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There's Nothing Magic About 50 Ohms

Gary Breed
Editorial Director



Once in a while I am reminded that some seemingly important technical “standards” are nothing more than convenient, more-or-less arbitrary, choices. The deeply-entrenched 50-ohm standard impedance for RF circuits came to mind as I was reviewing and researching this month’s tutorial on recent work in coaxial cables. Where did this important number come from?

The most common story is that 50-ohm high power coaxial lines were first made using standard sizes of copper pipe, such as 3/4 inch for the inner conductor and 2 inch for the outer conductor. While this may explain why certain transmission lines are 52 or 53 ohms versus 50 ohms, I don’t think this is the entire story of how 50 ohms became the most common standard. Being curious, I went digging through my small collection of old reference books.

The oldest of my books, a 1928 3rd edition of *Practical Radio* by Moyer and Wostrel, has no reference to transmission lines at all. Interstage connections are made directly, which is not surprising, but antennas are all shown connected directly to the tank circuits of the final amplifier. A 1936 edition of *Electrical Engineers’ Handbook* by Pender and McIlwain has a section on transmission lines, developed mainly from the paired wires of telephone technology, but also noting “concentric tube” lines, with a chart for a 50-ohm cable identified as RCA’s “Cabloy” product.

The 1st edition of Terman’s *Radio Engineers’ Handbook* (1943) includes an extensive treatment of transmission lines, but does not make note of any “standard” line impedance. It does include information that dates to the 1920s, when it was determined that a coaxial transmission line impedance of 77 ohms provides the lowest loss, while 30 ohms provides the highest power handling for a given cable size, both assuming air dielectric and identical inner and outer conductor material.

The 1950 1st edition of Kraus’ *Antennas* includes several references to the use of 50-ohm coaxial cable, but it also shows antennas for which the coaxial feedline is adapted to match the antenna impedance, as well as several antennas with “coaxial feed” noted, but no reference to a specific impedance. By 1955, Terman’s 4th edition teaching text, *Electronic and Radio Engineering*, included a much more detailed section on coaxial

transmission lines. This textbook's end-of-chapter problems generally use 50-ohm lines as the standard impedance.

The last text I checked was the 1st edition of Jasik's *Antenna Engineering Handbook* (1961). There is a complete reference to the "RG" series of flexible coaxial cables, as well as information on high power coax using solid tubing conductors. However, this text also includes information on 3-wire and 5-wire unbalanced lines and high power 4-wire balanced lines. At that time, these techniques were still in common use for high power broadcasting, particularly the very high powers of international short-wave and medium wave stations.

I got one more piece of information from the company history section of the Andrew Corporation Web site. In 1938, the company first made 70-ohm coaxial lines using

solid copper tubing, but 50-ohm lines of the same construction were not manufactured until 1958. In the 1970s and '80s, large-size 70-ohm solid copper coaxial lines were used for the antenna feed systems at some of the new television transmitting facilities I worked on.

So, Why 50 Ohms?

The answer seems to be twofold—the convenience of adapting standard size materials for early products, plus the fact that 50 ohms is a good compromise between lowest loss and highest power handling for a given cable size. It simply caught on and managed to become the de facto standard as interconnection became common between circuit sections, not just to the antennas.

One more note is that 50 ohms caught on for RF transmission rather than the well-established 75

ohms that had been used for video transmission for many years. The "common wisdom" passed on to me during my years in broadcasting was that differentiation in function was the reason: "75 ohms is video, 50 ohms is RF." This convention apparently did not influence the engineers developing cable TV distribution, who wisely chose to use 75 ohm cable for its optimal loss performance.

Coaxial cable impedance is not the only place where standards emerged for practical, not theoretical reasons. Modulation formats, data transmission protocols, device packages and sizes, substrate materials and thicknesses—and many other things we consider standardized—are also compromises among performance, cost, usability, availability of materials and ease of manufacturing.

Gary Breed, "There's nothing magic about 50 ohms", High Frequency Electronics, pp. 6-7, June 2007, Summit Technical Media LLC, archived 26 June 2015. Wai-Kai Chen, The Electrical Engineering Handbook, Academic Press, 2005. ISBN 0-12-170960-4. Walter S. Ciciora, Modern Cable Television Technology: Video, Voice, and Data Communications, Morgan Kaufmann, 2004. ISBN 1-55860-828-1. Gary Davis, Ralph Jones, The Sound Reinforcement Handbook, Hal Leonard Corporation, 1989. ISBN 0-88188-900-8. There's too much plot armor and plot holes here. Plus there's missing info which should be there in the story. And not to mention the story itself is quite shallow. MC doesn't really have much of a character. Like seriously, nothing makes sense in this story. It's all plot armor and BS to practically give MC anything and everything needed. 04.01.2021 at 14:58. A returner's magic should be special. 30.01.2021. Chapter 133 Chapter 132. everything RF. Whitepapers. There's Nothing Magic about 50 Ohms. There's Nothing Magic about 50 Ohms. High Frequency Electronics. Download Whitepaper. The deeply-entrenched 50-ohm standard impedance for RF circuits came to mind as I was reviewing and researching this month's tutorial on recent work in coaxial cables. Where did this important number come from? The most common story is that 50-ohm high power coaxial lines were first made using standard sizes of copper pipe, such as 3/4 inch for the inner conductor and 2 inch for the outer conductor. While this may explain why certain transmission lines are 52 or 53 ohms versus 50 ohms, I don't think this is the entire story of how 50 ohms became the most common standard.