



SuperPower AM



NX Series 3 – 2000 kW AM/MW/LW

Agenda

- **High Power MW and LW**
- **The NX Series**
- **Complete system packages**
- **Some examples**
- **MDCL makes \$ence!**
- **AUI functionality**
- **Nautel Commissioning,
Training and Support**
- **Your Questions**



Chuck Kelly
Director of Sales

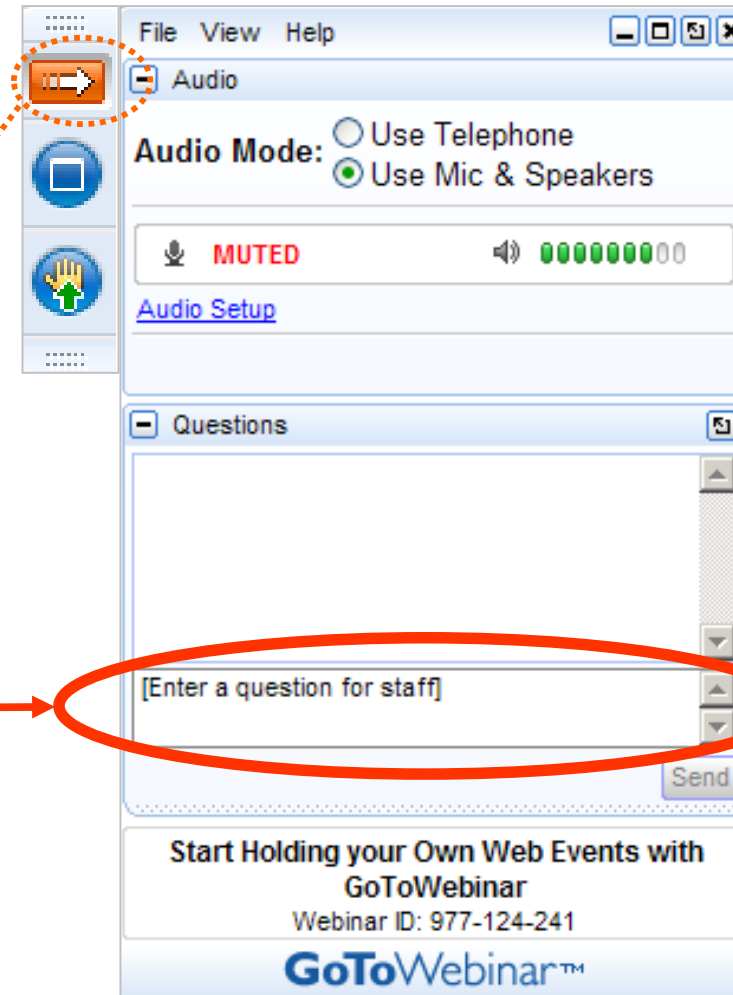


Wendell Lonergan
Head of Sales

Questions?

Click on  to
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Enter questions here
...then press **Send**



NX Series: High Power Solid-State

NX Innovation

- Industry's top efficiency: up to 90%
- Adaptive pre-correction
- RF + audio spectrum analyzers
- 1.8 MHz Direct digital modulation
- Intuitive touch-screen interface
- Ultra-compact
- Digital: All DRM modes + HD Radio



NX3/5/10



NX15/25



NX25



NX50



NX100



NX200



NX300



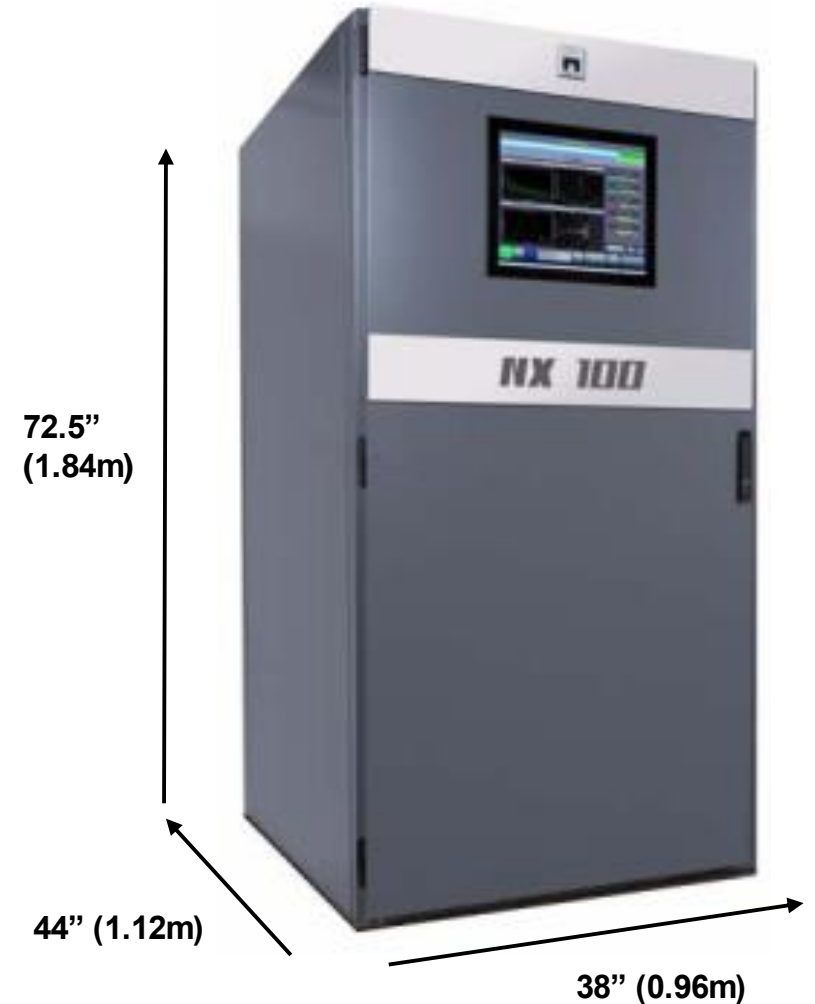
NX400



Combined Solutions up to 2 MW

Space *and* energy saving!

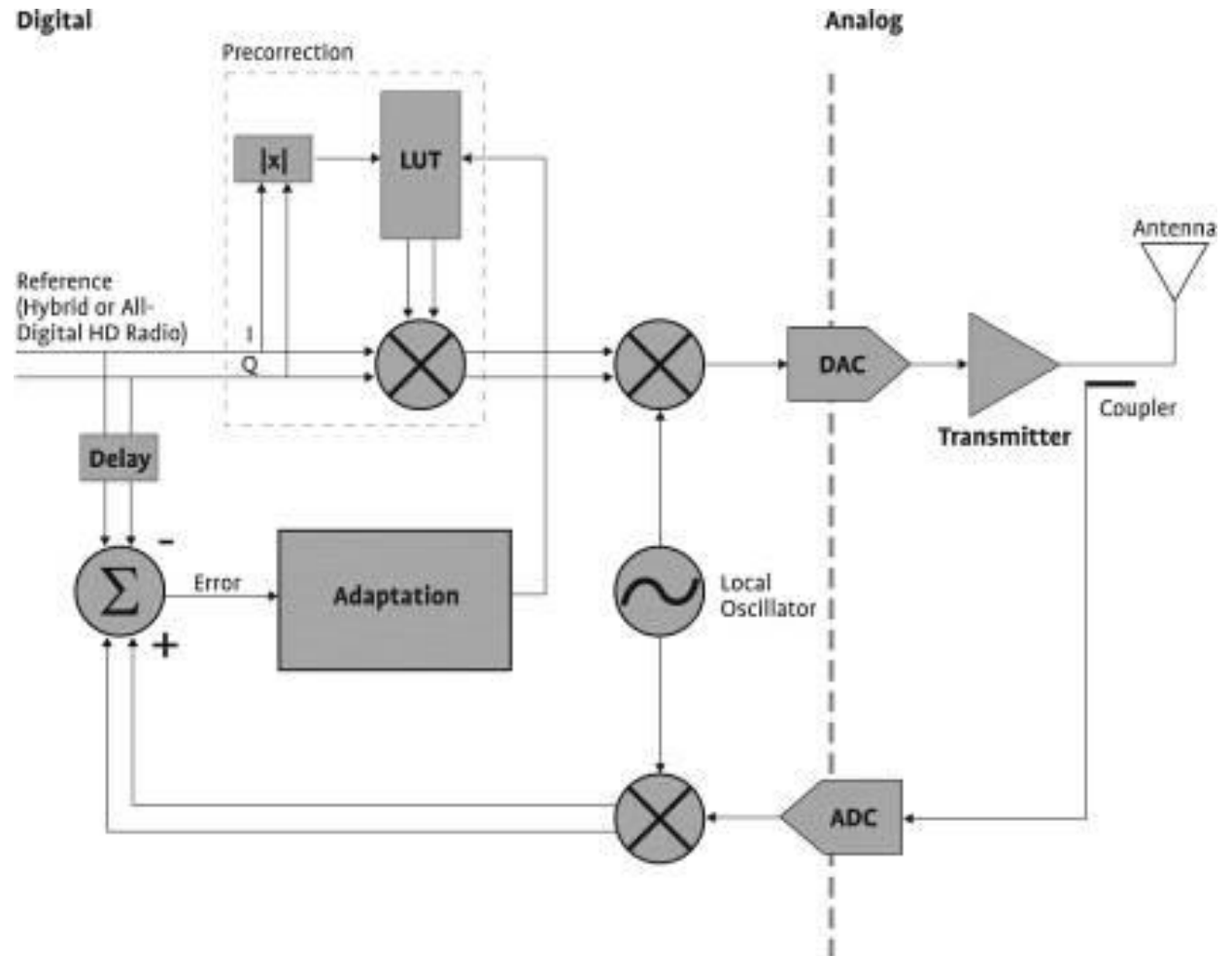
- The Nautel NX-400 takes only 1.84 m² including the transformer
- “Brand G” is nearly 3 times as large.
- “Brand T” is nearly 4 times as large
- “Brand S” is almost 4 times as large
- And at 90% total efficiency, the Nautel is more efficient than any of them!



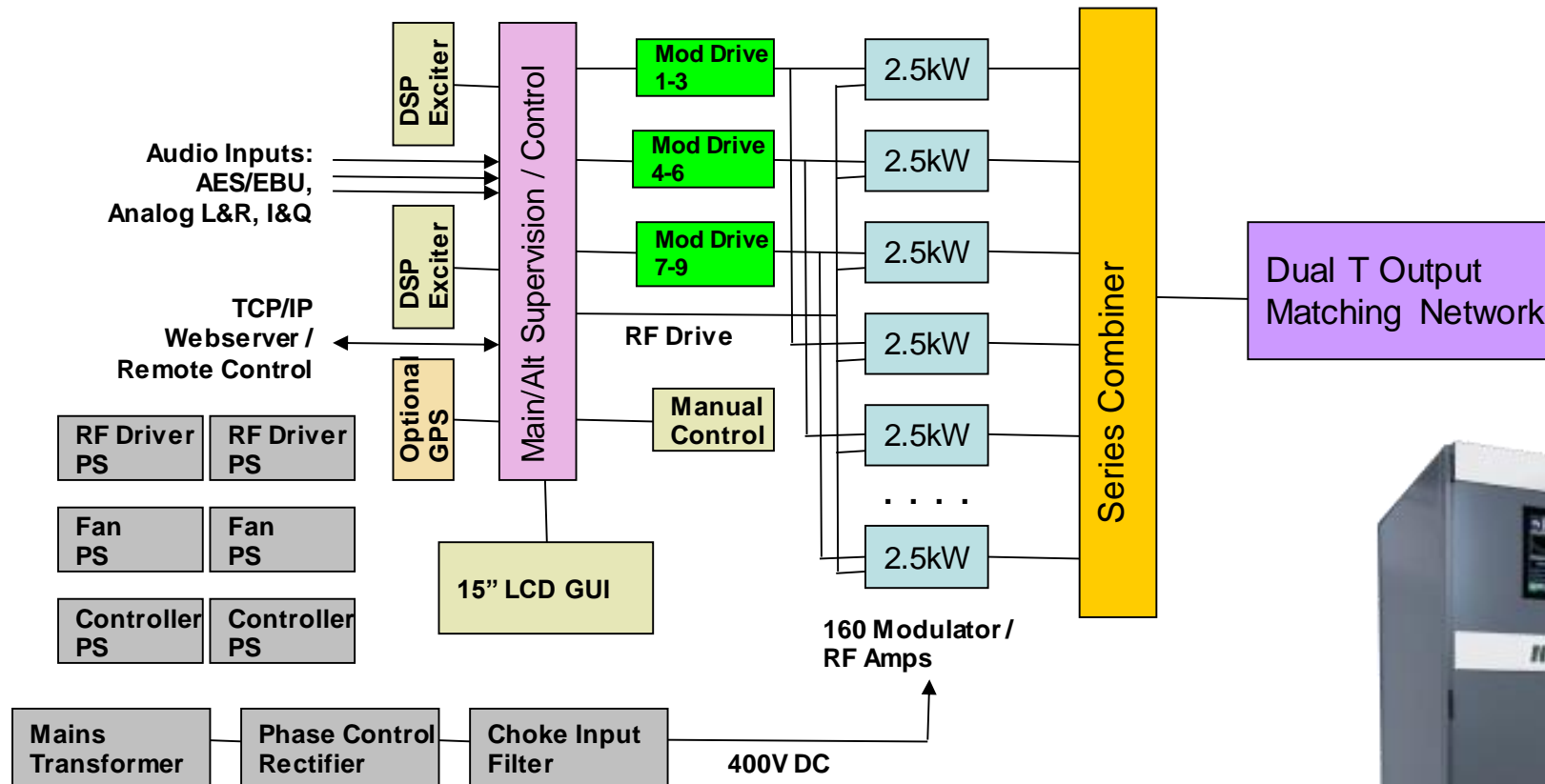
Dynamic Pre-Correction

“The NX Series of AM transmitters are the first high power AM transmitters to be provided with Dynamic Pre-correction”

- Corrects primary forms of distortion
- Applies to analog + digital broadcasting
- More Linear – Clean Spectrum
- Adaptive envelope equalization
- Adaptive AM-AM correction
- Adaptive AM-PM correction

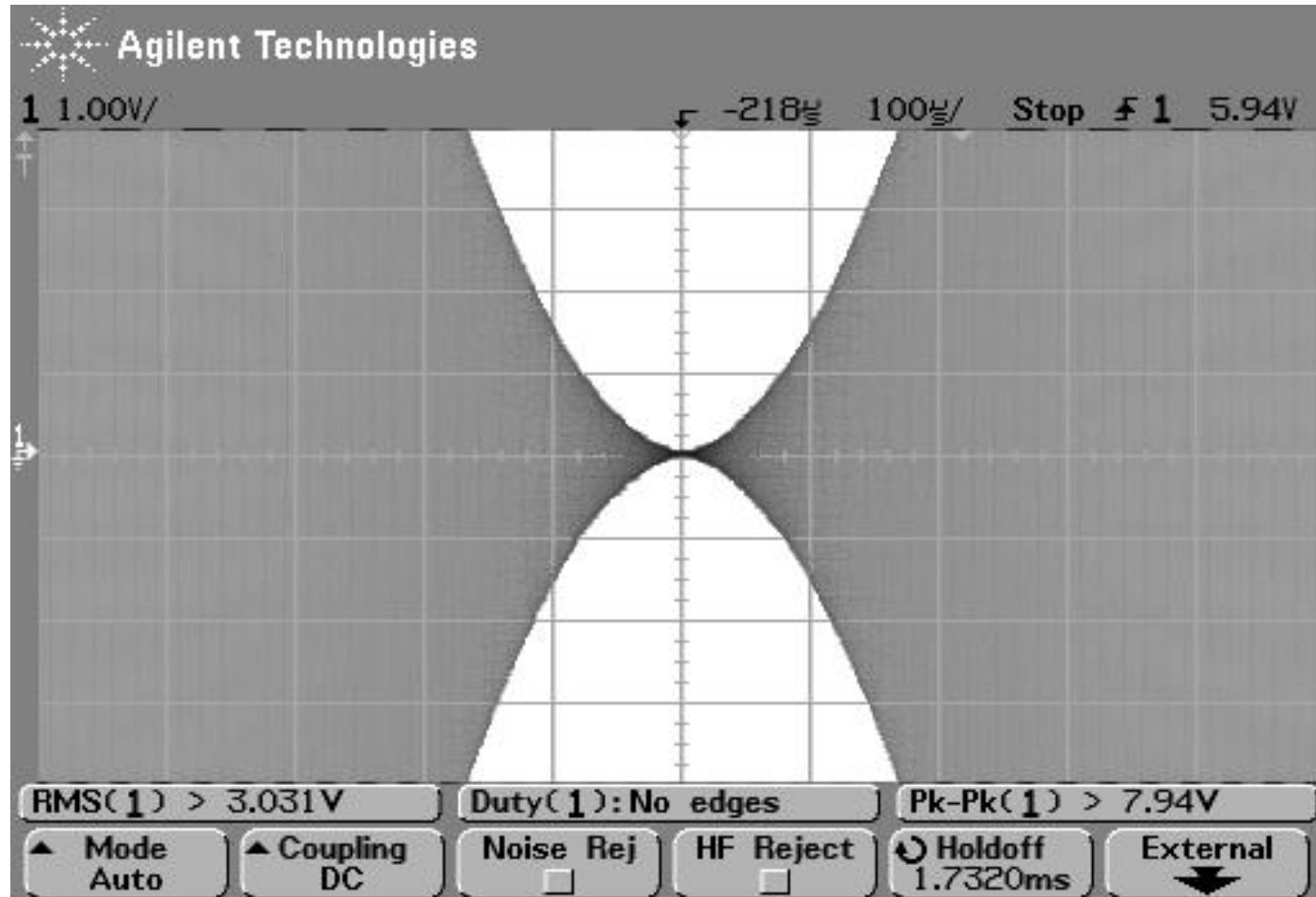


NX400: A small but powerful and efficient building block



Performance Results - AM

No visible distortion in the trough with AM to AM correction

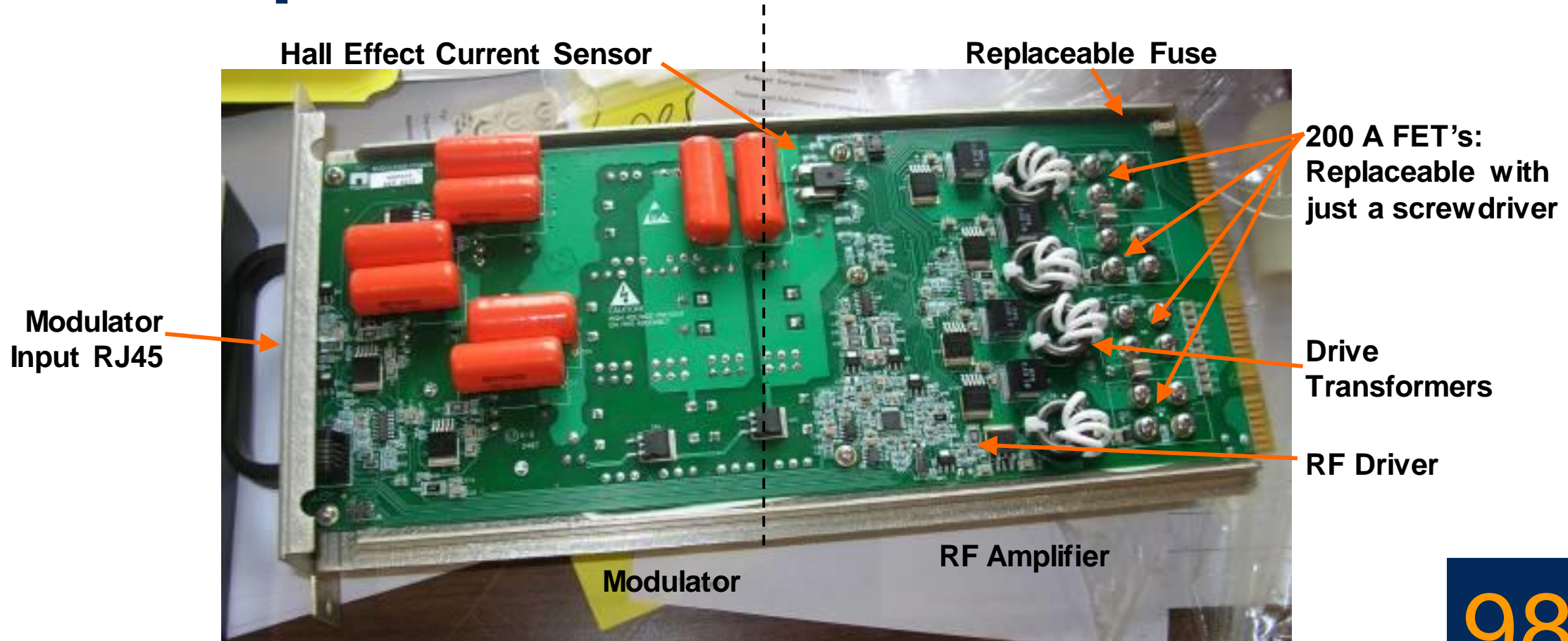


Main/Alternate Supervision & Control

- Interfaces dual DSP excitors
- Provides uninterrupted modulation + RF
- Dual AES/EBU inputs, Analog L&R, and I&Q inputs.
- Optional GPS input card for ultimate frequency accuracy.
- Parallel remote control
- Full web server TCP/IP control.
- Failsafe manual basic control.



RF Amplifier / Modulator Module

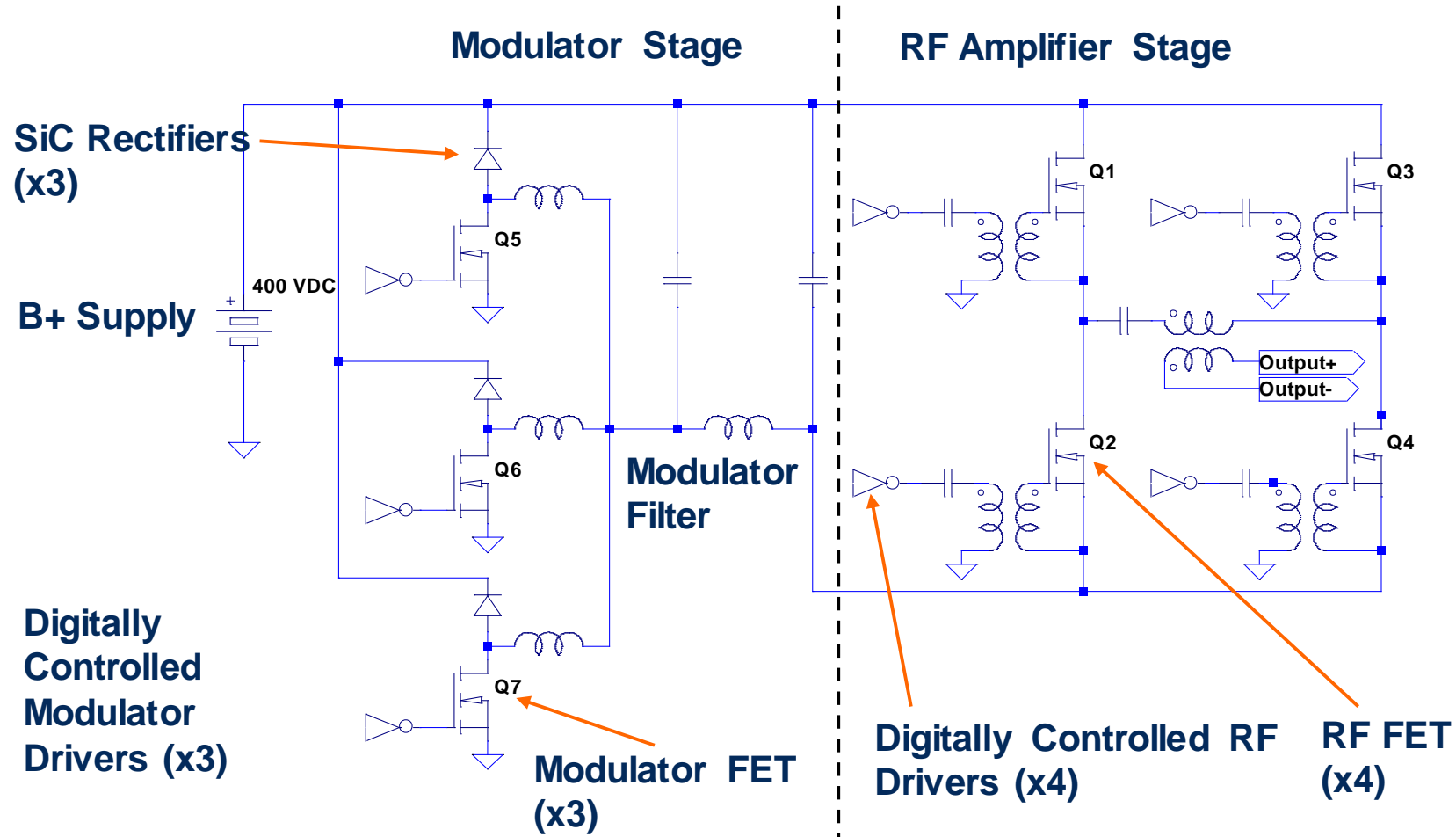


12 kW continuous power rating

(NX module operated at 2.5 kW of carrier)

98%
PA Efficiency

RF Amplifier/Modulator Module



RF Amplifier / Modulator Module

- No adjustments – no pots
- Totally broad banded – entire AM band
- Hot pluggable
- Heavy gold connectors both sides
- Heat sink: 2.5 X required size
- High Efficiency Silicon Carbide modulator diodes
- Balanced RS422 modulator and RF drive.



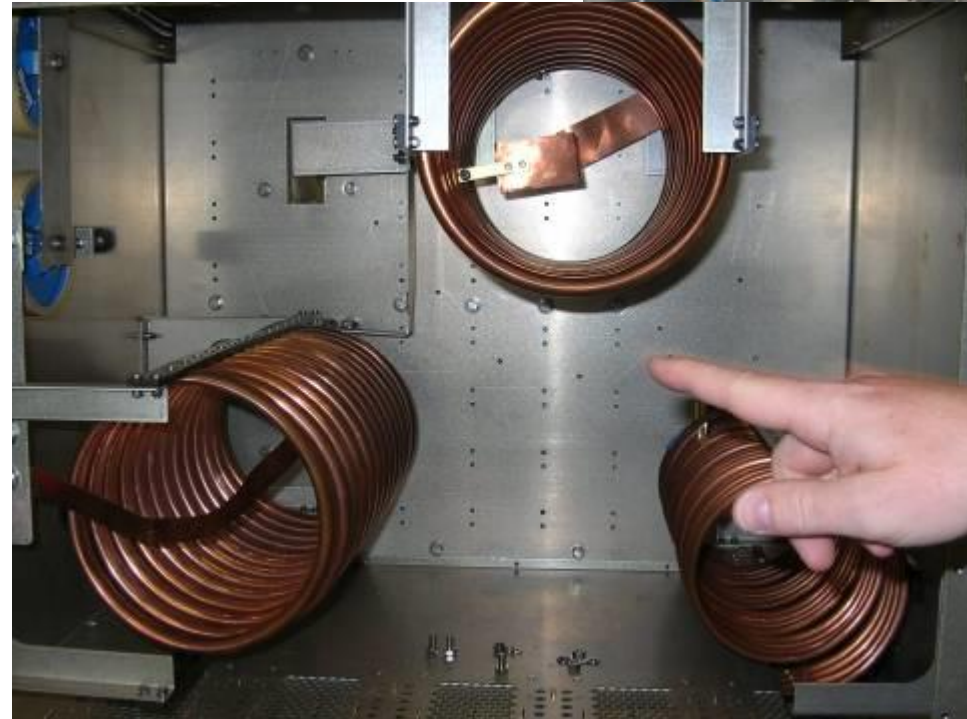
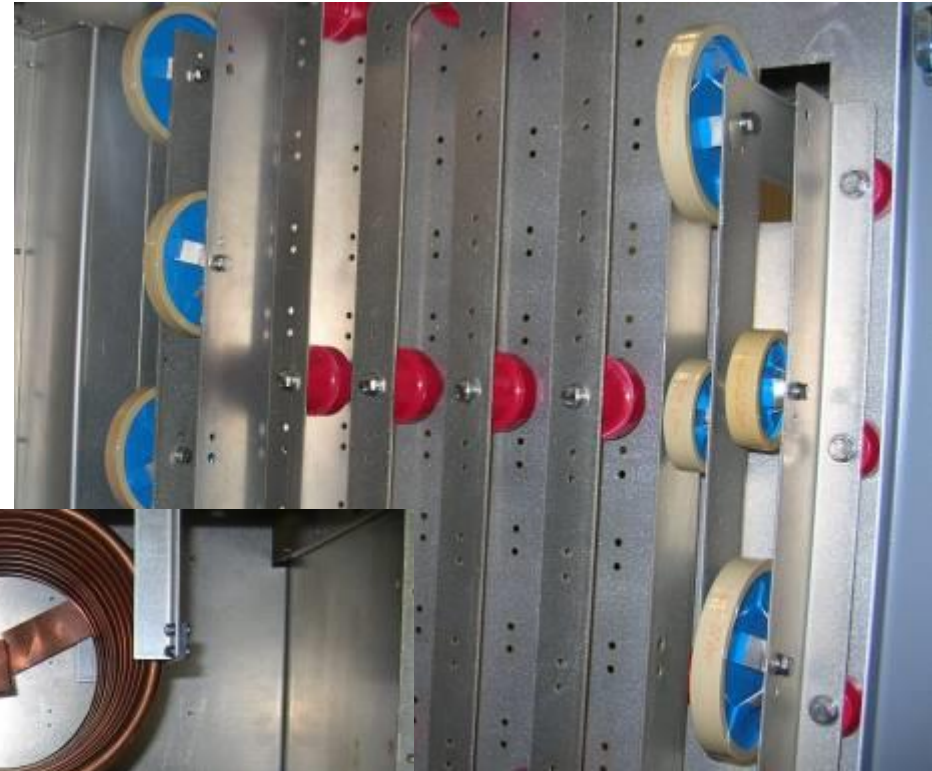
Series Combiner

- Consists of a two parallel copper pipes with ferrite cores which couple the RF output.
- Can handle many times the required power.
- Broad banded.
- Module isolation relay is one of only two moving parts in the NX (the other is the fans)

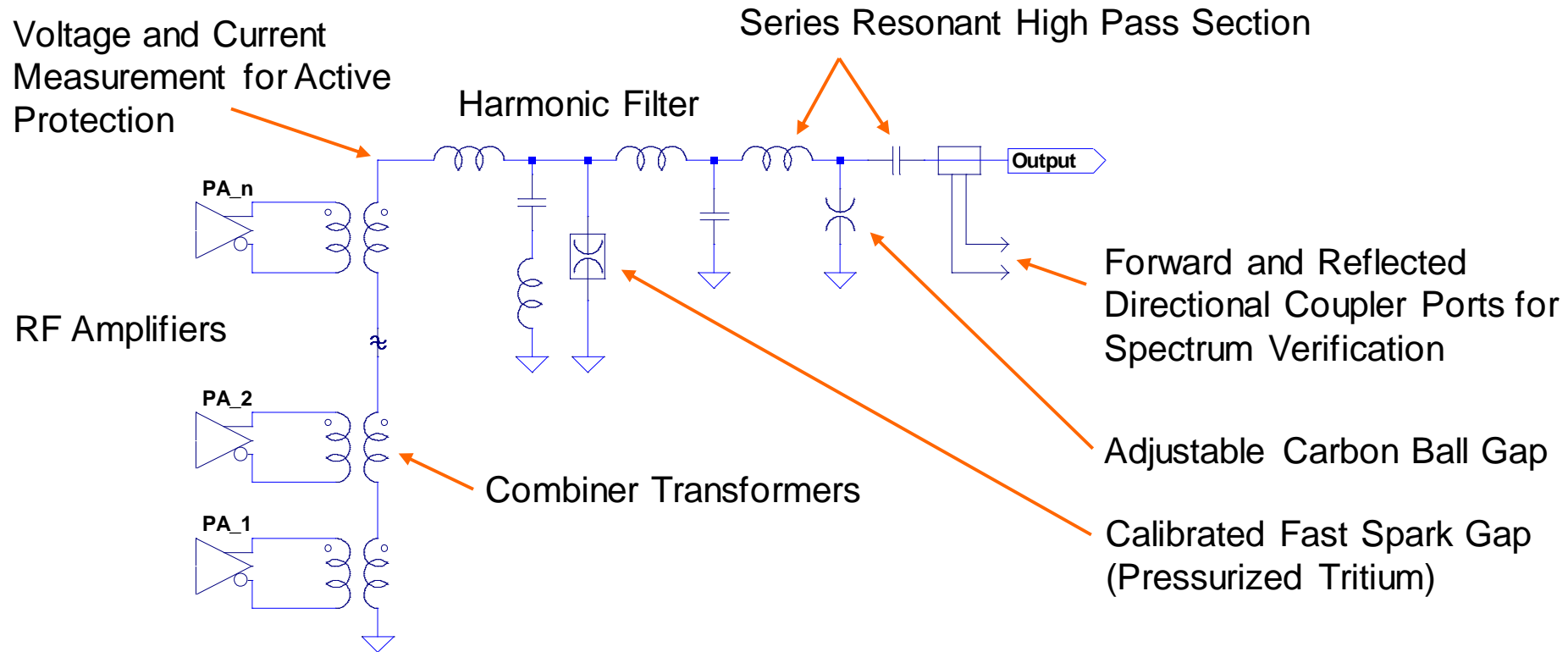


Output Network

- The Output Network is the ONLY frequency dependent section in the NX Series.
- Consists of two T networks, with a shunt 3rd harmonic trap.
- This is a low Q filter, which provides minimal amplitude and phase distortion to the RF signal.
- Adjustment of the NX series from one frequency any other in the AM band may be accomplished in just a few hours.
- Kit with frequency dependent parts for all MW frequencies is available.



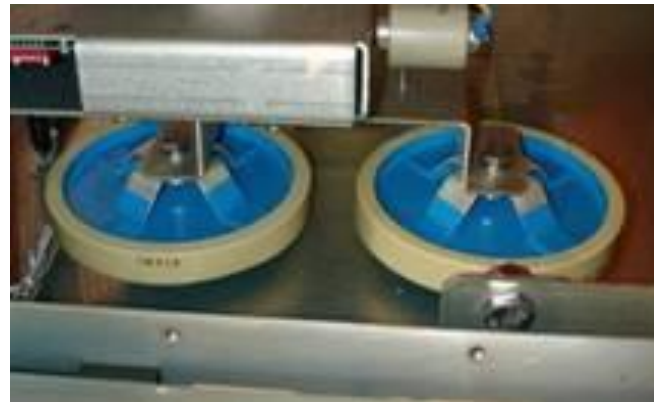
Combiner/Filter & Transient Protection



Frequency Agile: Harmonic Filter Re-Tune in a Few Hours

Lightning/Transient/AC Protection

- ~10 uS Active VSWR Shutdown
- Series Capacitor/High Pass Stage
- Carbon Adjustable Ball Gap
- Static Discharge Choke
- Calibrated Fast Spark Gap (Pressurized Tritium)
- MOV Protection on Incoming AC
- Transient Attenuator Capacitors on AC Transformer Secondary (Common Mode)
- AC Surges Corrected by Phase Controlled B+ Rectifiers (Differential Mode)



NX High Power: AC Power Systems

1.75 MV to LV Transformer
6600 VAC to 310 VAC
Single step conversion
increases system efficiency

LV AC feed to Transmitter
High Current Cabling System
310 VAC 3 Φ
2700 Amps per line
24 conductors in 8 groups
3 conductors to each 100 kW block



Cooling

- Five hot pluggable trays per cabinet, each containing two ball bearing fans.
- Transmitter will operate with just one working.
- Typical fan life is over 11 years.
- Fan operation and speed is monitored by the controller.
- In a 100 kW transmitter, only 10 kW of heat is produced, about the same as a typical 10 kW FM transmitter.
- Air is drawn in from the rear, through a washable metal air filter.



Cooling

Table 4.1: Cooling Requirements for the NX400

CARRIER POWER OUT (W)	MODULATION DEPTH (M x100)	AVERAGE POWER OUT (W)	WASTE HEAT (W)	WASTE HEAT (BTU/HOUR)	AIR CONDITIONING REQUIRED IN A CLOSED SYSTEM (TONNES)
400,000	100%	600,000	52,200	178,200	14.9
400,000	75%	512,500	44,600	152,300	12.8
400,000	50%	450,000	40,000	136,600	11.4

Table 4.2: Cooling Requirements for the Power Transformer

CARRIER POWER OUT (W)	MODULATION DEPTH (M x100)	AVERAGE POWER OUT (W)	WASTE HEAT (W)	WASTE HEAT (BTU/HOUR)	AIR CONDITIONING REQUIRED IN A CLOSED SYSTEM (TONNES)
400,000	100%	600,000	13,400	45,800	3.9
400,000	75%	512,500	11,400	39,000	3.3
400,000	50%	450,000	10,000	34,200	2.9

Power Supplies

- Three phase AC power of a broad range of configurations are fed through a large, high efficiency transformer in a separate cabinet. 250 V three phase is fed to the transmitter.
- The 250 V feed is rectified through a phase controlled three phase rectifier bank which provides voltage control and soft start.
- Ten large fuses protect banks of 4 modules.
- Filtering is done by dual choke input filters with a large bank of electrolytic capacitors.
- All LVPS (Controller, RF Drive, Fan) are completely redundant.



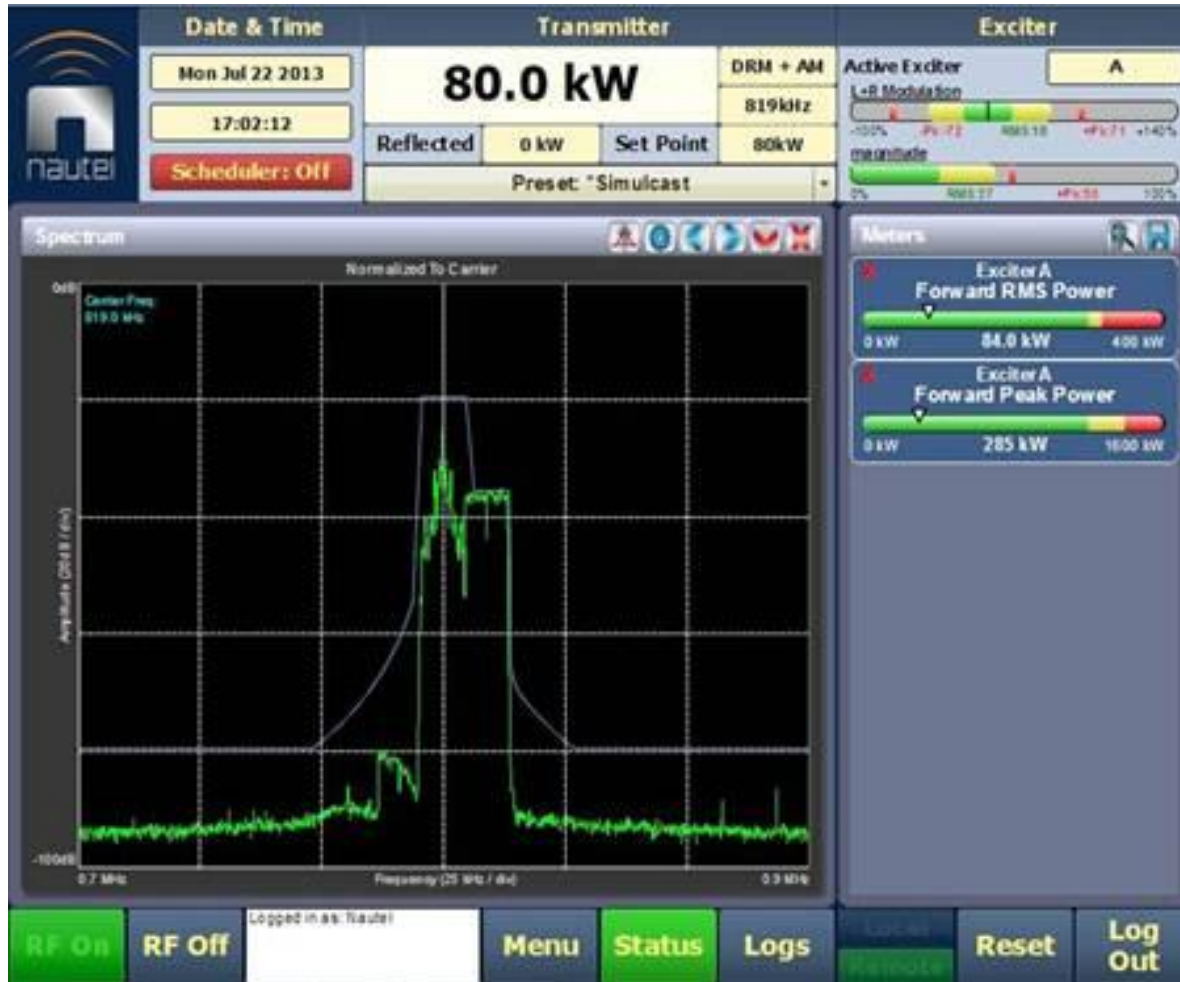
NXSeries Digital Radio leadership

The Nautel NX series leads the industry in Digital Radio development

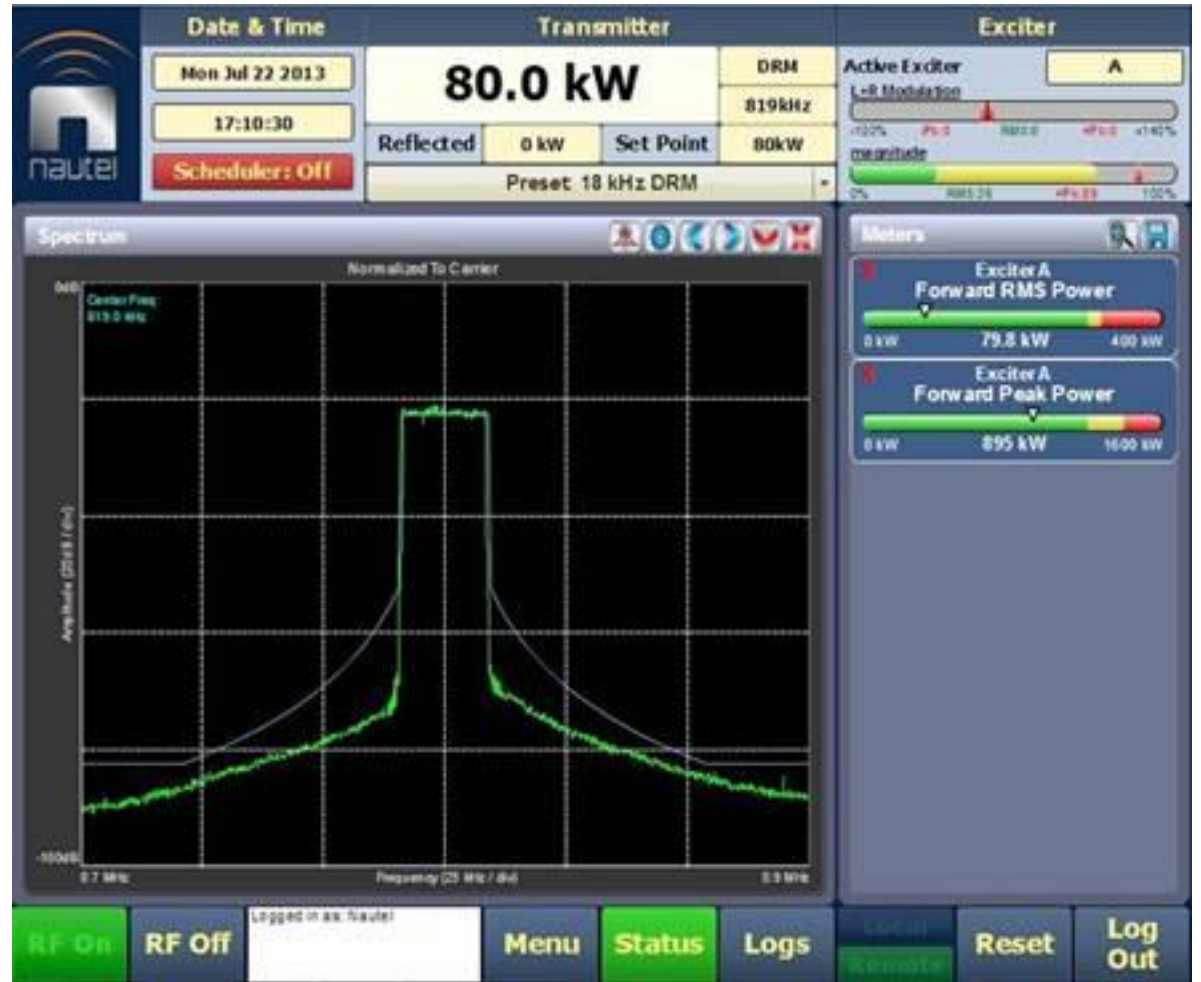
- Whether it's for DRM or HD Radio, Nautel has pushed the performance limits.
- Advanced PAPR and linearization algorithms provide more RMS power from a given power transmitter with better MER.
- Continuing development has further improved all-digital performance. See Brian Walker's paper from NAB 2014.
- Feeds the transmitter with true digital I/Q signals for best performance.
- All modes and bandwidths supported.



Advanced DRM modes

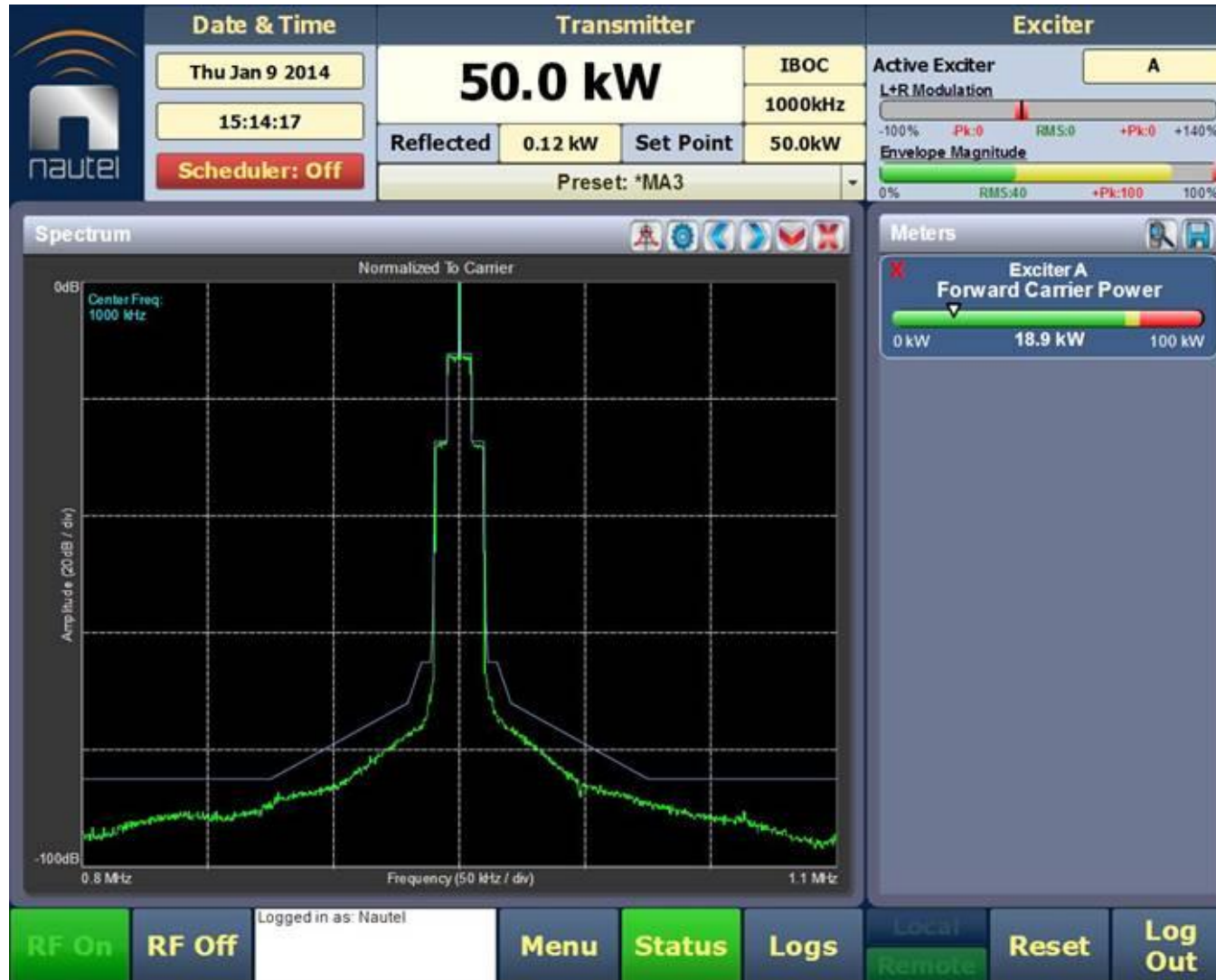


Simulcast



20 kHz DRM

NXSeries: All digital HD Radio



NX Efficiency

The Nautel NX is the world leader in high efficiency AM transmission

- Highest efficiency:
 - 90% for NX 100 kW and higher
 - 88% for 50 kW and below
- Even more power savings:
 - Modulation Dependant Carrier Level (MDCL) standard
 - all popular algorithms are included
 - up to an additional **30%** savings in electrical costs
 - no discernable coverage or performance reduction.

90%
EFFICIENCY



“With reduced electrical costs the purchase price of an NX can often be paid off in just a few years when compared to older tube and solid state designs.”

NX MDCL Power Saving: It's in there.

AM carrier

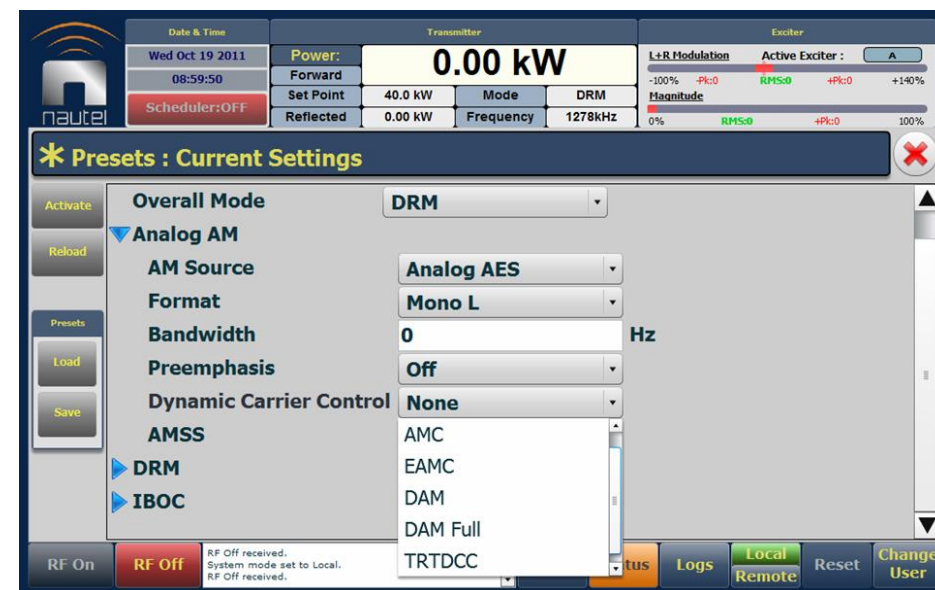
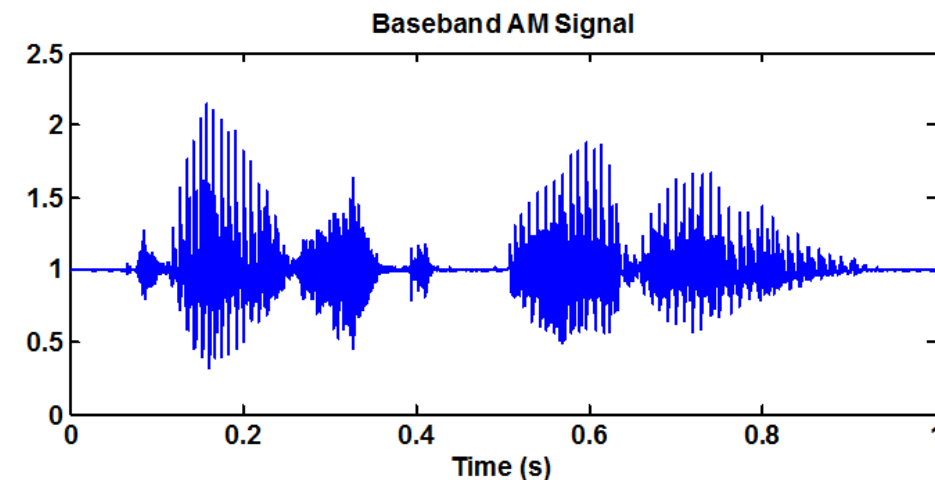
No information yet contains $>2/3$ of the transmitted power.

Challenge

Modify transmitted waveform to reduce power without reducing received quality in receivers

Algorithms supplied

DAM, Full DAM, DCC, AMC



Energy Savings Potential

- Most relevant to medium & high power stations
- State of the art AM transmitters are 90% efficient
- Assumptions/Calculations at the 400 kW level:
 - Average power consumption is approximately 666 kW @ 100% mod.
 - 8760 hours per year (24 hr station)
 - 5.83 MWhr per year
 - Electrical rates can range from 5 - 20 cents depending on the region

Assuming a 30% power reduction:

- Savings are \$175,000 per year at a 10 cent/kWhr rate
- Savings are \$262,000 per year at a 15 cent/kWhr rate

If replacing an older 70% efficient transmitter:

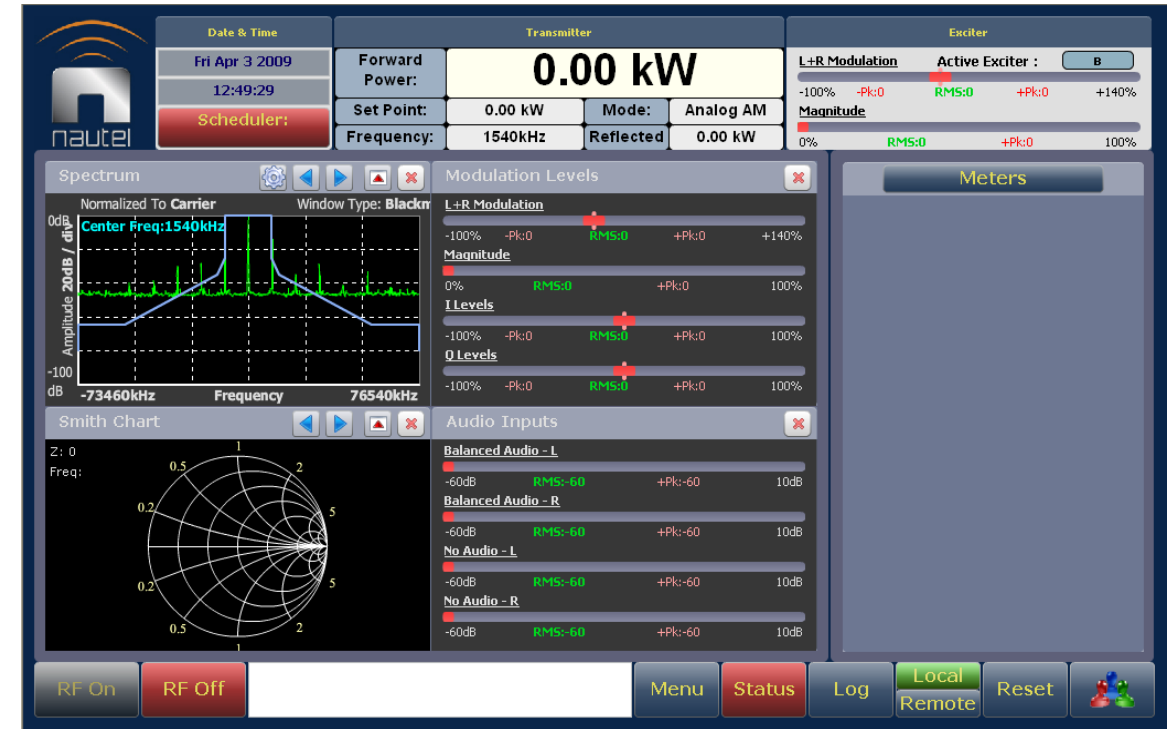
- Savings are \$291,000 per year at a 10 cent/kWhr rate
- Savings are \$437,000 per year at a 15 cent/kWhr rate



NX Advanced User Interface

NX Advanced User Interface includes extensive instrumentation features:

- Modulation monitors
 - Analog modulation: positive and negative peak and average levels
 - Digital modulation: I and Q levels, peak and average
 - Absolute modulation monitor 0 – 100% of peak envelope
- Spectrum analysis based on directional sample
- Real time impedance analysis displayed on Smith chart
- Digital carrier demodulation shown on constellation chart
- Pre-correction curves
- Extensive internal metering of voltages, currents, drive levels at all levels including the power modules



NX Instrument Panel

Spectrum Analyzer: Displays the spectrum of the transmitted signal.

EQ Frequency Response: Shows the frequency response of the modulator's EQ filter.

EQ Impulse Response: Shows the impulse response of the modulator's EQ filter.

EQ Filter Delay: Shows the delay of the modulator EQ across its bandwidth.

AM-AM Correction: Shows the amplitude compensation applied to the magnitude.

AM-PM Correction: Shows the phase compensation applied to the RF drive signal.

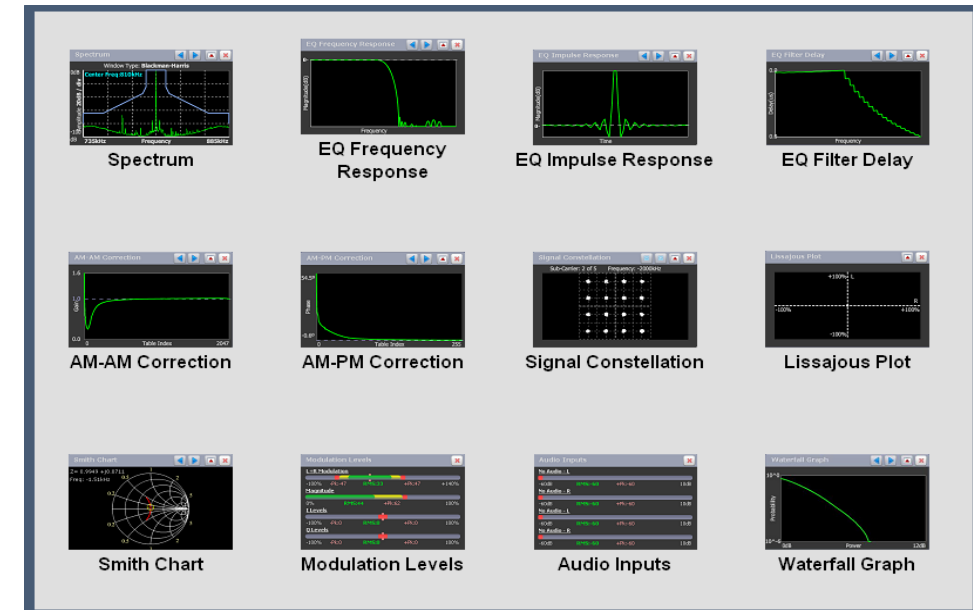
Signal Constellation: Shows the phase and amplitude of the symbols being modulated within an OFDM sub-carrier as dots on a cartesian graph.

Lissajous Plot: Displays the level and phase of L&R input audio.

Smith Chart: Displays the impedance of the load as seen at the combiner.

Modulation Levels: Displays L+R modulation, PDM and I/Q modulation.

Audio Inputs: Displays the program input levels. Bar graph labels indicate the source of each display.



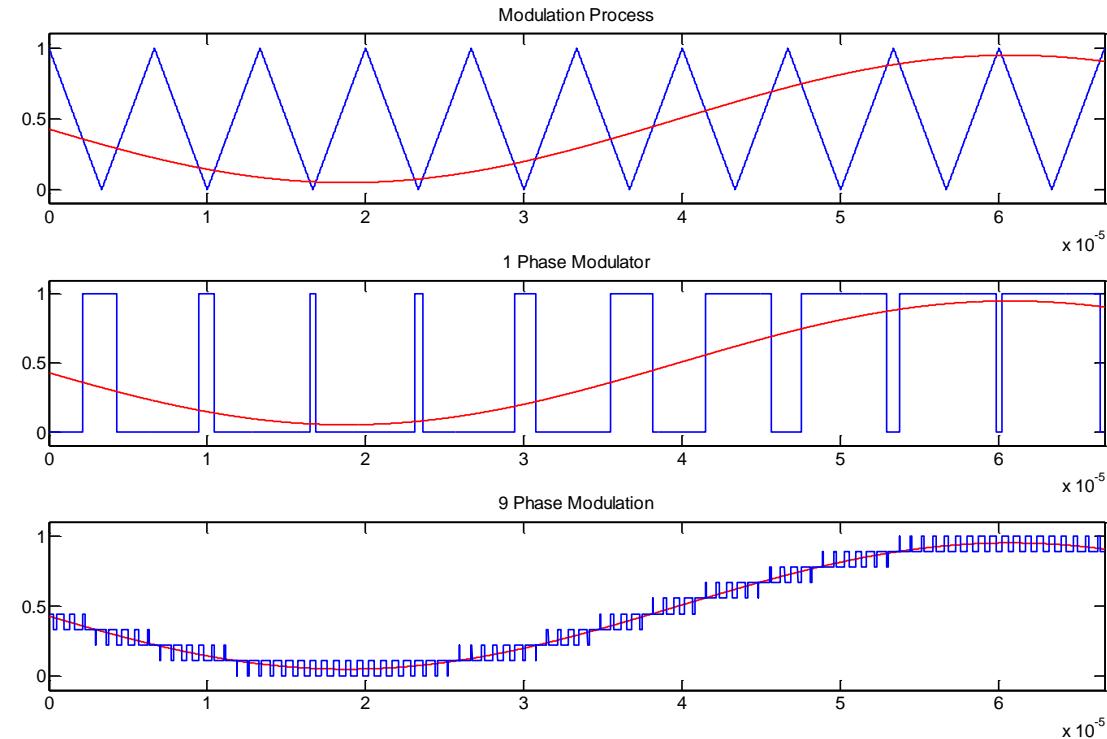
NX Presets

- Presets are a complete set of transmitter parameters including:
 - Power
 - Operating mode (Analog / DRM / Simulcast)
 - Audio input selected / audio input level
- The NX series transmitters provide for up to 62 stored presets.
- A built-in scheduler allows for the automatic switching of presets on a time / day / week basis.
- Presets may also be activated via the AUI web server.

Digital Modulation Technology

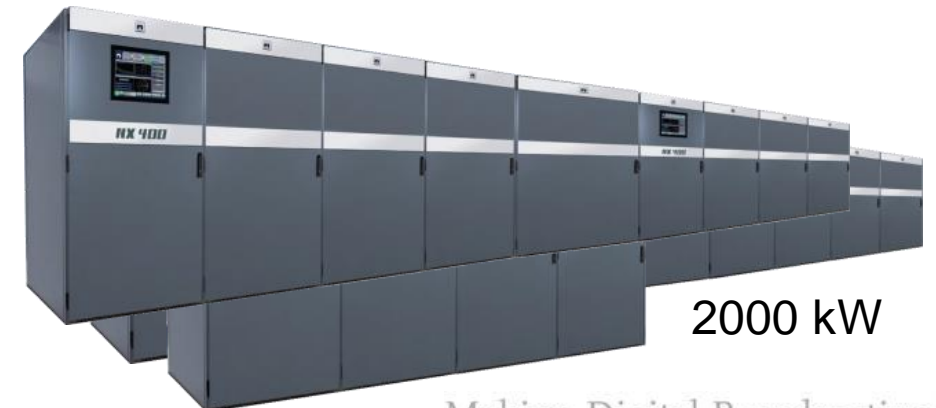
Separate power processing stages for Envelope Modulation and RF Amplification are employed. This approach enjoys the following benefits:

- Optimal RF transistor switching is maintained at all modulation levels. This cannot be achieved when the RF transistors must both convert DC to RF and vary the RF envelope.
- Digitally controlled RF Transistor switching nearly eliminates switching loss across the AM band
- Allows for very high current capability transistors to reduce conduction loss
- Results in ultra high PA efficiency (up to 98% at 1710 kHz)
- Controlled RF amplifier DC supply input improves robustness into VSWR
- RF amplifier DC supply can be shut down during transient events to further improve robustness
- All amplifiers see the same load at all power and modulation levels

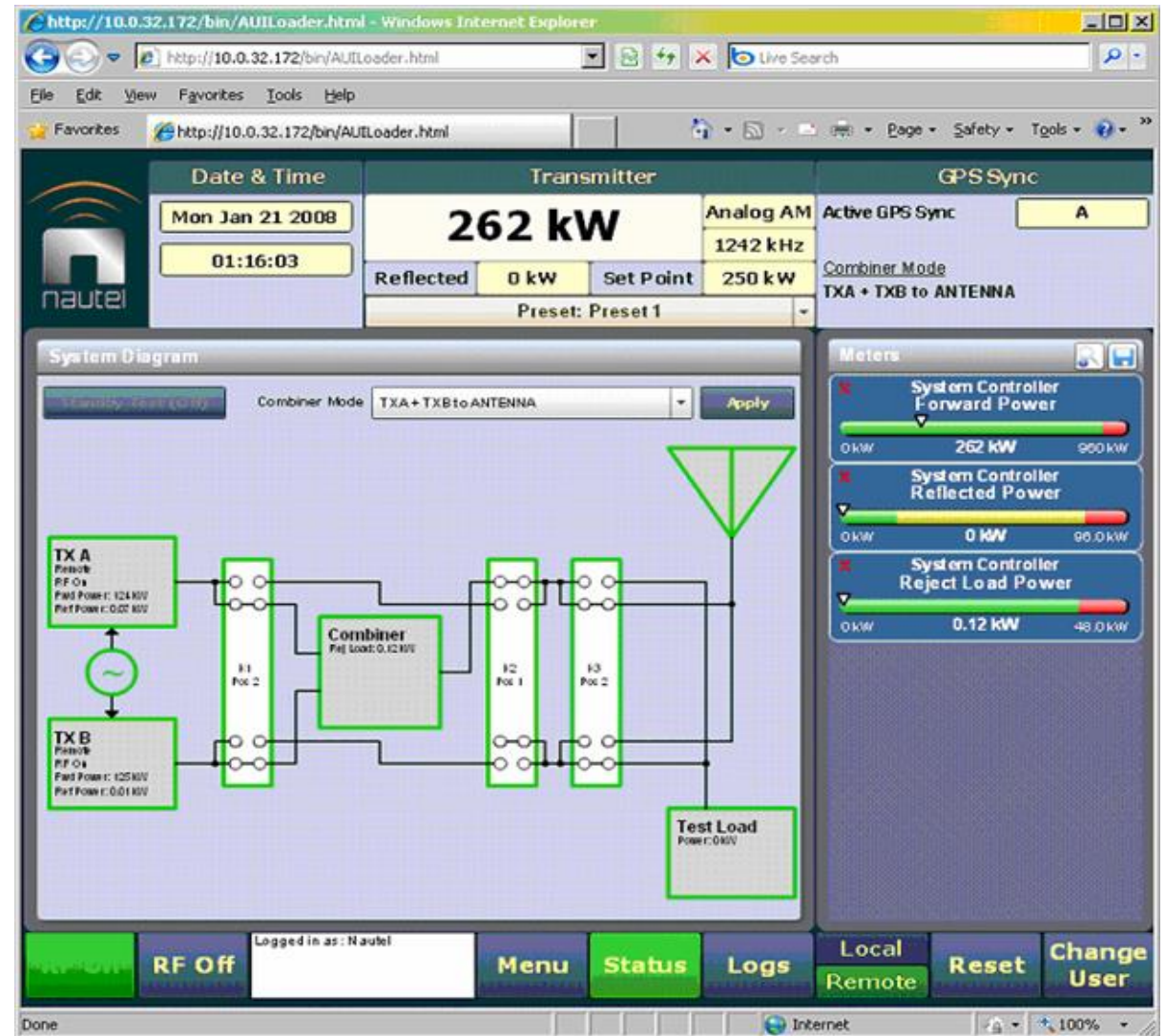
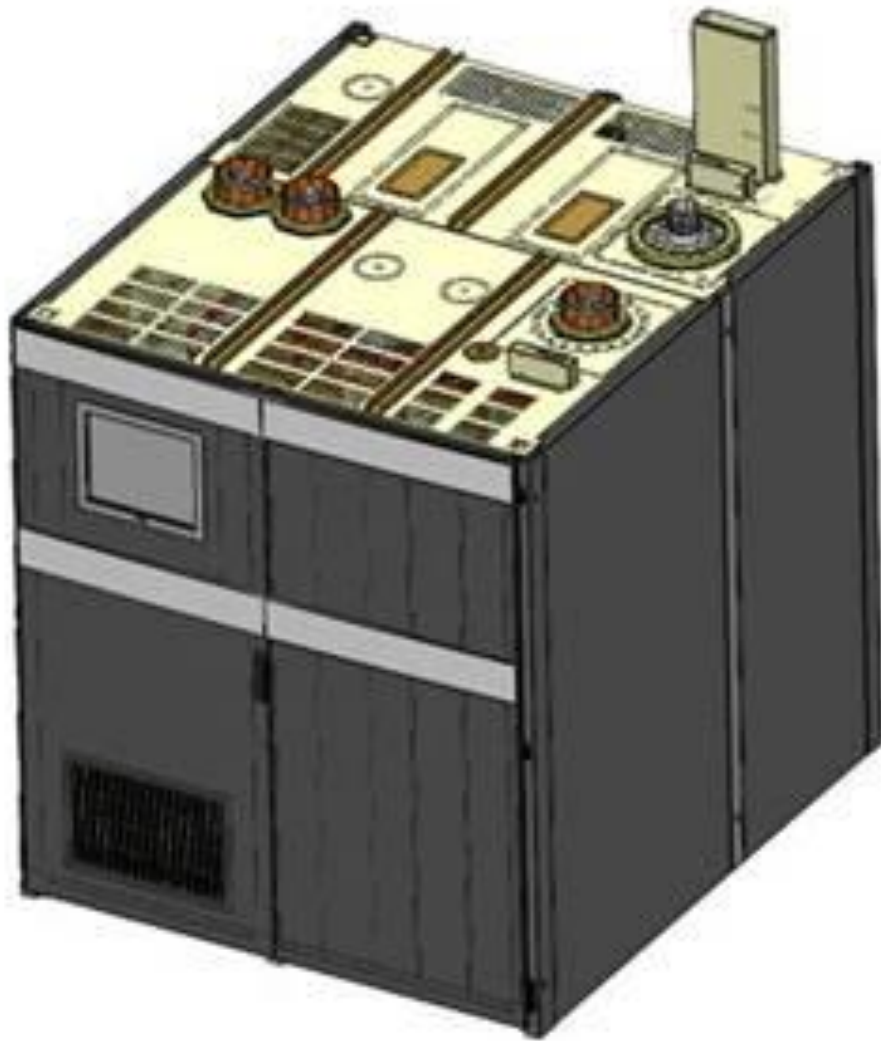


NXSeries: Scalable to 2 MW

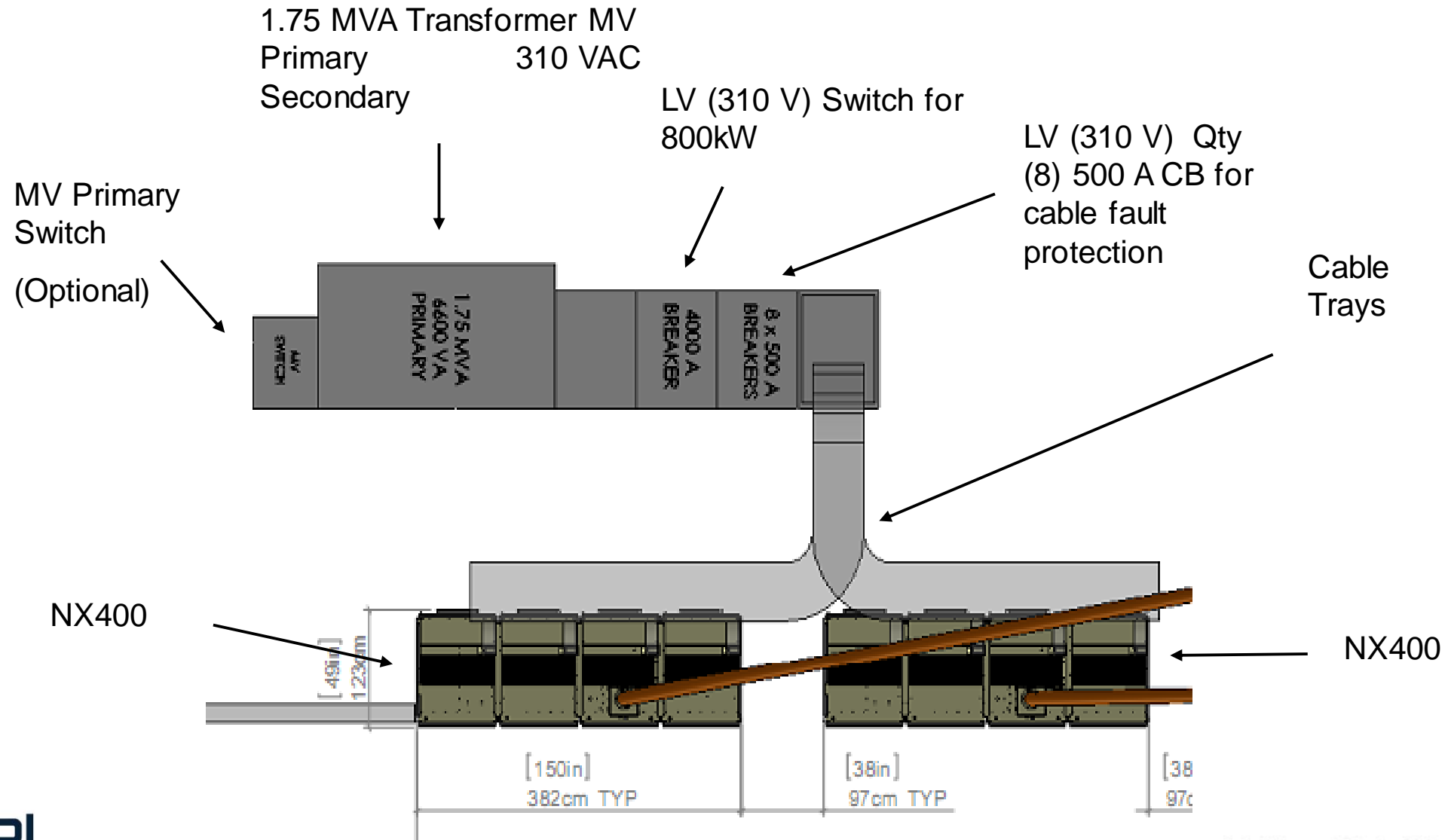
- High power building blocks:
100, 200, 300 or 400 kW systems
- Combiners: 2, 3, 4 or 5 port
- Even greater redundancy
- Nautel Dummy Loads
- 2 MW: 5 port combined NX400



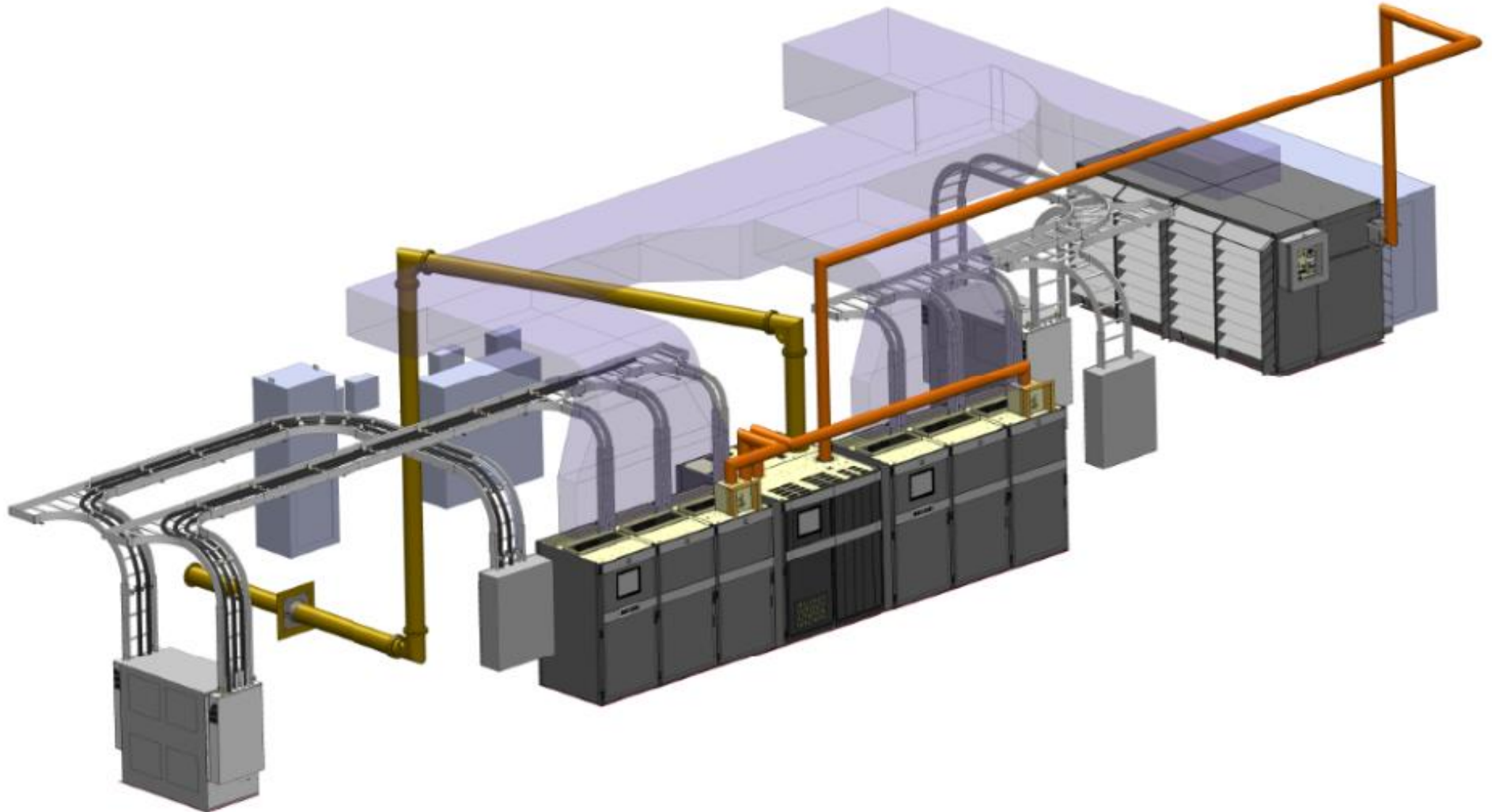
NXC Combiner



NX High Power: M/A Systems Design



NX High Power: Combined Installation

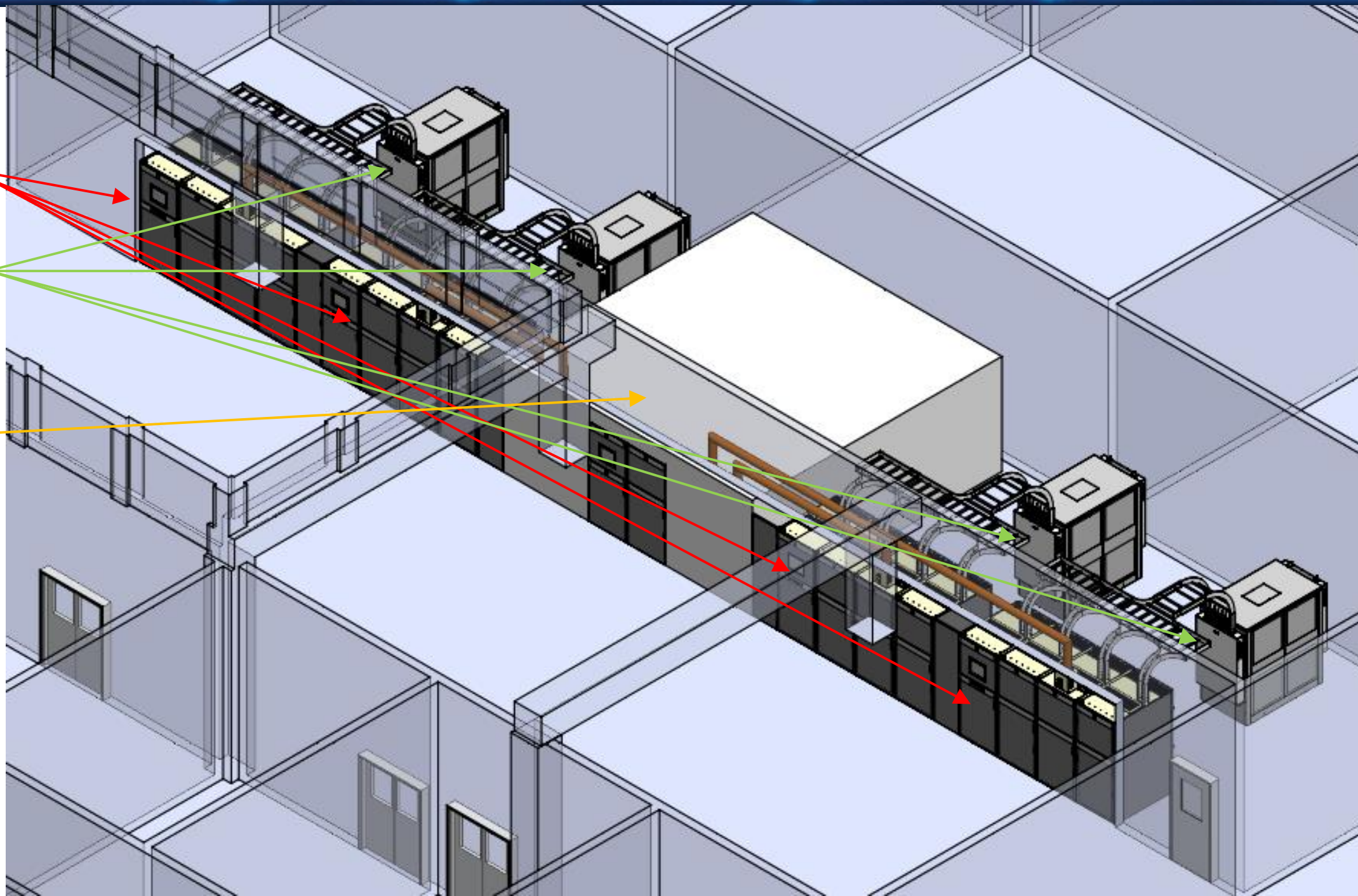


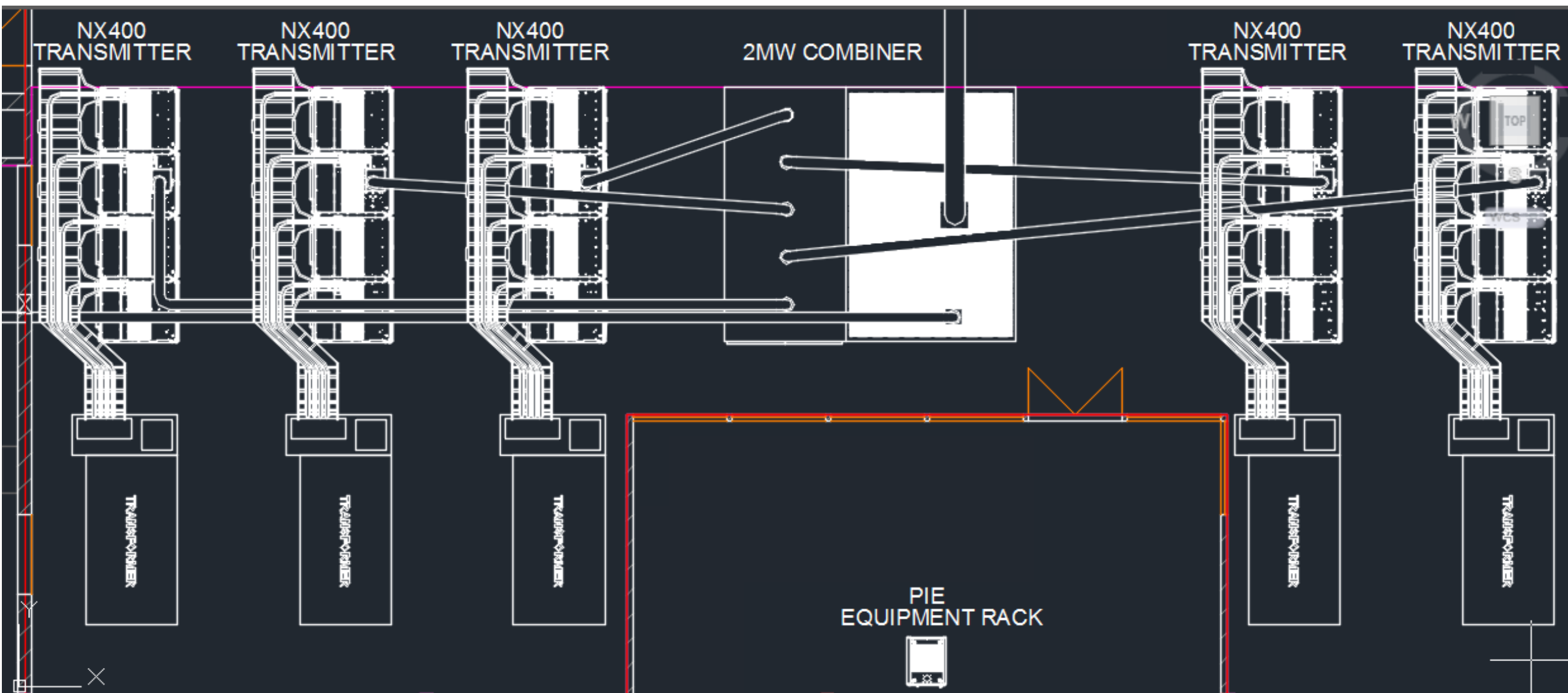
1.5 MW LW

(4) NX-400

(4) Mains
Transformers

Four port
1.5 MW
Combiner





NX Series: Long Wave Band

- Frequency Range: 129 to 283.5
- 90%+ efficiency
- 135% positive peak modulation
- 1.5:1 VSWR
- Other features are identical to the NX MW models



Nautel Installed Transmitters









300KW

300KW



00300



NX Series: Summary

- The NX Series is the most advanced MW transmitter series available today
- Available from 3 kW to 2 MW with unparalleled efficiency
- Ready for all forms of digital radio
- Complete with powerful test equipment
- Nautel Continuous Improvement



NX3/5/10

NX15/25

NX25

NX50



NX100



NX200



NX300



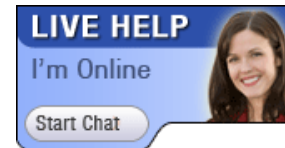
NX400



Combined to 2 MW

Nautel Support/Services

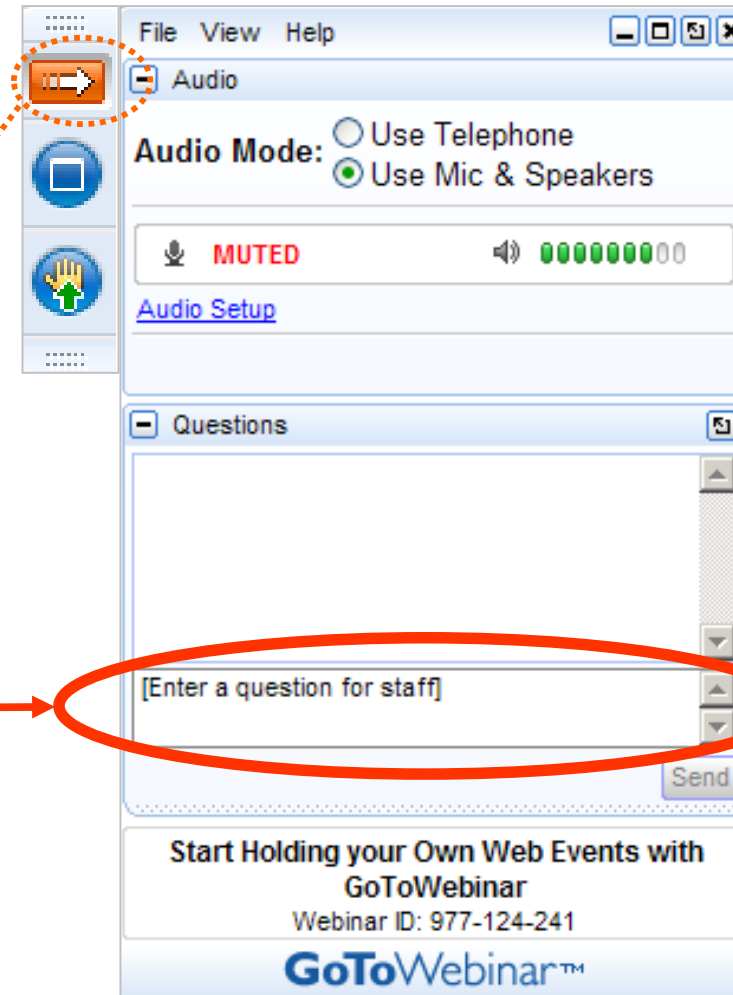
- **Support offices:**
 - Bangor, Halifax
- **Parts depots:**
 - Bangor, Halifax, Memphis
 - Memphis quick-ship depot
 - Order by 7:30 PM (Atlantic) for overnight delivery in USA
- **24/7 live support**
- **Live chat (business hours)**
- **Commitment**
 - Support for every Nautel product ever made, no matter when it was manufactured.



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