
It Only Hertz When You Process

The recent introduction of the ModMinder modulation monitor by Modulation Sciences created unexpected controversy. The purpose of this paper is to try to replace some of the rhetoric with hard engineering data.

The controversy centers on the definition of an occurrence of overmodulation in FM broadcasting. This debate was started by Modulation Sciences' introduction of a peak modulation monitor with a variable peak flash response time. The customer can choose a response time from 200 to 5000 μ seconds for the ModMinder. Peaks of overmodulation are ignored unless they are longer than the value for which the ModMinder is configured. Modulation Sciences suggests a response time of 900 μ seconds.

Most modulation monitors ignore peaks shorter than 200 μ seconds. By extending the response time to 900 μ seconds, many stations can either significantly increase their average modulation or decrease the amount of signal processing they use. This set off warnings, mostly from Modulation Sciences' competitors, of dire consequences from lengthening the peak response time.

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Our answer was to point out that in the pre-1983 FCC Rules governing the performance required to type approve a FM Modulation monitor, the minimum response time was specified as one millisecond (1000 μ seconds).

Our competitors argued: 1) the FCC was naive about these matters and didn't understand the issues when it wrote the specifications for modulation monitors in 1968; 2) the Rules were deregulated in 1983 and therefore have no weight today; and 3) it doesn't matter what the FCC said, peaks longer than 200 μ seconds will cause objectionable adjacent channel interference.

Prior to development of ModMinder, we went to a well-known attorney specializing in FCC legal issues and asked about the status of the pre-1983 rules. The lawyer responded with a written opinion. The opinion said that because the 1983 Docket that eliminated the monitor type acceptance requirement never said there was anything wrong with the rules, only that they were burdensome, no post deregulation requirements on modulation monitors could be more stringent than they were before deregulation. Put another way, if a monitor met the pre-1983 requirements today, it is in compliance today.

But our detractors kept hammering away at the legal issue. They said that an opinion from a lawyer was not the same as the FCC making a statement on the subject. Finally, after rumors that the FCC had said ModMinder was illegal began to circulate through the industry, we went to the FCC and asked for a statement. And we got one, in record time. From no less than the Chief Engineer of the FCC, Dr. Thomas P. Stanley. That put the FCC issue to rest.

Then our competitors went back to the argument that the FCC hadn't known what it was doing in 1968 when it said the peak flash indicator had to operate in ten cycles of 10 kHz (one millisecond). Increasing the response time to 900 μ seconds would cause awful adjacent channel interference and destroy the table of allocations, they said. That argument hinged on the assumption that ModMinder, responding at 900 μ seconds, would greatly increase the occupied bandwidth of any FM signal it was used to measure. A necessary part of that argument was that nothing had increased occupied bandwidth that much since the introduction of stereo in the mid 60's.

Well, refuting that argument would be tougher than going to the FCC for a letter. However, at least now we were dealing in engineering and not politics. First we needed a definition of occupied bandwidth. To some, all that means is running a spectrum analyzer back and forth across the signal and storing the results for several minutes. CCIR - the organization that writes the International Radio Regulations to which the United States is bound by treaty - says that a

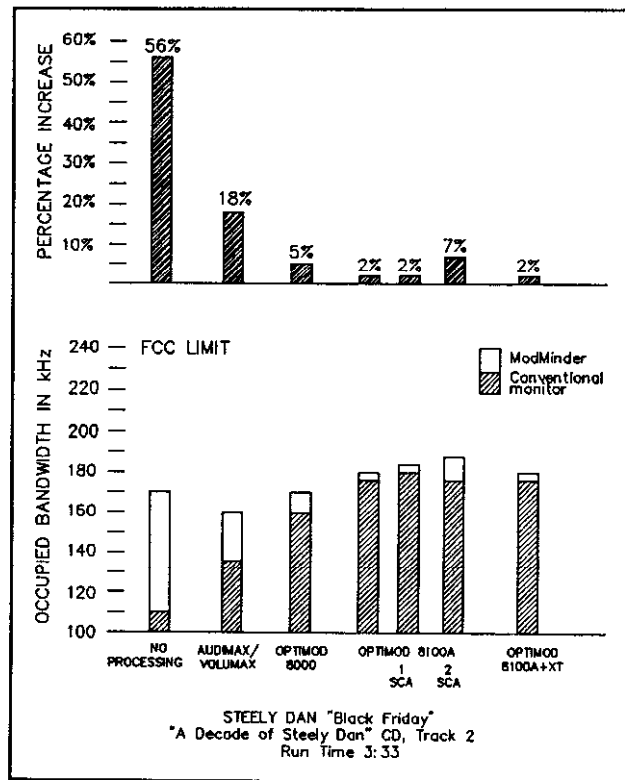
spectrum analyzer has major shortcomings as a tool to measure the bandwidth of radio emissions. They go on to define occupied bandwidth and suggest a technique for measuring it.

Section 147 of the International Radio Regulations and 47CFR2.1(c) of the FCC Rules define occupied bandwidth as the band containing 99.0% of the total power in the signal. CCIR, in its "Handbook for Monitoring Stations," provides the design for a specialized instrument for measuring occupied bandwidth. Modulation Sciences has constructed a instrument that meets the CCIR specifications and has validated its correct operation.

At the time of this writing, the Occupied Bandwidth Analyzer has been in operation for only two weeks, but in that time we have made more than a hundred data runs on various selections of music under different conditions of processing. A more complete description of the instrument, the test setup and the results is contained in the technical paper entitled "CCIR Compliant Occupied Bandwidth Measurement of Contemporary U.S. FM Stations."

Rather than try to present a great deal of data in this brief paper, one typical data set will be examined in detail. The data was generated from the selection by Steely Dan, "Black Friday." The selection was run through various audio processors, both with and without SCA's. The test conditions are described at the bottom of the bar chart. Data for each test condition was run twice, once with modulation set using a conventional 200 μ second response time modulation monitor, and once with modulation set using the 900 μ second response time of ModMinder. An extension of the bar shows how much the occupied bandwidth increased when ModMinder was used to set modulation.

A second bar chart, just above the first, shows the percentage increase in bandwidth for that set of test conditions.



Several conclusions can be reached from examining this data:

- 1) Using ModMinder to set modulation does not significantly increase the occupied bandwidth of heavily processed signals.
- 2) Even when used to set the modulation level of unprocessed audio, the occupied bandwidth of the signal set with ModMinder does not equal the occupied bandwidth of a processed signal set with a conventional monitor.
- 3) Modern processing does far more to increase the occupied bandwidth of FM signals. The jump from the Audimax/Volumax to the Optimod was by far the greatest increase in occupied bandwidth.

The data provided in this paper should put to rest any claim that ModMinder, when used as a 900 μ second response peak modulation indicator, causes excessive bandwidth.

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