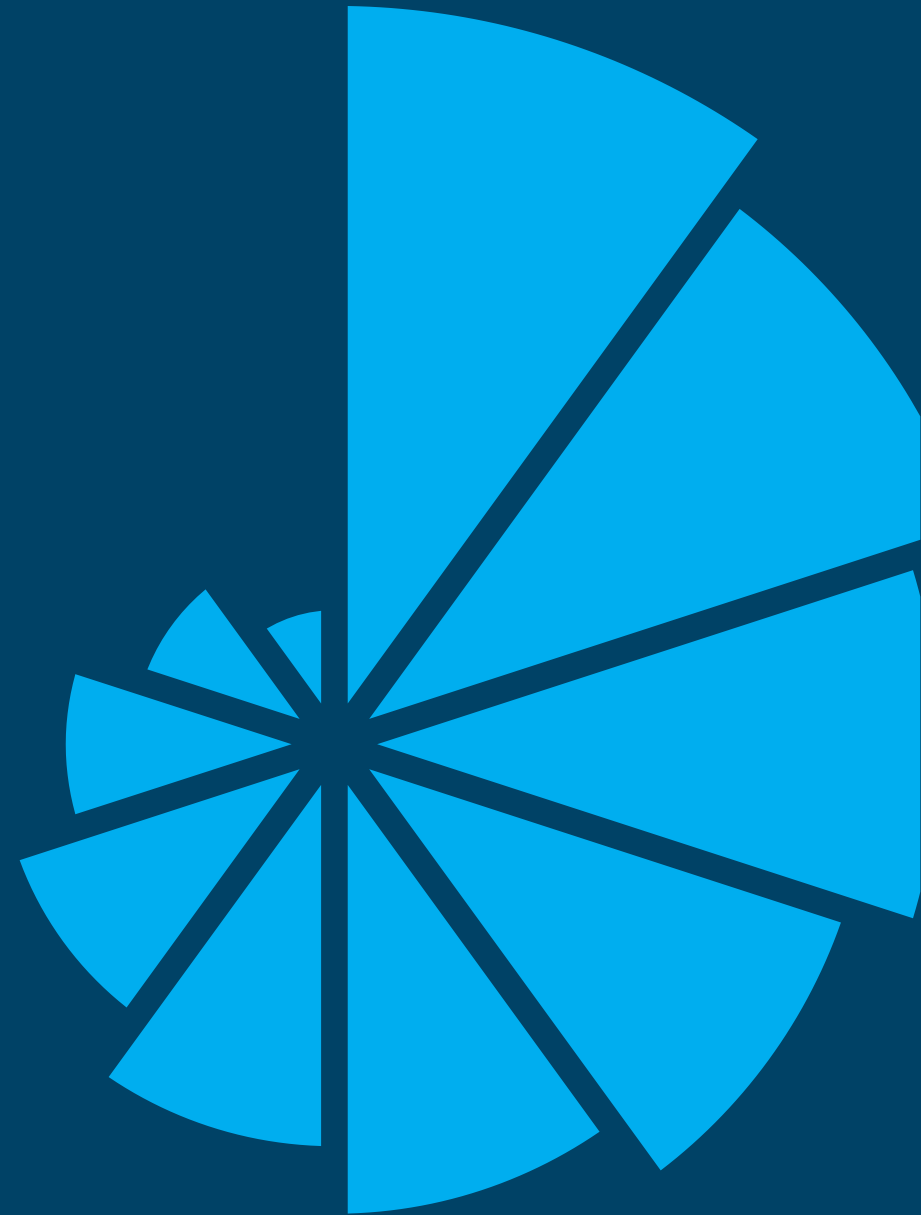


# NAB Kickoff Webinar

## Developments in FM HD Radio™

April 18, 2020



## Developments in FM HD Radio

- A brief history of HD Radio
- HD Radio basics
- The RF Supercomputer
- Where we are today
- PAPR and pre-correction techniques
- Where we are going
- Your questions



Your host:  
Chuck Kelly  
VP Market Development



Special Guest:  
Perry Priestley  
COO / CSO Broadcast Electronics



Special Guest:  
Morten Simonson  
CTO – Elenos Group



*Remember, watching this webinar qualifies for ½ credit towards SBE certification under Category 1.*



Innovation Lives  
Here

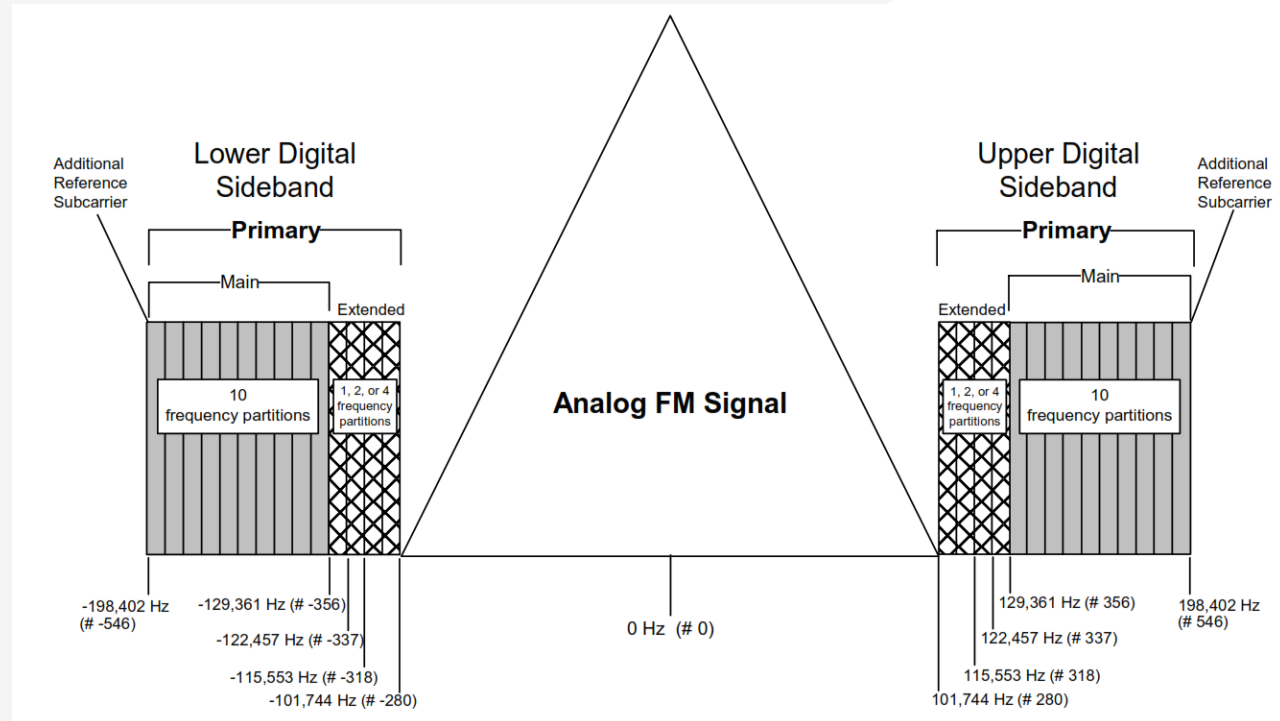
# A brief history of HD Radio

- In 2002, the US FCC endorsed HD Radio as the digital system for the US, and in 2007 added multicasting and datacasting services.
- HD Radio is a transitory technology, allowing stations to continue to broadcast their normal programming in analog, while adding new digital signals which offer better audio quality, and additional services.
- Today, there are 2,300 US FM broadcasters offering HD Radio, carrying 4,300 content channels. In the top 10 markets, 98% of the top 10 stations are using HD Radio.
- HD Radio is the digital radio standard for the US, Mexico, Panama and the Philippines. It's also on the air in Canada and in India.
- Over 65 million HD Radio receivers have been sold worldwide.
- Broadcast Electronics has been a leader in HD Radio transmitters since the beginning.



# FM HD Radio Basics: composition

- Hundreds of digital carriers are added both above and below the FM analog signal.
- The combined power level of these digital carriers is between -20dB and -10dB below the unmodulated FM carrier, so for a 10kW FM, the digital power is between 100W and 1kW.



- There are several methods of transmitting an FM HD Radio signal, but today the most common is an exciter capable of simultaneously creating the analog and digital components and following it with a PA in Class AB linear mode.
- Since any non-linearities in the PA stages can cause spectral regrowth, adaptive precorrection techniques are used to correct the non-linearities.



# FM HD Radio Basics: content

- All FM HD Radio stations carry a digital version of the main analog channel as HD1, and may have up to three additional new channels.
- The total digital bandwidth available is spread to the channels.

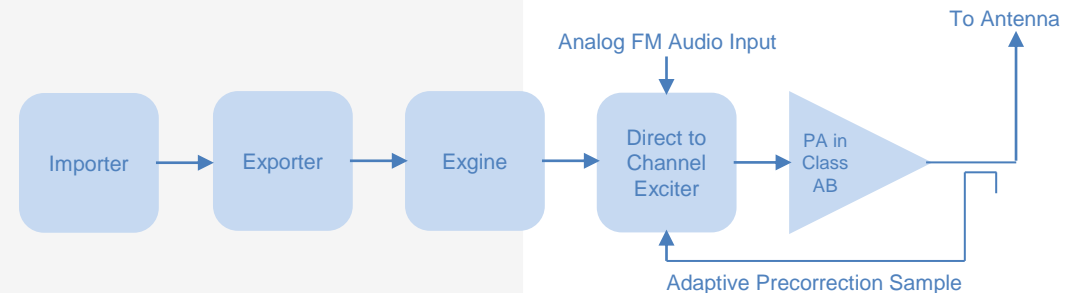
ADULT CONTEMPORARY	96.3-1	WHUR FM HD1 The Steve Harvey Morning Show
WORLD/VARIETY	96.3-2	WHUR FM HD2 Broadcasting culturally rich content to a diverse audience
R&B	96.3-3	WHUR FM HD3 The Best Mix of New Classic and Soul!
NEWS/TALK	96.3-4	WHUR FM HD4 DC Radio

- Higher data rates allocated to a channel allow better fidelity and robustness.
- Additional data services such as program information, graphics on the radio screen, Artist Experience, iTunes tagging support, and emergency alerting can also use some of the available data bandwidth.
- Eventually, when most of the receivers in field are HD Radio compatible, the analog can be shut off and additional bandwidth will be available for more audio channels or services.



# FM HD Radio Basics: components

- **Importer:** Multiplexes the audio content channels into a single stream.
- **Exporter:** Creates the HD Radio signal in E2X form.
- **Exgine:** Creates an IQ signal from the E2X data which is fed directly to the Direct to Channel Exciter.
- **Direct to channel Exciter:** Digitally synthesizes both the analog FM content as well as the HD Radio carriers and creates the total waveform on the RF frequency. Receives a directional sample of the signal being fed to the antenna, compares it with the mathematical ideal signal, and creates error terms which are used to pre-correct the generated signal.



# The RF Supercomputer

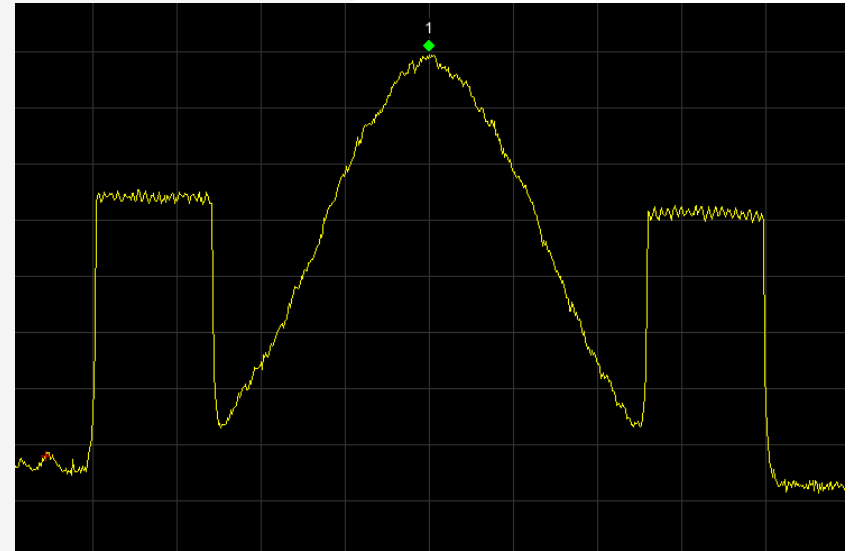
- A programmable hard real-time processor
- A programmable Linux real-time, multi-threaded processor
- A programmable DSP
- A large programmable FPGA
- One integrated board of programmable power
- 16-layer printed circuit board with 2200+ parts
- RF out from 30MHz to 760MHz in 1Hz steps
- Four Ethernet ports with individual MAC addresses
- Build-in GNSS (optional: GPS, Glonass, Galileo & BeiDou)
- Single supply voltage (5 to 50 V)
- Totally software defined with remote firmware upgrade
- Onboard webserver control / monitoring (no FLASH Or Java)
- 3 different levels of Reference Oscillator (holdover duration)
- Currently supports: DVB-T/H/T2, ATSC legacy/3.0, ISDB-T/Tbb, Analog PAL/NTSC, DAB/TDMB/DAB+, ..)



# Now the RF Supercomputer can do HD Radio!

The RF Supercomputer in-built functions:

- Direct to channel exciter
- Integrated Exgine
- Advanced Adaptive Precorrection
- GPS for timing and exact frequency lock
- HD Audio input using ATSC3 STL protocol
- Both linear and non-linear samples





# Let's see it in action

The screenshot displays the control interface for the A-TV Modulator PT3040. The main area features a block diagram with the following sections:

- INPUT:** Includes Video (1, 2), SDI (1, 2), SUB, NCAM L, Stereo R, Stereo L, and MPX.
- MODE:** PAL and G.
- PRE-CORRECTION:** Linear, Clipping, and Non-Linear stages.
- OUTPUT:** RF Output, ALC (0.00dBm, 474MHz), Non-Linear Sense(1) NA, and Linear Sense(2) NA.
- REFERENCE:** AUTO, 10MHz, GNSS, 10MHz, and 1PPS.

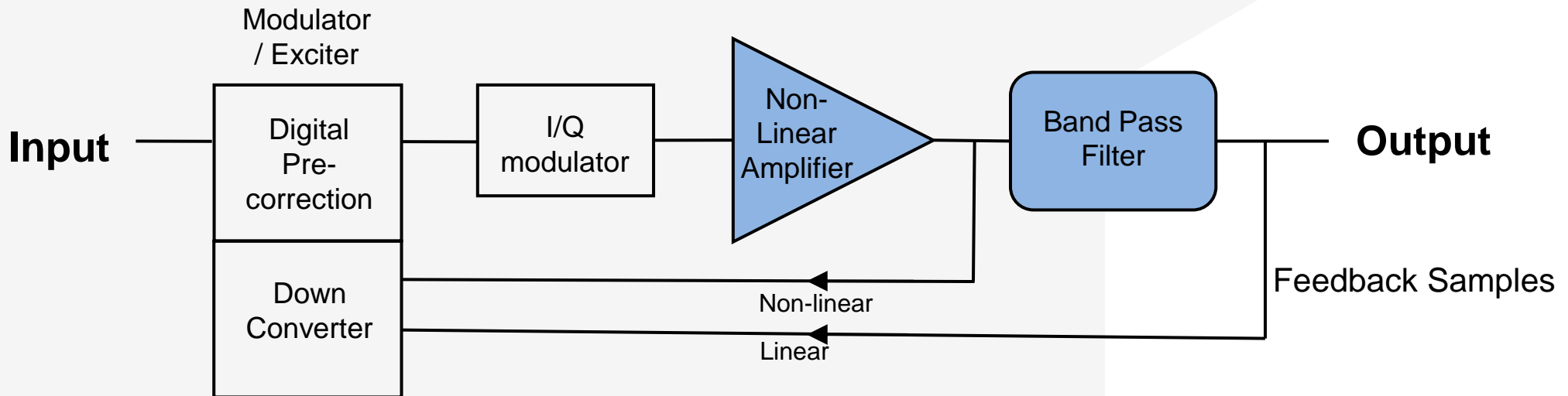
Below the diagram are three configuration panels:

Video	Mode	RF Output
<b>Switching</b> Primary: Video 1 Secondary: Video 2 Switching Policy: Only Primary Effective Policy: Only Primary Switch Delay Pri->Sec: 5 sec Switch Delay Sec->Pri: 5 sec <b>Video</b> Video 1 Man. Gain: 0.00 White limit: 90 Sync Level: 27 pct Residual Carrier: 10 pct <b>Video CTRL</b> Video Carrier: ON	Video Standard: G Color Encoding: PAL	Output Status: Normal Output Mute: <input type="checkbox"/> Min. Ramp-up Delay: 800 ms <b>RF Alarms</b> - Level Out of Range: Ok - ALC Range: Ok <b>Settings</b> Frequency: 474000000 Hz Frequency Offset: 0 Hz Spectrum Polarity: <input type="checkbox"/> Inverted Level: 0.00 dBm RF Output Filter Control: <input checked="" type="checkbox"/> Enabled <b>Cable Compensation RF Output Level</b> Cable Compensation Mode: None

The interface also includes a sidebar with navigation options (Back/Forward, Favorites, Applications, etc.), a top status bar with 'A-TV Modulator PT3040' and 'PRO TELEVISION TECHNOLOGIES', and a bottom status bar with 'SYSTEM', 'Clear', and 'Apply' buttons. The time 18:13:37 is displayed in the bottom right corner.



## What do we mean by Advanced Adaptive Precorrection?



- Most RF amplifiers that are organized for optimum efficiency generate **non-linear distortion**
- A typical Class AB amplifier can generate MER/SNR levels in the 20-25dB range, thus to obtain reasonable levels of greater than 35dB significant pre-correction is required
- Any RF device that has a phase change in or near the pass band will cause **linear distortion** (examples : filters, power combiners, channel combiners, feed lines etc..)



## What do we mean by Advanced Adaptive Precorrection?

- Most **non-linear** distortions caused by modern amplifiers are relatively constant, but variations in the amplifier of temperature and or ageing can require constant correction, in addition variation can occur to the passive rf components due to environmental influences
- A good pre-corrector can compensate for these (linear and non-linear) distortions and should support both automatic and adaptive pre-correction
- In addition to static non-linearity, dynamic non-linearity known as **Memory Error Effects** is also a cause of further degradation of MER/SNR and requires Memory Error Correction (**MEC**)
- **MEC** compensates for an amplifying device's **thermal memory**



## What's next?

- The Elenos Group is committed to digital radio
- Our new HD Radio Supercomputer available in Q3 2020. **We will be taking advanced orders soon**
- A new Importer and Exporter will also be released at the same time
- Integration of Importer and Exporter into the exciter will be released in 2021
- A new range of FM products derived from our ETG and STX lines will also be available before the end of 2020. Our new development of FM transmitters all support digital mode operation, provide the highest efficiency in the market as well as provide some unique features in redundancy and reliability... MORE TO FOLLOW!
- Further products available
  - A new 3kW FM transmitter; The **STXe-3**
  - A new enterprise cloud version of **AudioVault**
  - A new line of **Marti** STL products
  - A test and monitoring set for FM (**Avatar**)
  - And much, much more... stay tuned!



# Summary

- HD Radio is here to stay, now in 65M receivers worldwide
- It is the perfect time for a new HD Radio exciter/importer /exporter product combined with a revolutionary new Radio Transmitter
- Technology changes quickly, and future proof equipment with a brand name behind it is key to any radio stations success
- The **Elenos group** with 90 years corporate experience, 60,000 installations and some exciting new products for all radio stations is here to be of assistance
- Register for our schedule of upcoming free webinars at:  
<https://www.elenosgroup.com/webinar/>



# Your Questions?

*We'll try to answer them all here, but if we can't we'll email you.*



# Thank You



Radio & Television  
Broadcast Equipment  
and Solutions Worldwide

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We know how valuable your time is, and we are honored that you chose to spend time with us.

For further information, contact your regional Elenos Group sales professional

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