Alternative 2 -The RF Suppressor Ground System

This is the modern version of an ingenious device developed and introduced by several hams in recent years, notably by William Chesney/N8SA (See http://www.hamuniverse.com/grounding.html) who published the article in 2003. This grounding system addresses both the electrical ground and RF grounding requirements in Ham radio. The device is intended for long grounding wires. The grounding device utilizes a coaxial line where the ground wire is enclosed by a shield, such as RG-8 transmission line, to prevent the buildup of high voltage standing wave near the station equipment. This ground line is not length sensitive and can be used at any length without concern. It will keep out RF away from the shack. The wiring setup of this practical grounding system is shown in Fig. 7 below:

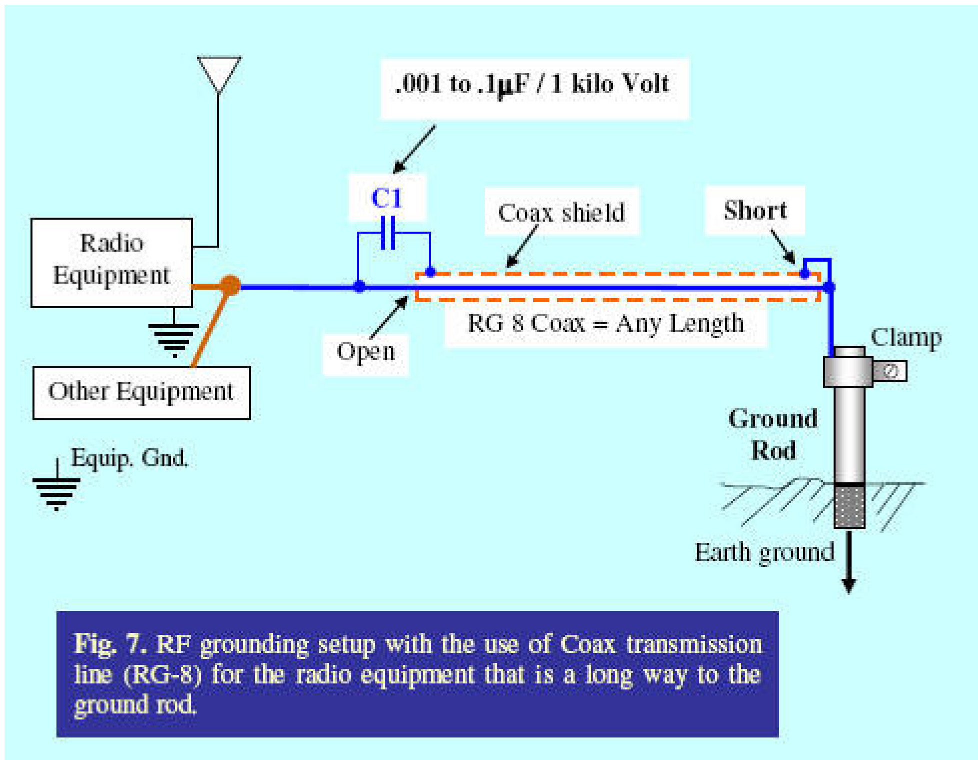

Figure 7.

Installation of the RF suppressor – Remove the existing ground wire and replace it with a length of RG-8 coax transmission line, enough to reach the ground rod and into the shack to connect to the ground bus. At one end, short (solder) the coax shield to the center conductor of the RG-8 and the remaining pig tail to be connected (soldered) to a short heavy gauge solid copper wire to reach the ground rod (See Fig. 7). At the other end, strip the coax to reveal the center conductor and remove part of its shield. Connect the center conductor to the circuit ground of the equipment. Leave the coax shield open at this end but connect a ceramic disc capacitor (Marked as C1 = 0.001 to 0.1 µF / I Kilo Volt). One terminal of this capacitor is connected to the coax shield and the other terminal to the center conductor (See Fig. 7). The RF suppressor ground system is now complete.

Of course the capacitor value is selectable depending on the lowest operating frequency band and length of Coax. The correct value is selected until RF disappears in the shack (at the lowest band). Or, when your lips doesn't get to be burned or electrocuted (when touching the metallic mic case) as you speak or transmit. However, YOU MUST USE A HIGH VOLTAGE CAPACITOR RATING, about 1KV minimum, but the higher the better. Otherwise, ZAPPP!!!, this capacitor will explode if a surge of high voltage standing wave will develop instantaneously at or above 500 volts at this terminal.

The circuit shown in Fig. 7 is an effective RF grounding setup. The author's shack is in the second floor and uses the same grounding system which has been in use since 1989 with no RFI in the shack even when the 1 KW linear amplifier is in use. DU1FLA/Estoy uses the same grounding system. We used a .01 µF / 1Kv capacitor for C1.

Principle of the RF suppressed grounding system – By inspection (see Fig. 7), the ground wire is enclosed effectively by the coax shield so no high voltage standing wave can buildup in this wire. However, since the shield is exposed and floating, a high voltage standing wave will appear at the outer surface of the coax shield. This voltage is Zero at the shorted end (ground rod terminal) and high at the open end. When you connect a capacitor between the high voltage end of the coax shield and the center conductor (See Fig. 7), the impedance of this capacitor is very low at the operating frequency, thus acting as a low impedance load (By virtue of its low reactance = Z, in Ohms) between the shield and center conductor. The RF current will flow easily through this capacitor and is diverted to the center conductor enclosed by the shield and finally to earth ground. The buildup of high voltage standing waves between the inside surface of external shield and the center conductor is suppressed because the characteristic impedance of the RG-8 is only 50-52Ω. And, the voltage drop across the external capacitor (C1) between the open end of the shield and center conductor is;

If C1 = 0.01 µF, then the reactance of C1 at 7.035 MHz is

$$X_C = \frac{1}{(2\pi)\ F \times C} = \frac{1 \times 10^{-6} \times 10^{6}}{(6.28)\ (7.035\ \text{Mhz})\ (0.01\mu\text{F})} = \mathbf{2.26\ \Omega}$$

Assuming that the transmit power is 100 watts. Therefore, the voltage drop across this capacitive reactance (2.26 **Ω**) is;

$$E = \sqrt{P \times Z} = \sqrt{100\ \text{W} \times 2.26\ \Omega} = \textbf{15.03 Volts rms ONLY!}$$

The combined parallel reactance of this capacitor and the total cable capacitance of the RG-8 transmission line will even decrease further the voltage drop. Also, as the operating frequency goes higher, the reactance of C1 will decrease. Hence, the voltage drop will be even lower. That is, as if the long physical length of coax ground wire is just about less than 1 meter long, electrically (See Table 1).

The voltage attenuation curve at higher RF operating frequencies above 7.035 MHz will in fact proceed at the rate of minus 6 dB per octave. This means, when the operating frequency is doubled (14.07 MHz); the voltage that exist across C1 will decrease to ½ the original amplitude. Further, because the center conductor of the coax line is connected directly to earth ground, it becomes automatically your electrical safety ground. How do you like that?

What we have presented and discussed dealt only on how we will keep out the troublesome RF energy near our equipment as far as ground loops and RF un-grounded grounds! But how we will make a good and effective RF earth ground to work with the antenna system during transmitting and receiving (Your system needs it whether you like it or not!) is another matter. In order to have an effective propagation for DX work requires a good RF earth ground setup. Merely having improved your equipment ground to earth ground is not a guarantee that you have also an effective RF earth ground….. Another fact!

Improving and or making a good RF earth ground to work with your antenna system is another topic that is not covered by this article. Similarly, to answer the anticipated question number 3 also requires a separate topic for another article. Dealing with numerous causes of RFI due to “near field effects” and gross exposure of ham equipment to high RF fields that are not caused by improper grounding systems, though somewhat related, is a separate subject. Available space does not warrant the extension of these topics but hopefully, these will be covered separately in future articles.

It is hoped that this article has enlightened the reader to understand the importance of effective grounding paradigms and, the facts and fallacies of grounding in ham radio. To make a shack RF free coupled with sound electrical grounding technique is a responsibility of the amateur operator to address the aspects of grounding when dealing with high levels of RF energy in the operating environment. Effective grounding of equipment is mandatory to address the issues of personal Safety, damage to sensitive equipment and prevention of severe RFI in the operating community.