To Isolate or Not

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Currently, most desirable communication sites are crowded with multiple repeaters and transmitters operating on many different frequencies and antennas. Additionally, with the shortage of channels, every imaginable combination of frequencies can be found in a site. Without proper site designs, antenna placement, or frequency management, some type of interference is likely to be experienced by users. One common type of interference is a product of intermodulation.

Intermodulation interference generally falls into three categories – transmitter-generated intermodulation, receiver-generated intermodulation, or externally-generated intermodulation. This discussion will focus on transmitter-generated intermodulation.

When two or more signals combine in a non-linear device, such as the output stage of a transmitter, they can produce new undesirable frequencies. These unwanted frequencies are called Intermodulation Products, IM products, or simply Intermods.

Intermod products may be manifest as one or more of the following conditions:

* Random sounds on the received audio such as chirps, squawks, and squeals.
* Highly distorted hollow sounding audio from the repeater.
* The repeater receiver might not unmute when it is receiving a transmission.
* The repeater might transmit randomly without any one keying the repeater.
* Hearing more than one user at a time in the received audio from the repeater.

Intermodulation interference is usually intermittent and can render normal voice communication unusable.

Figure 1 shows a frequency spectrum with two transmitter signals - one at 155 MHz and the other at 156 MHz. The upper and lower adjacent signals are the resulting intermods created when these frequencies combine or are mixed together through a non-linear device. The undesirable intermods are generated at 1 MHz intervals across the spectrum with the power level decreasing as they get further from the center.

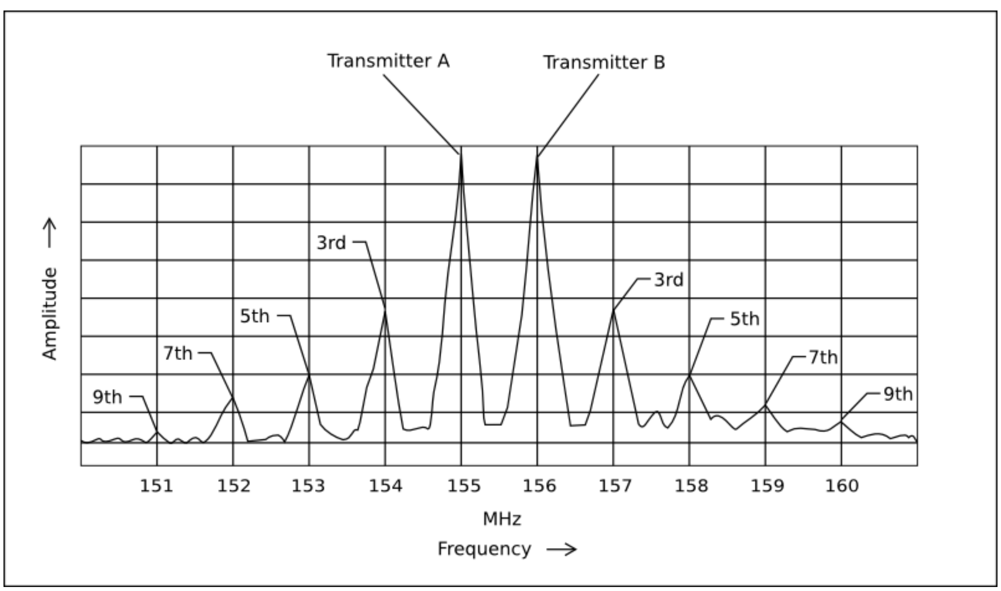

Figure 1 – Intermodulation products created due to transmitter mixing

The signals at 154 MHz and 157 MHz are called the third-order intermods. These are typically the most destructive intermods because they are the highest level. The next intermods are called fifth-order intermods at 153 MHz and 158 MHz. These intermods are a concern but not as great as third-order intermods. The higher-order intermods are generally not a concern unless a combining system is used for multiple transmitters.

Figure 2 is an example of how an intermod is generated at a communications site. Suppose the antennas of two high-power transmitters are closely located as depicted by the transmitter A antenna and transmitter B antenna. Also, consider a receiver antenna very close to the transmit antennas with a receive frequency of 157 MHz. Using the same transmit frequencies in figure 1, a third-order intermod is generated at 157 MHz when both transmitters are keyed. This 157 MHz intermod falls on top of the receiver frequency and will cause interference to the receiver. If the intermod signal is strong enough, it may overwhelm the receiver and block desired signals from getting into the receiver or distort the audio from the receiver.

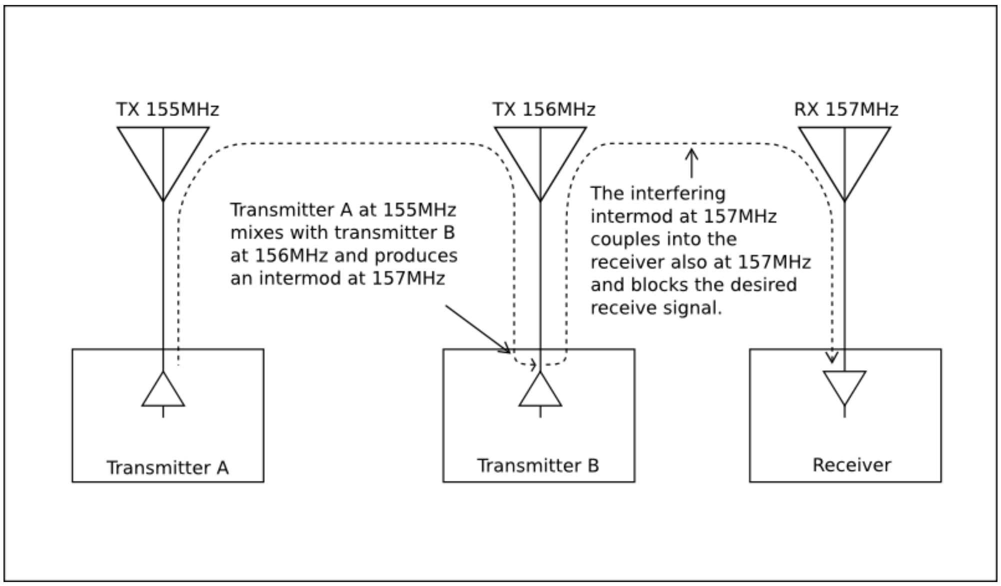

Figure 2 – Intermod generation at a communication site

An RF isolator can prevent the transmitter signals from mixing or combining to create intermods. An isolator is a device that allows a signal to pass through in the forward direction and attenuates signals in the reverse direction. You can think of an isolator as a one-way valve allowing the transmitter to get out but preventing anything from getting back into the transmitter. If an isolator is added to transmitter B as is shown in figure 3, it will prevent transmitter A from mixing with transmitter B. However, the isolator will not block the desired transmitter B signal from getting out the antenna.

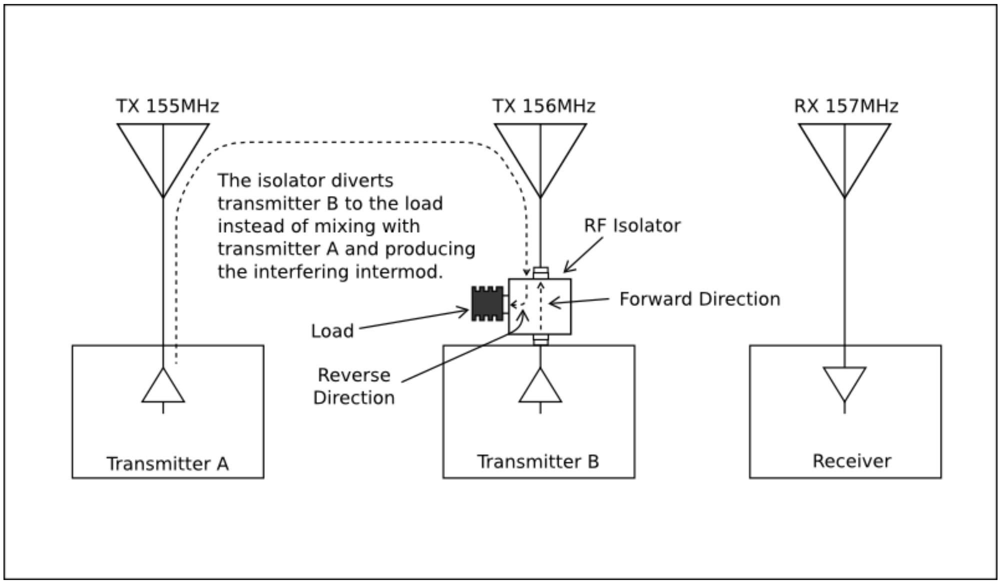

Figure 3 – RF isolator prevents mixing of transmitters

RF isolators typically have only 0.1 to 0.3 dB loss in the forward direction and 20 to 30 dB loss in the reverse direction. Any signal entering the forward direction of the isolator passes through the isolator with very little attenuation. A signal entering the reverse direction of the isolator is directed to the load attached to the third port of the isolator instead of getting back to the transmitter. Two individual isolators are often combined together to form a dual isolator for even more isolation in the reverse direction.

There are a few things to consider when using an RF isolator. Isolators can generate harmonics; therefore, a low-pass or band-pass filter must always follow an isolator. If a band-pass duplexer is used on the repeater, it can suffice for filtering the harmonics from the isolator. Also, the load on the isolator must be sized such that it can handle the full reflected power from the transmitter if the antenna or coax becomes damaged.

In answer to the question "To Isolate or Not", the general rule is "yes" if multiple transmitters are in use at the communication site. More specifically, dual stage RF isolators are normally required on the outputs of all transmitters to ensure enough isolation to reduce the possibility of transmitter generated intermods.