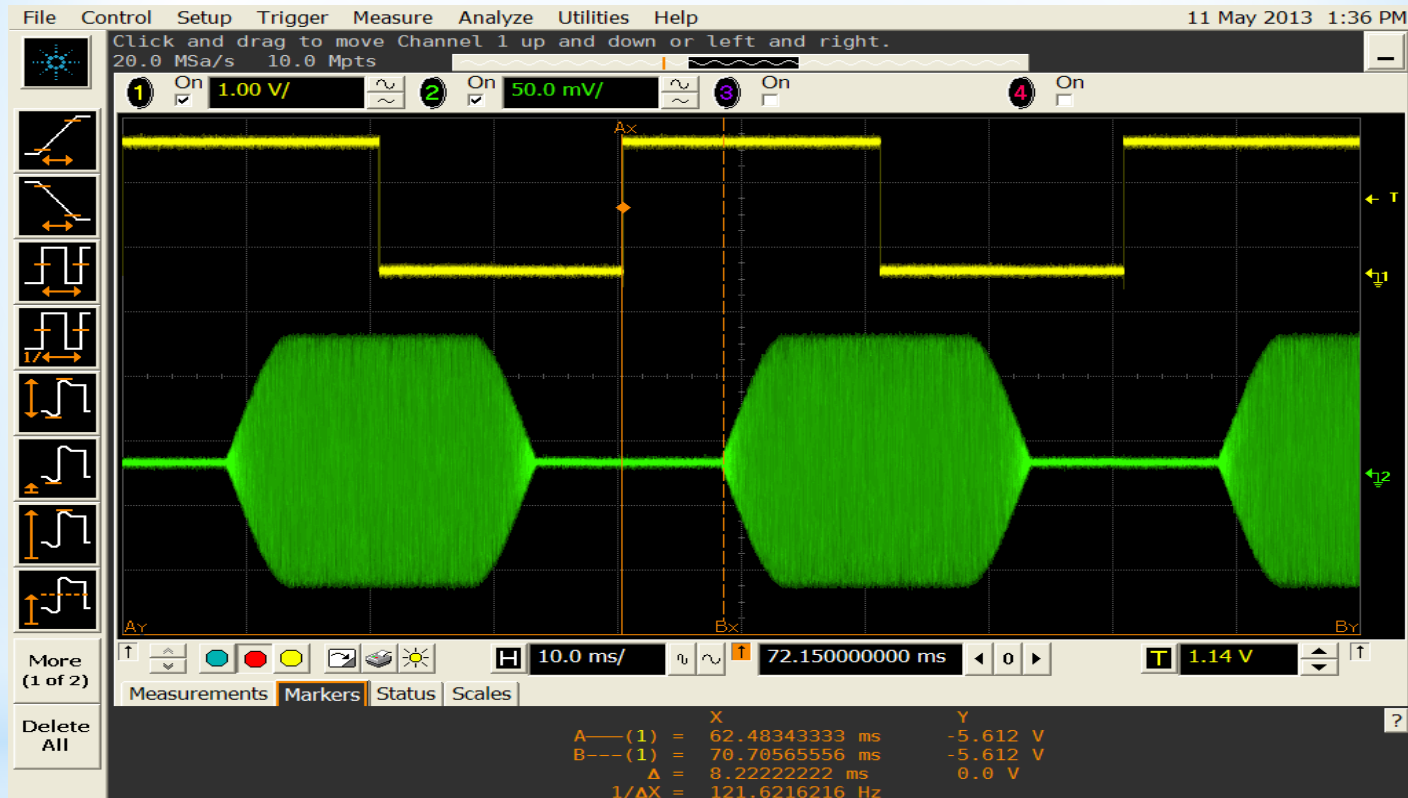
Legacy Icom 7700 -19dB
Modern Flex 6700 -26dB

Modern – 7dB Gain Advantage

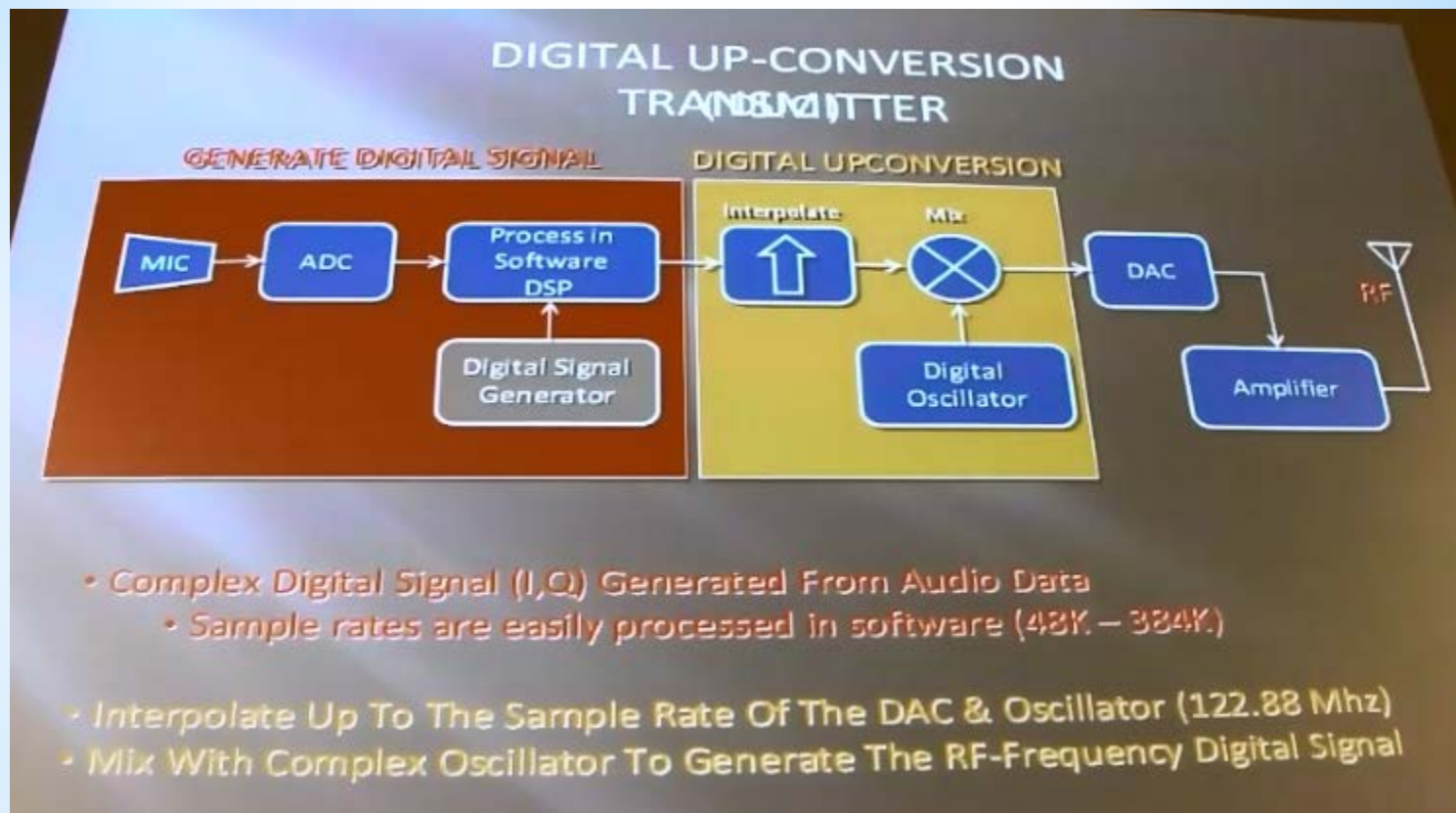


***Digital Modes**

- *Modern Radios - Perfect CW Signal Shaping
- *Modern Radios - No Distortion Audio



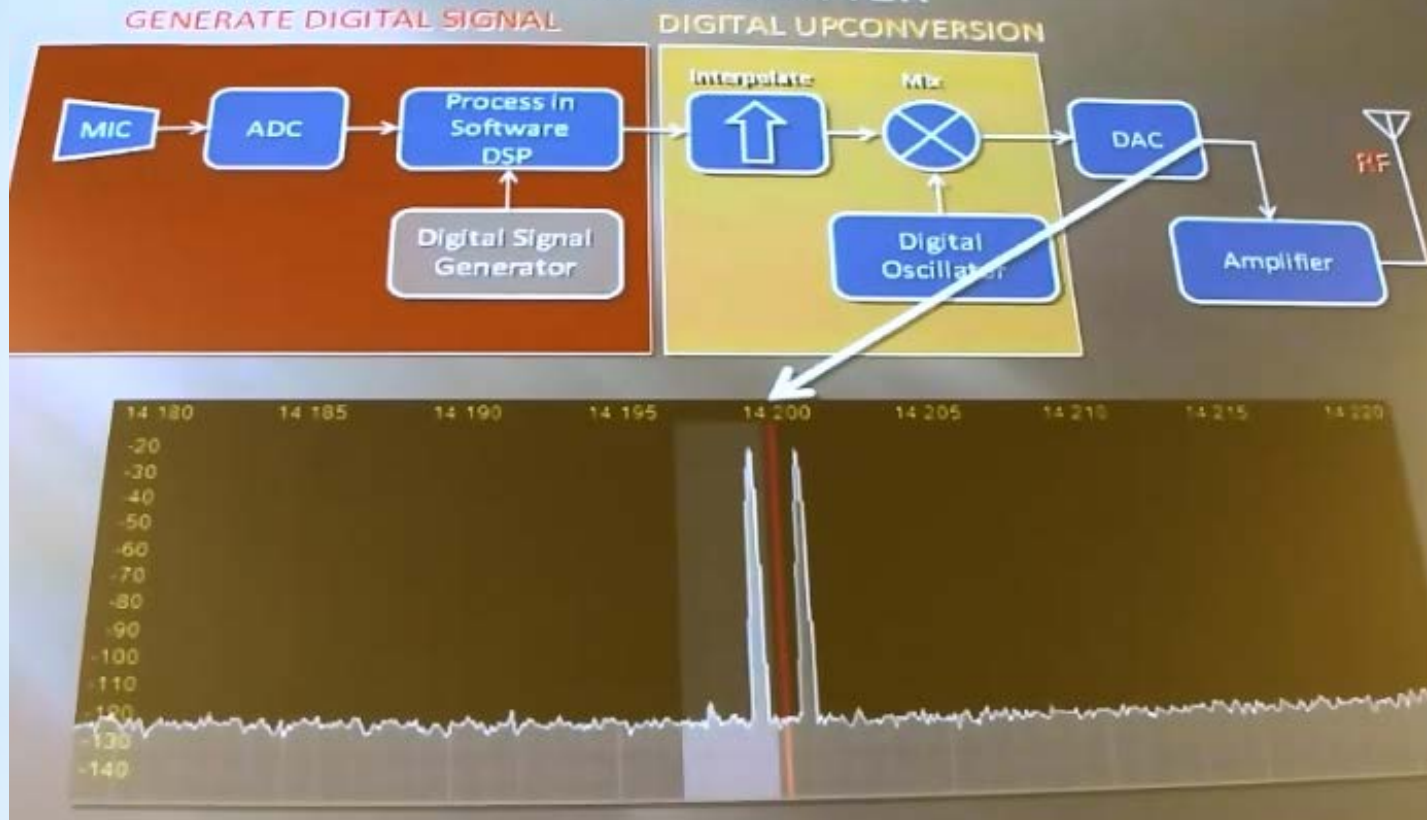
*Transmitting



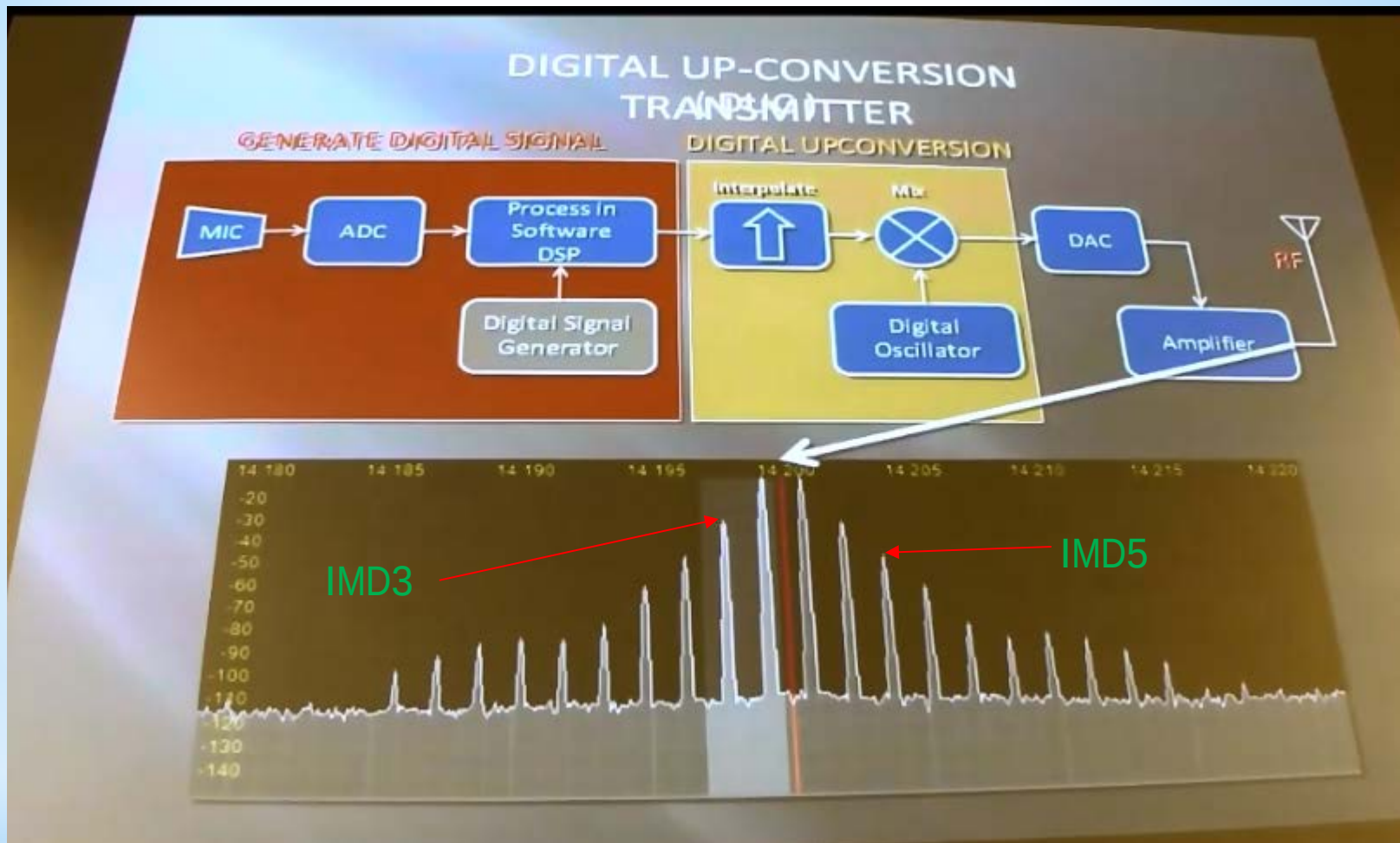
*Digital Up-Conversion Transmitter

Source Dr Warren Pratt NR0V
Friedrichshafen, June 2014

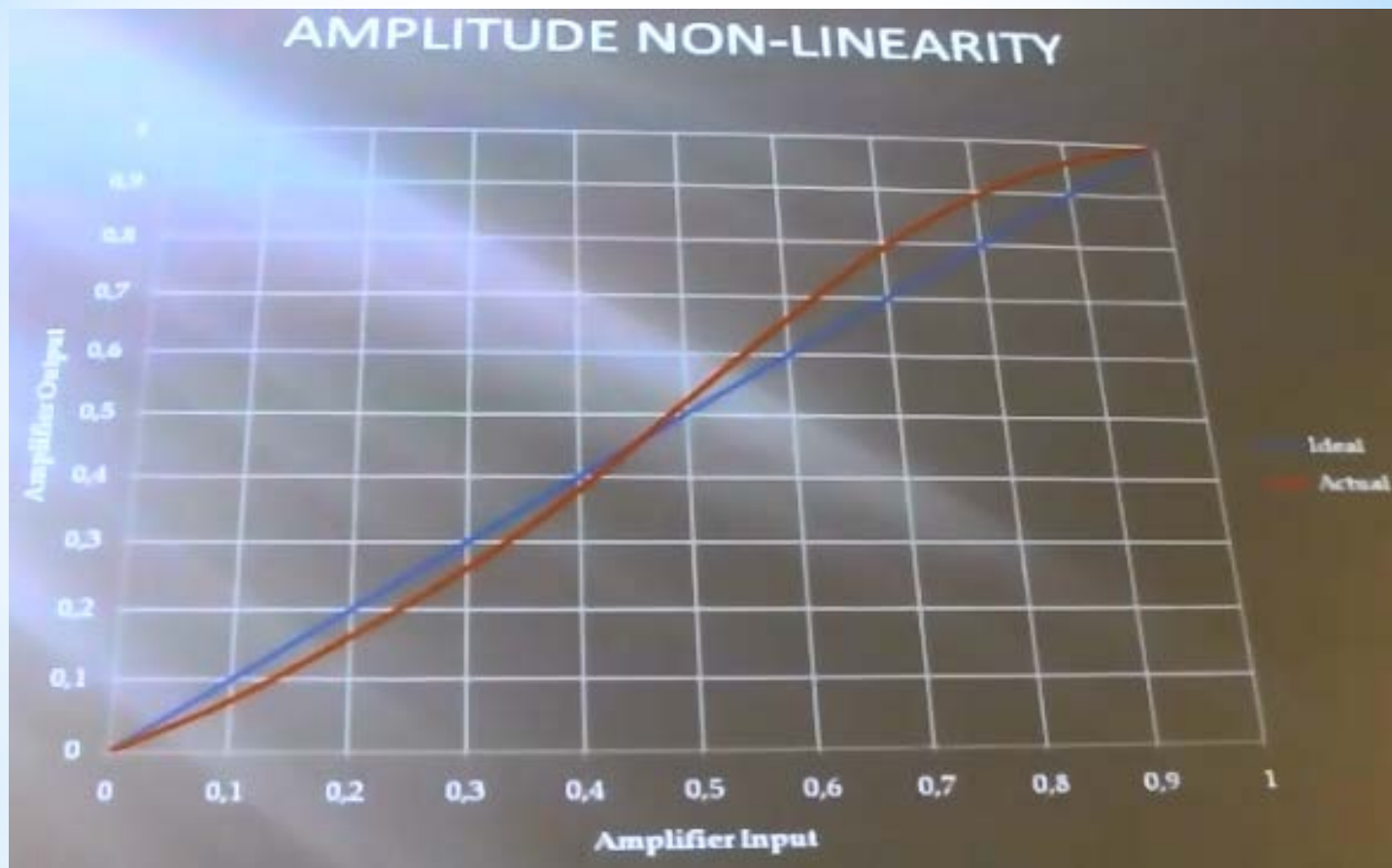
DIGITAL UP-CONVERSION TRANSMITTER



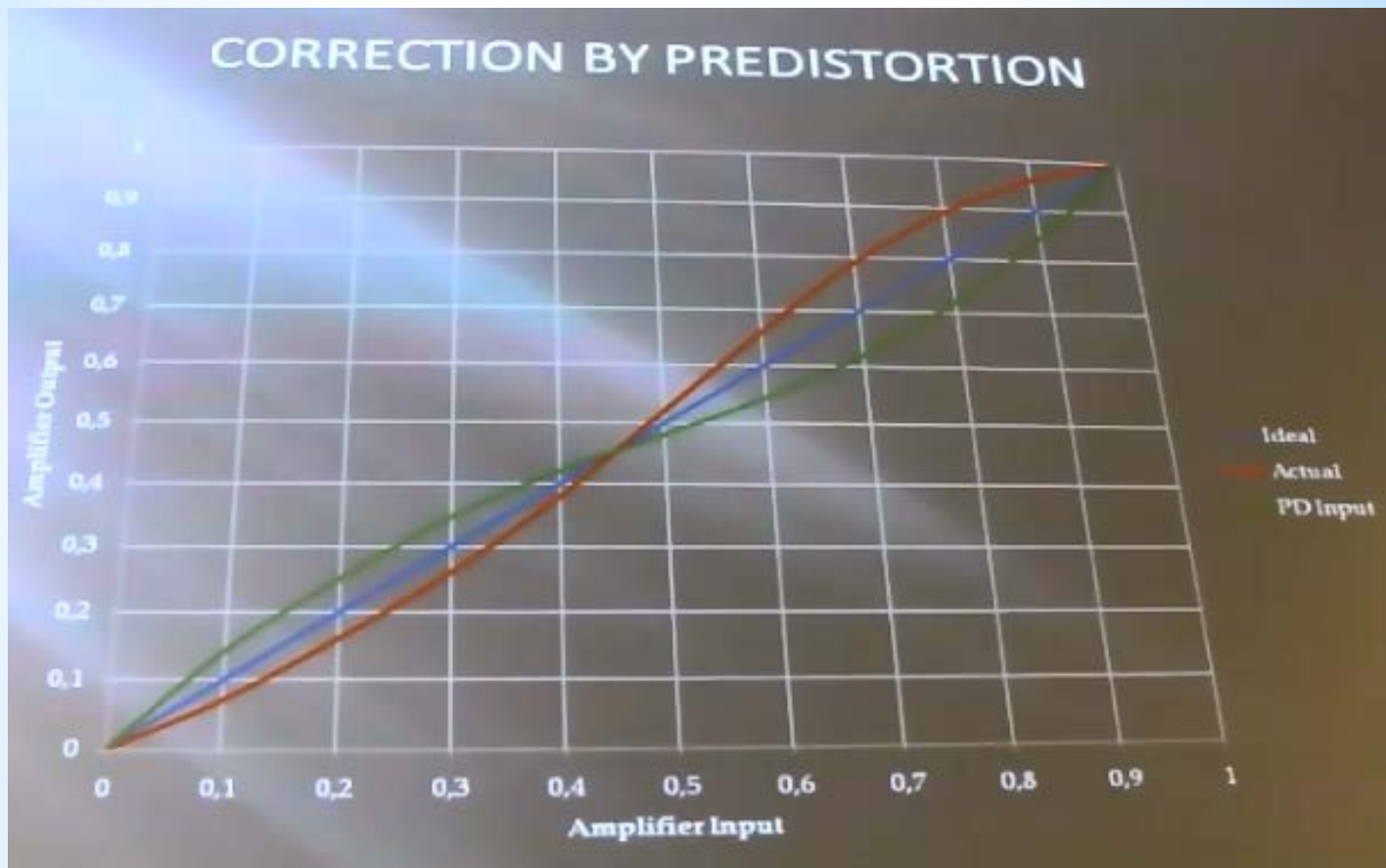
***Quiet SDR XMT
Noise Floor -100dB**



*** Analog Amp adds Noise**

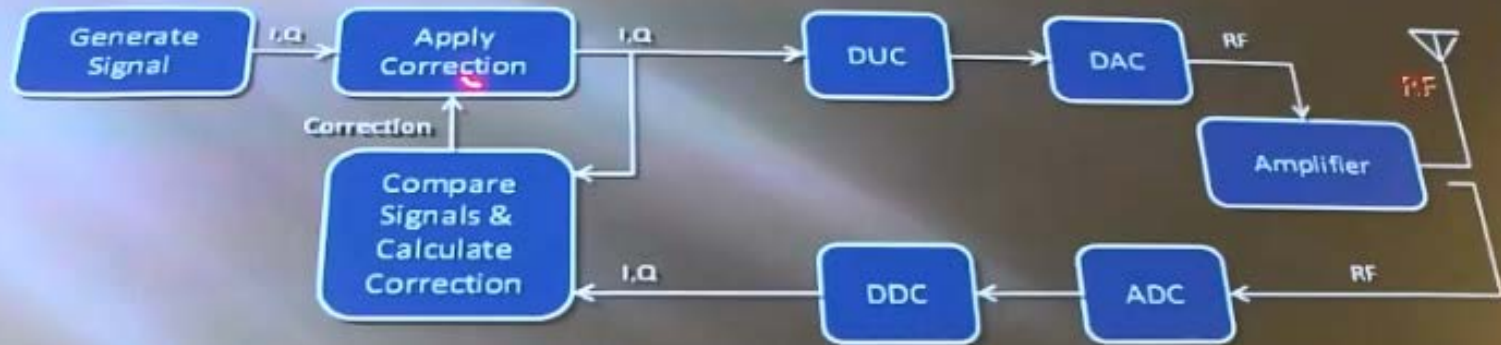


*Why Analog Amps Nonlinear



*Correction by Predistortion

ADAPTIVE BASEBAND PREDISTORTION Basic Concept



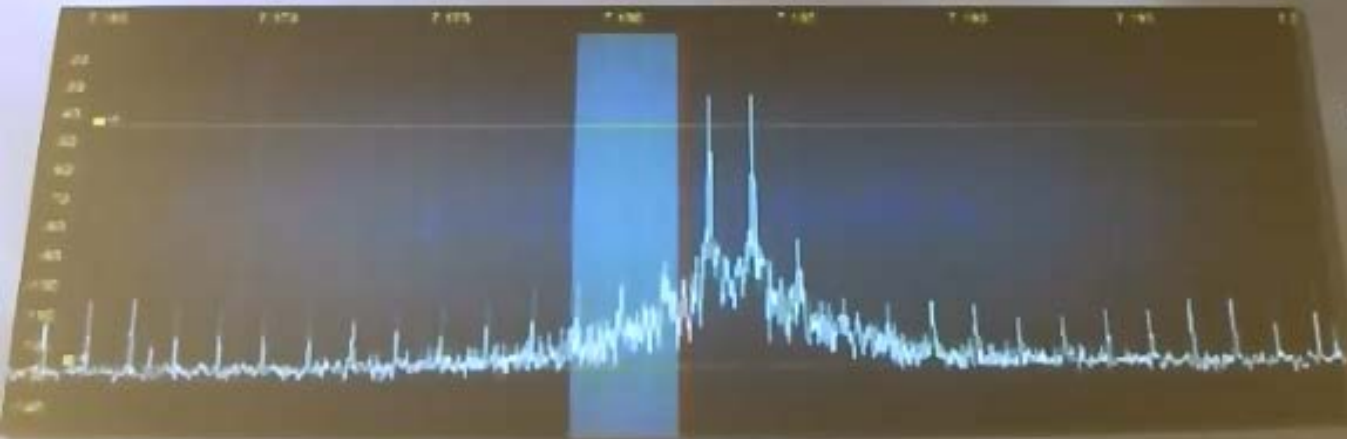
- Apply Correction to the out-bound signal
- Calculate Correction by Comparing the Input & Output of the Amplifier
 - BASEBAND – I,Q Before Up-Conversion / I,Q After Down-Conversion
 - ADAPTIVE – Repeat the process to Adapt to Changing Conditions

* Adaptive Predistortion

PURESIGNAL RESULTS Helmut, DC6NY



- 40 Meters, Class B
- PureSignal OFF
- IMD3 = -16 dBc
- IMD5 = -28 dBc



- PureSignal ON
- IMD3 = -51 dBc
- IMD5 = -64 dBc
- ~ 35 dB Improvement

***35dB improvement**

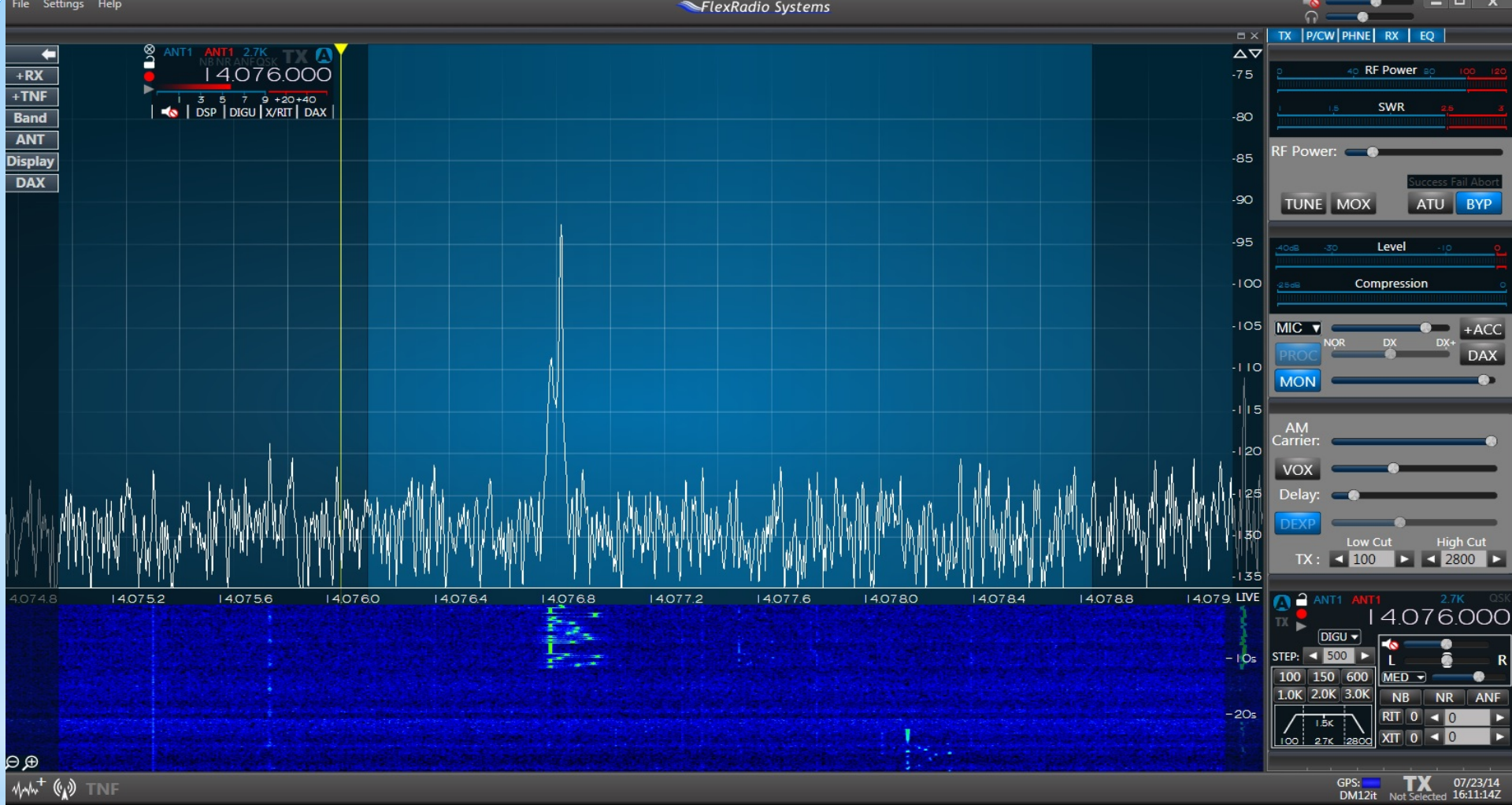
Yes Dennis



***Modern Radio's
can have Knobs**



*C130 - Human Interface



*787 Human Interface

- * Good Single Point Ground
- * Clean up your AC
- * Get Rid of Wall Warts
- * Use Battery DC for all power
- * Avoid Legacy Radios
- * Use Modern Radios
- * Clean up Transmit – Adaptive Pre-Distortion

*Summary



*QUESTIONS

*MY STATION LAYOUT

*KY6LA



*KY6LA VHF Stack



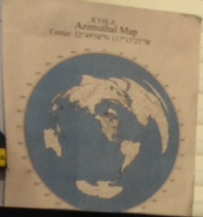
*KY6LA Antenna Control Stack



19:41
-GMT-

U.S. Amateur Bands
Phone Bands

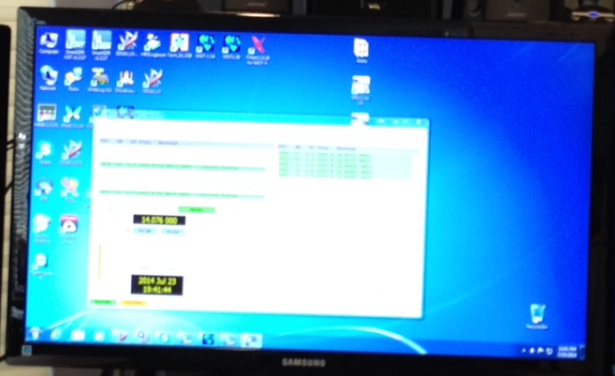
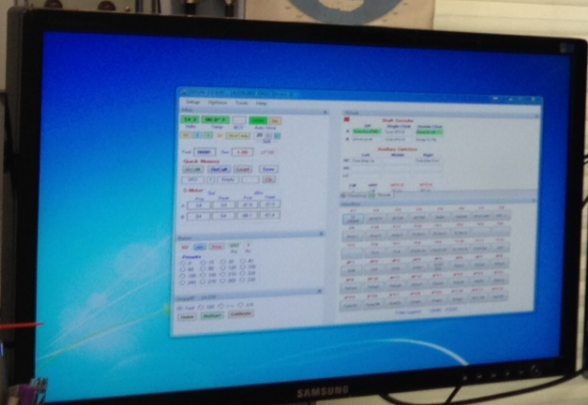
Band	1,800	2,000
160	1,800	2,000
80	3,600	4,000
40	7,125	7,300
30		
20	14,100	14,350
17	18,110	18,180
15	21,200	21,400
12	24,930	24,990
10	28,300	29,700
8	50,100	54,000
5	144,100	148,000
3	222,000	223,000
1.6	420,000	450,000

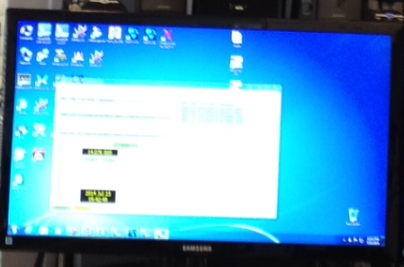
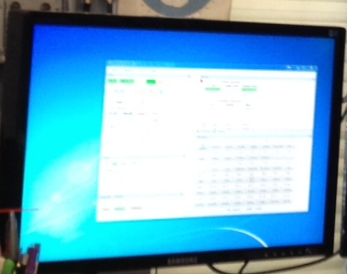
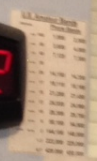


04



RADIO STATION
VE3GFW/K6





*Panafall - DX Secrets

Like Shooting DX Fish in
a Barrel

Working TX6G

DX Summit Equipment & Antennas Bracket | NCAA.com TX6G - Callsign Lookup by

www.dxsummit.fi/Search.aspx

DXSUMMIT BY RADIO X ARCALA

NEWS DX SPOTS BAND SPOTS ANNOUNCEMENTS SEND SPOT SEARCH FORUM DONATE RADIO ARCALA

» SPOT DATABASE SEARCH

Search string: Search: ☒ DX Call ☐ Any column

Year: Band: Mode: Number of spots:

W6TA	24908.0	TX6G	UP 3	1756	24 Mar	Not Found
WOROB-@	18146.0	TX6G	5/7 IN MN QSL G3TXF	1750	24 Mar	Not Found
UA3IKI-@	18146.0	TX6G	fnx for qso 73!	1749	24 Mar	Not Found
W3LPL	24908.1	TX6G	Heard in MD	1749	24 Mar	Not Found
UA3IKI-@	18146.0	TX6G	fnx for qso 73!	1748	24 Mar	Not Found
UA3IKI-@	18146.0	TX6G	fnx for qso 73!	1747	24 Mar	Not Found
WOZK	18146.0	TX6G	fnx for qso 73!	1746	24 Mar	Not Found
R8DX-@	18146.0	TX6G	TNX!	1739	24 Mar	Not Found
ES4IN-@	18146.0	TX6G	UP 5-10	1738	24 Mar	Not Found
W8LR-@	24908.0	TX6G	len up	1733	24 Mar	Not Found
RW4DJS-@	18146.0	TX6G	tnx 153	1727	24 Mar	Not Found
KB6KI-@	18146.0	TX6G	Always 5/9++ FB up 5-10	1725	24 Mar	Not Found
I28EJB	18146.0	TX6G	5/8 IOTA OC-114	1725	24 Mar	Not Found
KD4POJ-@	21035.0	TX6G	QRX 30 Minutes	1715	24 Mar	Not Found
K4WMS	24909.5	TX6G	up 1.5 579 in VA	1713	24 Mar	Not Found
Y08OU-@	21035.2	TX6G	tu , up38,95	1708	24 Mar	Not Found
RA6ARI	21035.1	TX6G	up1.8, tnx qso	1704	24 Mar	Not Found
UT6JAJ-@	24908.0	TX6G	up	1701	24 Mar	Not Found
KJ9C/7	24908.0	TX6G	Q5X 24911.15 UP STRONG IN MT	1701	24 Mar	Not Found
KL2YV	18146.0	TX6G	5/9 in Alaska	1656	24 Mar	Not Found
I22IPF	14182.0	TX6G	up 5/10 - pse	1655	24 Mar	Not Found
RO1B	21035.1	TX6G	Q5X 21036.38 cq up1	1652	24 Mar	Not Found
R4AZ-@	14182.0	TX6G	tnx QSO up 14.210 FB!	1643	24 Mar	Not Found
ACSRRK-@	18146.0	TX6G	5-10 up	1639	24 Mar	Not Found
A6SCA	10121.0	TX6G	OC-114 tnx! up 1	1638	24 Mar	Not Found

camtasiaup (1).exe

Sign In/Register

Solar-Terrestrial Data
24 Mar 2014 1753 GMT
SFI: 158 SN: 159
A-Index: 6
K-Index: 1
X-Ray: B7.7
304A: 176.0 @ SEM

Calculated Conditions

Band	Day	Night
80m-40m:	Poor	Good
30m-20m:	Fair	Good
17m-15m:	Good	Good
12m-10m:	Good	Poor
Signal Noise:	30-31	

Click to Install Solar Data On your Web Site
<http://www.n0nbn.com>
Copyright Paul L. Herrman 2010

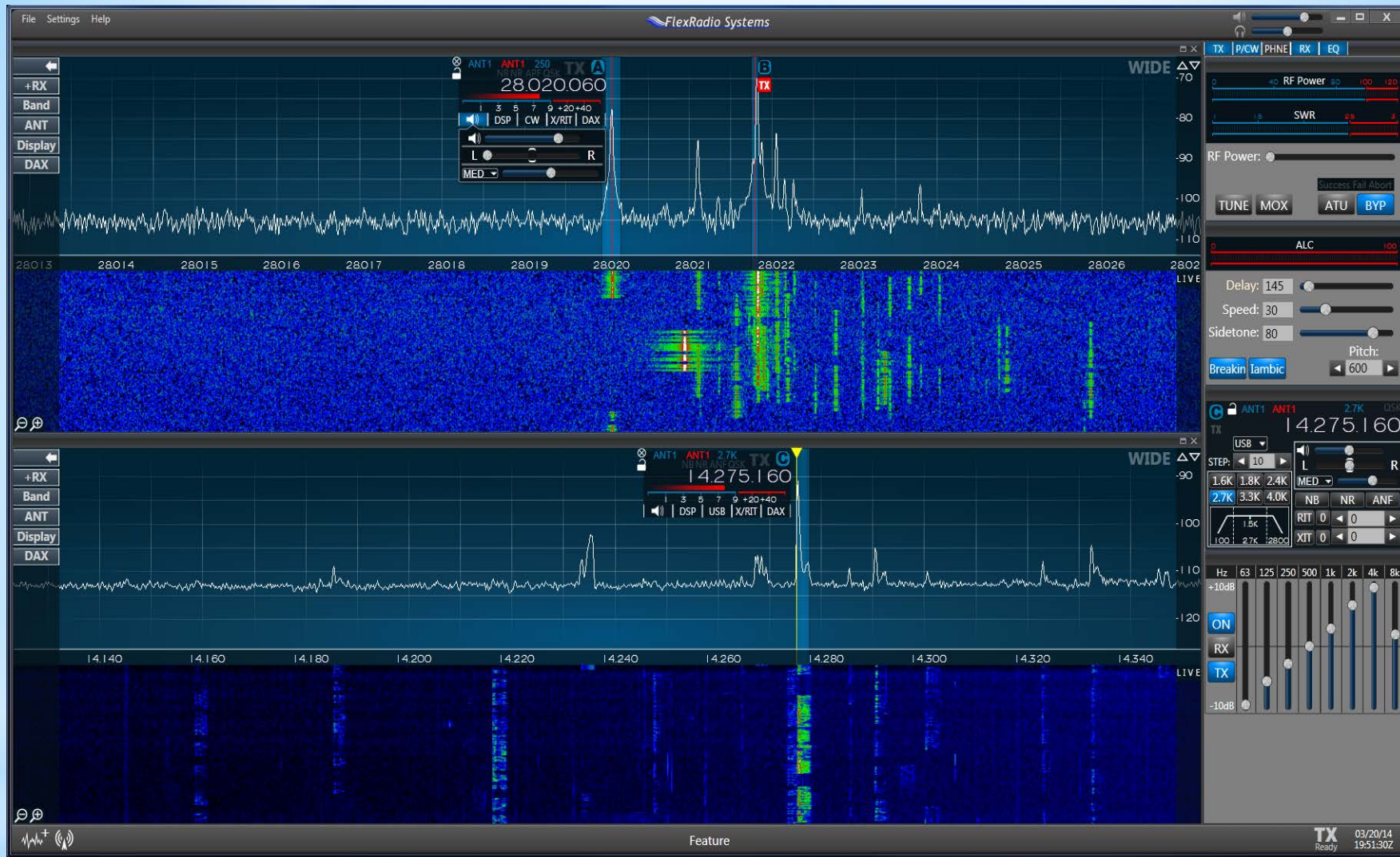
DX ENGINEERING

The World's Most Popular 43-Foot Vertical Antenna!

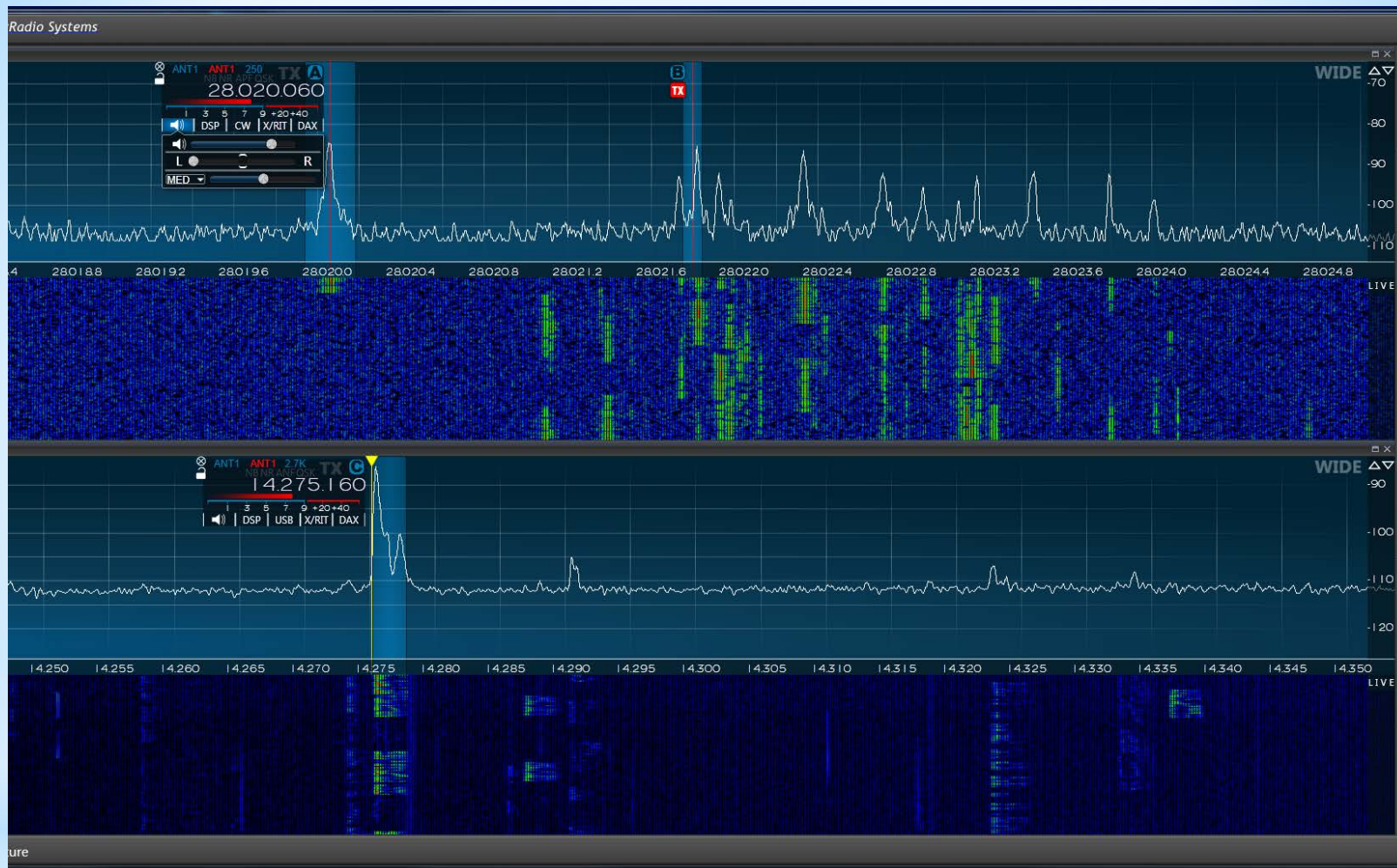
- High Quality
- Superior Performance
- Low Price

Thousands Sold!

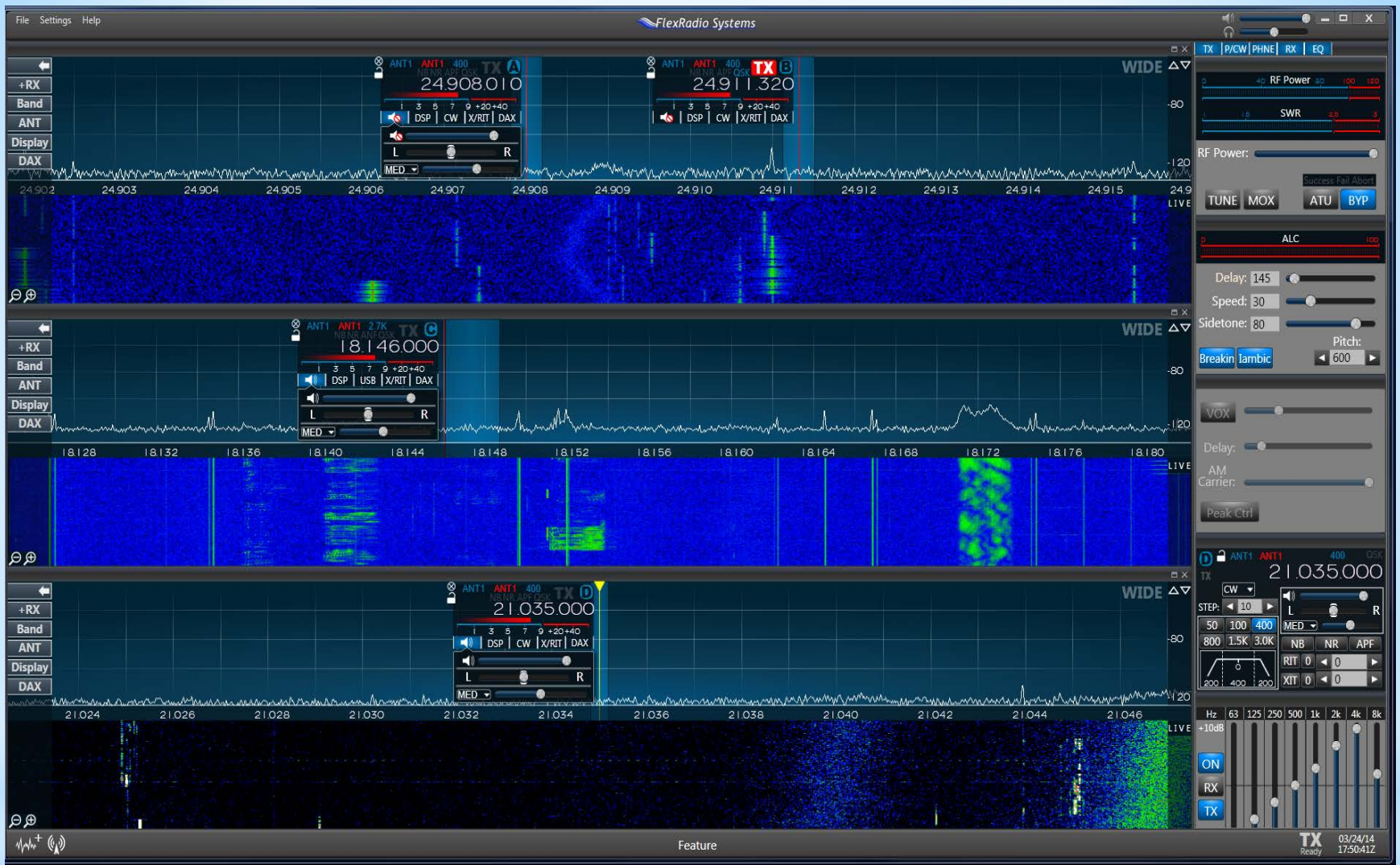
*TX6G Spots



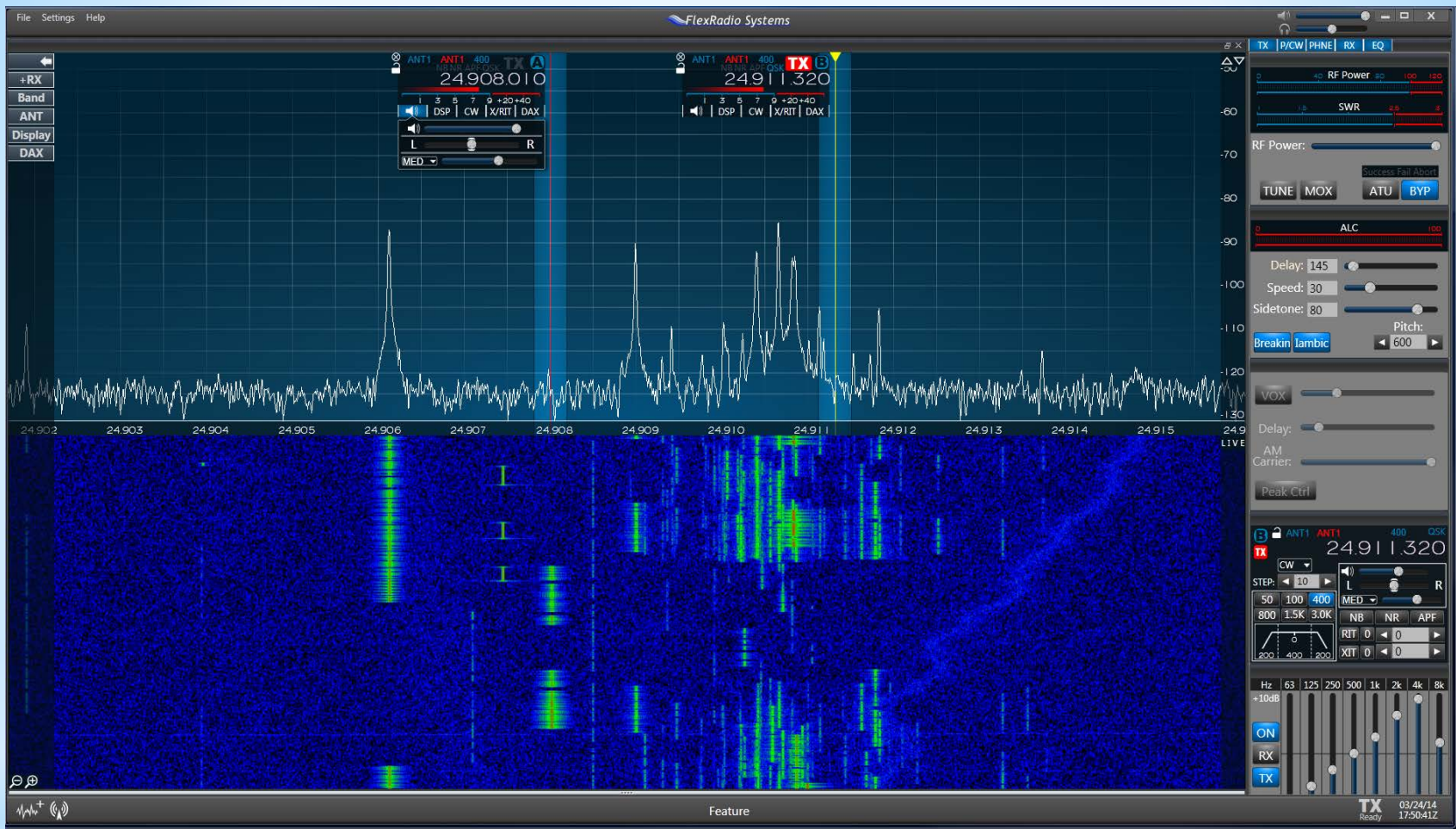
*TX6G



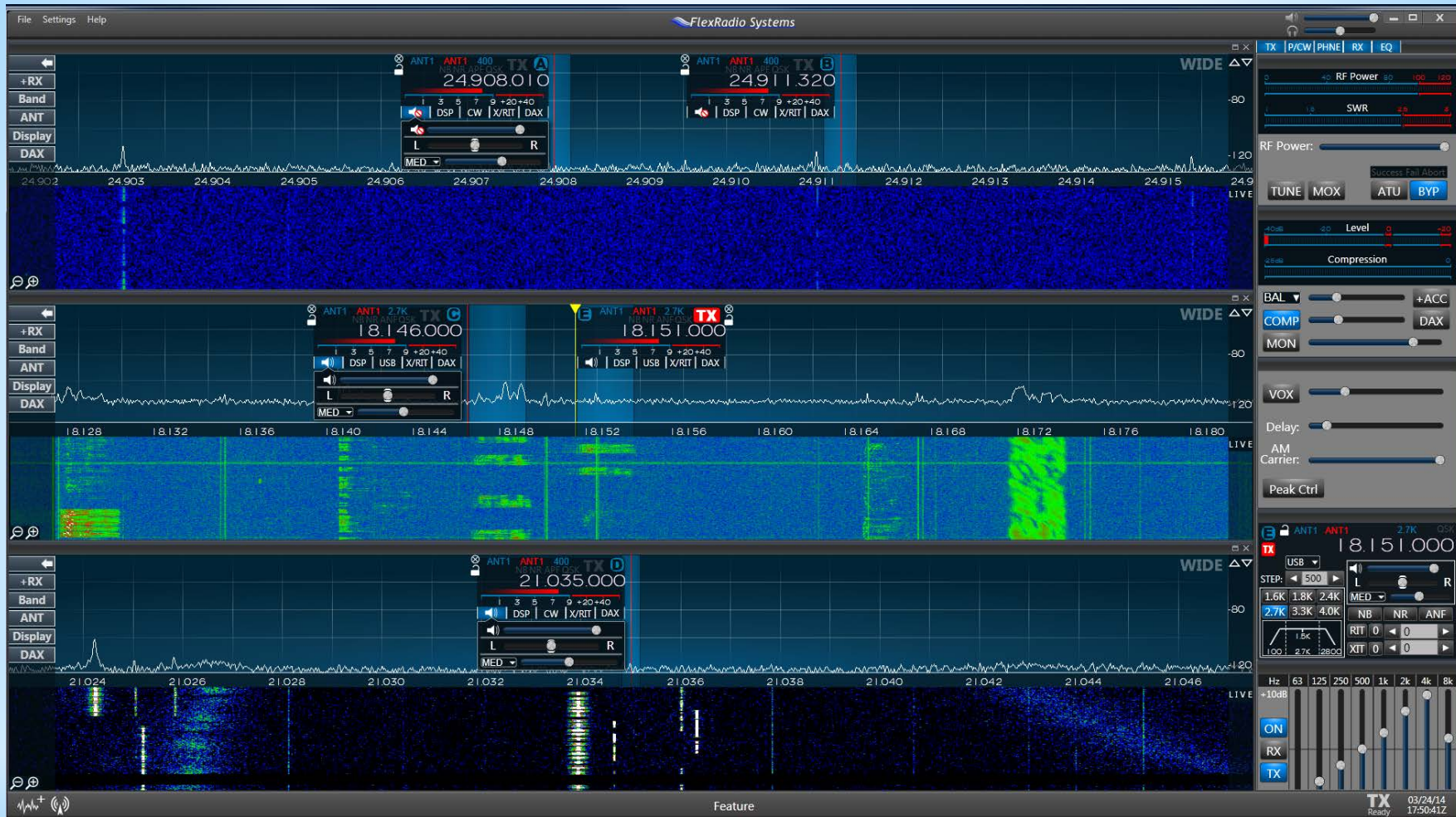
*TX6G Split (zoom)



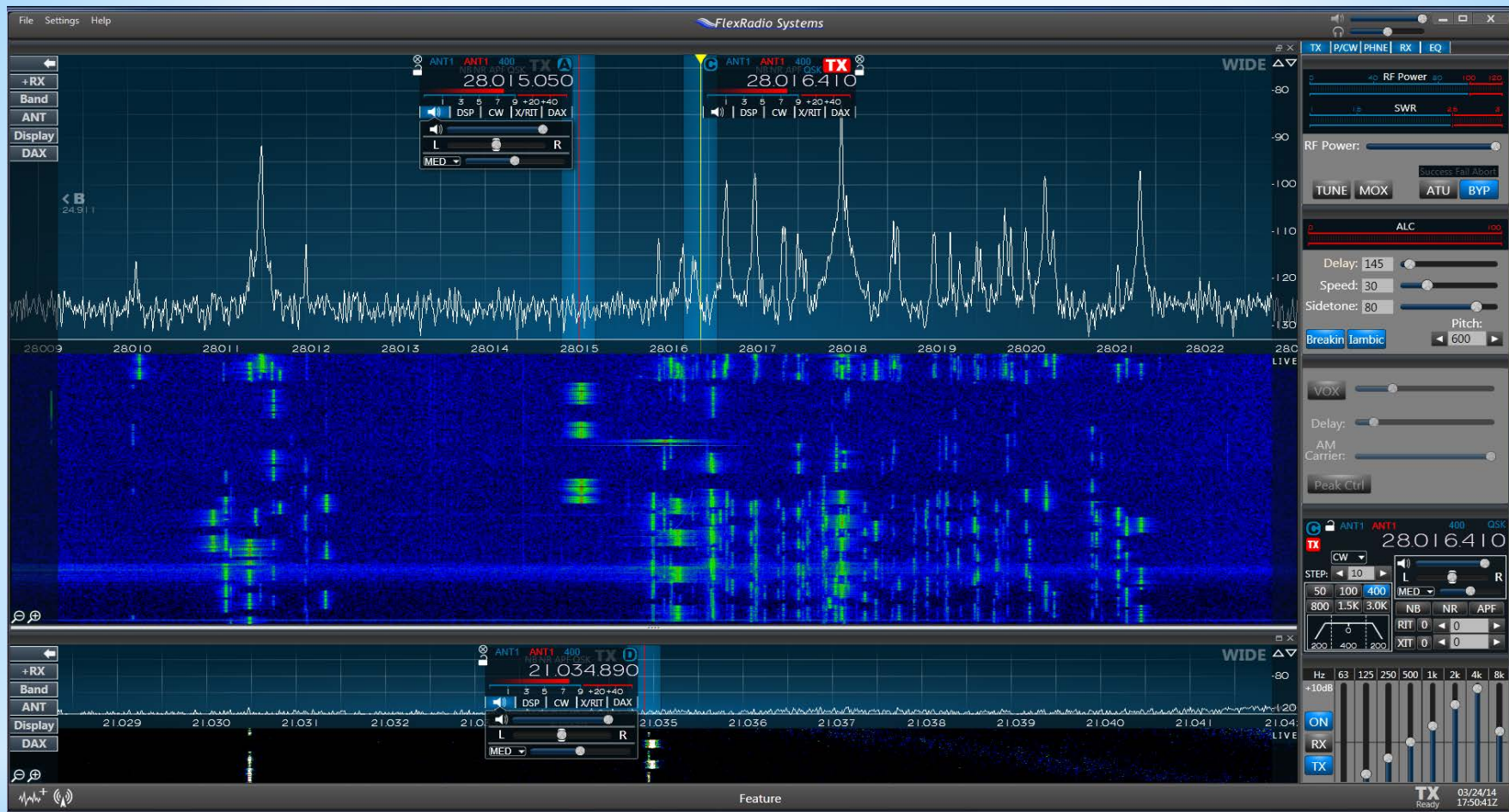
*TX6G 3-Band Panafall



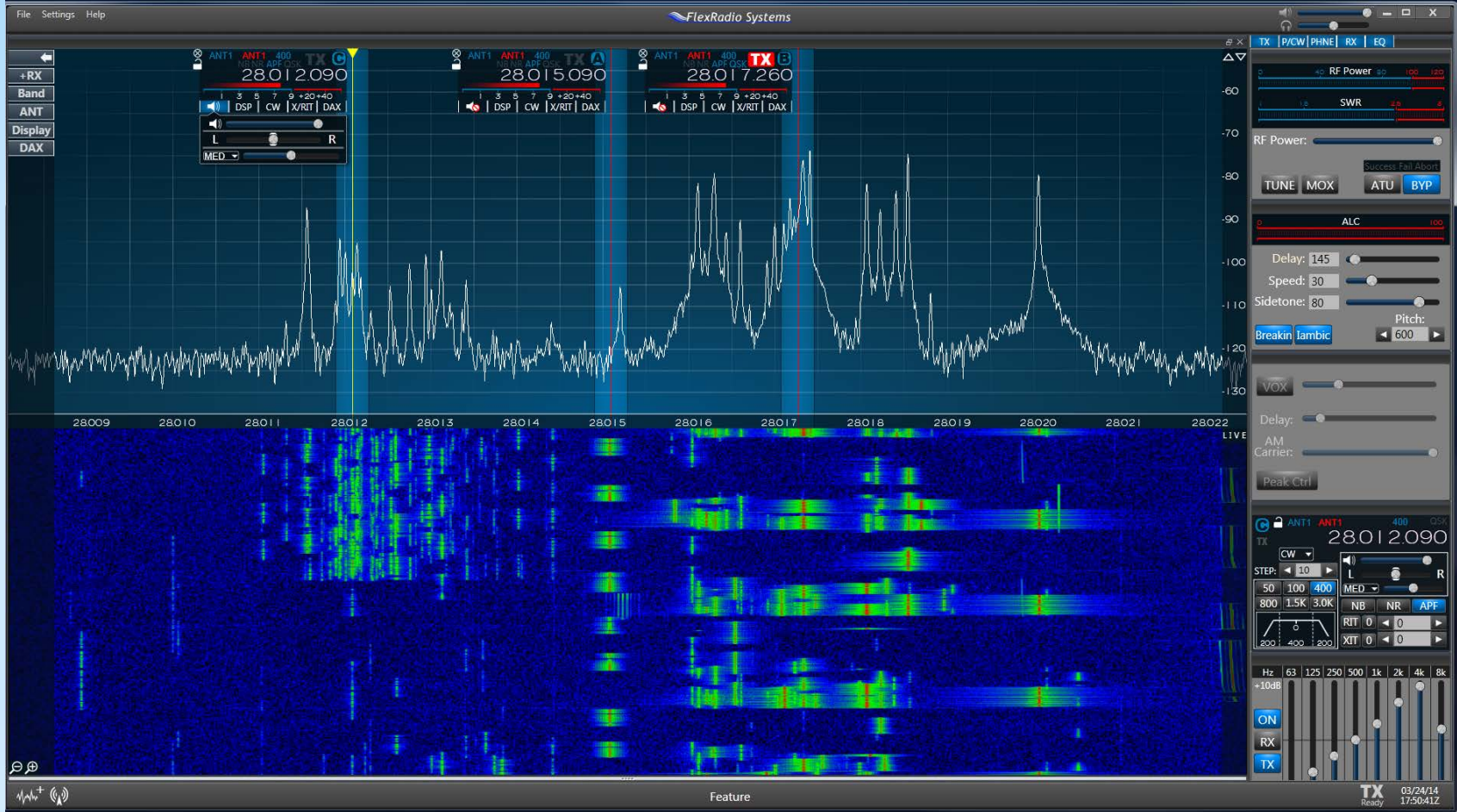
***TX6G - 12m Zoom**



*TX6G-17m SSB

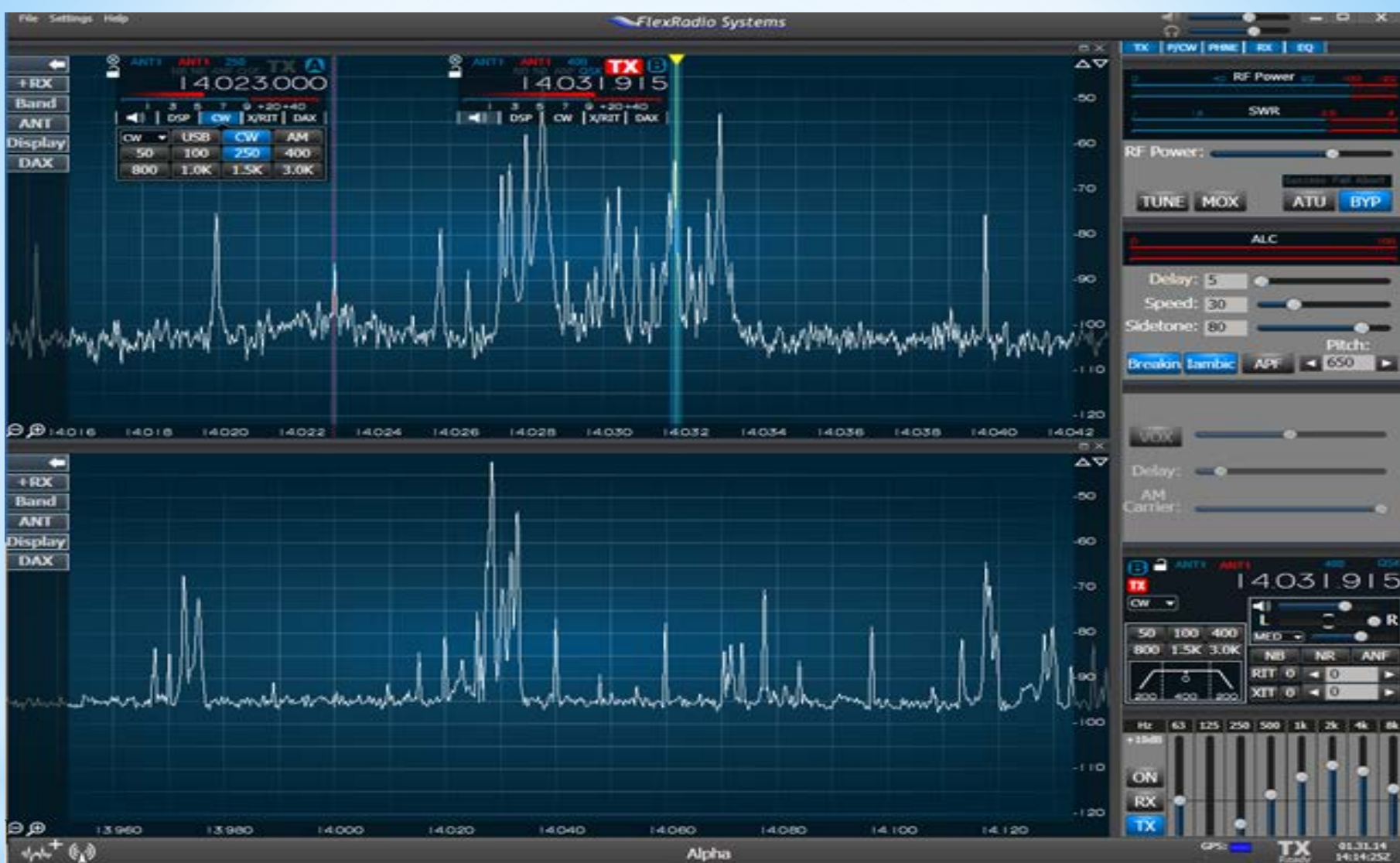


*TX6G- 10m UP UP EU EU!

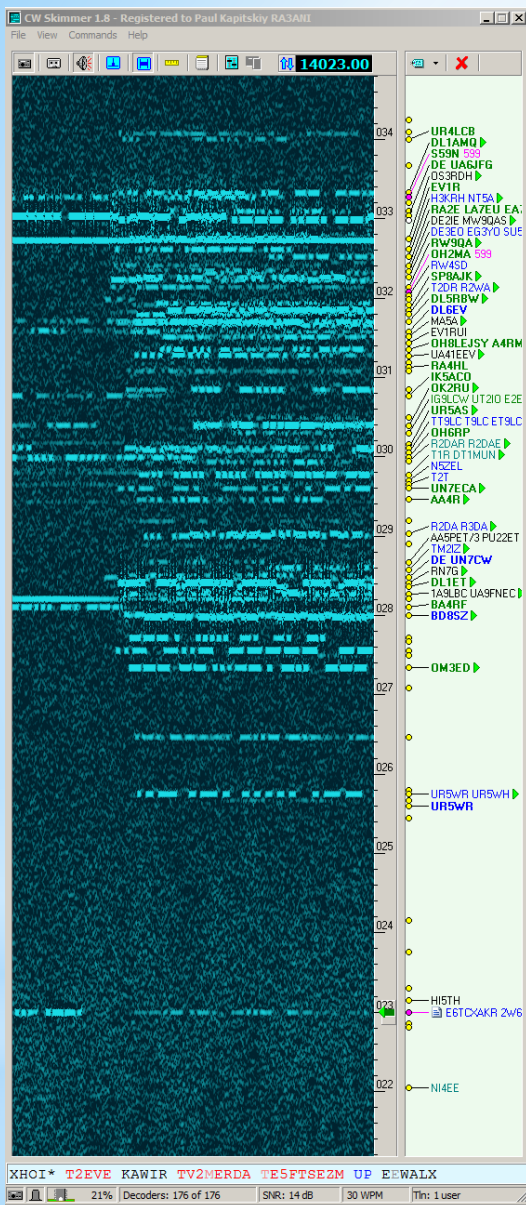


*TX6G - 10m

DX Secrets Working FT5ZM

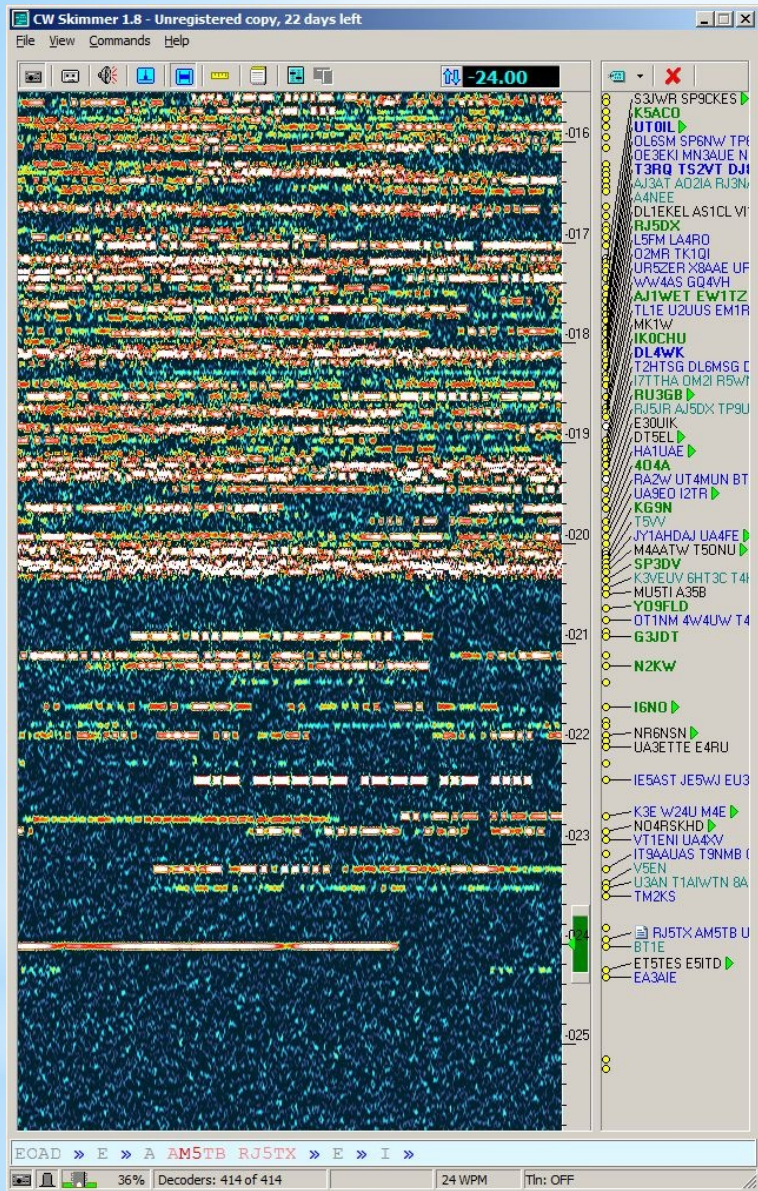


*ET5ZM



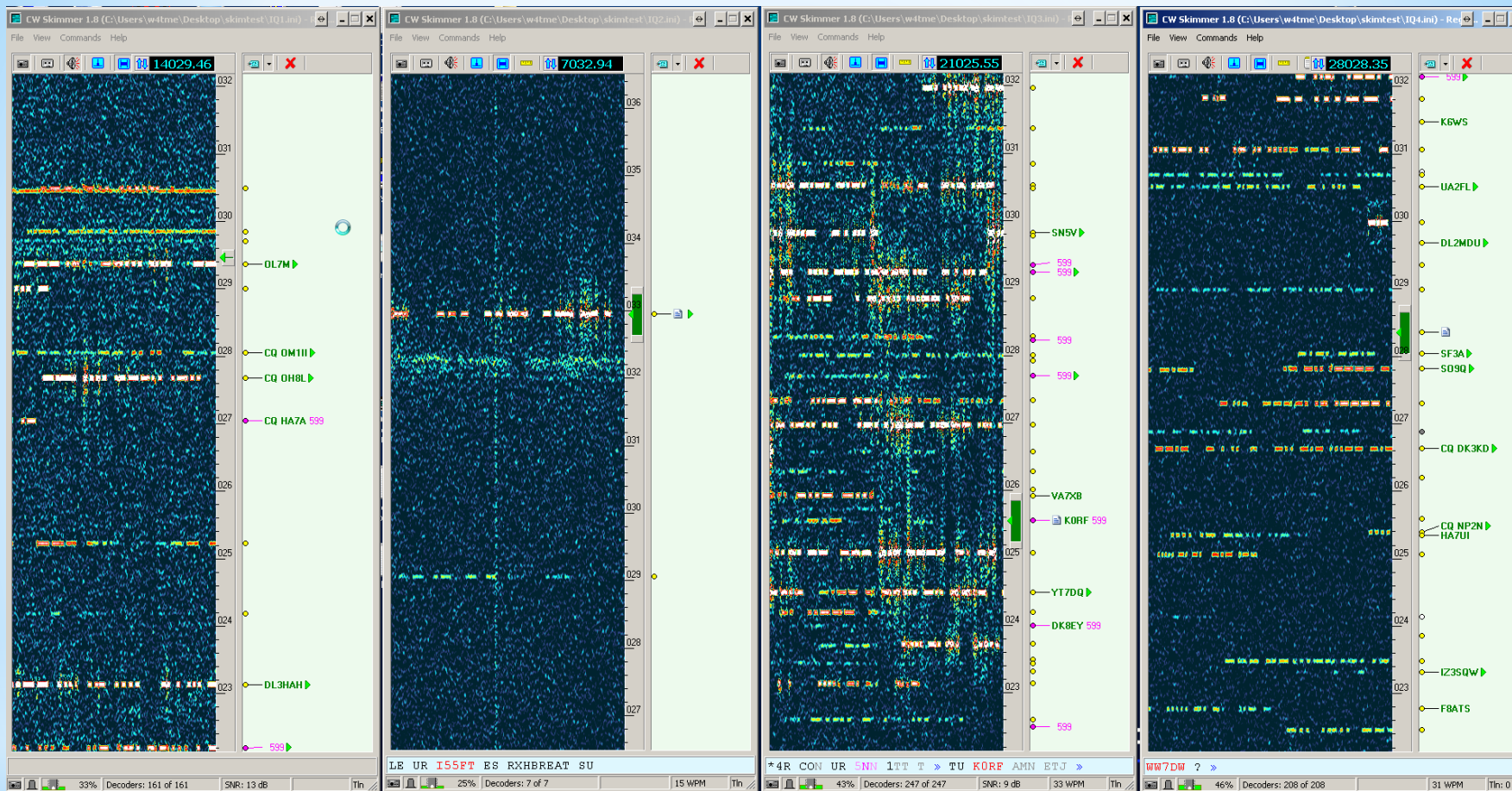
* Antenna Pointed at FT5ZM

* FT5ZM Skimmer



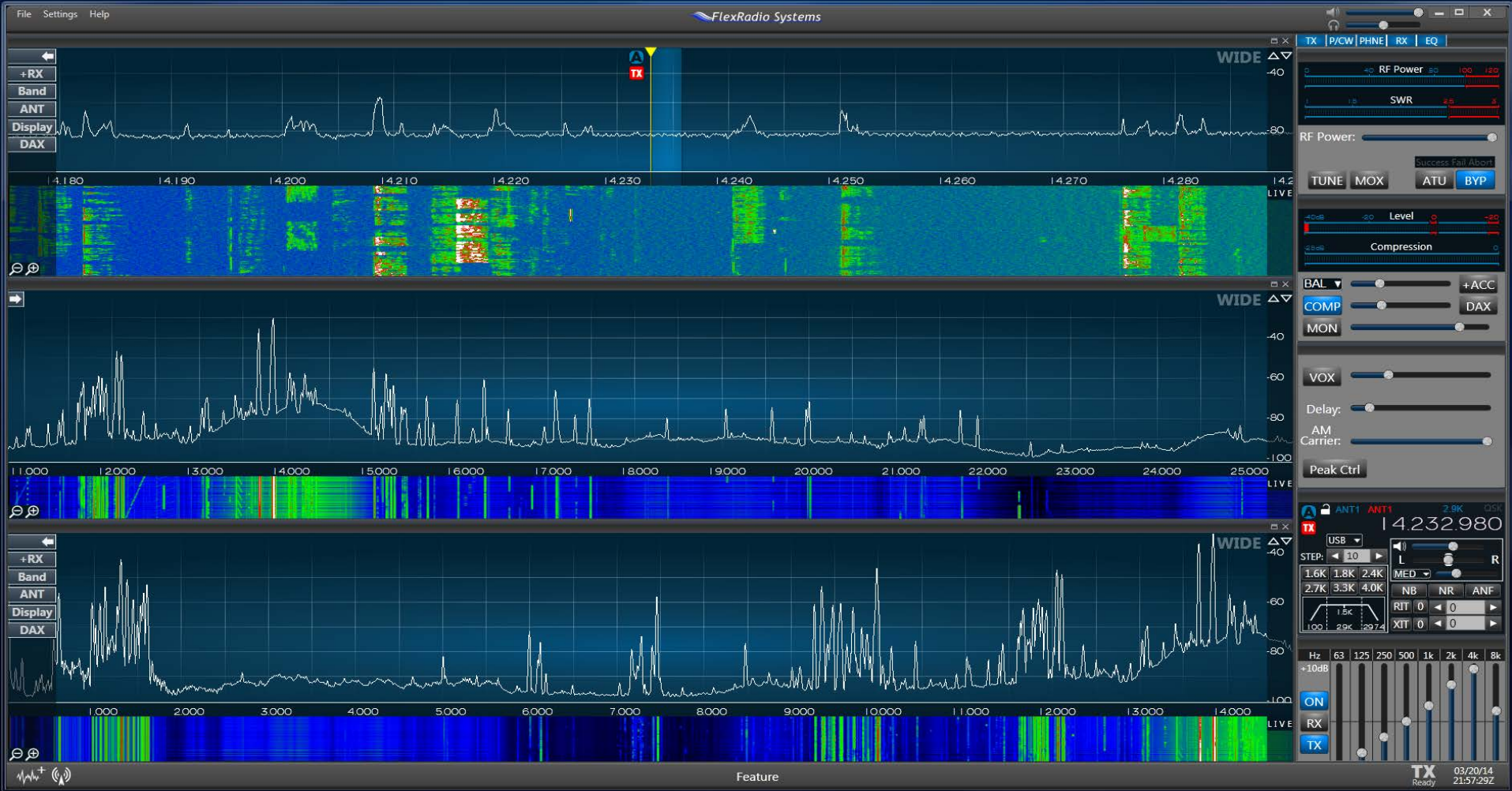
*Pointed towards EU

*FT5ZM Skimmer



*CW Skimmer x 4





*20M ±0 MHz-25MHz