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HD Radio Installation Checklist

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This checklist was assembled to assist broadcasters with the rollout and installation of HD Radio. Whenever a new technology or paradigm presents itself, there is usually no benchmark with which to reference or compare, so the early adopters endure the brunt of the rollout process. HD Radio was approved by the FCC for use in the USA in October 2002; as of fall 2003, commercial radios are not yet available, but broadcasters need to begin transmission in order for the consumer market to roll out.

HD Radio installations for FM and AM are basically straightforward, but to make them go smoothly there are certain items that need special attention and consideration. We strongly recommended that you investigate what's required before embarking, and realize that not only are you possibly adding another transmitter, but (if you are going to implement high-level combining) that your conventional transmitter has the required headroom in the Power Amplifier. Additionally, you must make sure that there's enough source power to handle another rig.

Open a dialog with transmitter manufactures, and related equipment vendors to ensure that your installation will operate as desired. Aside from the transmitter folks, it's a good idea to review your plans for STL, audio routing, audio processing, remote control, transmission line, dummy/reject load and antenna. I'm already aware of a major-market FM station that was dumped off-air due to audio failure of the HD Radio exciter. Because the conventional audio path was also routed through the HD exciter, the failure took the conventional transmitter off with it. This occurred, not due to anyone's negligence, but because we're dealing with a new *beast…* and the conventional path got lost in the planning process.

This is why it's a good idea to ask as many questions as possible before embarking on this effort; it's important that your installation meets the needs and requirements of your facility. Block diagrams are available from each transmitter manufacturer which detail equipment placement. Since HD Radio is still in it's first phase of evolution, please consider this checklist as a starting point. As with any new tech, field experience will provide additional information to guide all of us.

STL

The STL system does not have to be digital. So long as there is a conversion method at the transmitter site, input audio can arrive via the STL in either analog or digital format. For example, if the STL system is analog and it is connected to a digital audio processor at the transmitter site, the processor will provide the A/D conversion (more will be discussed regarding audio processing later). However, we will assume here that a digital STL will be employed.

The main issues to be aware of regarding the STL system are a combination of sampling rate and desired HD Radio audio bandwidth. The HDC FM System is capable of 20kHz response, while the HDC AM System provides 15kHz response. If you want to offer 20kHz audio response for HDC FM, then the STL system *must* employ a sampling rate of 44.1kHz or higher in order to pass the upper spectra. Since the HDC system requires a 44.1kHz master clock, there is a subtle advantage to using a digital STL system that operates at 44.1kHz, as it will eliminate a sample-rate-converter (SRC) — but this is not a requirement; STL systems employing either 32kHz or 48kHz sampling will work just fine.

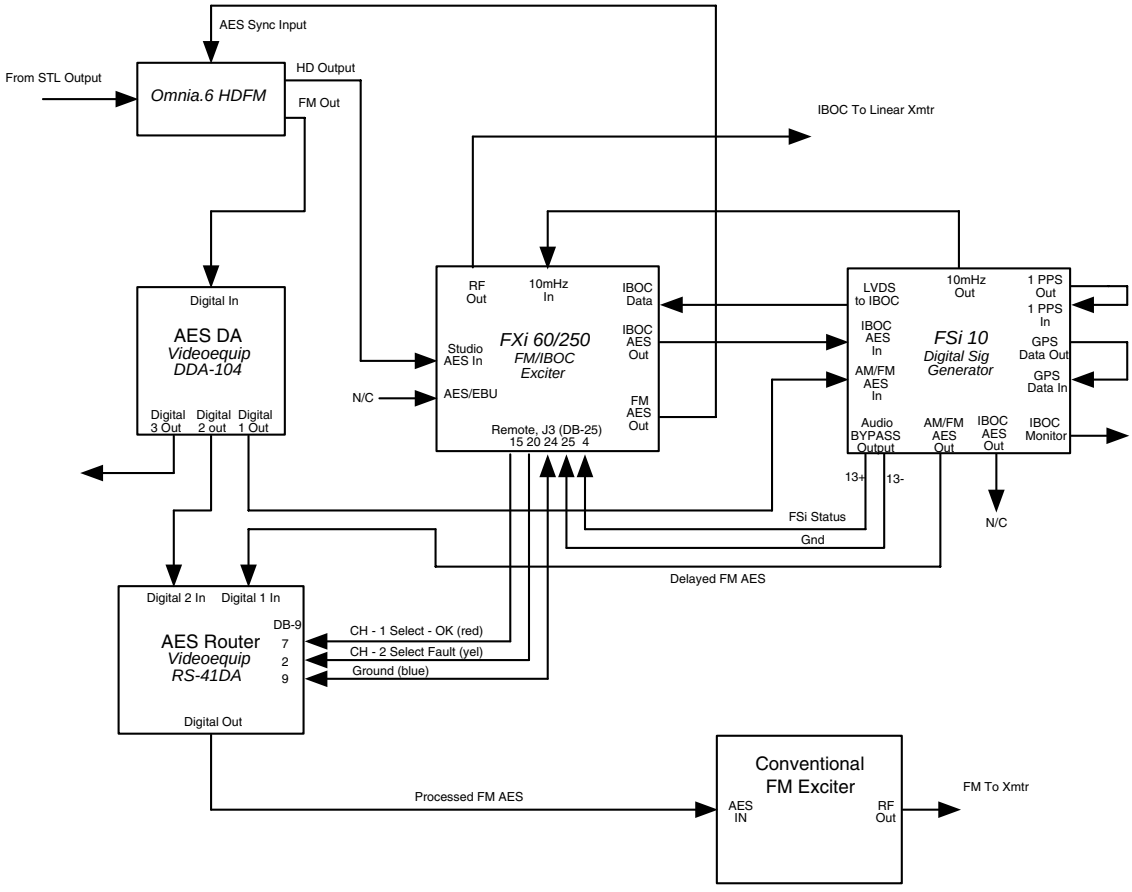
For facilities that operate using synchronous transmitter locations, it is vitally important that you have a well-defined plan for how *every* required signal will be delivered to the transmitter site, as well as planning for the corresponding timing issues that relate to synchronous operation. Synchronous operation may require additional paths, as there will be multiple audio paths not only for the conventional FM and HD Radio channels, but also the timing signals as well.

Audio Routing

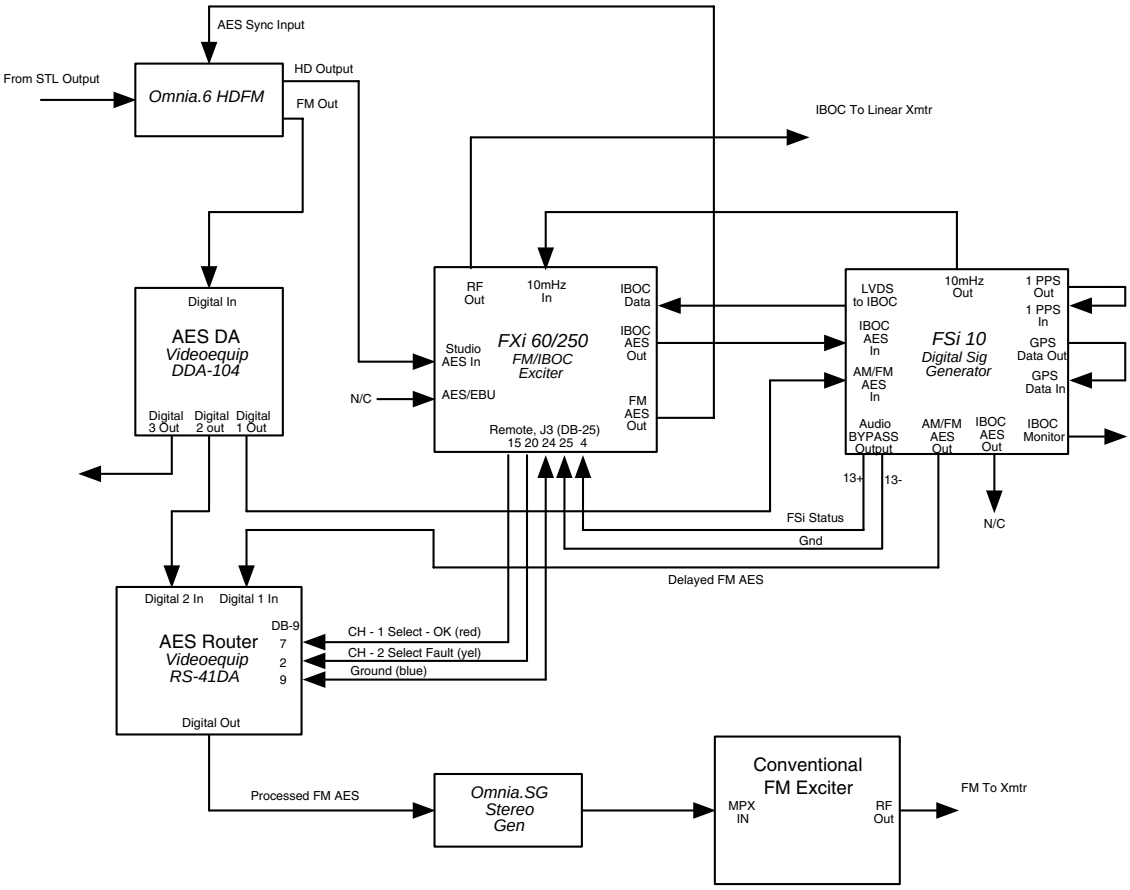
Quite possibly the area that can cause the most confusion. It is vitally important to fully understand the audio routing layout of your proposed installation. The HDC system employs a master clock to sync everything to the 44.1kHz sampling rate the system uses. Each of the transmitter manufacturers provides their own method of audio routing and sync, so make sure to study and understand this aspect or problems will develop. Ensuring that your processing is operating in sync with the system, and is set to the correct sampling rate, will positively affect on-air audio quality.

Also, it's important to have a *bypass* plan should the HDC exciter fail. The reason for this is that the diversity delay for the conventional (analog) channel is usually added in the HDC exciter. Should the HDC exciter fail for any reason, it takes the conventional path with it, and *both* channels are off the air. (Sorry to say that it's already happened folks.)

Below is a proposed block diagram that will provide automatic bypass switching should the HDC exciter fail. As of this writing, this layout works with the BE system; as other bypass plans are designed, they will be added to this generic document. (We are not product specific with regards to system use, but do wish to offer product specific ideas that will help for specific types of configurations. We offer these alternative configurations purely for illustration, it's best to verify setup with your respective manufacturer.) Note: In the block diagram the processor block can be any device of your choice, as long as it contains the required I/O to work within the system.



HD Radio AES *BYPASS* Configuration For Broadcast Electronics
Single Audio Processor



HD Radio AES BYPASS Configuration For Broadcast Electronics
Single Audio Processor and External Stereo Generator

It's quite possible that this same layout can be used with transmission equipment other than Broadcast Electronics. Again, confirm with your vendor.

Audio Processing

This section is not about how to adjust processing for HD Radio, rather how processing is implemented within the system. Processing can be used in two configurations: two separate units (One for HDC and one for conventional transmission), or a single dual output *combo* processor that provides dedicated processed audio for both channels. Either method will work, and the choice is basically determined by user preference.

As stated earlier, it's vitally important to make sure that the sync method is setup properly, and the correct output sampling rate of 44.1kHz is used. Some HDC exciters require an external master clock (that may be provided via the processor), but if the processor is being synchronized from the HDC exciter, then a paradoxical situations exists when the units power up, as a free-running condition can occur, and no audio will pass though. As of this writing, a method is being developed to ensure that this does not happen, but in the meantime, be aware when planning your system. If you choose to use the two-processor system, make sure that both processors are configured correctly with regards to sync and sample rate.

There is also the issue of implementing composite clipping/processing on the conventional channel. The diversity delay, which must be added to the conventional channel, renders the internal composite clipper/stereo generator in the processor useless, unless you choose to not use the diversity delay. But all is not lost! A separate external stereo generator that accepts an AES input will work. Refer to the

previous system diagrams for an example of how an external stereo generator can be inserted. In the example included, the external generator contains a composite clipper/processor, so the ability to add composite clipping is available.

Even though modern digital exciters for the conventional channel provide an AES input, field experience has proven that processor-system-provided stereo generators provide better peak control and cleaner limiting/clipping functions. This is another user preference, and it needs to be stated that the AES inputs on the conventional exciters will also *electrically* work, but the subjective issue regarding how it will sound when compared to the previously described method, must be given consideration.

Transmitter

Just as with processing, there are two methods available for HD transmission: Low-Level and High-Level, referring to the method of combining the two RF signals. Low-Level is a low power method that diplexes the output of the HDC and conventional exciter and then passes the signal to a common RF amplifier. The critically important factor here is that the RF amplifier must provide enough system linearity in order to pass the multiplexed signals without degradation. If you want to use your existing transmitter, contact the manufacturer to see if your rig will qualify to operate in this manner.

The High-Level method is the diplexing of two separate transmitters into a common feedline. The important criteria for this method is to make sure that the transmitter for the conventional signal has enough headroom to overcome the insertion loss of the combiner, so that the same RF power is delivered to the antenna, especially important if the existing conventional transmitter is going to be used. In this case, if the transmitter is already operating at or near its maximum rated output level, the insertion loss will reduce operating power to below the proper level. Remember, RF power level equals coverage area!

Speaking of power: when implementing the High-Level method it's imperative that AC service is properly augmented to insure that there's enough *juice* to keep the plant running smoothly. This can easily be determined by observing the power demands of the added transmitter and associated ancillary equipment.

Dummy/Reject Load

Most transmitter suppliers will specify a reject load for the diplexing system. Such loads are available for either High-Level or Low-Level combiners. Care must be used when working with combiners and reject loads as severe damage may result if proper operation is not observed. Do not take any chances when specifying the reject load, as it must bleed off various levels of RF energy (determined by the power requirements of your facility). Remember that if an under-rated reject load is used and a problem develops within the system where more RF power is fed than the load can handle, severe damage will occur to your RF amplifier sections.

Transmission Line

While it might not seem significant, it's important to make sure that all combined power levels fit comfortably within the specifications of the transmission line. This is also an excellent opportunity to make sure all RF connections are tight, and that there are no pressure leaks within the system.

RF Switching/Antenna(s)

Take the time to plan out the RF switching so that the various RF configurations can be accounted for. It would be prudent to have a well thought out scheme to bypass or switch out either transmitter for maintenance or troubleshooting purposes. If an auxiliary or backup transmitter is part of the plant, consideration must be given as to how it continues to function in the new configuration. Also, think about how best to place dummy loads for easy access during testing.

Make sure that your antenna can handle the new level of RF power. This would also be a good time to make sure that it is optimally tuned to match your frequency. Remember, there is going to be added RF spectra on the outskirts of your channel passing through your system now! Tuning and linearity of the transmitter and antenna are important to successful operation.

Monitoring Functions

When HD is turned on, you'll still need to monitor the conventional channel for power level and modulation. The antenna/directional specs must be maintained for AM, and the HDC transmitter needs a power level monitor. It's a good idea to have access to an indication of reject load level, too. Modulation monitoring becomes a thing of the past in the HDC world, as there is a maximum ceiling of 0dBfs — it is not possible to overmodulate the HDC system.

Off-Air monitoring for talent requires a separate system, as the 6-second-minimum delay to the conventional audio path makes it impossible for talent to listen to the air feed. Also, all remotes, traffic reports, and any situation that requires an off-air monitor will now require a separate IFB signal.

One simple solution to talent's monitoring needs would be to set up an older audio processor to feed the console monitor. This would provide them an on-air-like feel when the mic is open.

Remote Control

Good engineering practice will necessitate that any added transmission equipment have the capability of being remotely controlled. Ascertain that the existing remote control system and interface can accept not only the added transmitter, but also any ancillary switching mechanisms. Tally and control of these functions will be an important aid when the need arises for switching or troubleshooting the RF plant.

Continuing Contribution And Effort…

While some of the items mentioned here might seem like topics for a broadcasting *primer*, we've already come across quite a few issues that were encountered due to a seemingly simple item being overlooked. The HDC Radio system has the potential to provide an exciting experience for your listeners. This guide is a simple checklist to help you insure that this happens!

So please, treat this checklist a self-propagating effort. Anyone is welcome to edit, append, or modify it. It was authored, as an attempt to ease the rollout of HD Radio. All comment and contribution is welcomed!

— F.F