GATESAIRCONNECT VIRTUAL events

ADVANCES IN DAB TRANSMISSION SYSTEMS

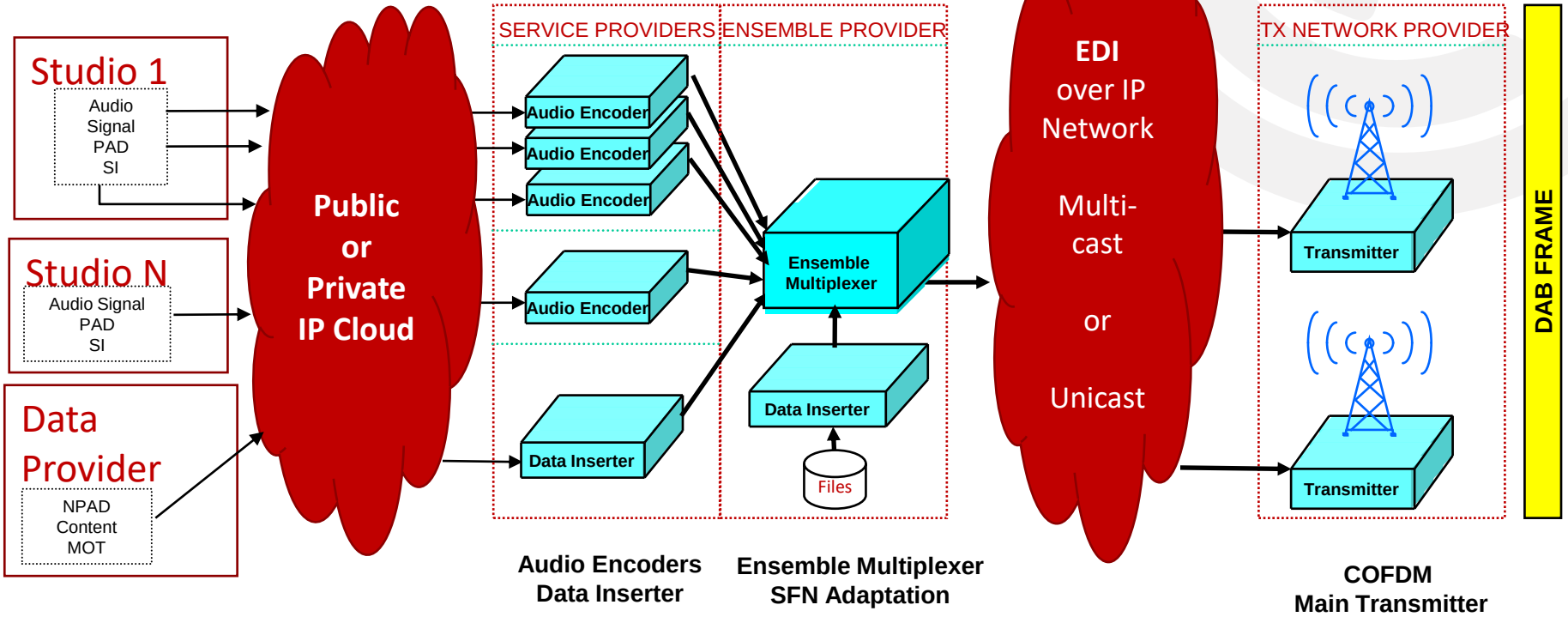
CONNECTING WHAT'S NEXT

RICH REDMOND

AGENDA

- Transmitter Options for DAB networks
- Advancements in energy efficiency
- Considerations using liquid or air cooled
- Configuration for redundant operations
  - Transmitter redundancy and link redundancy
- Reinventing transmitter sites
  - Multi - Channel Transmitter systems
  - Multi Carrier transmitter

STRUCTURE OF A DAB NETWORK IN PRACTICE



GATESAIR RADIO PRODUCT FAMILY

DAB

Low Power	Air Cooled	VLX Liquid Cooled

VAXT 80/150
Ultra Compact

VAX 300/450

VAX 550/750

VAX 1.2kW - 13.6kW

VLX 1.5kW - 45.6kW

DAB ULTRA-COMPACT MODELS - SUMMARY

KEY FEATURES

- High-efficiency Doherty PA's
  - VHF BIII is a single broadband design 170-240MHz
- ETI and EDI inputs
  - Additional input board options
  - 2 – EDI plus 2-ETI
  - 4 – ETI inputs
- Adaptive pre-correction circuits with MER $\geq$ 33dB
- Configurable as: Transmitter, On-channel SFN Gap-Filler, or Transposer
- Modular design, PA and Power Supply plug-in and can be replaced in a few minutes.

DAB ULTRA-COMPACT VHF MODELS / POWER LEVELS

1RU Models

80 W

150 W

2RU Models

300 W

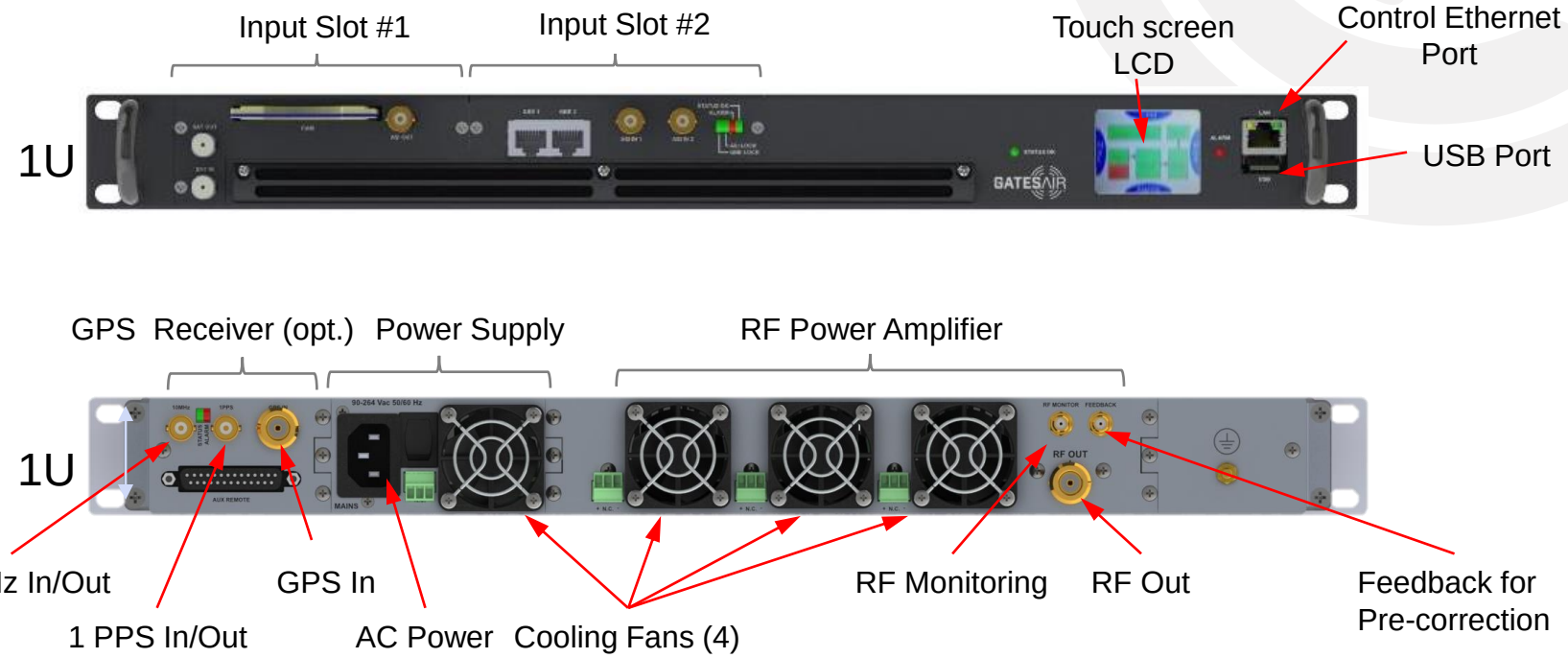
450 W

3RU Models

550 W

750 W

FRONT AND REAR OF 1RU ULTRA-COMPACT



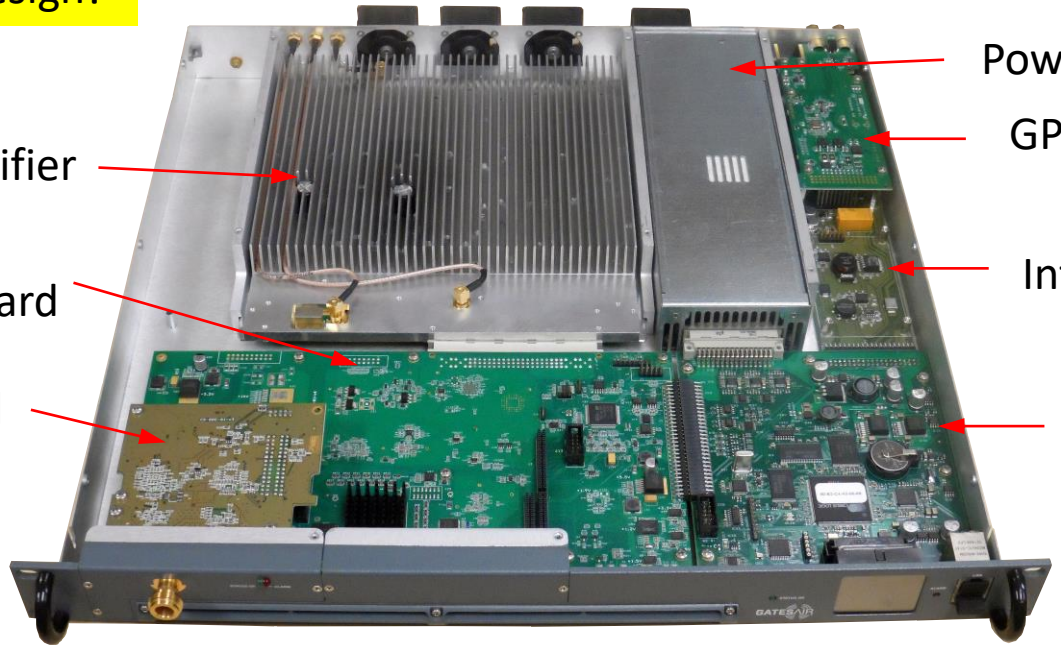
INPUT CARDS

FRONT PANEL

Note that one or two input cards can be used, for flexibility

UNDER THE HOOD - WHERE ARE THE CABLES?

"No Cable" Design!



MAXIVA DAB AIR-COOLED VAX-OP SERIES

Maxiva Air-Cooled VAX-OP VHF Series

300W to 1.2kW

2+1 RU / 3+1 RU

1.5kW – 1.9kW

3.5+1 RU

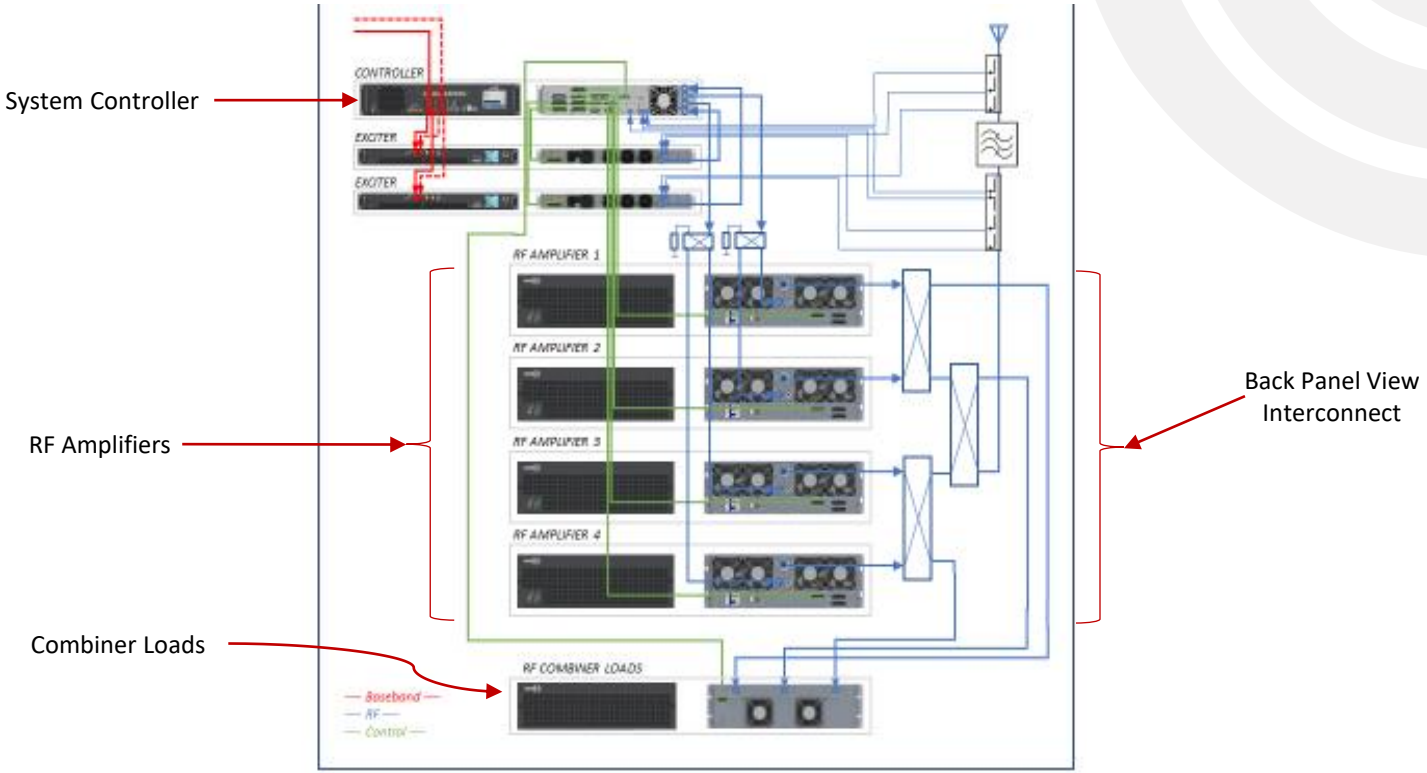
Same PA used in racked systems

3kW – 13.6kW

2, 3, 4, 6 and 8 PA Systems in 36RU Rack

- Same 1RU exciter/driver and same input option cards as Ultra-Compact
- Available with single-drive or dual-drive (option)
- Multiple PA systems include a 36RU rack (single PA systems - rack optional)
- GPS/GLONASS option

BLOCK DIAGRAM – 4 RF AMPLIFIERS



Maxiva DAB Liquid-Cooled VLX-OP Series

KEY FEATURES

- High Efficiency (Broadband PA's)
- Low consumption Pump and Heat Exchanger (pump + heat exchanger + external fans = 535W)
- Dual Redundant Pumps standard
- Coolant reserve tank (8 liters) for automatic liquid refilling, reduces on-site maintenance
- Liquid Cooled Control Unit: level (liquid + refilling), pressure, temperature, pump status, etc.
- Very small external heat exchanger with 24V power, 2 fans or 4 fans
- Heat Exchanger automatic reverse fan rotation feature to remove debris (user settable timing)

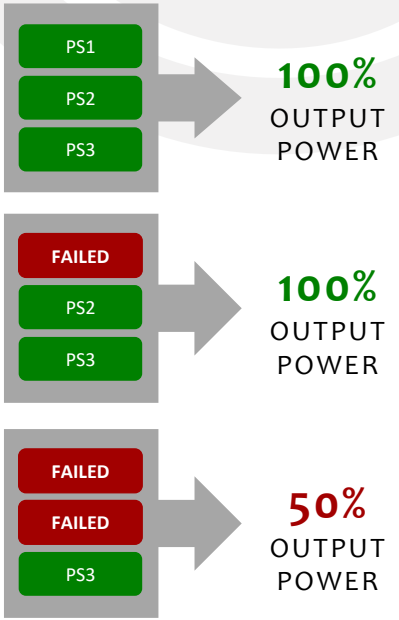
MAXIVA LIQUID-COOLED VLX-OP SERIES

Maxiva Liquid-Cooled VLX-OP VHF Series

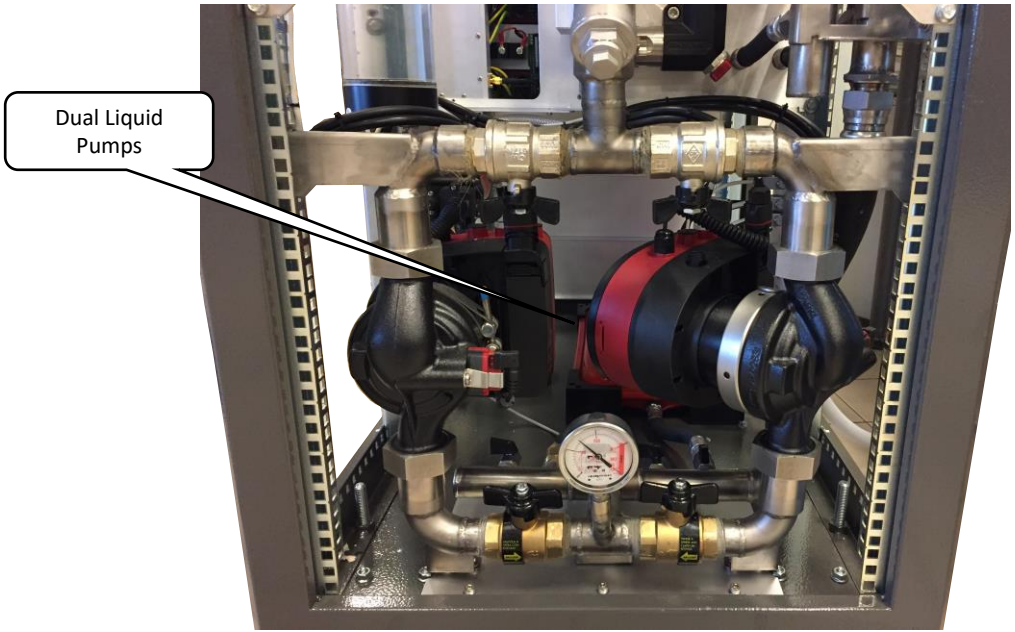
Single Rack Systems

- **15.2 kW** 8 PA's
- **11.4 kWz** 6 PA's
- **9.5 kW** 5 PA's
- **7.6 kW** 4 PA's
- **5.7 kW** 3 PA's
- **3.8 kW** 2 PA's

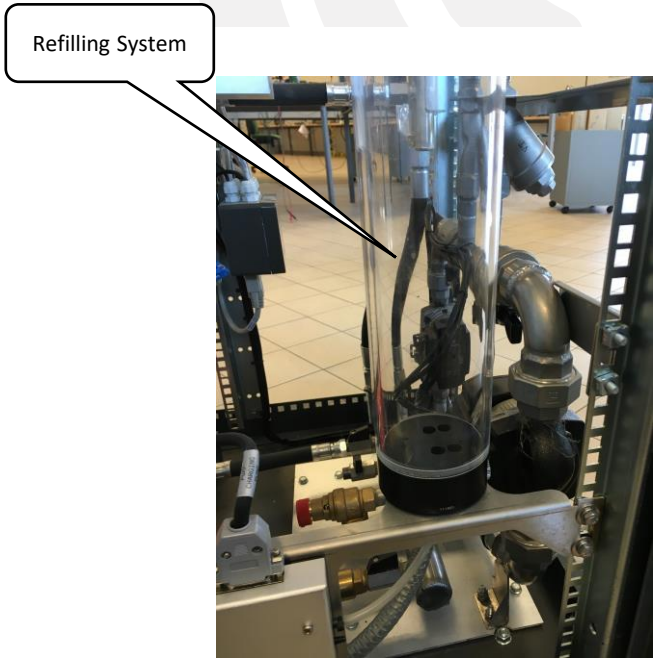
VLX-OP (6 PA's)



VLX-OP LIQUID-COOLING SYSTEM



Lower Portion of Liquid-Cooled Tx Rack

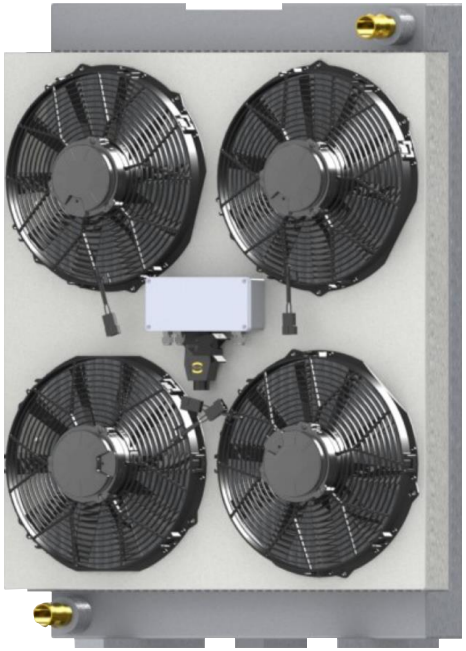


Automatic Liquid Refilling System (8 litres capacity)

VLX-OP HEAT EXCHANGERS

Fans 24V DC
Speed-controlled

Programmable
auto-reversing to
clear debris

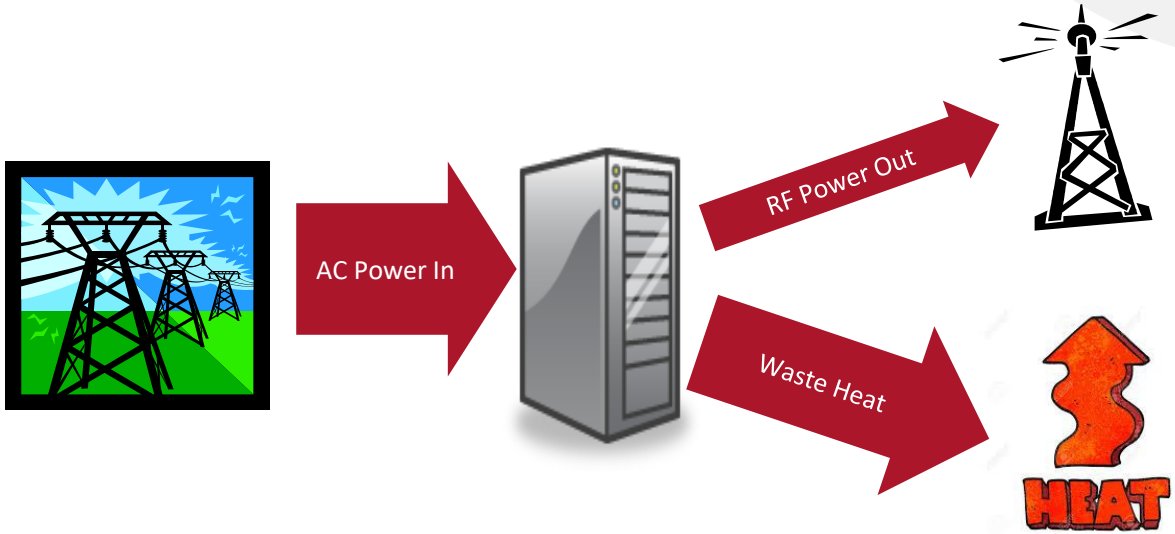


61 cm W x 80 cm H x 26 cm D
(24” W x 31.5” H x 10.2” D)

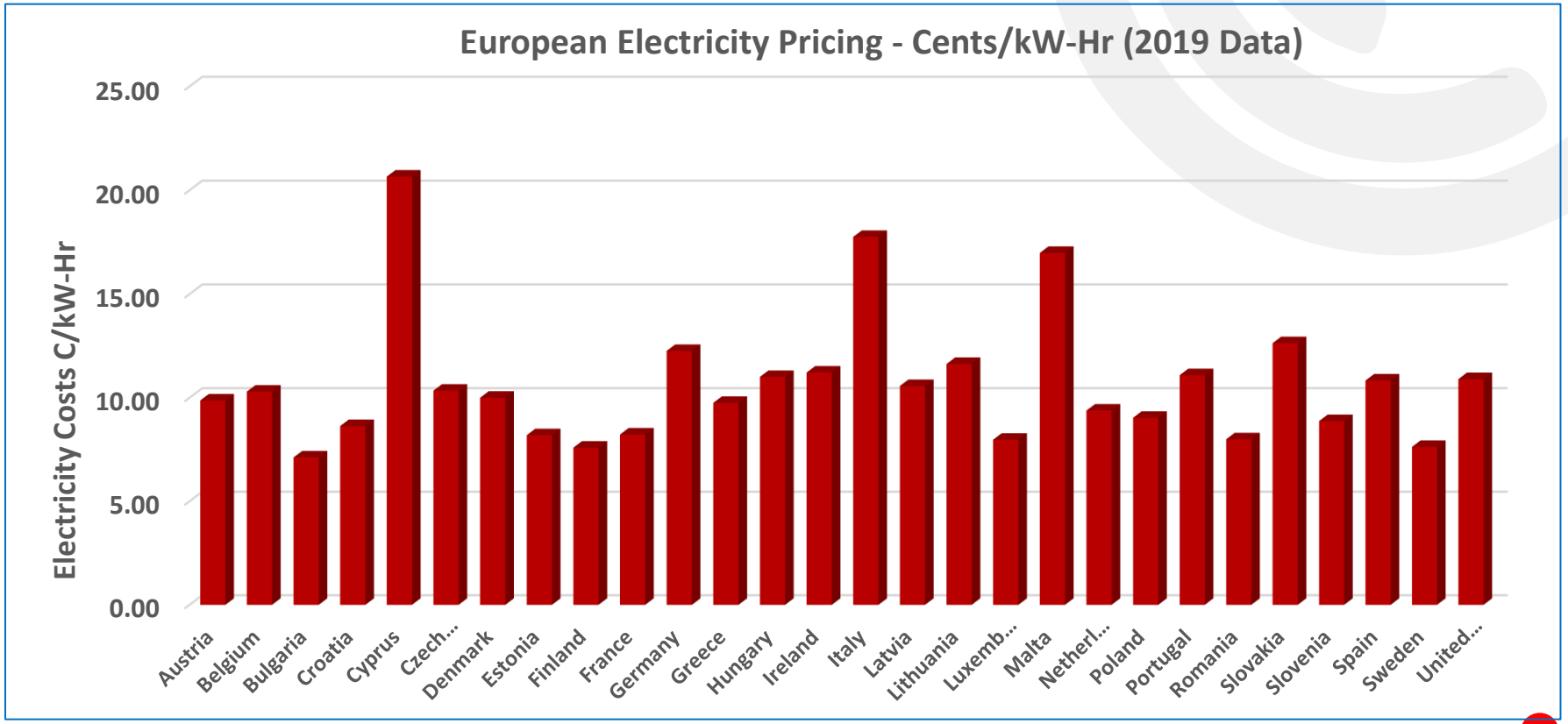
72 cm W x 96 cm H x 27 cm D
(28.3” W x 37.8” H x 10.6” D)

TRANSMITTER EFFICIENCY ADVANCES

- **Efficiency of a transmitter:**
  - Definition: (RF Power Out / AC Power In) x 100%

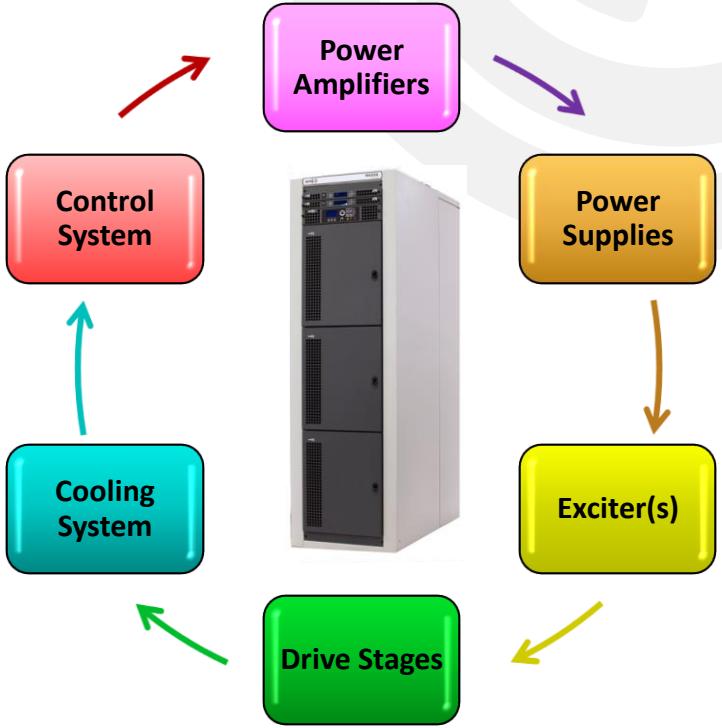


ELECTRIC POWER COSTS



TRANSMITTER EFFICIENCY

- Transmitter System Efficiency
- Some Items may have fixed losses:
  - Control System
  - Exciters
- Some Items may have varying losses:
  - PA Module (varies with modulation, saturation)
  - Drivers (varies with modulation, saturation)
  - Cooling System (speed-controlled pumps and fans)
  - Power Supplies (can vary depending on load)
- Why are low power transmitters less efficient than high power?
  - As power is reduced, fixed losses become a larger part of the equation



PRIMARY EFFICIENCY DRIVERS IN A TX

- Power Amplifiers
  - Most older designs used Class AB PA's
    - PA Efficiency in range 23% to 33% (Overall Tx efficiency in range of 16% to 27%)
  - Most new designs uses High-Efficiency (Doherty) PA's
    - PA Efficiency over 50% VHF and UHF (Overall Tx efficiency often > 40%)
- Power Supplies
  - 12 years ago 86% was "state-of-the-art" efficiency
  - Today – power supplies can be up to 96% efficient
- Cooling System
  - Older less efficient transmitters used large high volume and pressure blowers
  - Large pumps and heat exchangers in liquid-cooled transmitters
  - New systems use variable speed fans and pumps and have less heat to remove

EFFECT OF POWER SUPPLY EFFICIENCY

Item	Old Technology PS 86% Effy.	Recent Power Supply 90% Effy	New High Eff. PS 96% Effy.
RF Power Output (W)	10,000	10,000	10,000
Power Amplifier Efficiency	51%	51%	51%
Combining losses (dB)	0.30	0.30	0.30
RF power before losses (W)	10,715	10,715	10,715
DC Power to PA's (W)	21,010	21,010	21,010
Power Supply Efficiency	86%	90%	96%
AC Power to Power Supplies (W)	24,430	23,345	21,886
Power Supply Loss (W)	3420	2334	875
Drivers	600	600	600
Exciters	150	150	150
Control	120	120	120
Cooling	600	600	600
Total AC Input (kW)	29,321	27,149	24,231
Overall Tx Efficiency	34%	37%	41%

- Clearly, the design of the power supply has a significant impact on total efficiency
- Example of a high-efficiency power supply:
  - Efficiency 96% at 50% FL
  - Power factor typ. 0.995
- Input voltage range typ. 185 – 300 VAC

TCO VERSUS TRANSMITTER EFFICIENCY

TCO

- It's the total cost to own and operate the transmitter system over time
- Includes initial equipment cost and delivery
- Includes the installation / commissioning costs
- Routine and unscheduled maintenance costs
- Repair/replacement and other operational costs

EFFICIENCY

- Transmitter efficiency = Power Out / Power In (tx only)
- System level efficiency may also include::
  - AC transformers and voltage regulators
  - Heat load to the room (HVAC power costs)
  - RF system losses (often significant)
  - RF feeder losses (often significant)
  - Even antenna gain and pattern?

CALCULATING TCO & BREAKEVEN ANALYSIS

- Each element of the Transmitter lifecycle has a cost
- Over the lifetime of the Transmitter, the total cost may far exceed the purchase price by several times

Questions:

- Is it really worth buying a new transmitter?
- Will I see a return on investment?
- When will it pay back for itself?

Let's use the TCO Calculator and find out…

AIR TO LIQUID-COOLED 9.6KW TX TCO AND BREAKEVEN

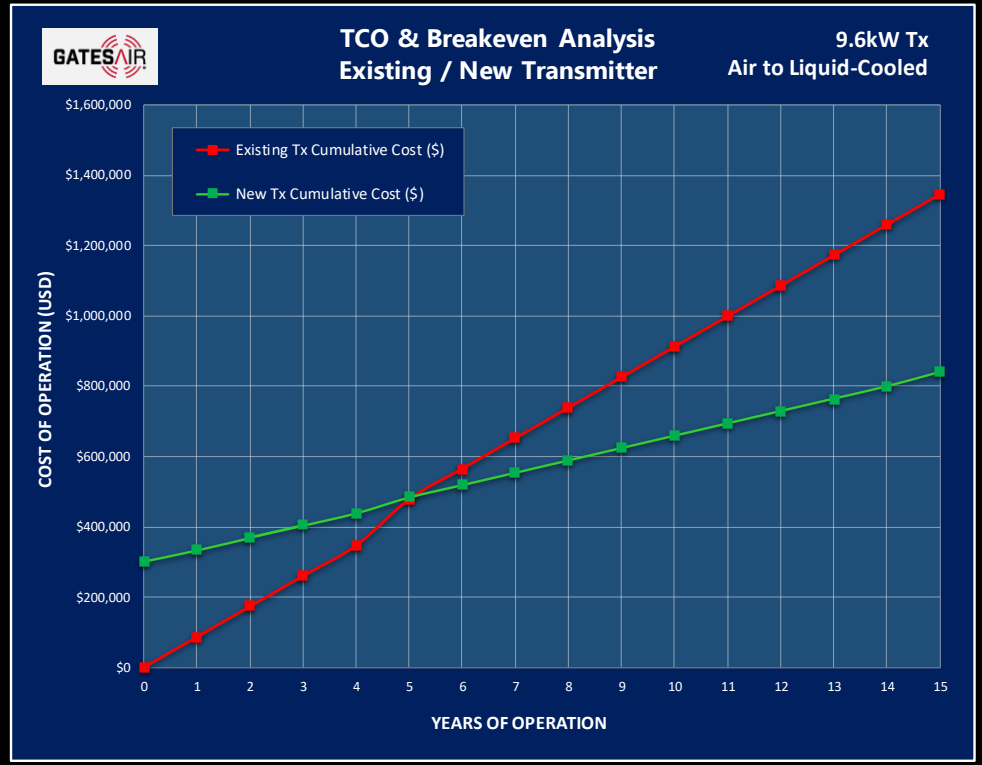
TCO & Breakeven Analysis

User Entry Cells:
Result Cells:

Item	Existing Transmitter	New Transmitter	Unit
Transmitter Model	**Diamond DHD45P2**	**ULXTE-16**	
Tx Average Power Output	9.6	9.6	kW
Cooling Method (select Air or Liquid)	Air	Liquid	
Planning Costs	$0	$1,200	USD
New Transmitter Cost	$0	$265,000	USD
Delivery / Shipping Costs	$0	$5,500	USD
Installation / Commssioning Costs	$0	$29,000	USD
Training Costs	$0	$2,500	USD
Average Annual Maintenance Costs	$11,000	$4,500	USD
Transmitter Efficiency	19.9%	42.2%	%
Electricity Cost ($ per kW/hr)	$0.15	$0.15	USD
Operational Hr/day	24	24	Hrs.
Operational days/year	365.25	365.25	Days
Major Repair / Upgrade at Year 5**	$45,000	$10,000	USD
Disposal Costs at EOL	$10,000	$10,000	USD
HVAC Efficiency Rating*	14	14	SEER

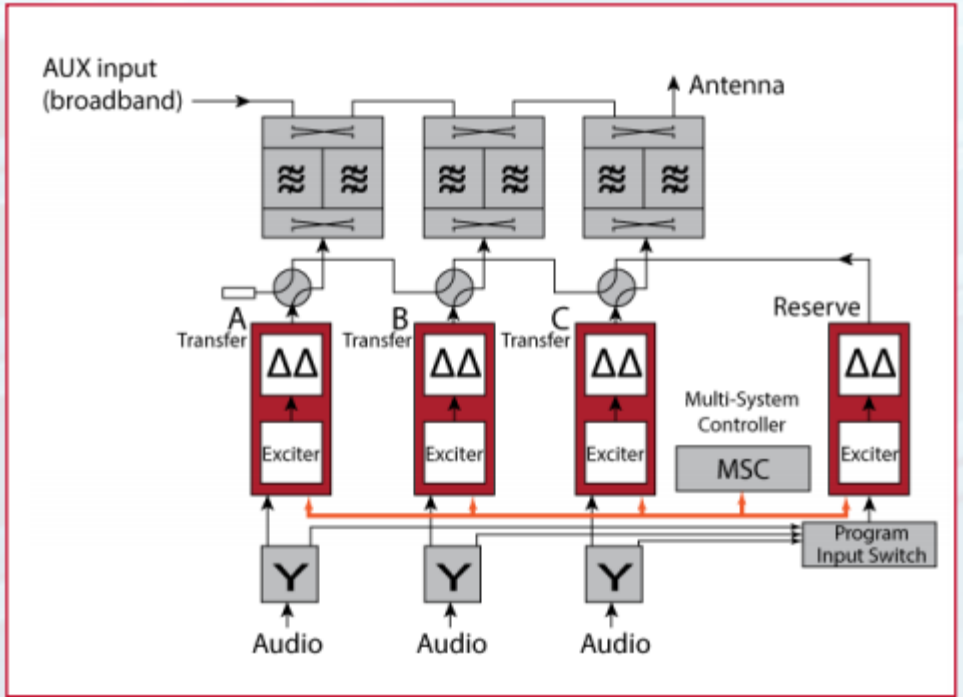
Calculated Summary Results		
Estimated Breakeven Period	**5 Years, 2 Months**	Y / M
Reduction in Heat Load to Room	**126,465**	Btu/hr
Annual Reduction in Carbon Emmissions	**149.8**	Tons CO_2
Tx Power cost savings per year	**$33,520**	USD
HVAC Power Cost Savings per Year	**$11,878**	USD
Total Power Cost Savings per year	**$45,398**	USD

** SEER (Seasonal Energy Effiiency Ratio) usually between 10 and 22 (typical 14)*
*** For Tube Transmitters, include replacement Tube Costs*



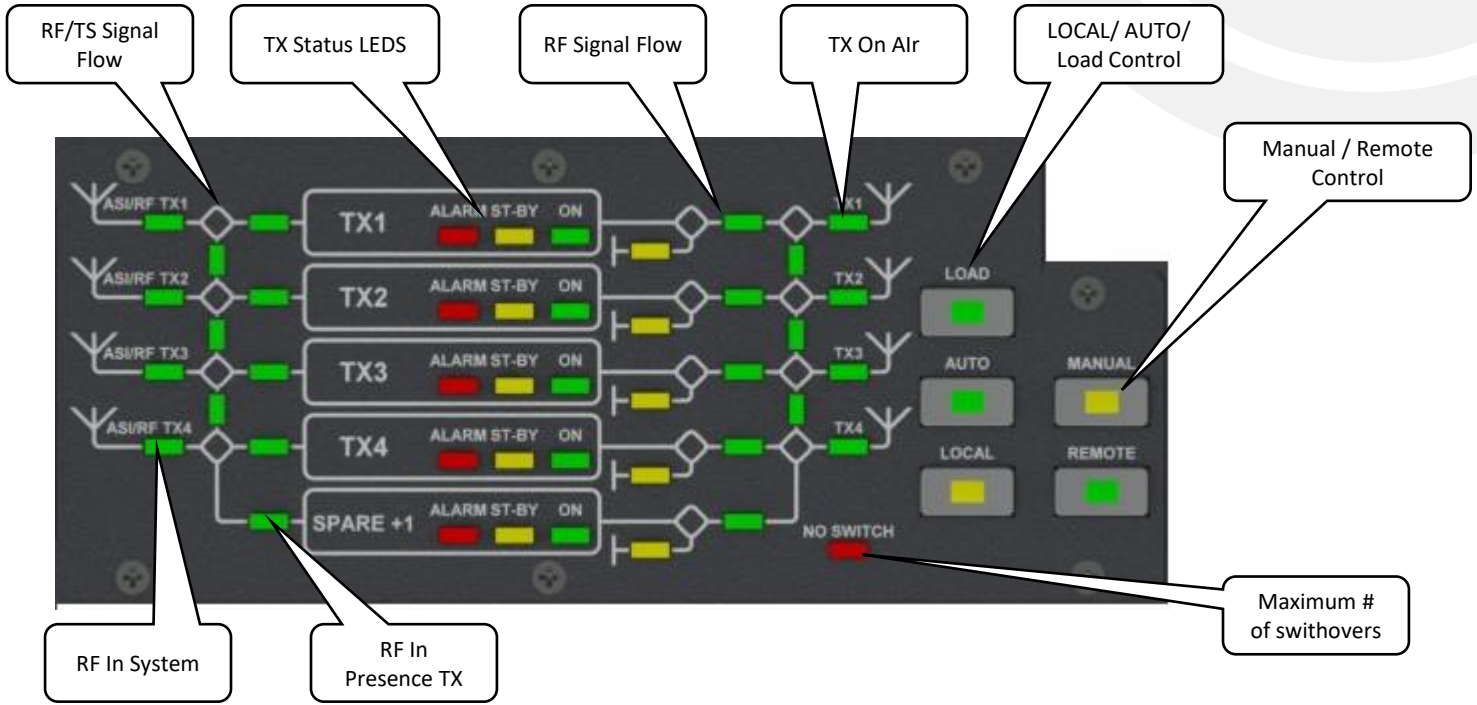
CONFIGURATIONS FOR REDUNDANT OPERATIONS

- 1+1 – Main – Alt
- N+1 – multi transmitter back up
- Dual Drive
- Evaluate your tolerance for risk vs the cost to provide insurance
- Share back up in a multi transmitter site can be affordable



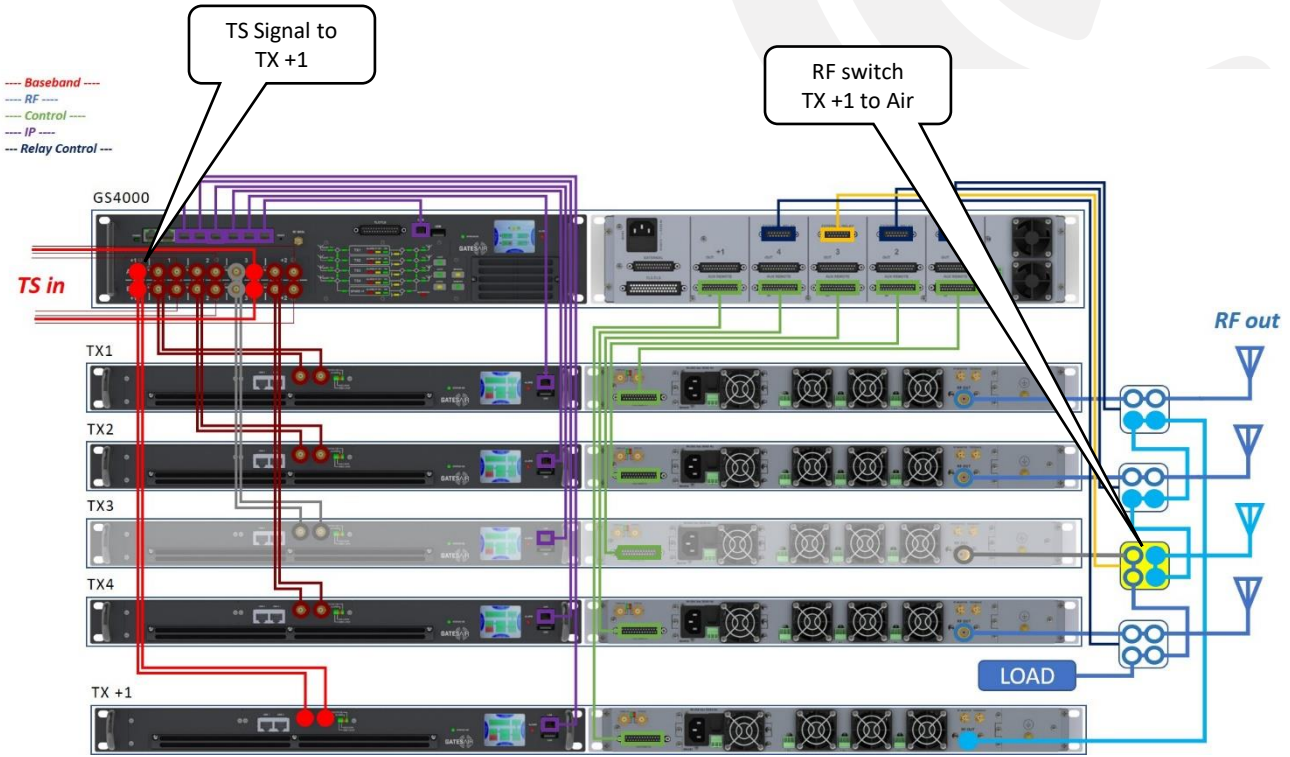
4000 SERIES FRONT PANEL

Front Panel Status on 4000 series

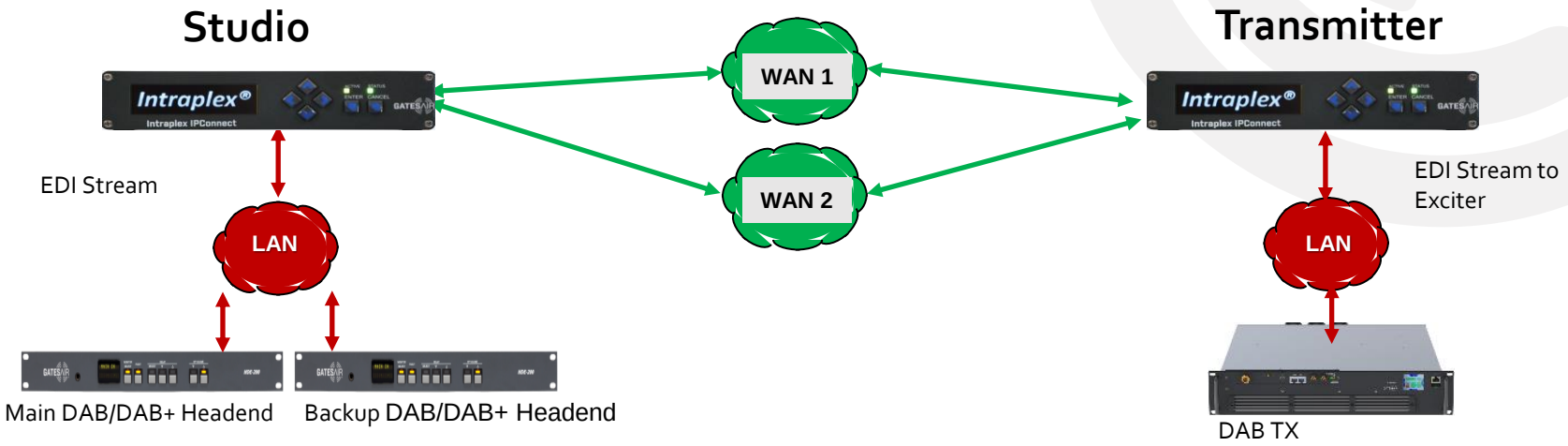


GATESWITCH 4000 LAYOUT – 4+1

- Illustration of +1 redundancy
- TX 3 is off-line, Transport stream (RED) is rerouted for TX3 to +1 spare
- RF coax switch relay (BLUE) positions to put +1 TX to air



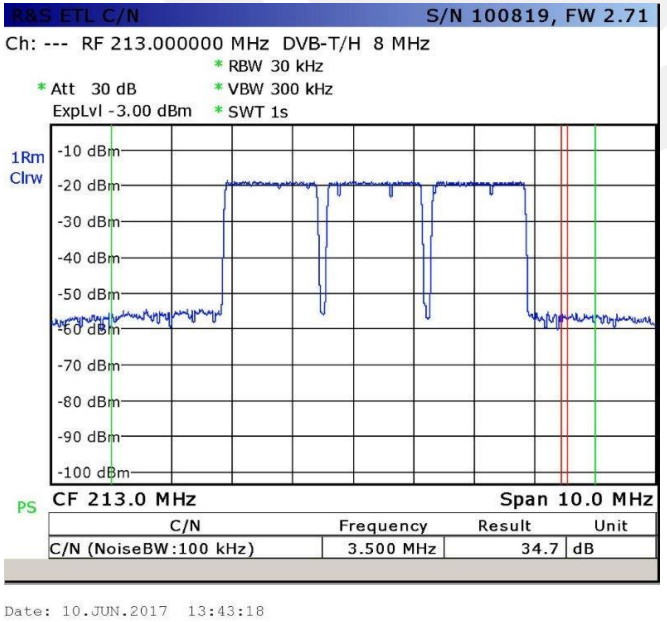
INTRAPLEX IPCONNECT APPLICATION



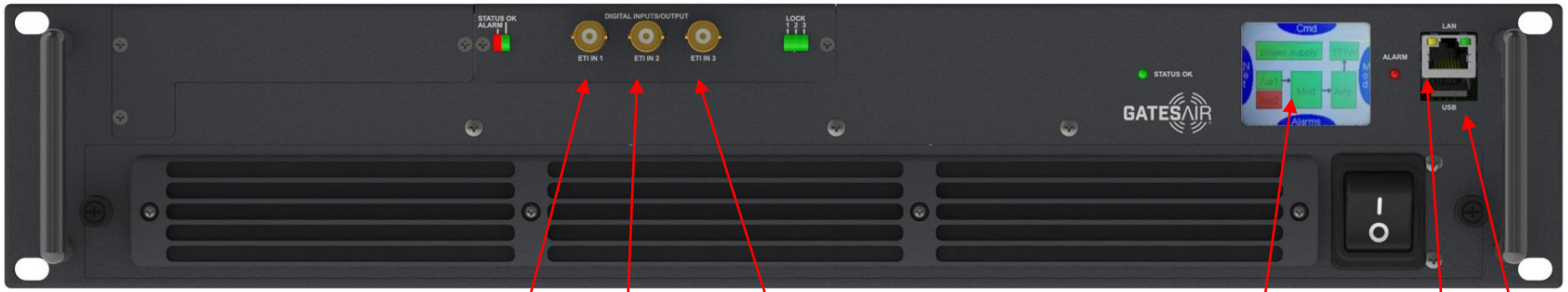
- Provides “Hitless” protection using Intraplex® Dynamic Stream Splicing technology for EDI streams
- IPConnect intercepts the streams from the Headend and reliably tunnels it to one or more exciters
- IPConnect works with unicast, multi-unicast and multicast topologies
- Also monitors and provides automatic failover between Main and Backup Headend at the Studio side

MULTICARRIER DAB+ TRANSMITTER

- Allows up to 3 DAB+ Carriers to be generated or re-transmitted through a single amplifier
- Advanced pre-correction and linear broadband amplification
- Unique solution ONLY available from GatesAir
- More economic than standard solutions
- More compact
- Less expensive to operate, lower power consumption



MULTICARRIER DAB+ 240W TOTAL POWER



ETI In #1

ETI In #2

ETI In #3

Touch screen LCD

USB Port

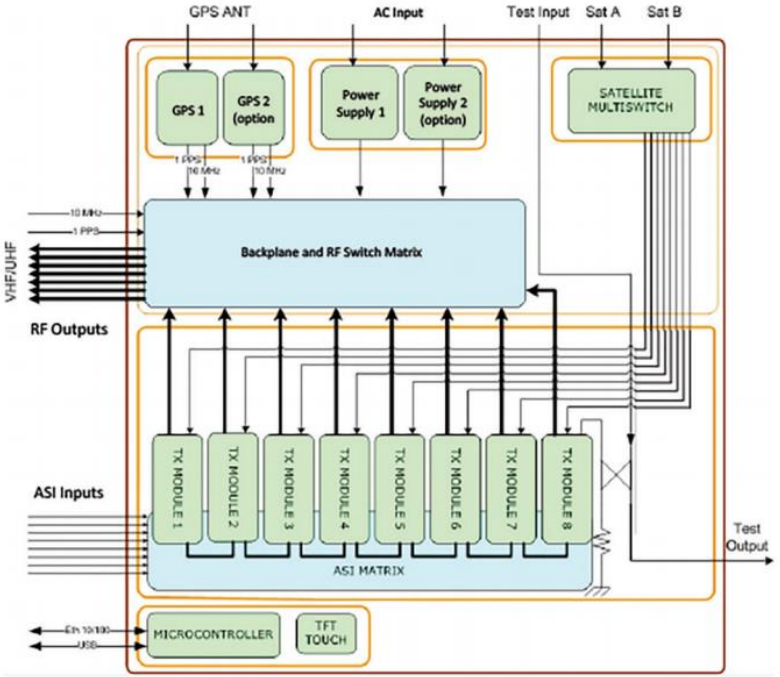
Control Ethernet Port

MULTICARRIER DAB+ TECHNICAL SPECIFICATIONS

- Compact 1U rack 19 "chassis.
- Output power up to 240W rms total
- Common RF amplification.
- Wide Band VHF BIII Doherty Amplifier technology with high efficiency.
- Supported Modulations: DAB / DAB + / T-DMB.
- Multi-carrier modulation (3 channels), for adjacent and non-adjacent frequencies.
- Adaptive pre-correction circuits.
- Built-in high-stability GPS / GLONASS receiver (Optional).
- Hot swappable amplifier and power supply.
- Input interface: 3 ETI inputs.
- SNMP, Web interface and Touch Screen display.
- USB service interface for up-grade / download.

MULTI CHANNEL TRANSMITTER

- Ideal for low power multi ensamble sites – shared redundancy
- 7+1 6+2 redundancy
- Integrated Satelite receiver card



SUMMARY

- New options for DAB transmission networks allow for network design flexibility
- Advancements in energy efficiency help reduce long term operating costs
- Energy consumption and costs can be impacted by using liquid or air-cooled transmitters
- Multiple options can allow for cost effective redundancy for transmitters and links
- Unique system configurations and modulation capabilities can simplify network deployment

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