Field Guide

by Grady Moates

The BE 4MX 50

With the new 50 kW transmitter – the 4MX 50 – now installed at several stations, real world field reports on the unit's operation are now arriving. The initial results already encouraged Broadcast Electronics to expand the line – a 25 kW model was introduced at the spring NAB show. In summarizing his experience, Grady Moates, owner of Loud & Clean Broadcast Science, answers the questions on the minds of many stations considering this innovative transmitter.

Late last year, WBIX replaced an aging Harris MW-50 with the new 4MX 50. The result has been everything we had hoped for – and more.

Our MW-50 was the WRKO-680 Rock 'n' Roll transmitter originally installed back in the mid-70's. An original MW-50, it had been field-upgraded to an "A," then to a "B" (although it never quite made the last step to a "C"). With all those field modifications, when I changed the frequency to 1060 kHz there were several times when it was difficult to get a handle on exactly what was in that old box.

It sure is nice to be able to breathe a sigh of relief now that the 4MX 50 is on the air.

A MODERN TRANSMITTER

When WBIX decided to look for a new transmitter, we looked at the various options. With the cost of electricity skyrocketing, efficiency was important.

Equally important was audio quality. With another 50 kW talk station right next to us on the radio dial, we simply *had* to improve our sound quality and be able to run at lower power levels without sacrificing audio performance.

The Broadcast Electronics 4MX 50 seemed to meet our needs. When running at less than 10 kW, the controller shuts down all but sixteen PA modules and power supplies; when running at less than 2 kW, it shuts down even more (we run 22 kW in critical hours, and 2.5 kW at night). This helps to keep energy consumption down.

A "SMALL" SIZE PROBLEM

One major concern was that, due to local zoning hassles which prevented expanding the transmitter room, we had to fit our new transmitter into a very small space.

If WBIX was to get a new 50 kW transmitter, it had to go here.

This constraint is where the 4MX 50 really saved the day. Fortunately, the 4MX 50 footprint is only 45 inches wide by 25 inches deep. This allowed the transmitter to be brought through the existing doors. In fact, we could not have put *any other* 50 kW transmitter into this room without removing the MW-50 to make room. That is space efficient.

After installing this 50 kW transmitter, we still have room to walk around to the back of the unit – so long as we do not try it after a large meal!

INSTALLATION

Not counting the time we spent modifying the site wiring to add a new transmitter to an existing triplex antenna system (that had not been designed for an additional transmitter), I think we spent six or seven man-hours between the truck arriving and it being on-the-air.

When the 4MX 50 was delivered, all the various modules were already in place. Because the 4MX 50 is two inches taller than our doublewide door frame, the least troublesome way to get it through the door was to remove the modules and flip the unit on its side for insertion into the room. The modules were then replaced in their original locations.

Loud & Clean's John Garrett tags and removes all the RF Power Supply and PA modules to lighten the 4MX 50 cabinet for insertion into the room.

We used a forklift to do the insertion into the room, but the unit was so light with the modules out that two engineers easily could slide it around and into place on the floor.

PREPARATION PAYS OFF

We had anticipated the transmitter's arrival by a couple of months, so the electrical conduit and ground strap were already roughed in at the final position of the 4MX 50. This permitted the electrician to be in and out in about an hour.

After installation – a comfortably tight fit.

Access to the I/O panel was simple; it was in its own little shielded compartment. The removable, 10-pin connectors made it easy to hook up control, telemetry and antenna system interlocks. A BNC connector was used for the RF sample and a separate three-pin connector was provided for audio.

All in all, we had the transmitter on the air with basic remote control, telemetry and interlocks quite quickly. Since this unit was one of the very first to be delivered, the factory had expected to send a couple of techs out to start it up and they were quite pleased that it was up and running before they got to town.

I switched back to the MW-50 after a day of running the 4MX 50 so that the BE guys could come in and bless my installation before we began regular, daily operation.

DESIGNED FOR SERVICE

Since we have an early, field-test unit, we have had the opportunity to dig into the box a bit.

There are sixteen PA motherboards (one for each pair of PA modules) and they are easy to remove and replace from the front of the transmitter – in about 15 minutes – by following the clear instructions provided.

The ability to remove any number of modules without turning off the transmitter (I have done it several times without incident) is very nice. It takes about 60 seconds to tell the controller to shut down a module, remove the RJ-45 control plug from the jack on the front of the module, unscrew the two thumbscrews holding the module in place, and slide it out.

Re-installation of a PA module while on-the-air does require that the 4MX 50 momentarily mute. This is so the relay that connects the PA module to the summing buss can energize without drawing an RF arc that would reduce the life of its contacts. The mute is automatic and lasts a couple of seconds.

INTELLIGENT PA MODULES

Each PA module has a temperature sensor that reports to the controller. This got a special test in our transmitter.

It turns out that a couple of the little circuit boards for the temperature sensor sub-assembly had imperfect wave-solder joints on the thermal device, resulting in overtemp alarms that did not actually exist. However, the controller was smart enough to know that a jump to 109 degrees Celsius was not real, so the transmitter never shut down.

The circuitry making the 4MX 50 so darned efficient is such a new concept that I have been surprised how little modification has been necessary since the field testing started. There were a couple of capacitor failures on two of the RF PA motherboards. The transmitter did not shut down when these two failures occurred; it simply adjusted the power of the other 31 modules up by 3% and continued to run.

I think it ran this way – at our full power – for a week until we had time to install the replacements. There have been no power supply failures at all, and no controller failures, either.

NOVEL, BUT NOT COMPLEX

The RF circuitry in the 4MX 50 is a totally new approach, and as such is a bit unusual (and patent-pending). However, there are not a lot of complex components involved; it is just a novel topology. (See Litz sidebar article.)

A lot of effort apparently went into making this transmitter easy to service.

As an example, on the evening when I saw the specious over-temperature alarm mentioned, I took the PA module out, completely disassembled it without a soldering apparatus, installed the new temp sensor sub-assembly, and reassembled the PA module with nothing more than a #2 Phillips screwdriver.

Testing for failed RF output devices is a simple ohm meter probing procedure that can be accomplished after removing just five screws, and the RF output devices also attach to the circuit board with screws, so they are quick and easy to replace. I have not had one fail, but I have seen a BE tech check them out.

The beauty of the design is that there is a one-for-one relationship between RF PAs and power supplies. This means that troubleshooting to determine whether a

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problem in, say, slot 17 is the RF PA, the power supply or the RF PA motherboard is simply a matter of swapping cards and seeing whether problems move with cards or stay with the slot.

SOLVING MINOR ISSUES

As delivered, the transmitter used a normally closed external circuit as the "pattern change mute," so an open in the phasor controller would mute the transmitter. The 4MX 50 responds so quickly to this momentary open that dirty contacts in the triplex antenna system controller were causing quick, momentary transmitter mutes.

The 4MX 50's "event log" screen quickly showed us that we were getting erratic mute commands from outside the 4MX 50 and it was then an easy job to pull the offending relays out of the antenna system controller to burnish and "DeOxit" the contacts. That stopped the immediate problem from recurring.

Meanwhile, BE quickly changed the software so that the "Fast Mute" is now a normally open circuit (like everyone else uses). Since we received the software revision, the muting problem no longer can happen at all.

The impression I got during this process was that everybody kind of gets treated like family by the BE folks. They appreciate their customers' support and know that word-of-mouth reputation spreads fast when there is bad stuff to tell – so they work hard to prevent any bad stuff happening.

JUDGING PERFORMANCE

Since installing the 4MX 50, our power bill has dropped about 20%, compared to using the MW-50. It would have dropped more than that, but our old transmitter runs on 480 VAC and the BE runs on 240 VAC, so we had to put in a step-down transformer that runs quite hot. I think we would easily get another ten percent drop in power consumption if we had a 240 VAC service from the utility company.

Steve Schmitt and Jerry Westberg are all smiles as the 4MX 50 comes up and sounds good.

We plan to make that change in the fall of this year, when one of the other stations on the site moves away and we can move our transmitter to their 240 Volt service.

As you might imagine, our triplexed antenna system is quite high-Q; our 4MX 50 operates at 1060 and there is a 10 kW station running into our antenna system on 1200 kHz, only 140 kHz away.

The traps in the system put *huge* lumps in the passbands of both stations. We could never run aggressive modulation with the old MW-50, preventing us from having the "presence" on the dial that we needed to compete in the Boston market.

The 4MX 50 has changed all that. When we have good-quality source material coming from the studio, we are now the loudest, most natural sounding AM in town. Boston has several 50 kW AM stations on the dial, and I feel we sound much more solid than they do over much of the metro area.

RELIABLE, COOL OPERATION

The 4MX 50 has been on-the-air all day, every day, since January 18th, 2006. It is hard to gauge MTBF (Mean Time Before Failure) at this early date, but all of the little problems that we have had have been associated with the field-test status of the unit and these problems have already been designed out of production units.

We have sustained no component failures due to passing weather-related electrical disturbances. The transmitter senses the VSWR change when a tower-base ball gap arcs over, momentarily mutes the transmitter (so as to not maintain the arc) and then returns it to air.

The transmitter room is a good 15 degrees cooler now than when the MW-50 was running. In the winter, the ventilation system does not even come on. My off-air calls have dropped to nearly zero and have been almost all related to studio automation problems.

So far, the 4MX 50 has lived up to my expectations – and then some.

Grady Moates, owner of Loud & Clean Broadcast Science, has been doing engineering in the Boston area for almost 30 years. Contact Grady at grady.moates@loudandclean.com

– Techie Stats –

- Smallest 50 kW transmitter footprint available (< 56 cubic feet, < 8 square feet floor space).
- Lightest 50 kW transmitter available (<1100 pounds).
- 88% overall efficiency (mains power input to modulated carrier output).
- Each RF PA has its own switching power supply for best reliability and redundancy, and high quality audio at power levels as low as 250 Watts.
- Unsurpassed modulation accuracy, due to patent-pending "Fourier Modulation(4M)" technique.
- HD Radio or DRM is accomplished directly from the digital encoder datastream through an ethernet port (I & Q method is also available).
- Switching power supplies are power-factor corrected to 99% or better and designed to operate at 300% of the current demand at 145% positive peak modulation.
- RF PAs can be removed while transmitter is on-air.
- High power devices in RF PAs can be replaced with a #2 Phillips screwdriver.
- Diagnostic screens that display various aspects of transmitter operation.
- Diagnostics, status, and control available over IP.

BE's Smaller Transmitters:

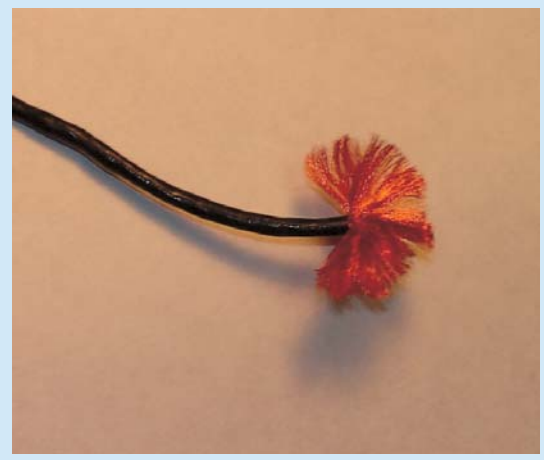
It's in the Litz

Why does the 4MX 50 kW require only about one-third the footprint and weight of most other transmitters in its power class? In a word: "Litz."

Broadcast Electronics uses Litz wire coils in its new 4MX 50 kW and 25 kW transmitters – specifically in the output networks and power amplifiers.

WIRE WITHIN WIRE

Litz is a multi-strand construction of 3,400 small-gauge (48 AWG) wires that are precision-twisted and film-insulated. The multi-strands are then coated with extruded Teflon.



Litz Wire

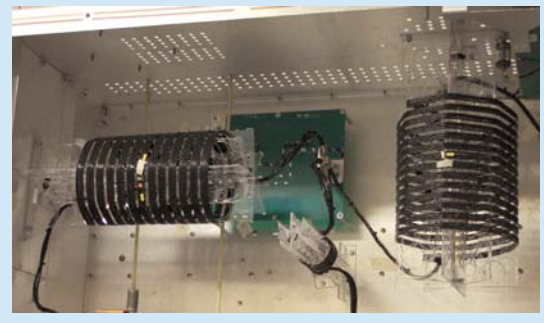
The word Litz is derived from the German word "litzendraht," which means woven wire. Litz cable consists of a number of individually insulated magnet wires twisted or braided into a uniform pattern, so that each strand tends to take all possible positions in the cross-section of the entire conductor.

LITZ COILS

The Litz coil design is different from solid conductance schemes in that it greatly reduces the "skin effect" of current running through the wires, which minimizes power losses and has the added benefit of reducing the physical size of the 4MX 50's output matching network.

Insulated wires are twisted together in a precision pattern to meet the transmitters' high conductance requirements. The strands in the Litz cable carry equal currents because each wire is surrounded by the same amount of flux per unit length, unlike a solid wire which has a high concentration of current that flows to the surface or skin and therefore creates greater power losses – the skin effect.

The result is that the Litz coils used in BE transmitters are small, requiring less space for the same power requirements.



Output coils in a 4MX 50.

Moreover, because Litz coils can easily be formed by wrapping wire strands around Lexan forms, versus forming copper tubing around solid conductors, the Litz coil is lighter than tubing coils.