## Interference and Suppression  B-008 Series Questions

It is important for the radio amateur to understand the various sorts of the interference that may be caused by the operation of an amateur radio station.  Once understood, solutions can be applied in the way of filters and installation techniques that can mitigate the problems.

## Radio Receiver (Front End) Overload and Desensitization

Radio receivers that are in close proximity to a radio transmitting station may experience the unintentional overload of the front end stages (RF amplifier and mixer) to a very strong radio signal even though the receiver may be designed to receive frequencies far different than the nearby radio transmitter.  The nature of the interference to the desired receiver reception may be a slight desensitization or a total blockage while radio transmissions are being made and may not necessarily influenced by the exact transmitting frequency within a particular band.   **See Questions B-008-01-001, -002, -003-005 and -009 .**

If operating your HF transmitter causes front-end overload interference to the off-air reception of VHF and UHF channels on your own or a neighbour's television receiver, a High Pass filter applied to the television set's cable input connection may remedy the problem.  The high pass filter is one designed to allow TV frequencies above 54 MHz to pass through unimpeded while highly attenuating HF frequencies below the TV band.  **See Questions B-008-001-004  and B-008-005-007 and -010**

**Picture of Inline TV cable HighPass Filter**


**Intermodulation Interference**

- When two or more radio signals mix together often within the receiver RF amplifier stage, their beat frequencies products can be on the desired reception frequency of your radio receiver. Sometimes, even the harmonics of signals come into play with the fundamental of another signal to produce “intermod” interference. This type of interference is particularly evident on the amateur 2 metre FM band in urban areas where there is a multitude of other commercial signals present just below and above the 144 to 148 MHz amateur band that mix and cause undesirable signals to be heard. **See Question B-008-001-004**

- When intermodulation interference is caused by mixing other signals within your radio, the solution is to block the offending signals from entering the receiver by using an appropriate band pass filter. **See Questions B-008-001-010 and -011**

## Examples of the mathematics of Intermodulating signals that may cause interference to desired reception.

**3rd Order intermod interference product with two VHF frequencies A and B causing interference to desired frequency of reception D.**

**Example of possible 2 interfering signals:**

**2(A)+ or – (B) = D(desired reception frequency)**

**(A) = 152.030**
**(B) = 156.160**

**(D)= desired reception frequency**

**2(152.030) – 156.160 = 147.900**

**- OR -**

**3rd Order intermod interference product with three VHF frequencies A and B and C causing interference to desired frequency of reception D.**

**Example 3 interfering signals**

**(A) + or – (B) + or – (C) = D(desired reception frequency)**

**(A) = 149.500**
**(B) = 155.670**
**(C) = 157.270**

**A = 149.500 + 155.670 – 157.270 = 147.900**

**In these examples above, 147.900 is the actual input frequency of amateur repeater VE3TWO and the above represents the possibility of 3rd Order intermodulation products from land mobile transmitters that may cause interference to the repeater if all were transmitting at the same time.**

## Audio Rectification

- Audio Rectification is a type of interference that is usually associated with AM modulation where an Amplitude Modulated radio signal can be detected and clearly resolved by radio receivers or even detected and heard within non radio receivering equipment such as audio public address systems, or HiFi (and stereo) sound systems. Audio rectification has even been known to happen in hearing- aids and church electronic organs in the presence of nearby radio transmitters and their antenna system. Land-line home telephones are also susceptible to audio rectification interference.

- Audio Rectification in a radio receiver is likely not influenced by tuning the radio dial to different frequencies and may or may not be affected by the volume control setting. **See Questions B-008-002-006 and -007 .**

- When detecting SSB, audio rectification interference sounds like a muffled voice and is not clearly discernible and when detecting CW Morse code, sounds like clicks or a thumping sound. **See Questions B-008-002-003, and -004**

- Audio Rectification is usually the ingress of strong RF signals **directly into the audio sections of receivers or non-radio audio amplifiers system such as a PA system or computer speakers**. The RF signals are detected by rectification from the diode action of active components such as tubes, transistors or diodes.

- The solution is to reduce the "conduction" of RF energy into equipment by the various wires and cabling in and out of the affected equipment. This includes power cables, long speaker wires, telephone lines and control lines all of which can act as antennas. Such cabling should be kept to a minimum in length if possible. **See Question B-008-002-009 and -011**

- Without being intrusive into the internal circuitry of equipment prone to audio rectification interference, exterior cabling acting as an antenna can be looped through snap-on ferrite cores close to the equipment cable entrance; these devices add considerable inductance to the cable and therefore inductive reactance stopping the flow of RF both in and out of the equipment. **See Question B-008-002-001, -008 and -010**

**Snap-on Ferrite Cable Chokes adding “common mode” inductance to existing cabling acting as an antenna.**


- A Home Phone may also be susceptible to audio rectification interference; suppression is a matter of RF de-coupling the telephone line (which can act as long antenna) from the telephone equipment. **See Question B-008-002-002** This can be accomplished by adding an in-line RF filter like the one shown here:

- To counter the possible radiation of signals directly from the station equipment causing audio rectification or other interference to your home electronic equipment, it is wise to have **good direct grounding** of all station equipment.

**Spurious Emissions from Transmitters.**

- Amateur Radio equipment that we buy in Canada and approved for sale in the USA must be tested and meet the requirement of **not having spurious emissions** (unwanted signal output) above a level that is at least 43 dB below the fundamental carrier output for HF equipment, and at least 40 dB below the carrier for VHF/UHF equipment having less than 25 watts RF power, and at least 60 dB below carrier for VHF/UHF equipment greater than 25 watts RF power. Therefore, modern commercial equipment we use in the amateur service is generally pretty clean and free of excessive spurious emissions that can cause interference to other radio services.

- **Spurious emissions can result from harmonics** of the fundament signal or **parasitic oscillations in an unstable transmitter RF amplifier** or other internal sources of the transmitter as well as interference from non-linear operation of the transmitter.

## Harmonic Spurious Emissions

- The main source of transmitter spurious output **used to be** harmonics (multiples) of the fundamental frequency of the transmitter which could result in interference in other HF amateur bands, most of which are harmonically related. **See Question B-008-004-004 and -005.**

- Generally, excessive harmonic output is generated in transmitters by overdriving stages into non-linear operation. This may be intentional or not in the design of the transmitter. **See Question B-008-004-009 .**

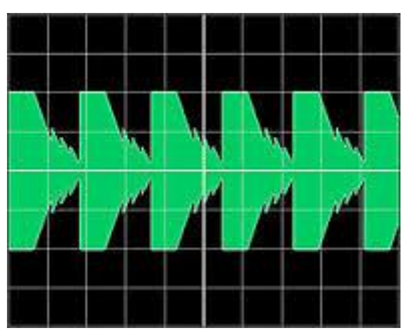
- Harmonic interference was also a major source of interference outside the ham bands and especially to VHF television or broadcast FM reception. This was generally suppressed by adding a **"low pass filter"** at the transmitter output that would effectively reduce the transmitter harmonic output above 30 MHz by a least 40 dB. **See Questions B-008-004-001, 002, 003, and 010 and Questions B-008-005-005, 006 and 011**

- The low pass filter impedance for the HF pass frequencies shown above (previous page) is approximately 50 ohms; this is the **same as the coaxial cable** used to connect device between the transceiver and the antenna system**. See Question B-008-005-004**

- Modern amateur radio transmitters are mandated not to have excessive harmonic spurious output and therefore have built-in band pass or low pass filtering. External low pass filters are now rarely needed. **See Question B-008-005-002**

- Radio transmitters where the RF power amplifier is driven into non-linear operation can result in excessive harmonic output from **"flat topping"** of the RF envelop, this is often a result of excessive modulation drive conditions by **excessive level of the microphone gain control. See Question B-008-004-008**

  **"Flat Topping"**



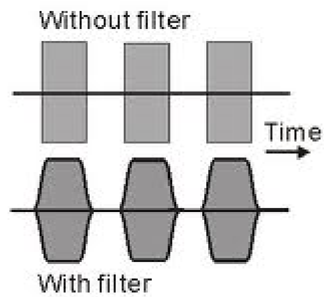
- **Over modulation of a voice transmitt**er can also cause what is called **"Splatter Interference"** where the signal occupies a much greater bandwidth than normal causing interference to adjacent frequency users when the offending station operator speaks loudly.  **See Question B-008-004-006**

## <u>Parasitic Oscillations</u>

- Parasitic oscillations can occur in the RF amplifier output stage when what is supposed to be **<u>solely an amplifier</u>** stage of the transmitter also becomes a very **unstable RF oscillator** at a frequency not controlled by the transmitter frequency stability circuits. Such spurious output can have an RF frequency output that typically wonders around causing interference to other radio services above or below your amateur band of operation.   To counter the tendency of parasitic oscillations, RF amplifier stages often required special oscillation **<u>neutralization</u>** circuitry and adjustment.  **See Questions B-008-003-009, -010 and -011**

## <u>CW Key-Click Interference</u>

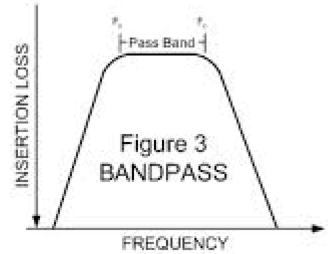
- When the shape of the keyed CW waveform has a too fast rise time, the  bandwidth of the transmission will be excessive; this will cause interference to adjacent frequency users of band.  Proper <u>keying circuit filtering</u> of the transmitter is the solution to the problem; this is now incorporated into most modern transceivers.  **See Questions B-008-003-001 and B-008-003-006, 007 and -008**



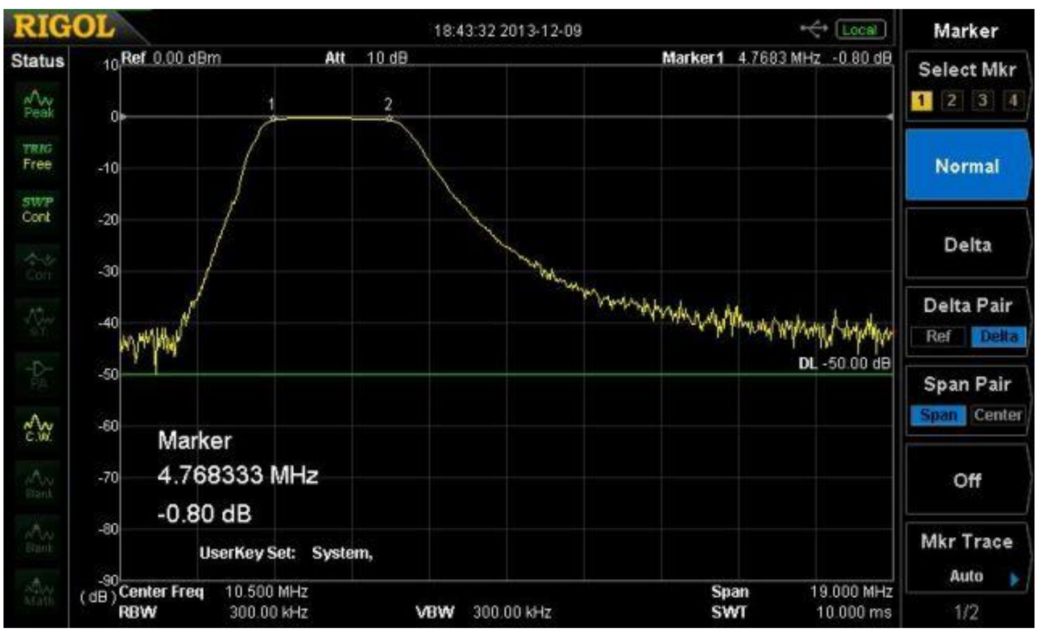

- Another type of key click interference **not associated with the keying waveform** may be the result of significant current being switched ON and OFF at the contacts of the Morse code key. This can result in **sparking** at the key contacts causing, in turn, a **clicking interference** to a local AM broadcast or shortwave receiver in the same premises. This is rarely a problem with modern equipment that do keying at very low current levels. **See Question B-003-003-005**

## Radio Frequency Filters

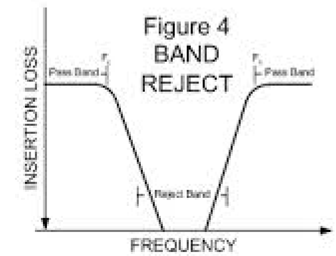
- Most transceivers have a common Band Pass filters for receiving and transmitting for the various frequency allocation of operation. A bandpass filter is one that blocks RF energy at frequencies above and below the bandpass frequency response. **See Questions B-008-005-003, -008 and -009**



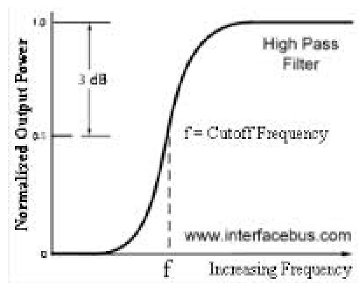

Spectrum tracing shown below is of an actual bandpass filter in a HF transceiver.



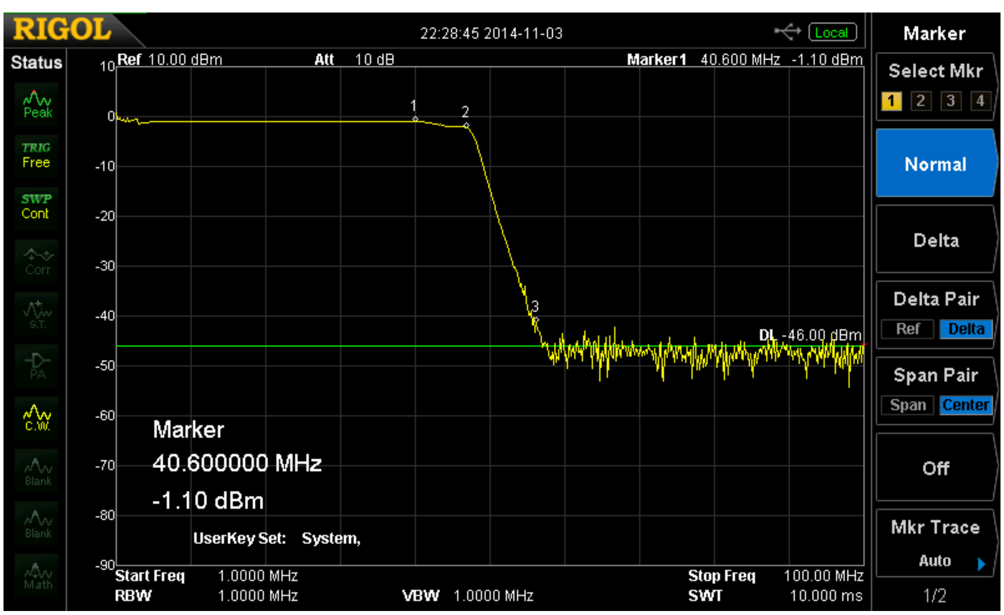
- A band reject filter is the opposite to bandpass filter; it will pass frequencies above and below the reject filter frequency response bandwidth. **See Question B-008-005-009** . The response curve of a band reject filter looks like this:




- A high pass filter will pass high frequencies but reject low frequencies; here's the response curve:




- Response curve of an actual Low Pass Filter used to reduce harmonic output of a HF amateur radio transmitter:



**ISED document EMCAB-2 "Criteria for Resolution of Immunity Complaints Involving Fundamental Emissions of Radiocommunications Transmitters"**

- We touched on this Policy document as part of Regulations and Policy part of the course.

- When it comes to interference caused by the fundamental emissions of a radio transmitter which can cause such interference as receiver front-end overload and audio rectification, the determination of responsibility is a matter of the amount of radiated RF intensity in the environment around the equipment that is suffering interference. The criteria is set by policy document EMCAB-2, that being **1.83 Volts / metre for a broadcast receiver** and associated equipment and **3.16 Volts / metre for other equipment**. If the RF intensity is below the criteria levels, the interference is a lack of immunity in the design of the receiver or other equipment and not the responsibility to radio transmitter operator to make any changes to their station equipment.