Chapter 38 of the Society of Broadcast Engineers
SBE
EL PASO - LAS CRUCES - JUAREZ

FEB
2011

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NEWS

High-power RF tuning

Even a newly installed transmission line is not perfect. You bolt together the new sections properly, install all bullets and tighten all the bolts, but still impedance imperfections cause unwanted VSWR or reflected power. Imperfections exist in every elbow, flange connection and transition, and these imperfections are expressed in impedance discontinuities. The perfect transmission line would present an exact impedance match to the RF output (transmitter) and to the load (antenna). In that situation, all power from the output would be transferred to the load with only the loss from attenuation equal to the length of the transmission line run. With a perfect impedance match, no power would be lost as it was reflected back to the source and no high voltage spots would be generated by a high voltage standing wave ratio (VSWR), which can cause arching within the transmission line. Unfortunately, perfect impedance matches do not exist; the most that can be achieved is a close match where most of the energy is transferred to the load and the VSWR is kept to a minimum.

Tuning a line

A transmission line's impedance is dictated by its physical parameters, i.e., the size and spacing of its components. Because of this, to tune or adjust the impedance of a point within a transmission line, its physical structure must be altered.

At low frequencies, such as those used for AM radio, the wavelengths are very long, which requires large devices to affect the RF signal. To broadcast the AM signal, the entire tower(s) is used to radiate the RF signal, and sometimes just a pipe acts as the transmission line to the tower. As we move up in frequency, the wavelengths get shorter and easier to interact with or alter. Rigid coax and waveguide can be tuned by putting a dent in them. Striking a transmission line with a hammer will definitely affect its impedance because it changes the physical dimensions of the line. This is one of the reasons why waveguide can be difficult to work with: Its large size makes it easier to damage while installing it, especially the thin-wall variety. Rigid coax is harder to dent due to its thick walls and round shape, but if it is dented, its impedance is changed at that spot.

In essence, all you have to do to change the impedance of a transmission line is to dent it. That dent changes the spacing of the outer to inner conductor in coax or between the top and bottom plates of the waveguide. Interacting with the rest of the components of the transmission line, standing waves can be created, resulting in higher internal voltages and loss of power transferred to the load.

To control the impedance to create a better match to the following components, you need to be able to control the change and the frequencies affected. This is where transmission line tuners come in.

NEWS CONTINUES IN PAGE 2

OUR SUSTAINING MEMBERS:

KTSM-TV

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Measurements

To know where to place the tuners, measurements must be made to determine where the impedance mismatch is occurring. A network analyzer is used for this purpose; it is specifically designed to measure the impedance and, thus, the reflected power within an RF device such as a transmission line.

In general, an RF network analyzer uses two different types of displays when making measurements. The first is based on the Smith chart showing impedance, and the second uses an X-Y display to show SWR (reflected power). These tests are performed using a test signal that covers the range of frequencies normally carried in the transmission line, such as your TV channel.

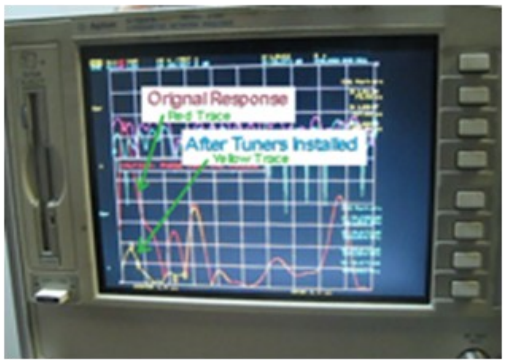

Figure 1. A network analyzer display shows the effects of installing a tuning section of transmission line.

The Smith chart display shows a series of circles that indicate by size and placement the impedance of the component being tested. The tighter and more centered the circles, the closer the impedance match is.

The X-Y display shows the amplitude of the SWR on the Y scale and time or distance on the X scale. In this mode, you would normally see all the flange connections as small peaks at the bottom of the display, spaced out at regular intervals.

News Continues in page 5

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Executive Committee:
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Enrique Lopez
Marvin Haney

EL PASO,TX CHAPTER 38 MEETING MINUTE
DATE 01/11/2011 LOCATION: CLEARCHANNEL.

MEETING CALLED TO ORDER: 19:25 PM, BY ANTONIO CASTRO, THERE WERE 11 MEMBERS AND GUESTS IN ATTENDANCE.

REPORT OF THE SECRETARY: MINUTES ACCEPTED AS POSTED IN THE NEWSLETER BY ENRIQUE LOPEZ

REPORT OF THE TREASURER: CURRENT BALANCE OF $ 5,963.73, SENT CHECK OF $ 125..00 DONATION TO "THE ONLINE ENGINEER". ACCEPTED BY NORBERT MILES

REPORT OF THE CERTIFICATION COMMITTEE: DON BOHRER STILL APPLING FOR CNBE CERTIFICATION. JUNE 2011 IS THE DEADLINE AND LOOKING FOR PROCTOR

REPORT OF THE MEMBERSHIP COMMITTEE: INVOICES FOR MEMBERS ANS SUSTAINING MEMBERS BEING SENT THIS MONTH.

REPORT OF THE FREQUENCY COORDINATOR COMMITTEE: NO REPORT AND NO PROBLEM WITH SUNBOWL.

REPORT OF THE SCHOLARSHIP COMMITTEE: RICHARD VILLARDEL PROPOSSED ONE SCHOOLARSHIP TO BE GIVEN TO A STUDENT IN HANK HIGH SCHOOL. ACCEPTED ONLY ONE FOR MAY THIS YEAR.

REPORT OF THE WEB SITE COMMITTEE : NO REPORT, JUST UP-DATING. 370 HITS.

REPORT OF THE EAS CHAIRMAN : DONA ANA/ OTERO COUNTIES LOST 911 SERVICE. KLAQ ACTIVATED.
REPORT OF THE PROGRAM COMMITTEE: HAVING KEVIN DENNIS FROM "MRC", NEXT MONTH TO HAVE DAN SESSLER, LEVEL MAGIC PRODUCTS BY JUNGER
UNFINISHED BUSINESS: NONE

NEW BUSINESS OR ANY ITEMS FOR THE CHAPTER INTEREST: WILL SEND BALLOTS FOR OFICIAL ELECTIONS BY E-MAIL
.
NEXT MEETING DATE AND LOCATION: FEBRUARY 8, 2011, LOCATION : TBD

MEEETING ADJOURNED: 19:59 PM .ACCEPTED BY RICHARD VILARDELL AND TURNED TO THE PRESENTATION OF MRC

NOTES FROM THE EDITOR:
The article of this month was extracted from the BROADCAST ENGINEERING and issued on Dec. 3, 2010 by Russell Brown, which in turn is the editor of the ON LINE ENGINEER.
NOTES FROM THE SECRETARY:
The invoices for membership renewal for local members and Sustaining members were Mailed and e-mailed.
If you didn't mail your payment, it can be done on the next SBE meeting, either cash or check.

FEBRUARY PROGRAM

January presentation was a last minute announcement, but very good in content, thanks to KEVIN DENNIS from VISLINK. The attendance was not the huge one...but

For February we will have the presentation from PANASONIC, finally, our friend Jim McGowan will introduce the newest AG-AF100 Series Camcorder. which is the world's first professional HD camcorder to adopt the Micro Four Thirds standard.

The invitation is for next Tuesday February 8, 2011 at CLEAR CHANNEL RADIO (4045 North Mesa) and it will start sharp @ 7 PM.
PIZZA, sodas and friendship will be offered.
Do not miss this sneak peek of NAB, and of course, you can have Hands On.
OH, it will be a meeting too !!!!
S E E Y O U T H E R E !

IN OUR WEBSITE ...
<<<WWW.KINT98.COM >>>
YOU CAN FIND A LINK FOR
THE "OnLineEngineer" (OLE)

Any large VSWR errors would show up as larger vertical peaks. By knowing the frequency of the test signal, the distance can be calculated to any discrepancy from the monitoring point, thus pinpointing the problem area. (See Figure 1.)

The X-Y display showing SWR is used to check transmission lines to the antenna when looking for bad bullets in rigid coax or improper flange connections. This type of test is performed whenever a new transmission line system is installed to verify its performance. You would also want to perform this test if you saw the reflected power levels increasing on your transmitter for no apparent reason.

The Smith chart display is used for adjusting the tuning or matching of the transmission line. The most common places tuning is required is where a series of elbows are installed, at transitions from waveguide to coax or vise versa, at the end of a long run of transmission line and at the input to an antenna. All of these areas usually require impedance matching to improve their capability to transfer as much RF power as possible to the following device through the use of RF tuners.

Tuners

Figure 2. These are paddle tuners used on rigid coax transmission lines.

Once the spot that requires matching is located, you need to be able to adjust the impedance of the transmission line within the bandwidth of interest in a controlled way (i.e., not denting it). This is where adjustable tuners are used. Tuners are nothing more than metal probes that are inserted into the transmission line with adjustable depth and spaced for the frequency being examined. The tuners are usually placed four in a row spaced one-eighth wavelength apart. For example, on Channel 33, whose frequency band is 584MHz-590MHz, the center frequency is 597MHz with a one-eighth wavelength of 2.47in. (See Figure 2.)

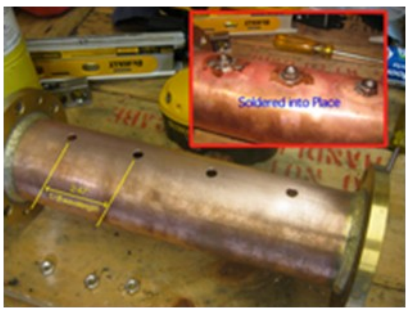

Figure 3. Shown is a section of rigid coax with holes drilled at one-eighth wavelength after the nuts have been soldered in place.

Once the section of transmission line just before where the mismatch occurs is removed, a set of four tuners would be installed into the transmission line spaced 2.47in apart. Not all the tuning holes will be used, but it's much easier to install all four and then tune out the VSWR using only adjacent tuners. One way to test this is to use a screwdriver. The screwdriver is inserted into the holes while the analyzer's display is monitored, and as long as the screwdriver is touching the outer metal of the transmission line, it will affect the matching as would the actual tuner. Once the correct position of the tuners is determined, the actual tuners are installed and adjusted for depth. Many times, however, the actual tuners are installed and adjusted to find the correct position without first testing with a screwdriver. (See Figure 3.)

On rigid coax, the tuners are installed with the use of 3/8in nuts soldered over the holes. Sometimes just a bolt is screwed in to act as the tune, but other times a special paddle tuner is used. A second nut is used to lock the bolt in place. If the line is pressurized, you have to be sure the nuts are soldered all the way around and rubber washers are used to make the bolt fitting airtight. The unused holes are sealed with short bolts to keep dirt out and nitrogen in. (See Figure 4.)

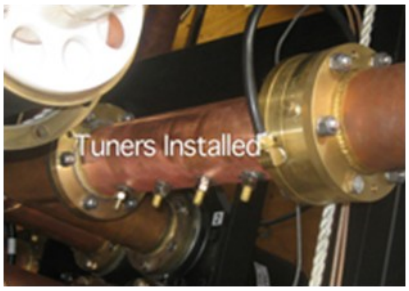

Figure 4. Once the tuners are installed, the transmission line section is installed and tuned.

For waveguide, special tuners are used that are much bigger, but the method of installation and adjustment is the same.

Conclusion

The knowledge required to analyze and adjust high-powered RF systems takes years of training and experience, but don't let that stop you from learning. If you have access to a network analyzer, learn how to use it and it will help you to better understand the world of RF.