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About Key Clicks

At International Radio we get a lot of questions about the FT-1000MP series key clicks and the effect of the Inrad mod. A lot of data exists, some of it taken with spectrum analyzers and some taken with second radios. No standard exists for comparison in the spectrum analyzer data, so it is difficult to draw any conclusions from it. Data taken with a second radio is very subjective at best and is essentially meaningless for comparison purposes.

We have taken data on unmodified FT-1000MPs (original version) and also on radios modified with the Inrad circuitry. no changes have been made in the keying circuitry in the Mark V or the Field versions. The data was taken on the same spectrum analyzer, with the same settings and with the analyzer settings clearly shown on the plots. To compare the MP performance with some other radios, we also are showing data taken under the same conditions, with the analyzer set the same way on several other radios.

Here is the technical explanation for the measurements. The radios are being keyed at 40 WPM by an external keyer. The spectrum generated by a CW transmitter is similar to amplitude modulation where the modulating frequency is the keying rate. Sidebands are produced on both sides of the carrier. If the modulating source were a perfect sine wave, only one sideband would be on each side of the carrier. However, the modulating source is nearly a square wave and is very rich in harmonics. So the sidebands created are spaced by the modulating frequency and have an envelope that is a function of the wave shape of the keying source. Note that the envelope does not change for different keying speeds. The number of sidebands within the envelope changes as the keying speed is changed, but this does not alter the bandwidth of the composite signal.

The really important thing here is the shape of the keying signal. If we pick a certain offset from the carrier and take a dB down reading, we can have a figure of merit for comparison purposes. One kHz is a good place to make this measurement as the sideband level is generally way out of the noise and is easy to read from the plots. These numbers are posted next to the analyzer plots.

Several things are readily apparent when viewing the plots. First, the Inrad modification makes a substantial reduction in the FT-1000MP spectrum. Also, the modified MP is quite good when compared with the other radios. As a matter of fact, it's narrower than some radios for which popular opinion claims good keying.

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The “bad name” that the MP has developed in recent times probably has something to do with the number of radios in the field. In a major contest, more MPs are in use than any other radio. Imagine, for example, if everyone in the last 160 meter contest was using an Omni VI+ or a K2 driving a KW amplifier. The popular press would then be saying that something has to be done about those radios. In truth, something needs to be done with most of the currently popular radios.

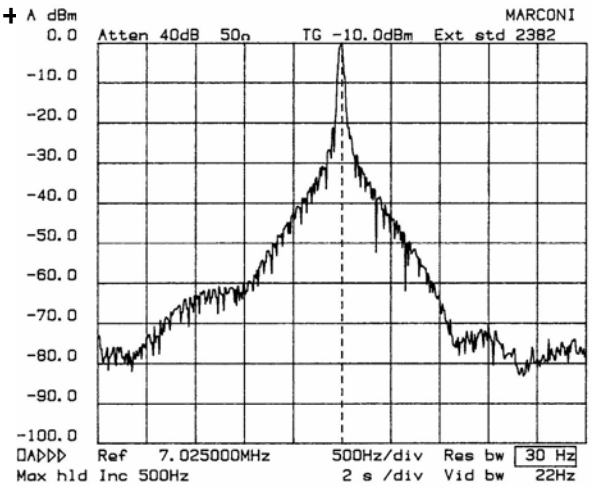
The Inrad mod

What is it and how does it work? The mod consists of three small components, two go on the IF board and one goes on the RF board. On the IF board, a 0.047 capacitor and a 100 K resistor in parallel are placed across C2148. On the RF board, a 0.1 µF cap is placed across C1004 (Mark V and Field) or C1216 in the original MP. (If you don't have a service manual, Louis, W7DZN has posted pictures on the VA3CR Web site.)

In each case, these capacitors are used to slow the waveform that is used to key the gate voltage on FETs. These stages are doing the CW keying. The resistor on the IF board is required to keep the duty cycle of the keyed waveform at 50% by rebiasing the gate of the FET.

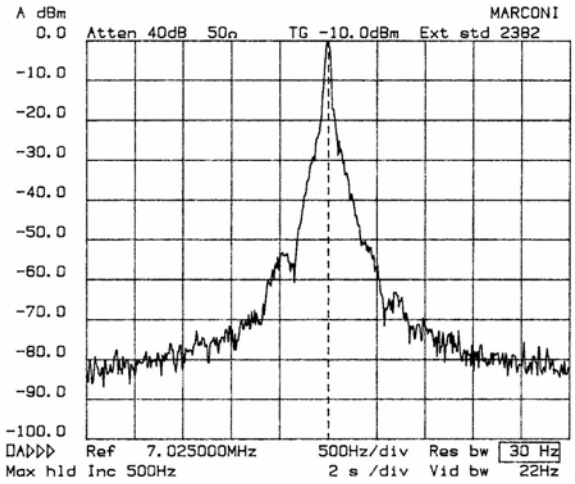
Some people have asked about routing the RF through the 500 Hz filter instead of the SSB filter. It seems like a good idea; however, the keying is done beyond the filters and this change would have no effect on the keyed waveform. Note that this is done in the Omni VI+, and the keying is distorted by the ALC loop. Another way to improve the keying would be to use a Gaussian or a transitional filter to shape the keying waveform. In a perfectly linear system, this would work very well. However, the FETs being keyed are far from linear. Thus it is not possible to improve the output spectrum beyond what the Inrad mod does without substantial changes in the radio.

2/4/03 W2VJN Unmodified MP Level at +



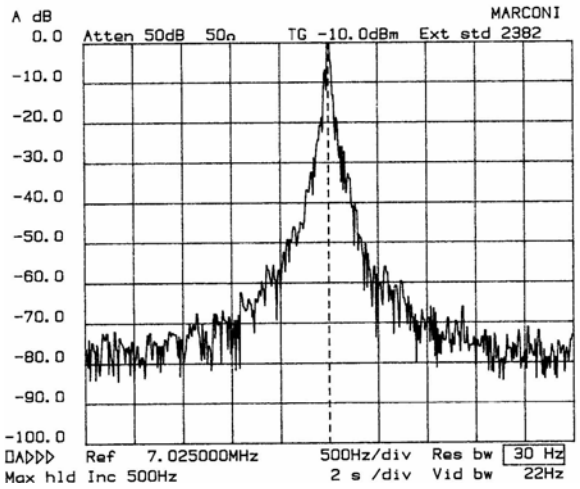
Modified MP-1

Level at +/-1 kHz= -73 dB



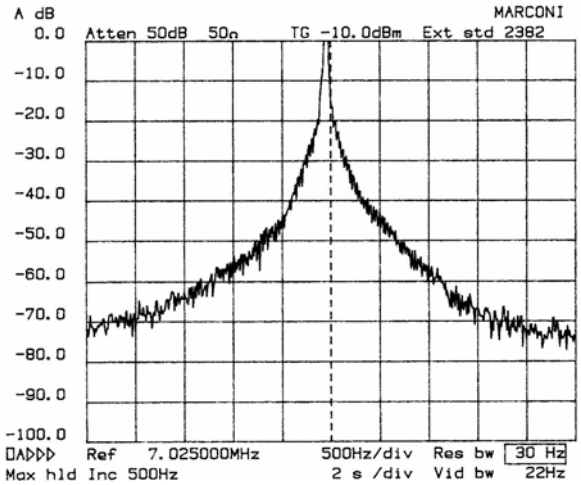
Modified MP-2

Level at +/-1 kHz= -72 dB



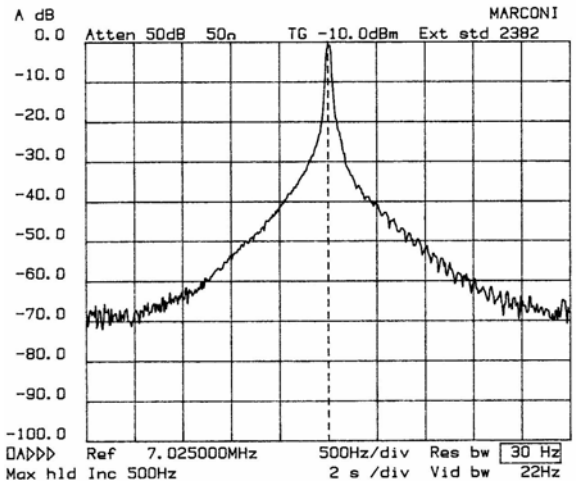
IC-765

Level at +/-1 kHz= -58 dB



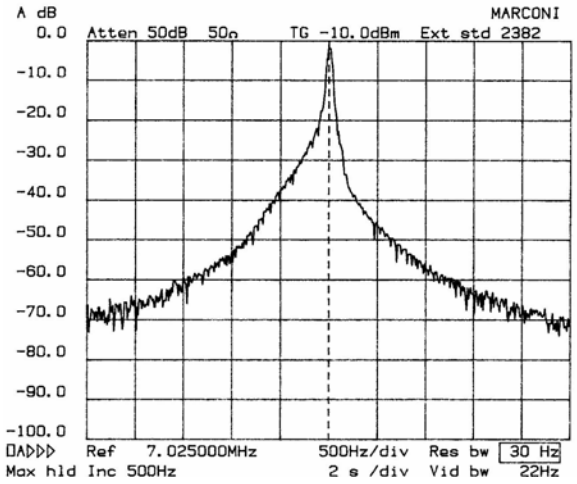
K2

Level at +/-1 kHz= -54 dB



Omni VI+

Level at +/-1 kHz= -56 dB



FT-817

Level at +/-1 kHz= -61 dB