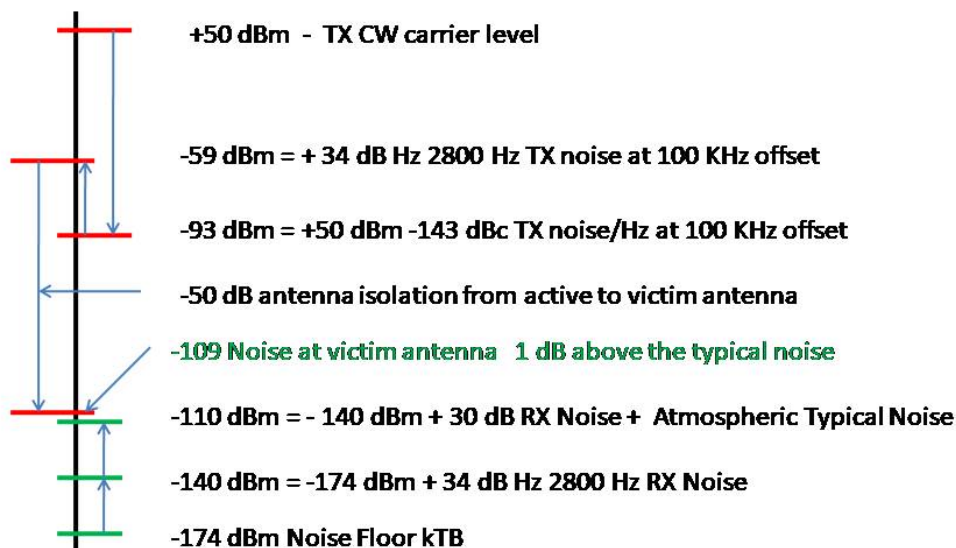


Field Day RF Interference Isolation Budgets

TX Noise and RX Blocking can be key limitations for inter-station interference for Field Day. RF Interference Isolation budgets between active TX and victim RX equipment are discussed in this paper. Placing dipoles end to end or Yagi's side to side are common and useful techniques to isolate antennas. For example, if two 40 meter dipoles are placed at 25 to 50 feet in height end to end, about 50 dB of isolation is achieved over average ground with 200 to 400 feet of separation of the centers. Detailed analysis and discussion on antennas, orientation and isolation including with EZNEC and AutoEZ modeling is discussed in other papers.

Achieving 50 dB of isolation between same band antennas for Field Day requires some planning and effort and achieving 60 to 70 dB or more is possible but is significantly more challenging. Without planning for antenna isolation, antenna isolations can be as poor as 30 dB or so, if 2 dipoles are placed relatively broadside, or if 2 verticals are used on the same band, for example. Actually measuring the isolation in the field with the antennas setup as planned is good practice. Several specific examples of TX noise and RX blocking budgets are considered here assuming 50 dB antenna isolations. George Cutsogeorge looks at RF isolation issues in his book: George Cutsogeorge, W2VJN, "Managing Interstation Interference with Coaxial Stubs and Filters".

K3S TX Noise Level Budget



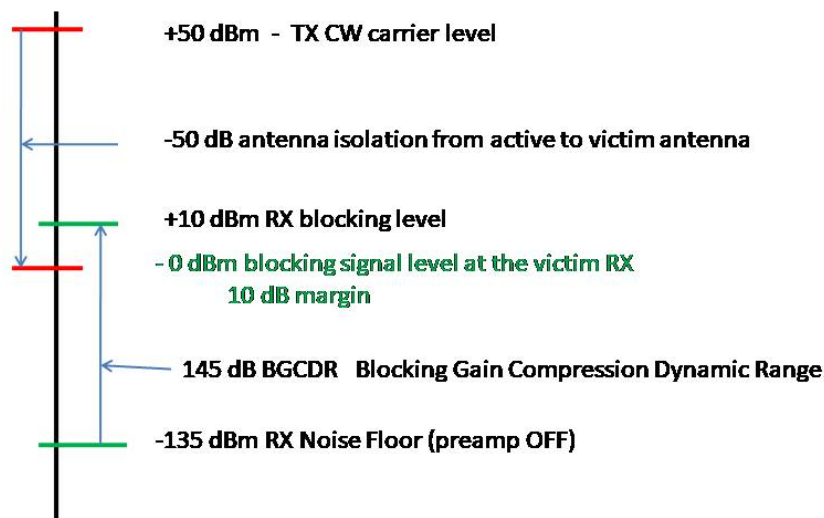
The Figure shows the TX noise signal level budget using Elecraft K3S rigs with 50 dB of isolation between an active antenna and a victim antenna. TX power levels of 100 Watts or +50 dBm are assumed. The victim RX is assumed to be on a frequency 100 KHz from the active TX. This might happen with a CW TX

active at about 7050 KHz and phone RX at about 7150. The noise from the TX at 100 KHz offset is calculated taking the measurement of -143 dBc/Hz TX noise which means -143 dB below the carrier or CW TX signal level measured in a 1 Hz bandwidth. This results in a value of -93 dBm/Hz for the TX noise at 100 KHz offset. Assuming the phone RX is set for 2800 Hz bandwidth, the total noise in the RX bandwidth is then calculated as -93 dBm/Hz + 34 dB Hz ($10 \times \log(2800)$) resulting in a noise level of -59 dBm which appears at the TX antenna. Given an antenna isolation of 50 dB, the noise which then reaches the RX is -109 dBm. Keeping in mind that this is based on a TX phase noise measurement, the total noise which reaches the RX may be somewhat higher.

Preferably the TX noise is lower than the noise which the victim RX sees from natural atmospheric noise. The fundamental thermal noise floor or kTB (Boltzmann's constant x Temperature degrees Kelvin x Bandwidth) is -174 dB/Hz. With 2800 Hz RX bandwidth, the noise is calculated as -174 dBm/Hz x 34 dB Hz or -140 dBm. The noise figure of modern HF rigs is generally only a few dB, but the atmospheric noise on 40 meters may be about 30 dB above kTB, so the rig noise is overwhelmed and it is ignored here. The atmospheric noise raises the RX noise to -110 dBm typically in a 2800 Hz bandwidth on 40 meters.

Considering the TX noise at the victim RX is calculated as -109 dBm, it is just 1 dB above the RX atmospheric noise level, and should not be a problem for Field Day. Some additional isolation would be good in this case, but there should be no significant problem with only 50 dB of antenna isolation.

K3S RX Blocking Level Budget



The Figure shows the RX blocking signal level budget for K3S rigs with the RX preamp OFF. The key RX metrics involved are the 500 Hz RX Noise Floor and the BGCDR (Blocking Gain Compression Dynamic

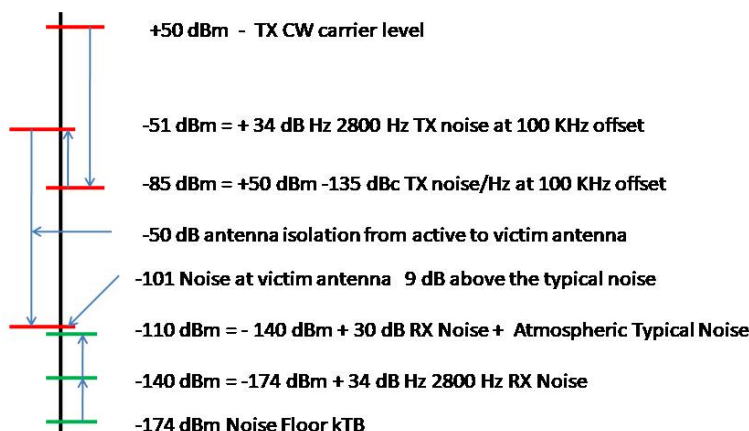
Range) which is defined as the blocking level minus the noise floor. The blocking level is expected to be largely independent of the RX BW, so the expected RX blocking levels in 2800 Hz RX BW is calculated as the measured noise floor in 500 Hz BW + BGCDR.

For the K3S RX, the noise floor in 500 Hz (with the preamp OFF) is -135 dBm, the blocking level is then calculated as -135 dBm + 145 dB BGCDR is +10 dBm RX blocking level. With 50 dB of antenna isolation and a TX power level of 100 W or +50 dBm, the signal level at the victim RX is 0 dBm. So, there is 10 dB of RX margin for blocking in this situation.

Overall the K3S would be expected to provide good performance with almost no inter-station interference problems due to TX noise or RX blocking for an antenna configuration with 50 dB of isolation which is quite doable for Field Day. Of course, if there is strong signal leakage between coaxes or due to ground bonding situations that bypass the antenna isolation, there can still be problems. Also, other issues such as interactions with generators or with data equipment,... can also cause problems.

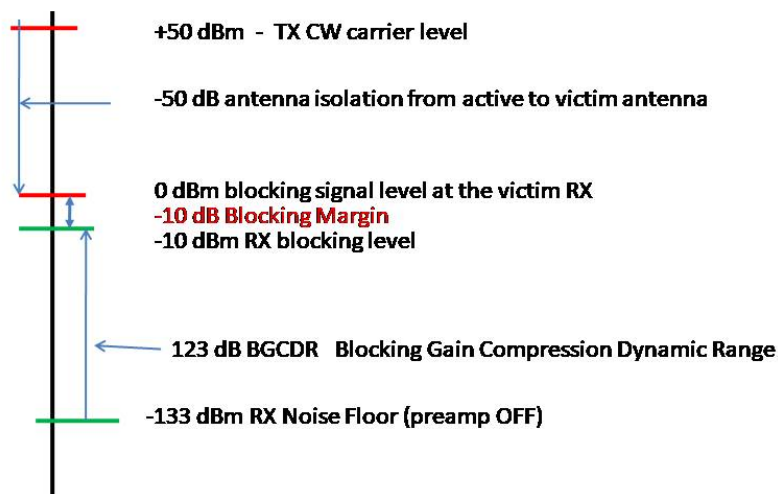
The behavior of TX noise and RX blocking should be understood to have some important differences. While the TX noise will generally be an additive interference where the noise gets progressively stronger with level, RX blocking can be more severe and non-linear as the TX inter-station interference levels approach the blocking level at the victim RX. Once the RX blocking level is past by an interfering TX, even very strong desired signals are likely to be unreadable. For this reason, maintaining good margins on the RX blocking level of at least 10 dB is desirable. It is desirable for TX noise levels to be below the atmospheric noise level, but if it is a bit higher, generally only weak desired signals will be impaired for readability. Disabling RX preamps is recommended also for Field Day inter-station same-band interference management.

7300 TX Noise Level Budget



The Figure shows the TX noise signal level budget using ICOM 7300 rigs with 50 dB of antenna isolation. Going through the calculations, the TX noise appears at 9 dB above the atmospheric noise.

7300 RX Blocking Level Budget



The Figure shows the RX blocking signal level budget using ICOM 7300 rigs. The calculations with 50 dB of antenna isolation shows a 10 dB gap for RX blocking, and severe interference would be expected unless attenuation is added to the RX front end or other measures are taken to protect the RX.

Increasing antenna isolation to about 70 dB is suggested using 7300 rigs for Field Day. The 7300 generally provides great performance, but the RX blocking and TX noise are limitations for Field Day same-band operations. However, 70 dB of isolation may not be easily achieved for same-band operation. If same-band operation is not used, and good bandpass filters are used, then 7300 operations should work well. If same-band antennas and rigs are separated by 600 to 900 feet combined with end-to-end or cross-pol antennas, interference can also be managed. Other measures include using USRX (Ultra-Sharp Receive) filters or very sharp pre-selectors which can separate signals only about 100 KHz apart in front of the rig using very high Q multi-stage notch filters or using external tunable pre-selectors with high Q.

Also high end rigs with SDR RX architectures will generally be more prone to RX blocking for FD. The trend by all the major manufacturers is to use pure SDR RX architecture with BGCDR ratings between 120 and 130 dB or 10 to 20 dB less than traditional high performance superhet rigs or rigs with hybrid SDR architecture. This suggests that RX blocking is likely to become more problematic for FD groups. Measures taken to protect and adapt to blocking with SDR receivers with preamps OFF can be useful, although they increase RX noise figures and sometimes considerably. Besides improving antenna isolations to about 70 dB, the use of high Q external pre-selectors and/or USRX filters can help address

these problems on FD where same-band interference levels can be very strong. Elecraft's K4 with an SDR architecture RX has similar RX blocking issues, however, an K4HD module is available which adds essentially a K3 RX front end with narrow crystal IF filters. The ICOM IC-7610 incorporates a very sharp digi-preselector which helps. It can provide about 20 dB of attenuation between 7 MHz and 7.3 MHz on the 40 meter band, but from 7.050 to 7.200 KHz between a typical CW and phone signal, it may be limited to 6 to 10 dB. The Yaesu FTDX101D and the FTDX10 continue to be available with IF filters, and the Kenwood TS-890S and the TS-990S are available with IF filters. The FTDX101D and the TS-990S have IF filters and they also have sharp preselector filters, but these preselectors provide limited attenuation of interference with only 100 to 200 KHz of separation. But the most recent rigs appear to be all SDR without IF filters.

CW key clicks can be a problem for FD, but generally this will affect operations fairly close in frequency. Digital and SSB TX modulation can cause problematic spectral splatter if a TX is overdriven. Also the RX RMDR (Reciprocal Mixing Dynamic Range) may be a limitation, but this is usually a factor only for signals within 20 KHz or so of a desired signal for newer rigs since front end phase noise has improved significantly. These possible inter-station interference issues are not considered in detail here as they are generally problems for very close inter-station interference baring poor performance rigs. With GOTA rigs and main rigs on the same band and CW to digital rigs on the same band, CW key clicks and RMDR are more likely to be factors. Analysis similar to TX noise and to RX blocking may be performed to address these factors. But also, on the bench testing using attenuation from a TX to a victim RX equivalent to expected antenna isolation in the field or measurements with antennas setups in the field are good practice to avoid surprises on FD and to take any corrective action.