DAB+ Transmitters

Agenda

- GatesAir Company Overview
- Current transmitter technology and architecture
- Air-Cooling versus Liquid-Cooling
- Output structures and redundancy options
- Control and monitoring

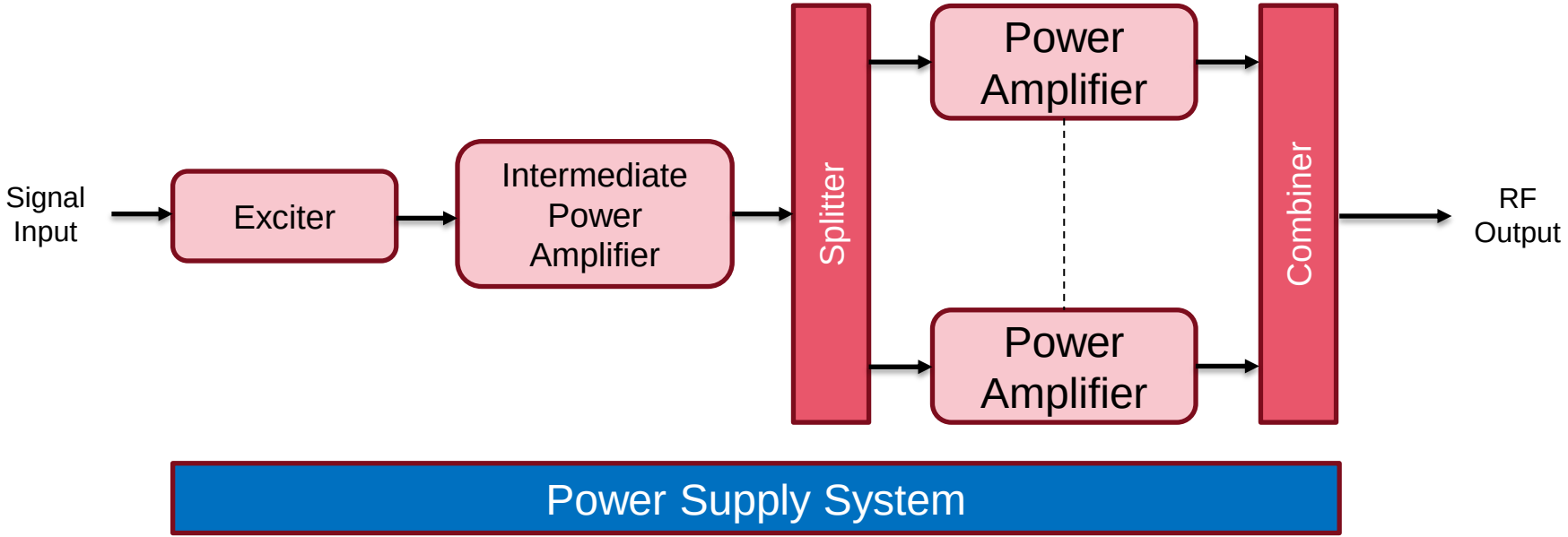
Our History

- **1922** – Gates Radio starts business. Parker Gates was only 15 years old
- **1950** - Gates Radio had become a major Radio equipment supplier in USA
- **1957** – Harris Corporation acquires Gates Radio
- **2013** – Gores Group acquires Harris Broadcast Division
- **2014** – Harris Broadcast splits into two companies – Imagine Communications and GatesAir

Current Transmitter Technology and Architecture

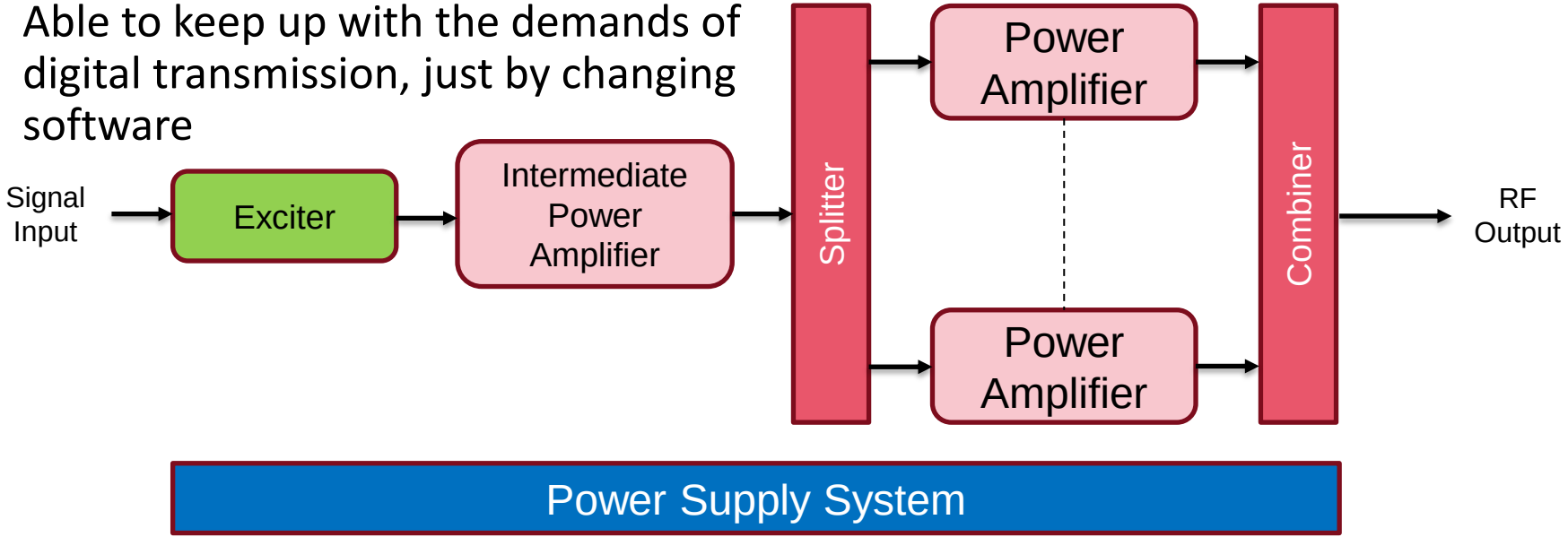
Simplified Transmitter Block Diagram

- Much has changed since the invention of radio transmitter by Marconi in 1894.



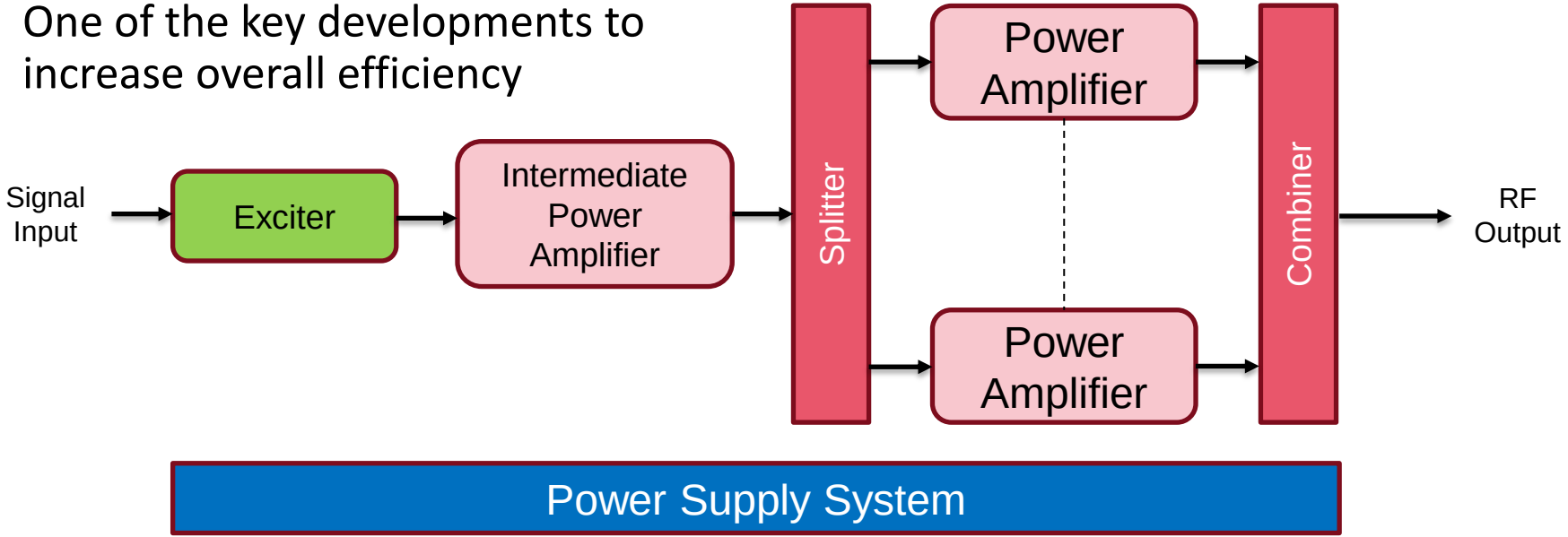
Exciter technology

- Exciter are currently software-defined modulators based on FPGA or microprocessors
- Able to keep up with the demands of digital transmission, just by changing software



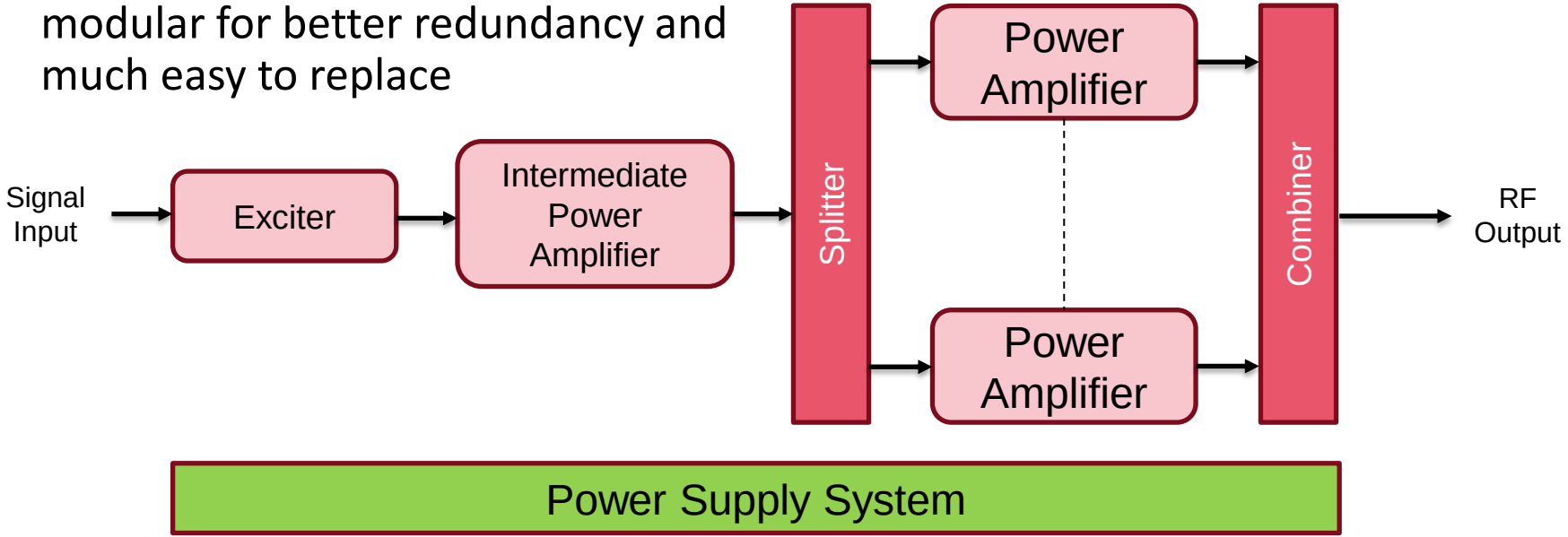
Exciter technology

- Capable of enhancing the RF performance for digital transmission, i.e. MER
- One of the key developments to increase overall efficiency



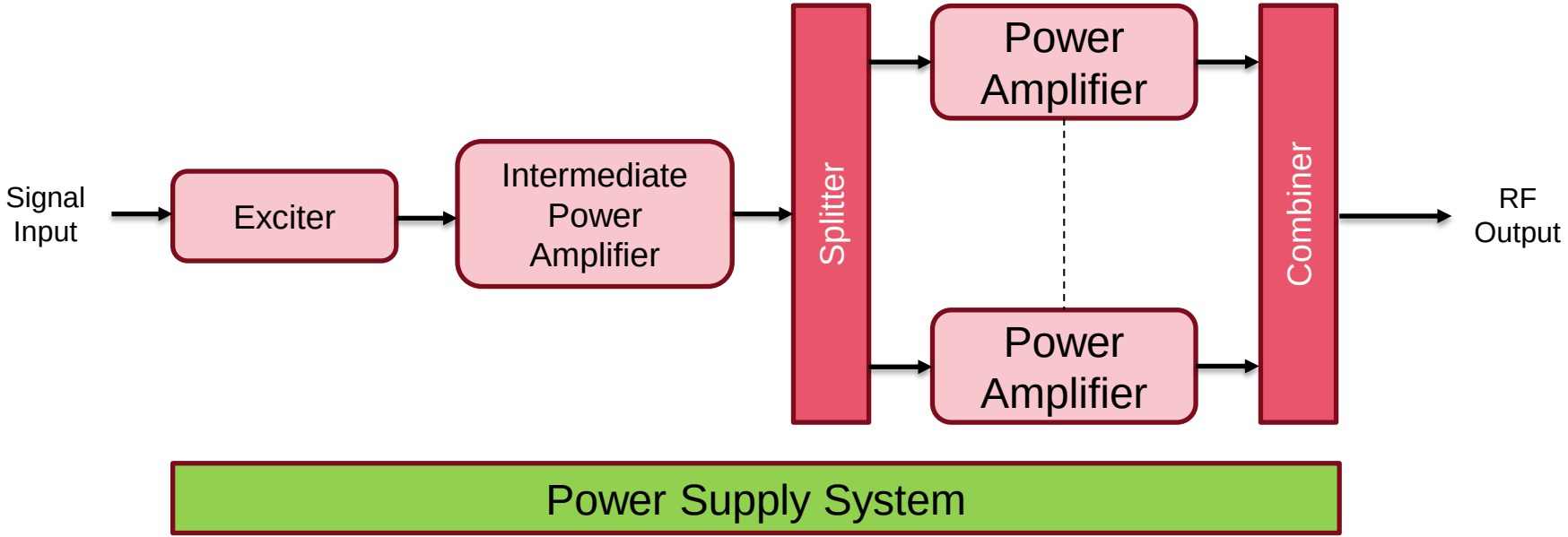
Power Supply Technology

- Advances in GSM/IT sector has been adopted for transmitters
- New generation power supply are modular for better redundancy and much easy to replace



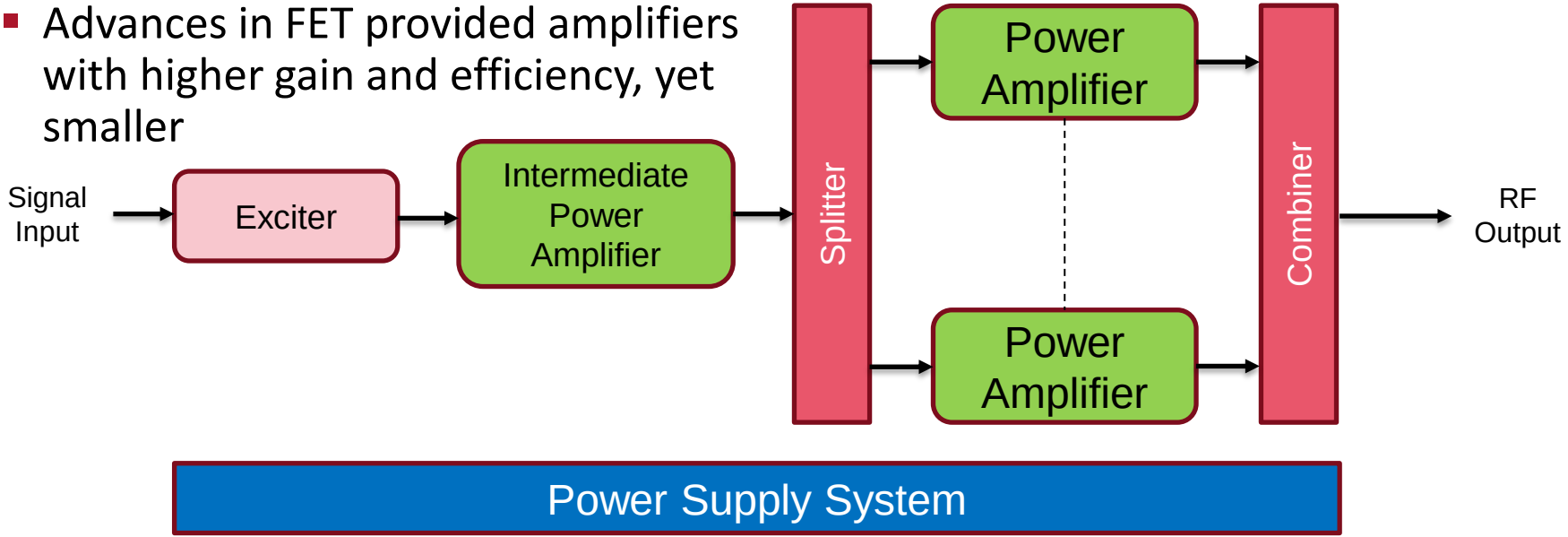
Power Supply Technology

- New generation power supply are also highly efficient and contributes to the overall efficiency



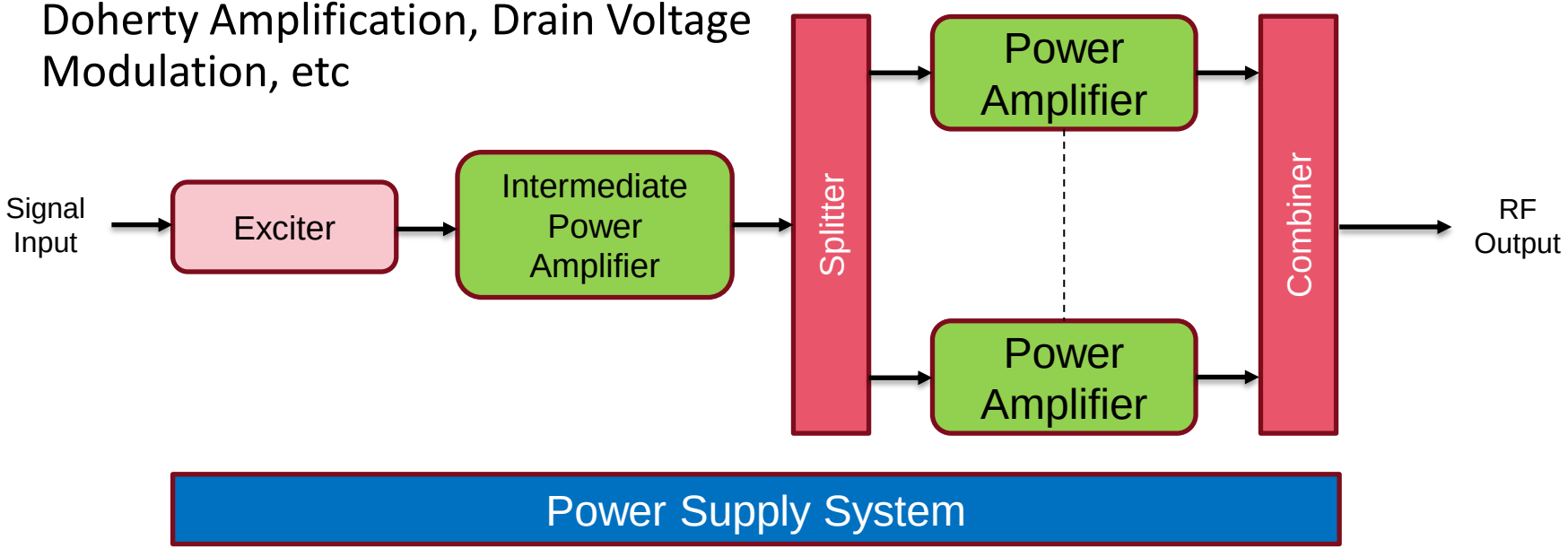
Power Amplifier Technology

- Various techniques to provide signal amplification, Field Effect Transistor is the most prevalent
- Advances in FET provided amplifiers with higher gain and efficiency, yet smaller



Power Amplifier Technology

- Together with latest exciter technology, able to explore other techniques for higher efficiency, i.e. Doherty Amplification, Drain Voltage Modulation, etc



A History of Technology Leadership

- **1981:** Introduced the “Mod Anode Pulser” — a simple technique that reduced the power consumption of klystron analog UHF transmitters by 19%
- **1990’s:** DiamondCD® and Ranger™ series transmitters leverage just debuted high-power UHF LDMOS solid-state devices, providing significant efficiency benefits compared to earlier transistor designs
- **2005:** Our PowerCD® UHF transmitters introduce an advanced IOT design that sets a new benchmark for performance
- **2008:** GatesAir throws out the old playbook with the debut of PowerSmart® — a pioneering architecture for VHF and UHF transmitters that “broke the mold” in power output, compact size and modularity
- **2013:** GatesAir once again leads the way with the introduction of a new line of next-generation, high efficiency VHF and UHF transmitters: Maxiva VAX and ULXT featuring PowerSmart® 3D high-efficiency technology - groundbreaking designs that set an all-new standard for transmitter efficiency

VAX16-3D
with dual drive
In deluxe 44RU rack

What is PowerSmart®?

PowerSmart® is the on-going GatesAir design initiative to create the most efficient transmitter designs and products. GatesAir leverages the most sophisticated tools to develop cost, energy, and space efficient solutions.

Television

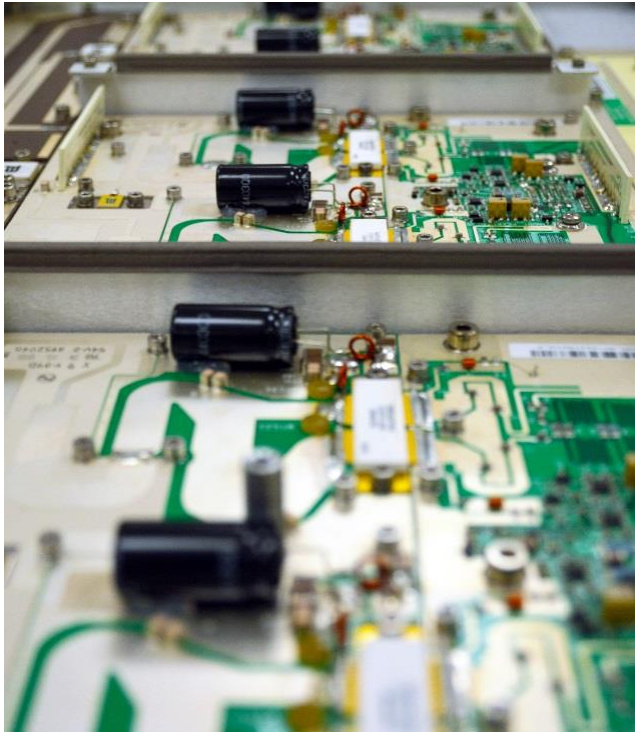
The Maxiva™ family of UHF transmitters led this initiative with the first 50V LDMOS device-driven transmitter in the industry setting a new benchmark for power density and efficiency.

Radio

The Flexiva™ family of FM transmitters set new benchmarks with operating efficiencies of up to 72%, the first FM design to use 50V LDMOS devices, and the smallest footprint at 10kW and higher power levels.

PowerSmart® to PowerSmart® Plus

- **What is PowerSmart®** - An on-going GatesAir initiative at GatesAir to improve efficiency & lower cost of ownership
- **PowerSmart® 3D -** Innovative, fully broadband, high efficiency solutions allowing dramatic power reduction
- **PowerSmart® Plus** - Uses several new techniques to further optimize efficiency:
  - Band-optimized Power Amplifiers, Power Supply management, cooling
  - New XTE Exciter with advanced correction techniques
  - Optimized High-efficiency UHF Transmitters (Maxiva ULXT w/PowerSmart™ Plus, 2016)

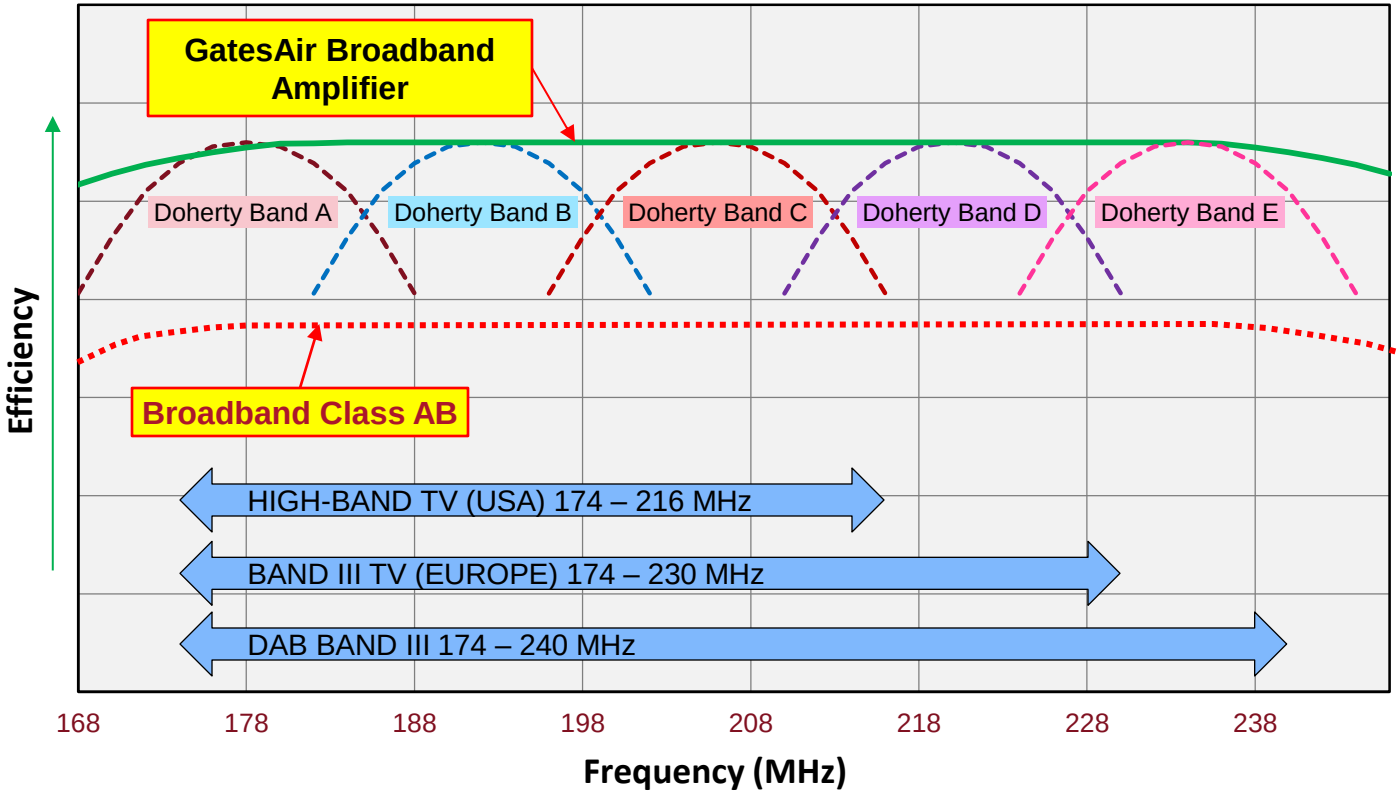


NEW High Efficiency VHF Technology

Introducing a new high-efficiency VHF Band III amplifier design which provides the industry's best power efficiency

- A further advancement of the GatesAir PowerSmart® initiative
- Proprietary GatesAir patent-pending amplifier technology – Introducing **PowerSmart® 3D**
- Delivers the highest DC to RF efficiency - without the compromises of Doherty or Drain Modulation techniques

GatesAir Broadband Technology for DAB



GatesAir VHF Technology - Key Benefits (1)

- **Broadband, high-efficiency design**
  - Highest available AC to RF efficiency along with fully broadband operation across VHF band III. This means only one spare power amplifier module is needed to service any VAX-3D series transmitter in the network. No adjustment, or retuning of any type, is required.
- **Future-proof architecture**
  - Re-pack (Restack) of the Band III TV spectrum could mean potential channel changes in the future. The broadband VAX-3D transmitter is ready for such changes, without any need to swap PA modules, combiners, or other components.

GatesAir VHF Technology - Key Benefits (2)

- **Modular design with small, lightweight, PA modules**
  - A module weighs only 4.5kg (10lb), far lighter than comparable PA modules from others. This makes it much easier to replace while on the air and its small size and weight reduces shipping costs between either our service department, or your spares depot and each transmitter site.

- **Small, lightweight, individual PA power supplies**
  - Each power supply is a separate assembly from the PA module, making it much easier to service and replace, if needed. PA power supplies weigh less than 2kg (4.4lb) and can be swapped on-air in less than 1 minute.

GatesAir VHF Technology - Key Benefits (3)

- **Designed for ease of servicing**
  - Front load hot-swappable lightweight PA modules and power supplies make servicing simple.
  - Since PA's are broadband, network spares are minimized
  - The VAX Compact drive uses high reliability, on-air replaceable DC fans
- **Optimized efficiency & performance**
  - New patent-pending PowerSmart® 3D amplifier technology – efficiencies over 40% (DAB & ATSC), over 37% OFDM TV
  - High-efficiency DC power supplies
  - Variable speed cooling fans for optimum cooling efficiency
  - Best-in Class Real Time Adaptive Correction (RTAC)

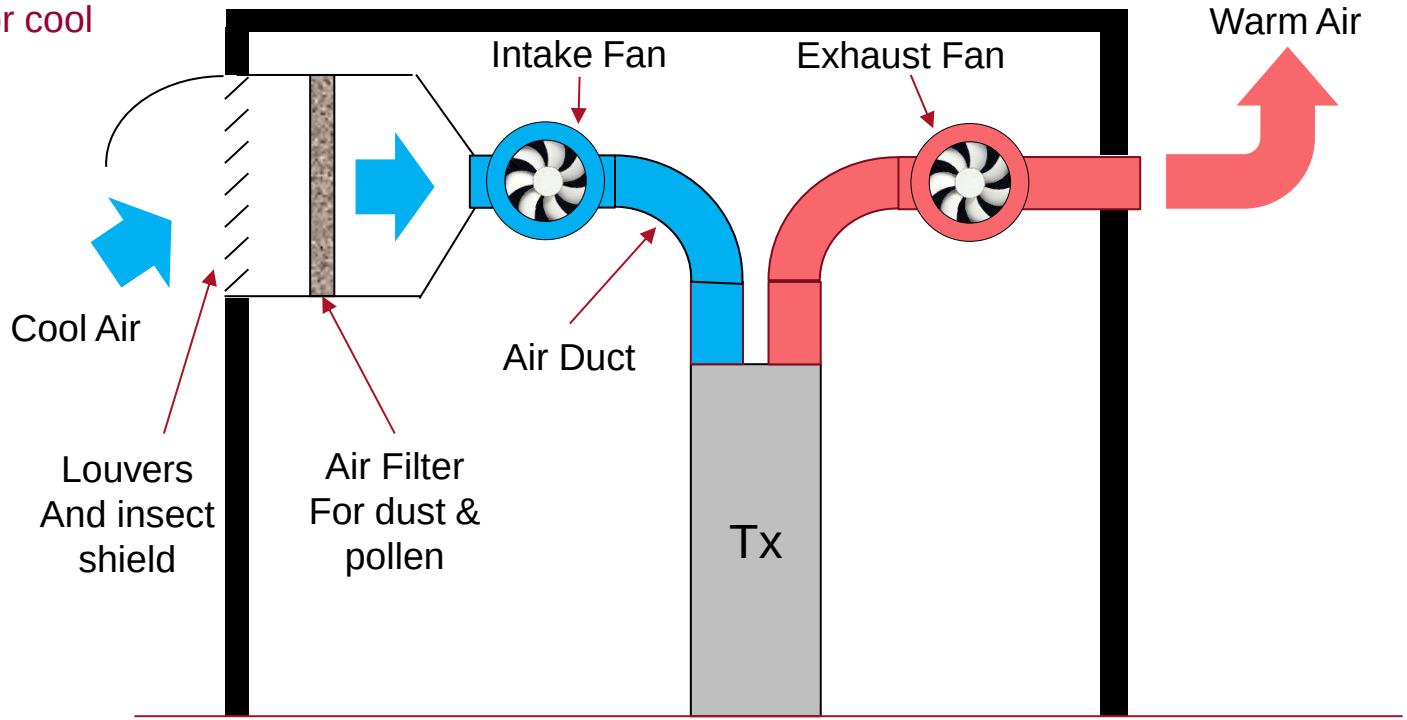
Air-Cooling vs Liquid-Cooling

Optimized Cooling Systems

- Three common cooling methods for broadcast transmitters
  1. Air-cooled using outside air
  2. Air-cooled using inside air and Air-Conditioning for room
  3. Liquid cooling
- Each of these has some advantages and disadvantages

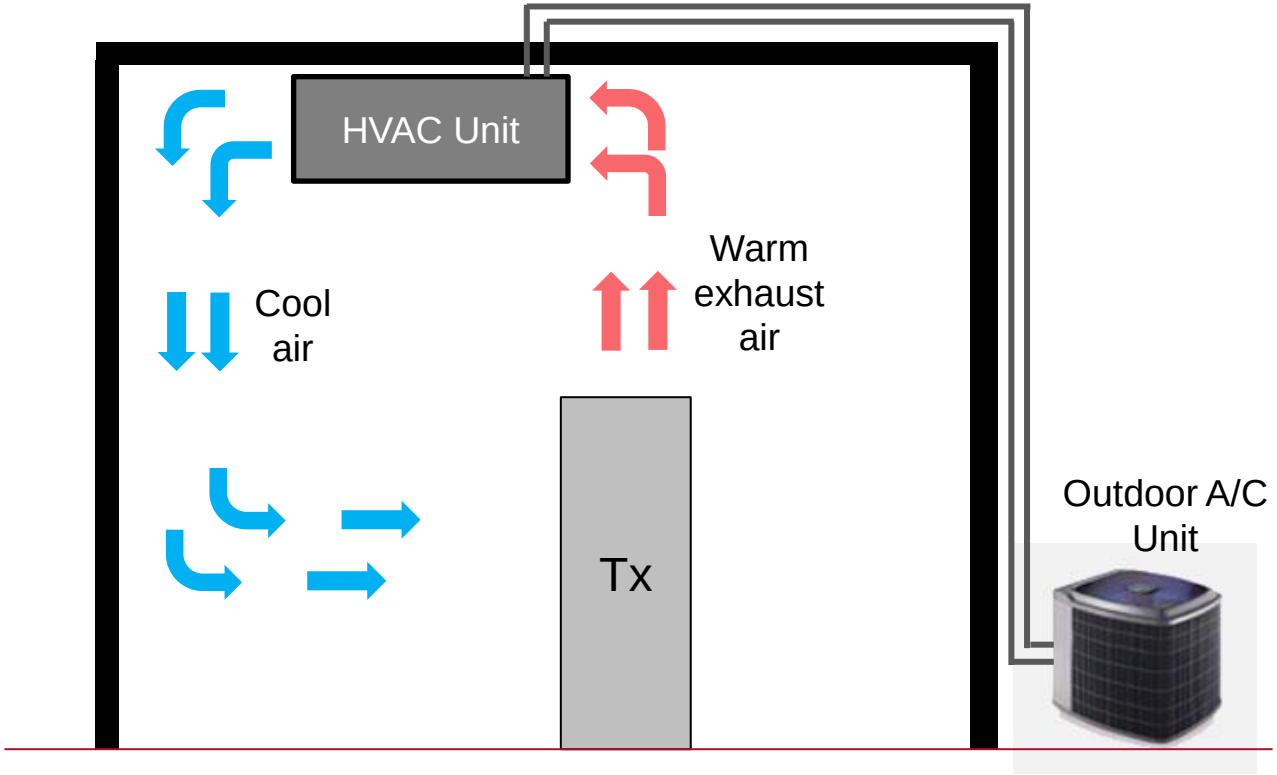
Air Cooling – Outside Air (no Air-con)

Recommended
(but better for cool climates)



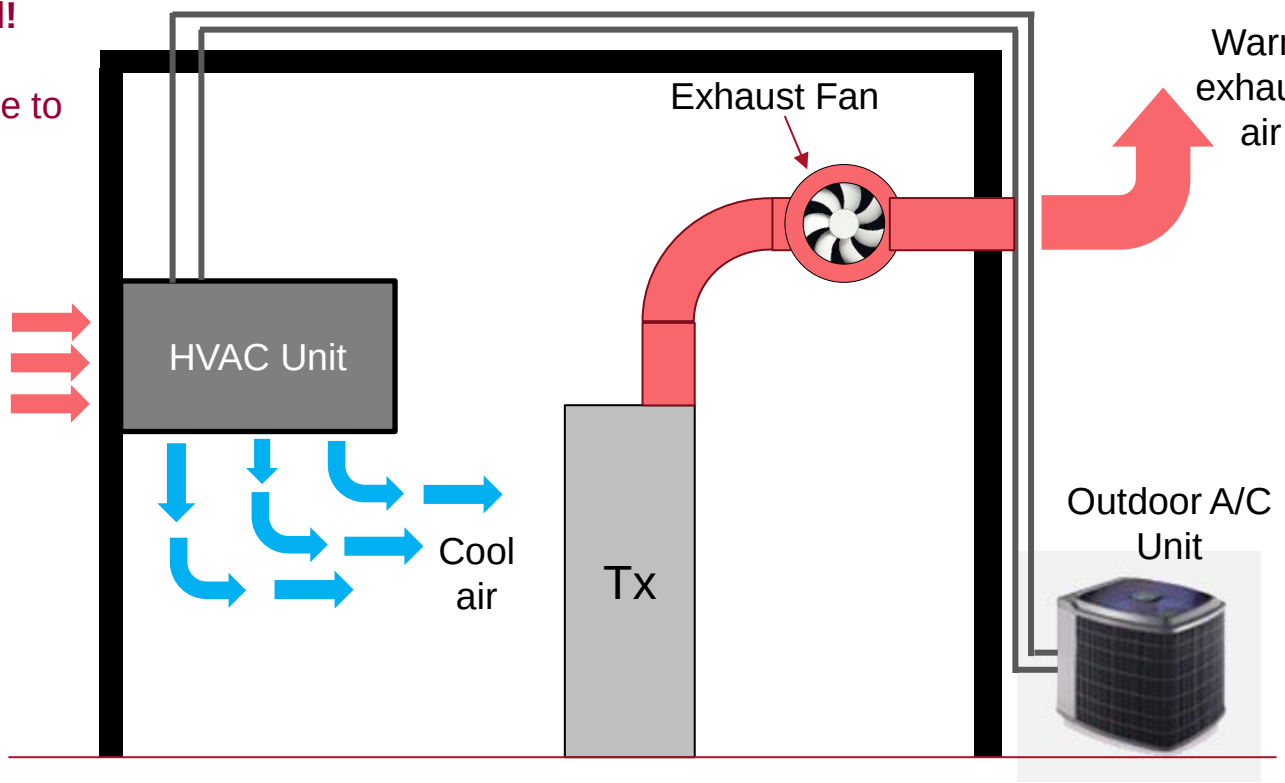
Air Cooling – Sealed Room with Air-con

Recommended (better for hotter climates)

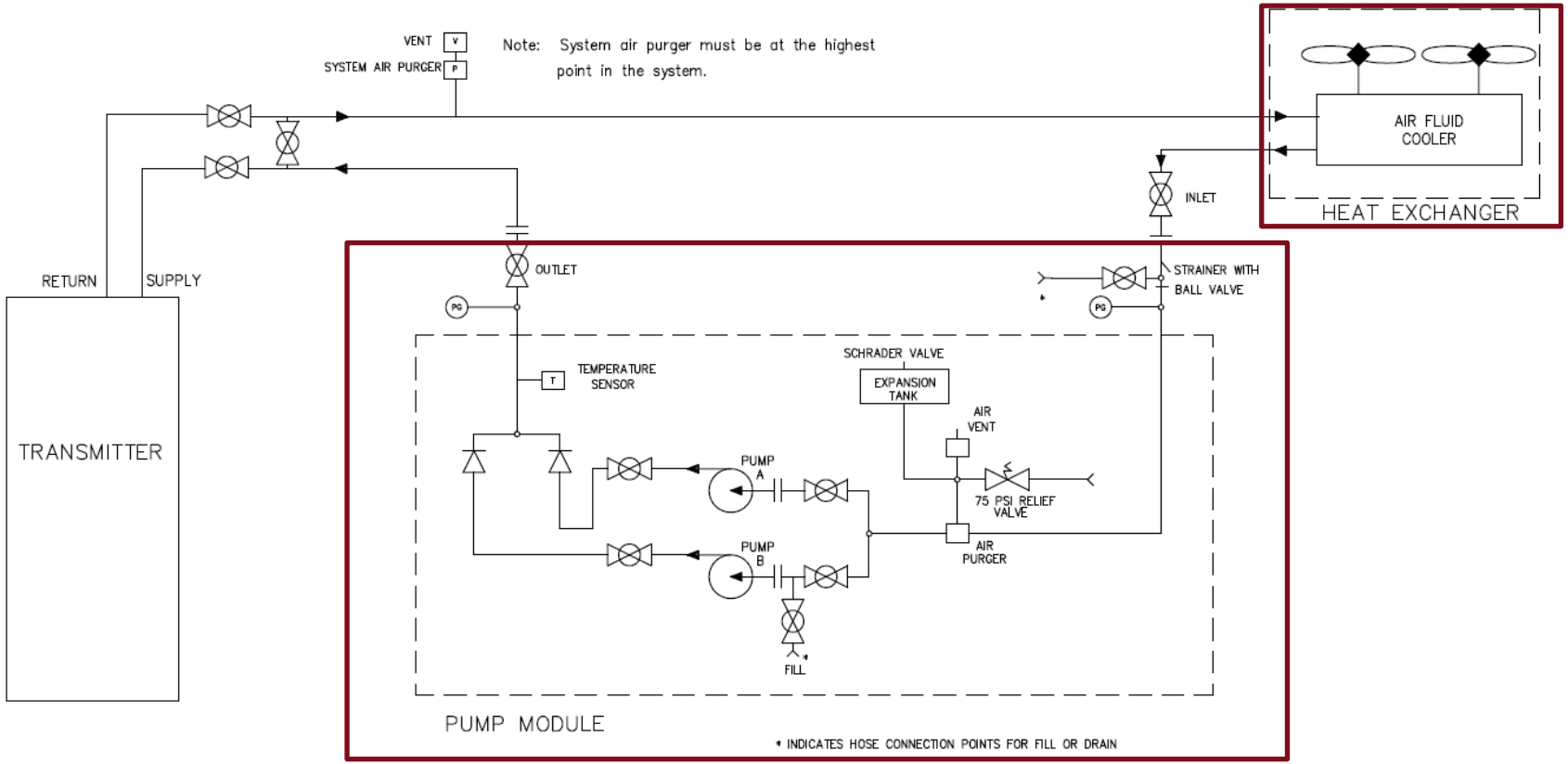


Air Cooling – Outside Air through Air-con

Not Recommended!
(much more cooling capacity required due to high volume of warm/hot intake air)



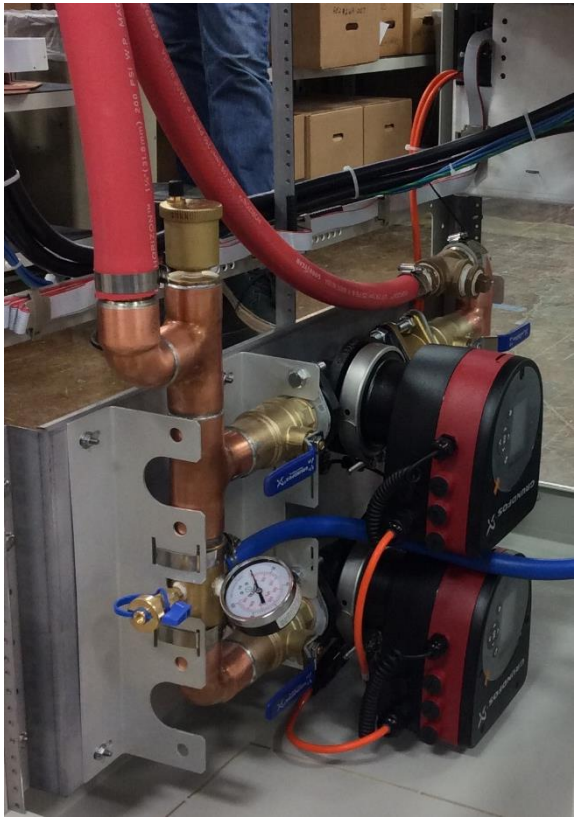
Liquid-Cooling System Block Diagram



High Efficiency Pump Module

Internal or External Dual Pumps, with auto/manual changeover

- Pump speed inverter controlled
- Optimized for High Efficiency
- Reliable, proven
- Small physical size
- Low maintenance, closed-loop pressurized system
- Quiet – Designed for indoor installation



High Efficiency Heat Exchanger

- GatesAir manufacture
- Dual fans - on-air replacement
- Low noise, high-efficiency fan blades
- Speed controlled for maximum efficiency
- Vertical or horizontal airflow (mounting can be adapted on site for either configuration)
- Two sizes available 20kW & 50kW heat dissipation

Vertical Air Flow

Horizontal Air Flow

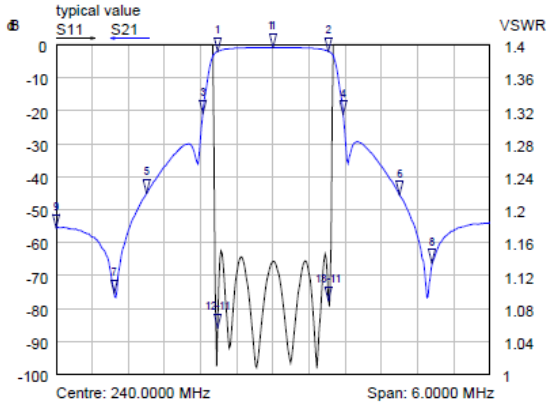
Cooling Comparison

Item	Air-Cooled (outside air)	Air-Cooled (HVAC)	Liquid Cooled
Energy cost	Low	Very High	Low
Maintenance	Very High	High	Low/Medium
Installation cost	High	Medium	Medium
Site visits	Frequent	Infrequent	Infrequent
Humidity control	None	Excellent	Excellent
Dust & dirt	Filter dependent	Excellent	Excellent
Reliability	Medium	Low	Excellent

Output structures and redundancy options

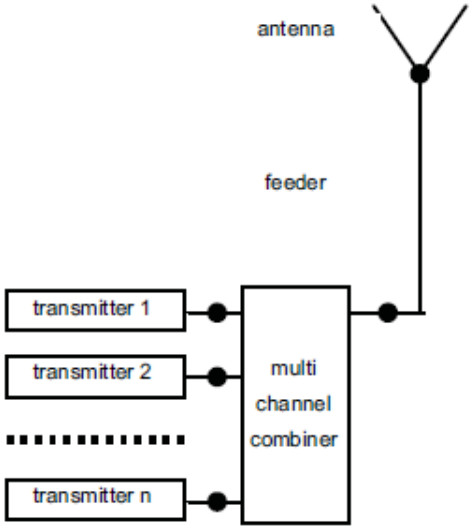
Output Structure of DAB System

- Transmitter -> Bandpass Filter -> Antenna
  - BPF is used to reduce spurious output from a transmitter, allowing adjacent channel operation, Ch 5A, 5B, 5C & 5D.



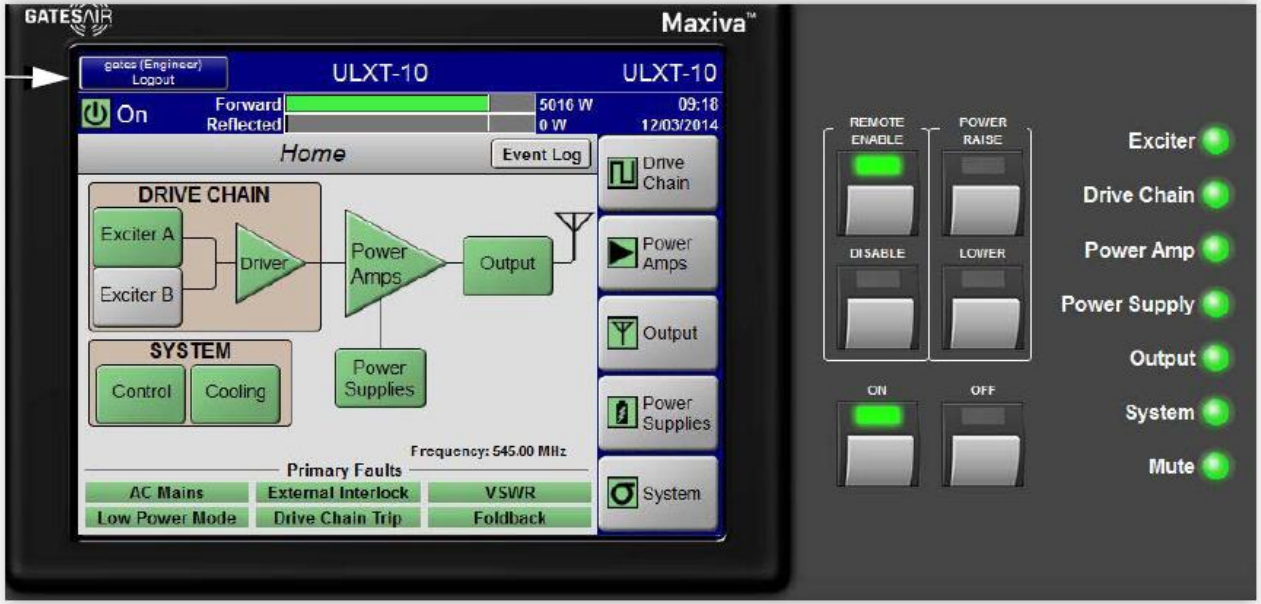
Output Structure of DAB System

- TX -> BPF -> Channel Combiner -> Antenna
  - Recommend to have TX -> Channel Combiner (with BPF built-in) -> Antenna
  - Cost effective to have BPF built into channel combiner, lower insertion losses for the transmission chain
- Possible to use existing VHF TV antenna system for DAB
- Alternative solution to above point is to “overlay” DAB antenna system over existing VHF TV system



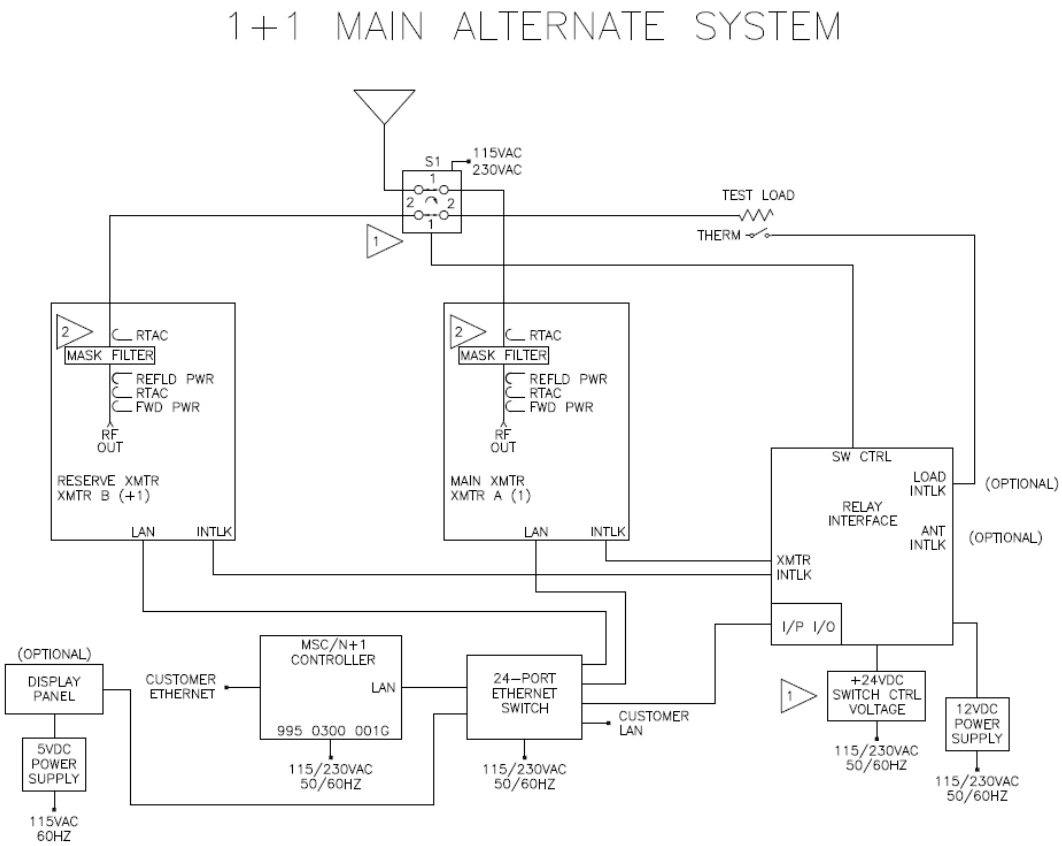
Redundancy Options of DAB System

- Cost effective to have Dual Exciters
  - Each exciter can have different feeds from different paths, i.e. main input from E1/IP and backup from microwave/IP.
  - PA modules failure will only reduce output power and modular approach means quick replacement time even when on air.



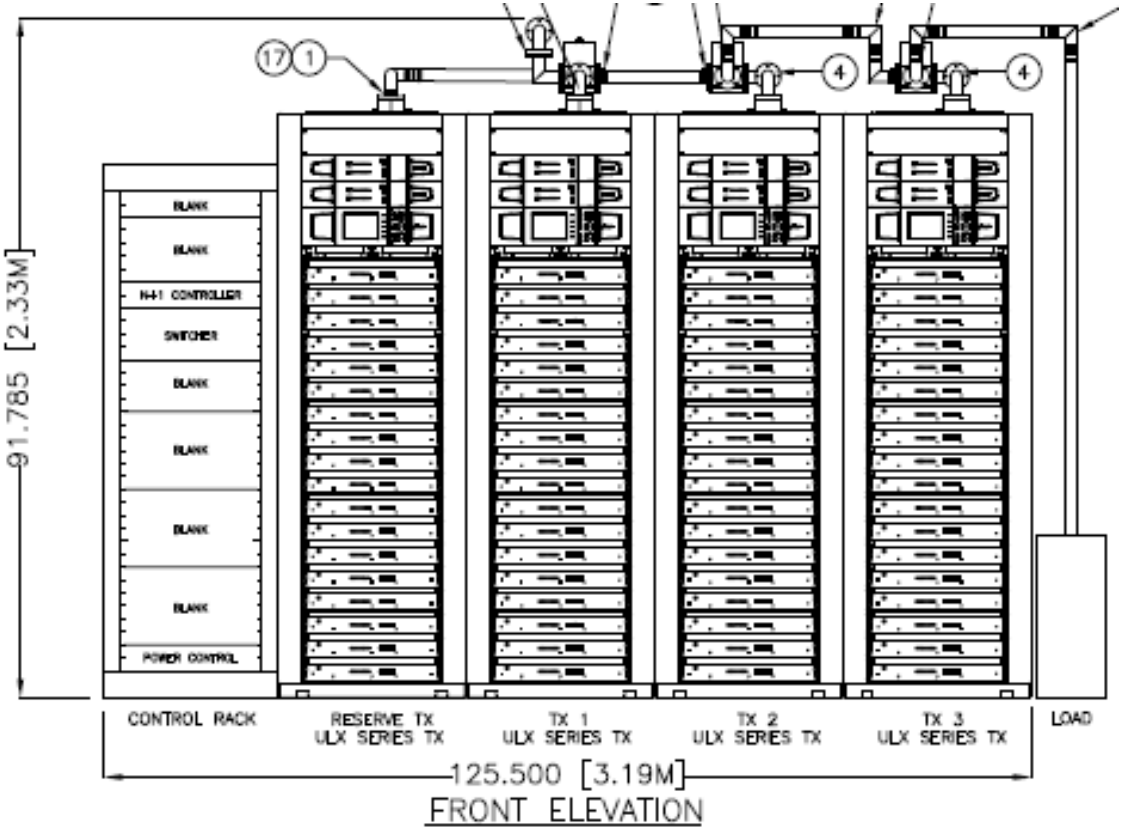
Redundancy Options of DAB System

- Some broadcasters prefer Main/Alt systems. 2 transmitters working in “Main” and “Backup” with auto/manual switching using coaxial switch.



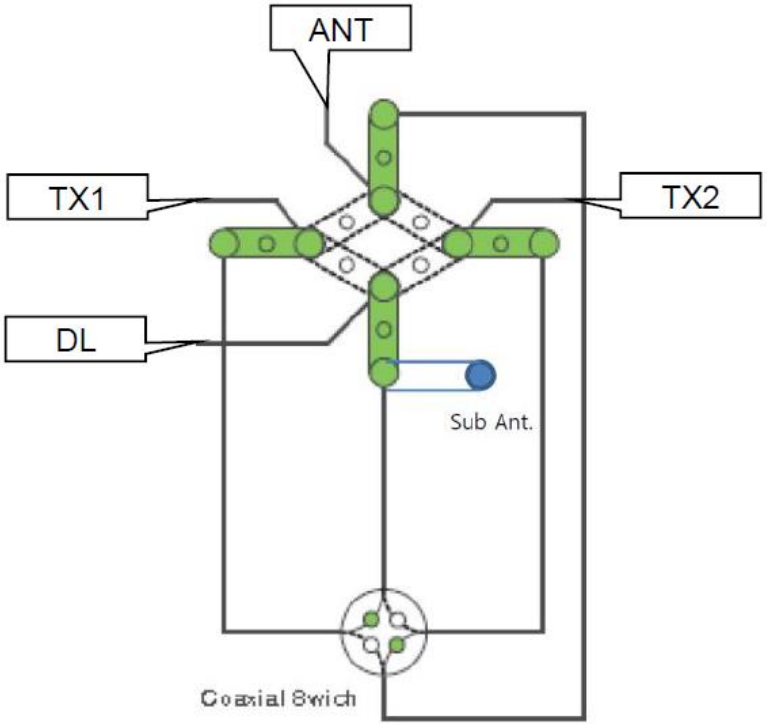
Redundancy Options of DAB System

- For broadcasters with more than 1 DAB system, they prefer N+1 system
  - “+1” or backup transmitter will takeover the Tx that is faulty, this is done using a coaxial switching system.



Redundancy Options of DAB System

- For broadcasters with more than one transmission tower, a U-link patch panel can be used to route the transmission to a backup tower or antenna. This is useful during tower maintenance and zero transmission downtime is required.



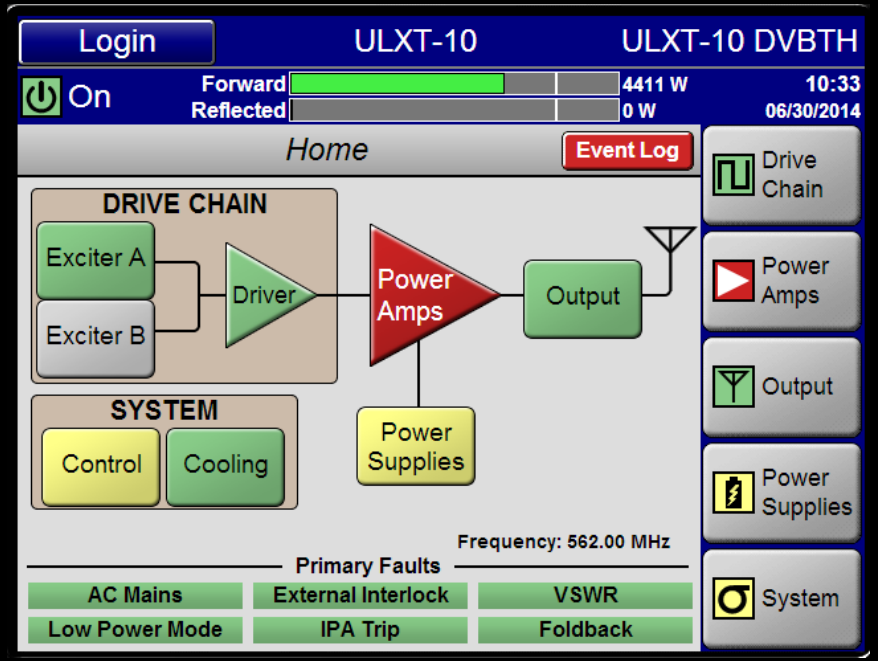
Control and monitoring

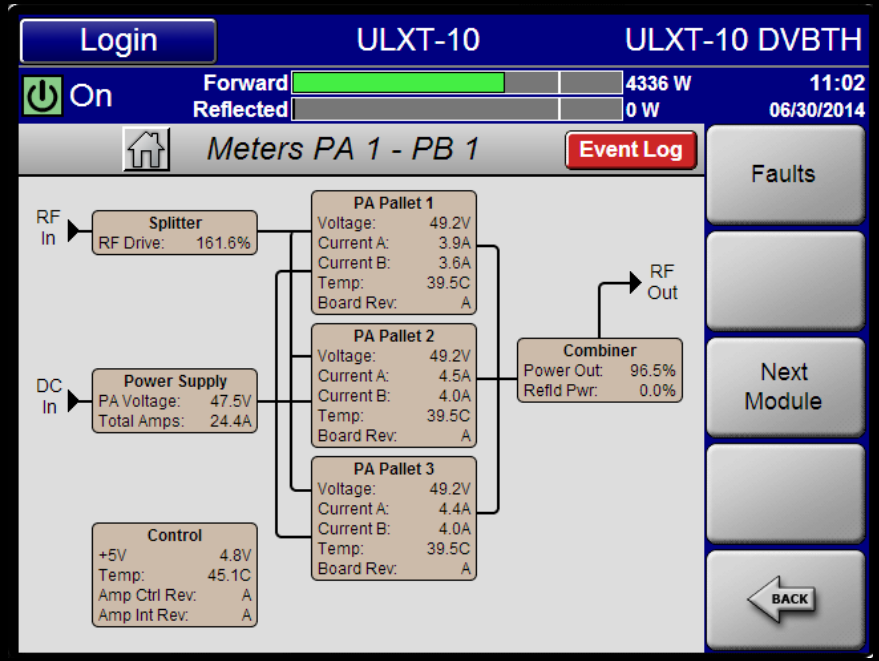
Control & Monitoring

- Tri-colour LEDs on front panel for fast status on important functions
- Front display panel, to access detail information

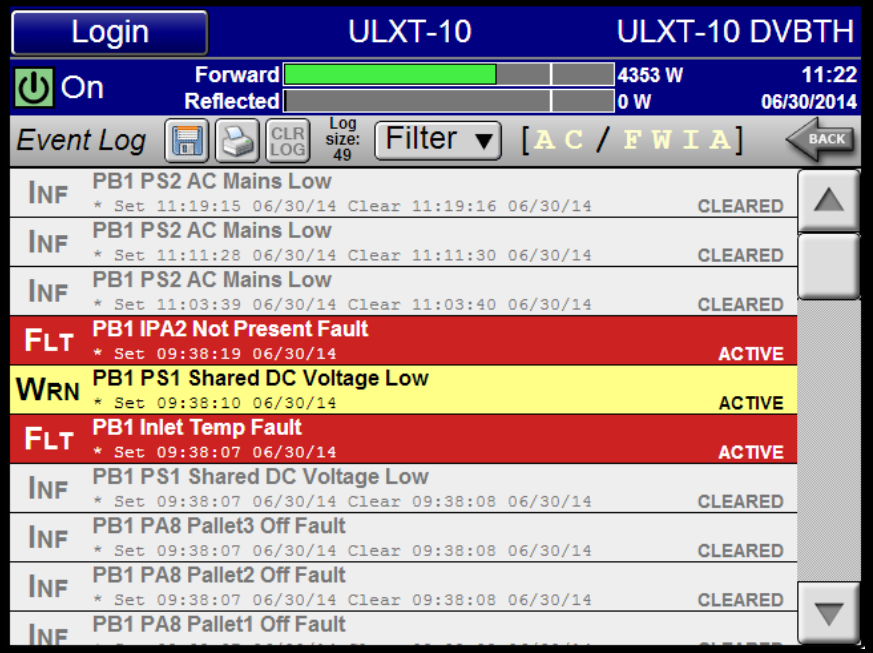
- Green – Normal
- Orange – Warning
- Red – Fault

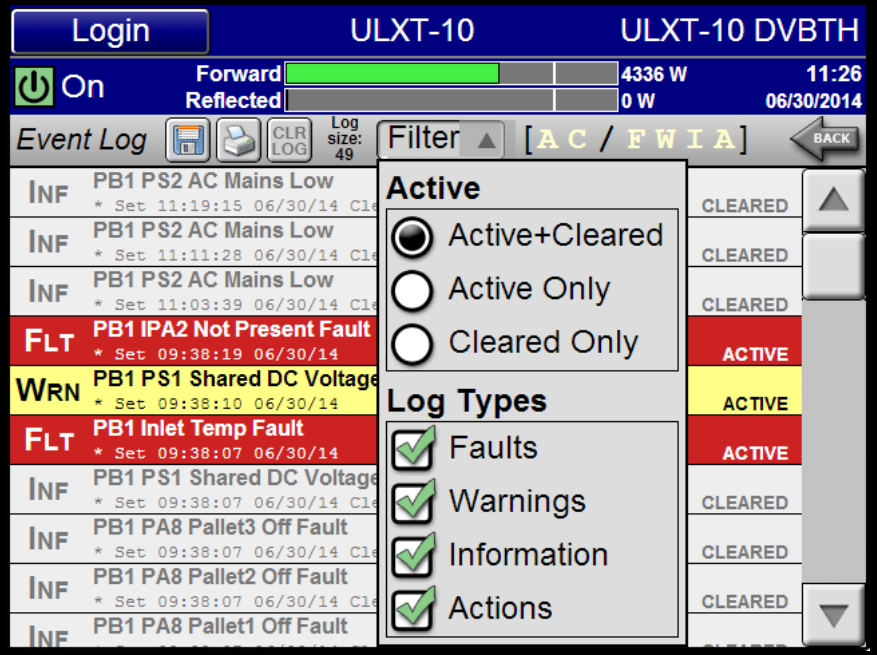
Web GUI Screens





ULXT- GUI Fault Screen





Control & Monitoring – Remote Interfaces

- Parallel remote control interface with connections for control, status, and analog monitoring. For interface to legacy remote control and monitoring systems.
- SNMP should be available to provide integration with most network control systems via the Internet or LAN.

User Remote - 25 Pin Female			
	Signal	**Direction**	**Description**
1	Forward Power	Output	0 – 4.096VDC output representing Forward power level
2	Reflected Power	Output	0 – 4.096VDC output representing reflected power level
3	Spare Analog In 1	Input	
4	Spare Analog In 2	Input	
5	+12Vdc	Output	+12Vdc, 200mA max
6	GND		Ground
7	GND		Ground
8	Reboot		Momentary Ground reboots LPU.
9	GND		Ground
10	GND		Ground
11	Alarm O Common		Alarm 0 Relay Common
12	Alarm 0 Normally Closed		Alarm 0 Relay Normally Closed (Faulted) Position
13	Alarm 0 Normally Open		Alarm 0 Relay Normally Open (Non-Faulted) Position
14	Alarm 1 Common		Alarm 1 Relay Common
15	Alarm 1 Normally Closed		Alarm 1 Relay Normally Closed (Faulted) Position
16	Alarm 1 Normally Open		Alarm 1 Relay Normally Open (Non-Faulted) Position
17	Alarm 2 Common		Alarm 2 Relay Common
18	Alarm 2 Normally Closed		Alarm 2 Relay Normally Closed (Faulted) Position
19	Alarm 2 Normally Open		Alarm 2 Relay Normally Open (Non-Faulted) Position
20	Alarm 3 Common		Alarm 3 Relay Common
21	Alarm 3 Normally Closed		Alarm 3 Relay Normally Closed (Faulted) Position
22	Alarm 3 Normally Open		Alarm 3 Relay Normally Open (Non-Faulted) Position
23	Alarm 4 Common		Alarm 4 Relay Common
24	Alarm 4 Normally Closed		Alarm 4 Relay Normally Closed (Faulted) Position
25	Alarm 4 Normally Open		Alarm 4 Relay Normally Open (Non-Faulted) Position

QoS & QoE Monitoring

Transport Stream

- Verify transport stream, audio, video and ancillary data ahead of transmitter
- Record raw Transport Stream
- Optional – Transcode, stream and record video

Transmitter

RF

- Verify RF, transport stream, audio, video and ancillary data after transmitter
- Transcode, stream and record video for confidence monitoring at Control Center

Transport Stream Monitoring

Transmitter Monitoring

RF Signal Monitoring

Correlate main Exciter, Modulator and Transmitter parameters with signal conditions

Off-Air Monitoring

- Professional DAB monitoring receiver for transmitter, content and field monitoring.
- Complete audio and data service decoder.
- RF measurements, SFN synchronization monitoring and comprehensive ETI analyzer.
- Remote capability so that this can be deployed in field.

Thank you for your attention!

It's time for DAB+ !