Reducing Electronic RF QRM

By G8MNY (Updated Aug 07)

(8 Bit ASCII Graphics use code page 437 or 850)

There are 3 principles to removing QRM & 1 for putting up with it.

1/ Stop the RF being generated at the source. RFI Enforcement?

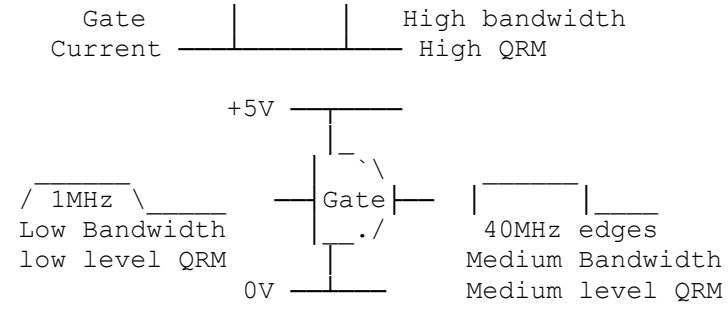
2/ Stop Source RF from radiating.

3/ Stop Rx system seeing the RF QRM.

4/ Living with it.

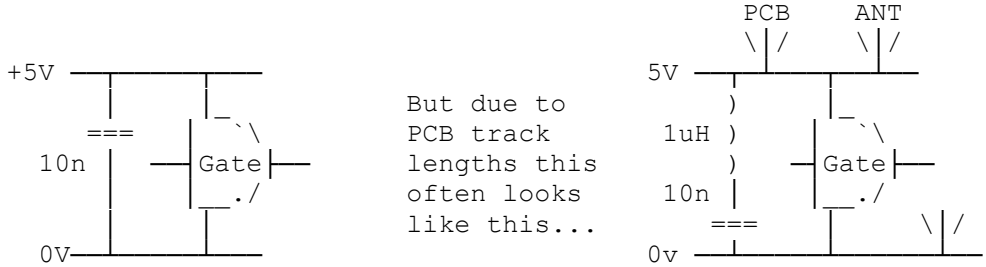
1/ In electronic systems the use of radio frequencies is common, but the need for wideband signals is less common.

Lets look at a logic gate that runs at 1MHz but uses a fast 40MHz totem pole output stage. This produces a high current power rail pulse @ > 120MHz on the switching edges.



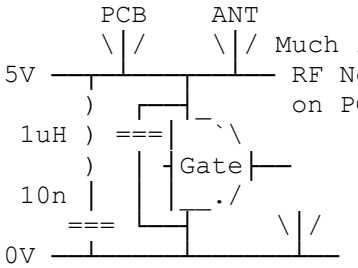
The output fast edge shape is often wanted, but power rail noise is not.

Filtering is normally provided on the power rails to provide an on PCB path for these high pulse currents..



One cure is to put a C directly across any noisy ICs, these can identified by scopeing the power rails on a PCB looking for the worst RF noise sources.

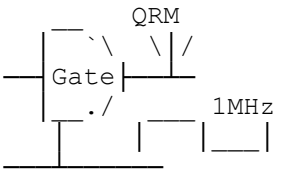
Then putting a Cs (surface mount?) across the power pins without loads of track en-route.... Cs of 10n-10u in the right place can make a huge difference to power rail noise radiation.

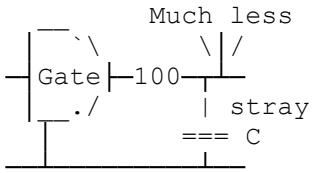


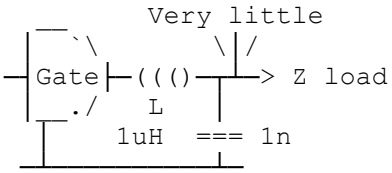
It is not usually possible to add extra L to the PCB power rails to help the decoupling.

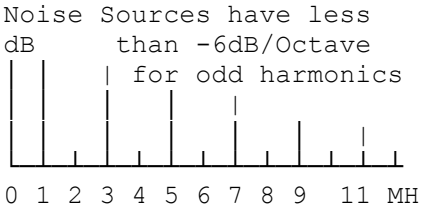
Data bus radiation is more difficult to cure as there are more lines & the RF power level is normally quite low from any particular line.

But filtering of a R or LC is sometimes effective (e.g. on a PC printer port), but both type must consider the timing delay & loss & any undamped resonance on the data line.









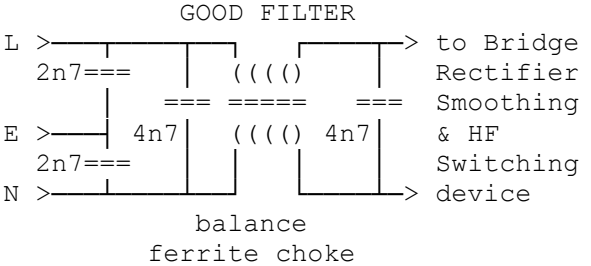
With R C the RF Harmonics drop @ 12dB/O after -3dB point where Xc=R

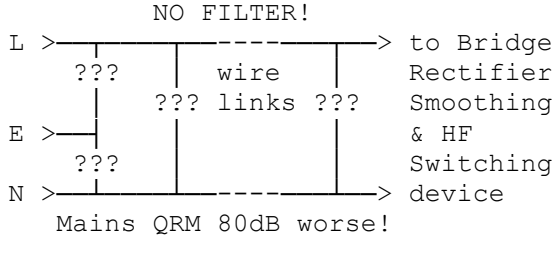
With L & C the Harmonics drop @ 18dB/O after the damped resonant Freq.

The actual radiation from PCB track is proportional to the frequency in addition to any resonant track. So a 1MHz square wave may be very weak at 11MHz as the PCB track length is very small compared to a 1/4 wave, but radiate quite loudly at 50 to 144MHz where the track becomes a good aerial.

These principles also apply to SMPSUs as well as TV/Monitor Line stages, just that it is very difficult to apply in those high power cases.

Quite often to save money makers drop the use of RFI components in mains SMPSU. eg. they have bought in GREY illegal imports of unfiltered SMPSU, & put them in their PCs etc. hoping no one will notice! If you have a look look inside one of these offending PSU's you will see the straps that bridge out the missing C-L-C mains filter.



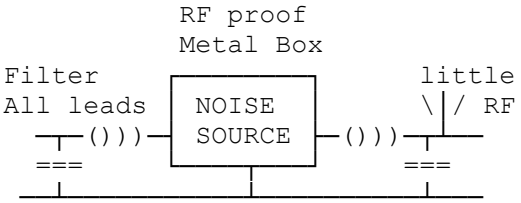


As the ferrite & mains rated caps are relatively expensive, quite a saving

is made. But as the main smoothing capacitor ages & dries out, its' ability to suppress HF on the HT rail is greatly reduced & QRM levels reaching the mains can only get worse! Some SMPSU carry on working fine with no mains smooth!!

If your track down a new example of this practice, your local radio administration/RFI enforcement body should be informed, & if they are on the ball (some could not care these days) a prosecution could result.

2/ Applies the last filtering principle to the whole noise source..



You can see this approach used on all PCs nowadays in an attempt to meet not very stringent the RFI laws. Ferrites are used on all leads close to any noise source box to reduce (but not eliminate!) any currents flowing into the leads & reduce them acting as aerials.

Full screening is often not used due to dangerous voltages screen needs to be see etc. But it may also be left off due to cost, & design / aesthetics / sales considerations. e.g. a metal box around an RF economy lamp. :-)

For TV -> HF QRM, consider the UHF aerial system as a HF aerial, put a HF braid breaker in the aerial & ferrites on the mains lead etc. as these filters work both for Tx & Rx QRM.

If QRM source items in 1 or 2 are not yours, then modification can be risky & unadvisable!

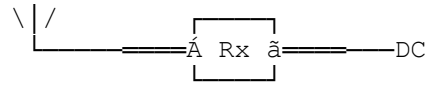
I have heard of hams with interference cases, who are prepared to buy a neighbour a brand new TV etc. to solve the problem. But note well, modern items can be a lot worse than some older designs! eg. low voltage 12V lighting now uses 80kHz 150W square wave power inverters with radiating unscreened leads, rather than a straight forward 50Hz transformer!

3/ Reducing the QRM seen by the Rx can be simple or hard to achieve depending on the location etc.

a) If it is yours, turn the QRM source off. (TV / PC / RF lamp)

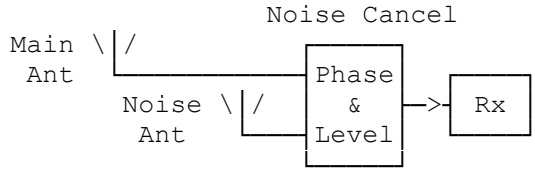
b) Prove the path of the QRM to the Rx, eg. not 12V pick up/mains pick up. Put the Rx on battery, or via wound up extension lead to test. If not down the aerial, then filter mains/other leads.

For UHF/VHF QRM try braid cover leads of 1/4 wave long bonded to Rx earth.



c) Increase the distance from Rx aerial to the QRM source. Move TV/ Aerials. True RF fields die away @ the square law e.g. 6dB per doubling distance. But near fields with transformer/stray capacitance coupling like TVs timebase etc. obey a cube law. e.g. 9dB per doubling of distance.

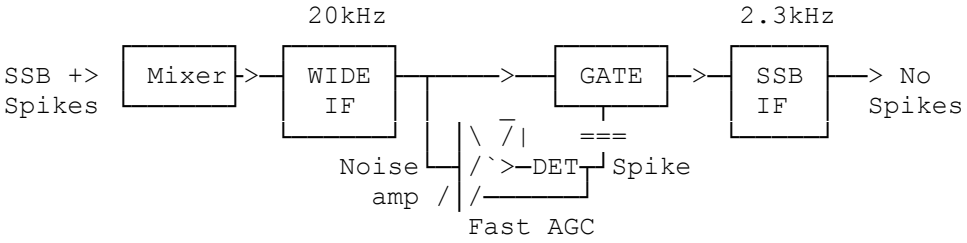
d) If QRM is steady & only from one source, it can be nulled out with a 2nd aerial & phase/amplitude system.



4/ Operate when the QRM is not there. Operate on bands/frequencies unaffected.

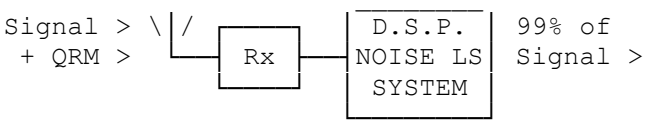
Or filter it out after/in the Rx.

Impulse Noise gates or blankers were the 1st attempt to do this, they remove car ignition & spiky mains noise quite well on SSB mode.



The noise amp AGC is fast enough (300uS) to follow a single SSB voice envelope, maintaining a fairly steady RF signal. When a wideband spike occurs the rise time is too fast & it produces an AGC spike that is used to turn off the IF gate to the narrow SSB filter. The result is very narrow holes (e.g. 1mS) in the audio rather than loud clicks, that could also have turned the Rx AGC down as well. Drawbacks are if there are too many stations in the passband or big signals (e.g. contests) the noise amp miss operates the gate making signals break up or sound very wide.

Try a modern noise DSP processing in or after the Rx, as much of some types of QRM can be 99% removed without too much loss of intelligence in the Dx signal underneath. One external "add on DSP LS system" I tested with a steady carrier noise was reduced by 65dB automatically at the max noise reduction setting, or 35dB for more broadband noises.



It works by digitally analysing the AF spectrum into 100s of narrow frequency bands, with an "FM noise squelch" system on each one, deciding if the signal in the band is significantly above the noise to let through. If the level on any band has not changed after 2 seconds ignore that band.

The drawback is that a voice with high levels of noise will sound like a nasty cellphone call at high noise reduction levels, as the voice pitch to allow through may be the wrong one!

When living with QRM, remember that our hobby is just a good a pastime a any other. So you don't have to put up with it really. If you can, get help to get the problem sorted. Try an intermediary, local radio club, radio authority, other radio users affected? (e.g. police, ambulance, aircraft, broadcast bands etc). This can all help if you can find the right person to take up the case.

However Andy g0ftd reminded me that this hobby is protected by:-

DIRECTIVE 2004/108/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 15 December 2004 on the approximation of the laws of the Member States relating to electromagnetic compatibility and repealing Directive 89/336/EEC.

Where Amateur radio is _specifically_ mentioned/protected.

Why don't U send an interest bul?

73 de John G8MNY @ GB7CIP