HI-FI PRODUCT REPORT

EW LAB TESTED

by Hirsch-Houck Labs

Sound Technology 1000A FM Generator

A basic requirement for any measurements on FM tuners, either mono or stereo, is an FM signal generator. There are several well-established companies manufacturing laboratory-grade FM signal generators, but until recently there has been no single instrument whose performance parameters matched or surpassed those of a modern FM tuner and whose operating functions met the needs of an equipment manufacturer or a hi-fi specialist's service department.

The traditional laboratory-grade FM signal generator is a general-purpose instrument. It covers a wide range of frequencies, with a calibrated tuning dial, and its metered and calibrated output level is adjustable down to a fraction of a microvolt, usually with an accuracy of ±10%, or ±1 dB. Often the generator is equipped for other modes of modulation such as AM or pulse. Its versatility is reflected in its price, typically from almost $1000 to over $6000, yet it still requires the use of an external multiplex generator ($500 to $1000 for an instrument of comparable quality) and a low-distortion audio generator in order to make measurements on a stereo-FM tuner.

Even with such an imposing and costly array of equipment, it is not possible to make meaningful distortion measurements on most FM tuners. The inherent distortion of the signal generator's own modulating circuits is about 0.5% at best (at 75 kHz deviation), and even this level cannot be guaranteed except over a limited frequency range. Most tuner and receiver manufacturers claim distortion levels under 0.2% for their products. Measurement or verification of these specifications heretofore has required a specially modified and calibrated signal generator.

A new company, *Sound Technology* of Cupertino, California, has recently introduced a unique instrument designed specifically for the hi-fi FM-receiver manufacturer or service organization. Its Model 1000A FM alignment generator represents a radical departure in features and performance from any previous commercial FM test equipment we have seen.

Features and Specifications

The Model 1000A is a multipurpose instrument. It is an FM signal generator, covering 88 to 108 MHz, with an output attenuator calibrated from 0.5 microvolt to 30 millivolts. The frequency dial is calibrated only at the ends and middle of the FM band (88, 98, and 108 MHz), but its smooth planetary drive permits a tuning resolution of 10 kHz. The output level, into 50 ohms, has a rated accuracy of ±2.5 dB and its shielding is adequate for making accurate measurements down to 0.5 microvolt.

A unique feature of the Model 1000A is its wide-band linear modulator. Deviations up to ±300 kHz are possible and, with 100% modulation (±75 kHz deviation) at 1 kHz, the generator harmonic distortion is less than 0.1%. There is a built-in 1-kHz low-distortion (less than 0.1%) source and an external modulating signal can be used for modulation over the full range of 50 Hz to 15 kHz (flat within ±0.5 dB). One-hundred-percent modulation requires a signal of 0.4 volt r.m.s. at the 10k-ohm input connector. With modulation removed (CW mode), the residual FM noise level is at least 70 dB below 100% modulation. Modulation level, either from internal or external sources, is adjustable and is read directly on a meter scale calibrated from 0 to 150%, with 100% corresponding to ±75-kHz deviation.

The instrument also contains a stereo multiplex generator capable of delivering a standard composite modulating signal from the 1-kHz internal oscillator, or from an external source. A selector switch connects the internal signal source to provide L, R, L+R (mono), or L–R modulation modes. Separate input connectors for external L and R signals can be switched into the circuit. The 19-kHz pilot carrier level is read on the meter by pushing a button, which expands the meter scale by a factor of ten. The pilot carrier may then be set accurately, within the standard 8% to 10% modulation limits, since the meter reads 15% full scale. Three connectors on the front panel carry out the 19-kHz pilot signal, the internal 1-kHz modulating signal, and the composite stereo modulating signal, for scope synchronization or for checking a multiplex demodulator unit. All connectors are type BNC.

The function selector switch has positions for Stereo, Mono, CW, SCA, and Dual Sweep. In the SCA position, external modulation is removed and an internal 67-kHz signal is applied to the modulator, for checking or aligning SCA traps in stereo tuners and receivers.

The Dual-Sweep function is a unique feature of the generator. It provides a means for aligning an FM tuner rapidly, with a constant display of over-all distortion on an oscilloscope as the alignment is performed. The Dual-Sweep technique in effect plots the *slope* of the discriminator S-curve over a wide and adjustable deviation range. The generator frequency is swept by a 60-Hz signal, on which is superimposed a small deviation at a 10-kHz rate. The sweep width is adjustable from 0 to 600 kHz, and is indicated on the meter.

The audio output from the tuner is returned to the instrument where the 60-Hz component is filtered out and a clean 10-kHz signal is extracted. The amplitude of the 10-kHz component is proportional at all times to the slope of the tuner's discriminator characteristic. With a perfectly linear discriminator, it would have a constant level as the 60-Hz sweep moves the generator frequency across the tuner passband.

Two output connectors on the generator supply vertical (10 kHz) and horizontal (60 Hz) deflection signals to an external oscilloscope. Any variation in the vertical dimension

of the swept display indicates a nonlinearity in the tuner. The i.f. and discriminator circuits are aligned to produce the smoothest, widest, and most uniform display possible. As a final check, the sweep width can be reduced to 150 kHz, corresponding to 100% modulation, and the vertical scale of the oscilloscope expanded to reveal the smallest departure from flatness. The amplitude of any irregularity, expressed as a percentage of the total vertical amplitude, is a direct measure of IM distortion. The rated peak nonlinearity of the generator in the Dual-Sweep mode is less than ±0.3% over a 150-kHz bandwidth.

Clearly, the Model 1000A is an uncommonly versatile instrument. It was designed for a manufacturer's final-test or quality-assurance departments, or for the service specialist dealing in the highest caliber of home receiving equipment. This unit makes more use of up-to-date components and techniques than any comparable laboratory instrument we have seen. For example, its design employs 8 linear IC operational amplifiers, an IC power-supply voltage regulator, and two digital IC's serving flip-flop and gating functions. In addition, there are 22 transistors (5 of them FET's) and 13 diodes.

The end result is a compact instrument, 8 3/8" high by 11 1/8" wide by 11 3/4" deep and weighing only 12 pounds. It is very nearly a single unit FM/stereo-FM test laboratory, whose functions could only be partially duplicated by a clumsy and expensive array of separate instruments.

Tests and Evaluation

Our tests of an instrument such as this had to be done indirectly, by comparison with other instruments whose performance was in some respects inferior to the unit we were "testing." Nevertheless, we were able to satisfy ourselves that this instrument does what is claimed for it, and then some.

Our own FM signal generator, a *Boonton* Model 202B, has a residual distortion of about 0.5% at 75-kHz deviation. We used it to measure the IHF usable sensitivity, distortion, signal-to-noise ratio, and stereo crosstalk of a new FM receiver, and similar measurements (except for crosstalk) on an older mono-FM tuner of high quality. A *Scott* Model 830 multiplex generator was used to develop the composite modulating signal for the stereo measurements. The same measurements were then repeated using only the *Sound Technology* Model 1000A.

With our own equipment, the IHF sensitivity of the receiver measured 3.0 microvolts; with the Model 1000A it was 2.9 microvolts—remarkably close in view of its relatively loose output-level specifications. The distortion measured 0.54% with our equipment, and a remarkable 0.07% with the Model 1000A. The two sets of stereo-crosstalk measurements agreed within 3 dB at all frequencies. The signal-to-noise ratio was 72 dB with our equipment; 73 dB with the Model 1000A.

With the mono tuner, our equipment showed an IHF sensitivity of 2.1 microvolts, while the Model 1000A gave a reading of 2.6 microvolts—still within specification limits. Distortion with our generator was 0.53%; with the Model 1000A it was 0.19%. The signal-to-noise ratios were, respectively, 70 dB and 73 dB.

We then used the Dual-Sweep mode to align the mono receiver. It was interesting to note how easily rather large irregularities from 100 kHz to 300 kHz away from the center frequency could be produced by conventional alignment methods. With a little practice, the Dual-Sweep technique allowed a modest reduction in distortion, but with an improved symmetry over a wide bandwidth which makes the receiver easier to tune for low distortion.

In effect, Dual Sweep replaces the rapid, but purely *qualitative* sweep alignment of a discriminator by visual display of its S-curve with an equally fast, but precise and *quantitative* indication of the tuner's IM distortion.

Our only criticism of the generator is the choice of 1 kHz as its internal modulating frequency. The IHF standard on FM tuner measurements specifies a 400-Hz modulating frequency and this frequency has long been a part of other standard measurement practices for home FM receivers. The principal reason for this, we believe, is that harmonics of 400 Hz appear in the correct amplitude relationship to the fundamental, even the third harmonic is reduced by only about 1 dB by the tuner's de-emphasis circuits. On the other hand, the second harmonic of a 1-kHz modulating signal is reduced by 1.9 dB, and the third harmonic is down 3.8 dB, relative to the 1000-Hz level, since de-emphasis begins just below 1000 Hz. This can give misleadingly optimistic readings of tuner distortion. Of course, 400 Hz can be used with the Model 1000A, from an external source (which we did), but it should be internally available, either instead of or in addition to the 1-kHz signal.

(Editor's Note: The manufacturer will supply the instrument with a 400-Hz modulating frequency if desired at no extra cost. However, this means that separation will have to be measured at 400 Hz rather than 1 kHz. Both frequencies are available at the flick of a switch as an extra-charge option.)

All in all, the *Sound Technology* Model 1000A is a fine instrument, which we wouldn't mind having in our own laboratory. Its price is $1250. ▲

REPRINTED FROM

Electronics World

THE MAGAZINE FOR THE ELECTRONICS PROFESSIONAL

April, 1971