



Selecting the Right RF Coax for Wideband EW and SIGINT Applications

Introduction

In modern electronic warfare (**EW**) and signals intelligence (**SIGINT**) systems, the demand for reliable and high-performance coaxial cables is paramount. These systems often require wideband frequency coverage, precise signal integrity, and robust performance in harsh environments. To meet these demands, selecting the appropriate RF coaxial cable becomes critical to ensuring system reliability and mission success. RF coax cables must not only support the wideband frequency spectrum but also withstand the rigorous conditions common in military applications, where factors like signal attenuation, shielding effectiveness, phase stability, and temperature ratings play a significant role. This paper will explore vital criteria for selecting RF coax cables, particularly in the context of **EW and SIGINT** applications, and will compare the performance characteristics of common mil-spec coax families. By understanding these important factors, engineers can make informed decisions that optimize system performance in complex and demanding environments.

Electronic Warfare (EW)

EW involves the use of electromagnetic energy to attack or defend against enemy electronic systems, including radar jamming, spoofing, or other disruption tactics.

Wideband EW

Wideband refers to a broad range of frequencies that are used in the communication or signal environment. In electronic warfare, this typically refers to technologies that can operate across a wide spectrum of radio frequencies to disrupt, intercept, or jam enemy communications, radar, or other electronic systems.

SIGINT (Signals Intelligence)

Signals Intelligence refers to the interception and analysis of electronic signals to gather intelligence. These signals can include communications (such as phone calls, emails, radio transmissions) or non-communications signals (like radar or other electronic emissions).

SIGINT is often used for military, espionage, and surveillance purposes. It is typically divided into two main categories:



1. **COMINT** (Communications Intelligence): This involves intercepting and analyzing communications between people or devices, such as phone conversations, emails, and radio communications.
2. **ELINT** (Electronic Intelligence): This focuses on intercepting and analyzing non-communication signals like radar emissions or signals from other electronic devices, to detect enemy activity or gather information on military systems.

SIGINT plays a crucial role in modern intelligence operations, allowing organizations (such as military or intelligence agencies) to monitor adversary communications and electronic activities for strategic advantage.

Signal Attenuation in Wideband Applications

Attenuation is one of the primary concerns when selecting RF coax cables for **EW and SIGINT** systems. It refers to the loss of signal strength as the signal travels through the cable, which can degrade the quality of the signal over long distances. In wideband applications, where frequencies range from low to high, the attenuation characteristics of coax cables become more pronounced. For instance, cables like **RG-213/U** and **LMR-400** tend to exhibit lower attenuation at higher frequencies due to their superior construction and materials. A careful analysis of these attenuation rates is essential to guarantee that signal degradation does not affect the operation of critical systems.

Shielding Effectiveness for Signal Integrity

Shielding effectiveness plays a crucial role in maintaining signal integrity by preventing external interference and reducing crosstalk between cables. This is especially important in **EW and SIGINT** systems, where the presence of unwanted signals from external sources can compromise the reliability of the system. Mil-spec cables such as **RG-58/U** and **RG-174/U** are often chosen for their strong shielding, typically featuring multiple layers of shielding to protect against electromagnetic interference (EMI). In comparison, cables like **LMR-240** offer even higher shielding effectiveness, which is beneficial in environments where high levels of EMI are expected.

Phase Stability Over Frequency and Temperature

Phase stability is critical in systems that rely on precise signal synchronization, such as those used in **SIGINT** applications for direction finding or in **EW** systems for jamming. Phase distortion, caused by variations in temperature and frequency, can result in inaccurate signal processing. Coax cables like **RG-58A/U** and **RG-8/U** exhibit phase stability across a wide frequency range, making them suitable for a variety of RF applications. However, cables with specialized low-loss characteristics, such as **LMR-400**



and **LMR-600**, offer superior phase stability over a broader temperature range, making them more suitable for high-precision military applications.

Temperature Ratings and Environmental Durability

The ability of a coax cable to withstand extreme temperatures and environmental conditions is a pivotal consideration for military and aerospace applications. Coax cables are often exposed to harsh outdoor environments, with temperature ranges varying from freezing cold to extreme heat. For instance, **LMR cables** are rated for a broader temperature range and exhibit superior durability against environmental stressors such as moisture, UV radiation, and mechanical stress. This makes them ideal for applications in which the system must function reliably in diverse and unpredictable conditions.

Examples and Descriptions of Coaxial Cables

1. LMR (Low Loss Microwave Radio) Cables

- **LMR-400** – A popular low-loss coaxial cable, ideal for use in high-frequency applications such as Wi-Fi, GPS, and cellular communications. It has a larger diameter and lower attenuation compared to standard RG cables.
- **LMR-600** – Used for long distance signal transmission. It features low attenuation at high frequencies and is designed for applications where higher power handling and shielding effectiveness are needed.
- **LMR-240** - More flexible option used in applications like cellular, broadcast, and military communications. It offers good performance at both low and high frequencies.

2. RG-213U

- **RG-213U** - This is a mil-spec, flexible coaxial cable widely used in high-power RF applications. It offers a good balance between flexibility, durability, and electrical performance. Common applications include amateur radio, military communications, and broadcast.
- **Construction** – Typically features a solid copper center conductor, a foam dielectric insular, and a tinned copper shield for enhanced shielding effectiveness.

3. RG-58U

- **RG-58U** - It is a widely used coaxial cable for lower-power applications. It's common in RF communication systems like base stations, networking, and various electronics.
- **Construction** -It features a stranded center conductor, which makes it more flexible than RG-213U, but it has higher attenuation at higher frequencies.



- **Applications** – It’s typically used for low-power, short-distance connections in amateur radio, mobile communications, and laboratory environments.

Each one of these cables is used for different purposes based on their signal loss (attenuation), shielding, and power handling characteristics.

Conclusion

Selecting the right RF coax cable for wideband **EW and SIGINT** applications is a complex decision that requires careful consideration of various performance characteristics, including attenuation, shielding effectiveness, phase stability, and temperature ratings. By comparing the performance of common mil-spec coax families such as **RG-213/U**, **RG-58/U**, **LMR-400**, and **LMR-600**, engineers can identify the optimal solution for their specific needs. Cables like **LMR-400** and **LMR-600** provide enhanced attenuation performance, shielding effectiveness, and phase stability, making them suitable for demanding environments where signal integrity is paramount. Ultimately, the right choice of RF coax will validate that **EW and SIGINT** systems operate with the highest reliability, precision, and resilience under all conditions.