

# RFI REMEDIATION

## RADIO FREQUENCY INTERFERENCE AND REMEDIATION IN TELCO AND NETWORK EQUIPMENT

Electromagnetic Interference (EMI) occurs when nearby equipment emits a magnetic and/or electrical field which interferes with other electrical devices. It is a very broad interference category. Radio Frequency Interference (RFI) is a subcategory of EMI which is most frequently encountered.

RFI can cause many apparently random issues in electronic equipment. Telecommunications and network equipment can be particularly susceptible to it due to long, unshielded cable runs that feed into the electronics. It is unfortunate, but true, that many electrical design engineers do not understand RFI and how to properly design equipment and/or circuits that mitigate its effects. It is also true that many vendors are unwilling to spend another few pennies per device to properly counter RFI/EMI.

### CAUSES OF RADIO FREQUENCY INTERFERENCE

RFI can be generated by multiple different sources.

1. Two-way radio systems generate Radio Frequency Interference (RFI).
  - a. Many companies utilize two-way handheld 'walkie-talkies'. The majority of these operate in the UHF (400-500 MHz) frequency bands. Some companies have licensed communications in the VHF (100-200 MHz) frequency bands. Some companies, very few, utilize the HF (1-50 MHz) frequency bands.
  - b. Companies will generally have at least 1 fixed location 'base station' operating at high power and a myriad of portable units that move around at random. Each of these devices will generate RFI.
2. Site equipment may generate RFI. Heavy motors, electromagnets, fluorescent and LED based lighting systems, and switching-mode power supplies can generate low frequency RFI. Some specialty equipment will generate high intensity RFI as a normal part of operation. Microwave ovens are a good example. The ubiquitous 'portable power pack' used to remotely power / recharge consumer electronics with USB cables can generate huge amounts of RFI when being charged!
3. Heavy motors that are near network cables generate large magnetic fields that can generate current flow in the network cable, much like electrical power generators. This form of interference is referred to as inductance. It is extremely difficult to counter by any mechanism other than rerouting the cables to another pathway. The interference comes and goes as the motor(s) start and stop.
4. Nearby high-power commercial / government radio transceivers may be to blame when the RFI is constant or very frequent. Broadcast stations generally operate on the same frequency or frequencies day in and day out on a set schedule. Amateur radio operations (HAMs) and CB radio operators using high-power amplifiers may induce RFI sporadically and on many different frequency bands.

## HOW DOES RFI IMPACT TELECOMMUNICATIONS / NETWORK EQUIPMENT

Telecommunication equipment and network equipment may exhibit a variety of ill effects as the result of RFI.

- The analog portions of the equipment may pick up the RFI and superimpose it on top of the desired audio stream. It may vary in intensity / volume seemingly at random as the source of the RFI changes distance or intensity. It may present as static or as a second audio stream overlaying your desired audio stream.
- The effect on digital portions of equipment will vary from simply ignoring commands/keypresses to equipment failing/rebooting or having to be reset frequently.

## HOW CAN RFI EFFECTS BE MITIGATED

There are several ways in which the impact of RFI can be reduced or eliminated. Much depends on the intensity of the RFI, the RF frequency of the RFI, and the mechanism(s) by which it enters the impacted equipment.

RFI can enter the equipment by way of the power cord, be it AC or DC powered. A Ferrite clamp-on choke applied as close to the equipment as possible will usually fix this issue. Note that in severe cases you may need to loop the power cord (the entire feed, all conductors) through the ferrite core multiple times to achieve the reduction needed. Ferrite clamp-on chokes may be ordered with many different inside diameters to achieve this effect.

RFI can enter equipment through unshielded data cables, be it USB, HDMI, Ethernet, or Serial.

- Where possible, cable runs should be made in metallic conduit / raceway. Provided the conduit / raceway is properly grounded, it will shield the cable(s) from EMI / RFI very effectively. This is particularly important when cable runs go through or terminate in areas with lots of motors and/or fluorescent lights.
- Where this is not possible or is insufficient you should swap the cables out for shielded cables (STP or ScTP). This solution assumes the devices at both ends of the cable are properly designed to bond/ground the shield. If only one end is grounded the shield will act as an antenna and exacerbate the problem. Inexpensive appliances with plastic covers are usually very bad choices and may have to be replaced.
- If all else fails or is not possible, you may utilize the same type of clamp-on ferrite chokes mentioned above. **Make sure to use one at each end of the cable!** Many cables already come with ferrite cores installed. In severe cases you may need to loop the cable through the ferrite core multiple times and/or use multiple ferrite cores. If you must loop the cable through multiple times you must ensure that the loop is not too tight as tight bends can worsen the situation. Ensure that the diameter of the loop is at least 5-6 inches (13-15cm).

In some rare cases integrated circuit chips have been found to have design flaws that turn them into radio receivers. This situation cannot usually be remedied in the field and requires a complete redesign/rebuild of the equipment.

Ferrite Chokes are made of specific metal/ceramic material mixtures. Each mixture acts on specific RFI frequency ranges. Unless you are certain of the source of the RFI you should try all these mixtures. Note that some cases require two different mixtures in series.

## RADIO FREQUENCY INTERERENCE REMEDIATION – REV 1.1.0 (2020-0909)

Mixture	Frequency Range
75	200KHz – 2MHz (AM Radio Broadcast and certain Government/Military bands)
31	1MHz – 300MHz (Best general purpose range, covers HF and VHF bands and the lower UHF bands) <i>[If the interference is in the lower part of this band you may need to have a type 75 and a type 31 in series to obtain the best results.]</i>
61	200MHz – 1GHz (Low UHF bands and above – Many commercial radio systems)

### MECHANICS



Figure 1 - Clamp-on Ferrite Choke ready to use



Figure 2 - Clamp-on Ferrite Choke applied to cable



Figure 3 - Clamp-on Ferrite Choke with multiple cable turns. **Note that the diameter of the loops pictured is too small.** The picture below shows the proper size of the loops.



Figure 4 - Use of multiple Ferrite Chokes with multiple cable loops

### SOURCE

Sample kits of the 3 different mixtures in a variety of sizes can be obtained from [Palomar-engineers.com](http://Palomar-engineers.com). The following part numbers can be ordered and used to build a field test kit. Beware of inexpensive Chinese knock-offs, the mixtures are frequently wildly inaccurate or incorrect, and results will vary widely.

- FMSCP-61-6 – Type 61, 6 snap-ons in differing sizes
- FMSCP-31-10 – Type 31, 10 snap-ons in differing sizes
- FMSCP-75-6 – Type 75, 6 snap-ons in differing sizes

Production quantities of Fair-Rite clamp-on ferrites (Round Cable Snap-Its) can be obtained from Mouser Electronics or any other Fair-Rite distributor. Ferrites are fragile ceramic constructs and are frequently damaged in shipping; it is best to order in box quantities so that the manufacturers' original packaging does not have to be disturbed.

## INTERNAL RESOURCES

Custom Engineering has a test kit based on the three sample kits discussed above. SEs may borrow the kit for test purposes by opening a Customer Engineering ticket and contacting Tim McKee or, if not available, Clarke Russell.



The clamp-on ferrites have labels and colored paint dots on them to keep the mixtures identifiable. Type 61s (for 200MHz and above) have RED markings. Type 31s (for 1MHz through 300MHz) have GOLD markings. Type 75s (for 200KHz – 2MHz) have SILVER markings. Please replace them in the correct slots before returning the kit.

Diagnostic and remediation support can be obtained by opening a Custom Engineering ticket.

**Good Luck !!!**

THE CONTENT OF THIS ARTICLE WAS REVIEWED  
BY AN UNAFFILIATED ELECTRICAL ENGINEER  
SPECIALIZING IN LOW VOLTAGE DATA /  
NETWORK / TELECOMMUNICATIONS CABLING  
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