DVB-T2 Technology and New Products

July 2014

Featuring GatesAir’s Martyn Horspool
Product Manager, TV Transmission
DVB-T2 Technology and New Products

Martyn Horspool
Product Manager, TV Transmission
GatesAir
Mason, Ohio, USA
**Agenda**

- **09:00 – 09:05am**  
  Welcome and Opening speech – by Emico

- **09:05 – 09:20am**  
  Introduction & History of GatesAir

- **09:20 – 10:00am**  
  DVB-T2 Technology - The main advantages/benefits

- **10:00 – 10:30am**  
  Tea Break

- **10:30 – 10:40am**  
  Overview of GatesAir TV Product Portfolio

- **10:40 – 11:45am**  
  New High Efficiency UHF Transmitters (Maxiva ULXT / UAXT)  
  - Energy savings and Total Cost of Ownership (TCO)  
  - New technology RF devices  
  - High efficiency broadband techniques compared  
  - Power density and footprint  
  - Cooling System  
  - Multi Transmitters in 1 rack  
  - N+1 Systems

- **11:45 – 12:15pm**  
  Advantages of GatesAir Transmitters compared to other brands

- **12:15 – 12:30pm**  
  Questions & Answers

- **12:30pm**  
  Lunch
Part 1 – Introduction & History of GatesAir

- **1922** - Henry C. and Cora B. Gates founded the Gates Radio & Supply Company in Quincy, Ill., to create a job for their son, Parker S. Gates, who was only 15 years old at the time.

- **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

Quincy, Illinois, USA
Connecting What's Next

GatesAir - Company Vision and Values

**VISION**
Connecting Our Customers to What's Next in Over-The-Air Television, Radio and Distribution

**MISSION**
To Continuously Exceed the Expectations of our Customers

**CORE VALUES**
At GatesAir there are no limitations. We seek to find a new way, a better way, in everything we do to serve our customers and each other: We are passionate, innovative, collaborative, accountable and service-oriented.
End-to-End Terrestrial Transmission Solutions
GatesAir Transmission Solutions

- **Best in Class Transmission Solutions**
  - Lowest transmission TCO for broadcasters worldwide
  - Innovative, world class products that solve evolving customer needs
  - Exceptional Pre and Post Sales Services
  - Unique capability to deliver transmission solutions that enable new revenue

- **Market Leader in Transmission solutions for Core Broadcasters, Network Operators and Government Sponsored Broadcast networks:**

  GatesAir Transmission Solutions

  - Television
  - Clear Channel
  - norkring
  - PTPC
  - telequebec.tv
  - swisscom
  - Shaw Media
  - VTV
  - Cox
  - CBSO
  - Rai
  - tdf
  - भारतीय प्राप्ति सेवा बूम्बर (PRAASAR BHARATI)
  - वन वैश्विक नेटवर्क (BAND)
  - ब्रॉडकास्ट आस्ट्रेलिया (BROADCAST AUSTRALIA)
  - SARFT
  - शृंखला (SMG)

Connecting What's Next
Global Footprint

- Customers include top media companies around the world
- Systems are mission-critical to customer’s business
- Tenure of relationships with key customers range from 10 to 70+ years

Presence in Over 140 Countries Globally
Market-Leading Products

- Consistent market leader in both in TV and Radio Transmission
- Thousands of products deployed globally
- Extensive history of successive OTA innovations

Customer Ratings and Industry Recognition

Customer Statistics & Ratings*

**Transmitters**
- Top 2 in product advantage, innovation, reliability, value for money, and reliability

**Audio Products**
- 7 of top 10 revenue producing radio stations in North America trust their audio to GatesAir

*Source: Devoncroft Big Brand Survey 2013, BIA

Notable Awards

- **2013**
  - **PICK HIT Radio**
  - Intraplex® IP Link 200

- **2012**
  - **PICK HIT Radio**
  - Intraplex® IP Link 100

- **2008** - Pioneering RF Combiners for Adjacent Channels

- **EMMY® Award Winner** 2007, 2008

- **2007** - RF Combiners for ATSC Transmission System

*Notable Awards*
Market Growth Trends

- Strong growth in TV households
- Faster growth in Digital TV
- Over-the-Air (OTA) business benefits from this growth
- GatesAir is among the largest in OTA technology
World Digital TV Trends

- Many countries just starting the transition to digital
- Often fast growing, but lack wired infrastructure (e.g., cable)
- Significant opportunity exists to enable OTA transitions
- Economics and distances favor OTA as the primary distribution means

Digital TV Penetration as % of Total Households

Source: Digital TV Research, ITU 2013
GatesAir Product Portfolio

Create
Networked Digital Radio Studios

Transport
Contribution & Distribution – IP - TDM - RF

 Transmit Radio
AM - FM - DAB Analog & Digital

Transmit TV
VHF - UHF Analog & Digital
Advanced Technology

- VHF and UHF Broadband High Efficiency technology for digital TV and radio delivers lowest total cost of ownership

- Software defined modulation capability addresses today's needs and tomorrows opportunities

Introducing Maxiva™ with PowerSmart® 3D
Best-in-class broadband performance with no tradeoff in efficiency

Maxiva ULXT

- 40% less weight
- 50% less volume
- 55% more efficient
DVB-T2 Technology Overview
DVB-T2 Technology

- What is DVB-T2?
- How does DVB-T2 compare with DVB-T?
- Summary of Technical Highlights of DVB-T
- Resources for further information
- Questions?
DVB-T2 – What is it?

- DVB-T2 is currently the most advanced digital terrestrial television (DTT) system
- It offers more robustness and flexibility
- At least 50% more efficient than any other DTT system available today
- It supports SD, HD, UHD, mobile TV, or any combination of these
- But…. DVB-T2 is **NOT** compatible with DVB-T receivers (STB required, or new TV)
Additional DVB-T2 Notes

- DVB-T2 is able to use existing antenna installations and re-use existing transmitter infrastructures.
- It works with both fixed and portable receivers.
- It provides a large capacity increase over DVB-T, with similar planning constraints and conditions as DVB-T.
- Improved Single Frequency Network (SFN) performance compared to DVB-T.
- Includes a mechanism for service-specific robustness (i.e., provide different levels of robustness to some services compared to others. Also possible to target some services for roof-top reception and other services for portable reception).
- Provides bandwidth and frequency flexibility.
- Provides the ability to reduce the peak-to-average ratio (PAPR), in order to reduce transmission costs.
How Does DVB-T2 Work?

- Like its predecessor, DVB-T2 uses **OFDM** (orthogonal frequency division multiplex) modulation with a large number of sub-carriers delivering a robust signal, and offers a range of different modes, making it a very flexible standard.

- DVB-T2 uses the same error correction coding as used in DVB-S2 and DVB-C2:
  - **LDPC** (Low Density Parity Check) coding
  - **BCH** (Bose-Chaudhuri-Hocquengham) coding, offering a very robust signal. The number of carriers, guard interval sizes and pilot signals can be adjusted, so that the overheads can be optimized for any target transmission channel.
Main Advantages of DVB-T2

- New generation Forward Error Correction and 256 QAM
  - Capacity gain of > 30%
- OFDM carrier increase up to 32k and additional guard
  Interval selections
  - In SFN can provide up to 18% overhead gain
- Rotated Constellations
  - Robust transmission in difficult conditions
- Bandwidth extension
  - 2% payload gain
- Extended Interleaving
  - Including bit, cell, time and frequency interleaving
- Multiple PLP’s (Physical Layer Pipes)
  - See next slide
- DVB-T2 Lite
  - Optimized for Mobile applications
Multiple Physical Layer Pipes (PLP’s)

“The commercial requirement for service-specific robustness together with the need for different stream types is met by the concept of fully transparent physical-layer pipes, which enable the transport of data independently of its structure, with freely selectable, PLP-specific physical parameters.”

“Both the allocated capacity and the robustness can be adjusted to the content/service providers' particular needs, depending on the type of receiver and the usage environment to be addressed.”

(Excerpt from: A133 DVB Implementation Guidelines)

• PLP’s allow a broadcaster to achieve the best optimization of services for their viewers
Physical Layer Pipes

DVB-T2 uses single and multiple physical layer pipes (PLP). A PLP contains a single transport stream and all services in a single transport stream are in a single PLP. Multiple PLPs still have one transport stream per PLP, the advantage is each PLP can have different modulations and coding modes. The Guard Interval will be the same for all PLPs.

Each service is given a slice of data cells within a ‘T2 frame’

- Each slice is part of a Physical Layer Pipe for that service
- Also enables power saving in the receiver
- Slices can be sub-divided into sub-slices within frame in order to give more time diversity (Type 2 PLP)
Multiple Physical Layer Pipes

Simplified Explanation of Concept:

- All PLPs are broadcast over the same frequency (TV channel)
- Every PLP carries an MPEG-TS
- Every PLP has its own modulation, FEC code rate and interleaving
- PLP-based robustness configurations allow adjustment bandwidth and coverage area per PLP
## DVB-T and DVB-T2 Comparison

<table>
<thead>
<tr>
<th></th>
<th>DVB-T</th>
<th>DVB-T2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forward error correction (FEC) &amp; Code Rates</strong></td>
<td>Convolutional Coding + Reed Solomon 1/2, 2/3, 3/4, 5/6, &amp; 7/8</td>
<td>LDPC + BCH 1/2, 3/5, 23, 3/4, 4/5, &amp; 5/6</td>
</tr>
<tr>
<td><strong>Modulation</strong></td>
<td>QPSK, 16QAM, &amp; 64QAM</td>
<td>QPSK, 16QAM, 64QAM &amp; 256QAM</td>
</tr>
<tr>
<td><strong>Rotated constellation Mode</strong></td>
<td>N/A</td>
<td>Rotated or None rotated modes</td>
</tr>
<tr>
<td><strong>Guard intervals</strong></td>
<td>1/4, 1/8, 1/16, &amp; 1/32</td>
<td>1/4, 19/256, 1/8, 19/128, 1/16, 1/32, &amp; 1/128</td>
</tr>
<tr>
<td><strong>Discrete Fourier Transform (DFT size)</strong></td>
<td>2k &amp; 8k</td>
<td>1k, 2k, 4k, 8k, 16k, &amp; 32k</td>
</tr>
<tr>
<td><strong>Scattered Pilots</strong></td>
<td>8% of total</td>
<td>1%, 2%, 4%, or 8%</td>
</tr>
<tr>
<td><strong>Pilot Patterns</strong></td>
<td>N/A</td>
<td>8 Patterns Available</td>
</tr>
<tr>
<td><strong>Continual Pilots</strong></td>
<td>2.6% of total</td>
<td>0.35% of total</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Single or Multiple PLP</td>
</tr>
</tbody>
</table>
DVB-T2: Bitrate vs. Robustness vs. Coverage

BITRATE VS. ROBUSTNESS VS. COVERAGE: THE ETERNAL DILEMA

Illustration courtesy of Teamcast
The DVB T2-lite profile was added in June 2011 to the DVB-T2 standard v1.3.1 as Annex I.

The T2-Lite profile is mostly a subset of the DVB-T2 standard which is now called the "DVB T2-base" profile.

Two additional code rates were added for improvement of mobile performance.

### DVB-T2 Lite

<table>
<thead>
<tr>
<th></th>
<th>LDPC 16k only</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEC block size</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Code Rate</strong></td>
<td>1/2, 3/5, 2/3, 3/4, 2/5*, 1/3*</td>
</tr>
<tr>
<td>(* New code rates)</td>
<td></td>
</tr>
<tr>
<td><strong>Constellation Size</strong></td>
<td>QPSK, 16QAM, 64QAM, 256QAM (up to code rate 3/5)</td>
</tr>
<tr>
<td><strong>Rotated Constellation</strong></td>
<td>Only for QPSK, 16QAM and 64QAM</td>
</tr>
<tr>
<td><strong>Guard Interval</strong></td>
<td>Reduced set of combinations of FFT size, guard interval and pilot pattern.</td>
</tr>
<tr>
<td><strong>FFT size</strong></td>
<td>2K, 4K, 8K, 16K, 16K ext.</td>
</tr>
<tr>
<td><strong>Scattered pilots</strong></td>
<td>PP8 not allowed</td>
</tr>
<tr>
<td><strong>Max. Bandwidth</strong></td>
<td>4 Mb/s</td>
</tr>
<tr>
<td><strong>P1 Signalling</strong></td>
<td>New signalling for T2-mobile SISO/MISO</td>
</tr>
<tr>
<td><strong>L1 Scrambling</strong></td>
<td>Optional scrambling of L1-post only or entire L1</td>
</tr>
</tbody>
</table>
DVB-T2 Lite

- The T2-Lite signal may either be transmitted as a stand-alone signal ie. in a regular PLP, or as a T2-Lite signal with FEF parts.

- The Future Extension Frame (FEF) carries a T2 Frame dedicated for mobile services and may have different modulation parameters (FFT size, Guard Interval, SFN/MISO, Pilot pattern) than the other T2 Frame to improve mobile reception. The FEF interval and size of the T2-Lite super frame can be defined in the T2 Gateway. The maximum duration of a FEF part is 1 second.
The T2 Lite profile allows simpler receiver implementations for very low capacity applications such as mobile broadcasting (50% smaller chip size).

This new profile can be mixed with conventional T2 signals in a single multiplex, to allow separate optimization of the individual components.

DVB-T2 1.3.1 Provides both optimum waveform (Fixed vs. Mobile) & Multiple PLP Robustness (Outdoor vs. Indoor)
Programs Per RF Channel – Analog / T / T2

- Analogue 1 Program
- DVB-T SD 5 SD
- DVB-T HD 2 HD
- DVB-T2 SD 18 SD
- DVB-T2 HD 4 HD

24 Mbps
36 Mbps
Summary of Main DVB-T2 Benefits

- Flexibility for network design
  - Frame rates, bit rates, modulation rates, Guard Intervals, etc. to fit what any particular operator desires to achieve.
- Pilots (fixed and scattered) to enable receiver lock in tough conditions (channel estimation)
- PAPR reduction techniques
  - TR and ACE
- Performance limits very near theoretical Shannon limit
- Multiple PLP’s
- T2-MI for multiplex management
- FEF’s for other data formats (LTE-A+), T2-Lite
DVB-T2 Resources for Further Reading

- Useful documents are available to assist in better understanding DVB-T2 and network planning aspects:

  1. DVB-T2 Fact sheet (Copy on Thumb Drive)
     DVB.org web site: [http://www.dvb.org/technology/dvbt2/](http://www.dvb.org/technology/dvbt2/)

  2. Frequency and Network Planning Aspects of DVB-T2 (Copy on Thumb Drive)
     EBU Technical Document 3348: [http://tech.ebu.ch/publications](http://tech.ebu.ch/publications)

  3. DVB-T2 Standards (ETSI EN 302 755 V1.3.1 and others) (Copy on Thumb drive)
     DVB.org web site: [https://www.dvb.org/standards?__noframe=8031](https://www.dvb.org/standards?__noframe=8031)
Overview of GatesAir TV Product Line
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
Maxiva Product Family

**UHF**
- Maxiva™ UAX & UAXT
- Maxiva™ ULX & ULXT
- Maxiva™ ULXT & Power CD (IOT)

**VHF**
- Maxiva™ VAX / VAX-3D
- Maxiva™ VLX

(Band III TV and DAB Digital radio)
GatesAir High Efficiency Roadmap - UHF

UHF Solutions

Maxiva ULX
Up to 25% efficiency
(2009-2014)

PowerSmart® 3D

Maxiva ULXT
Up to 38% efficiency
Available Now
GatesAir High Efficiency Transmitters

- The GatesAir new line of VHF and UHF transmitters: Maxiva™ VAX, UAXT & ULXT, all featuring PowerSmart® 3D high-efficiency technology.

- Maxiva™ VAX, UAXT and ULXT transmitters offer full broadband coverage across UHF, VHF Band III for DAB and DTV with a simple, highly reliable design. No adjustments of any kind are required.

Low Total Cost of Ownership Without Compromise
**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.

**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.

**TV**

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.
Transmitter Efficiency: What Does It Include?
High Efficiency Amplifier Techniques
High Efficiency Power Amplifier Technology

- High interest among broadcasters and RF network operators in new power amplifier technology that offers improved efficiency

- Benefits of higher power amplifier efficiency include:
  - AC power consumption savings
  - Reduction in physical size
  - Reduction in cooling requirements
  - Reduction of carbon footprint in support of green technology
Linear RF Amplification Issues

- Digital TV & DAB signals have high Crest Factor / Peak to Average power Ratio (PAR) compared to a constant envelope signal.

- Digital modulation waveforms (OFDM / 8VSB) contain complex, simultaneous, AM & PM modulation requiring linear amplification.

- Linear amplification needed to meet RF emission mask and minimize in-band RF IMD that degrades the digital signal to noise ratio (EVM / MER).
Linear RF Amplification Issues

- Efficiency lost when PA operates between saturation and cutoff
- Loading on PA not optimum for RF waveform at point where static bias current through amplifying device is significant portion of total current
- RF Power amplifiers operate at highest efficiency when saturated for maximum power output

Digital TV / DAB Waveform

PA must be sized to handle the peak power
To accommodate a digital signal with 8dB peak to average ratio, the amplifier needs to be biased into linear, Class-AB, mode

- Average power reduced by ~ 8dB to achieve good linearity
- Current VHF & UHF solid state devices can achieve saturated DC to RF efficiencies of up to 70%
- Backed off by 8dB into Class-AB operation, DC to RF efficiency can drop to ~ 30%
**Drain Modulation**

- Varies the RF amplifier device drain voltage exactly in time with the waveform
- Also called “Envelope Tracking”
- Evaluated in depth by Harris Broadcast in 2011 – but not implemented into products due to cost/complexity
- Provides 37% to 38% TV OFDM tx efficiency

Diagram courtesy of Nujira
High Efficiency Amplifiers – Classic Doherty

- **Doherty Amplifier (Classic - Narrowband)**
  - Invented in 1936 by W.H. Doherty of Bell Telephone Laboratories
  - The classic Doherty amplifier consists of two amplifiers: a carrier amplifier biased to operate in Class AB mode, and a peaking amplifier biased to operate in Class C mode
  - Typically 36% to 39% TV OFDM efficiency
  - Tested by Harris Broadcast in early 2000’s – Bandwidth limitations at that time (6% to 10% BW) reduced it’s usefulness – and not suitable for our fully broadband design initiative
High Efficiency Amplifiers - Broadband Doherty

- **Broadband Doherty (Ultra Wideband)**
  - Recent development work by device manufacturers has resulted in optimized LDMOS devices and innovative amplifier circuitry that allows broadband operation of Doherty.
  - One example by NXP is the new BLF-888D (110W @ 40% PA Efficiency).
  - Patent pending NXP technique.

![NXP’s BLF-888D Ultra-Wideband Doherty Amplifier](image)

![Average DVB-T/T2 Power & Efficiency versus Frequency at Pallet Level](image)
High Efficiency Push-Pull Amplifier (patent pending)

- Harris Broadcast patent application on file
- Provides excellent efficiency
- Broadband technique
- Deployed in new series of VHF Band III DAB/TV transmitters
- DAB Amplifier efficiency up to 52-54% across band III
- Overall transmitter efficiency:
  - 40% in DAB
  - 42% in ATSC
  - 36% in OFDM TV (DVB-T/T2, ISDB-T, etc.)
New High Efficiency UHF Transmitters
Liquid-Cooled ULXT Series
Maxiva ULXT - Key Benefits (1)

- **Broadband, high-efficiency design**
  - Maxiva ULXT provides the highest available AC to RF efficiency along with fully broadband operation across the UHF band. This means only one spare power amplifier module is needed to service any ULXT series transmitter in the network. No adjustment, or retuning of any type, is required.

- **Future-proof architecture**
  - Re-pack (Restack) of the UHF TV spectrum could mean potential channel changes in the future. The broadband ULXT transmitter is ready for such changes, without any need to swap PA modules, combiners, or other components.
Maxiva ULXT - Key Benefits (2)

- **Modular design with small, lightweight, PA modules**
  - A complete ULXT PA module weighs only 11kg (24lb), far lighter than comparable PA modules from others, often weighing in excess of 24kg (53lbs). 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 PA module has its own dedicated power supply. 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.
Maxiva ULXT - Key Benefits (3)

- **Less expensive PA Module and Power Supply**
  - Our modular design approach with smaller/lighter replaceable PA’s and associated DC Power Supplies are less expensive to replace than combined PA/Power supply assemblies that others may use.

- **Robust Control System with redundant controllers**
  - Our layered control system allows safe operation even if the main control board is defective or needs to be removed for service. An HTML web browser interface and SNMP is included with every transmitter.
General Product Overview:

- Hot swappable front load PA Modules and Power Supplies
- Incorporates field-proven Maxiva™ M2X exciter technology for best in class performance
- All-digital linear and nonlinear pre-correction: Real-Time Adaptive Correction (RTAC™)
- All Worldwide digital modulation standards supported
- Modular & upgradeable architecture
- Rugged, reliable design and construction
- CE Marked / RoHS Compliant
Block Diagram ULXT-10xx

10 PA System - Dual Drive Option Shown

- M2X Exciter A
- M2X Exciter B
- IPA 1
- IPA 2
- Control 1
- Control 2
- Main Controller
- PA 1
- PA 10
- PS 1
- PS 10
System Block Diagram - Detailed

Exciter A

Exciter B

RF Control

External Interface B "B"

Drive Chain Interface "C"

Drive Chain Module "D"

Drive Chain Module "E"

Shutdown

Control

Display

Control & Display

AC Distribution

Power Supply

Manifold

10 PA System
5.5kW OFDM
Internal/Integral Pump System

- With up to 5.5kW DVB-T2 systems, an integral pump system is available
- Save floor space
- Save plumbing
- Smaller pumps – lower power consumption – more efficient!
- External pump module also available
High Efficiency External Pump Module

- Leveraged from ULX system – Reliable, proven
- 3rd generation – Optimized for High Efficiency
- Small physical size
- 2 Pumps, with auto/manual changeover
- Low maintenance, closed-loop pressurized system
- Quiet – Designed for indoor installation
- Pump speed inverter controlled
High Efficiency Heat Exchanger

- GatesAir manufactured
- Dual fans with on-air servicing/replacement capability
- 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
- Redundant heat exchangers available
Maxiva M2X TV Exciter

- RTAC Controls
- Input Status LED’s
- RTAC Status LED’s
- Status LED’s
- Access to:
  - RF Sample
  - 10MHz ref.
  - 1 PPS ref
Maxiva M2X - Features

- RoHS Compliant / CE Compliant
- Software Defined Modulator
- Backwards compatible with many GatesAir transmitters.
- RTAC – Real Time Adaptive linear and non-linear Correction – standard
- Internal GPS option (now with GLONASS)
- Internal UPS option – Full exciter power for 1 minute and frequency processing for 20 minutes
- Simple browser interface
- No manual adjustments
- Software key defines modulation:
  - Analog / DVB-T / DVB-T2, etc.
  - Easy change between standards
M2X Mechanical – Inside View

Top cover and front panel removed

- Signal Processing Board
- Power Supply
- 12V DC Fans (2)
- Up/Down Converter Board
- Precision Frequency Reference Unit
- 1PPS, 10MHz & RF Sample Ports
Exciter – Rear Panel

- RTAC RF Sample Inputs
- RF Output
- RS-232 & CAN Interfaces
- 1 PPS & 10MHz Ref Inputs
- Transport Stream Monitor Output
- ASI / 310 Transport Stream Inputs
- 10/100 BaseT Ethernet
- GPS Antenna Input
- Transmitter Interface Board
- Input Option Board (ASI/IP Shown)
Power Amplifier Block

- Modular architecture on a larger scale
ULXT-2T2

- Up to 1.25kW – 2 PA Modules

Exc A
Exc B (option)
IPA A
IPA B
PA 1
PA 2

4 RU
7 RU
ULXT-4T2

- Up to 2.5 kW – 4 PA Modules
ULXT-6T2

- Up to 3.6 kW
ULXT-6T2 / ULXT-10T2

- Up to 3.6 kW and 5.5kW
High Power ULXT Solutions

ULXT-12 / 20xx (12 or 20 PA's)

ULXT-30xx (30 PA's)

ULXT-40 / 50 / 60xx (up to 60 PA's)
# Maxiva™ ULXT Models: Size, Weight & Power Levels

<table>
<thead>
<tr>
<th>Transmitter Model</th>
<th># Racks (Rack Size)</th>
<th>Transmitter Width</th>
<th>Transmitter Height</th>
<th>Transmitter Depth</th>
<th>Transmitter Weight</th>
<th>DVB-T2 Pre-Filter Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Units</td>
<td>RU</td>
<td>mm</td>
<td>in</td>
<td>mm</td>
<td>in</td>
</tr>
<tr>
<td>ULXT-2xx</td>
<td>1 (37)</td>
<td>593</td>
<td>23</td>
<td>1,803.3</td>
<td>71.0</td>
<td>1,128.6</td>
</tr>
<tr>
<td>ULXT-4xx</td>
<td>1 (37)</td>
<td>593</td>
<td>23</td>
<td>1,803.3</td>
<td>71.0</td>
<td>1,128.6</td>
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<td>1 (37)</td>
<td>593</td>
<td>23</td>
<td>1,803.3</td>
<td>71.0</td>
<td>1,128.6</td>
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<tr>
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<td>593</td>
<td>23</td>
<td>1,803.3</td>
<td>71.0</td>
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</tr>
<tr>
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<td>23</td>
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<td>ULXT-40xx</td>
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<tr>
<td>ULXT-50xx</td>
<td>2 (44)</td>
<td>1,186</td>
<td>47</td>
<td>2,114.3</td>
<td>83.2</td>
<td>1,128.6</td>
</tr>
<tr>
<td>ULXT-60xx</td>
<td>2 (44)</td>
<td>1,186</td>
<td>47</td>
<td>2,114.3</td>
<td>83.2</td>
<td>1,128.6</td>
</tr>
</tbody>
</table>

Note: xx = Modulation code
IPA / Drive Chain

- Two redundant 1RU amplifier trays provide a very robust solution to drive the PA Modules in a power block (2, 4, 6 or 10)
- This system provides fully redundant drive capability in case of failure
- Redundant, optimized. Linear RF drive for the PA’s
- Power supplies are shared among drivers for further redundancy (power supply failure will not affect drive stage)
IPA (Driver) Module

- Provides gain stage before PA section
- Front hot pluggable, redundant modules
- Uses same cold plate as the PA for cooling of FETs
- Operated in linear, class AB
- Module interface is a passive assembly which provides electrical and cooling. Hot plug interconnect
PA Block Control Redundancy

- Each IPA module includes the Power Amplifier Block control circuitry.
- PA Block controller is incorporated on the Phase & Gain board.
- Fully redundant PA block control is provided due to redundant drive chain / IPA module architecture.
New High Efficiency PA Module

- Power ~ 640W OFDM / 1kW ATSC
- Efficiency ~ 44% OFDM / 49% ATSC
- Configuration: 3 Pallets in parallel/6 LDMOS devices total
- Liquid cooled
- Light weight ~ 11kg / 24lb
  - Easy to remove and service
  - Lower shipping cost
  - DC power supply is separate assembly
- Hot-swap front plug-in design using push-on / pull-off connectors
- Up to 10 PA Modules per Power Block
PA Module & Power Supply Status LED’s

Power Supply Status LED’s
- Input Okay
- Output Okay
- Over-temperature Warning
- Fault

PA Module Status LED’s
- Pallet 3: Green = On / Red = Fault
- Pallet 2: Green = On / Red = Fault
- Pallet 1: Green = On / Red = Fault
- Module Enable: Green
- PA On = Green / Red = Summary Fault

Note: Cover removed to show LED’s
High Efficiency DC Power Supply

- Separate assembly from the PA module
  - Small and light (<2kg / 5lb)
  - Lower replacement cost
- Hot swap, easy replacement in seconds
- One Power Supply per PA module
- IPA’s powered by all PA power Supplies (paralleled)
- Rating: 50 VDC / 2,725W / 0.98PF
- Wide AC input regulation (±15%)
- Same power supply as used in Maxiva UAXT and FAX FM transmitters
  - Consolidate network spares
Options & Accessories

- 37 RU rack is standard for 1 and 2 Power Block systems
- 44 RU rack is used for other systems, or as appropriate
- Internal GPS receiver, now with GLONASS
- GPS antenna and RF cable
- Exciter UPS – Provides 1 minute full exciter back-up and 20 minutes for frequency processing circuits
- Dual drive, 1+1 (main/alternate), or N+1 configurations
- SFN
- Internal pump system for single power block systems
  - Customer can always opt for external pump system
Use Case 1: ULXT vs. ULX (or older tx) in DVB-T/T2

- Major benefits include:
  - Dramatic reduction in system electrical power consumption
    - Low TCO
    - More than 35% power savings versus older technology equipment
    - Green design, less waste energy
  - Latest technology RF devices provide rugged, reliable operation
  - Broadband design – minimizes network spares holdings
  - High efficiency and broadband PA modules
  - Highest power density on the market
Use Case 1: ULXT vs. ULX in DVB-T/T2

- **ULXT-10T2**
  - At 5.5kW
  - Efficiency 37.1%
  - Czech Republic – 16.5 c/kW-hr
  - 10 year cost to operate = $252.12k

- **ULX-5500T2**
  - At 5.5kW
  - Efficiency 20.3%
  - Czech Republic – 16.5 c/kW-hr
  - 10 year cost to operate = $445.5k
Use Case 1: ULXT vs. ULX side-by-side

<table>
<thead>
<tr>
<th>Transmitter Models:</th>
<th>ULXT-10DV/T2/IS</th>
<th>ULX-5500</th>
</tr>
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<tbody>
<tr>
<td>Product Series</td>
<td>Maxiva ULXT COFDM</td>
<td>Maxiva ULX COFDM</td>
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<tr>
<td>Model</td>
<td>ULXT-10DV/T2/IS</td>
<td>ULX-5500</td>
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<tr>
<td>Tx Maximum Output Power</td>
<td>6,010 W</td>
<td>5,500 W</td>
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<tr>
<td>Required Output Power</td>
<td>5,500 W</td>
<td>5,500 W</td>
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<td>Total Cost</td>
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<table>
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<tbody>
<tr>
<td>Region</td>
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<td>Czech Republic</td>
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<tr>
<td>Country/State</td>
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<td></td>
</tr>
<tr>
<td>Price/kWh</td>
<td>50.165</td>
<td>50.165</td>
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<tr>
<td>Tx System Efficiency</td>
<td>37.1%</td>
<td>20.3%</td>
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<th>ULX-5500</th>
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<tbody>
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<td>Annual OPEX</td>
<td>24,813</td>
<td>44,150</td>
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<tr>
<td>Year 1 TCO</td>
<td>28,813</td>
<td>46,150</td>
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<tr>
<td>Year 5 TCO</td>
<td>128,064</td>
<td>224,752</td>
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<tr>
<td>Year 10 TCO</td>
<td>252,128</td>
<td>445,503</td>
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<tr>
<td>Year 15 TCO</td>
<td>376,192</td>
<td>866,255</td>
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<tr>
<td>Year 20 TCO</td>
<td>500,255</td>
<td>887,007</td>
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</table>

Graph showing comparison of ULXT-10DV/T2/IS and ULX-5500 over years 1 to 20 TCO.
GatesAir Maxiva ULXT - The Best Choice...

SUMMARY:

- Broadband, high-efficiency design
- Future-proof architecture
- Modular design with small, lightweight, hot-pluggable PA modules
- Small, lightweight, hot pluggable PA power supplies
- Less expensive PA Module and Power Supply
- Robust Control System with redundant controllers
- Best Trained Service Dept. Available 24/7

= Lowest Total Cost of Ownership!
New High Efficiency UHF Transmitters
Air-Cooled UAXT Series
Maxiva UAXT - Key Benefits (1)

- **Broadband, high-efficiency design**
  - Maxiva UAXT provides the highest available AC to RF efficiency along with fully broadband operation across the UHF band. This means only one spare power amplifier module is needed to service any ULXT series transmitter in the network. No adjustment, or retuning of any type, is required.

- **Future-proof architecture**
  - Re-pack (Restack) of the UHF TV spectrum could mean potential channel changes in the future. The broadband UAXT transmitter is ready for such changes, without any need to swap PA modules, combiners, or other components.
Maxiva UAXT - Key Benefits (2)

- **Power Supplies**
  - New high efficiency hot-swappable redundant power supplies
  - 96% AC to DC conversion efficiency

- **Cooling System**
  - Air-cooled systems use fans/blowers to extract heat and move it outside of cabinet
  - Variable speed cooling fans, based on RF amplifier temperature - optimizes cooling efficiency, and power consumed by the fans
Maxiva UAXT - Key Benefits (3)

- **Identical RF pallets and PA components as the ULXT transmitter:**
  - Common spares stock for both UAXT and ULXT
  - Common design reduces need for additional personnel training

- **Uses identical 50 Volt DC power Supplies as the ULXT transmitter:**
  - Common spares stock for both UAXT and ULXT

- **Very modular design with smaller lightweight components**
  - Compact PA and Power supply assemblies make removal and replacement extremely simple and easy
  - Front load hot swappable power supplies
  - Power amplifier blocks can be replaced while on air (2 to 4 PA block systems)
  - Lower cost replacement parts than the larger integrated PA/Power supply configurations from other tx manufacturers
Exciter/Driver Block Diagram

- Pre-Filter Sample
- Post-Filter Sample
- GPS Ant
- 1 PPS
- 10 MHz
- Parallel I/O
- Ethernet
- ASI / SMPTE Inputs
- AC In 1-PH
- 110 – 240V 50/60Hz
- LV Power Supply
- PA Interface
- AC / DC Converter
- Fwd Ref
- RTAC RF Samples
- UHF Up/Down Converter
- Precise Frequency Reference Unit
- Signal Processing Board
- Front Panel / Display
- PA
- Fwd Ref
- RF Sample (front panel)
- Splitter
- RF Out to PA Stage (10-50W)
UAX Compact Exciter/Driver

Front Panel

- LC Display
- Control & Status
- RF Monitor Sample
- Air Filter / Fan (on-air replaceable)
- LCD Navigation
- On/Off
- Ethernet
- 10MHz / 1PPS Monitor

Rear View

- Serial Ports
- Ext. 1PPS & 10MHz In
- ASI/SMPTE Inputs
- Rear Ethernet
- Post Filter RTAC
- RF Out Type ‘N’
- GPS Ant. Input (option)
- Parallel Remote & Tx Interface
- Slot for IP input or Satellite Rx option
- AC Power Input
UAX Compact Driver – Top View

- Directional Coupler
- Power Amplifier
- 50V Power Supply
- Up/Down Converter
- PFRU (Precise Frequency Reference Unit)
- RF Output (Type N)
- Ext 10MHz / 1PPS Inputs
- ASI / SMPTE Inputs
- Signal Processing Board
- Exciter Power Supply (w/ optional UPS)
Product Details Maxiva UAXT TV Transmitter

- High-Efficiency design, using Harris Broadcast PowerSmart 3D™
- Extremely compact (640W/1kW = 5RU)
- OFDM efficiency up to 36% for complete system
- Models:

<table>
<thead>
<tr>
<th>Model Number (xx = modulation)</th>
<th>OFDM Power Before Filter (Watts)*</th>
<th>RF Output Connector</th>
<th>Total Rack Space (1 exciter)</th>
<th>Total Rack Space (2 exciters)</th>
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<tbody>
<tr>
<td>UAXT-1xx</td>
<td>640</td>
<td>DIN 7-16</td>
<td>5RU</td>
<td>8RU</td>
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<td>UAXT-2xx</td>
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<td>11RU</td>
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<td>UAXT-3xx</td>
<td>1,800</td>
<td>1-5/8” EIA</td>
<td>11RU</td>
<td>14RU</td>
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<tr>
<td>UAXT-4xx</td>
<td>2,300</td>
<td>1-5/8” EIA</td>
<td>14RU</td>
<td>17RU</td>
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</table>
Maxiva UAXT - Product Details 640W / 1kW

- Front User Interface
- Front Control
- Status LED's
- 1PPS/10MH
- RF samples & Ethernet
- PA cooling Air Intake
- Cooling Air Intake
- 2 RU
- 3 RU
Block Diagram – UAXT Series (1 to 4 PA modules)
PA Block – Front and Rear

Front View
(Cover Removed)

- Front access Hot-swappable Power Supply
- Space for optional Redundant power supply

Rear View

- RF Output
- Cooling fans (2) (Rear access)
- DIP Switches
- RF Input
- Control / Remote
- AC Power
High Efficiency Power Supply

- Conversion Efficiency typically 96%
- Rated for 2.725kW DC Power at 50V
- Power factor corrected (>0.98)
- Hot Swappable, plug in design
- Same power supply as used in other products (Maxiva ULXT, Flexiva FM)
- Compact and lightweight
- Separate from Power Amplifier for reduced spares cost and modularity
UAXT Configurations (available in 37RU & 44RU Racks)
Options & Accessories – Maxiva UAXT

- 37 RU rack is standard for most systems
- 44 RU rack is used for larger and multi-tx in a rack systems
- Internal GPS receiver, now with GLONASS
- GPS antenna and RF cable
- Exciter section UPS – Provides 1 minute full exciter back-up and 20 minutes for frequency processing circuits
- Dual drive, 1+1 (main/alternate), or N+1 configurations
- SFN
Additional Options (included in Deluxe Rack)

AC Distribution Panel:
- Provided with “Deluxe Rack” option
- Provides convenient AC power distribution to each sub-assembly

Customer I/O Panel:
- Included with “Deluxe Rack”
- Provides a convenient location to connect data inputs, GPS antenna, remote control, etc.
Harris Broadcast’s Maxiva UAXT High Efficiency Transmitter provides:

- The most efficient broadband UHF transmitter available
  - Efficiency improvement from 22% up to 36% OFDM /40% ATSC
  - Provides significant AC power savings and lowest total cost of ownership

- Dramatic rack space savings
  - Examples:
    - 640W OFDM / 1kW ATSC single drive tx is 5 Rack Units high (previously 12RU – 58% savings)
    - 1.28kW OFDM / 2kW ATSC dual drive tx is 11 Rack Units high (previously 32RU – 66% savings)
    - Higher power, or multiple transmitters in one rack for N+1 or 1+1 systems

- Reliable / Redundant
  - 3 RF pallets per PA block
  - Redundant power supply option
Harris Broadcast - The Best Choice...

- Most Modern Architecture – Lowest Risk of Obsolescence
- Modular Common Design – Minimizes Spares Requirements
- Broadband – Reduces Network Spares Inventory
- Smallest Facility Space Required – Reduces Costs
- Financial Strength of Harris Broadcast
- Best Trained Service Dept. Available 24/7

Lowest Total Cost of Ownership!
Multiple Transmitters in 1 Rack
Multiple Transmitters in Single Rack

- Separate Power Blocks allow easy way to configure multiple transmitters in a single rack

- 3 x 1.25kW or 2.5kW Single Exciter
- 3 x 1.25kW or 2.5kW Dual Exciter
- 2 x 3.6kW or 5.5kW Single Exciter
- 2 x 3.6kW or 5.5kW Dual Exciter

37RU (1.8m)
37RU (1.8m)
37RU (1.8m)
44RU (2.1m)
Multi-System Controller (MSC-2)
N+1 Controller Solution

- **GatesAir MSC-2 (Multi-System Controller)**
  - Provides control & switching
  - 1+1 (passive reserve) swicthing
  - N+1 Systems up to 8+1
  - Manual or Automatic switching – Priority selectable
  - Local control
  - Remote web GUI interface (Ethernet RJ-45)
  - Controls program source switching
  - Provides contacts to control RF switches from multiple vendors

---

The GatesAir's Multi-System Controller (MSC) is engineered to ensure your television or radio broadcast is seamless—even in the event of transmitter failure. This next-generation multi-system control platform extends the redundancy capabilities of our transmitters to both new and legacy transmitter platforms—the first system on the market that integrates legacy transmitters into N+1 systems.*

The MSC incorporates the latest advances in technology, reflecting GatesAir's commitment to innovation and history as the industry-leading provider of redundancy solutions for television and radio transmitters.

* Requires an optional MSC I/O module

**Product Features**

- Factory scalable and configurable for N = 1 to 9
- Front-panel control and readout of system status
- Operation in automatic or manual mode, and by local or remote control
- Local and remote selection on the front panel to lock out remote inputs during servicing
- One of N logos output to control an external video or audio router
- Ethernet interface to each transmitter and RF switch control board for easy-to-manage connections
- External program router control — routes the correct service to the redundant transmitter
- Fast, reliable operation
- Fail-safe — a remote system configuration is retained in the event of MSC built-in power failure
- Compatible with 4-port coaxial switches from multiple vendors
- Remote software upgrades available via network connection. Latest software is available on the GatesAir Service Portal (requires a Windows®-based PC, not provided)
- Clear, intuitive GUI — easy navigation of system level or individual transmitter control and monitoring with a single IP connection
- Sacramento with a backup function to extend life of backhaul and prevent accidental front-panel button operation
- SNMP® (Simple Network Management Protocol) network agent for broadcast manager operations
- External switch monitoring — can be removed for servicing without interruption of the network chain
- Programmable N+1 priority — for backup of the most important programing during multi-far transmitter outages

*Windows is a registered trademark of Microsoft Corporation in the United States and other countries.

**Cost-effective, Reliable, Flexible**

Proprietary and confidential. | 99
Maxiva Advantages versus Competition
## Comparison between GatesAir and Main Competitor

<table>
<thead>
<tr>
<th>Item</th>
<th>GatesAir</th>
<th>Competitor</th>
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</thead>
<tbody>
<tr>
<td>Modularity</td>
<td>3 pallets per PA Module</td>
<td>6 pallets per PA module</td>
</tr>
<tr>
<td>PA Module weight</td>
<td>11kg. Easy for 1 person to remove</td>
<td>&gt; 25kg. 2-person lift to meet safety code</td>
</tr>
<tr>
<td>Power Supply separate from PA</td>
<td>Yes</td>
<td>No – Power supply inside PA module</td>
</tr>
<tr>
<td>Power Supply weight</td>
<td>2kg</td>
<td>Part of 25kg PA module</td>
</tr>
<tr>
<td>Time replace Power Supply</td>
<td>&lt;1 minute (front access, hot swap)</td>
<td>Estimated at 1 hour (inside PA module)</td>
</tr>
<tr>
<td>Time to replace PA module</td>
<td>&lt;1 minute with 1 person (front access)</td>
<td>&lt;1 minute with 2 persons (front access)</td>
</tr>
<tr>
<td>Broadband Design</td>
<td>Yes (1 PA up top 750MHz)</td>
<td>No, 7 bands across UHF (parts change)</td>
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</table>
## Comparison between GatesAir and Main Competitor

<table>
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<tr>
<th>Item</th>
<th>GatesAir</th>
<th>Competitor</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Efficiency Design</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>50 Volt LDMOS</td>
<td>Yes, newest device</td>
<td>Yes, last generation device</td>
</tr>
<tr>
<td>PA Complexity</td>
<td>Simple single gain stage, higher</td>
<td>More complex, much harder to repair, lower MTBF</td>
</tr>
<tr>
<td></td>
<td>MTBF</td>
<td></td>
</tr>
<tr>
<td>Web GUI included in transmitter</td>
<td>Included in price</td>
<td>Extra cost option</td>
</tr>
<tr>
<td>GPS Receiver option</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Exciter easily accessible</td>
<td>Yes</td>
<td>No, located in top of rack</td>
</tr>
<tr>
<td>Common spare parts between Liquid and air cooled transmitters</td>
<td>Yes, Power supplies, PA pallets, exciter boards</td>
<td>Power supplies are different - increases network spares cost</td>
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</tbody>
</table>
Martyn Horspool
Product Manager, TV Transmission
GatesAir, Mason, Ohio USA
martyn.horspool@gatesair.com
www.gatesair.com

Thank you for attending