Easing the transition to AM IBOC

Tools and techniques to help the broadcaster

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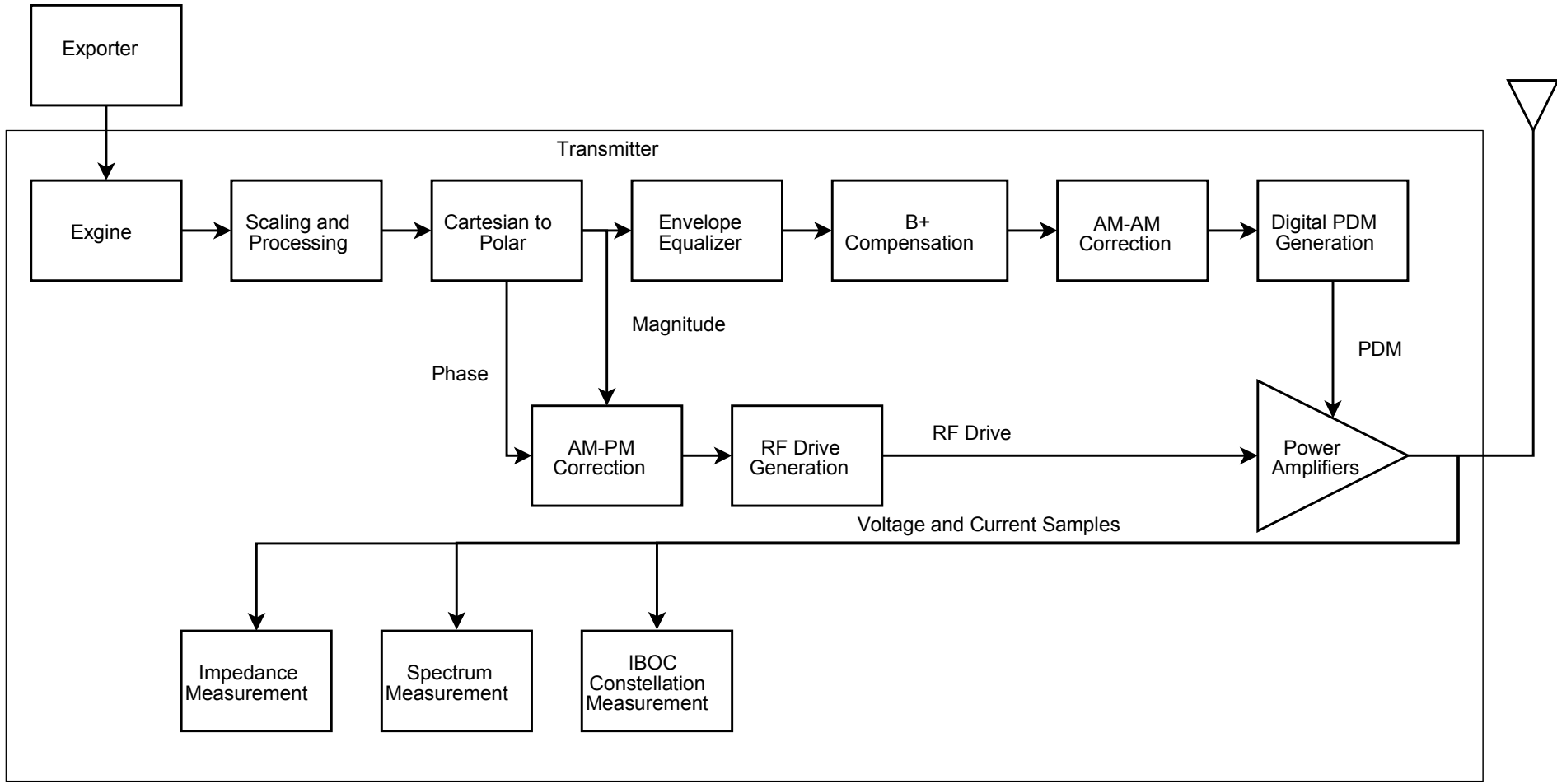
Nautel NX series

- Designed for IBOC and other digital modulation schemes
- Includes adaptive precorrection for AM-AM, AM-PM, and modulator filter characteristics
- Digital PDM and RF drive
- Includes instrumentation to aid in IBOC installations

Key technologies

- Transmitter instrumentation
- Advanced digital PDM synthesis and AM-AM correction
- Wideband modulator filter and equalization
- Wideband RF drive network and AM-PM correction
- Soft peak limiting

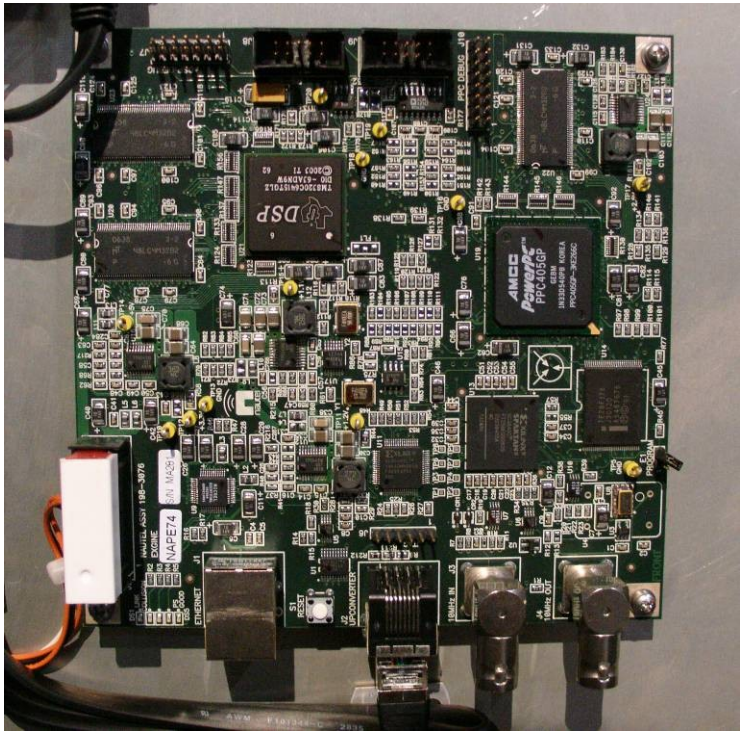
System diagram



Exporter/Exgine architecture

Exporter and Exgine replace the previous IBOC exciter solution.

- Completely embedded solution
- IBOC comes into the transmitter as digital I/Q, rather than analog mag/phase
- Allows for a much cleaner signal with a reduced risk for RF contamination



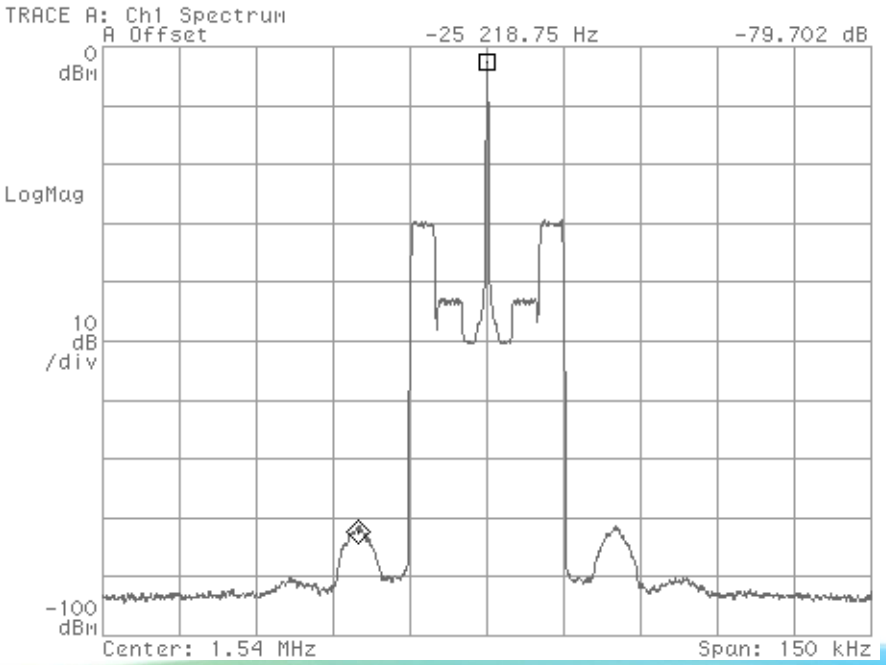
Instrumentation

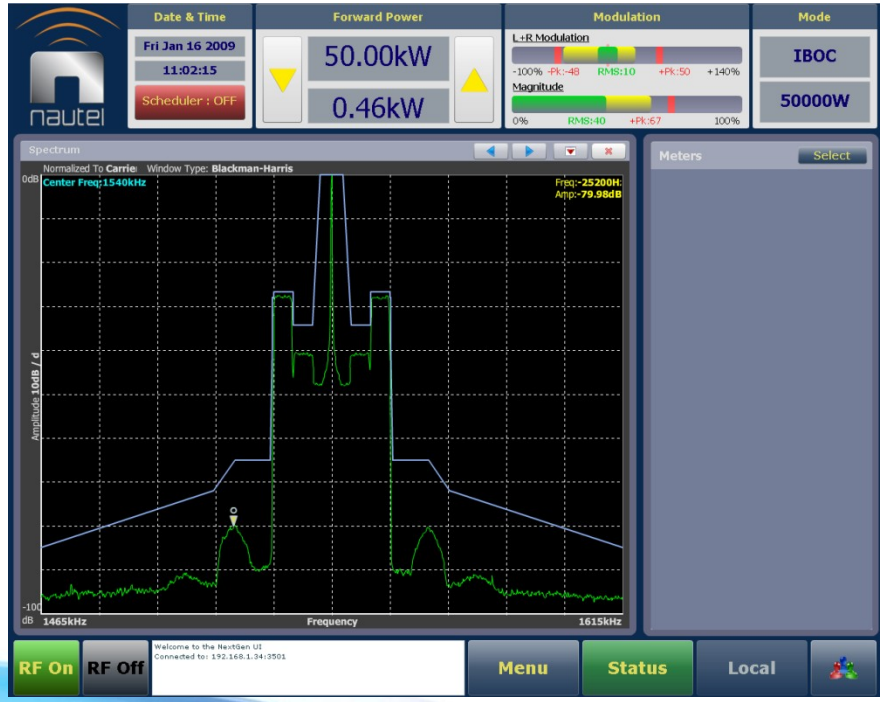
Several tools can be used to troubleshoot the IBOC installation.

- Spectrum analysis
- Impedance analysis
- IBOC quality measurements

Spectrum analysis

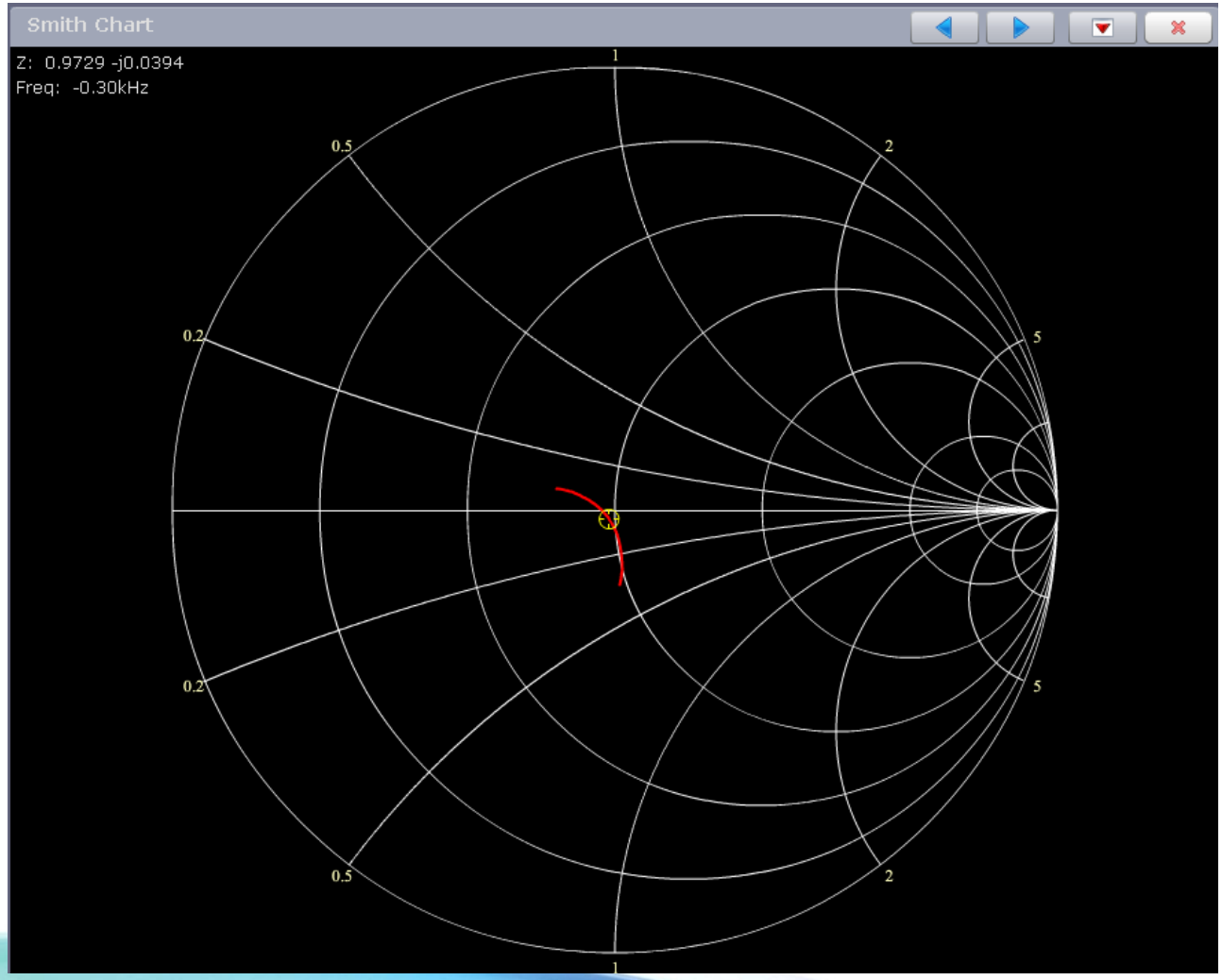
- FFT-based spectrum analyzer based on directional forward voltage calculation
- Comparable results to other analyzers





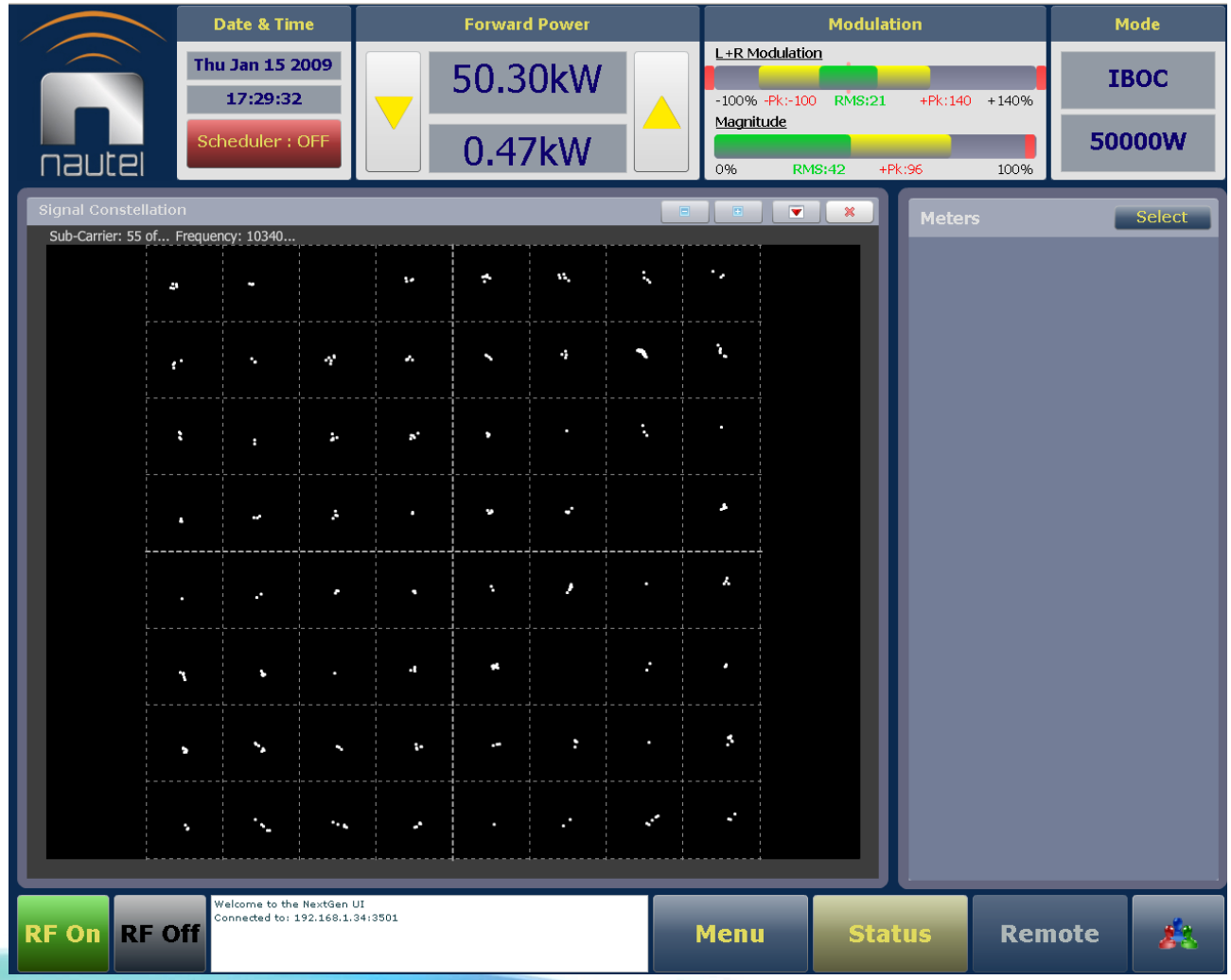
Impedance analysis

- Based on modulation signal – no training sequence
- Updates in real time with load changes
- Provides data at all modulated frequencies

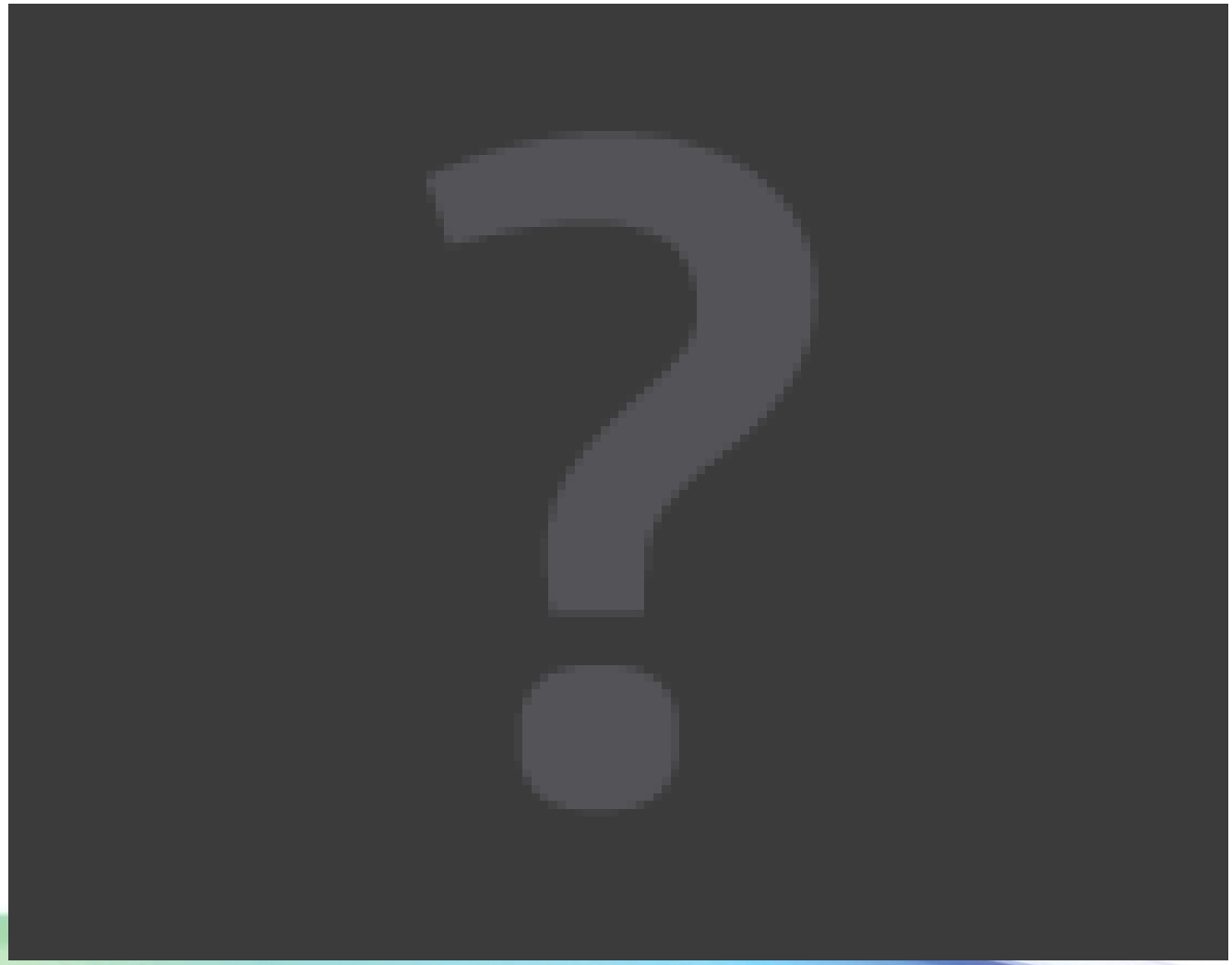


IBOC constellation

- All IBOC subcarriers are demodulated
- Noise or distortion will result in spreading
- Over modulation on the analog audio can also affect the IBOC signal quality

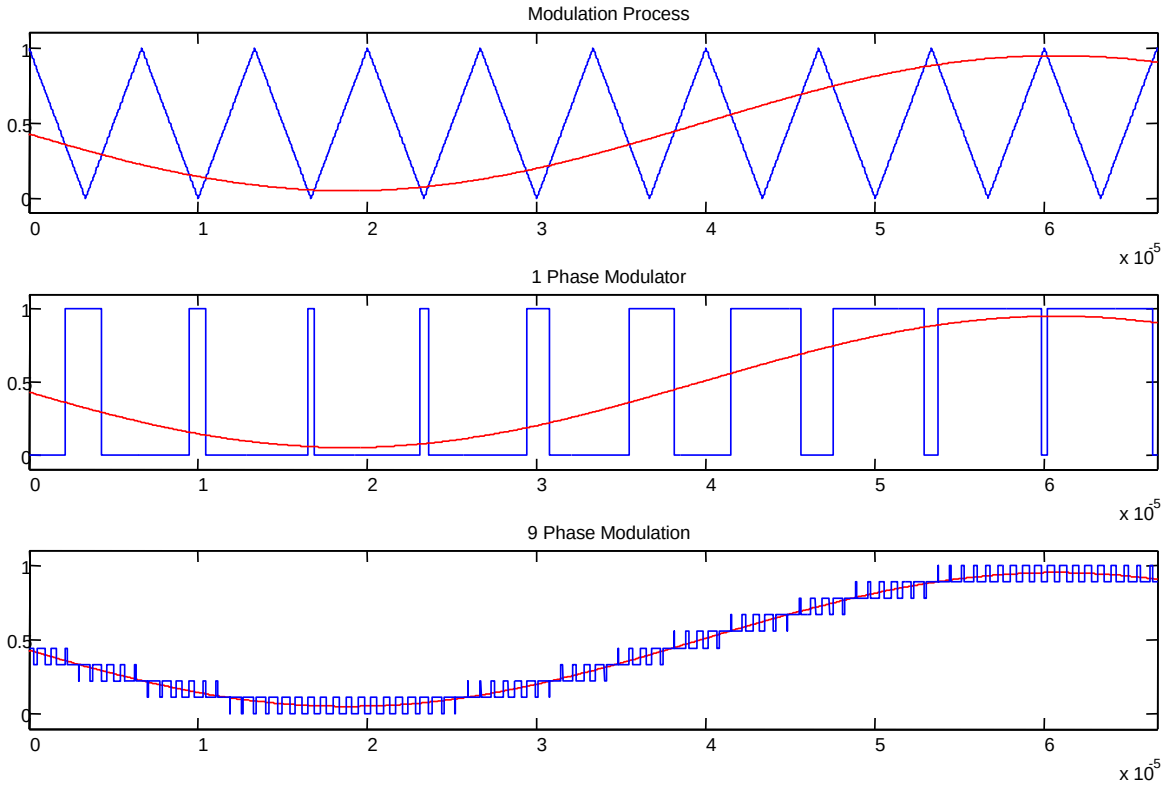


Instruments demo



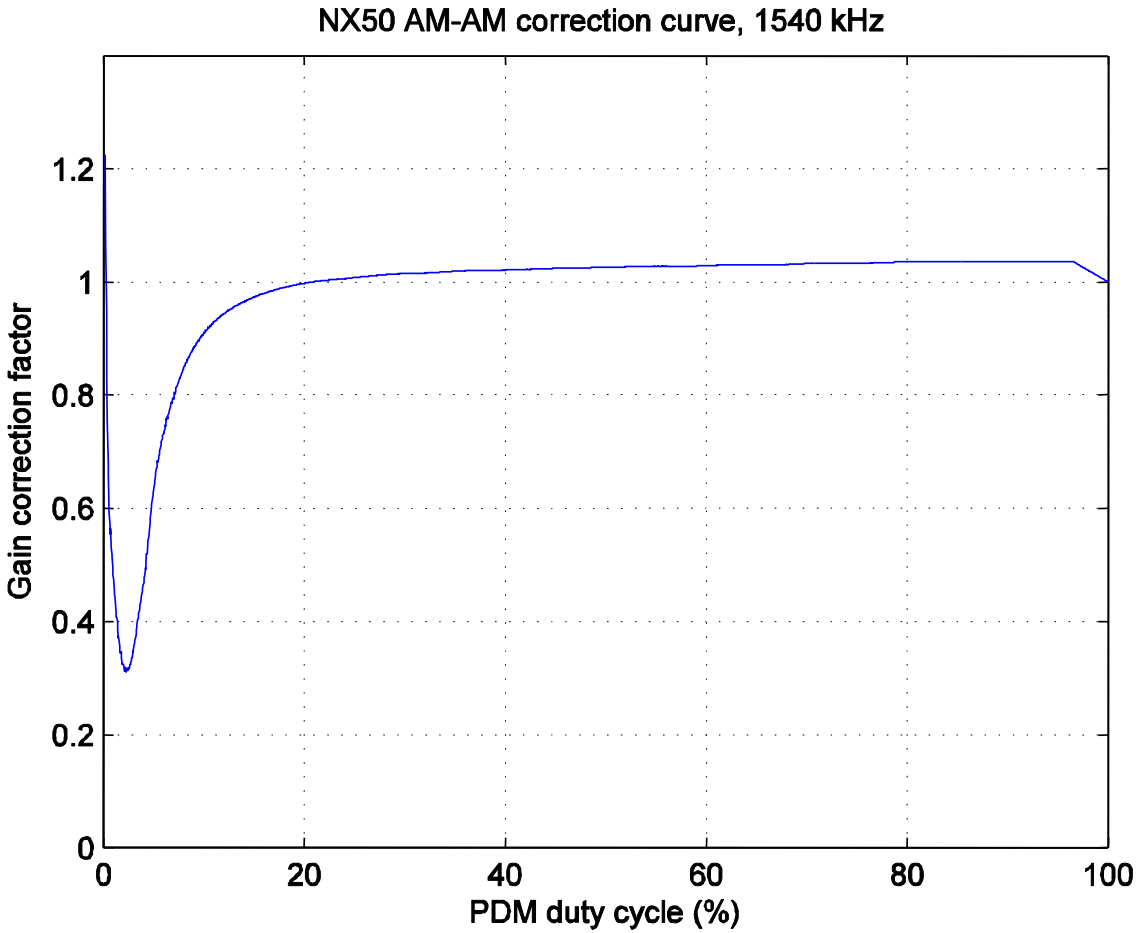
Digital PDM synthesis

- Effective sampling rate of 320 MHz
- 9-phase PDM: spaced every 40°
- Cancellation out to $3*f_{PDM}$ in the power module
- Cancellation out to $9*f_{PDM}$ in the transmitter
- PDM edge rate of 2.7 MHz
- Avoids all distortion-causing mechanisms inherent in analog PDM synthesis



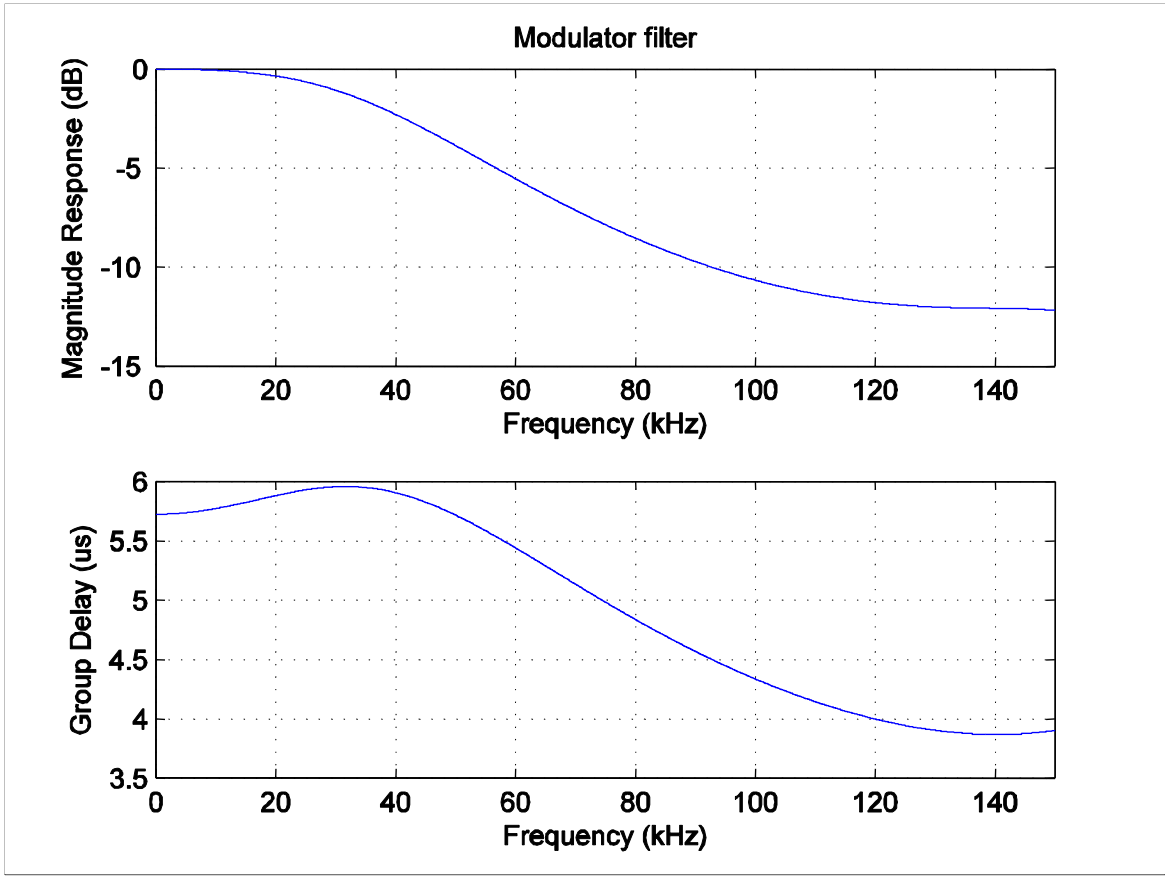
AM-AM correction

- Corrects for pulse stretching at low PDM duty cycles
- Multiplies incoming signal by a gain corresponding to the incoming duty cycle
- Allows for extremely low AM distortion
- No loss in efficiency, unlike most hardware solutions



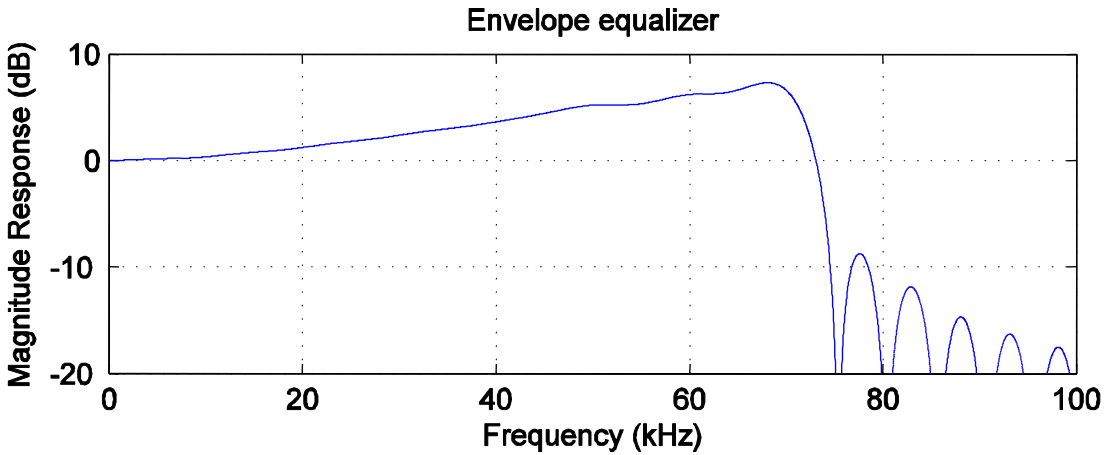
Modulator filter design

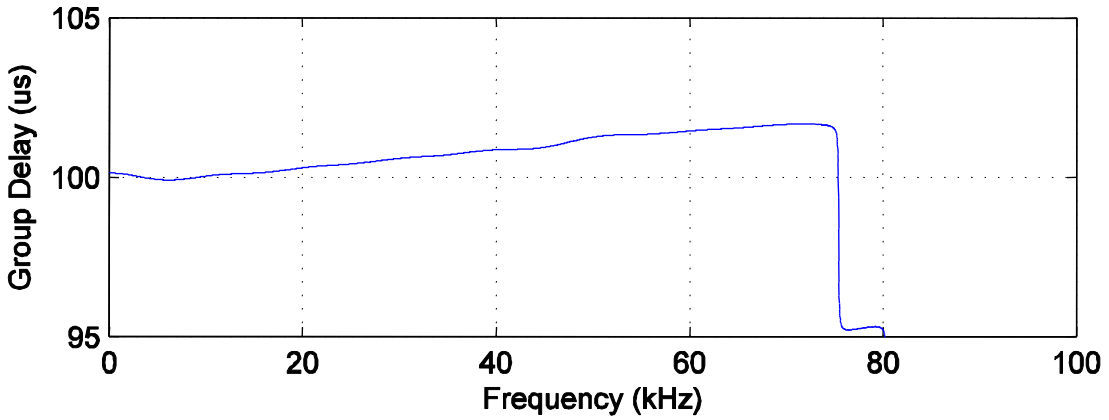
- Digital PDM ensures cancellation of PDM harmonics, allowing for wideband filter
- Gentle filter response is less sensitive to antenna loading
- Well-suited to equalization, allowing flat response



Envelope equalization

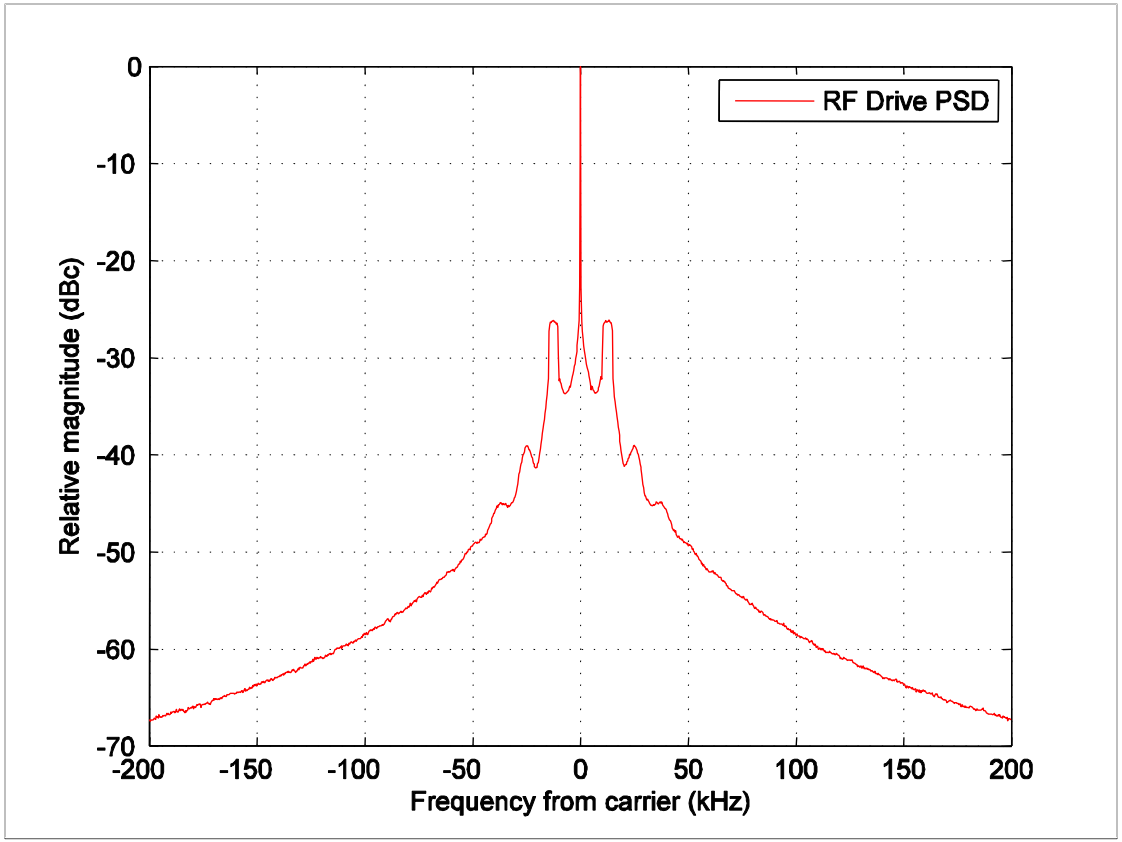
- Adapts to modulator filter response in transmitter
- Can compensate for small changes in load impedance
- Flat frequency response on the envelope is critical to IBOC performance





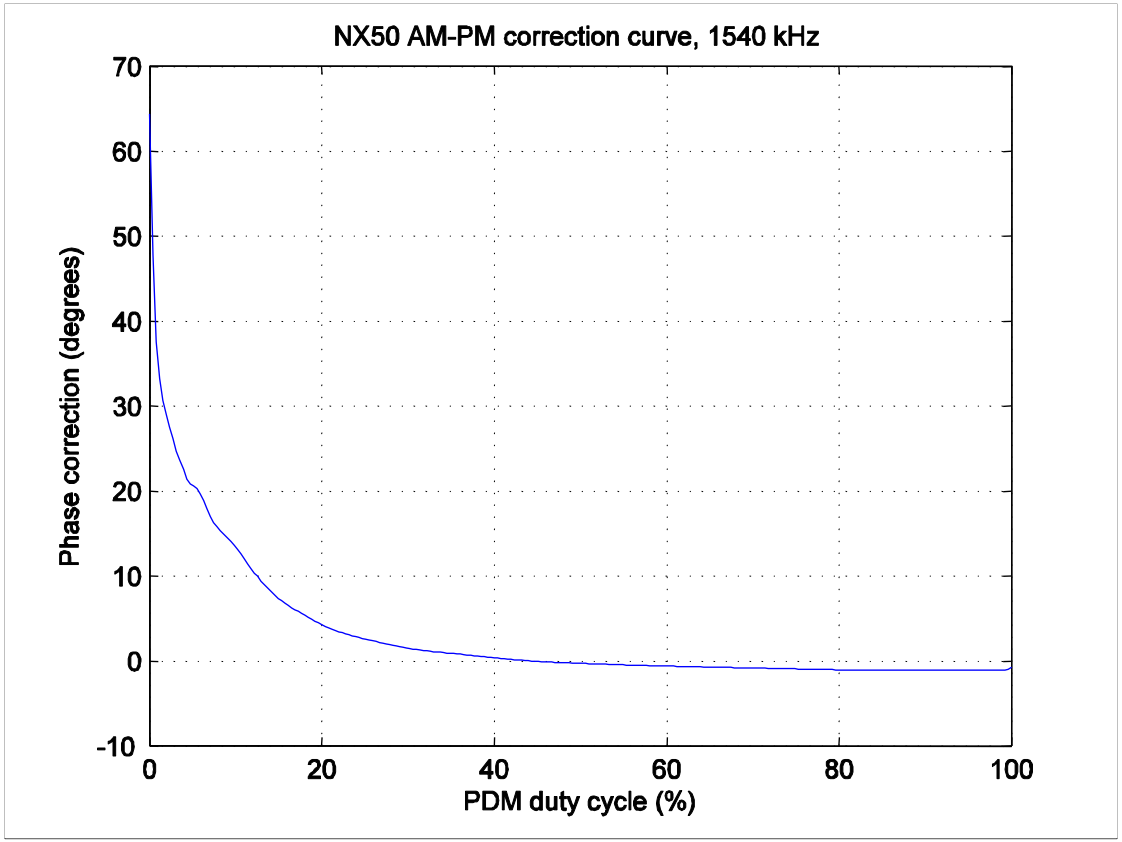
Digital RF drive

- RF drive generated using high speed DAC
- No tuned components in RF drive distribution
- Allows high frequency component in drive signal to pass through unaltered



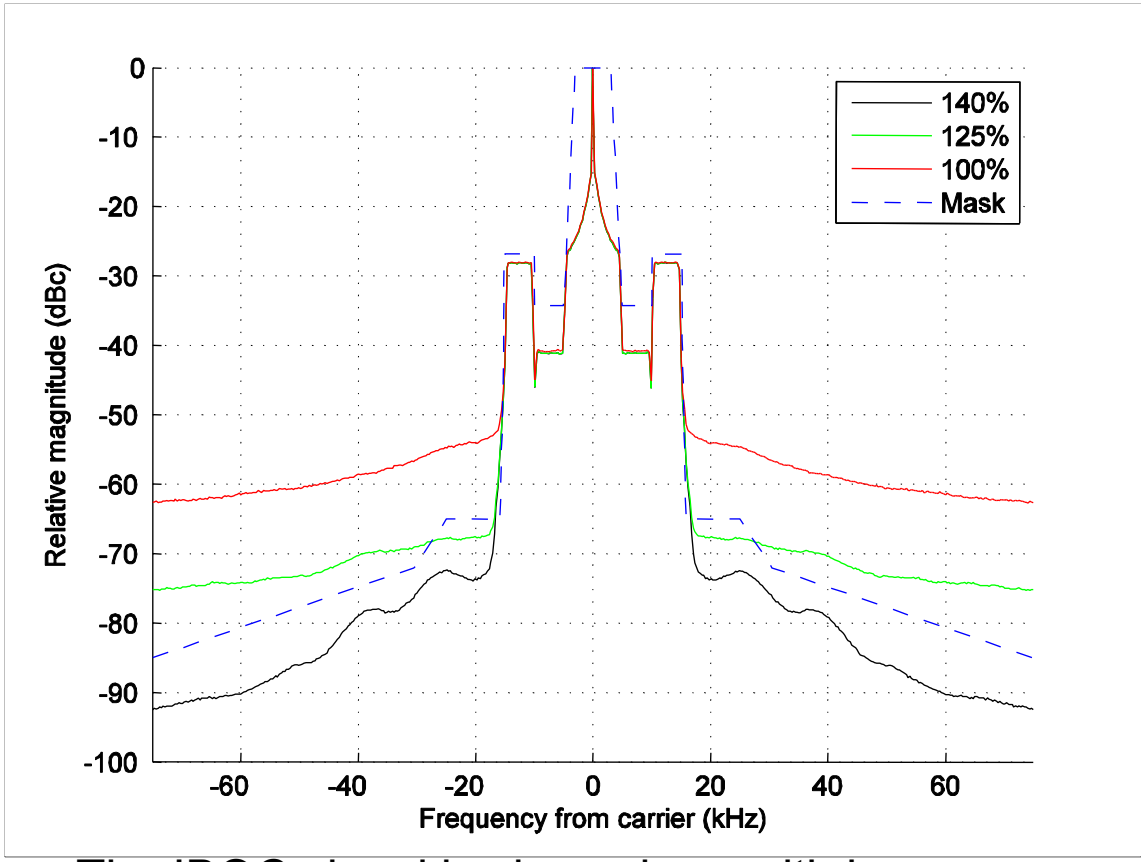
AM-PM correction

- Corrects for unwanted phase shift in the PA at low PDM duty cycles
- Heavily frequency dependent, but affected only slightly by the antenna
- Critical for good IBOC performance, especially with analog modulation



Soft peak limiting

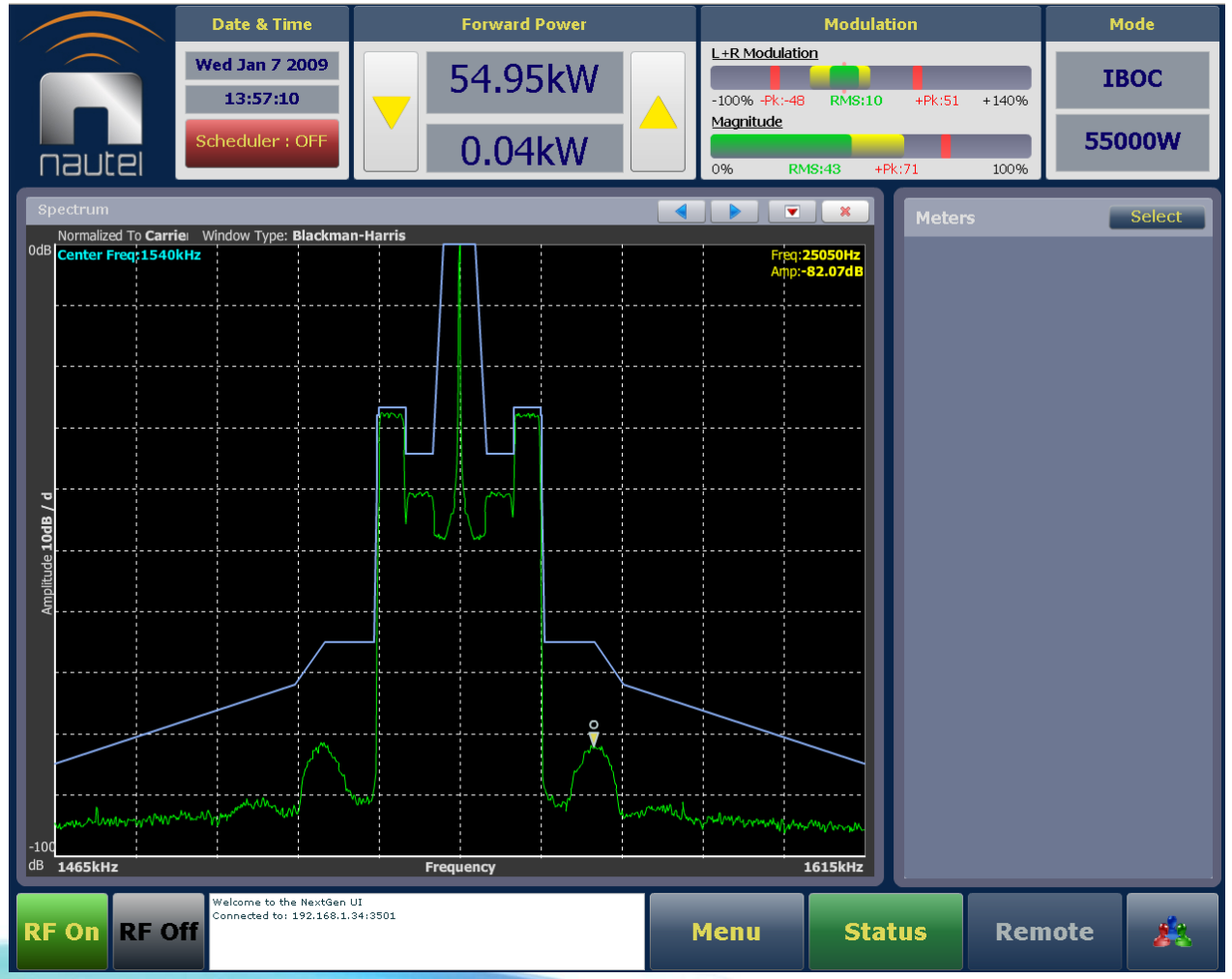
- Similar to FM IBOC, excessive peaks in AM IBOC can affect the spectrum
- Signal processing reduces the spectral effects of overmodulation
- Allows the transmitter to operate normally, even with 15% of power modules removed



The IBOC signal is shown here with heavy modulation at various modulation capacities without soft peak limiting – turning it on eliminates this regrowth due to clipping.

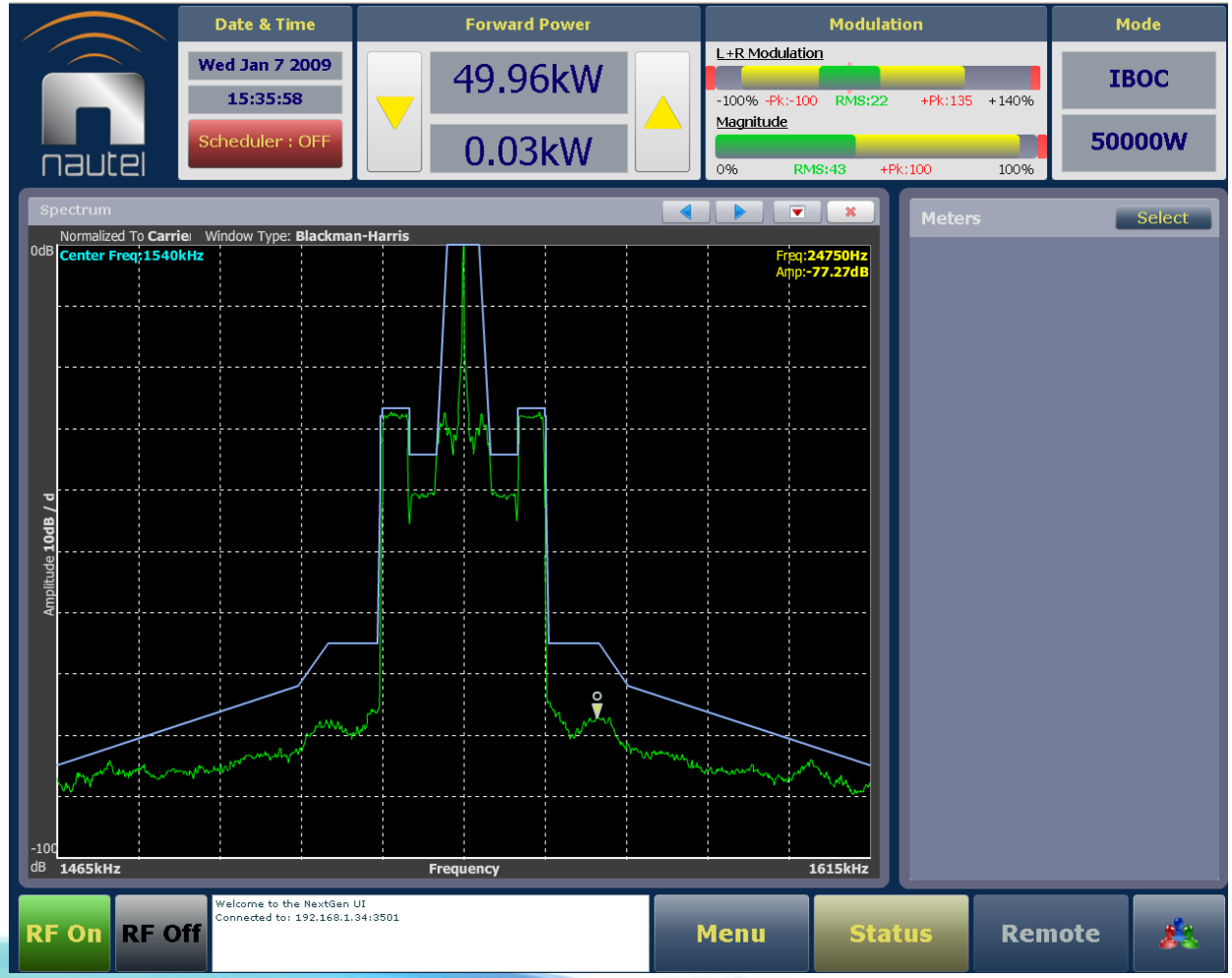
Results: IBOC only

- No audio
- First intermodulation product at -82 dBc



Results: IBOC with analog modulation

- Heavily processed audio in use
- +125%/-95% peaks
- First intermodulation product at -77 dBc



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