A Preview of the AM Antenna Computer Modeling Course

Course Description
The FCC now permits moment method computer modeling of many AM directional arrays as an alternative to traditional cut-and-try adjustments and field strength measurements as a means of performance verification (“proof”). This alternative has the potential in many cases of saving a tremendous amount of time and expense, allowing the licensee of an AM station using a directional antenna to tune up and proof the antenna system for a fixed and greatly reduced cost.

Modeling of AM antenna systems, while not particularly difficult, does require some specific steps and proper model calibration in order to be valid and acceptable to the FCC. This course will take the student through the modeling and measurement process specifically for AM broadcast antennas, providing a general understanding of the process and procedures as well as operation of the recommended software.

It should be noted that this is not an omnibus method moment modeling training course. It does assume a basic understanding of modeling techniques and procedures. It is recommended that students who do not already have this basic understanding enroll in and complete a suitable training course. We recommend the ARRL’s Antenna Modeling Course. While this course focuses on amateur radio antennas, it provides an excellent understanding of the modeling process, good modeling procedure, and the advantages, disadvantages and limitations of the NEC and MININEC moment method cores.

Course Content
Broadcast Moment Method Modeling
- Overview
- Limitations of Traditional Field Strength Measurements
- Method of Moments Basics
- FCC Modeling Rules
- Using Moment Method Modeling for Directional Antenna Proofs
- A Step-by-Step Modeling Example
- A Loop Sampling Example
- Analyzing Potential Reradiators

Measurements for AM Antenna Computer Modeling
- Field Measurement Overview
- Impedance Matrix Measurements
- Antenna Monitor Sampling Systems for Moment Method Proofs

SBE Recertification Credit
The completion of a course through SBE University qualifies for 1 credit, identified under Category I of the Recertification Schedule for SBE Certifications.

Course Enrollment
SBE Member Price: $99

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Introduction to Broadcast Moment Method Modeling

For decades, traditional magnetic field strength measurements have been used as a means of verifying the performance of AM directional antennas. In the 1970s, numerical moment method computer modeling was developed and shortly thereafter began finding its way into broadcast consulting engineer circles as a means of predicting self- and driving point impedances of directional arrays. As the moment method cores improved, so did the knowledge and experience of those using them. In 2008, after a 19-year rulemaking process, the FCC changed its AM technical rules to permit moment method modeling to be used in some circumstances as a means of directional antenna performance verification. This tutorial will give the student the basics of moment method modeling as they apply to AM broadcast antennas as well as some of the underlying theory, reasoning and benefits/advantages.

Overview

Sinusoidal Current Distribution

Since the earliest days of radio, analysis of the vertical radiators and directional arrays of AM radio stations has made use of assumed current distribution for each tower. For the sake of simplicity, uniformity and convenience, sinusoidal current distribution was assumed. It simplified the mathematical integration of current along the length of each radiator for calculating its radiation characteristics. This wasn't a bad assumption — it was the best we had to work with. But out in the real world, and especially when dealing with a multi-tower directional array, top-loading and towers in the presence of nearby conductive objects, that validity of that assumption goes out the window.
As electromagnetic energy leaves the antenna, the forward and reflected tower currents are continuously attenuated as they travel the length of the tower. As a result, the current vectors get progressively smaller as they travel up and then down the tower. When the forward and reflected current vectors are summed, understandably they will not trace a sinusoidal curve.

Conventional methods of directional antenna analysis not only assume sinusoidal current distribution for each tower, but they also require uniform, current distribution for elements in an array. Additionally, the tower currents used in the calculations are not directly responsible for the far fields for each tower.

**Tower currents required to produce a required directional pattern cannot be accurately calculated using traditional approaches.**

In the directional mode, there are two or more currents flowing in any element of the array. One is the current in the **transmitting mode**; the others are the currents in the **receiving mode**, i.e. currents induced into the tower from the incident fields from all the other array elements. The actual DA tower current is the sum of the transmitting mode current and all the receive mode currents. As a result, the current distributions of the towers differ, and the relationships of the base currents to the tower far-field contributions are not uniform.

Therefore, the tower currents required to produce a required directional pattern cannot be accurately calculated using traditional approaches. Theoretical parameters provides a good starting point, but the only way to adjust the array to produce the proper pattern is through trial and error. This is a
lengthy process that starts with a set of ND field strength measurements on all the null and lobe radials followed by a few directional measurements at some of the same points. Once one or more points on each radial can be determined to be "representative" of the overall radial, the array is adjusted through trial-and-error to achieve the proper ratios at each of these "tune points." Again, until method-of-moments modeling came along, this was the best way we had to adjust an array to produce the proper pattern shape and size.

**A Better Way**

In moment method modeling of an antenna, the radiator is divided up into segments. Tower segment currents are solved numerically, taking into account the field coupling between segments on the radiator and the currents conducted from adjacent segments. If the modeler is careful in his selection of segment length, a close approximation of actual current distribution can be obtained from the model. This has the benefit of predicting base drive impedances much more accurately than any other method. It's not hard to see how knowing the actual current distribution on the tower and the driving point impedances would benefit the engineer designing a phasing and coupling system or tuning up an array.

**Advantages of Modeling**

Moment method modeling has several big advantages over the traditional ways of directional antenna analysis. First, as mentioned above, modeling solves for very close approximations of tower current distributions within a directional antenna. This is probably the most important advantage, and the one from which all the other advantages stem.
Modeling solves for very close approximations of tower current distributions within a directional antenna.

Modeling predicts tower currents and voltages that are directly related to directional antenna parameters. This makes it possible to adjust the array to the desired parameters using antenna monitor parameters, provided that they accurately represent the tower currents or voltages. This is the big time saver. It eliminates all the trial and error that is so much a part of the traditional array tune-up.

Finally, modeling predicts base driving point impedances very accurately, allowing close design of the phasing and coupling system. Using traditional analysis, the designing engineer had to allow for large variations in power distribution, phase and load impedance because it was unknown exactly what operating parameters (and the resulting driving point impedances) would be required to "make" the pattern. Modeling eliminates that guesswork, allowing the phasing and coupling system to be designed without all the "slack" for the unknowns.

These advantages convert directly to savings — time savings by eliminating all the field work to "talk" a pattern in through trial and error and to proof the pattern thereafter, money savings by eliminating all the man-hours to get the pattern right by trial and error and the labor required to produce a traditional directional proof of performance based on field measurements, and money savings by allowing proper component selection at design time.

Another advantage is the fixed cost represented by the modeling option. A traditional directional antenna tune-up and proof is an open-ended process. At the outset, no one knows how long it will take or how much it will cost because there is no way to know how many iterations it will take to get the pattern right. If there are reradiators or other factors that distort the measured field, months or even years can be added to the process. All this can be eliminated through modeling.

We all have to do more with less these days. The time and cost savings represented by the modeling option makes this a very attractive choice indeed.

What current distribution is assumed with traditional AM directional antenna analysis?

- Gaussian
- Sinusoidal
- Trapezoidal
- Linear

What two types of currents flow in the elements of a directional antenna system?

- Normal and induced
- Sinusoidal and linear
- Transmit and receive mode
- RF and AC lighting currents