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

Scaling and Processing

Cartesian to Polar

Envelope Equalizer

B+ Compensation

AM-AM Correction

Digital PDM Generation

Transmitter

AM-PM Correction

RF Drive Generation

Power Amplifiers

Impedance Measurement

Spectrum Measurement

IBOC Constellation Measurement

Voltage and Current Samples

Magnitude

Phase

PDM

RF Drive
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 $3f_{PDM}$ in the power module
-Cancellation out to $9f_{PDM}$ 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
Thank You