Kintronic Labs Provides Critical Product for the HAARP Research Station

by Steve Floyd

This is a story that must be told. When a vendor in the broadcast industry rises so far above and beyond reasonable expectations, well, the good news must be shared. That vendor is Kintronic Labs. First, a little background on the High Frequency Active Auroral Research Program (HAARP). The HAARP Research Station, located in Gakona, Alaska, was completed in June, 2007 and is a U.S. government funded world class ionoshperic research facility used to further advance our knowledge of the physical and electrical properties of the Earth's ionoshpere. This HF transmitting system consists of 180 HF transmitters each with an RF output of 20 kW, operating in authorized bands from 2.8 to 10 MHz, providing a combined total input RF power to the 180 element antenna array of 3600 kW, generating an electronically steerable antenna beam with an ERP approaching 96 dBW (4 GigaWatts)! The antenna array consists of 180 individual towers with each tower supporting 2 sets of crossed dipoles, one dipole pair for Low Band (2.8 to 8.1 MHz) operation, and the other dipole pair spaced lower on the tower for High Band (7 to 10 MHz) operation. There are a total of 360 Low Band Dipoles, and 360 High Band dipoles. The antenna system is a 12 by 15 close spaced planer array, with the close tower and dipole spacing driven by antenna pattern performance in the High Band up to 10 MHz. An undesired effect in this closely spaced antenna array is the mutual coupling of RF energy to each individual dipole antenna from neighboring dipoles that will create an even mode RF current on the dipole antenna. This even mode RF current has the same polarity on each dipole side, thus it cannot radiate, and must be controlled to eliminate potentially catastrophic RF voltage or current peaks from occurring in the antenna matching units, and to also eliminate RF current on the antenna support tower. The fixed tuned antenna matching units designed at BAE Systems - AT Division in Washington, DC, provides a reject output port for this even mode energy at each dipole feed point. What we needed was a 50 Ohm load that could handle up to 3 kW of RF energy, with a low VSWR, and be maintenance free for a 30 year lifetime in the outside Alaska environment where temperatures routinely range from – 65 F to + 90 F every year. With high wind, rain, and lots of snow and ice, this is a terrible environment for any antenna system component to withstand.

After contacting many vendors in the broadcast antenna component area, only two companies responded with proposals. Kintronic Labs under the direction of Tom King provided by far the most technically credible response, and Tom pledged to work closely with our design team to develop a cost effective load design that would meet our needs. Now here is where the story gets, well, a little embarrassing for the HAARP design team. Kintronic Labs was challenged to provide a 50 Ohm load design with a completely sealed architecture to withstand the extreme weather environment in Alaska. Tom and his Principal Engineer, Larry Arnold, arrived at our Washington DC office with a technically sound proposal for a sealed load design. After review by our technical staff we sent them back to the drawing board (first time) to both reduce cost and pursue a field serviceable design using a surface mount resistor technology. Graciously Tom and Larry accepted our direction and went off to try this new design approach. Several months later Tom

and Larry returned to our Washington DC office with not only a surface mount component design and supporting thermal analysis, but with a first prototype built providing real measured RF and thermal test data to show us. We were thrilled! However, after many internal debates our technical staff decided that this new design would not be sufficiently low in cost and rugged enough for our liking. We sent Kintronic back to the drawing board again (2nd time)! Ouch! The direction this time was to use the snap-in clip mounted ceramic core power resistors found in many indoor load applications. The snap-in clip mounting would provide for the anticipated thermal expansion of the ceramic tubular resistors and prevent resistor component cracking from the expected thermal shock during winter operation. Again Tom and Larry graciously started over and produced a completely new load design using the snap-in low inductance ceramic core power resistors! We approved the design and instructed Kintronic to complete the final production design. After completing the new load design, and constructing a pre-production model, thoroughly tested by Larry Arnold, we were done! Not so fast! The HAARP program manager suddenly realized that the contract required that all RF antenna connections in the HAARP antenna system must be welded, soldered, or bolted and contain no dissimilar metal electrical connection junctions. No clip-in components were allowed. Oh no! You guessed it! Kintronic was again sent back to the drawing board (3rd time)! Yikes! Any normal, less committed vendor would have simply said "no thanks" to a potential customer at this point, especially since no funding had yet been provided to Kintronic to support their pursuit of this business opportunity, and there was no guarantee that Kintronic would win our business. Amazingly, Tom King, Larry Arnold, and the Kintronic design team did not give up. They simply started over and with clever innovation used a very high quality, low inductance, wire wound, ceramic core, screw mounted, resistor product configured in quantity to provide a very low VSWR with no additional tuning components. Larry Arnold, completely unfazed by our technical team's indecision, obtained custom value resistor samples, rented a temperature chamber and high power excitation equipment, then proceeded to thoroughly test the new design, specifically the thermal shock survivability. Given that the resistors were now bolted into place without the clip mount to provide for thermal expansion, the concern was that thermal expansion would cause cracking and failure of the resistor components, especially when applying maximum rated RF power after the outdoor mounted loads have been sitting at subzero temperatures to -65 F. Larry ran many temperature shock tests and demonstrated the robustness of their design. Kintronic Labs had actually achieved an affordable, very rugged, convection cooled load design that would satisfy all specifications. Thankfully, limited funding was now provided to Kintronic Labs and 2 production prototypes were built to be installed in Alaska at the HAARP facility for real life testing through a winter period. Success!? Well, not so fast. After tower installation the even mode loads were deemed "too large" and you guessed it, back to the drawing board (4th time) for Kintronic Labs. Fortunately Larry Arnold kept tempers in check at the Kintronic factory and the load design was greatly reduced in size, new prototypes using the rugged wire wound ceramic core resistors were constructed and tested, and yet another set were then sent to Alaska for test and evaluation, all in several months time.

Tom King, Larry Arnold, and the team at Kintronic Labs came up with a winning design that exceeded all of our expectations. Believe me, we tested their final compact 2.5 kW design at more than four times the rated power (10 kW), applying tremendous thermal shock, and no problems were observed. Now we were finally ready for production. Not so fast! Testing in the HAARP antenna array provided new measured data that showed the required even mode load rating for the High Band dipoles was actually only 1 kW, not the 2.5 kW required for the Low Band dipoles. Now we asked Tom King and Larry Arnold to develop a 1 kW load version, much smaller and cheaper of course, for the High Band application. With a "can do" spirit second to none, and the incredible patience of Larry Arnold, Kintonic developed a 1 kW load design that was much smaller and cheaper for the High Band dipole application. After providing new production prototypes with test data, the smaller High Band load design was tested and approved! Ultimately an order for 720 loads, plus 20 spares, was placed with Kintronic Labs. Production went smoothly, stayed on schedule, and Larry Arnold was sent to the HAARP facility in Alaska to oversee the installation and to train our staff on the repair and test procedures for these serviceable and rugged loads. To date, with 720 even mode loads installed since the summer of 2005 we have not had any Kintronic loads fail in the HAARP system.

What is remarkable here is that Kintronic Labs never gave up, repeatedly provided new innovative designs with mathematically modeled performance data, actual prototype measured test data, and they recovered from so many design concept changes that surely any other less committed company would have given up on this business opportunity. I salute Larry Arnold for his patient and incredible commitment to our even mode load requirement, and we thank Tom King and the excellent staff at Kintronic Labs for a job well done!

Steve Floyd is the Chief RF Engineer at the HAARP Research Station and he can be reached at; steve.floyd@baesystems.com
Contact Kintronic Labs at: 423-878-3141 and www.kintronic.com