Pete Erskine's RF Coordination for Roadies

Frequency coordination is a process. Follow the steps and it's easy.

The need for coordination is because the wireless mics, ears and guitar transmitters mostly operate in the UHF TV bands – which are currently channel 14 to 51 in the USA and 21 to 59 in Europe. Every location has different channels actually in use and it is imperative to avoid picking frequencies, which are on or near these TV stations. First of all it's illegal to interfere with the TV broadcast (which really doesn't happen because they are so much more powerful than your puny wireless mic) and more importantly, the mic won't work well for you. You could however interfere with a nearby television set attempting to receive a distant over the air station. This should be avoided.

Often you can get by just setting your systems to any clear frequency which is separated from all your other wireless and the TV stations. Typically a user will just turn on their receiver, see if it's on a clear channel (no RF showing on the meter) and then set their transmitter on that freq.

However the process listed here will give a better result in the end. This manual uses these tools:

1. The software program by Professional Wireless is called Intermodulation Analysis System which costs $550.00. The software has a database of most wireless equipment and their frequency bands. It calculates the frequencies based on avoiding intermodulation products. The icon says IMD even though the program name says IAS. In this manual we will call it IMD.

   A good white paper on the basics of intermodulation interference and simple calculations was written by James Web from NASA, "What is Intermodulation Interference"

2. Rhode & Schwartz FSH3 Spectrum analyzer costs about $7,000.00 in it's basic configuration. It's better to get it with a built in preamp and a tracking generator for RF tests and adjustments (the model .23)

   An inexpensive Spectrum analyzer is the TTI PSA Series2 for about $1400.00.

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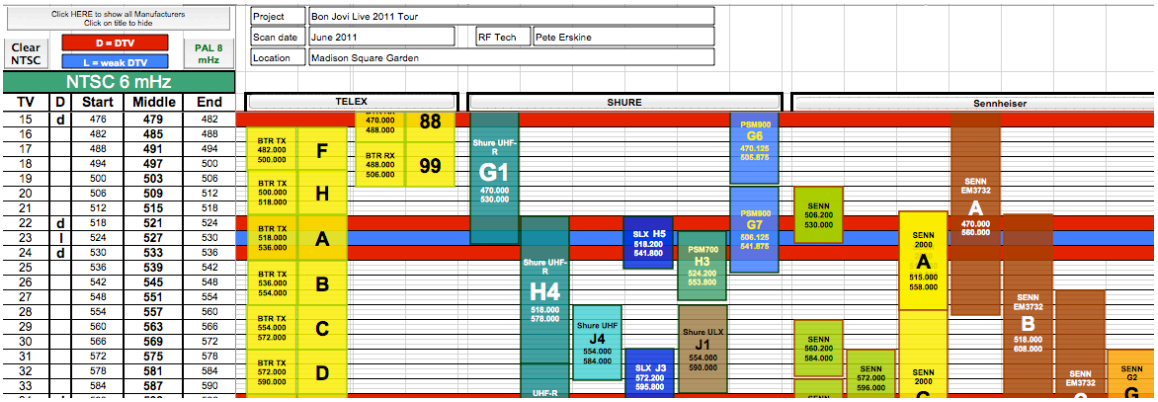
3. The "CHANNEL GUIDE" which is FREE is a basic frequency and channel reference. Listed on the page are many manufacturers and their programmed standard groups. Your scans from the local venue can be entered and you can easily see what RF bands are affected.



I. Basic steps – create the basic file:

A. Scan venue for TV stations in use
B. Enter as generic, in a separate ZONE, other nearby wireless mic/com/IEM transmitters
C. Select equipment freqs in IMD software
D. Label frequencies with function names
E. Examine each freq closely for interference on the SA
F. Program Ear transmitters and walk test – adjust if it doesn't work.
G. Program Intercom Base TX and walk test.
H. Program Intercom Beltpacks RX, Mics and Guitar systems.
I. Review each freq while all are turned on – kill each TX one at a time and look underneath for intermod peaks. This is called war gaming.

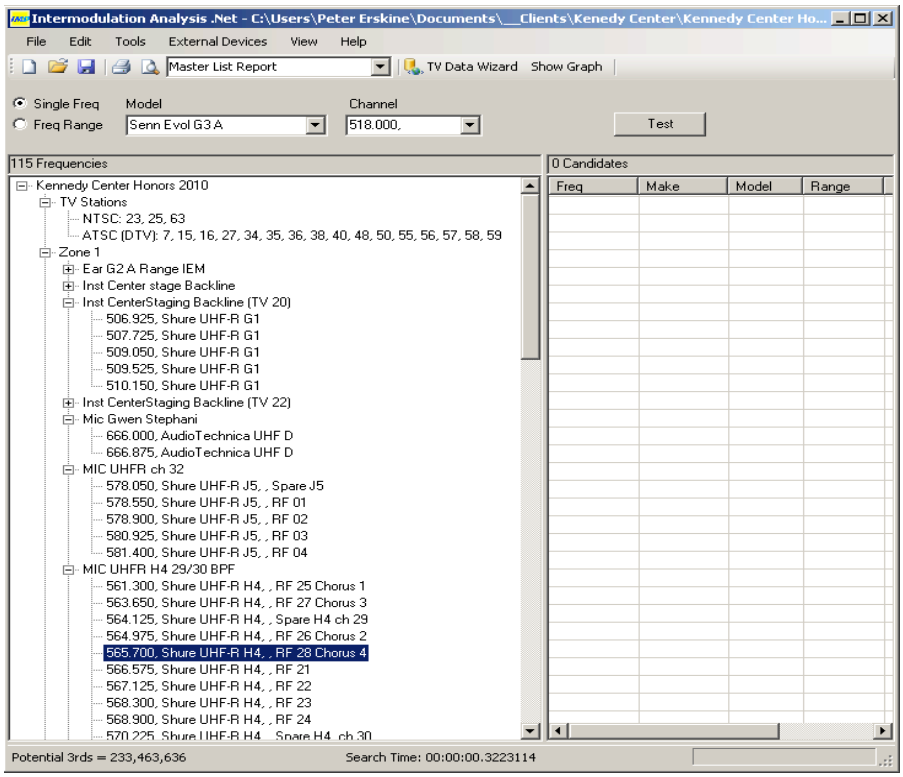
II. Repeat shows in a different venue:

A. Open your last used IMD file
B. Rename it with your new venue name.
C. Change the title line as well.
D. Scan TV channels and change them in the TV station screen
E. Select most stringent Options and select **Recalculate all freqs**
F. If any are RED (cannot find a freq) lower the Option stringency and recalculate just that one freq.
G. Continue with section I.D above.

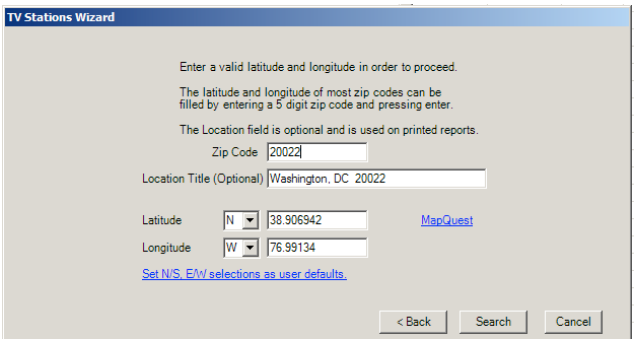
III. Long explanation:

1. In IMD, use the TV data Wizard to find the TV stations for the address of your venue by entering the zip code. Be sure that the data is current as downloaded from the FCC website via the IMD program. Note that this information is not usually totally correct. If you are not onsite this is the way to start, however if at the venue, I rely on on-site scanning and do not use the FCC database. *(you can also get the lat/lon of the venue from Google Earth and use the FCC's Media Database.)*

   This is the IMD program screen with some frequencies already selected.

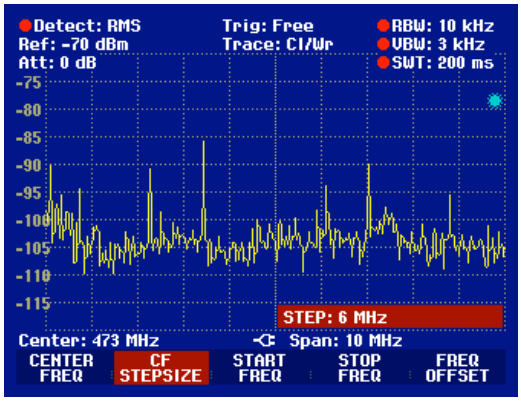


The TV stations wizard starts with the entry of the local zip code.



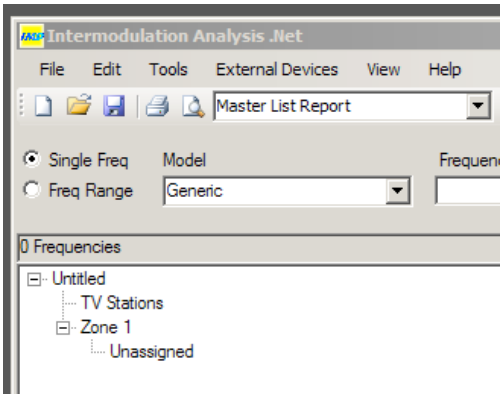
2. Scan TV channels manually at your venue performance location for the most reliable information.
    a. On the R&S FSH3 spectrum analyzer I set the screen for a 10 mHz span window and **<u>Center frequency step size</u>** of 6 mHz. This will shift the window 6 mHz each time you press the up arrow. Select the center of channel 14, or 473 mHz or channel 21, 474 mHz in Europe with a step size of 8 mHz. Set RBW to 10kHz for better resolution, preamp on if available. Inside metropolitan locations where there are a lot of RF sources, the preamp might give too much information. Try it both ways, pre on for detail, pre off fo the most strong signals only.

    This is the start screen for a scan at channel 14. It shows a high noise floor and several channels occupying the span already.



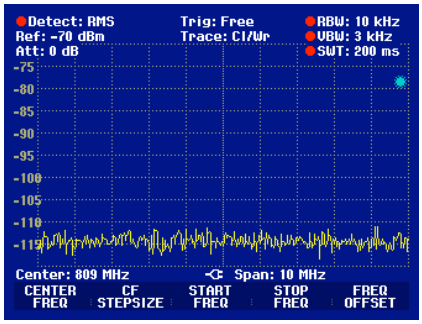
    b. Start the IMS software and select a new coordination file. Save your file with the show name. You might also enter the name within the file which will display it in printouts.

    c. Double click on the TV stations to open the checklist.

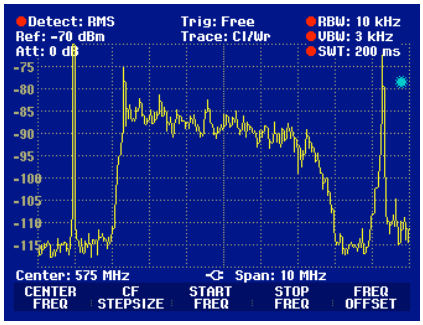


d. Step thru all TV channels using the up arrow key.

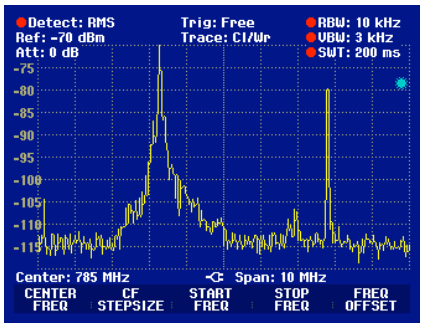
i. A clear channel looks like this. Not much but a very low noice floor. The display is set for a span of 10 mHz which will show an entire TV channel.



ii. A DTV channel like this. It resembles a box which is 6 mHz wide (here in the USA). This shot shows other RF channels to the left and right as well.



iii. An analog channel looks like this. The large peak is the video carrier and the peak on the right is the audio carrier. The small bump to the right of the video is the color carrier.



iv. Weak DTV can also be a problem, however if it is very weak you might still be able to place frequencies there. The effect will be noticeable by limiting the distance a frequency can be reliably received. If your receive antennas are close to the transmitters you can live with a higher noise floor or a weak DTV station under it.

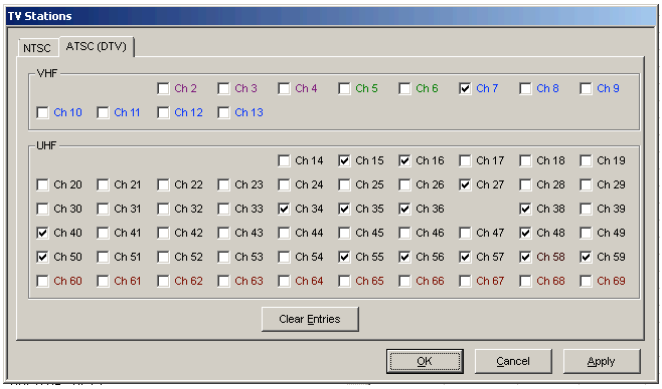
e. As you find the channels, check the boxes in the IMD TV station list.

There are separate tabs for analog and DTV.

Selecting an analog station will tell the program to include the channel in its intermod calculations and will also allow channels to be inserted within the analog channel in the empty spaces.

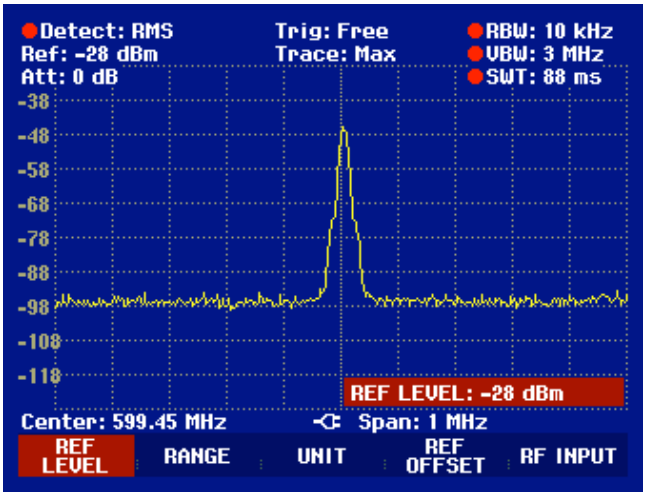
Labeling a channel as DTV totally excludes frequencies in that section except for the very small guard band between DTV stations. Occasionally the IMD program will suggest a channel at the guard band between two DTV channels. If the DTV is not too strong this might work.

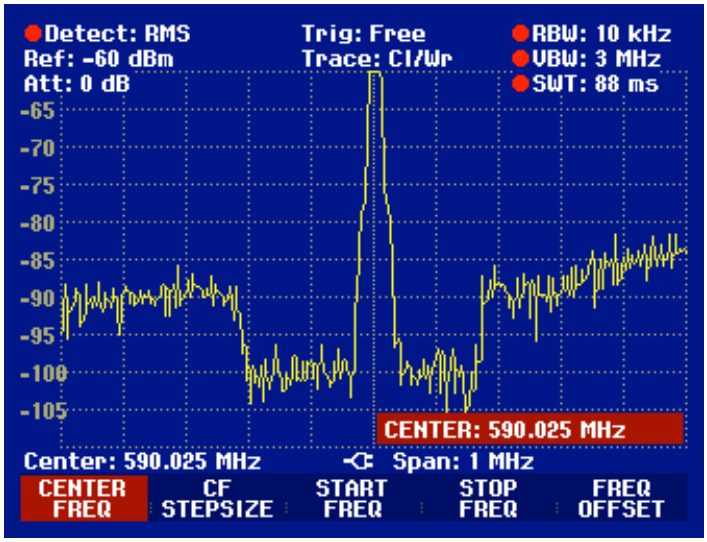
f. Save your file



3. Set the SA to monitor individual frequencies. Set the span to 1 mHz to get a close up view of the area around a specific frequency. Each division will be 100 kHz. Typically you want the area to the left and right of a frequency clear for 300 kHz or 3 divisions. A clear channel will look like the picture in III.2.d.i above. Enter each frequency and look at their detail.

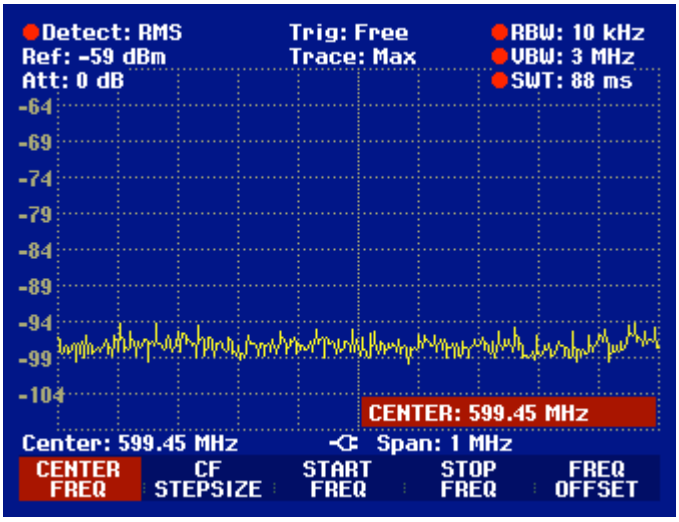
An individual frequency with the transmitter on in a clear area will look like this:





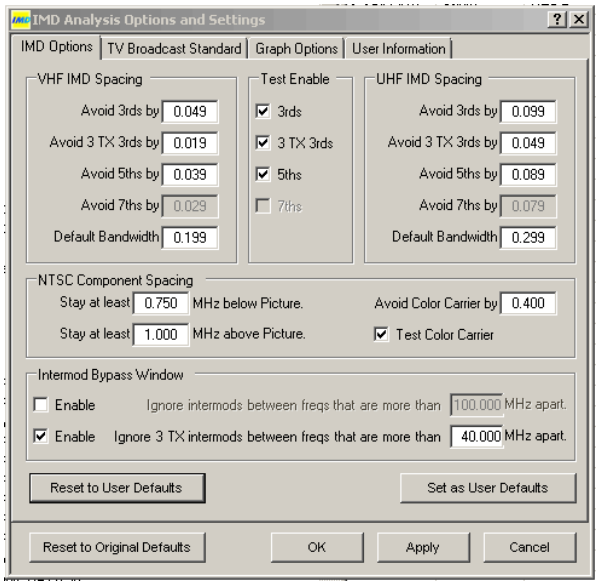
A frequency in a noisy or DTV area might look like this: The interference to the left and right is very close but might be usable. Usually I like to see at least 200 or 300 kHz on each side. This channel has 200 kHz below and about 175 kHz above. Not the best situation but it might work over short distances.

This is what you would like it to look like before the transmitter is turned on and what you check for each time you pick a frequency.



4. The Screen **Tools>Options** sets the kind of calculations the IMD program will use. Using this screen you can set the program to be very stringent in intermodulation calculations or just check for frequency separation and do no intermod calculations.

   This setting, shown has a check mark in the ignore section for triple frequency IM which will ignore calculations which have intermod further than 40 mHz from the channel. This allows a better possibility to find frequencies. The selectivity of your receiver(s) front end(s)will dictate how much frequency separation will work.

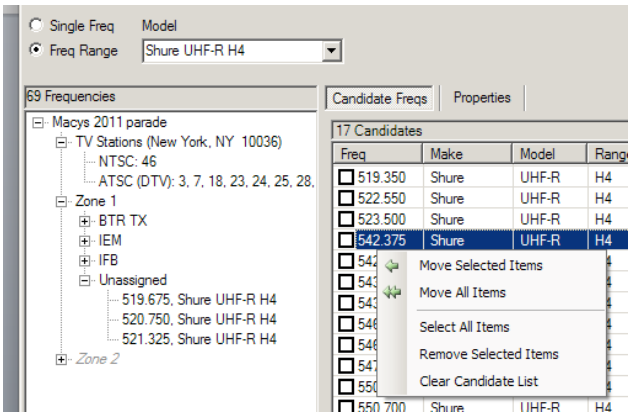


5. Start frequency selection with the wireless systems which are the least flexible because of a limited number of adjustable frequencies or if they are fixed frequency and can't be adjusted, and work your way up to the systems with the most frequency selection options. If you wait till other freqs are selected you may find out that none of the fixed or limited frequency systems can be selected without intermod issues. When IMD does a global recalculation, this is the priority it uses too.

6. Next select all your transmit freqs. It is most important to have intermodulation free transmit frequencies since often they are combined in an active antenna system. Start with the Options set like above, for the most stringent calculations.

7. After you have selected all your TX freqs, turn them all on. One at a time, turn each transmitter off and look at the underlying RF of that frequency on the spectrum analyzer. What you are looking for is intermod products. If there are none it will look like a clear frequency as in figure III.2.D.i on page 5. Another place to look is in the RF meter of the recievers. This is called **"War Gaming"** and should be done with all freqs after you are done programming.

8. Next, for wireless microphones work through your list using the pull down menus for each type of mic. As you complete each selection, check each frequency on the SA and if it is clear, put a check mark next to it. When you are finished, right click and move all selected to the left side to the Unassigned section (your finished list) and rename the section such as "MICS"

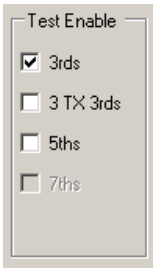


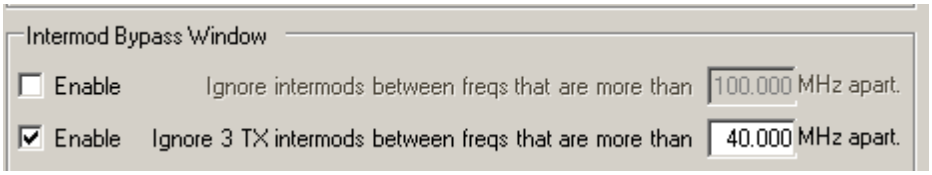
9. The IMD program divides the frequency list into ZONES. The difference between zones is that intermod is not calculated, just separation. I find that many momentary frequencies, such as the transmits of an intercom BTR beltpack, are best assigned to a different zone. This makes intermod calculations easier in your main zone.

10. If it becomes hard to find frequencies (none show up when you test), the stringency of the options needs to be lowered.

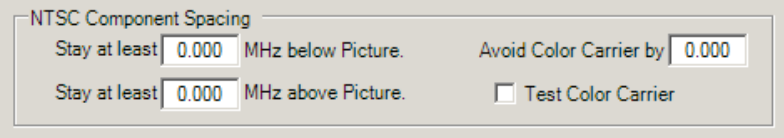
    a. First to go is testing the color carrier, then 3 TX 3rds, then 5th order.

    b. Next lower the distance between intermods down to 40 mHz and later as low as 20 mHz. Try to keep it no lower than twice the receiver front end filter window.



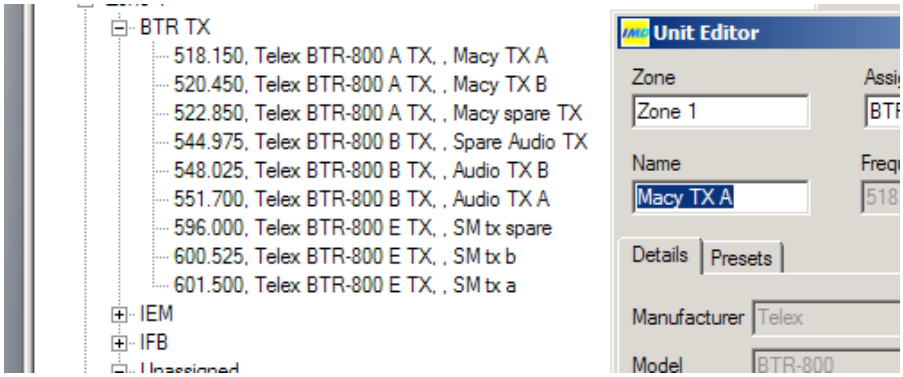


c. Setting all of the NTSC parameters to 0 helps to find more freqs also. This is OK since the US is Mostly DTV now.

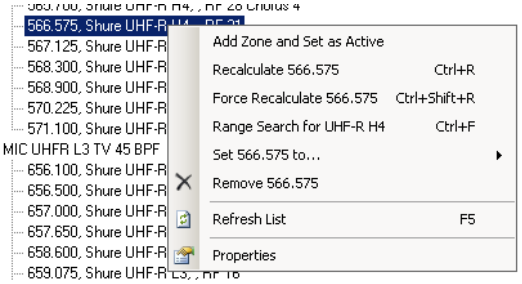


d. Lastly, consider checking weak DTV channels that you had avoided originally to see if frequencies work in them as well. Your transmit distance will be limited but it is possible, particularly with shows which are inside and have the shielding of the building.

11. Once you have your complete wireless plan, double click on each frequency and name each frequency such as mic 1, mic 2, ear 1, BTR T1, or BTR R2. Naming each frequency will help if you need to select a replacement or are using this list as a touring system list for global frequency recalculation.



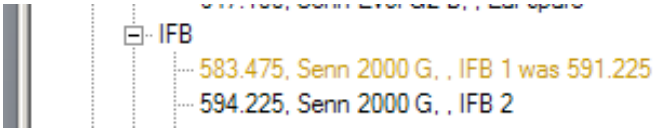
12. Re selection of new frequencies is facilitated by the right click menu:



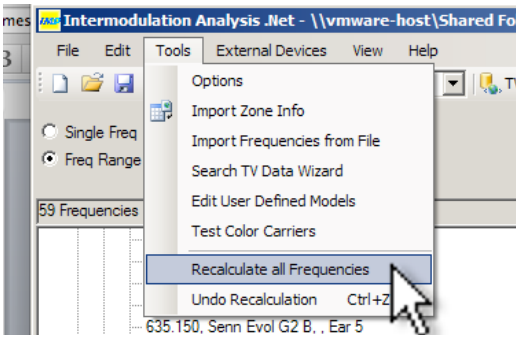
Selecting a problem frequency and entering ctrl-f will do the group frequency list for that model. This creates a list of possible replacement freqs on the right side of the screen. (Note that the normal pull down model menu does not reflect this search, only the list on the right). If you cannot find a freq, lower the calculation stringency. Force recalculate finds a frequency and immediately changes it on your list.

13. Another way to force a new frequency calculation is to select the problem frequency and enter shift-ctrl-R. This will find you a frequency which is different than the current one and put it in your list replacing the bad one. I find it is useful

to add to the name of the bad frequency "was 555.123" listing what the frequency currently is. That way when you do a forced recalculation it will end up like this:



14. If you are on a tour and have moved to another venue, do the TV channel scan in a new copy of your file, renamed for the new location. Set your stringency options to maximum and then select Tools>Recalculate all Frequencies. This process is the same as we did above. Fixed or limited frequency items are calculated first, then transmit frequencies and last RX freqs for frequency agile equipment. Frequencies, which cannot be found, will be red. Lower your Stringency and do individual forced recalculate on sections or individual frequencies.



15. Your list can be customized by exporting to Excel. Set the File>Report format to Master List. Select preview to see it in a browser. Now select ALL and copy then paste into Excel.

Best Audio
Frequency Coordination Report

Show Name:
Kennedy Center Honors 2010
113 Frequencies Listed

Customer:
Point of Contact:
Show Notes: December 1 - 5, 2010
Washington DC 20566

TV Channels (Washington, DC 20566):
NTSC: 23, 25, 63
ATSC (DTV): 7, 15, 16, 27, 34, 35, 36, 38, 40, 48, 50, 55, 56, 57, 58, 59

Sorted By Frequency

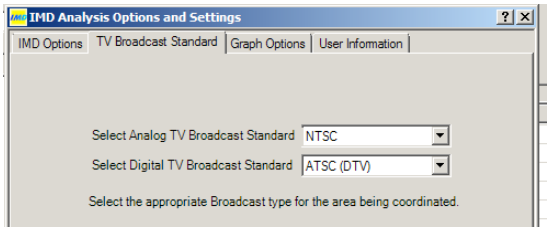
Name	Model	Frequency	Channel	Zone	Assignment	TV Ch
	Shure UHF-R G1	**506.925**		Zone 1	Inst CenterStaging Backline (TV 20)	20
	Shure UHF-R G1	**507.725**		Zone 1	Inst CenterStaging Backline (TV 20)	20
	Shure UHF-R G1	**509.050**		Zone 1	Inst CenterStaging Backline (TV 20)	20
	Shure UHF-R G1	**509.525**		Zone 1	Inst CenterStaging Backline (TV 20)	20
	Shure UHF-R G1	**510.150**		Zone 1	Inst CenterStaging Backline (TV 20)	20

After inserting in Excel, you can format and sort your list.

	A	B	C	D	E	F	G
1	Name	Model	Frequency	Channel	Zone	Assignment	TV Ch
2	Ear 01	Senn Evol G2 A	539.350		Zone 1	Ear G2 A Range IEM	25 N
3	Ear 02	Senn Evol G2 A	539.800		Zone 1	Ear G2 A Range IEM	25 N
4	Ear 03	Senn Evol G2 A	520.925		Zone 1	Ear G2 A Range IEM	22
5	Ear 04	Senn Evol G2 A	522.075		Zone 1	Ear G2 A Range IEM	22
6	Ear 05	Senn Evol G2 A	522.650		Zone 1	Ear G2 A Range IEM	22
7	Ear 06	Senn Evol G2 A	523.525		Zone 1	Ear G2 A Range IEM	22
8	Ear 07	Senn Evol G2 A	536.150		Zone 1	Ear G2 A Range IEM	25 N
9	Ear 08	Senn Evol G2 A	538.750		Zone 1	Ear G2 A Range IEM	25 N
10	Ear 09	Senn Evol G2 A	519.550		Zone 1	Ear G2 A Range IEM	22
11	Ear 10	Senn Evol G2 A	540.400		Zone 1	Ear G2 A Range IEM	25 N
12	Spare Ear	Senn Evol G2 A	526.500		Zone 1	Ear G2 A Range IEM	23 N
13	Spare Ear	Senn Evol G2 A	541.175		Zone 1	Ear G2 A Range IEM	25 N
14	Spare Ear	Senn Evol G2 A	554.000		Zone 1	Ear G2 A Range IEM	27 D
15	System 1 ch 1	Telex BTR-800 3 RX	652.475		Zone 2	House C3 BTR	44
16	System 1 ch 2	Telex BTR-800 3 RX	652.775		Zone 2	House C3 BTR	44
17	System 1 ch 3	Telex BTR-800 3 RX	655.175		Zone 2	House C3 BTR	44
18	System 1 ch 4	Telex BTR-800 3 RX	659.975		Zone 2	House C3 BTR	45
19	System 1 T1	Telex BTR-800 C TX	562.775		Zone 2	House C3 BTR	29
20	System 1 T2	Telex BTR-800 C TX	559.300		Zone 2	House C3 BTR	28
21	System 2 ch 1	Telex BTR-800 3 RX	664.175		Zone 2	House C3 BTR	46

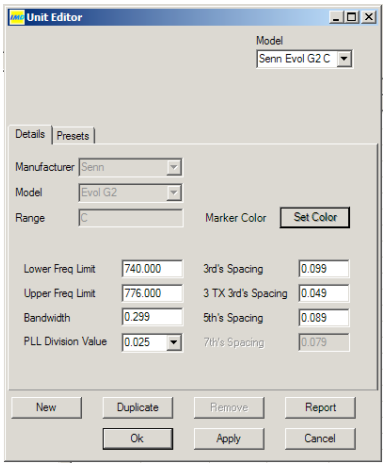
IV. Other IMD functions:

1. Setting the TV standard. In the options screen the tab TV standard allows the selection of most of the worlds TV standards.

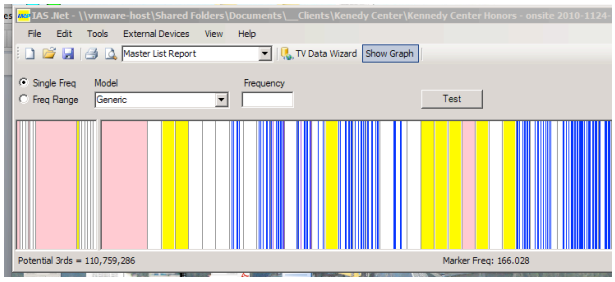


2. Edit user defined wireless models. You can enter a strange wireless system which is not part of the standard pull down menu models. Although it is possible to start with a model and duplicate it before editing, this is not a good idea. The tab labeled **Presets** lists all the possible settins of frequencies and is for those wireless which have limited random frequency possibilities. This list is very hard to edit or delete.

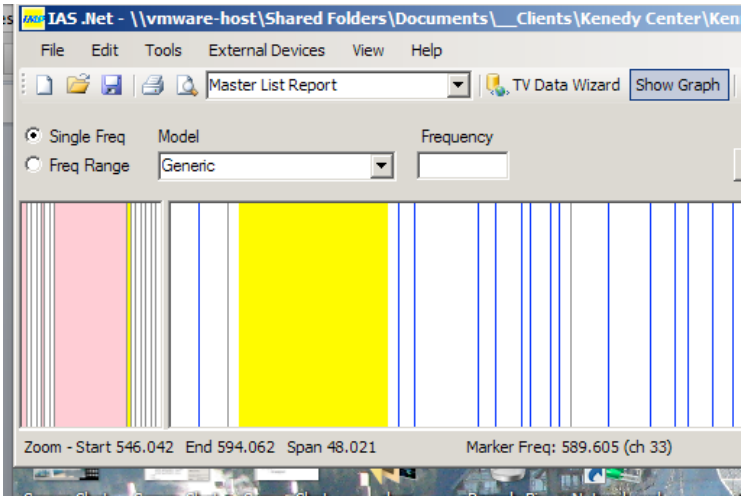
   Best to start with a new entry for your custom wireless model.



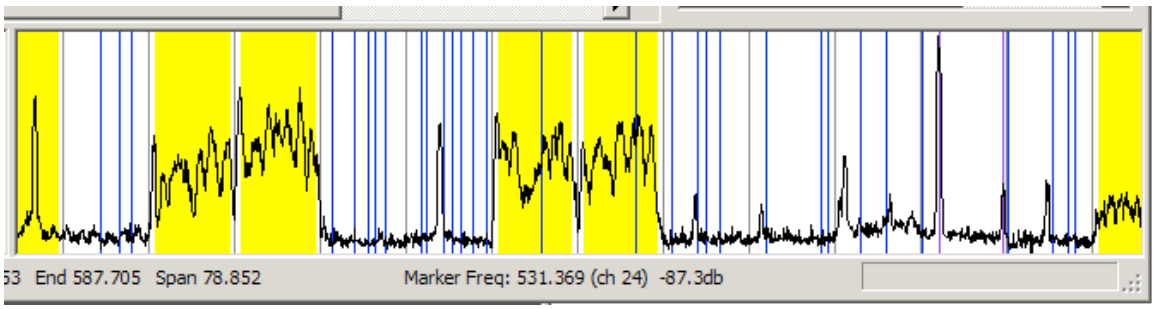
3. The frequency graph shows the spectrum as you have entered it, yellow for DTV and blue lines for your frequencies. This is just a graphical representation of the spectrum and not from a spectrum analyzer.



You can zoom in on a section of the graph. The graph is helpful to see where you still have available holes in the spectrum.



A future improvement in IMD's frequency graph will allow scans done with your SA to be imported and overlaid on the graph.



4. The menu option VIEW>List Of Models shows the database of wireless.

List of Models

Manufacturer	Model	Range	Color	Start Freq	End Freq	Edition	# of Presets	Prebuilt	VHF/UHF	Bandwidth	IMD 3	IMD 3 TX 3rd	IMD 5	Gui
AKG	DMS700	Band 1		548.100	697.900	Professional	5746	Yes	UHF	.449	.399	.099	-1.000	032
AKG	DMS700	Band 2		710.100	861.900	Professional	6073	Yes	UHF	.449	.399	.099	-1.000	ed5
AKG	IVM4 IEM	500-530 MHz		500.100	529.900	Professional	1193	Yes	UHF	.399	Default	Default	Default	ea1
AKG	IVM4 IEM	570-600 MHz		570.100	599.900	Professional	1193	Yes	UHF	.399	Default	Default	Default	b6e
AKG	IVM4 IEM	790-820 MHz		790.100	819.900	Professional	1193	Yes	UHF	.399	Default	Default	Default	e67
AKG	IVM4 IEM	835-865 MHz		835.100	864.900	Professional	1193	Yes	UHF	.399	Default	Default	Default	309
AKG	WMS4000	650-680 MHz		650.000	680.000	Professional	1201	Yes	UHF	Default	Default	Default	Default	234
AKG	WMS4000	680-710 MHz		680.000	710.000	Professional	1201	Yes	UHF	Default	Default	Default	Default	19b
AKG	WMS4000	720-750 MHz		720.000	750.000	Professional	1201	Yes	UHF	Default	Default	Default	Default	962
AKG	WMS4000	760-790 MHz		760.000	790.000	Professional	1201	Yes	UHF	Default	Default	Default	Default	e39
AKG	WMS4000	790-820 MHz		790.000	820.000	Professional	1201	Yes	UHF	Default	Default	Default	Default	fe97
AKG	WMS4000	835-863 MHz		835.000	863.000	Professional	1121	Yes	UHF	Default	Default	Default	Default	6fbc
AKG	WMS450	Band 1		650.100	680.000	Professional	1197	Yes	UHF	.299	.149	.099	.049	25f